

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

Test Report No. : W166R-D011
AGR No. : A164A-140
Applicant : LG Electronics USA
Address : 1000 Sylvan Avenue, Englewood Cliffs, New Jersey, 7632, United States
Manufacturer : LG Electronics USA
Address : 1000 Sylvan Avenue, Englewood Cliffs, New Jersey, 7632, United States
Type of Equipment : BT Module
FCC ID. : BEJ-LGBTM
Model Name : LGBTM
Serial number : N/A
Total page of Report : 84 pages (including this page)
Date of Incoming : April 25, 2016
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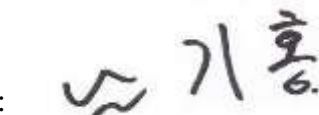
SUMMARY

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 / Asst, Chief Engineer
ONETECH Corp.

Approved by:



Sung-Ik, Han/ Managing Director
ONETECH Corp.

CONTENTS

PAGE

1. VERIFICATION OF COMPLIANCE	6
2. TEST SUMMARY	7
2.1 TEST ITEMS AND RESULTS	7
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS	7
2.3 RELATED SUBMITTAL(S) / GRANT(S)	7
2.4 PURPOSE OF THE TEST	7
2.5 TEST METHODOLOGY	7
2.6 TEST FACILITY	8
3. GENERAL INFORMATION	9
3.1 PRODUCT DESCRIPTION	9
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT	9
4. EUT MODIFICATIONS	9
5. SYSTEM TEST CONFIGURATION	10
5.1 JUSTIFICATION	10
5.2 PERIPHERAL EQUIPMENT	10
5.3 MODE OF OPERATION DURING THE TEST	10
5.4 CONFIGURATION OF TEST SYSTEM	11
6. PRELIMINARY TEST	11
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS	11
6.2 GENERAL RADIATED EMISSIONS TESTS	11
7. MINIMUM 20 DB BANDWIDTH	12
7.1 OPERATING ENVIRONMENT	12
7.2 TEST SET-UP	12
7.3 TEST EQUIPMENT USED	12
7.4 TEST DATA FOR 1 MBPS	13
7.5 TEST DATA FOR 2 MBPS	15
7.6 TEST DATA FOR 3 MBPS	17
8. HOPPING FREQUENCY SEPARATION	19
8.1 OPERATING ENVIRONMENT	19
8.2 TEST SET-UP	19
8.3 TEST EQUIPMENT USED	19
8.4 TEST DATA FOR 1 MBPS	20

8.5 TEST DATA FOR 2 MBPS	21
8.6 TEST DATA FOR 3 MBPS	22
9. NUMBER OF HOPPING CHANNELS	23
9.1 OPERATING ENVIRONMENT	23
9.2 TEST SET-UP	23
9.3 TEST EQUIPMENT USED	23
9.4 TEST DATA FOR 1 MBPS	24
9.5 TEST DATA FOR 2 MBPS	27
9.6 TEST DATA FOR 3 MBPS	30
10. TIME OF OCCUPANCY	33
10.1 OPERATING ENVIRONMENT	33
10.2 TEST SET-UP	33
10.3 TEST EQUIPMENT USED	33
10.4 TEST DATA FOR 1 MBPS	34
10.5 TEST DATA FOR 2 MBPS	37
10.6 TEST DATA FOR 3 MBPS	40
11. MAXIMUM PEAK OUTPUT POWER	43
11.1 OPERATING ENVIRONMENT	43
11.2 TEST SET-UP	43
11.3 TEST EQUIPMENT USED	43
11.4 TEST DATA FOR 1 MBPS	44
11.5 TEST DATA FOR 2 MBPS	46
11.6 TEST DATA FOR 3 MBPS	48
12. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND	50
12.1 OPERATING ENVIRONMENT	50
12.2 TEST SET-UP FOR CONDUCTED MEASUREMENT	50
12.3 TEST SET-UP FOR RADIATED MEASUREMENT	50
12.4 TEST EQUIPMENT USED	50
12.5 TEST DATA FOR CONDUCTED EMISSION	51
12.5.1 Test data for 1 Mbps	51
12.5.2 Test data for 2 Mbps	57
12.5.3 Test data for 3 Mbps	63
12.6 TEST DATA FOR TRANSMITTING MODE RADIATED EMISSION	69
12.6.1 Radiated Emission which fall in the Restricted Band	69
12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz	72
13. RADIATED EMISSION TEST	75

13.1 OPERATING ENVIRONMENT	75
13.2 TEST SET-UP	75
13.3 TEST EQUIPMENT USED	75
13.4 TEST DATA FOR 1 MBPS	76
<i>13.4.1 Test data for 30 MHz ~ 1 000 MHz.....</i>	<i>76</i>
<i>13.4.2 Test data for Below 30 MHz.....</i>	<i>77</i>
<i>13.4.3 Test data for above 1 GHz</i>	<i>77</i>
13.5 TEST DATA FOR 2 MBPS	78
<i>13.5.1 Test data for 30 MHz ~ 1 000 MHz.....</i>	<i>78</i>
<i>13.5.2 Test data for Below 30 MHz.....</i>	<i>79</i>
<i>13.5.3 Test data for above 1 GHz</i>	<i>79</i>
13.6 TEST DATA FOR 3 MBPS	80
<i>13.6.1 Test data for 30 MHz ~ 1 000 MHz.....</i>	<i>80</i>
<i>13.6.2 Test data for Below 30 MHz.....</i>	<i>81</i>
<i>13.6.3 Test data for above 1 GHz</i>	<i>81</i>
14. CONDUCTED EMISSION TEST	82
14.1 OPERATING ENVIRONMENT	82
14.2 TEST SET-UP	82
14.3 TEST EQUIPMENT USED	82
14.4 TEST DATA	83

Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W166R-D011	June 08, 2016	Initial Issue	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Electronics USA
Address : 1000 Sylvan Avenue, Englewood Cliffs, New Jersey, 7632, United States
Contact Person : Yongduk Kwon / Research Engineer
Telephone No. : +82-31-610-9606
FCC ID : BEJ-LGBTM
Model Name : LGBTM
Serial Number : N/A
Date : June 08, 2016

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
KIND OF EQUIPMENT	Modular Transmitter
E.U.T. DESCRIPTION	BT Module
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 (b) (5)	Radio Frequency Exposure Level	Met requirement / 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-4617/ G-666/ T-1842

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

-. 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 LGBTM (referred to as the EUT in this report) is a BT Module. The product specification described herein was obtained from product data sheet or user's manual.

Device Type	BT Module	
Temperature Range	-25 °C ~ +75 °C	
Operating Frequency	2 402 MHz ~ 2 480 MHz	
RF Output Power	1 Mbps	-2.50 dBm
	2 Mbps	-0.76 dBm
	3 Mbps	-0.11 dBm
Number of Channel	79 Channel	
Modulation Type	GFSK for 1Mbps, $\pi/4$ -QPSK for 2Mbps, 8-DPSK for 3Mbps	
Antenna Type	Chip Antenna	
USED RF CHIP	Marker: TOSHIBA	
	Model Name: TC35668IXBG	
Antenna Gain	3.5 dBi	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	38.4 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	LG Electronics USA	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
LGBTM	LG Electronics USA	BT Module (EUT)	BT RF Test Board
R510	LG	Notebook PC	BT RF Test Board
BT RF Test Board	N/A	Jig board	Notebook PC
			BT Module (EUT)

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, 2 441 MHz and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XZ” axis, but the worst data was recorded in this report.

5.4 Configuration of Test System

Line Conducted Test: The jig board of 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 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 Tests, 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 Tests, the following operating modes were investigated

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

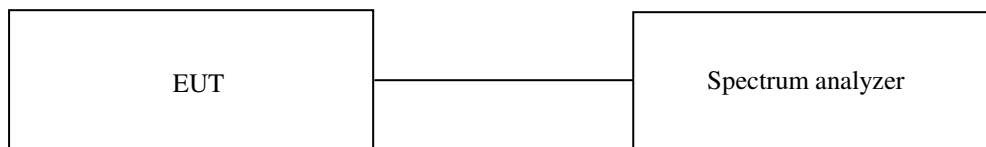
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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	Jul. 22, 2015 (1Y)

All test equipment used is calibrated on a regular basis.

7.4 Test data for 1 Mbps

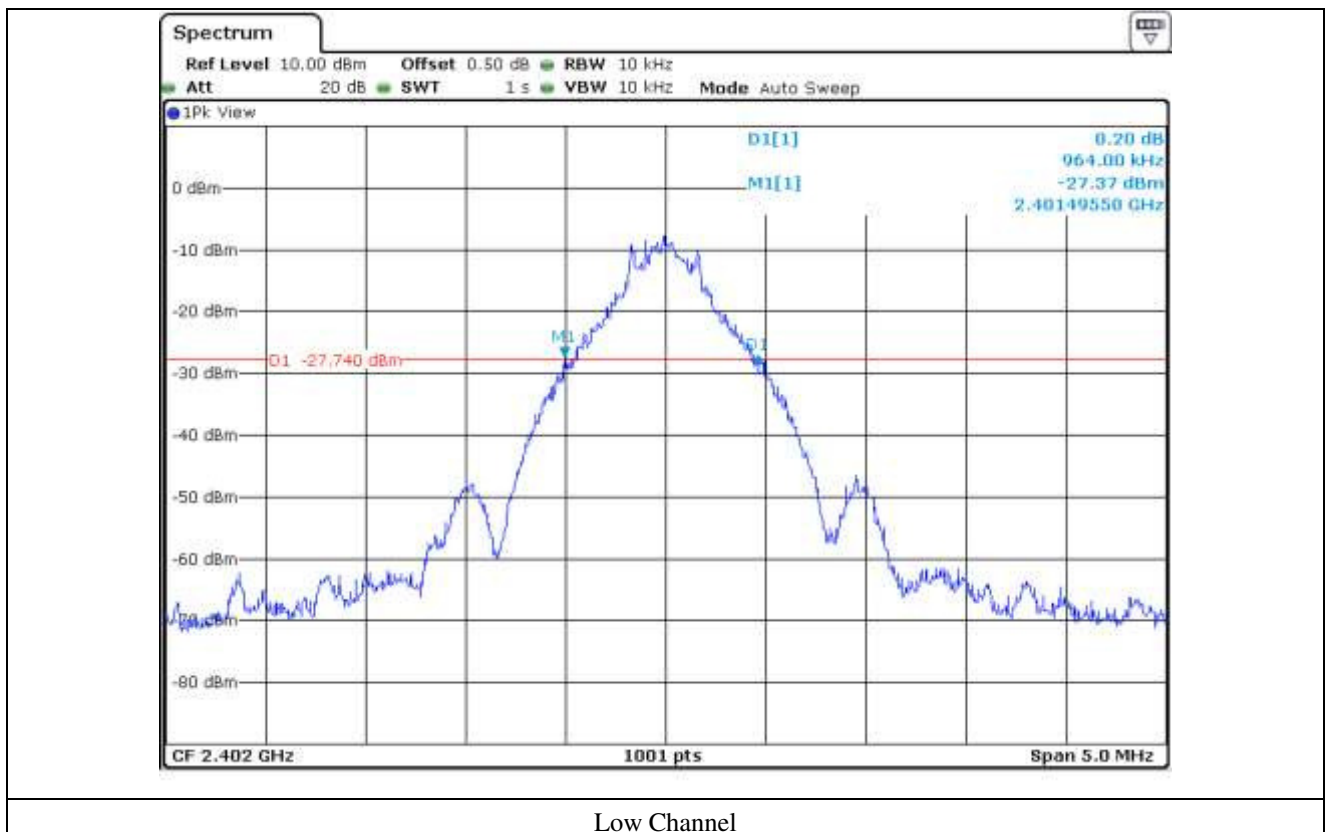
-. Test Date : May 02, 2016

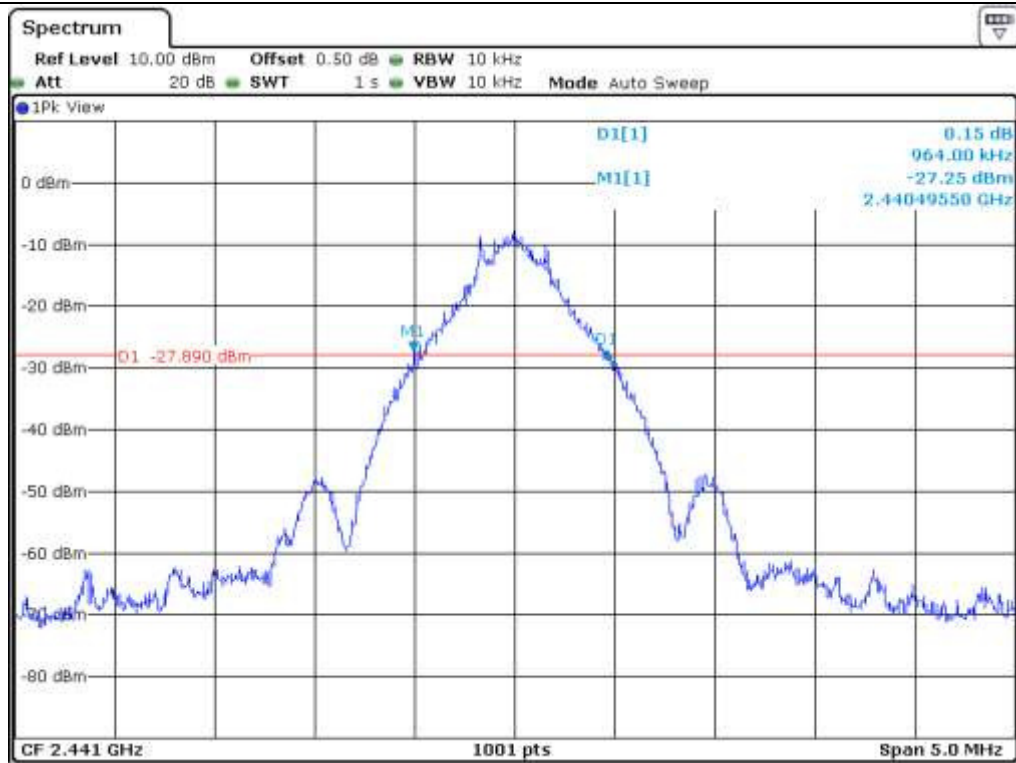
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	20 dB BANDWIDTH (kHz)
Low	2 402	964.00
Middle	2 441	964.00
High	2 480	959.00

