

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : OT-212-RWD-016

Reception No. : 2101000274

Applicant : LG Electronics USA

Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States

Manufacturer : LG Electronics Inc

Address : 10, Magokjungang 10-ro, Gangseo-gu, Seoul, Republic of Korea

Type of Equipment : NAVIGATION RADIO

FCC ID. : BEJLANR21

Model Name : LANR21

Serial number : N/A

Total page of Report : 82 pages (including this page)

Date of Incoming : January 28, 2021

Date of issue : February 08, 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.

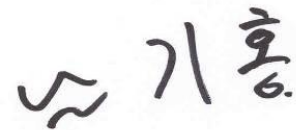
It is not a generally valid assessment of the features of the respective products of the mass-production.



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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-212-RWD-016	February 08, 2021	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Electronics USA

Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States

Contact Person : Dae Woong Kim / Director, Regulatory and Environmental Affairs

Telephone No. : 201-266-2215

FCC ID : BEJLANR21

Model Name : LANR21

Brand Name : -

Serial Number : N/A

Date : February 08, 2021

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
E.U.T. DESCRIPTION	NAVIGATION RADIO
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)	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 Power.

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 LG Electronics USA, Model LANR21 (referred to as the EUT in this report) is a NAVIGATION RADIO. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	NAVIGATION RADIO	
Temperature Range	-40 °C ~ 80 °C	
OPERATING FREQUENCY	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	Bluetooth	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(VHT20))
		5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(VHT40))
		5 210 MHz (802.11ac(VHT80))
	5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 805 MHz (802.11a/n(HT20)/ac(VHT20))
		5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(VHT40))
		5 775 MHz (802.11ac(VHT80))
MODULATION TYPE	Bluetooth LE	GFSK for 1 Mbps / 2 Mbps
	Bluetooth	GFSK for 1 Mbps, $\pi/4$ -DQPSK for 2 Mbps, 8-DPSK for 3 Mbps
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK)
		802.11g/n(HT20): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
	WLAN 5 GHz	802.11a/n(HT20)/n(HT40)/ac(VHT80): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)

RF OUTPUT POWER	Bluetooth LE	1 Mbps	-3.31 dBm
		2 Mbps	-3.65 dBm
	Bluetooth	1 Mbps	-2.69 dBm
		2 Mbps	-4.40 dBm
		3 Mbps	-4.06 dBm
	WLAN 2.4 GHz	16.23 dBm(802.11b) 16.45 dBm(802.11g) 15.46 dBm(802.11n_HT20)	
	5 150 MHz ~ 5 250 MHz Band	12.83 dBm(802.11a) 8.73 dBm(802.11n_HT20) 8.01 dBm(802.11n_HT40) 6.00 dBm(802.11ac_VHT80)	
	5 725 MHz ~ 5 850 MHz Band	11.26 dBm(802.11a) 11.12 dBm(802.11n_HT20) 11.98 dBm(802.11n_HT40) 8.99 dBm(802.11ac_VHT80)	
ANTENNA TYPE	Bluetooth LE	Chip Antenna	
	Bluetooth	Chip Antenna	
	WLAN 2.4 GHz	PCB Antenna	
	WLAN 5 GHz	Chip Antenna	
ANTENNA GAIN	Bluetooth LE	2.86 dBi	
	Bluetooth	2.86 dBi	
	WLAN 2.4 GHz	-2.91 dBi	
	5 150 MHz ~ 5 250 MHz Band	2.75 dBi	
	5 725 MHz ~ 5 850 MHz Band	2.13 dBi	
	List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		32.768 kHz, 20 MHz, 25 MHz, 28.636 36 MHz, 38.4 MHz, 55.466 67 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	LG Electronics Inc	N/A	N/A
Audio Board	LG Electronics Inc	N/A	N/A
Antenna Board	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
LANR21	LG Electronics Inc	NAVIGATION RADIO (EUT)	
TC-3000C	TESCOM	BLUETOOTH TESTER	EUT
CMW500	ROHDE & SCHWARZ	WLAN / Bluetooth Signalling	EUT
PWS-3003D	Protek	DC Power Supply (DC 30 V 3 A)	

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.

-. Channel List (Bluetooth)

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
0	2 402.00	27	2 429.00	54	2 456.00
1	2 403.00	28	2 430.00	55	2 457.00
2	2 404.00	29	2 431.00	56	2 458.00
3	2 405.00	30	2 432.00	57	2 459.00
4	2 406.00	31	2 433.00	58	2 460.00
5	2 407.00	32	2 434.00	59	2 461.00
6	2 408.00	33	2 435.00	60	2 462.00
7	2 409.00	34	2 436.00	61	2 463.00
8	2 410.00	35	2 437.00	62	2 464.00
9	2 411.00	36	2 438.00	63	2 465.00
10	2 412.00	37	2 439.00	64	2 466.00
11	2 413.00	38	2 440.00	65	2 467.00
12	2 414.00	39	2 441.00	66	2 468.00
13	2 415.00	40	2 442.00	67	2 469.00
14	2 416.00	41	2 443.00	68	2 470.00
15	2 417.00	42	2 444.00	69	2 471.00
16	2 418.00	43	2 445.00	70	2 472.00
17	2 419.00	44	2 446.00	71	2 473.00
18	2 420.00	45	2 447.00	72	2 474.00
19	2 421.00	46	2 448.00	73	2 475.00
20	2 422.00	47	2 449.00	74	2 476.00
21	2 423.00	48	2 450.00	75	2 477.00
22	2 424.00	49	2 451.00	76	2 478.00
23	2 425.00	50	2 452.00	77	2 479.00
24	2 426.00	51	2 453.00	78	2 480.00
25	2 427.00	52	2 454.00		
26	2 428.00	53	2 455.00		

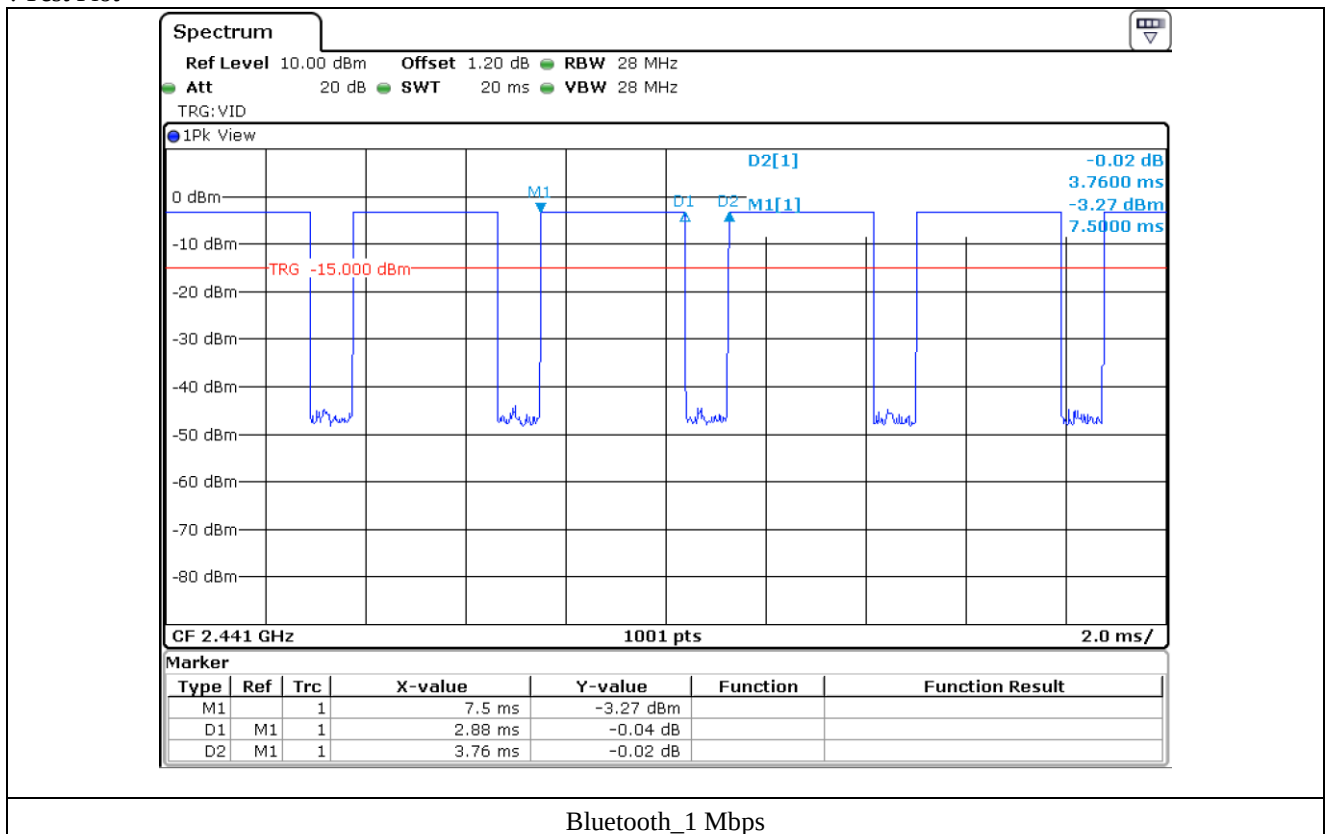
-. Duty Cycle

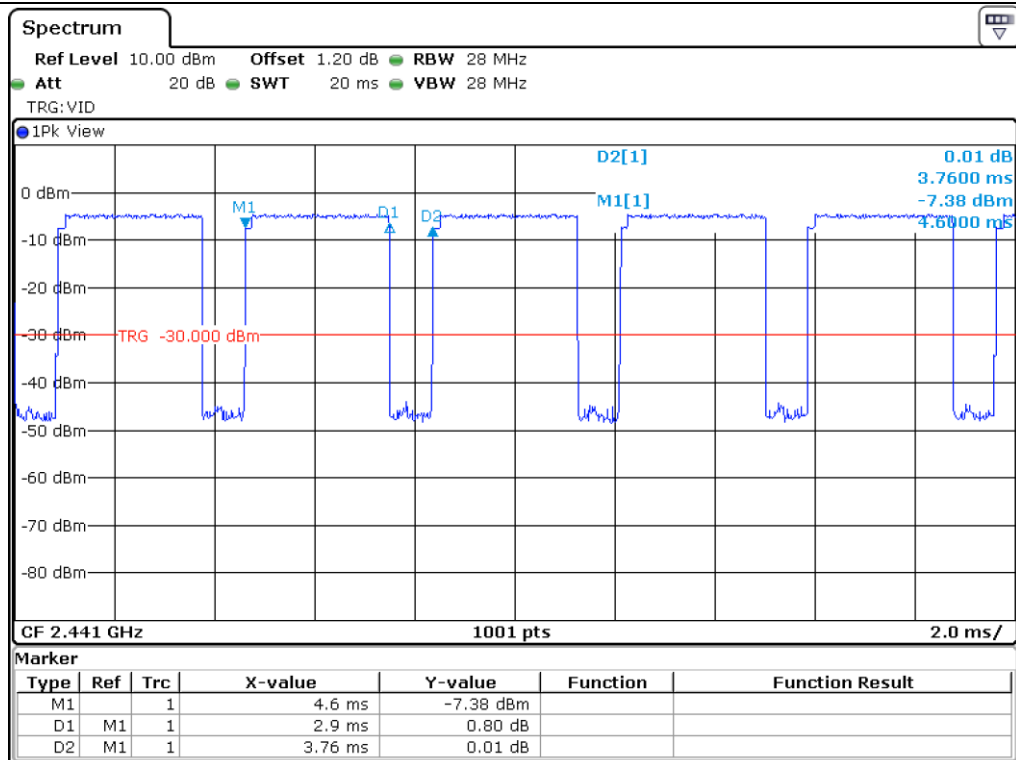
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.88	0.88	76.60	1.16
Bluetooth [2 Mbps]	2.90	0.86	77.13	1.13
Bluetooth [3 Mbps]	2.88	0.88	76.60	1.16

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

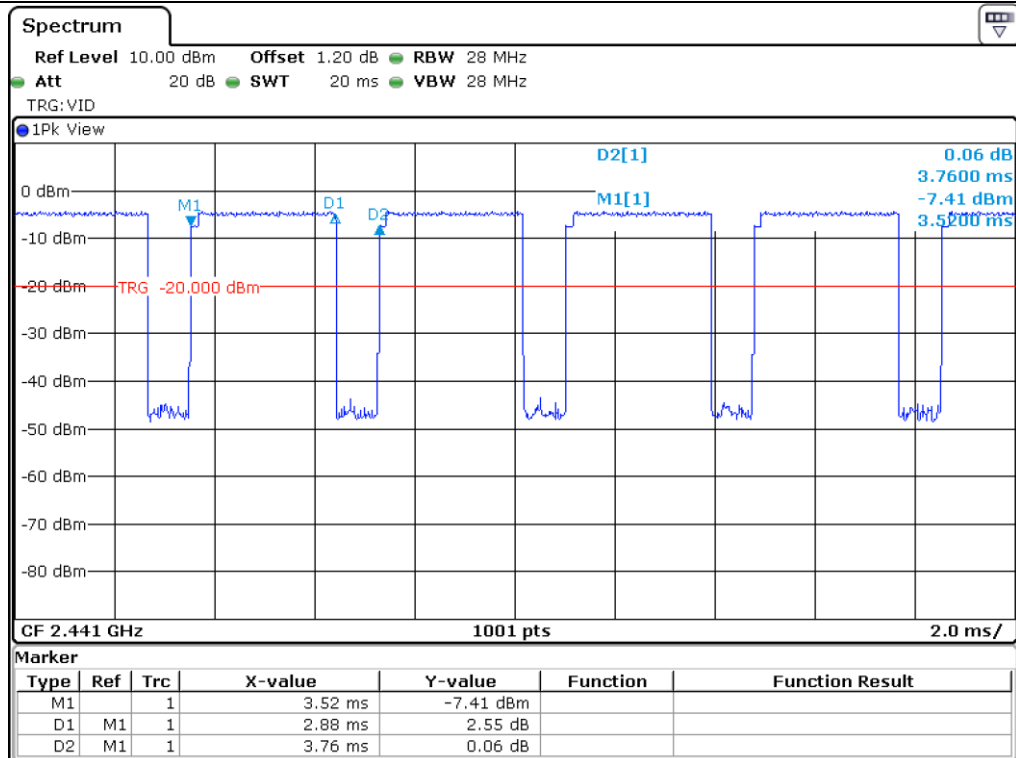
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot





Bluetooth_2 Mbps



Bluetooth_3 Mbps

5.4 Configuration of Test System

Line Conducted Test: It is not need to test this requirement, because the EUT shall be operated by DC Power.

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 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)
It is not need to test this requirement, because the power of the EUT is supplied by DC Power.	

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

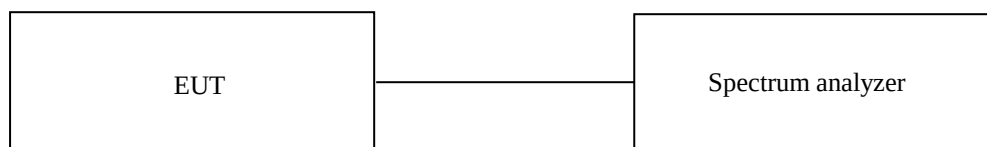
7. MINIMUM 20 dB BANDWIDTH

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 1 % to 5 % of the OBW, 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.

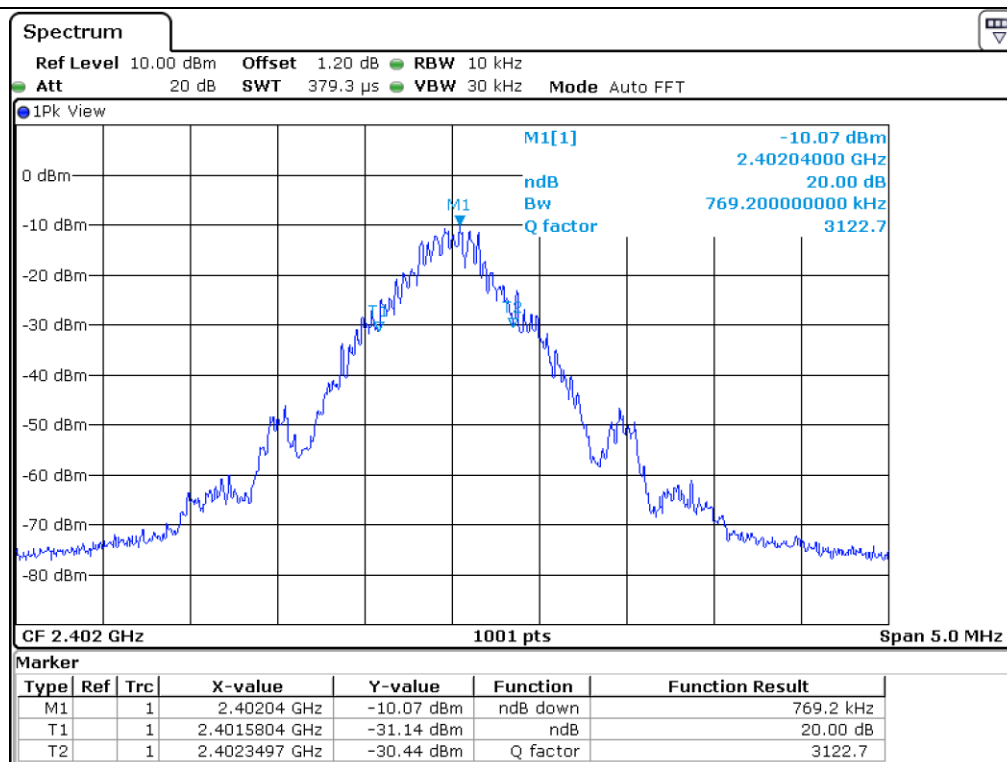


7.3 Test Date

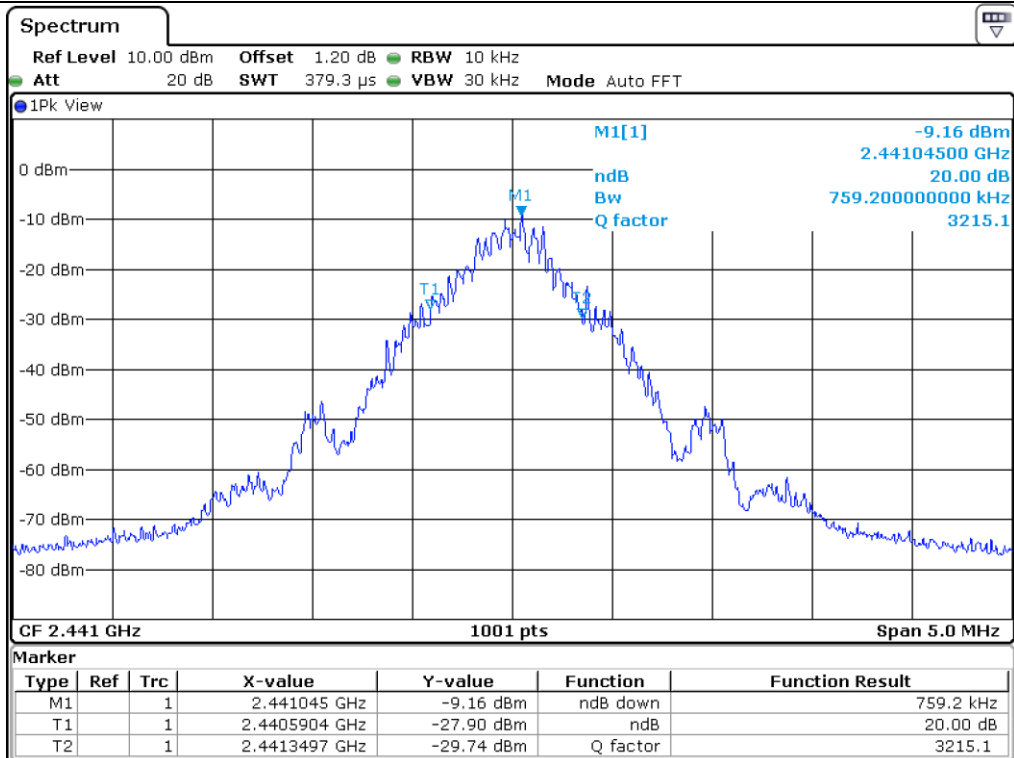
January 28, 2021 ~ February 04, 2021

7.4 Test data for 1 Mbps

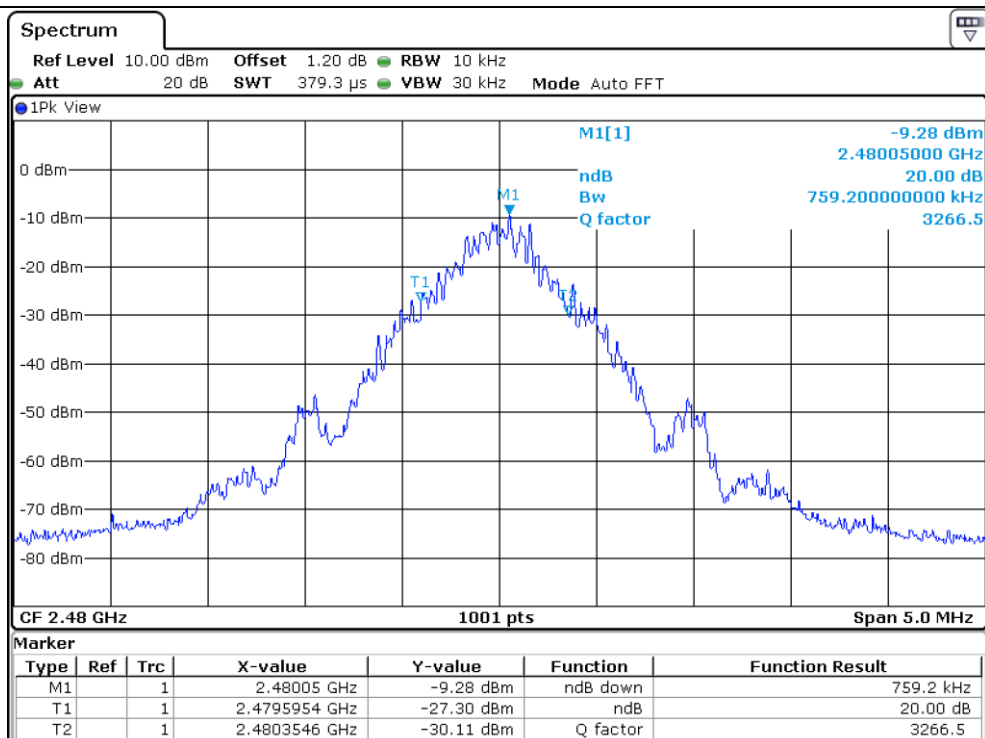
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	769.20
Middle	2 441.00	759.20
High	2 480.00	759.20



Low Channel



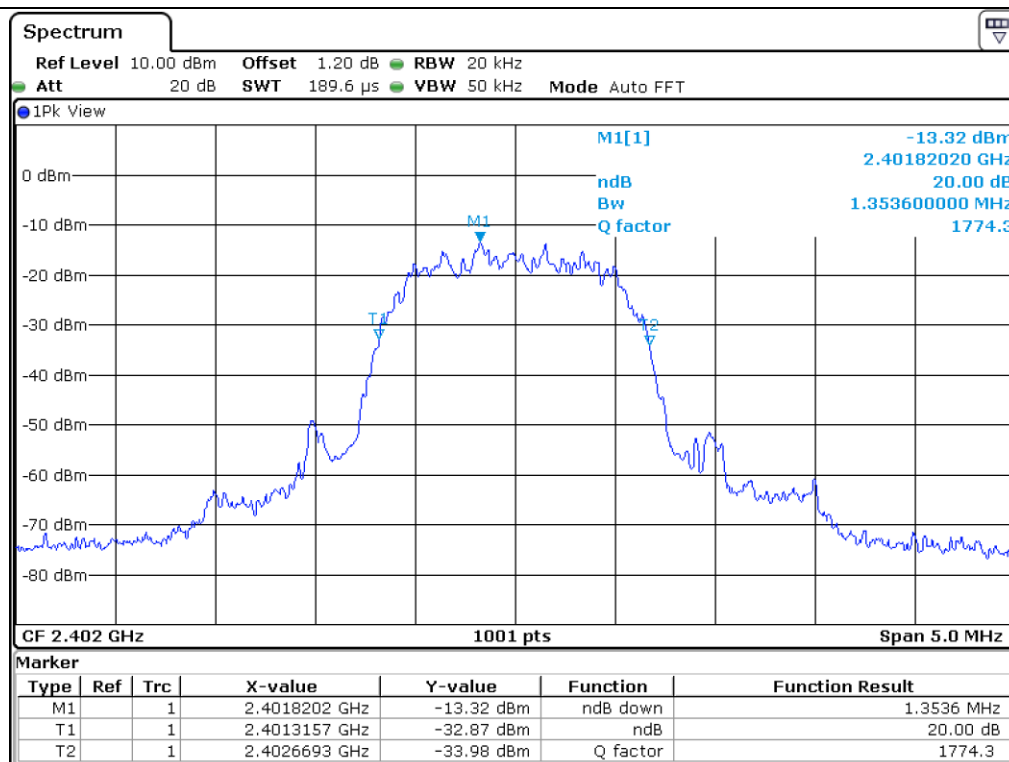
Middle Channel



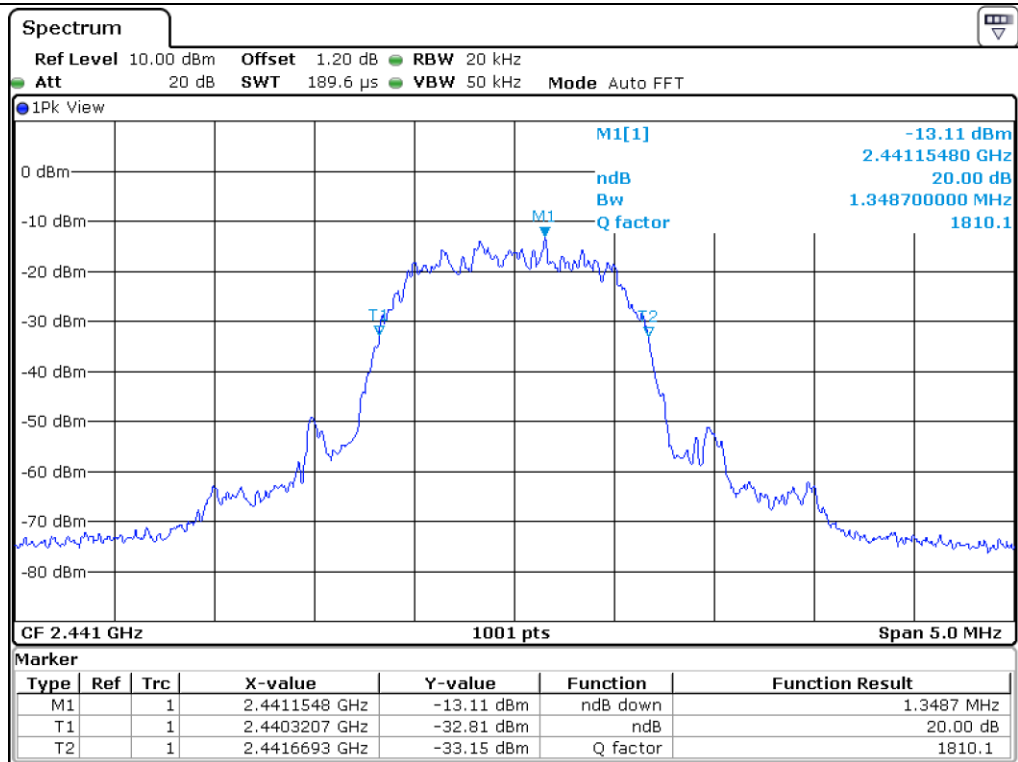
High Channel

7.5 Test data for 2 Mbps

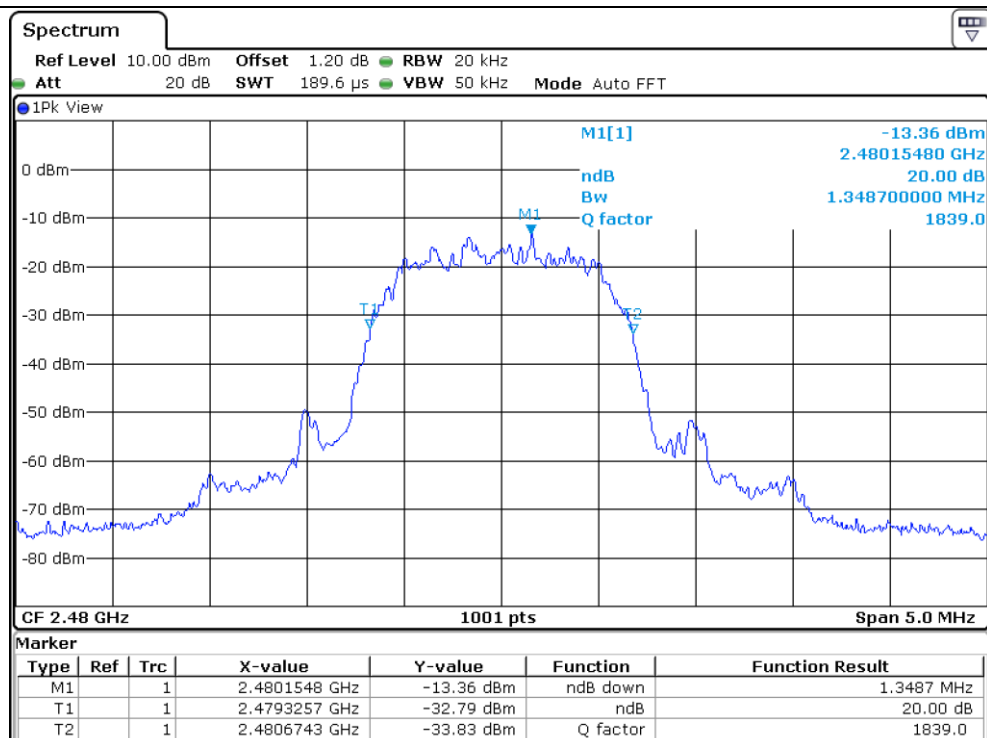
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 353.60
Middle	2 441.00	1 348.70
High	2 480.00	1 348.70



