

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-19D-RWD-052
AGR No. : A19NA-376
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. : A3LWCT732M
Model Name : WCT732M
Serial number : N/A
Total page of Report : 55 pages (including this page)
Date of Incoming : November 29, 2019
Date of issue : December 16, 2019

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.

Reviewed by: 

Yu-Seog Sim / Assistant Manager
ONETECH Corp.

Approved by: 

Jae-Ho Lee / Chief Engineer
ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-19D-RWD-052	December 16, 2019	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 : minhyung, cho / Senior Engineer

Telephone No. : +82-31-277-2688

FCC ID : A3LWCT732M

Model Name : WCT732M

Brand Name : 

Serial Number : N/A

Date : December 16, 2019

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-4112/ C-14617/ G-10666 / T-1842

-. Lab Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The Samsung Electronics Co Ltd, Model WCT732M (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 ~ 5 700 MHz (802.11a/n(HT20)/ac(VHT20))
		5 510 MHz ~ 5 670 MHz (802.11n(HT40)/ac(VHT40))
		5 530 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	12.27 dBm
		2 Mbps	12.26 dBm
	Bluetooth	1 Mbps	11.23 dBm
		2 Mbps	10.79 dBm
		3 Mbps	10.99 dBm
	WLAN 2.4 GHz	Antenna 0	19.25 dBm(802.11b) 15.07 dBm(802.11g) 14.01 dBm(802.11n_HT20) 12.23 dBm(802.11n_HT40)
		Antenna 1	20.53 dBm(802.11b) 16.02 dBm(802.11g) 14.99 dBm(802.11n_HT20) 13.61 dBm(802.11n_HT40)
		Multiple Antenna	18.53 dBm(802.11g) 17.49 dBm(802.11n_HT20) 15.95 dBm(802.11n_HT40)

RF OUTPUT POWER	5 150 MHz ~ 5 250 MHz Band	Antenna 0	11.73 dBm(802.11a) 10.58 dBm(802.11n_HT20) 9.20 dBm(802.11n_HT40) 8.70 dBm(802.11ac_VHT80)
		Antenna 1	11.46 dBm(802.11a) 10.27 dBm(802.11n_HT20) 8.87 dBm(802.11n_HT40) 8.43 dBm(802.11ac_VHT80)
		Multiple Antenna	14.61 dBm(802.11a) 13.44 dBm(802.11n_HT20) 12.05 dBm(802.11n_HT40) 11.58 dBm(802.11ac_VHT80)
	5 250 MHz ~ 5 350 MHz Band	Antenna 0	12.13 dBm(802.11a) 10.80 dBm(802.11n_HT20) 9.80 dBm(802.11n_HT40) 9.26 dBm(802.11ac_VHT80)
		Antenna 1	11.85 dBm(802.11a) 10.42 dBm(802.11n_HT20) 9.22 dBm(802.11n_HT40) 8.51 dBm(802.11ac_VHT80)
		Multiple Antenna	15.00 dBm(802.11a) 13.59 dBm(802.11n_HT20) 12.53 dBm(802.11n_HT40) 11.91 dBm(802.11ac_VHT80)

RF OUTPUT POWER	5 470 MHz ~ 5 725 MHz Band	Antenna 0	11.93 dBm(802.11a) 10.72 dBm(802.11n_HT20) 9.11 dBm(802.11n_HT40) 9.09 dBm(802.11ac_VHT80)
		Antenna 0_Straddle	10.89 dBm(802.11a) 10.44 dBm(802.11n_HT20) 9.48 dBm(802.11n_HT40) 8.78 dBm(802.11ac_VHT80)
		Antenna 1	12.09 dBm(802.11a) 11.10 dBm(802.11n_HT20) 9.45 dBm(802.11n_HT40) 9.20 dBm(802.11ac_VHT80)
		Antenna 1_Straddle	11.19 dBm(802.11a) 10.83 dBm(802.11n_HT20) 9.83 dBm(802.11n_HT40) 8.98 dBm(802.11ac_VHT80)
		Multiple Antenna	15.02 dBm(802.11a) 13.86 dBm(802.11n_HT20) 12.23 dBm(802.11n_HT40) 12.16 dBm(802.11ac_VHT80)
		Multiple Antenna _Straddle	14.05 dBm(802.11a) 13.65 dBm(802.11n_HT20) 12.67 dBm(802.11n_HT40) 11.89 dBm(802.11ac_VHT80)

RF OUTPUT POWER	5 725 MHz ~ 5 850 MHz Band	Antenna 0	11.98 dBm(802.11a) 10.75 dBm(802.11n_HT20) 9.56 dBm(802.11n_HT40) 9.15 dBm(802.11ac_VHT80)
		Antenna 0_Straddle	3.57 dBm(802.11a) 3.57 dBm(802.11n_HT20) -1.86 dBm(802.11n_HT40) -5.51 dBm(802.11ac_VHT80)
		Antenna 1	12.16 dBm(802.11a) 11.39 dBm(802.11n_HT20) 10.02 dBm(802.11n_HT40) 9.80 dBm(802.11ac_VHT80)
		Antenna 1_Straddle	4.09 dBm(802.11a) 3.89 dBm(802.11n_HT20) -1.53 dBm(802.11n_HT40) -5.42 dBm(802.11ac_VHT80)
		Multiple Antenna	15.08 dBm(802.11a) 14.09 dBm(802.11n_HT20) 12.81 dBm(802.11n_HT40) 12.50 dBm(802.11ac_VHT80)
		Multiple Antenna _Straddle	6.85 dBm(802.11a) 6.74 dBm(802.11n_HT20) 1.32 dBm(802.11n_HT40) -2.45 dBm(802.11ac_VHT80)

ANTENNA TYPE	Chip Antenna		
ANTENNA GAIN	Bluetooth LE	-0.94 dBi	
	Bluetooth	-0.94 dBi	
	WLAN 2.4 GHz	Antenna 0	2.01 dBi
		Antenna 1	2.06 dBi
		Multiple Antenna	5.05 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	0.92 dBi
		Antenna 1	1.24 dBi
		Multiple Antenna	4.09 dBi
	5 250 MHz ~ 5 350 MHz Band	Antenna 0	1.79 dBi
		Antenna 1	2.66 dBi
		Multiple Antenna	5.25 dBi
	5 470 MHz ~ 5 725 MHz Band	Antenna 0	2.73 dBi
		Antenna 1	1.72 dBi
		Multiple Antenna	5.25 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	1.71 dBi
		Antenna 1	0.69 dBi
		Multiple Antenna	4.23 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-2095S V2.2	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
WCT732M	Samsung Electronics Co., Ltd.	Wi-Fi/BT Transceiver (EUT)	
HP Probook	HP	Notebook PC	EUT
PPP009C	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 “XZ” axis, but the worst data was recorded in this report.

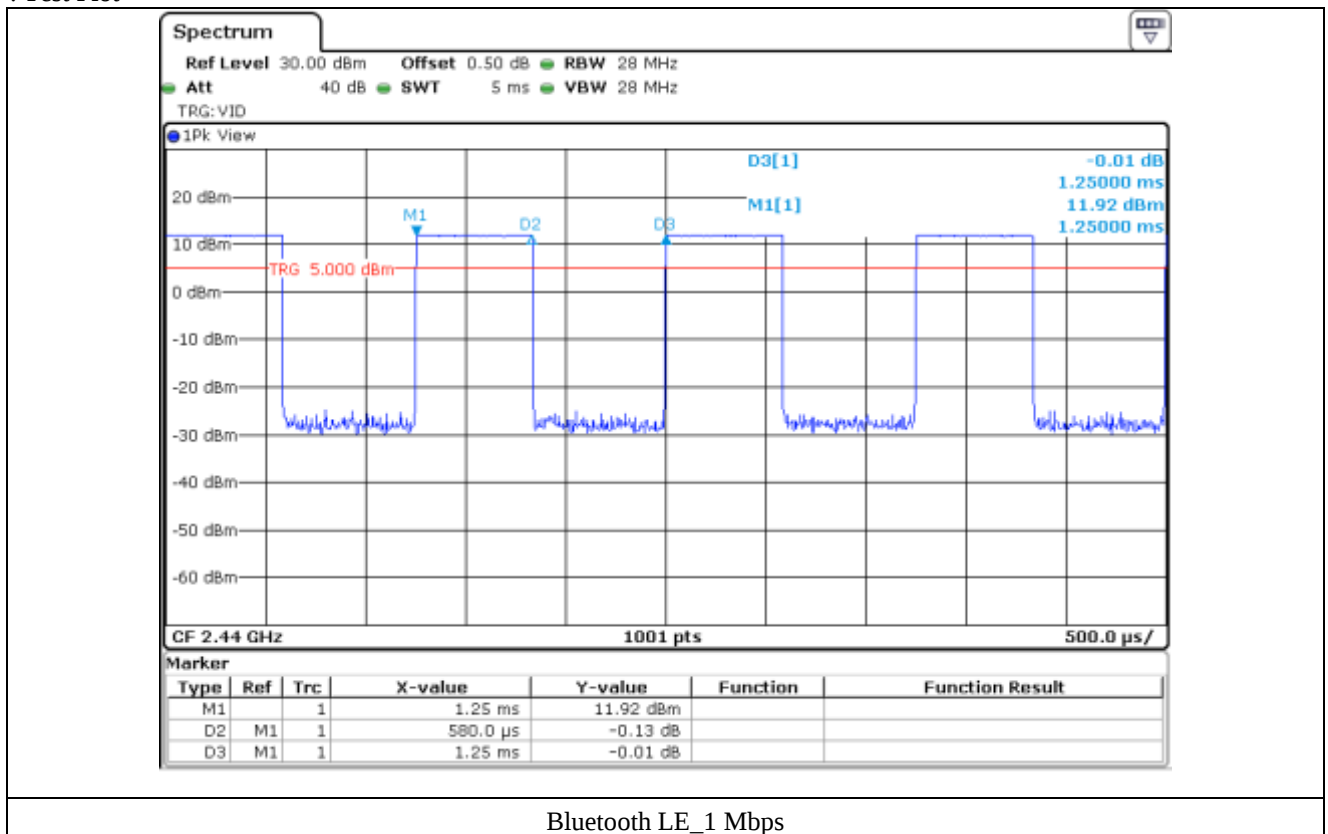
-. Duty Cycle

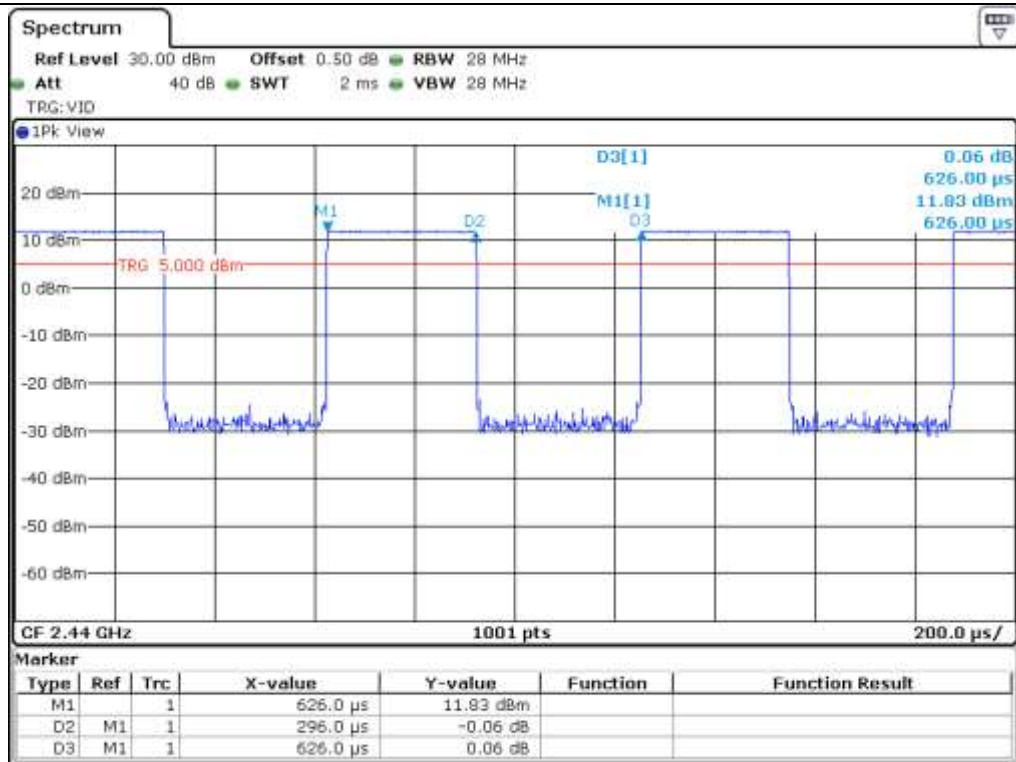
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE [1 Mbps]	0.580	0.670	46.40	3.33
Bluetooth LE [2 Mbps]	0.296	0.330	47.28	3.25

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

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

-. Test Plot





Bluetooth LE_2 Mbps

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

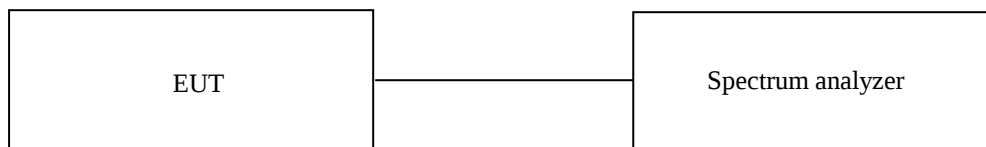
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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 equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