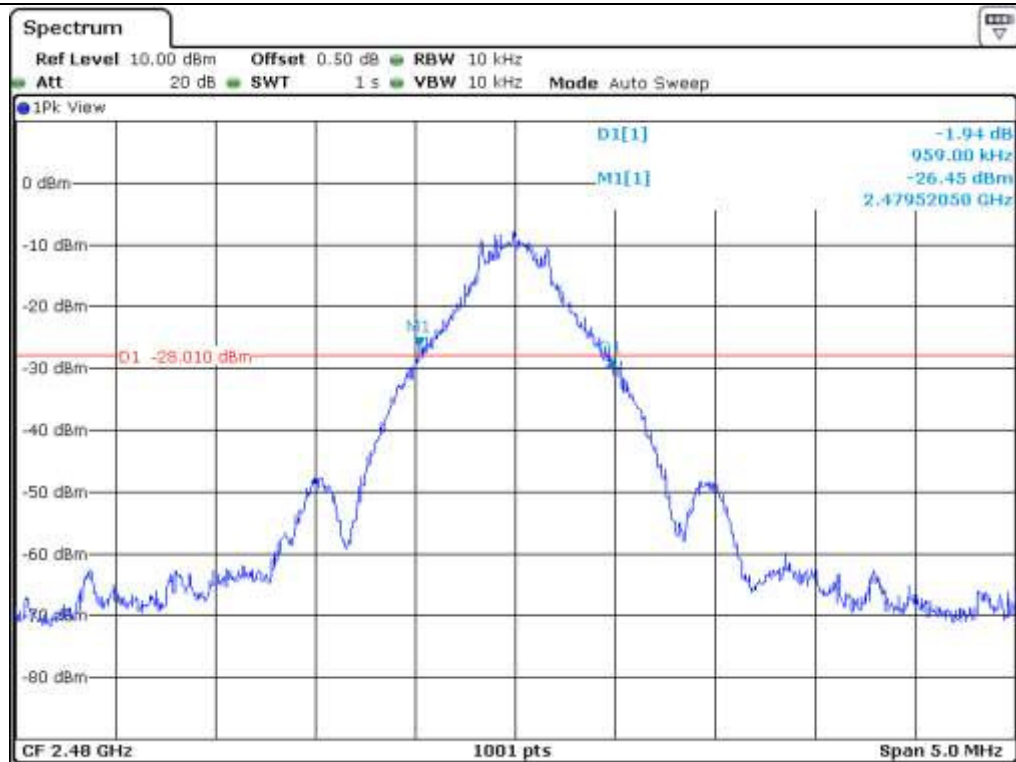


Tested by: Hyung-Kwon, Oh / Engineer





Middle Channel



High Channel

7.5 Test data for 2 Mbps

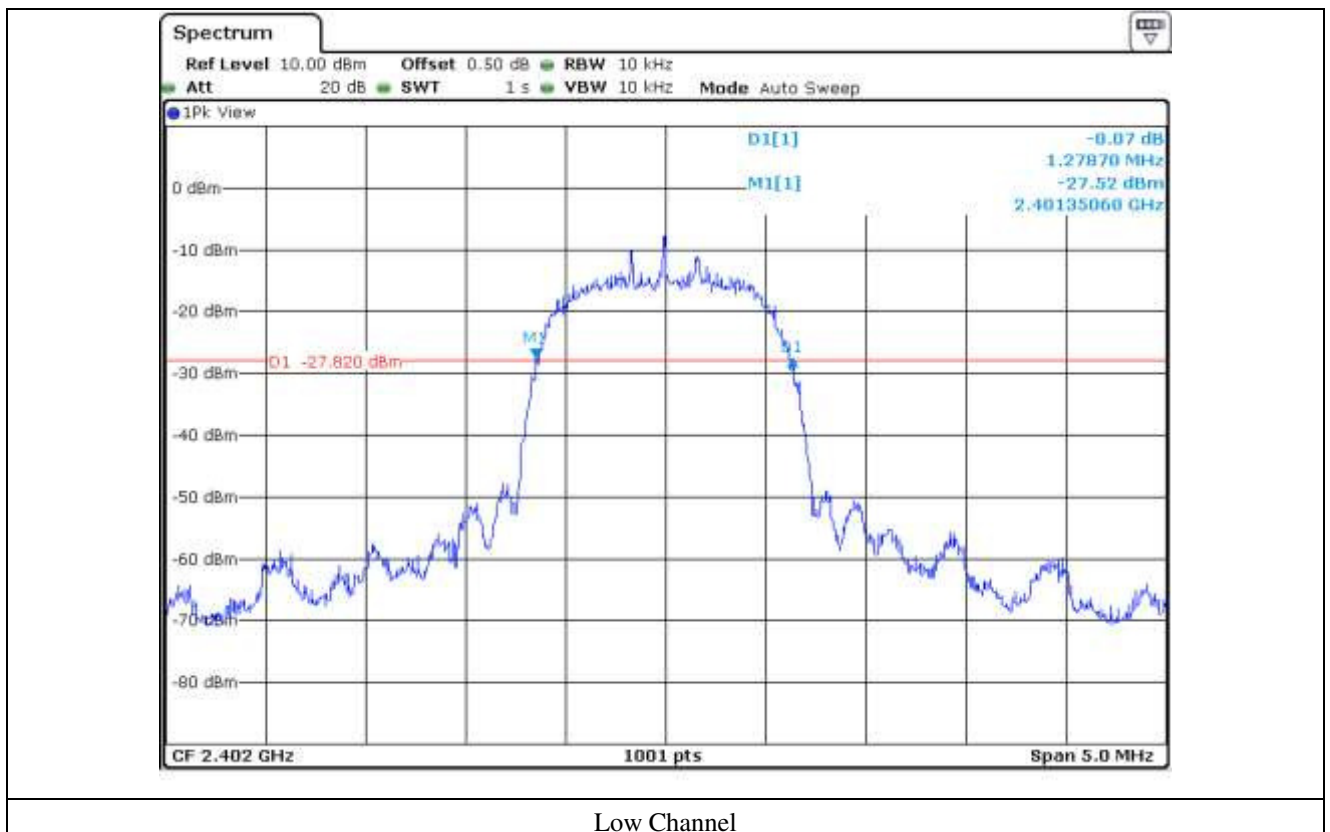
-. Test Date : May 02, 2016

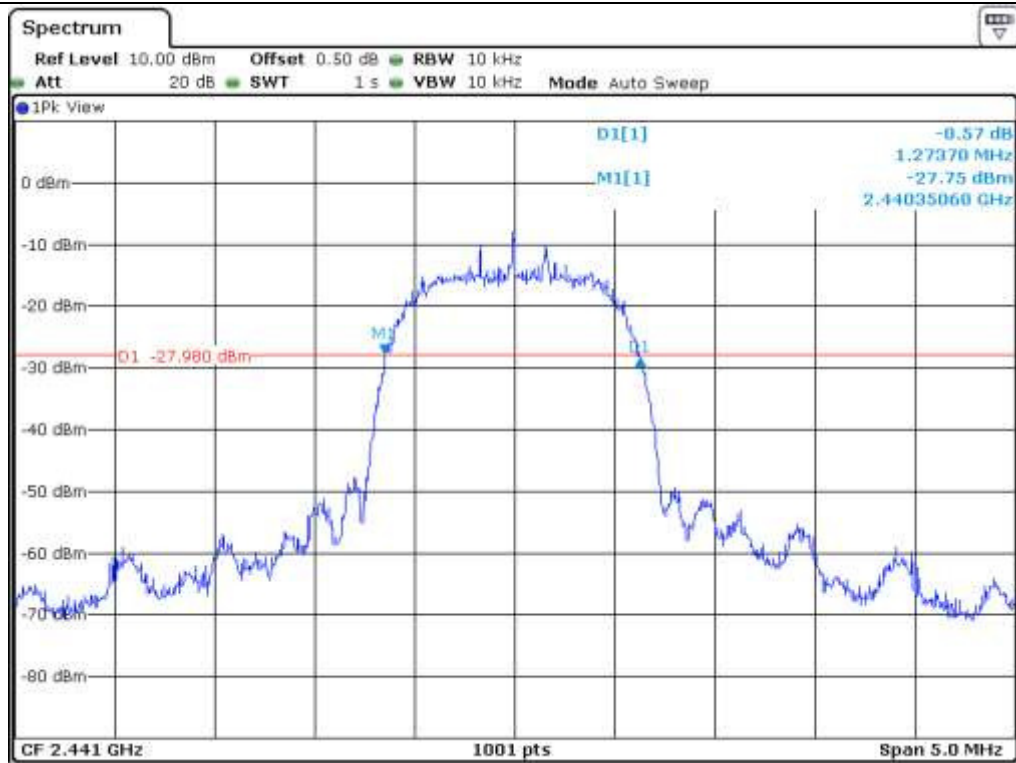
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	20 dB BANDWIDTH (kHz)
Low	2 402	1 278.70
Middle	2 441	1 273.70
High	2 480	1 263.70

