

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-215-RWD-099
Reception No. : 2104002159
Applicant : Samsung Electronics Co Ltd
Address : 19 Chapin Rd., Building D, Pine Brook, New Jersey, 07058, United States
Manufacturer : Samsung Electronics Co Ltd
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do 16677, Korea
Type of Equipment : Wi-Fi/BT Transceiver
FCC ID. : A3LWCA736M
Model Name : WCA736M
Serial number : N/A
Total page of Report : 56 pages (including this page)
Date of Incoming : May 10, 2021
Date of issue : May 28, 2021

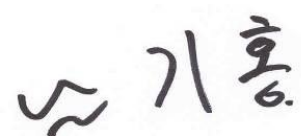
SUMMARY

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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 ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-215-RWD-099	May 28, 2021	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Samsung Electronics Co Ltd

Address : 19 Chapin Rd., Building D, Pine Brook, New Jersey, 07058, United States

Contact Person : Jenni Chun / General Manager

Telephone No. : 973-808-6375

FCC ID : A3LWCA736M

Model Name : WCA736M

Brand Name : 

Serial Number : N/A

Date : May 28, 2021

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Modular Transmitter, Wi-Fi/BT Transceiver
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) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	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
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	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

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OTC-TRF-RF-001(0)

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

3. GENERAL INFORMATION

3.1 Product Description

The Samsung Electronics Co Ltd, Model WCA736M (referred to as the EUT in this report) is a Wi-Fi/BT Transceiver. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Wi-Fi/BT Transceiver	
Temperature Range	-20 °C ~ 50 °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 ~ 2 472 MHz (802.11b/g/n(HT20))
		2 422 MHz ~ 2 462 MHz (802.11n(HT40))
	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))
	5 250 MHz ~ 5 350 MHz Band	5 260 MHz ~ 5 320 MHz (802.11a/n(HT20)/ac(VHT20))
		5 270 MHz ~ 5 310 MHz (802.11n(HT40)/ac(VHT40))
		5 290 MHz (802.11ac(VHT80))
	5 470 MHz ~ 5 725 MHz Band	5 500 MHz ~ 5 720 MHz (802.11a/n(HT20)/ac(VHT20))
		5 510 MHz ~ 5 710 MHz (802.11n(HT40)/ac(VHT40))
		5 530 MHz ~ 5 690 MHz (802.11ac(VHT80))
	5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 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 1Mbps, $\pi/4$ -DQPSK for 2Mbps, 8-DPSK for 3Mbps
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK)
		802.11g/n(HT20)/n(HT40): 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	7.65 dBm
		2 Mbps	7.66 dBm
	Bluetooth	1 Mbps	11.69 dBm
		2 Mbps	10.64 dBm
		3 Mbps	10.71 dBm
	WLAN 2.4 GHz	Antenna 0	14.28 dBm(802.11b) 11.84 dBm(802.11g) 12.58 dBm(802.11n_HT20) 9.23 dBm(802.11n_HT40)
		Antenna 1	16.31 dBm(802.11b) 12.87 dBm(802.11g) 13.65 dBm(802.11n_HT20) 10.16 dBm(802.11n_HT40)
		Multiple Antenna	15.40 dBm(802.11g) 16.16 dBm(802.11n_HT20) 12.73 dBm(802.11n_HT40)

RF OUTPUT POWER	5 150 MHz ~ 5 250 MHz Band	Antenna 0	9.22 dBm(802.11a) 9.46 dBm(802.11n_HT20) 10.54 dBm(802.11n_HT40) 10.61 dBm(802.11ac_VHT80)
		Antenna 1	10.08 dBm(802.11a) 9.98 dBm(802.11n_HT20) 10.68 dBm(802.11n_HT40) 10.68 dBm(802.11ac_VHT80)
		Multiple Antenna	12.68 dBm(802.11a) 12.74 dBm(802.11n_HT20) 13.62 dBm(802.11n_HT40) 13.66 dBm(802.11ac_VHT80)
	5 250 MHz ~ 5 350 MHz Band	Antenna 0	13.79 dBm(802.11a) 14.24 dBm(802.11n_HT20) 12.55 dBm(802.11n_HT40) 13.25 dBm(802.11ac_VHT80)
		Antenna 1	14.95 dBm(802.11a) 14.74 dBm(802.11n_HT20) 13.16 dBm(802.11n_HT40) 13.58 dBm(802.11ac_VHT80)
		Multiple Antenna	17.37 dBm(802.11a) 17.49 dBm(802.11n_HT20) 15.83 dBm(802.11n_HT40) 16.43 dBm(802.11ac_VHT80)

RF OUTPUT POWER	5 470 MHz ~ 5 725 MHz Band	Antenna 0	13.65 dBm(802.11a) 13.31 dBm(802.11n_HT20) 13.37 dBm(802.11n_HT40) 12.65 dBm(802.11ac_VHT80)
		Antenna 0_Straddle	12.73 dBm(802.11a) 11.37 dBm(802.11n_HT20) 11.84 dBm(802.11n_HT40) 11.63 dBm(802.11ac_VHT80)
		Antenna 1	14.69 dBm(802.11a) 14.56 dBm(802.11n_HT20) 14.42 dBm(802.11n_HT40) 14.06 dBm(802.11ac_VHT80)
		Antenna 1_Straddle	11.81 dBm(802.11a) 12.13 dBm(802.11n_HT20) 11.13 dBm(802.11n_HT40) 11.29 dBm(802.11ac_VHT80)
		Multiple Antenna	17.21 dBm(802.11a) 16.99 dBm(802.11n_HT20) 16.94 dBm(802.11n_HT40) 16.42 dBm(802.11ac_VHT80)
		Multiple Antenna _Straddle	15.30 dBm(802.11a) 14.78 dBm(802.11n_HT20) 14.51 dBm(802.11n_HT40) 14.47 dBm(802.11ac_VHT80)

RF OUTPUT POWER	5 725 MHz ~ 5 850 MHz Band	Antenna 0	14.43 dBm(802.11a) 14.48 dBm(802.11n_HT20) 13.14 dBm(802.11n_HT40) 13.26 dBm(802.11ac_VHT80)
		Antenna 0_Straddle	5.02 dBm(802.11a) 4.10 dBm(802.11n_HT20) -0.02 dBm(802.11n_HT40) -3.02 dBm(802.11ac_VHT80)
		Antenna 1	15.15 dBm(802.11a) 15.28 dBm(802.11n_HT20) 14.15 dBm(802.11n_HT40) 14.21 dBm(802.11ac_VHT80)
		Antenna 1_Straddle	3.98 dBm(802.11a) 4.88 dBm(802.11n_HT20) -0.67 dBm(802.11n_HT40) -3.30 dBm(802.11ac_VHT80)
		Multiple Antenna	17.75 dBm(802.11a) 17.91 dBm(802.11n_HT20) 16.68 dBm(802.11n_HT40) 16.77 dBm(802.11ac_VHT80)
		Multiple Antenna _Straddle	7.54 dBm(802.11a) 7.52 dBm(802.11n_HT20) 2.68 dBm(802.11n_HT40) -0.15 dBm(802.11ac_VHT80)

ANTENNA TYPE	PCB Antenna		
ANTENNA GAIN	Bluetooth LE	1.81 dBi	
	Bluetooth	1.81 dBi	
	WLAN 2.4 GHz	Antenna 0	-1.04 dBi
		Antenna 1	0.45 dBi
		Multiple Antenna	2.78 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	3.95 dBi
		Antenna 1	2.07 dBi
		Multiple Antenna	6.12 dBi
	5 250 MHz ~ 5 350 MHz Band	Antenna 0	4.91 dBi
		Antenna 1	2.44 dBi
		Multiple Antenna	6.86 dBi
	5 470 MHz ~ 5 725 MHz Band	Antenna 0	6.18 dBi
		Antenna 1	2.23 dBi
		Multiple Antenna	7.65 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	5.27 dBi
		Antenna 1	2.77 dBi
		Multiple Antenna	7.21 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		40 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	Samsung Electronics Co Ltd	HDWB-2106SA V1.2	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
WCA736M	Samsung Electronics Co Ltd	Wi-Fi/BT Transceiver (EUT)	
HP Probook	HP	Notebook PC	EUT
PPP009L-E	LIE-ON TECHNOLOGY (CHANGZHOU)CO.,LTD.	AC Adapter	

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 402 MHz, 2 440 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
19	2 440
39	2 480

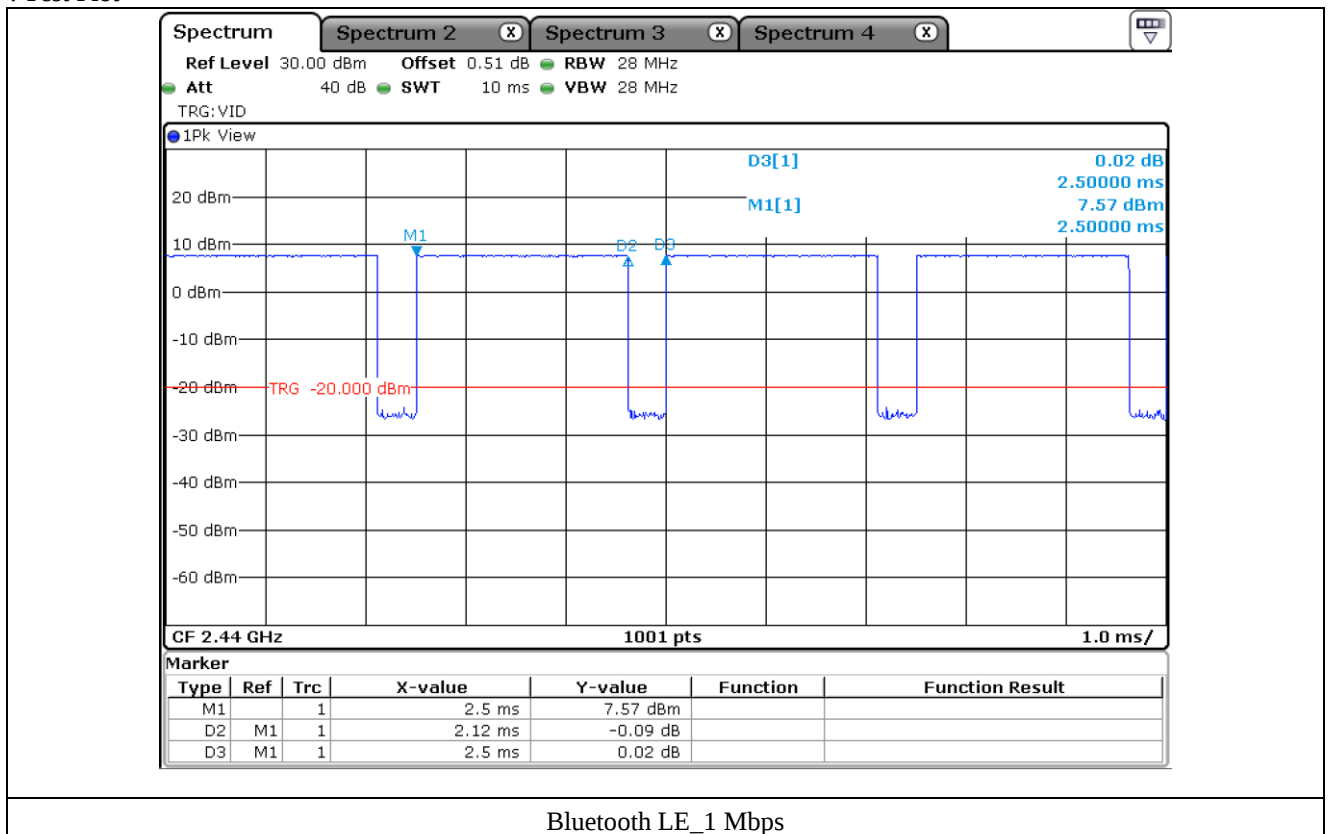
-. Duty Cycle

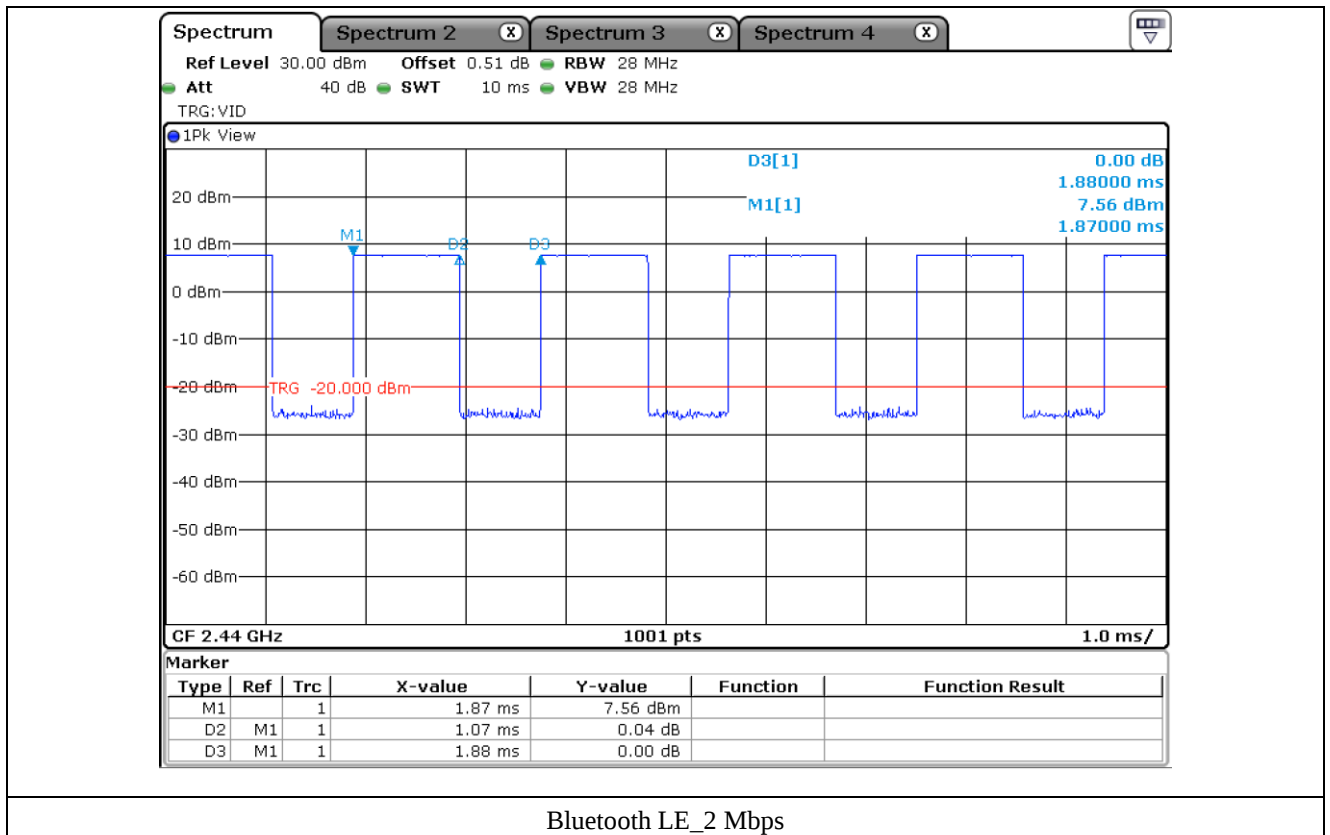
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE [1 Mbps]	2.12	0.38	84.80	0.72
Bluetooth LE [2 Mbps]	1.07	0.81	56.91	2.45

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

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

-. Test Plot





5.4 Configuration of Test System

Line Conducted Test: The EUT was connected to USB and the power of USB was connected to Notebook PC. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

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)
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

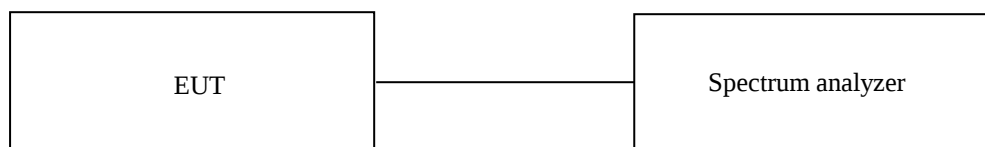
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 22 °C
Relative humidity : 44 % 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 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



