

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

Test Report No. : OT-193-RWD-059
AGR No. : A18DA-151R
Applicant : LG Electronics USA
Address : 1000 Sylvan Avenue, Englewood Cliffs, New Jersey, United States, 07632
Manufacturer : LG Electronics Inc.
Address : 222 LG-ro, Jinwi-Myeon, Pyeongtaek -Si, Gyeonggi-Do, 451-713, Korea
Type of Equipment : Car Navigation
FCC ID. : BEJ-MIB3OI
Model Name : MIB3 OI
Serial number : N/A
Total page of Report : 82 pages (including this page)
Date of Incoming : January 11, 2019
Date of issue : March 26, 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:



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 ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-193-RWD-059	March 26, 2019	Initial Issue	All

Document History

Revision No.	Issued Date	Revisions	Effect Section
Original	March 26, 2019	Initial Issue	-
Rev. 01	June 03, 2019	3.1 Product Description	-

1. VERIFICATION OF COMPLIANCE

APPLICANT : LG Electronics USA
 ADDRESS : 1000 Sylvan Avenue, Englewood Cliffs, New Jersey, United States, 07632
 CONTACT PERSON : Kyung-Su Han / Director
 TELEPHONE NO : (201) 266-2215
 FCC ID : BEJ-MIB3OI
 MODEL NAME : MIB3 OI
 BRAND NAME : LG, Volkswagen, Seat
 SERIAL NUMBER : N/A
 DATE : March 26, 2019

EQUIPMENT CLASS	<i>DSS – PART 15 SPREAD SPECTRUM TRANSMITTER</i>
KIND OF EQUIPMENT	Car Navigation
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
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

IC (Industry Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

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

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The LG Electronics USA, Model MIB3 OI (referred to as the EUT in this report) is a Car Navigation. Product specification information described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Car Navigation			
FREQUENCY RANGE	Bluetooth	2 402 MHz ~ 2 480 MHz		
	WLAN 2.4 GHz Band	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))		
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n/ac(HT20))	
			5 190 MHz ~ 5 230 MHz (802.11n/ac(HT40))	
			5 210 MHz (802.11ac(VHT80))	
		5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n/ac(HT20))	
			5 755 MHz ~ 5 795 MHz (802.11n/ac(HT40))	
			5 775 MHz (802.11ac(VHT80))	
MAX. RF OUTPUT POWER	Bluetooth	1 Mbps	-1.40 dBm	
		2 Mbps	-0.61 dBm	
		3 Mbps	-0.07 dBm	
	WLAN 2.4 GHz Band	Wi-Fi 802.11b (15.43 dBm) Wi-Fi 802.11g (17.26 dBm) Wi-Fi 802.11n(HT20) (15.97 dBm)		
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (10.49 dBm) Wi-Fi 802.11n(HT20) (10.44 dBm) Wi-Fi 802.11n(HT40) (8.21 dBm) Wi-Fi 802.11ac(VHT80) (7.34 dBm)
			Antenna 1	Wi-Fi 802.11a (10.15 dBm) Wi-Fi 802.11n(HT20) (10.07 dBm) Wi-Fi 802.11n(HT40) (8.35 dBm) Wi-Fi 802.11ac(VHT80) (7.68 dBm)
			Multiple transmit	Wi-Fi 802.11n(HT20) (13.24 dBm) Wi-Fi 802.11n(HT40) (11.29 dBm) Wi-Fi 802.11ac(VHT80) (10.52 dBm)

MAX. RF OUTPUT POWER	WLAN 5 GHz Band	5 725 MHz ~ 5 850 MHz Band		Antenna 0	Wi-Fi 802.11a (9.37 dBm) Wi-Fi 802.11n(HT20) (9.39 dBm) Wi-Fi 802.11n(HT40) (7.29 dBm) Wi-Fi 802.11ac(VHT80) (6.34 dBm)		
				Antenna 1	Wi-Fi 802.11a (10.42 dBm) Wi-Fi 802.11n(HT20) (10.52 dBm) Wi-Fi 802.11n(HT40) (8.49 dBm) Wi-Fi 802.11ac(VHT80) (7.74 dBm)		
				Multiple transmit	Wi-Fi 802.11n(HT20) (12.84 dBm) Wi-Fi 802.11n(HT40) (10.94 dBm) Wi-Fi 802.11ac(VHT80) (10.11 dBm)		
MODULATION TYPE	Bluetooth			GFSK for 1 Mbps, $\pi/4$ -DQPSK for 2 Mbps, 8-DPSK for 3 Mbps			
	WLAN 2.4 GHz Band			DSSS Modulation(DBPSK/DQPSK/CCK) OFDM Modulation(BPSK/QPSK/16QAM/64QAM)			
	WLAN 5 GHz Band			OFDM Modulation(BPSK/QPSK/16QAM/64QAM)			
ANTENNA TYPE	Bluetooth			PCB Antenna			
	WLAN (2.4GHz Band)			Chip Antenna			
	WLAN (5GHz Band)	Antenna 0	PCB Antenna				
		Antenna 1	Chip Antenna				
ANTENNA GAIN	Bluetooth			2.5 dBi			
	WLAN 2.4 GHz Band			3.8 dBi			
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz 5 725 MHz ~ 5 850 MHz		ANT0	3.8 dBi		
				ANT1	1.6 dBi		
				ANT0	5.5 dBi		
				ANT1	2.4 dBi		
	5 GHz Band (ANT 0 + 1)	5 150 MHz ~ 5 250 MHz		5.78 dBi			
		5 725 MHz ~ 5 850 MHz		7.10 dBi			
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)				31.25 MHz, 28.63636 MHz			
RATED SUPPLY VOLTAGE				DC 12.0 V			

- Directional Gain Calculations

$$\text{Directional gain} = 10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{GN/20})^2 / N_{\text{ANT}}] \text{ dBi}$$

3.2 Alternative type(s)/model(s); also covered by this test report.

-. The following lists consist of the added config and their differences:

Brand	Model	Config	Feature							Tested
			BT	Wi-Fi	RVC	DAB	Amp	Tuner Configuration	Platform	
LG Volkswagen Seat	MIB3 OI	L91VW3-N200	O	O	O	O	4CH	Mercury,Merlin	MQB	☒
		L91VW3-N20A	O	O	O	O	4CH	Titan,Merlin	MQB	☐
		L91VW3-N320	O	O	O	X	4CH	Mercury,Merlin	MQB	☐
		L91VW3-N160	O	O	O	O	4CH	Mercury,Merlin	MQB	☐
		L91VW3-N16A	O	O	O	O	4CH	Titan,Merlin	MQB	☐
		L91VW3-N740	O	O	O	X	4CH	Titan,Merlin	MQB	☐
		L91VW3-N760	O	O	O	X	4CH	Mercury,Merlin	MQB	☐
		L92VW3-N200	O	O	X	O	4CH	Mercury,Titan	MQB37	☐
		L92VW3-N20A	O	O	X	O	4CH	Mercury,Titan	MQB37	☐
		L92VW3-N320	O	O	X	X	4CH	Titan,Merlin	MQB37	☐
		L92VW3-N160	O	O	X	O	4CH	Mercury,Titan	MQB37	☐
		L92VW3-N16A	O	O	X	O	4CH	Mercury,Titan	MQB37	☐
		L92VW3-N740	O	O	X	X	4CH	Titan,Merlin	MQB37	☐
		L92VW3-N760	O	O	X	X	4CH	Titan,Merlin	MQB37	☐
		L91SE3-N200	O	O	O	O	4CH	Mercury,Merlin	MQB	☐
		L91SE3-N20A	O	O	O	O	4CH	Mercury,Merlin	MQB	☐
		L91SE3-N320	O	O	O	X	4CH	Titan,Merlin	MQB	☐
		L91SE3-N620	O	O	O	O	4CH	Mercury,Merlin	MQB	☐
		L91SE3-N62A	O	O	O	O	4CH	Mercury,Merlin	MQB	☐
		L91SE3-N670	O	O	O	X	4CH	Titan,Merlin	MQB	☐
		L91SE3-N680	O	O	O	X	4CH	Titan,Merlin	MQB	☐
		L92SE3-N620	O	O	X	O	4CH	Mercury,Titan	MQB37	☐
		L92SE3-N62A	O	O	X	O	4CH	Mercury,Titan	MQB37	☐
		L92SE3-N670	O	O	X	X	4CH	Titan,Merlin	MQB37	☐
		L92SE3-N680	O	O	X	X	4CH	Titan,Merlin	MQB37	☐

Note: 1. Applicants must delegate only the models with all features applied to be tested, Therefore, this test report only guarantees the unit tested.

2. The Applicant/manufacturer is responsible for the compliance of all configs.

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	N/A	N / A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
G6-1121TV	HP	Notebook PC	EUT, AC/DC Adapter
PPP009C	HP	AC/DC Adapter	Notebook PC

5.3 Mode of operation during the test

For Bluetooth function testing, software used to control the EUT for staying in continuous transmitting and receiving mode is programmed. The EUT was set at Low Channel (2 402 MHz), Middle Channel (2 441 MHz), and High Channel (2 480 MHz) with each data transfer rate, 1 Mbps, 2 Mbps, and 3 Mbps. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this test report.

5.4 Configuration of Test System

Line Conducted Test: The EUT was tested in a Charging & Transmitting mode. The EUT was connected to USB and the power of USB was connected to Notebook PC. All supporting equipment 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: The EUT was tested in a Charging & Transmitting mode. Preliminary radiated emissions test was conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m 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 as to be attached permanently to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The transmitter antenna of the EUT is a PCB Antenna, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

- As this product is only using DC power, AC conducted emission test has not been performed.

6.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

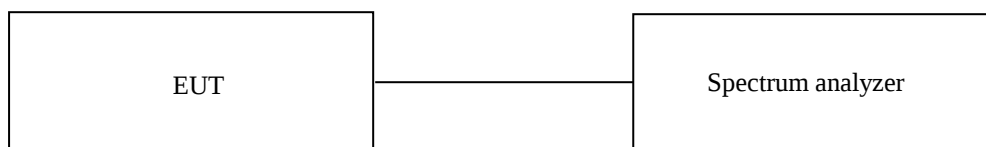
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 24 °C
Relative humidity : 45 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 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.

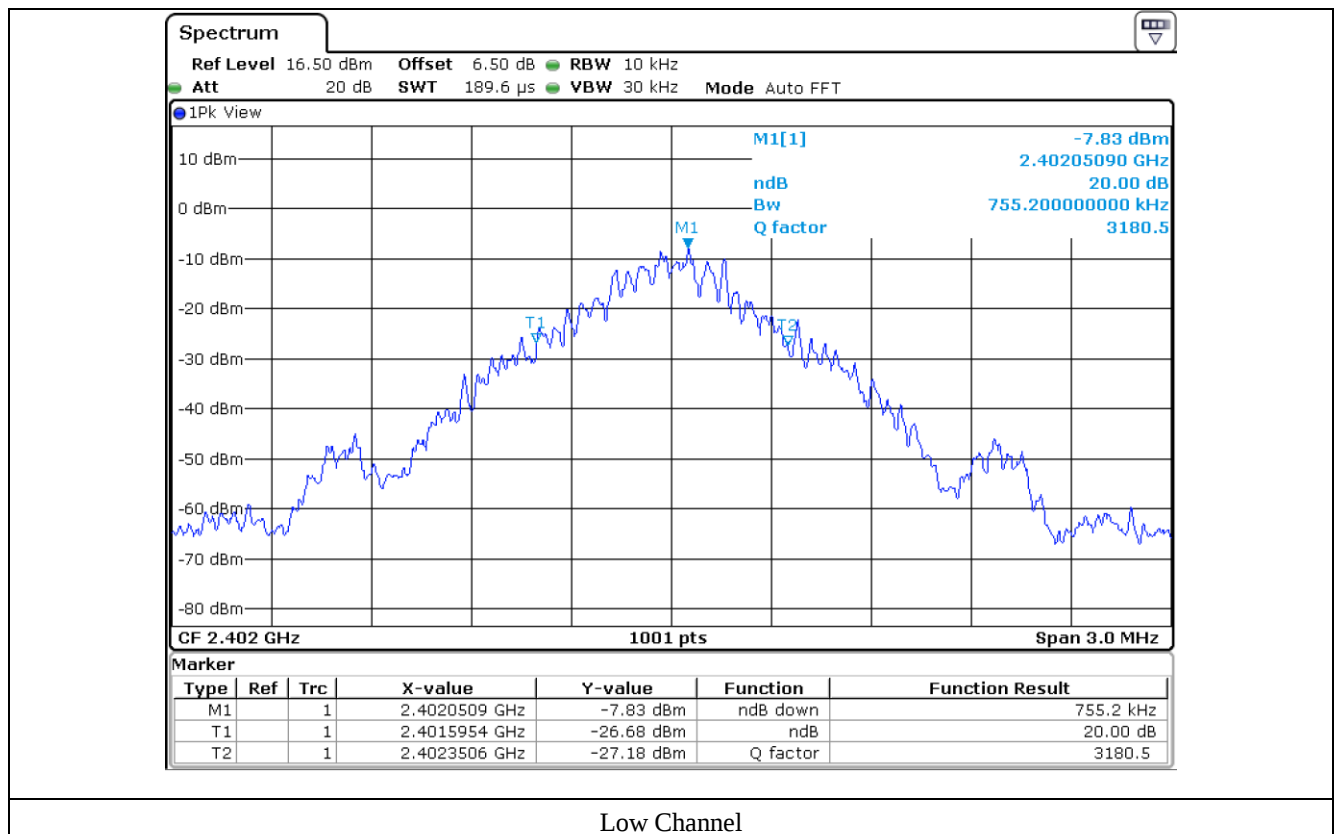
7.4 Test data for 1 Mbps

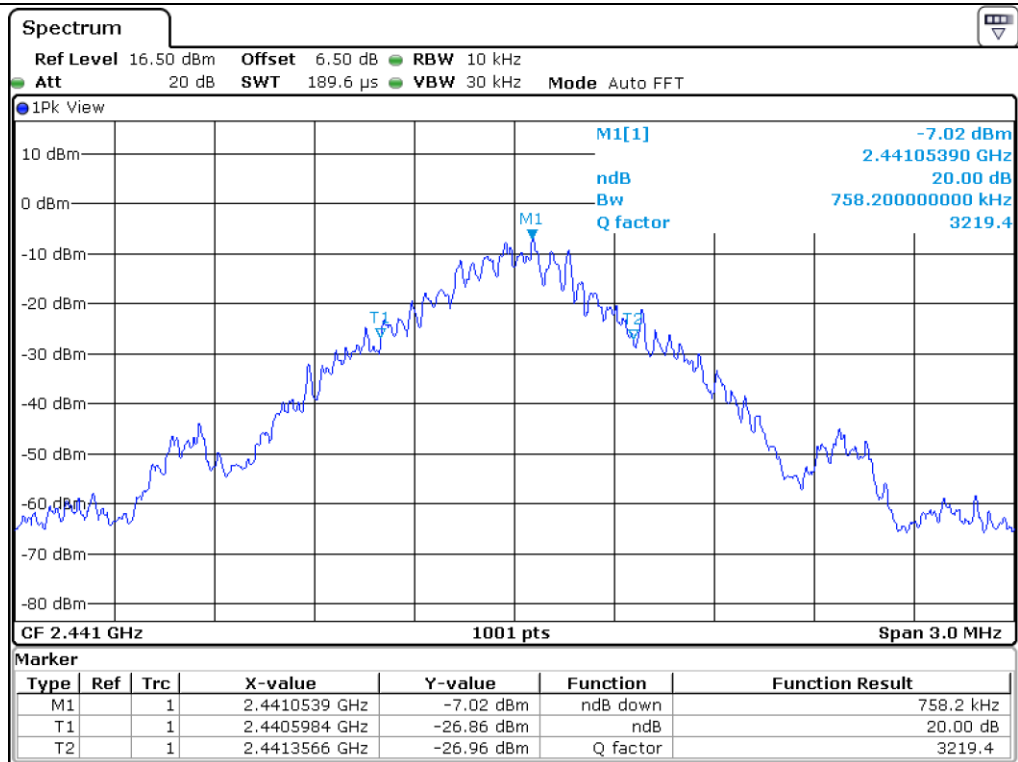
-. Test Date : February 18, 2019

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	755.20
Middle	2 441	758.20
High	2 480	704.30

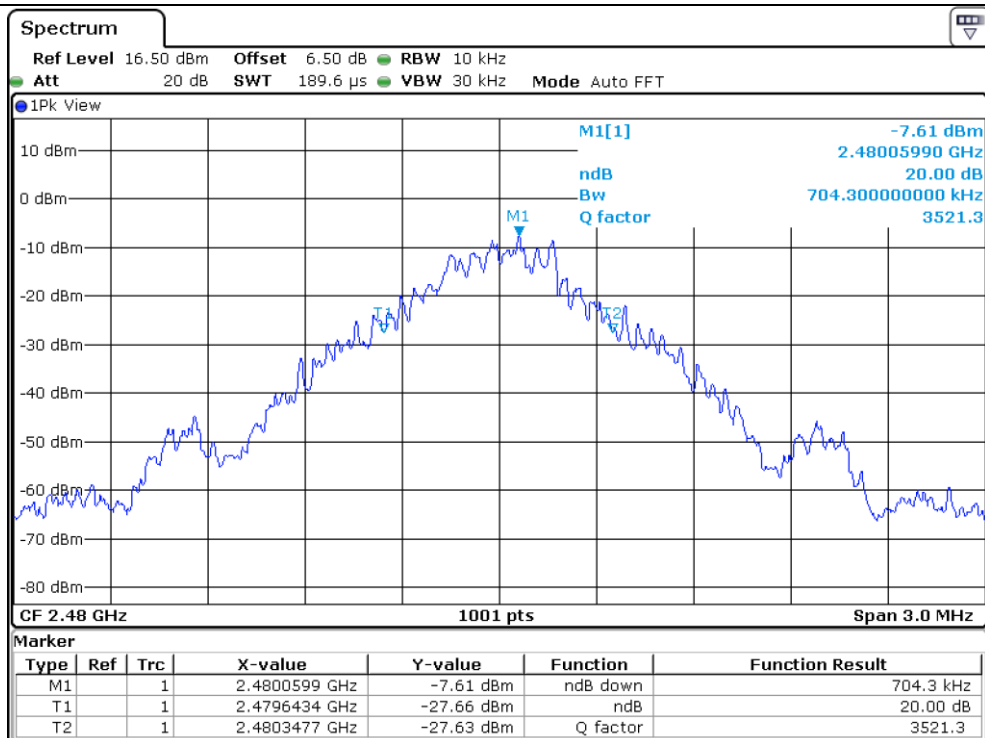


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Middle Channel



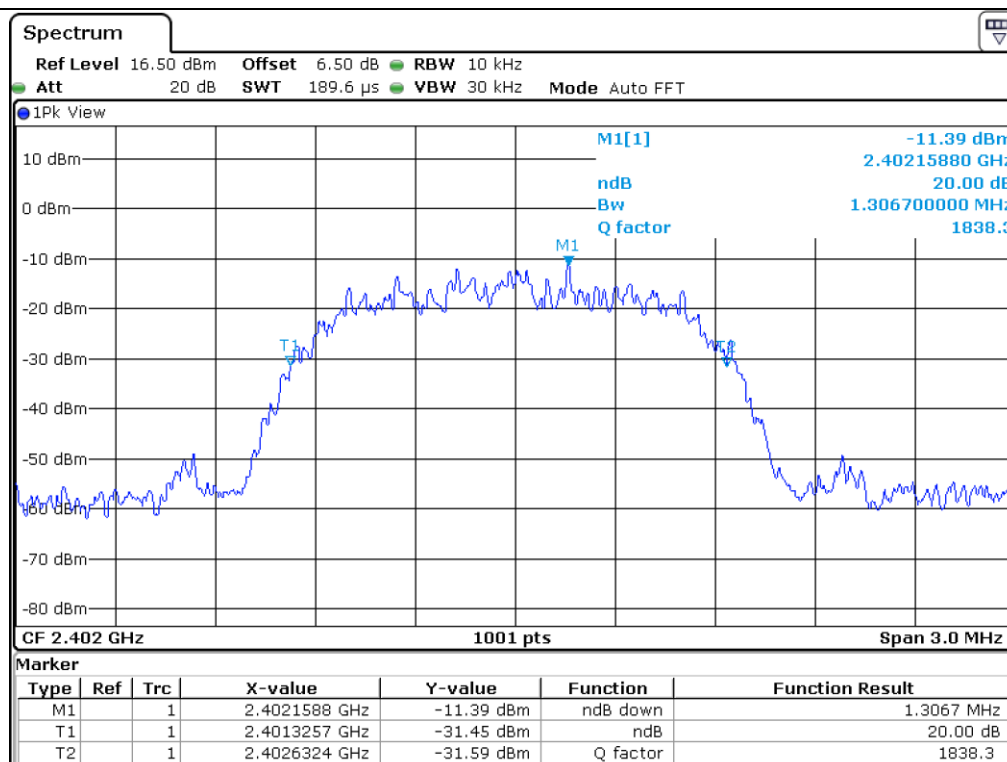
High Channel

-. Test Date : February 18, 2019

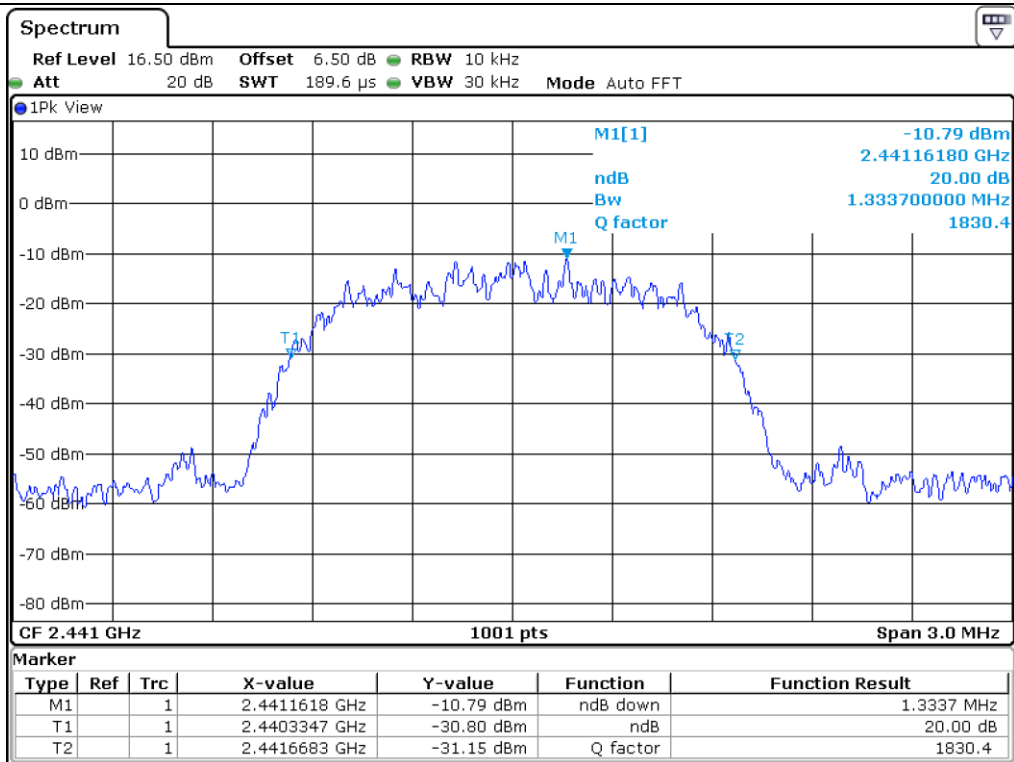
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	1306.70
Middle	2 441	1333.70
High	2 480	1333.70



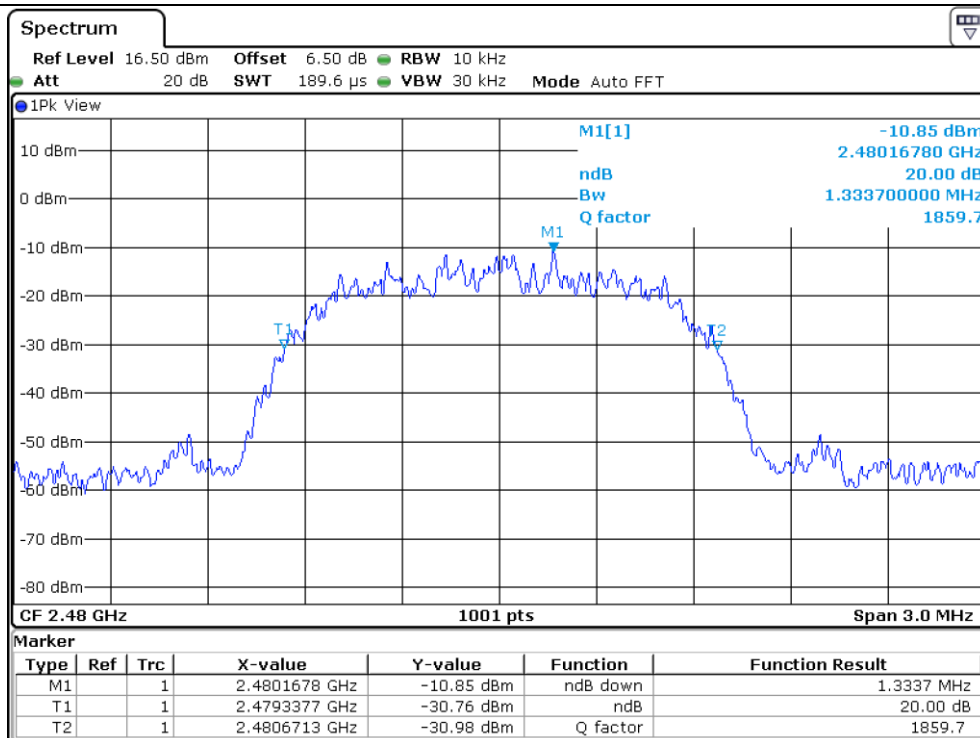
Tested by: Ha-Ram Lee / Assistant Manager