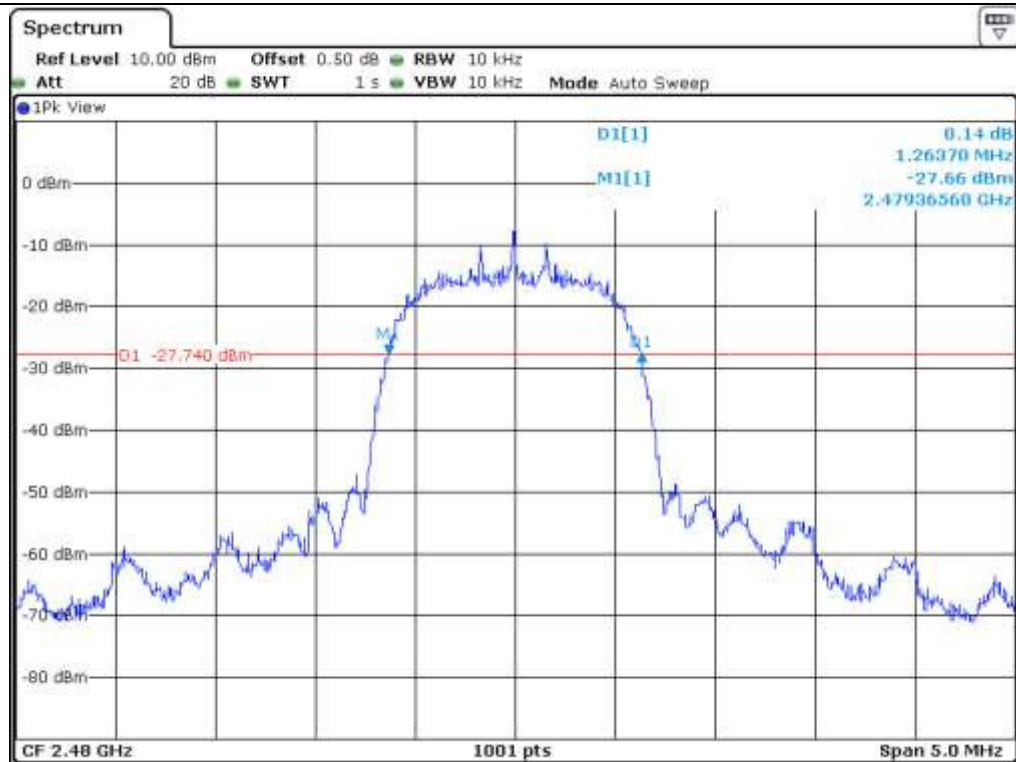


Tested by: Hyung-Kwon, Oh / Engineer





Middle Channel



High Channel

7.6 Test data for 3 Mbps

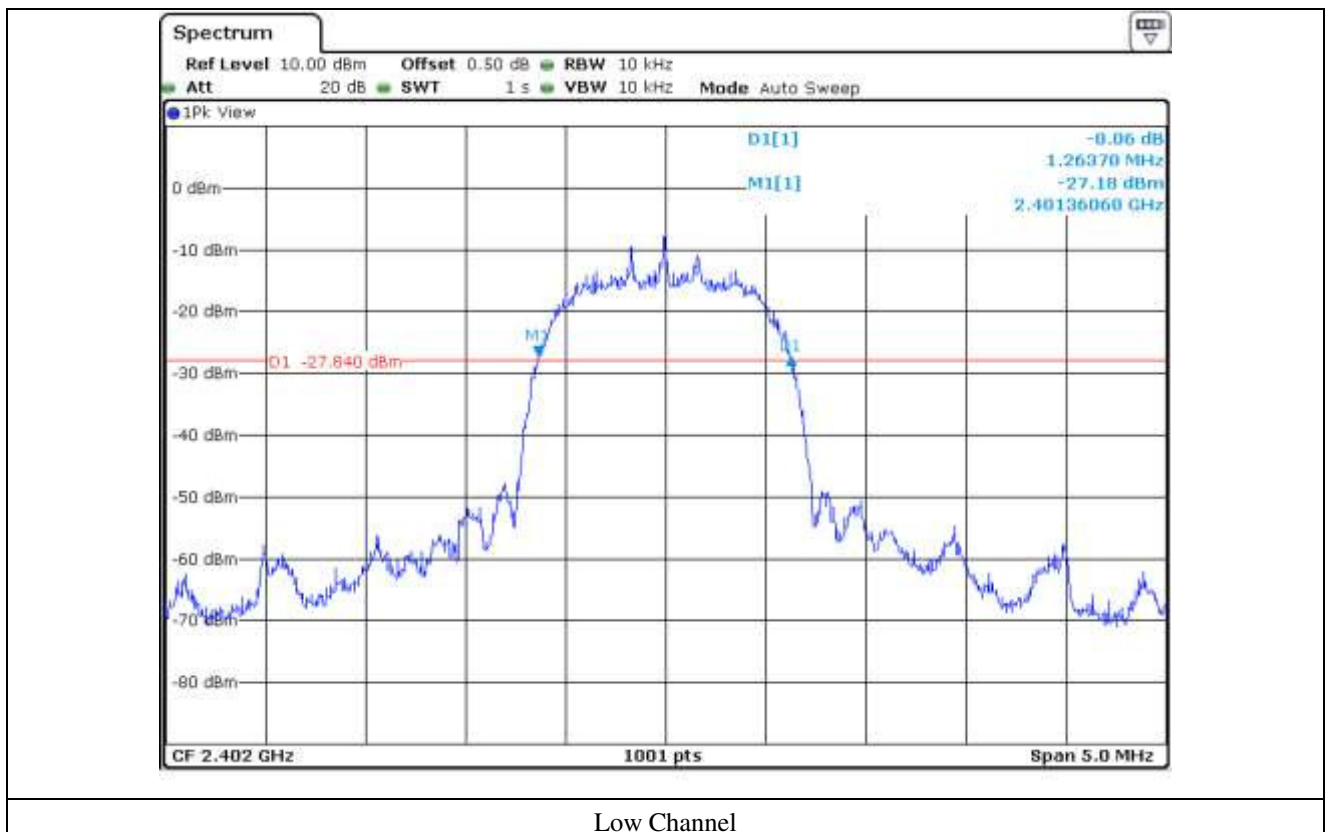
-. Test Date : May 02, 2016

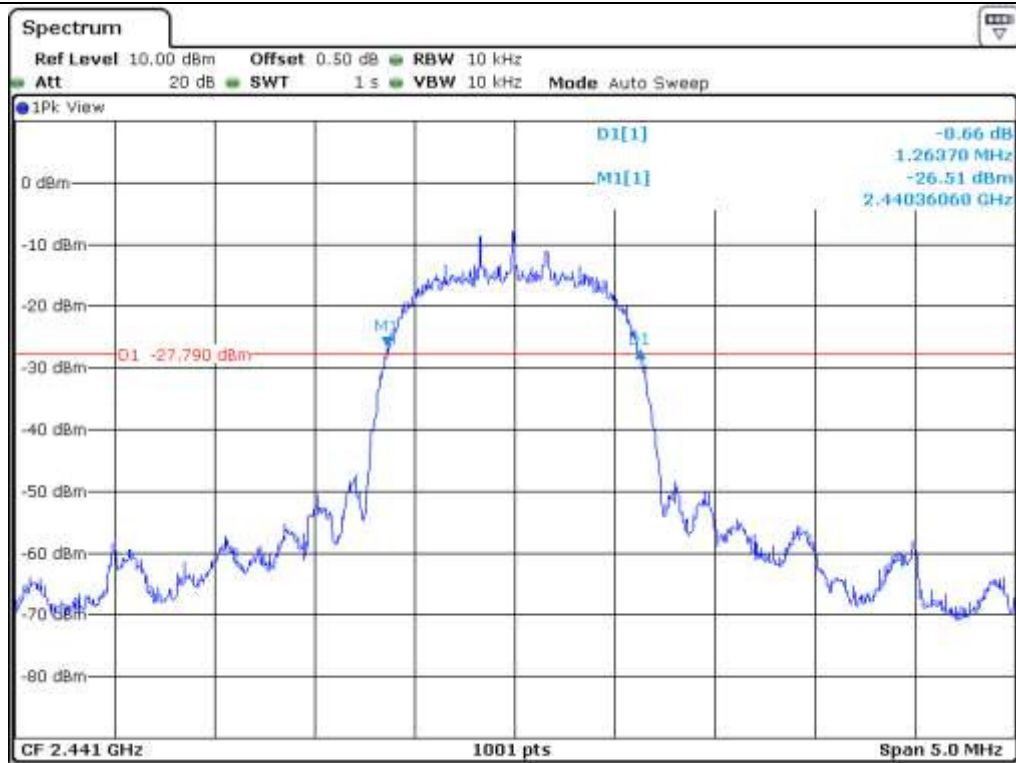
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	20 dB BANDWIDTH (kHz)
Low	2 402	1 263.70
Middle	2 441	1 263.70
High	2 480	1 288.70

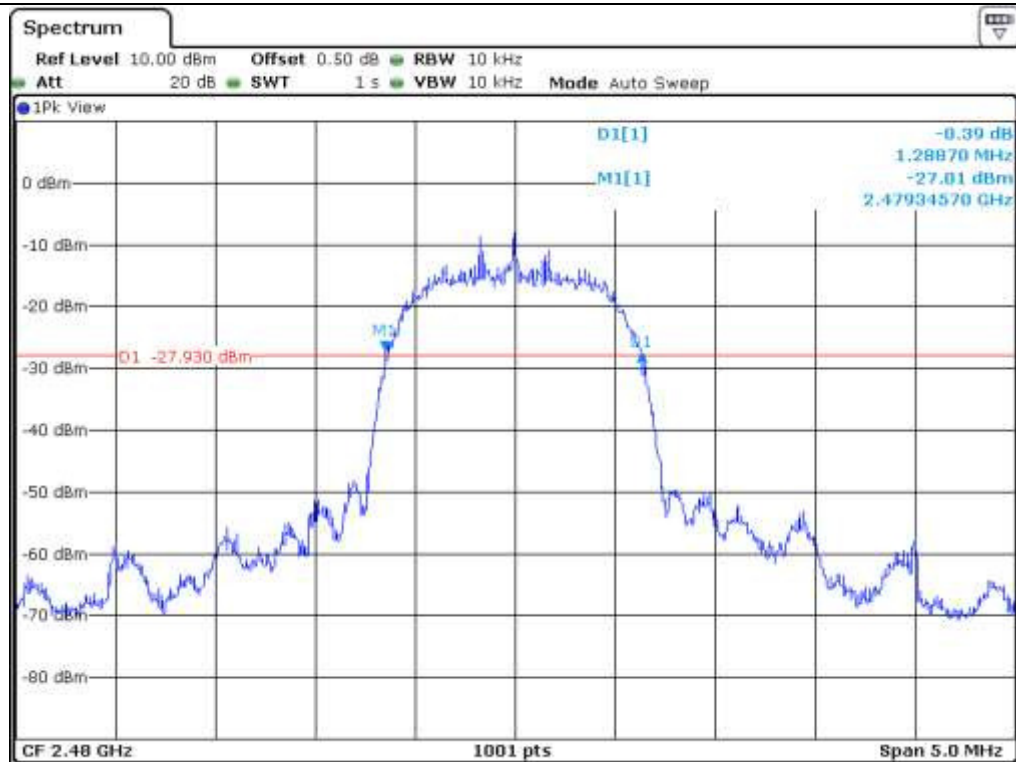


Tested by: Hyung-Kwon, Oh / Engineer





Middle Channel



High Channel

8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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	Jul. 22, 2015 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 1 Mbps

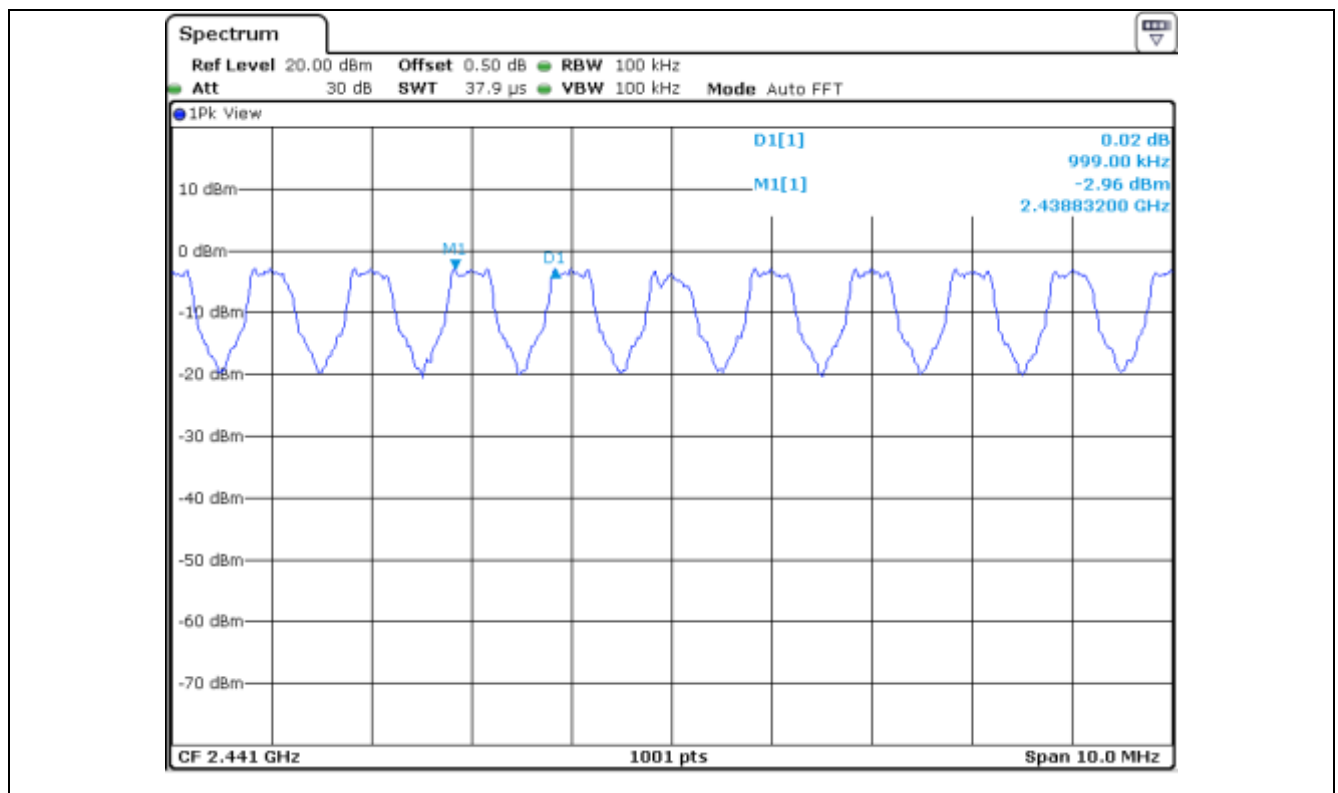
-. Test Date : May 02, 2016

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	642.67	Separated by a minimum of 25 kHz



Tested by: Hyung-Kwon, Oh / Engineer



8.5 Test data for 2 Mbps

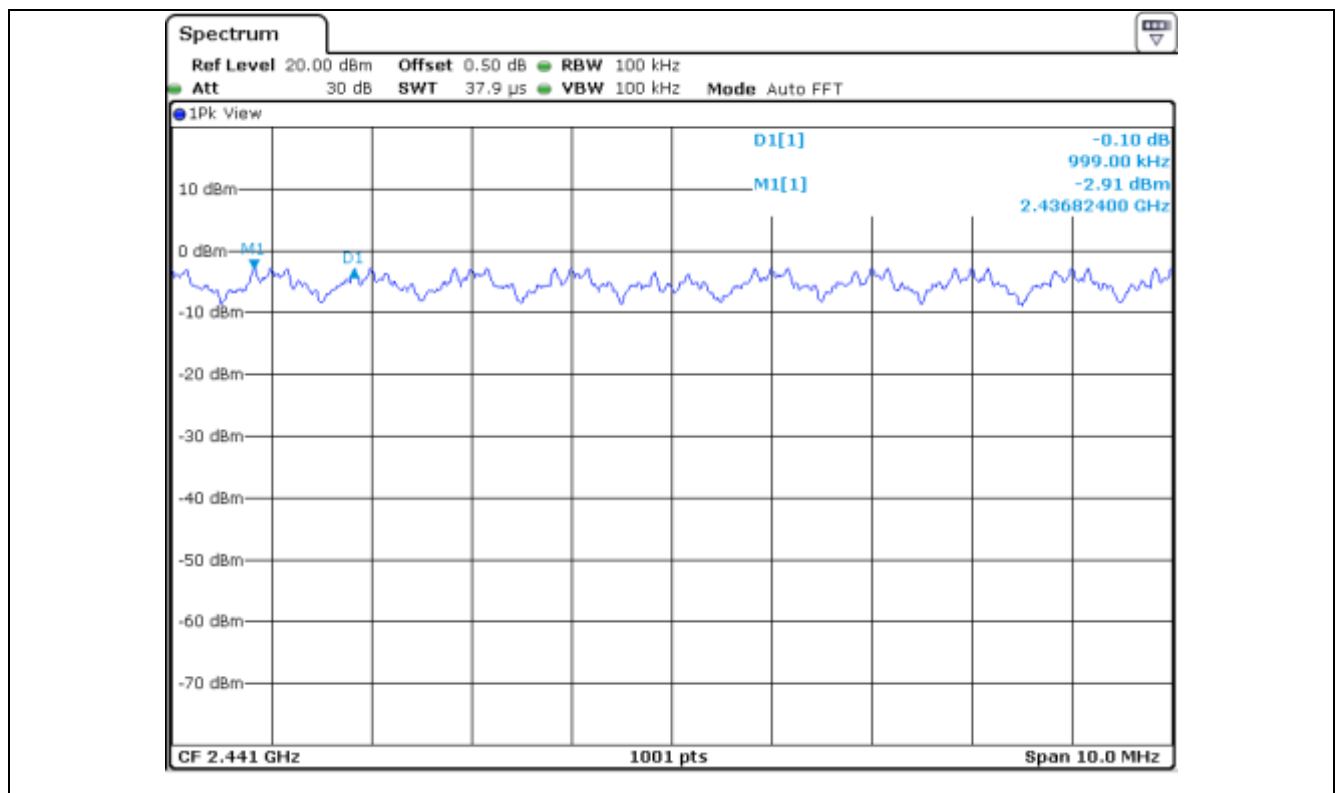
-. Test Date : May 02, 2016

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	849.13	Separated by a minimum of 25 kHz