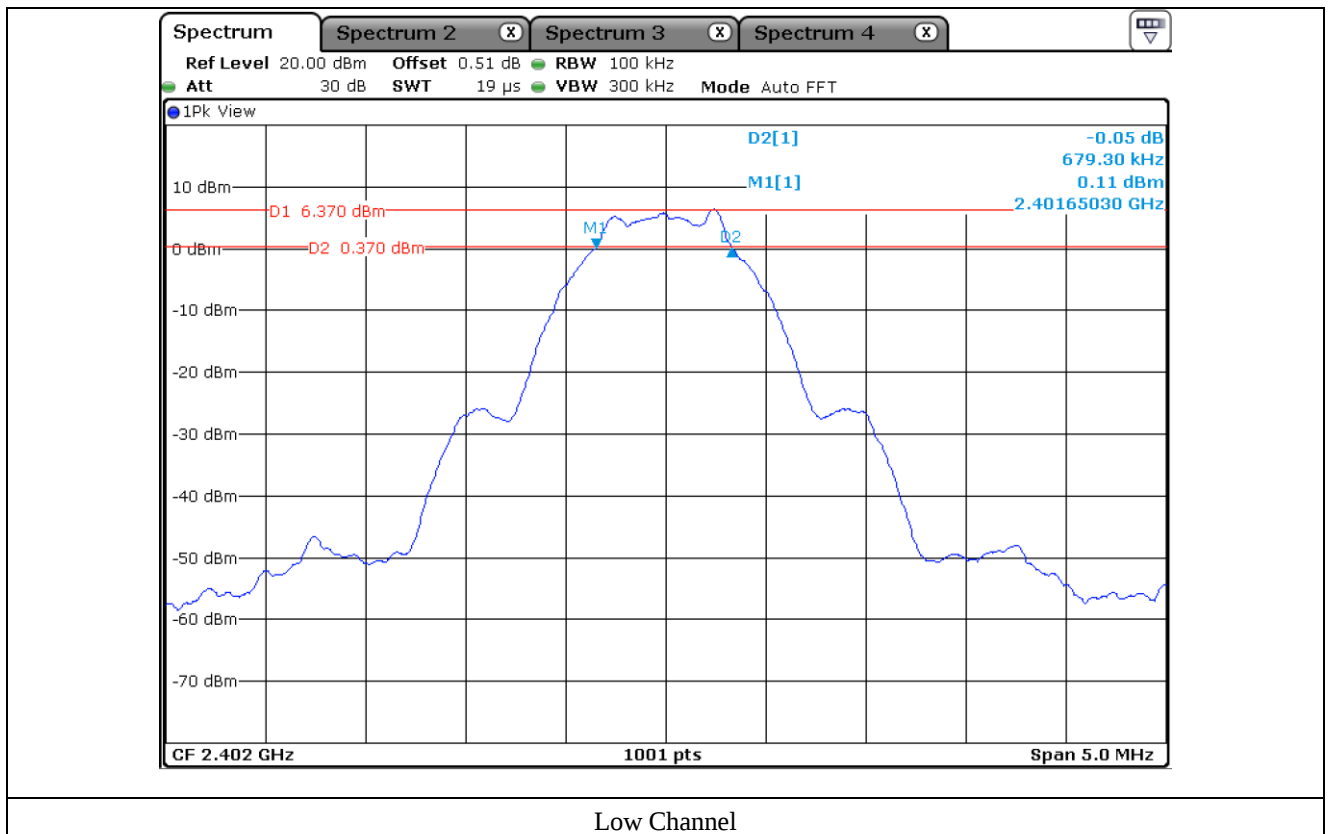
7.3 Test Date

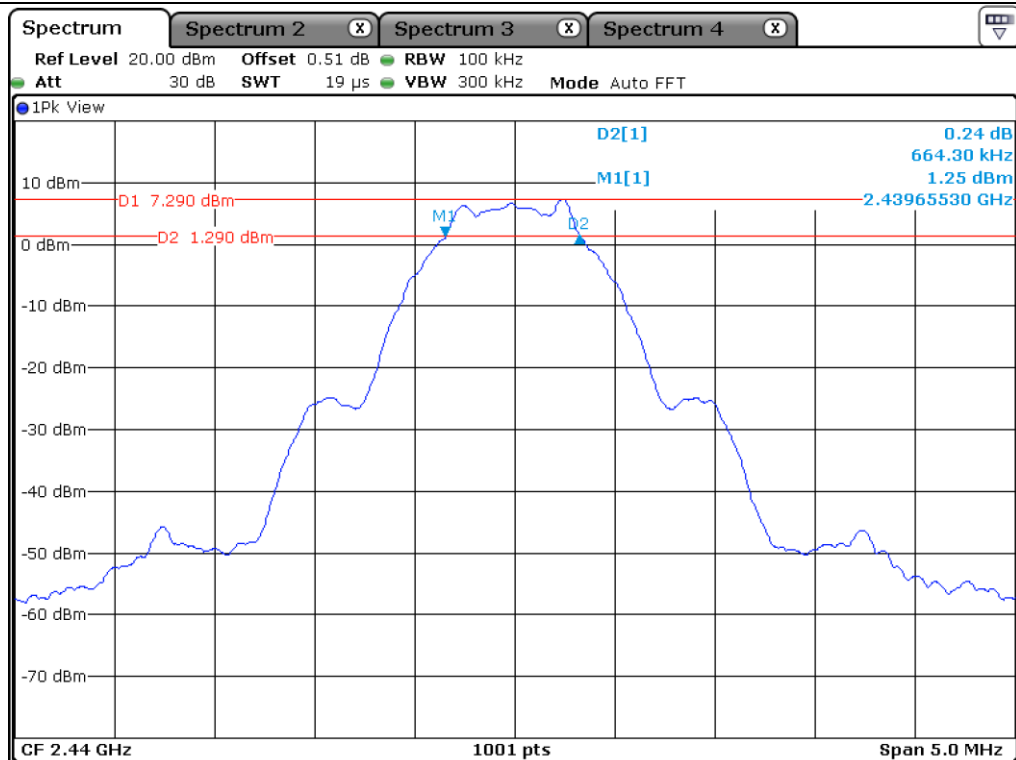
May 10, 2021 ~ May 26, 2021

7.4 Test data for 1 Mbps

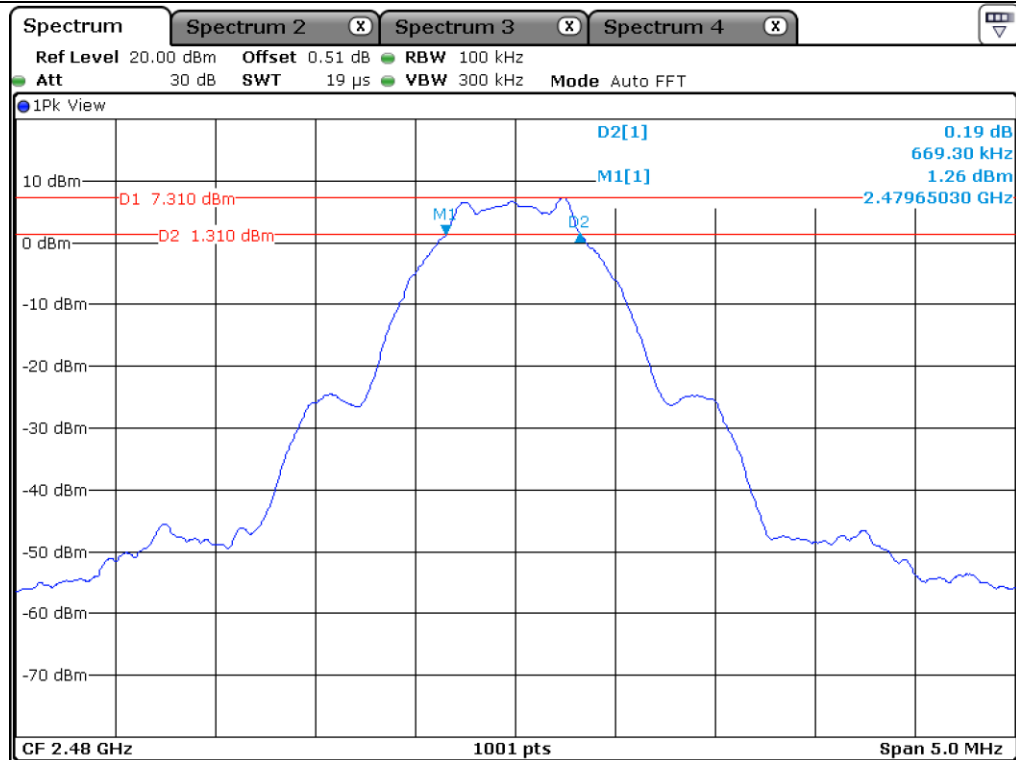
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	679.30	500.00	179.30
Middle	2 440.00	664.30	500.00	164.30
High	2 480.00	669.30	500.00	169.30

Remark. Margin = Measured Value - Limit





Middle Channel

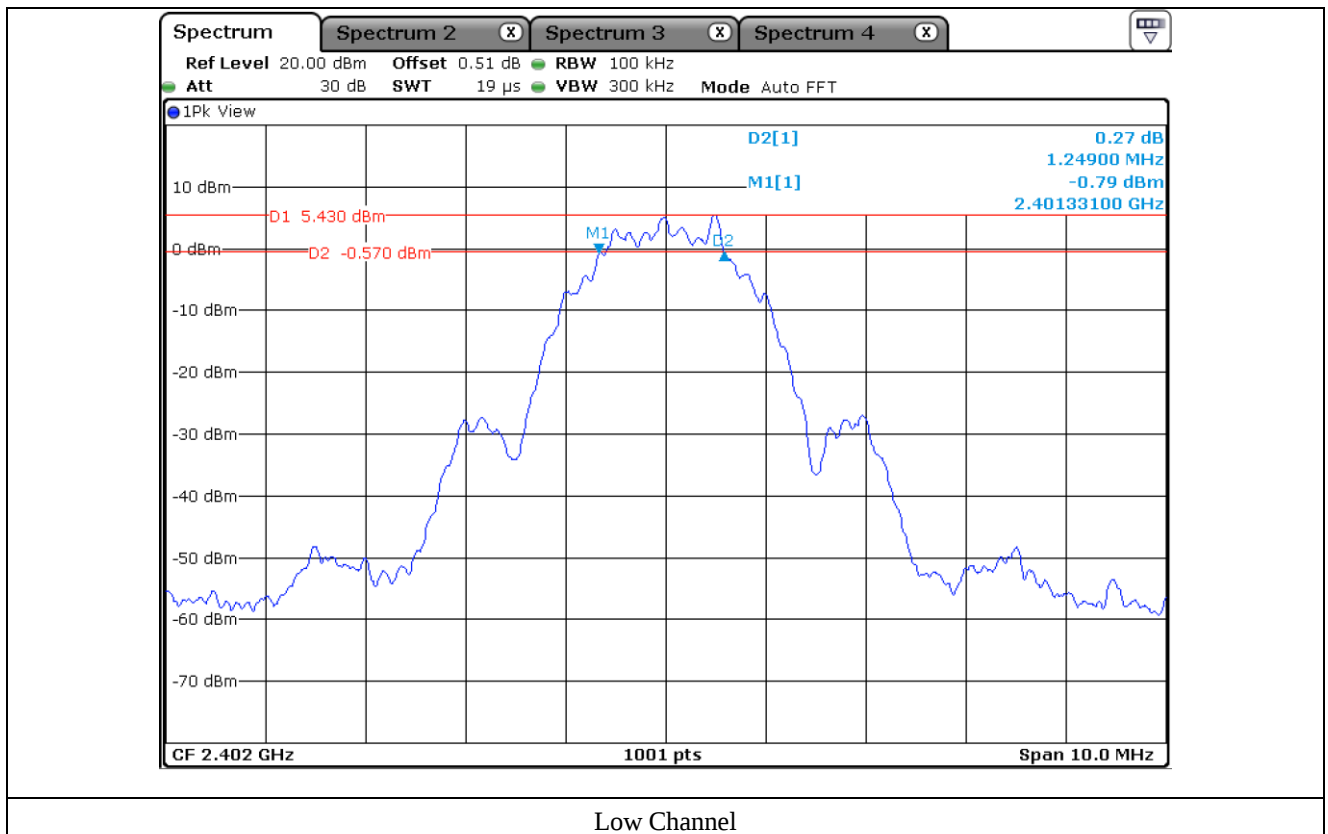


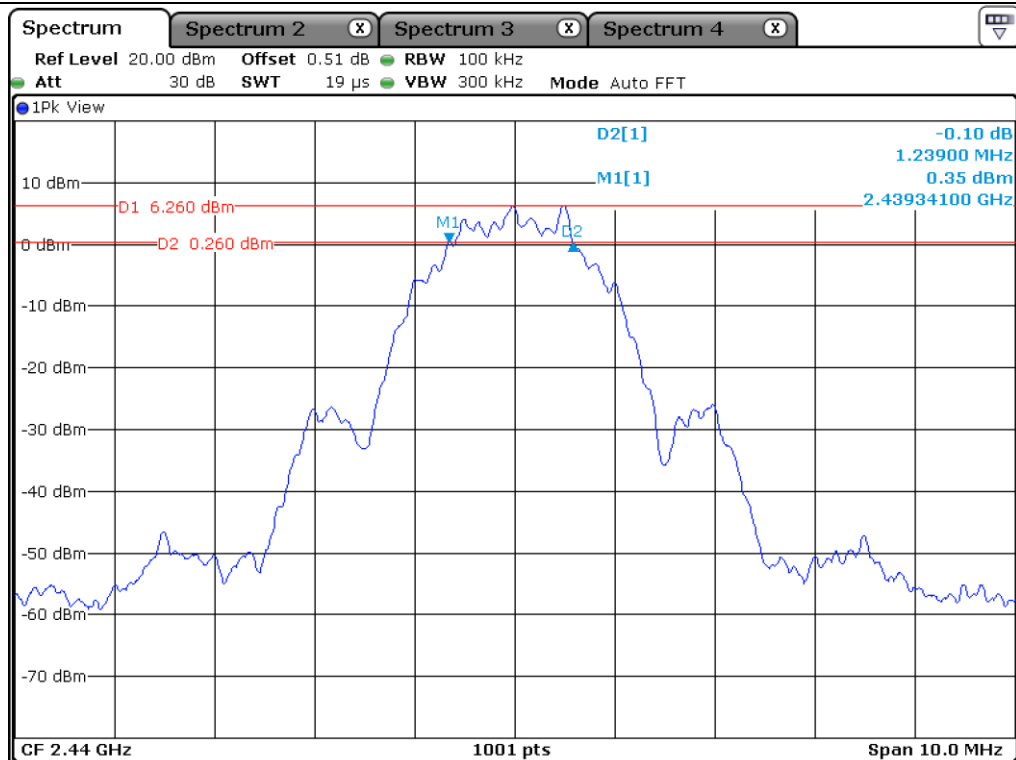
High Channel

7.5 Test data for 2 Mbps

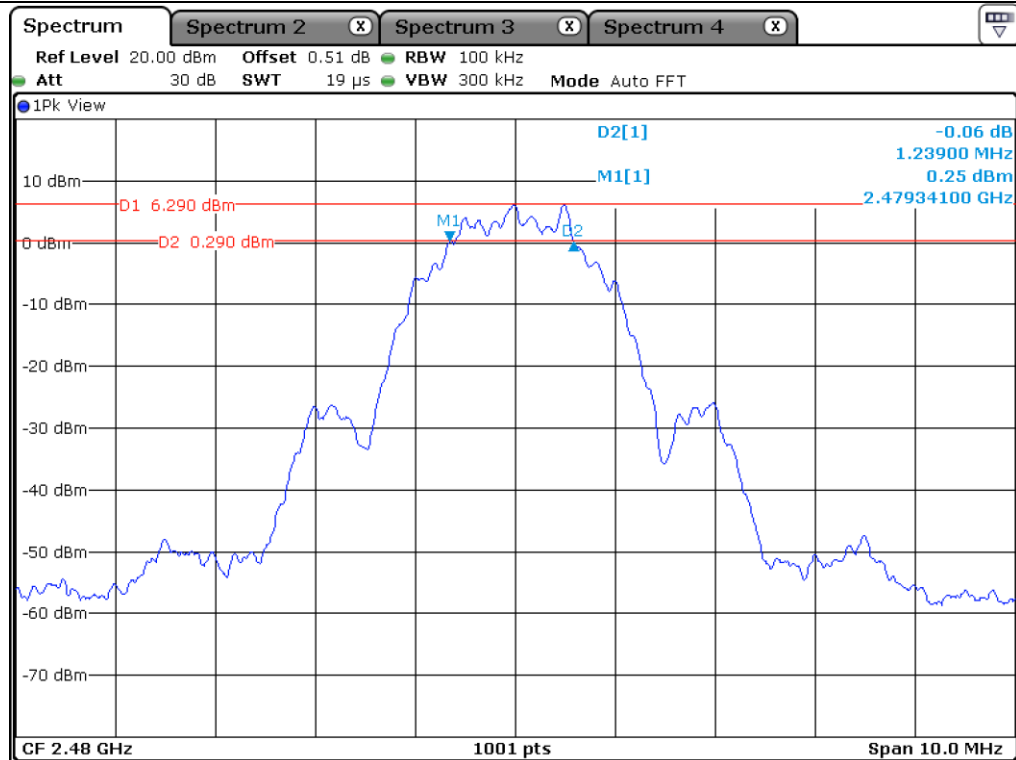
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	1 249.00	500.00	749.00
Middle	2 440.00	1 239.00	500.00	739.00
High	2 480.00	1 239.00	500.00	739.00

Remark. Margin = Measured Value - Limit





Middle Channel



High Channel

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

8. MAXIMUM PEAK OUTPUT POWER

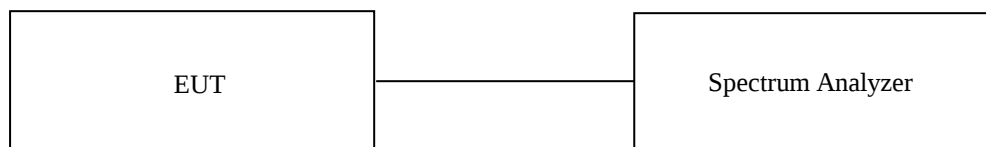
8.1 Operating environment

Temperature : 22 °C
Relative humidity : 44 % R.H.

8.2 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.



