

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-19D-RWD-054
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 : 86 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-054	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 : Jenni Chun / General 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	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
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) (1)	Carrier Frequency Separation	Met the Limit / PASS
15.247 (a) (1) (iii)	Minimum Number of Hopping Channels	Met the Limit / PASS
15.247 (a) (1) (iii)	Average Time of Occupancy	Met the Limit / PASS
15.247 (b) (1)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.209	Radiated Emission Limits, General Requirement	Met the Limit / PASS
15.207	Conducted Limits	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-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 441MHz, and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XZ” axis, but the worst data was recorded in this report.

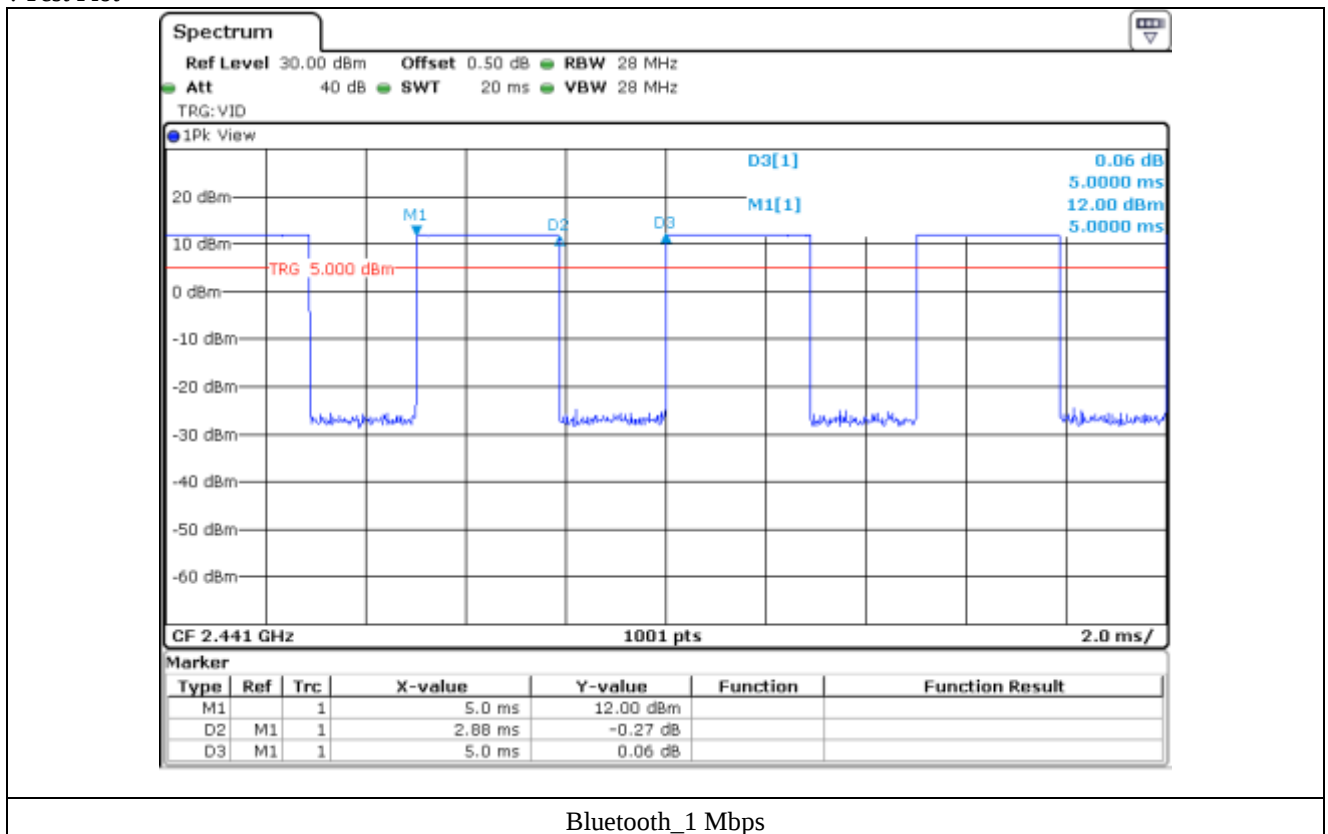
-. Duty Cycle

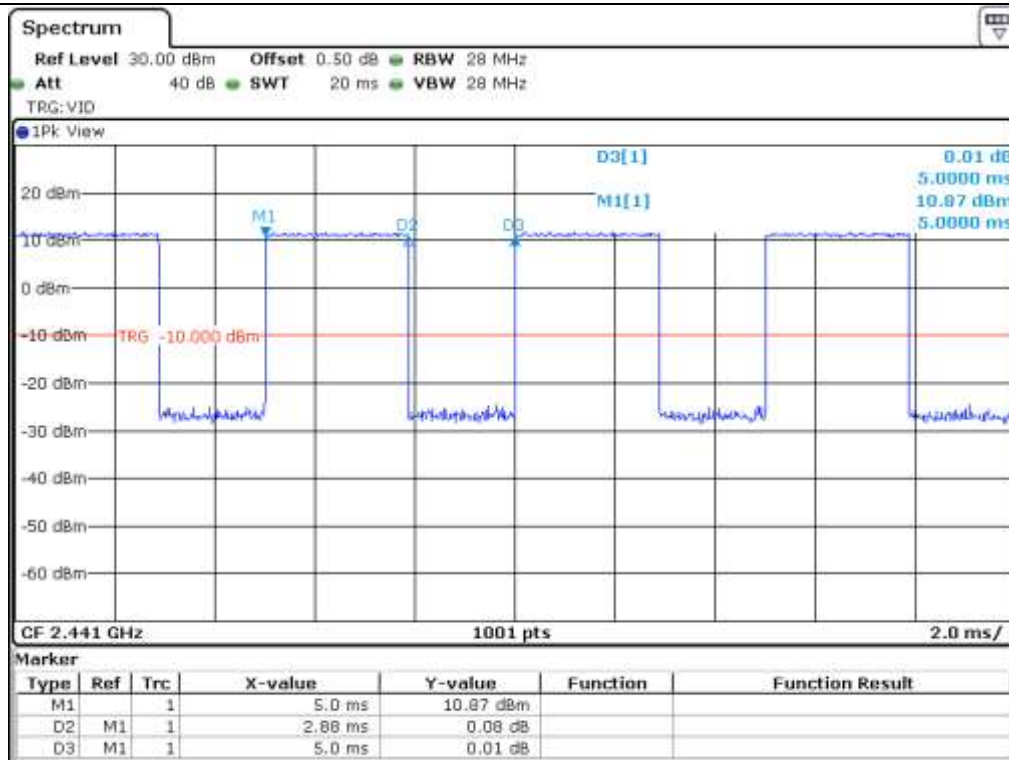
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.88	2.12	57.60	2.40
Bluetooth [2 Mbps]	2.88	2.12	57.60	2.40
Bluetooth [3 Mbps]	2.88	2.12	57.60	2.40

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

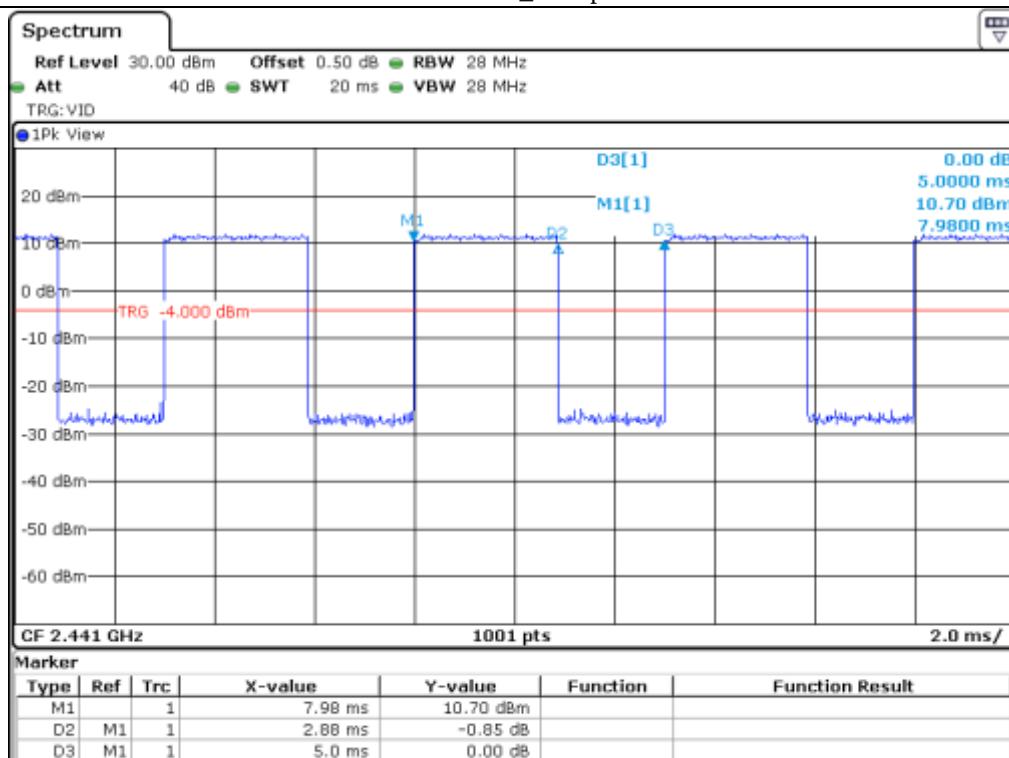
Correction Factor : $10 * \log(1 / (\text{Duty Cycle} / 100))$

-. Test Plot





Bluetooth_2 Mbps



Bluetooth_3 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

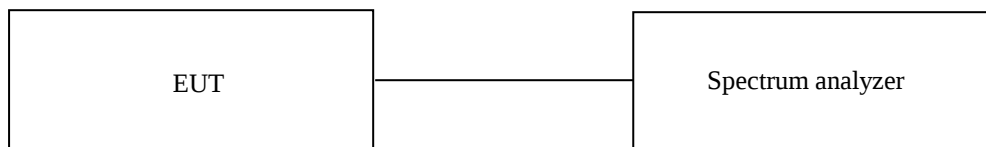
7. MINIMUM 20 dB BANDWIDTH

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 10 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.



7.3 Test 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.

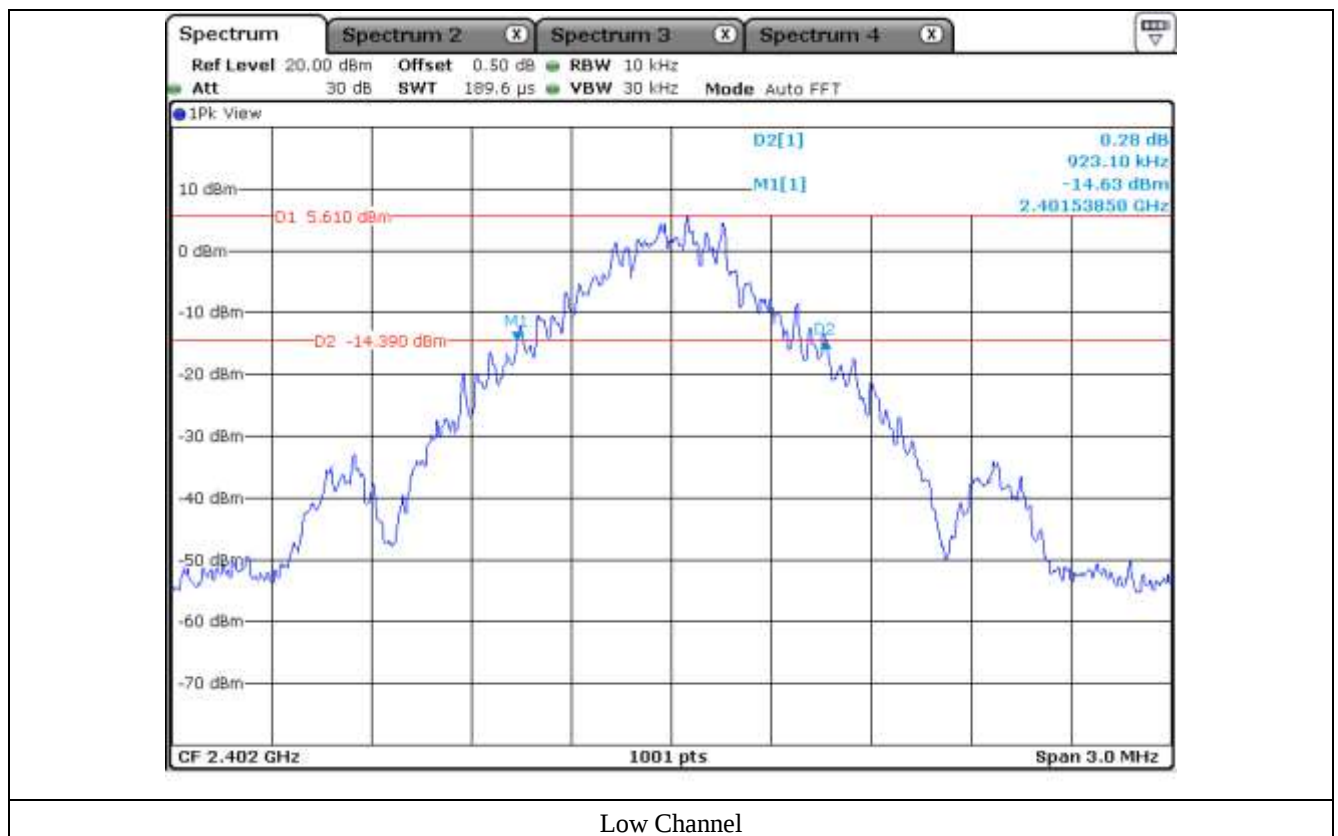
7.4 Test data for 1 Mbps

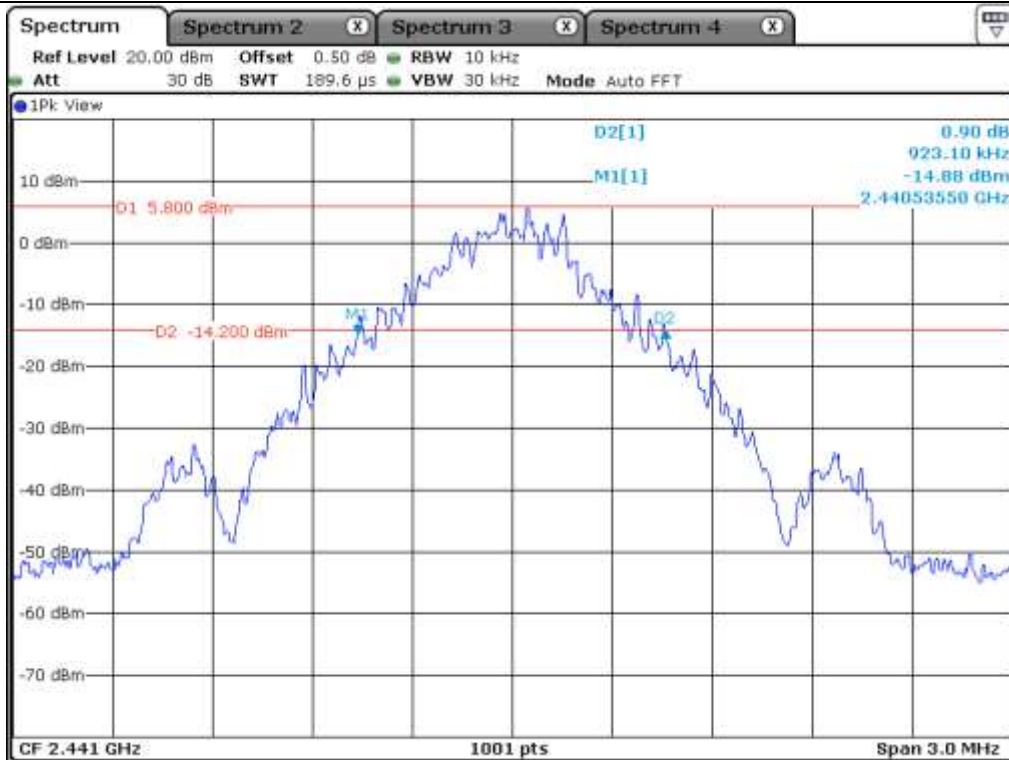
-. Test Date : December 02, 2019 ~ December 11, 2019

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	923.10
Middle	2 441.00	923.10
High	2 480.00	923.10

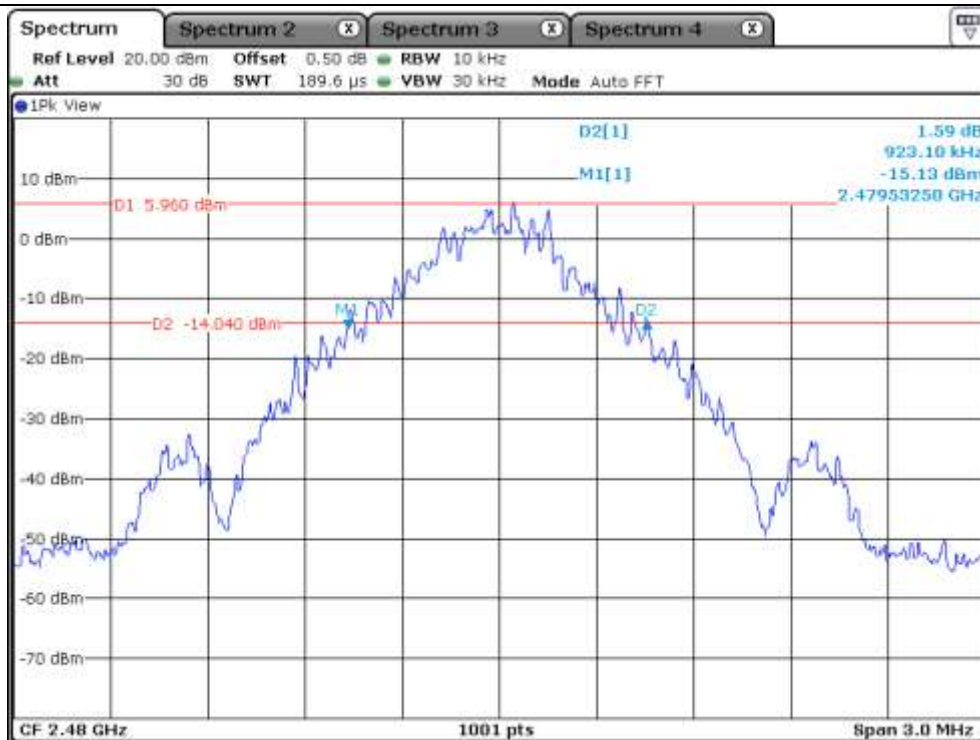


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Middle Channel



High Channel

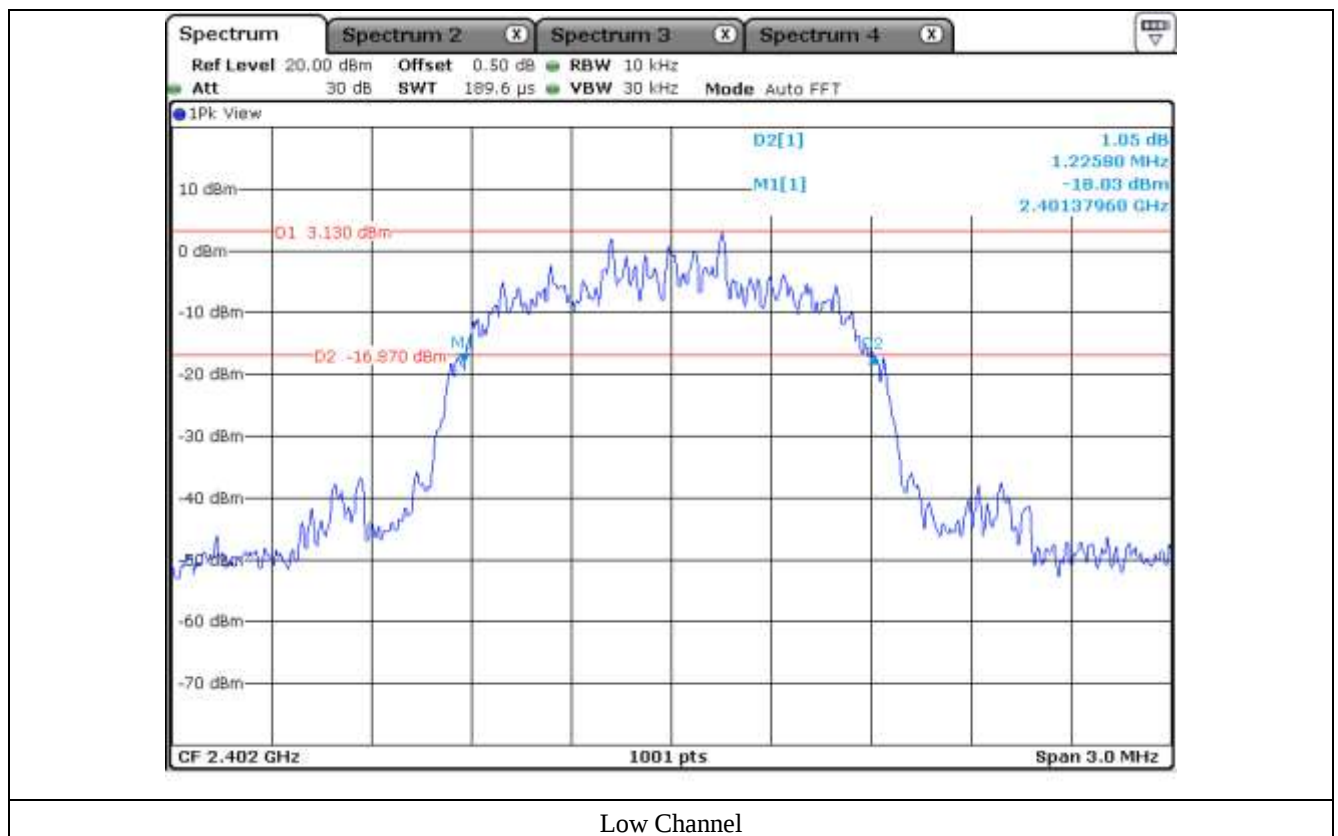
7.5 Test data for 2 Mbps

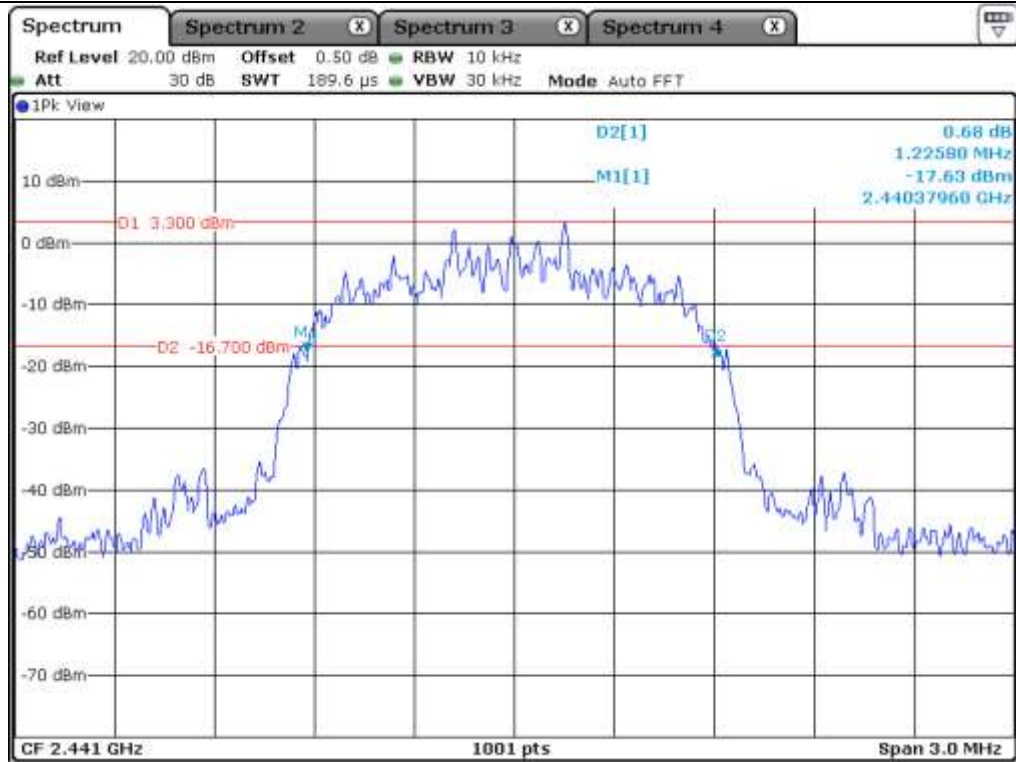
-. Test Date : December 02, 2019 ~ December 11, 2019

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 225.80
Middle	2 441.00	1 225.80
High	2 480.00	1 222.80