7.4 Test data for 1 Mbps

-. Test Date : December 02, 2019 ~ December 11, 2019

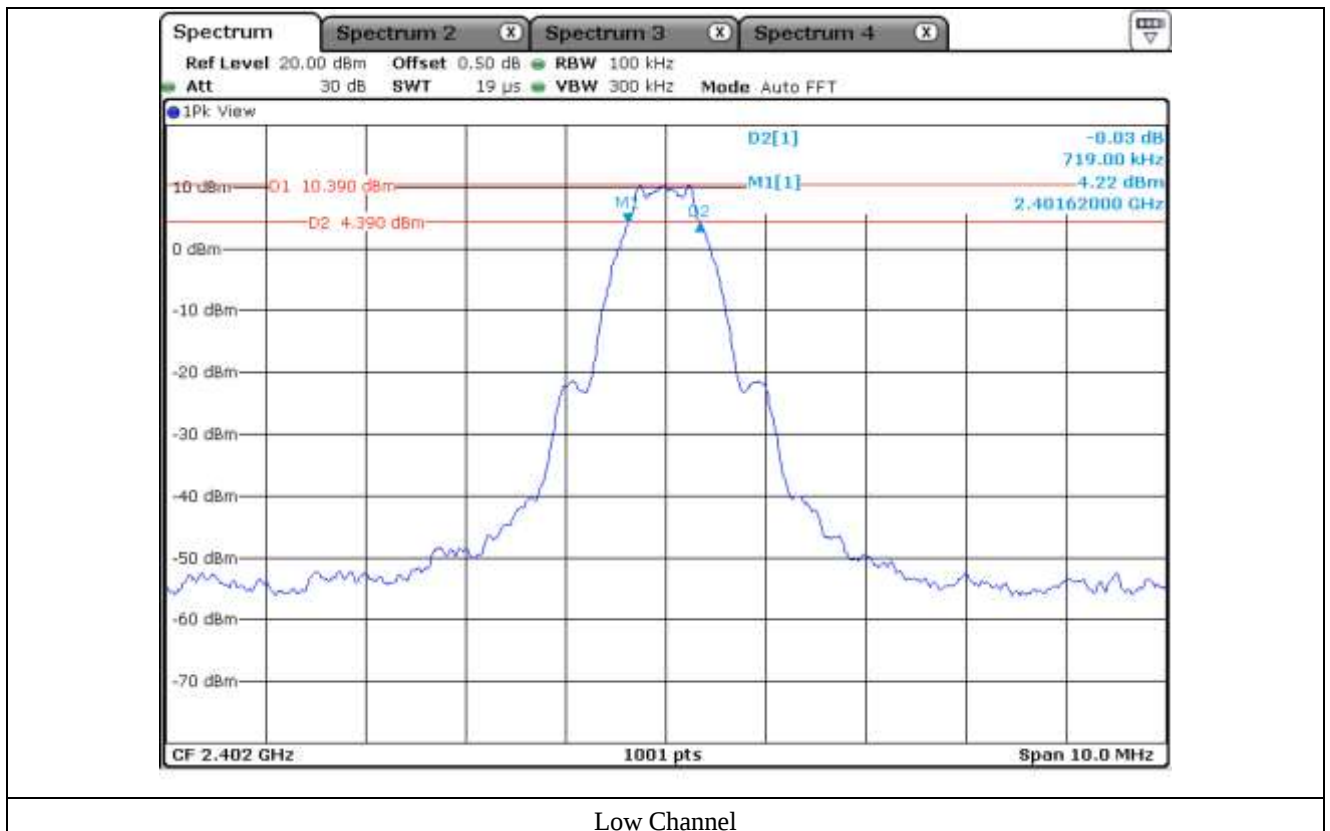
-. Test Result : Pass

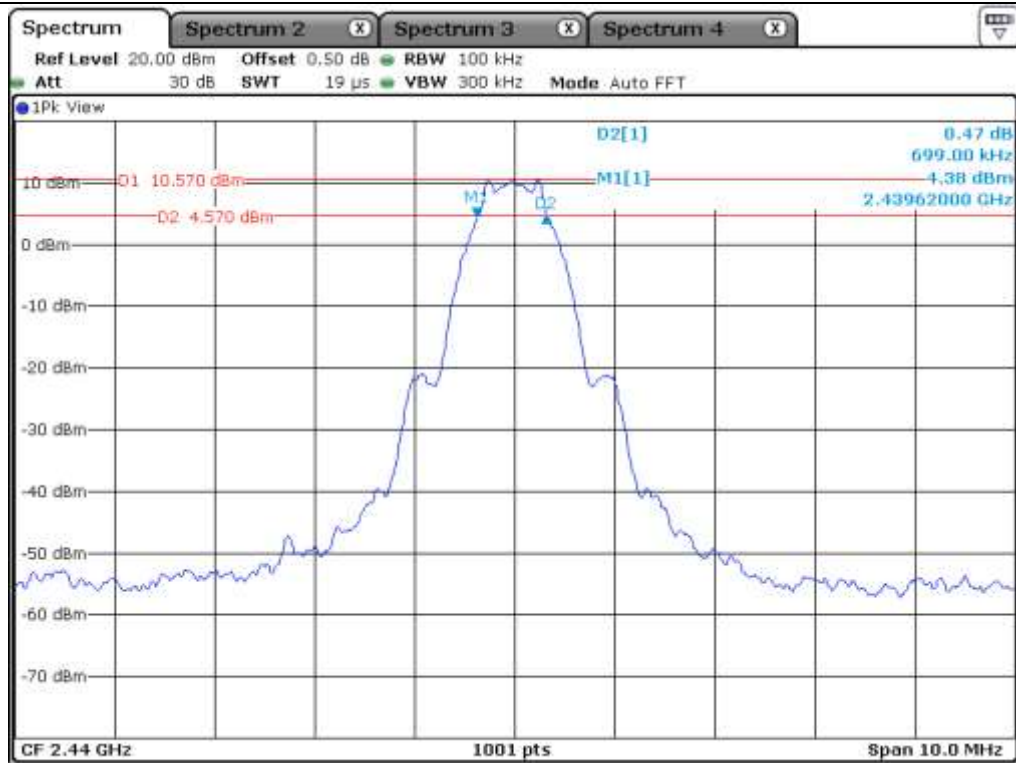
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	719.00	500.00	224.30
Middle	2 440.00	699.00	500.00	219.30
High	2 480.00	709.00	500.00	219.30

Remark. Margin = Measured Value - Limit

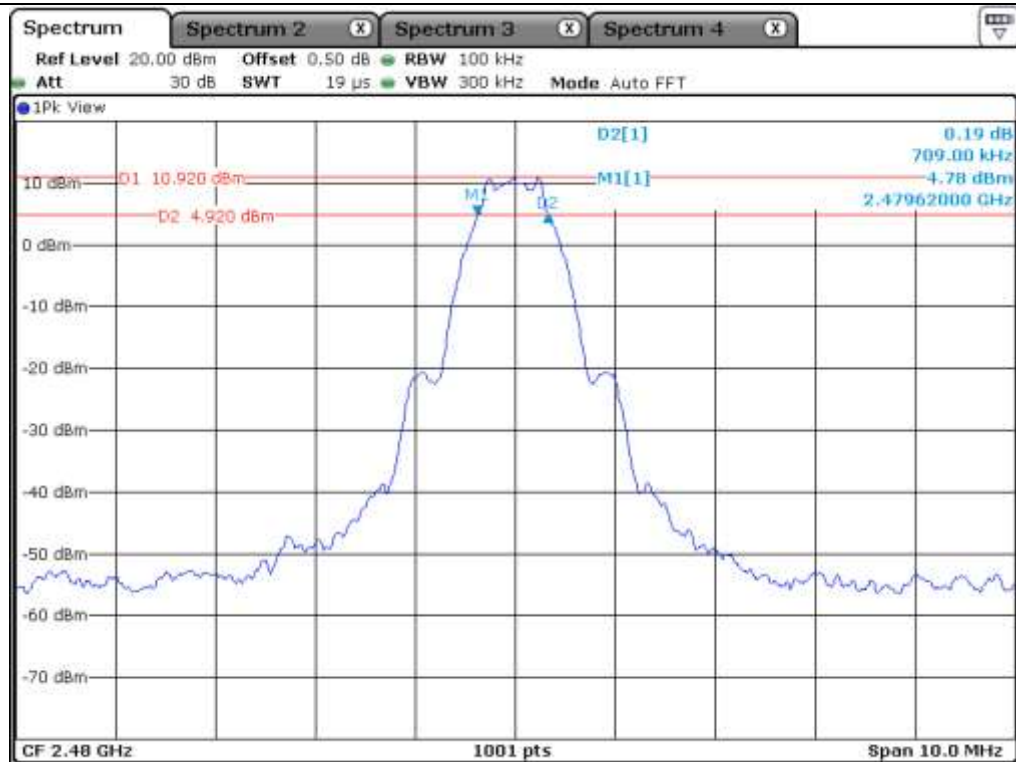


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

7.5 Test data for 2 Mbps

-. Test Date : December 02, 2019 ~ December 11, 2019

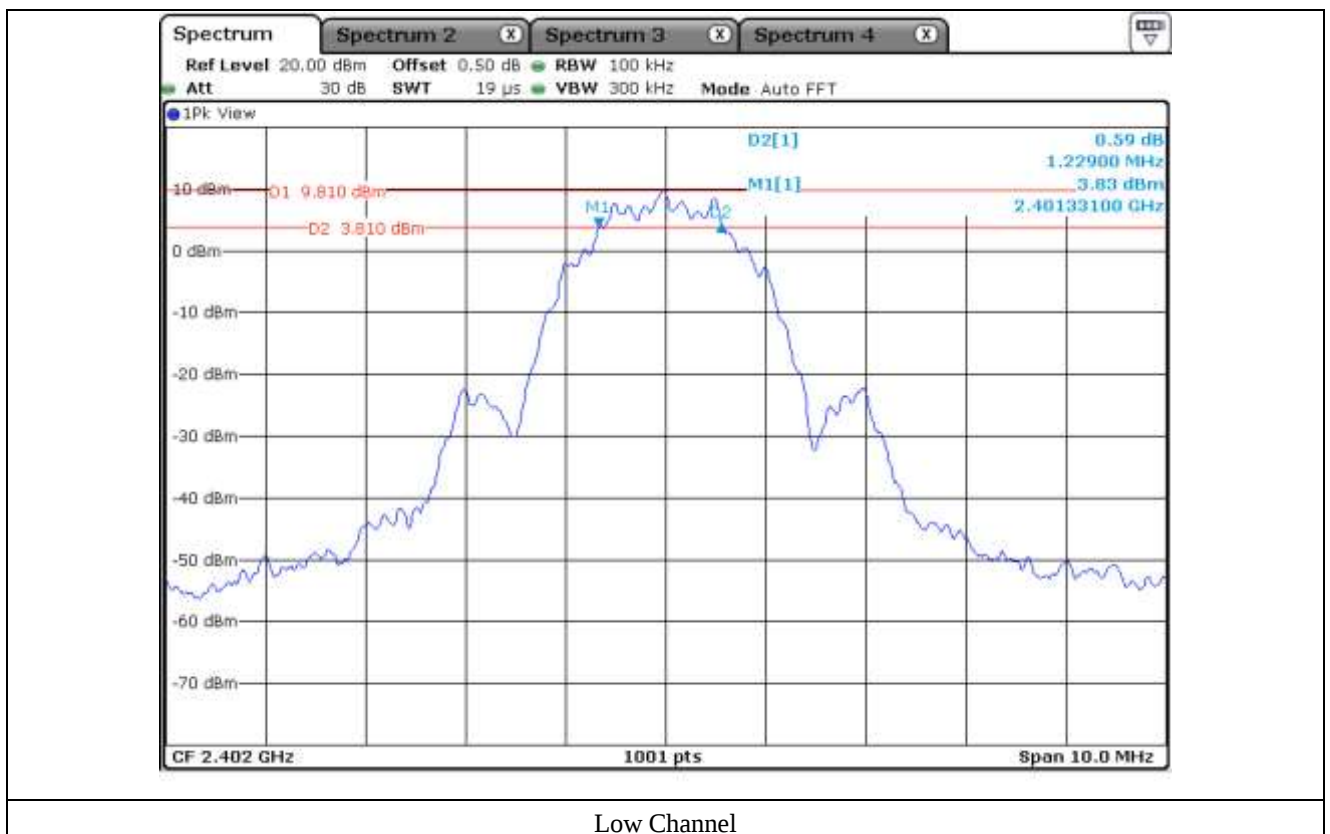
-. Test Result : Pass

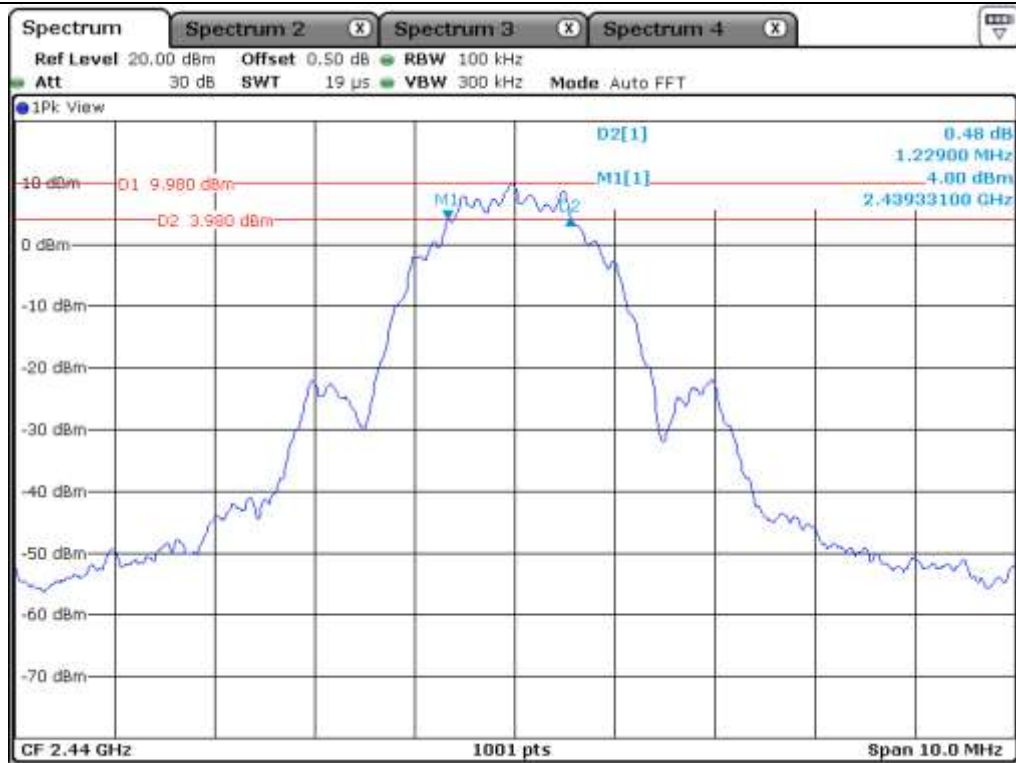
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	1 229.00	500.00	739.00
Middle	2 440.00	1 229.00	500.00	729.00
High	2 480.00	1 249.00	500.00	729.00

Remark. Margin = Measured Value - Limit



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Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

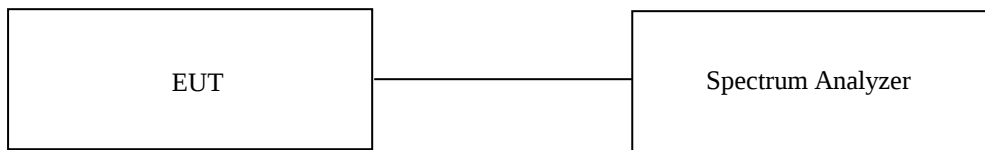
8.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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 equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 1 Mbps

-. Test Date : December 02, 2019 ~ December 11, 2019

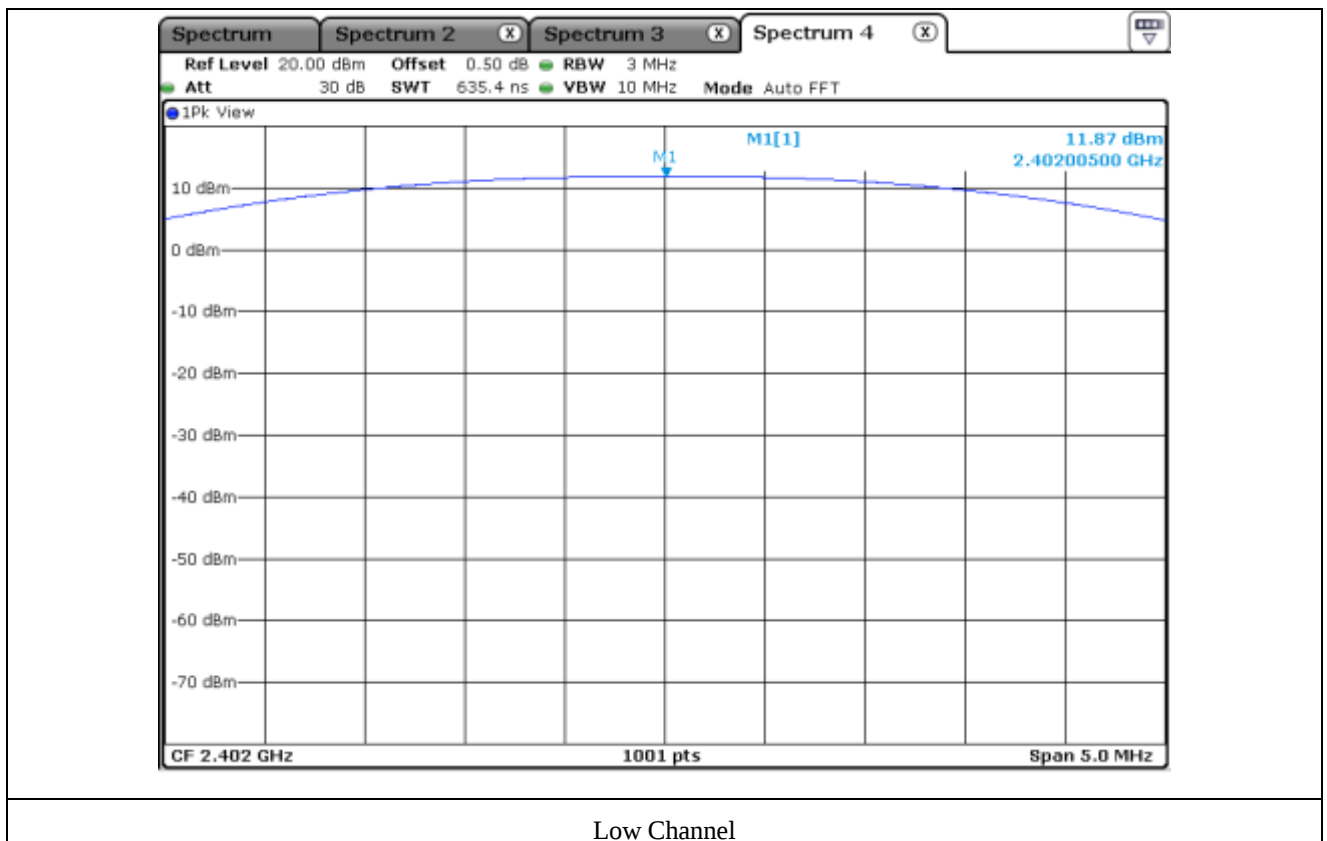
-. Test Result : Pass

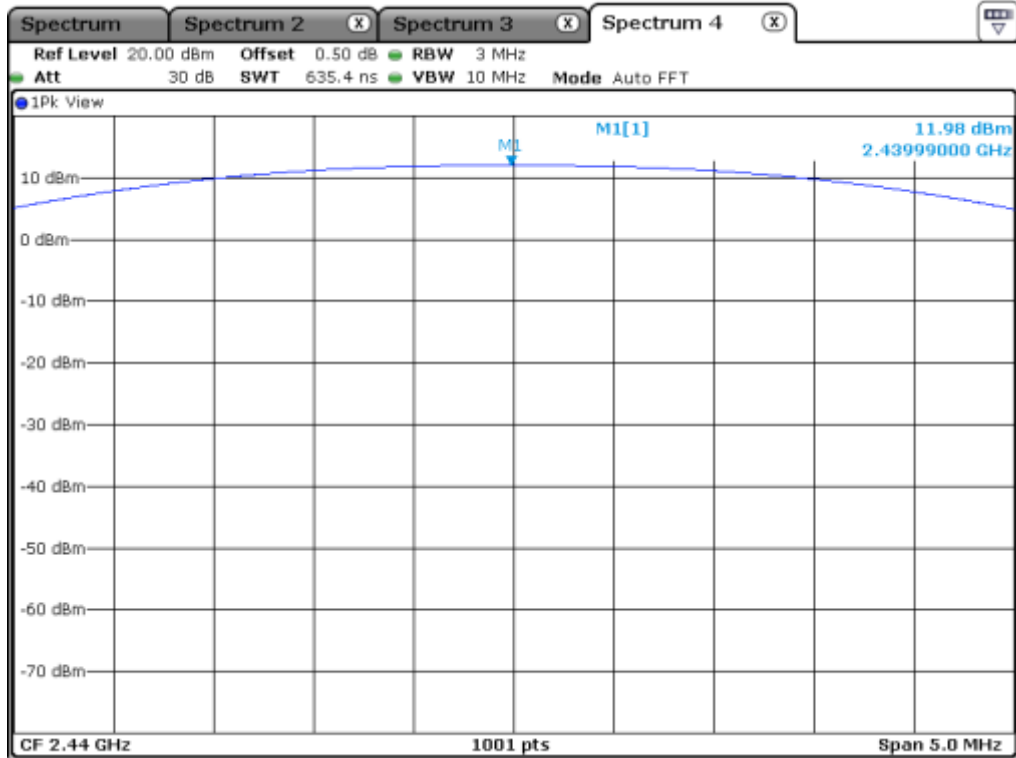
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.87	30.00	18.13
MIDDLE	2 440.00	11.98	30.00	18.02
HIGH	2 480.00	12.27	30.00	17.73