Low Channel



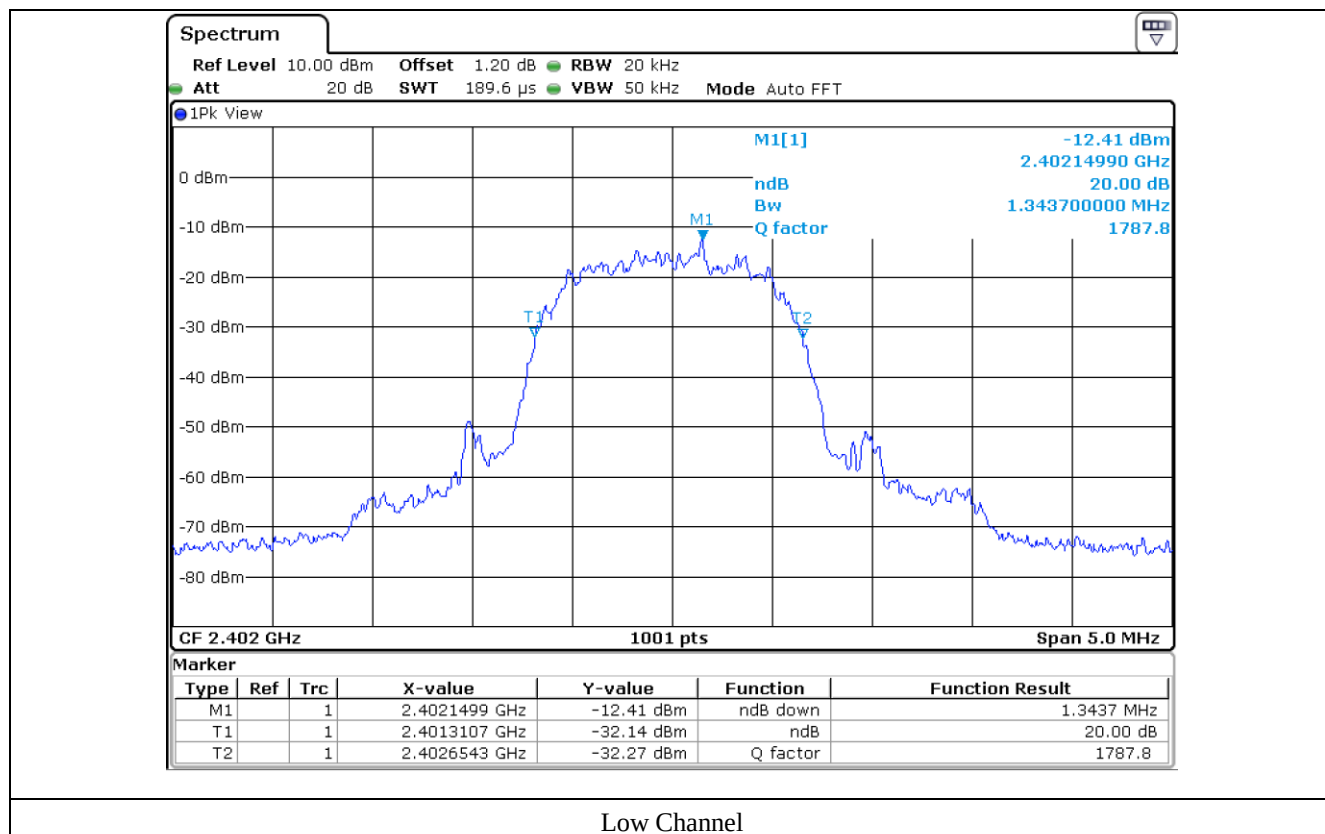
Middle Channel

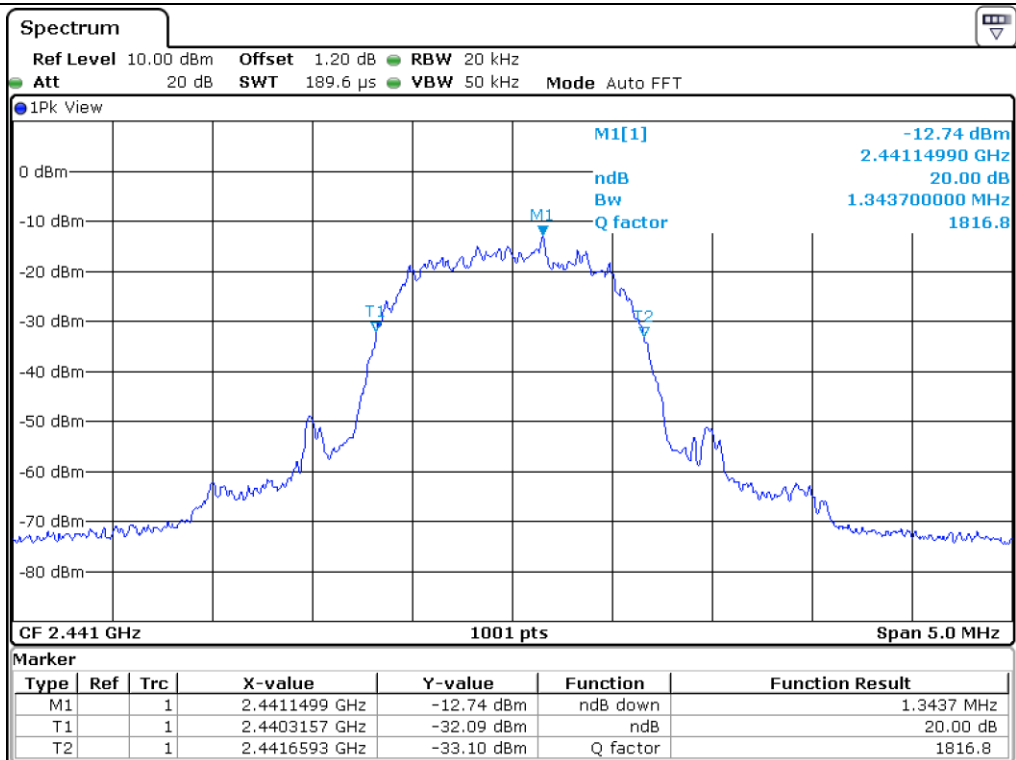


High Channel

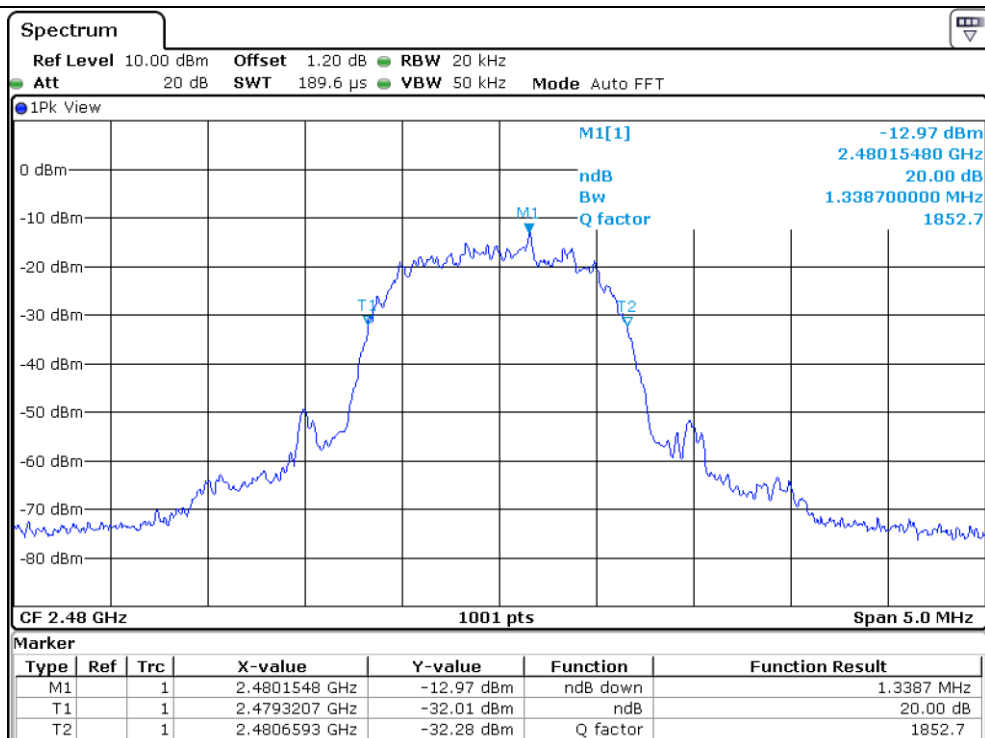
7.6 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 343.70
Middle	2 441.00	1 343.70
High	2 480.00	1 338.70





Middle Channel



High Channel

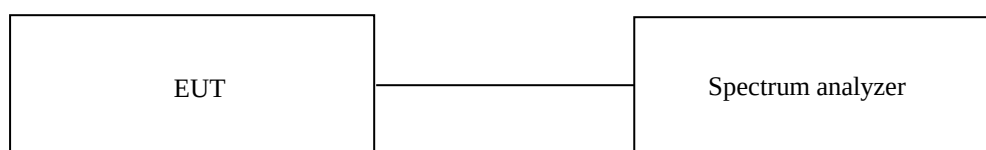
8. HOPPING FREQUENCY SEPARATION

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.



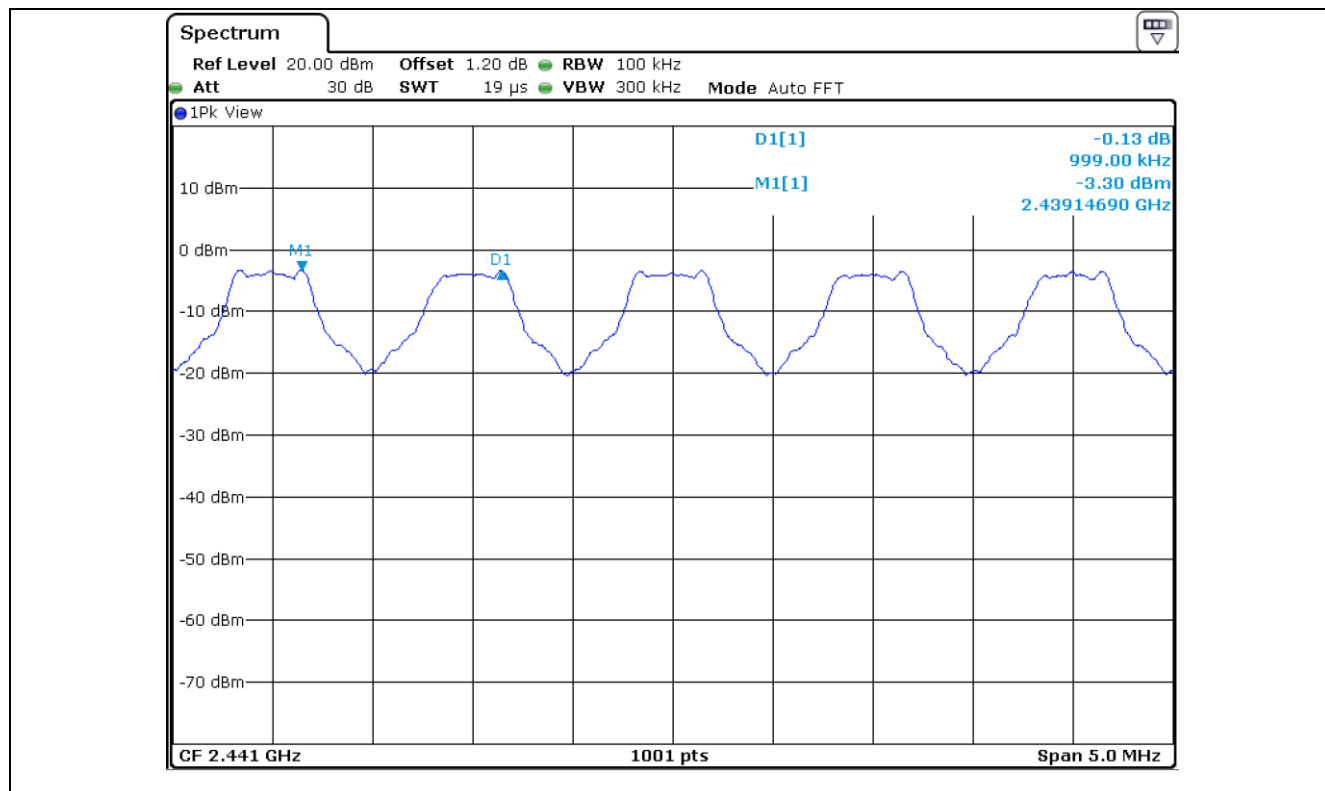
8.3 Test Date

January 28, 2021 ~ February 04, 2021

8.4 Test data for 1 Mbps

-. Test Result : Pass

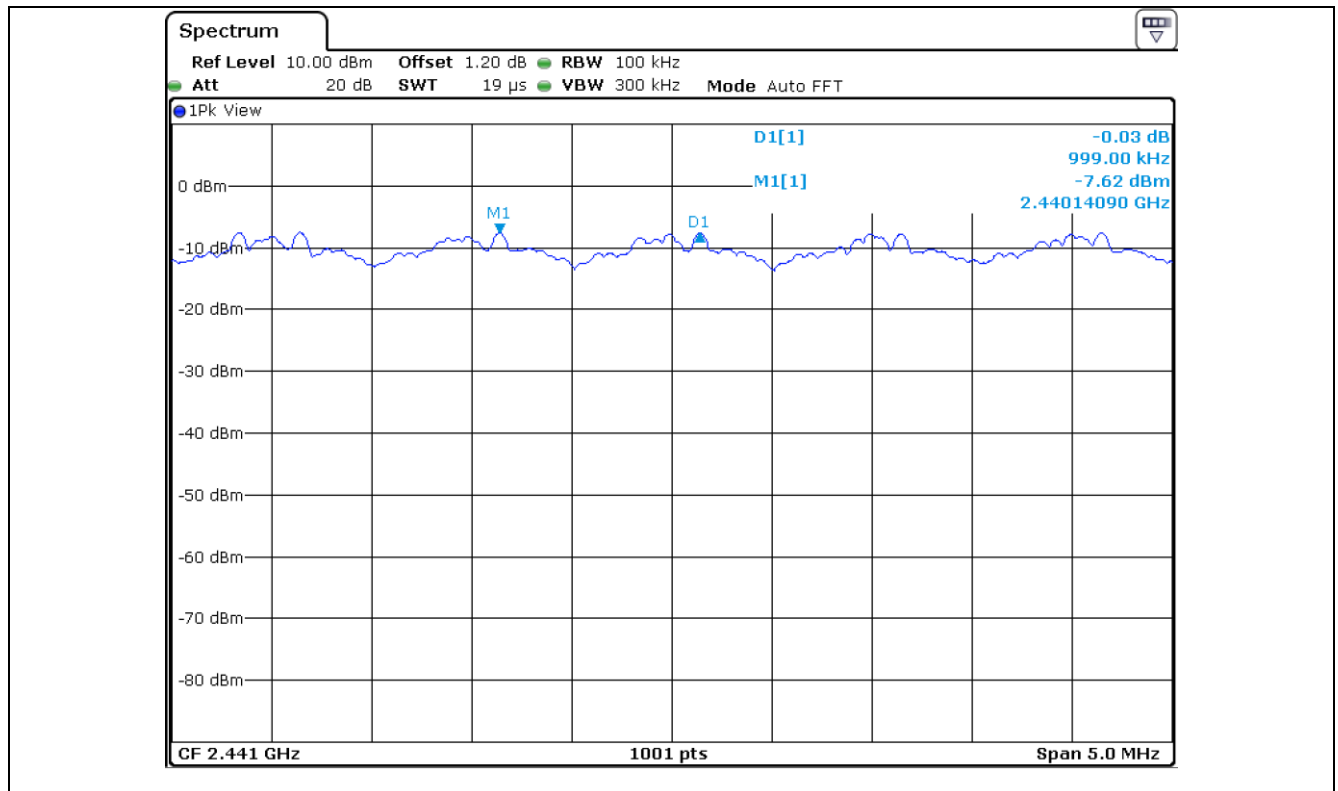
MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	506.13	Separated by a minimum of 506.13 kHz



8.5 Test data for 2 Mbps

-. Test Result : Pass

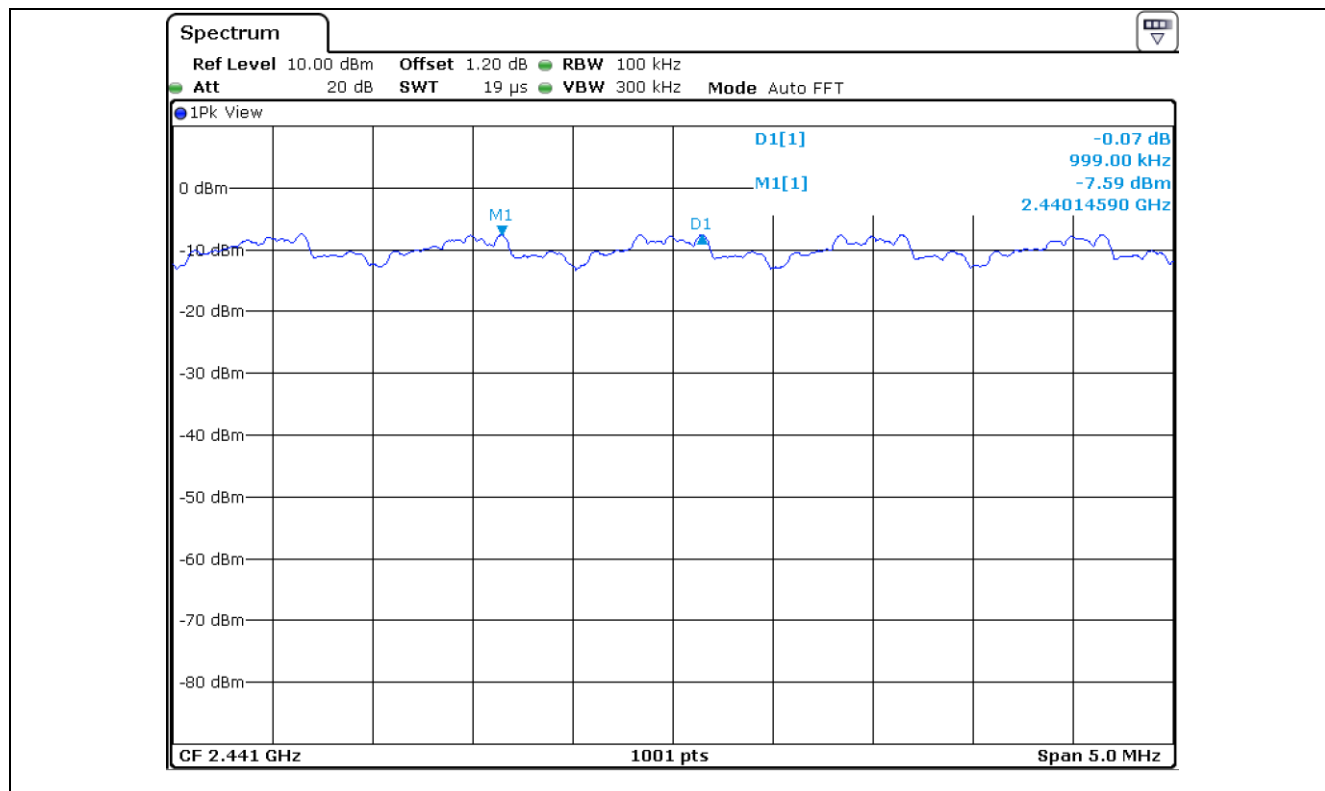
MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	899.13	Separated by a minimum of 899.13 kHz



8.6 Test data for 3 Mbps

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	895.80	Separated by a minimum of 895.80 kHz



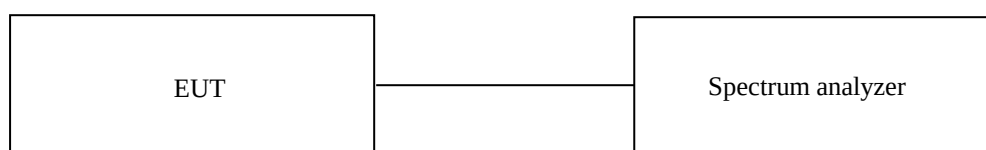
9. NUMBER OF HOPPING CHANNELS

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 kHz and the resolution bandwidth is set to 300 kHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.