Tested by: Hyung-Kwon, Oh / Engineer



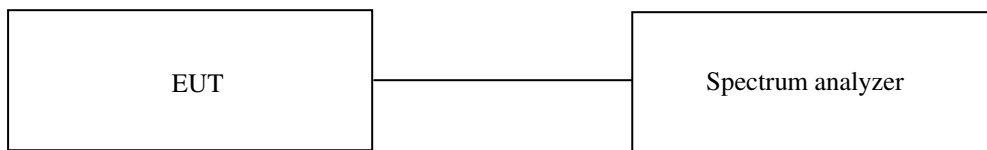
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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	Jul. 22, 2015 (1Y)

All test equipment used is calibrated on a regular basis.

9.4 Test data for 1 Mbps

-. Test Date : May 02, 2016

-. Test Result : Pass

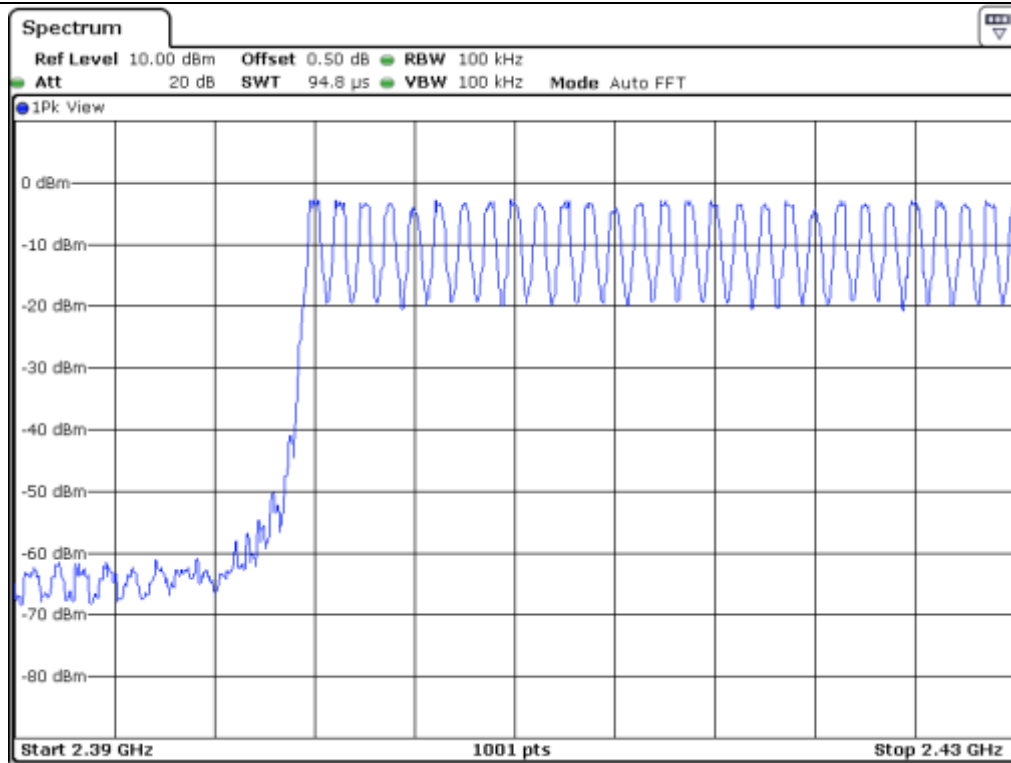
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
1 Mbps	79	Minimum of 15	64



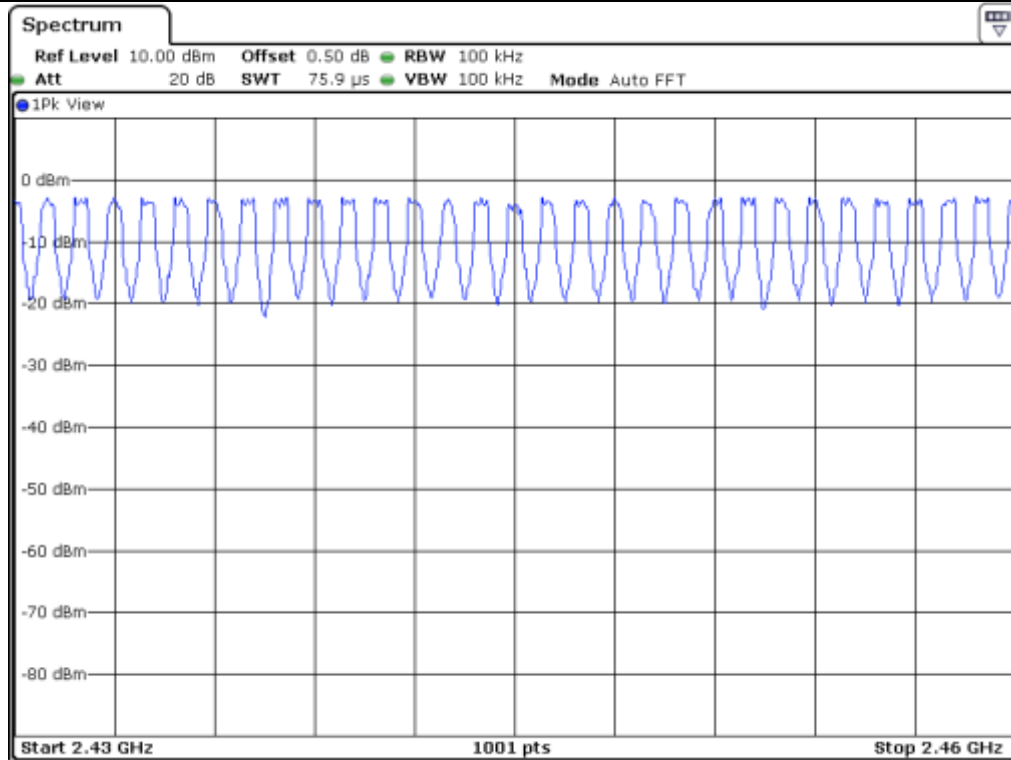
Tested by: Hyung-Kwon, Oh / Engineer



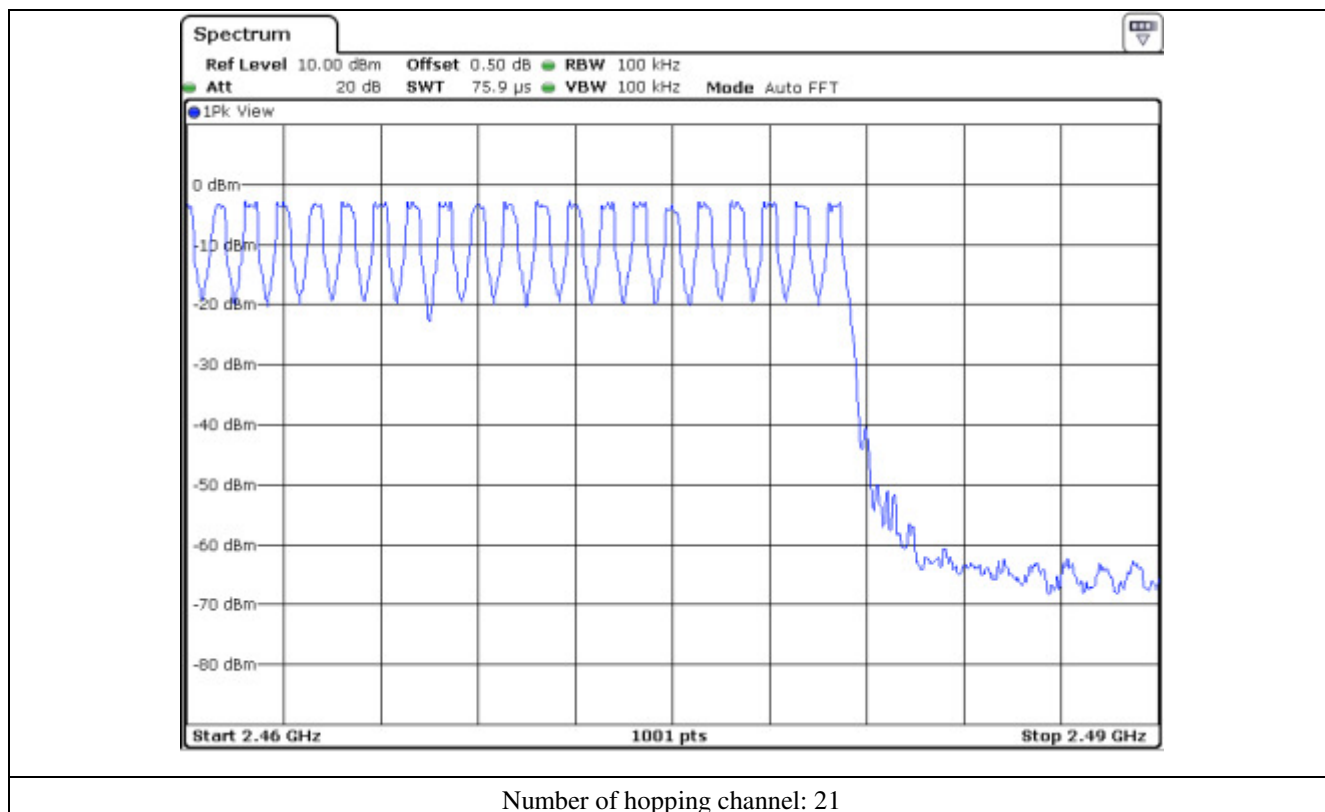
Total number of hopping channel: $28+30+21 = 79$



Number of hopping channel: 28



Number of hopping channel: 30



9.5 Test data for 2 Mbps

-. Test Date : May 02, 2016

-. Test Result : Pass

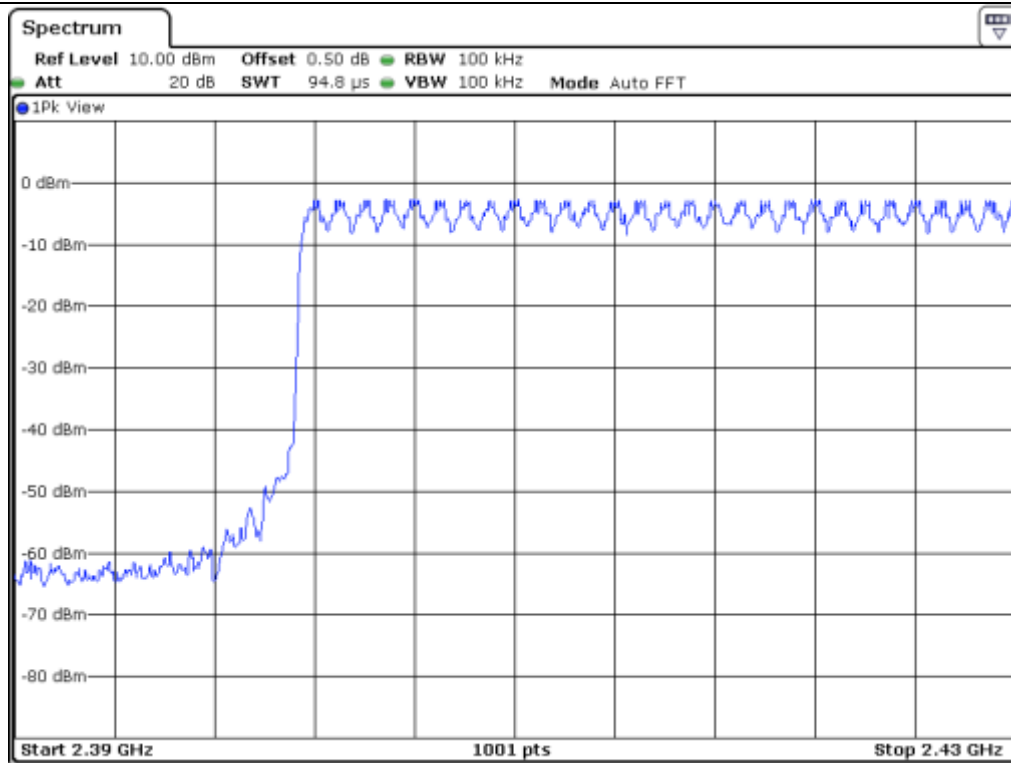
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
2 Mbps	79	Minimum of 15	64