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

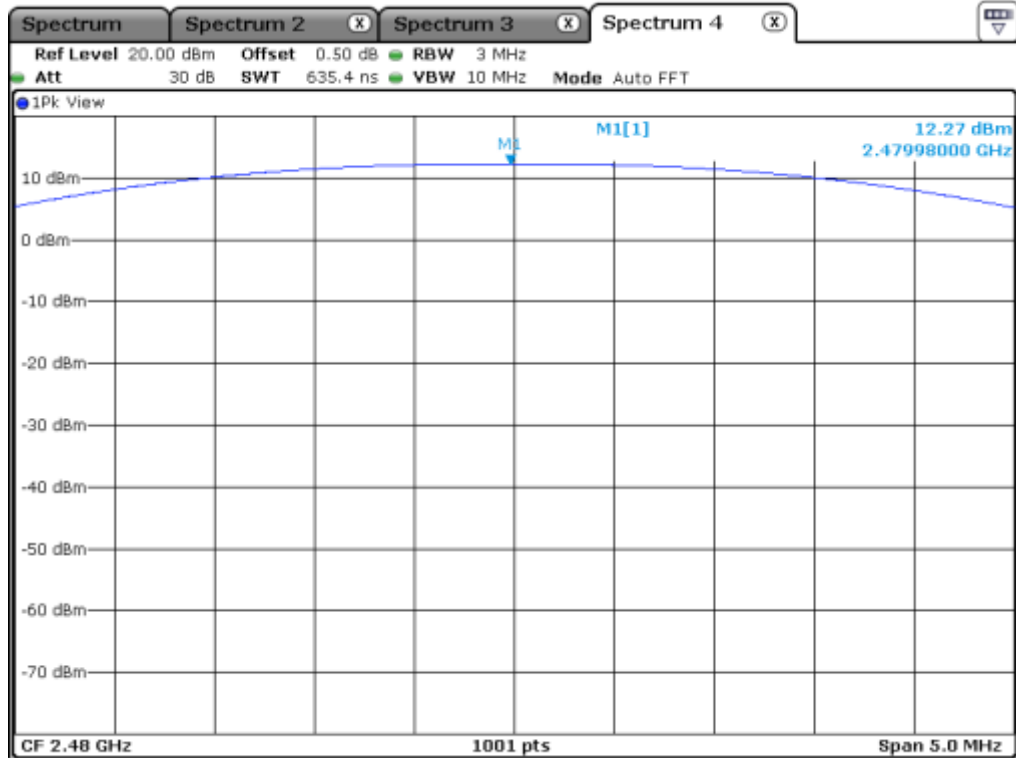


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

8.5 Test data for 2 Mbps

-. Test Date : December 02, 2019 ~ December 11, 2019

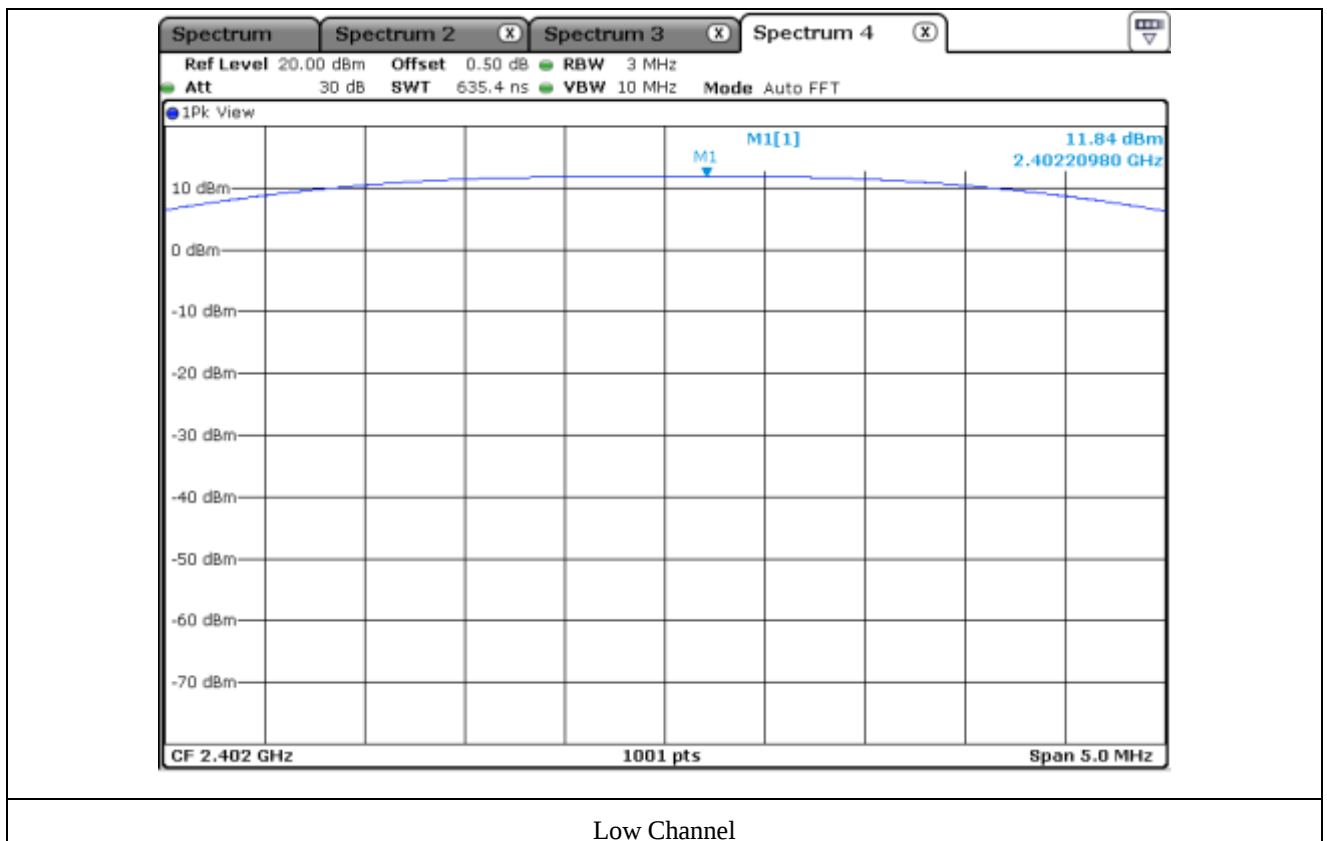
-. Test Result : Pass

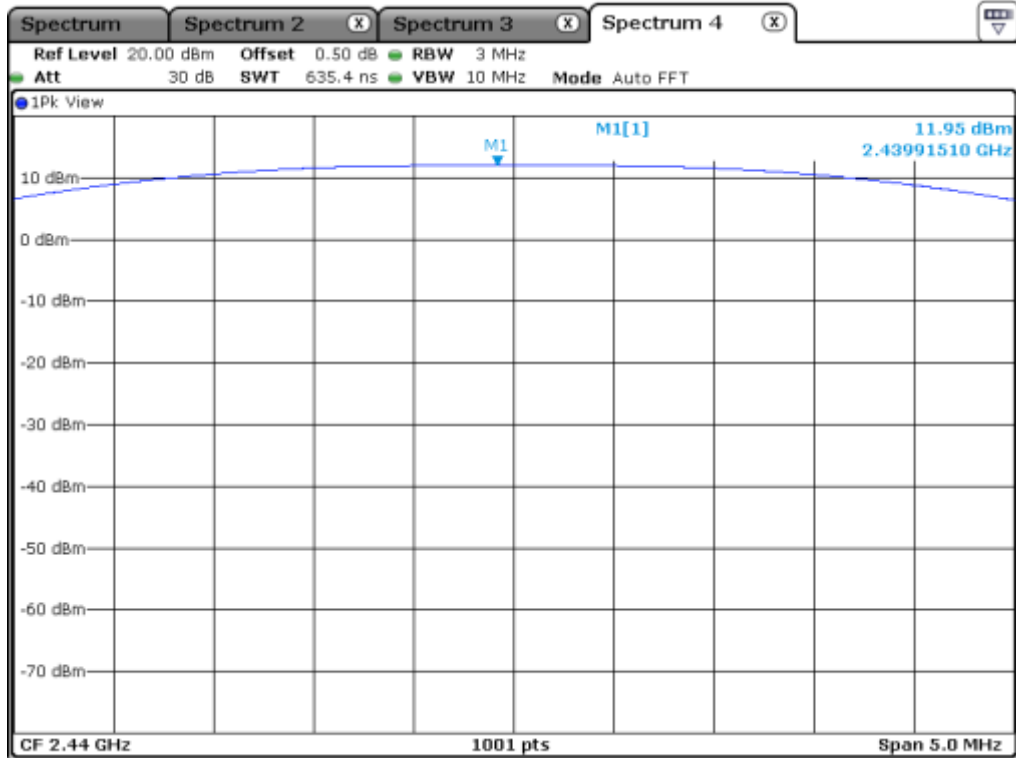
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	11.84	30.00	18.16
MIDDLE	2 440.00	11.95	30.00	18.05
HIGH	2 480.00	12.26	30.00	17.74

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

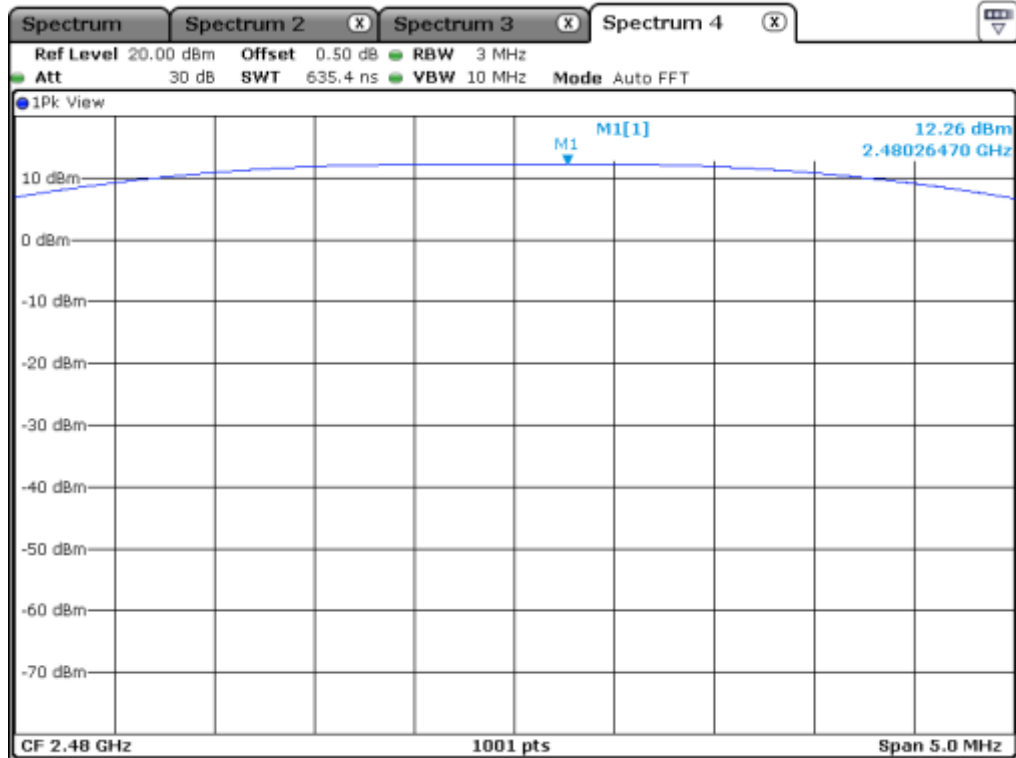


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

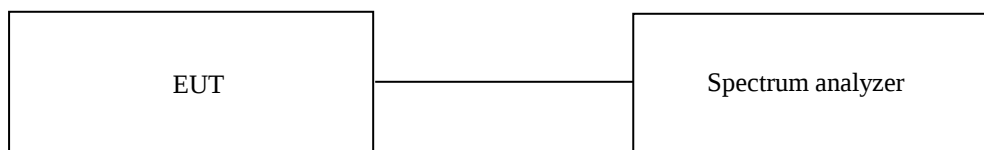
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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.

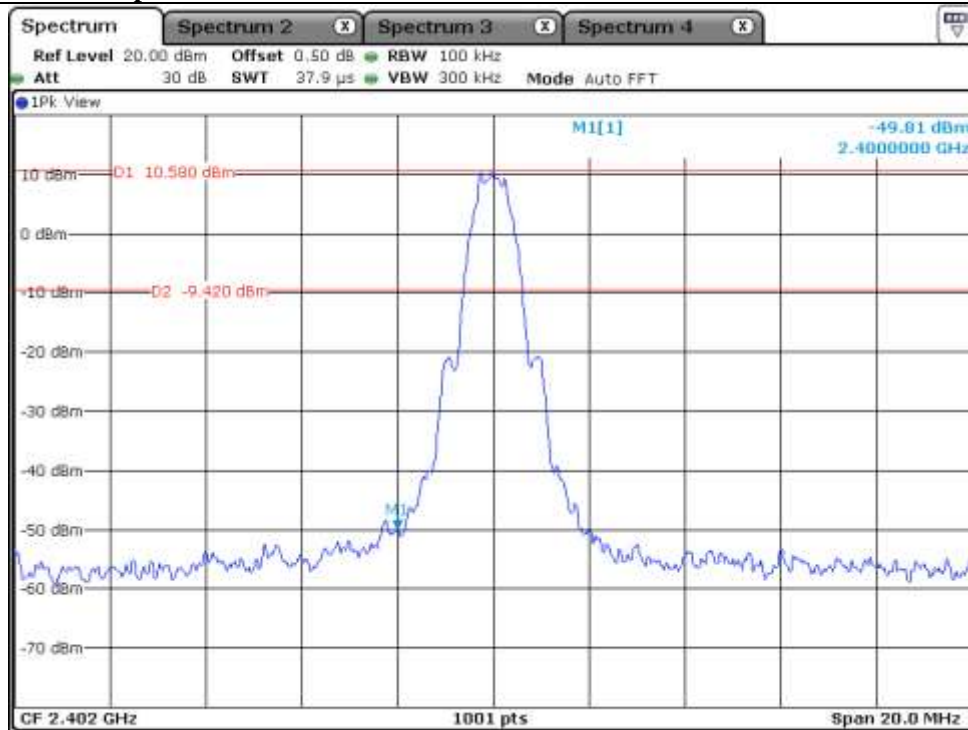
9.4 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)
■ -	ESW	Rohde & Schwarz	EMI Test Receiver	101851	Aug. 07, 2019 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 18, 2019 (1Y)
■ -	DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ -	MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 13, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 16, 2019 (1Y)

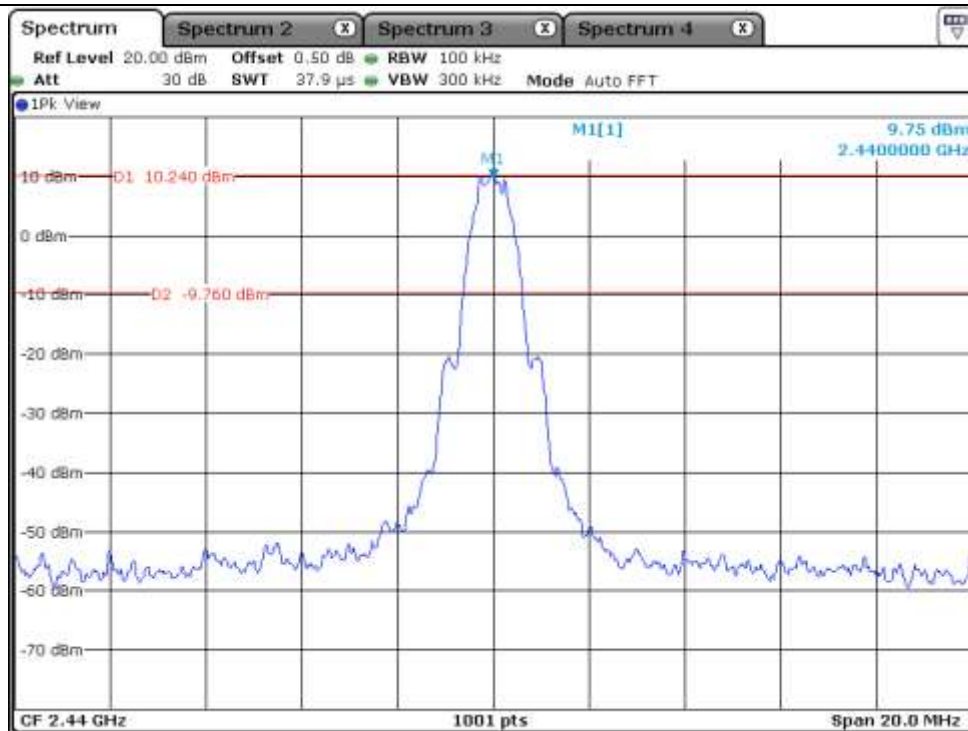
All test equipment used is calibrated on a regular basis.