Low Channel



Middle Channel



High Channel

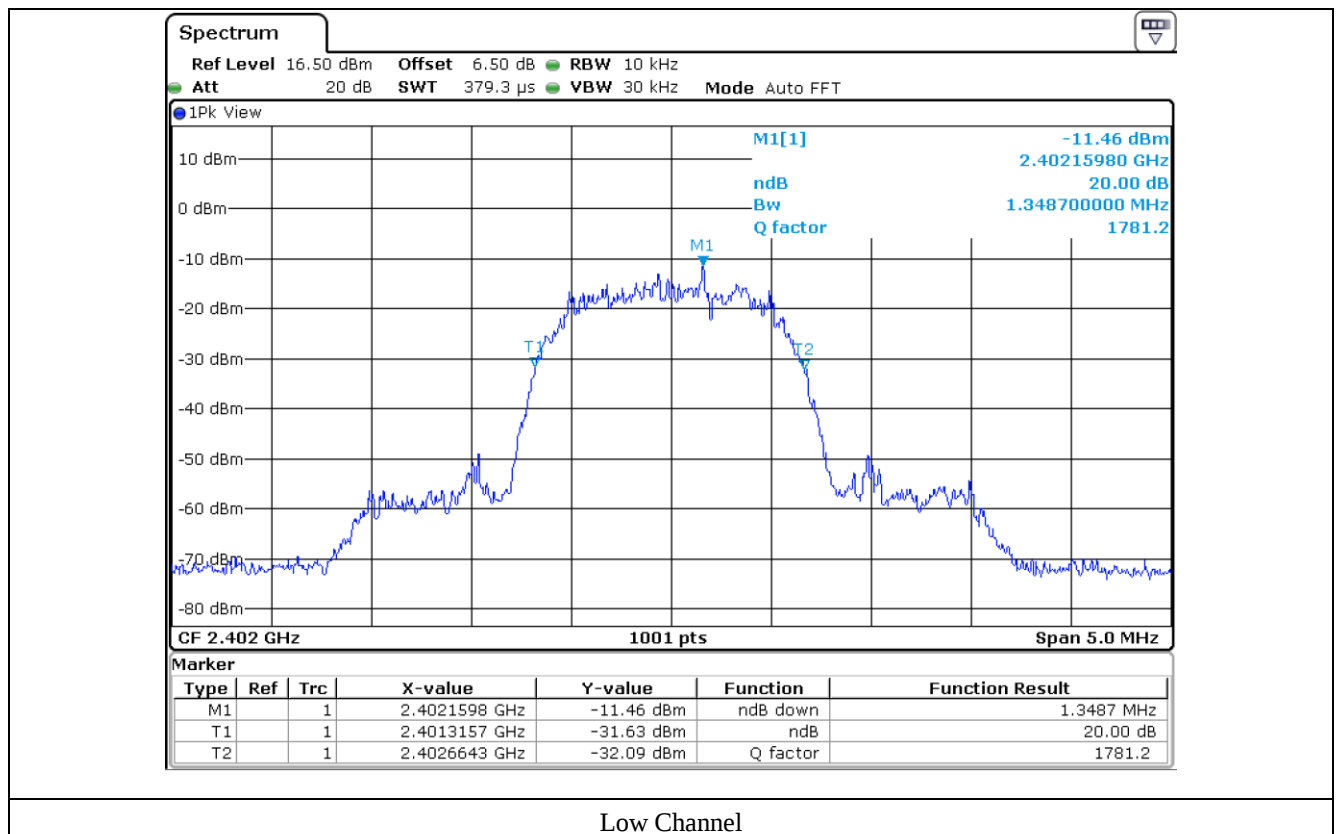
7.6 Test data for 3 Mbps

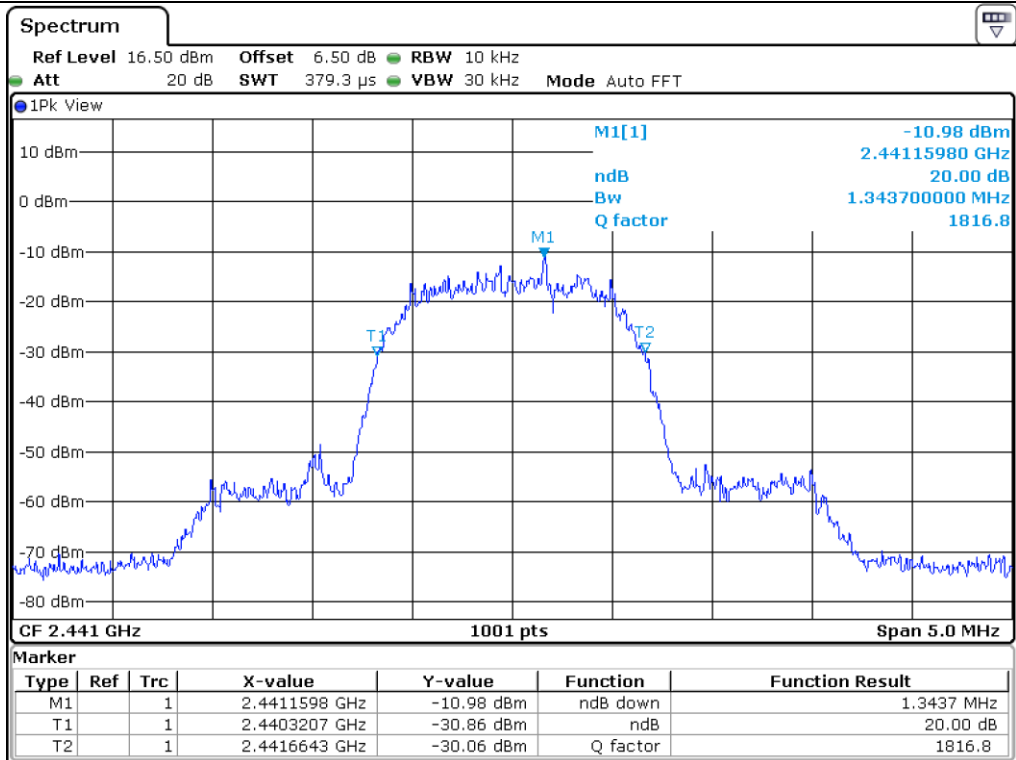
-. Test Date : February 18, 2019

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	1348.70
Middle	2 441	1343.70
High	2 480	1343.70

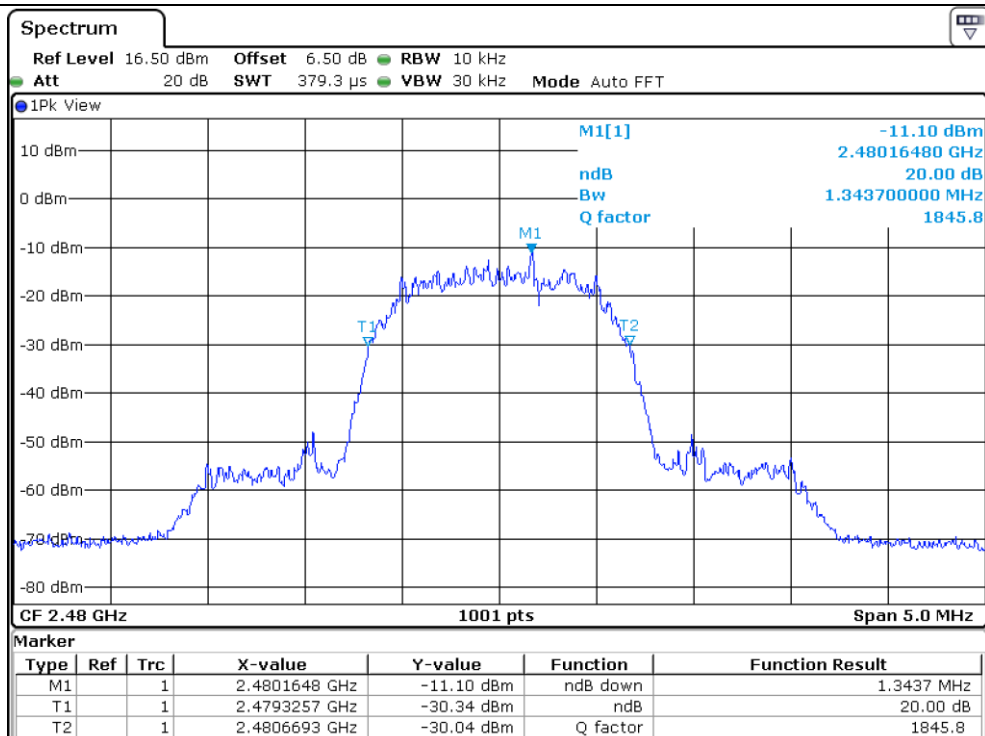


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Middle Channel



High Channel

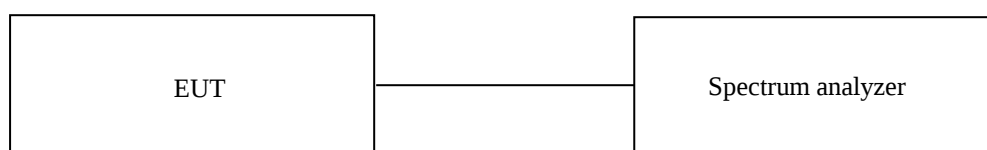
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 24 °C
Relative humidity : 45 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 10 MHz. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.



8.3 Test 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

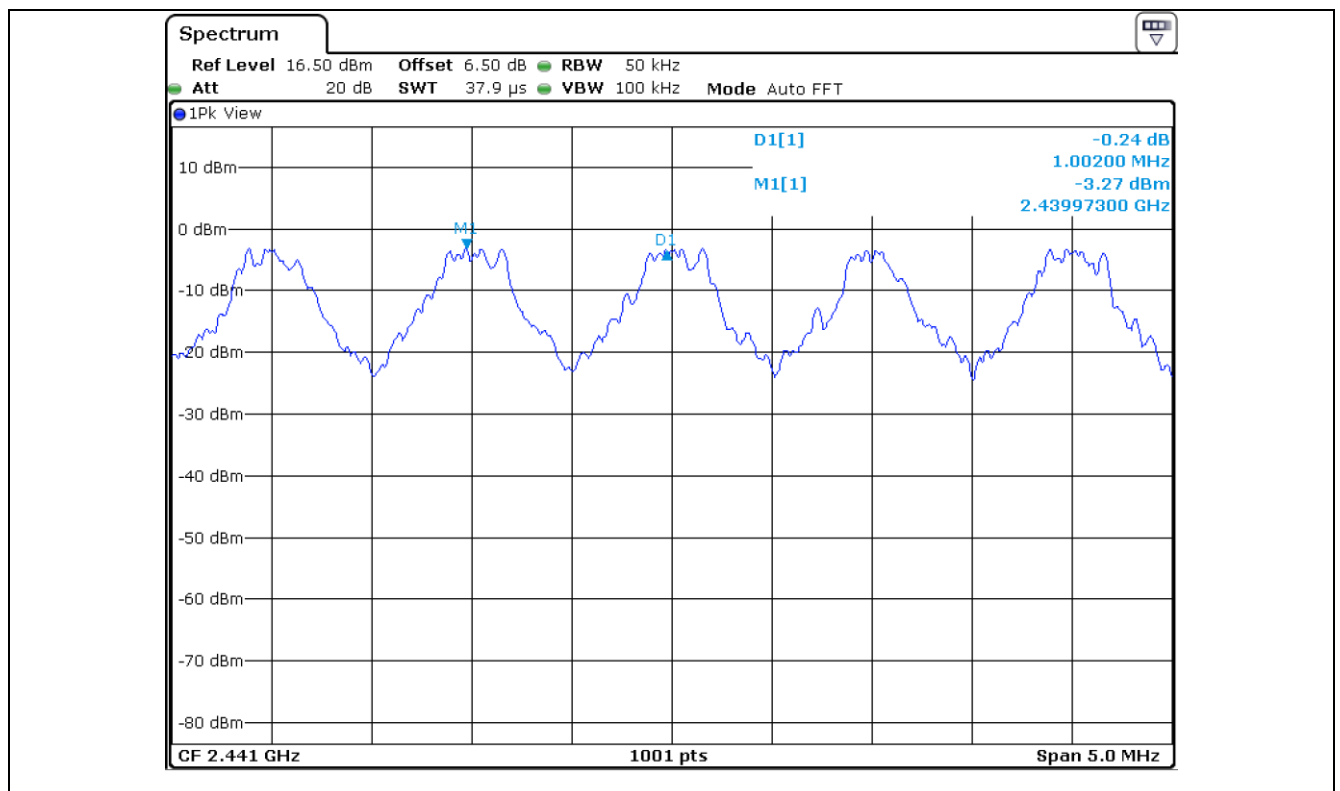
-. Test Date : February 18, 2019

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1002.00	505.47	Separated by 25 kHz or <u>two-thirds of the 20 dB bandwidth of the hopping channel</u> , whichever is greater.



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8.5 Test data for 2 Mbps

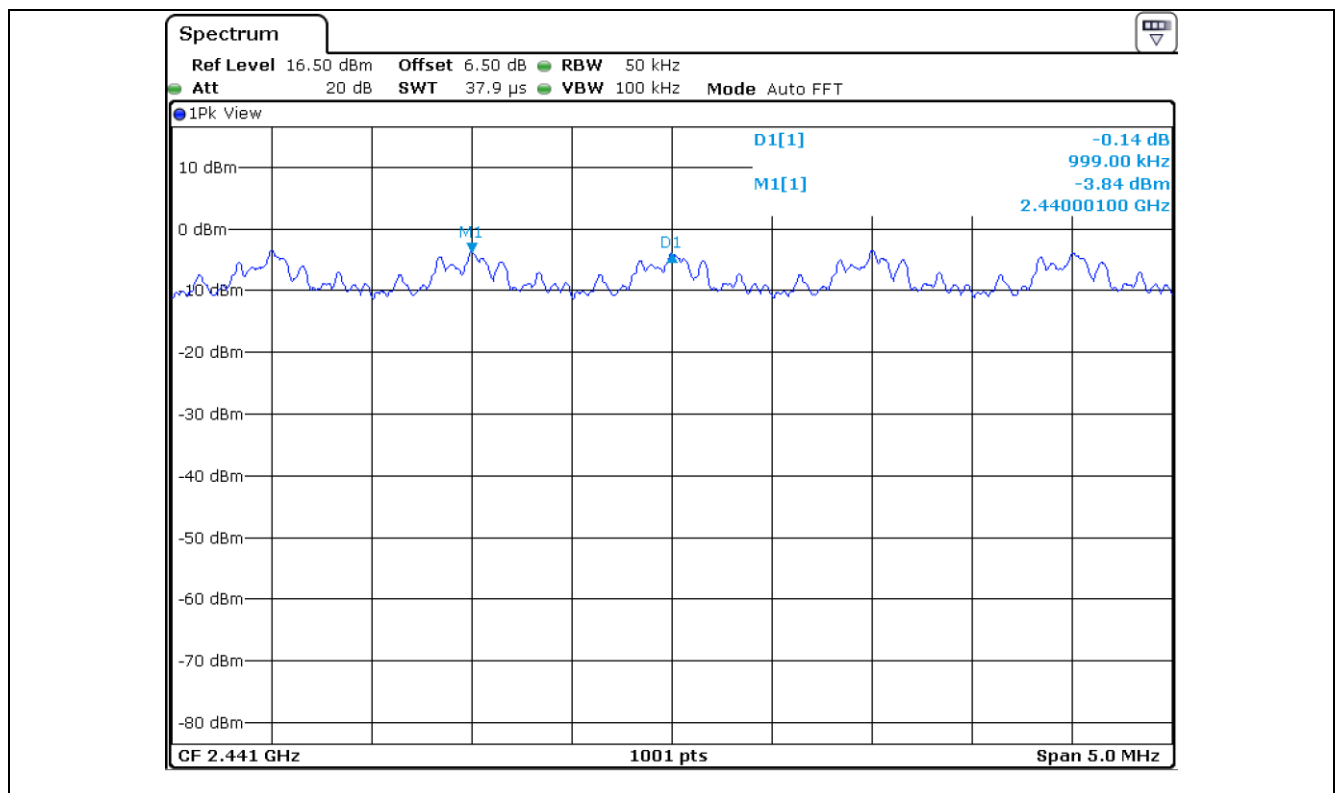
-. Test Date : February 18, 2019

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	469.53	Separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.



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8.6 Test data for 3 Mbps

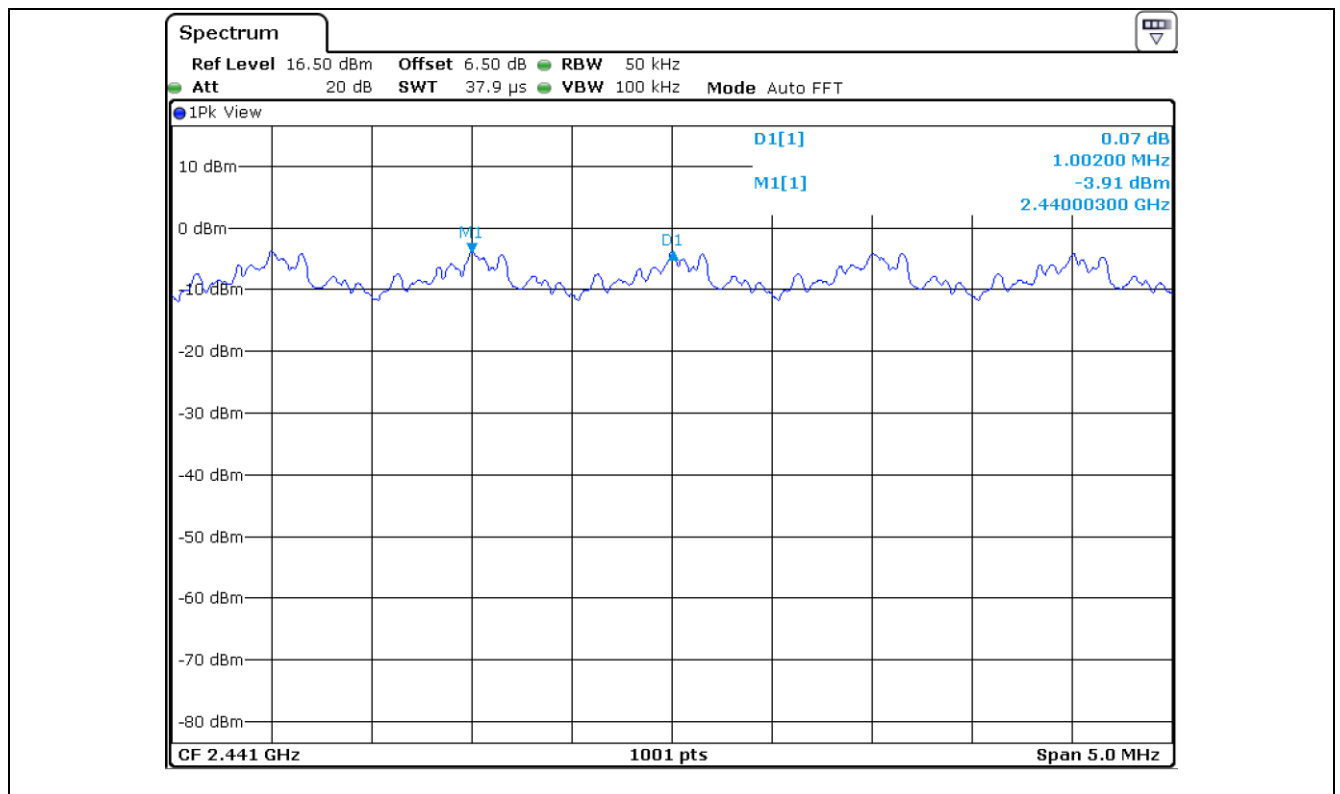
-. Test Date : February 18, 2019

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1002.00	871.13	Separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.



Tested by: Ha-Ram Lee / Assistant Manager



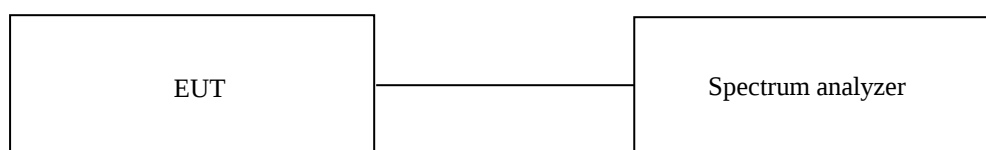
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 24 °C
Relative humidity : 45 % R.H.

9.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 100 MHz and the resolution bandwidth is set to 1 MHz. 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