8.3 Test Date

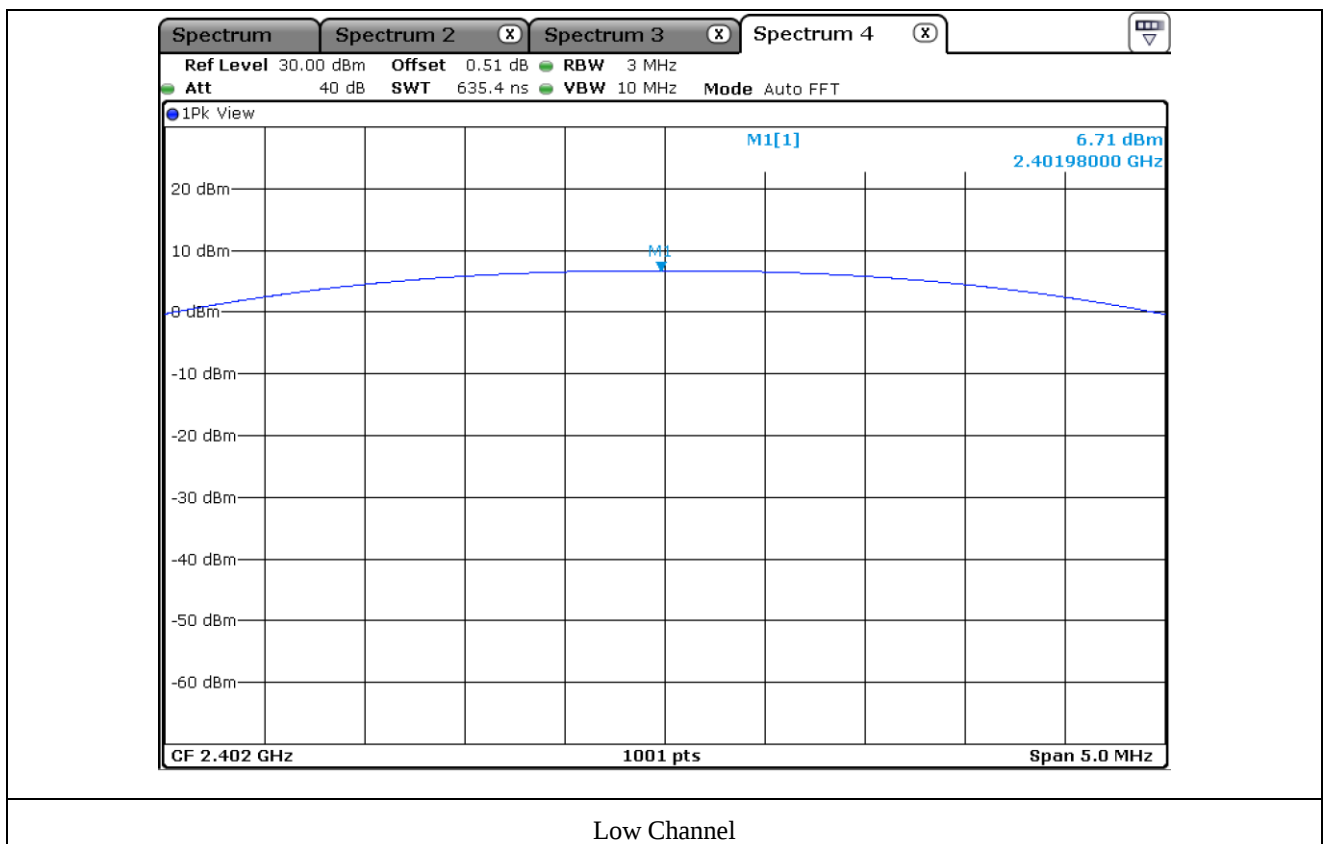
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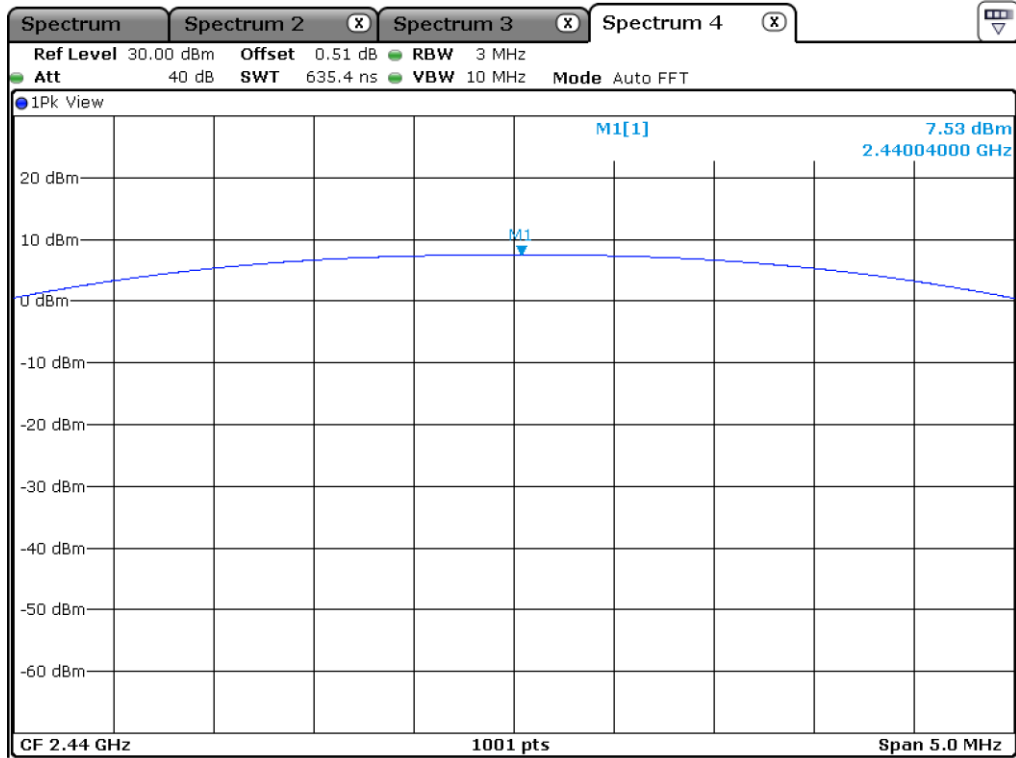
8.4 Test data for 1 Mbps

-. Test Result : Pass

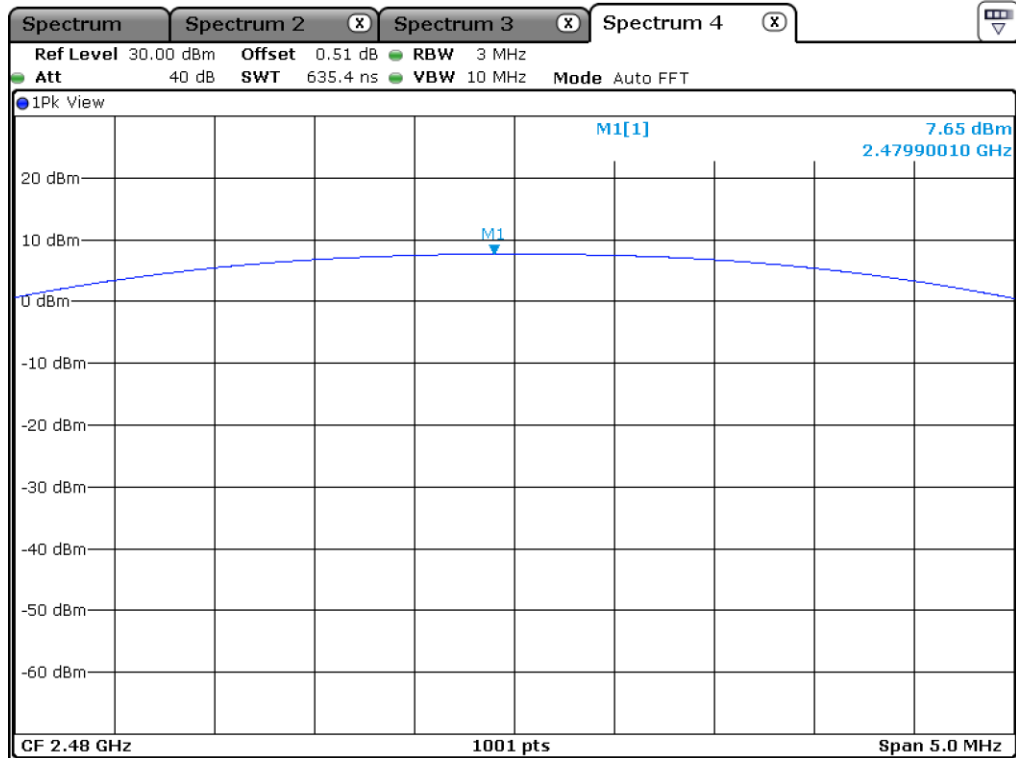
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	6.71	30.00	23.29
MIDDLE	2 440.00	7.53	30.00	22.47
HIGH	2 480.00	7.65	30.00	22.35

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





Middle Channel



High Channel

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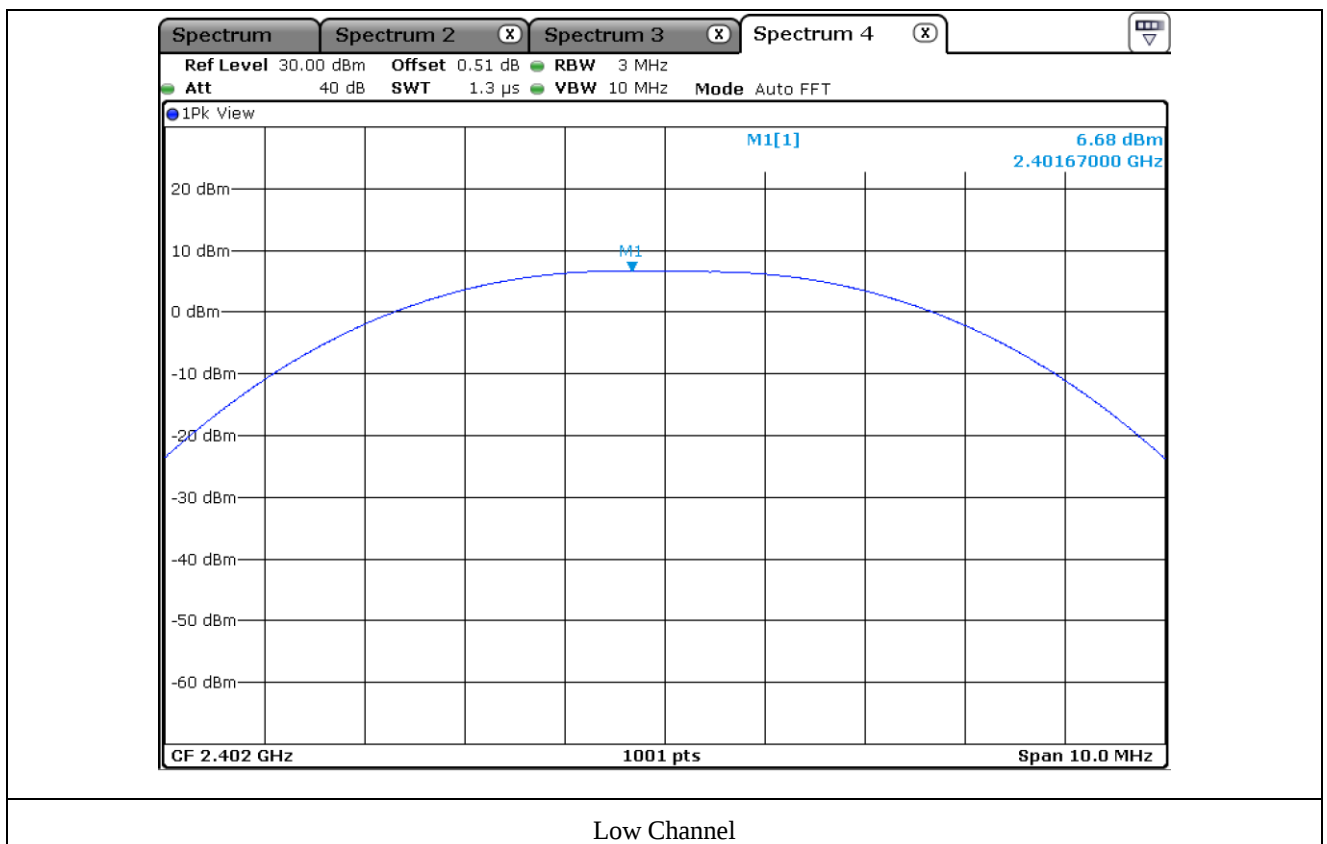
ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

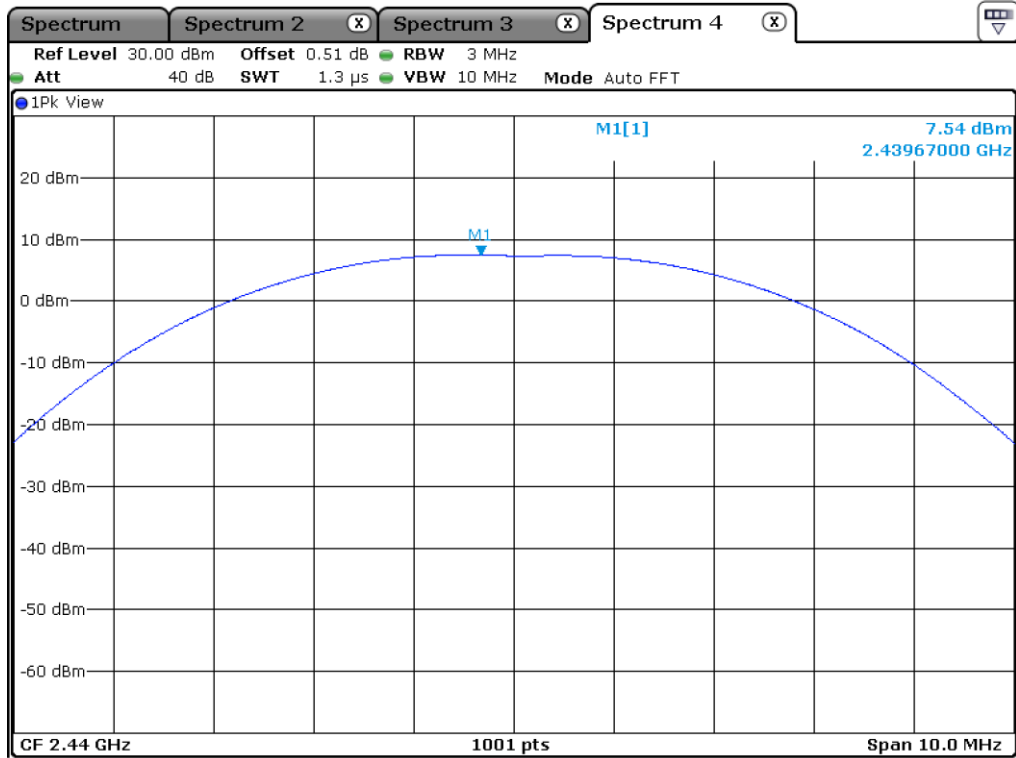
8.5 Test data for 2 Mbps

-. Test Result : Pass

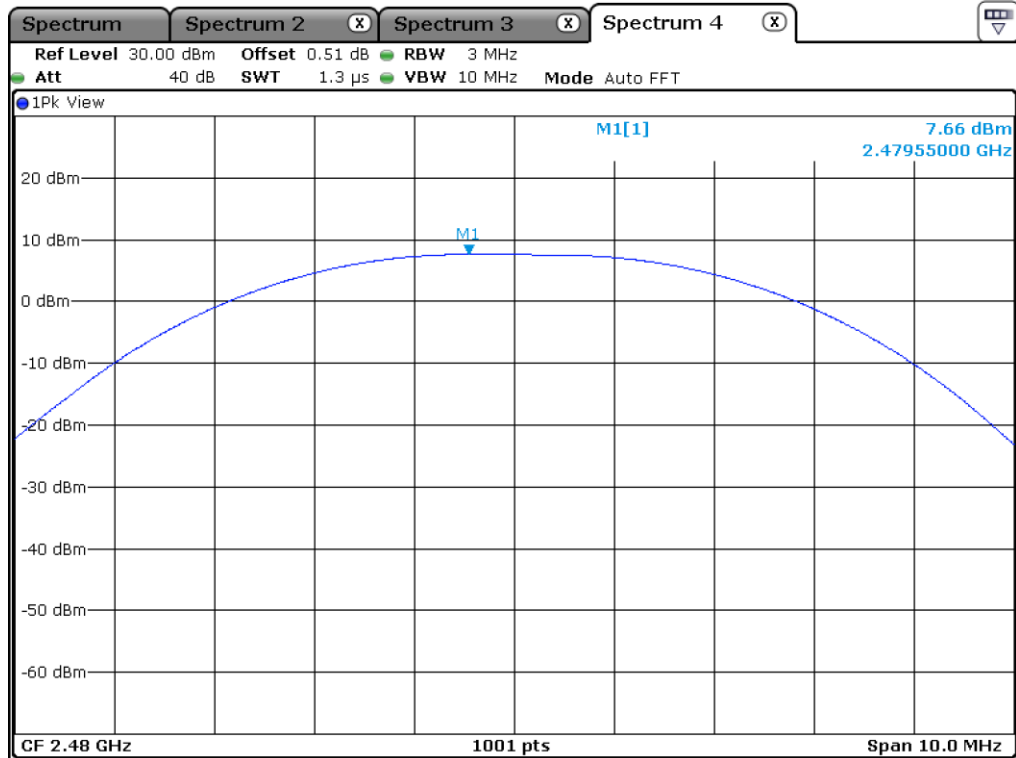
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	6.68	30.00	23.32
MIDDLE	2 440.00	7.54	30.00	22.46
HIGH	2 480.00	7.66	30.00	22.34

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





Middle Channel



High Channel

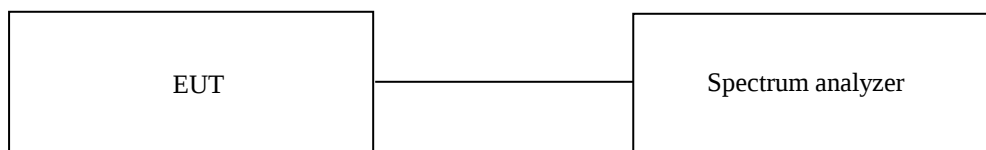
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 22 °C
Relative humidity : 44 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, the video bandwidth is set to 3 times the resolution bandwidth and peak detection was used.



9.3 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.