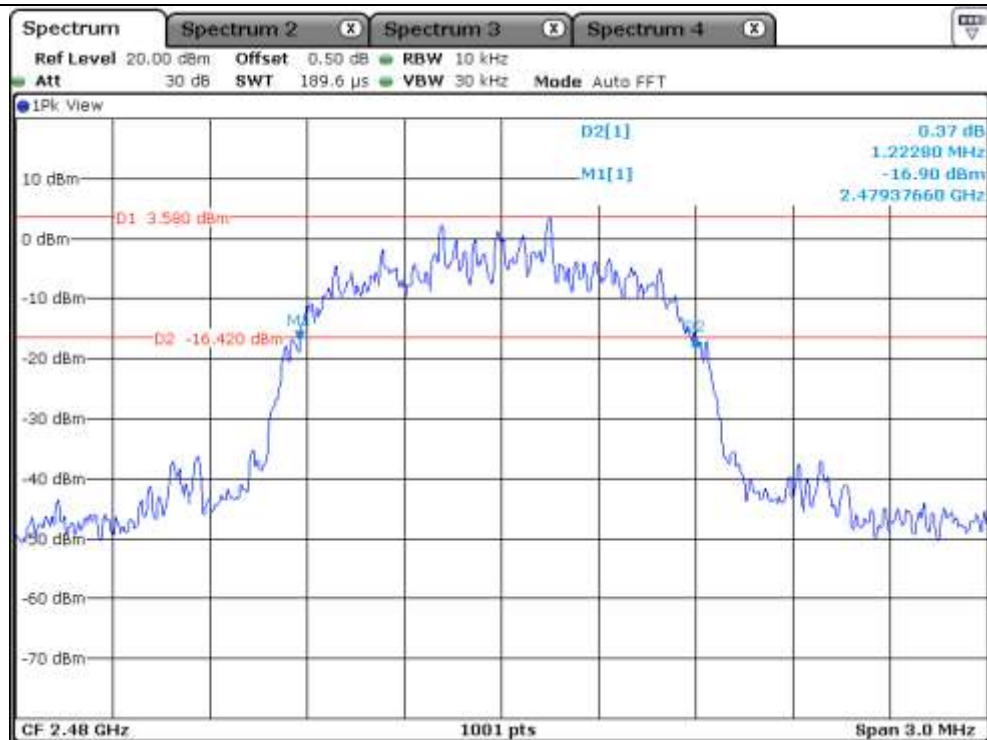


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Middle Channel



High Channel

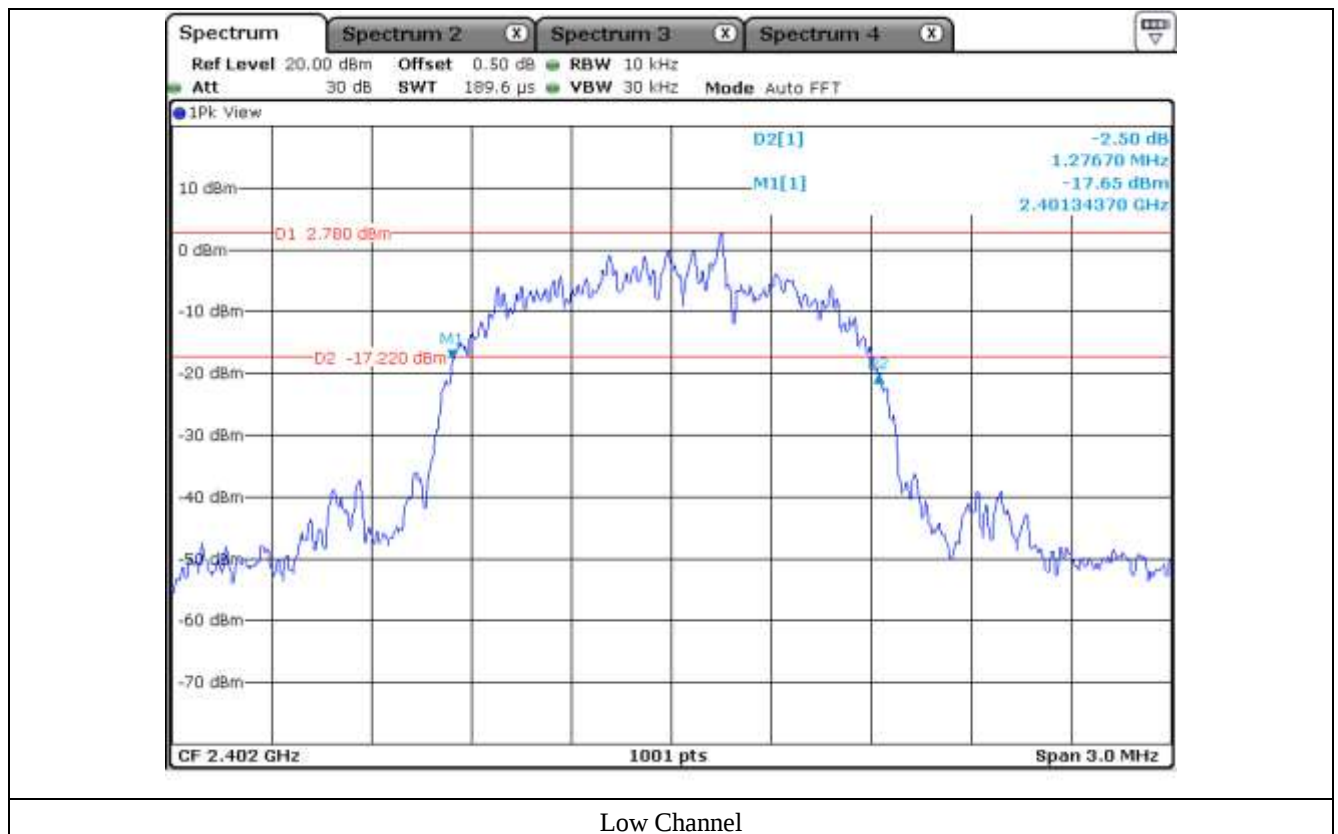
7.6 Test data for 3 Mbps

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

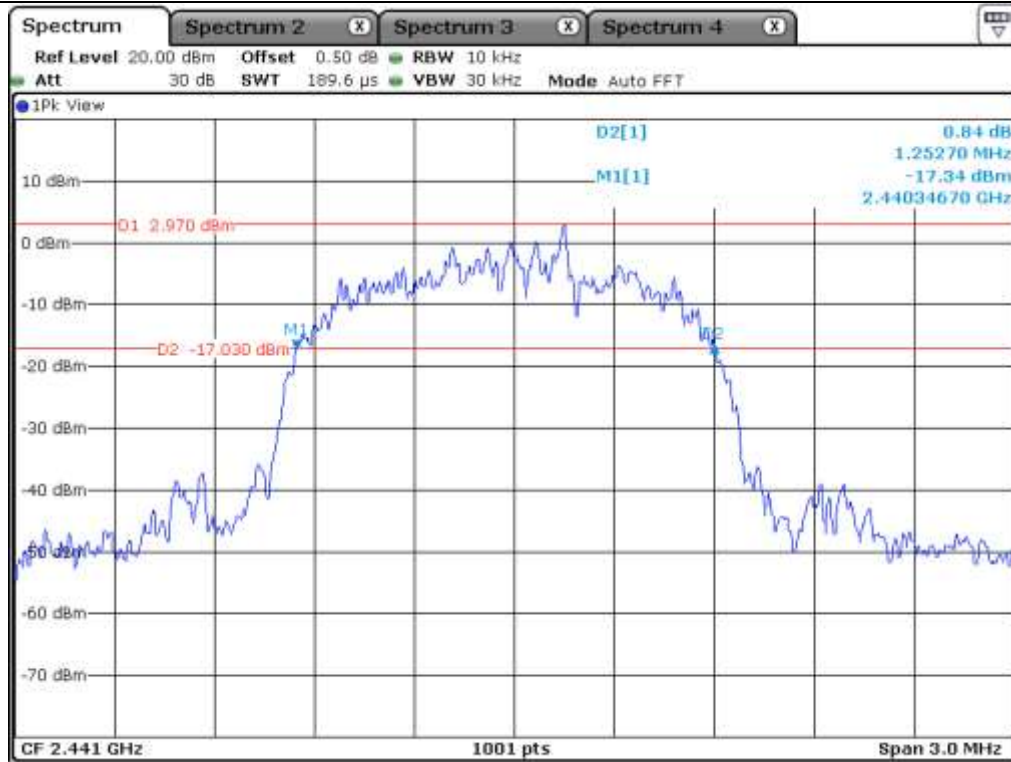
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 276.70
Middle	2 441.00	1 252.70
High	2 480.00	1 258.70

[Handwritten Signature]

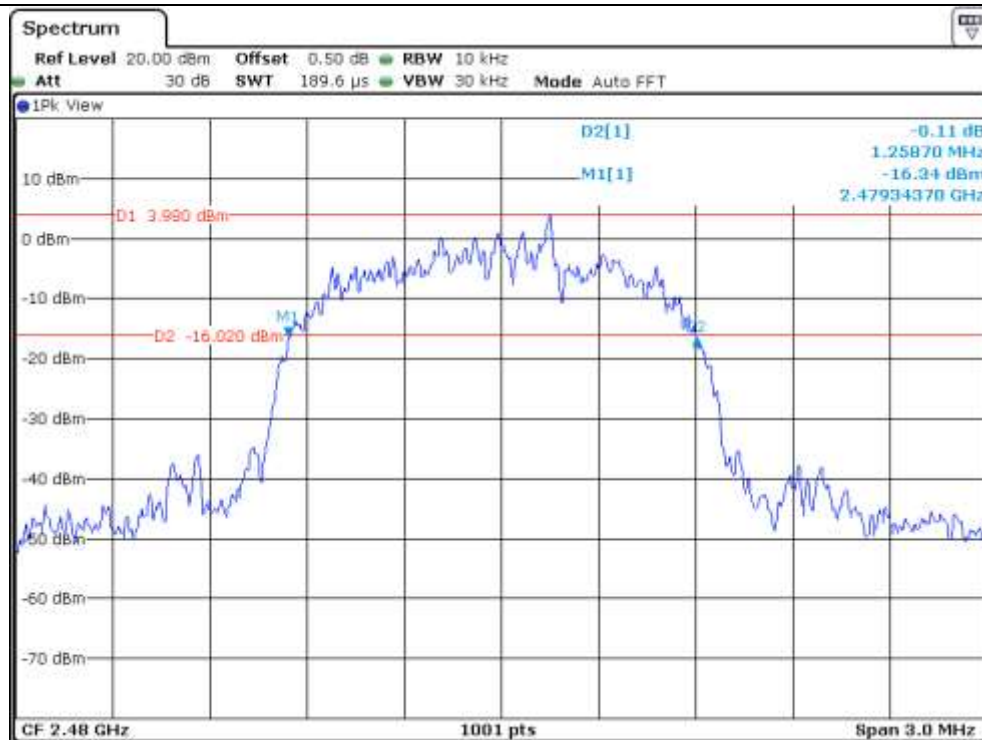
Tested by: Ha-Ram, Lee / Assistant Manager



Low Channel



Middle Channel



High Channel

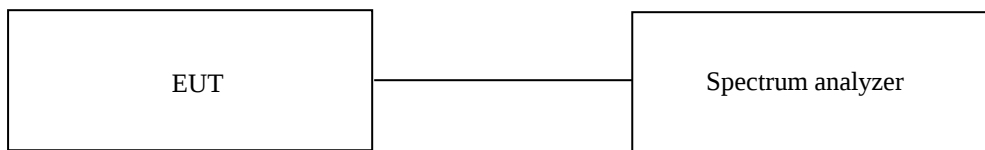
8. HOPPING FREQUENCY SEPARATION

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 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 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

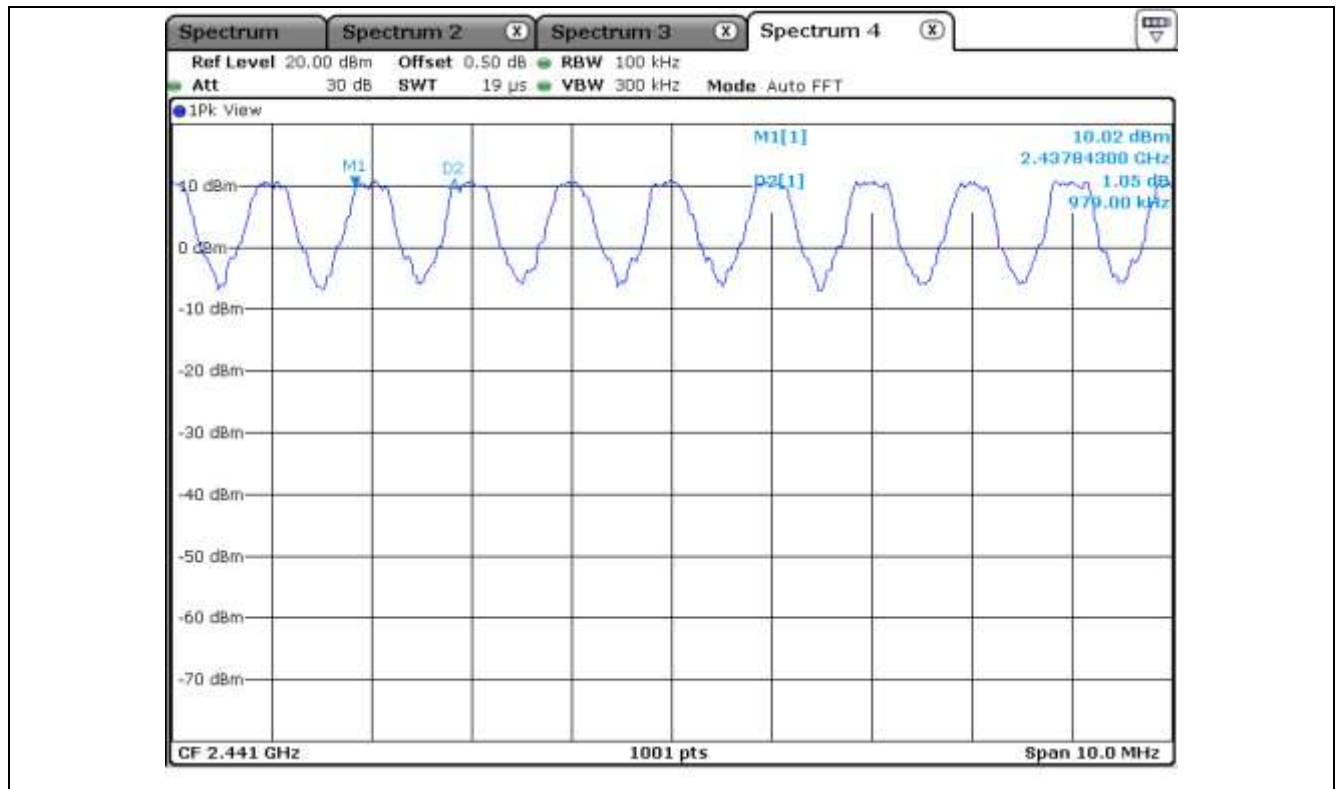
-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
979.00	616.07	Separated by a minimum of 25 kHz



Tested by: Ha-Ram, Lee / Assistant Manager



8.5 Test data for 2 Mbps

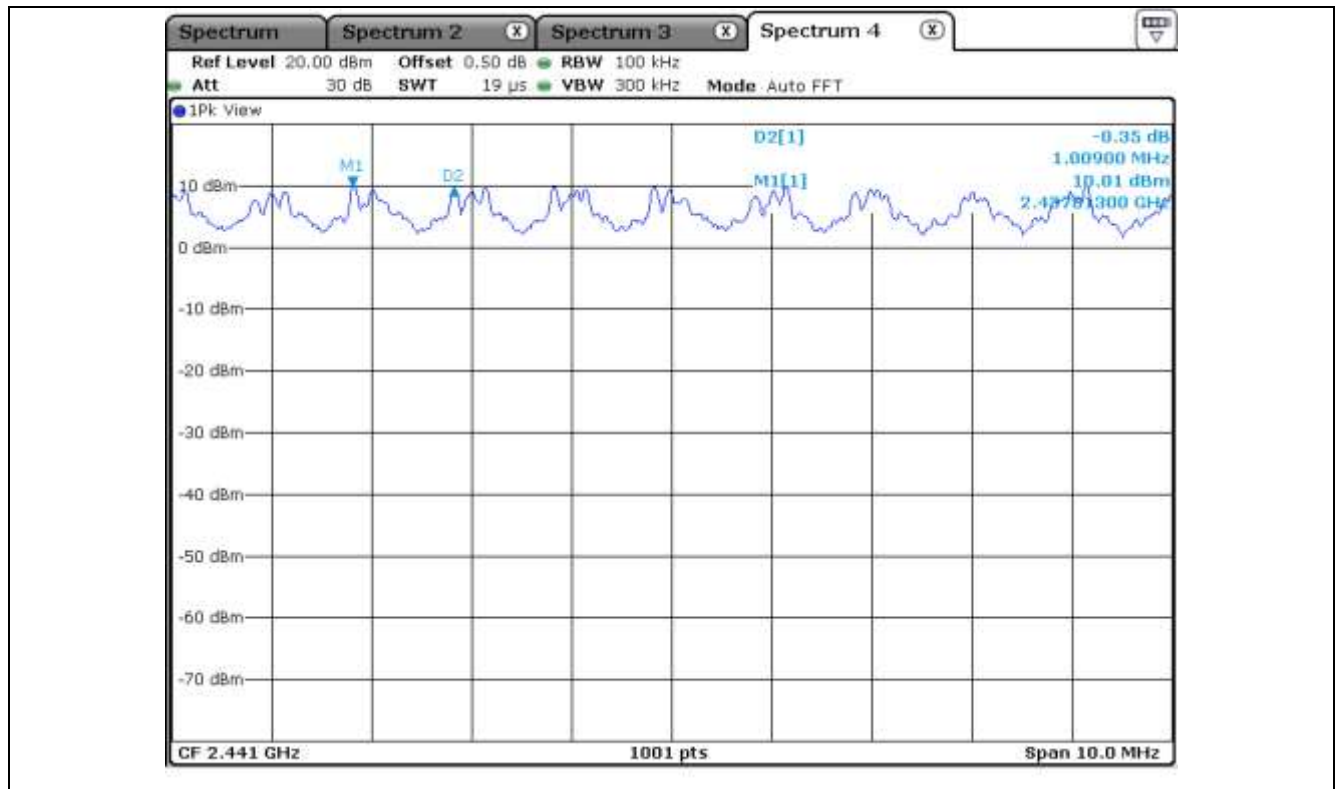
-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1009.00	817.20	Separated by a minimum of 25 kHz



Tested by: Ha-Ram, Lee / Assistant Manager



8.6 Test data for 3 Mbps

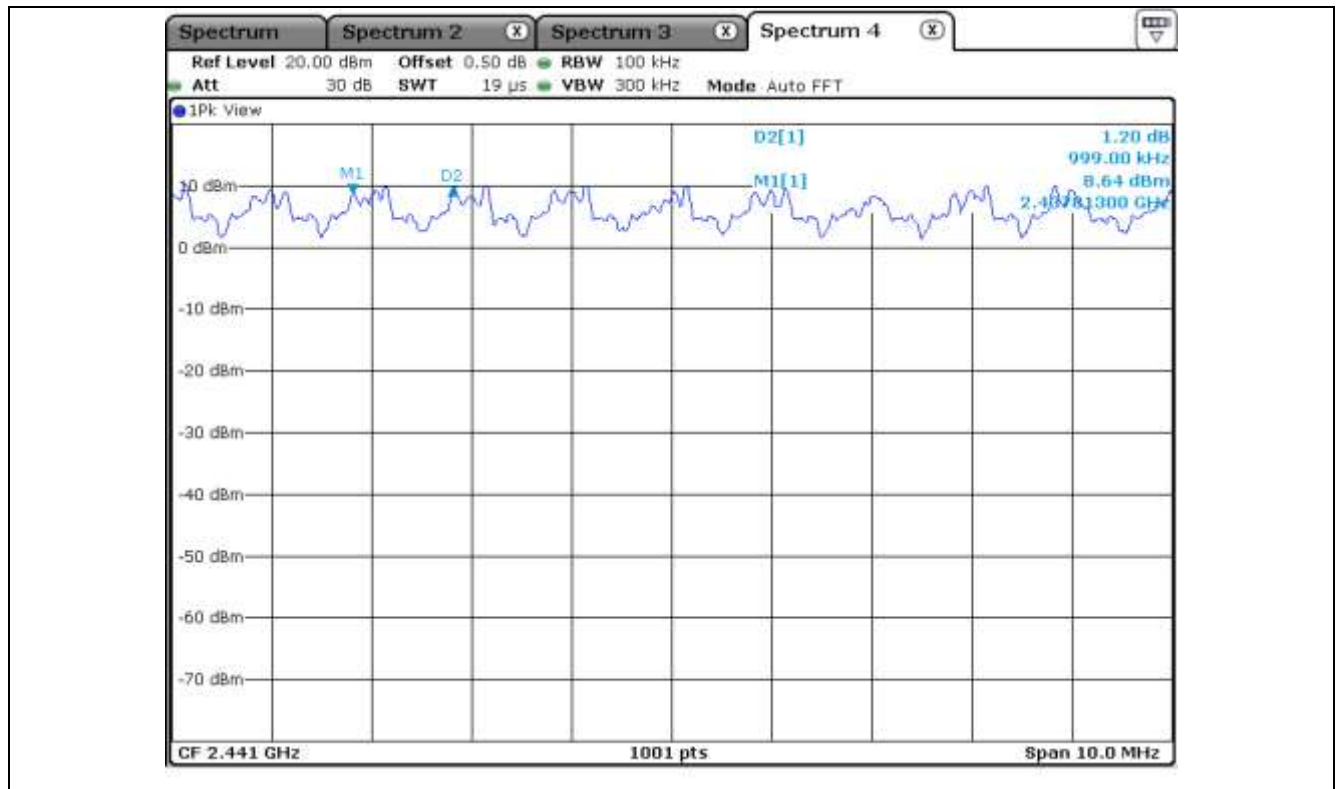
-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	835.13	Separated by a minimum of 25 kHz



Tested by: Ha-Ram, Lee / Assistant Manager



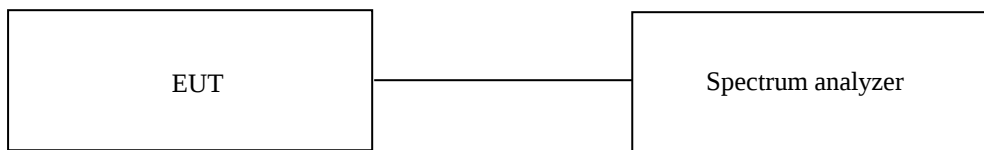
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

9.2 Test set-up

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



9.3 Test 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.

9.4 Test data for 1 Mbps

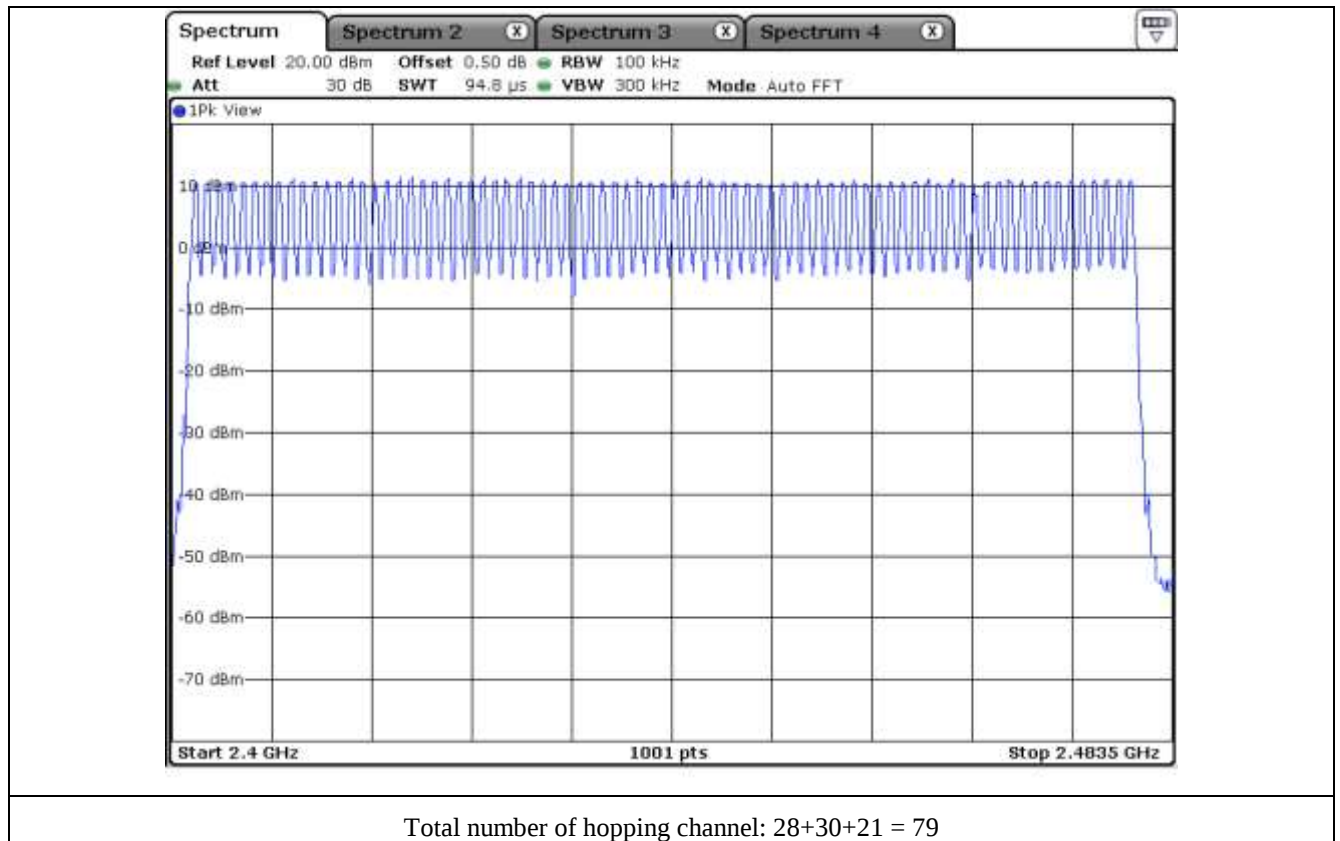
-. Test Date : December 02, 2019 ~ December 11, 2019