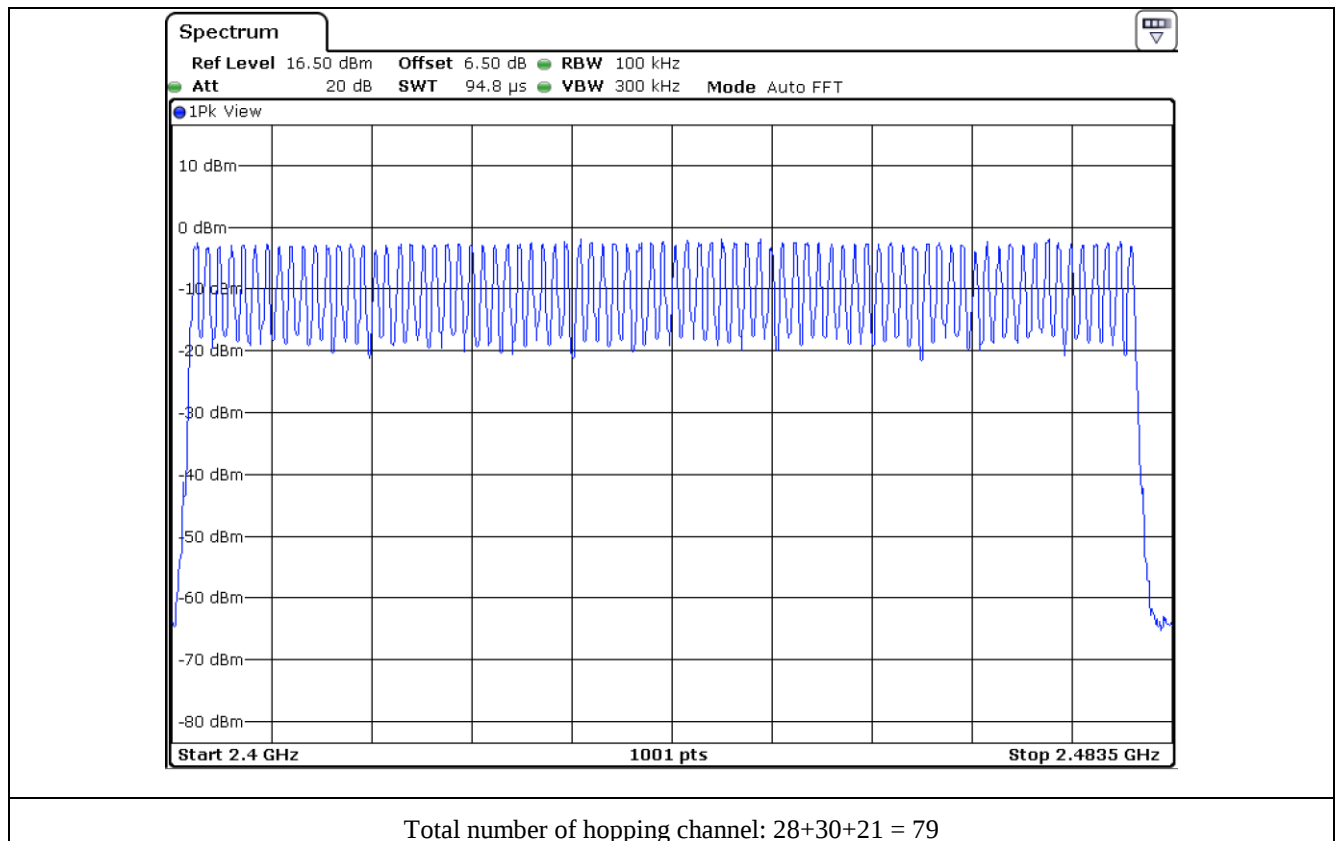
-. Test Date : February 18, 2019

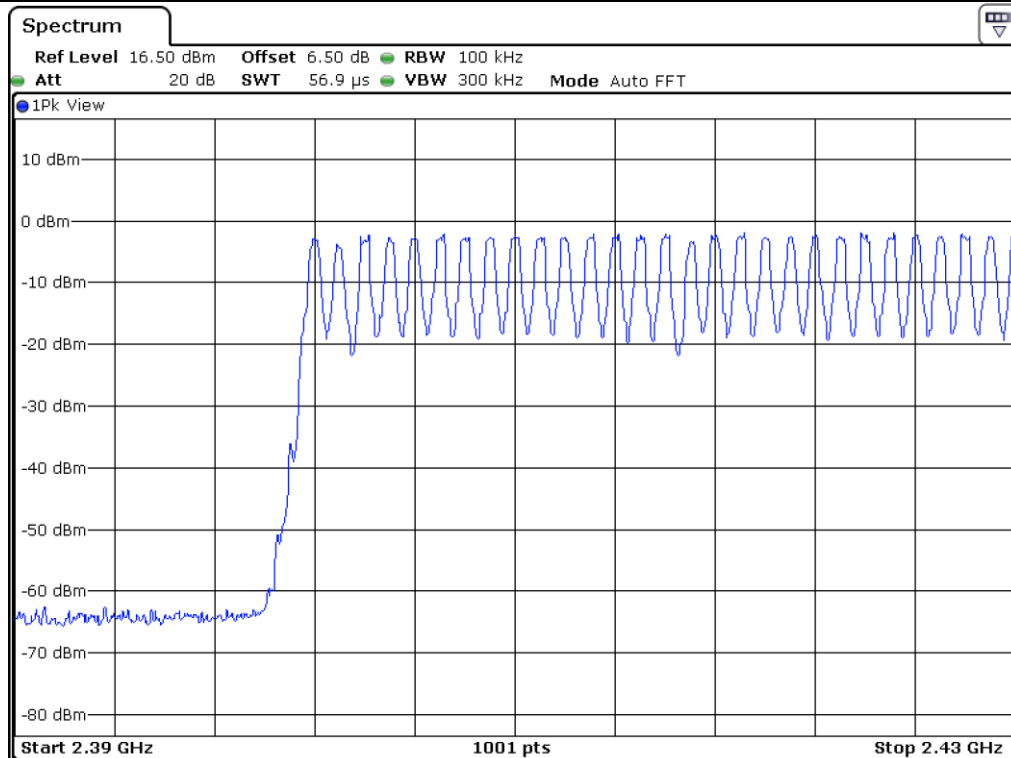
-. Test Result : Pass

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

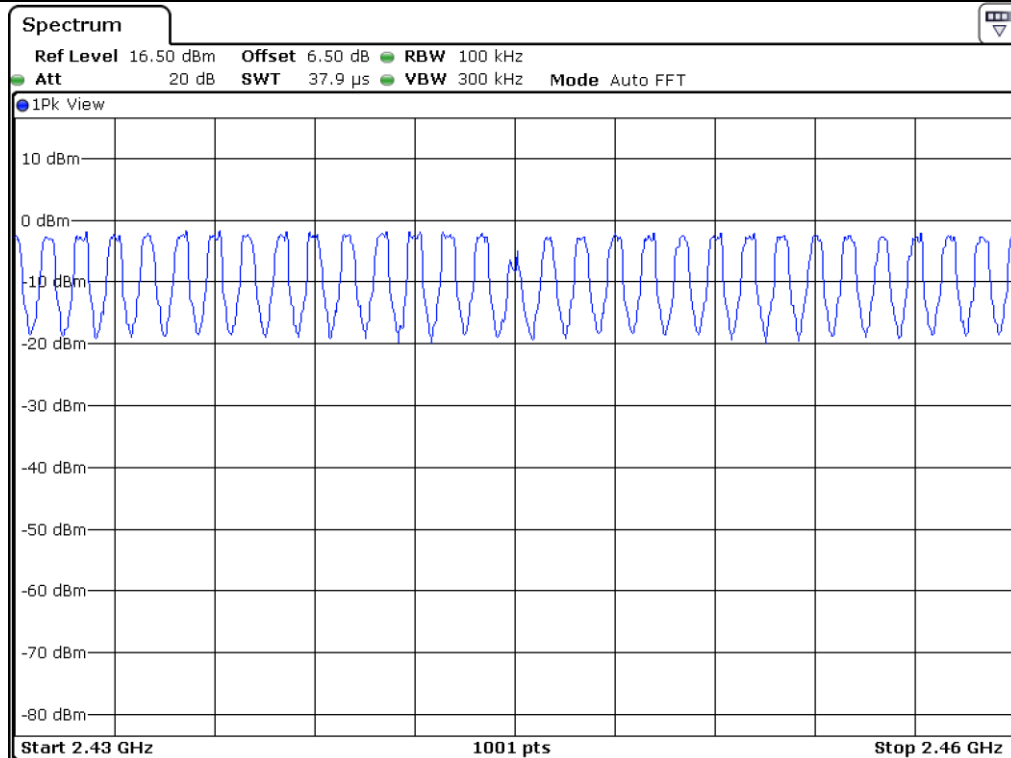


Tested by: Ha-Ram Lee / Assistant Manager

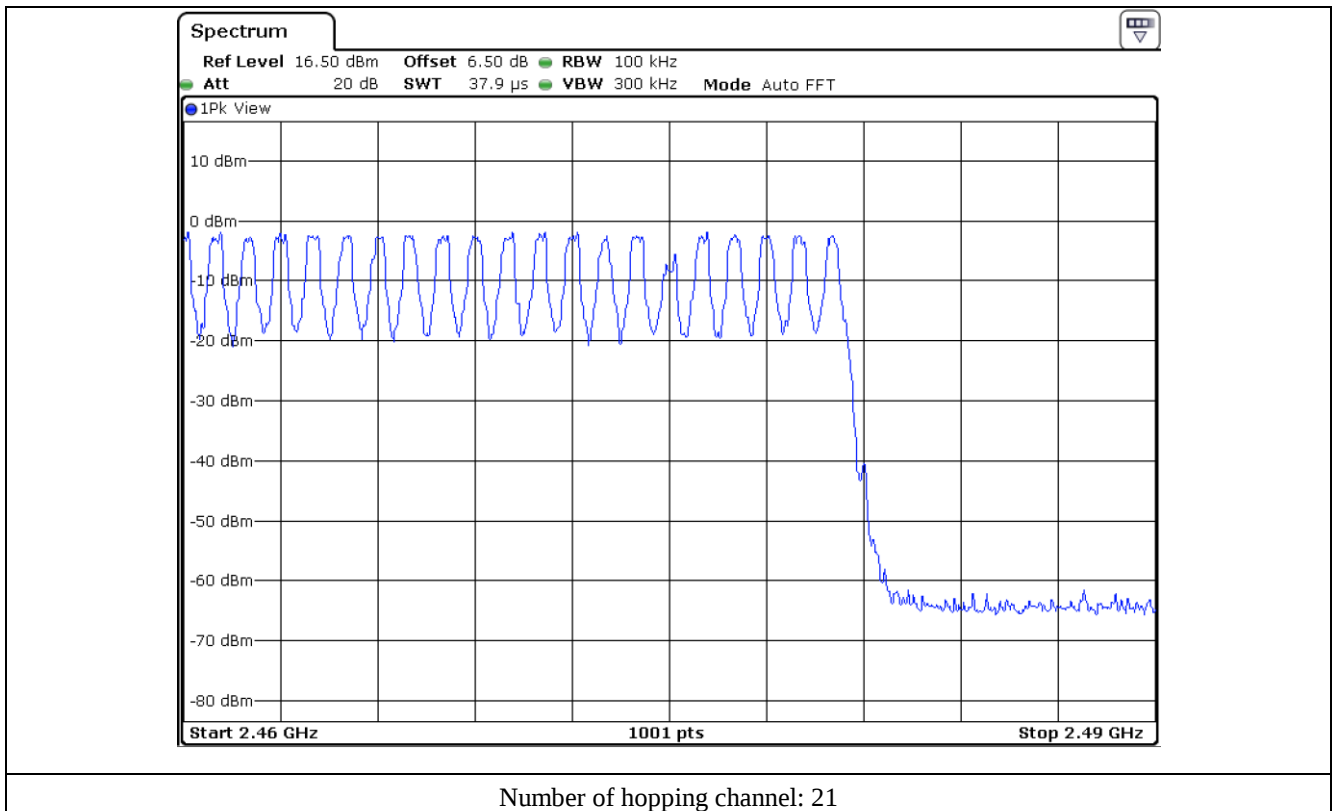




Number of hopping channel: 28



Number of hopping channel: 30



9.5 Test data for 2 Mbps

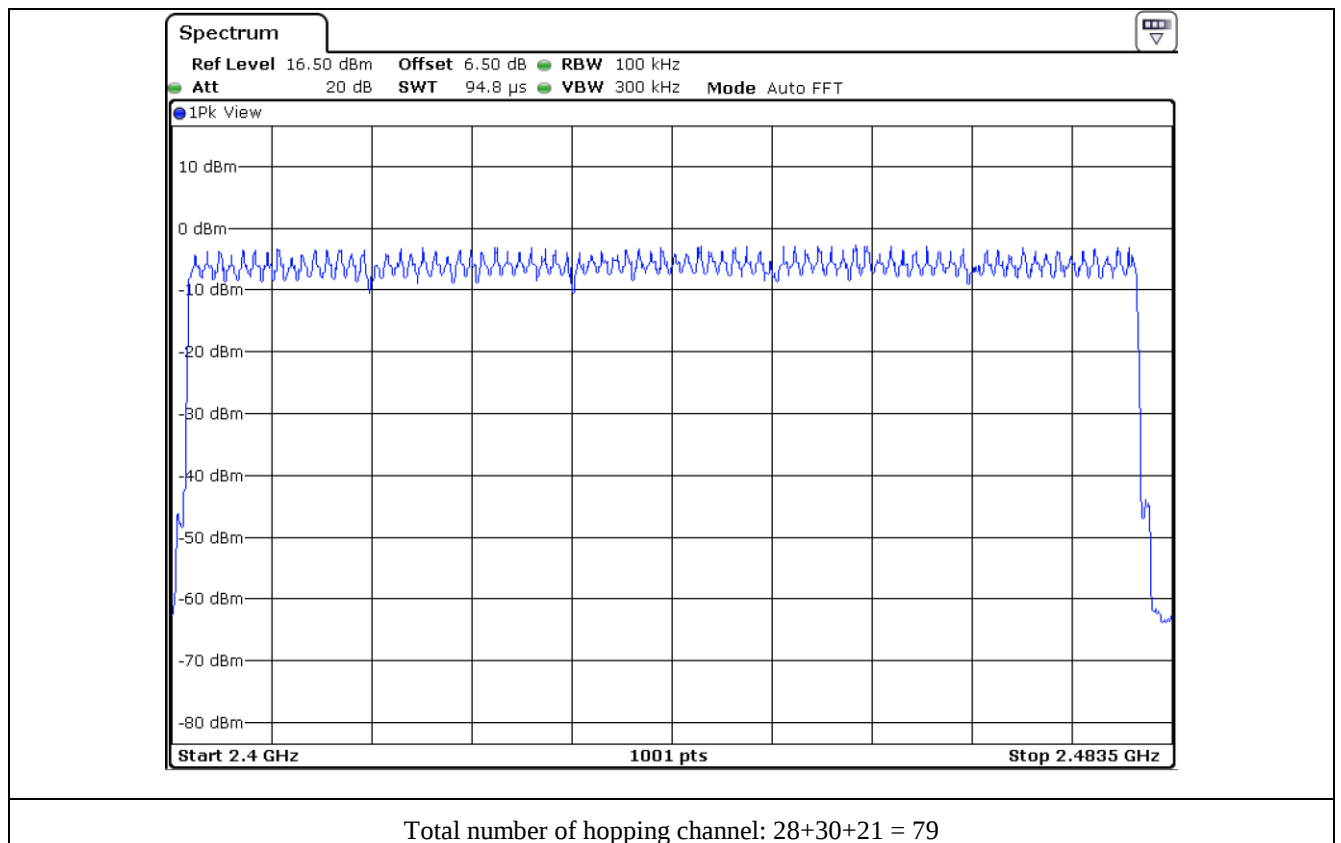
-. Test Date : February 18, 2019

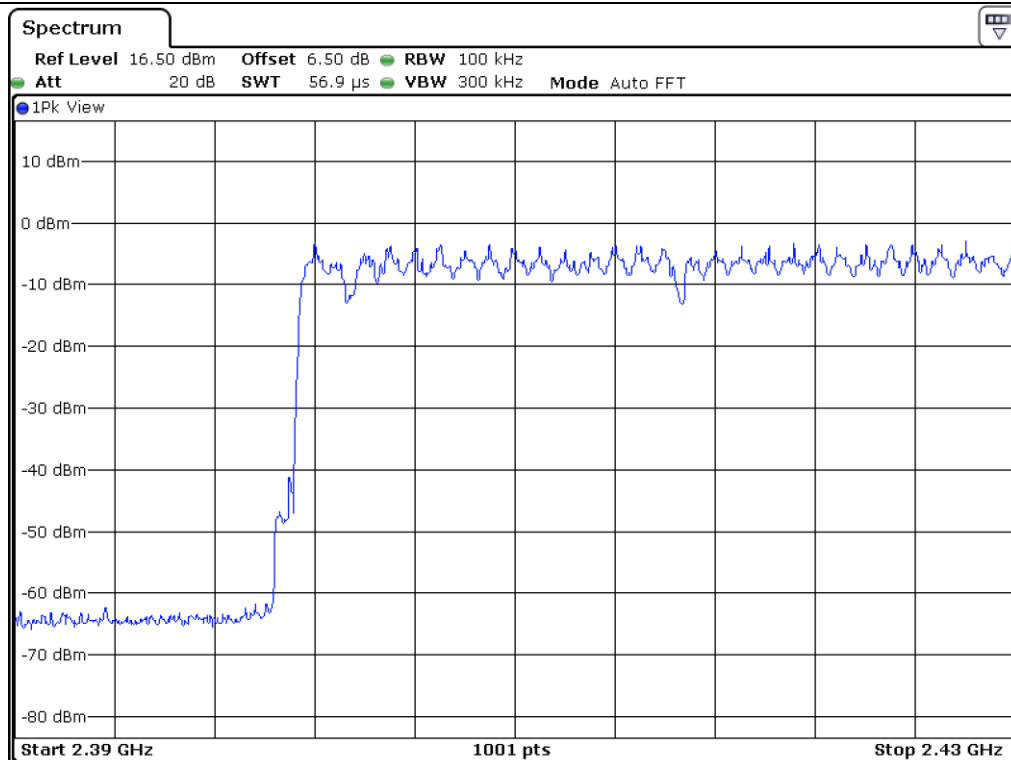
-. Test Result : Pass

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

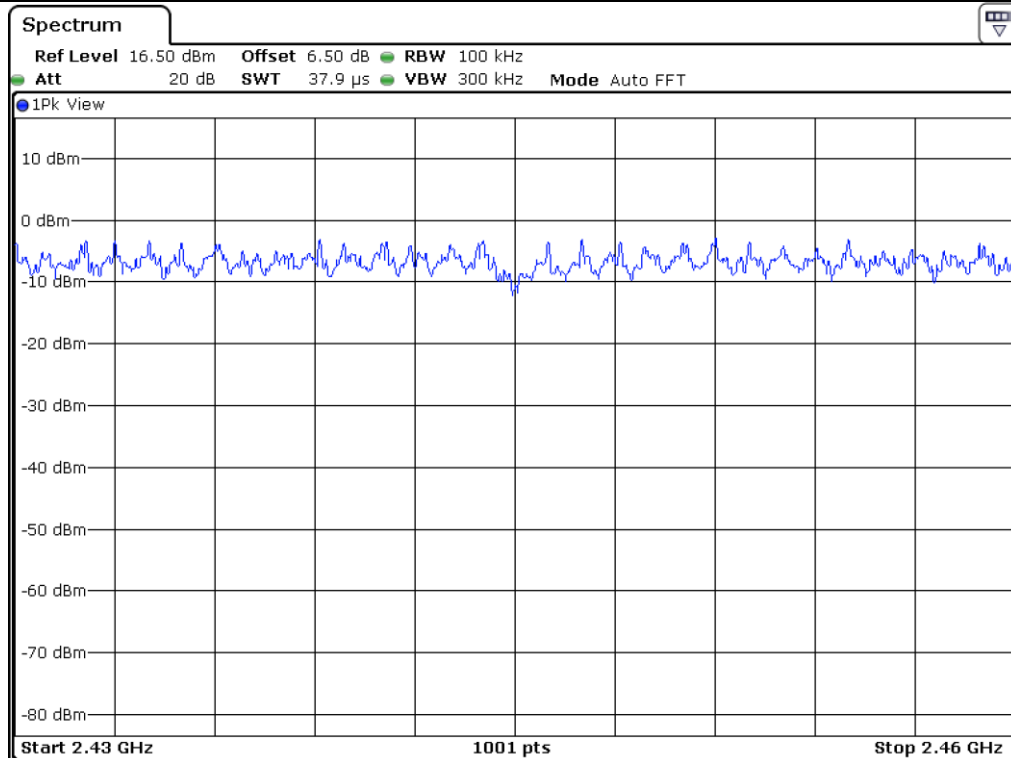


Tested by: Ha-Ram Lee / Assistant Manager

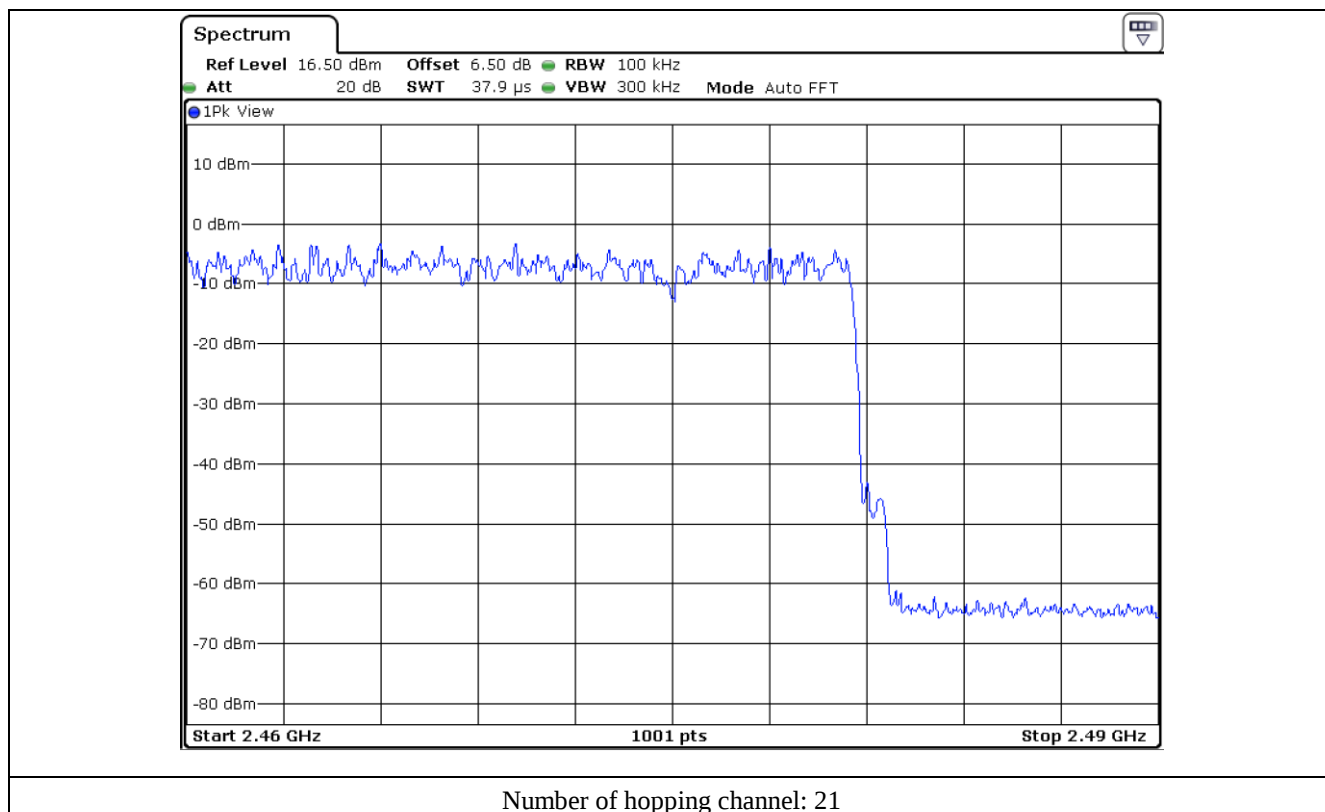




Number of hopping channel: 28



Number of hopping channel: 30



9.6 Test data for 3 Mbps

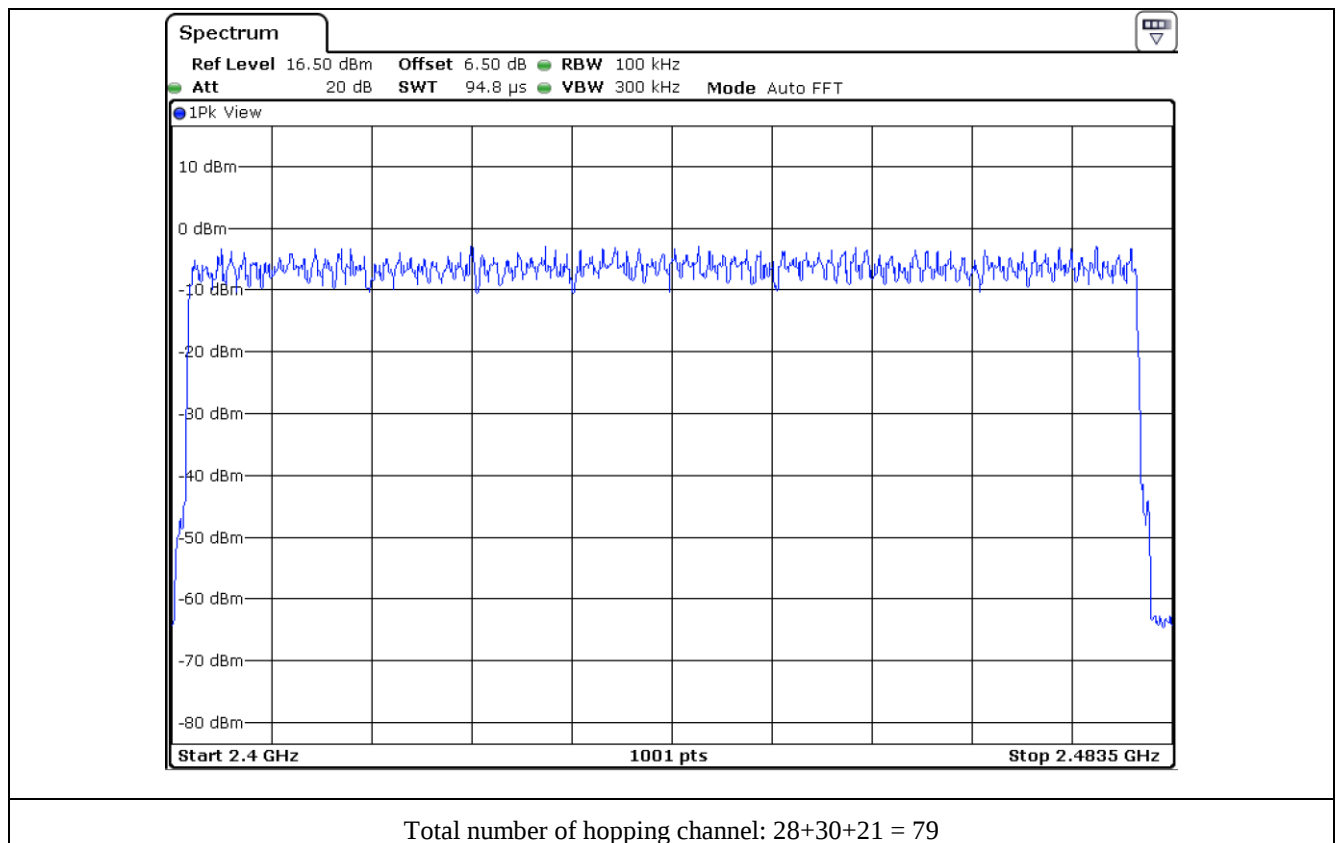
-. Test Date : February 18, 2019

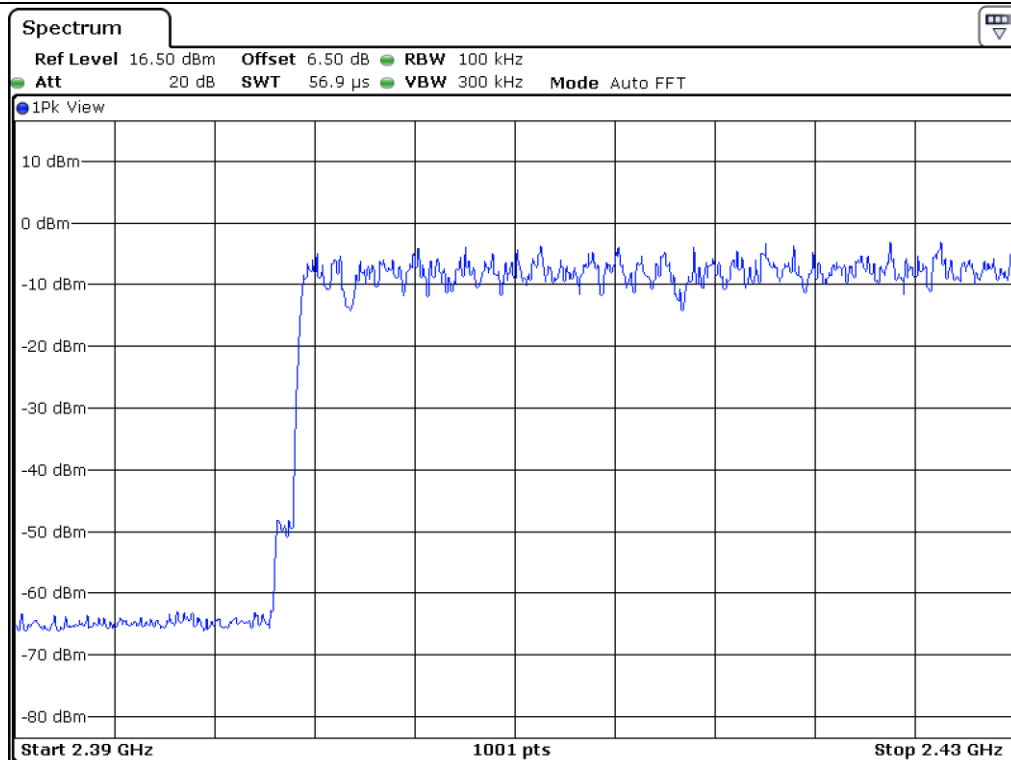
-. Test Result : Pass

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

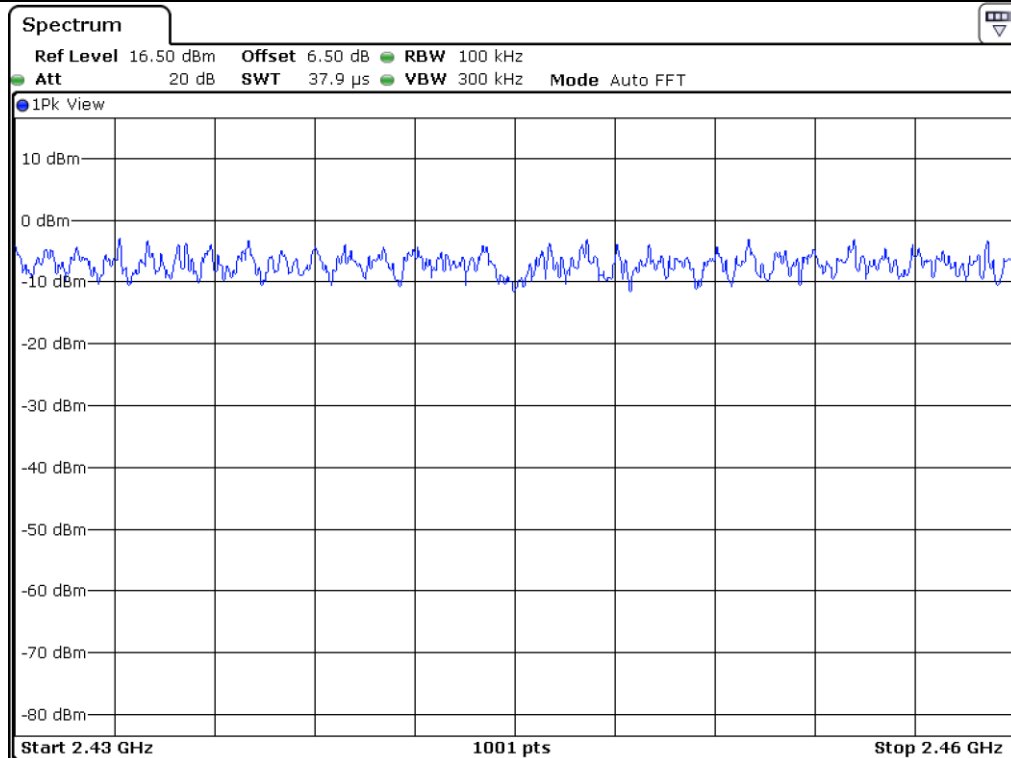


Tested by: Ha-Ram Lee / Assistant Manager

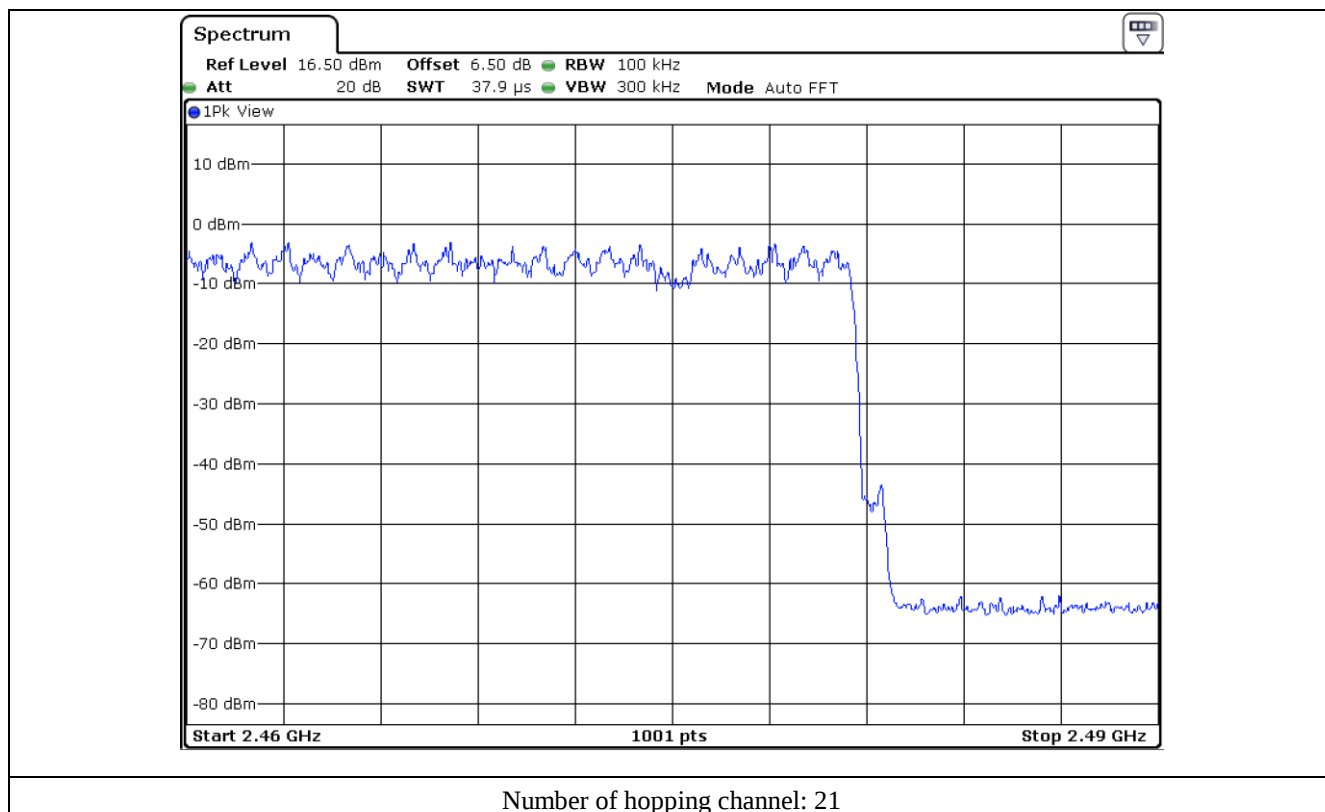




Number of hopping channel: 28



Number of hopping channel: 30



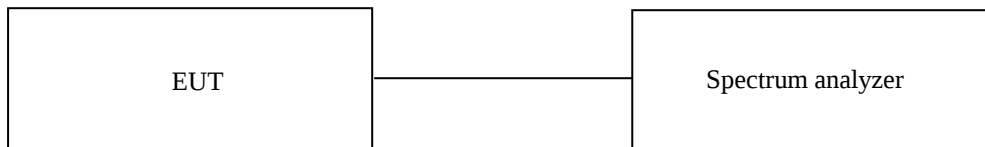
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 24 °C
Relative humidity : 45 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.



