

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

Test Report No. : OT-189-RWD-003
AGR No. : A187A-312
Applicant : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
Manufacturer : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
Type of Equipment : Beam Projector
FCC ID. : O6ZW1
Model Name : W1
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 80 pages (including this page)
Date of Incoming : August 02, 2018
Date of issue : September 05, 2018

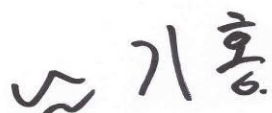
SUMMARY

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:


Ki-Hong, Nam / Chief Engineer
ONETECH Corp.

Approved by:


Keun-Young, Choi / Vice President
ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-189-RWD-003	2018.09.05	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Humax Co., Ltd.
 Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
 Contact Person : Nak Yool Sung / Engineer
 Telephone No. : +82-31-776-6448
 FCC ID : O6ZW1
 Model Name : W1
 Brand Name : -
 Serial Number : N/A
 Date : September 05, 2018

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
E.U.T. DESCRIPTION	Beam Projector
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 Humax Co., Ltd., Model W1 (referred to as the EUT in this report) is a Beam Projector. Product specification information described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	Beam Projector		
Operating Frequency	Bluetooth LE	2 402 MHz ~ 2 480 MHz	
	Bluetooth	2 402 MHz ~ 2 480 MHz	
	WLAN	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))	
	2.4 GHz Band	2 422 MHz ~ 2 452 MHz (802.11n(HT40))	
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(VHT20))
			5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(VHT40))
			5 210 MHz (802.11ac(VHT80))
		5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n(HT20)/ac(VHT20))
5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(VHT40))			
5 775 MHz (802.11ac(VHT80))			
RF Output Power	Bluetooth LE	1.91 dBm	
	Bluetooth	1 Mbps (-5.49 dBm)	
		2 Mbps (-7.21 dBm)	
		3 Mbps (-6.73 dBm)	
	WLAN 2.4 GHz Band	Antenna 0	Wi-Fi 802.11b (17.70 dBm)
			Wi-Fi 802.11g (21.34 dBm)
		Antenna 1	Wi-Fi 802.11n(HT20) (21.53 dBm)
Wi-Fi 802.11n(HT40) (22.44 dBm)			
Wi-Fi 802.11b (17.62 dBm)			
Antenna 0 + Antenna 1	Wi-Fi 802.11g (20.99 dBm)		
	Wi-Fi 802.11n(HT20) (21.47 dBm)		
	Wi-Fi 802.11n(HT40) (22.44 dBm)		
Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (21.20 dBm)		
	Wi-Fi 802.11n(HT40) (22.09 dBm)		

RF Output Power	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (14.72 dBm) Wi-Fi 802.11n(HT20) (14.66 dBm) Wi-Fi 802.11n(HT40) (16.49 dBm) Wi-Fi 802.11ac(HT80) (14.99 dBm)
			Antenna 1	Wi-Fi 802.11a (14.74 dBm) Wi-Fi 802.11n(HT20) (14.74 dBm) Wi-Fi 802.11n(HT40) (16.38 dBm) Wi-Fi 802.11ac(HT80) (14.78 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (14.69 dBm) Wi-Fi 802.11n(HT40) (16.23 dBm) Wi-Fi 802.11ac(HT80) (14.95 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (15.18 dBm) Wi-Fi 802.11n(HT20) (14.88 dBm) Wi-Fi 802.11n(HT40) (16.55 dBm) Wi-Fi 802.11ac(HT80) (15.21 dBm)
			Antenna 1	Wi-Fi 802.11a (15.11 dBm) Wi-Fi 802.11n(HT20) (14.94 dBm) Wi-Fi 802.11n(HT40) (16.48 dBm) Wi-Fi 802.11ac(HT80) (15.03 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (14.94 dBm) Wi-Fi 802.11n(HT40) (16.46 dBm) Wi-Fi 802.11ac(HT80) (15.10 dBm)

Modulation Type	Bluetooth LE	DSSS Modulation(GFSK)	
	Bluetooth	GFSK (1 Mbps), $\pi/4$ -QPSK (2 Mbps), 8-DPSK (3 Mbp)	
	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 LE	Antenna 1	5.60 dBi
	Bluetooth		
	WLAN 2.4 GHz Band	Antenna 0	5.50 dBi
		Antenna 1	5.60 dBi
		Antenna 0 + Antenna 1	8.56 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	6.90 dBi
		Antenna 1	5.90 dBi
		Antenna 0 + Antenna 1	9.44 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	6.90 dBi
		Antenna 1	5.90 dBi
		Antenna 0 + Antenna 1	9.44 dBi
	Antenna Type	FPCB Antenna	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	24 MHz, 37.4 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	Humax Co., Ltd.	CPU B/D REV 0.4	N/A
Button Board	Humax Co., Ltd.	W1 MIC B/D REV 0.4	N/A
AMP Board	Humax Co., Ltd.	W1 AMP B/D REV 0.4	N/A
Module	Humax Co., Ltd.	N/A	N/A
Adapter	Humax Co., Ltd.	ADS-48PI-12N-2 12048E	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
ThinBe	Hironic Co., Ltd	Beam Projector (EUT)	-
JIG	N/A	TEST JIG	EUT
ProBook 650 G2	H.P.	Notebook PC	-

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.

5.4 Configuration of Test System

Line Conducted Test: The EUT was connected to LISN. 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 FPCB 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

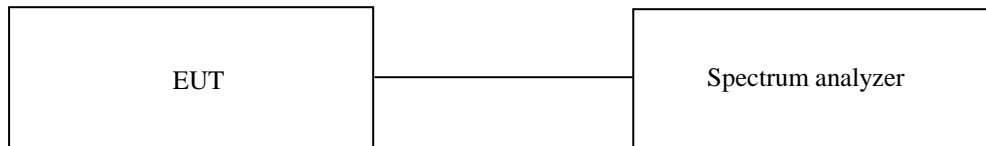
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)

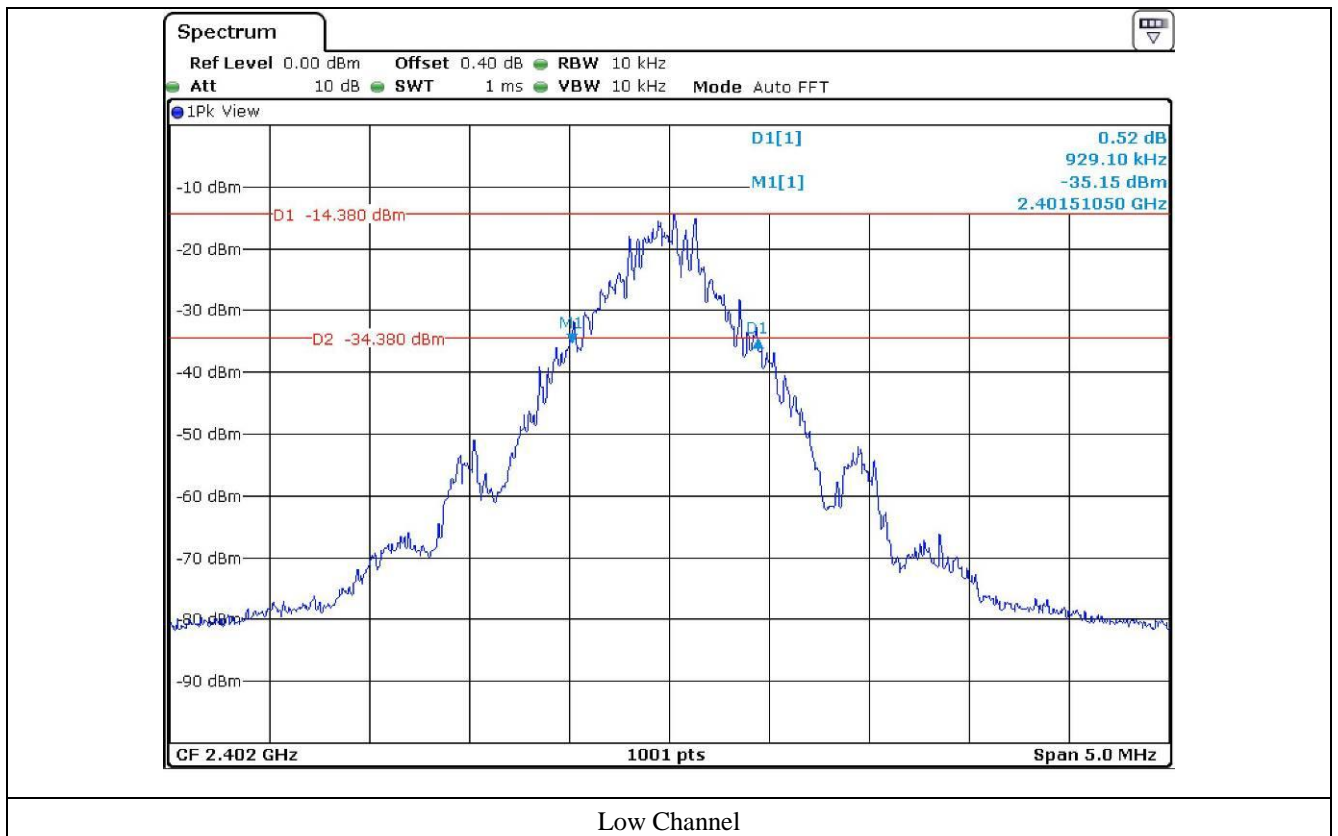
All test equipment used is calibrated on a regular basis.