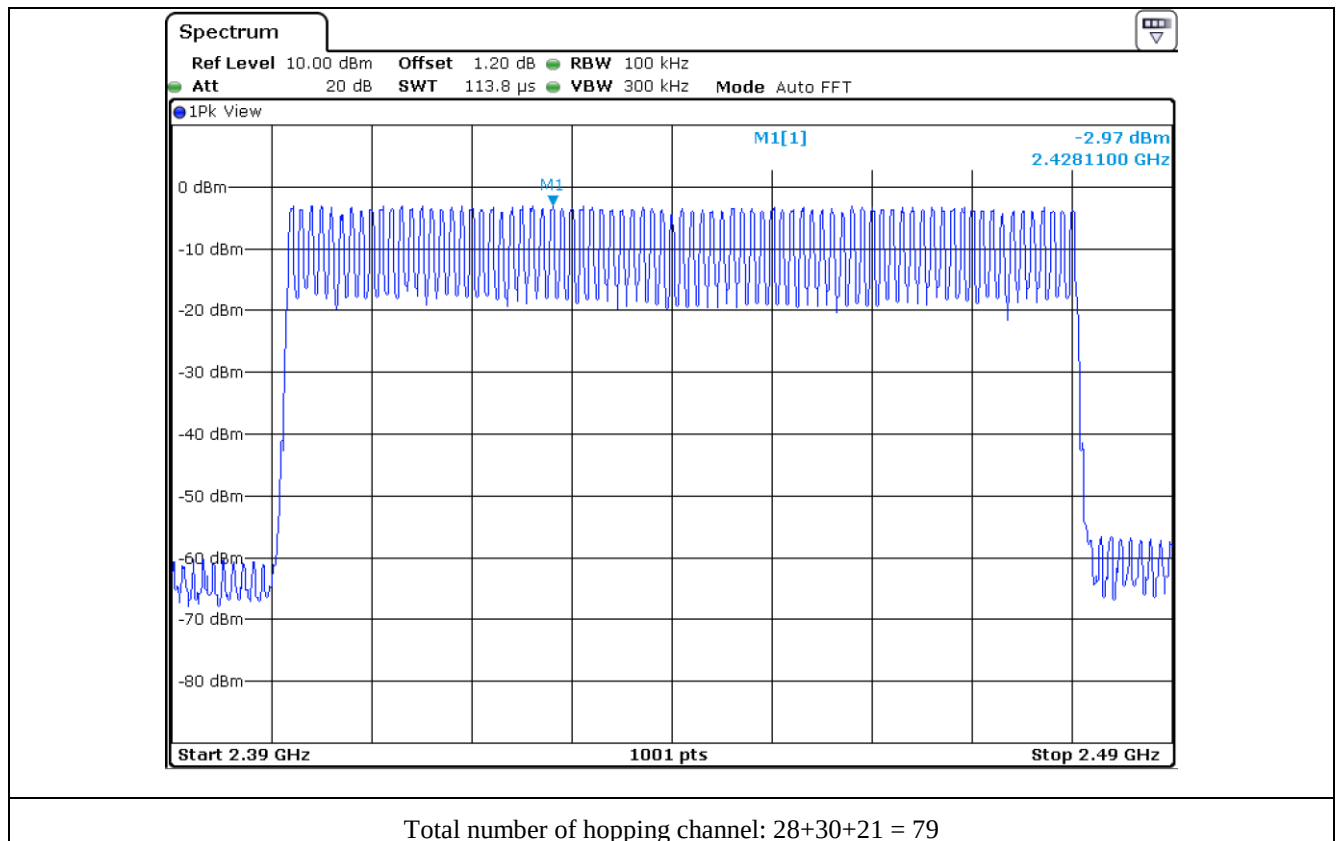
9.3 Test Date

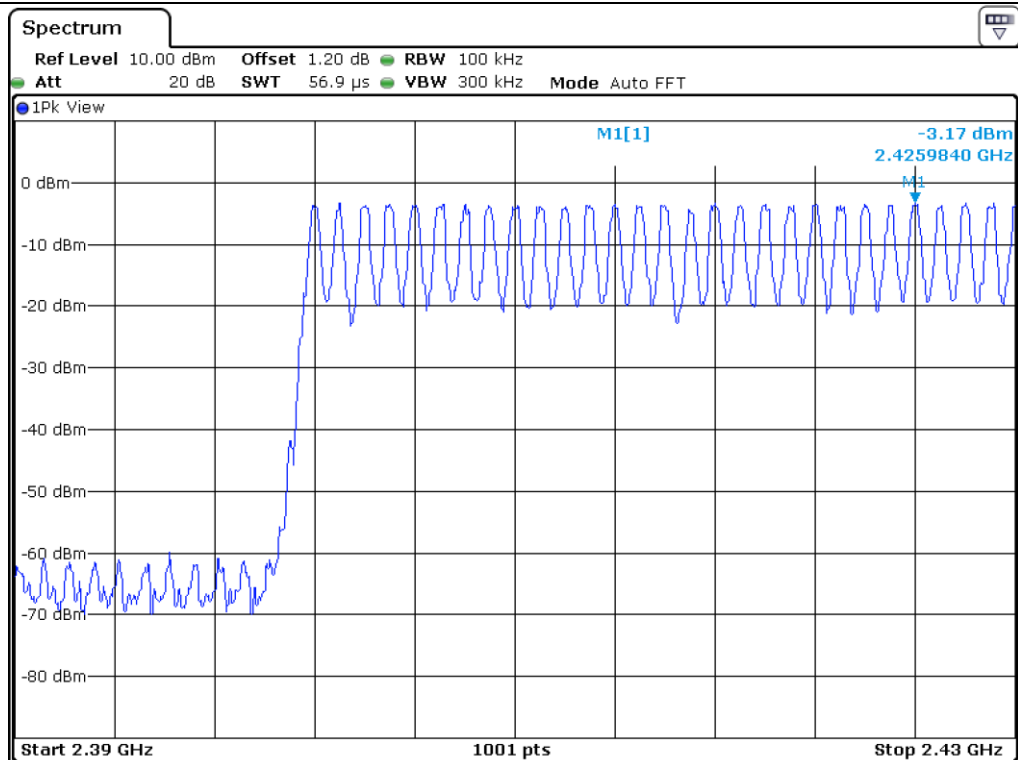
January 28, 2021 ~ February 04, 2021

9.4 Test data for 1 Mbps

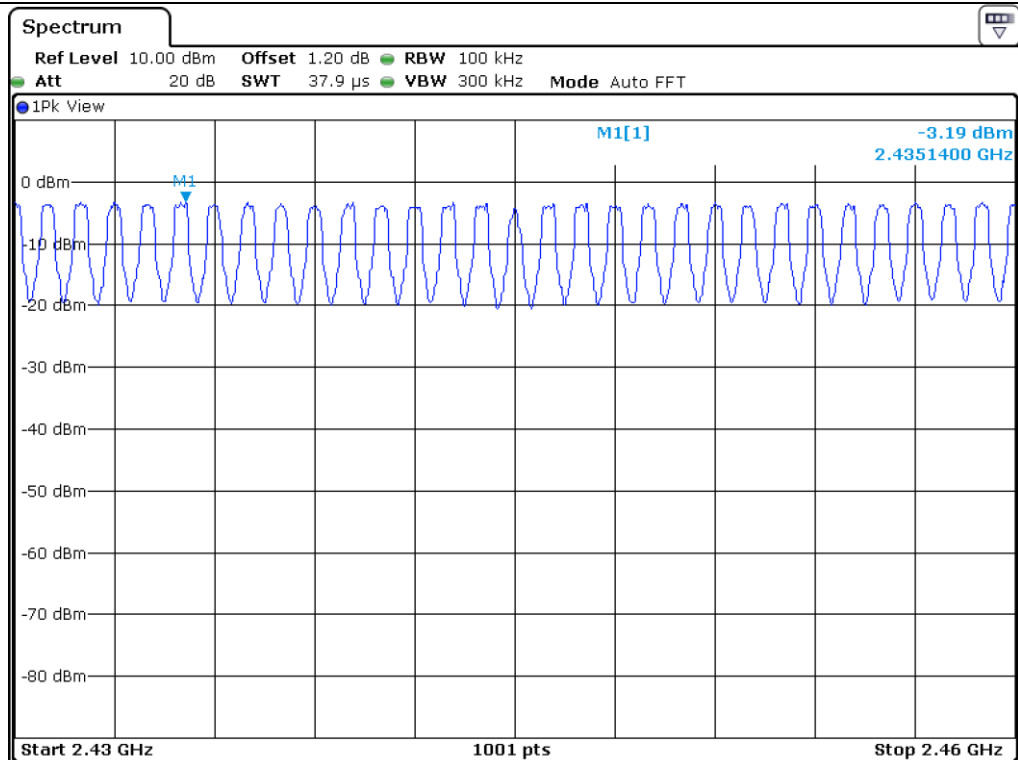
-. Test Result : Pass

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

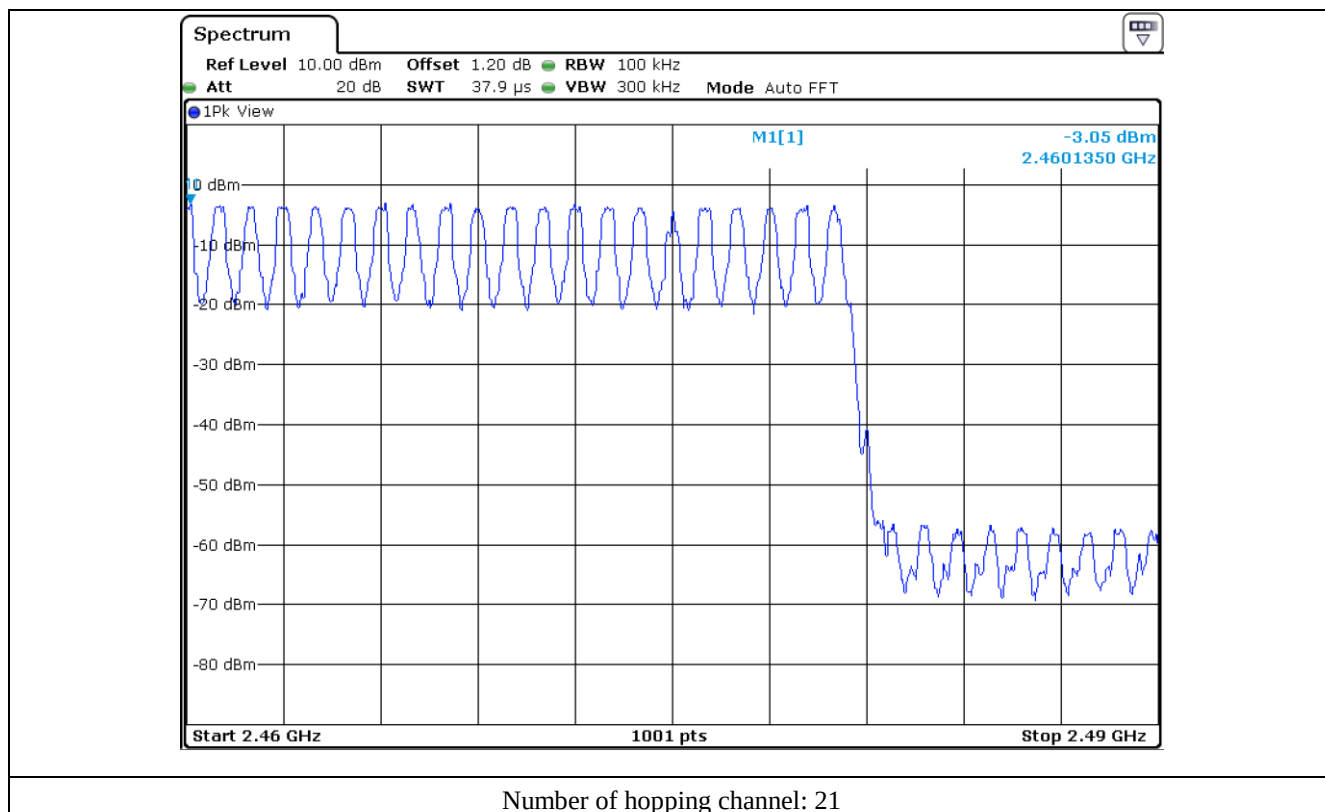




Number of hopping channel: 28



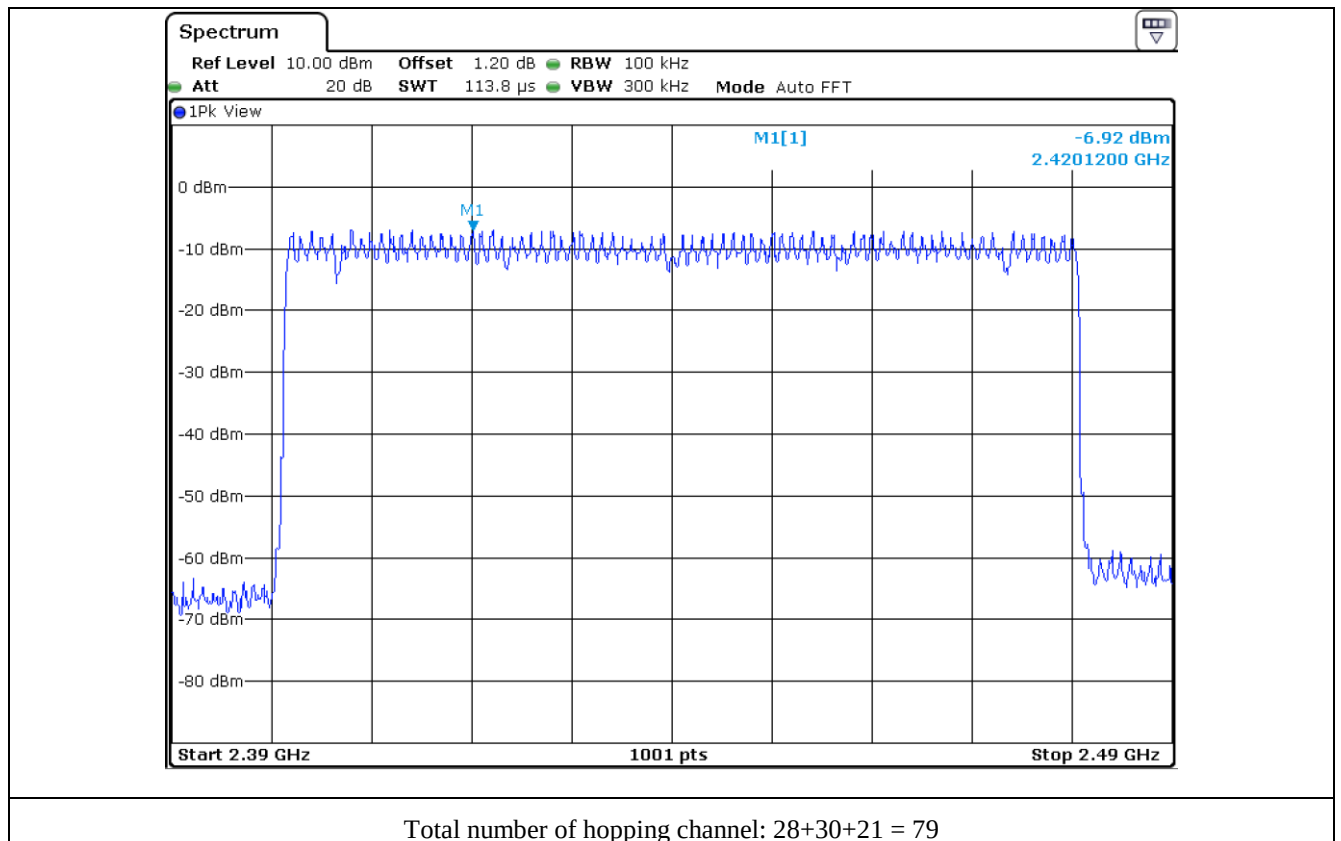
Number of hopping channel: 30

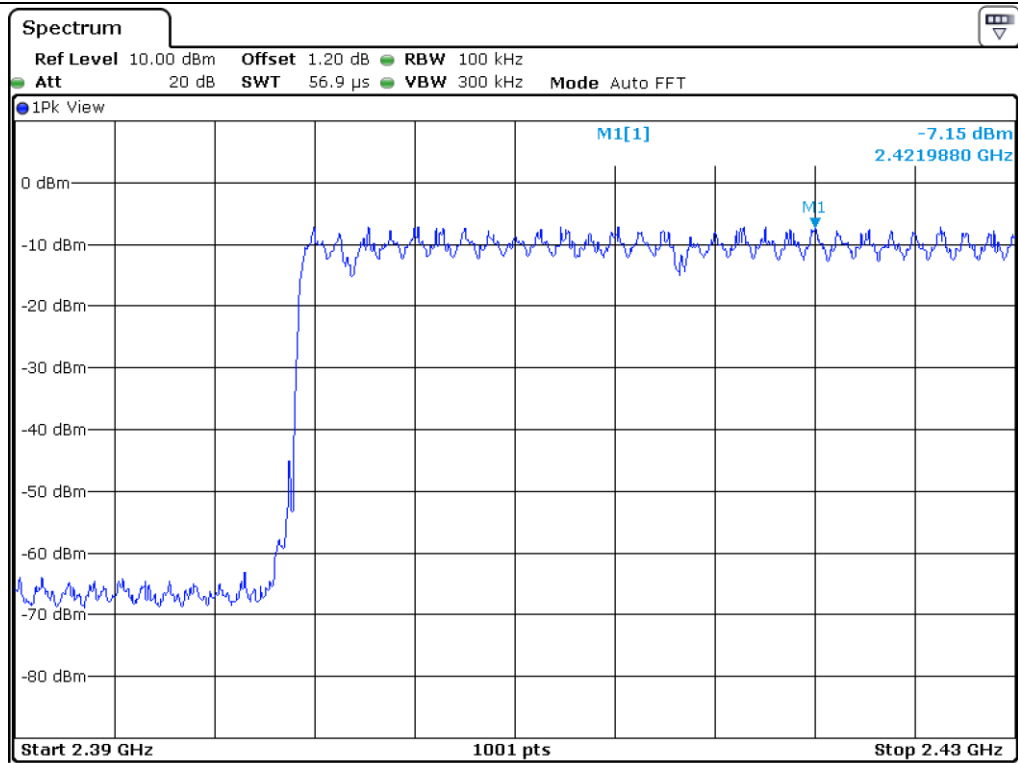


9.5 Test data for 2 Mbps

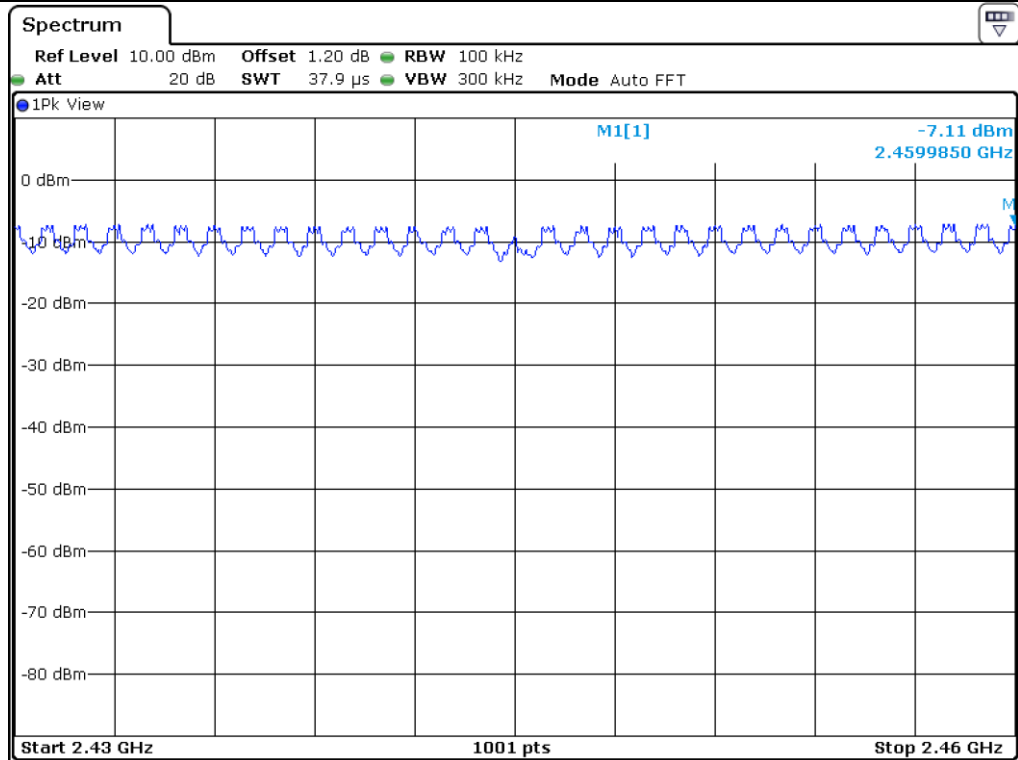
-. Test Result : Pass

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

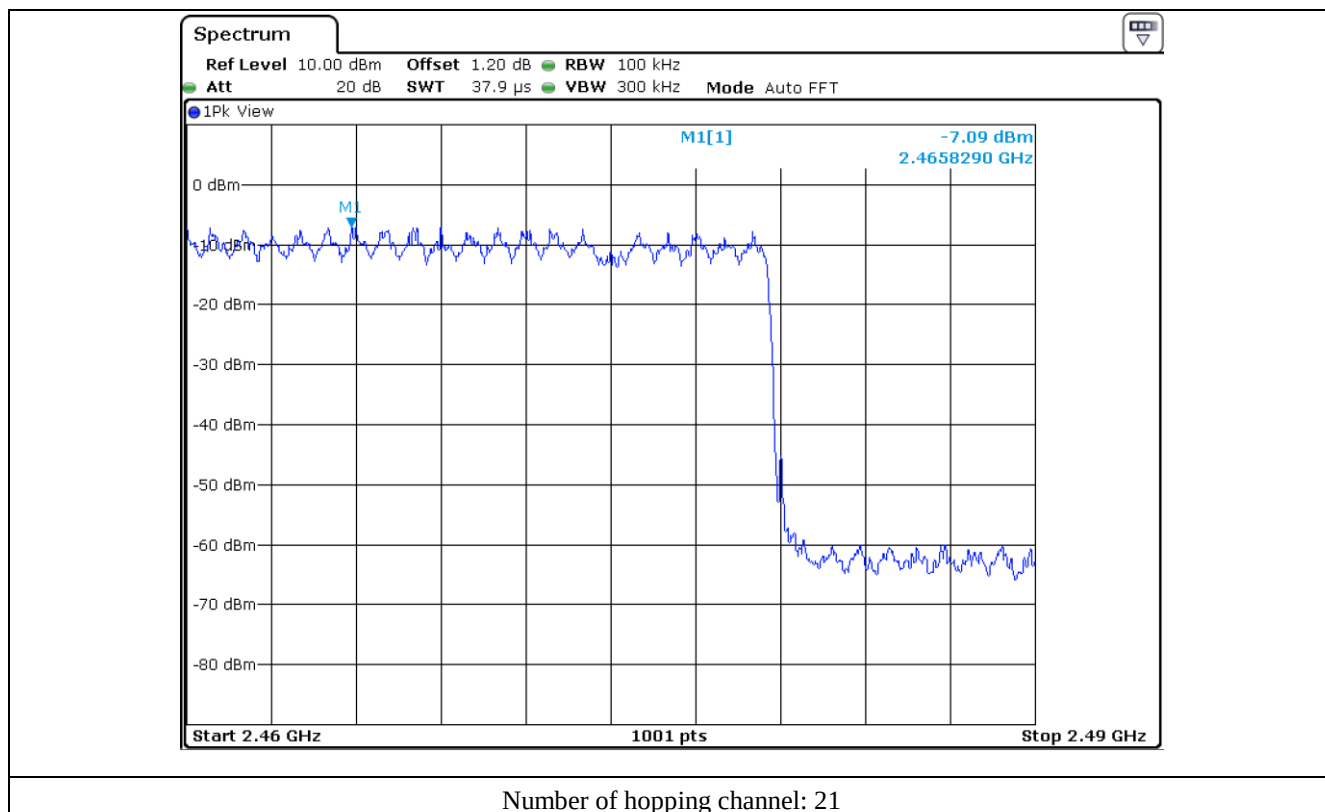




Number of hopping channel: 28



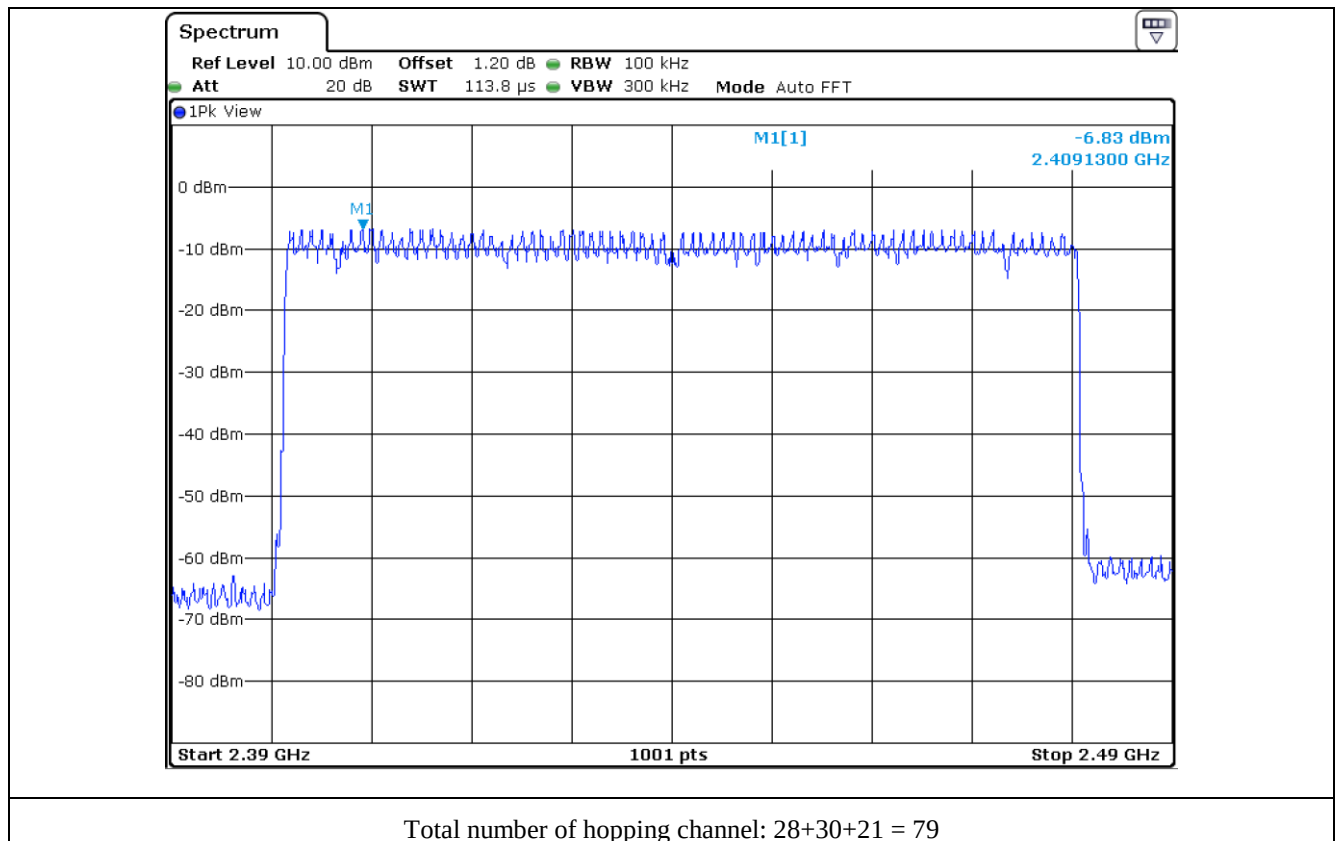
Number of hopping channel: 30

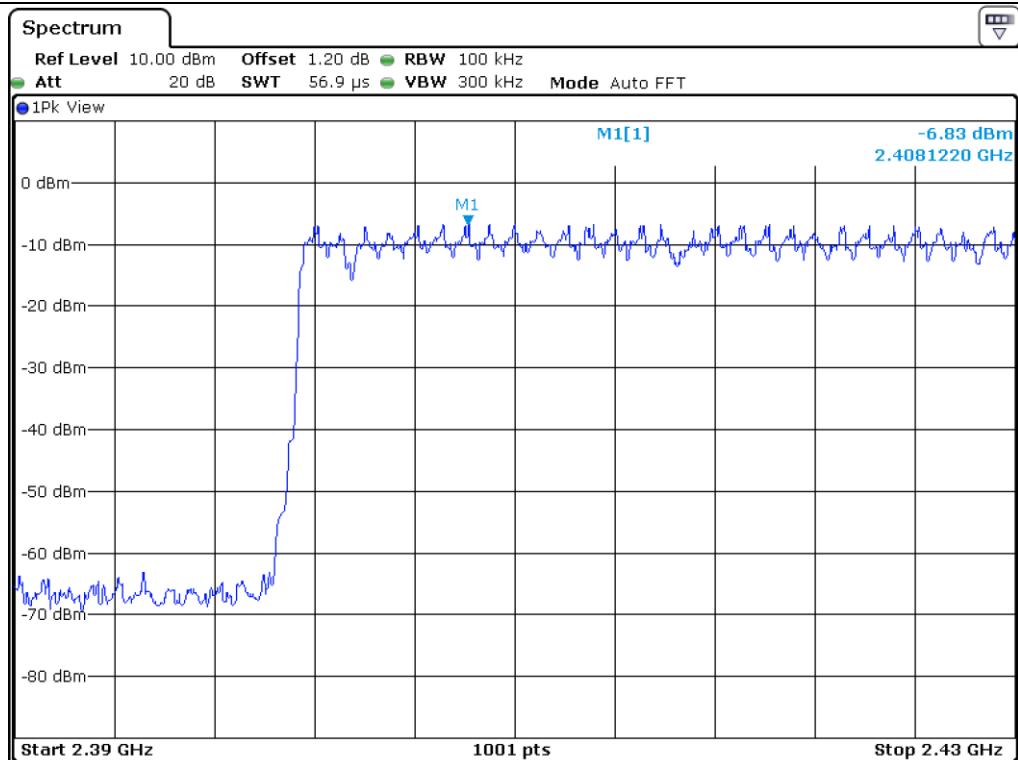


9.6 Test data for 3 Mbps

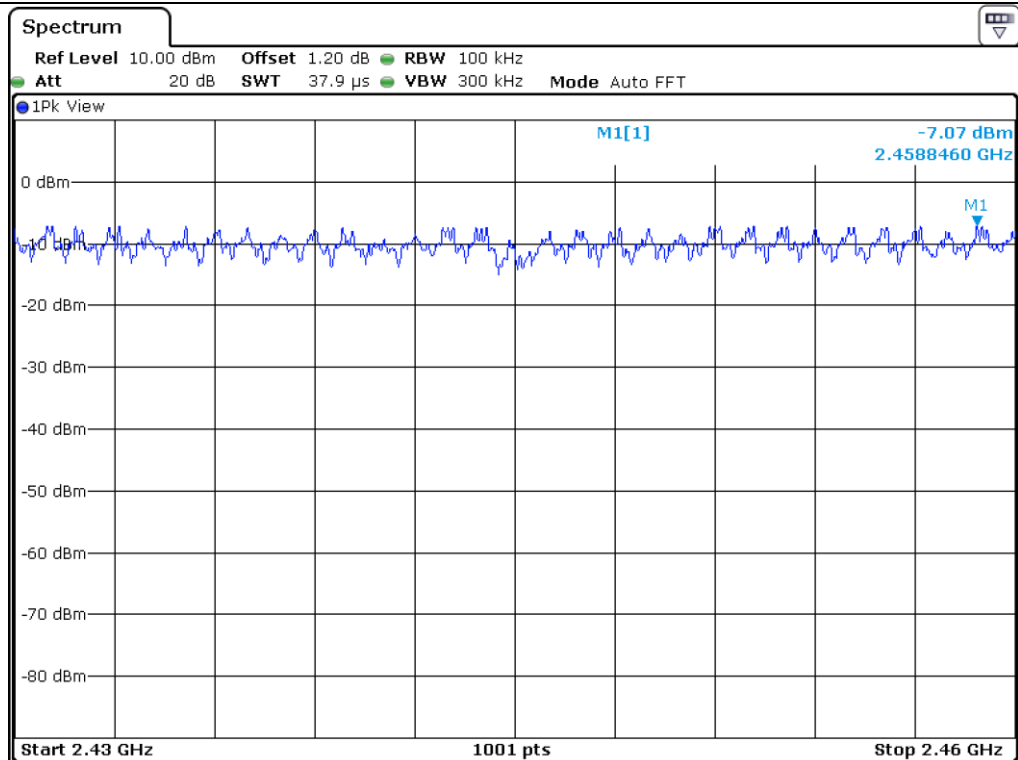
-. Test Result : Pass

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

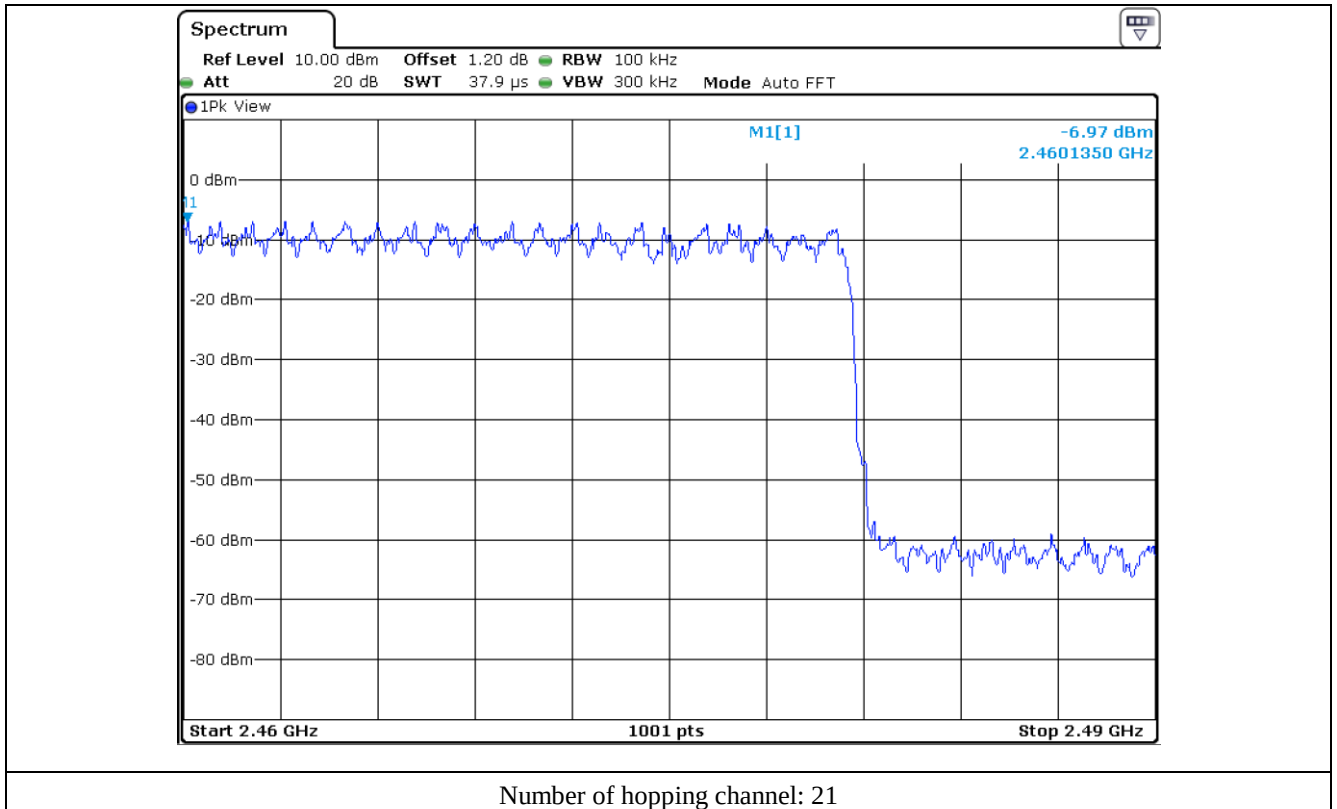




Number of hopping channel: 28



Number of hopping channel: 30



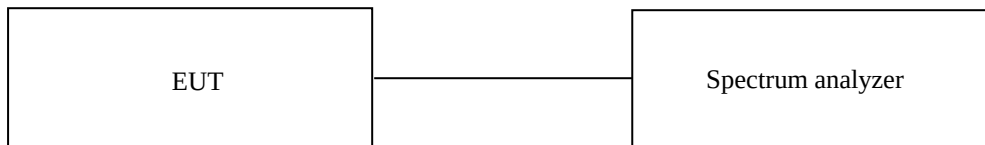
10. TIME OF OCCUPANCY

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

January 28, 2021 ~ February 04, 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.

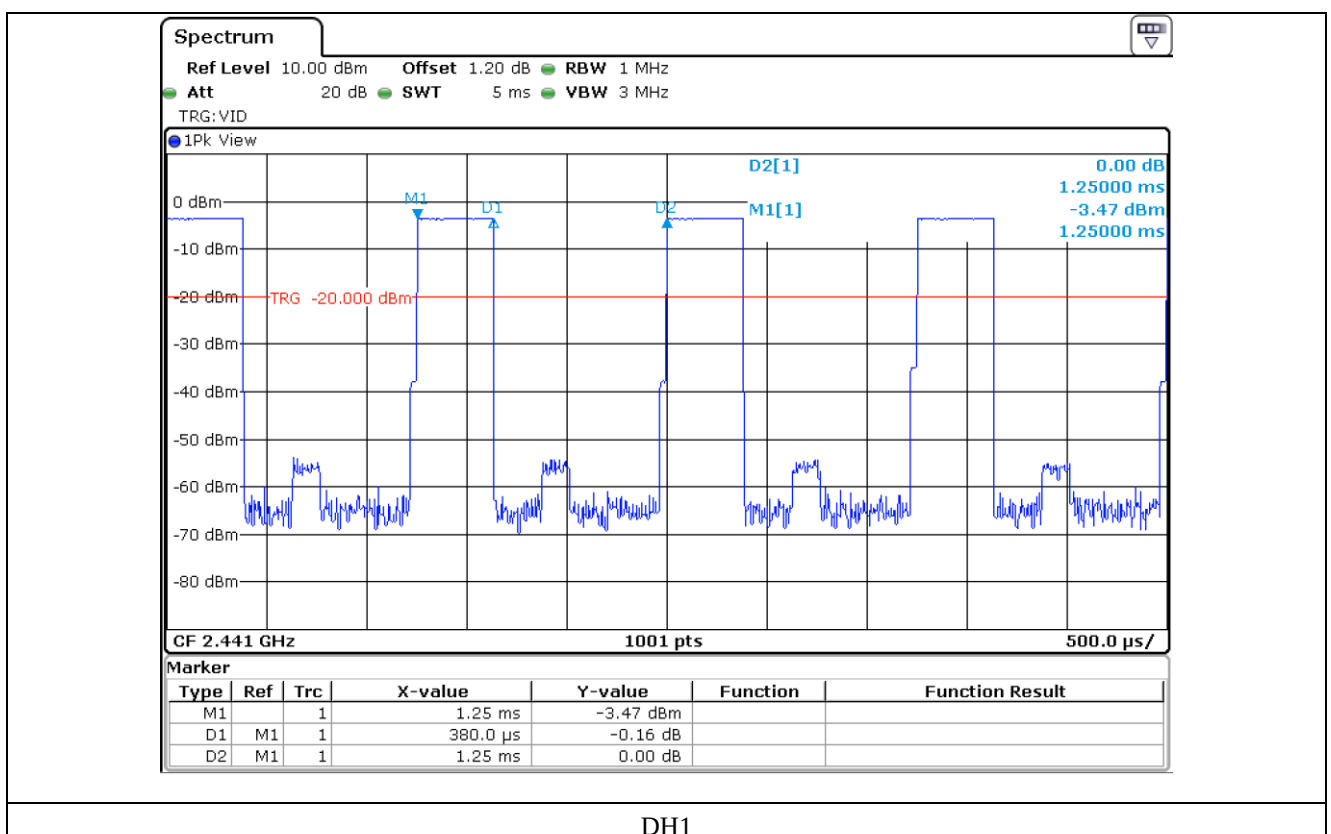
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel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

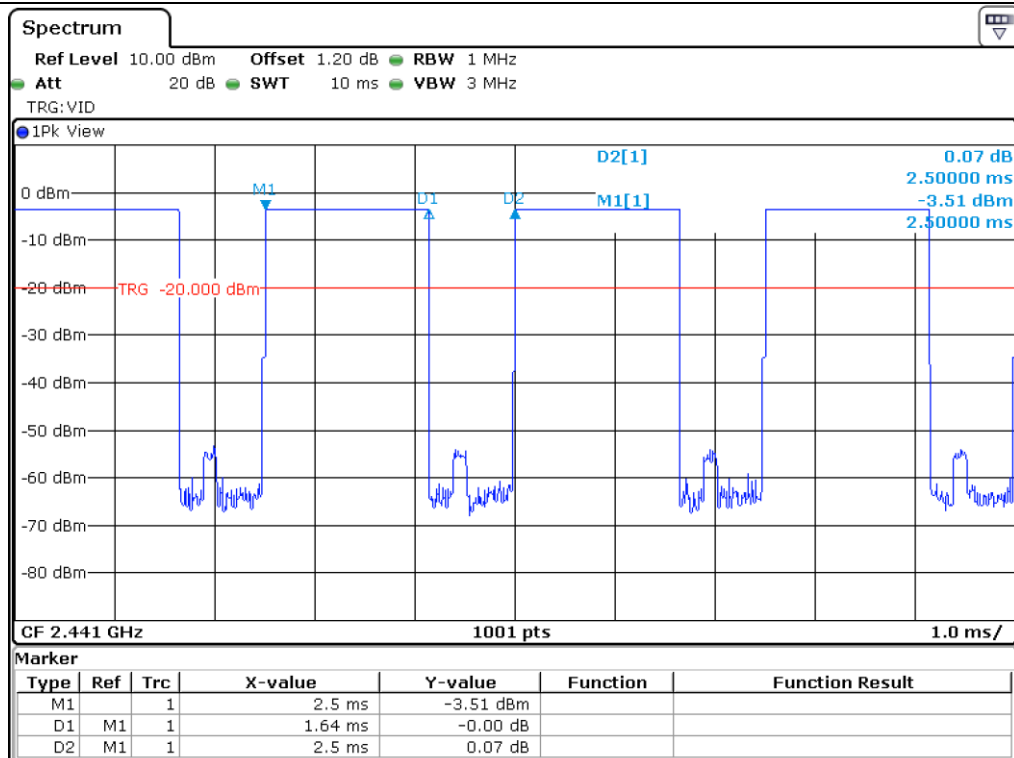
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.380	10.13	31.60	121.64	400.00	PASS
DH3	1.640	5.06	31.60	262.23	400.00	
DH5	2.900	3.38	31.60	309.74	400.00	

Total dwell time is calculated as following.

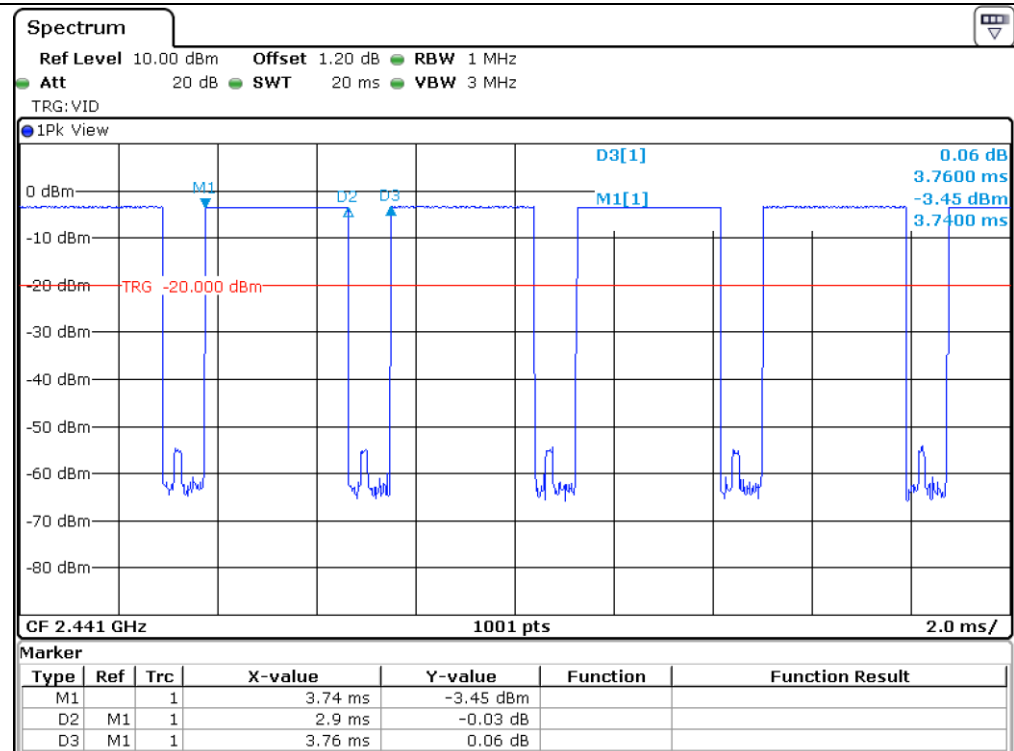
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





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.