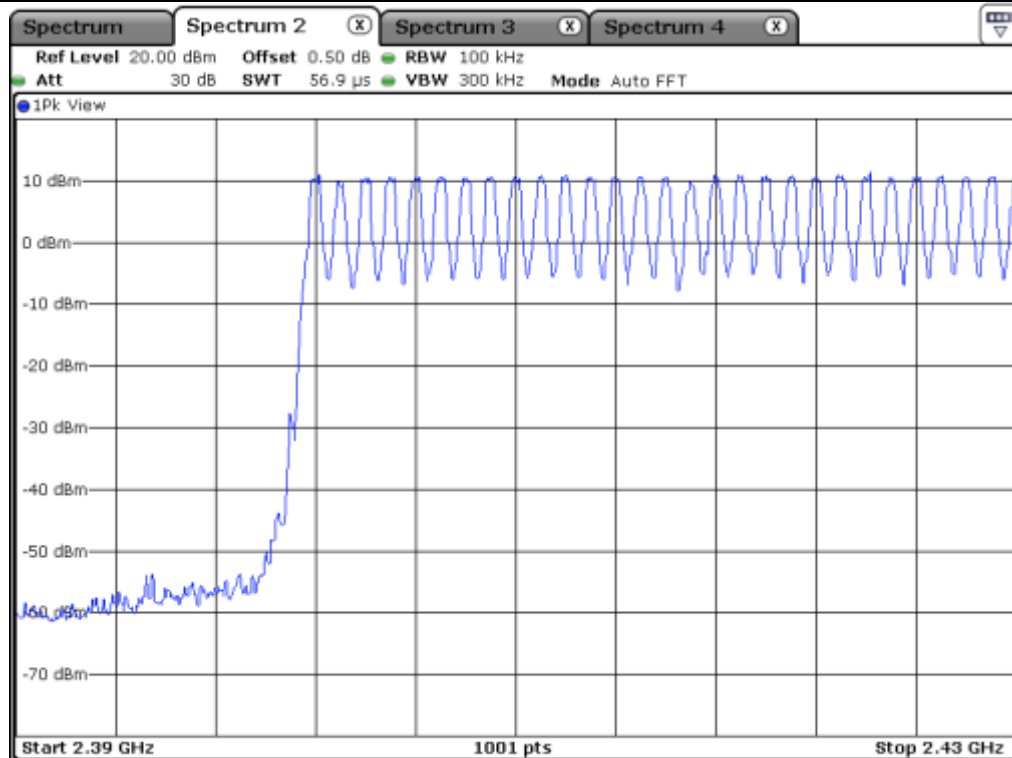
-. Test Result : Pass

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

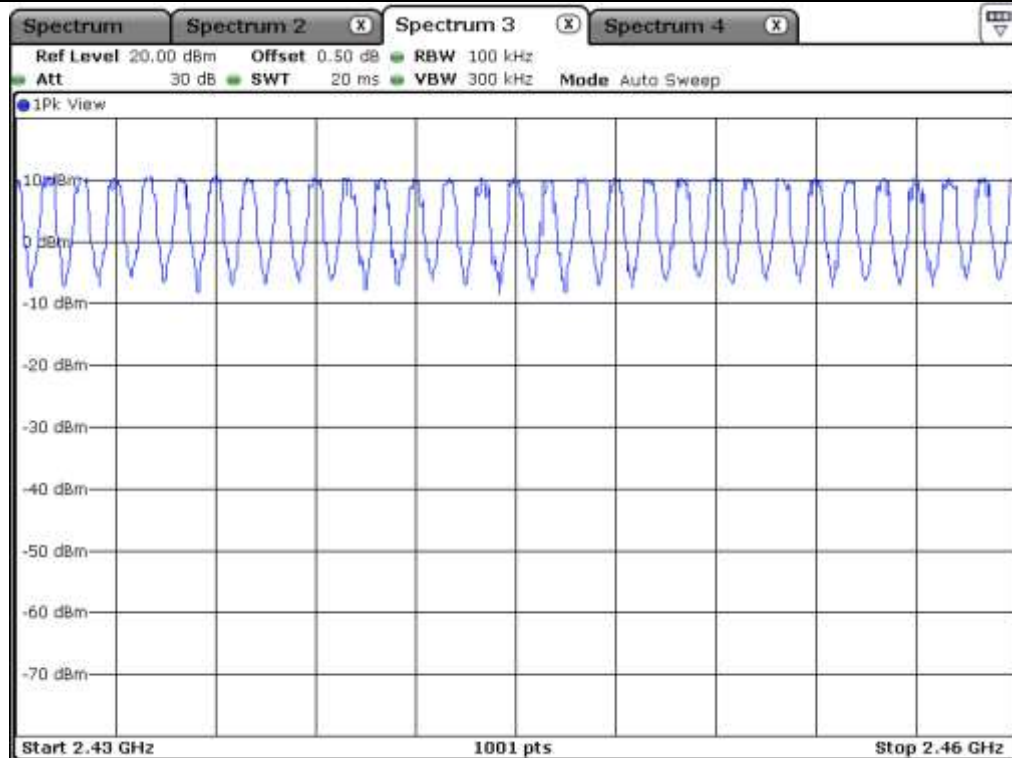


Tested by: Ha-Ram, Lee / Assistant Manager

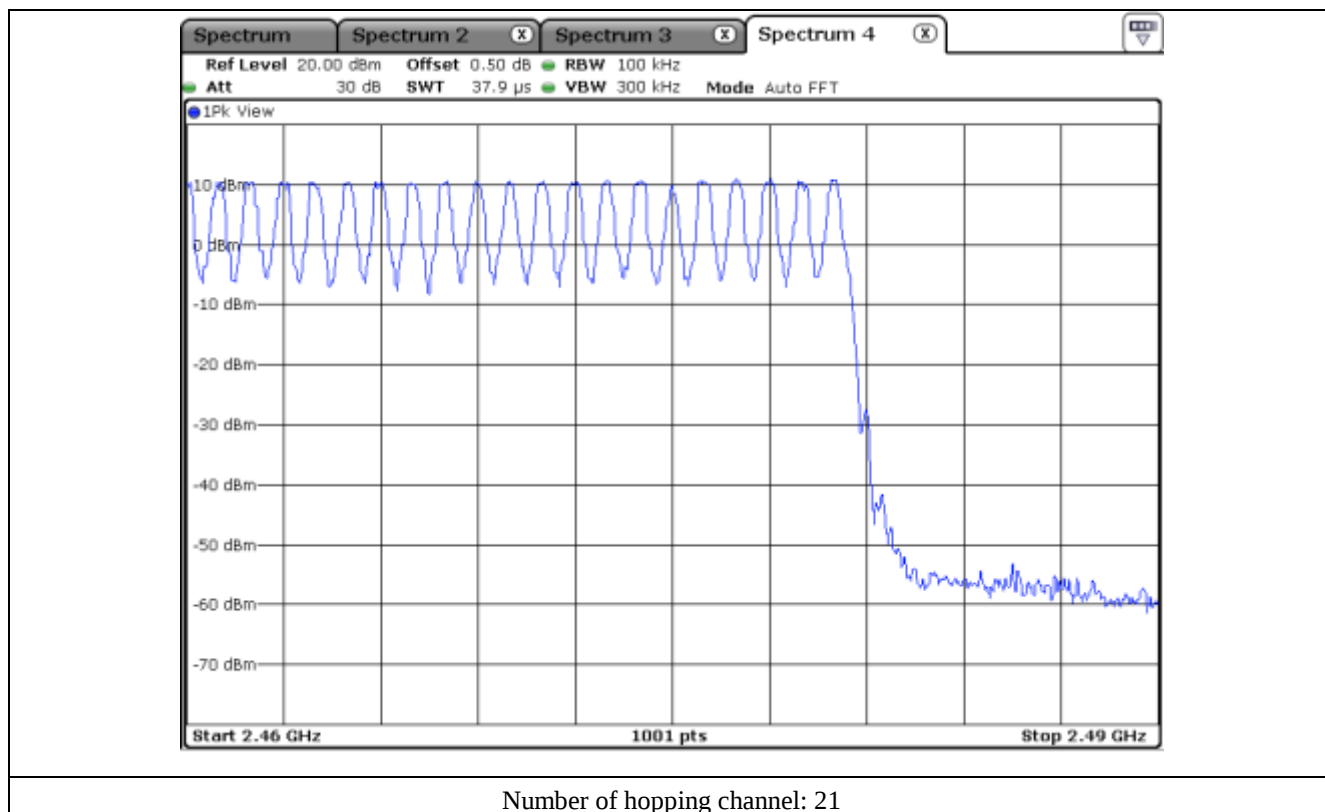




Number of hopping channel: 28



Number of hopping channel: 30



9.5 Test data for 2 Mbps

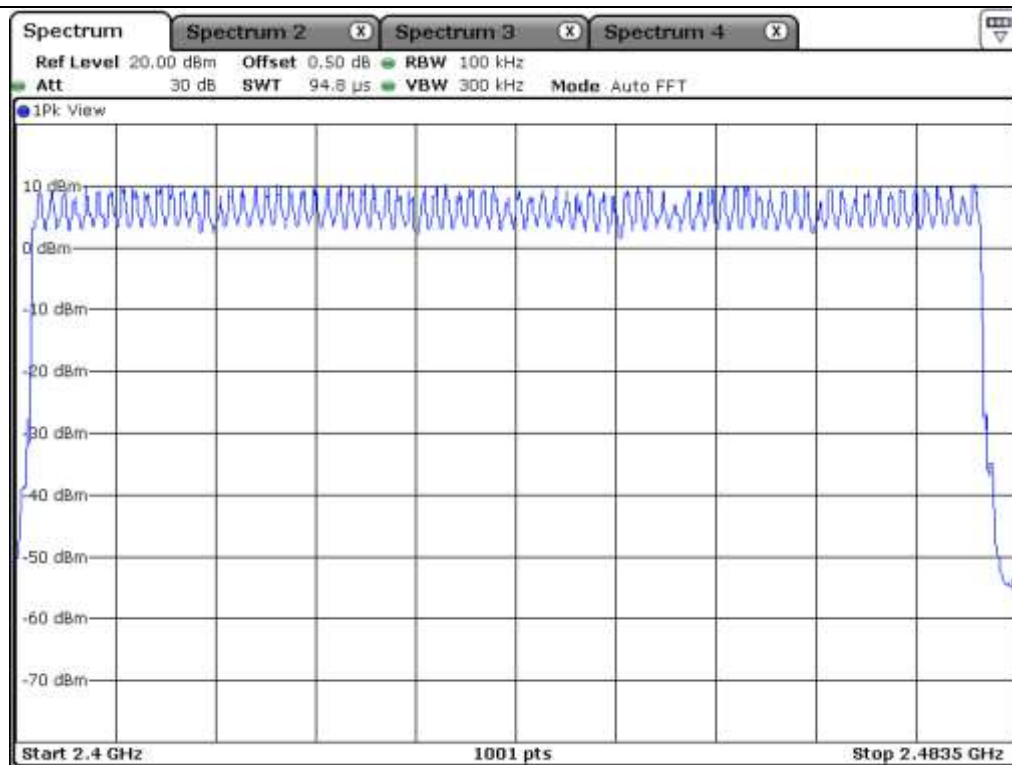
-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

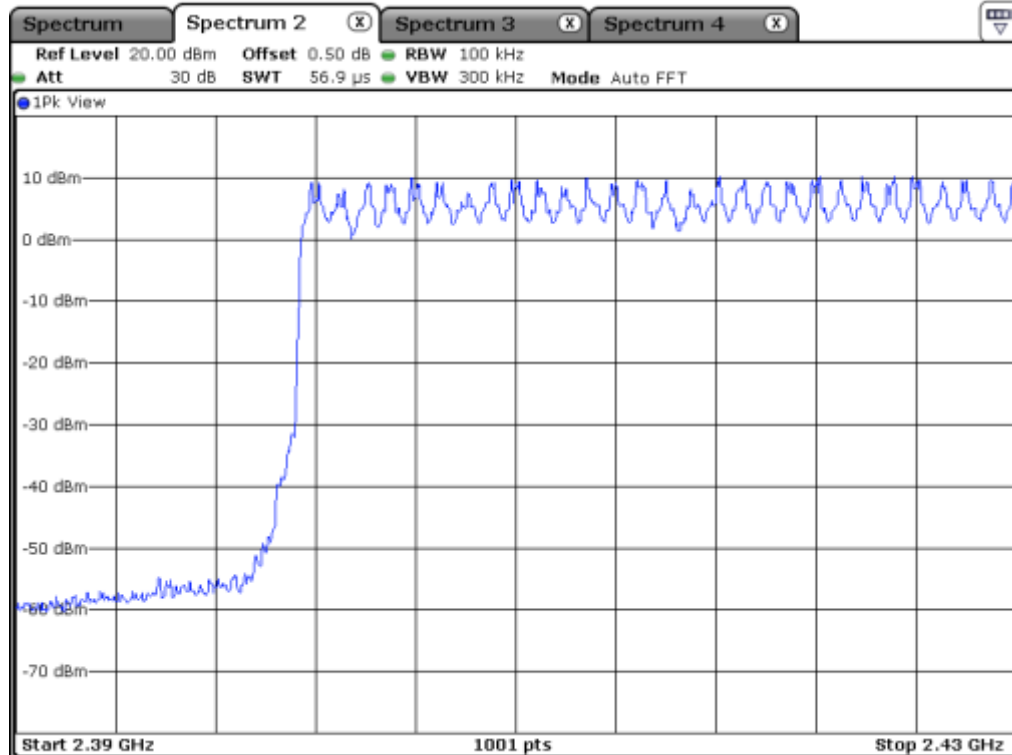
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
2 Mbps	79	Minimum of 15	64



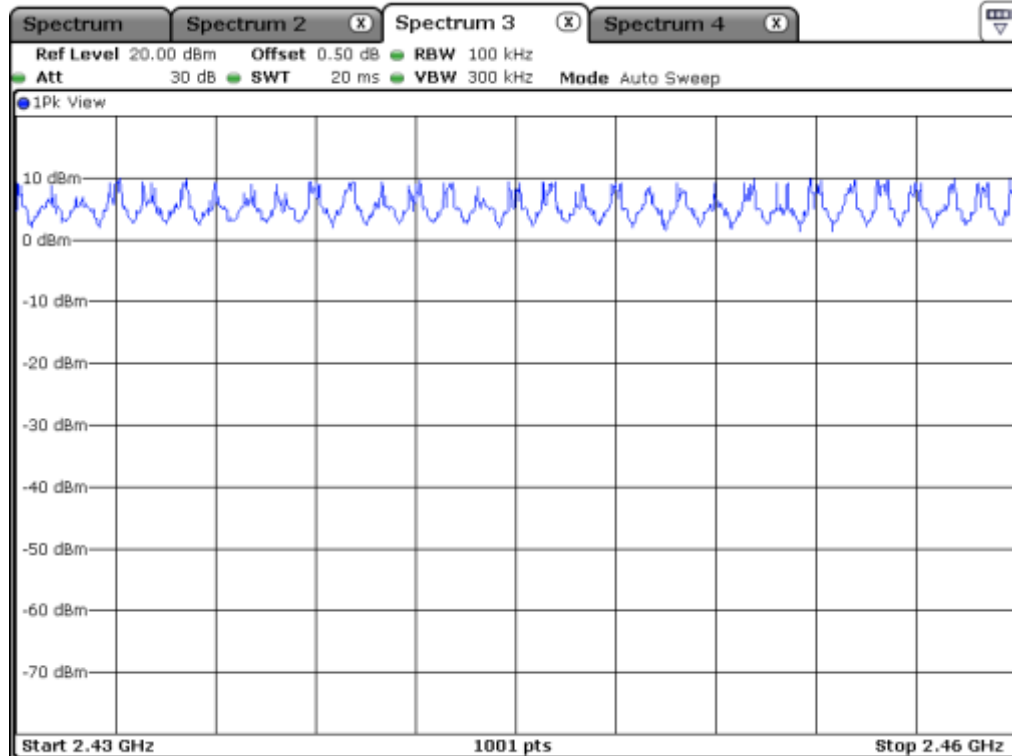
Tested by: Ha-Ram, Lee / Assistant Manager



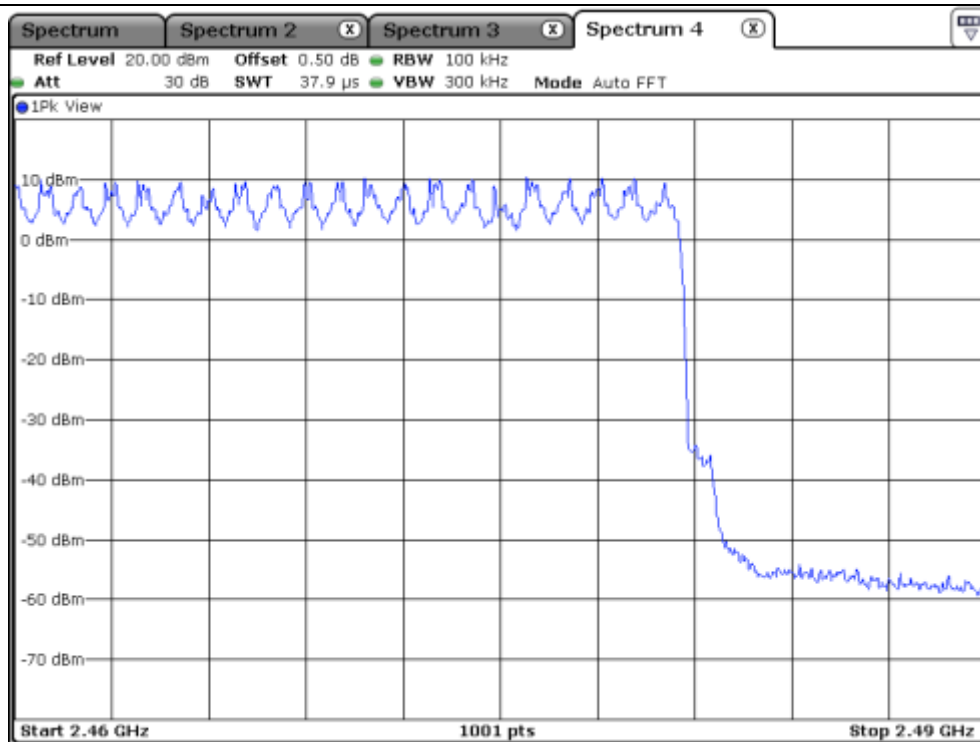
Total number of hopping channel: 28+30+21 = 79



Number of hopping channel: 28



Number of hopping channel: 30



Number of hopping channel: 21

9.6 Test data for 3 Mbps

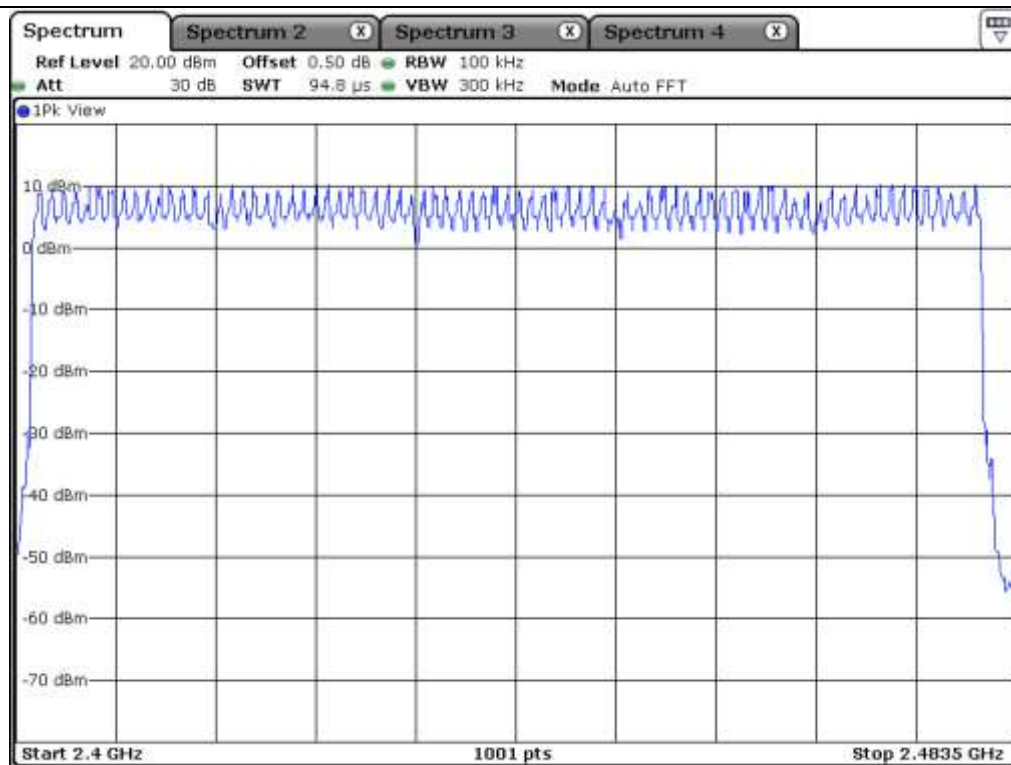
-. Test Date : December 02, 2019 ~ December 11, 2019

-. Test Result : Pass

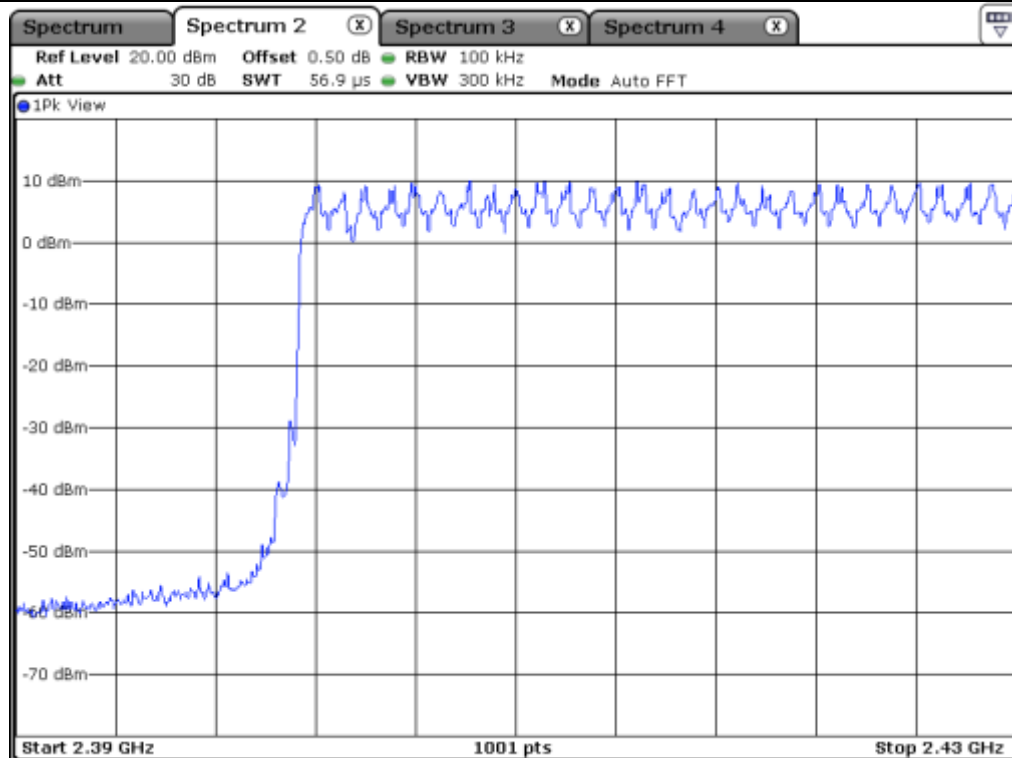
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
3 Mbps	79	Minimum of 15	64



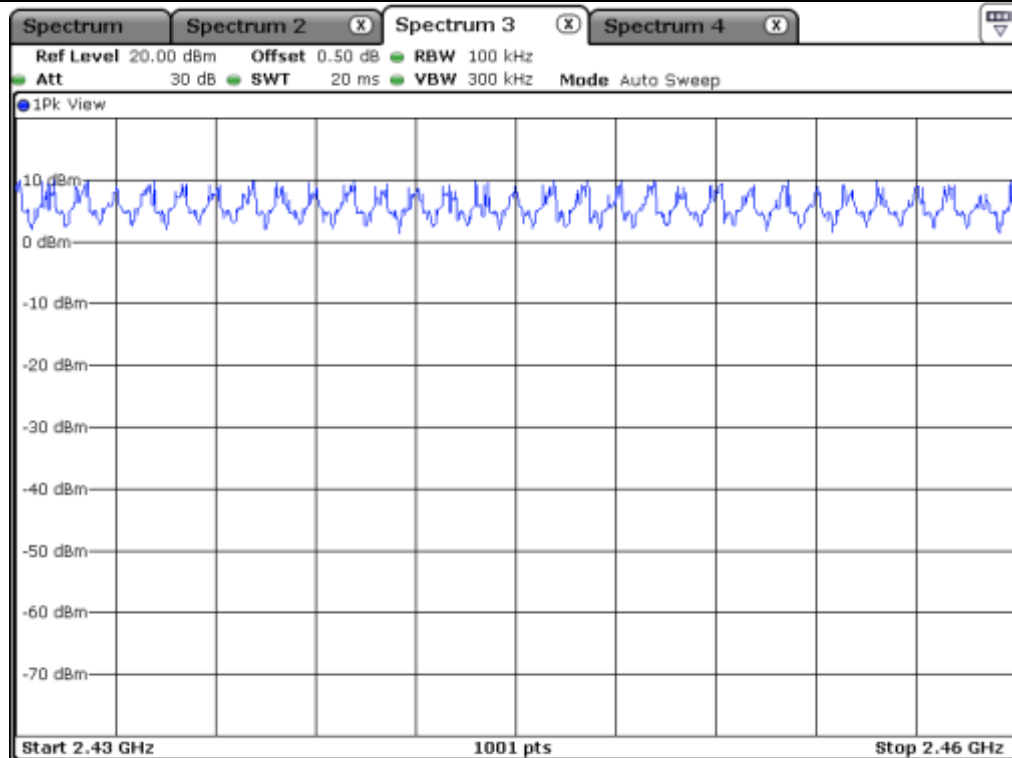
Tested by: Ha-Ram, Lee / Assistant Manager



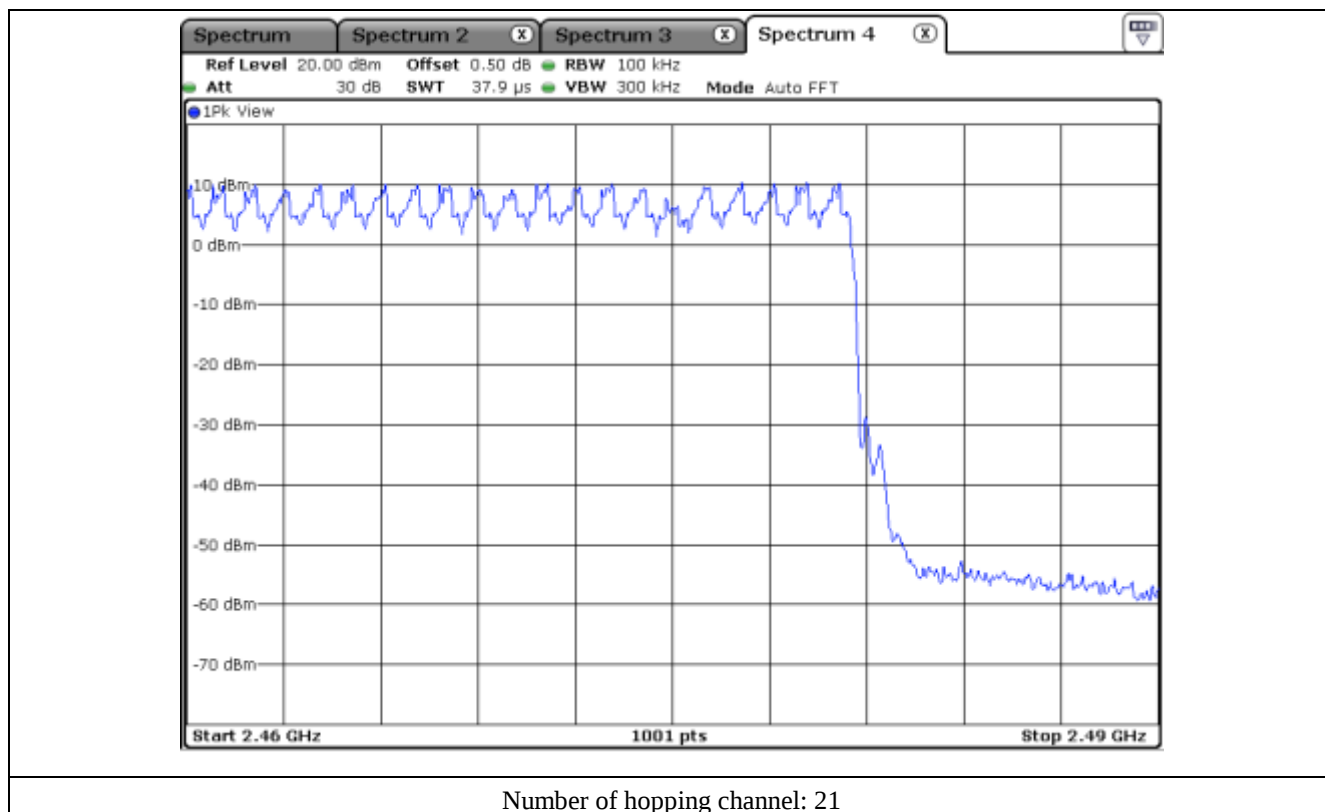
Total number of hopping channel: $28+30+21 = 79$



Number of hopping channel: 28



Number of hopping channel: 30



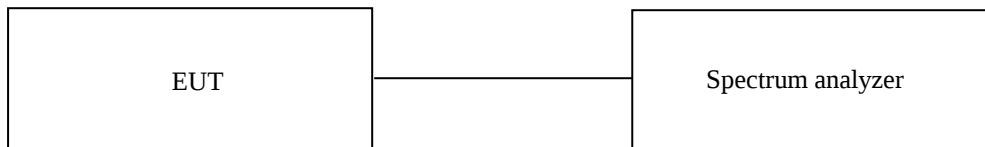
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 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 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 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

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	0.370	10.13	31.60	118.44	400	PASS
DH3	1.630	5.06	31.60	260.63	400	
DH5	2.880	3.38	31.60	307.61	400	

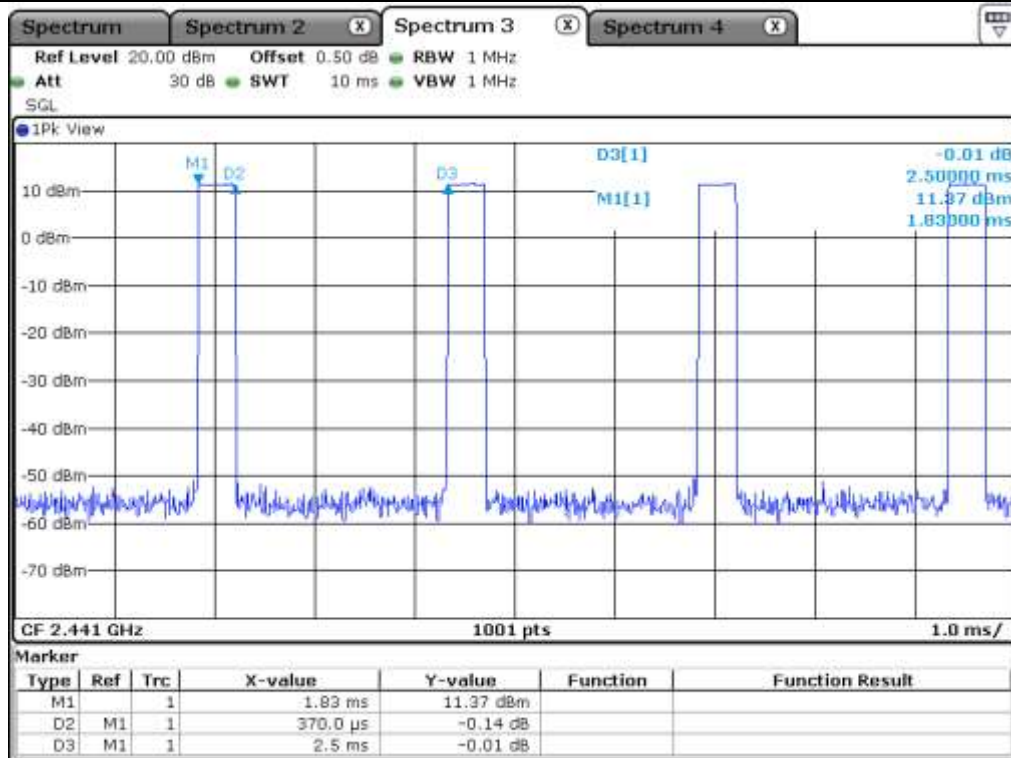
Total dwell time is calculated as following.