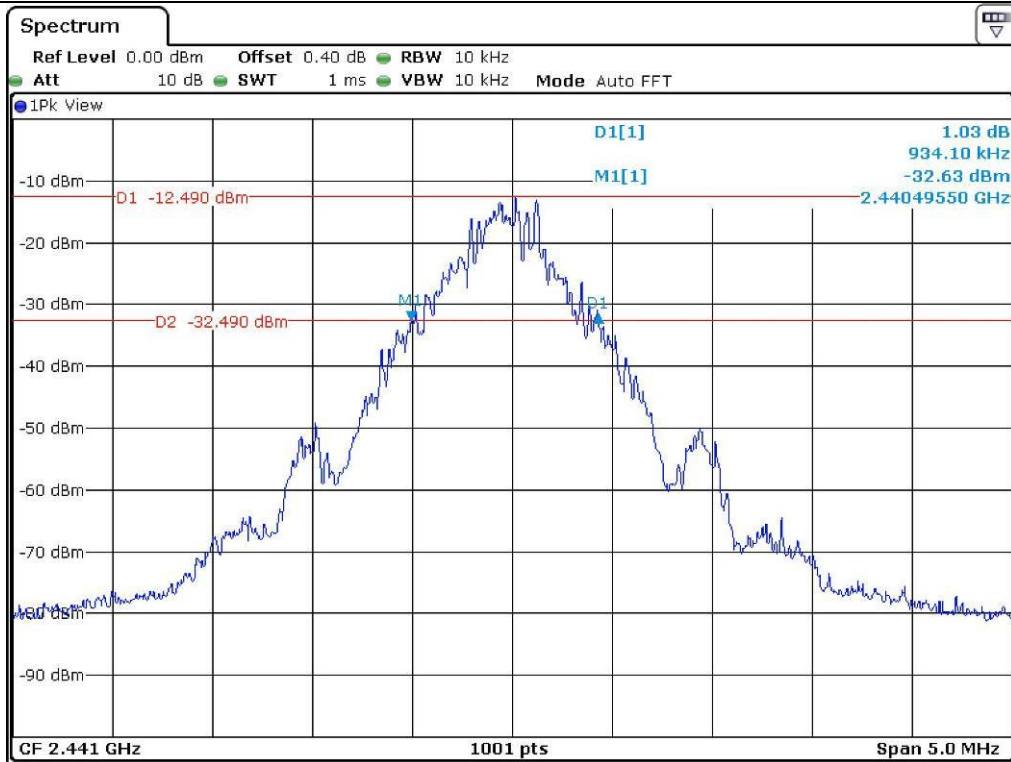
7.4 Test data for 1 Mbps

-. Test Date : August 16, 2018 ~ August 28, 2018

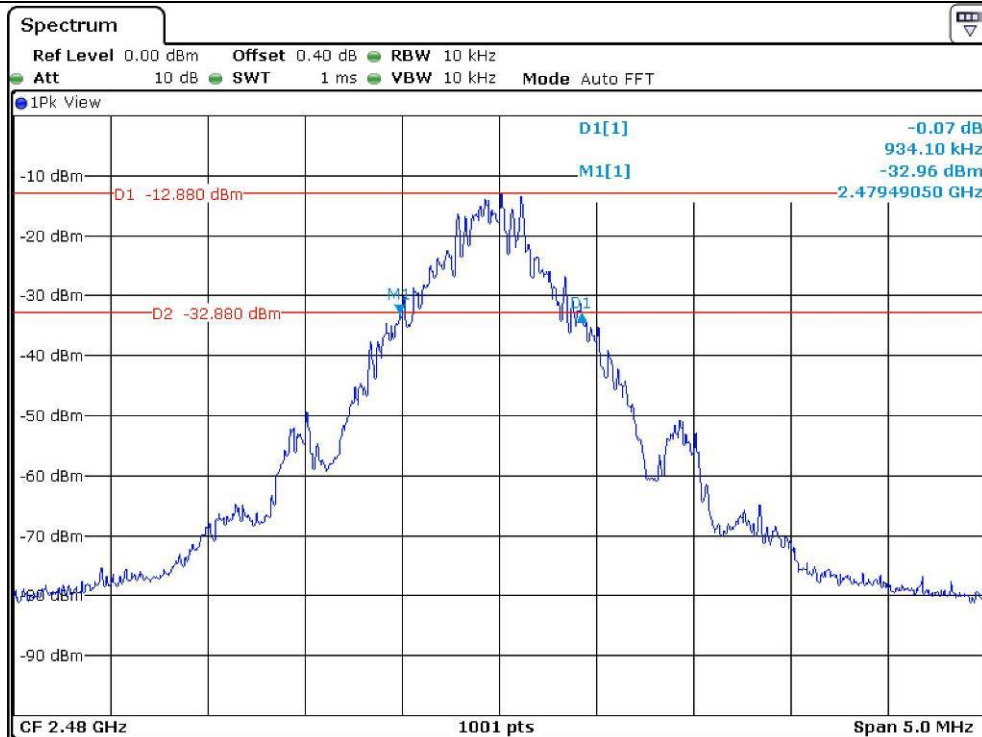
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	929.10
Middle	2 441.00	934.10
High	2 480.00	934.10

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Middle Channel



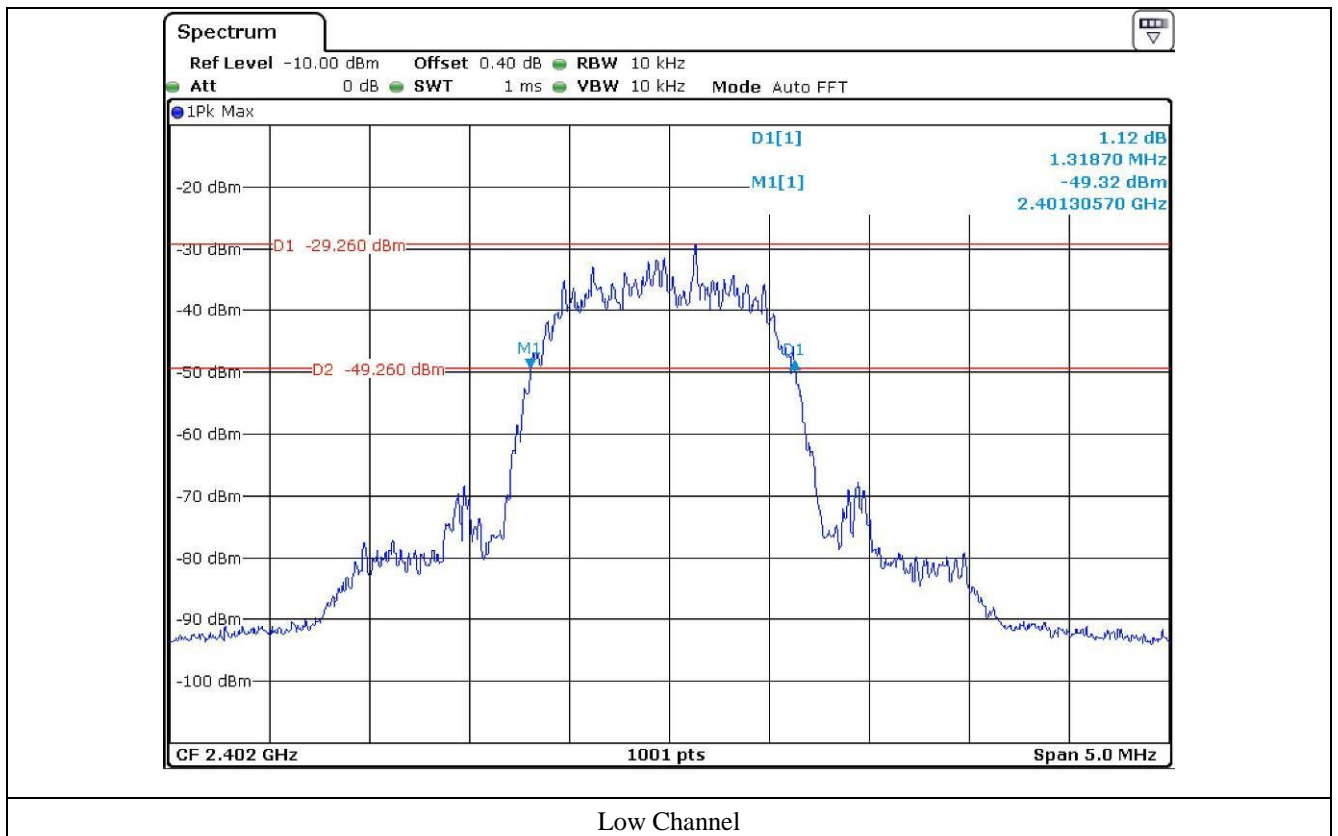
High Channel

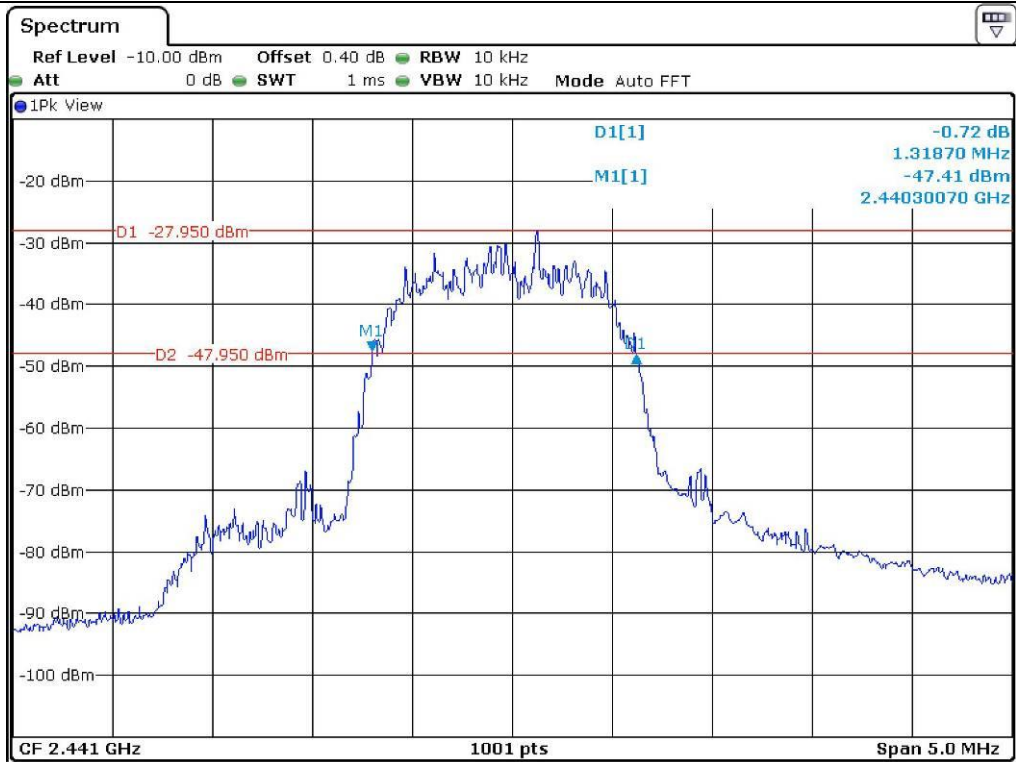
7.5 Test data for 2 Mbps

-. Test Date : August 16, 2018 ~ August 28, 2018

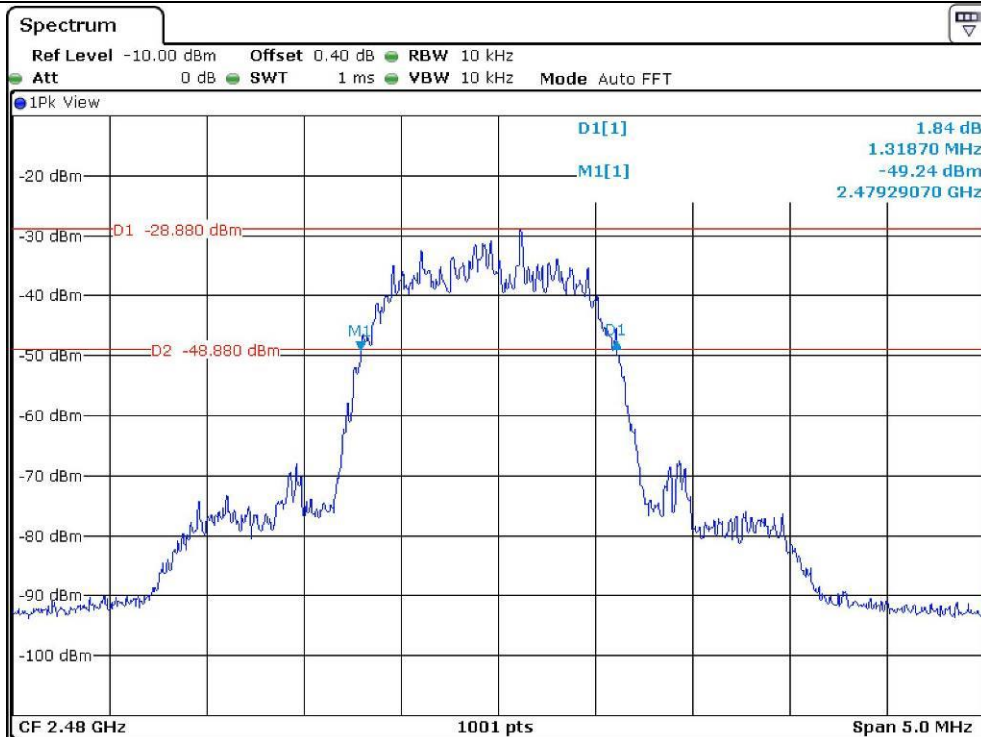
CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 318.70
Middle	2 441.00	1 318.70
High	2 480.00	1 318.70