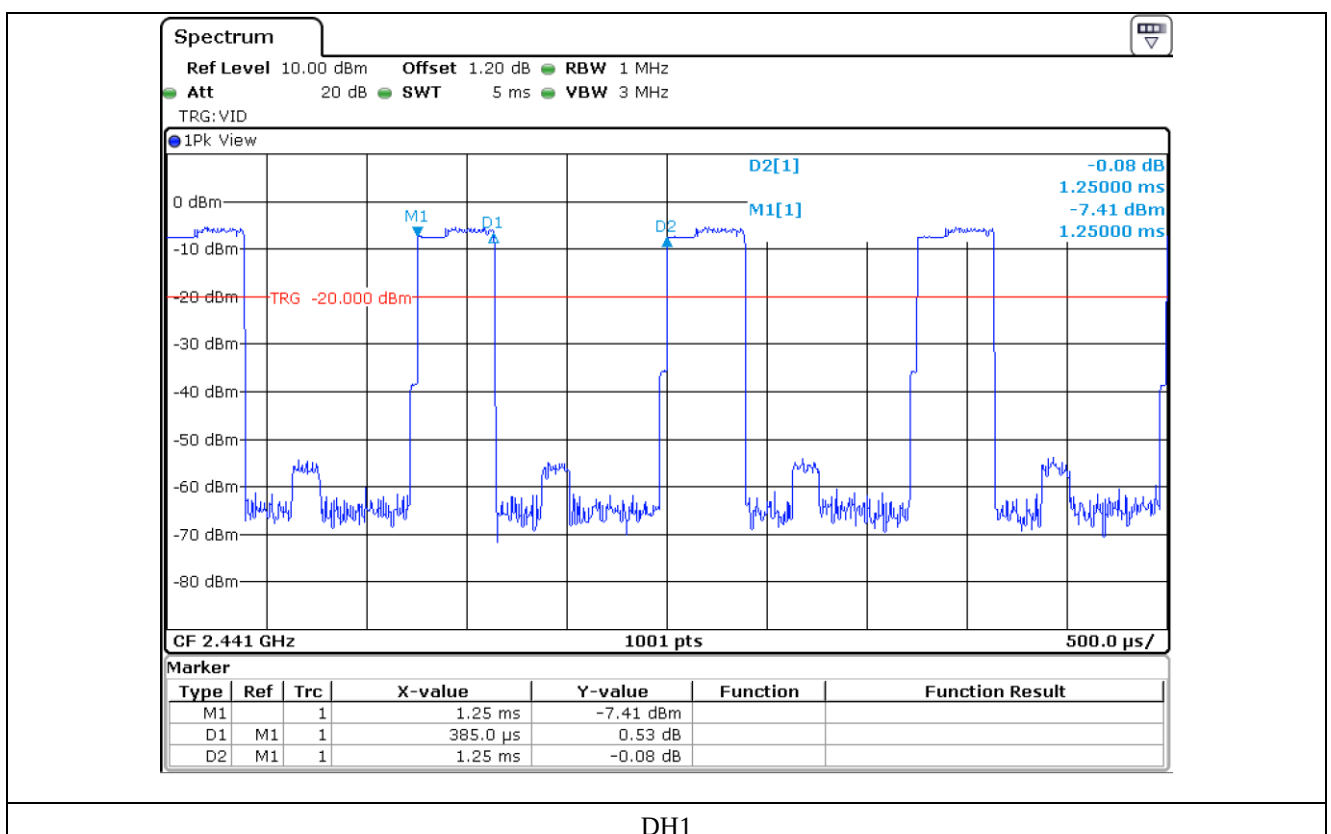
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel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

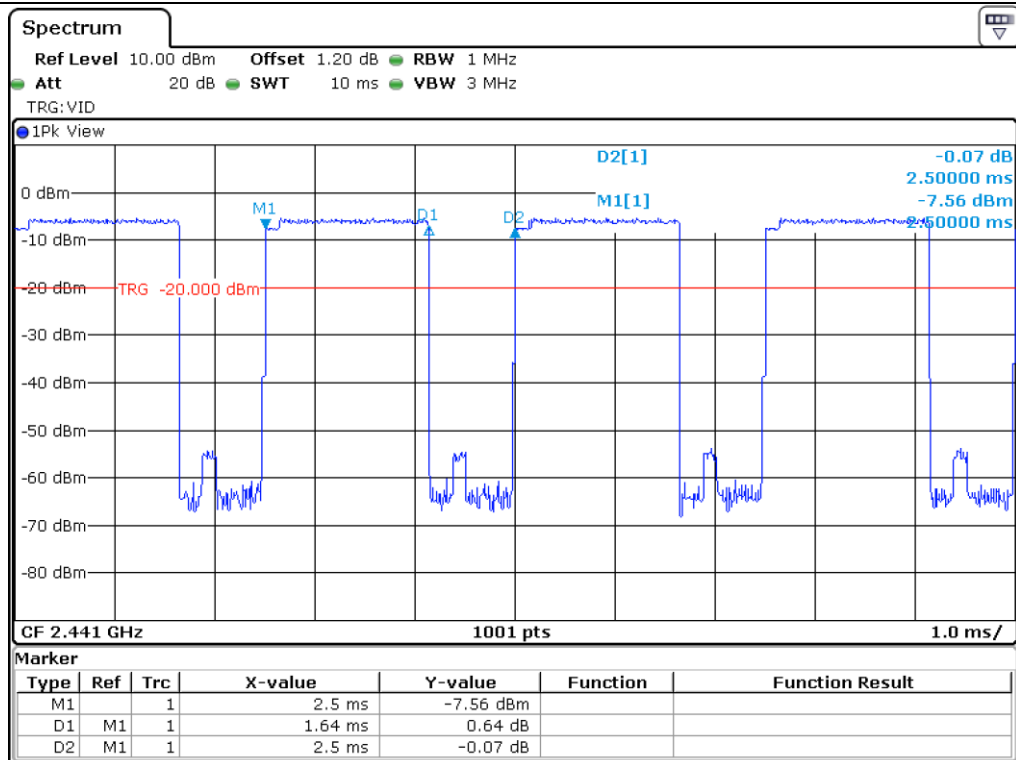
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.385	10.13	31.60	123.24	400.00	PASS
DH3	1.640	5.06	31.60	262.23	400.00	
DH5	2.900	3.38	31.60	309.74	400.00	

Total dwell time is calculated as following.

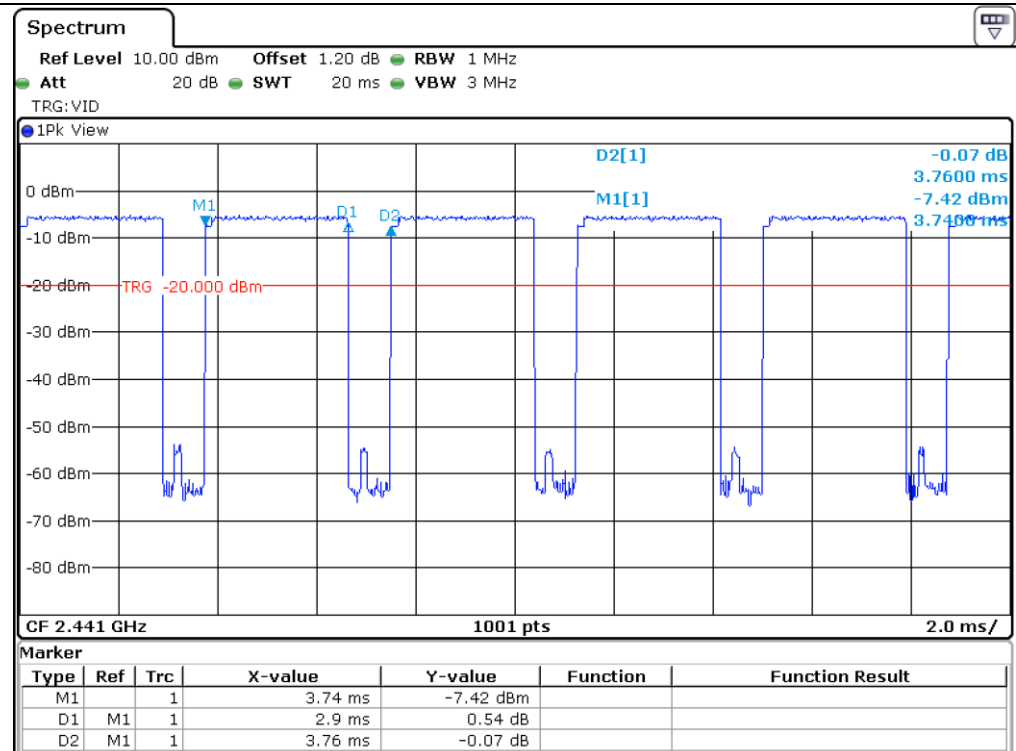
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





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.

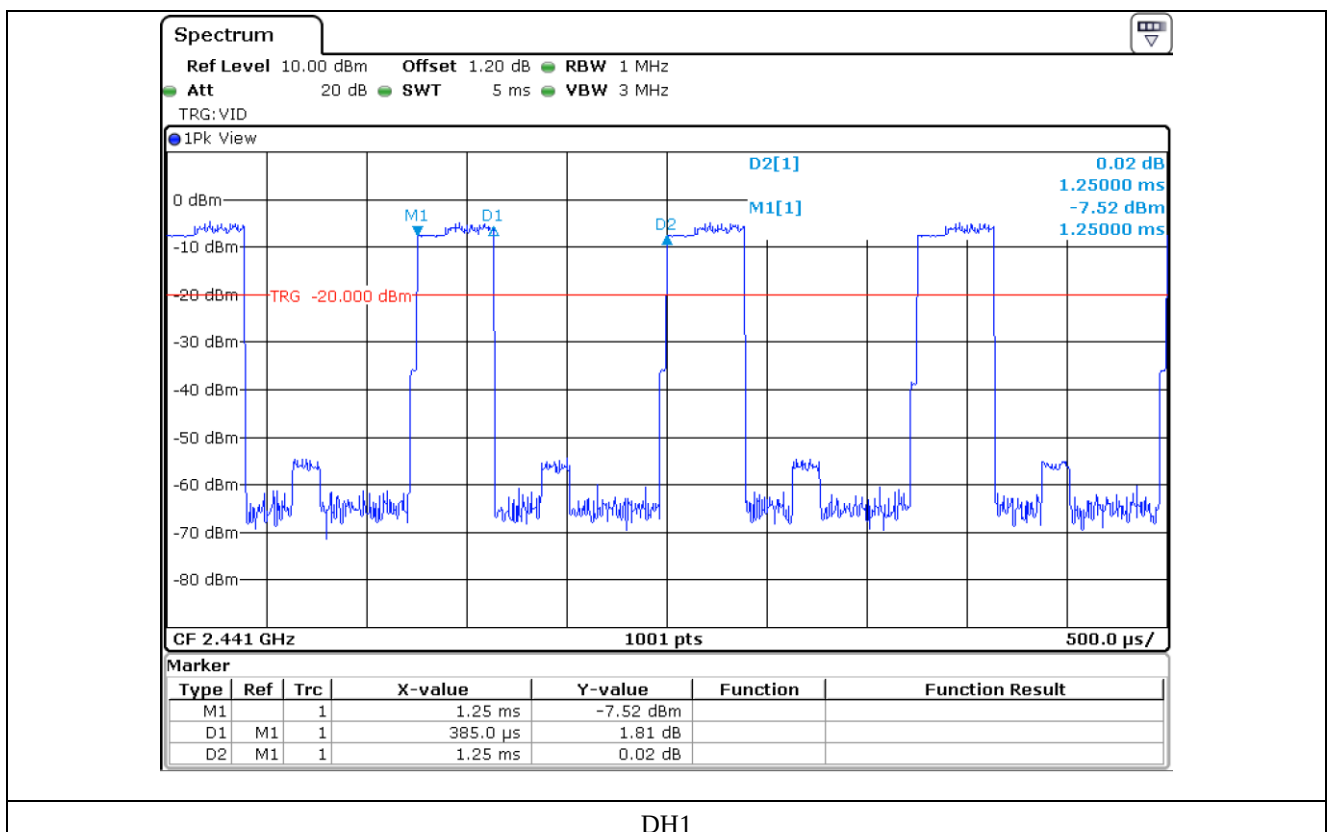
For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel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

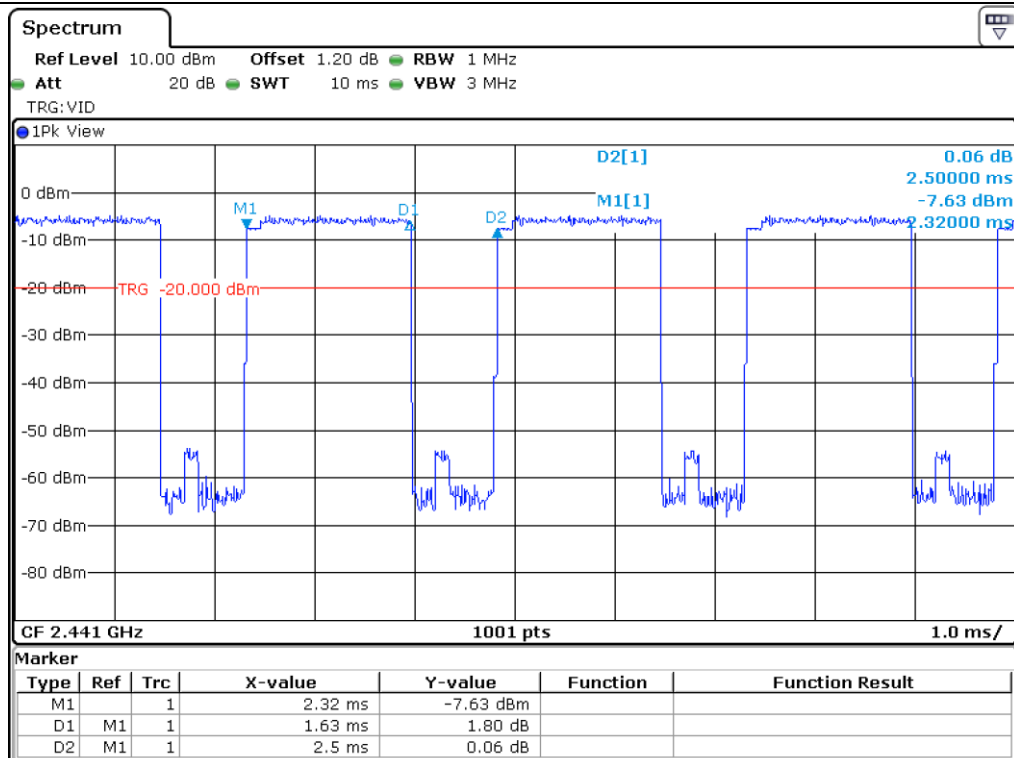
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.385	10.13	31.60	123.24	400.00	PASS
DH3	1.630	5.06	31.60	260.63	400.00	
DH5	2.900	3.38	31.60	309.74	400.00	

Total dwell time is calculated as following.

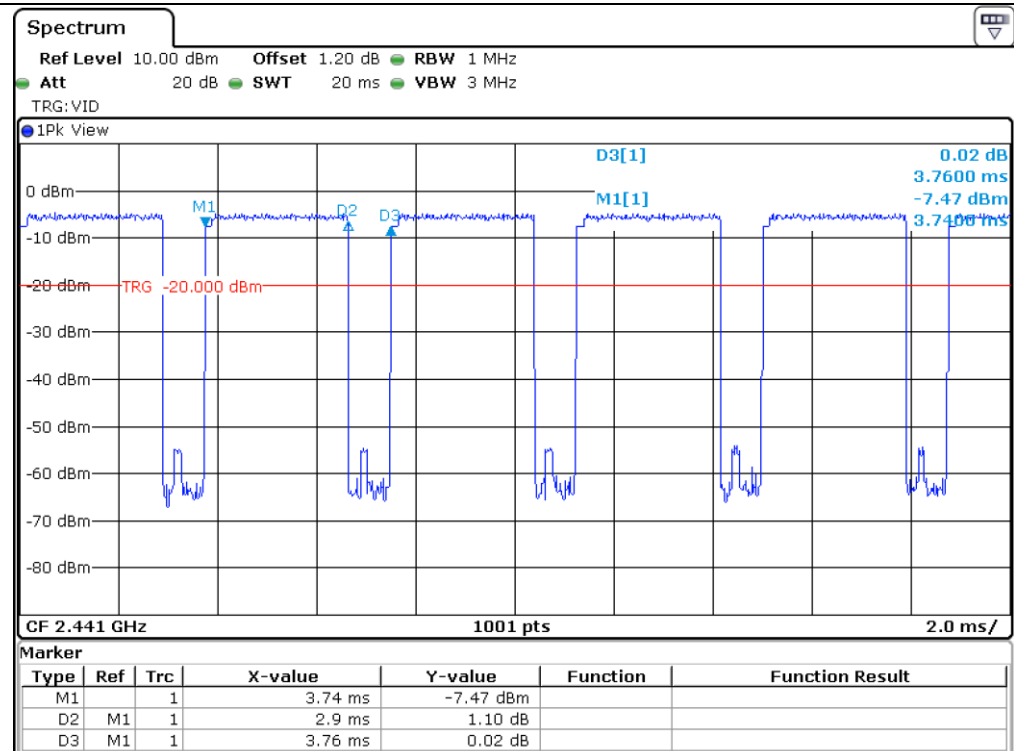
Total Dwell Time = Pulse time * Hops per second with channels * period time

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





DH3



DH5

11. MAXIMUM PEAK OUTPUT POWER

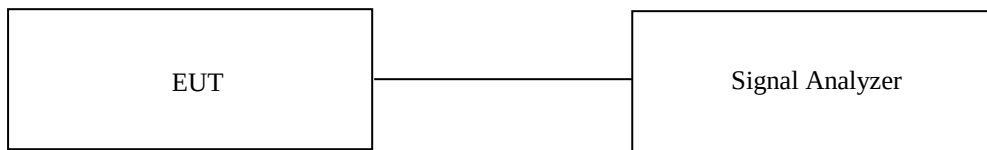
11.1 Operating environment

Temperature : 23 °C
Relative humidity : 45 % 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

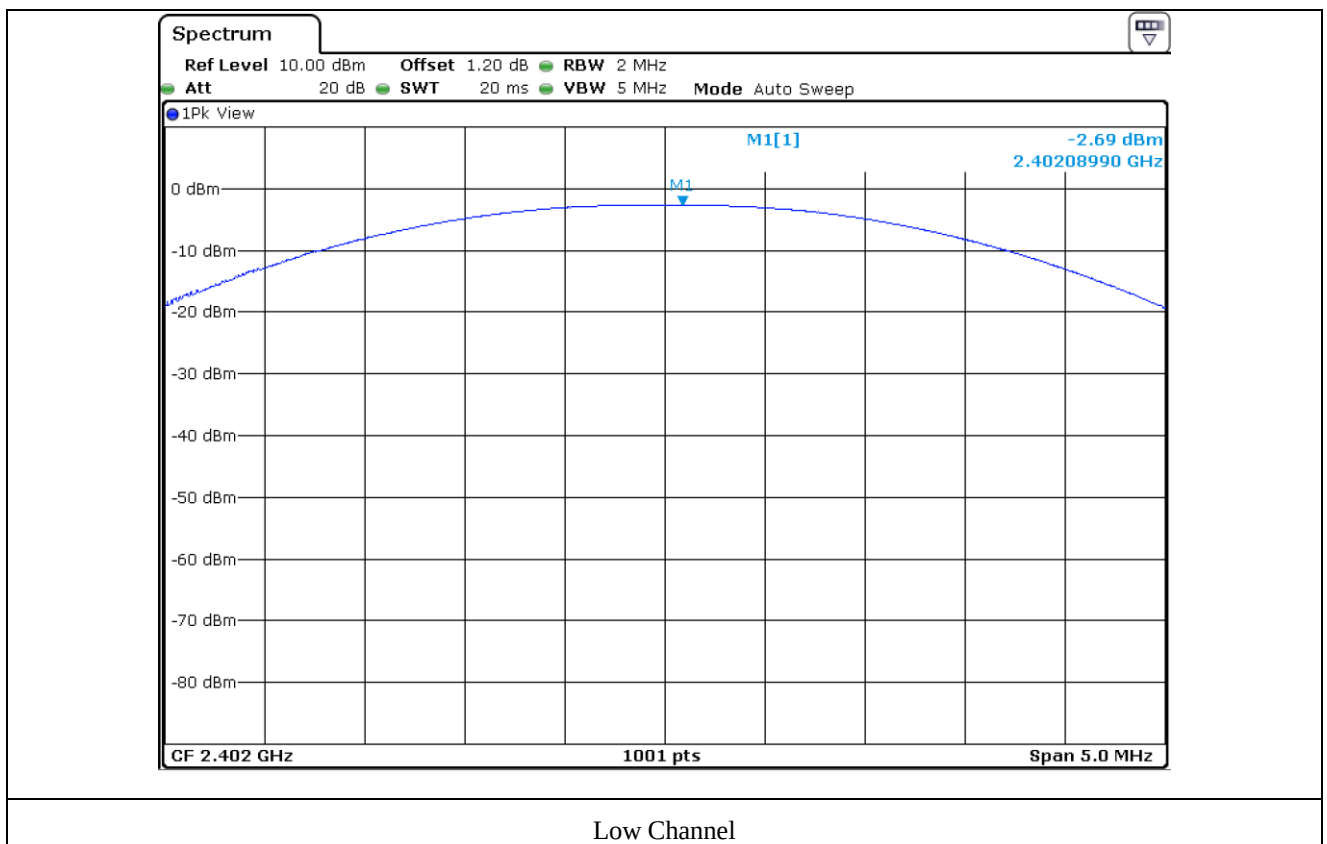
January 28, 2021 ~ February 04, 2021

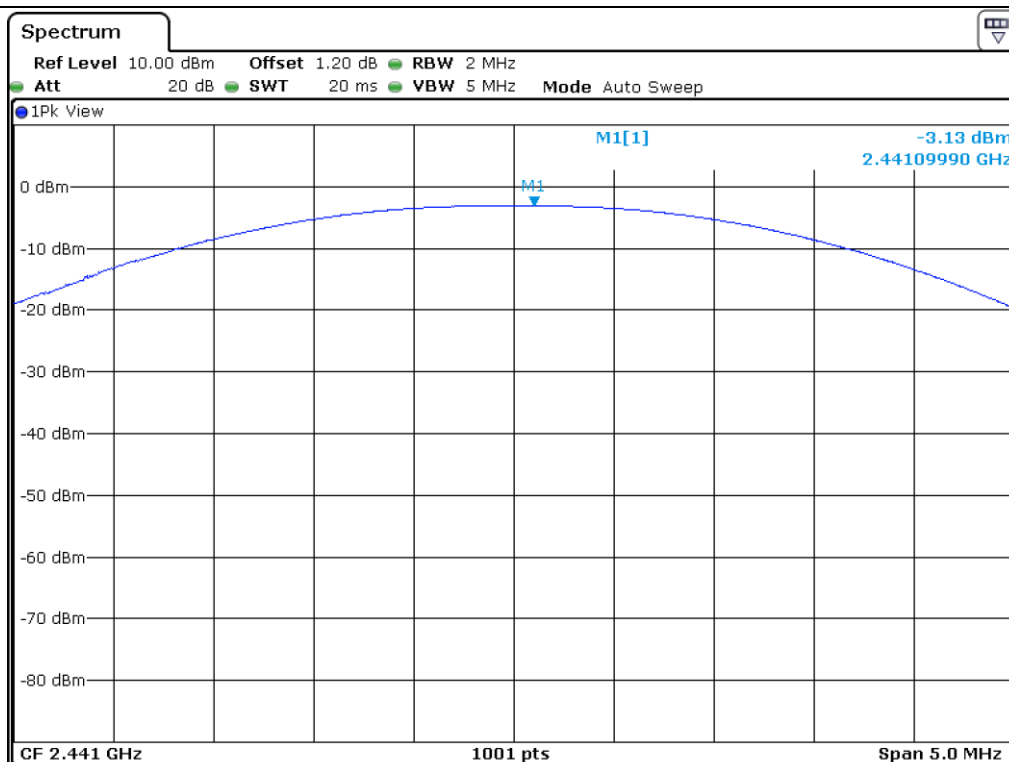
11.4 Test data for 1 Mbps

-. Test Result : Pass

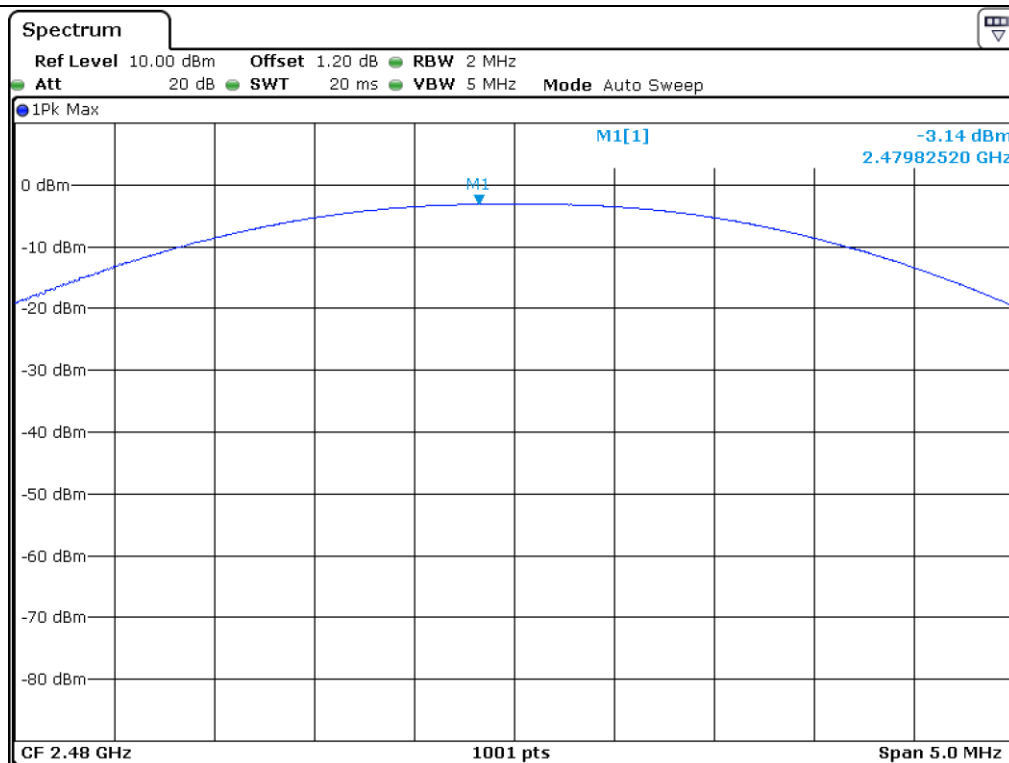
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-2.69	21.00	23.69
MIDDLE	2 441.00	-3.13	21.00	24.13
HIGH	2 480.00	-3.14	21.00	24.14

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





Middle Channel



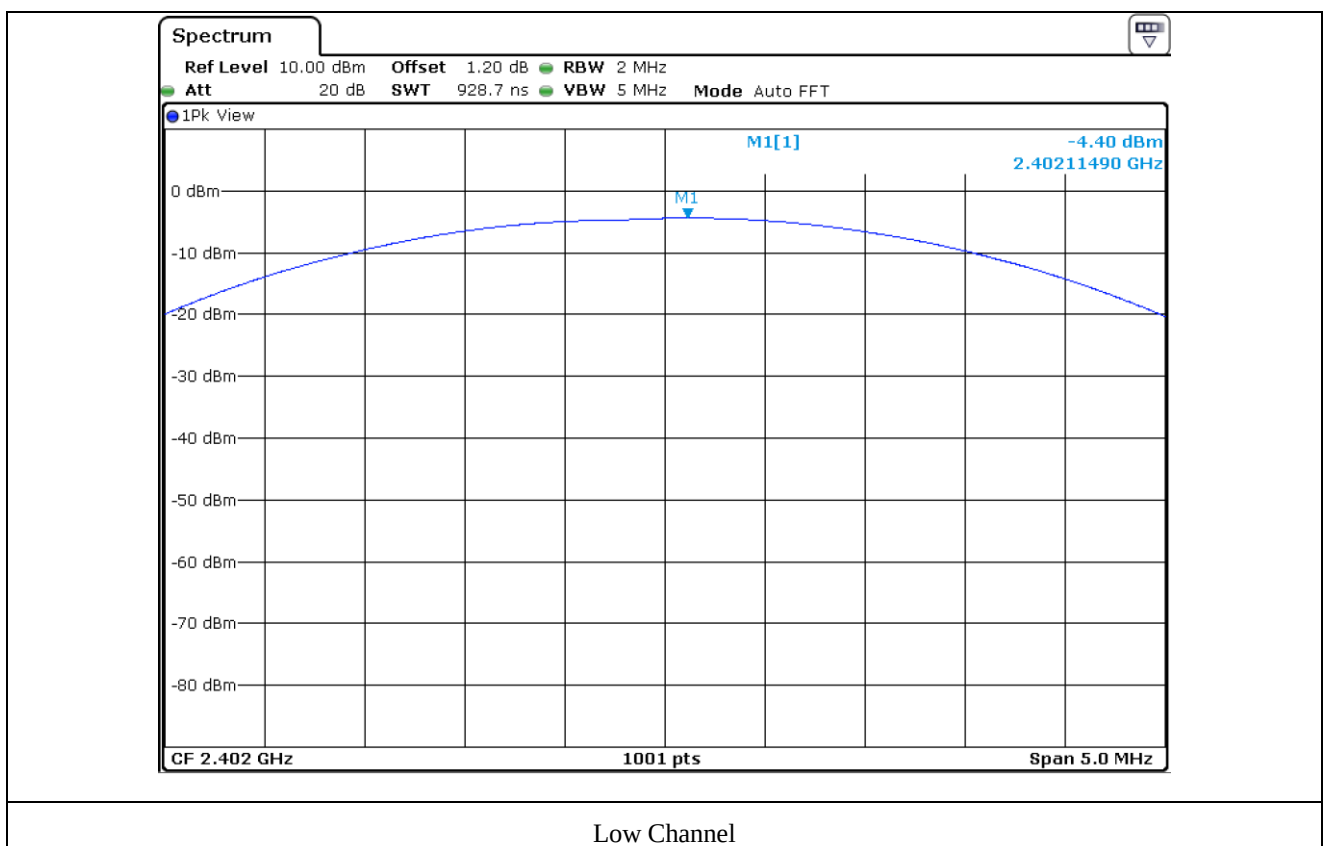
High Channel

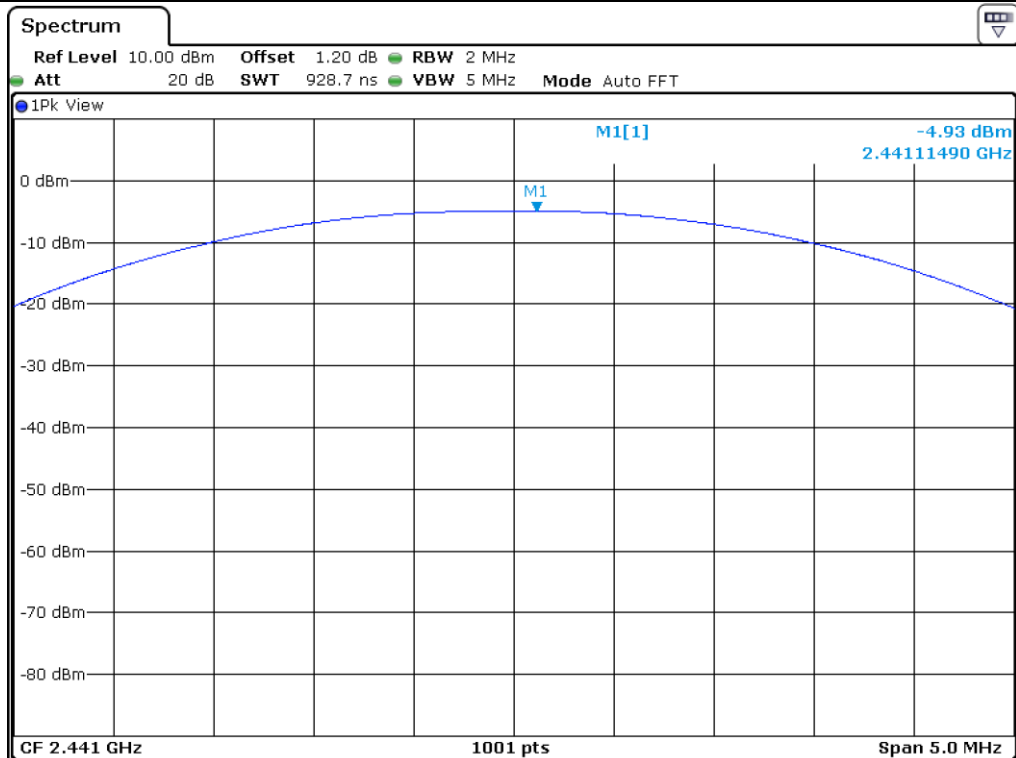
11.5 Test data for 2 Mbps

-. Test Result : Pass

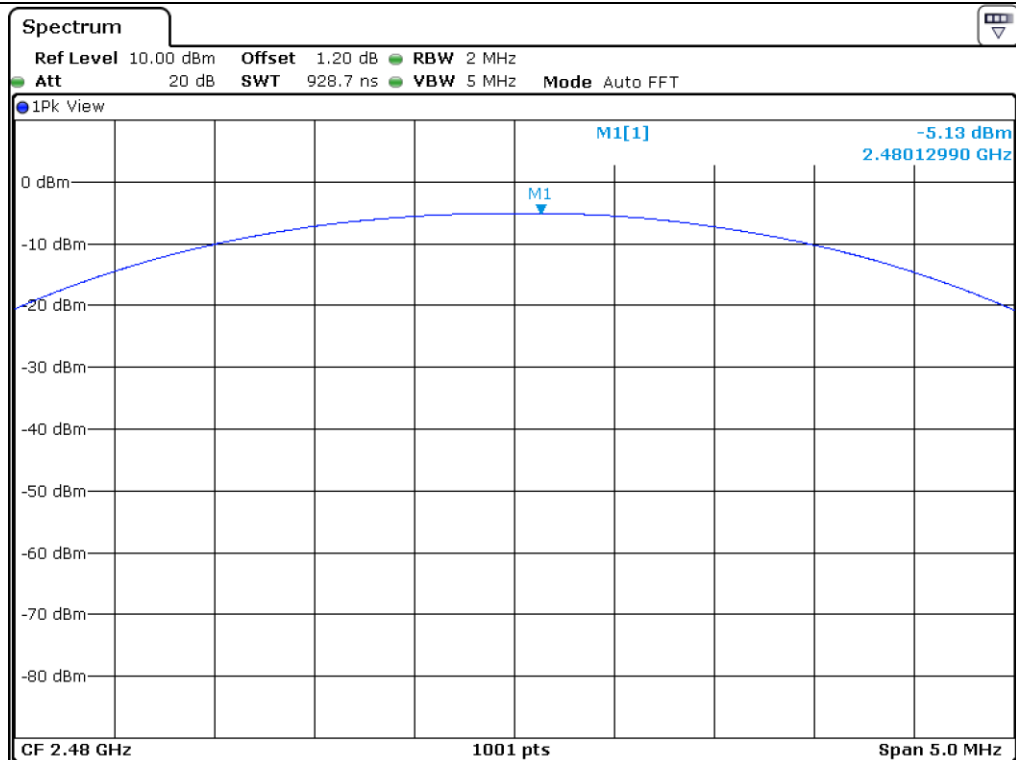
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-4.40	21.00	25.40
MIDDLE	2 441.00	-4.93	21.00	25.93
HIGH	2 480.00	-5.13	21.00	26.13