10.3 Test 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 : February 18, 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 (s)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.380	10.13	31.6	121.64	400	PASS
DH3	1.640	5.060	31.6	262.23	400	
DH5	2.890	3.38	31.6	308.68	400	

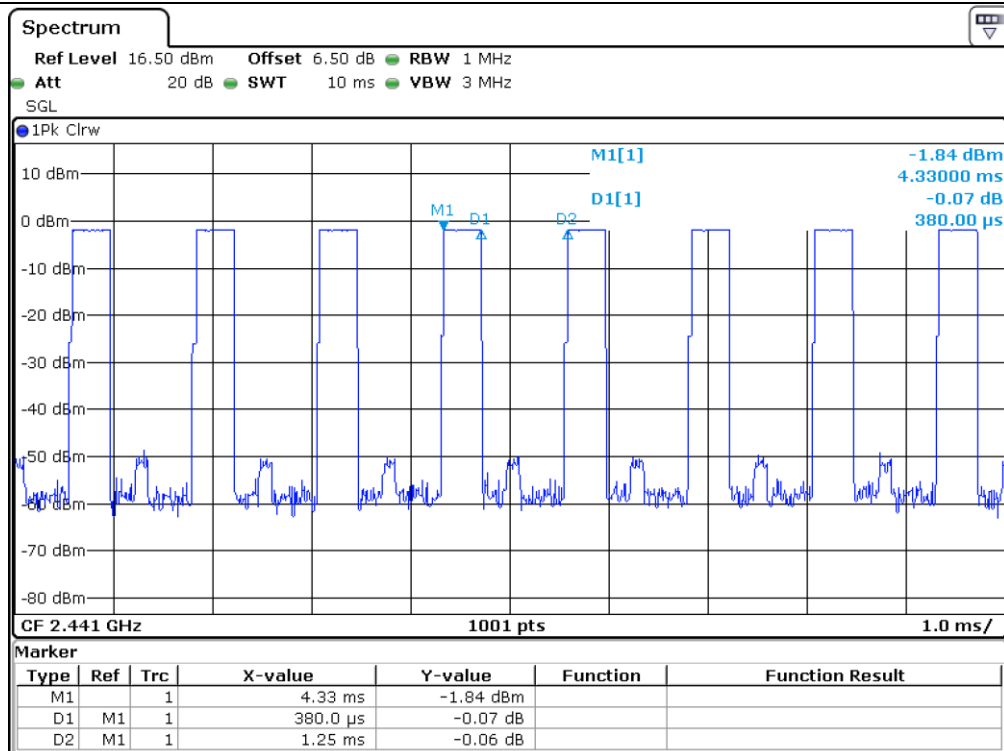
Total dwell time is calculated as following.

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

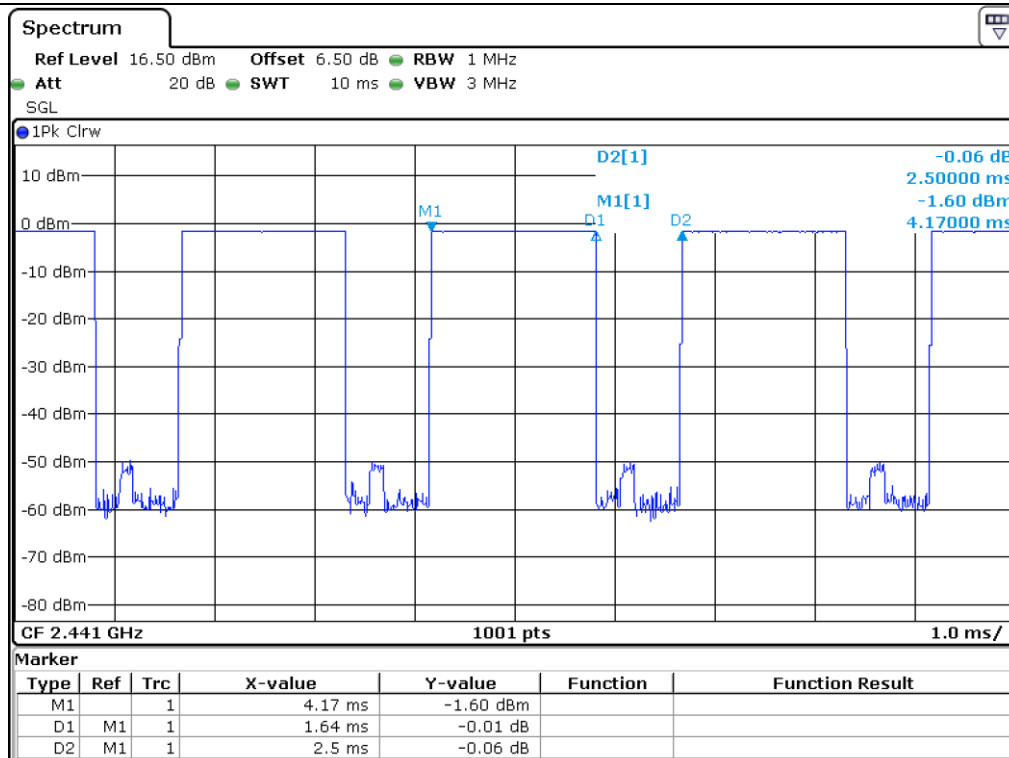
Remark: See next page for an overview sweep performed with peak detector.



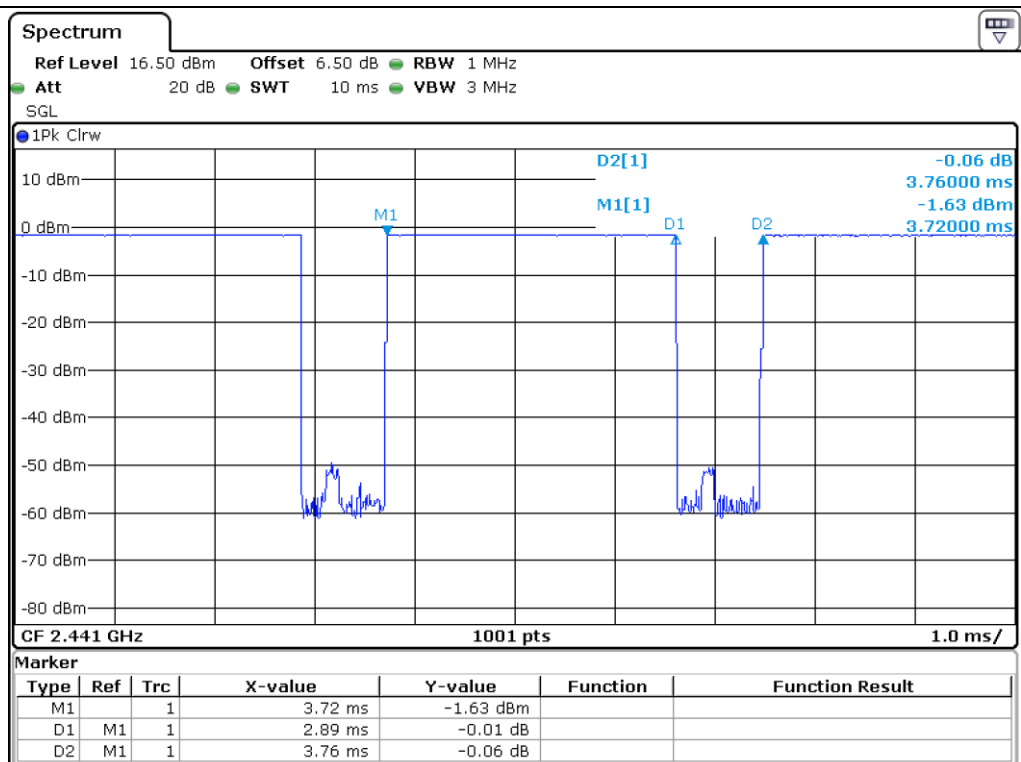
Tested by: Ha-Ram Lee / Assistant Manager



DH1



DH3



DH5

10.5 Test data for 2 Mbps

-. Test Date : February 18, 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 2-DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for 2-DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and 2-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 2-DH1, and 5.06 times ($= 1\,600/4/79$) for 2-DH3, and 3.38 times ($= 1\,600/6/79$) for 2-DH5.

Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (s)	Total Dwell Time (ms)	Limit (ms)	Test Result
2-DH1	0.390	10.13	31.6	124.84	400	PASS
2-DH3	1.640	5.060	31.6	262.23	400	
2-DH5	2.890	3.38	31.6	308.68	400	

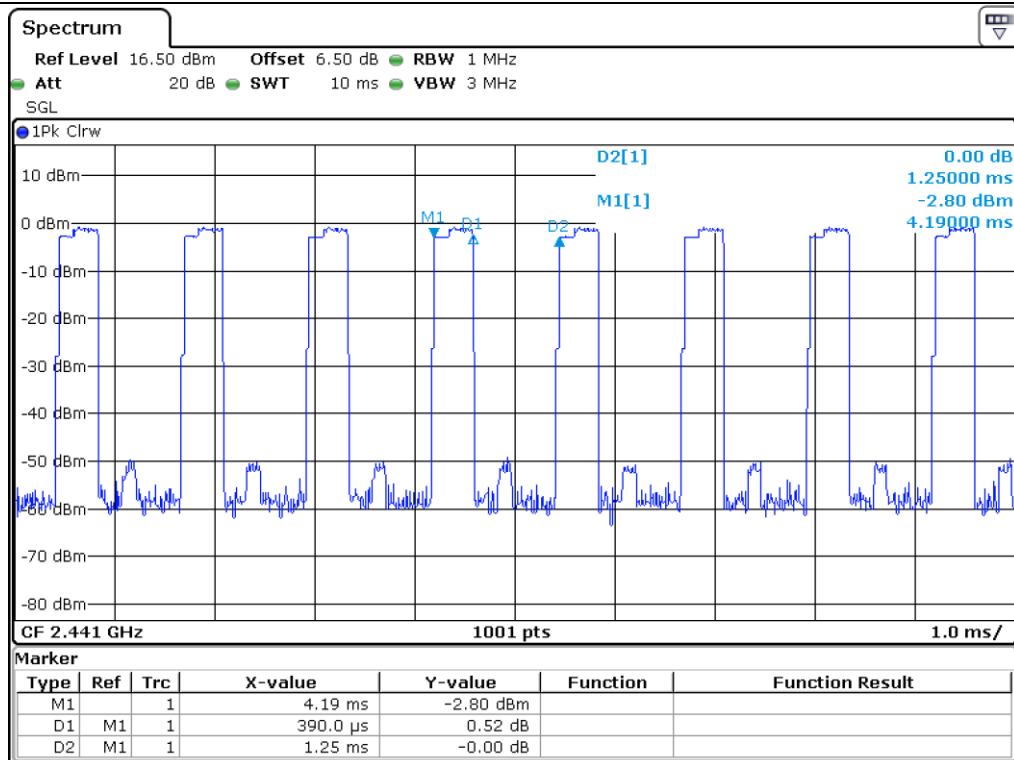
Total dwell time is calculated as following.

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

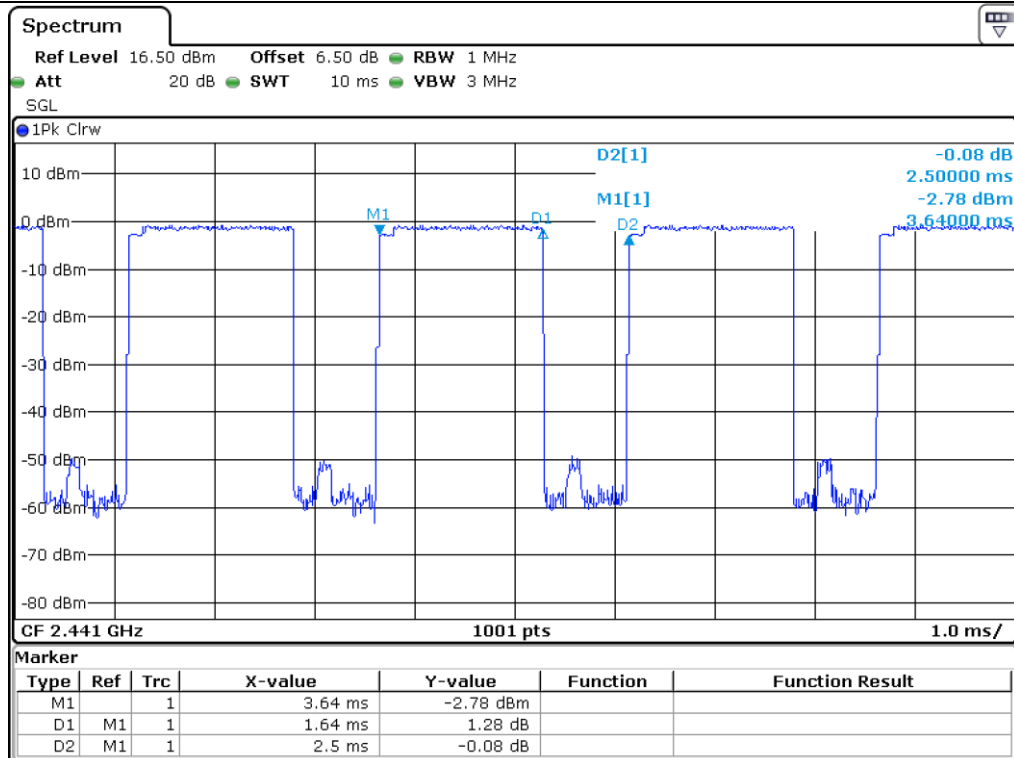
Remark: See next page for an overview sweep performed with peak detector.



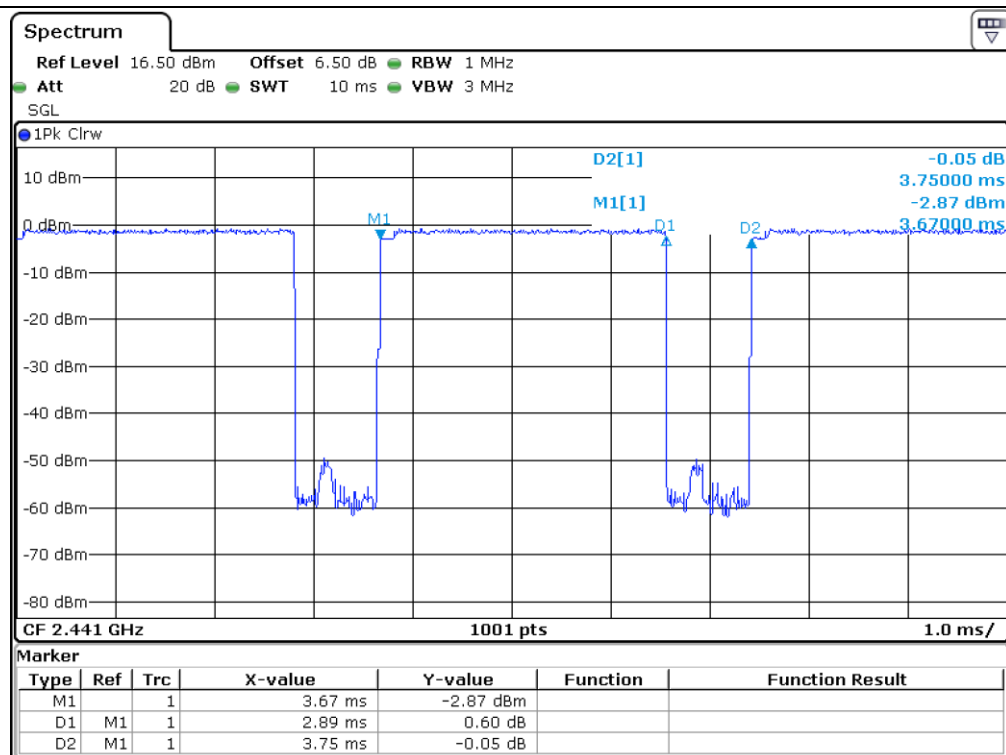
Tested by: Ha-Ram Lee / Assistant Manager



2-DH1



2-DH3



2-DH5

10.6 Test data for 3 Mbps

-. Test Date : February 18, 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 3-DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for 3-DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and 3-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 3-DH1, and 5.06 times ($= 1\,600/4/79$) for 3-DH3, and 3.38 times ($= 1\,600/6/79$) for 3-DH5.

Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (s)	Total Dwell Time (ms)	Limit (ms)	Test Result
3-DH1	0.390	10.13	31.6	124.84	400	PASS
3-DH3	1.640	5.060	31.6	262.23	400	
3-DH5	2.890	3.38	31.6	308.68	400	

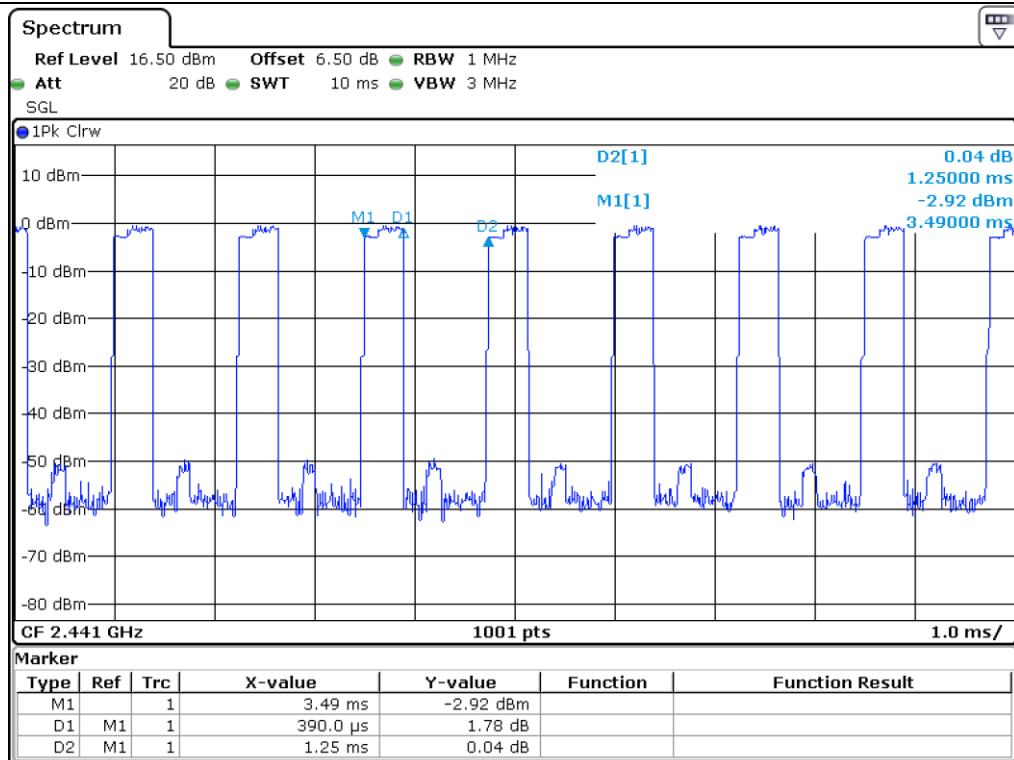
Total dwell time is calculated as following.

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

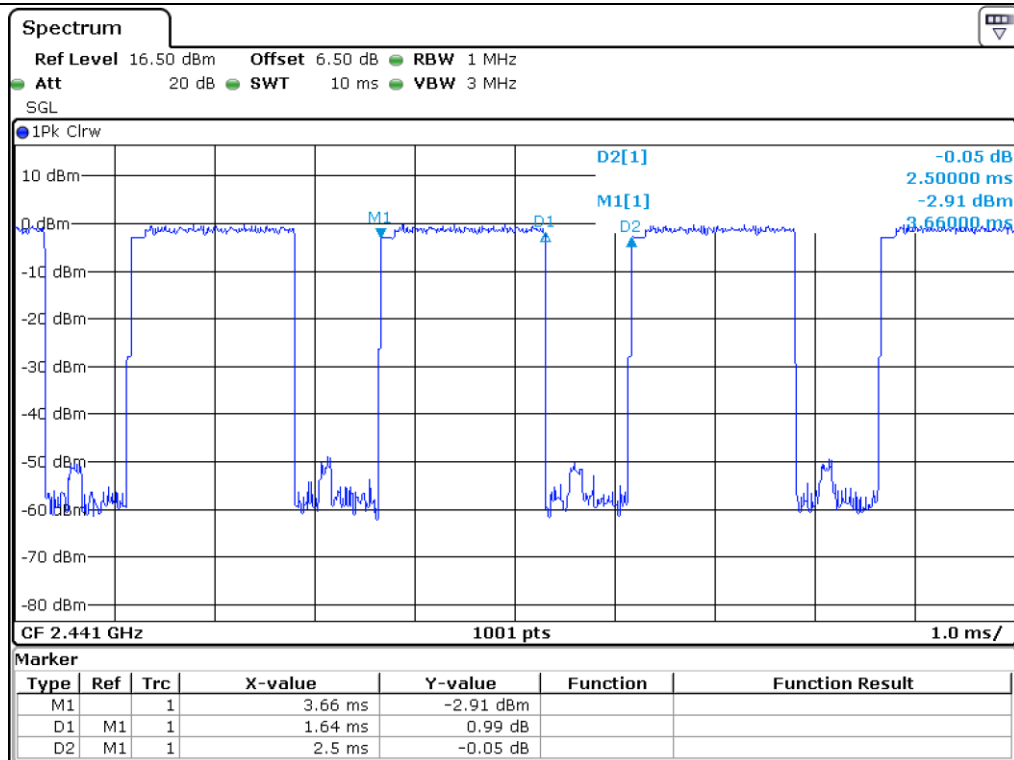
Remark: See next page for an overview sweep performed with peak detector.



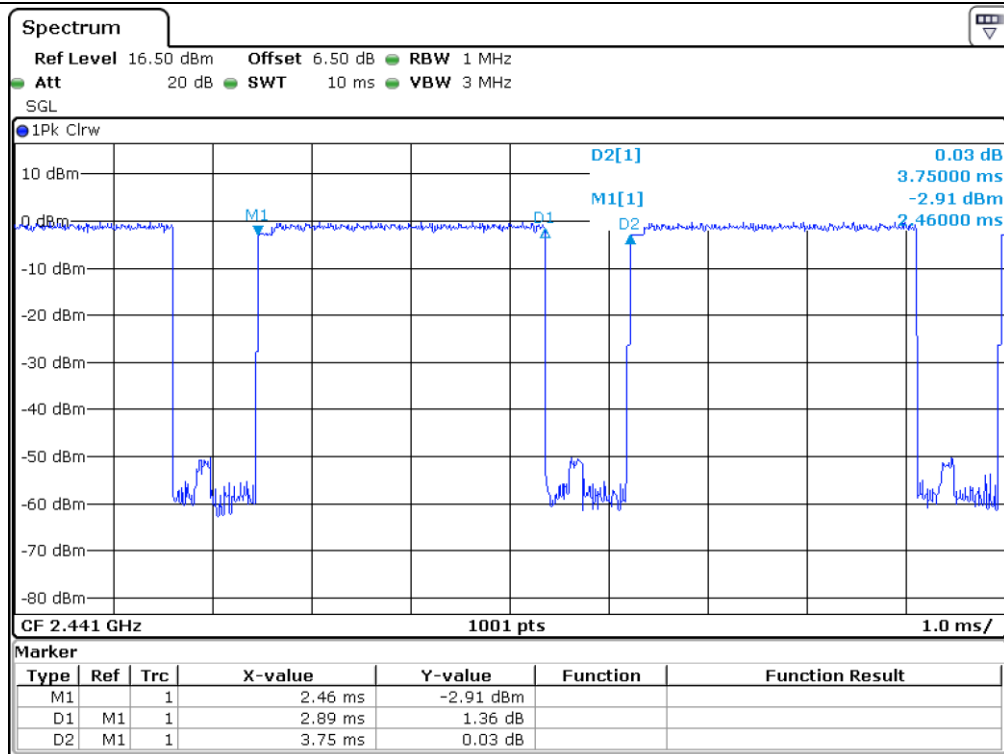
Tested by: Ha-Ram Lee / Assistant Manager



3-DH1



3-DH3



3-DH5

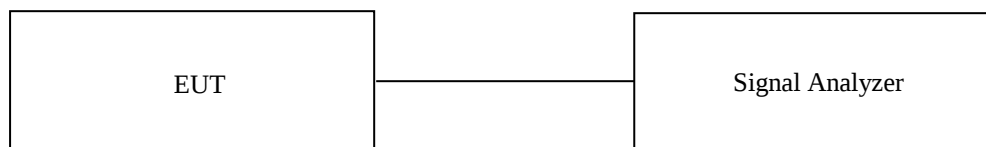
11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

Temperature : 24 °C
Relative humidity : 45 % R.H

11.2 Test set-up

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT.
The EUT was operating in transmit mode at the appropriate center frequency.