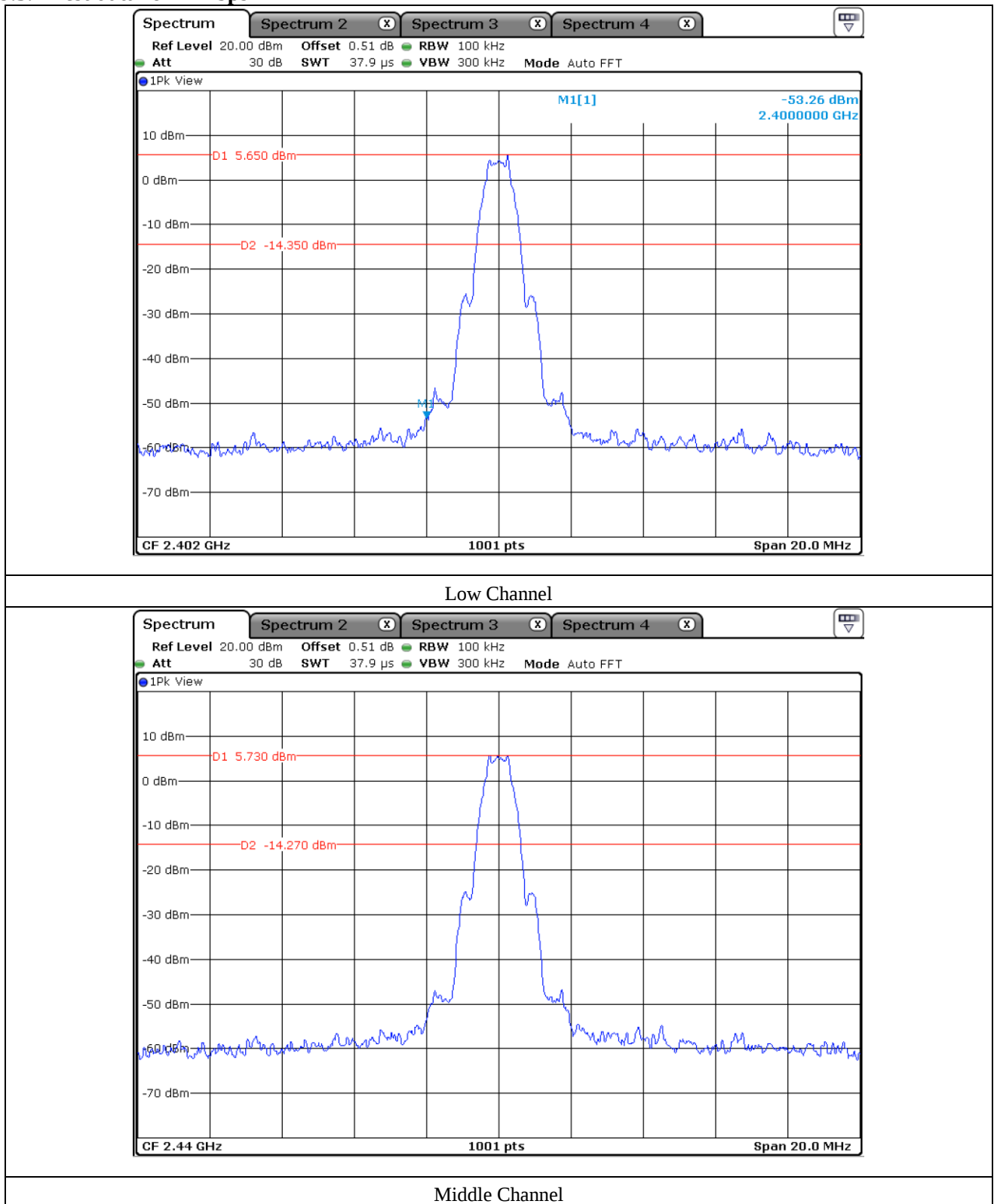
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal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

9.4 Test Date

May 10, 2021 ~ May 26, 2021

9.5 Test data for conducted emission

9.5.1 Test data for 1 Mbps

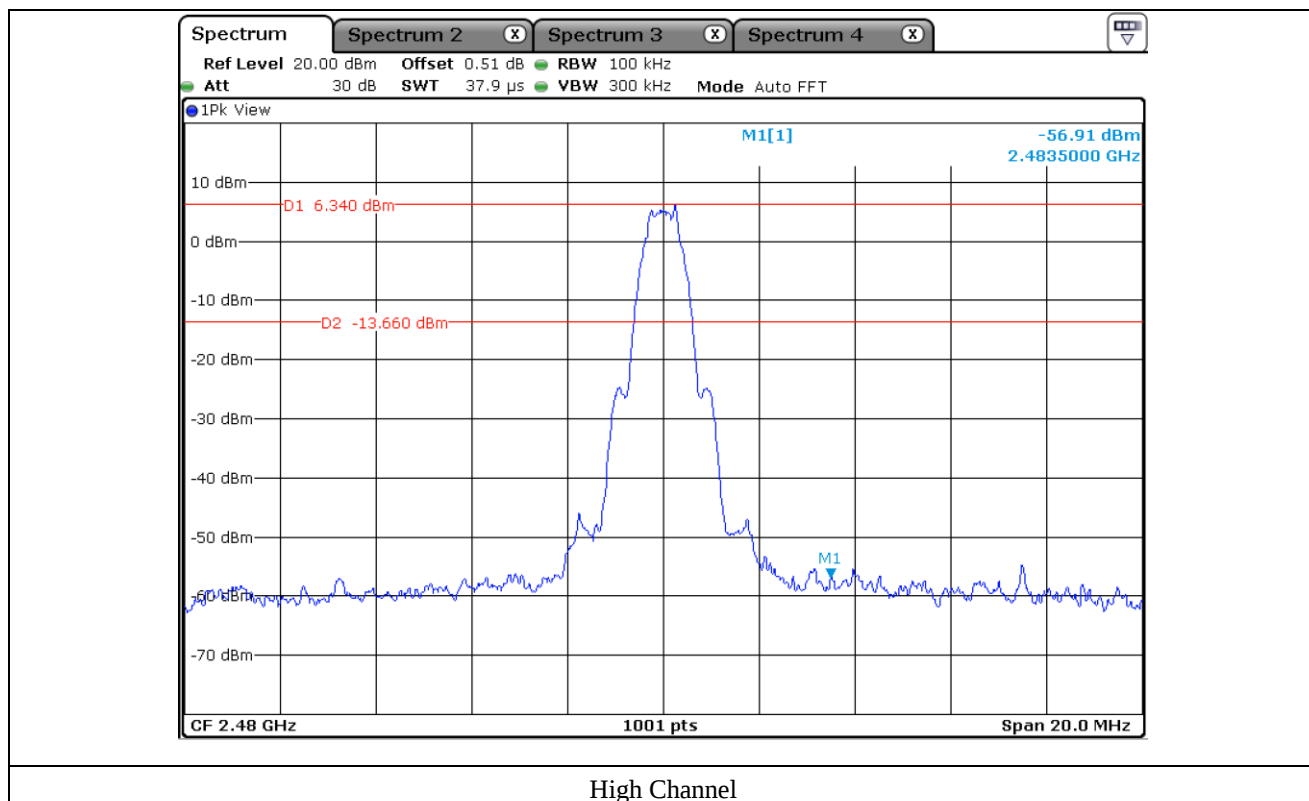


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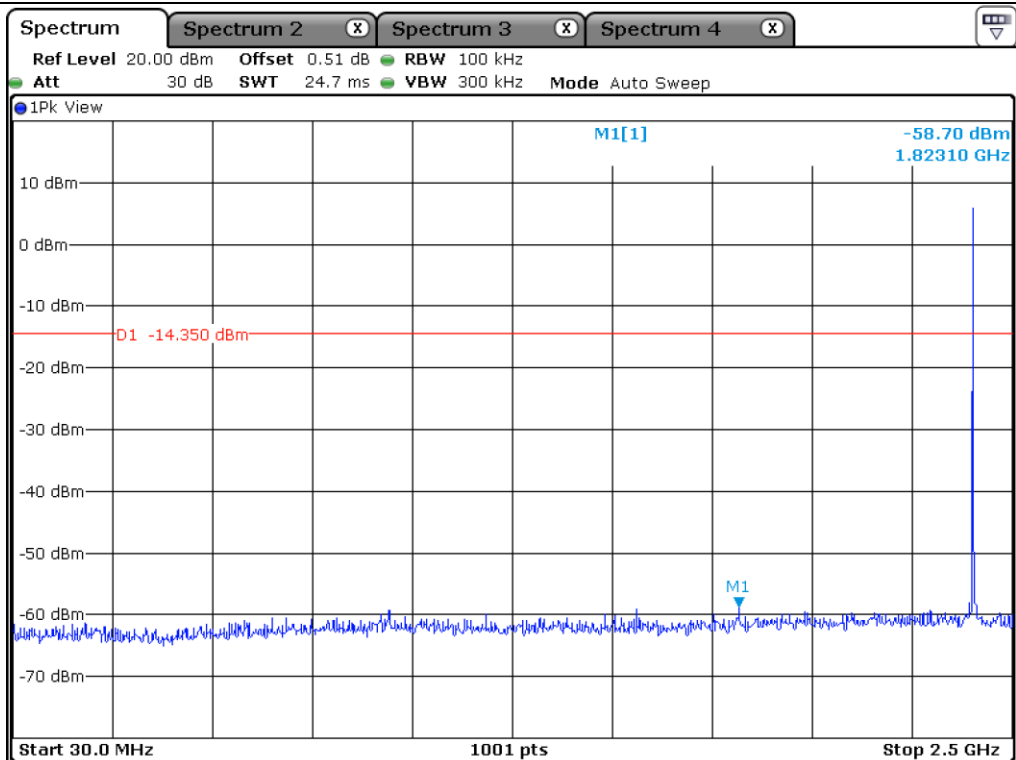
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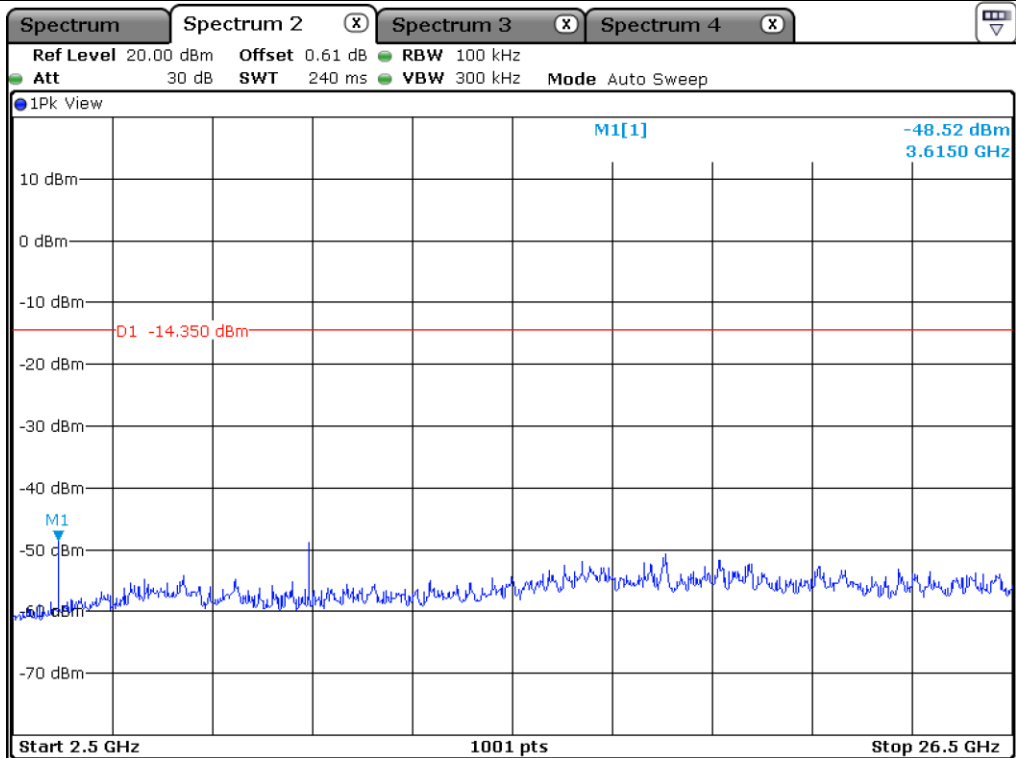
ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)



High Channel



Low Channel



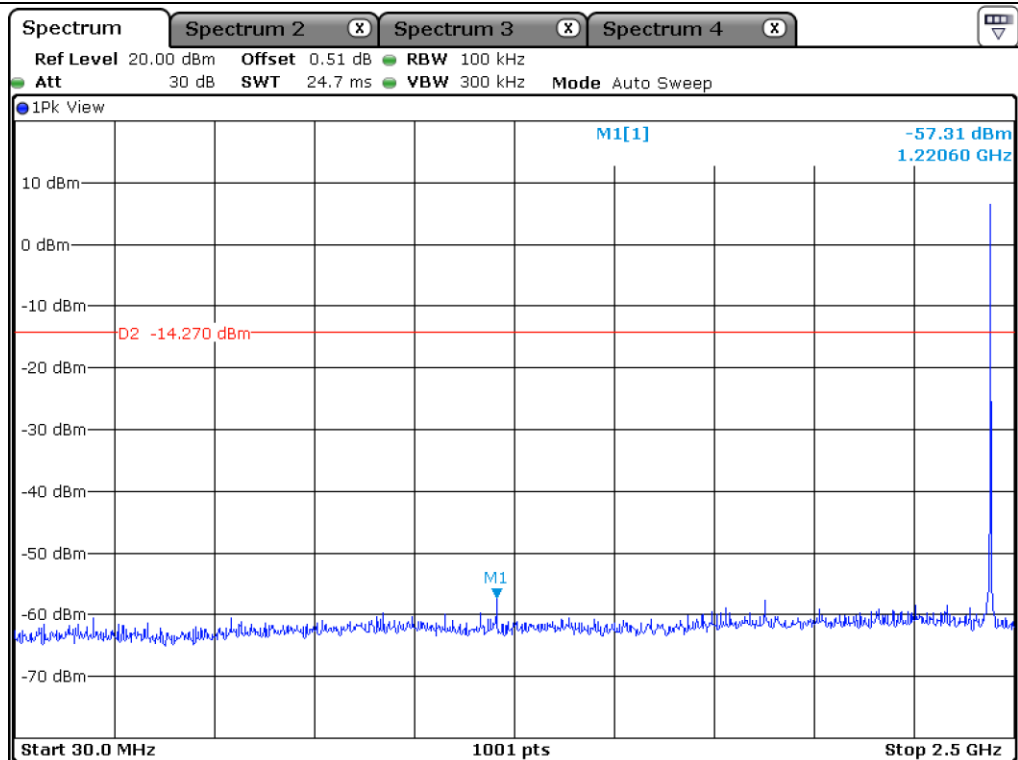
Low Channel

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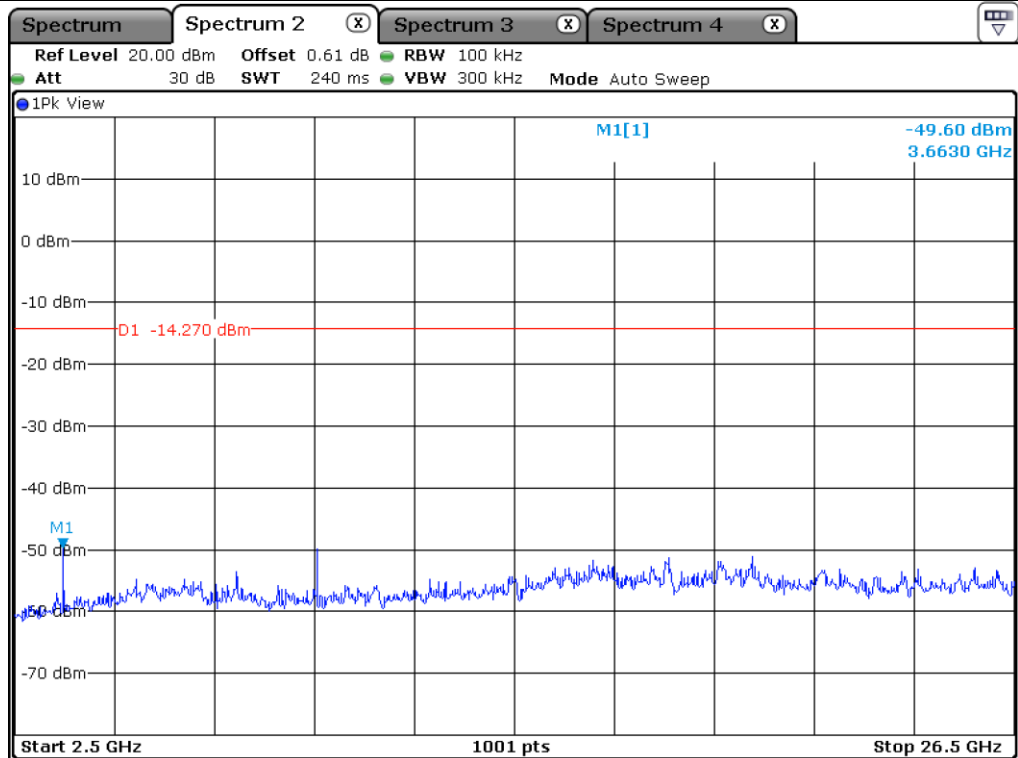
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Middle Channel