9.5 Test data for conducted emission

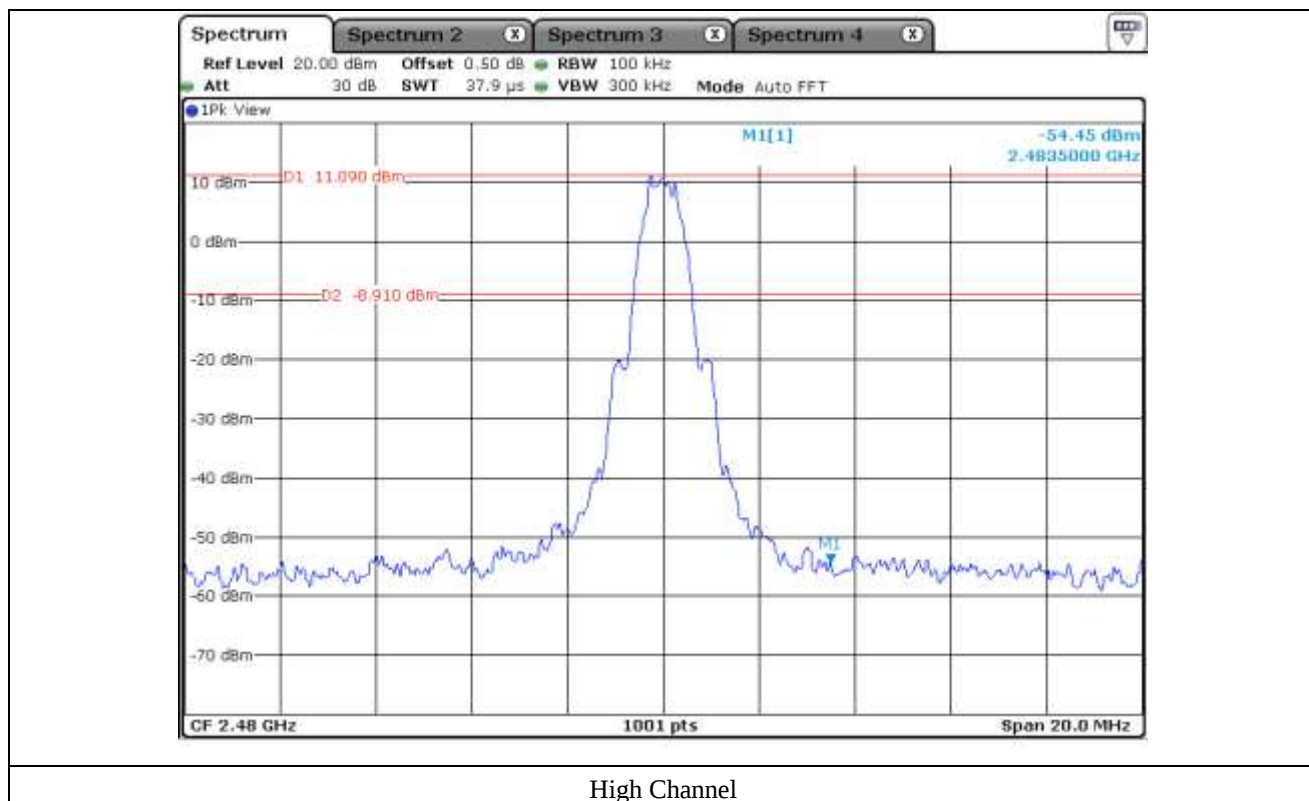
9.5.1 Test data for 1 Mbps

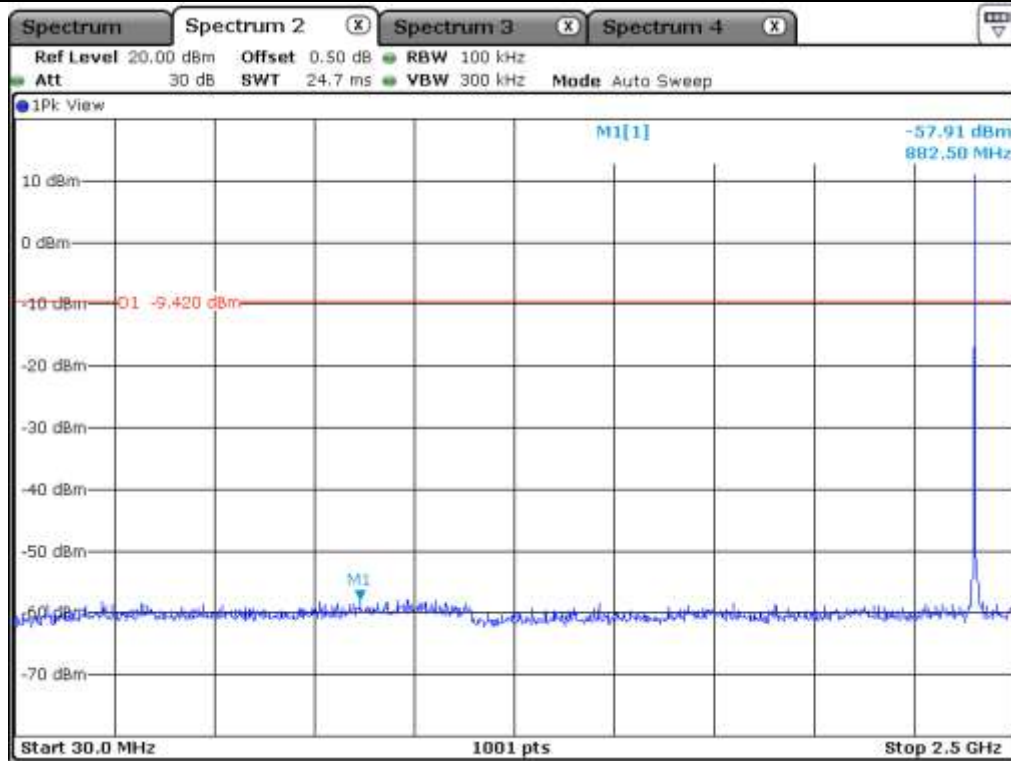


Low Channel

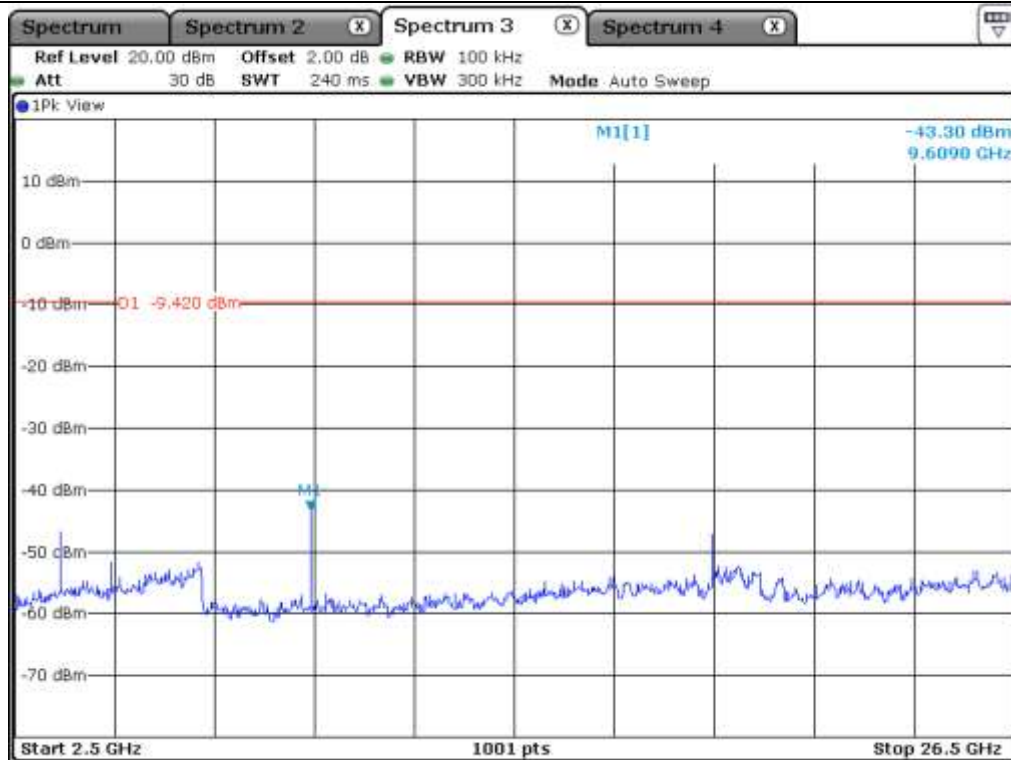


Middle Channel

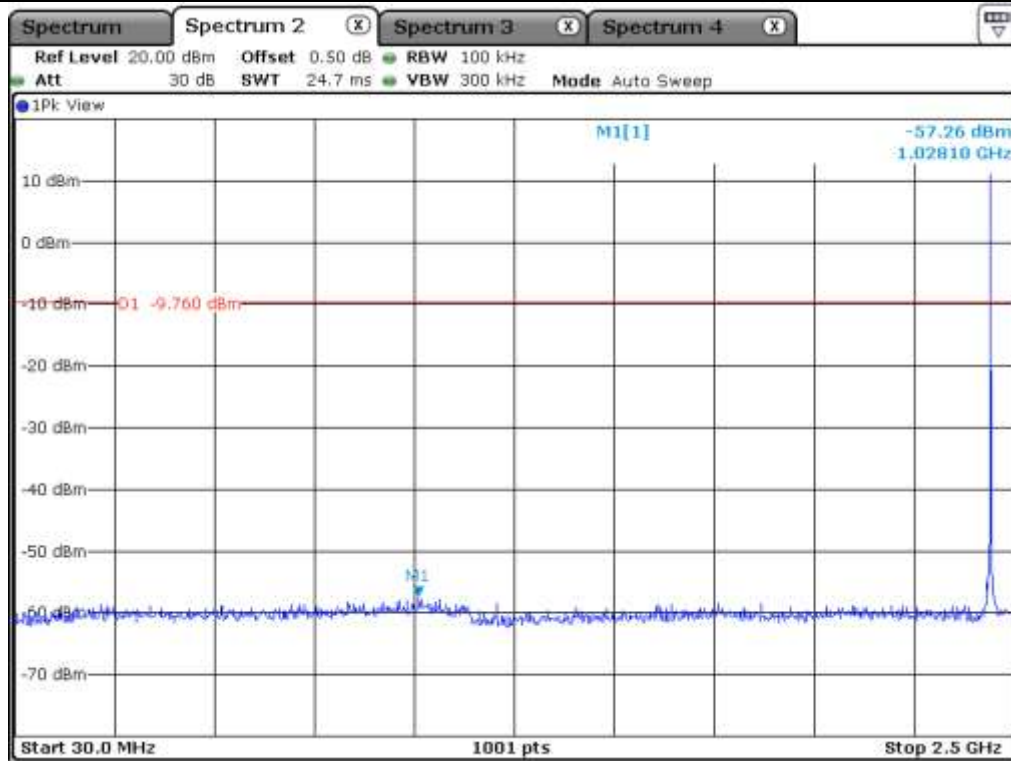




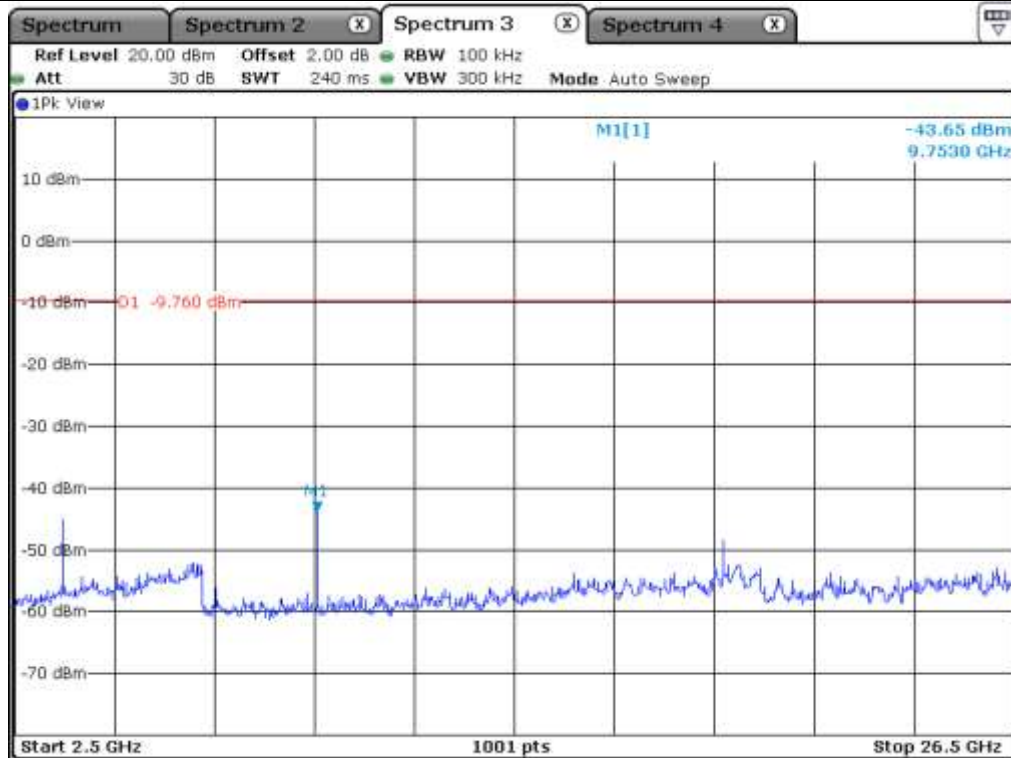
Low Channel



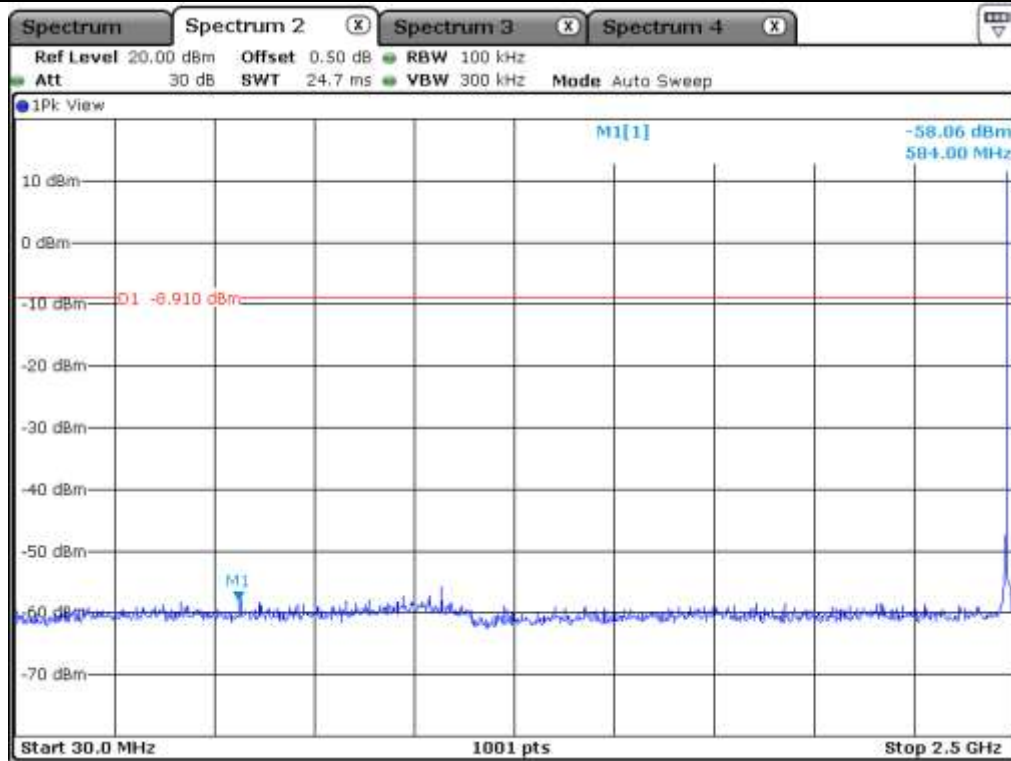
Low Channel



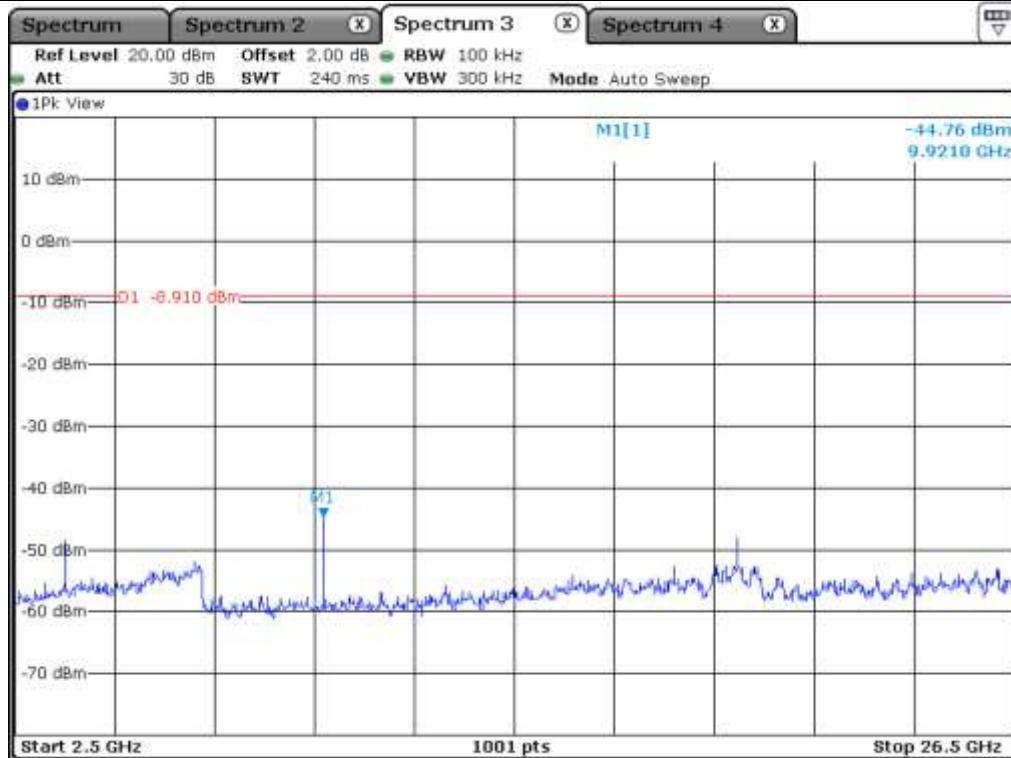
Middle Channel



Middle Channel

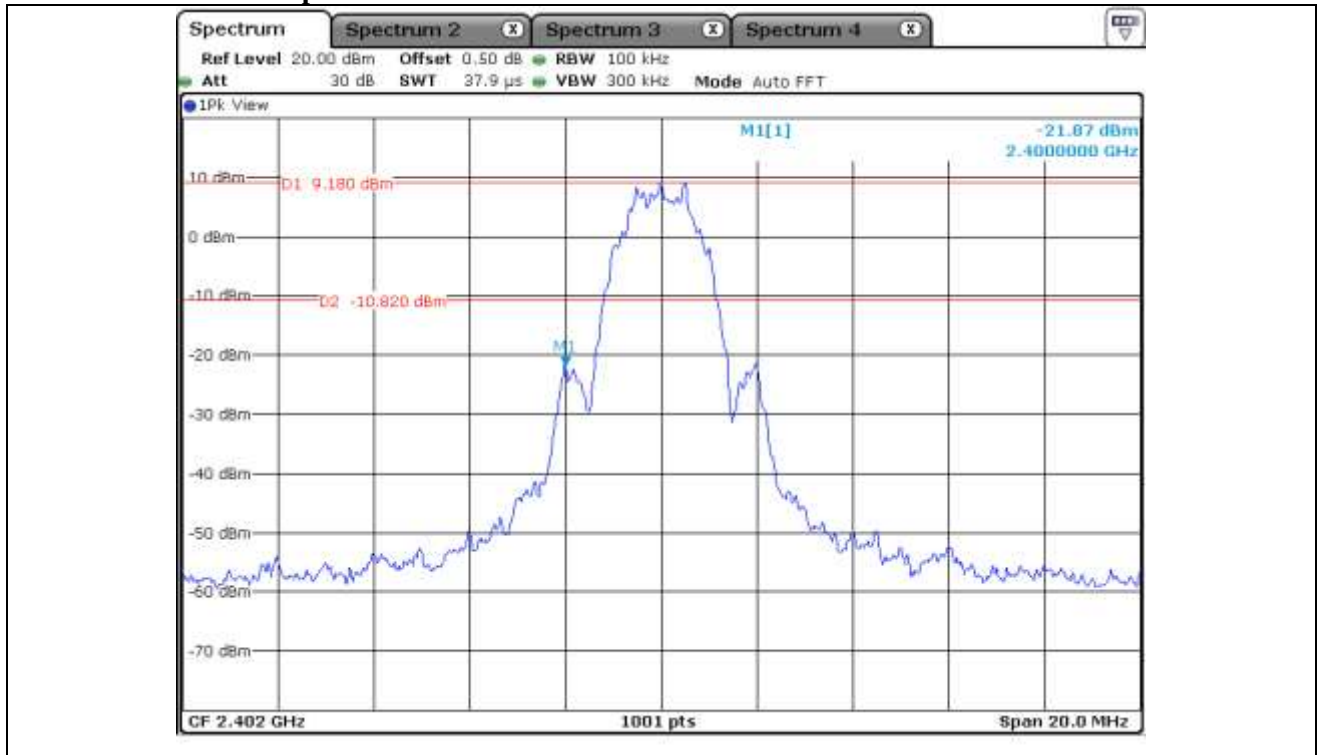


High Channel

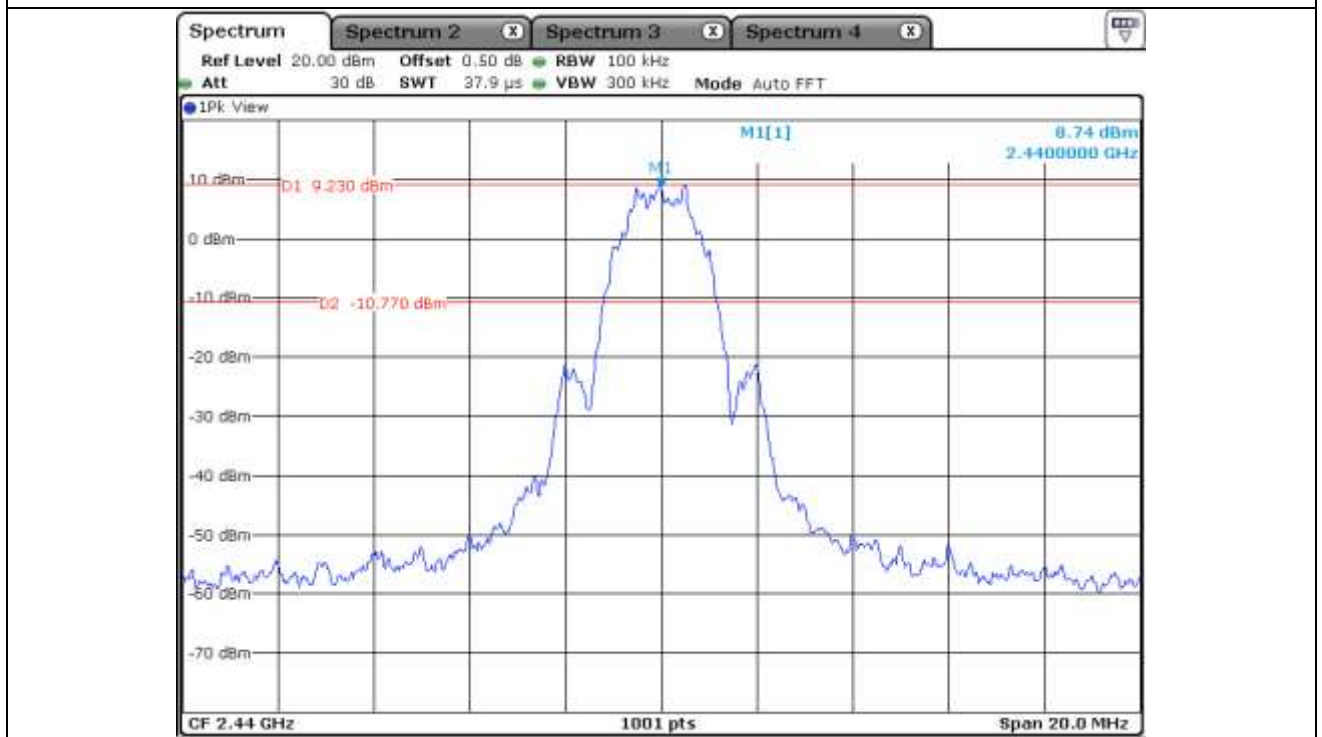


High Channel

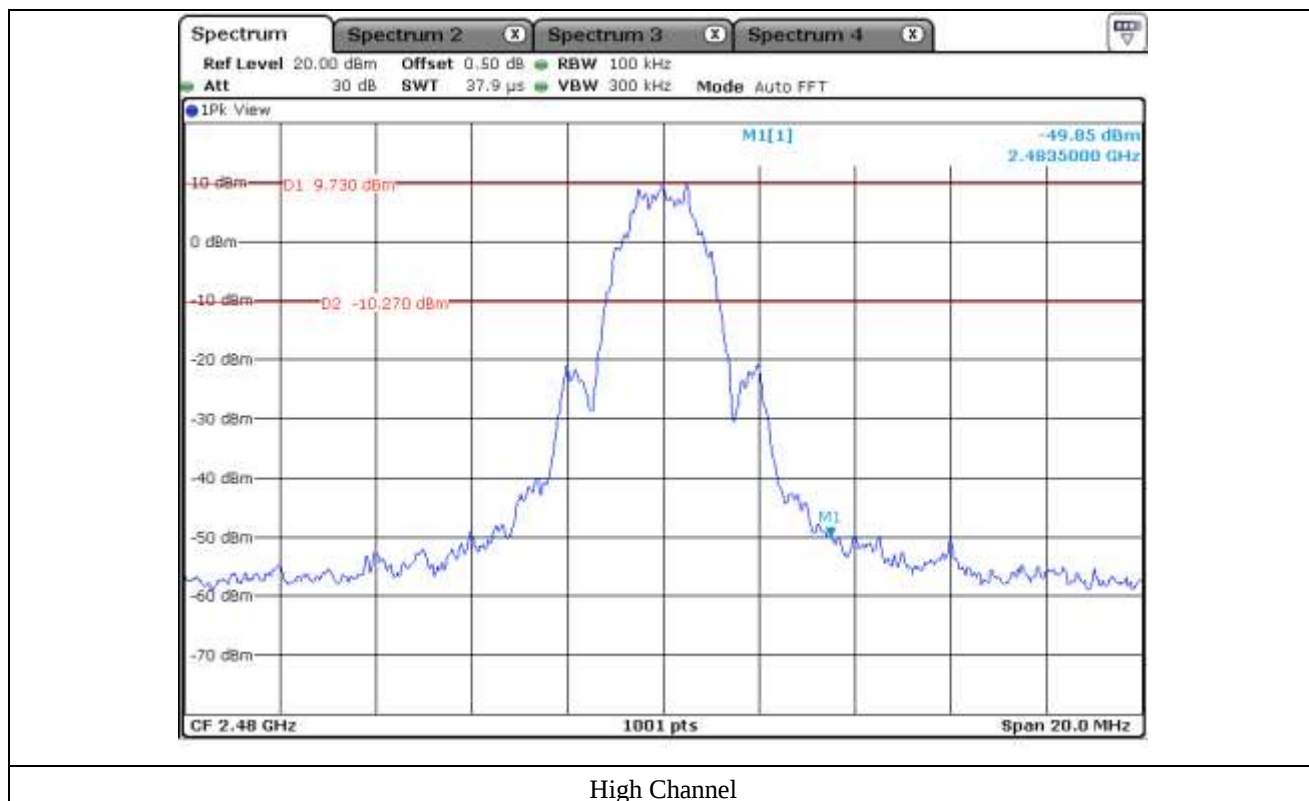
9.5.2 Test data for 2 Mbps



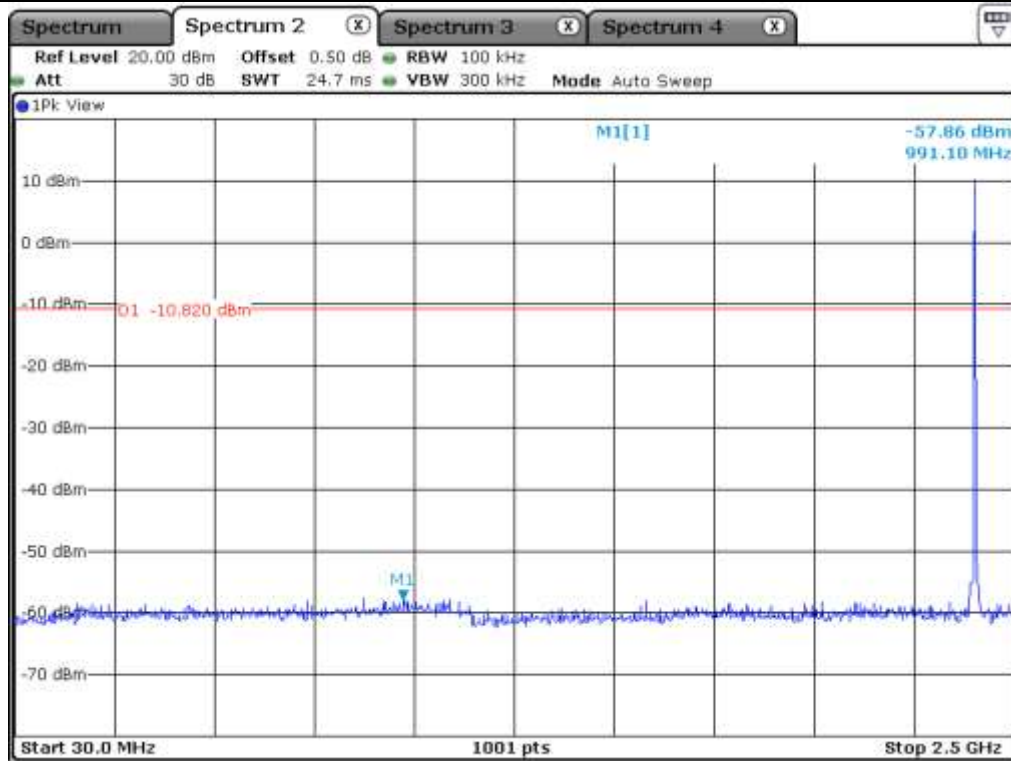
Low Channel



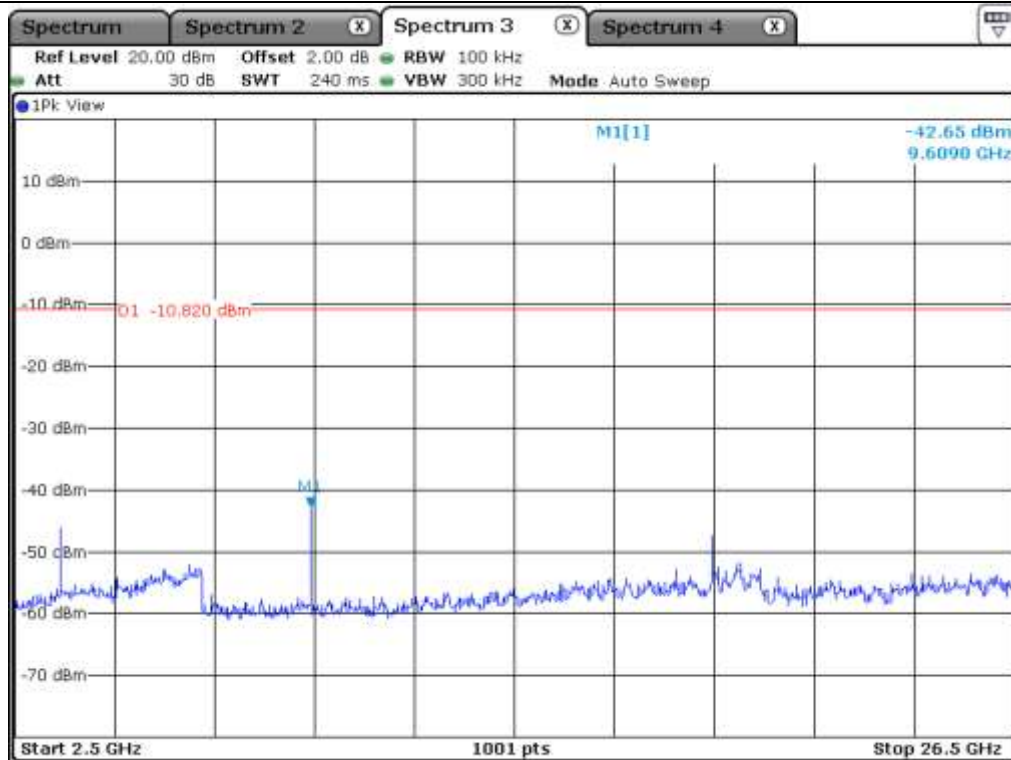
Middle Channel



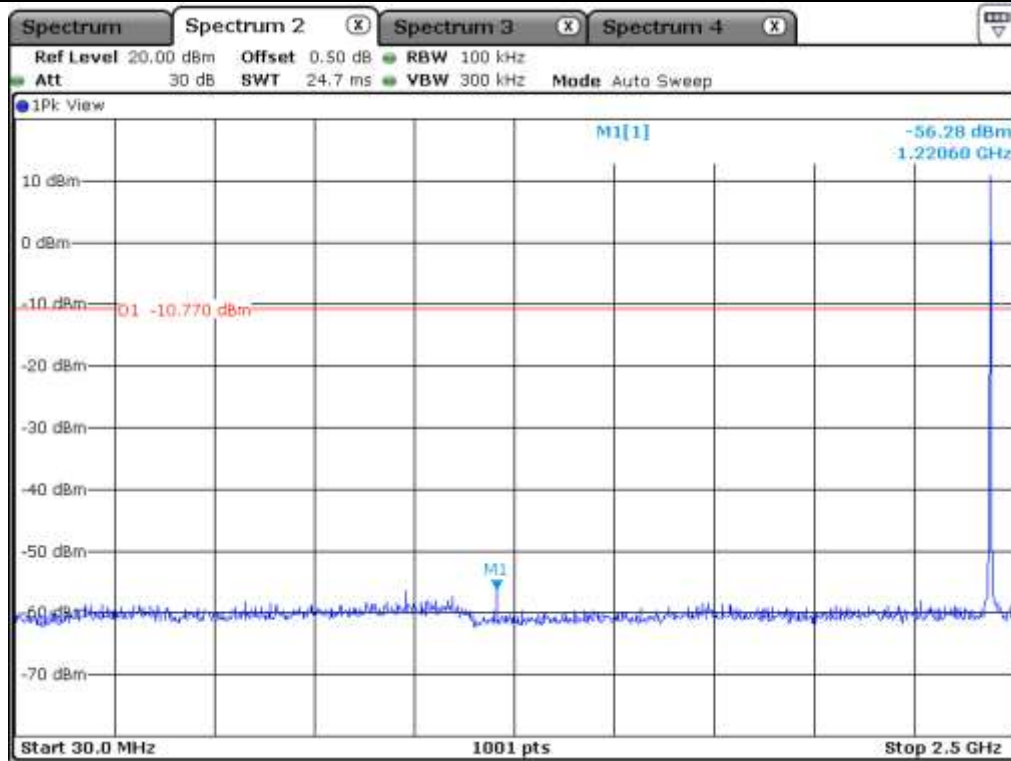
High Channel



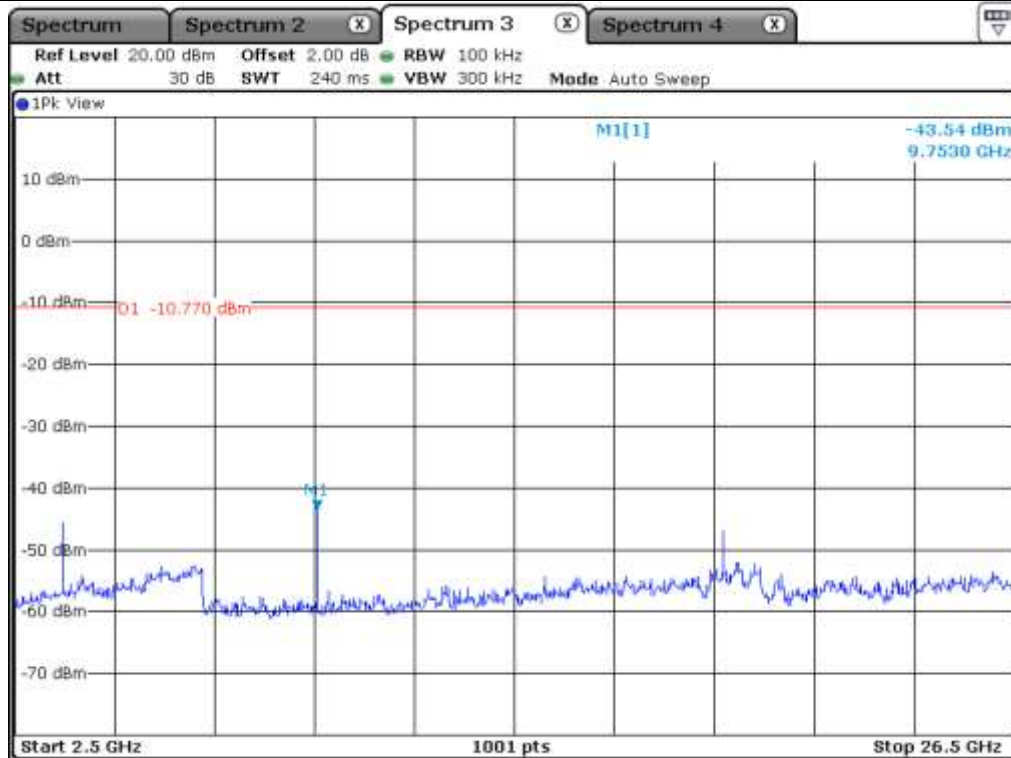
Low Channel



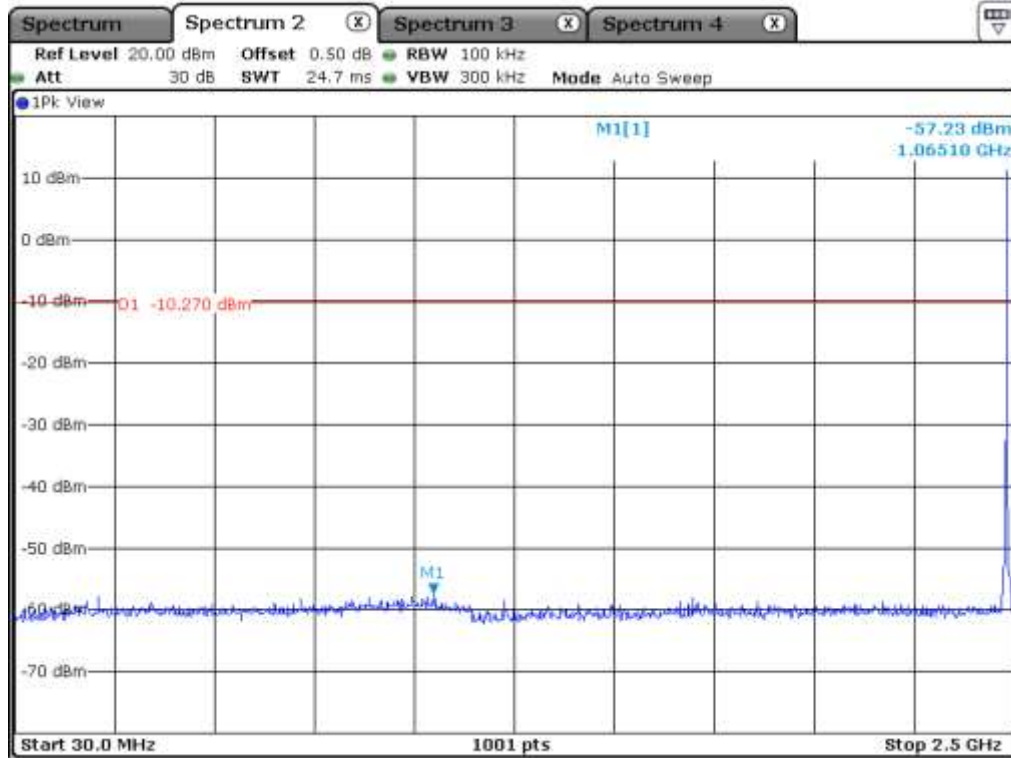
Low Channel



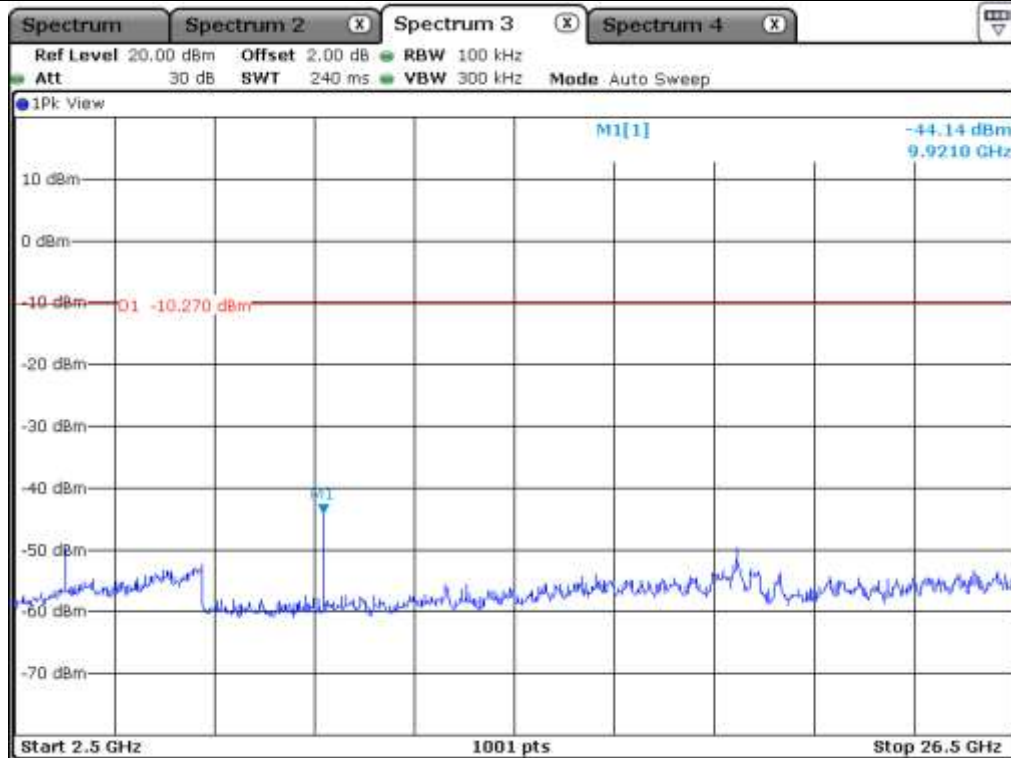
Middle Channel



Middle Channel



High Channel



High Channel

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

- . Test Date : December 02, 2019 ~ December 11, 2019
- . 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 : 46.40 %
- . Result : PASSED

Frequency (GHz)	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									
2 362.55	14.02	Peak	H	27.60	2.91	-	44.53	74.00	29.47
2 389.64	4.61	Average	H	27.60	2.91	3.33	38.45	54.00	15.55
2 334.34	13.66	Peak	V	27.60	2.91	-	44.17	74.00	29.83
2 337.37	4.47	Average	V	27.60	2.91	3.33	38.31	54.00	15.69
Test Data for High Channel									
2 483.51	19.62	Peak	H	27.50	3.02	-	50.14	74.00	23.86
2 483.51	8.40	Average	H	27.50	3.02	3.33	42.25	54.00	11.75
2 483.51	17.73	Peak	V	27.50	3.02	-	48.25	74.00	25.75