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

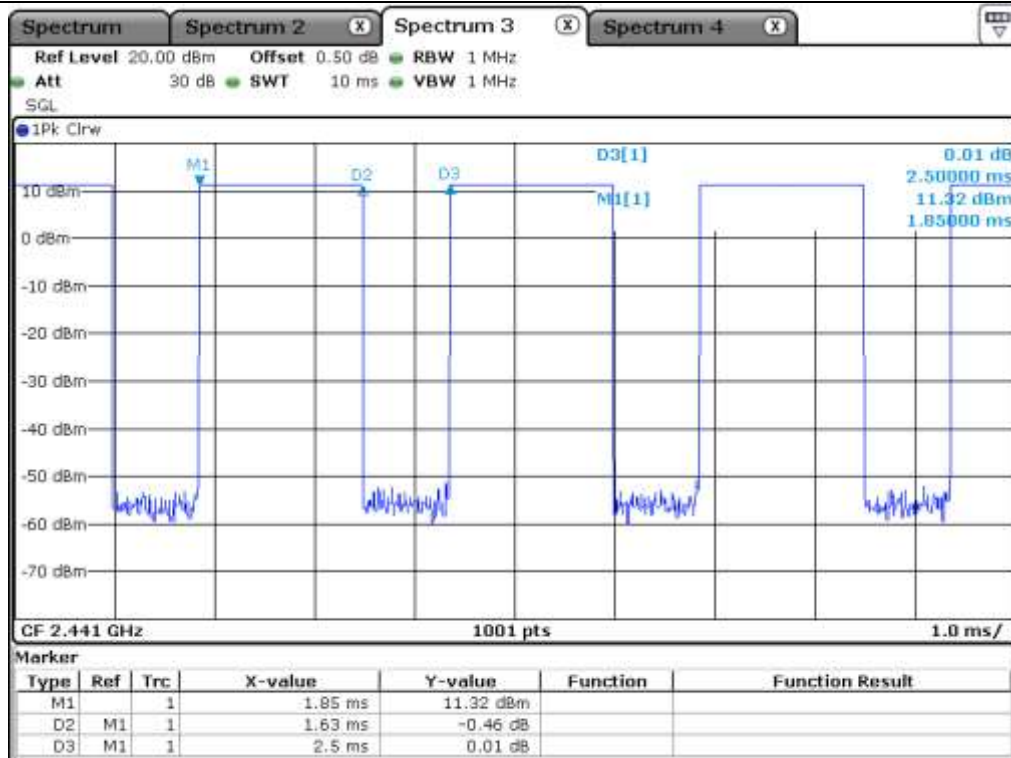
Remark: See next page for an overview sweep performed with peak detector.



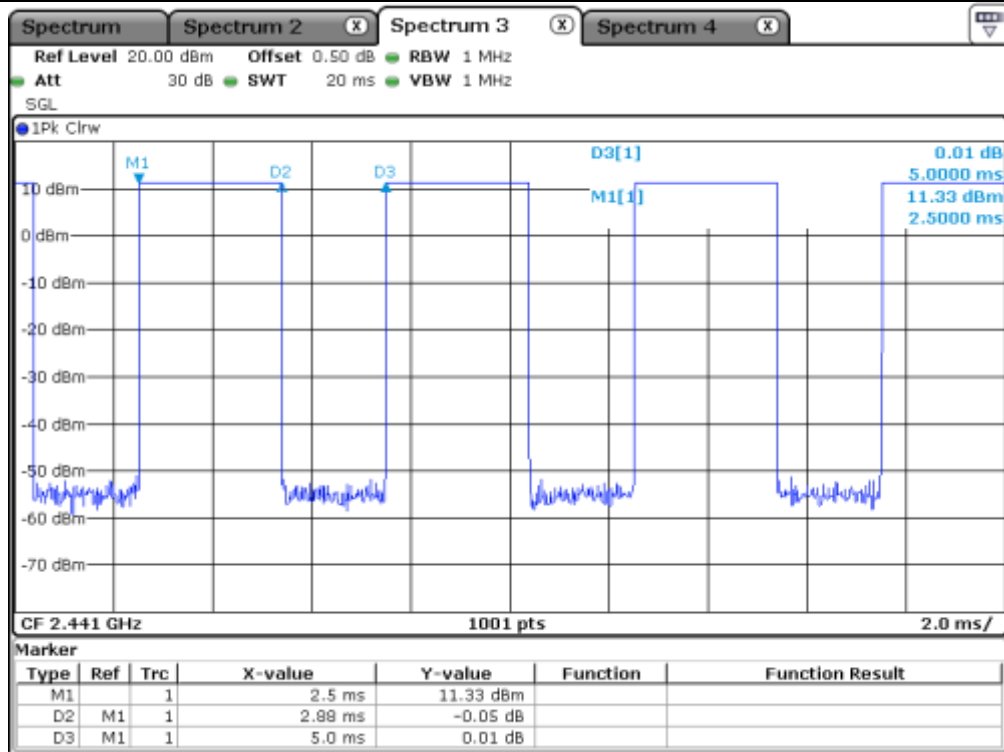
Tested by: Ha-Ram, Lee / Assistant Manager



DH1



DH3



DH5

10.5 Test data for 2 Mbps

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

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	PASS
DH3	1.620	5.06	31.60	259.03	400	
DH5	2.860	3.38	31.60	305.47	400	

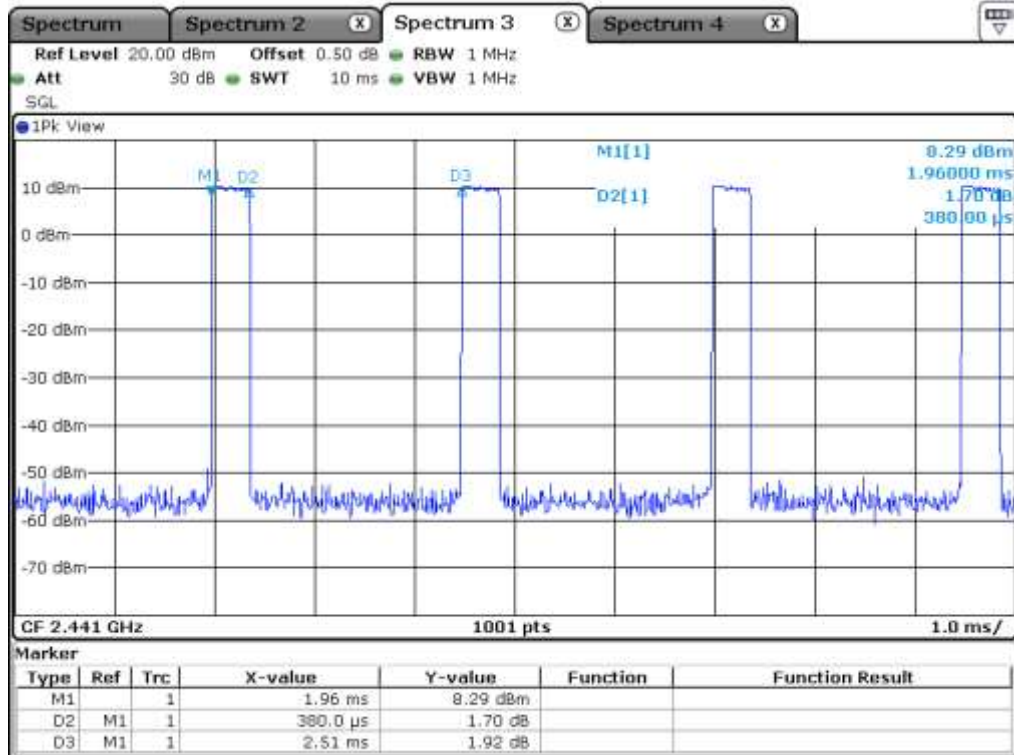
Total dwell time is calculated as following.

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

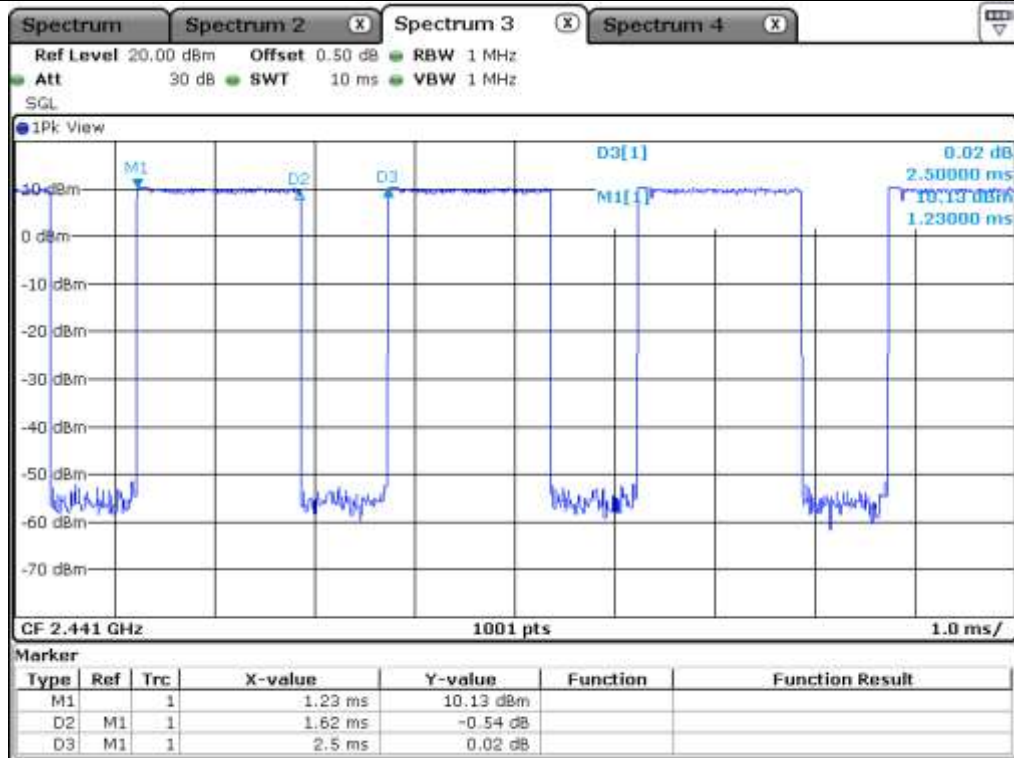
Remark: See next page for an overview sweep performed with peak detector.



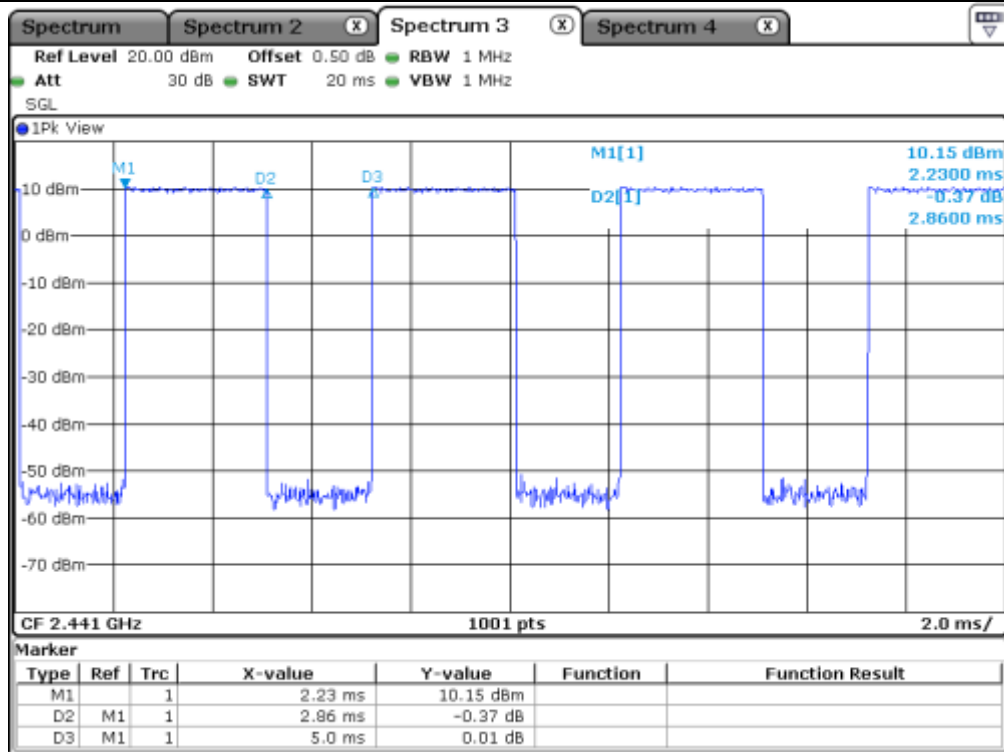
Tested by: Ha-Ram, Lee / Assistant Manager



DH1



DH3



DH5

10.6 Test data for 3 Mbps

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

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	PASS
DH3	1.630	5.06	31.60	260.63	400	
DH5	2.860	3.38	31.60	305.47	400	

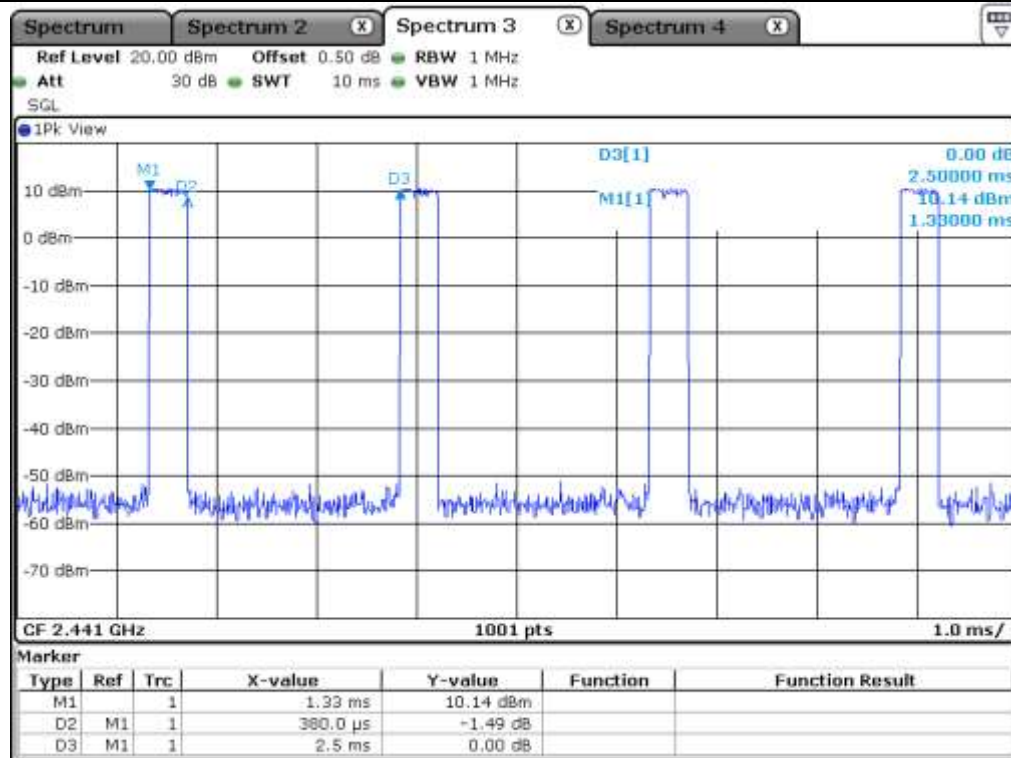
Total dwell time is calculated as following.

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

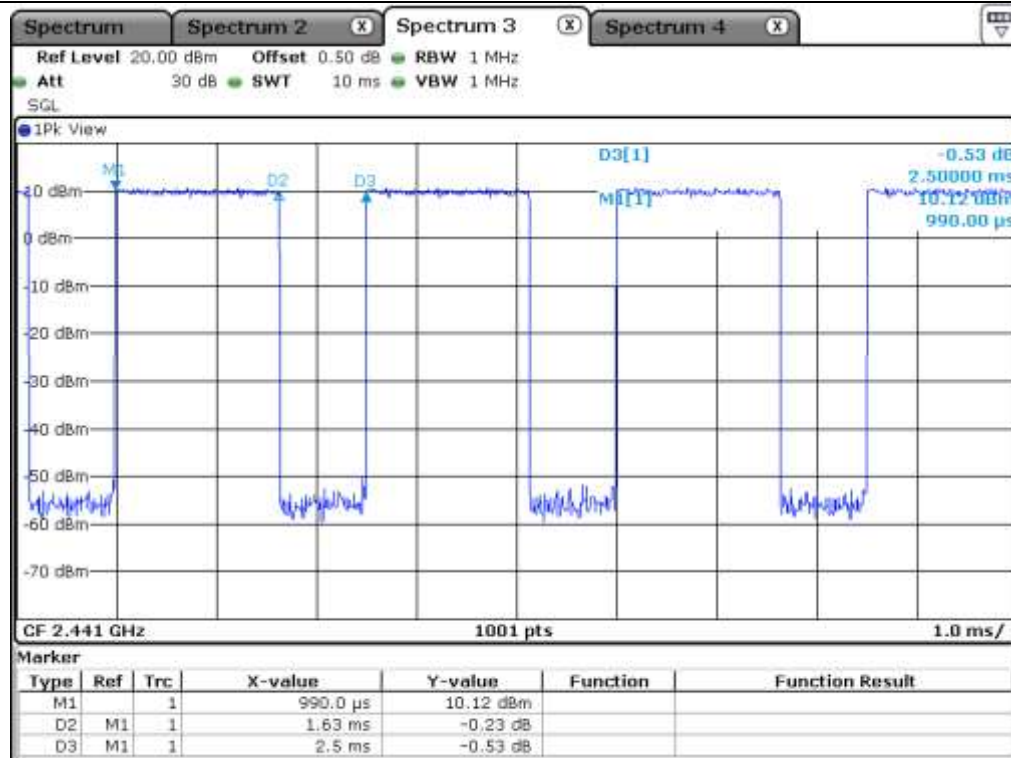
Remark: See next page for an overview sweep performed with peak detector.



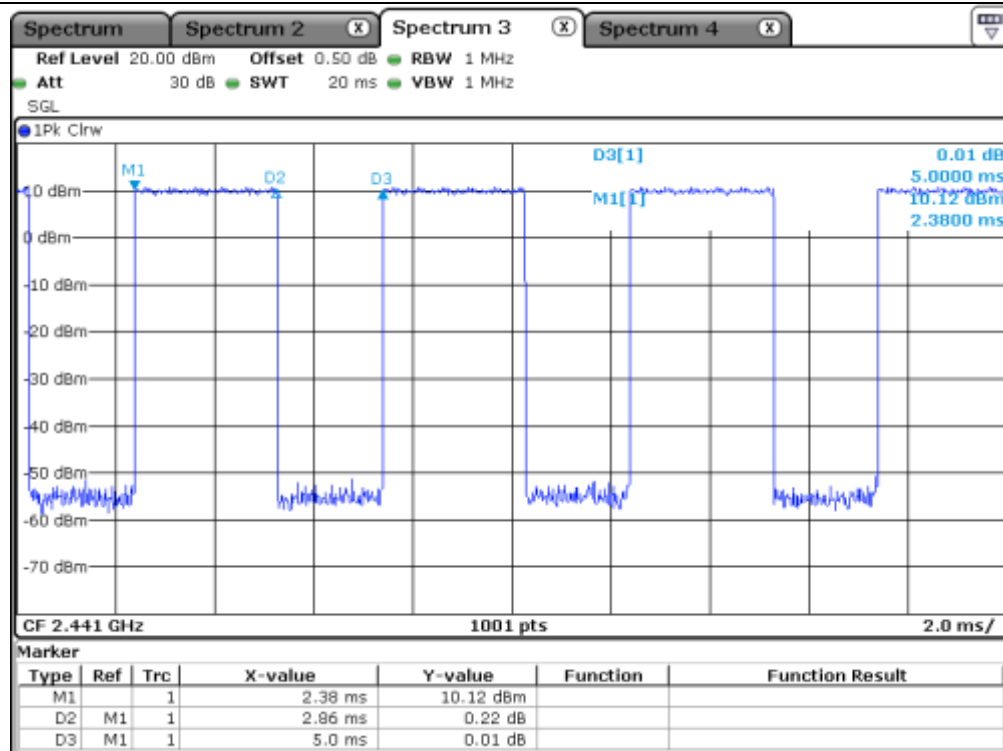
Tested by: Ha-Ram, Lee / Assistant Manager



DH1



DH3



DH5

11. MAXIMUM PEAK OUTPUT POWER

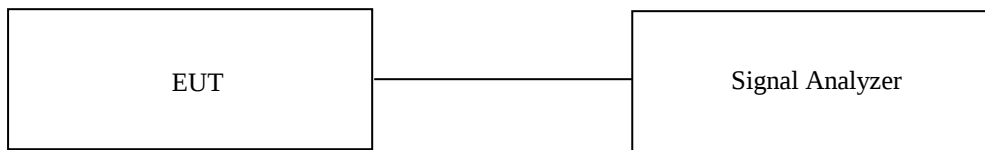
11.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % 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 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.

11.4 Test data for 1 Mbps

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

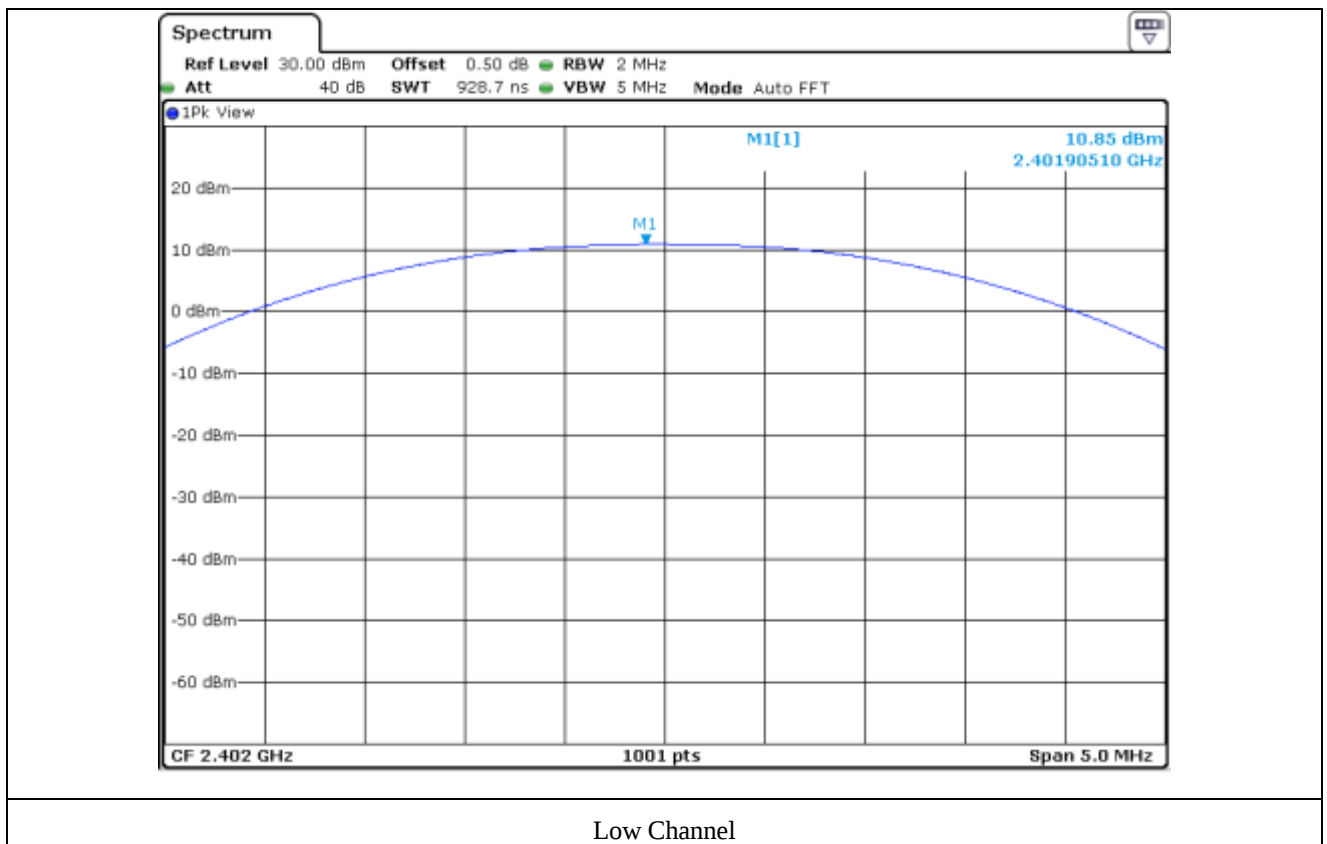
-. Test Result : Pass

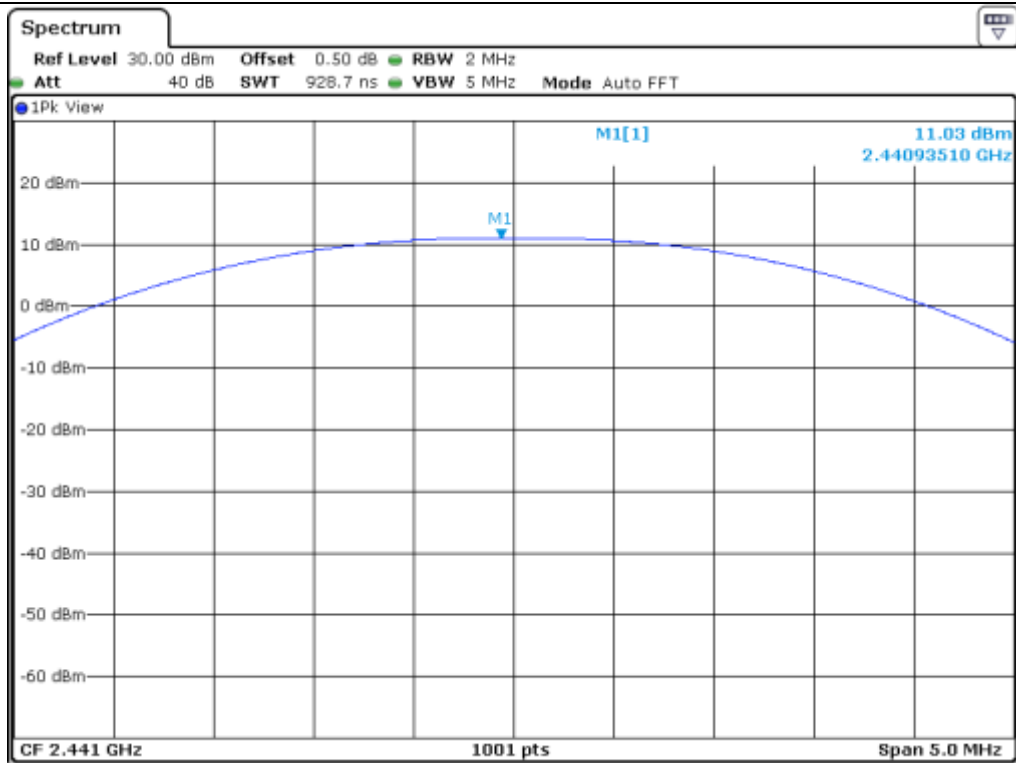
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	10.85	21.00	10.15
MIDDLE	2 441.00	11.03	21.00	9.97
HIGH	2 480.00	11.23	21.00	9.77