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

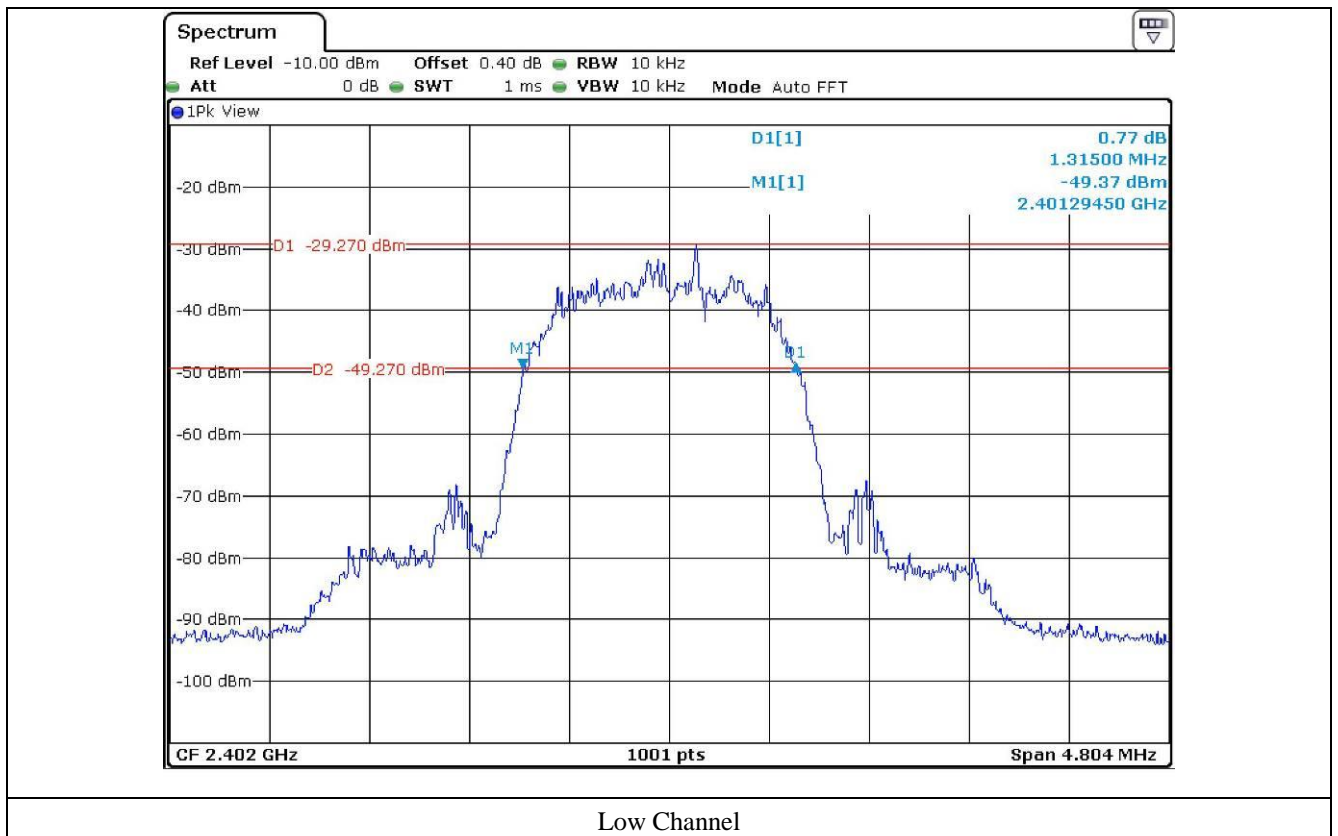
7.6 Test data for 3 Mbps

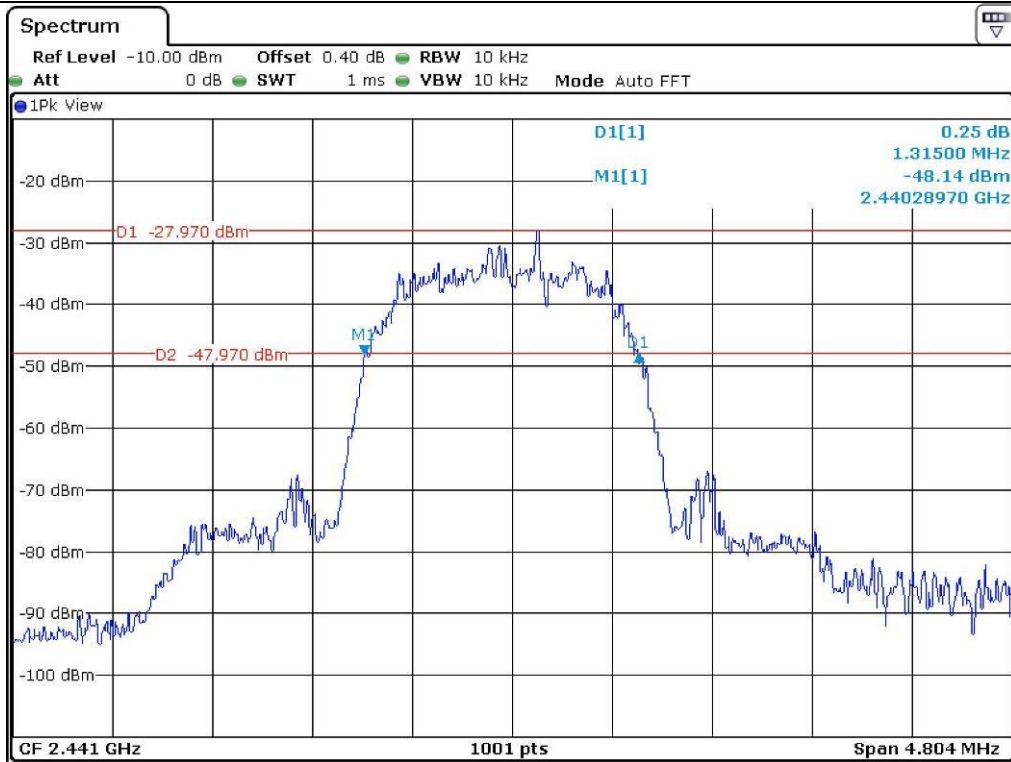
-. Test Date : August 16, 2018 ~ August 28, 2018

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 315.00
Middle	2 441.00	1 315.00
High	2 480.00	1 310.20

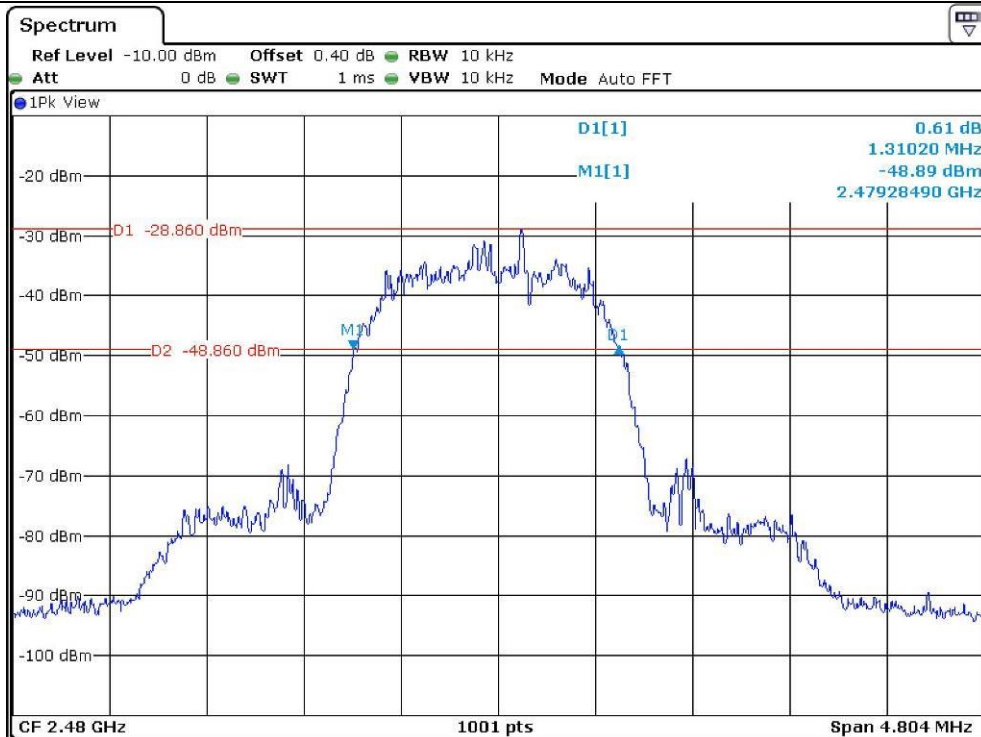


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Middle Channel



High Channel

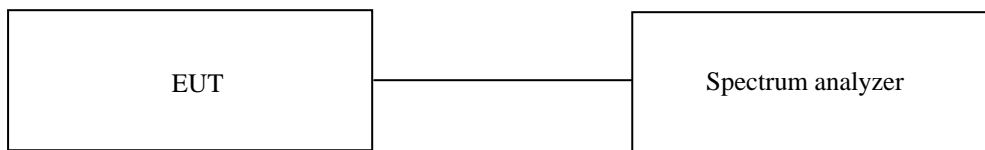
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 1 Mbps