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





Middle Channel



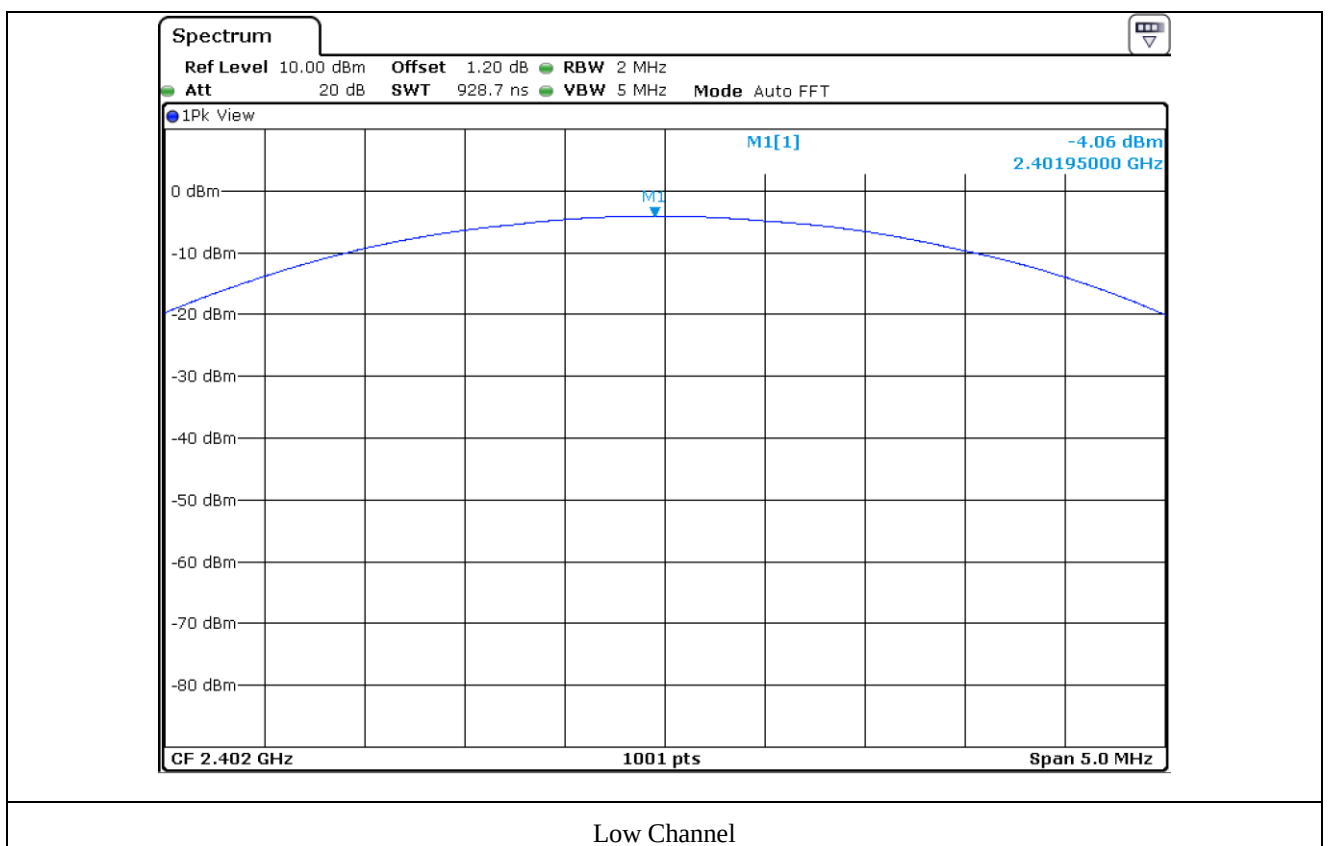
High Channel

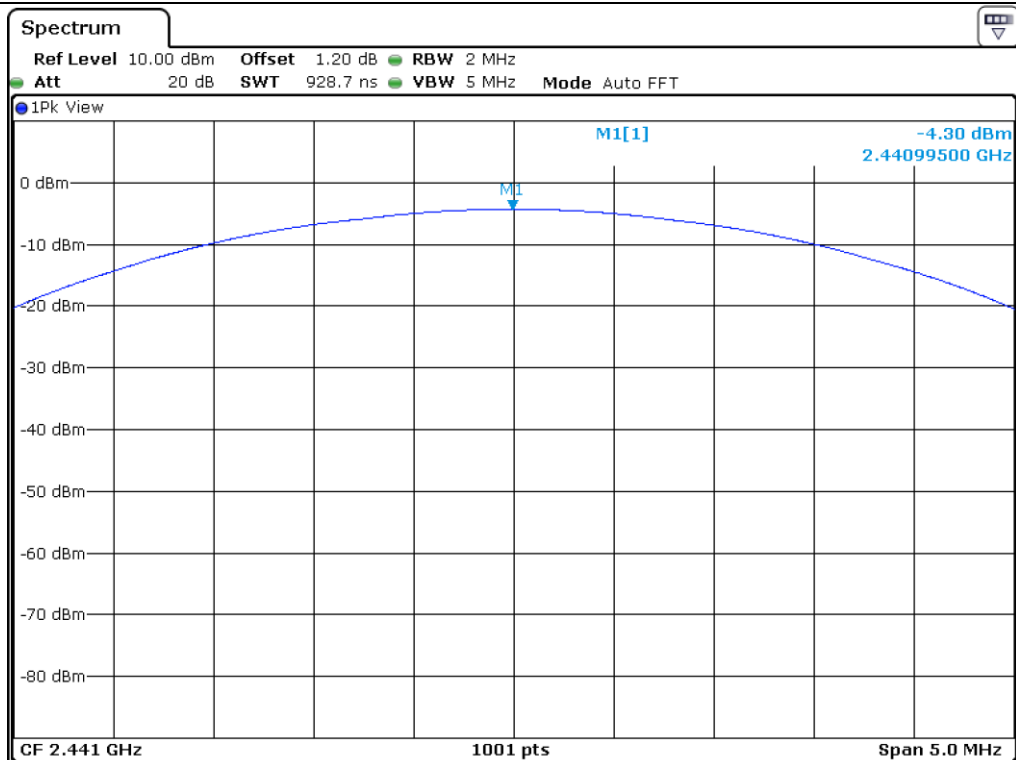
11.6 Test data for 3 Mbps

-. Test Result : Pass

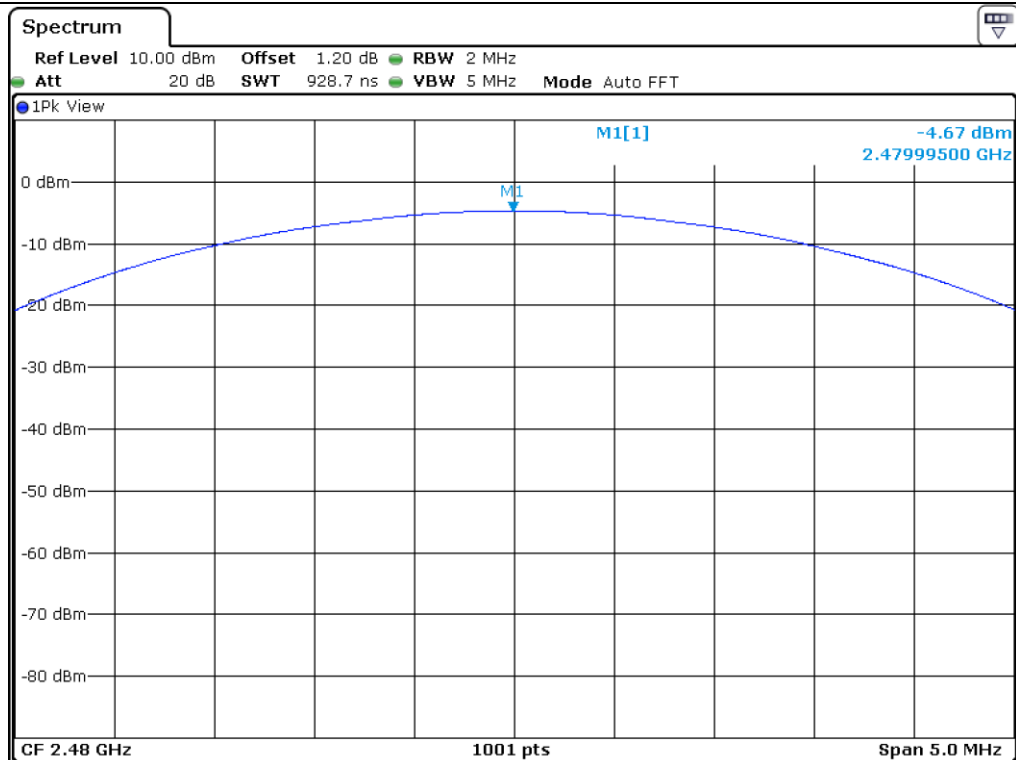
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-4.06	21.00	25.06
MIDDLE	2 441.00	-4.30	21.00	25.30
HIGH	2 480.00	-4.67	21.00	25.67

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





Middle Channel



High Channel

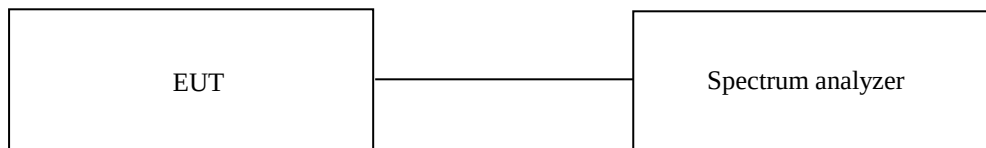
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 23 °C
Relative humidity : 45 % 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.



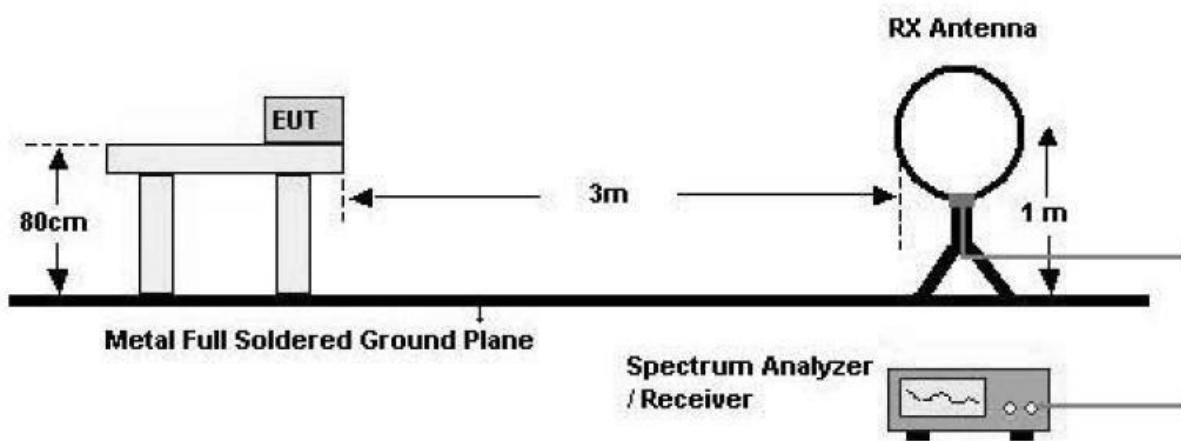
12.3 Test set-up for radiated measurement

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.

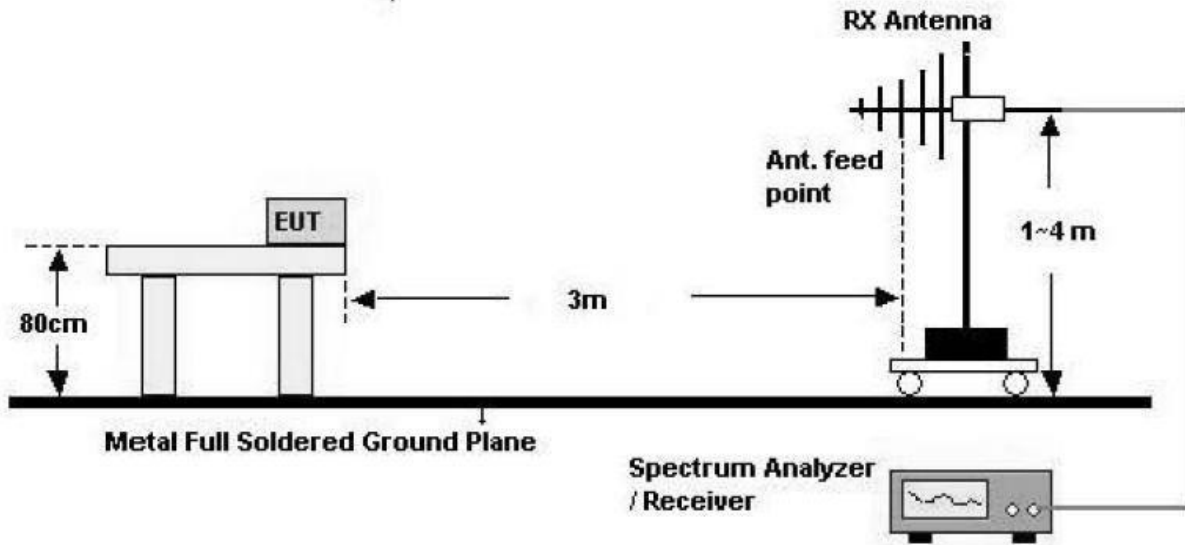
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal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

- Test Configuration

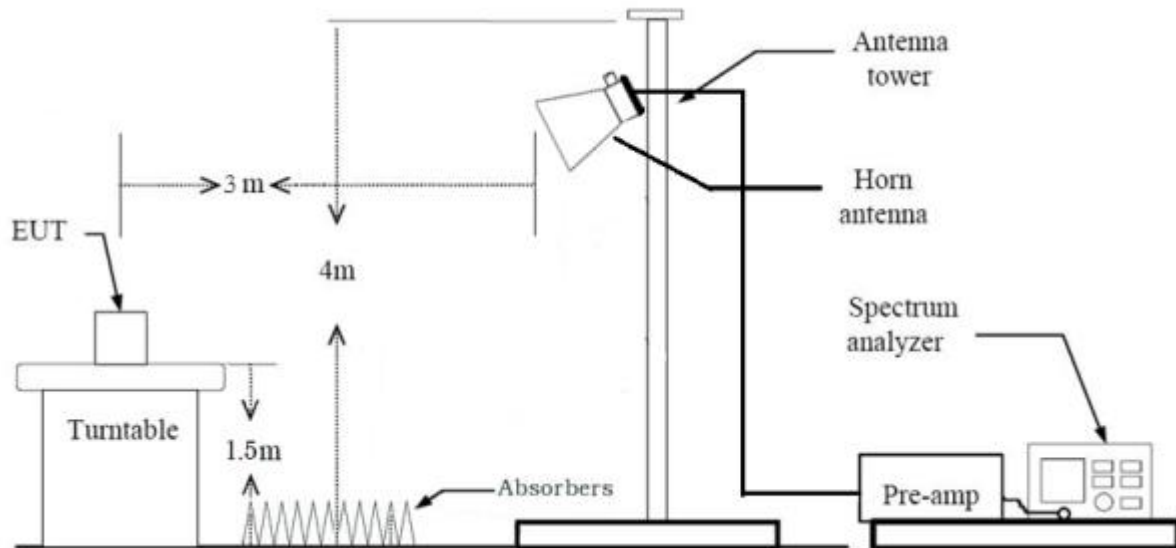
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz