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

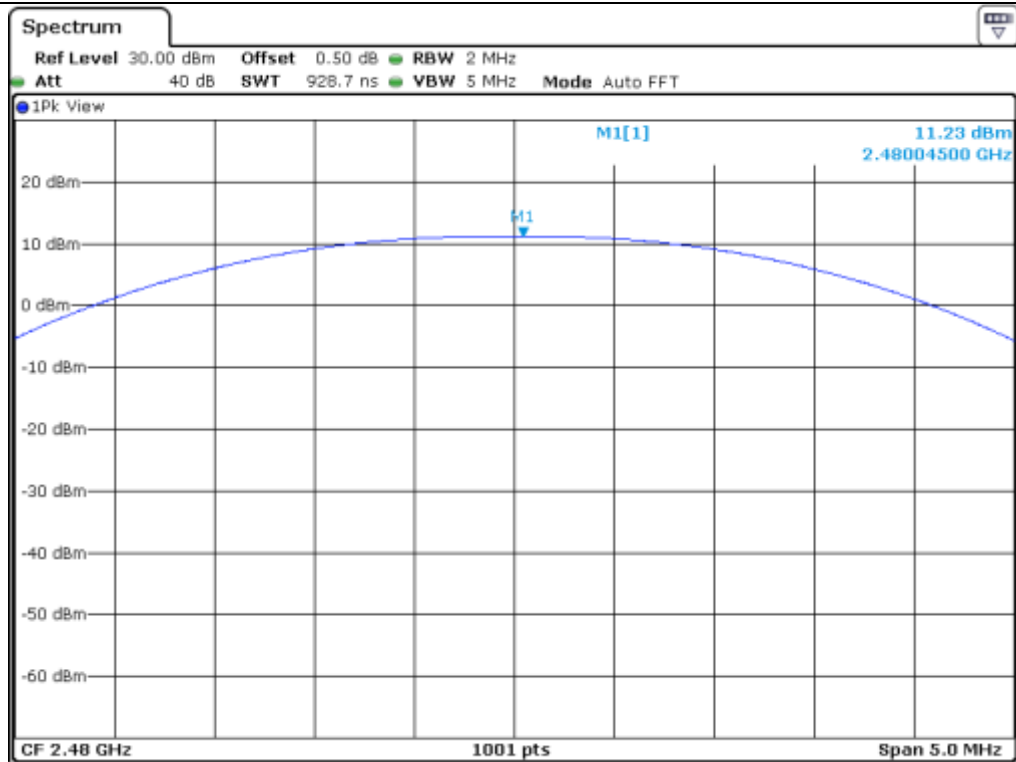


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

11.5 Test data for 2 Mbps

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

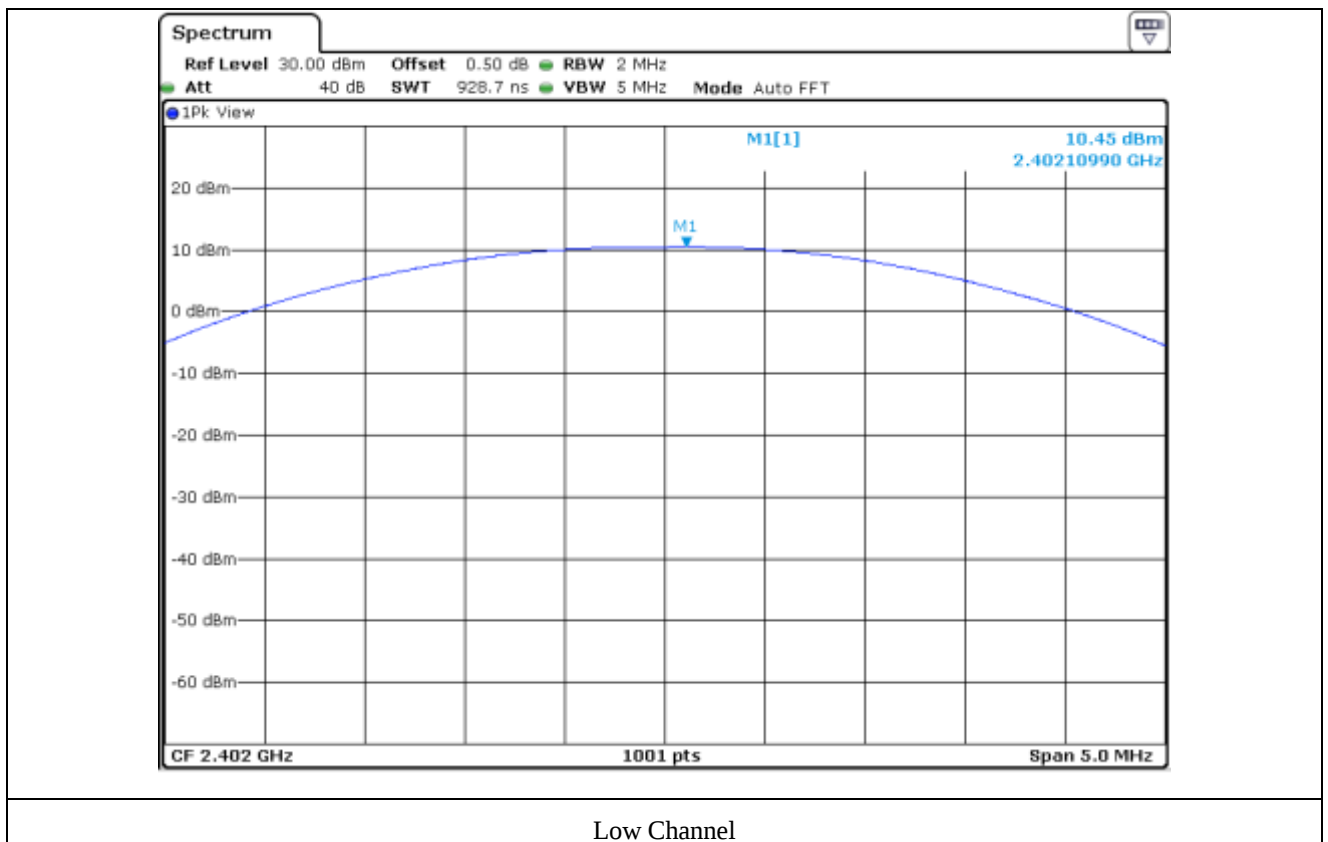
-. Test Result : Pass

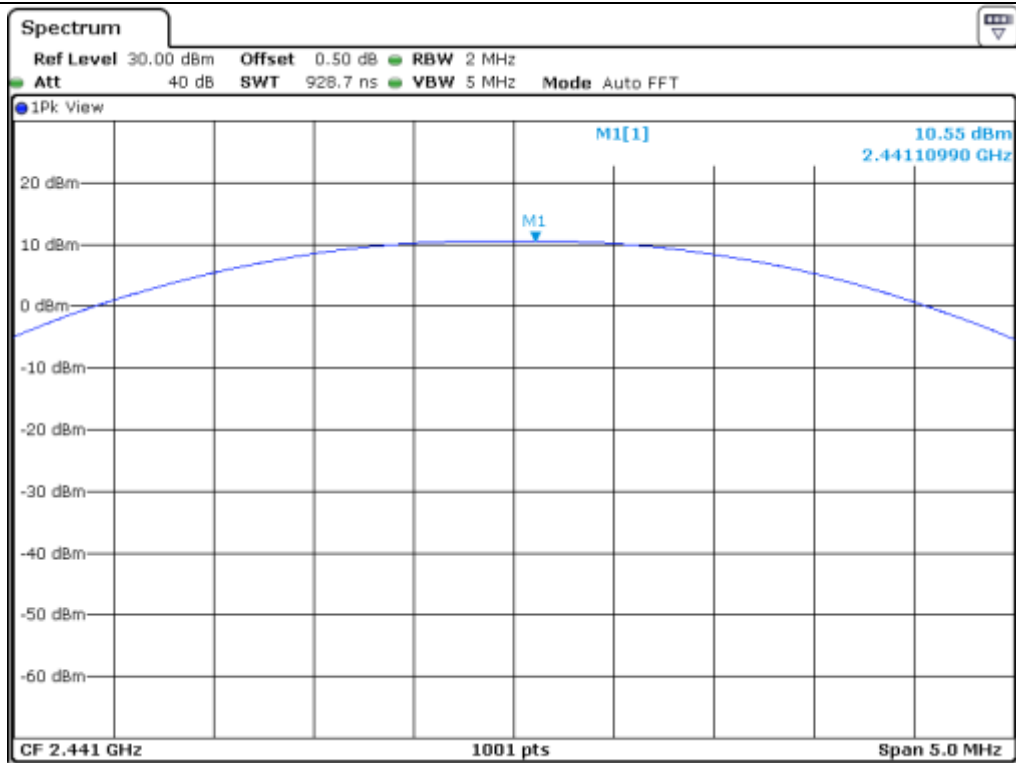
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	10.45	21.00	10.55
MIDDLE	2 441.00	10.55	21.00	10.45
HIGH	2 480.00	10.79	21.00	10.21

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

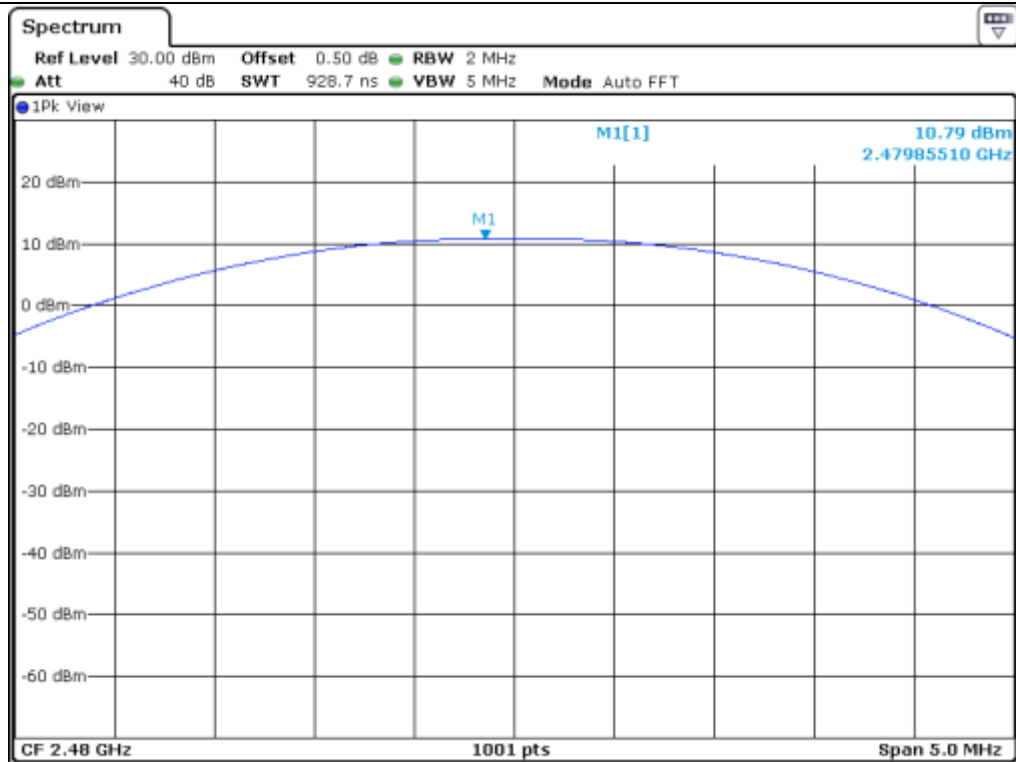


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

11.6 Test data for 3 Mbps

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

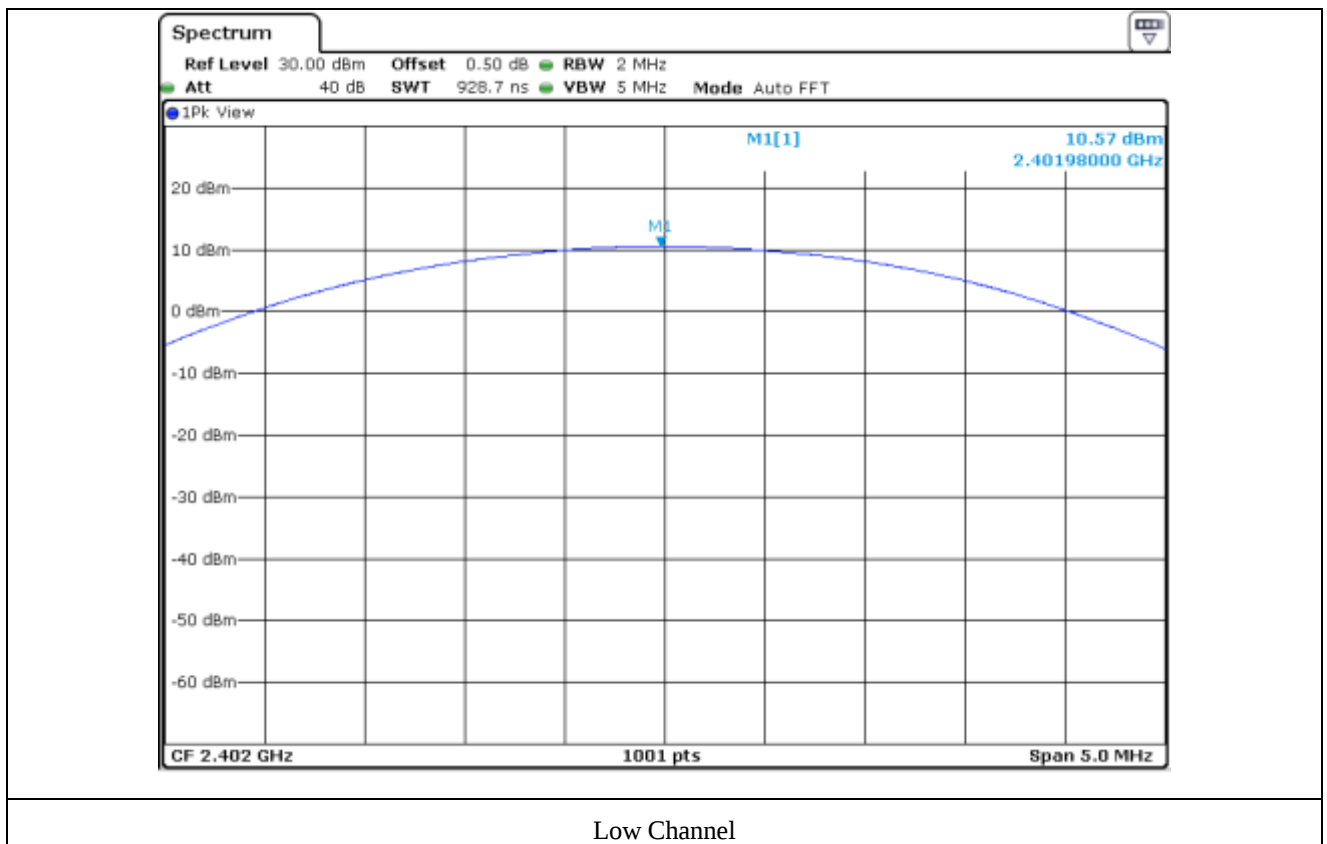
-. Test Result : Pass

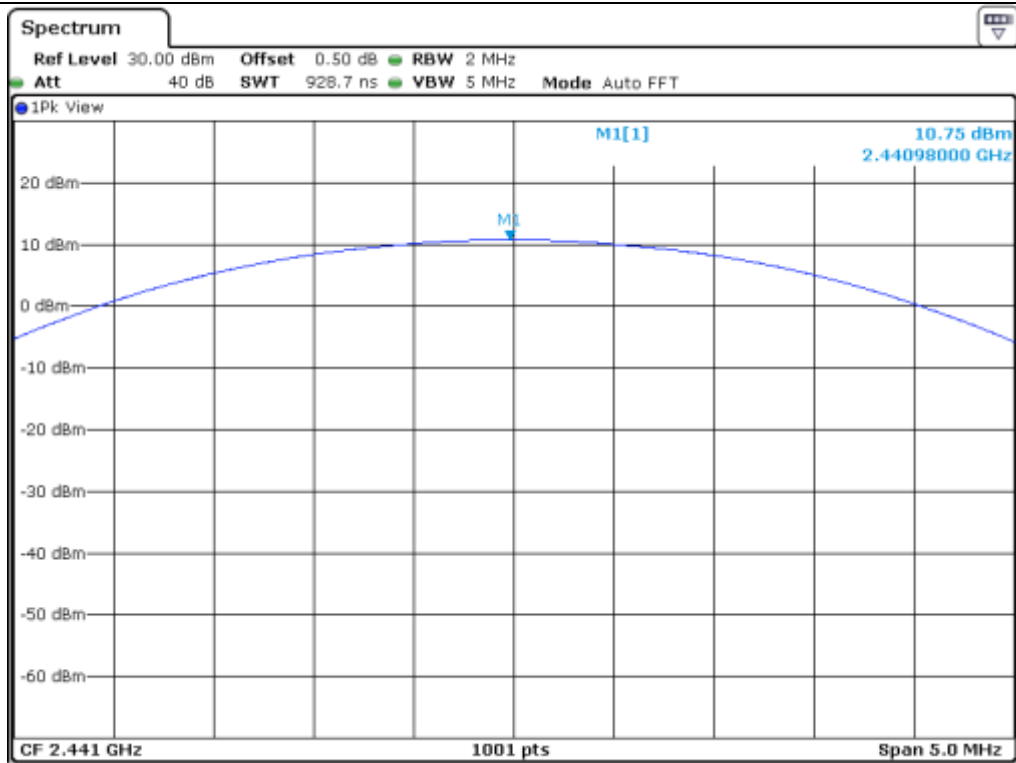
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	10.57	21.00	10.43
MIDDLE	2 441.00	10.75	21.00	10.25
HIGH	2 480.00	10.99	21.00	10.01

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

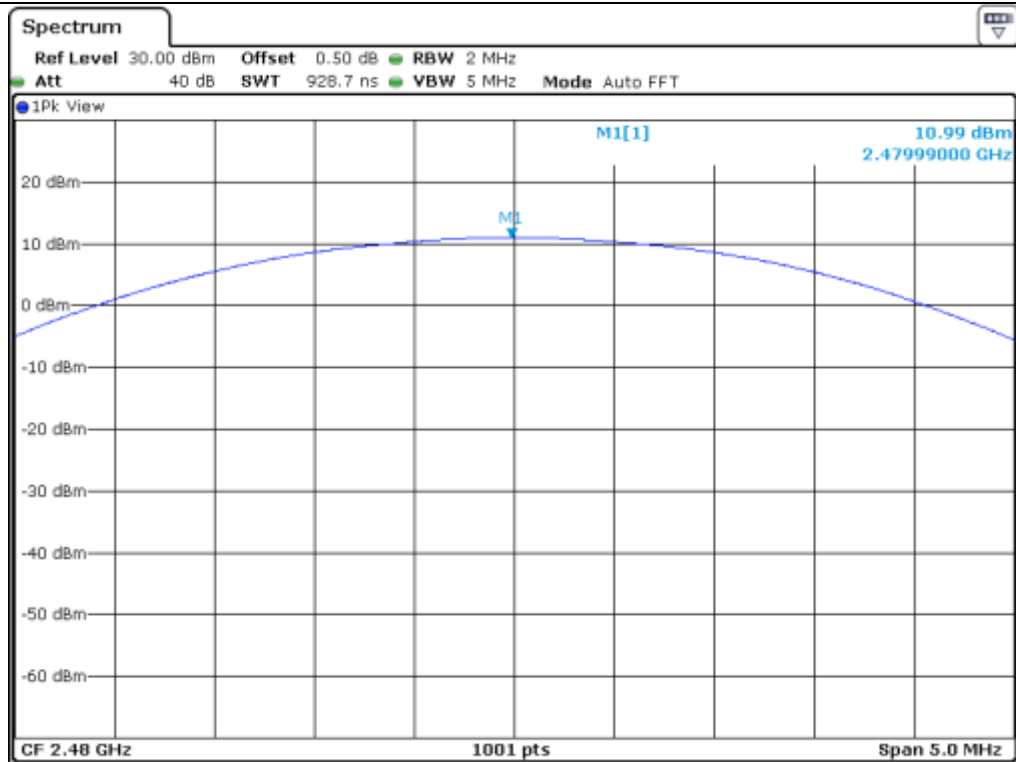


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

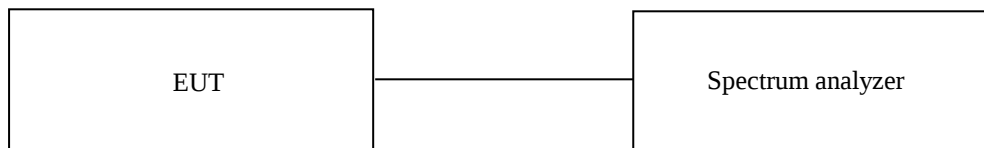
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

12.2 Test set-up for conducted measurement

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



12.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

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

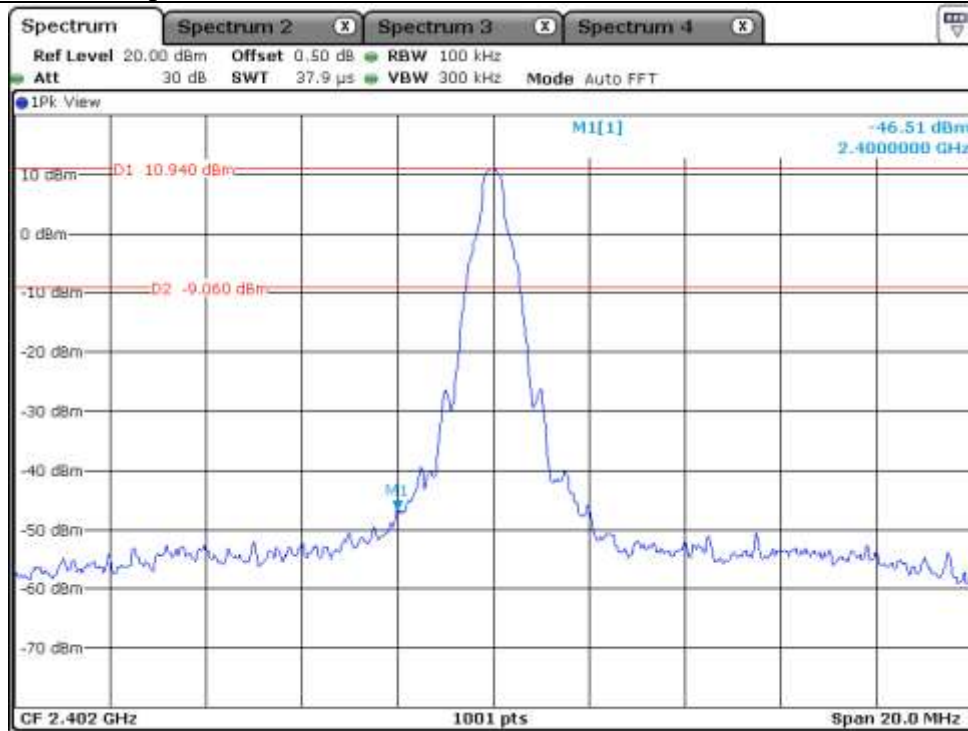
12.4 Test equipment used

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)

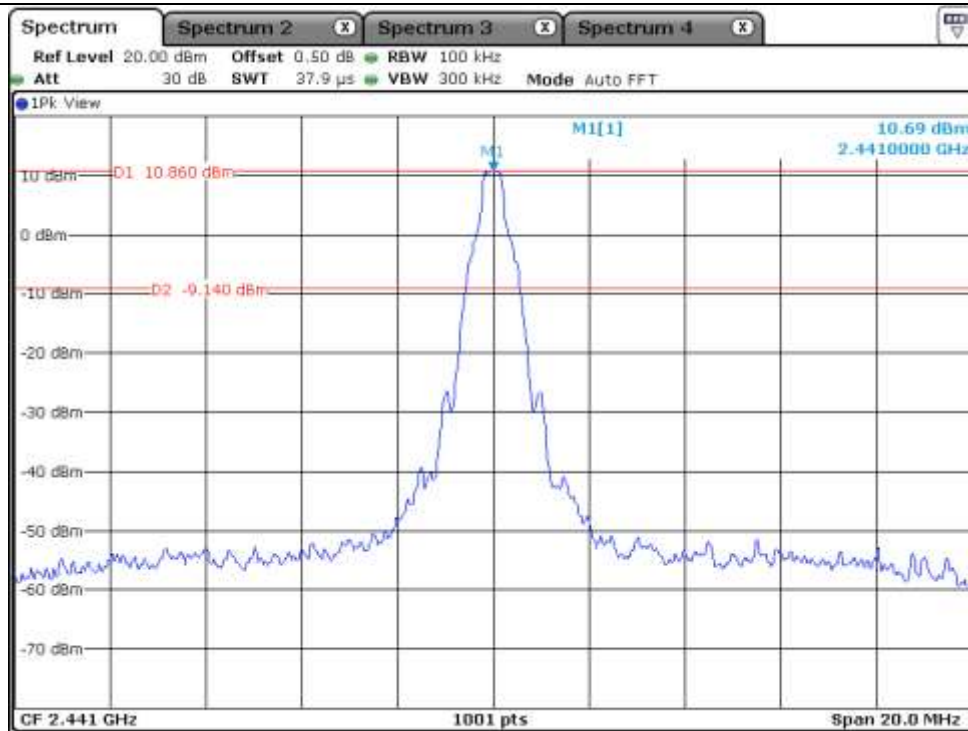
All test equipment used is calibrated on a regular basis.