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 : February 18, 2019

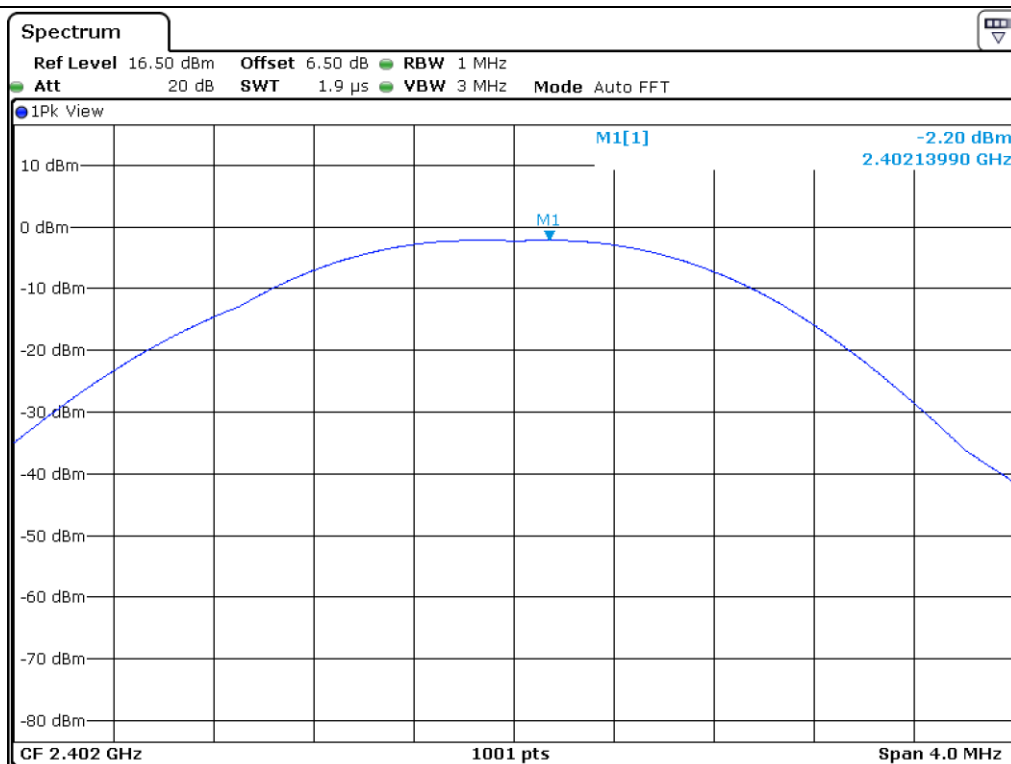
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-2.20	21.00	23.20
MIDDLE	2 441	-1.40	21.00	22.40
HIGH	2 480	-1.73	21.00	22.73

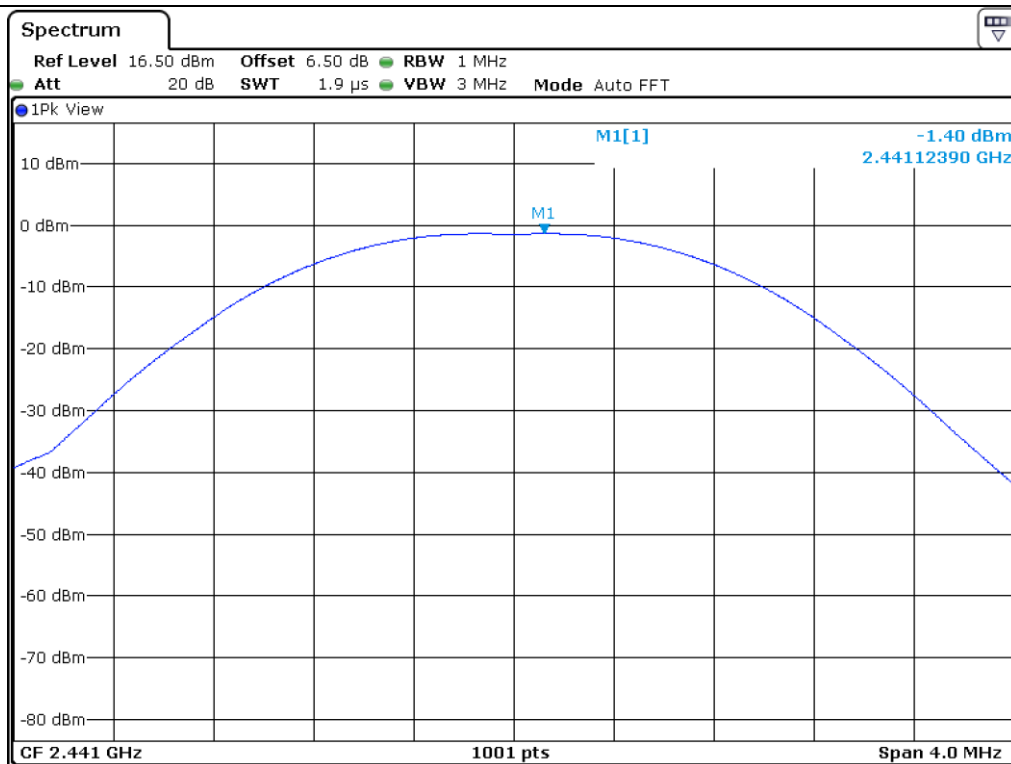
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



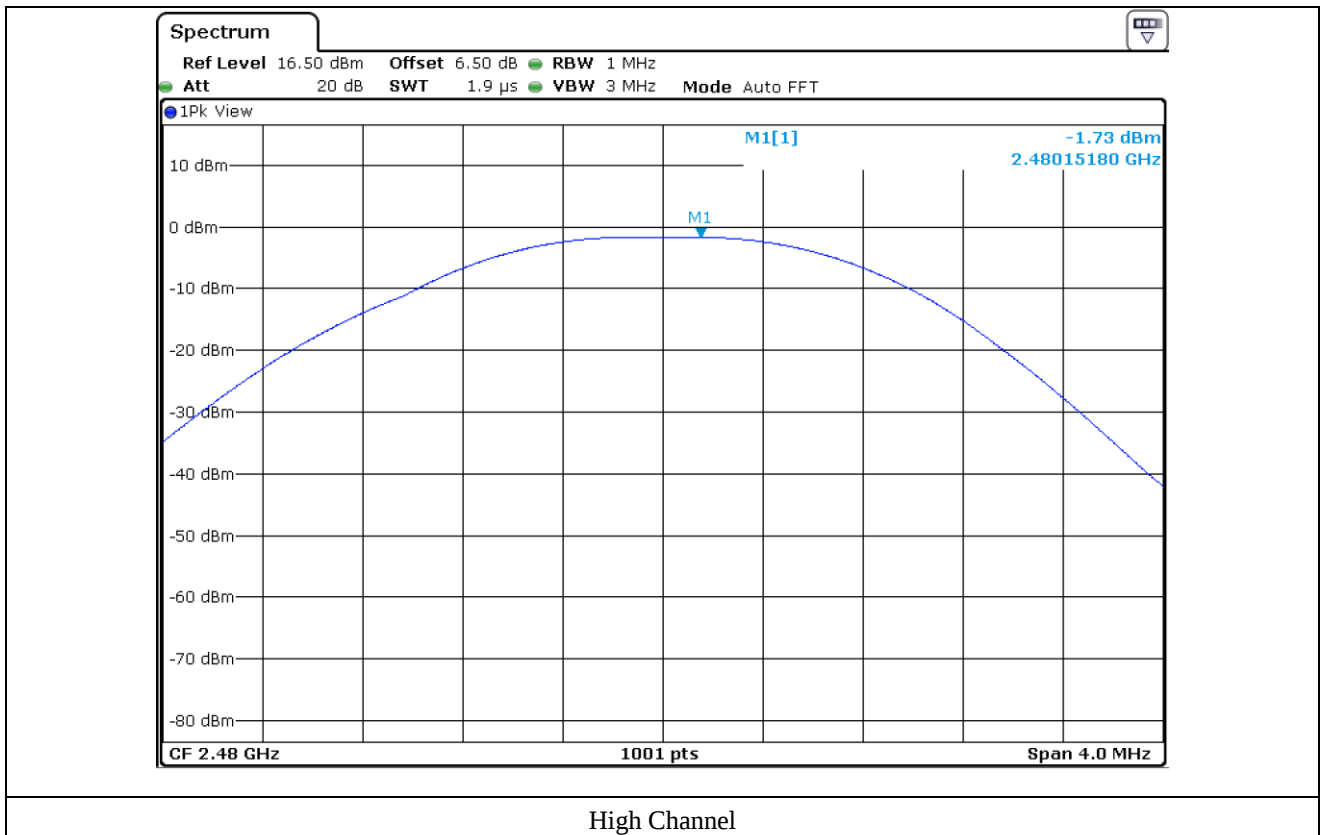
Tested by: Ha-Ram Lee / Assistant Manager



Low Channel



Middle Channel



11.5 Test data for 2 Mbps

-. Test Date : February 18, 2019

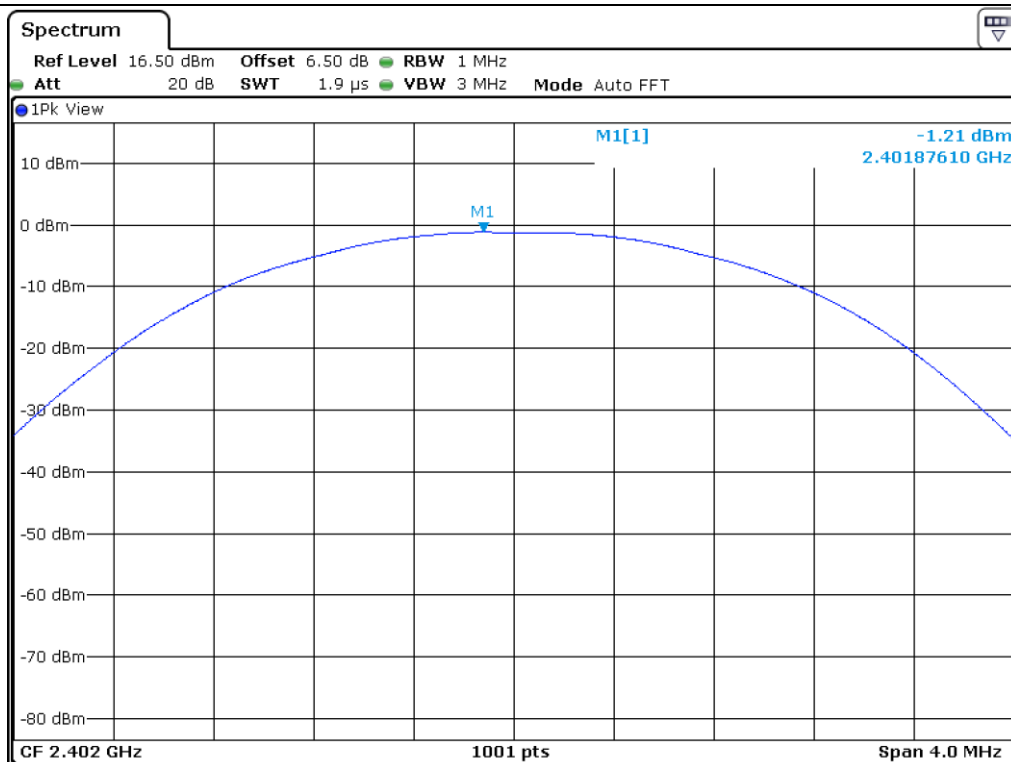
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-1.21	21.00	22.21
MIDDLE	2 441	-0.61	21.00	21.61
HIGH	2 480	-0.88	21.00	21.88

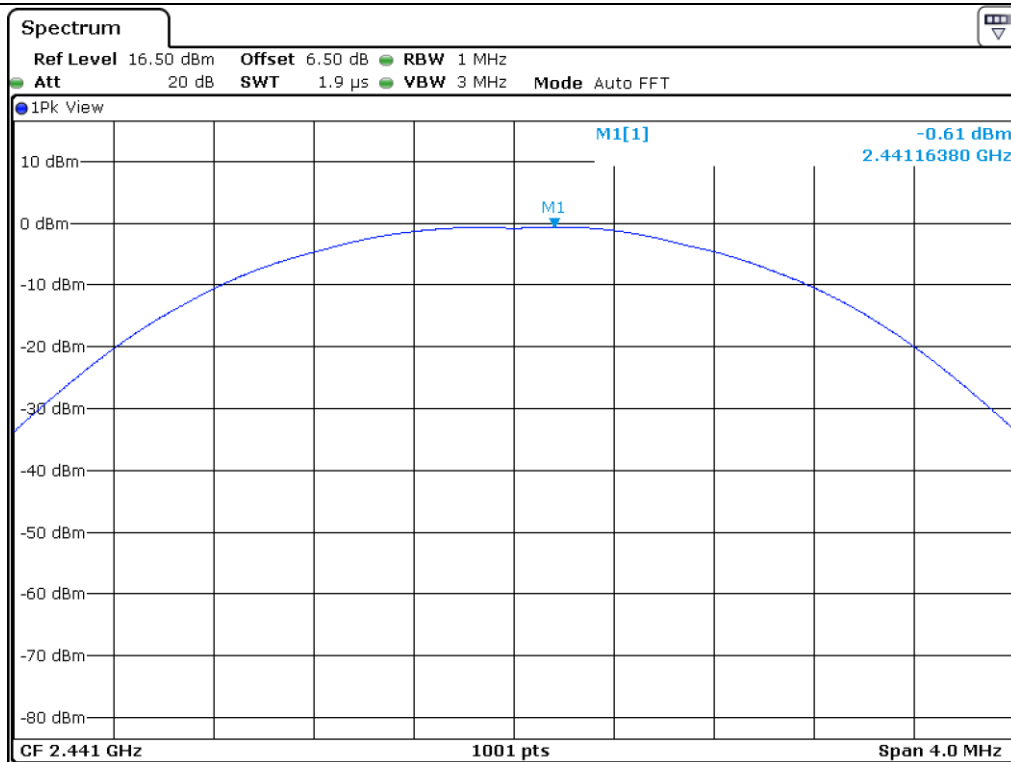
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



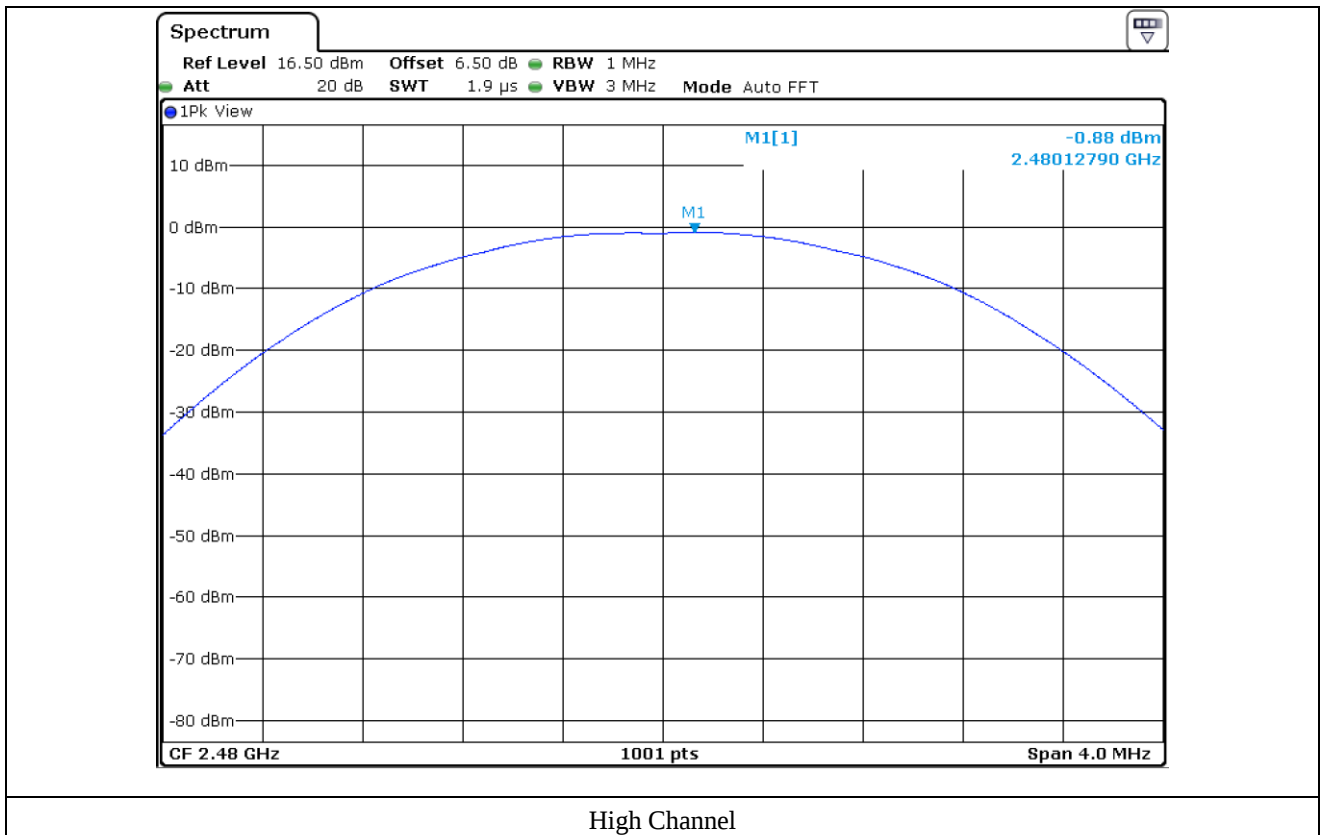
Tested by: Ha-Ram Lee / Assistant Manager



Low Channel



Middle Channel



11.6 Test data for 3 Mbps

-. Test Date : February 18, 2019

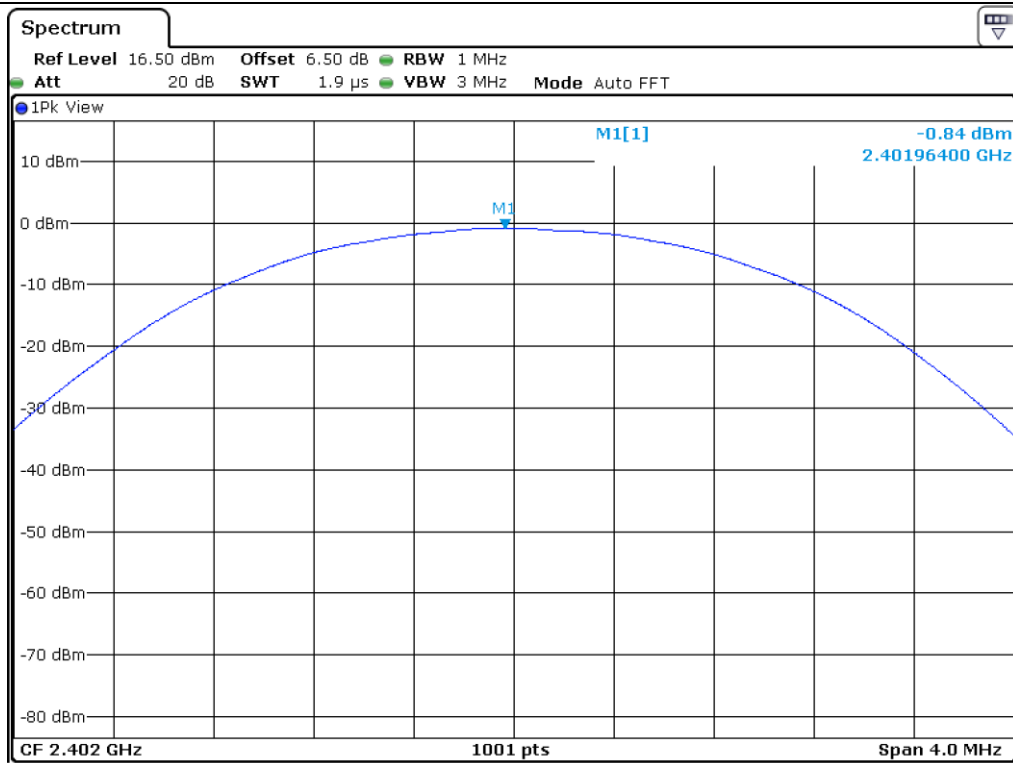
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-0.84	21.00	21.84
MIDDLE	2 441	-0.07	21.00	21.07
HIGH	2 480	-0.34	21.00	21.34

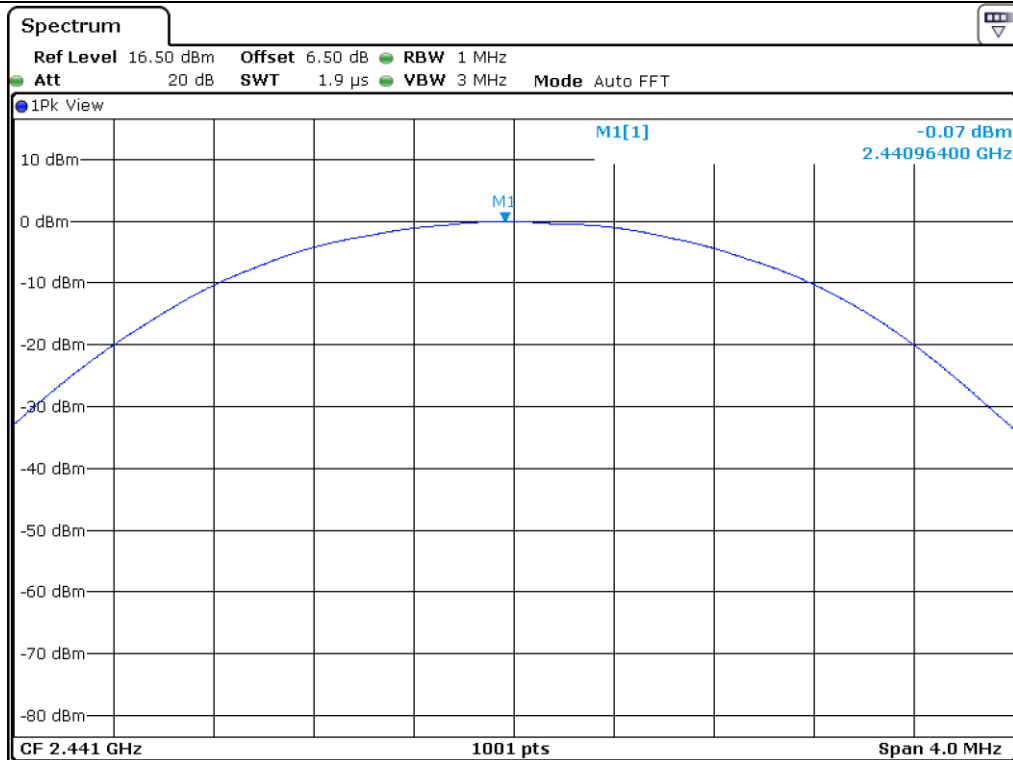
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



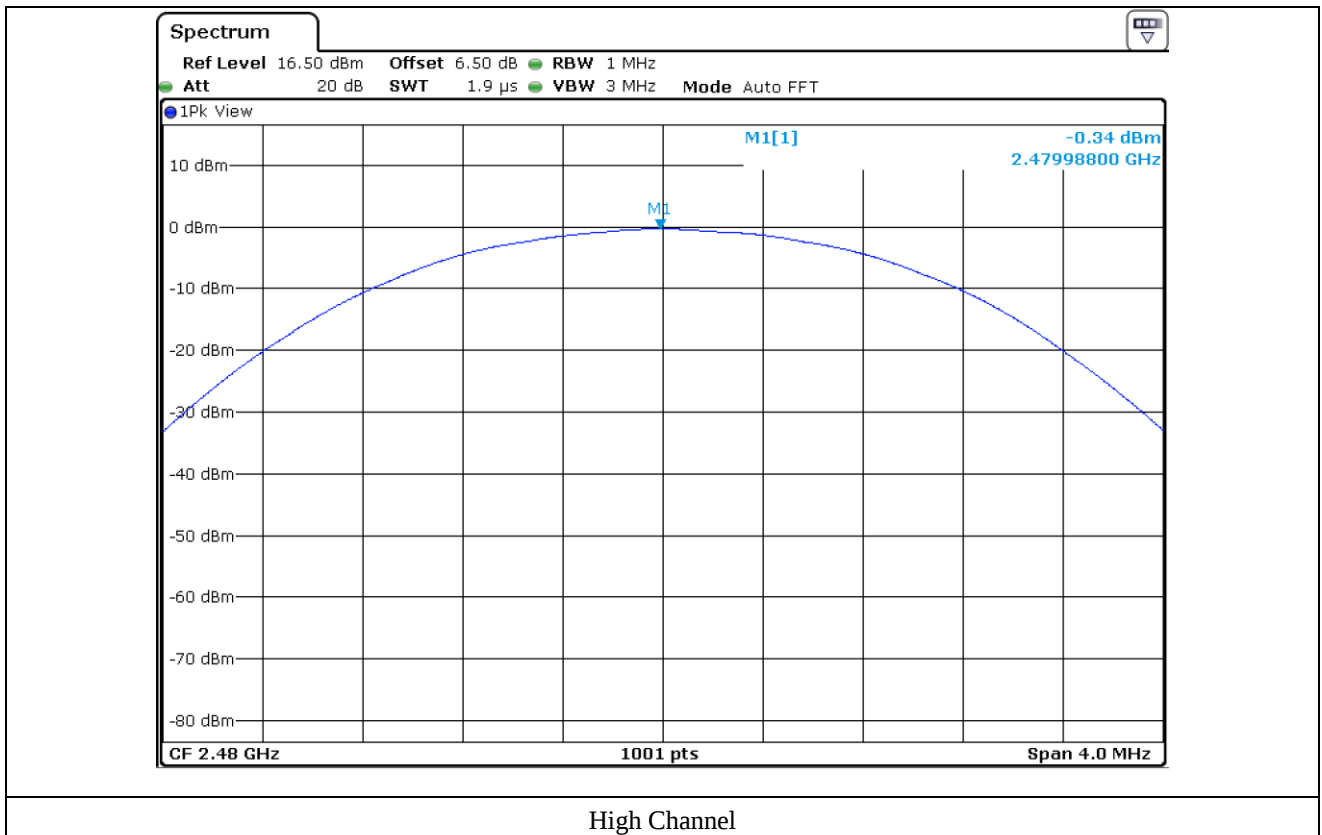
Tested by: Ha-Ram Lee / Assistant Manager



Low Channel



Middle Channel



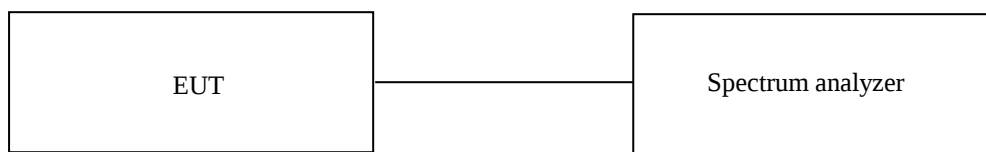
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 24 °C
Relative humidity : 52 % 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, open-field test site. The EUT was placed on a non-conductive turntable approximately 0.8 m above the ground plane.