2 483.51	6.25	Average	V	27.50	3.02	3.33	40.10	54.00	13.90

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 + Correction Factor



Tested by: Ha-Ram, Lee / Assistant Manager

9.6.1.2 Test data for 2 Mbps

- Test Date : December 02, 2019 ~ December 11, 2019
- 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 : 47.28 %
- Result : PASSED

Frequency (GHz)	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									
2 375.97	13.97	Peak	H	27.60	2.91	-	44.48	74.00	29.52
2 387.32	4.62	Average	H	27.60	2.91	3.25	38.38	54.00	15.62
2 356.71	13.78	Peak	V	27.60	2.91	-	44.29	74.00	29.71
2 337.05	4.44	Average	V	27.60	2.91	3.25	38.20	54.00	15.80
Test Data for High Channel									
2 483.51	24.84	Peak	H	27.50	3.02	-	55.36	74.00	18.64
2 483.51	15.25	Average	H	27.50	3.02	3.25	49.02	54.00	4.98
2 483.51	22.31	Peak	V	27.50	3.02	-	52.83	74.00	21.17
2 483.51	11.26	Average	V	27.50	3.02	3.25	45.03	54.00	8.97

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 + Correction Factor



Tested by: Ha-Ram, Lee / Assistant Manager

9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for 1 Mbps

- Test Date : December 02, 2019 ~ December 11, 2019
- 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 : 46.40 %
- Result : PASSED

Frequency (GHz)	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									
4 804.000	16.62	Peak	H	31.20	4.65	-	52.47	74.00	21.53
4 804.000	6.74	Average	H	31.20	4.65	3.33	45.92	54.00	8.08
4 804.000	16.31	Peak	V	31.20	4.65	-	52.16	74.00	21.84
4 804.000	6.02	Average	V	31.20	4.65	3.33	45.20	54.00	8.80
Test Data for Middle Channel									
4 880.000	17.05	Peak	H	31.40	4.72	-	53.17	74.00	20.83
4 880.000	7.01	Average	H	31.40	4.72	3.33	46.46	54.00	7.54
4 880.000	16.87	Peak	V	31.40	4.72	-	52.99	74.00	21.01
4 880.000	6.04	Average	V	31.40	4.72	3.33	45.49	54.00	8.51