12.5 Test data for conducted emission

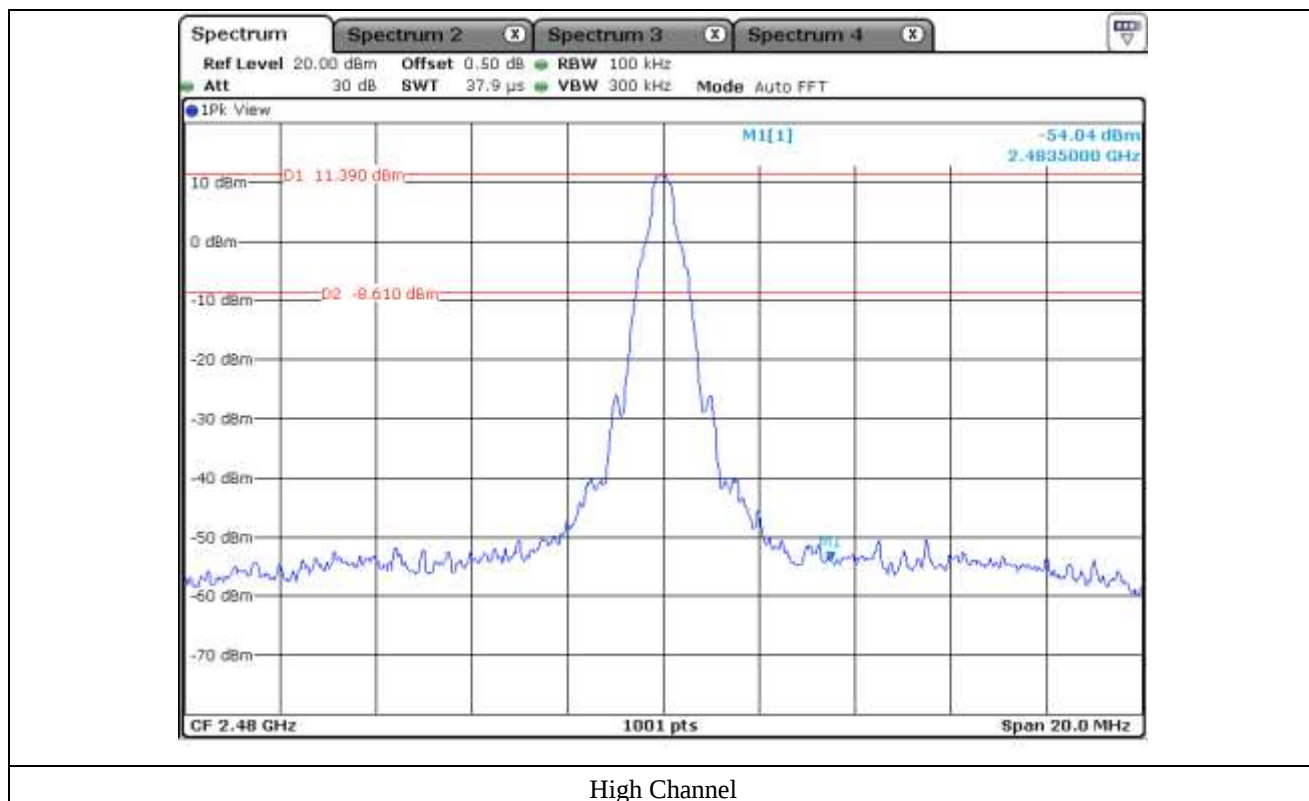
12.5.1 Test data for 1 Mbps



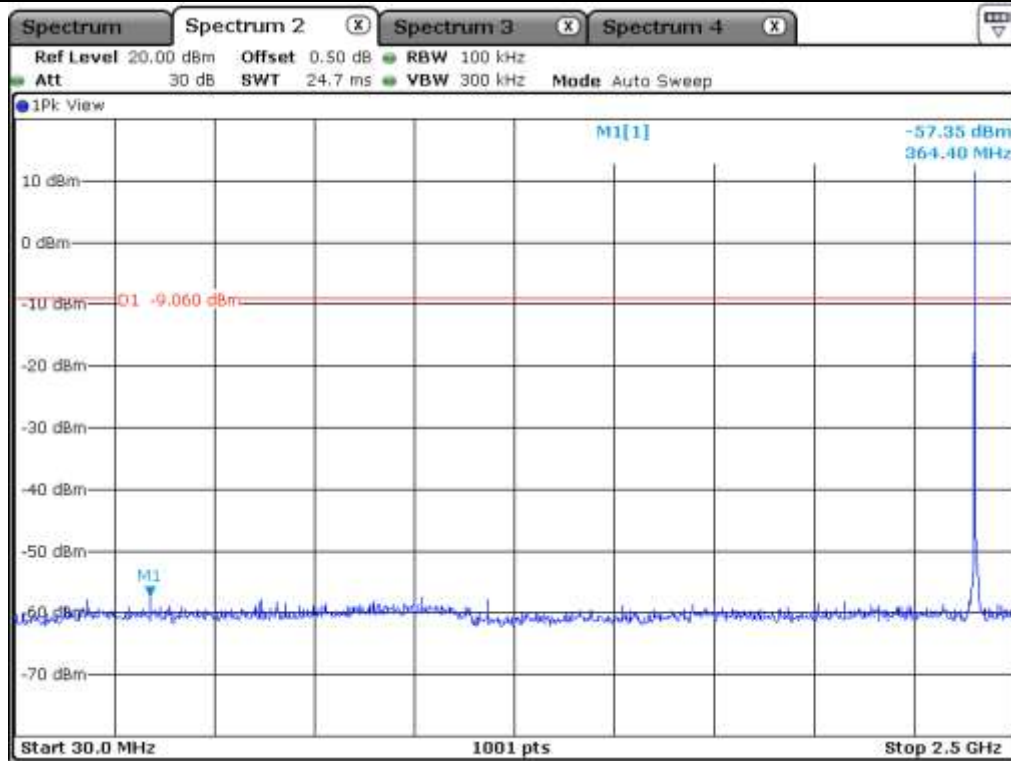
Low Channel



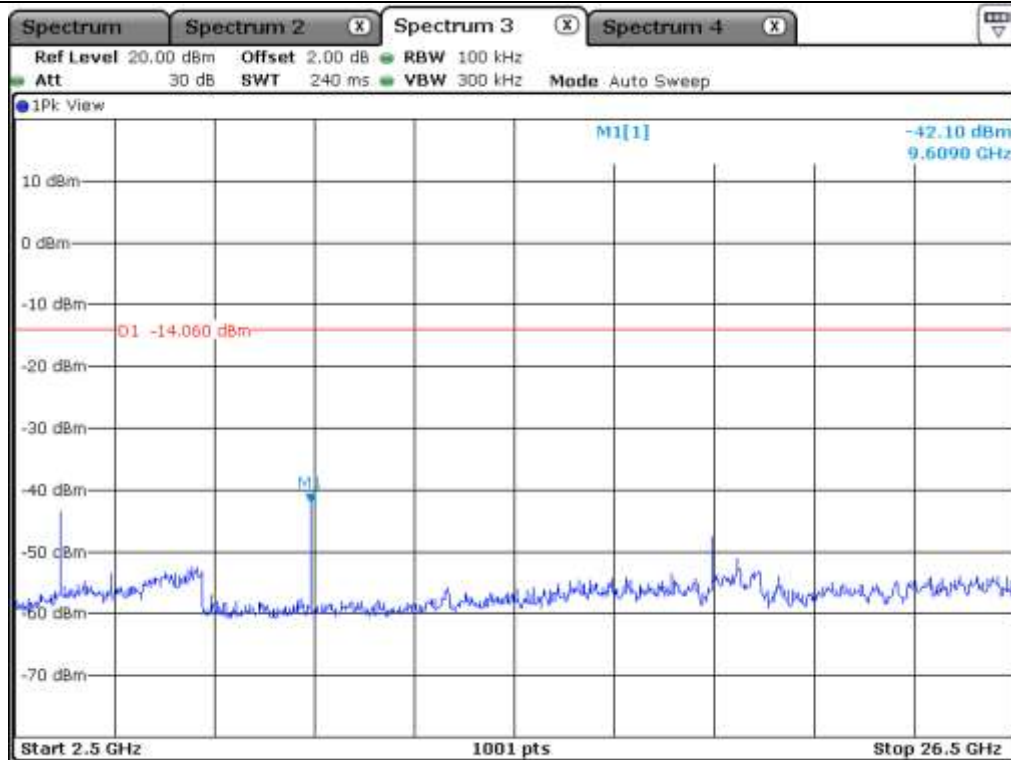
Middle Channel



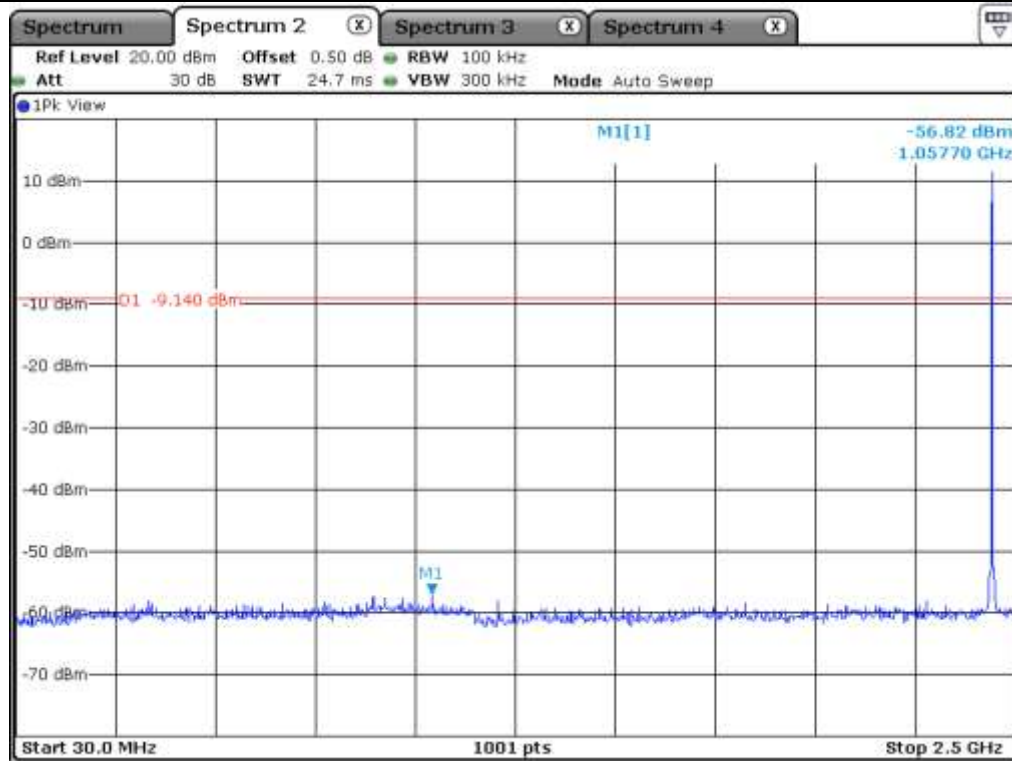
High Channel



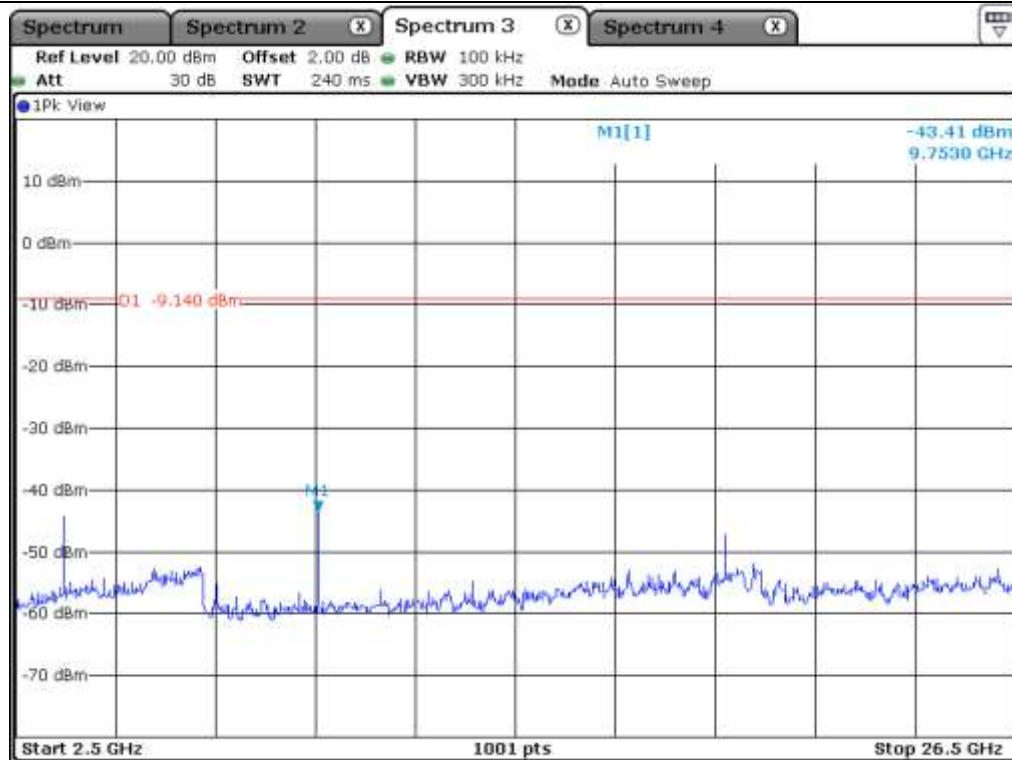
Low Channel



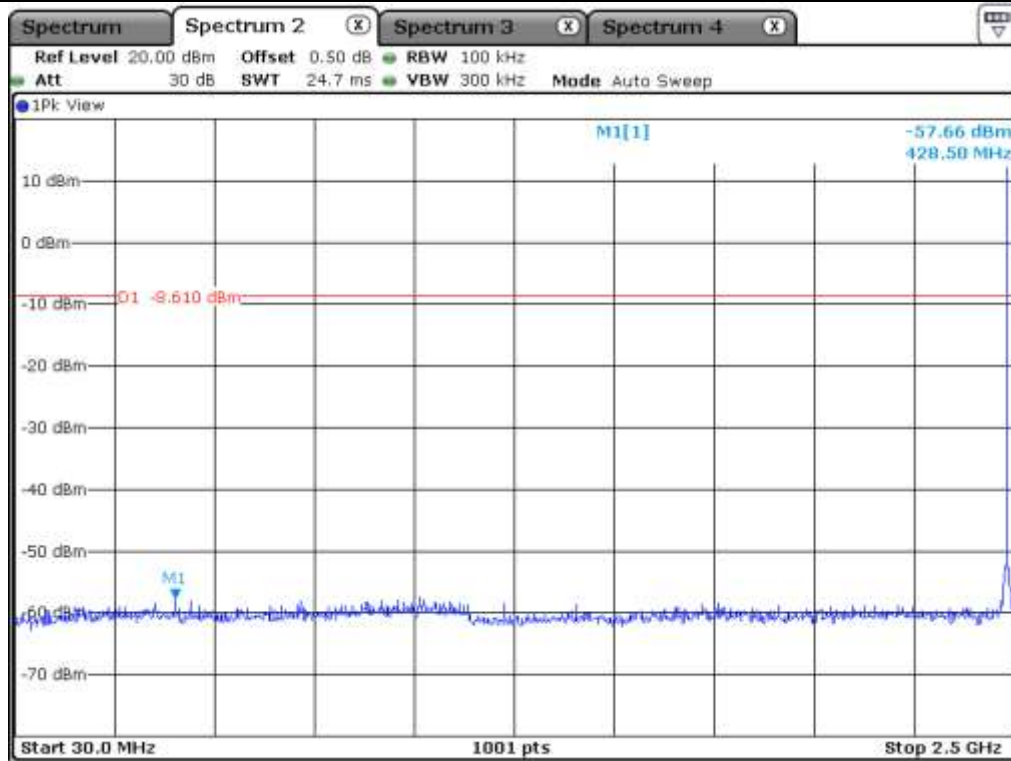
Low Channel



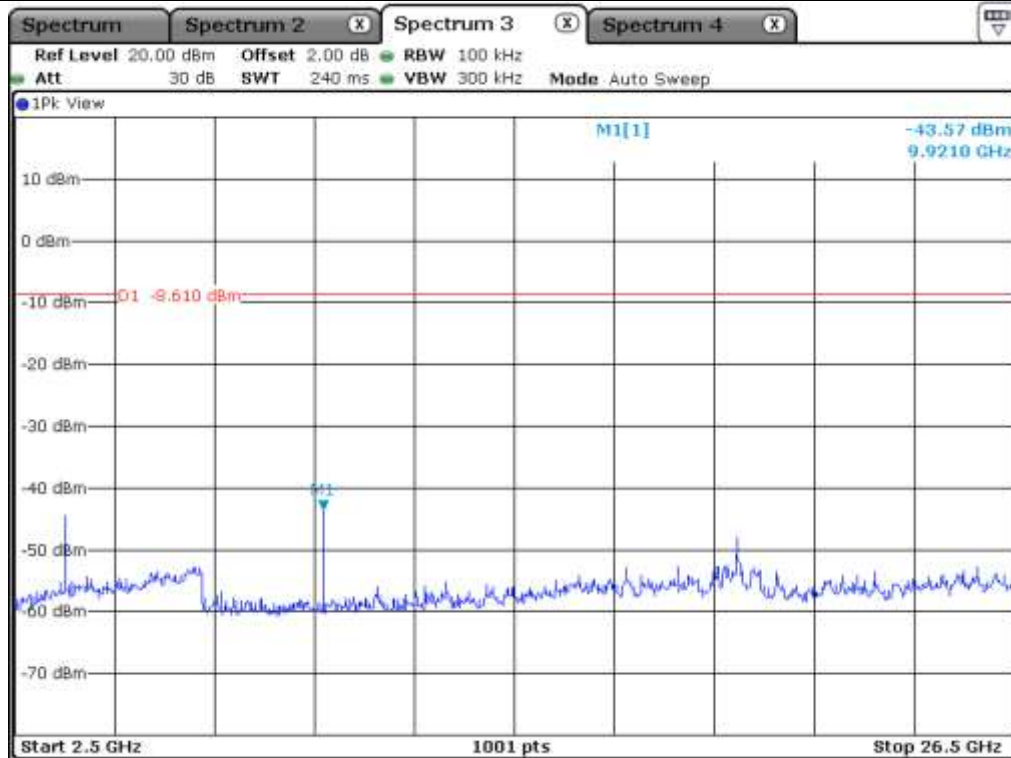
Middle Channel



Middle Channel

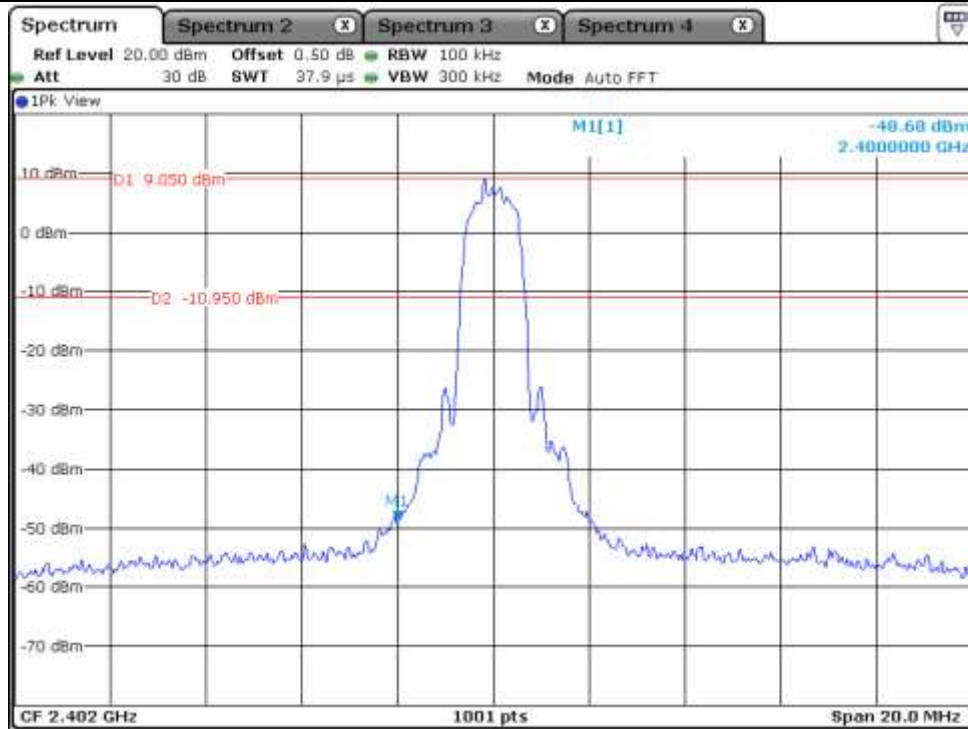


High Channel

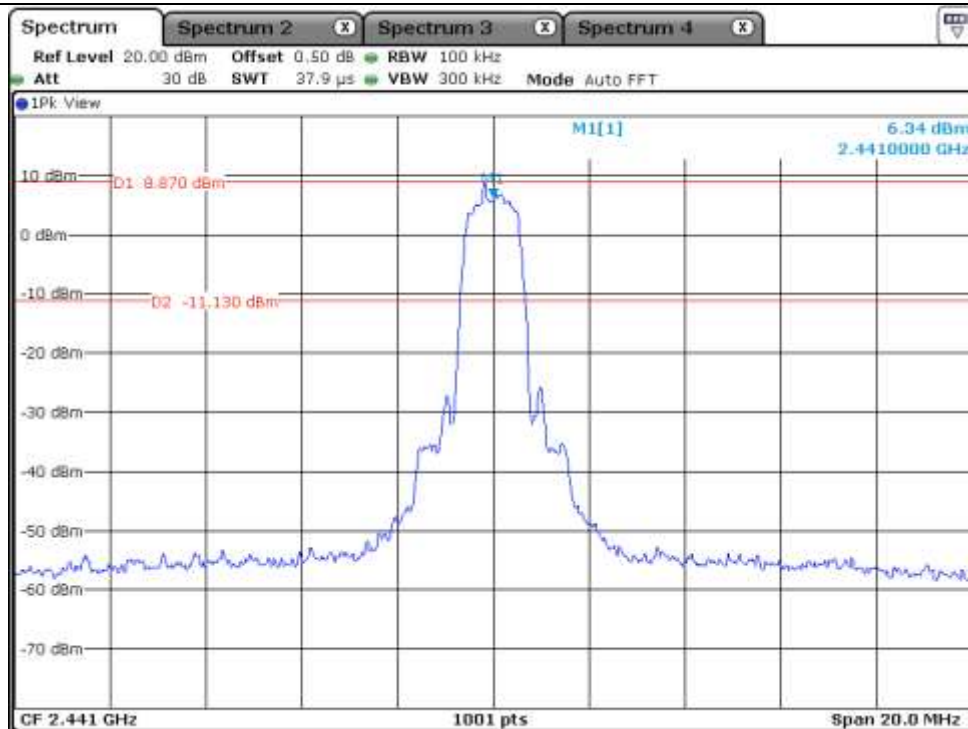


High Channel

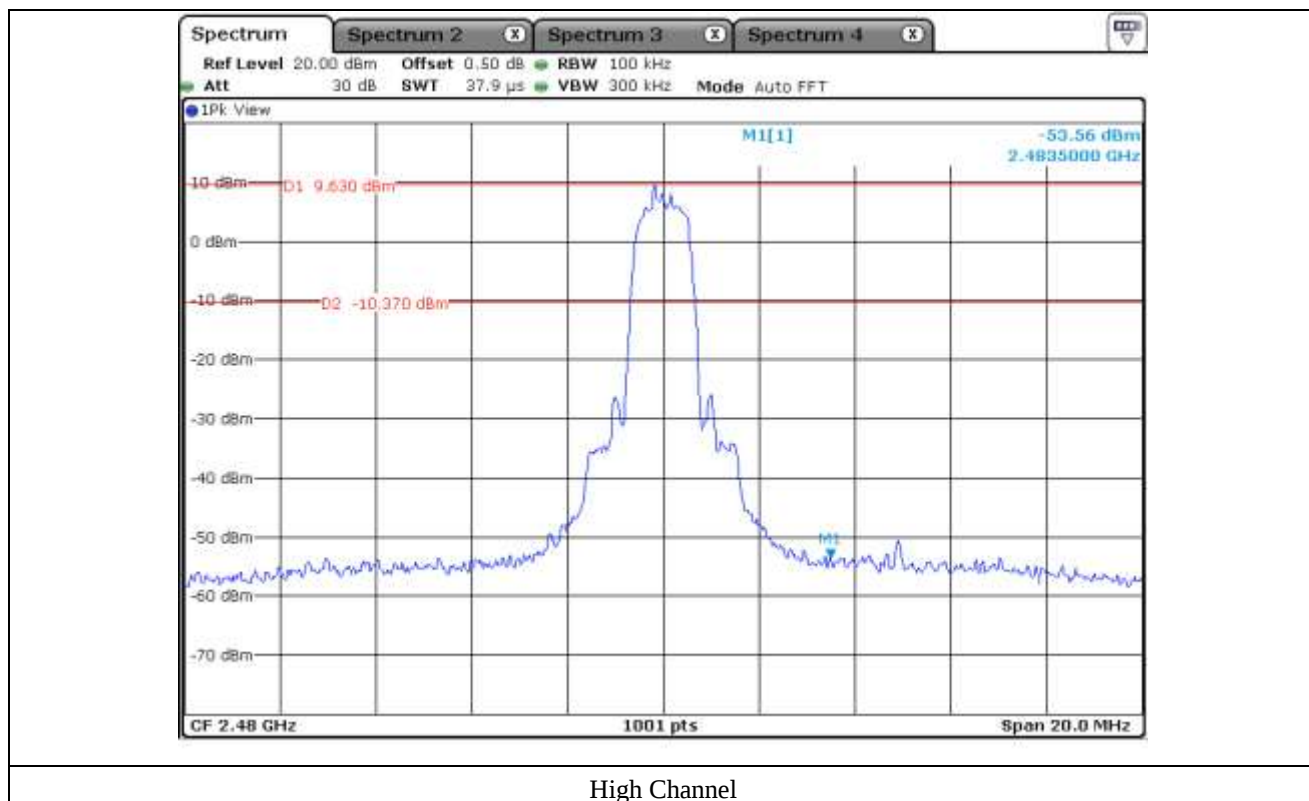
12.5.2 Test data for 2 Mbps

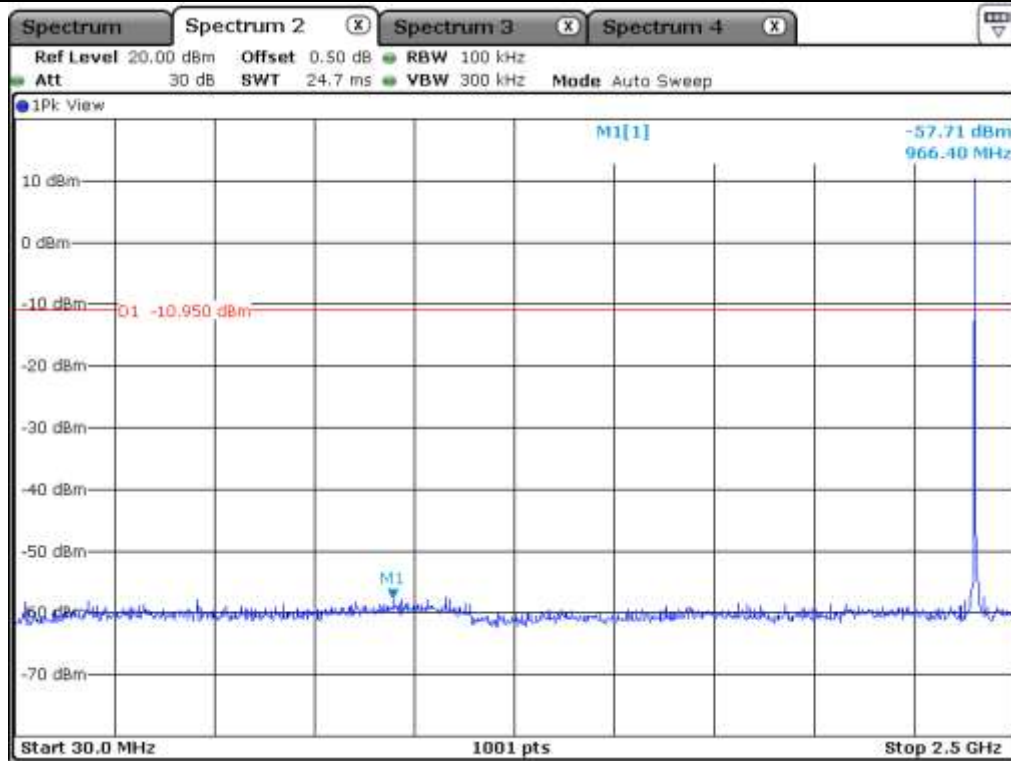


Low Channel

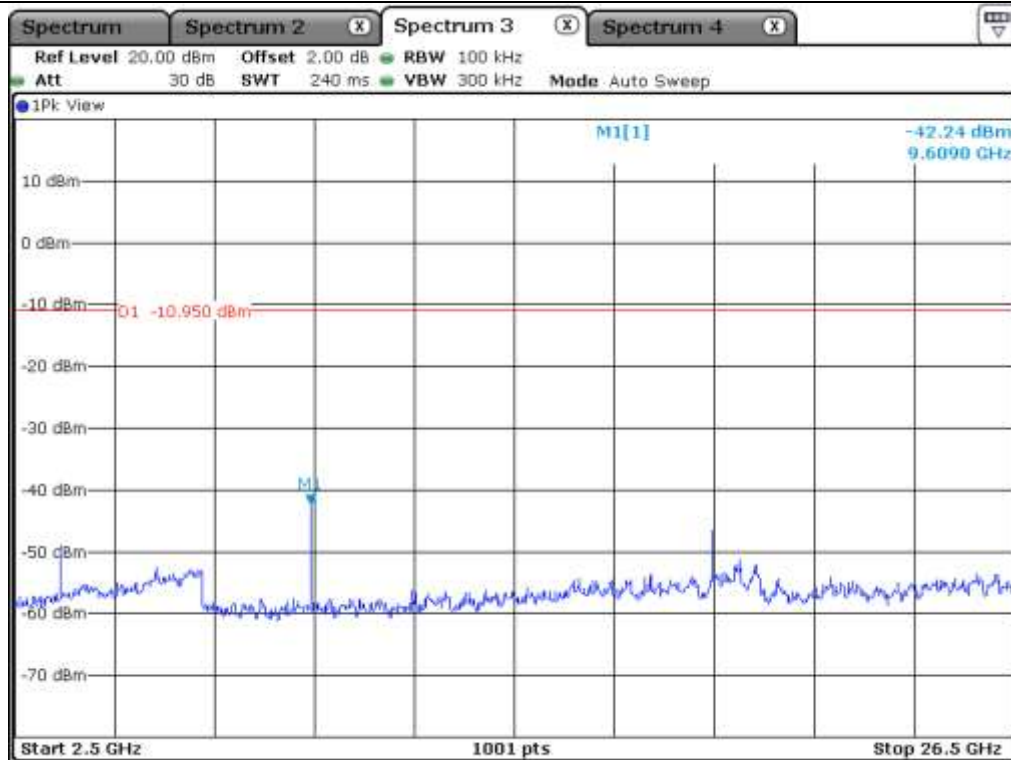


Middle Channel

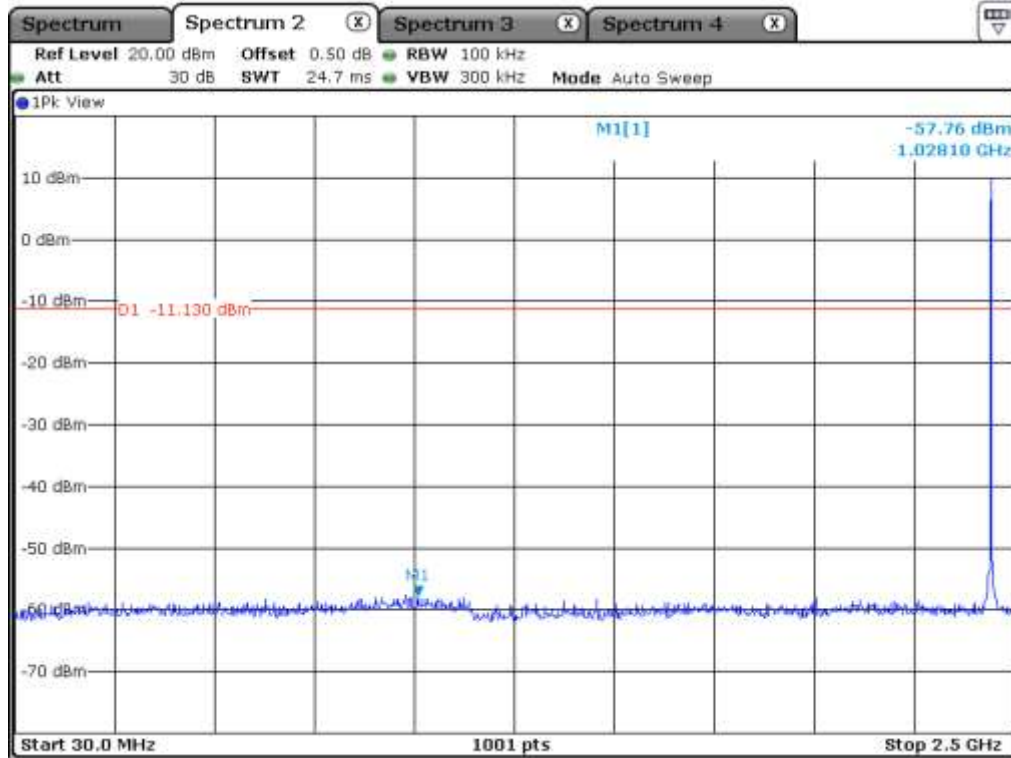




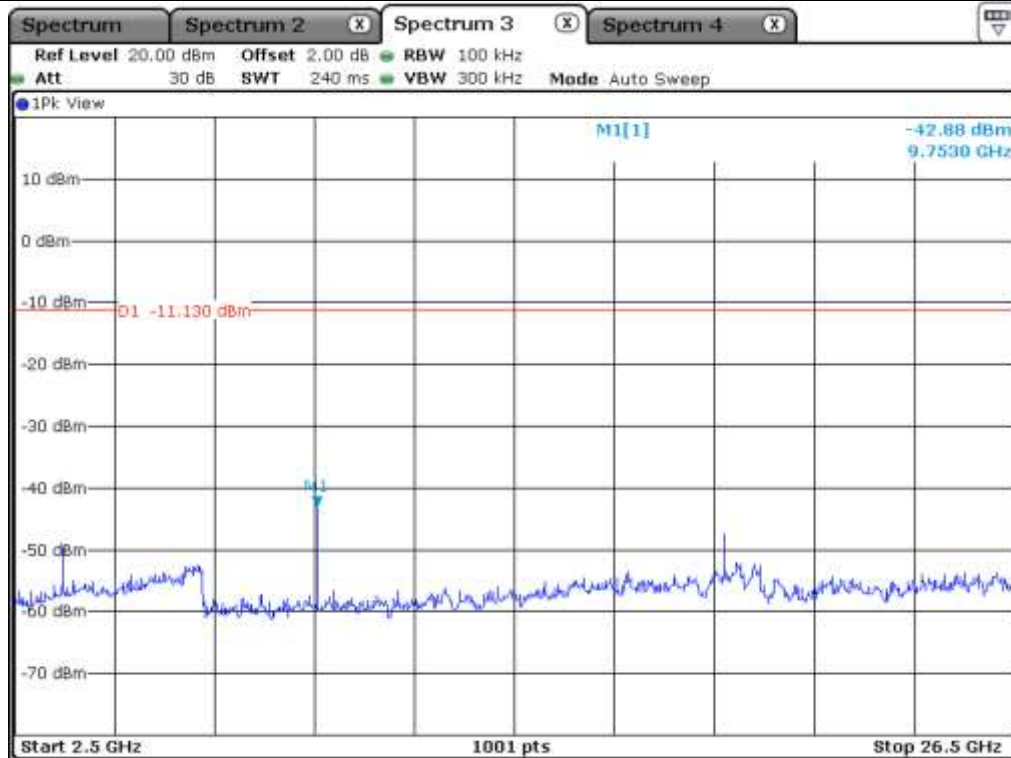
Low Channel



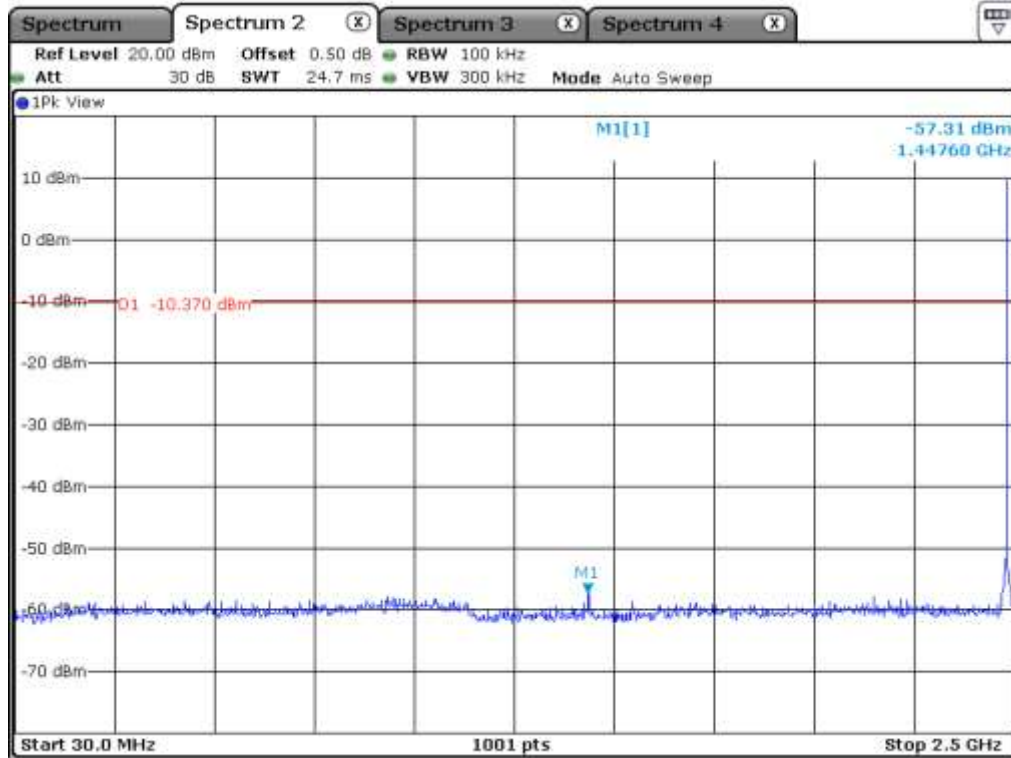
Low Channel



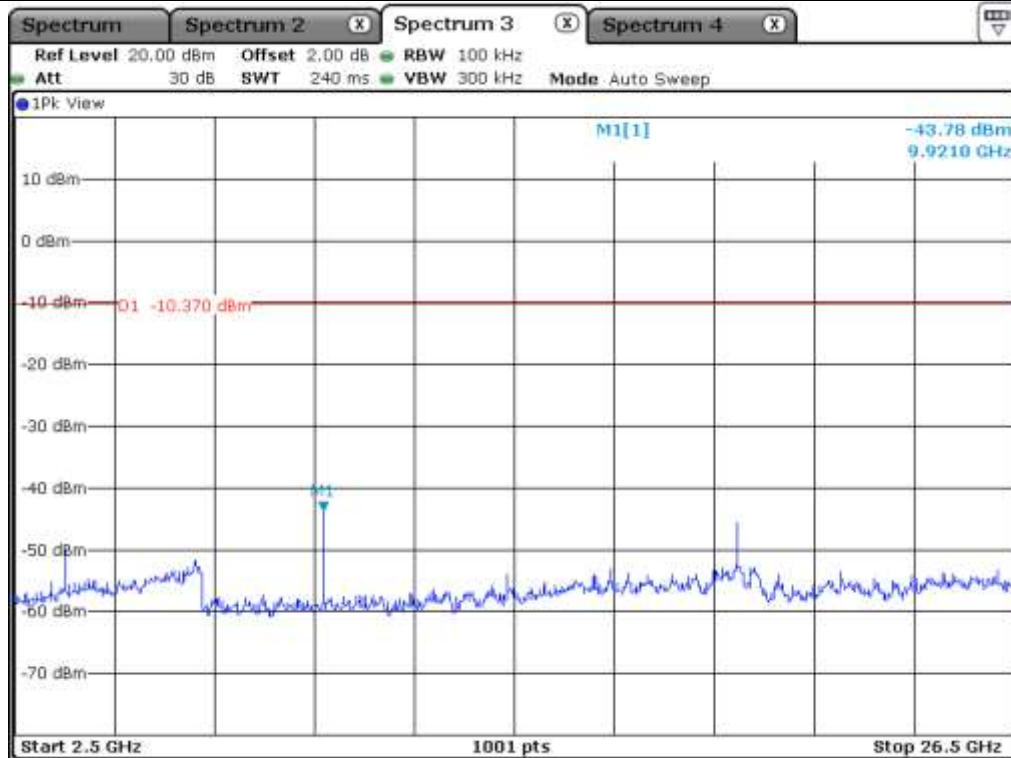
Middle Channel



Middle Channel

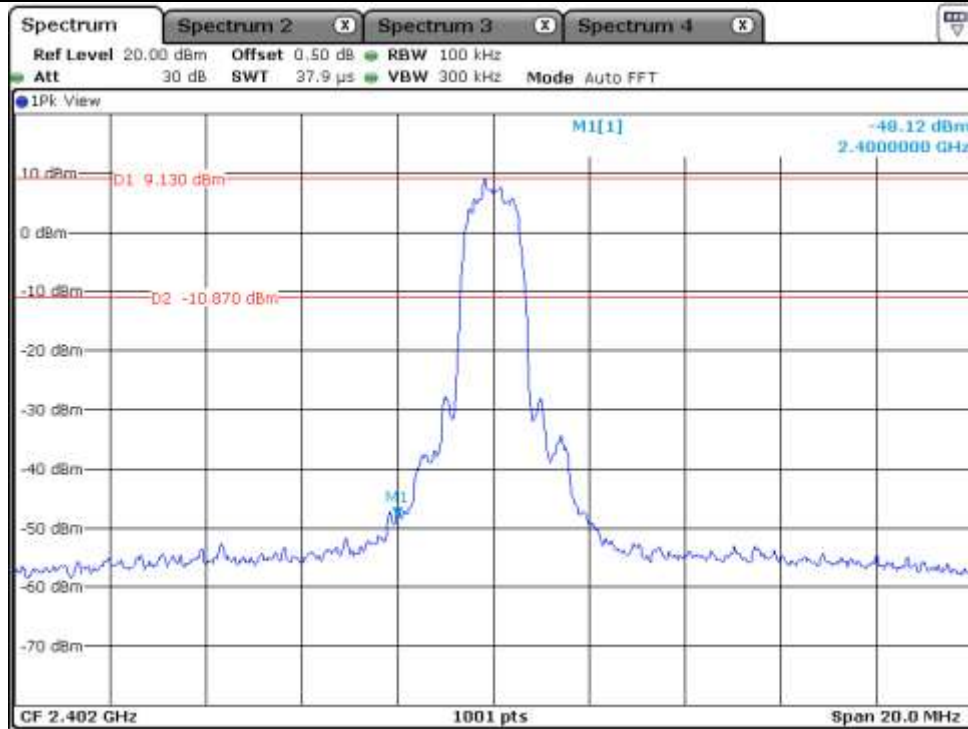


High Channel

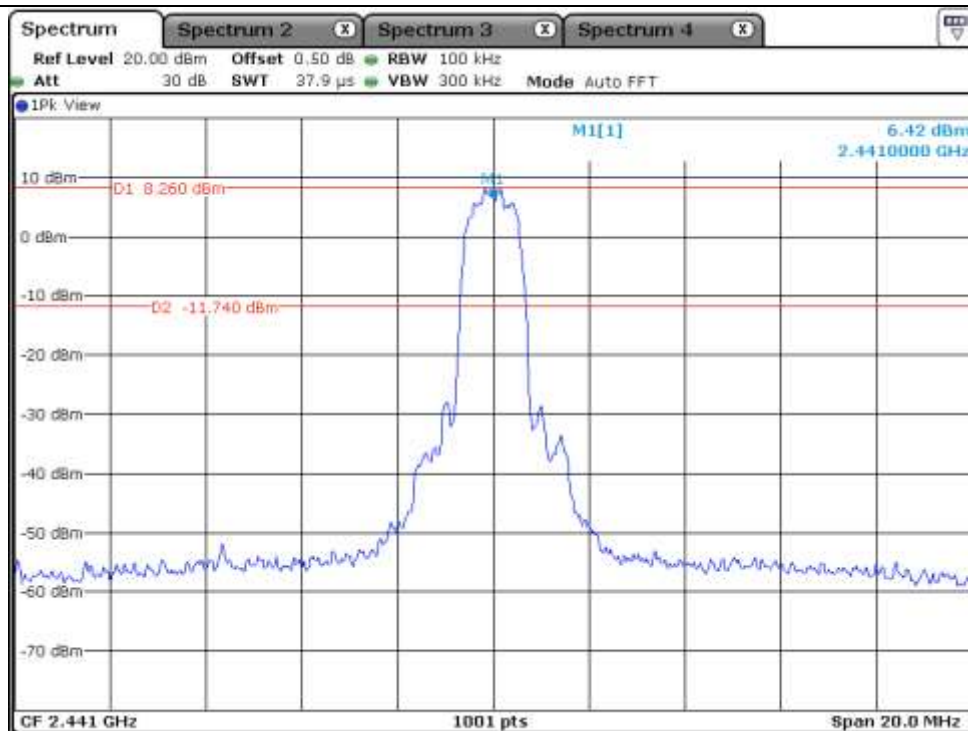


High Channel

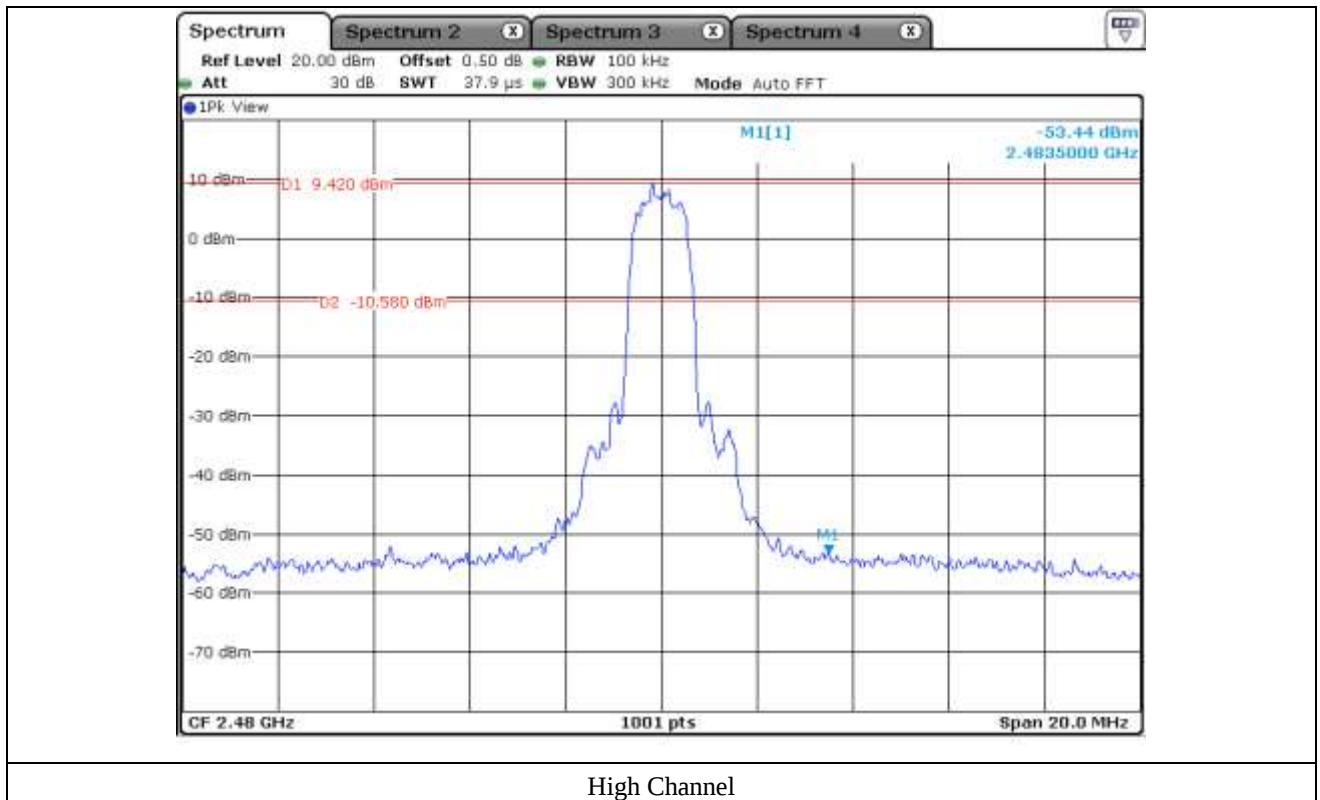
12.5.3 Test data for 3 Mbps

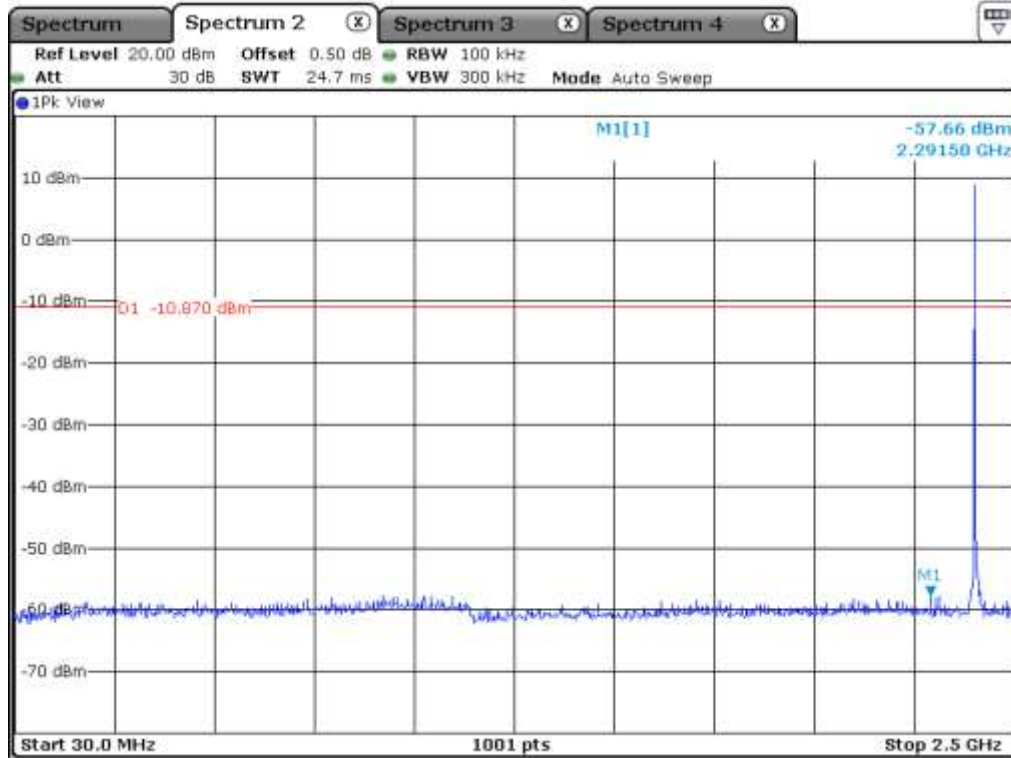


Low Channel

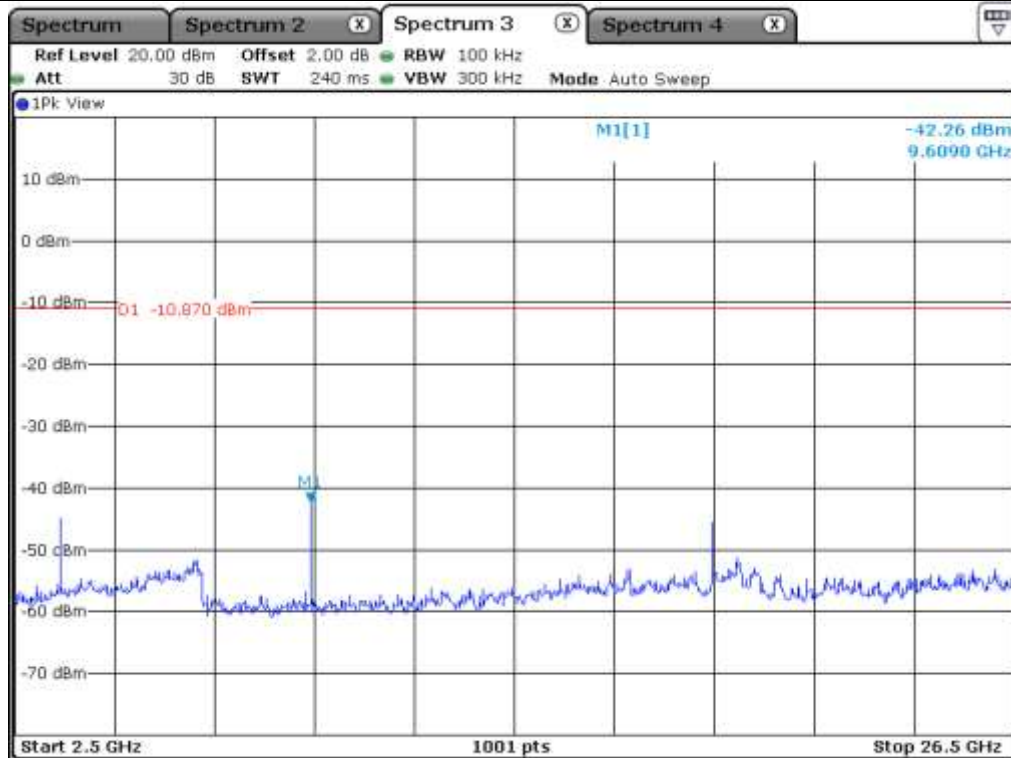


Middle Channel

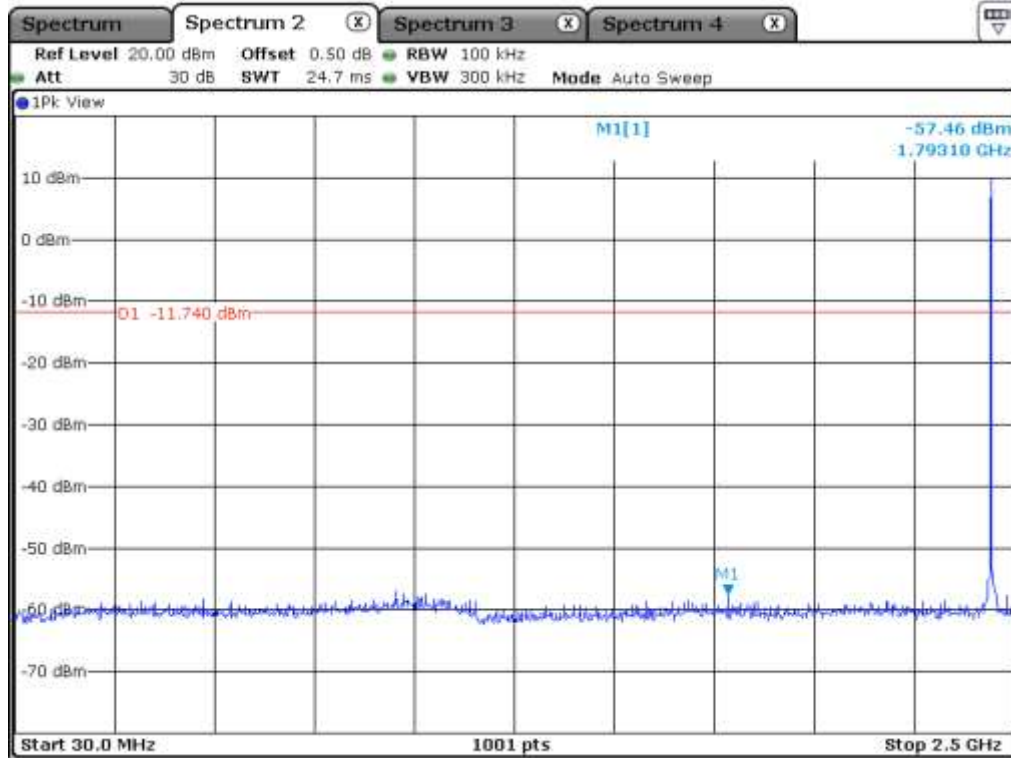




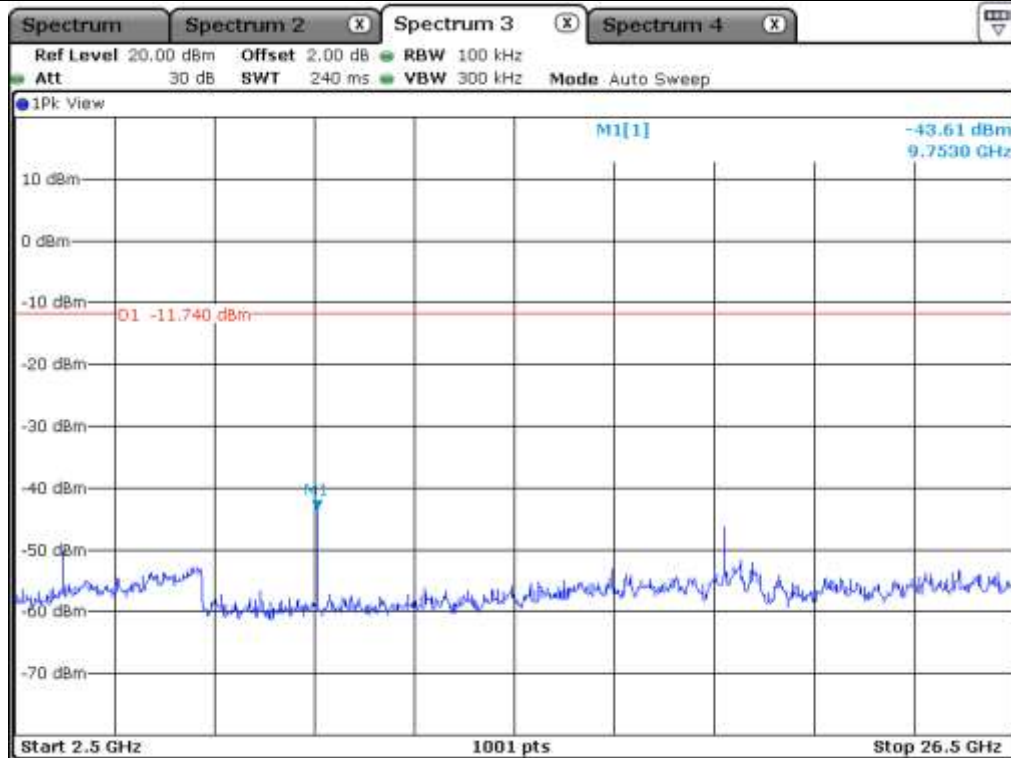
Low Channel



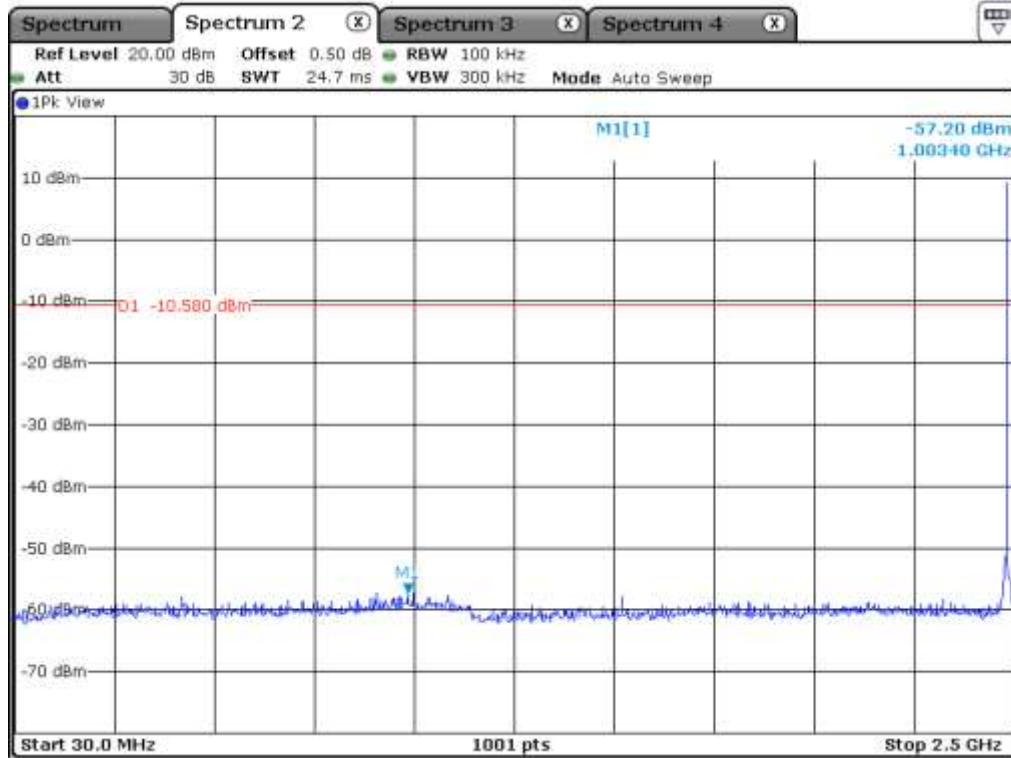
Low Channel



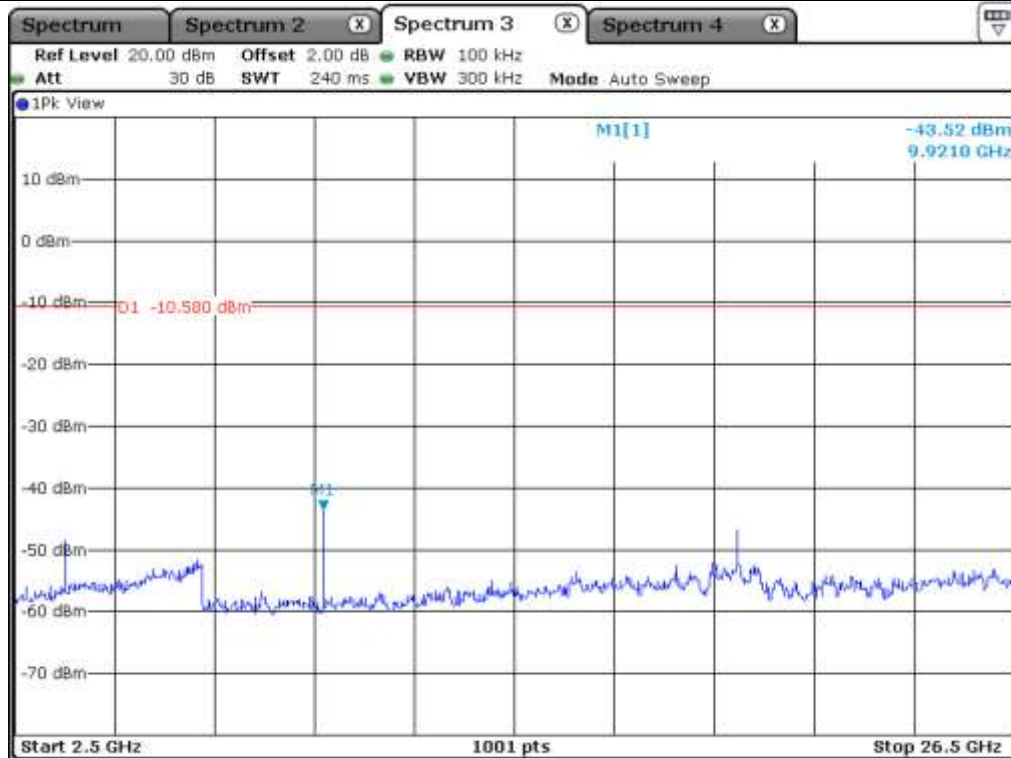
Middle Channel



Middle Channel



High Channel



High Channel

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

- Test Date : December 03, 2019 ~ December 05, 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 : 57.60 %
- 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									
2 327.54	14.25	Peak	H	27.60	2.91	-	44.76	74.00	29.24
2 346.16	4.84	Average	H	27.60	2.91	2.40	37.75	54.00	16.25
2 327.54	14.16	Peak	V	27.60	2.91	-	44.67	74.00	29.33
2 345.13	4.61	Average	V	27.60	2.91	2.40	37.52	54.00	16.48
Test Data for High Channel									
2 483.51	19.65	Peak	H	27.50	3.02	-	50.17	74.00	23.83
2 483.51	8.69	Average	H	27.50	3.02	2.40	41.61	54.00	12.39
2 483.51	17.22	Peak	V	27.50	3.02	-	47.74	74.00	26.26
2 483.51	7.47	Average	V	27.50	3.02	2.40	40.39	54.00	13.61

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

12.6.1.2 Test data for 2 Mbps

- Test Date : December 03, 2019 ~ December 05, 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 : 57.60 %
- 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									
2 378.93	14.11	Peak	H	27.60	2.91	-	44.62	74.00	29.38
2 341.53	4.93	Average	H	27.60	2.91	2.40	37.84	54.00	16.16
2 345.92	13.80	Peak	V	27.60	2.91	-	44.31	74.00	29.69
2 343.21	4.47	Average	V	27.60	2.91	2.40	37.38	54.00	16.62
Test Data for High Channel									
2 483.51	19.22	Peak	H	27.50	3.02	-	49.74	74.00	24.26
2 483.51	8.21	Average	H	27.50	3.02	2.40	41.13	54.00	12.87
2 483.72	16.83	Peak	V	27.50	3.02	-	47.35	74.00	26.65
2 483.74	6.55	Average	V	27.50	3.02	2.40	39.47	54.00	14.53

Tabulated test data for Restricted Band

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

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

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



Tested by: Ha-Ram, Lee / Assistant Manager

12.6.1.3 Test data for 3 Mbps

- Test Date : December 03, 2019 ~ December 05, 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 : 57.60 %
- 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									
2 346.96	14.00	Peak	H	27.60	2.91	-	44.51	74.00	29.49
2 342.97	4.86	Average	H	27.60	2.91	2.40	37.77	54.00	16.23
2 365.27	13.70	Peak	V	27.60	2.91	-	44.21	74.00	29.79
2 315.55	4.78	Average	V	27.60	2.91	2.40	37.69	54.00	16.31
Test Data for High Channel									
2 483.62	19.08	Peak	H	27.50	3.02	-	49.60	74.00	24.40
2 483.51	8.22	Average	H	27.50	3.02	2.40	41.14	54.00	12.86
2 484.22	17.66	Peak	V	27.50	3.02	-	48.18	74.00	25.82
2 483.51	6.69	Average	V	27.50	3.02	2.40	39.61	54.00	14.39

Tabulated test data for Restricted Band

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

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