The frequency spectrum from 30 kHz 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 ms in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

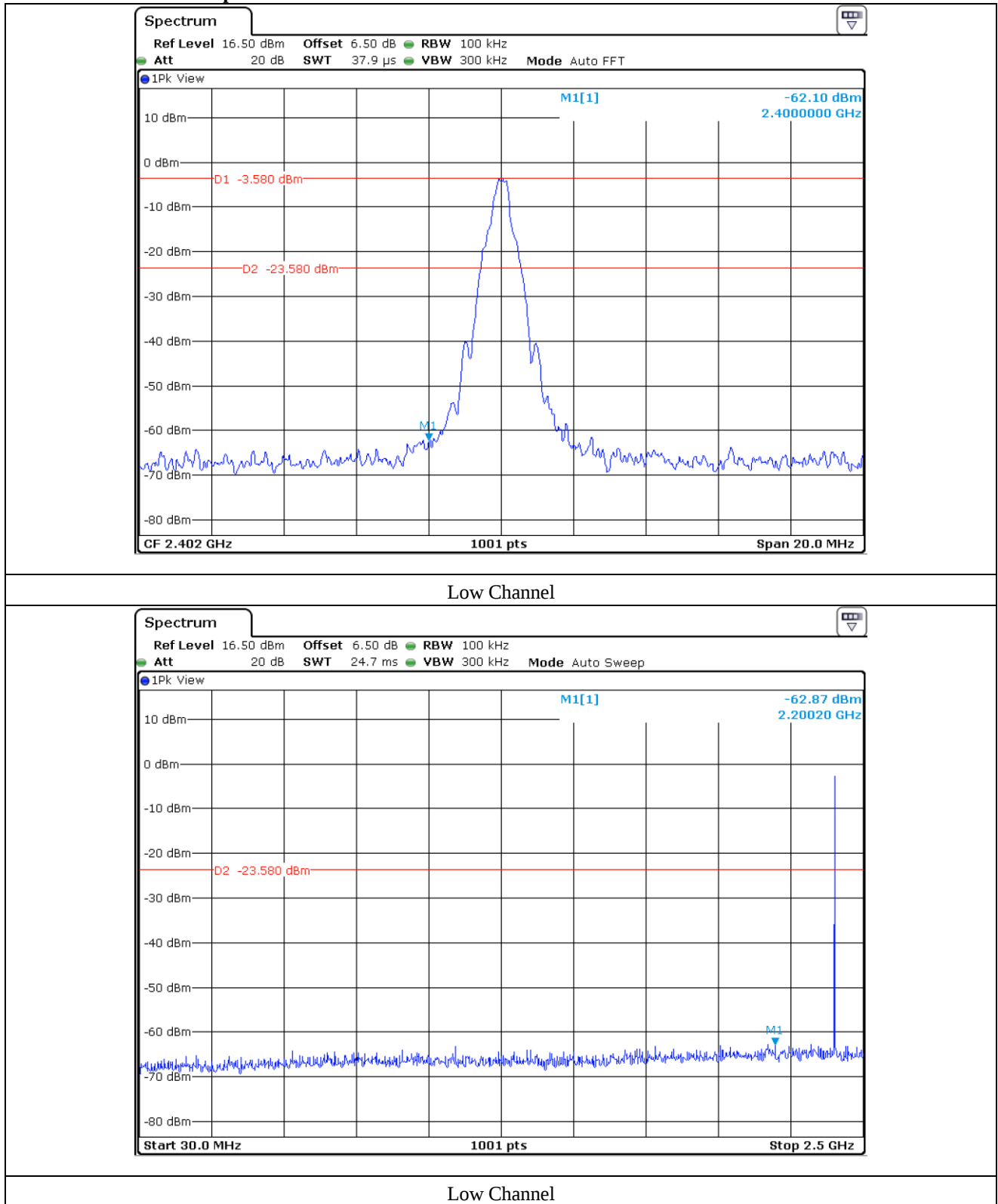
12.4 Test equipment used

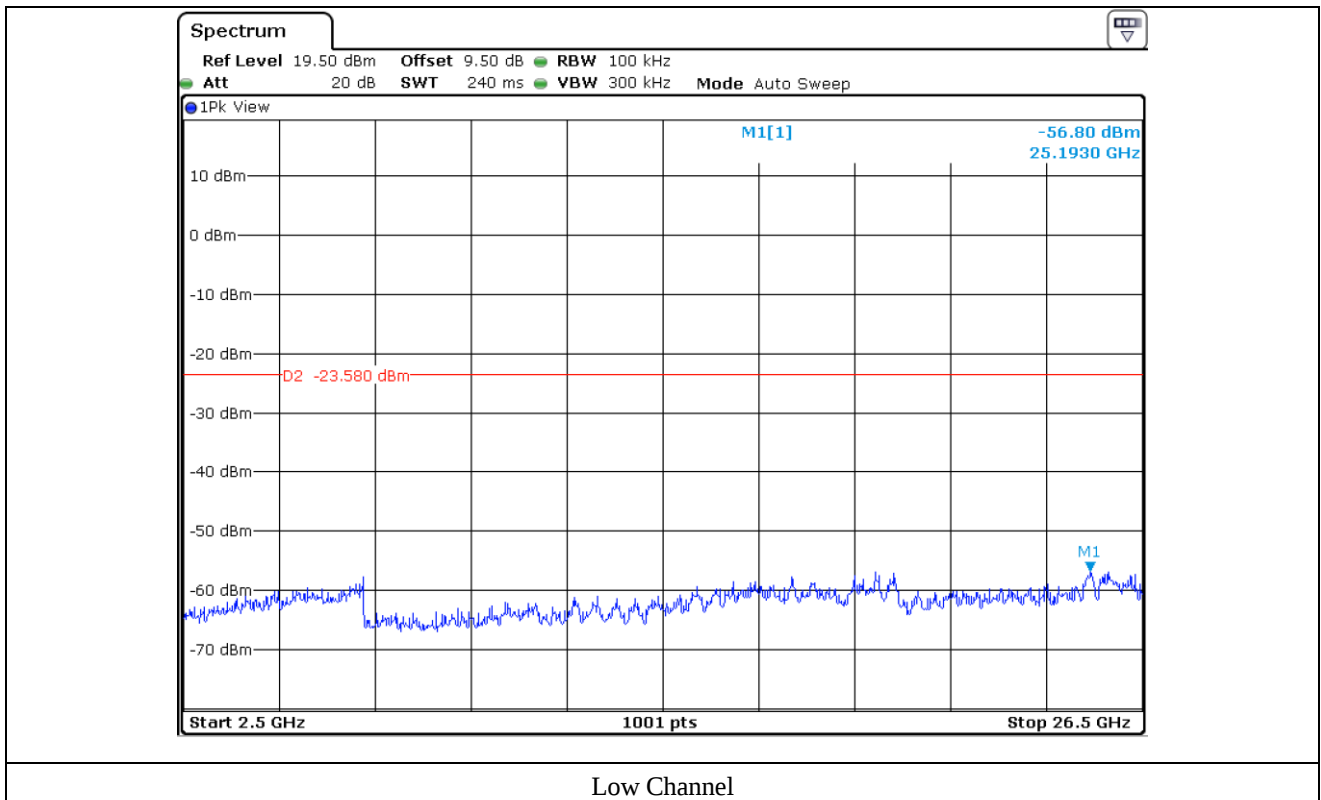
	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
☐ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Mar. 28, 2018 (1Y)
☒ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
☒ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
☐ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug. 23, 2018 (1Y)
☒ -	BBV 9718 B	Schwarzbeck	Broadband Pre-Amplifier	009	Mar. 20, 2019 (1Y)
☒ -	MA240	HD GmbH	Antenna Master	N/A	N/A
☐ -	HD100	HD GmbH	Position Controller	N/A	N/A
☒ -	DS420S	HD GmbH	Turn Table	N/A	N/A
☐ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May. 13, 2018 (2Y)
☒ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	Jun. 05, 2018 (2Y)
☒ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
☐ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Dec. 04, 2017 (2Y)
☐ -	83051A	Agilent	Microwave System Preamplifier	3950M00201	Mar. 15, 2018 (1Y)

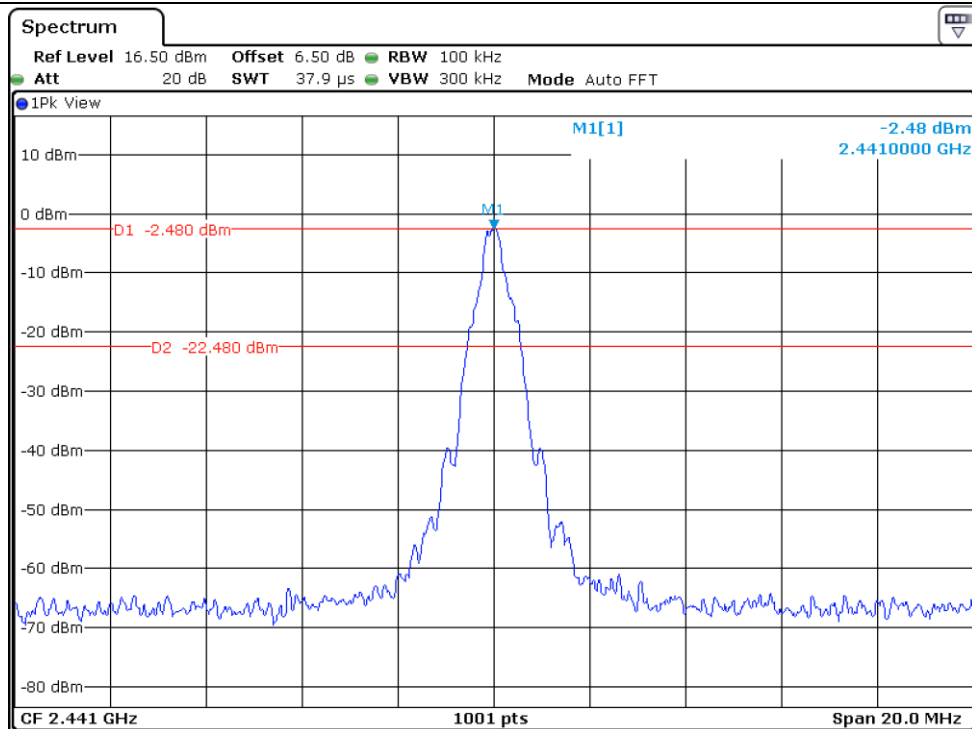
All test equipment used is calibrated on a regular basis.