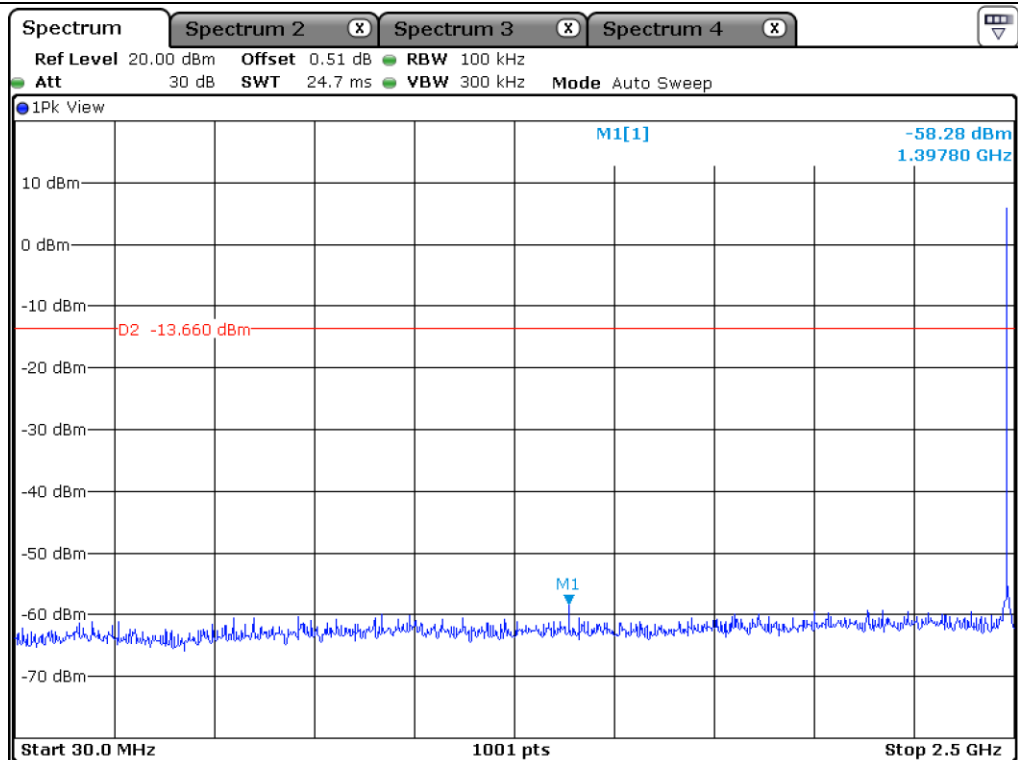
Middle Channel

This Report is not correlated with the authentication of KOLAS

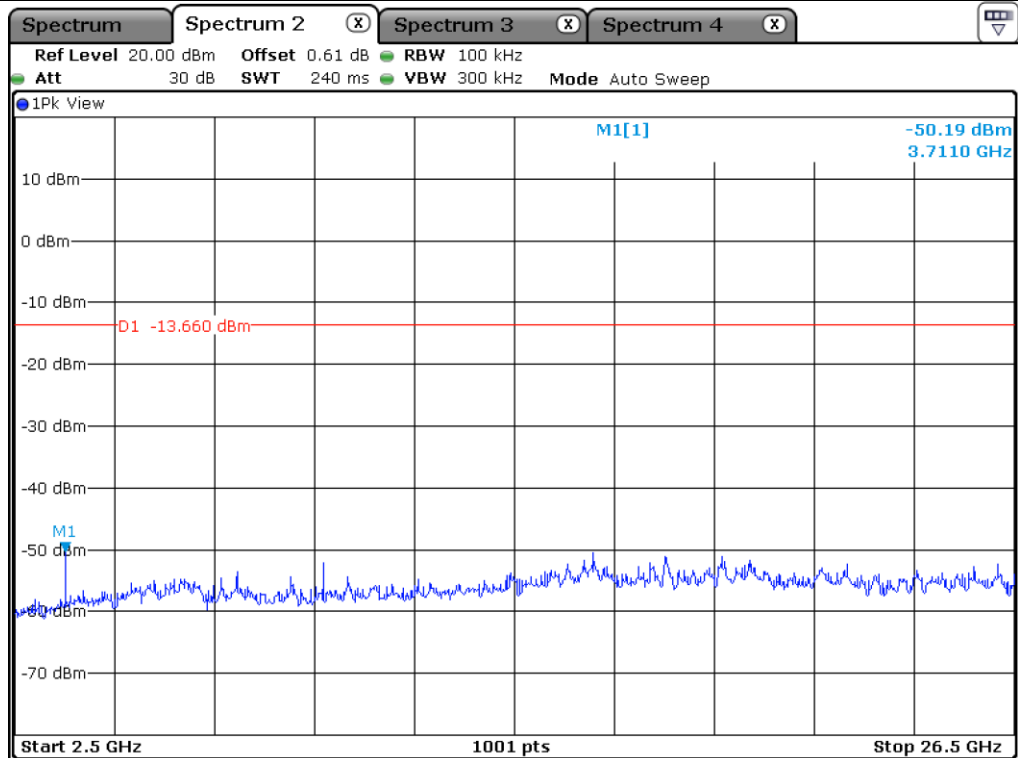
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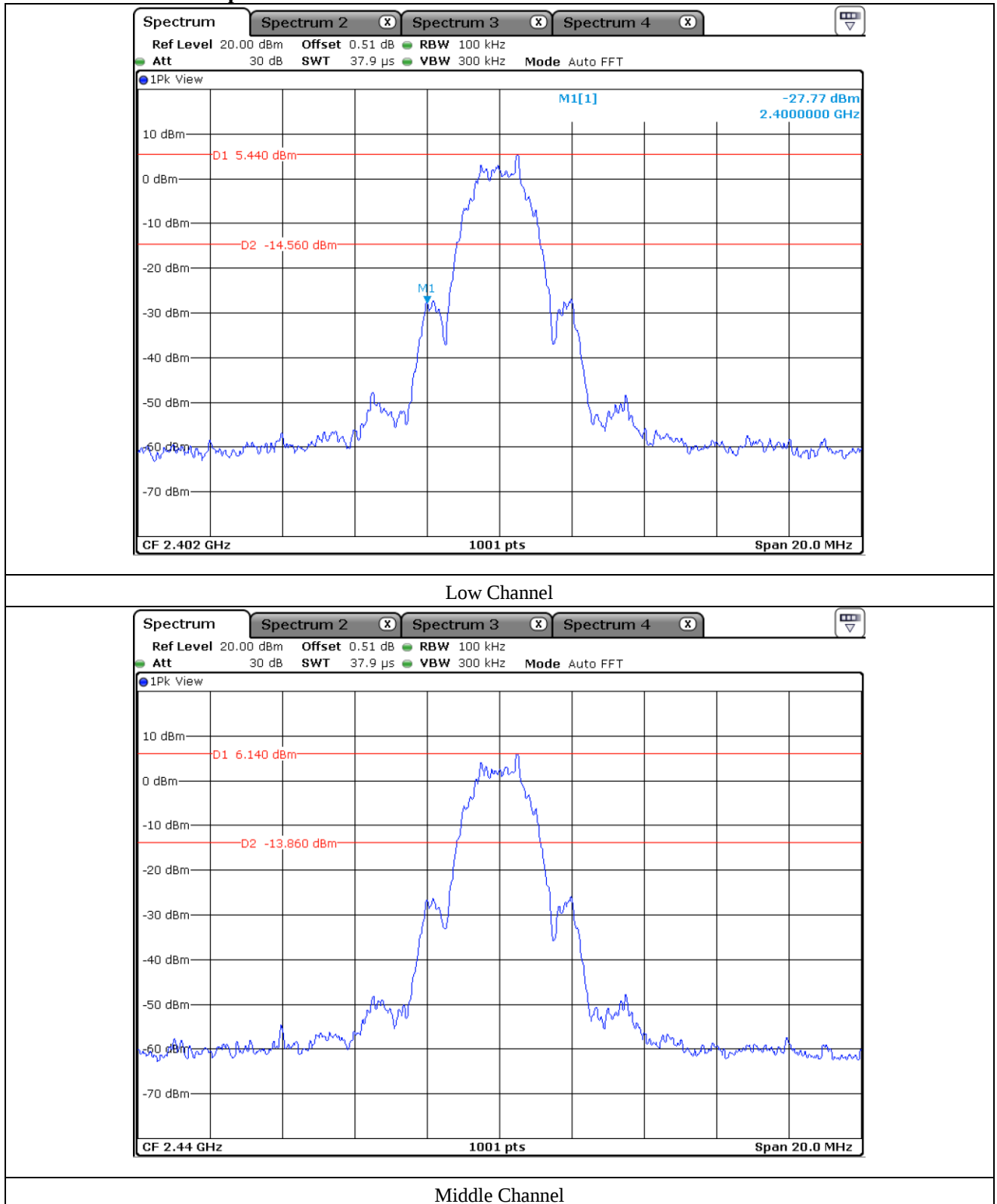


High Channel



High Channel

9.5.2 Test data for 2 Mbps

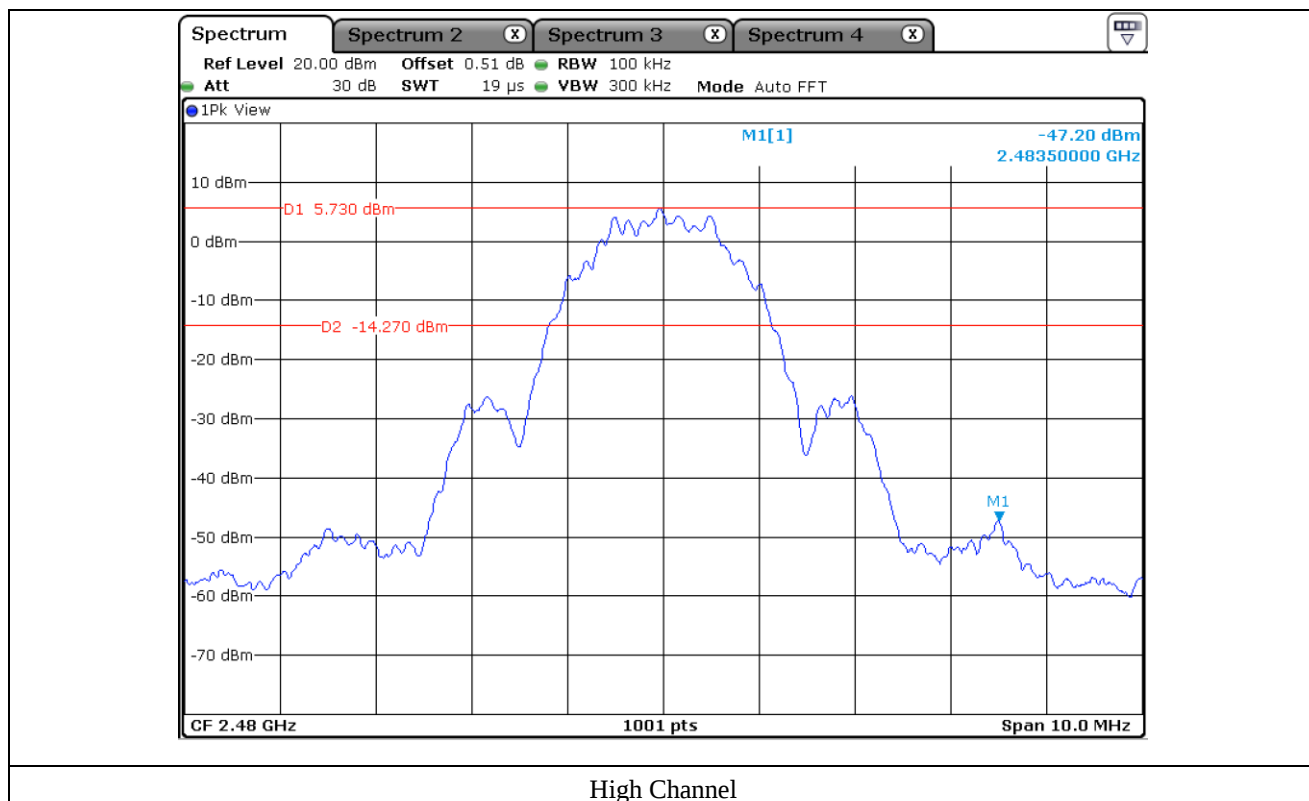


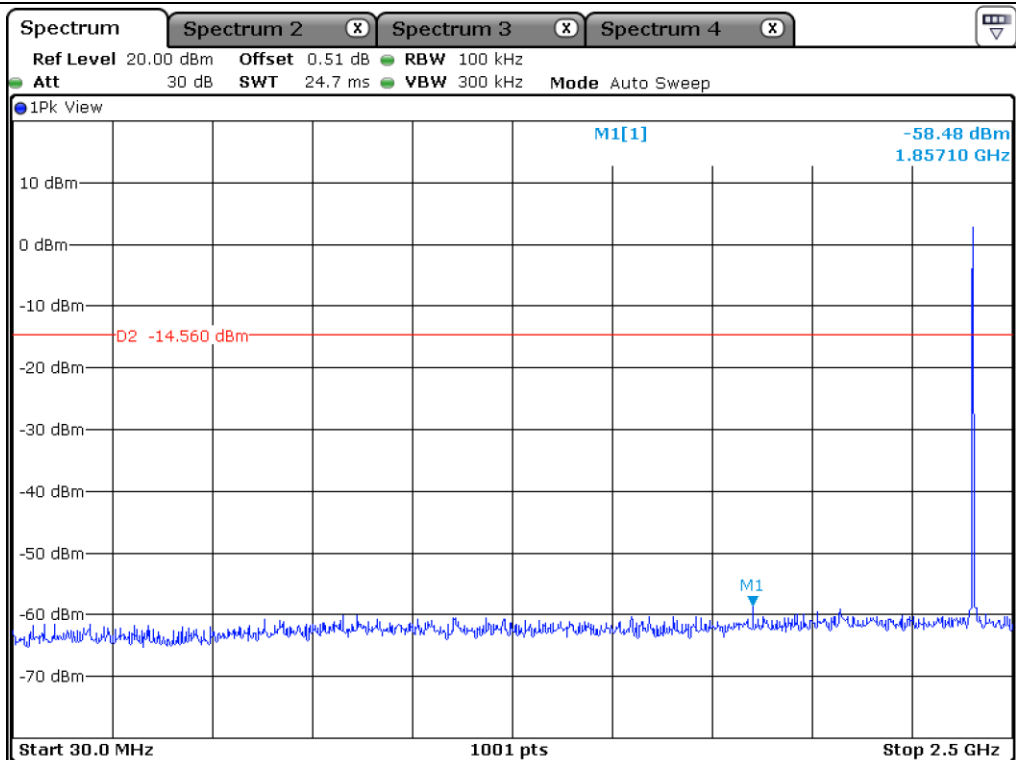
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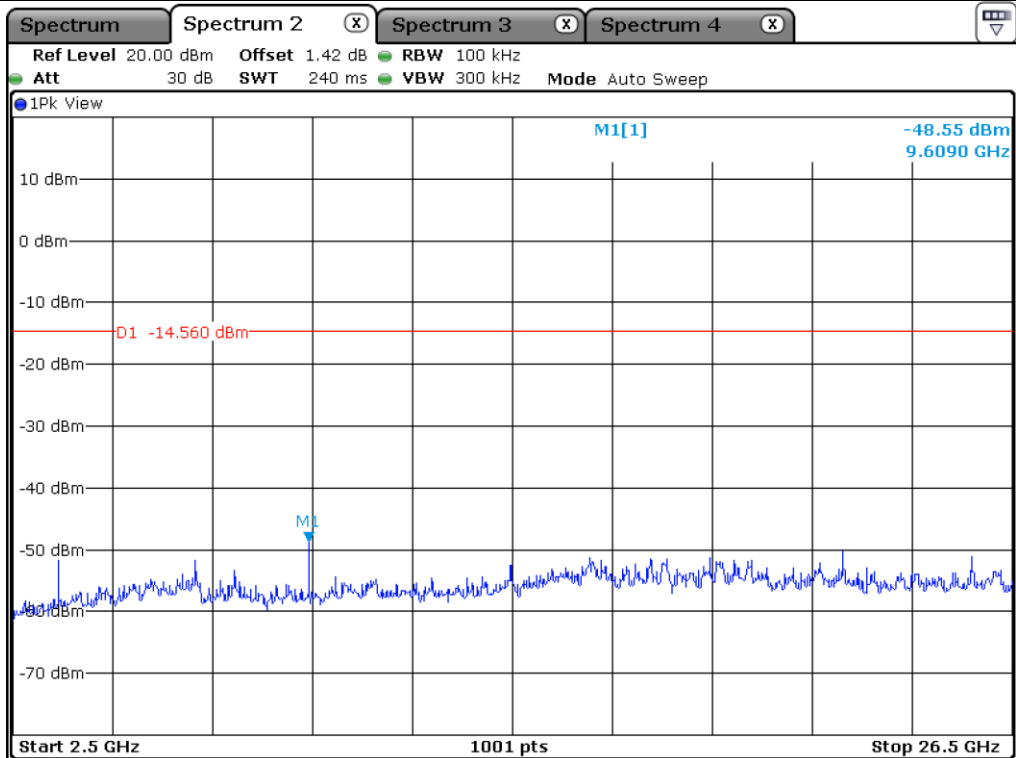
OTC-TRF-RF-001(0)