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



Tested by: Ha-Ram, Lee / Assistant Manager

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data for 1 Mbps

- . Test Date : December 03, 2019 ~ December 05, 2019
- . 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 : 57.60 %
- . 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	17.46	Peak	H	31.20	4.65	-	53.31	74.00	20.69
4 804.000	6.35	Average	H	31.20	4.65	2.40	44.60	54.00	9.40
4 804.000	16.95	Peak	V	31.20	4.65	-	52.80	74.00	21.20
4 804.000	5.75	Average	V	31.20	4.65	2.40	44.00	54.00	10.00
Test Data for Middle Channel									
4 882.000	17.24	Peak	H	31.40	4.72	-	53.36	74.00	20.64
4 882.000	7.63	Average	H	31.40	4.72	2.40	46.15	54.00	7.85
4 882.000	16.13	Peak	V	31.40	4.72	-	52.25	74.00	21.75
4 882.000	6.12	Average	V	31.40	4.72	2.40	44.64	54.00	9.36
Test Data for High Channel									
4 960.000	19.29	Peak	H	31.70	4.86	-	55.85	74.00	18.15
4 960.000	10.36	Average	H	31.70	4.86	2.40	49.32	54.00	4.68
4 960.000	17.26	Peak	V	31.70	4.86	-	53.82	74.00	20.18
4 960.000	7.18	Average	V	31.70	4.86	2.40	46.14	54.00	7.86

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

12.6.2.2 Test data for 2 Mbps

- . Test Date : December 03, 2019 ~ December 05, 2019
- . 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 : 57.60 %
- . 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	16.02	Peak	H	31.20	4.65	-	51.87	74.00	22.13
4 804.000	5.92	Average	H	31.20	4.65	2.40	44.17	54.00	9.83
4 804.000	15.77	Peak	V	31.20	4.65	-	51.62	74.00	22.38
4 804.000	5.85	Average	V	31.20	4.65	2.40	44.10	54.00	9.90
Test Data for Middle Channel									
4 882.000	16.95	Peak	H	31.40	4.72	-	53.07	74.00	20.93
4 882.000	6.55	Average	H	31.40	4.72	2.40	45.07	54.00	8.93
4 882.000	16.53	Peak	V	31.40	4.72	-	52.65	74.00	21.35
4 882.000	5.89	Average	V	31.40	4.72	2.40	44.41	54.00	9.59
Test Data for High Channel									
4 960.000	16.85	Peak	H	31.70	4.86	-	53.41	74.00	20.59
4 960.000	6.71	Average	H	31.70	4.86	2.40	45.67	54.00	8.33
4 960.000	15.86	Peak	V	31.70	4.86	-	52.42	74.00	21.58
4 960.000	6.61	Average	V	31.70	4.86	2.40	45.57	54.00	8.43

Tabulated test data for Restricted Band

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

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

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



Tested by: Ha-Ram, Lee / Assistant Manager

12.6.2.3 Test data for 3 Mbps

- . Test Date : December 03, 2019 ~ December 05, 2019
- . 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 : 57.60 %
- . 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	15.99	Peak	H	31.20	4.65	-	51.84	74.00	22.16
4 804.000	6.28	Average	H	31.20	4.65	2.40	44.53	54.00	9.47
4 804.000	15.78	Peak	V	31.20	4.65	-	51.63	74.00	22.37
4 804.000	6.19	Average	V	31.20	4.65	2.40	44.44	54.00	9.56
Test Data for Middle Channel									
4 882.000	16.31	Peak	H	31.40	4.72	-	52.43	74.00	21.57
4 882.000	6.43	Average	H	31.40	4.72	2.40	44.95	54.00	9.05
4 882.000	16.16	Peak	V	31.40	4.72	-	52.28	74.00	21.72
4 882.000	5.89	Average	V	31.40	4.72	2.40	44.41	54.00	9.59
Test Data for High Channel									
4 960.000	16.94	Peak	H	31.70	4.86	-	53.50	74.00	20.50
4 960.000	6.61	Average	H	31.70	4.86	2.40	45.57	54.00	8.43
4 960.000	16.68	Peak	V	31.70	4.86	-	53.24	74.00	20.76
4 960.000	6.55	Average	V	31.70	4.86	2.40	45.51	54.00	8.49

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

13. RADIATED EMISSION TEST

13.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

13.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

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

13.3 Test equipment used

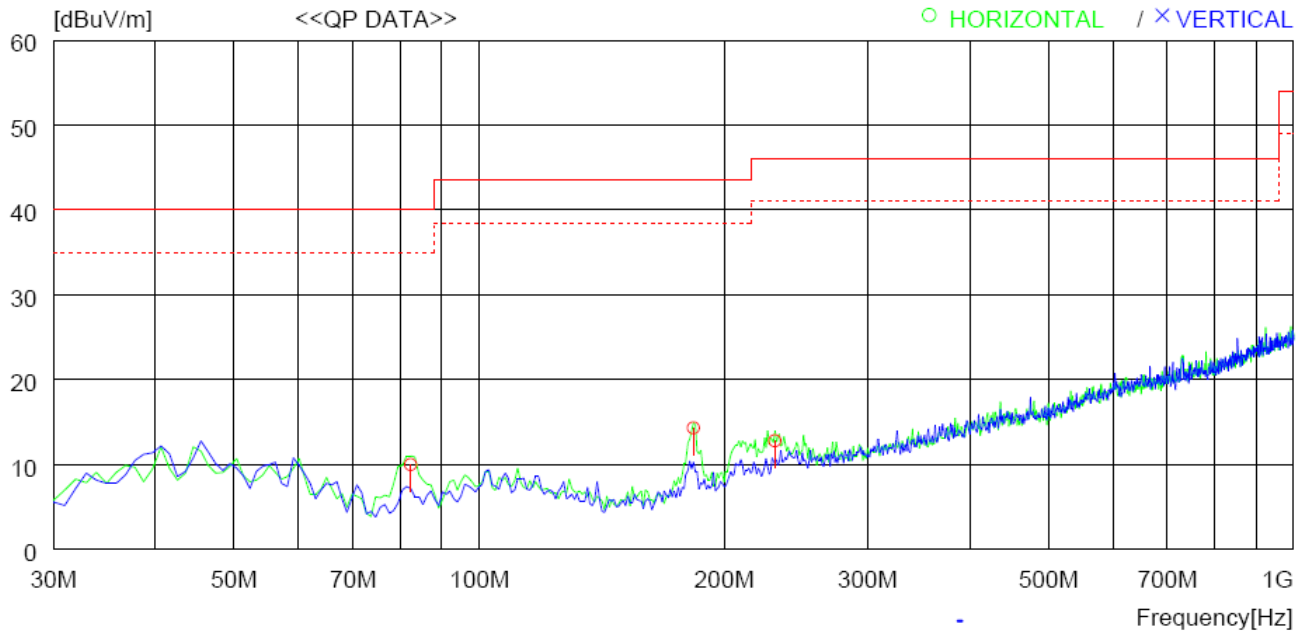
	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101199	Mar. 11, 2019 (1Y)
■ -	ESW	Rohde & Schwarz	EMI Test Receiver	101851	Aug. 07, 2019 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 18, 2019 (1Y)
■ -	DT3000-3t	Innco System	Turn Table	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)

All test equipment used is calibrated on a regular basis.

13.4 Test data for 30 MHz ~ 1 GHz

13.4.1 Test data for Bluetooth Mode

- Test Date : December 03, 2019 ~ December 05, 2019