12.5 Test data for conducted emission

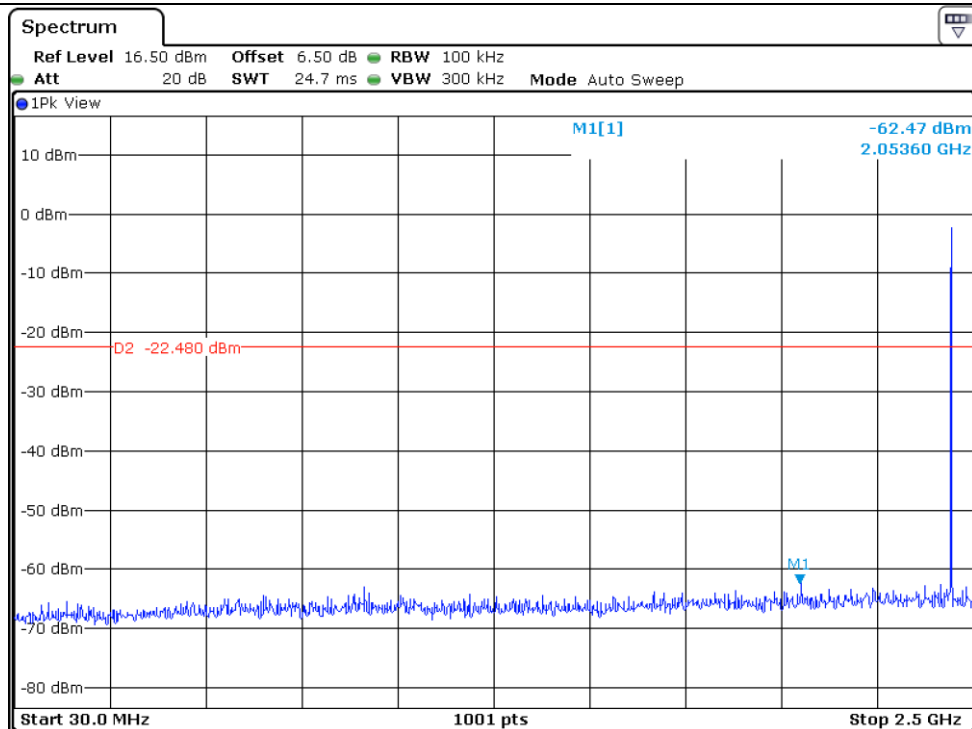
12.5.1 Test data for 1 Mbps



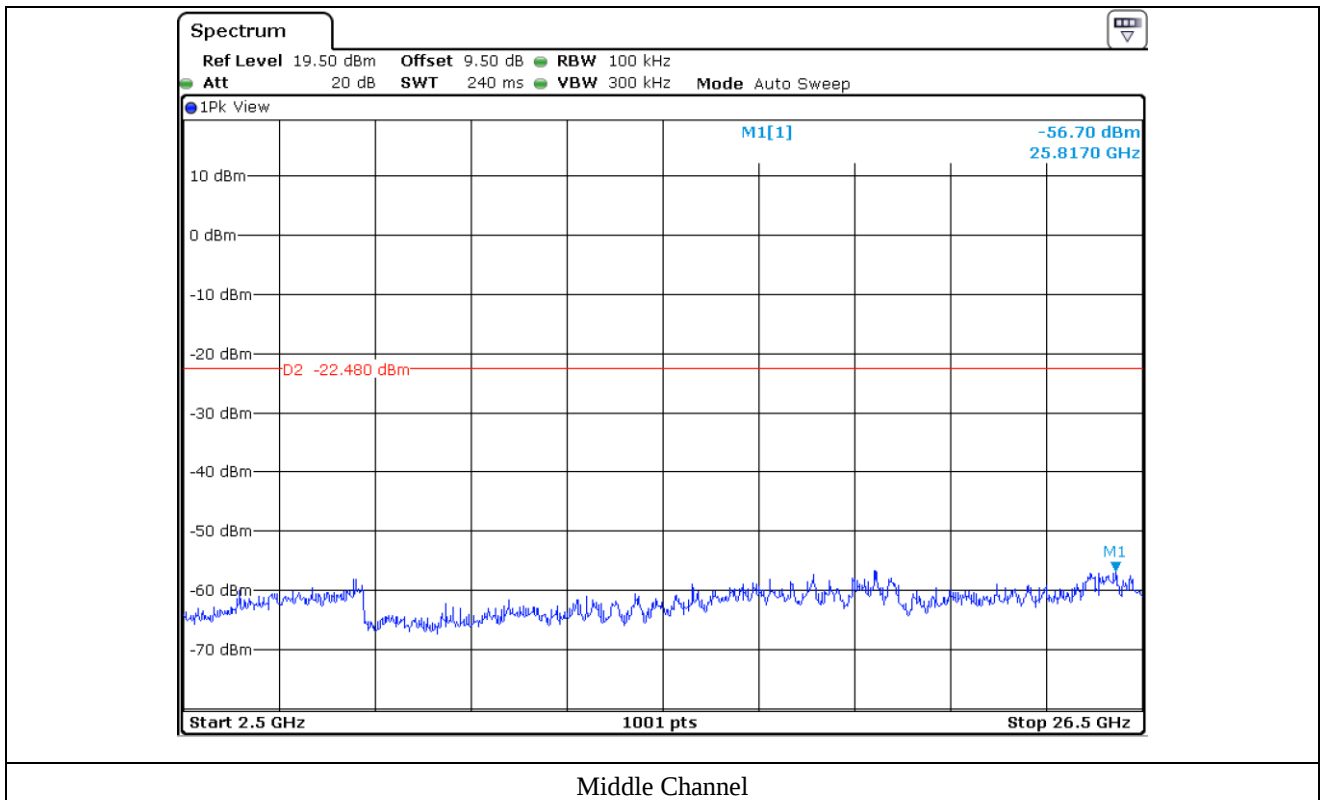


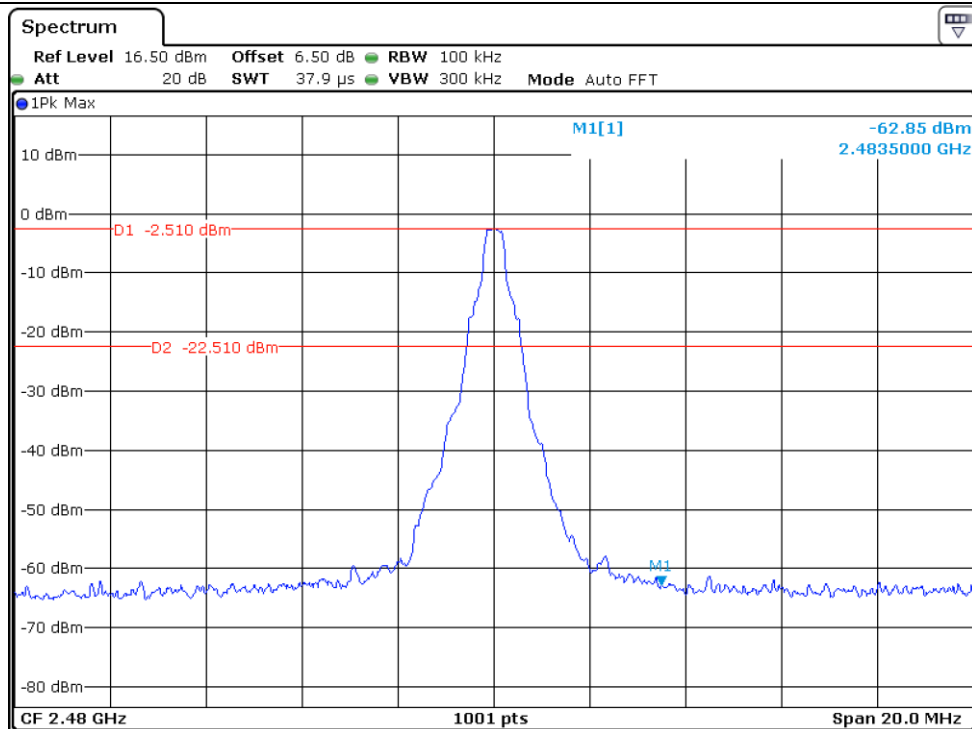


Middle Channel

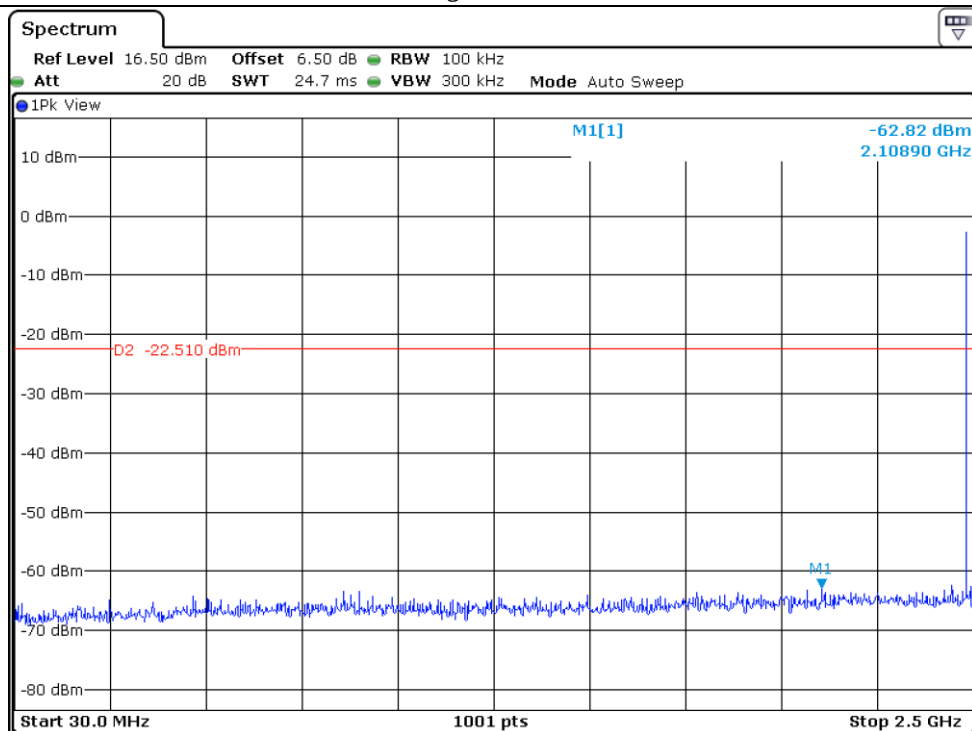


Middle Channel

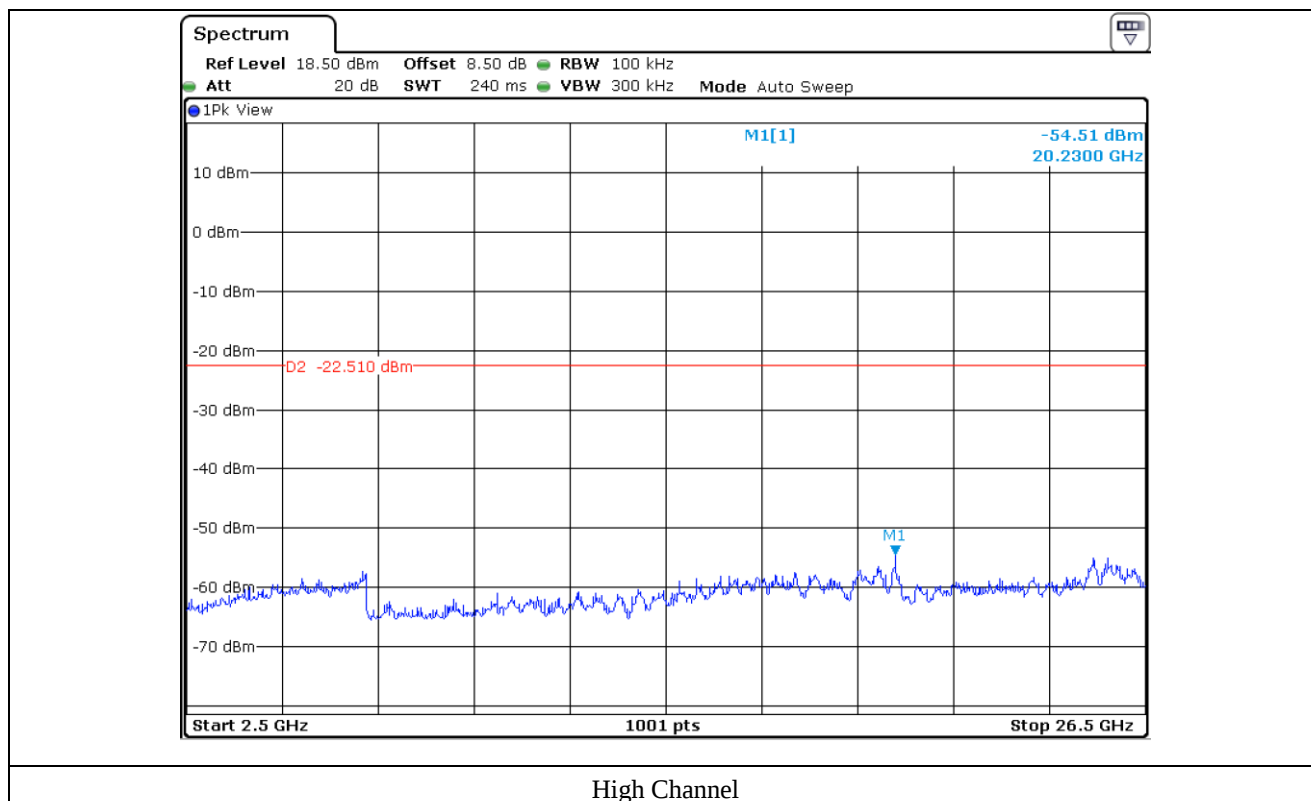




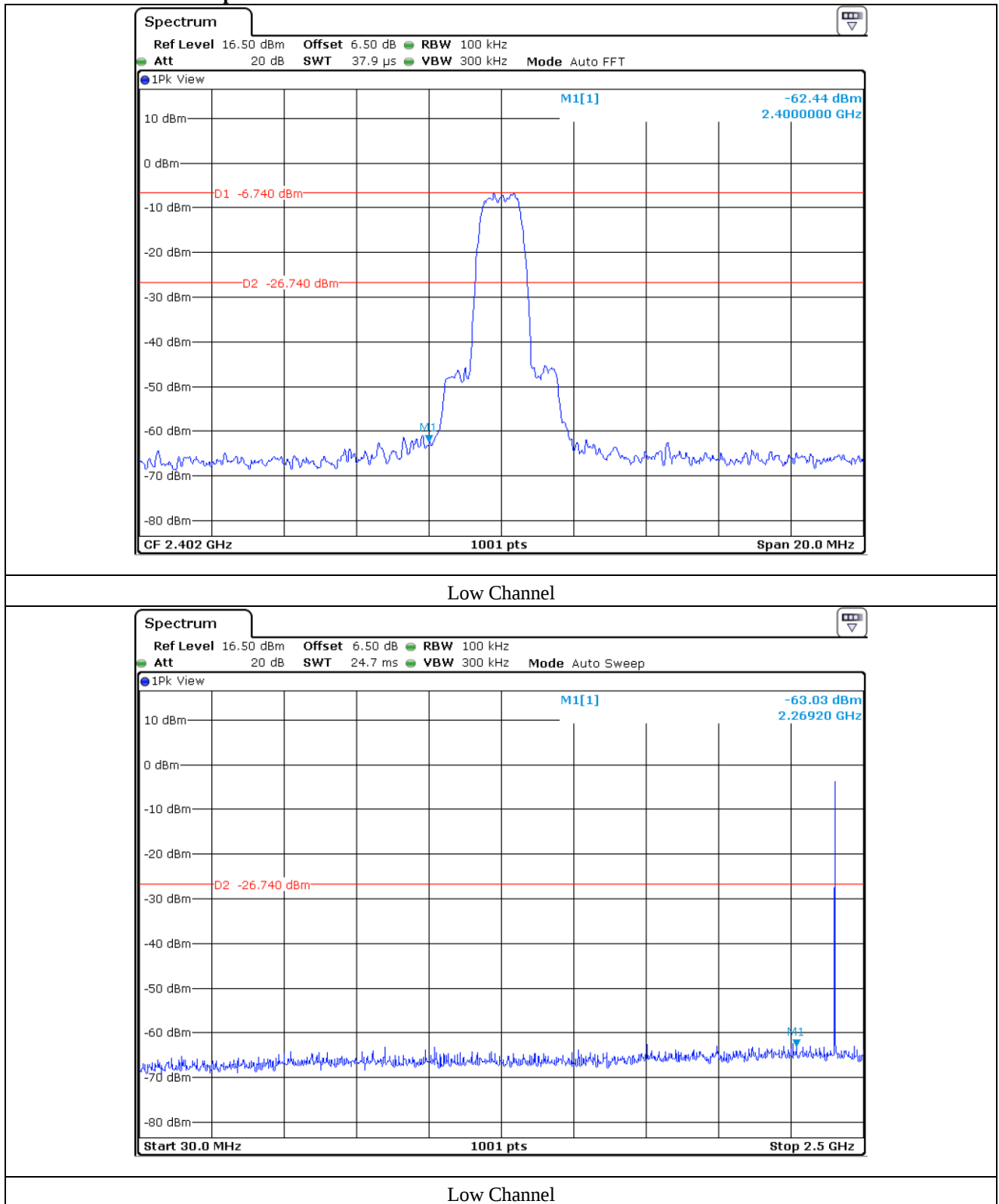
High Channel

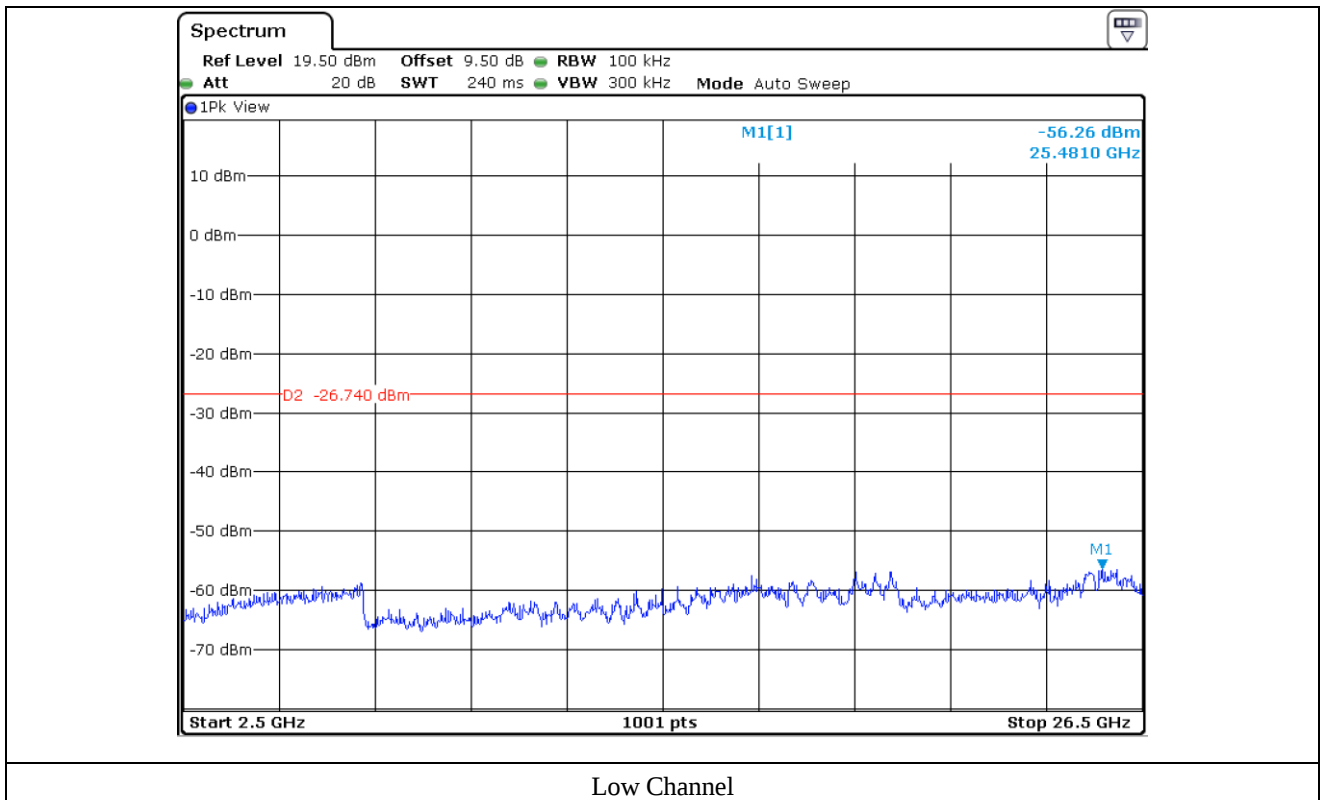


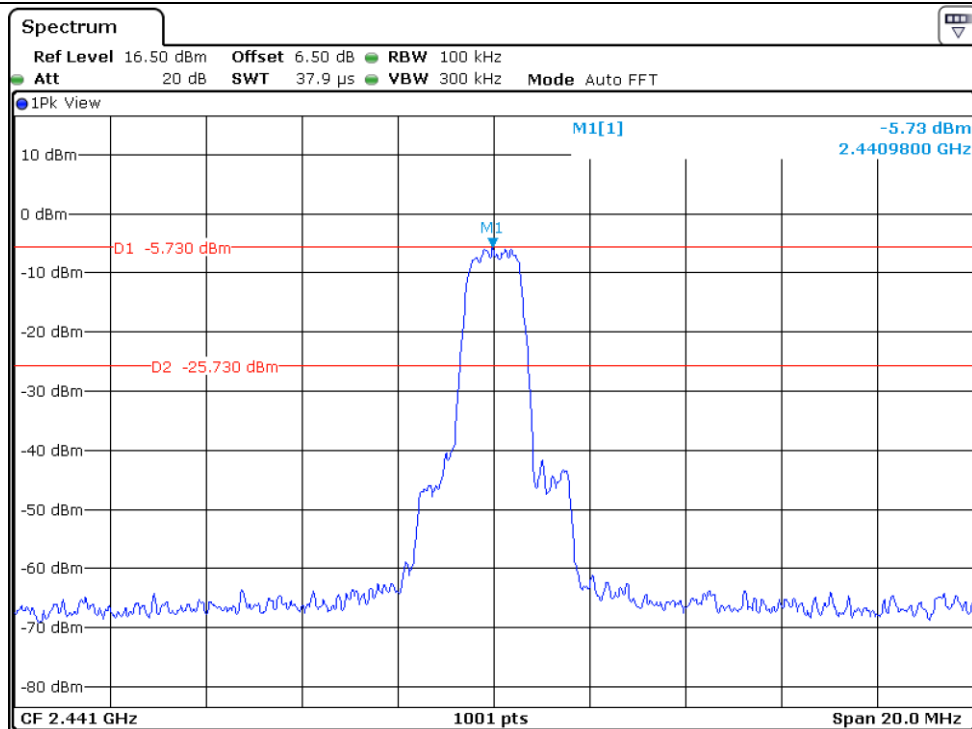
High Channel



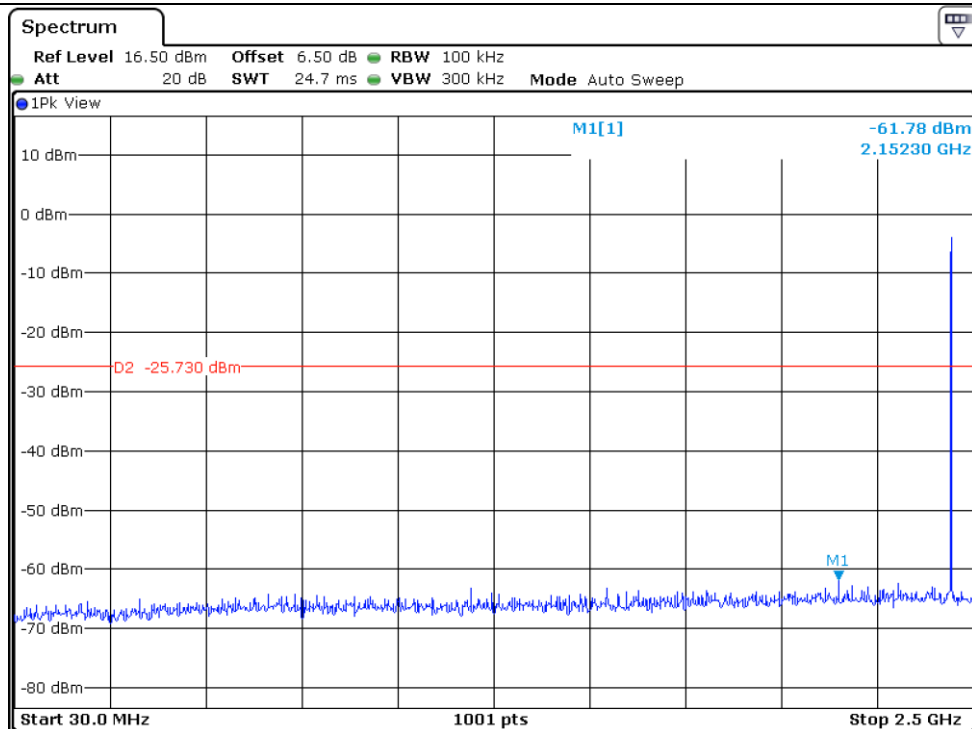
12.5.2 Test data for 2 Mbps



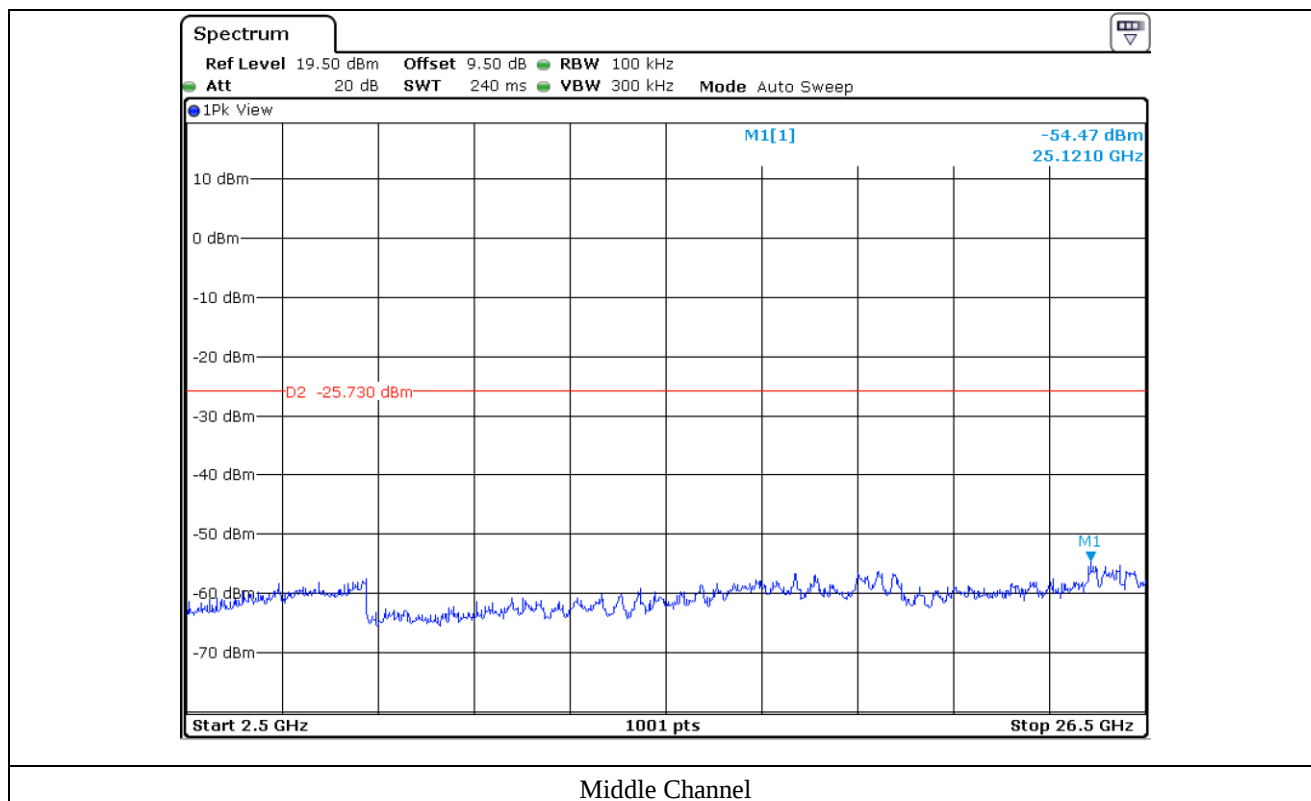


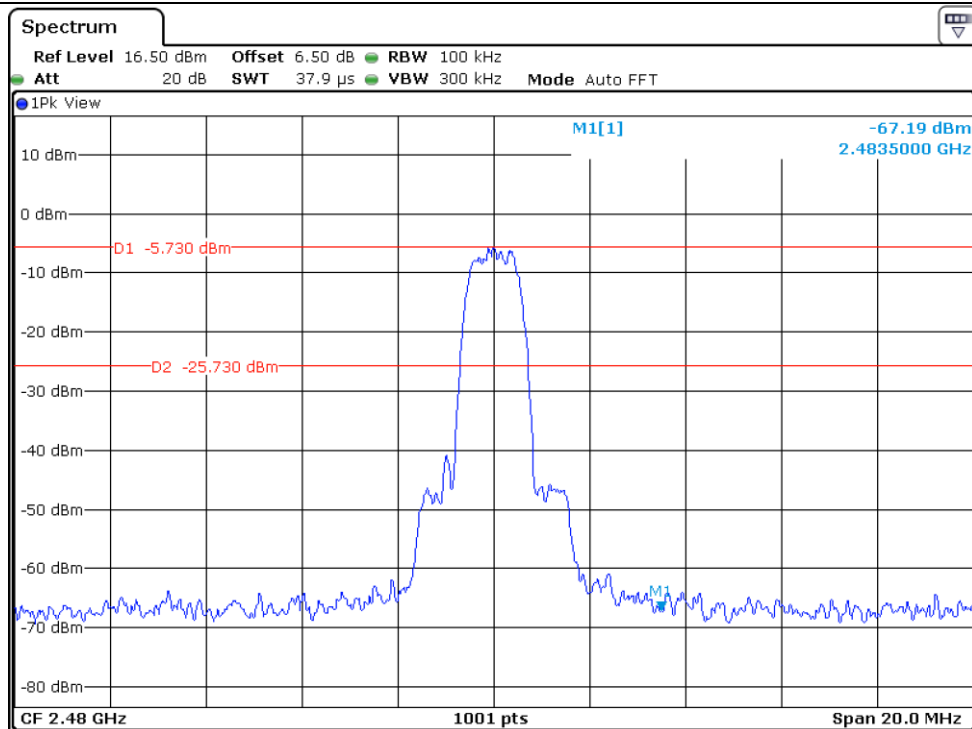


Middle Channel

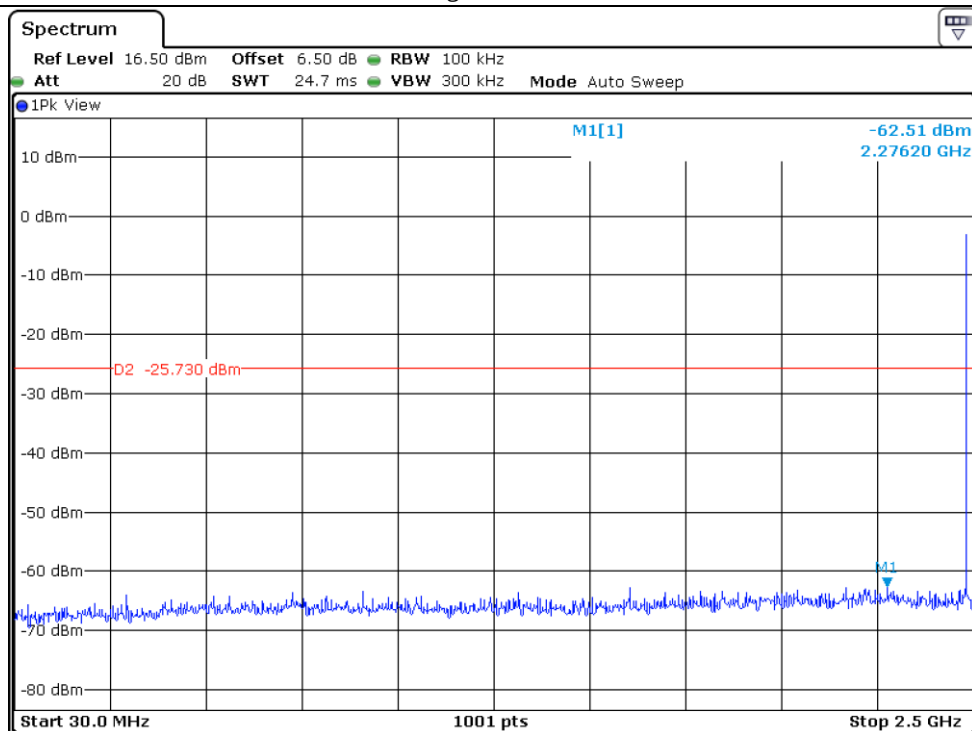


Middle Channel

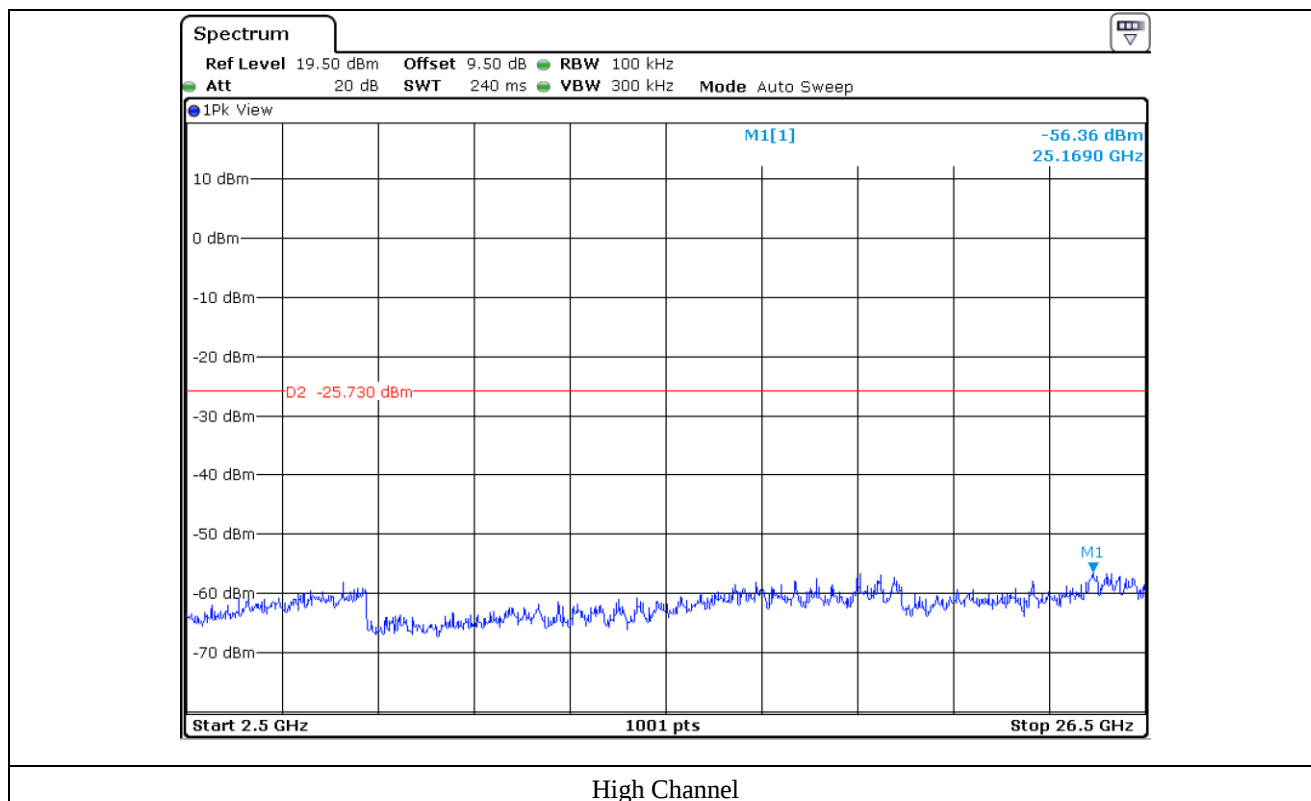




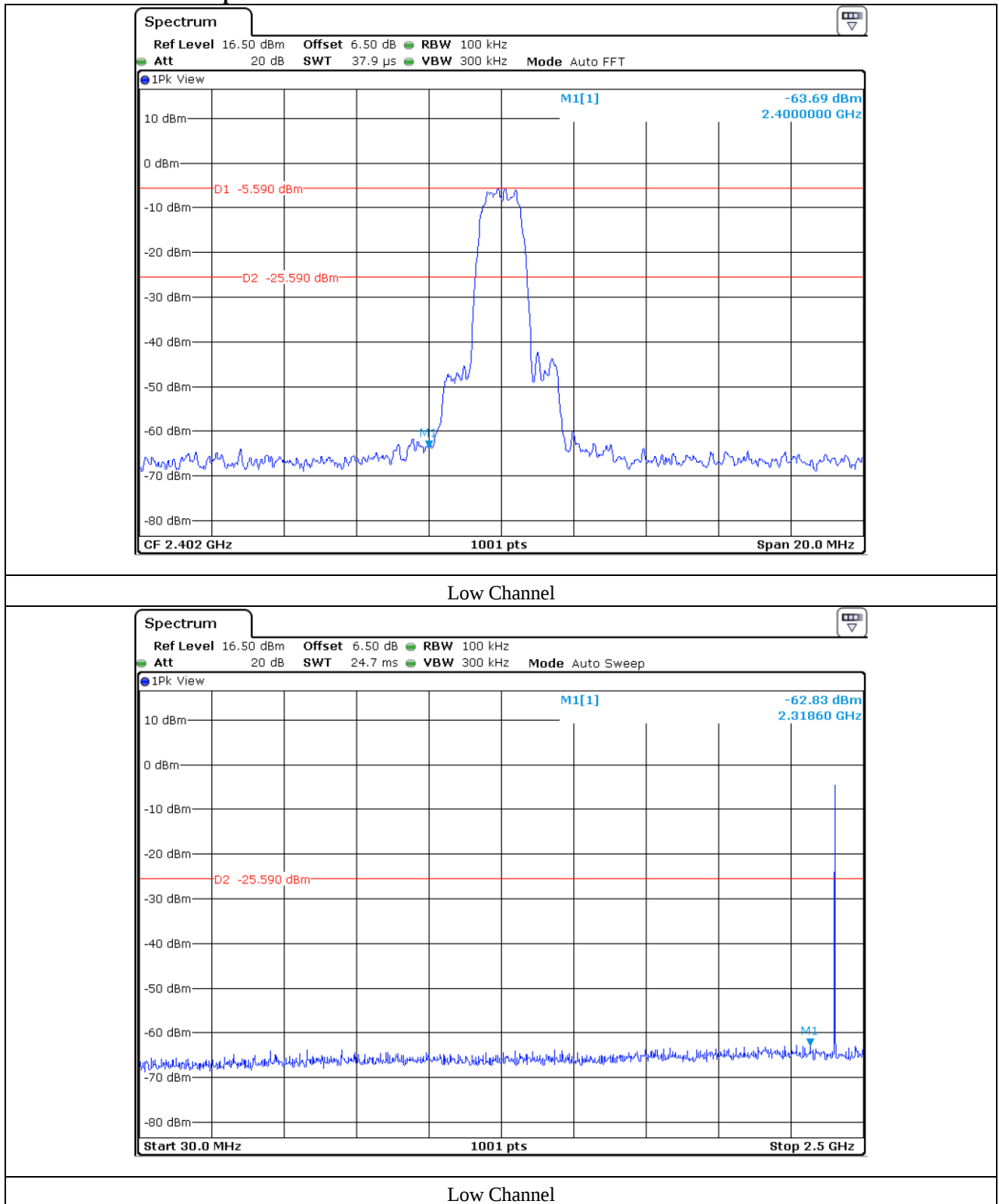
High Channel

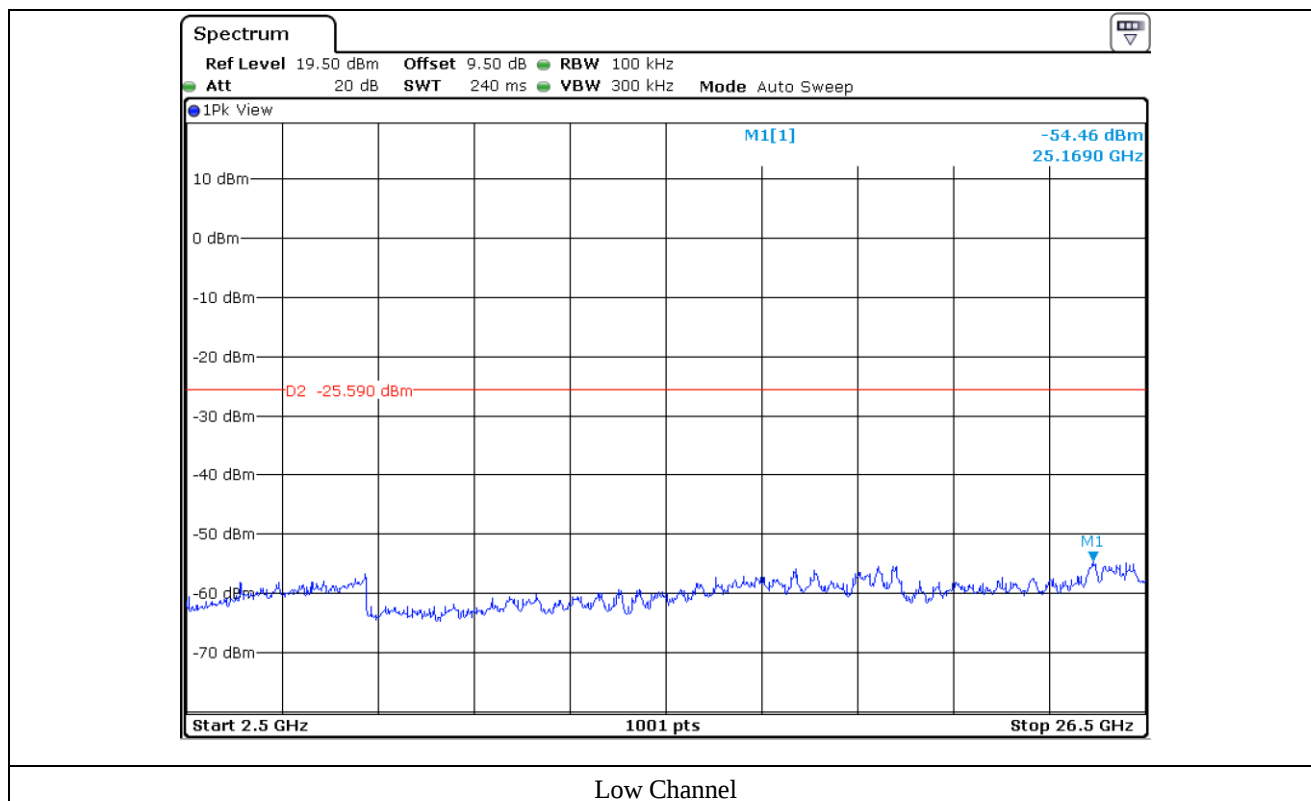


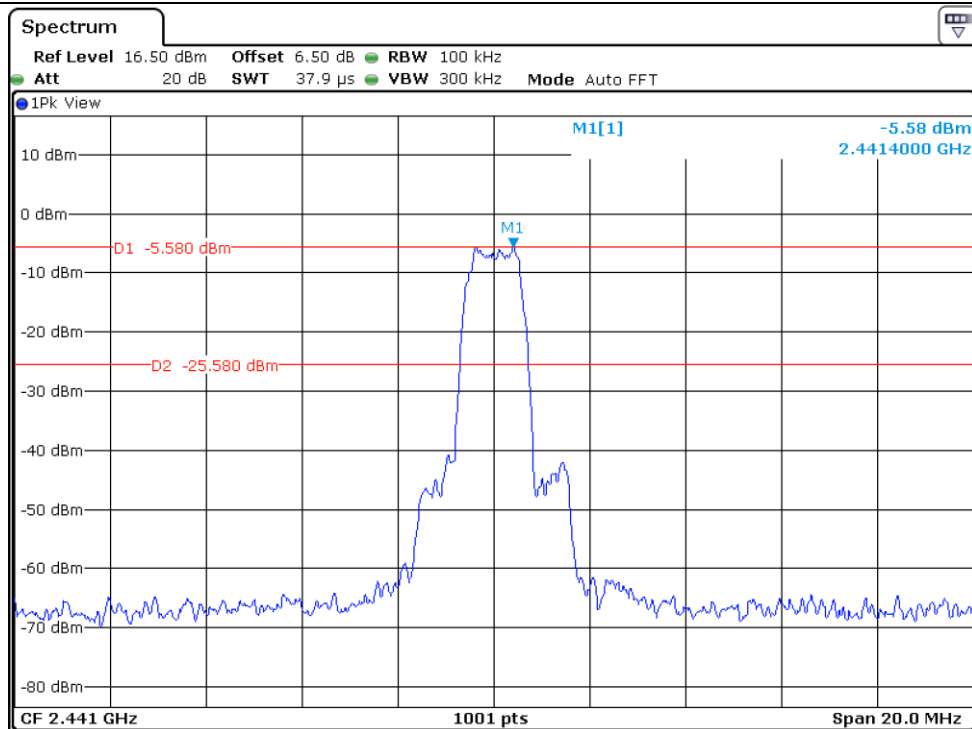
High Channel



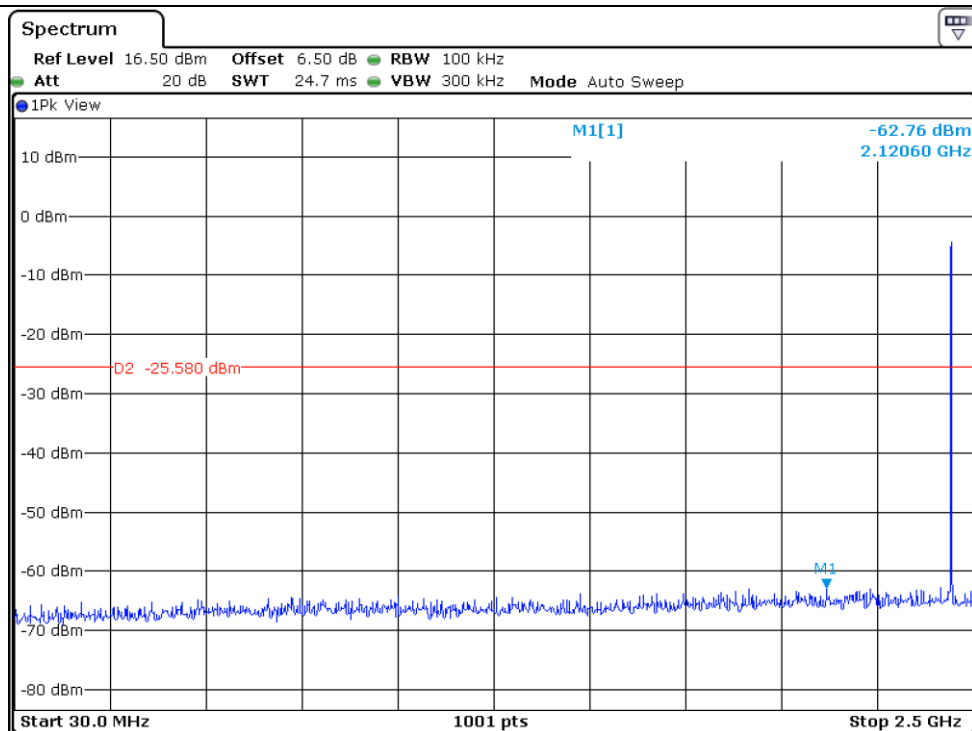
12.5.3 Test data for 3 Mbps



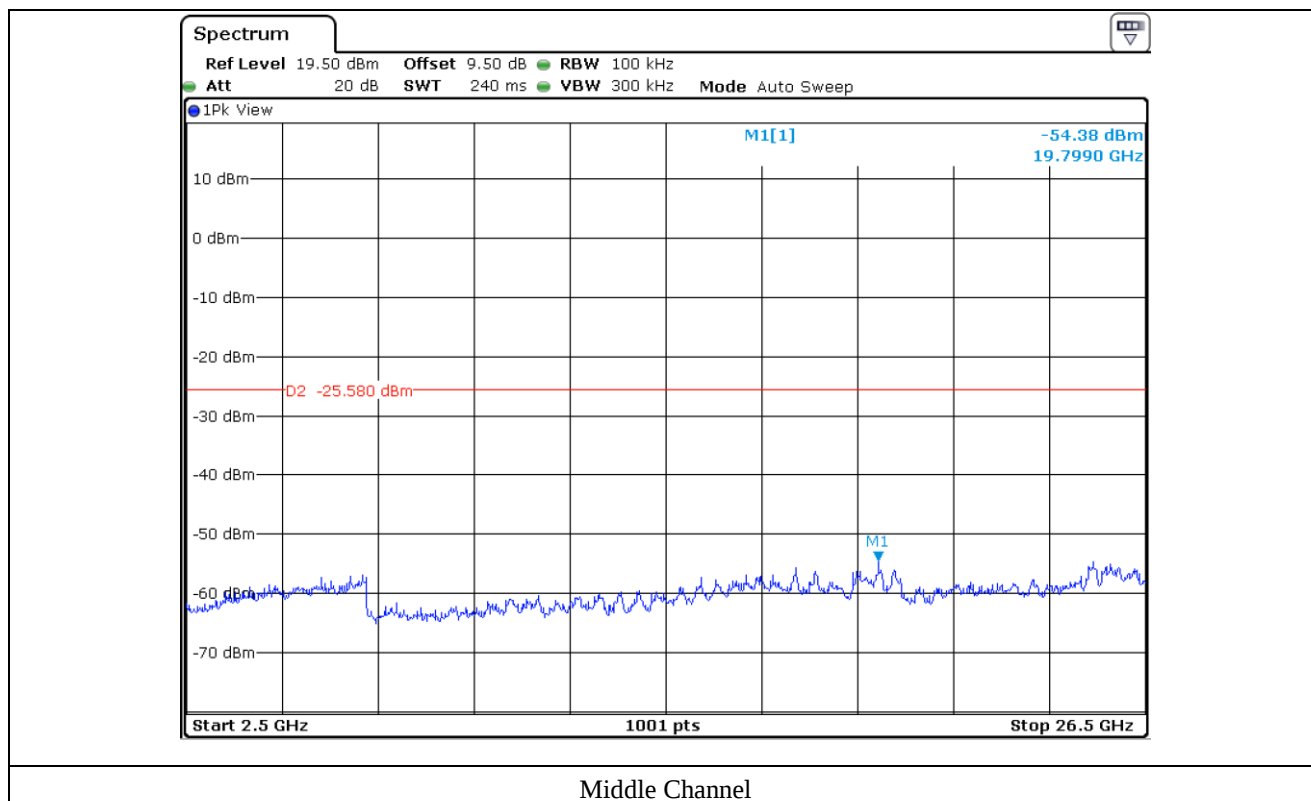


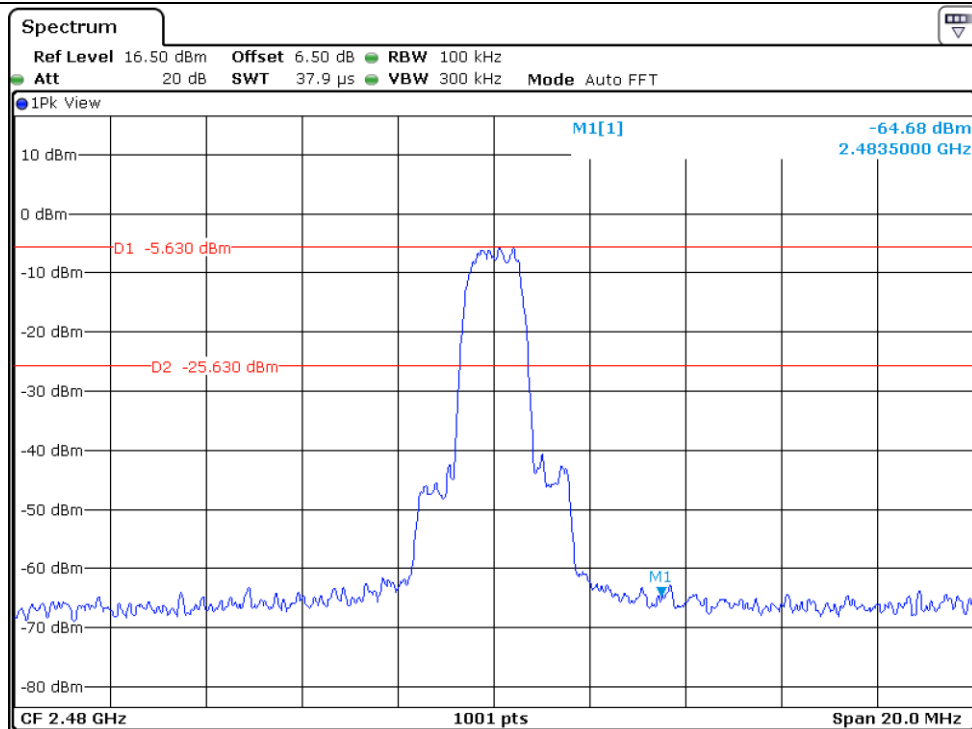


Middle Channel

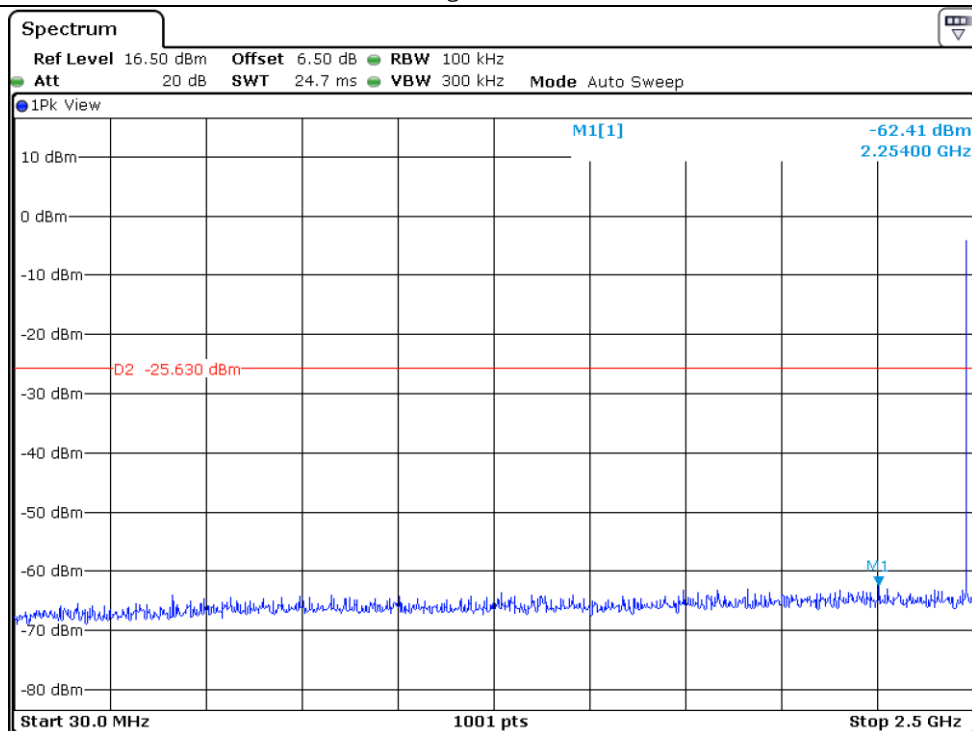


Middle Channel

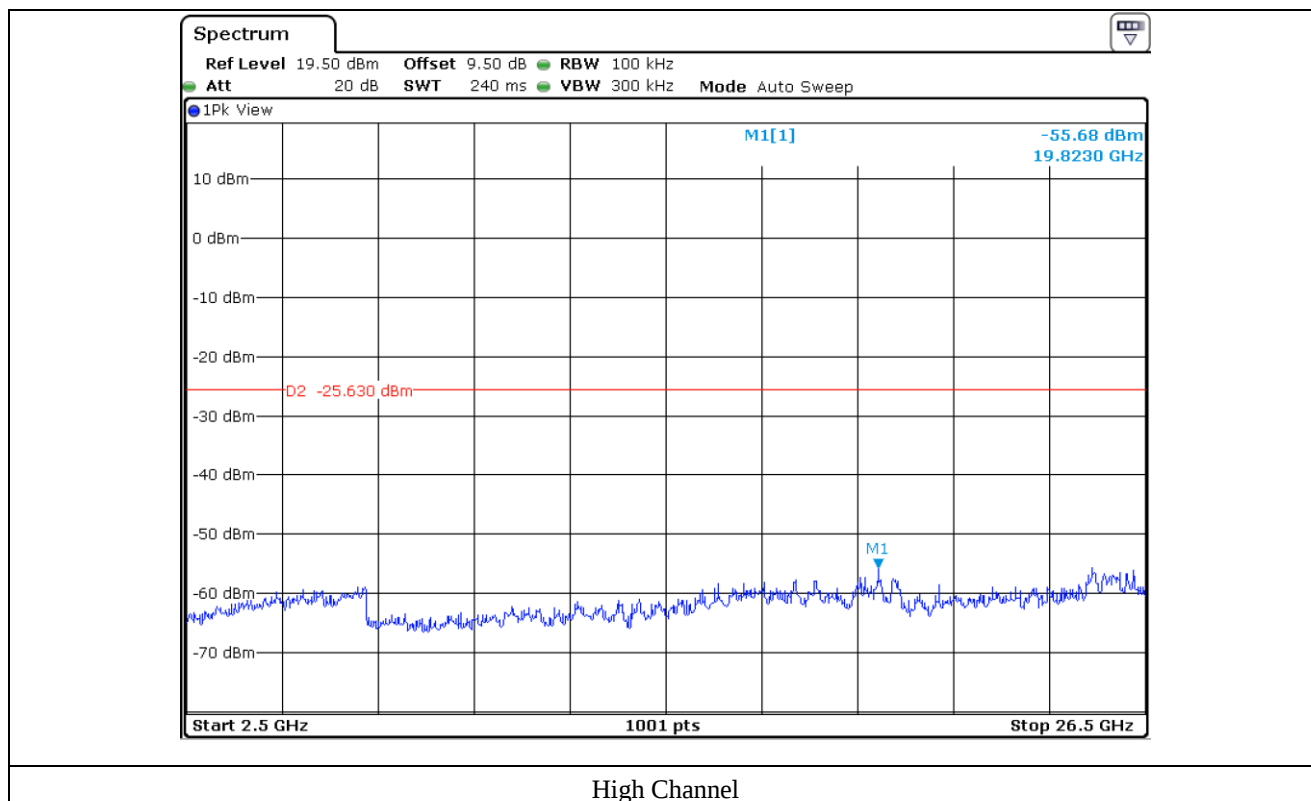




High Channel



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 : January 30, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 375.89	38.42	Peak	H	27.60	8.80	34.31	40.51	74.00	33.49
2 375.97	25.74	Average	H				27.83	54.00	26.17
2 375.81	39.66	Peak	V				41.75	74.00	32.25
2 375.97	25.25	Average	V				27.34	54.00	26.66
Test Data for High Channel									
2483.62	39.32	Peak	H	27.80	8.80	34.40	41.52	74.00	32.48
2483.50	21.94	Average	H				24.14	54.00	29.86
2491.52	38.10	Peak	V				40.30	74.00	33.70
2491.21	22.24	Average	V				24.44	54.00	29.56

Tabulated test data for Restricted Band

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



Tested by: Ha-Ram Lee / Assistant Manager

12.6.1.2 Test data for 2 Mbps

- . Test Date : January 30, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 375.81	39.62	Peak	H	27.60	8.80	34.31	41.71	74.00	32.29
2 375.97	25.23	Average	H				27.32	54.00	26.68
2 375.89	41.16	Peak	V				43.25	74.00	30.75
2 375.89	29.64	Average	V				31.73	54.00	22.27
Test Data for High Channel									
2 483.50	38.43	Peak	H	27.80	8.80	34.40	40.63	74.00	33.37
2 483.50	22.76	Average	H				24.96	54.00	29.04
2 499.99	38.49	Peak	V				40.69	74.00	33.31
2 491.29	23.95	Average	V				26.15	54.00	27.85

Tabulated test data for Restricted Band

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



Tested by: Ha-Ram Lee / Assistant Manager

12.6.1.3 Test data for 3 Mbps

- . Test Date : January 30, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 375.81	38.57	Peak	H	27.60	8.80	34.31	40.66	74.00	33.34
2 375.97	24.80	Average	H				26.89	54.00	27.11
2 375.89	40.98	Peak	V				43.07	74.00	30.93
2 375.97	26.85	Average	V				28.94	54.00	25.06
Test Data for High Channel									
2 483.51	38.34	Peak	H	27.80	8.80	34.40	40.54	74.00	33.46
2 491.34	24.95	Average	H				27.15	54.00	26.85
2 483.62	37.07	Peak	V				39.27	74.00	34.73
2 491.42	23.04	Average	V				25.24	54.00	28.76

Tabulated test data for Restricted Band

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



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 : January 30, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	33.49	Peak	H	31.30	13.30	35.23	42.86	74.00	31.14
	22.27	Average	H				31.64	54.00	22.36
	33.50	Peak	V				42.87	74.00	31.13
	20.10	Average	V				29.47	54.00	24.53