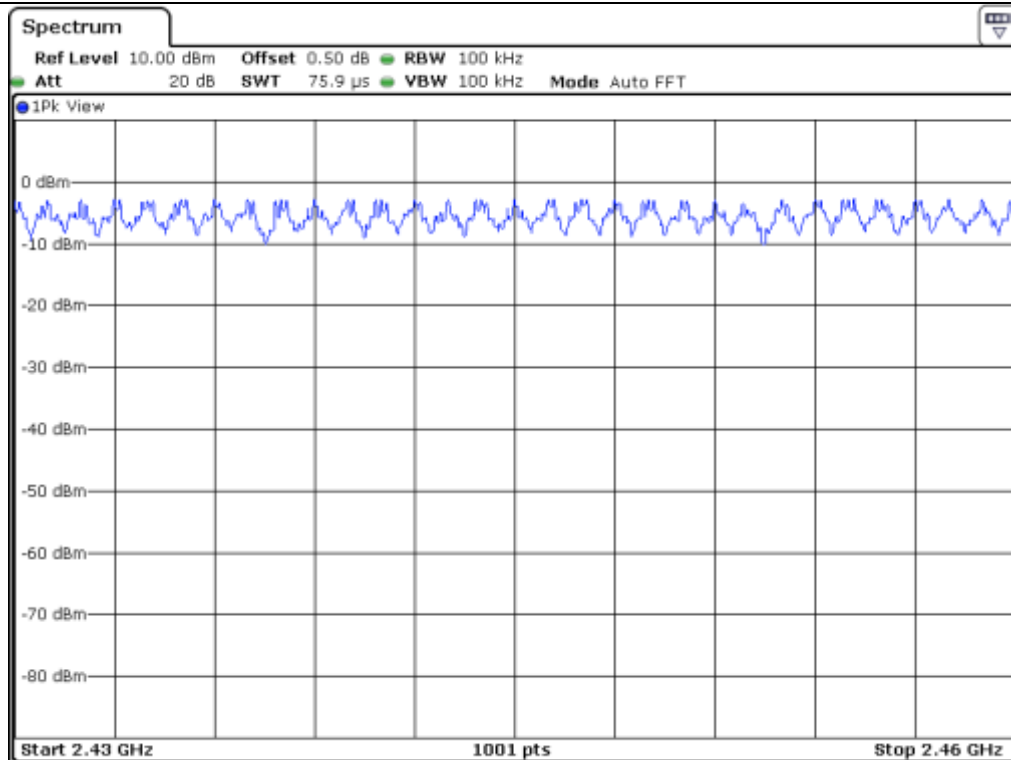
Tested by: Hyung-Kwon, Oh / Engineer



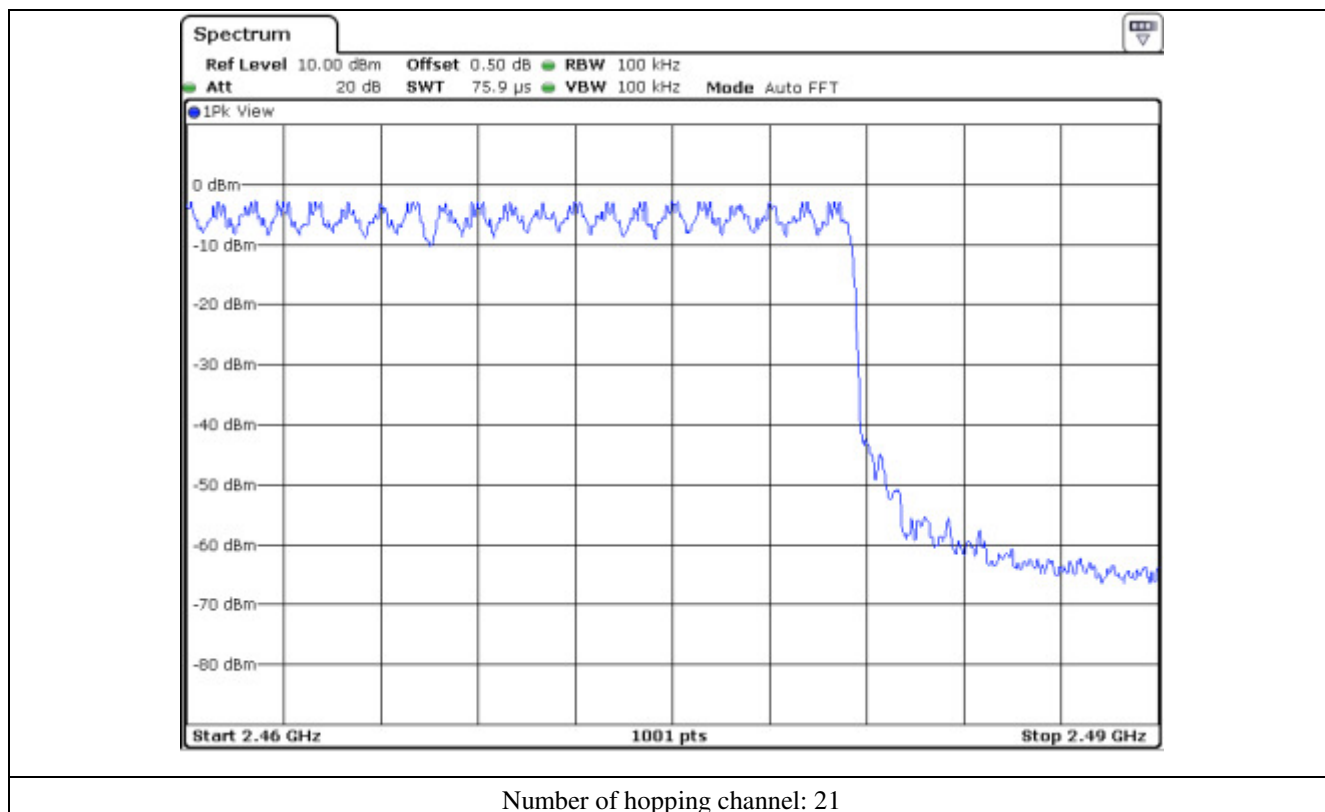
Total number of hopping channel: $28+30+21 = 79$