Test Data for High Channel									
4 960.000	18.49	Peak	H	31.70	4.86	-	55.05	74.00	18.95
4 960.000	9.92	Average	H	31.70	4.86	3.33	49.81	54.00	4.19
4 960.000	17.61	Peak	V	31.70	4.86	-	54.17	74.00	19.83
4 960.000	6.84	Average	V	31.70	4.86	3.33	46.73	54.00	7.27

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 + Correction Factor



Tested by: Ha-Ram, Lee / Assistant Manager

9.6.2.2 Test data for 2 Mbps

- Test Date : December 02, 2019 ~ December 11, 2019
- 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 : 47.28 %
- Result : PASSED

Frequency (GHz)	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									
4 804.000	15.82	Peak	H	31.20	4.65	-	51.67	74.00	22.33
4 804.000	5.72	Average	H	31.20	4.65	3.25	44.82	54.00	9.18
4 804.000	15.54	Peak	V	31.20	4.65	-	51.39	74.00	22.61
4 804.000	6.08	Average	V	31.20	4.65	3.25	45.18	54.00	8.82
Test Data for Middle Channel									
4 880.000	16.34	Peak	H	31.40	4.72	-	52.46	74.00	21.54
4 880.000	6.53	Average	H	31.40	4.72	3.25	45.90	54.00	8.10
4 880.000	16.30	Peak	V	31.40	4.72	-	52.42	74.00	21.58
4 880.000	6.13	Average	V	31.40	4.72	3.25	45.50	54.00	8.50
Test Data for High Channel									
4 960.000	18.68	Peak	H	31.70	4.86	-	55.24	74.00	18.76
4 960.000	8.32	Average	H	31.70	4.86	3.25	48.13	54.00	5.87
4 960.000	16.21	Peak	V	31.70	4.86	-	52.77	74.00	21.23
4 960.000	6.57	Average	V	31.70	4.86	3.25	46.38	54.00	7.62

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 + Correction Factor



Tested by: Ha-Ram, Lee / Assistant Manager

10. PEAK POWER SPECTRAL DENSITY

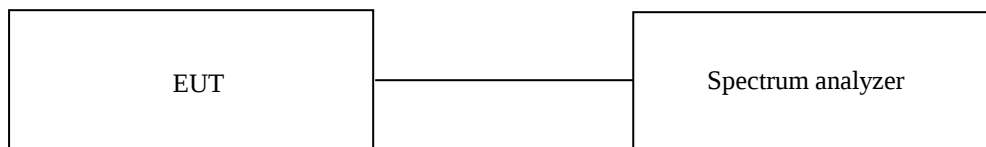
10.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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 equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for 1 Mbps