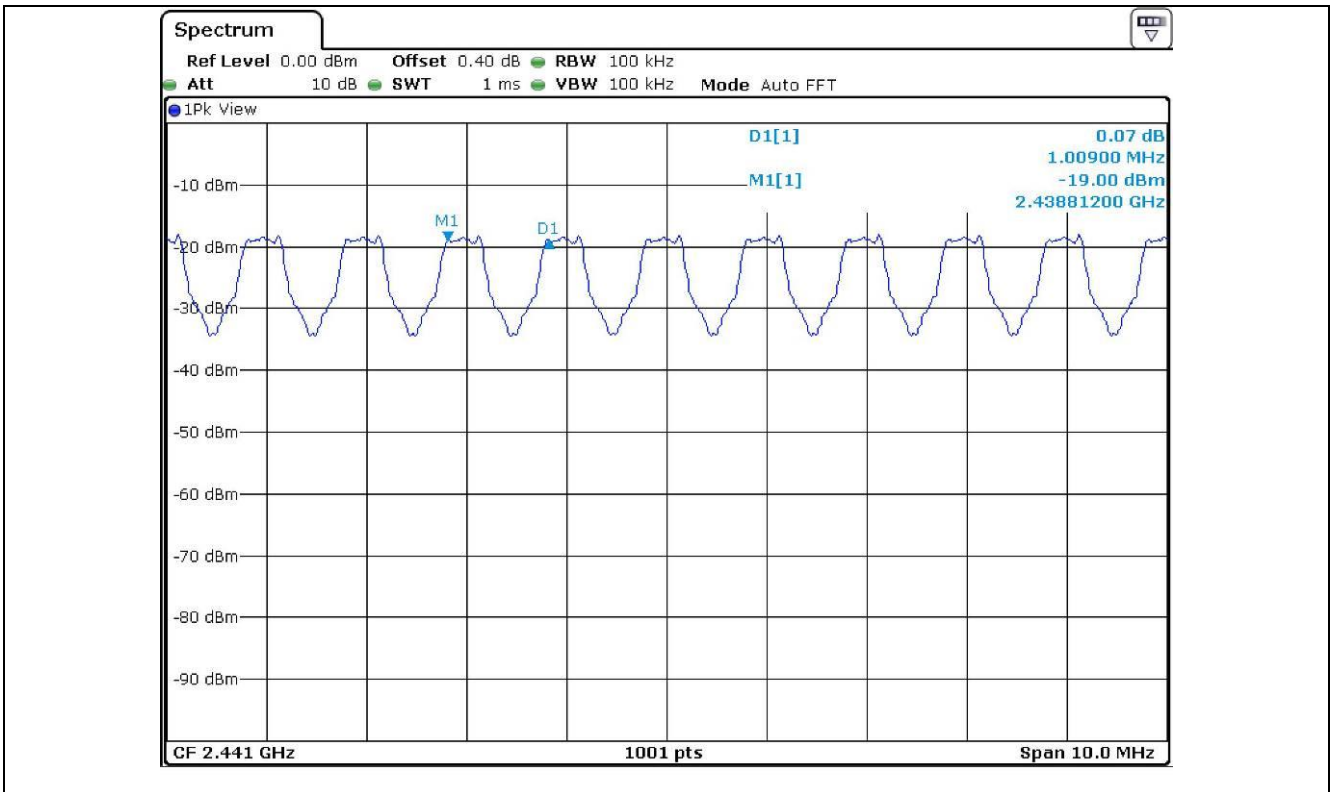
- Test Date : August 16, 2018 ~ August 28, 2018

- Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 009.00	934.10	Separated by a minimum of 25 kHz



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8.5 Test data for 2 Mbps

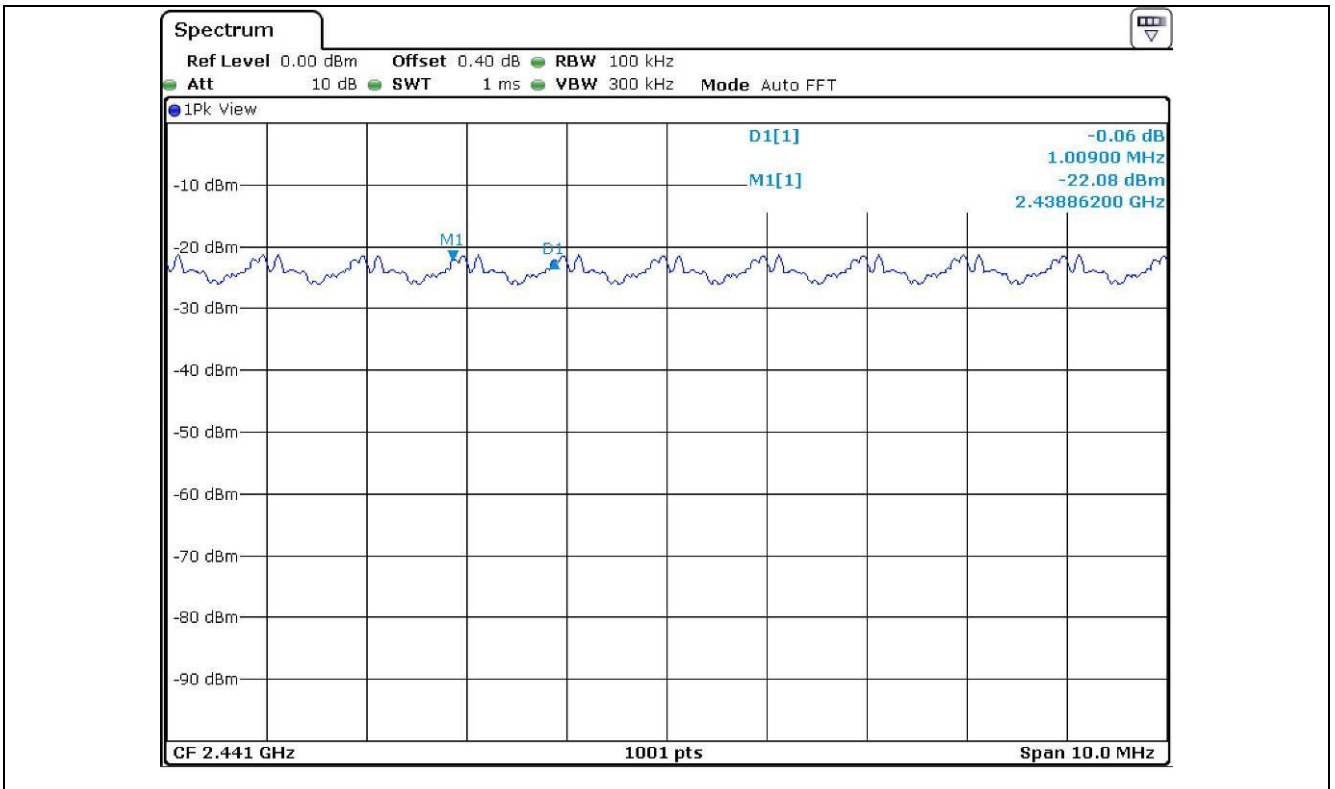
-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 009.00	1 318.70	Separated by a minimum of 25 kHz



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8.6 Test data for 3 Mbps

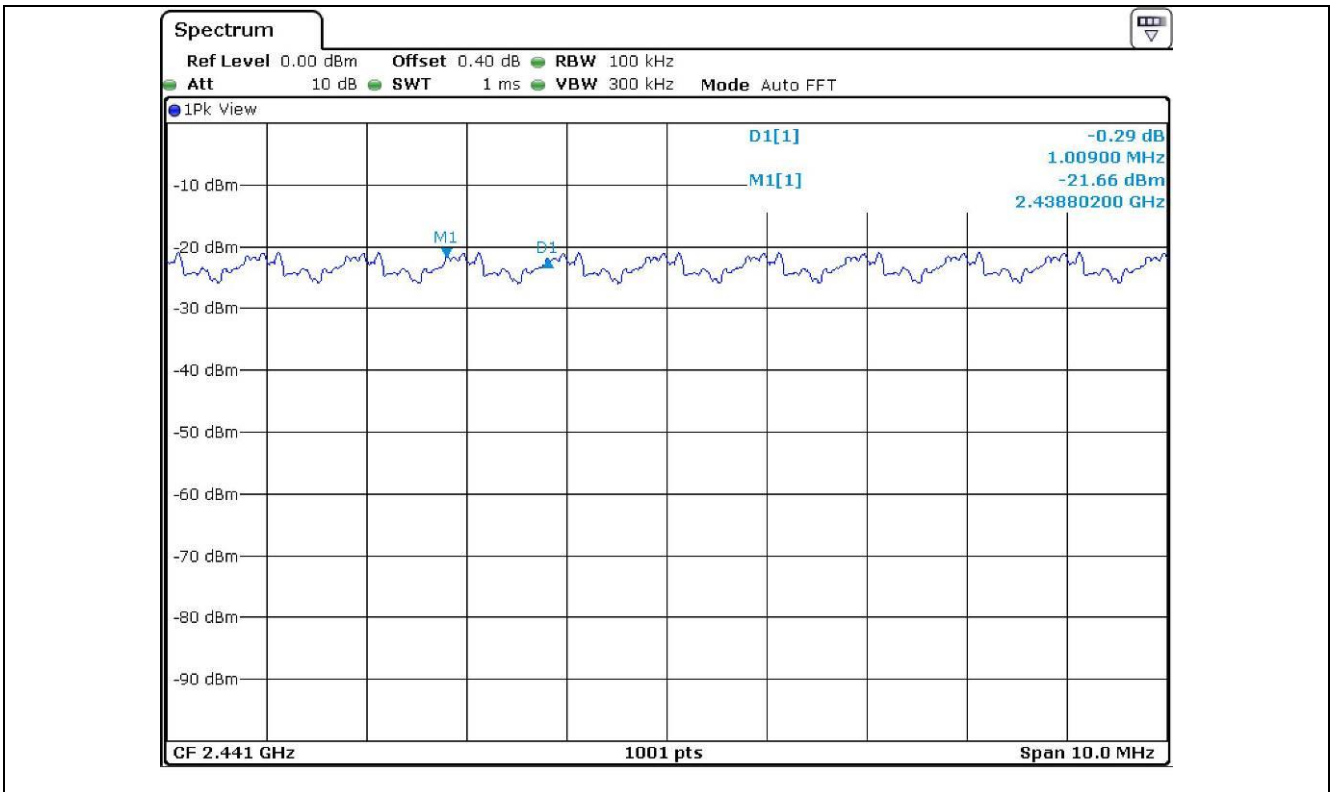
- Test Date : August 16, 2018 ~ August 28, 2018

- Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 009.00	1 315.00	Separated by a minimum of 25 kHz



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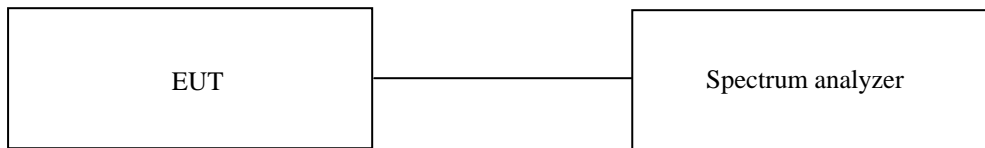
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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

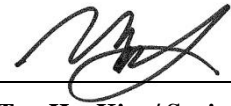
Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