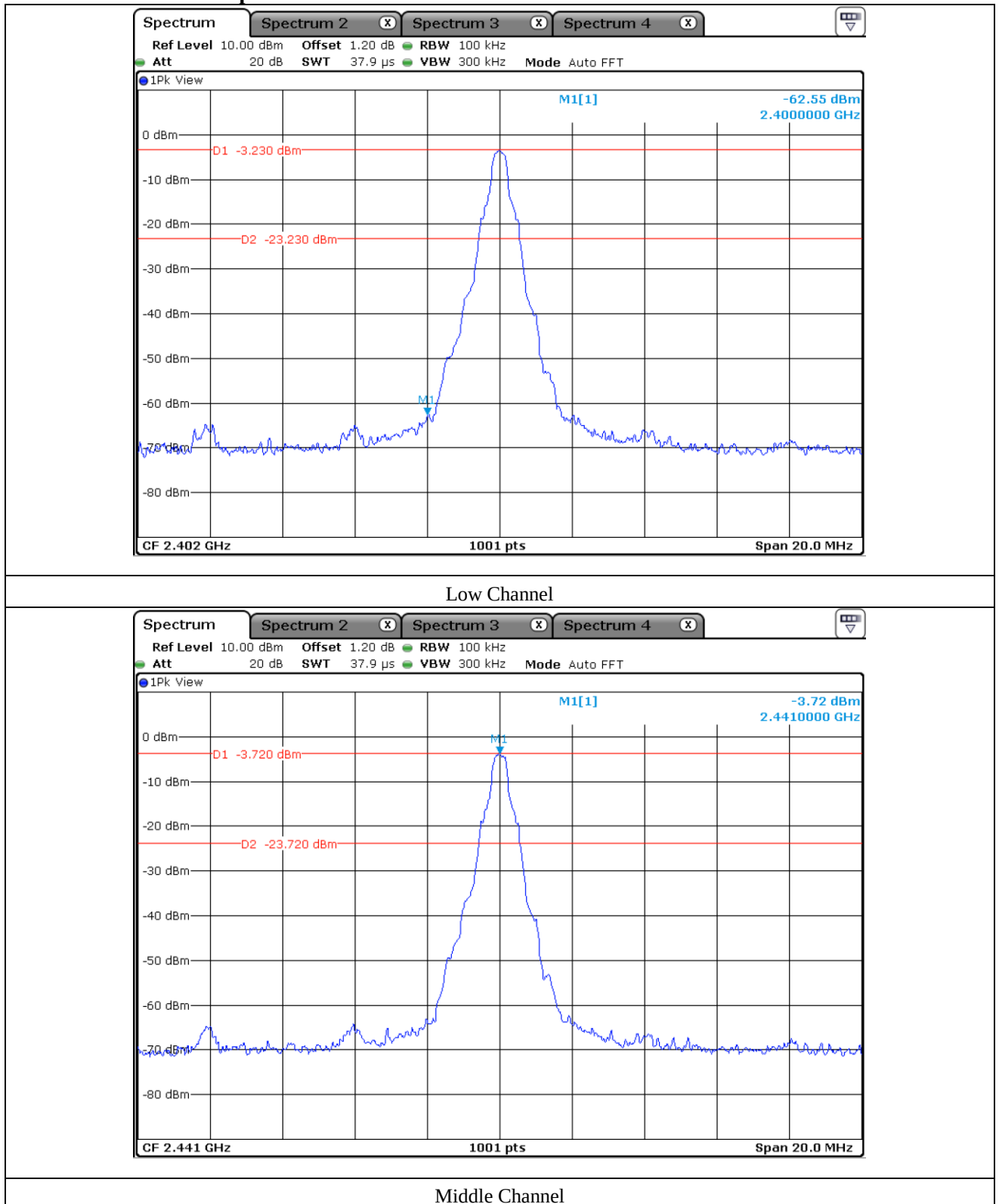


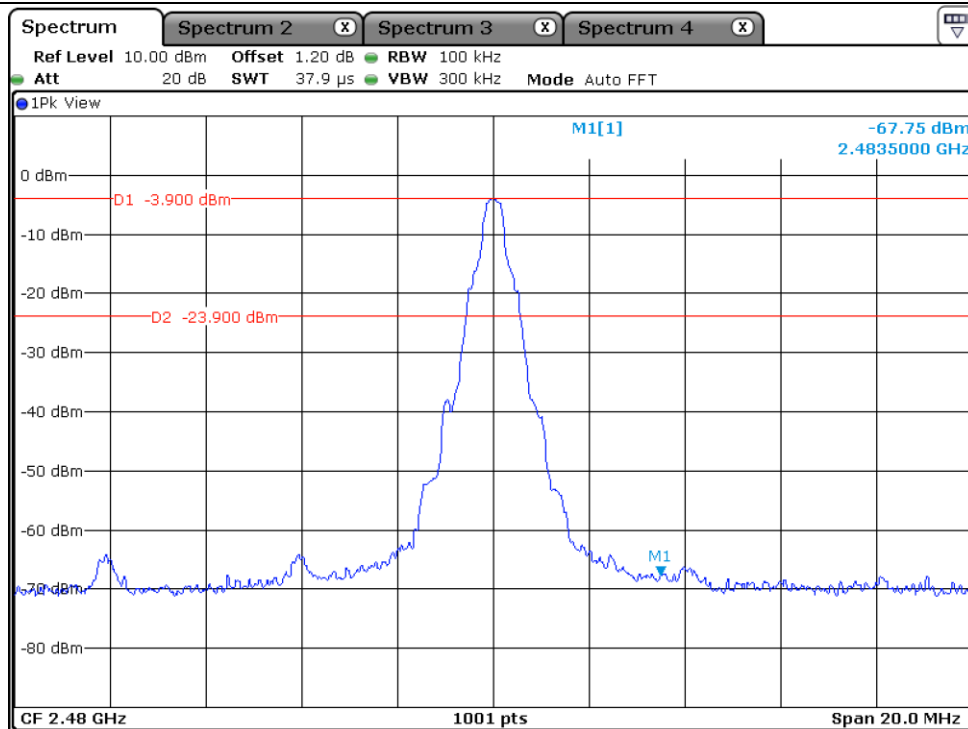
12.4 Test Date

January 28, 2021 ~ February 04, 2021

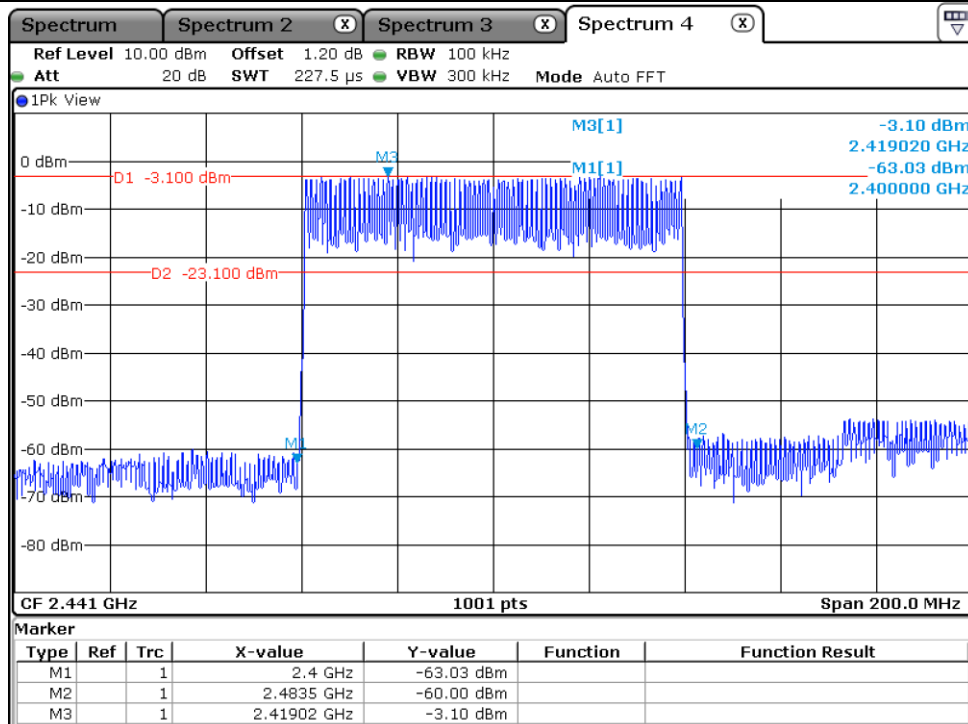
12.5 Test data for conducted emission

12.5.1 Test data for 1 Mbps

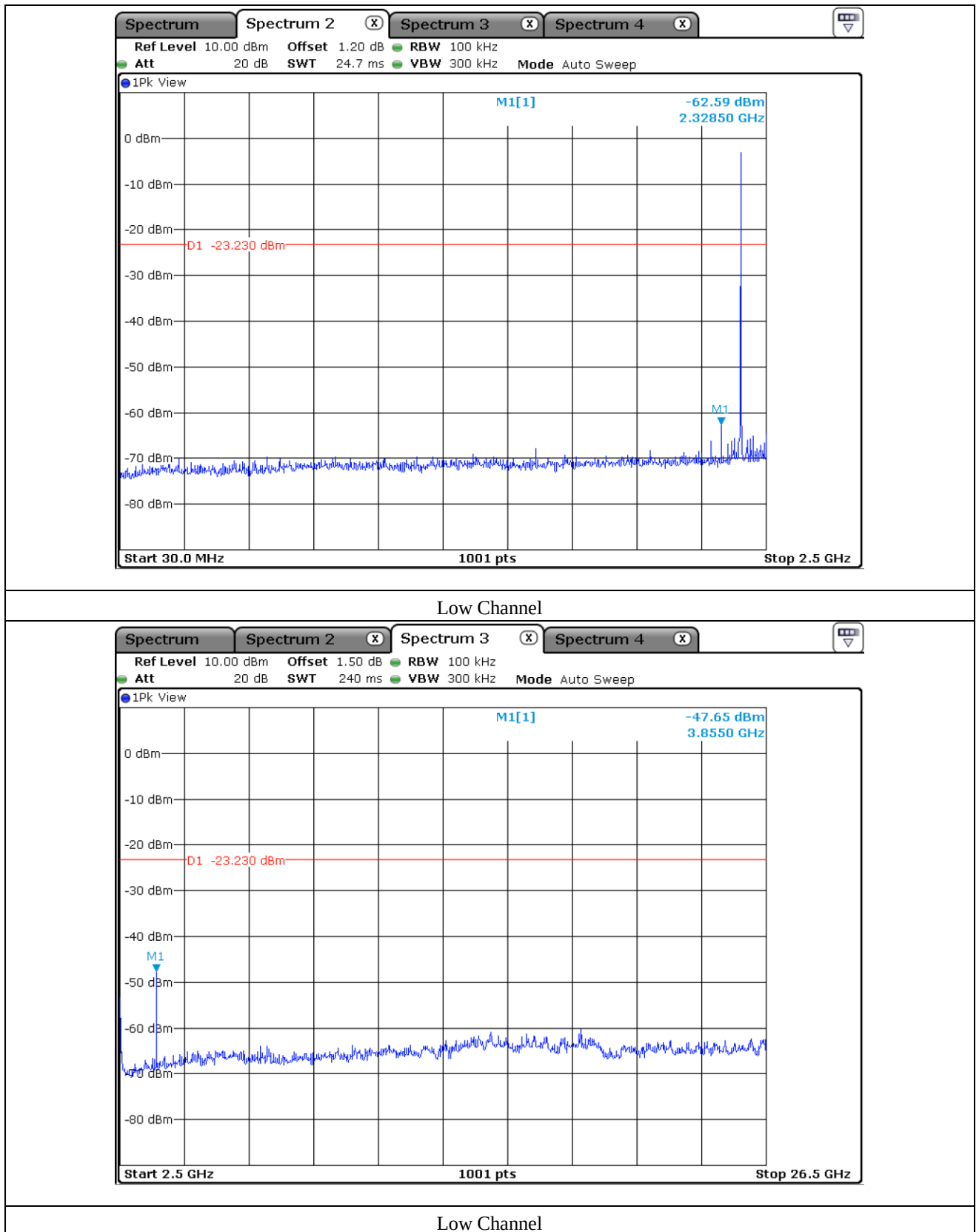


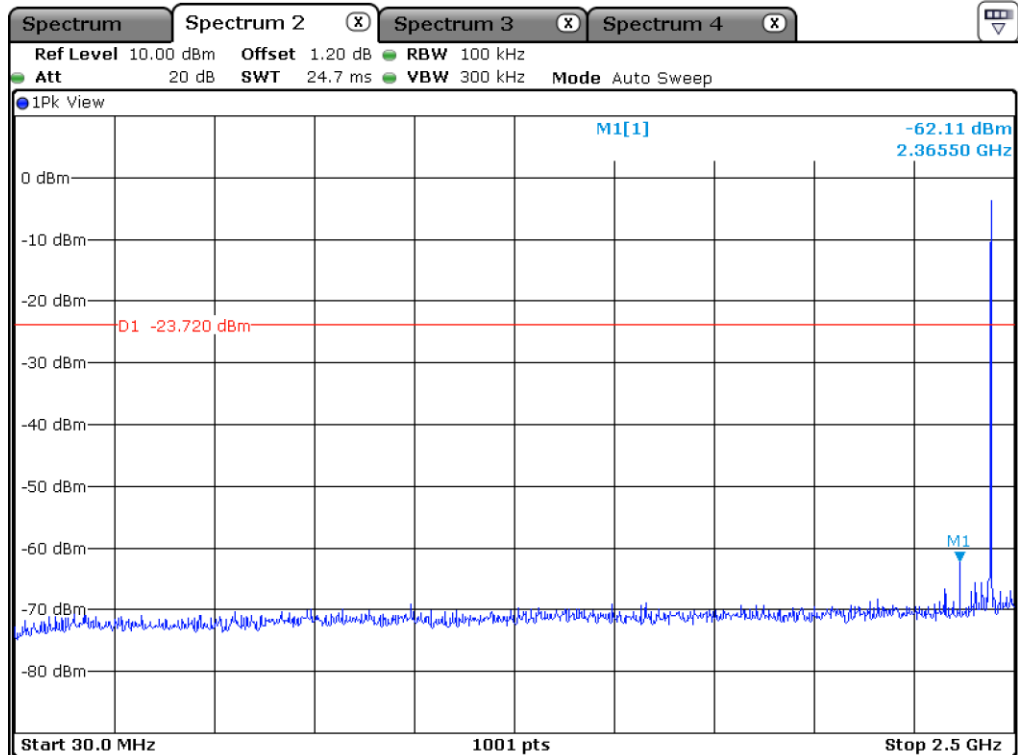


High Channel

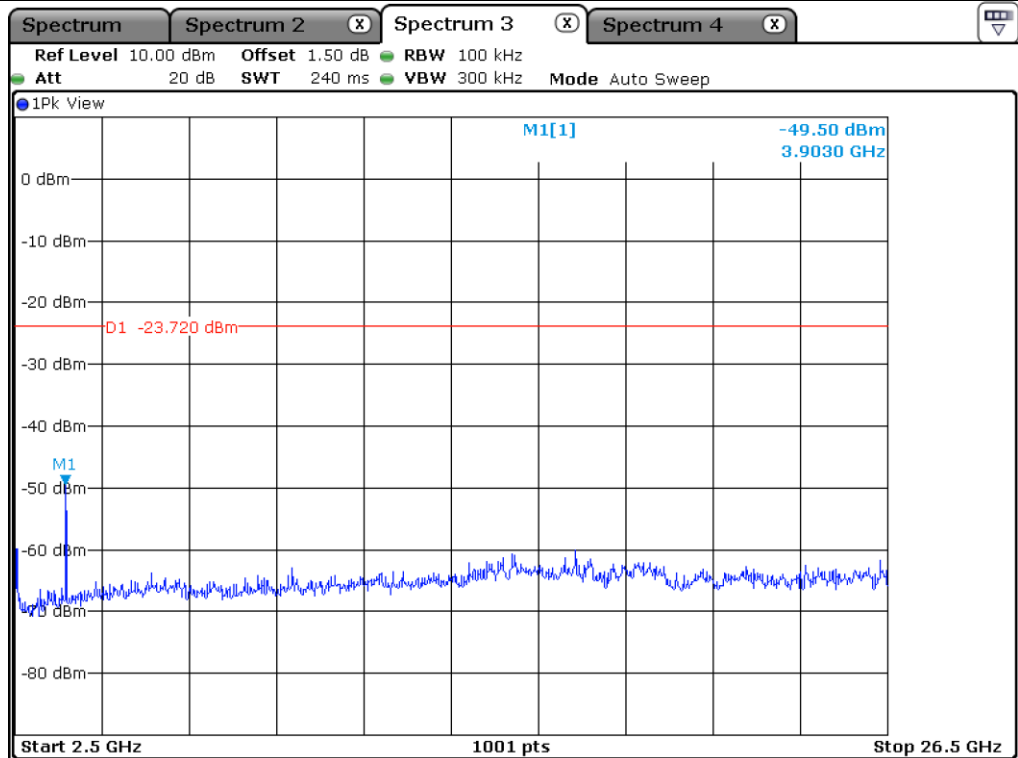


Hopping Mode

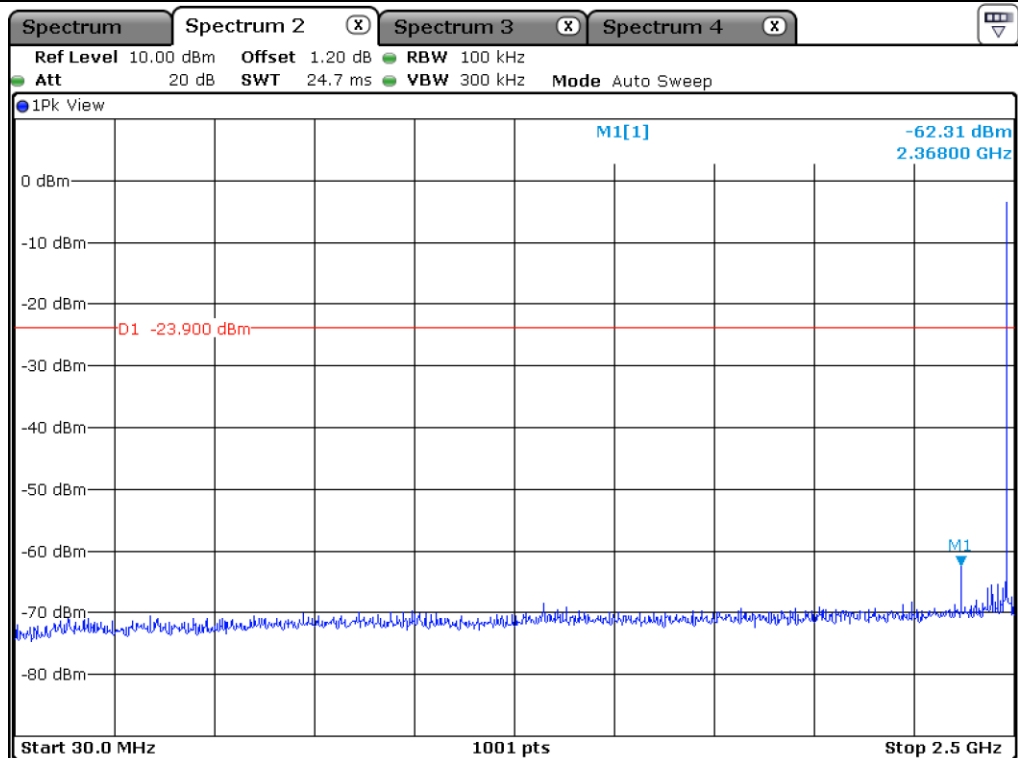




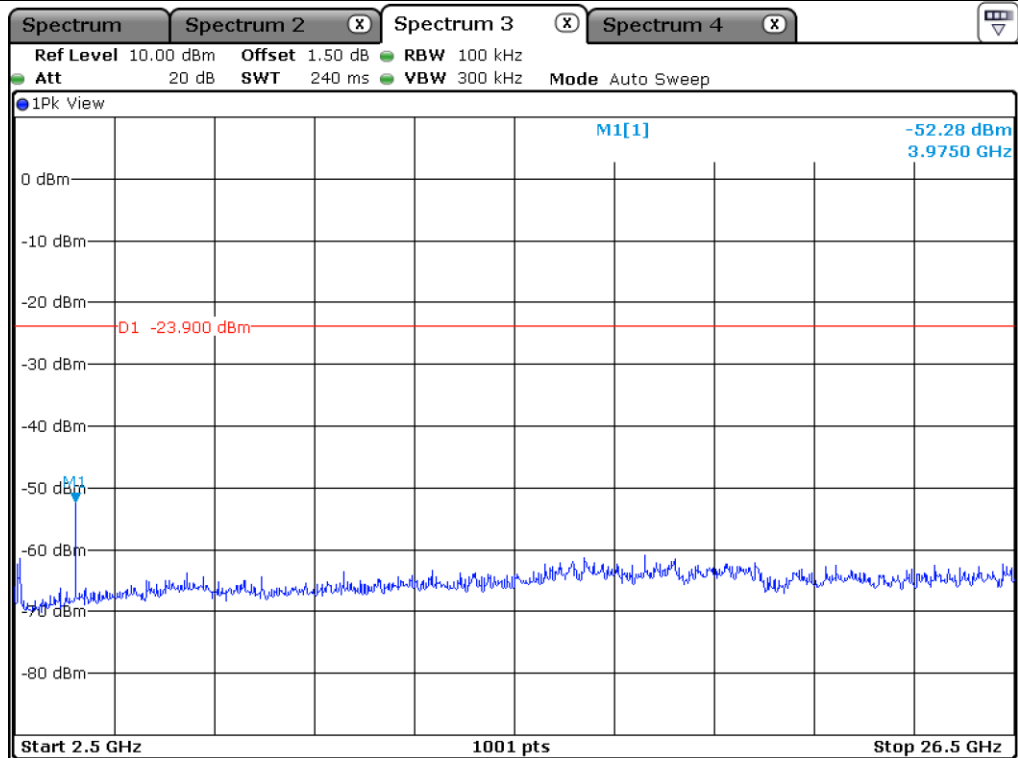
Middle Channel



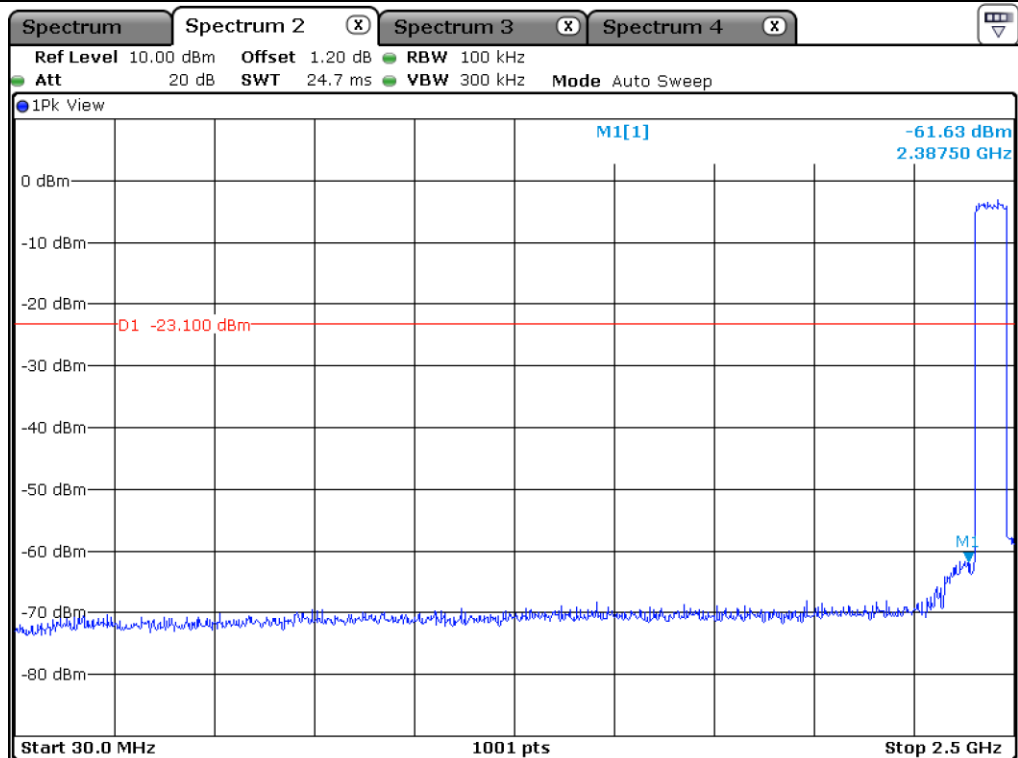
Middle Channel



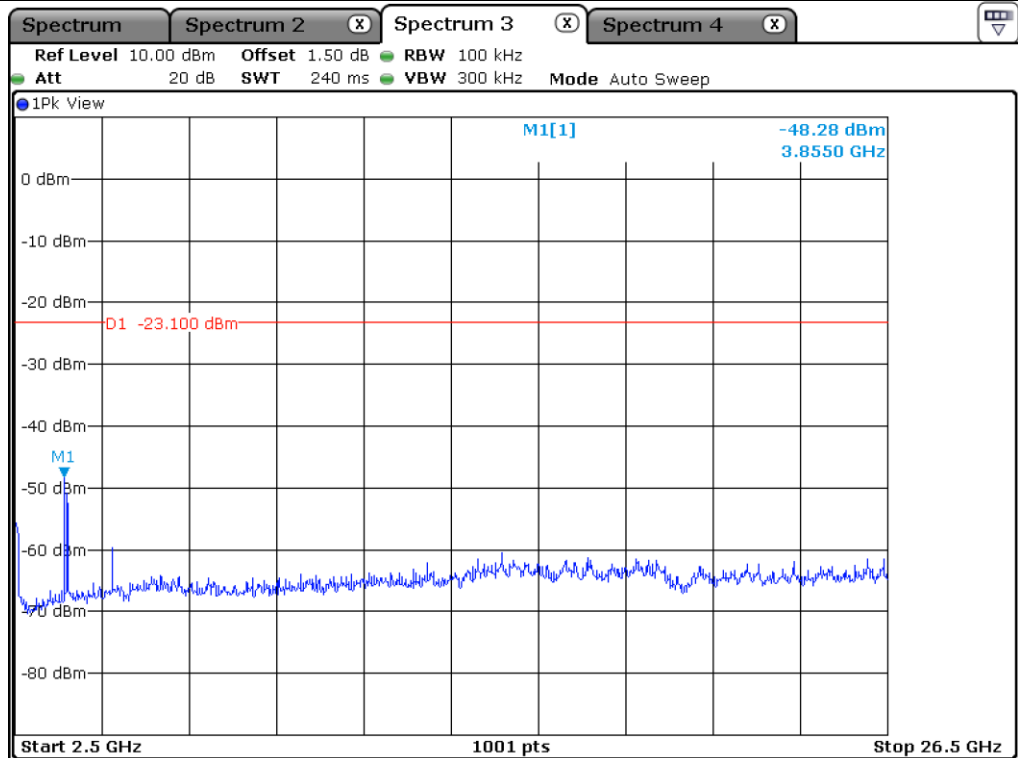
High Channel



High Channel

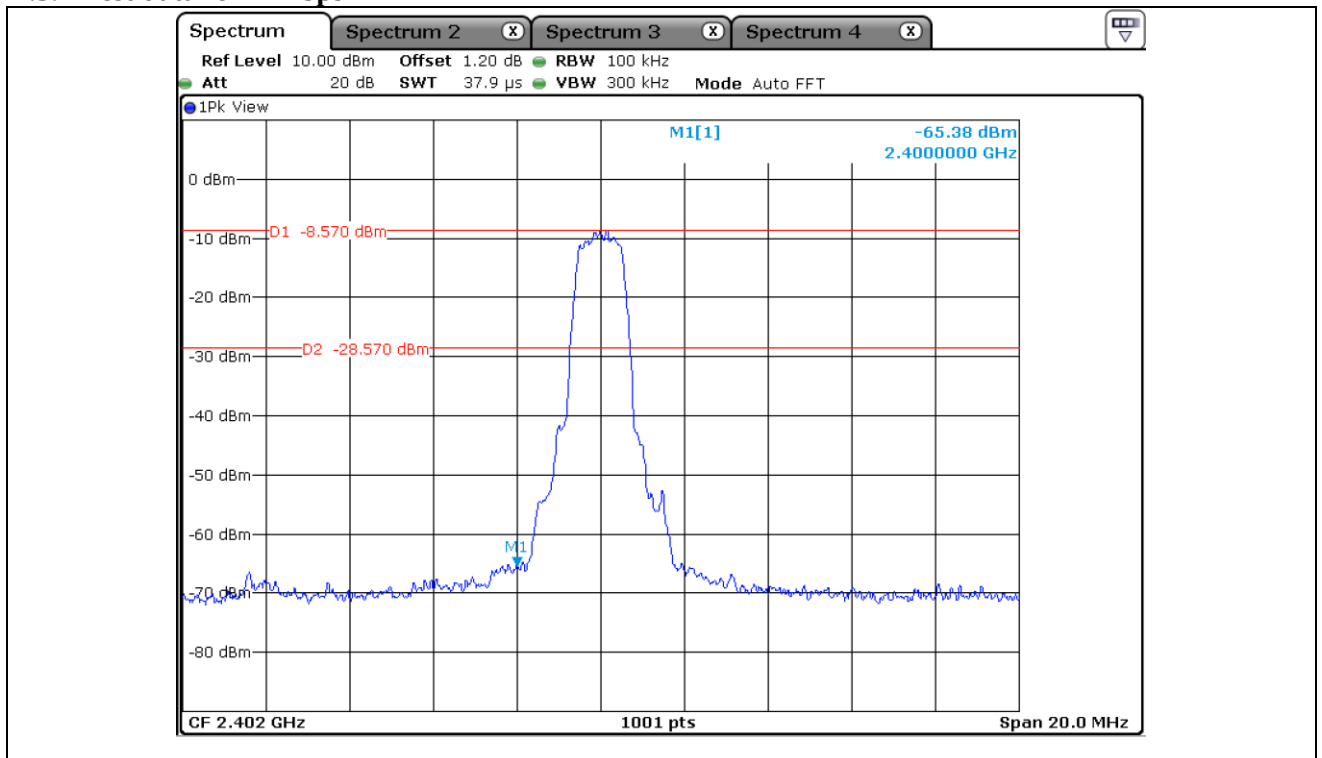


Hopping Mode

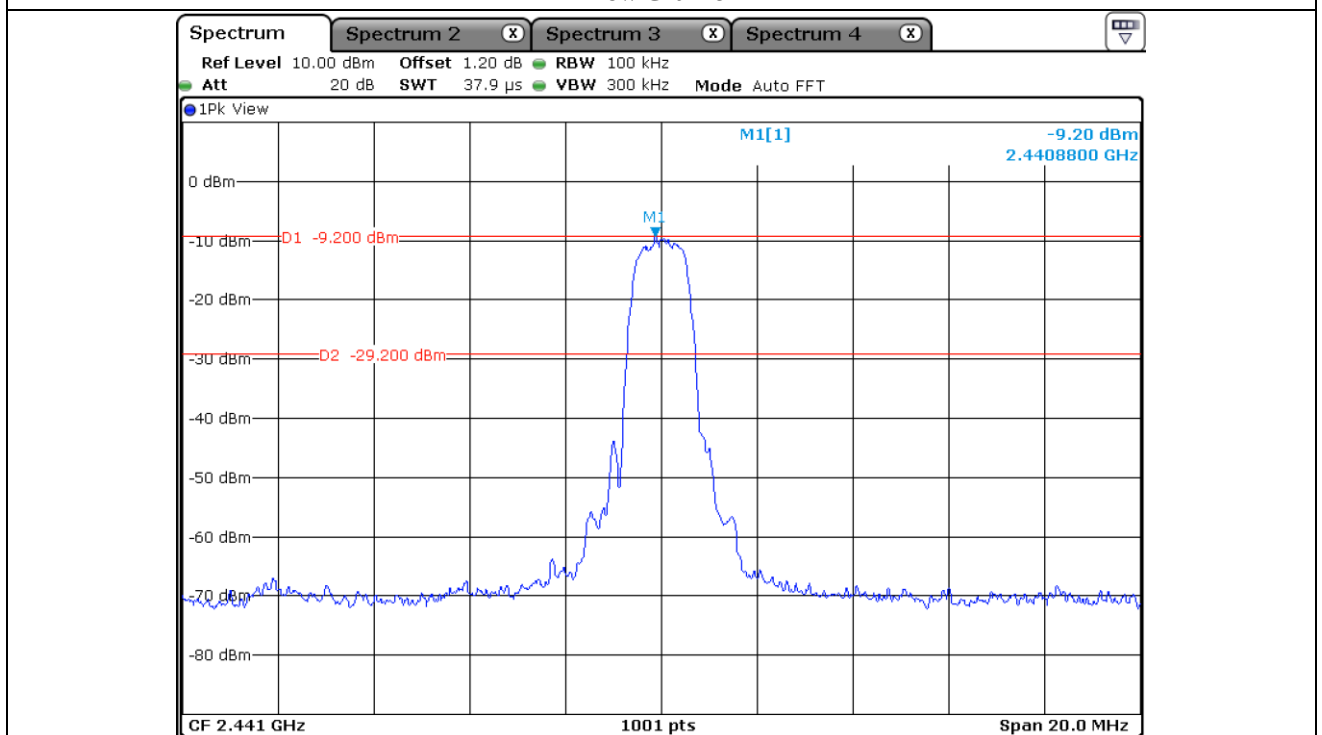


Hopping Mode

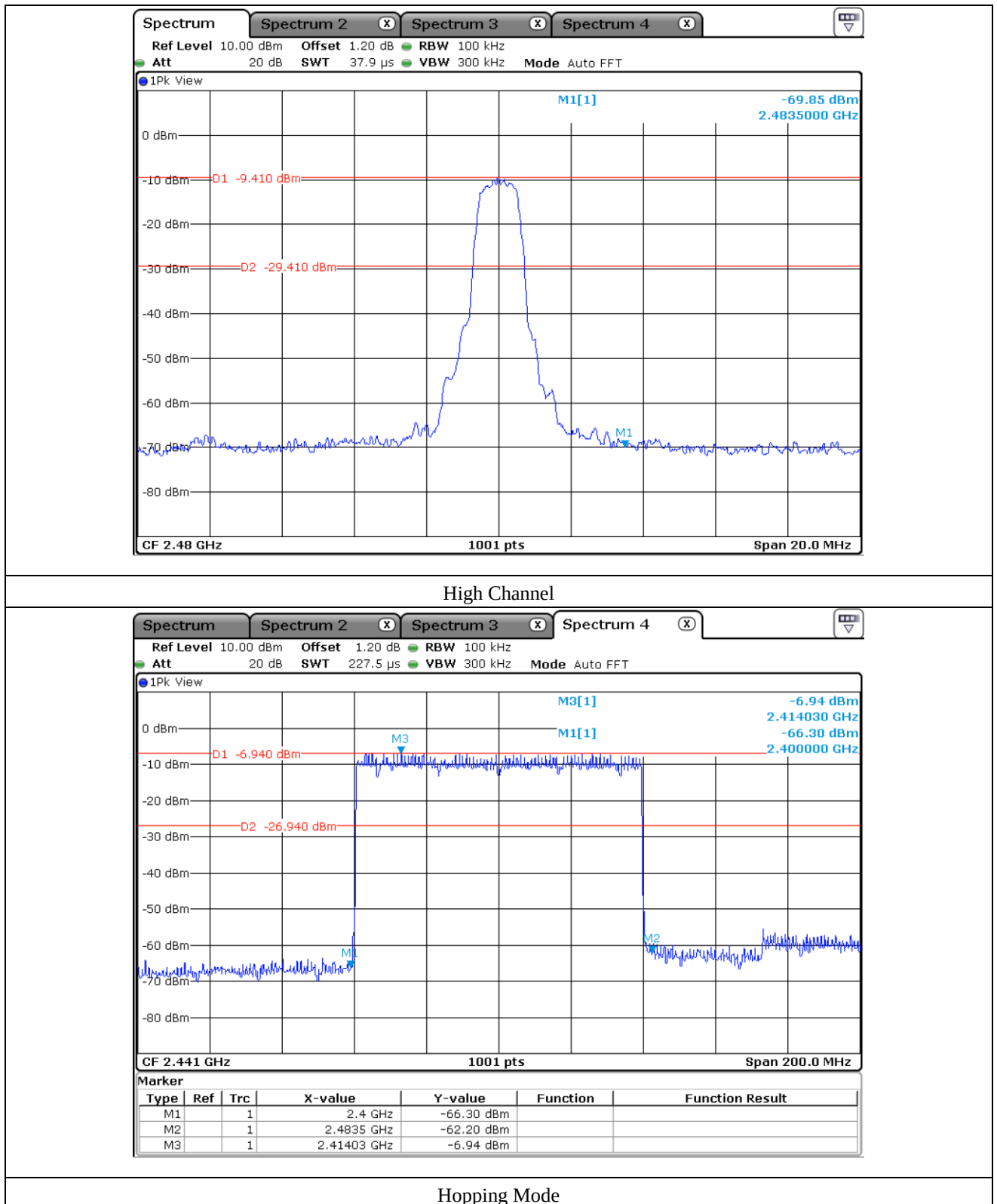
12.5.2 Test data for 2 Mbps

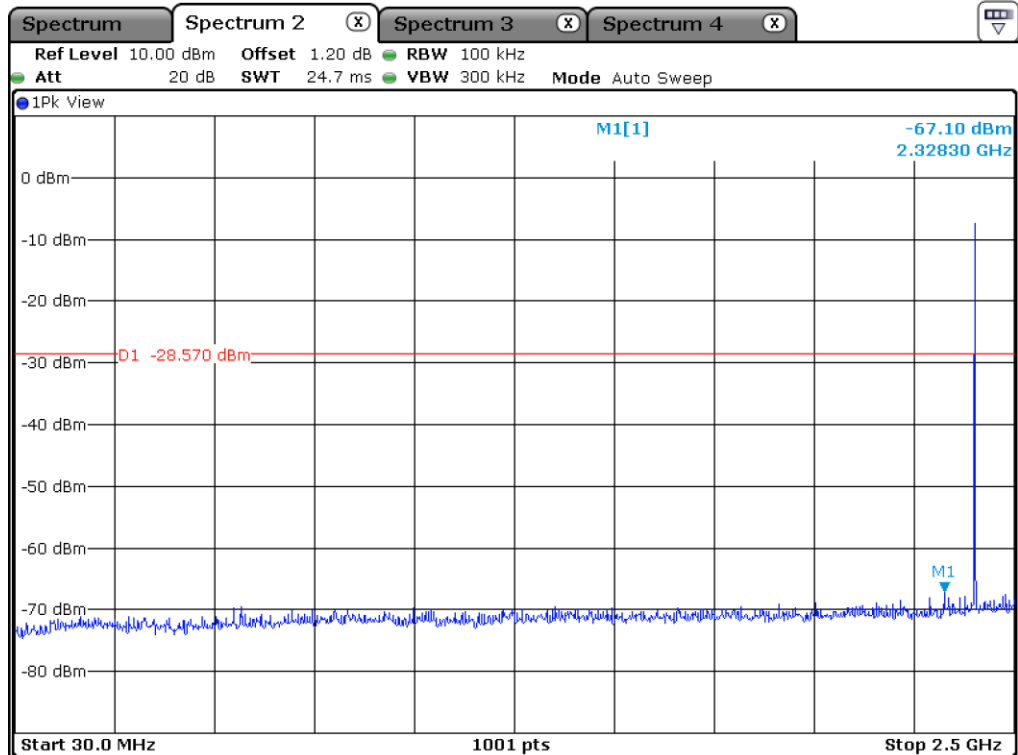


Low Channel

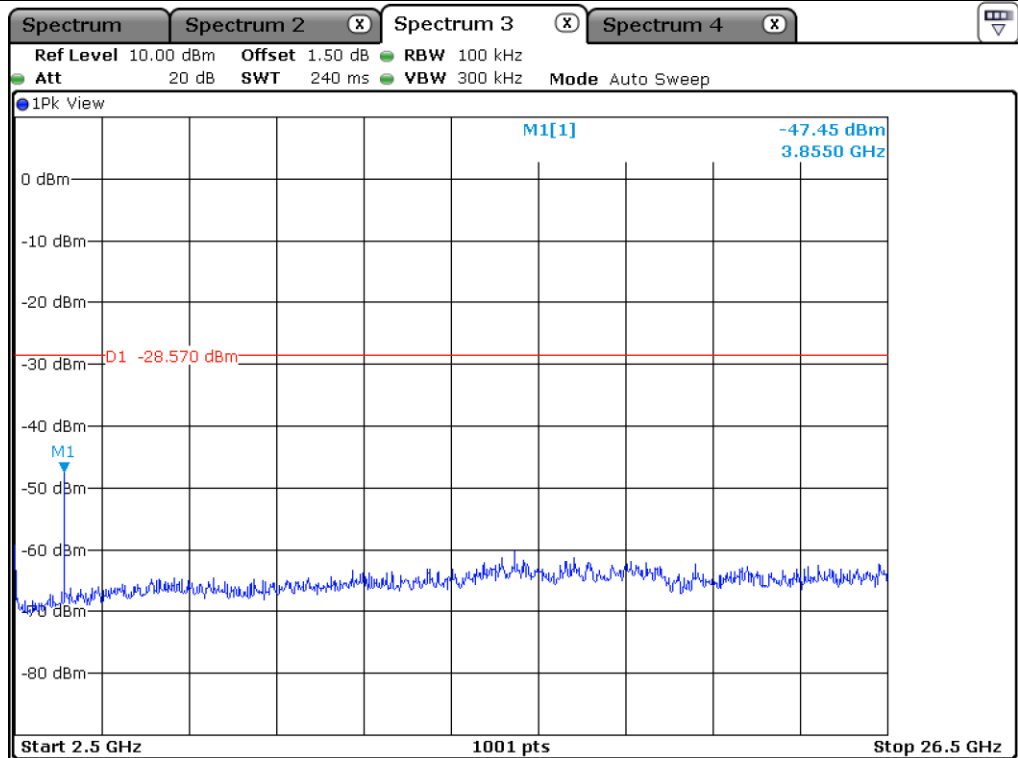


Middle Channel

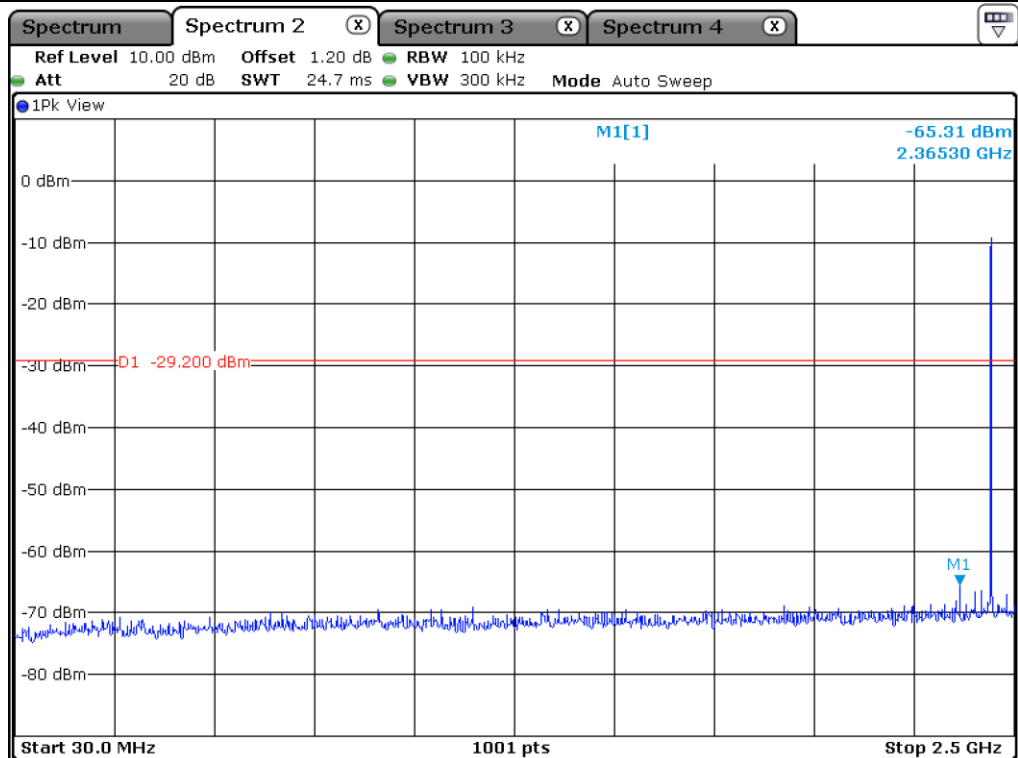




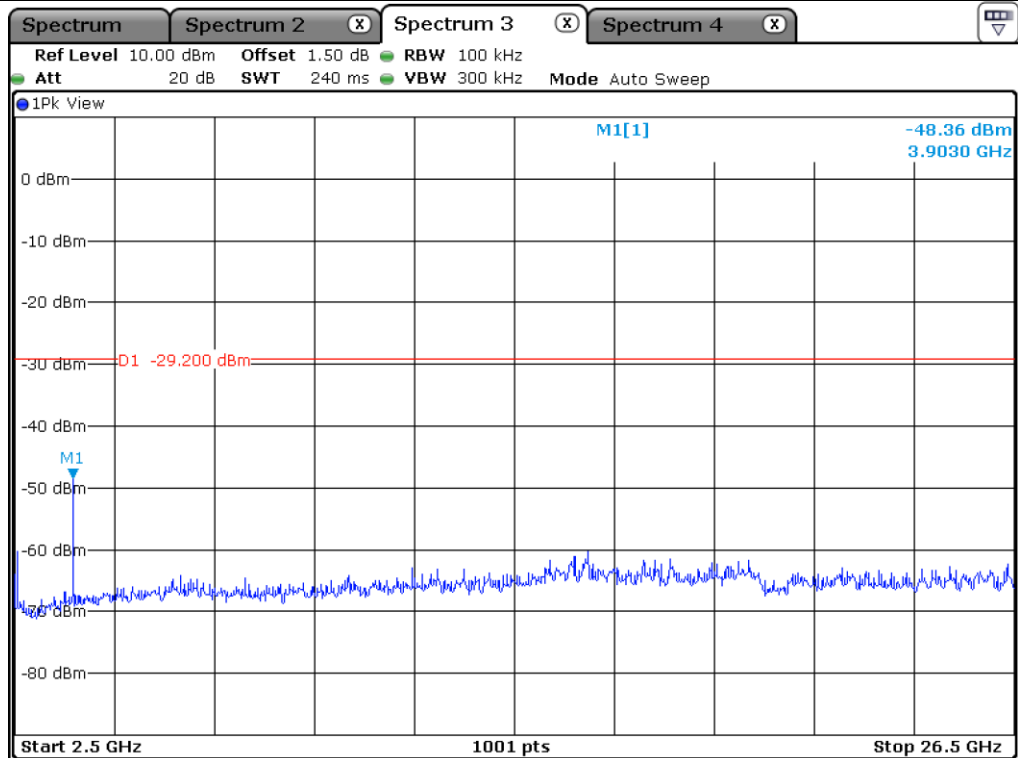
Low Channel



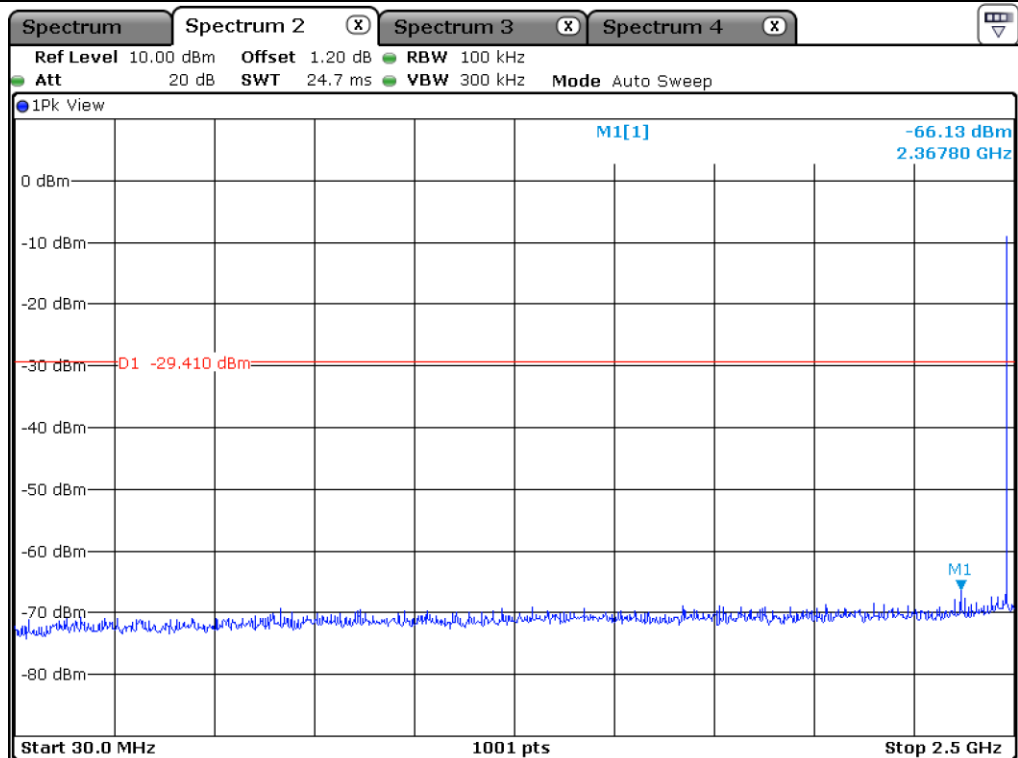
Low Channel



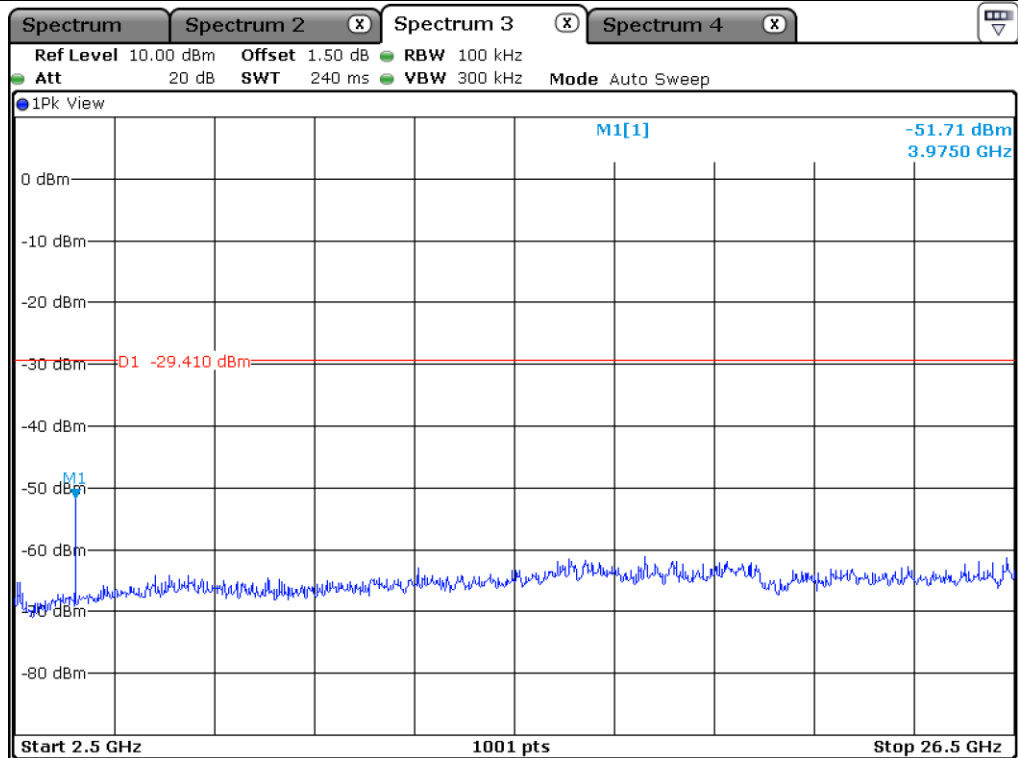
Middle Channel



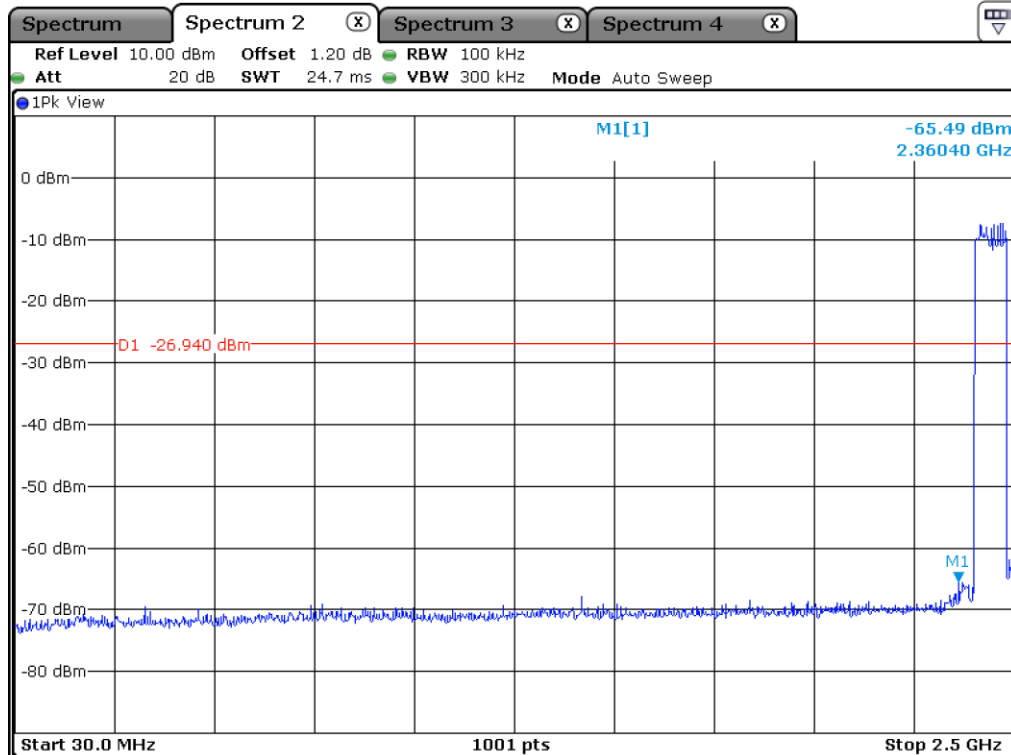
Middle Channel



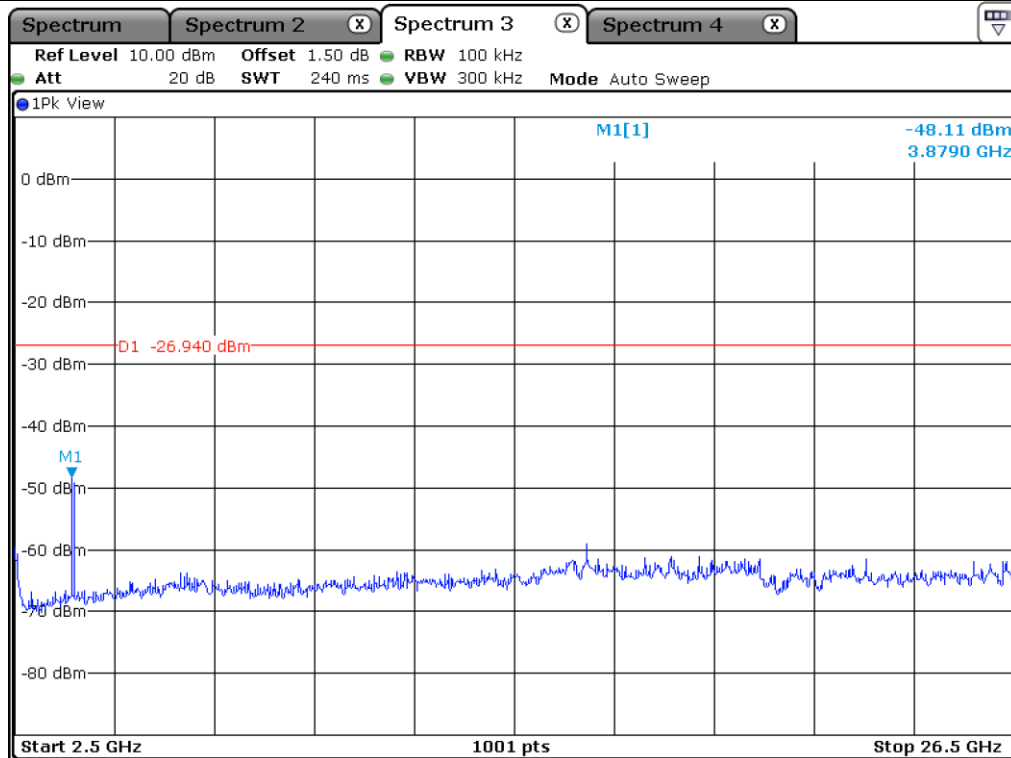
High Channel



High Channel

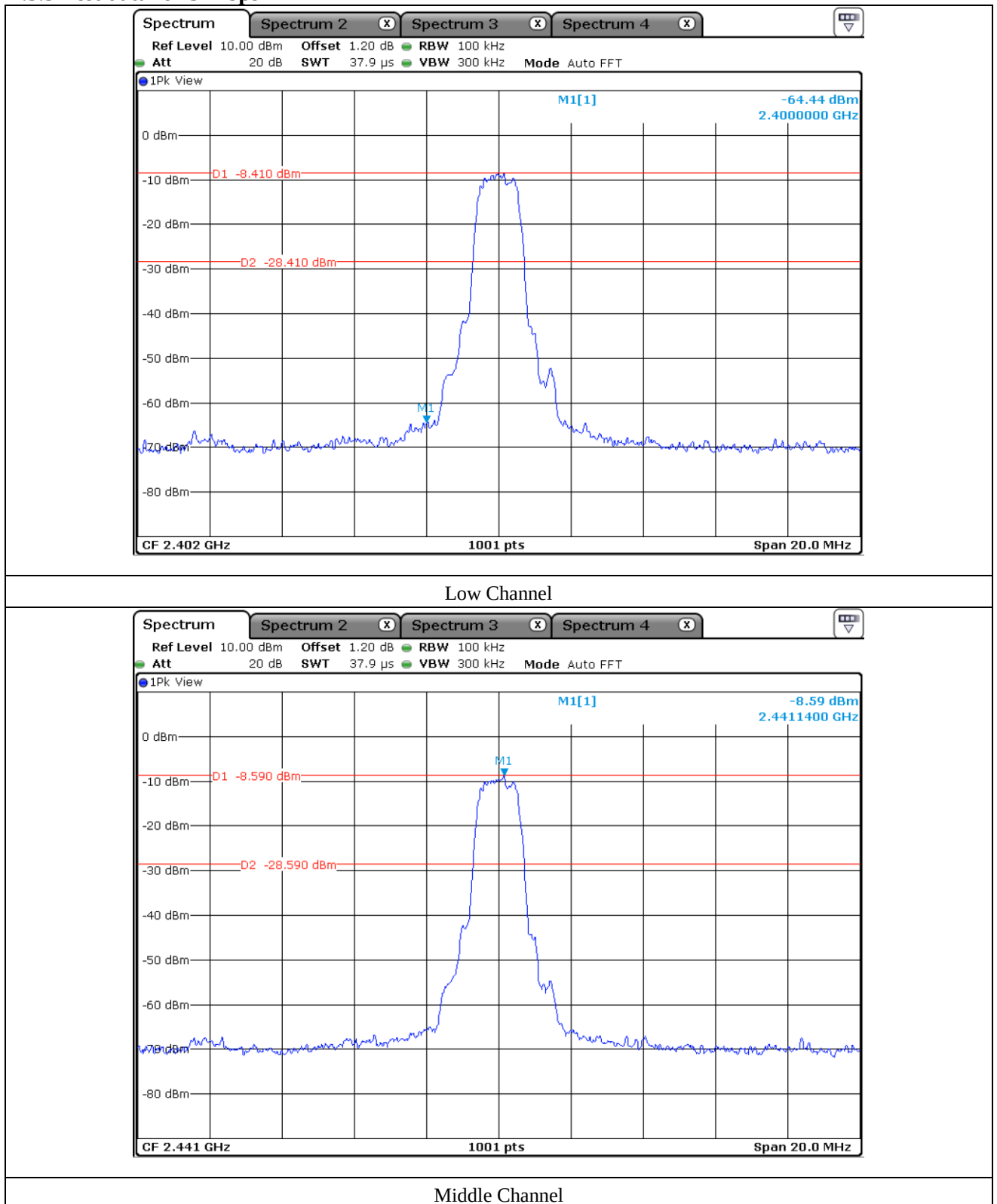


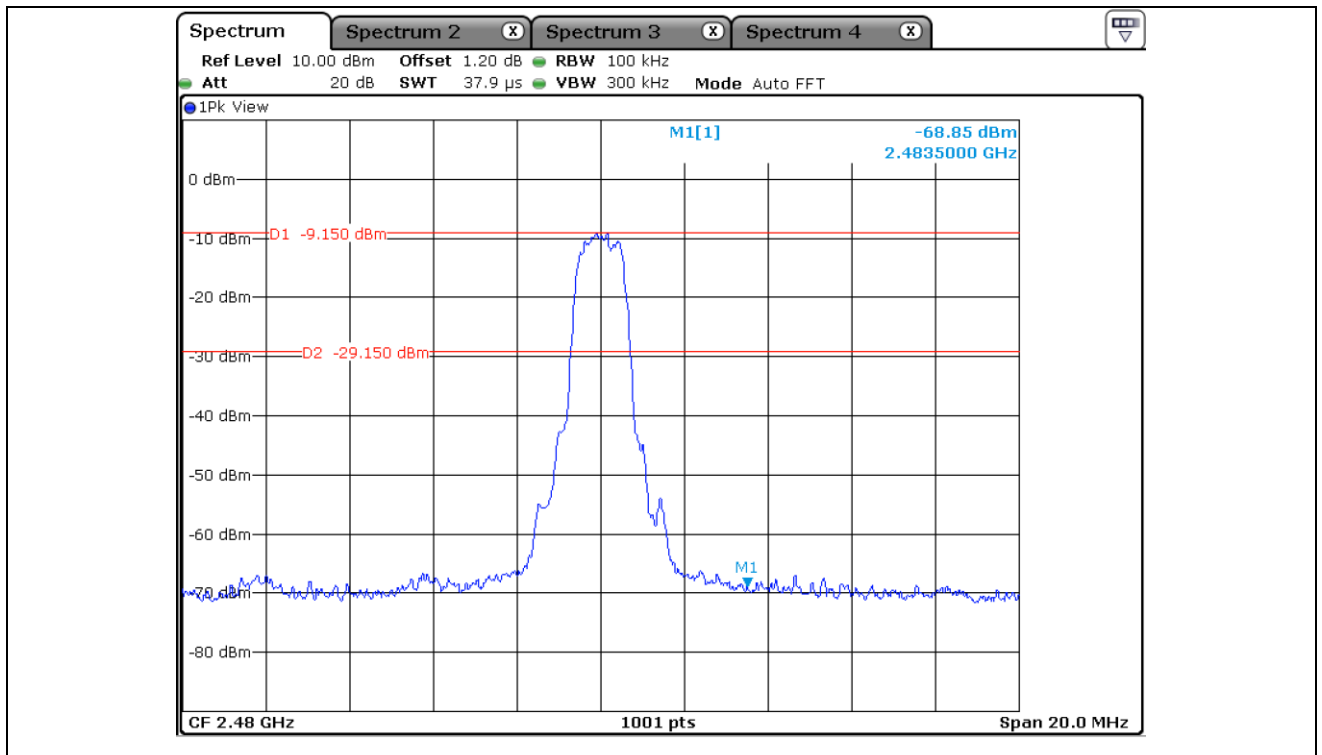
Hopping Mode



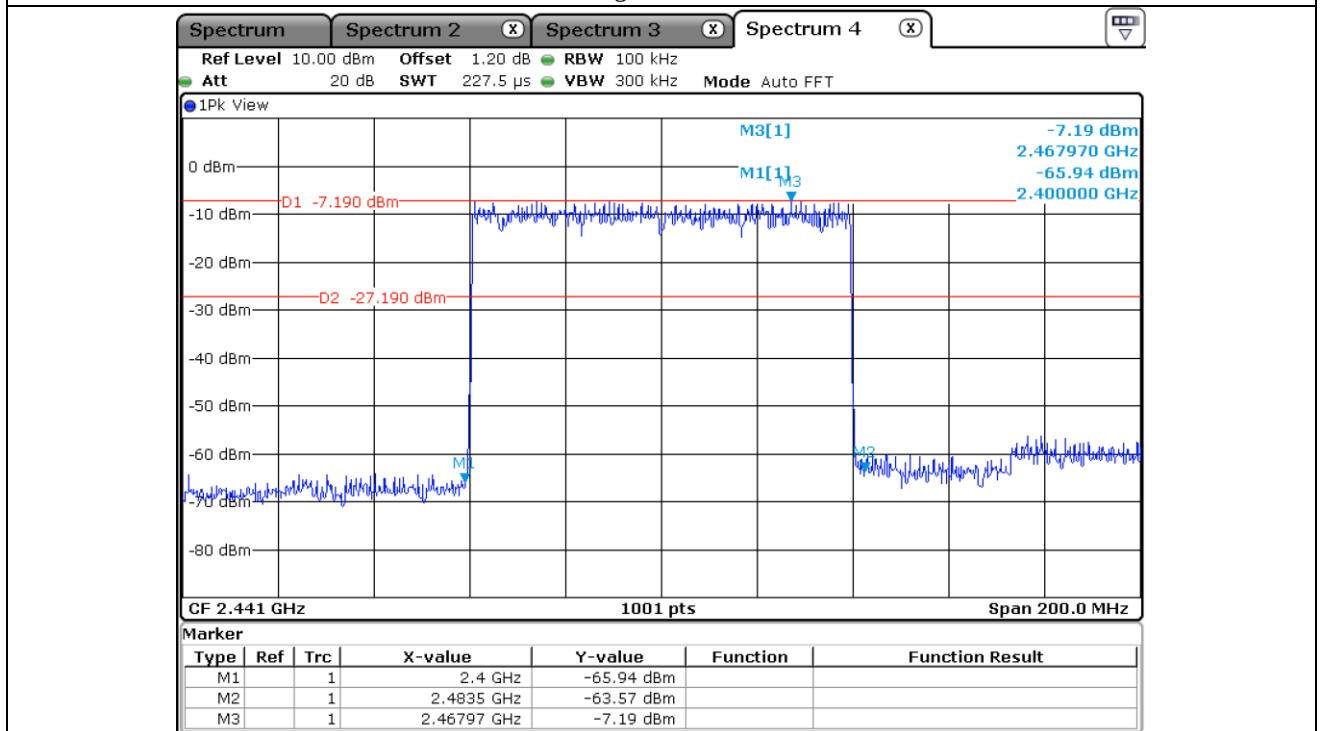
Hopping Mode

12.5.3 Test data for 3 Mbps

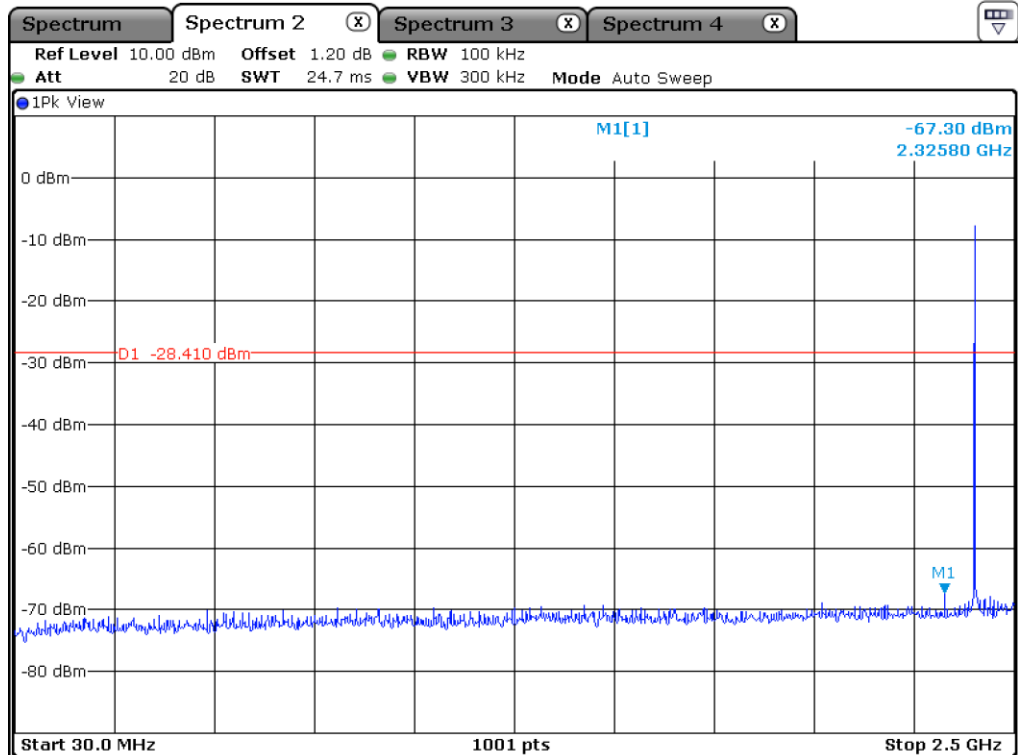




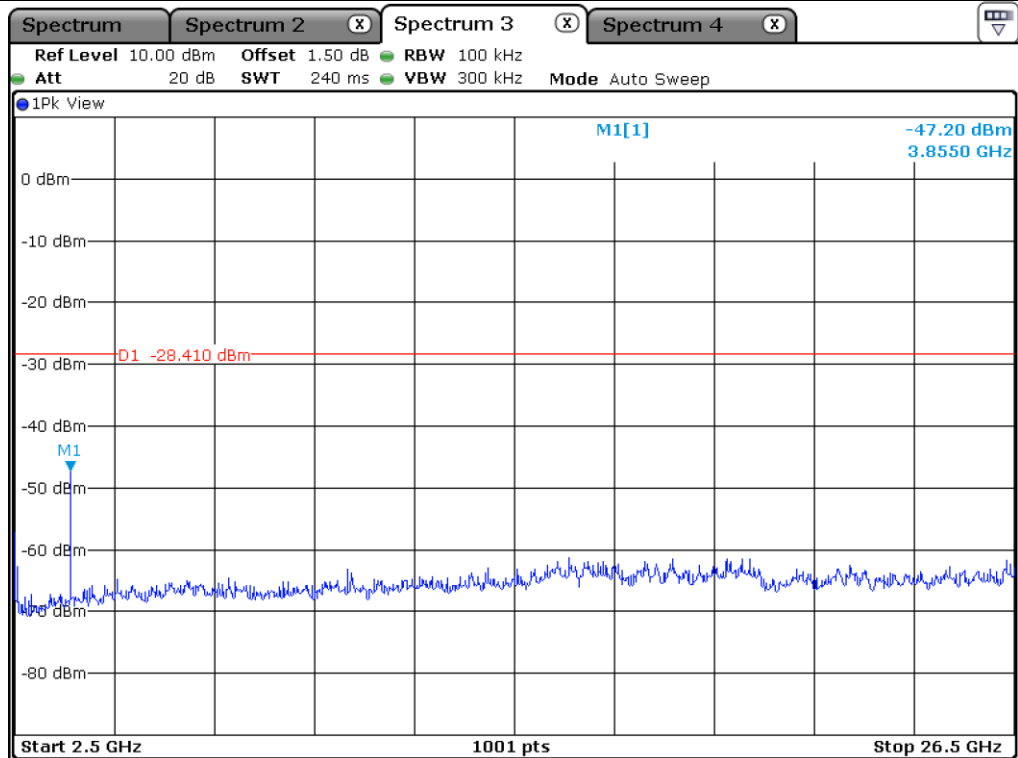
High Channel



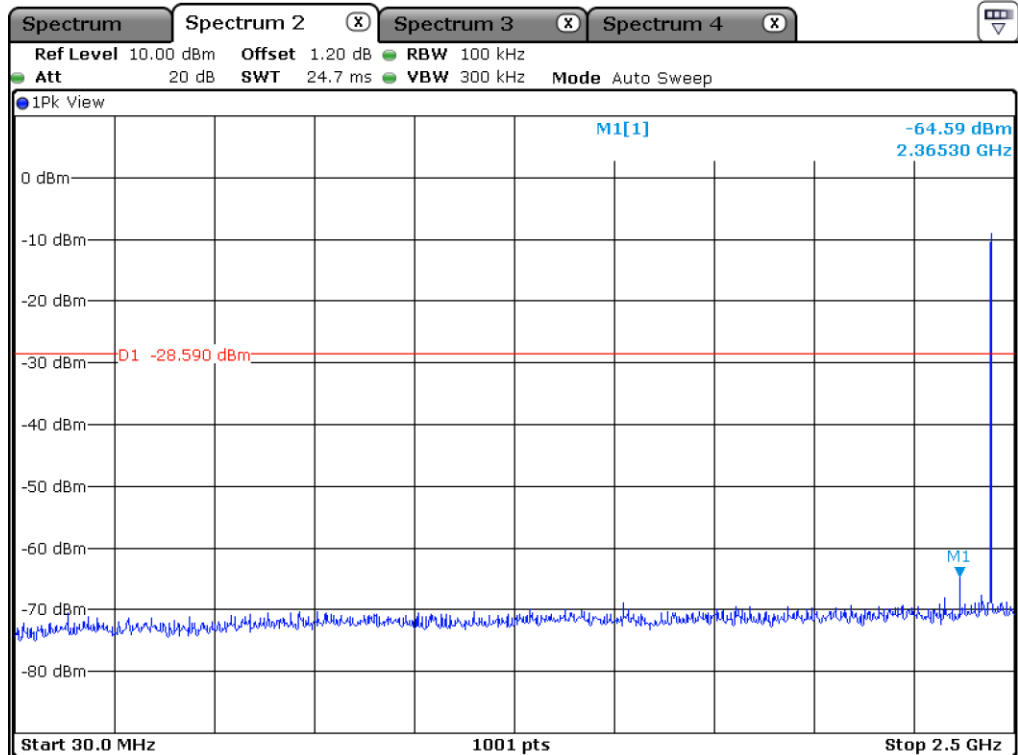
Hopping Mode



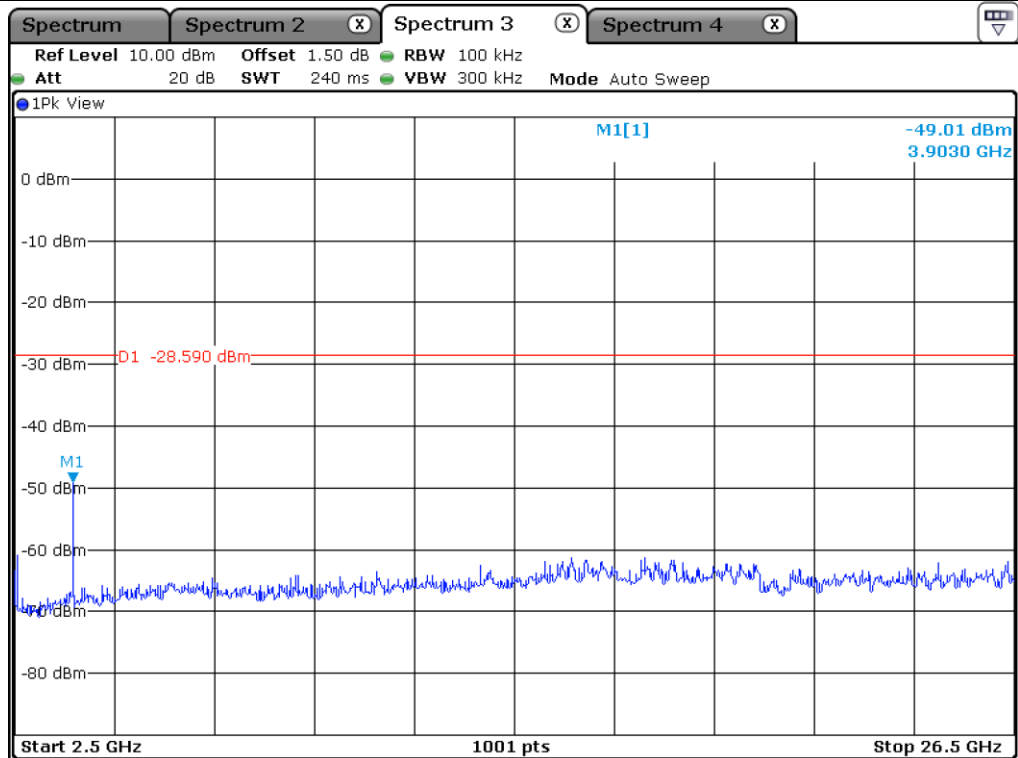
Low Channel



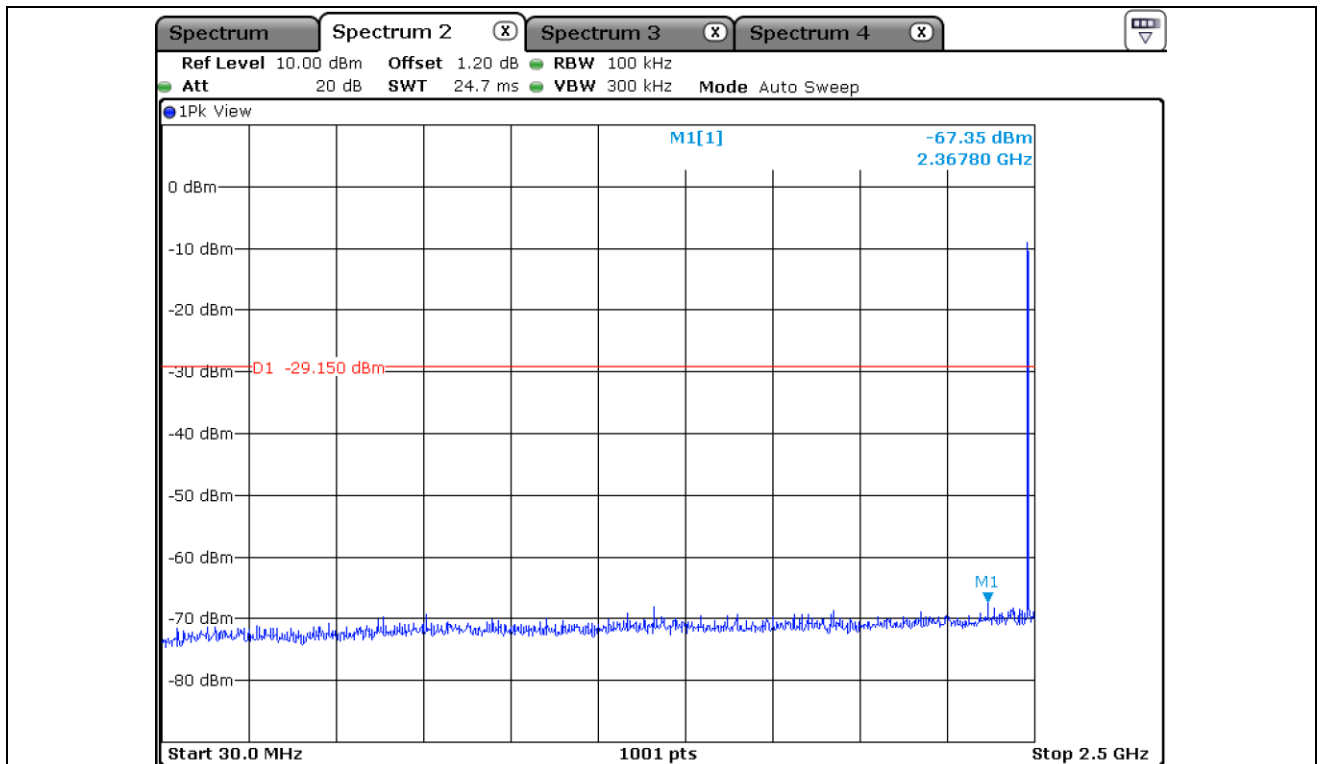
Low Channel



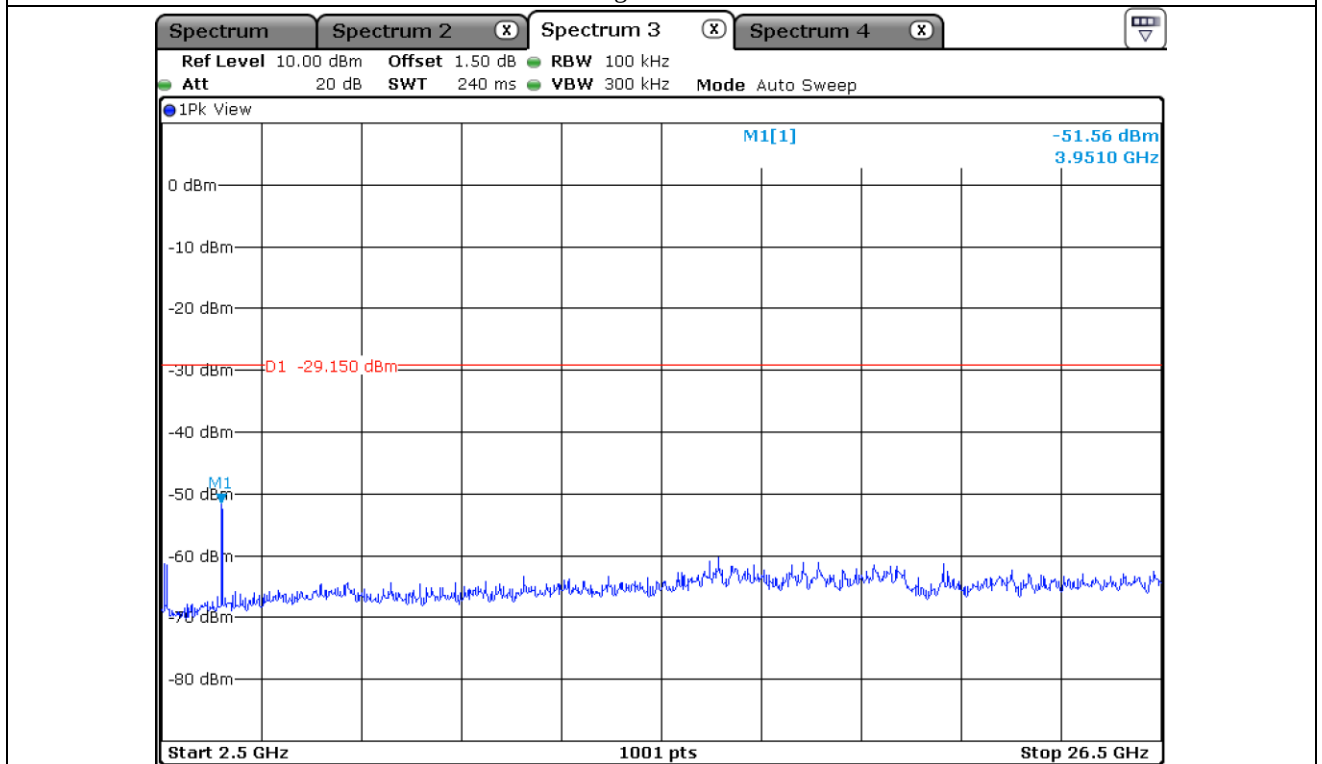
Middle Channel



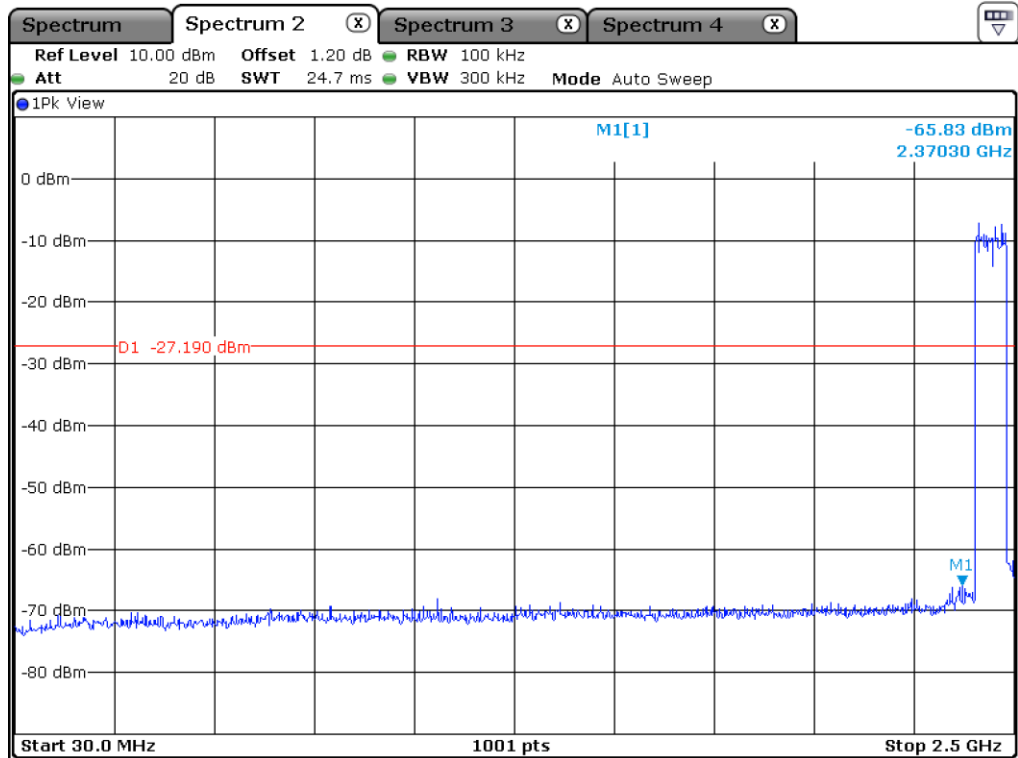
Middle Channel



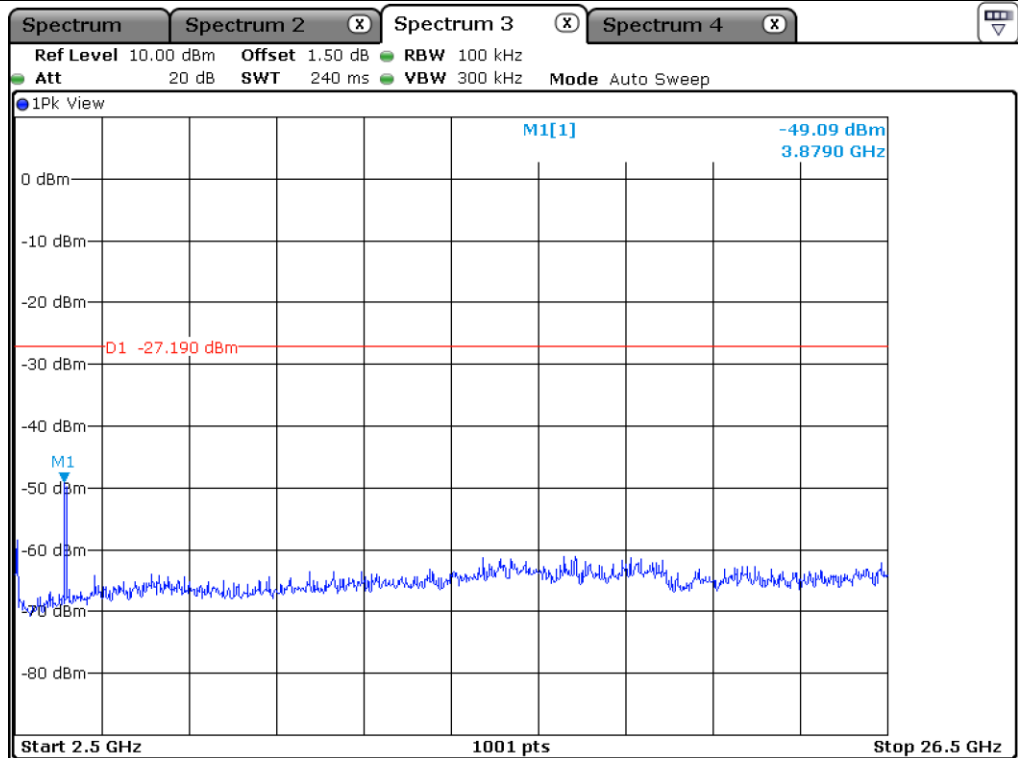
High Channel



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

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 : 76.60 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 378.452	21.24	Peak	H	28.30	8.20	-	57.74	74.00	16.26
2 389.960	7.35	Average	H	28.30	8.20	1.16	45.01	54.00	8.99
2 378.531	19.29	Peak	V	28.30	8.20	-	55.79	74.00	18.21
2 349.281	6.88	Average	V	28.30	8.20	1.16	44.54	54.00	9.46
Test Data for High Channel									
2 488.563	18.67	Peak	H	28.70	8.23	-	55.60	74.00	18.40
2 484.264	6.80	Average	H	28.70	8.23	1.16	44.89	54.00	9.11
2 489.865	17.99	Peak	V	28.70	8.23	-	54.92	74.00	19.08
2 499.563	6.82	Average	V	28.70	8.23	1.16	44.91	54.00	9.09

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Correction 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 : 77.13 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 378.292	21.22	Peak	H	28.30	8.20	-	57.72	74.00	16.28
2 345.684	6.84	Average	H	28.30	8.20	1.13	44.47	54.00	9.53
2 375.654	19.20	Peak	V	28.30	8.20	-	55.70	74.00	18.30
2 322.108	6.96	Average	V	28.30	8.20	1.13	44.59	54.00	9.41
Test Data for High Channel									
2 488.783	18.05	Peak	H	28.70	8.23	-	54.98	74.00	19.02
2 484.234	6.46	Average	H	28.70	8.23	1.13	44.52	54.00	9.48
2 490.365	18.00	Peak	V	28.70	8.23	-	54.93	74.00	19.07
2 499.920	6.73	Average	V	28.70	8.23	1.13	44.79	54.00	9.21

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Correction 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 : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 375.095	20.37	Peak	H	28.30	8.20	-	56.87	74.00	17.13
2 347.043	6.93	Average	H	28.30	8.20	1.16	44.59	54.00	9.41
2 333.057	18.10	Peak	V	28.30	8.20	-	54.60	74.00	19.40
2 343.766	6.89	Average	V	28.30	8.20	1.16	44.55	54.00	9.45