-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

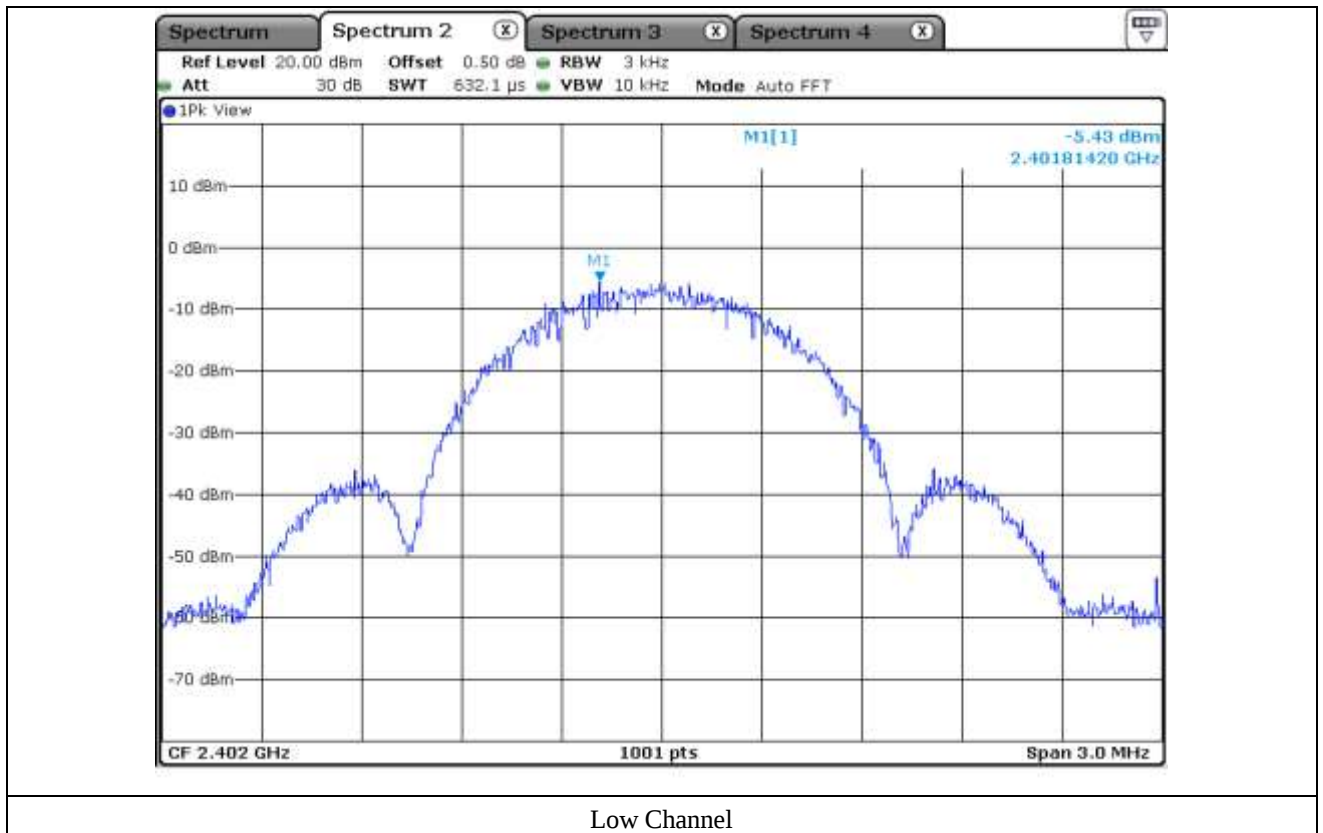
-. Operating Condition : Continuous transmitting mode

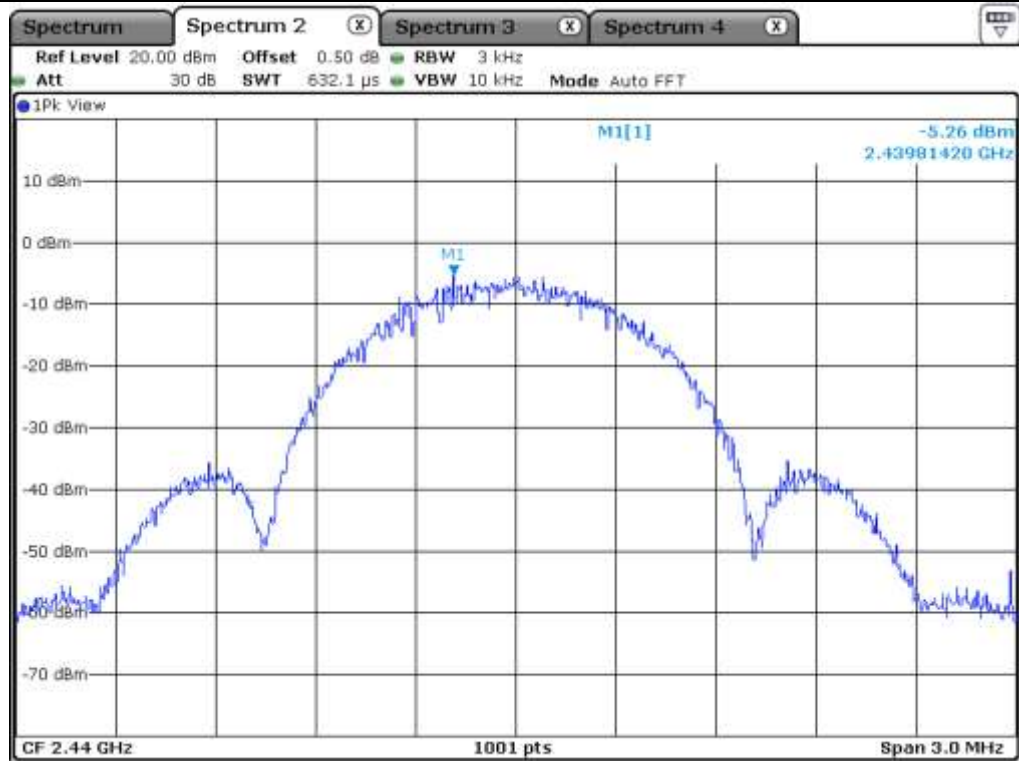
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-5.43	8.00	13.43
Middle	2 440.00	-5.26	8.00	13.26
High	2 480.00	-4.91	8.00	12.91

Remark. Margin = Limit – Measured value

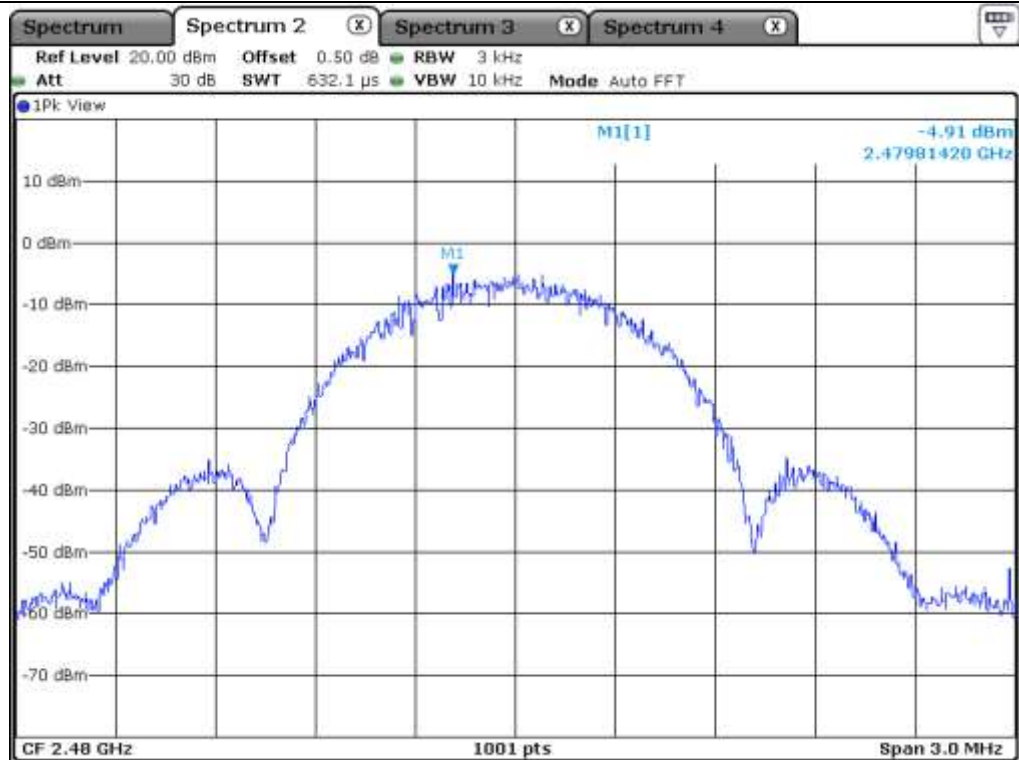


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

10.5 Test data for 2 Mbps

-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

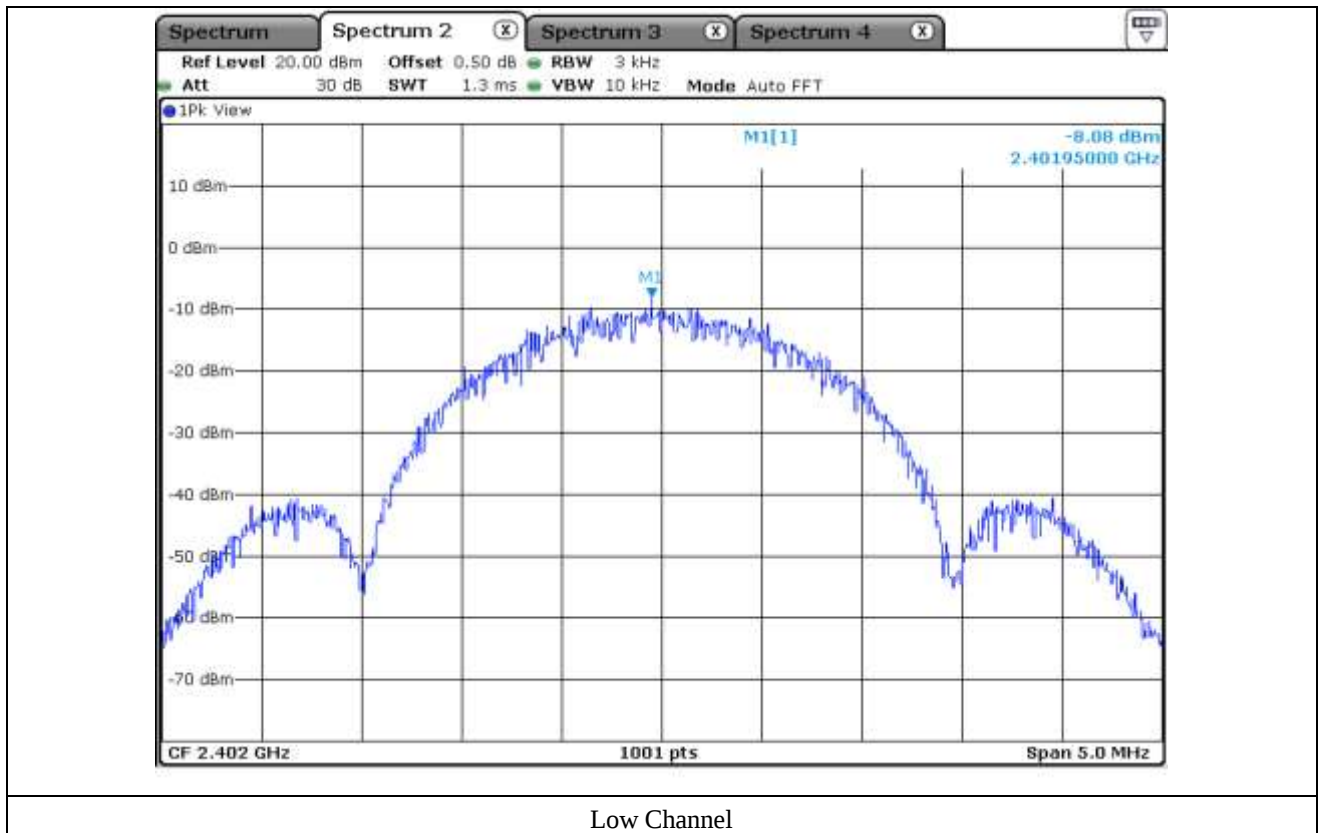
-. Operating Condition : Continuous transmitting mode

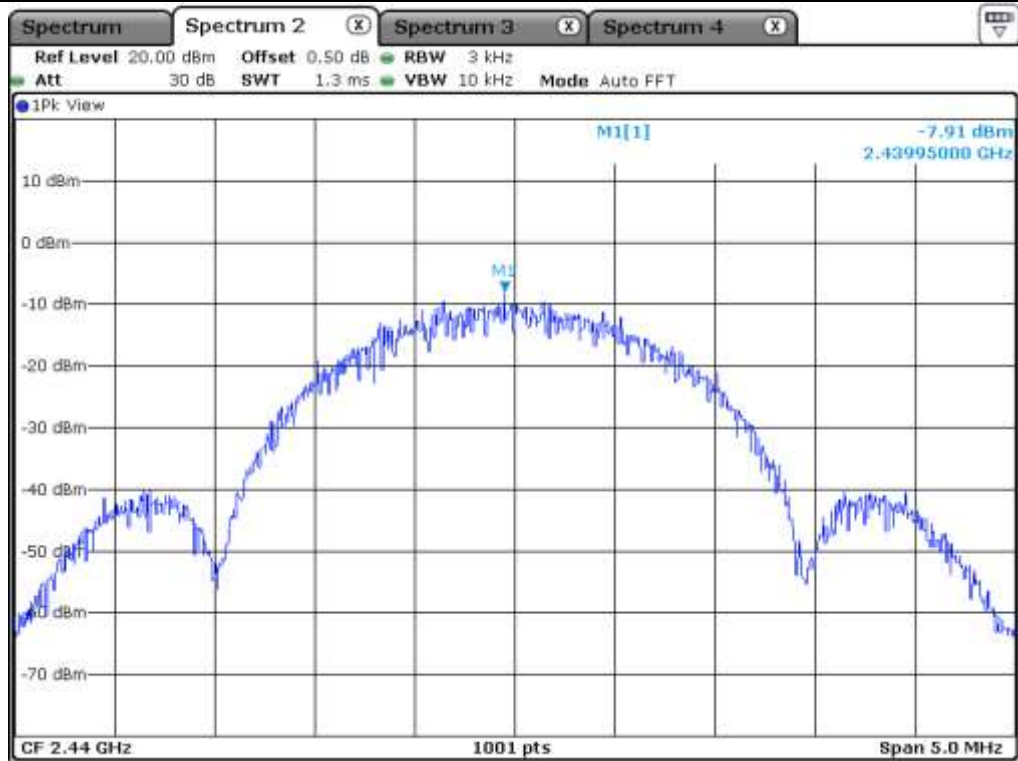
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-8.08	8.00	16.08
Middle	2 440.00	-7.91	8.00	15.91
High	2 480.00	-7.55	8.00	15.55

Remark. Margin = Limit – Measured value

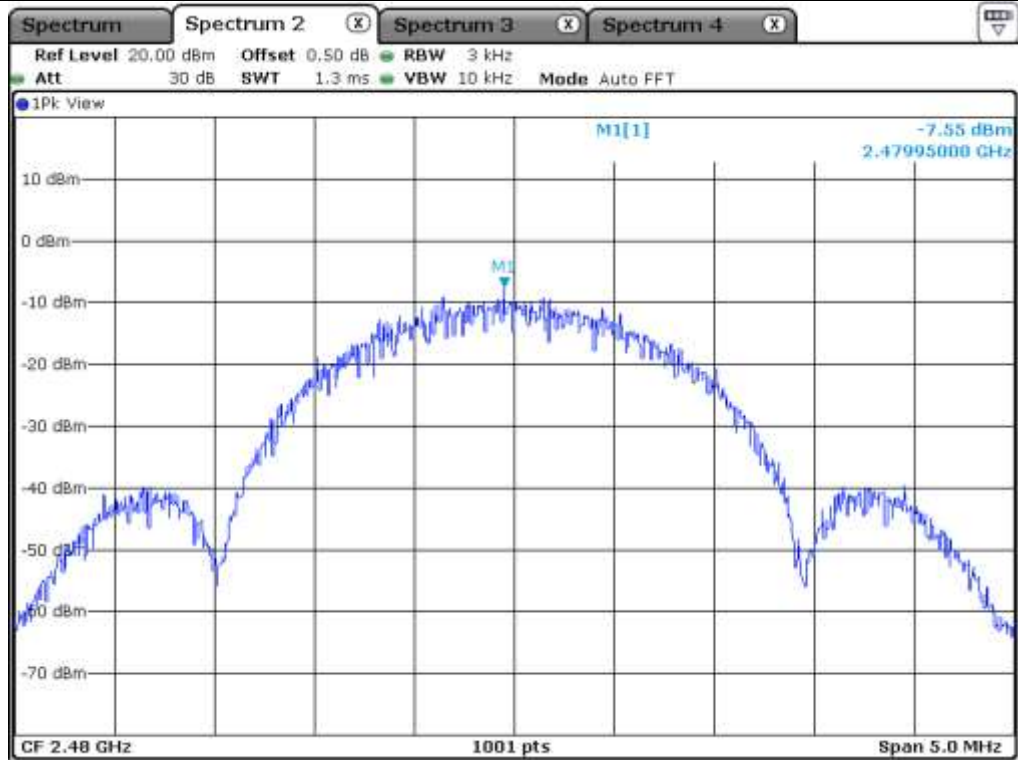


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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 equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)
■ - ESW	Rohde & Schwarz	EMI Test Receiver	101851	Aug. 07, 2019 (1Y)
■ - 310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 18, 2019 (1Y)
■ - DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ - MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ - Loop Antenna	Schwarzbeck	FMZB 1513	1513-235	May. 13, 2018 (2Y)
■ - VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 13, 2018 (2Y)
■ - BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 16, 2019 (1Y)
■ - BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jun. 10, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

11.4 Test data for 30 MHz ~ 1 GHz

11.4.1 Test data for Bluetooth LE

Humidity Level : 48 % R.H.