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 GHz
- Measurement distance : 3 m



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	82.380	33.0	8.2	1.9	33.1	10.0	40.0	30.0	100	359
2	183.260	35.1	9.7	2.6	33.1	14.3	43.5	29.2	400	146
3	230.790	31.2	11.7	2.9	33.0	12.8	46.0	33.2	400	0

[Signature]

Tested by: Ha-Ram, Lee / Assistant Manager

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

Humidity Level : 45 % R.H.

Temperature: 23 °C

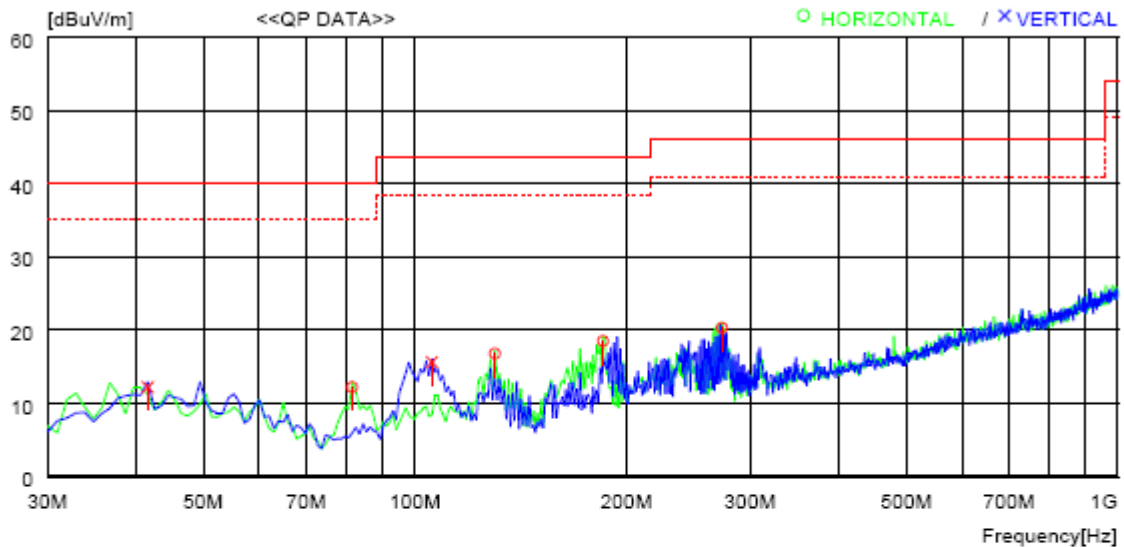
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

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 QF [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	81.410	35.4	8.0	1.9	33.1	12.2	40.0	27.8	300	165
2	129.910	38.2	9.4	2.2	33.0	16.8	43.5	26.7	200	47
3	185.200	39.1	9.8	2.7	33.1	16.5	43.5	25.0	100	359
4	273.470	37.2	12.9	3.2	33.0	20.3	46.0	25.7	100	359
----- Vertical -----										
5	41.640	30.1	13.8	1.4	33.1	12.2	40.0	27.8	200	359
6	105.660	35.0	11.6	2.1	33.1	15.6	43.5	27.9	100	56



Tested by: Ha-Ram, Lee / Assistant Manager

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

Humidity Level : 45 % R.H.

Temperature: 23 °C

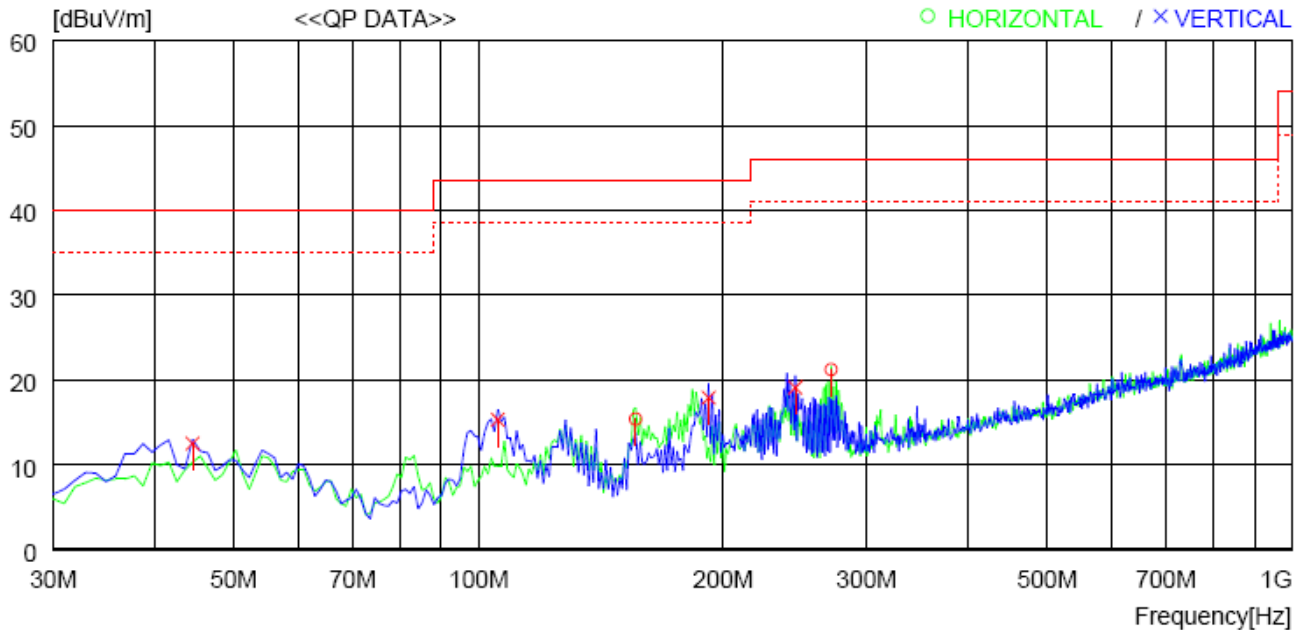
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

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]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	156.100	37.4	8.6	2.4	33.0	15.4	43.5	28.1	200	223
2	271.530	38.1	12.9	3.2	33.0	21.2	46.0	24.8	100	113
----- Vertical -----										
3	44.550	30.0	14.1	1.5	33.1	12.5	40.0	27.5	100	0
4	105.660	34.7	11.6	2.1	33.1	15.3	43.5	28.2	100	244
5	191.990	38.2	10.1	2.7	33.1	17.9	43.5	25.6	100	0
6	245.340	36.9	12.2	3.0	33.0	19.1	46.0	26.9	100	65



Tested by: Ha-Ram, Lee / Assistant Manager

13.5 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

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)
All emissions observed were 20 dB below the limit.								

13.6 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

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)
All emissions observed were 20 dB below the limit.								



Tested by: Ha-Ram, Lee / Assistant Manager

14. CONDUCTED EMISSION TEST

14.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

14.2 Test set-up

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

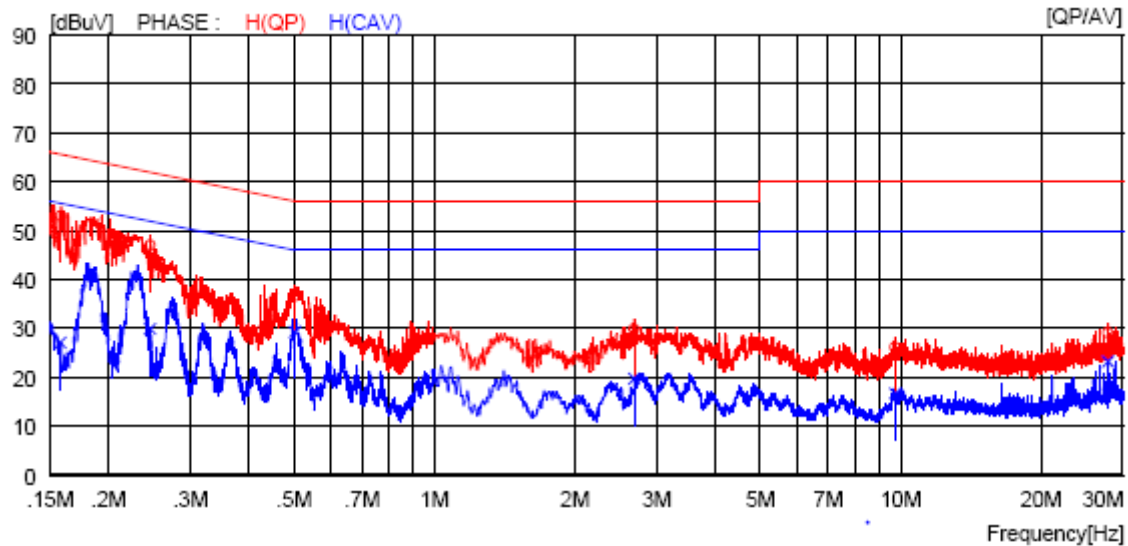
14.3 Test equipment used

	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.

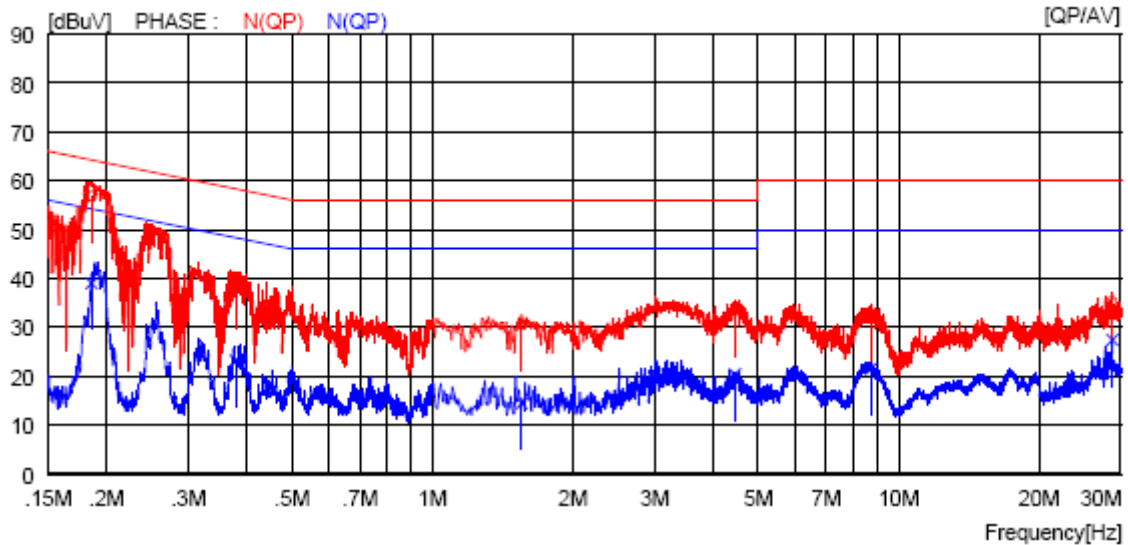
14.4 Test data

- 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	0.15800	43.0	----	10.0	53.0	----	65.6	----	12.6	----	H (QP)
2	0.24600	37.1	----	10.0	47.1	----	61.9	----	14.8	----	H (QP)
3	0.50300	26.6	----	10.0	36.6	----	56.0	----	19.4	----	H (QP)
4	2.68400	19.8	----	10.1	29.9	----	56.0	----	26.1	----	H (QP)
5	9.74500	15.9	----	10.3	26.2	----	60.0	----	33.8	----	H (QP)
6	27.88000	18.3	----	10.8	29.1	----	60.0	----	30.9	----	H (QP)
7	0.15800	----	17.1	10.0	----	27.1	----	55.6	----	28.5	H (CAV)
8	0.24600	----	19.9	10.0	----	29.9	----	51.9	----	22.0	H (CAV)
9	0.50300	----	19.3	10.0	----	29.3	----	46.0	----	16.7	H (CAV)
10	2.68400	----	9.6	10.1	----	19.7	----	46.0	----	26.3	H (CAV)
11	9.74500	----	6.4	10.3	----	16.7	----	50.0	----	33.3	H (CAV)
12	27.88000	----	12.4	10.8	----	23.2	----	50.0	----	26.8	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	0.18600	46.9	----	10.0	56.9	----	64.2	----	7.3	----	N (QP)
2	0.37900	29.3	----	10.0	39.3	----	58.3	----	19.0	----	N (QP)
3	1.55600	20.5	----	10.1	30.6	----	56.0	----	25.4	----	N (QP)
4	4.46000	23.4	----	10.1	33.5	----	56.0	----	22.5	----	N (QP)
5	8.74000	22.4	----	10.3	32.7	----	60.0	----	27.3	----	N (QP)
6	28.74000	24.4	----	10.8	35.2	----	60.0	----	24.8	----	N (QP)
7	0.18600	----	29.0	10.0	----	39.0	----	54.2	----	15.2	N (CAV)
8	0.37900	----	13.2	10.0	----	23.2	----	48.3	----	25.1	N (CAV)
9	1.55600	----	4.4	10.1	----	14.5	----	46.0	----	31.5	N (CAV)
10	4.46000	----	10.3	10.1	----	20.4	----	46.0	----	25.6	N (CAV)
11	8.74000	----	11.2	10.3	----	21.5	----	50.0	----	28.5	N (CAV)
12	28.74000	----	16.6	10.8	----	27.4	----	50.0	----	22.6	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