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

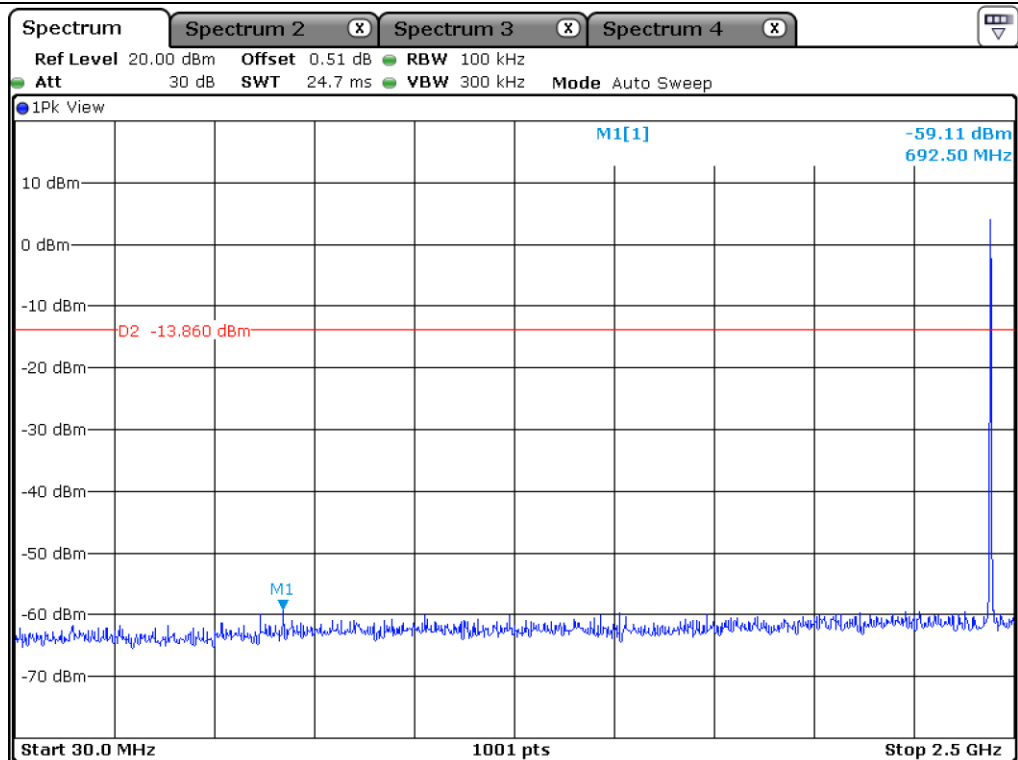




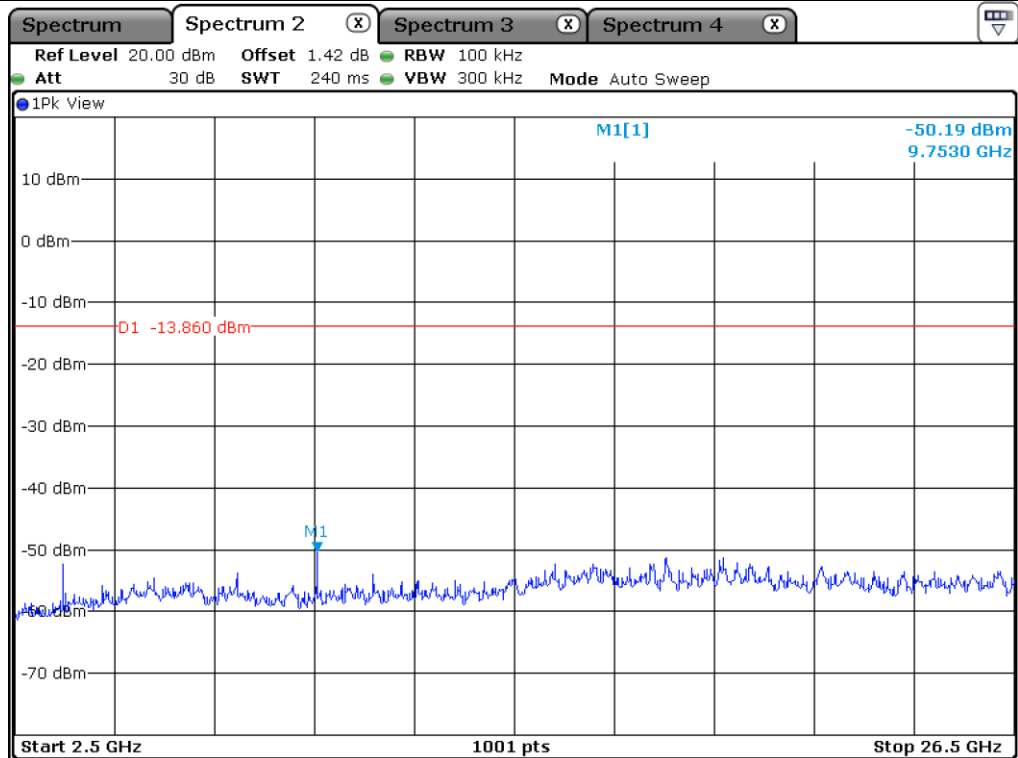
Low Channel



Low Channel



Middle Channel



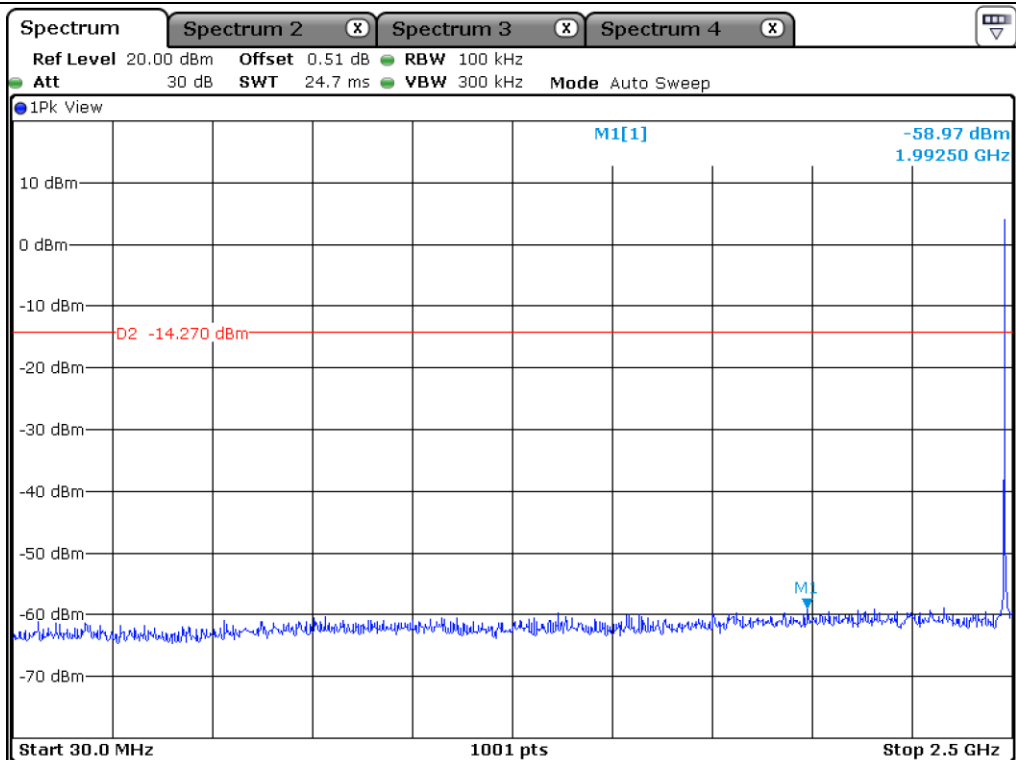
Middle Channel

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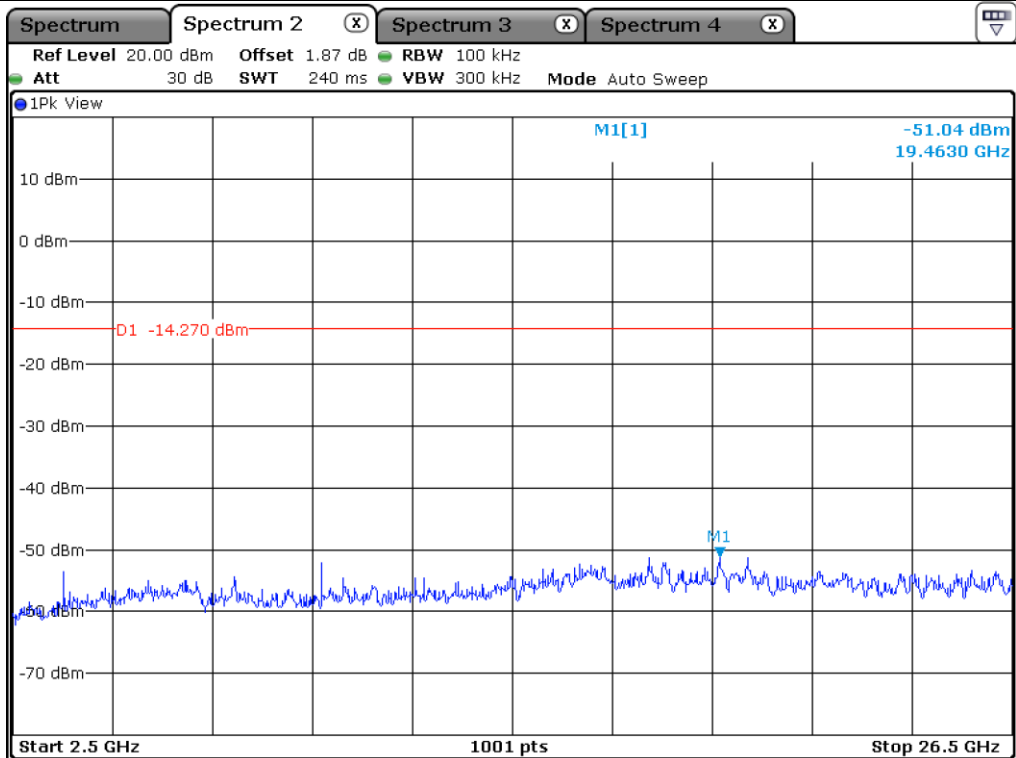
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High Channel



High Channel

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9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

9.6.1.1 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 : 84.80 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 385.043	48.82	Peak	H	27.60	7.23	-	41.90	41.75	74.00	32.25
2 339.890	39.78	Average	H	27.60	7.23	0.72	41.90	33.43	54.00	20.57
2 338.550	47.85	Peak	V	27.60	7.23	-	41.90	40.78	74.00	33.22
2 351.610	39.15	Average	V	27.60	7.23	0.72	41.90	32.80	54.00	21.20
Test Data for High Channel										
2 483.500	61.95	Peak	H	27.40	7.35	-	41.70	55.00	74.00	19.00
2 483.500	51.50	Average	H	27.40	7.35	0.72	41.70	45.27	54.00	8.73
2 483.500	60.68	Peak	V	27.40	7.35	-	41.70	53.73	74.00	20.27
2 483.500	50.23	Average	V	27.40	7.35	0.72	41.70	44.00	54.00	10.00

Tabulated test data for Restricted Band

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

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

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

9.6.1.2 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 : 56.91 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 377.598	51.09	Peak	H	27.60	7.23	-	41.90	44.02	74.00	29.98
2 388.490	38.12	Average	H	27.60	7.23	2.45	41.90	33.50	54.00	20.50
2 384.661	50.14	Peak	V	27.60	7.23	-	41.90	43.07	74.00	30.93
2 378.551	38.31	Average	V	27.60	7.23	2.45	41.90	33.69	54.00	20.31
Test Data for High Channel										
2 483.500	61.95	Peak	H	27.40	7.35	-	41.70	55.00	74.00	19.00
2 483.500	53.28	Average	H	27.40	7.35	2.45	41.70	48.78	54.00	5.22
2 483.500	60.17	Peak	V	27.40	7.35	-	41.70	53.22	74.00	20.78
2 483.500	52.57	Average	V	27.40	7.35	2.45	41.70	48.07	54.00	5.93

Tabulated test data for Restricted Band

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

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

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

9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz 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 : 84.80 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.000	45.21	Peak	H	31.20	9.48	-	41.30	44.59	74.00	29.41
4 804.000	35.46	Average	H	31.20	9.48	0.72	41.30	35.56	54.00	18.44
4 804.000	45.18	Peak	V	31.20	9.48	-	41.30	44.56	74.00	29.44
4 804.000	35.32	Average	V	31.20	9.48	0.72	41.30	35.42	54.00	18.58
Test Data for Middle Channel										
4 880.000	45.26	Peak	H	31.20	9.56	-	41.30	44.72	74.00	29.28
4 880.000	35.18	Average	H	31.20	9.56	0.72	41.30	35.36	54.00	18.64
4 880.000	45.33	Peak	V	31.20	9.56	-	41.30	44.79	74.00	29.21
4 880.000	35.26	Average	V	31.20	9.56	0.72	41.30	35.44	54.00	18.56
Test Data for High Channel										
4 960.000	45.31	Peak	H	31.30	9.61	-	41.50	44.72	74.00	29.28
4 960.000	35.26	Average	H	31.30	9.61	0.72	41.50	35.39	54.00	18.61
4 960.000	45.28	Peak	V	31.30	9.61	-	41.50	44.69	74.00	29.31
4 960.000	35.17	Average	V	31.30	9.61	0.72	41.50	35.30	54.00	18.70

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

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

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

9.6.2.2 Test data for 2 Mbps

- . Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz 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 : 56.91 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4804.000	44.65	Peak	H	31.20	9.48	-	41.30	44.03	74.00	29.97
4804.000	35.16	Average	H	31.20	9.48	2.45	41.30	36.99	54.00	17.01
4804.000	45.67	Peak	V	31.20	9.48	-	41.30	45.05	74.00	28.95
4804.000	35.22	Average	V	31.20	9.48	2.45	41.30	37.05	54.00	16.95
Test Data for Middle Channel										
4880.000	46.51	Peak	H	31.20	9.56	-	41.30	45.97	74.00	28.03
4880.000	35.28	Average	H	31.20	9.56	2.45	41.30	37.19	54.00	16.81
4880.000	45.65	Peak	V	31.20	9.56	-	41.30	45.11	74.00	28.89
4880.000	35.31	Average	V	31.20	9.56	2.45	41.30	37.22	54.00	16.78
Test Data for High Channel										
4960.000	45.95	Peak	H	31.30	9.61	-	41.50	45.36	74.00	28.64
4960.000	35.33	Average	H	31.30	9.61	2.45	41.50	37.19	54.00	16.81
4960.000	45.61	Peak	V	31.30	9.61	-	41.50	45.02	74.00	28.98
4960.000	35.23	Average	V	31.30	9.61	2.45	41.50	37.09	54.00	16.91

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

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

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

10. PEAK POWER SPECTRAL DENSITY

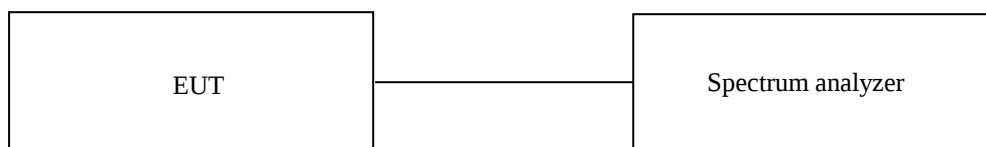
10.1 Operating environment

Temperature : 22 °C
Relative humidity : 44 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test Date

May 10, 2021 ~ May 26, 2021

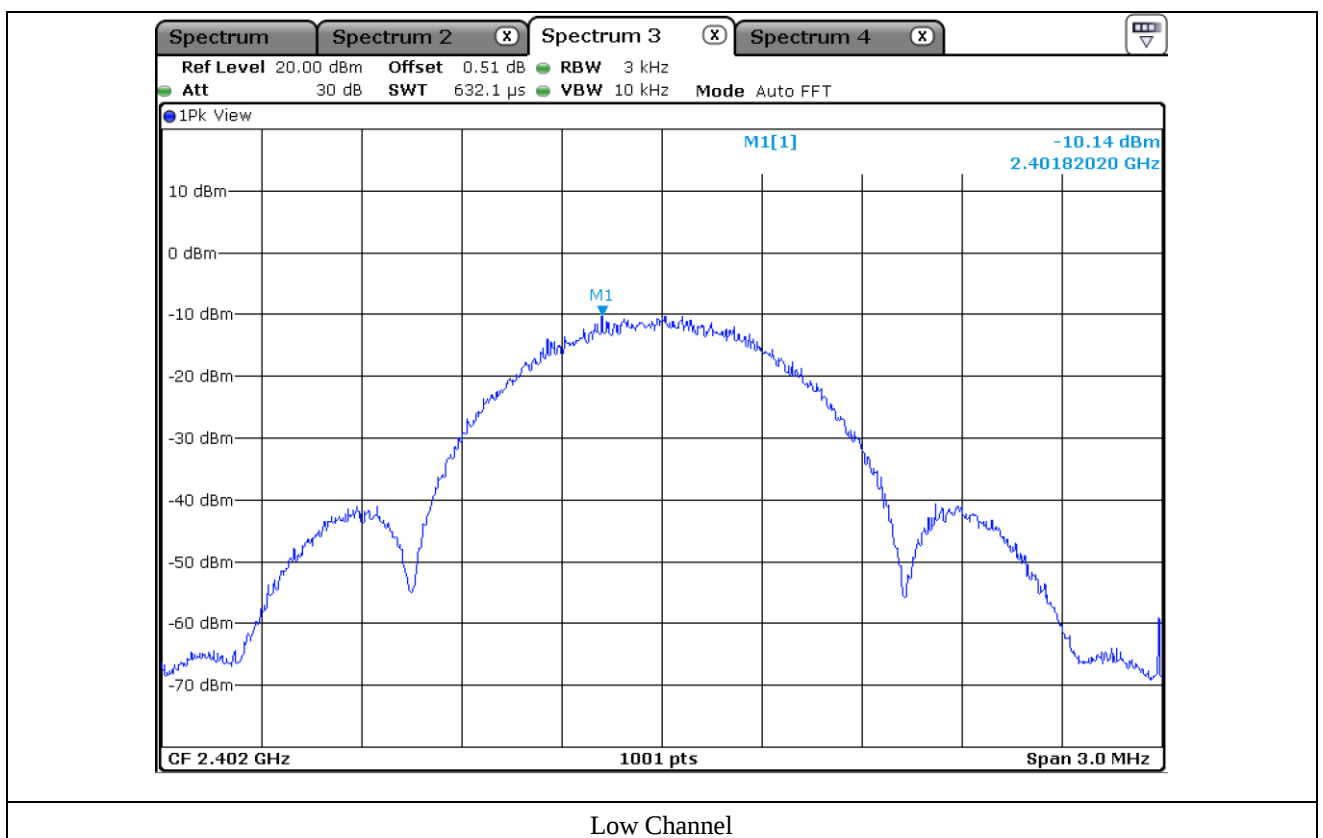
10.4 Test data for 1 Mbps

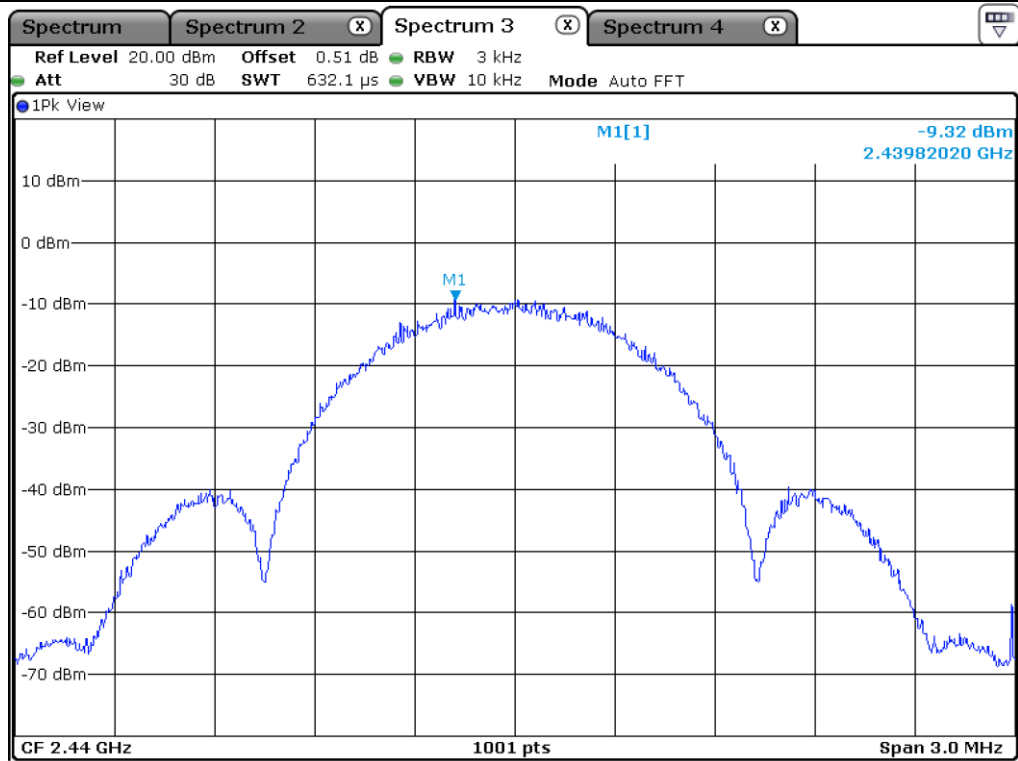
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