Number of hopping channel: 28



Number of hopping channel: 30



9.6 Test data for 3 Mbps

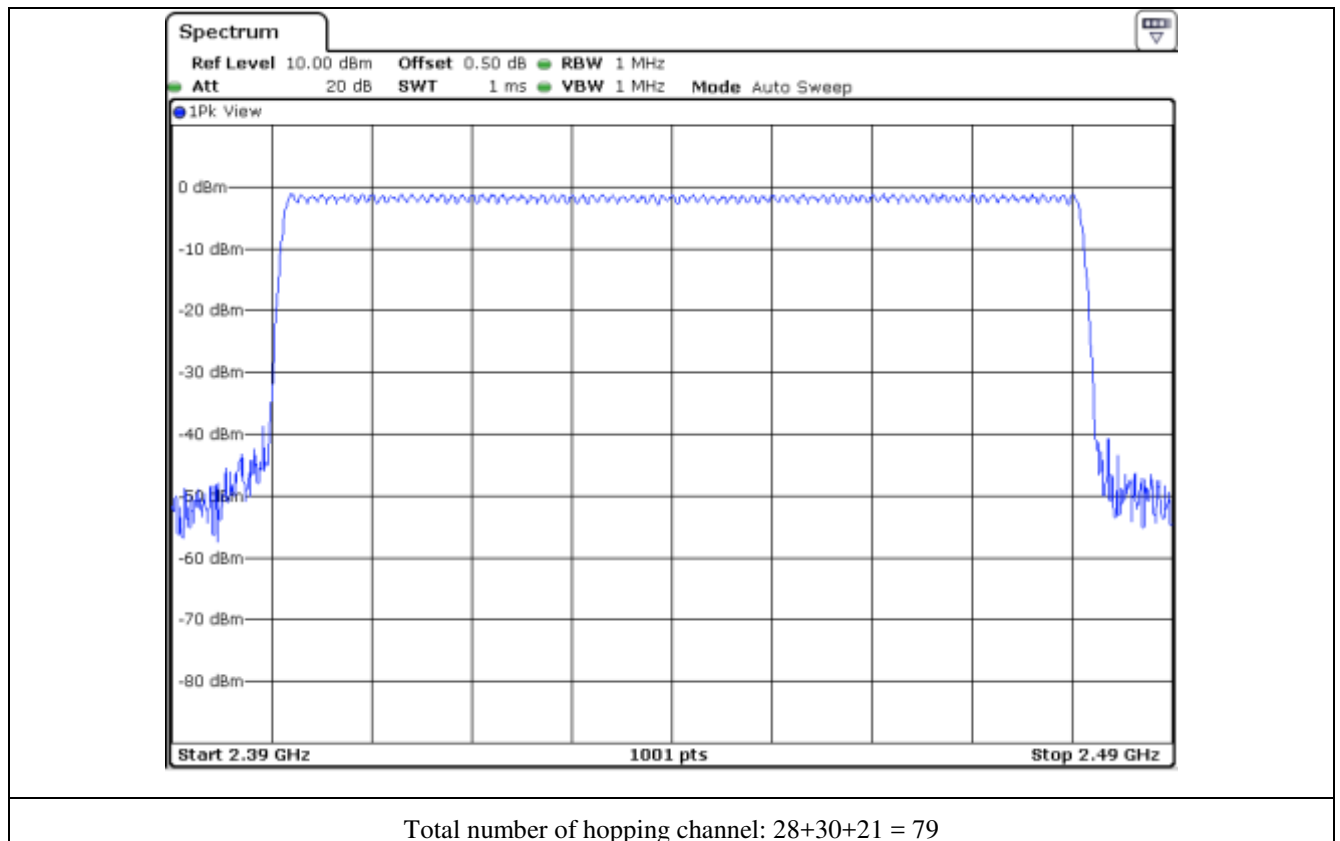
-. Test Date : May 02, 2016

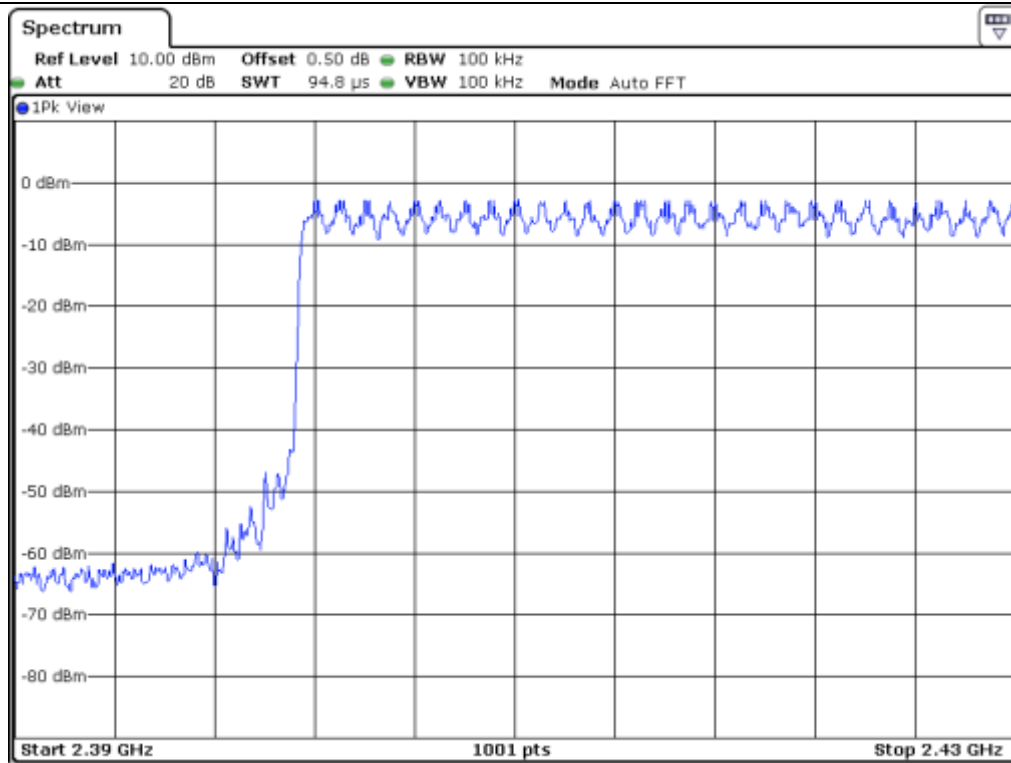
-. Test Result : Pass

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

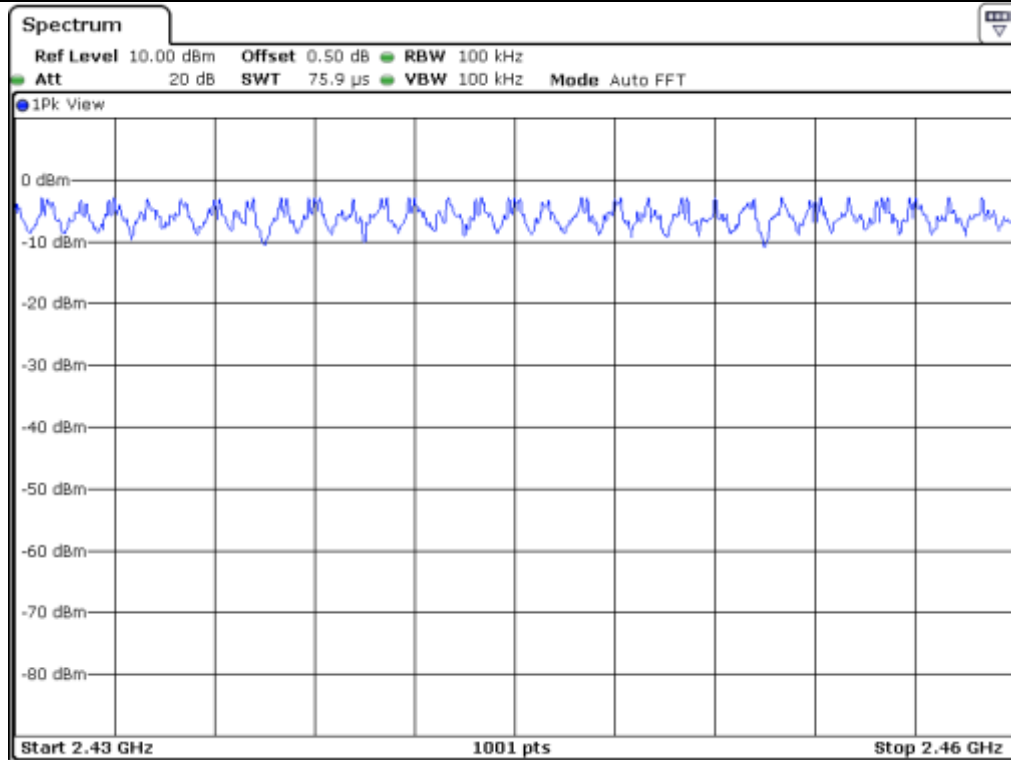


Tested by: Hyung-Kwon, Oh / Engineer

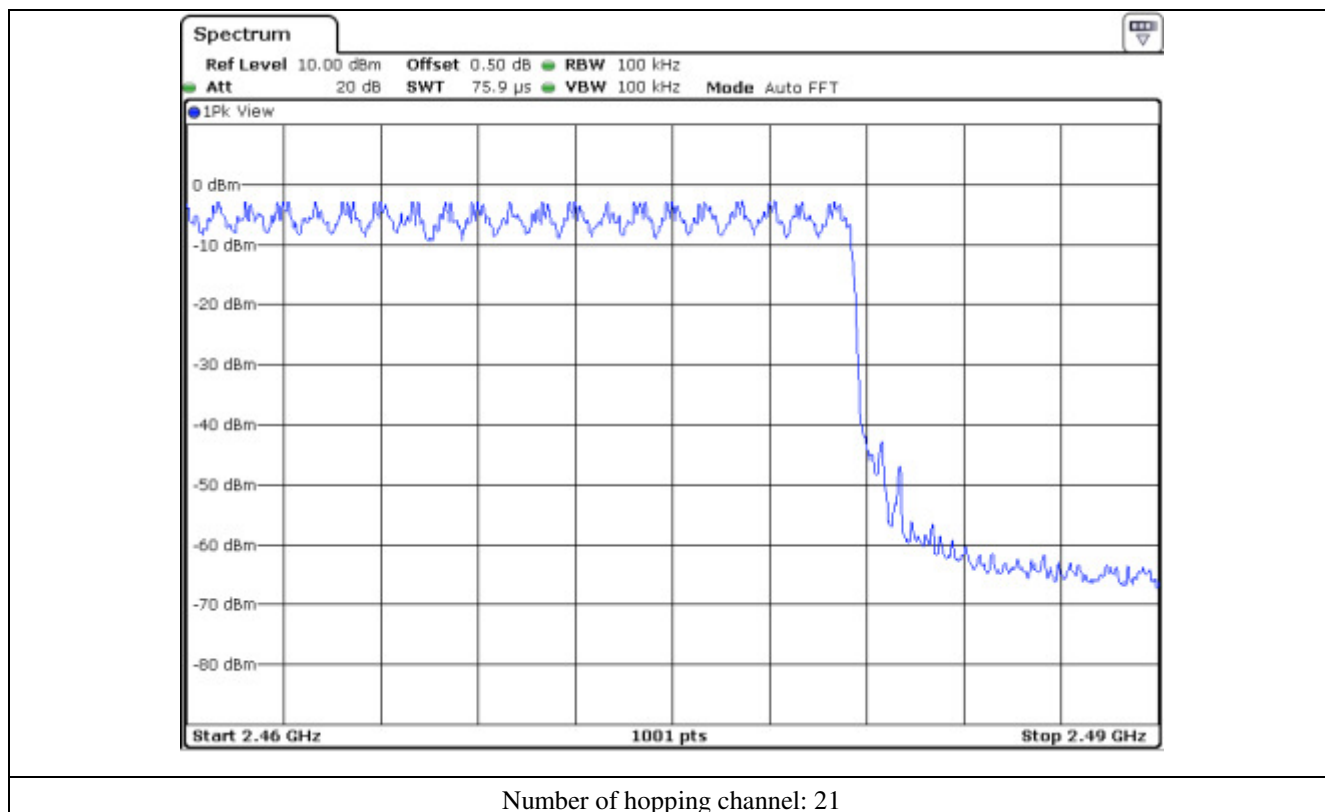




Number of hopping channel: 28



Number of hopping channel: 30



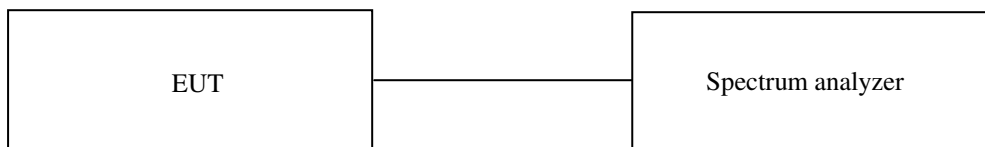
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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	Jul. 22, 2015 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for 1 Mbps

-. Test Date : May 02, 2016

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	0.420	10.13	31.6	134.45	400	PASS
DH3	1.680	5.06	31.6	268.63	400	
DH5	2.930	3.38	31.6	312.95	400	

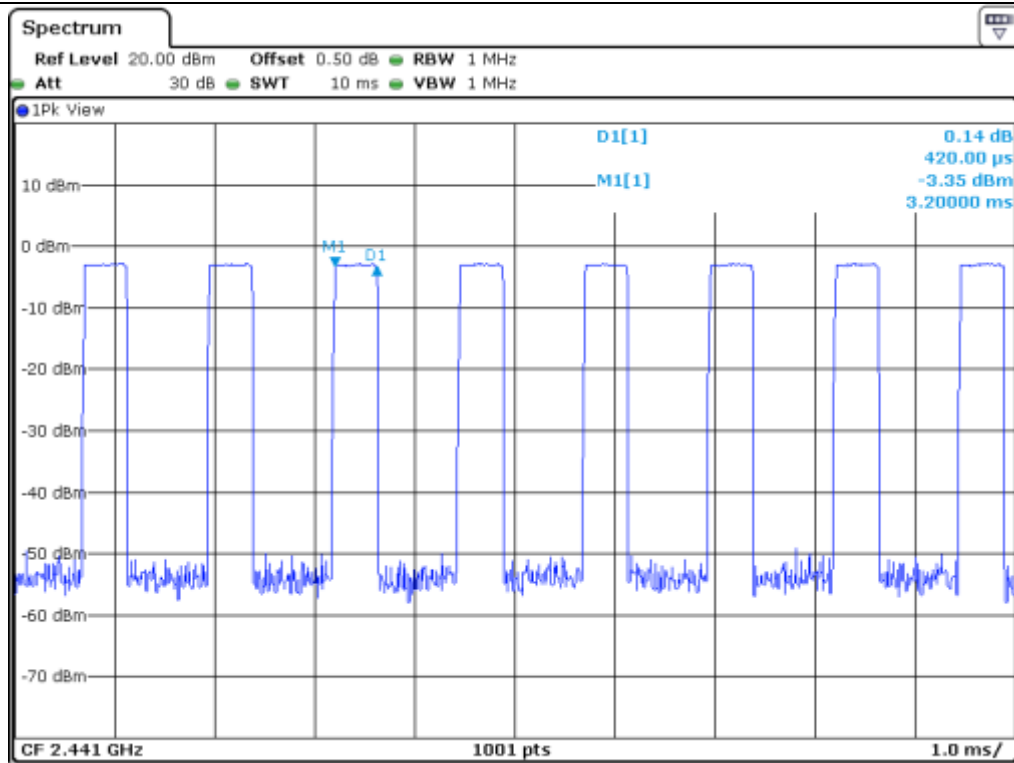
Total dwell time is calculated as following.

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

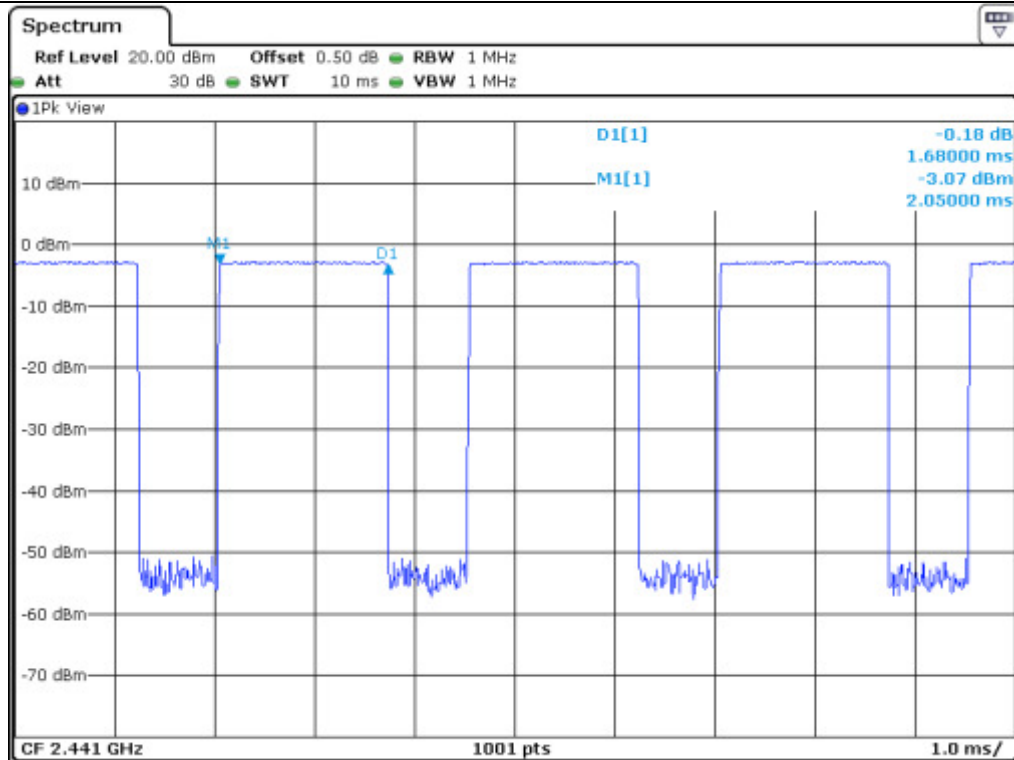
Remark: See next page for an overview sweep performed with peak detector.



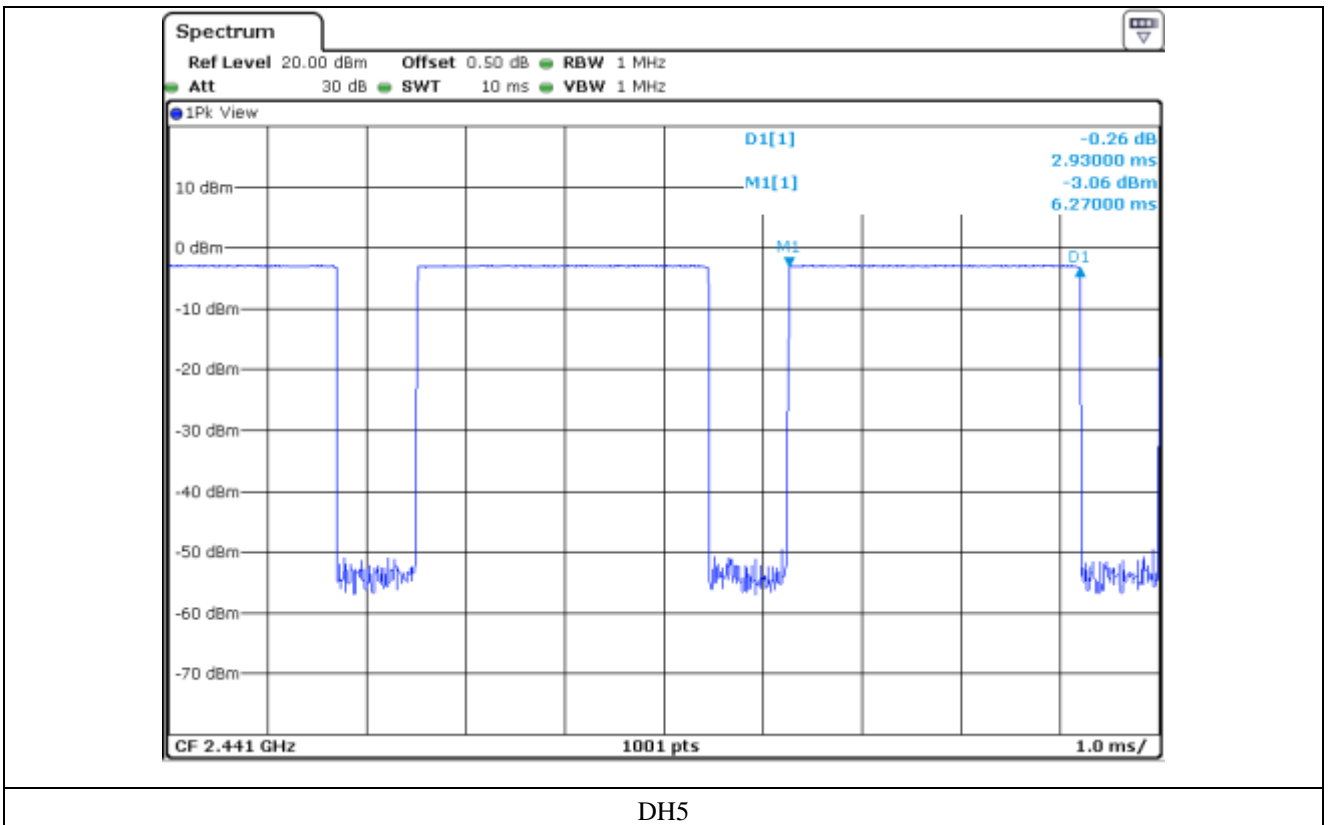
Tested by: Hyung-Kwon, Oh / Engineer



DH1



DH3



10.5 Test data for 2 Mbps

-. Test Date : May 02, 2016

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	0.420	10.13	31.6	134.45	400	PASS
DH3	1.670	5.06	31.6	267.03	400	
DH5	2.920	3.38	31.6	311.88	400	