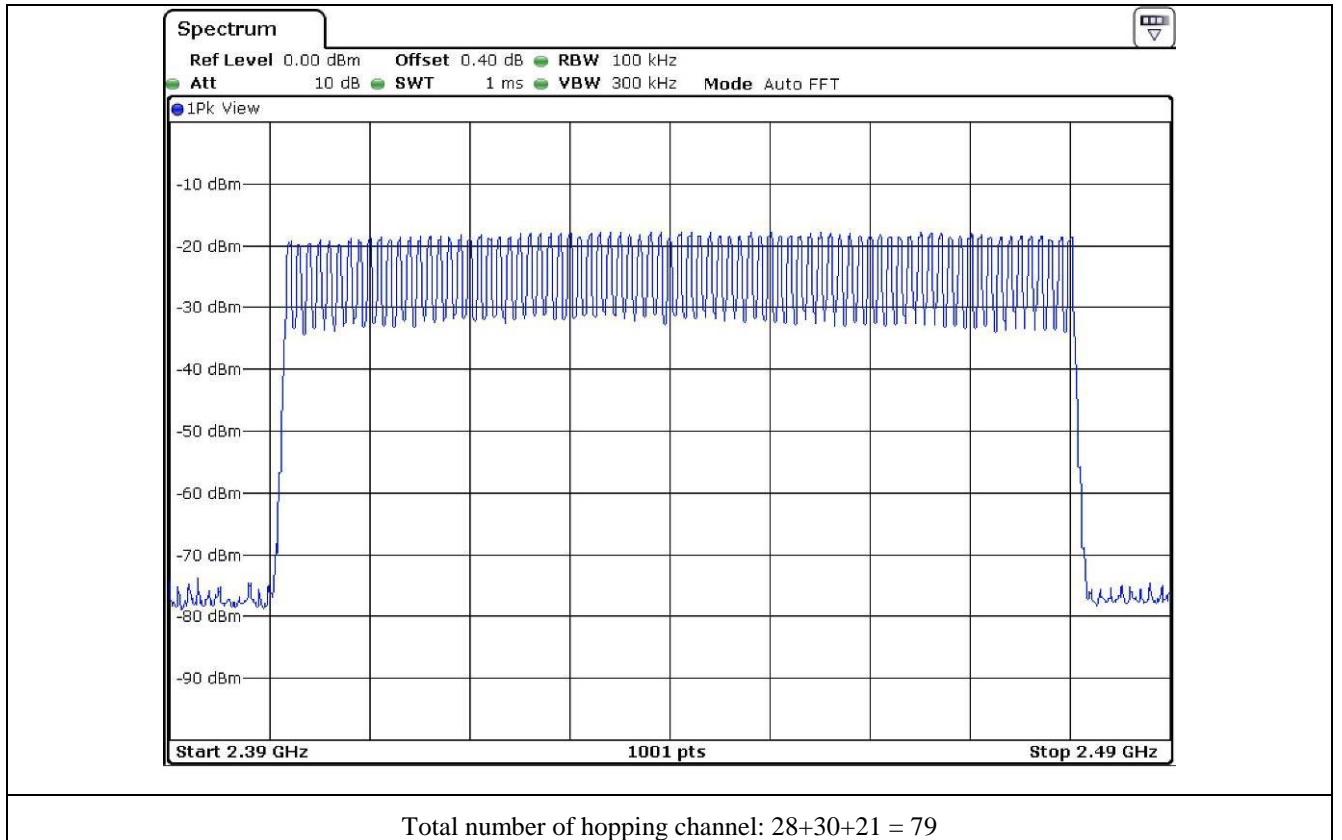
9.4 Test data for 1 Mbps

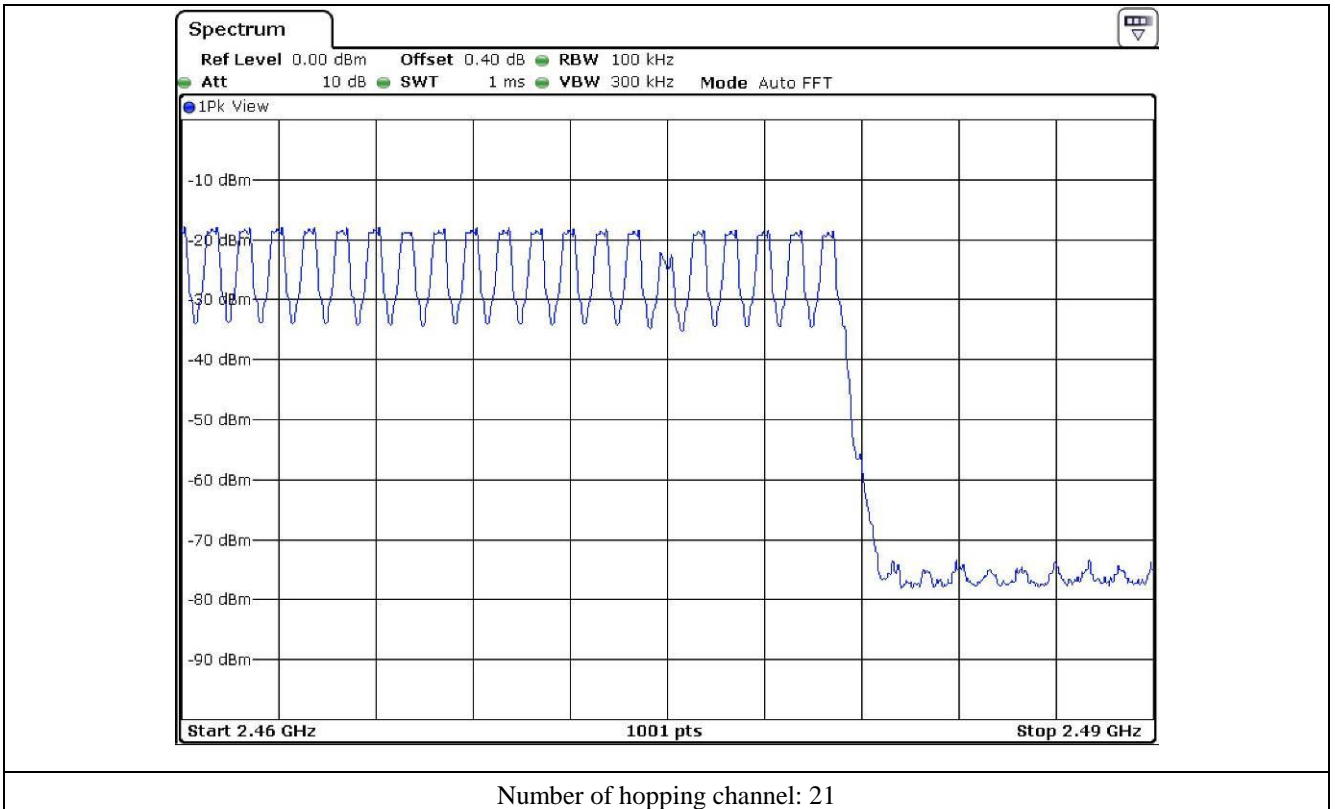
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