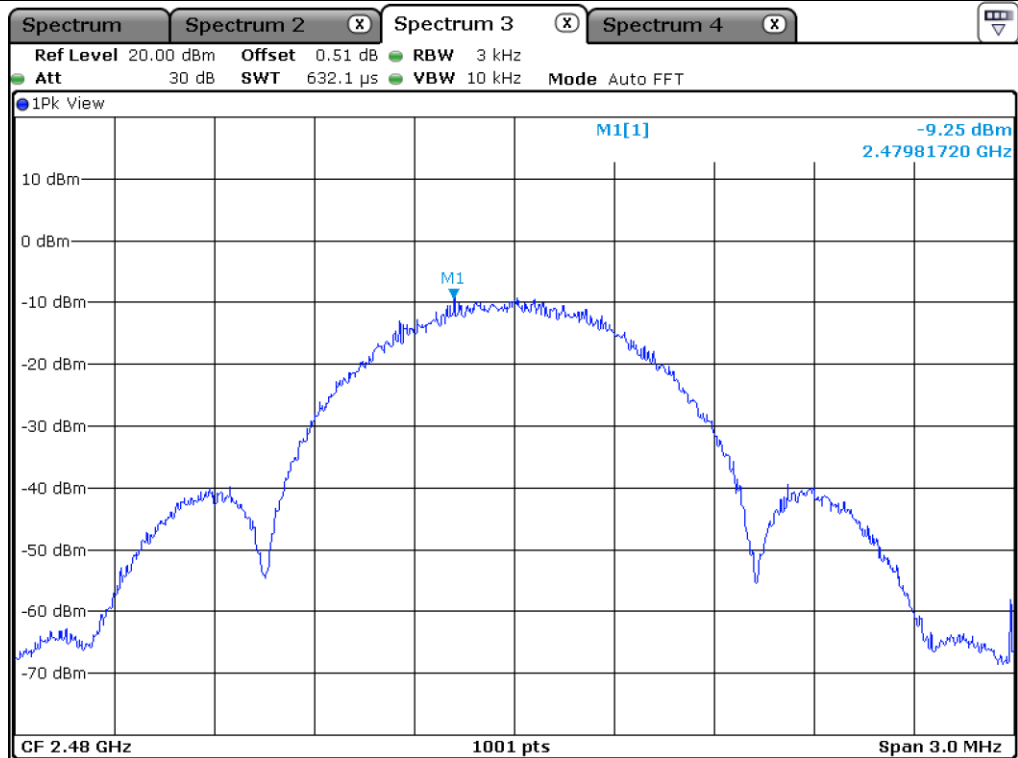
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-10.14	8.00	18.14
Middle	2 440.00	-9.32	8.00	17.32
High	2 480.00	-9.25	8.00	17.25

Remark. Margin = Limit – Measured value





Middle Channel



High Channel

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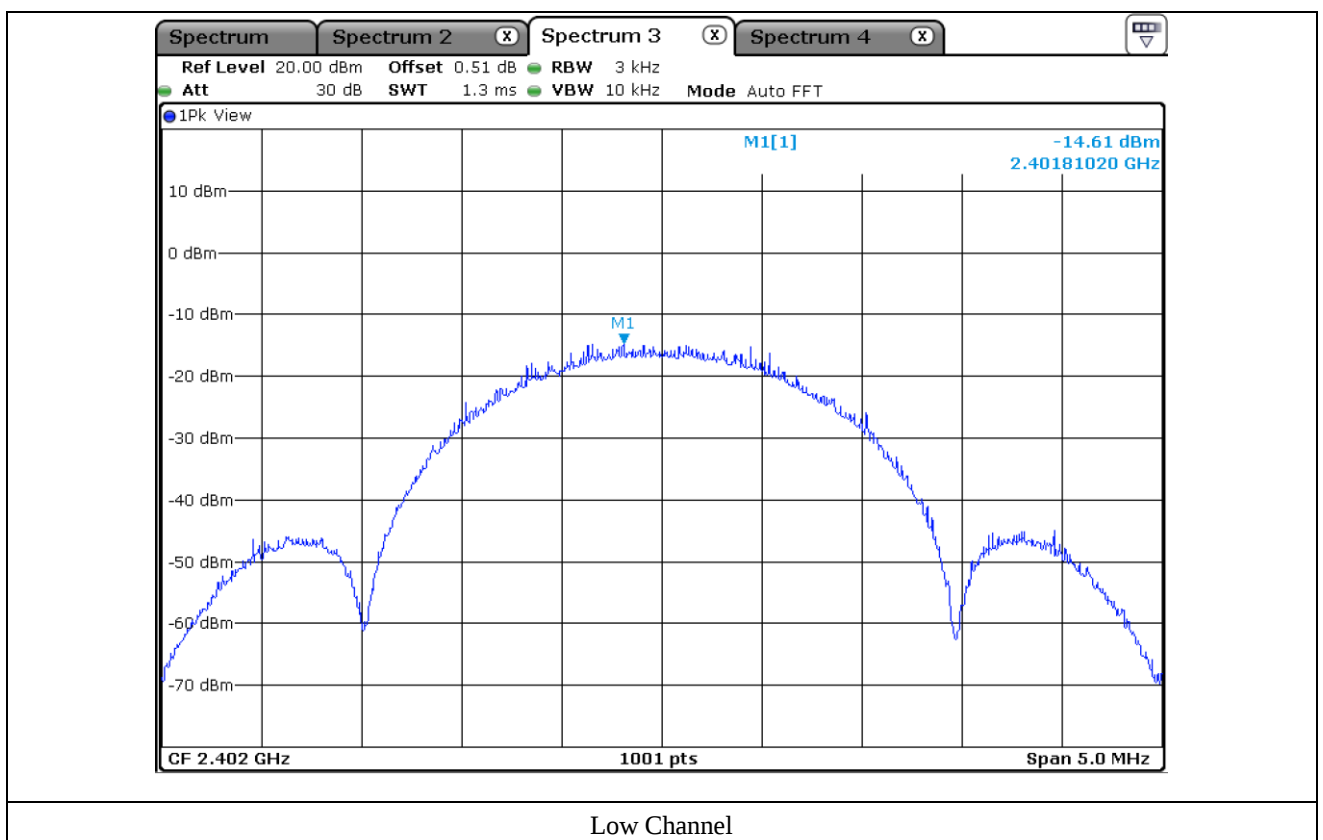
10.5 Test data for 2 Mbps

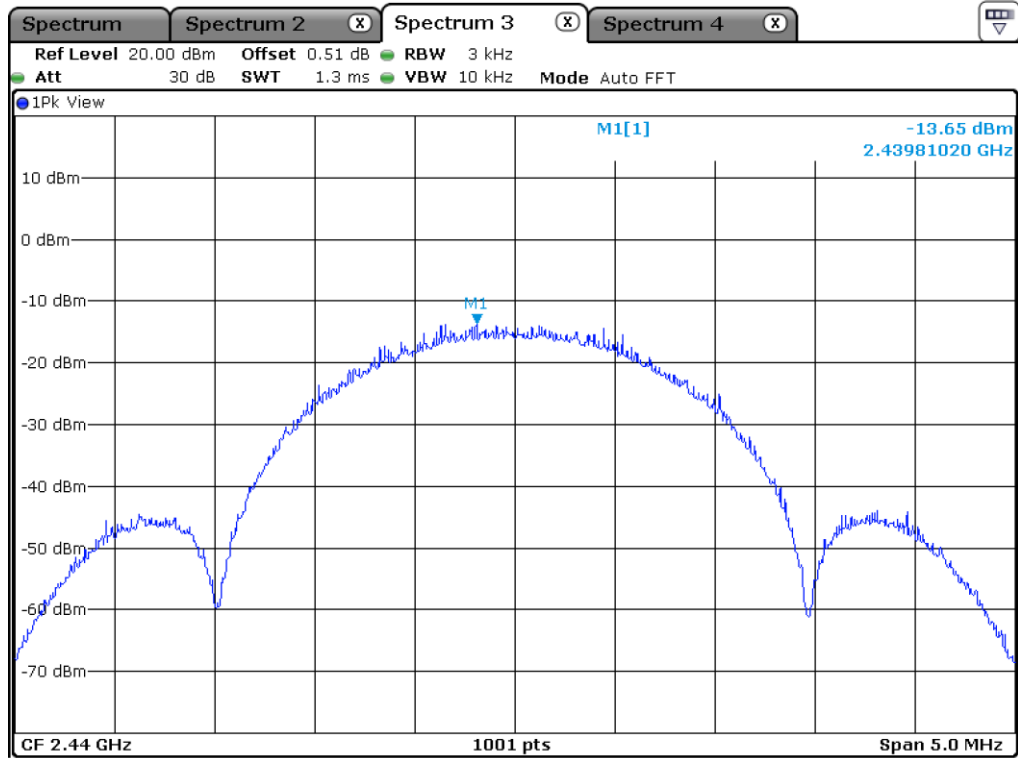
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

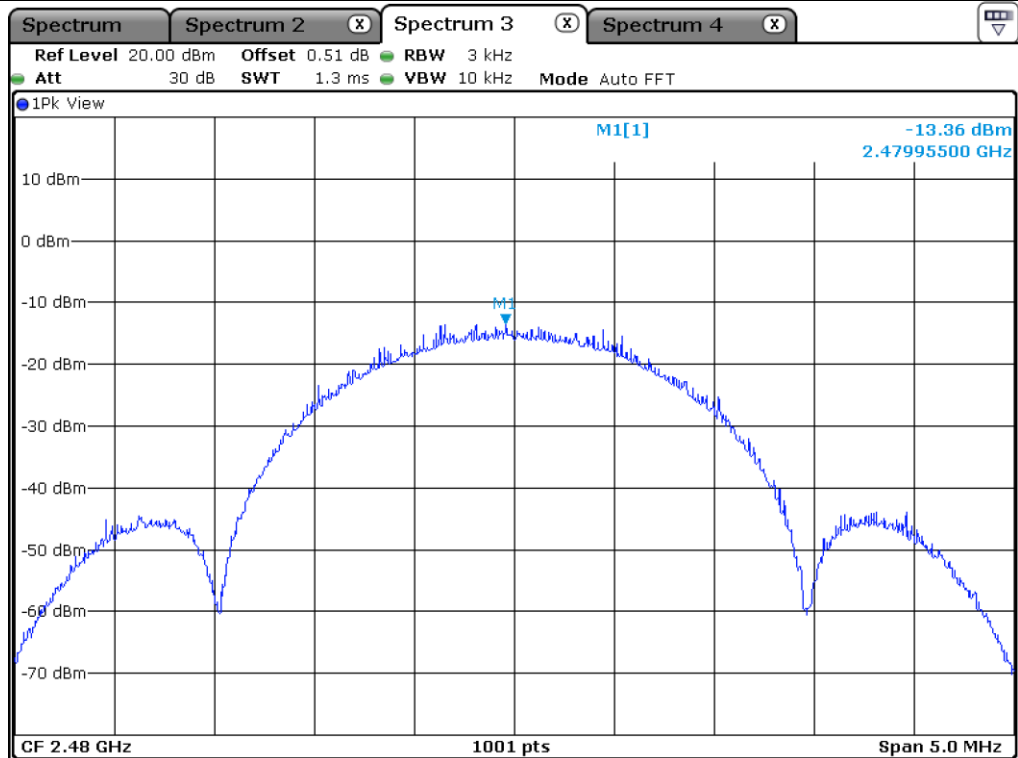
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-14.61	8.00	22.61
Middle	2 440.00	-13.65	8.00	21.65
High	2 480.00	-13.36	8.00	21.36

Remark. Margin = Limit – Measured value





Middle Channel



High Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 22 °C
Relative humidity : 44 % R.H.

11.2 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.

11.3 Test Date

May 10, 2021 ~ May 26, 2021

11.4 Test data for 30 MHz ~ 1 000 MHz

11.4.1 Test data for Bluetooth LE

Humidity Level : 44 % R.H.

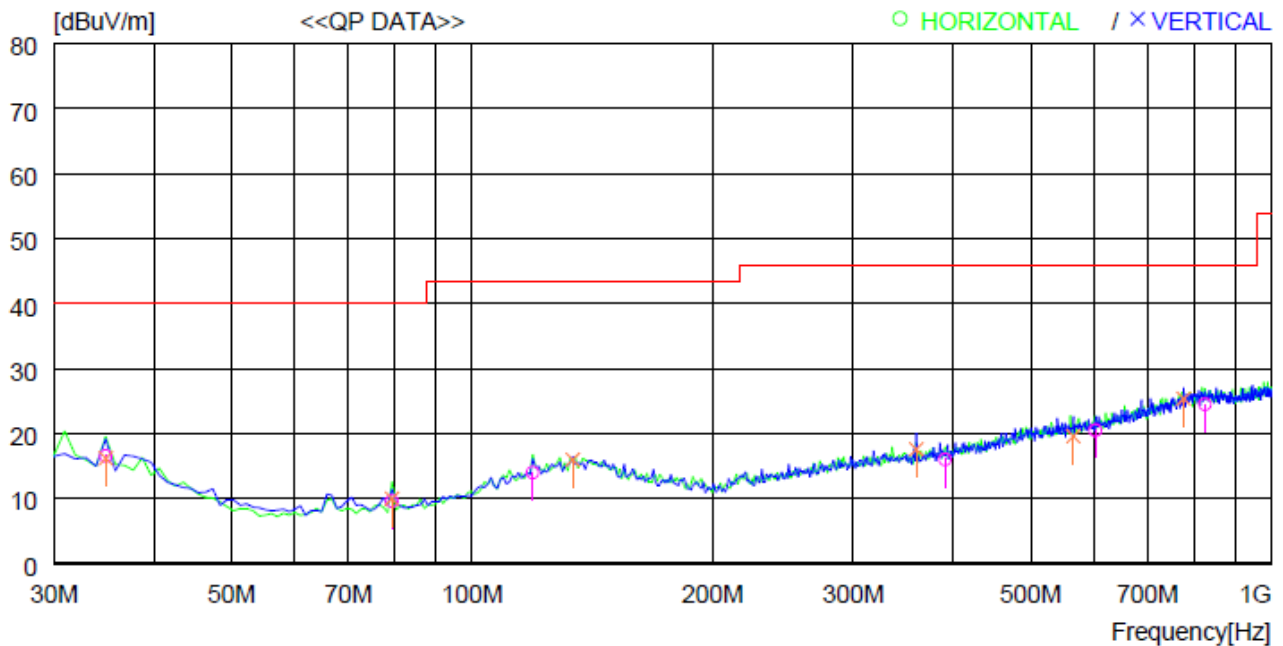
Temperature: 22 °C

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

Result : PASSED

EUT : Wi-Fi/BT Transceiver

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



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
		QP	FACTOR							
	[MHz]	[dBuV]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	34.850	28.8	19.2	0.6	32.0	16.6	40.0	23.4	400	359
2	79.470	27.7	12.9	1.0	32.0	9.6	40.0	30.4	100	0
3	119.240	26.3	18.5	1.2	32.0	14.0	43.5	29.5	400	359
4	390.840	25.3	20.4	2.4	32.1	16.0	46.0	30.0	400	359
5	602.298	25.8	24.2	2.9	32.4	20.5	46.0	25.5	200	129
6	826.361	25.1	27.2	4.1	31.9	24.5	46.0	21.5	400	273
----- Vertical -----										
7	34.850	28.4	19.2	0.6	32.0	16.2	40.0	23.8	400	0
8	79.470	28.1	12.9	1.0	32.0	10.0	40.0	30.0	300	359
9	133.790	27.5	19.2	1.3	32.0	16.0	43.5	27.5	400	0
10	359.800	27.6	19.9	2.2	32.1	17.6	46.0	28.4	400	0
11	565.439	25.3	23.8	2.9	32.4	19.6	46.0	26.4	300	359
12	776.893	26.7	26.8	4.0	32.1	25.4	46.0	20.6	300	220

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11.4.2 Test data for Intermodulation Mode(Bluetooth LE + WLAN 2.4 GHz + WLAN 5 GHz)

Humidity Level : 44 % R.H.