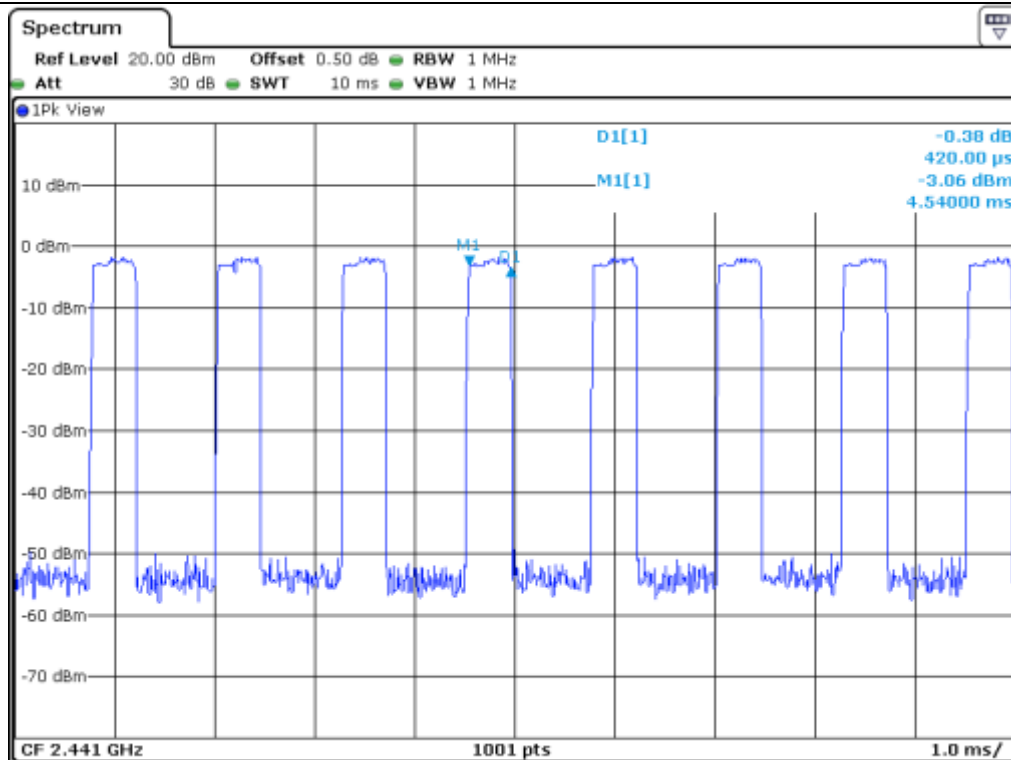
Total dwell time is calculated as following.

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

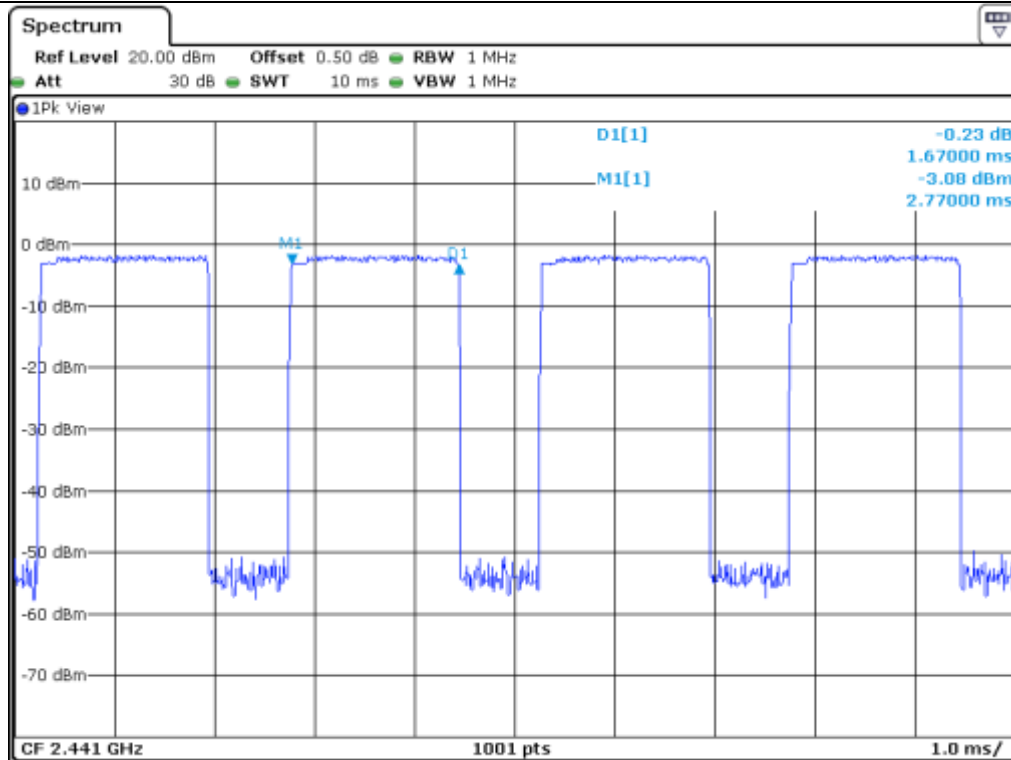
Remark: See next page for an overview sweep performed with peak detector.



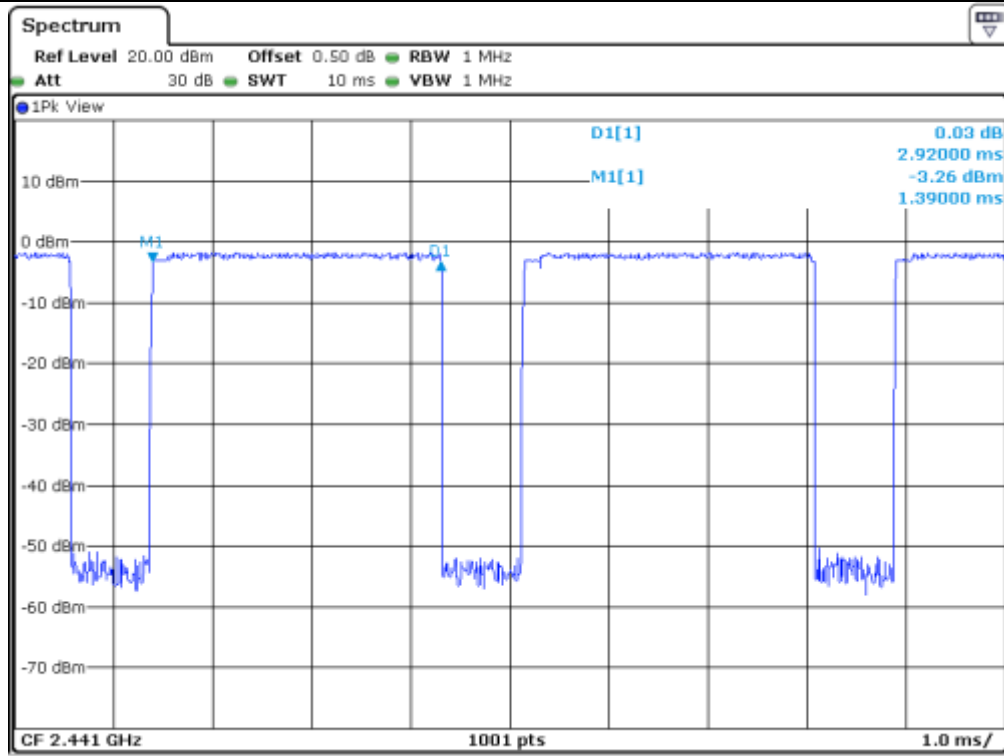
Tested by: Hyung-Kwon, Oh / Engineer



DH1



DH3



DH5

10.6 Test data for 3 Mbps

-. Test Date : May 02, 2016

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	0.410	10.13	31.6	131.24	400	PASS
DH3	1.660	5.06	31.6	265.43	400	
DH5	2.920	3.38	31.6	311.88	400	

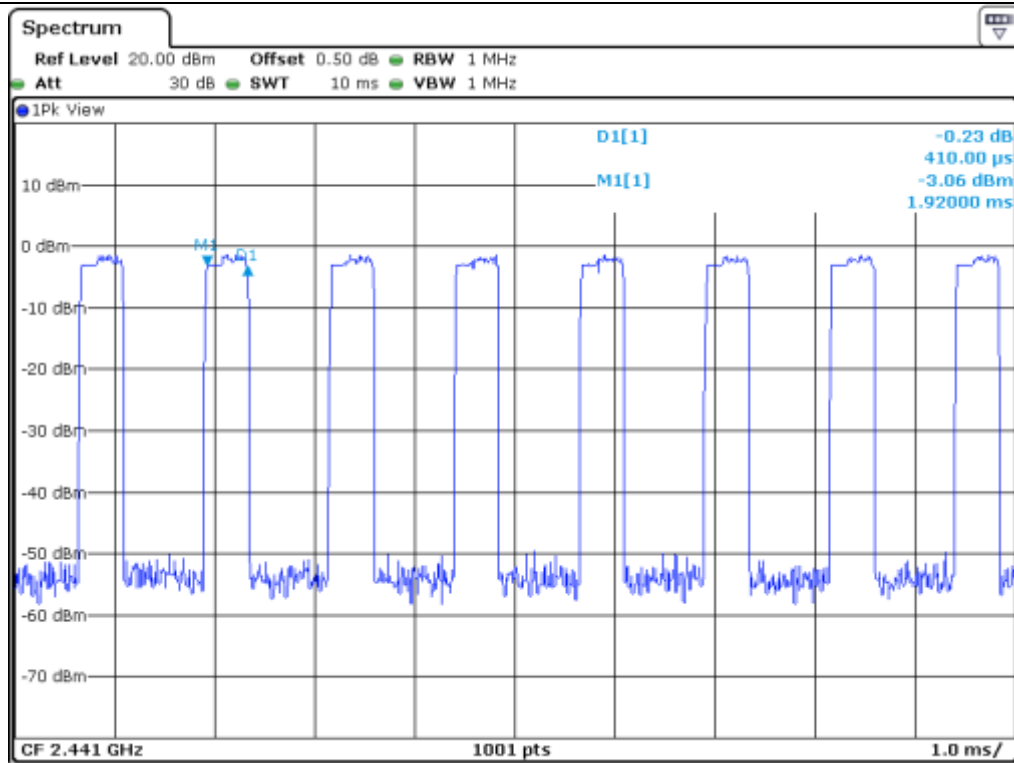
Total dwell time is calculated as following.