Test Data for High Channel									
2 496.184	18.75	Peak	H	28.70	8.23	-	55.68	74.00	18.32
2 483.508	6.46	Average	H	28.70	8.23	1.16	44.55	54.00	9.45
2 499.992	18.33	Peak	V	28.70	8.23	-	55.26	74.00	18.74
2 499.992	6.68	Average	V	28.70	8.23	1.16	44.77	54.00	9.23

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 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 : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	13.60	Peak	H	33.40	11.21	-	58.21	74.00	15.79
4 804.00	2.79	Average	H	33.40	11.21	1.16	48.56	54.00	5.44
4 804.00	13.11	Peak	V	33.40	11.21	-	57.72	74.00	16.28
4 804.00	2.86	Average	V	33.40	11.21	1.16	48.63	54.00	5.37
Test Data for Middle Channel									
4 882.00	12.97	Peak	H	33.50	11.23	-	57.70	74.00	16.30
4 882.00	2.54	Average	H	33.50	11.23	1.16	48.43	54.00	5.57
4 882.00	12.67	Peak	V	33.50	11.23	-	57.40	74.00	16.60
4 882.00	2.50	Average	V	33.50	11.23	1.16	48.39	54.00	5.61
Test Data for High Channel									
4 960.00	12.64	Peak	H	33.30	11.25	-	57.19	74.00	16.81
4 960.00	3.29	Average	H	33.30	11.25	1.16	49.00	54.00	5.00
4 960.00	13.52	Peak	V	33.30	11.25	-	58.07	74.00	15.93
4 960.00	3.18	Average	V	33.30	11.25	1.16	48.89	54.00	5.11

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

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

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

12.6.2.2 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 : 77.13 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	12.84	Peak	H	33.40	11.21	-	57.45	74.00	16.55
4 804.00	2.73	Average	H	33.40	11.21	1.13	48.47	54.00	5.53
4 804.00	13.64	Peak	V	33.40	11.21	-	58.25	74.00	15.75
4 804.00	3.19	Average	V	33.40	11.21	1.13	48.93	54.00	5.07
Test Data for Middle Channel									
4 882.00	12.53	Peak	H	33.50	11.23	-	57.26	74.00	16.74
4 882.00	3.30	Average	H	33.50	11.23	1.13	49.16	54.00	4.84
4 882.00	13.54	Peak	V	33.50	11.23	-	58.27	74.00	15.73
4 882.00	2.81	Average	V	33.50	11.23	1.13	48.67	54.00	5.33
Test Data for High Channel									
4 960.00	13.26	Peak	H	33.30	11.25	-	57.81	74.00	16.19
4 960.00	2.79	Average	H	33.30	11.25	1.13	48.47	54.00	5.53
4 960.00	13.68	Peak	V	33.30	11.25	-	58.23	74.00	15.77
4 960.00	2.59	Average	V	33.30	11.25	1.13	48.27	54.00	5.73

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor

12.6.2.3 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 : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	12.79	Peak	H	33.40	11.21	-	57.40	74.00	16.60
4 804.00	2.66	Average	H	33.40	11.21	1.16	48.43	54.00	5.57
4 804.00	13.52	Peak	V	33.40	11.21	-	58.13	74.00	15.87
4 804.00	3.08	Average	V	33.40	11.21	1.16	48.85	54.00	5.15
Test Data for Middle Channel									
4 882.00	13.05	Peak	H	33.50	11.23	-	57.78	74.00	16.22
4 882.00	2.90	Average	H	33.50	11.23	1.16	48.79	54.00	5.21
4 882.00	13.04	Peak	V	33.50	11.23	-	57.77	74.00	16.23
4 882.00	3.42	Average	V	33.50	11.23	1.16	49.31	54.00	4.69
Test Data for High Channel									
4 960.00	13.13	Peak	H	33.30	11.25	-	57.68	74.00	16.32
4 960.00	2.78	Average	H	33.30	11.25	1.16	48.49	54.00	5.51
4 960.00	13.76	Peak	V	33.30	11.25	-	58.31	74.00	15.69
4 960.00	2.85	Average	V	33.30	11.25	1.16	48.56	54.00	5.44

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Correction Factor

13. RADIATED EMISSION TEST

13.1 Operating environment

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

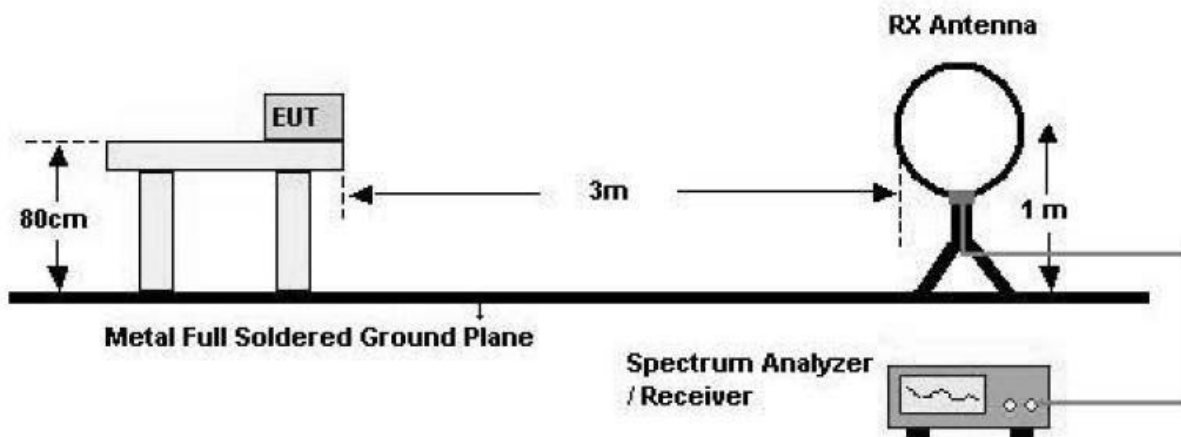
13.2 Test set-up

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.

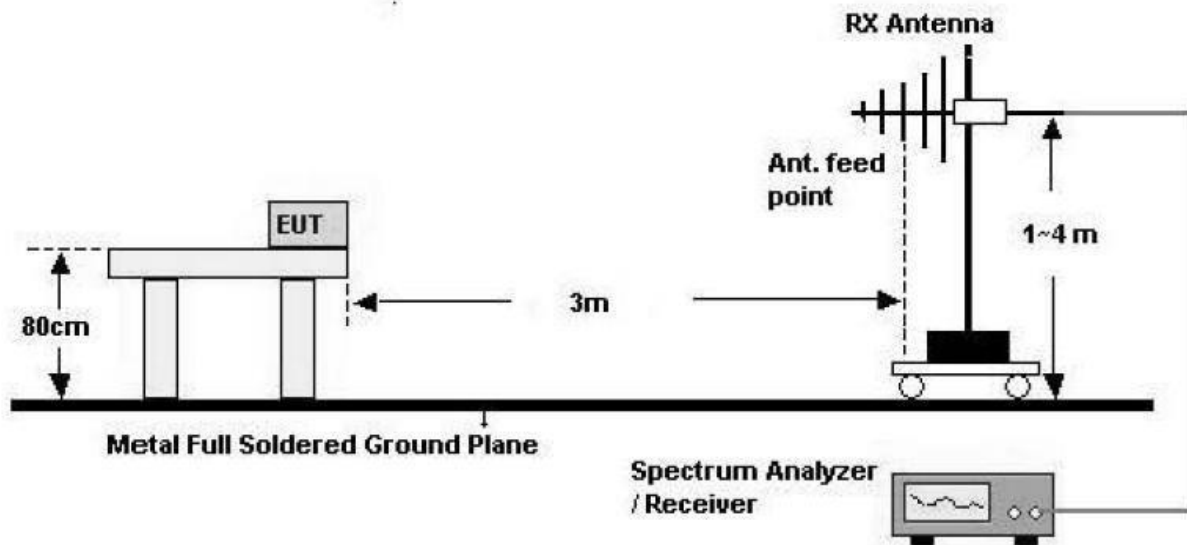
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal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

- Test Configuration

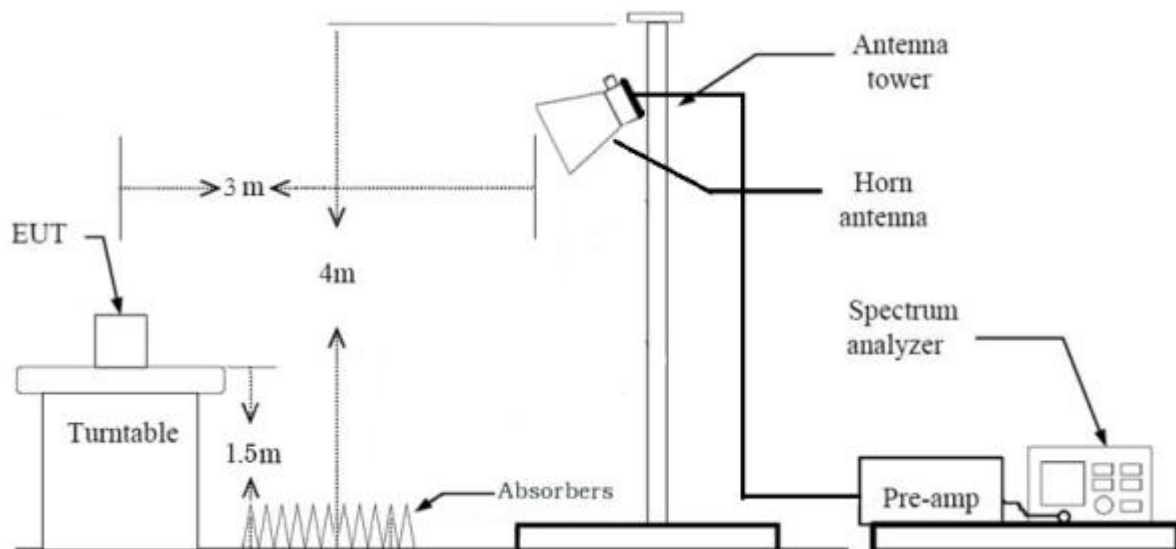