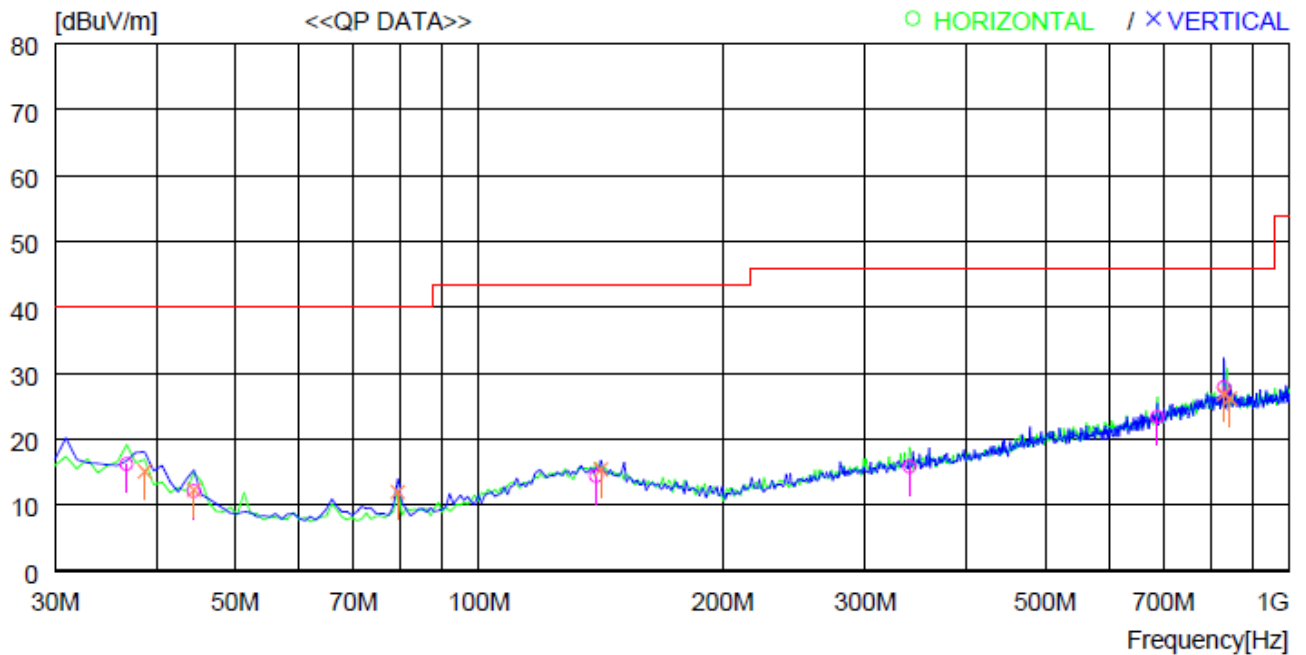
Temperature: 22 °C

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

Result : PASSED

EUT : Wi-Fi/BT Transceiver

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	36.790	29.2	18.4	0.6	32.0	16.2	40.0	23.8	400	127
2	44.550	28.1	15.3	0.7	32.0	12.1	40.0	27.9	300	167
3	139.610	25.7	19.4	1.3	32.0	14.4	43.5	29.1	100	358
4	340.400	25.9	19.7	2.2	32.0	15.8	46.0	30.2	300	200
5	687.655	26.9	25.4	3.4	32.3	23.4	46.0	22.6	300	256
6	831.211	28.5	27.2	4.1	31.9	27.9	46.0	18.1	200	2
----- Vertical -----										
7	38.730	28.7	17.7	0.7	32.0	15.1	40.0	24.9	200	40
8	44.550	28.3	15.3	0.7	32.0	12.3	40.0	27.7	200	359
9	79.470	30.1	12.9	1.0	32.0	12.0	40.0	28.0	200	359
10	141.550	26.7	19.3	1.4	32.0	15.4	43.5	28.1	200	350
11	831.211	27.5	27.2	4.1	31.9	26.9	46.0	19.1	300	0
12	844.791	26.9	27.2	4.0	31.9	26.2	46.0	19.8	200	304

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11.5 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
- . Operating mode : Transmitting mode

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

11.6 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
- . Operating mode : Transmitting mode

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

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 22 °C
Relative humidity : 44 % R.H.

12.2 Test set-up

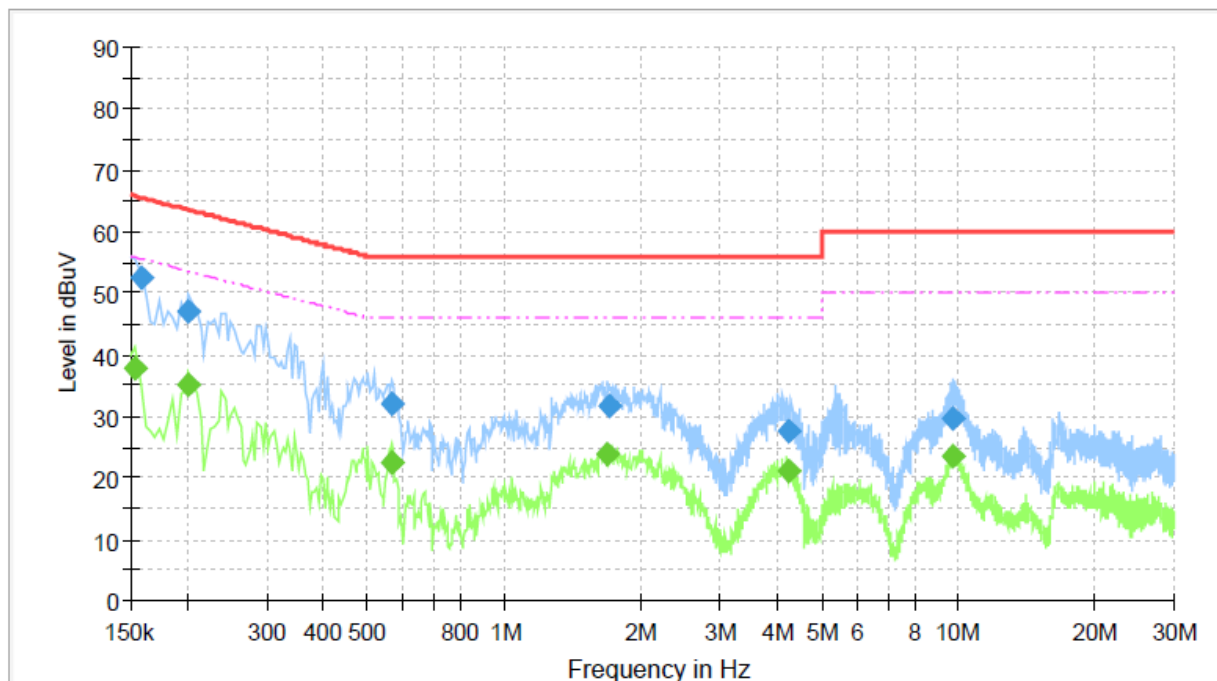
The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μ H + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

12.3 Test Date

May 10, 2021 ~ May 26, 2021

12.4 Test data for Bluetooth LE

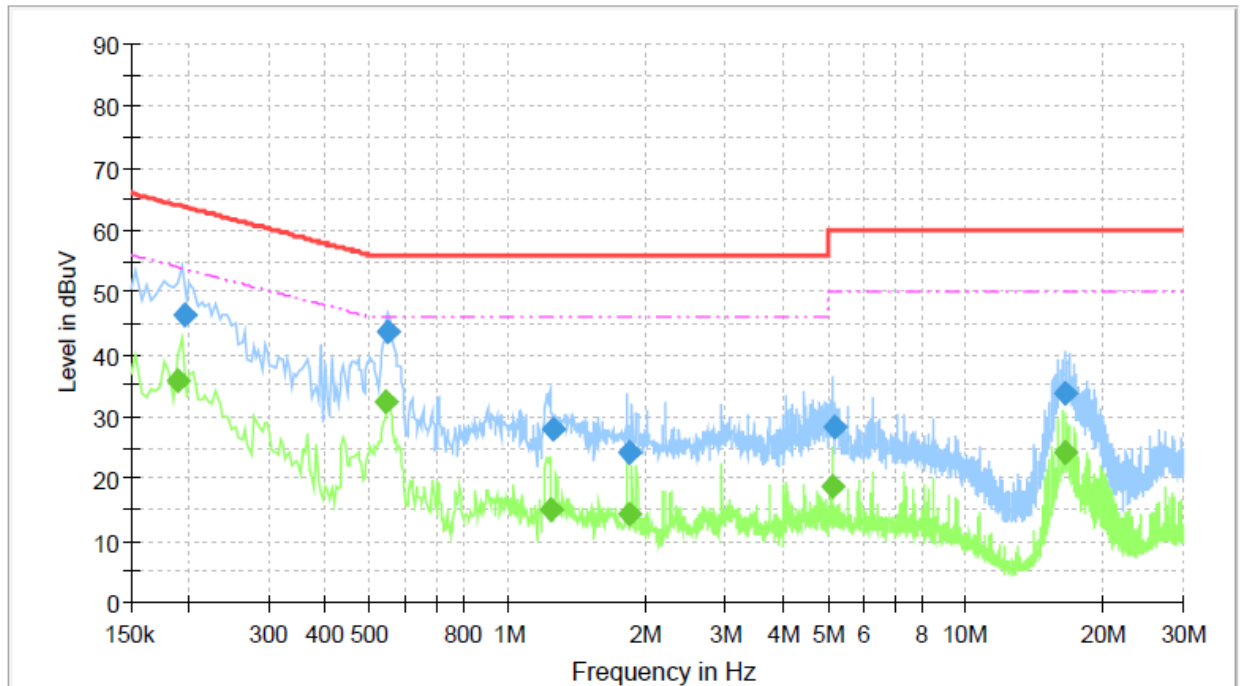
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : LIVE LINE



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
4.252	27.73	---	56.00	28.27	3000.0	9.0	L1	10.05
9.713	29.62	---	60.00	30.38	3000.0	9.0	L1	10.32
1.699	31.56	---	56.00	24.44	3000.0	9.0	L1	10.00
0.568	32.14	---	56.00	23.86	3000.0	9.0	L1	9.94
0.202	47.05	---	63.55	16.50	3000.0	9.0	L1	9.92
0.158	52.48	---	65.57	13.09	3000.0	9.0	L1	9.93
0.154	---	37.98	55.78	17.80	3000.0	9.0	L1	9.93
0.202	---	35.24	53.55	18.31	3000.0	9.0	L1	9.92
0.568	---	22.67	46.00	23.33	3000.0	9.0	L1	9.94
1.677	---	23.93	46.00	22.07	3000.0	9.0	L1	10.00
4.228	---	21.16	46.00	24.84	3000.0	9.0	L1	10.05
9.757	---	23.63	50.00	26.37	3000.0	9.0	L1	10.32

-. Tested Line : NEUTRAL LINE



Final Result

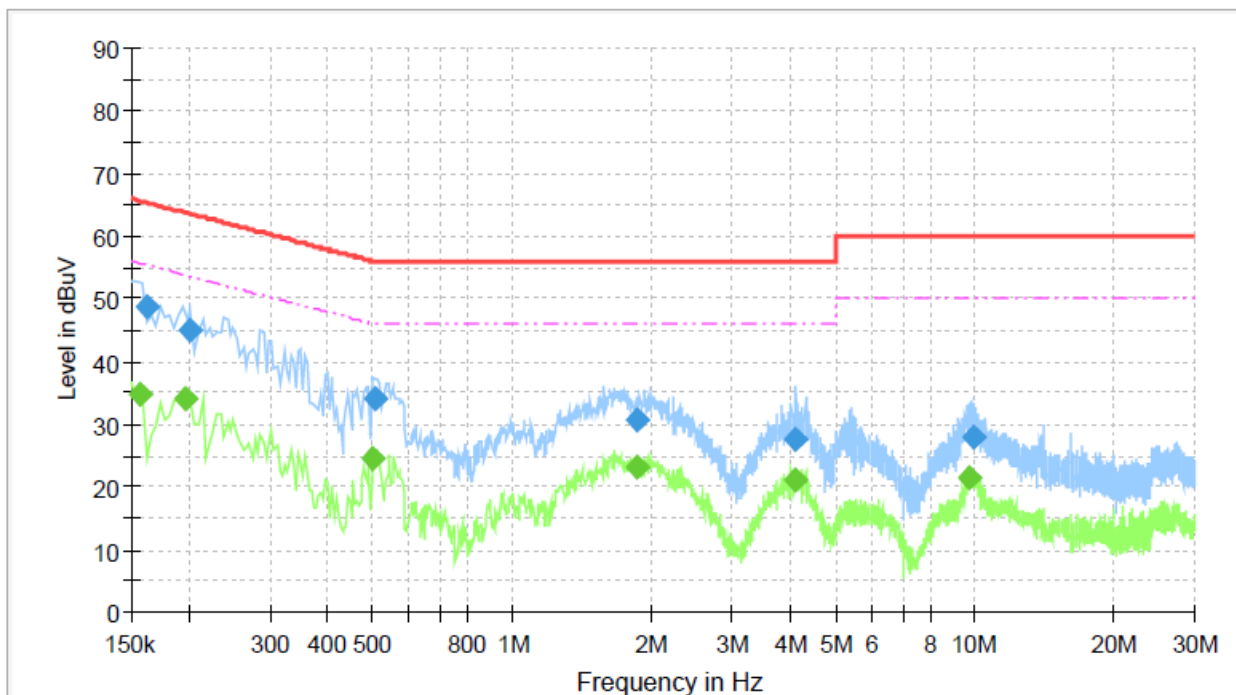
Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
1.840	24.20	---	56.00	31.80	3000.0	9.0	N	10.02
1.250	27.85	---	56.00	28.15	3000.0	9.0	N	10.00
5.198	28.34	---	60.00	31.66	3000.0	9.0	N	10.10
16.576	33.75	---	60.00	26.25	3000.0	9.0	N	10.68
0.545	43.63	---	56.00	12.37	3000.0	9.0	N	9.95
0.198	46.37	---	63.72	17.35	3000.0	9.0	N	9.94
0.190	---	35.88	54.06	18.18	3000.0	9.0	N	9.94
0.541	---	32.47	46.00	13.53	3000.0	9.0	N	9.95
1.242	---	15.03	46.00	30.97	3000.0	9.0	N	10.00
1.840	---	14.17	46.00	31.83	3000.0	9.0	N	10.02
5.106	---	18.63	50.00	31.37	3000.0	9.0	N	10.10
16.605	---	24.31	50.00	25.69	3000.0	9.0	N	10.68

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.

12.5 Test data for Intermodulation Mode(Bluetooth LE + WLAN 2.4 GHz + WLAN 5 GHz)

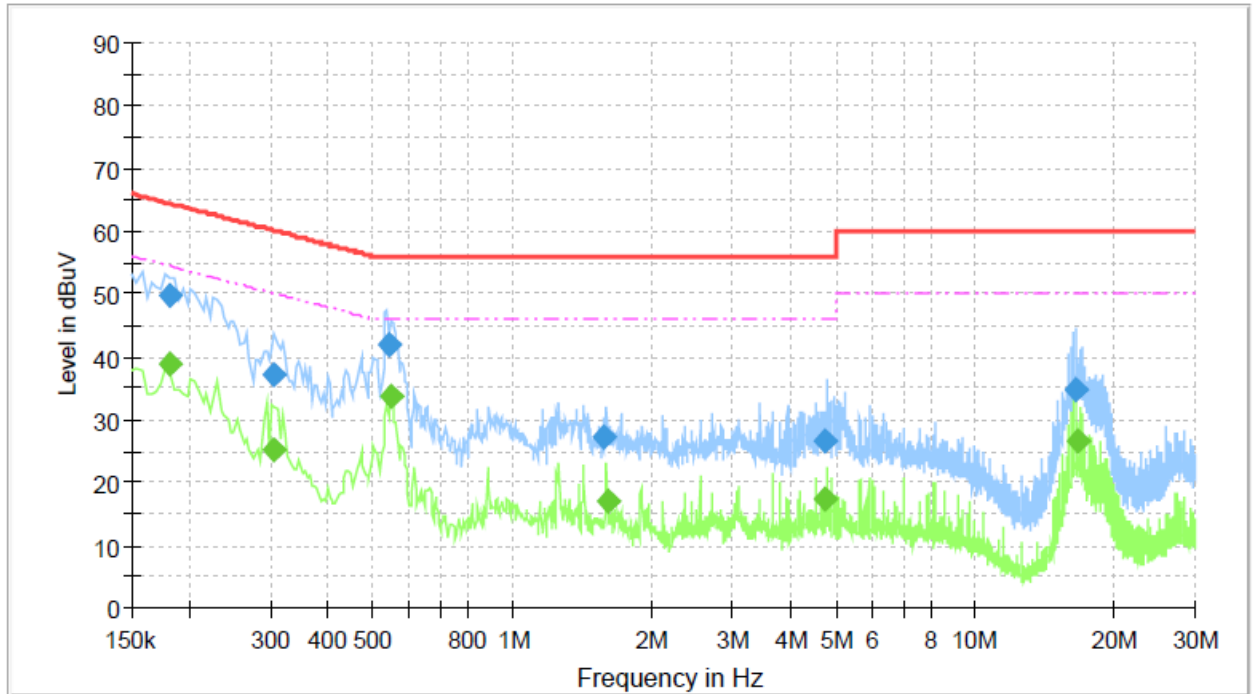
- . Resolution bandwidth : 9 kHz
- . Frequency range : 0.15 MHz ~ 30 MHz
- . Tested Line : LIVE LINE



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
4.105	27.71	---	56.00	28.29	3000.0	9.0	L1	10.05
9.911	27.84	---	60.00	32.16	3000.0	9.0	L1	10.33
1.873	30.79	---	56.00	25.21	3000.0	9.0	L1	10.01
0.505	34.18	---	56.00	21.82	3000.0	9.0	L1	9.93
0.202	44.90	---	63.55	18.65	3000.0	9.0	L1	9.92
0.162	48.66	---	65.39	16.73	3000.0	9.0	L1	9.92
0.158	---	34.75	55.60	20.84	3000.0	9.0	L1	9.93
0.198	---	34.17	53.72	19.54	3000.0	9.0	L1	9.92
0.501	---	24.52	46.00	21.48	3000.0	9.0	L1	9.93
1.867	---	23.13	46.00	22.87	3000.0	9.0	L1	10.01
4.077	---	21.17	46.00	24.83	3000.0	9.0	L1	10.05
9.783	---	21.40	50.00	28.60	3000.0	9.0	L1	10.32

-. Tested Line : NEUTRAL LINE



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
4.754	26.50	---	56.00	29.50	3000.0	9.0	N	10.08
1.582	27.39	---	56.00	28.61	3000.0	9.0	N	10.01
16.573	34.72	---	60.00	25.28	3000.0	9.0	N	10.68
0.306	37.18	---	60.09	22.91	3000.0	9.0	N	9.94
0.539	41.97	---	56.00	14.03	3000.0	9.0	N	9.95
0.181	49.72	---	64.42	14.69	3000.0	9.0	N	9.94
0.182	---	38.83	54.42	15.59	3000.0	9.0	N	9.94
0.306	---	25.17	50.09	24.92	3000.0	9.0	N	9.94
0.549	---	33.63	46.00	12.37	3000.0	9.0	N	9.95
1.614	---	16.88	46.00	29.12	3000.0	9.0	N	10.01
4.742	---	17.50	46.00	28.50	3000.0	9.0	N	10.08
16.637	---	26.60	50.00	23.40	3000.0	9.0	N	10.68

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.

13. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	102177	Apr. 16, 2021 (1Y)
FSW43	Rohde & Schwarz	Signal Analyzer	104544	Jul. 15, 2020 (1Y)
ESW 44	Rohde & Schwarz	EMI Test Receiver	101851	Mar. 23, 2021 (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, 2021(1Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter	N/A	Feb. 08, 2021 (1Y)
ESR3	Rohde & Schwarz	EMI TEST RECEIVER	102602	Mar. 15, 2021 (1Y)
NSLK8126	Schwarzbeck	AMN	8126-404	Mar. 15, 2021 (1Y)
ESH3Z2	Rohde & Schwarz	PULSE LIMITER	357.8810.52	Mar. 15, 2021 (1Y)

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