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



Tested by: Tae-Ho, Kim / Senior Manager





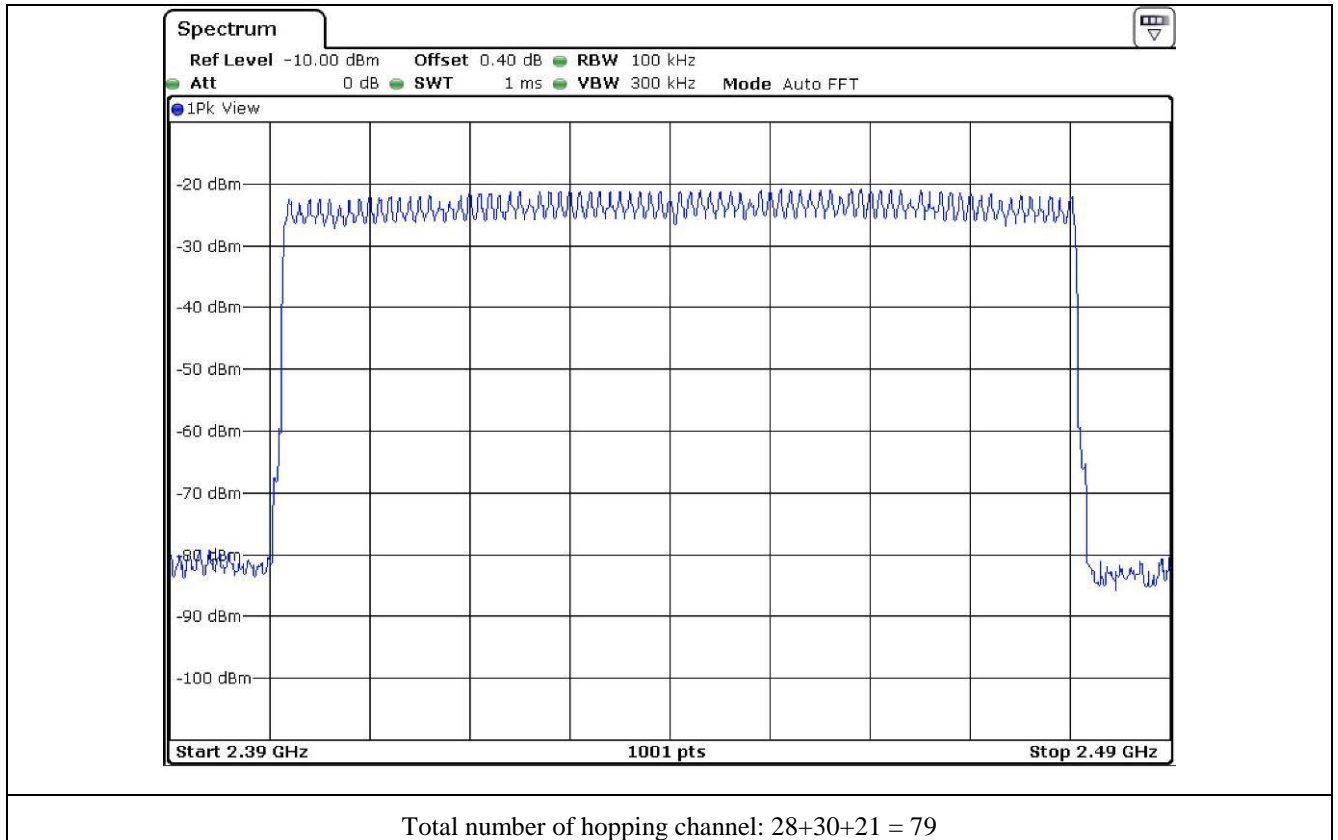
9.5 Test data for 2 Mbps

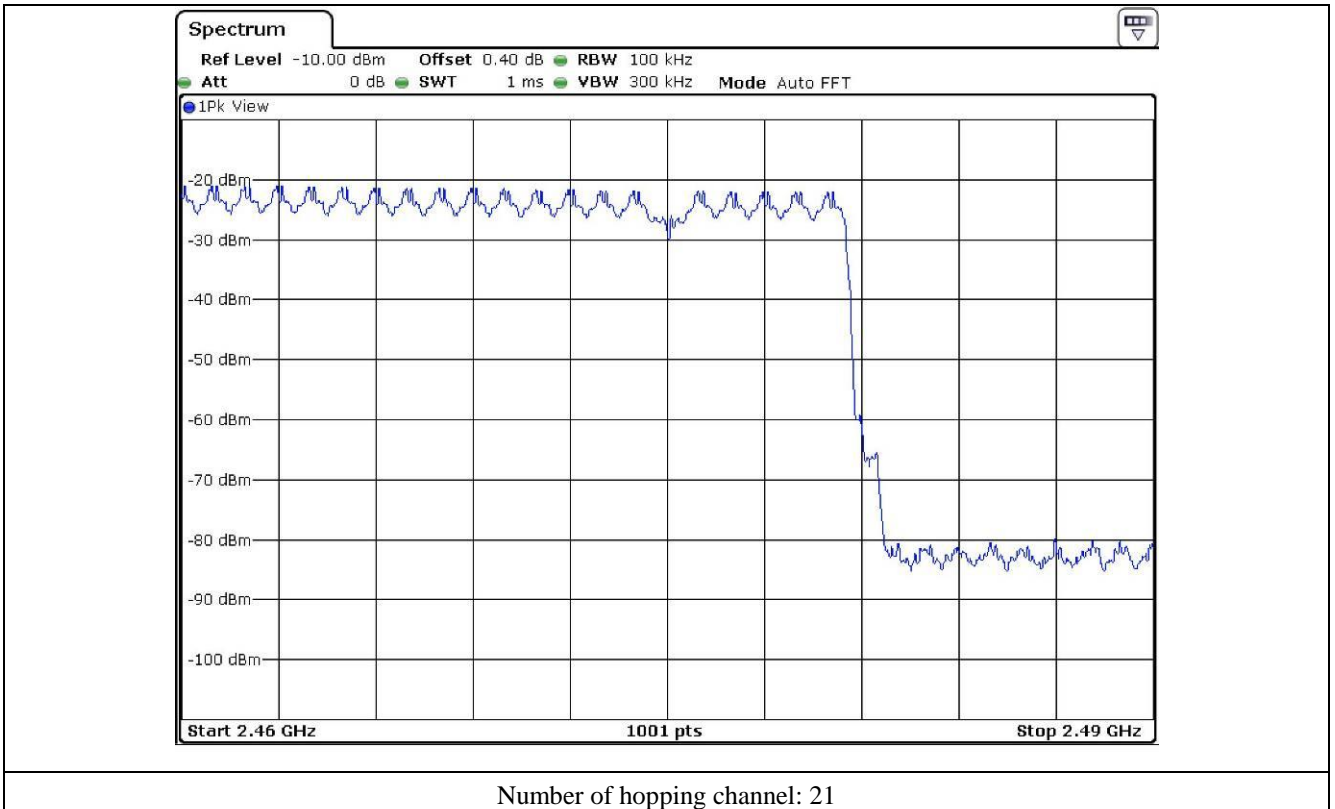
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

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



Tested by: Tae-Ho, Kim / Senior Manager



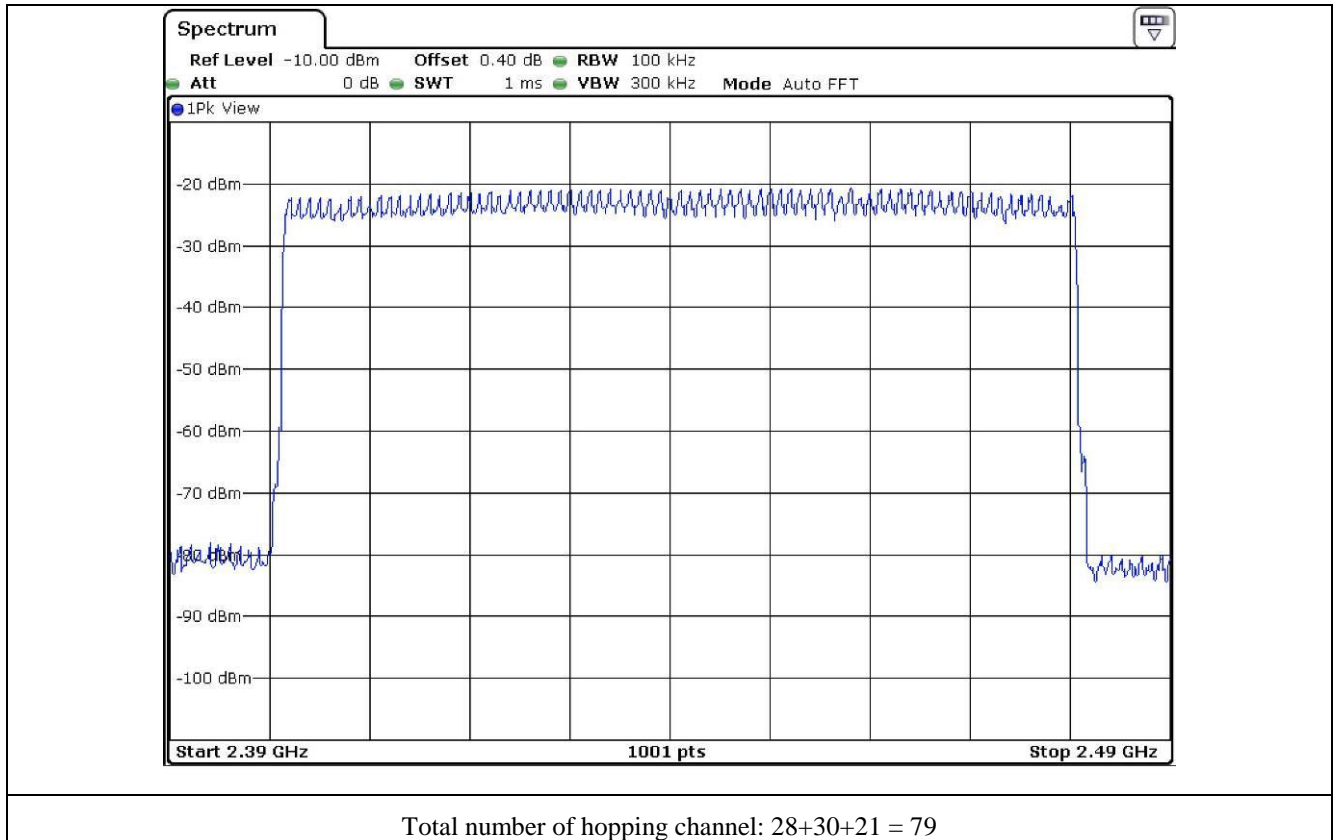


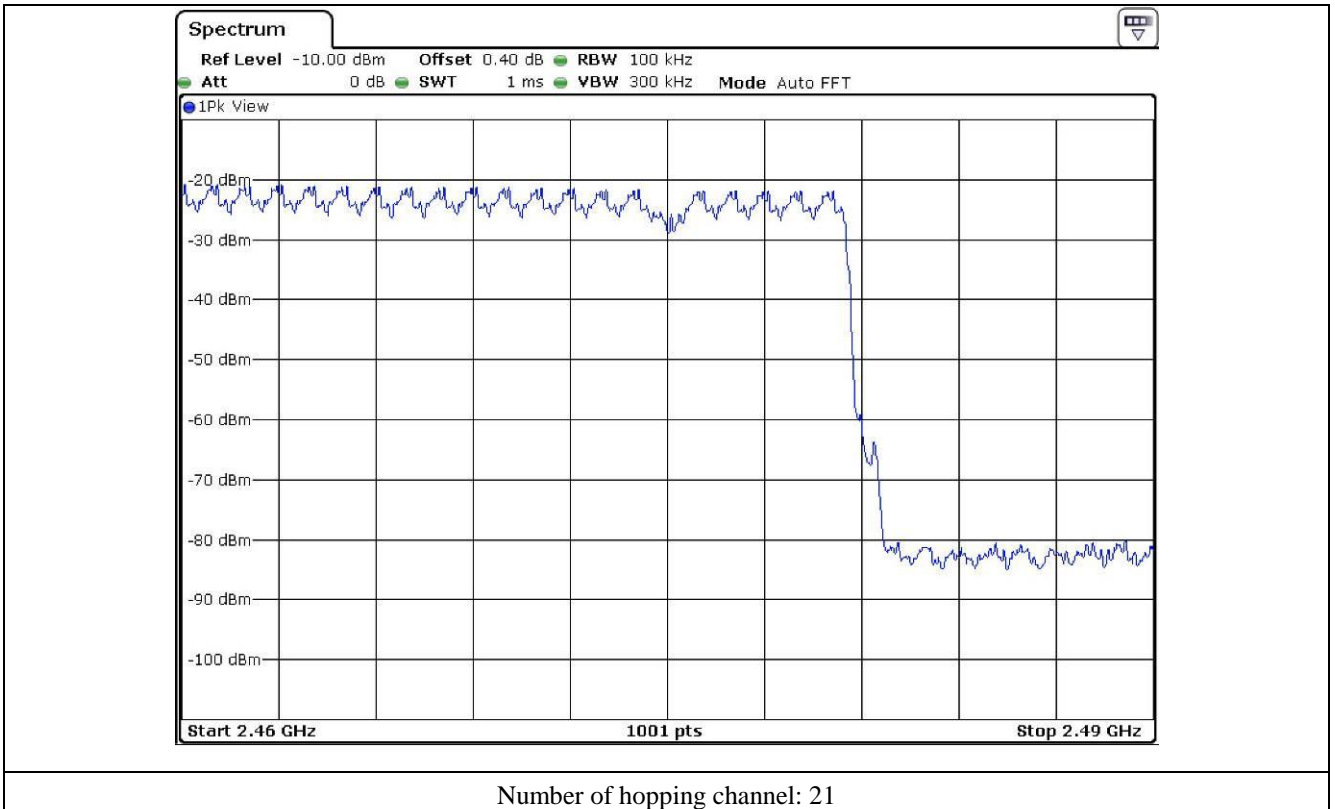
9.6 Test data for 3 Mbps

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

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

Tested by: Tae-Ho, Kim / Senior Manager





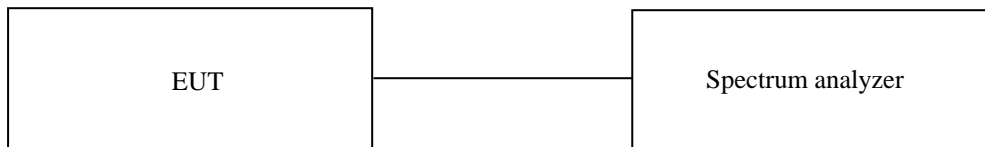
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for 1 Mbps

-. Test Date : August 16, 2018 ~ August 28, 2018

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs 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	0.390	10.13	31.6	124.84	400	PASS
DH3	1.640	5.06	31.6	262.23	400	
DH5	2.880	3.38	31.6	307.61	400	

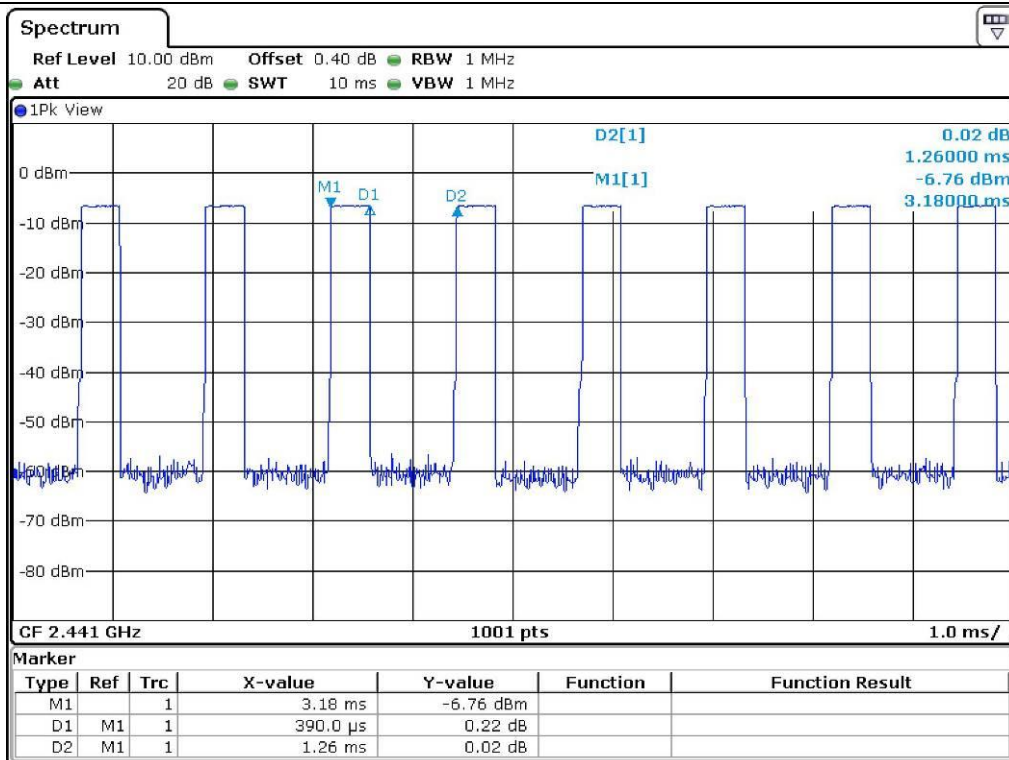
Total dwell time is calculated as following.