Temperature: 24 °C

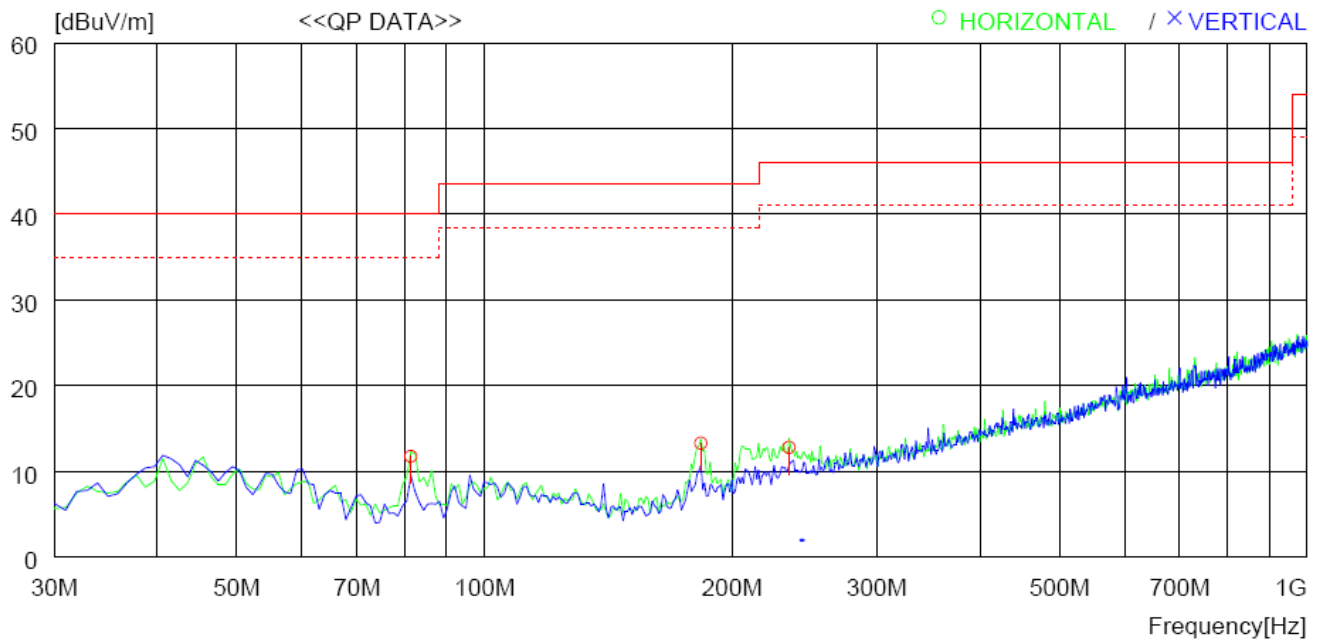
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Wi-Fi/BT Transceiver

Date: December 03, 2019 ~ December 05, 2019

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	81.410	35.0	8.0	1.9	33.1	11.8	40.0	28.2	100	165
2	183.260	34.1	9.7	2.6	33.1	13.3	43.5	30.2	400	3
3	234.670	31.1	11.8	2.9	33.0	12.8	46.0	33.2	200	0



Tested by: Ha-Ram, Lee / Assistant Manager

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

Humidity Level : 48 % R.H.

Temperature: 24 °C

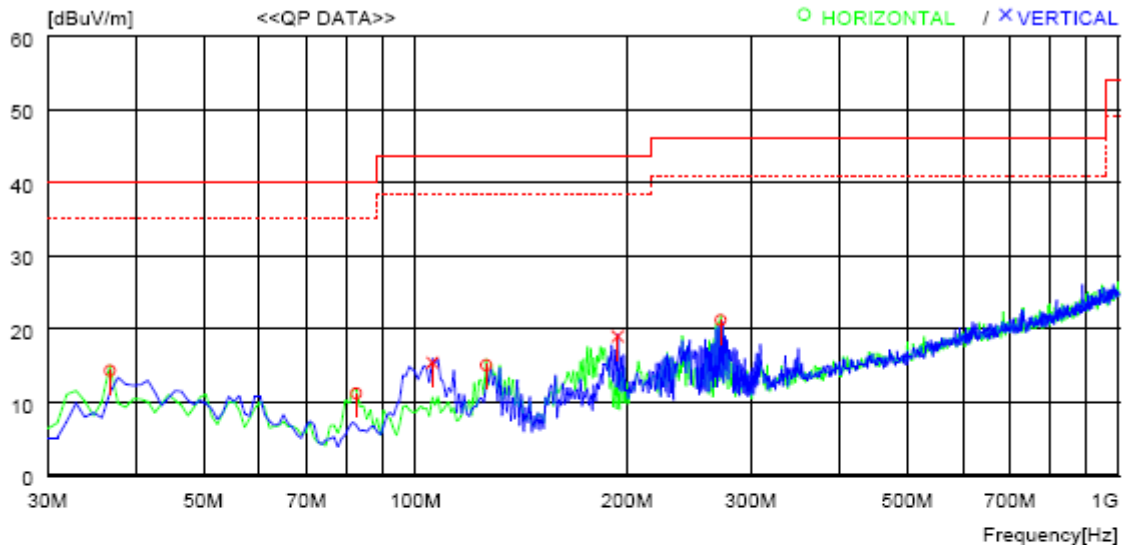
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Wi-Fi/BT Transceiver

Date: December 03, 2019 ~ December 05, 2019

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



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	36.790	33.1	13.0	1.3	33.1	14.3	40.0	25.7	100	154
2	82.380	34.2	8.2	1.9	33.1	11.2	40.0	28.8	400	8
3	126.030	36.2	9.8	2.2	33.1	15.1	43.5	28.4	200	76
4	271.530	38.1	12.9	3.2	33.0	21.2	46.0	24.8	100	359
----- Vertical -----										
5	105.660	34.8	11.6	2.1	33.1	15.4	43.5	28.1	100	0
6	193.930	39.2	10.2	2.7	33.1	19.0	43.5	24.5	100	0



Tested by: Ha-Ram, Lee / Assistant Manager

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

Humidity Level : 48 % R.H.

Temperature: 24 °C

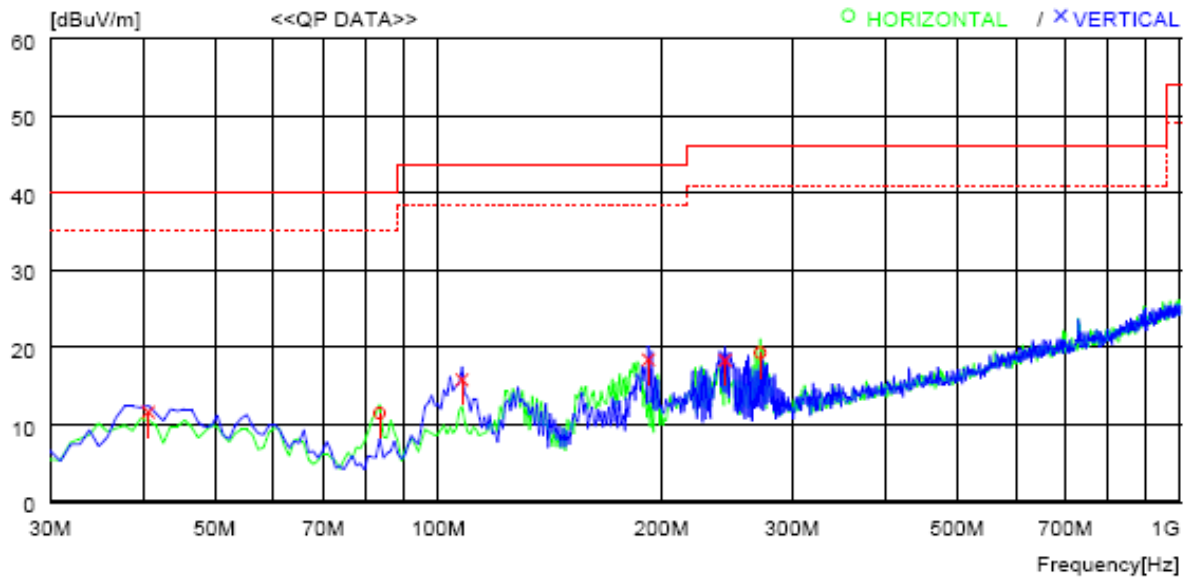
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Wi-Fi/BT Transceiver

Date: December 03, 2019 ~ December 05, 2019

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	83.350	34.2	8.5	1.9	33.1	11.5	40.0	28.5	100	197
2	271.530	36.2	12.9	3.2	33.0	19.3	46.0	26.7	100	359
----- Vertical -----										
3	40.670	29.5	13.8	1.4	33.1	11.6	40.0	28.4	300	299
4	107.600	35.2	11.5	2.2	33.1	15.8	43.5	27.7	100	69
5	191.990	38.7	10.1	2.7	33.1	18.4	43.5	25.1	100	229
6	243.400	36.2	12.1	3.0	33.0	18.3	46.0	27.7	100	0



Tested by: Ha-Ram, Lee / Assistant Manager

11.5 Test data for Below 30 MHz

- . Test Date : December 03, 2019 ~ December 05, 2019
- . 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)
All emissions observed were 20 dB below the limit.									

11.6 Test data for above 1 GHz

- . Test Date : December 03, 2019 ~ December 05, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 1 MHz for Peak Mode, 10 Hz for 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)
All emissions observed were 20 dB below the limit.									



Tested by: Ha-Ram, Lee / Assistant Manager

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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.

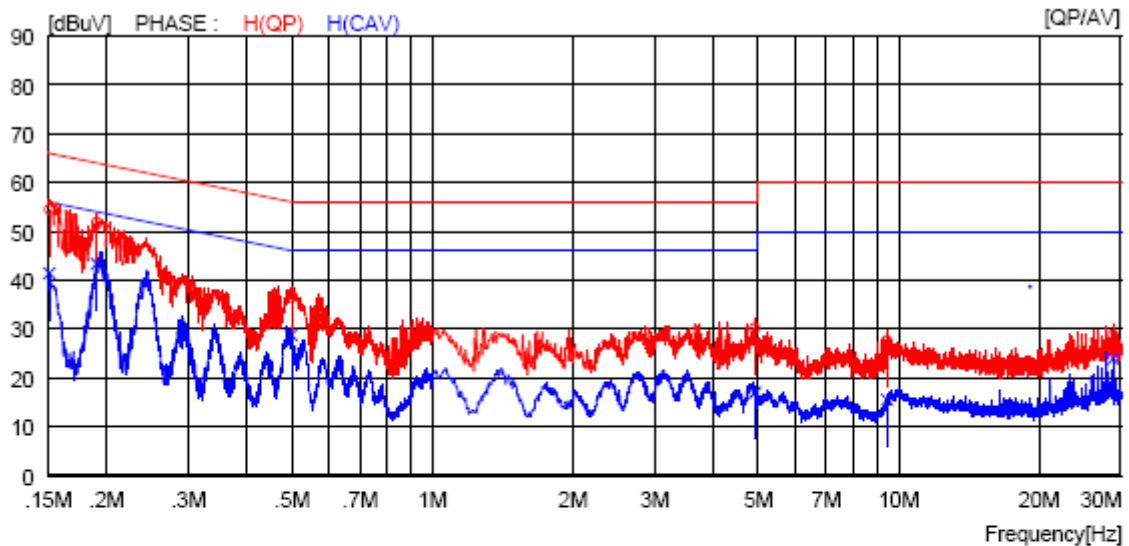
12.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESCI	Rohde & Schwarz	Test Receiver	101012	Oct. 22, 2019 (1Y)
□ -	ESU	Rohde & Schwarz	Test Receiver	100261	Mar. 28, 2019 (1Y)
□ -	NSLK8128	Schwarzbeck	AMN	8128-216	Mar. 20, 2019 (1Y)
■ -	NSLK8126	Schwarzbeck	AMN	8126-404	Mar. 19, 2019 (1Y)
□ -	3825/2	EMCO	AMN	9109-1869	Mar. 19, 2019 (1Y)
■ -	3825/2	EMCO	AMN	9109-1867	Mar. 27, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

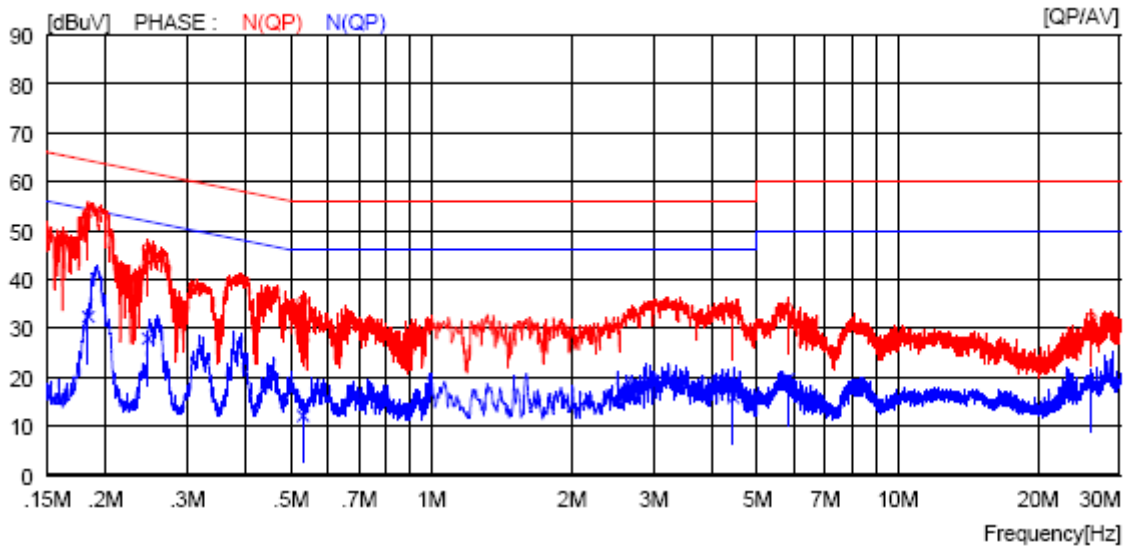
12.4 Test data

- Test Date : December 09, 2019
- 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	0.15100	44.4	----	10.0	54.4	----	65.9	----	11.5	----	H(QP)
2	0.19100	41.8	----	10.0	51.8	----	64.0	----	12.2	----	H(QP)
3	0.49900	26.5	----	10.0	36.5	----	56.0	----	19.5	----	H(QP)
4	4.92000	20.0	----	10.1	30.1	----	56.0	----	25.9	----	H(QP)
5	9.45500	17.3	----	10.3	27.6	----	60.0	----	32.4	----	H(QP)
6	28.88000	18.0	----	10.8	28.8	----	60.0	----	31.2	----	H(QP)
7	0.15100	----	31.4	10.0	----	41.4	----	55.9	----	14.5	H(CAV)
8	0.19100	----	33.4	10.0	----	43.4	----	54.0	----	10.6	H(CAV)
9	0.49900	----	18.8	10.0	----	28.8	----	46.0	----	17.2	H(CAV)
10	4.92000	----	6.9	10.1	----	17.0	----	46.0	----	29.0	H(CAV)
11	9.45500	----	5.2	10.3	----	15.5	----	50.0	----	34.5	H(CAV)
12	28.88000	----	13.1	10.8	----	23.9	----	50.0	----	26.1	H(CAV)

-. Tested 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	0.18400	43.5	----	10.0	53.5	----	64.3	----	10.8	----	N(QP)
2	0.24700	36.2	----	10.0	46.2	----	61.9	----	15.7	----	N(QP)
3	0.53100	25.4	----	10.0	35.4	----	56.0	----	20.6	----	N(QP)
4	4.44800	23.1	----	10.1	33.2	----	56.0	----	22.8	----	N(QP)
5	5.82000	23.9	----	10.2	34.1	----	60.0	----	25.9	----	N(QP)
6	26.10000	21.2	----	10.8	32.0	----	60.0	----	28.0	----	N(QP)
7	0.18400	----	22.4	10.0	----	32.4	----	54.3	----	21.9	N(CAV)
8	0.24700	----	17.9	10.0	----	27.9	----	51.9	----	24.0	N(CAV)
9	0.53100	----	2.1	10.0	----	12.1	----	46.0	----	33.9	N(CAV)
10	4.44800	----	5.8	10.1	----	15.9	----	46.0	----	30.1	N(CAV)
11	5.82000	----	9.4	10.2	----	19.6	----	50.0	----	30.4	N(CAV)
12	26.10000	----	7.7	10.8	----	18.5	----	50.0	----	31.5	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.

[Signature]

Tested by: Ha-Ram, Lee / Assistant Manager