Test Data for Middle Channel									
4 882.00	36.35	Peak	H	31.30	13.50	35.27	45.88	74.00	28.12
	27.10	Average	H				36.63	54.00	17.37
	32.92	Peak	V				42.45	74.00	31.55
	19.45	Average	V				28.98	54.00	25.02
Test Data for High Channel									
4 960.00	39.66	Peak	H	31.10	13.70	35.28	49.18	74.00	24.82
	32.23	Average	H				41.75	54.00	12.25
	33.19	Peak	V				42.71	74.00	31.29
	19.40	Average	V				28.92	54.00	25.08

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical, "*" Frequency fall in restricted band



Tested by: Ha-Ram Lee / Assistant Manager

12.6.2.2 Test data for 2 Mbps

- Test Date : January 30, 2019
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	33.45	Peak	H	31.30	13.30	35.23	42.82	74.00	31.18
	20.43	Average	H				29.80	54.00	24.20
	32.64	Peak	V				42.01	74.00	31.99
	19.53	Average	V				28.90	54.00	25.10
Test Data for Middle Channel									
4 882.00	36.42	Peak	H	31.30	13.50	35.27	45.95	74.00	28.05
	23.44	Average	H				32.97	54.00	21.03
	31.57	Peak	V				41.10	74.00	32.90
	19.75	Average	V				29.28	54.00	24.72
Test Data for High Channel									
4 960.00	38.44	Peak	H	31.10	13.70	35.28	47.96	74.00	26.04
	26.23	Average	H				35.75	54.00	18.25
	31.24	Peak	V				40.76	74.00	33.24
	19.76	Average	V				29.28	54.00	24.72

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical, "*" Frequency fall in restricted band



Tested by: Ha-Ram Lee / Assistant Manager

12.6.2.3 Test data for 3 Mbps

- Test Date : January 30, 2019
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	33.62	Peak	H	31.30	13.30	35.23	42.99	74.00	31.01
	20.53	Average	H				29.90	54.00	24.10
	32.98	Peak	V				42.35	74.00	31.65
	19.93	Average	V				29.30	54.00	24.70
Test Data for Middle Channel									
4 882.00	37.00	Peak	H	31.30	13.50	35.27	46.53	74.00	27.47
	24.87	Average	H				34.40	54.00	19.60
	32.69	Peak	V				42.22	74.00	31.78
	19.77	Average	V				29.30	54.00	24.70
Test Data for High Channel									
4 960.00	40.53	Peak	H	31.10	13.70	35.28	50.05	74.00	23.95
	29.72	Average	H				39.24	54.00	14.76
	33.48	Peak	V				43.00	74.00	31.00
	19.59	Average	V				29.11	54.00	24.89

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical, "*" Frequency fall in restricted band



Tested by: Ha-Ram Lee / Assistant Manager

12.6.3 Spurious Radiated Emission

12.6.3.1 Test Data for 30 MHz ~ 1 000 MHz

Humidity Level : 52 % R.H.

Temperature: 24 °C

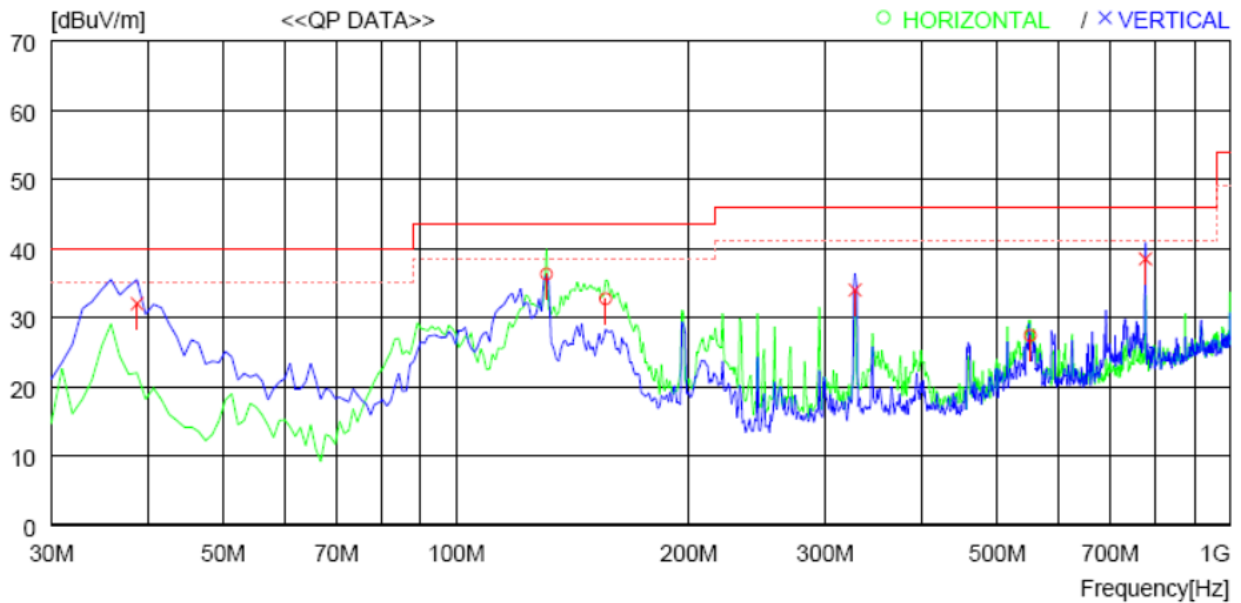
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Car Navigation

Date: January 30, 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	130.880	57.6	9.1	2.6	33.0	36.3	43.5	7.2	200	222
2	156.100	54.3	8.4	3.0	33.0	32.7	43.5	10.8	200	241
3	551.859	37.4	17.9	5.4	33.3	27.4	46.0	18.6	200	0
----- Vertical -----										
4	38.730	50.2	13.4	1.5	33.1	32.0	40.0	8.0	100	0
5	327.790	48.6	14.2	4.2	33.0	34.0	46.0	12.0	200	163
6	777.863	44.2	20.9	6.5	33.1	38.5	46.0	7.5	100	0

[Signature]

Tested by: Ha-Ram Lee / Assistant Manager

12.6.3.2 Test Data for Below 30 MHz

- . Test Date : January 30, 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 Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

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 20dB below the limit and thus not reported.								

12.6.3.3 Test Data for above 1 GHz

- . Test Date : January 30, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

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 20dB below the limit and thus not reported.								



Tested by: Ha-Ram Lee / Assistant Manager