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



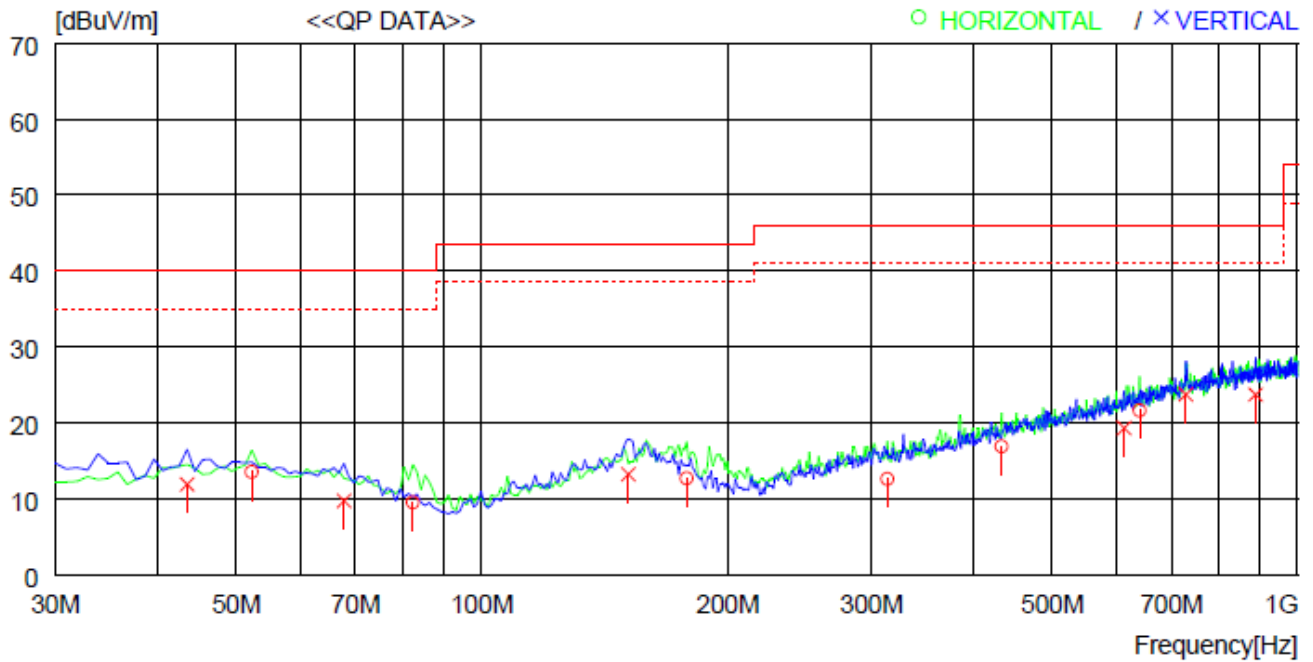
13.3 Test Date

January 28, 2021 ~ February 04, 2021

13.4 Test data for 30 MHz ~ 1 000 MHz

13.4.1 Test data for Bluetooth Mode

- . 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]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	52.310	35.9	9.7	0.6	32.7	13.5	40.0	26.5	100	354
2	82.380	33.7	7.7	0.8	32.7	9.5	40.0	30.5	100	354
3	178.410	30.9	13.1	1.3	32.6	12.7	43.5	30.8	100	84
4	314.210	29.6	14.0	1.7	32.7	12.6	46.0	33.4	100	354
5	433.521	30.8	16.9	2.0	32.8	16.9	46.0	29.1	100	250
6	640.127	31.8	20.3	2.5	33.0	21.6	46.0	24.4	100	354
----- Vertical -----										
7	43.580	33.5	10.5	0.6	32.7	11.9	40.0	28.1	100	352
8	67.830	32.7	9.0	0.7	32.7	9.7	40.0	30.3	100	3
9	151.250	32.8	11.8	1.2	32.6	13.2	43.5	30.3	100	3
10	612.968	29.9	20.0	2.4	33.0	19.3	46.0	26.7	100	7
11	729.364	32.9	21.2	2.4	32.8	23.7	46.0	22.3	100	3
12	887.469	29.9	23.1	2.8	32.1	23.7	46.0	22.3	100	3

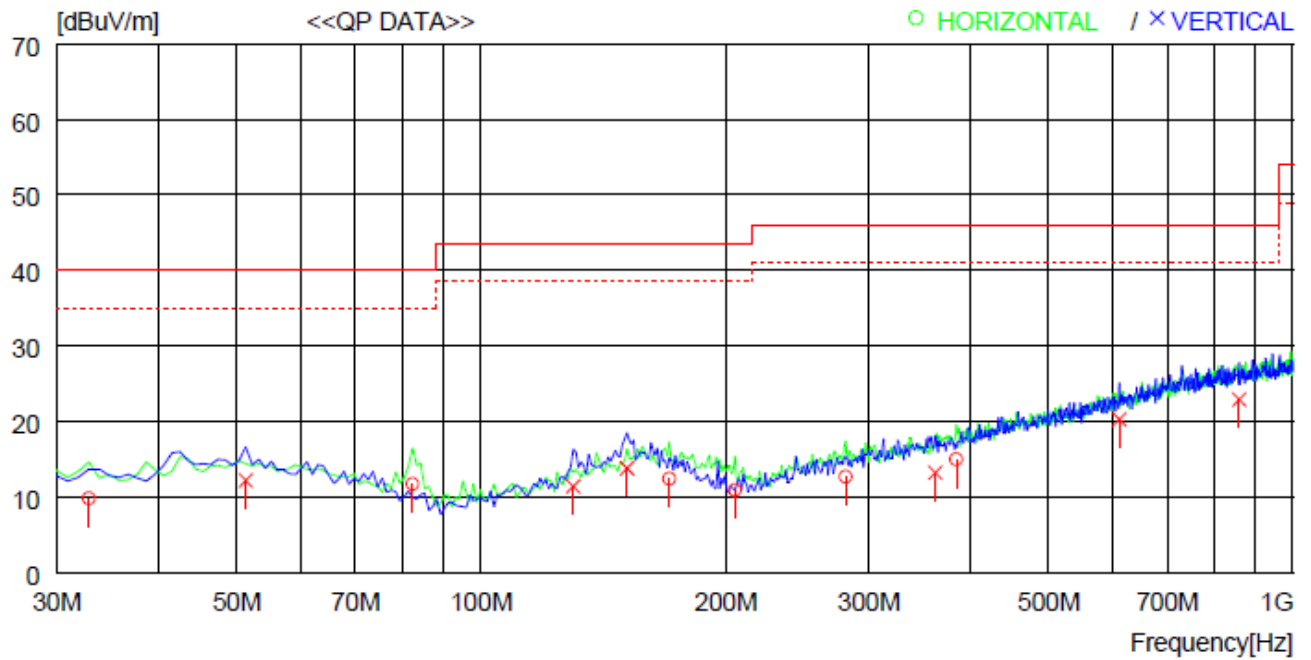
13.4.2 Test data for Intermodulation Mode(Bluetooth + WLAN 2.4 GHz)

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : NAVIGATION RADIO

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



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	32.910	30.9	11.0	0.5	32.6	9.8	40.0	30.2	100	123
2	82.380	35.9	7.7	0.8	32.7	11.7	40.0	28.3	100	358
3	170.650	30.9	12.9	1.2	32.6	12.4	43.5	31.1	100	358
4	205.570	29.8	12.3	1.4	32.6	10.9	43.5	32.6	100	250
5	281.230	31.5	12.3	1.6	32.7	12.7	46.0	33.3	100	175
6	385.020	29.8	16.0	1.9	32.7	15.0	46.0	31.0	100	358
----- Vertical -----										
7	51.340	34.6	9.7	0.6	32.7	12.2	40.0	27.8	100	4
8	129.910	32.2	10.8	1.1	32.7	11.4	43.5	32.1	100	183
9	151.250	33.4	11.8	1.2	32.6	13.8	43.5	29.7	100	4
10	362.710	28.6	15.4	1.9	32.7	13.2	46.0	32.8	100	241
11	611.028	30.9	20.0	2.4	33.0	20.3	46.0	25.7	100	4
12	858.370	29.9	22.7	2.5	32.2	22.9	46.0	23.1	100	320

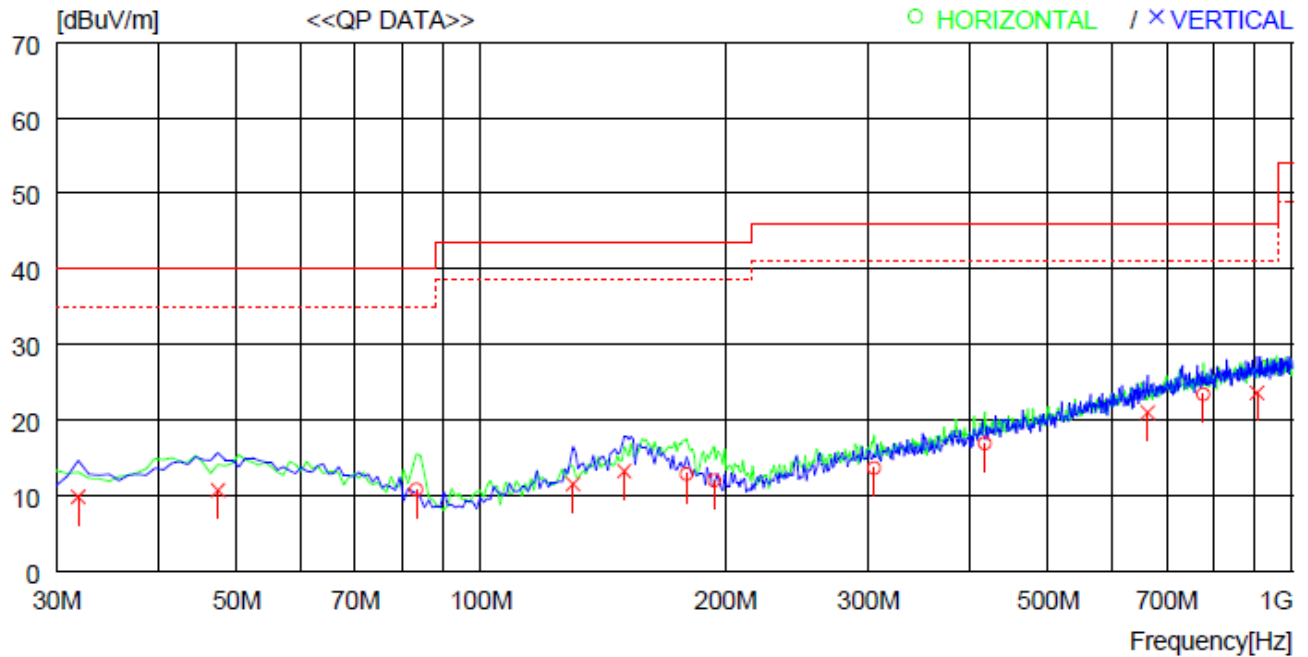
13.4.3 Test data for Intermodulation Mode(Bluetooth + WLAN 5 GHz)

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : NAVIGATION RADIO

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	83.350	34.9	7.8	0.8	32.7	10.8	40.0	29.2	100	357
2	179.380	31.0	13.1	1.3	32.6	12.8	43.5	30.7	100	263
3	193.930	30.6	12.7	1.3	32.6	12.0	43.5	31.5	100	74
4	305.480	30.9	13.7	1.7	32.7	13.6	46.0	32.4	100	56
5	418.001	30.9	16.7	2.0	32.7	16.9	46.0	29.1	100	90
6	776.893	32.3	21.7	2.1	32.7	23.4	46.0	22.6	100	357
----- Vertical -----										
7	31.940	31.0	10.9	0.5	32.6	9.8	40.0	30.2	100	8
8	47.460	32.7	10.1	0.6	32.7	10.7	40.0	29.3	100	229
9	129.910	32.3	10.8	1.1	32.7	11.5	43.5	32.0	100	8
10	150.280	32.9	11.7	1.2	32.6	13.2	43.5	30.3	100	8
11	663.406	30.9	20.5	2.5	32.9	21.0	46.0	25.0	100	212
12	904.929	29.4	23.3	2.9	32.0	23.6	46.0	22.4	100	271

13.5 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.								

13.6 Test data for above 1 GHz

-. 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

-. 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	102177	Apr. 20, 2020 (1Y)
FSW43	Rohde & Schwarz	Signal Analyzer	104544	Jul. 15, 2020 (1Y)
ESW	Rohde & Schwarz	EMI Test Receiver	101851	Mar. 27, 2020 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	392756	Oct. 16, 2020 (1Y)
PAM-118A	Com-Power	Pre-Amplifier	18040081	Oct. 12, 2020 (1Y)
PAM-840A	Com-Power	Pre-Amplifier	461339	Oct. 16, 2020 (1Y)
DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2020 (2Y)
HLP-2008	TDK	Hybrid Antenna	131316	Feb. 27, 2020 (2Y)
AH-118	Com-Power	Horn Antenna	10050061	Oct. 15, 2020 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 07, 2020(1Y)
ESR	Rohde & Schwarz	EMI TEST RECEIVER	102602	Mar. 17, 2020 (1Y)