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

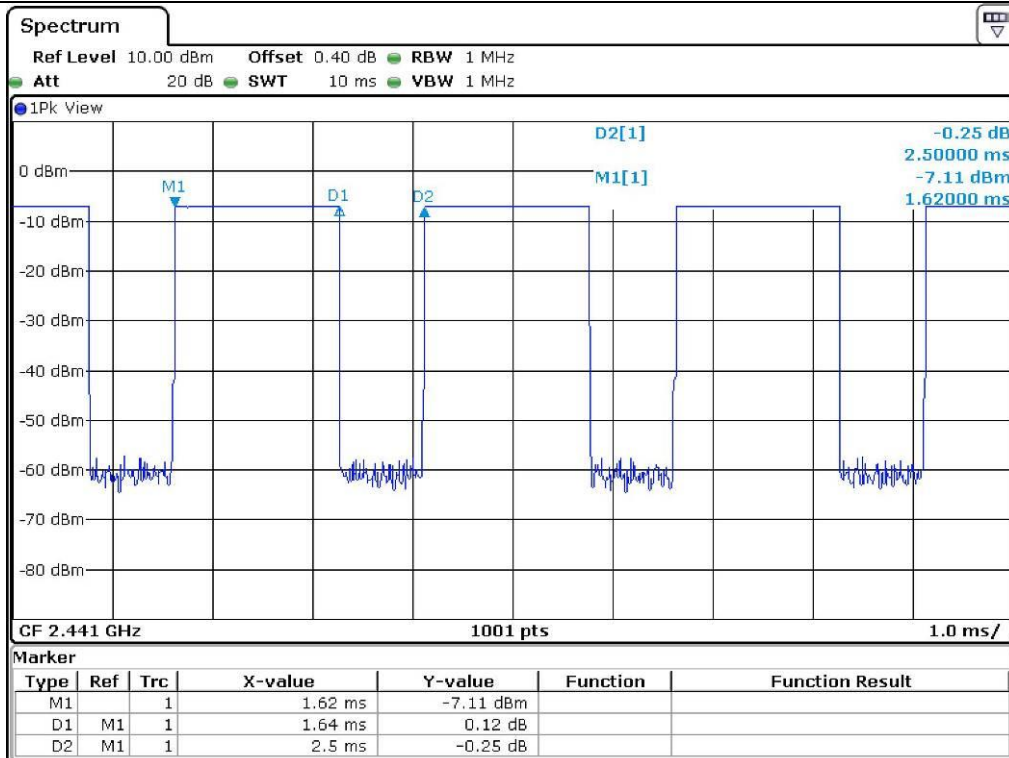
Remark: See next page for an overview sweep performed with peak detector.



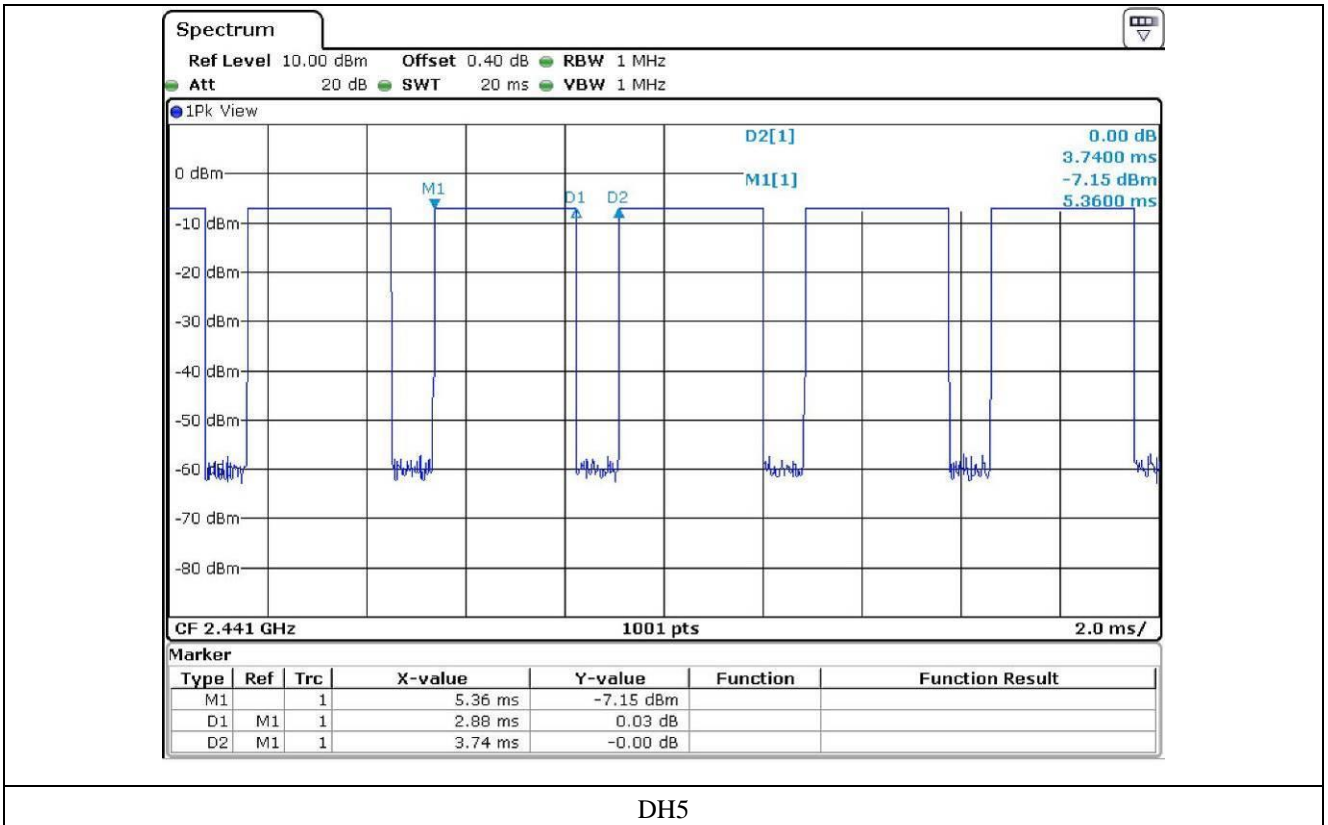
Tested by: Tae-Ho, Kim / Senior Manager



DH1



DH3



10.5 Test data for 2 Mbps

- Test Date : August 16, 2018 ~ August 28, 2018

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs 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	0.390	10.13	31.6	124.84	400	PASS
DH3	1.640	5.06	31.6	262.23	400	
DH5	2.880	3.38	31.6	307.61	400	

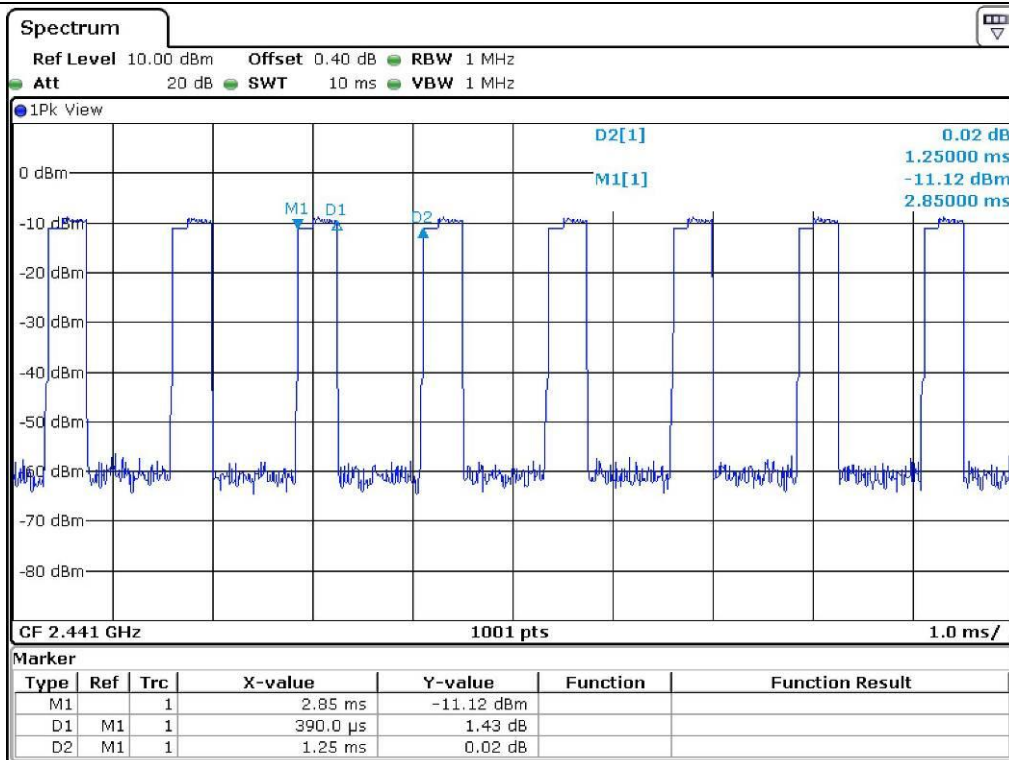
Total dwell time is calculated as following.

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

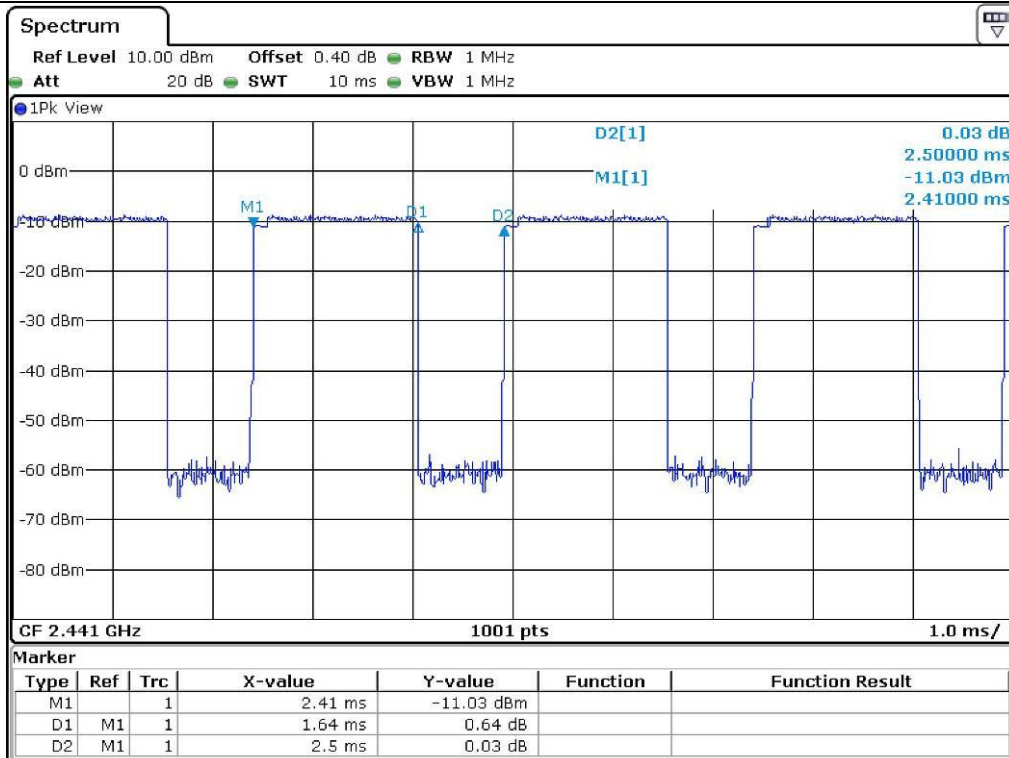
Remark: See next page for an overview sweep performed with peak detector.



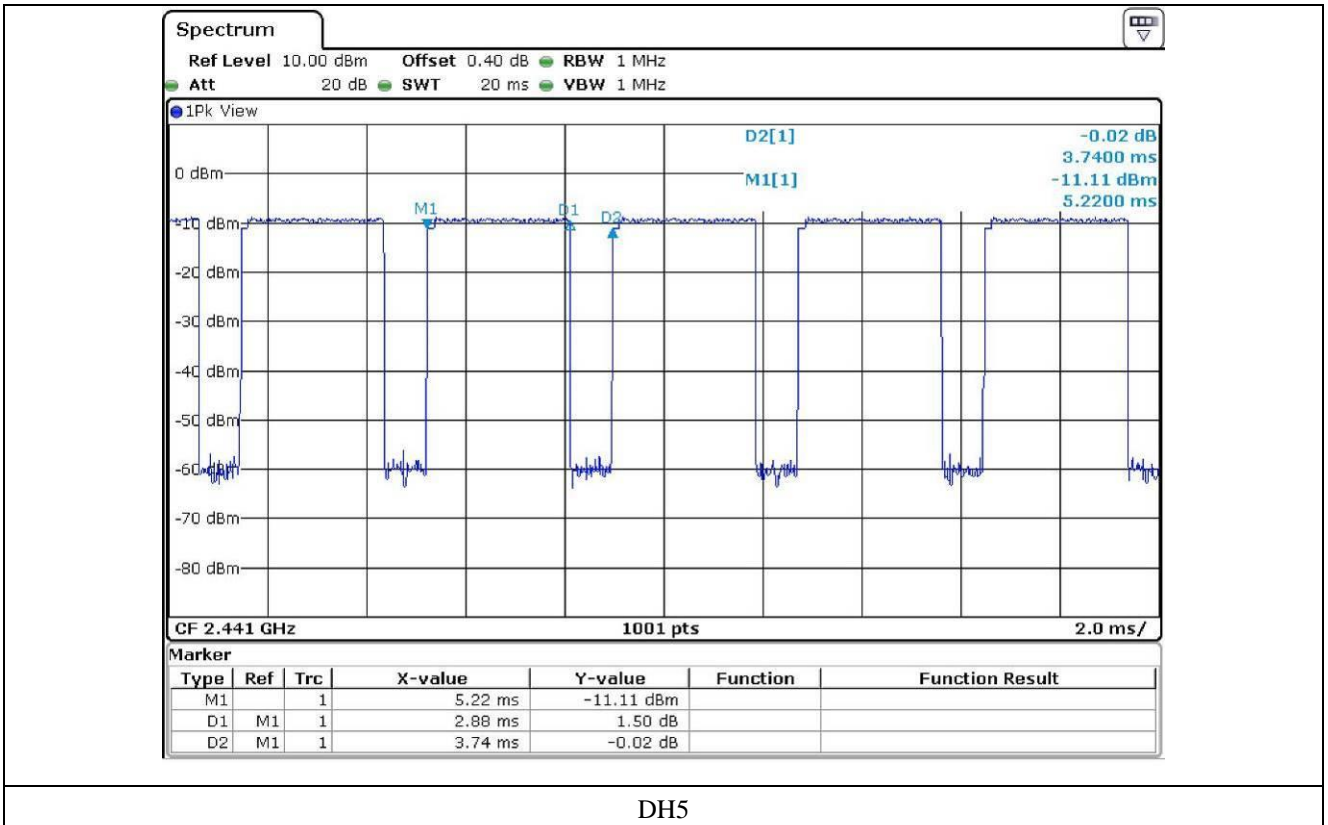
Tested by: Tae-Ho, Kim / Senior Manager



DH1



DH3



10.6 Test data for 3 Mbps

- Test Date : August 16, 2018 ~ August 28, 2018

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs 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	0.390	10.13	31.6	124.84	400	PASS
DH3	1.640	5.06	31.6	262.23	400	
DH5	2.900	3.38	31.6	309.74	400	

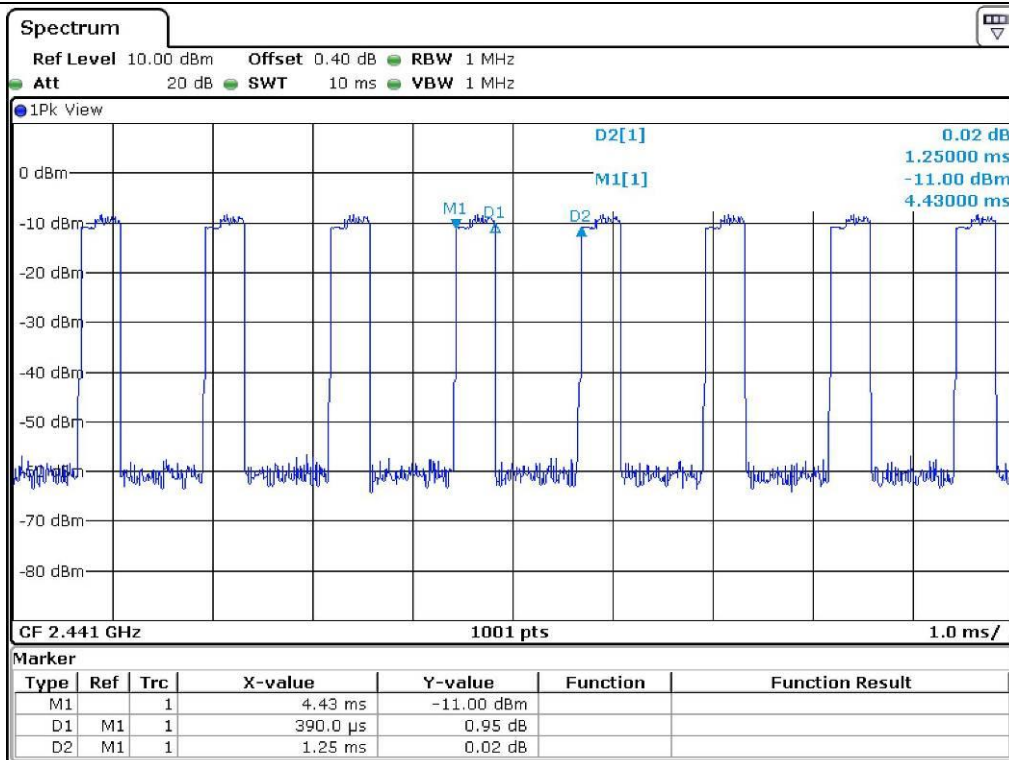
Total dwell time is calculated as following.

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

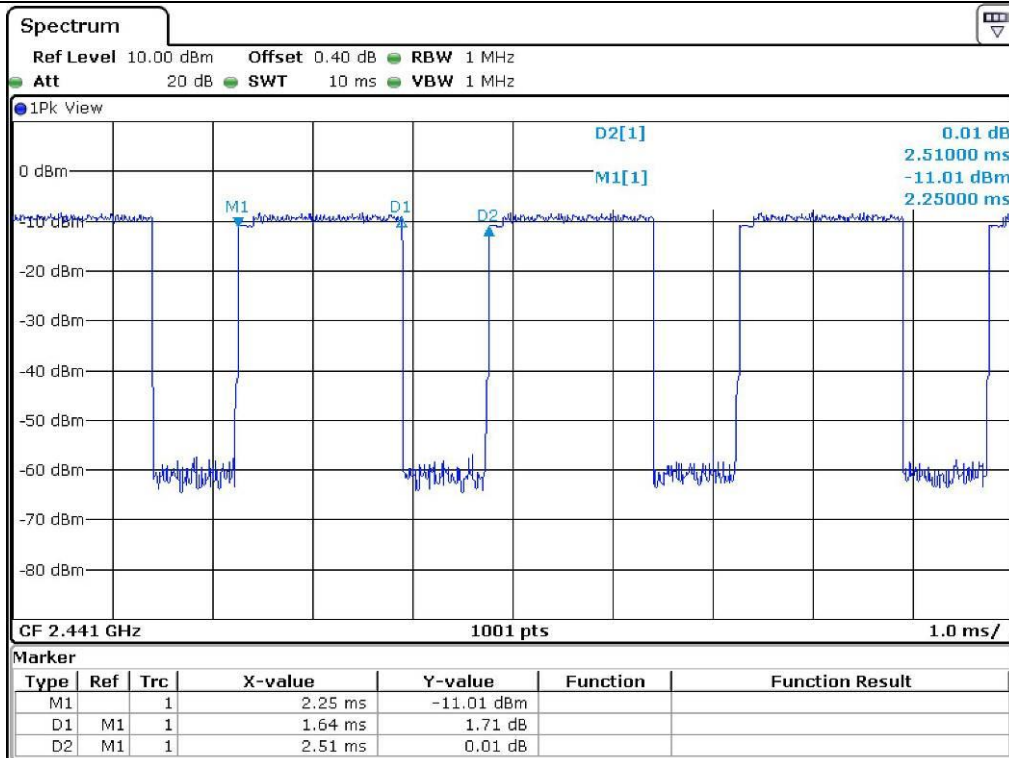
Remark: See next page for an overview sweep performed with peak detector.



Tested by: Tae-Ho, Kim / Senior Manager



DH1



DH3