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

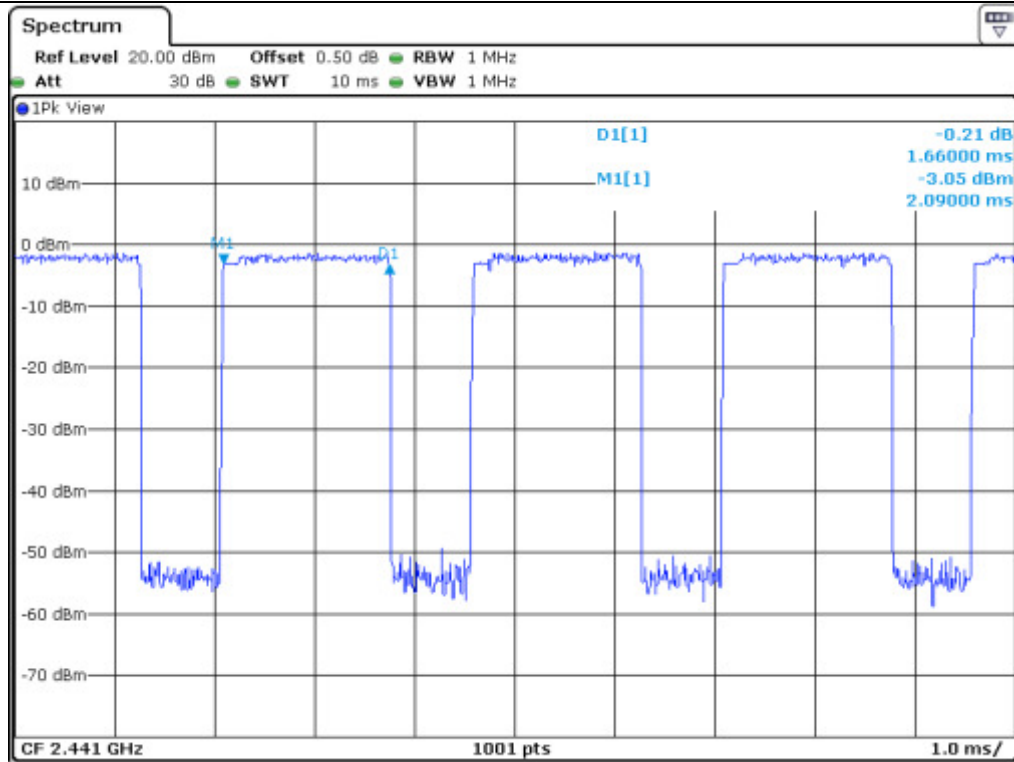
Remark: See next page for an overview sweep performed with peak detector.



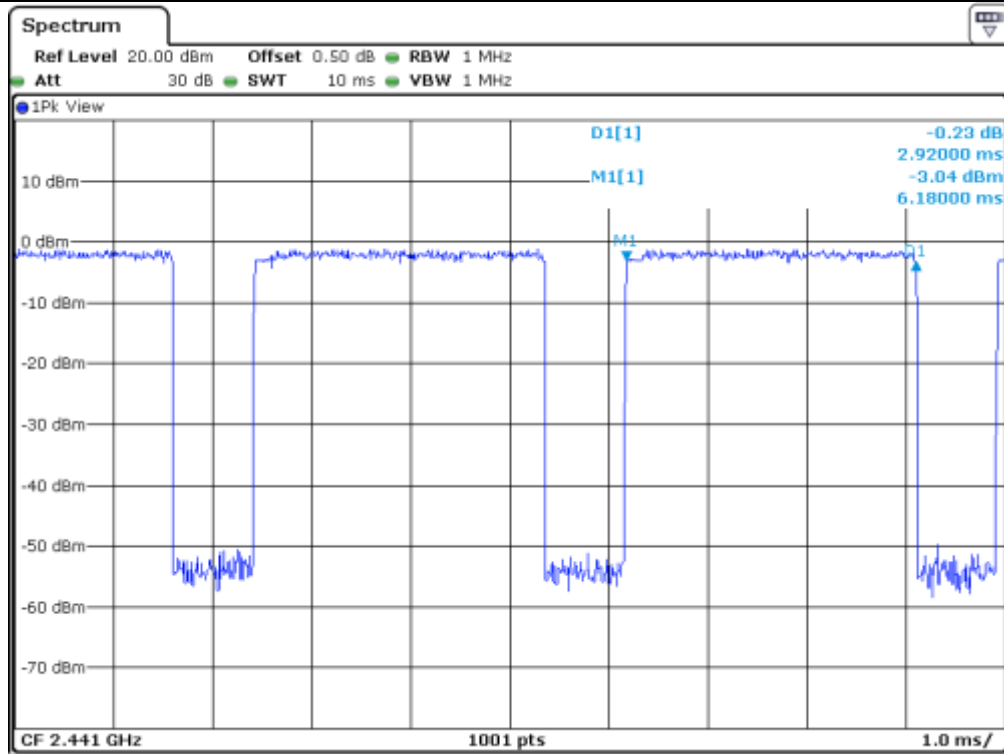
Tested by: Hyung-Kwon, Oh / Engineer



DH1



DH3



DH5

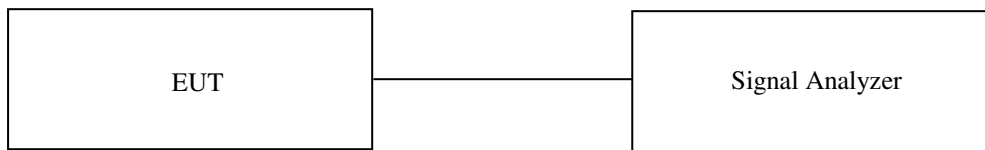
11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 22, 2015 (1Y)

All test equipment used is calibrated on a regular basis.

11.4 Test data for 1 Mbps

-. Test Date : May 02, 2016

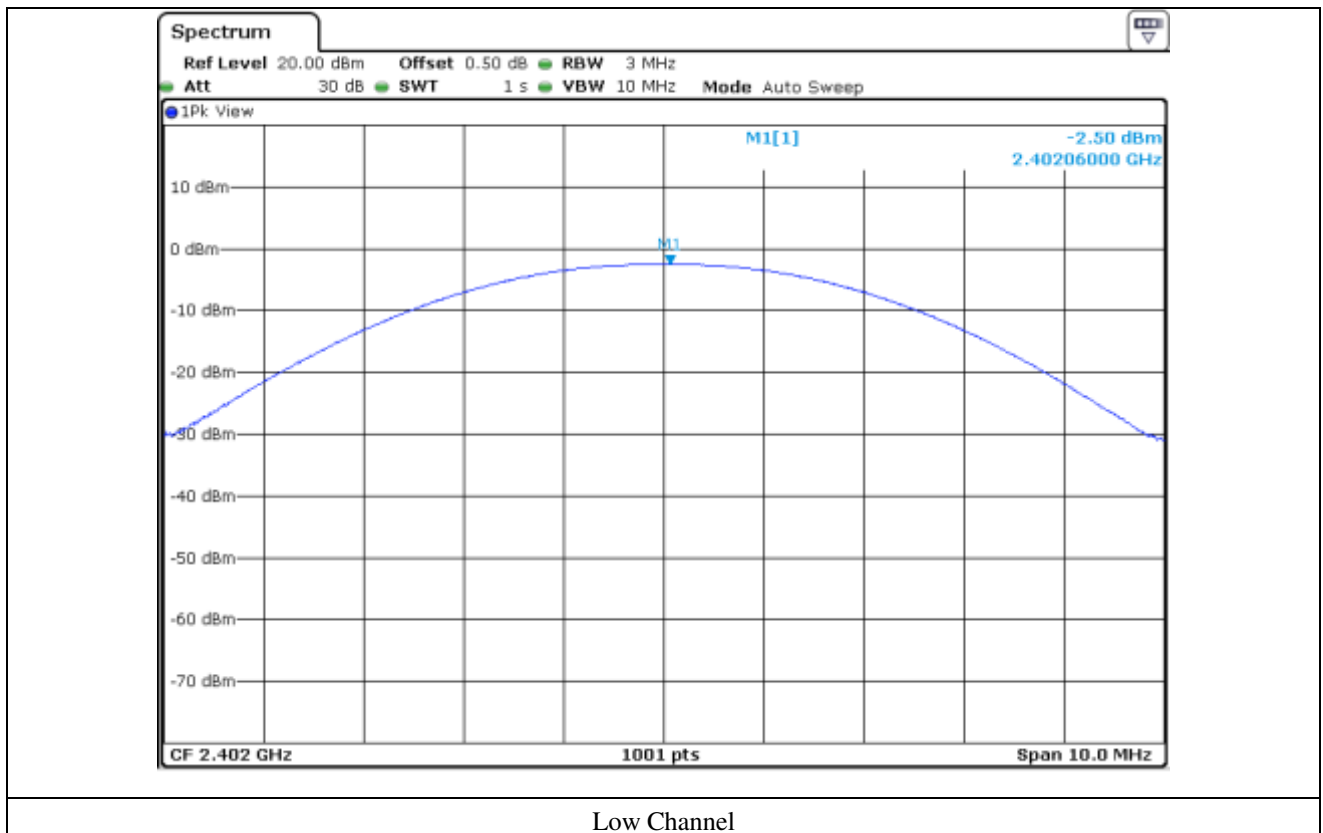
-. Test Result : Pass

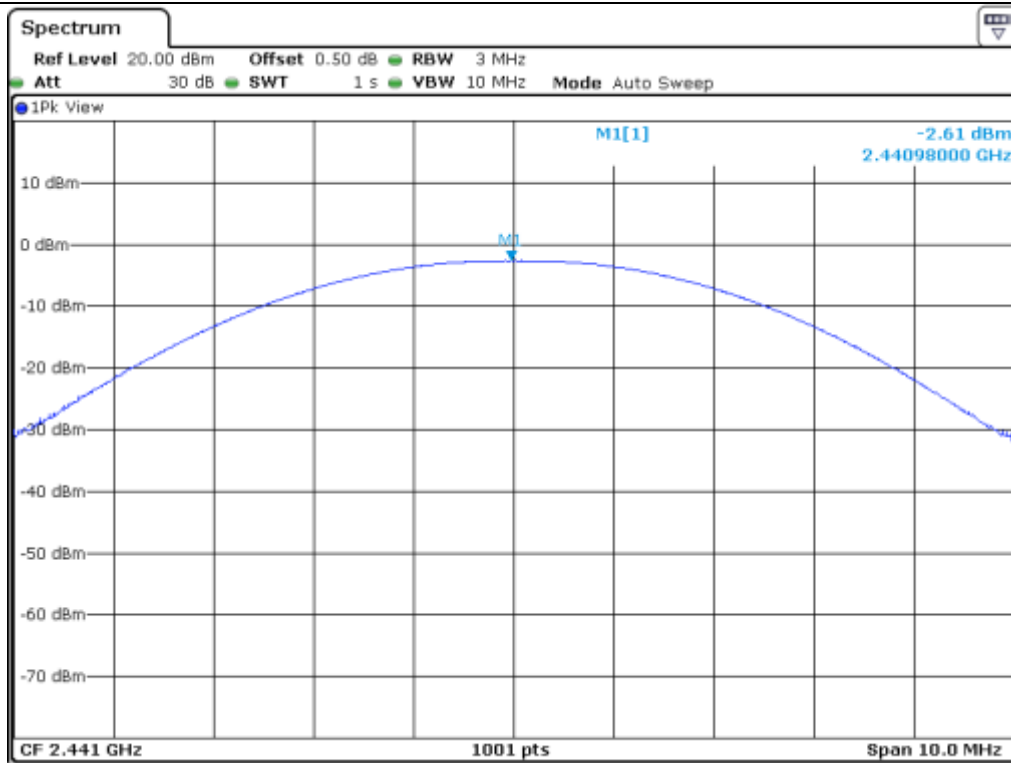
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-2.50	21.00	23.50
MIDDLE	2 441	-2.61	21.00	23.61
HIGH	2 480	-2.50	21.00	23.50

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

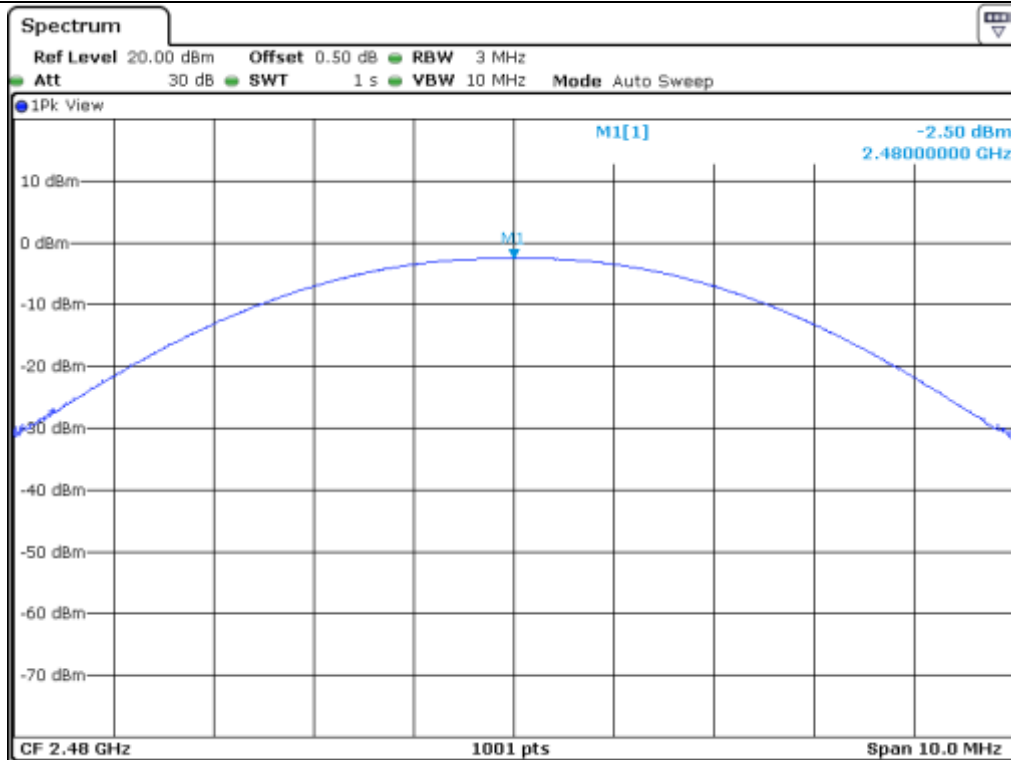


Tested by: Hyung-Kwon, Oh / Engineer





Middle Channel



High Channel

11.5 Test data for 2 Mbps

-. Test Date : May 02, 2016

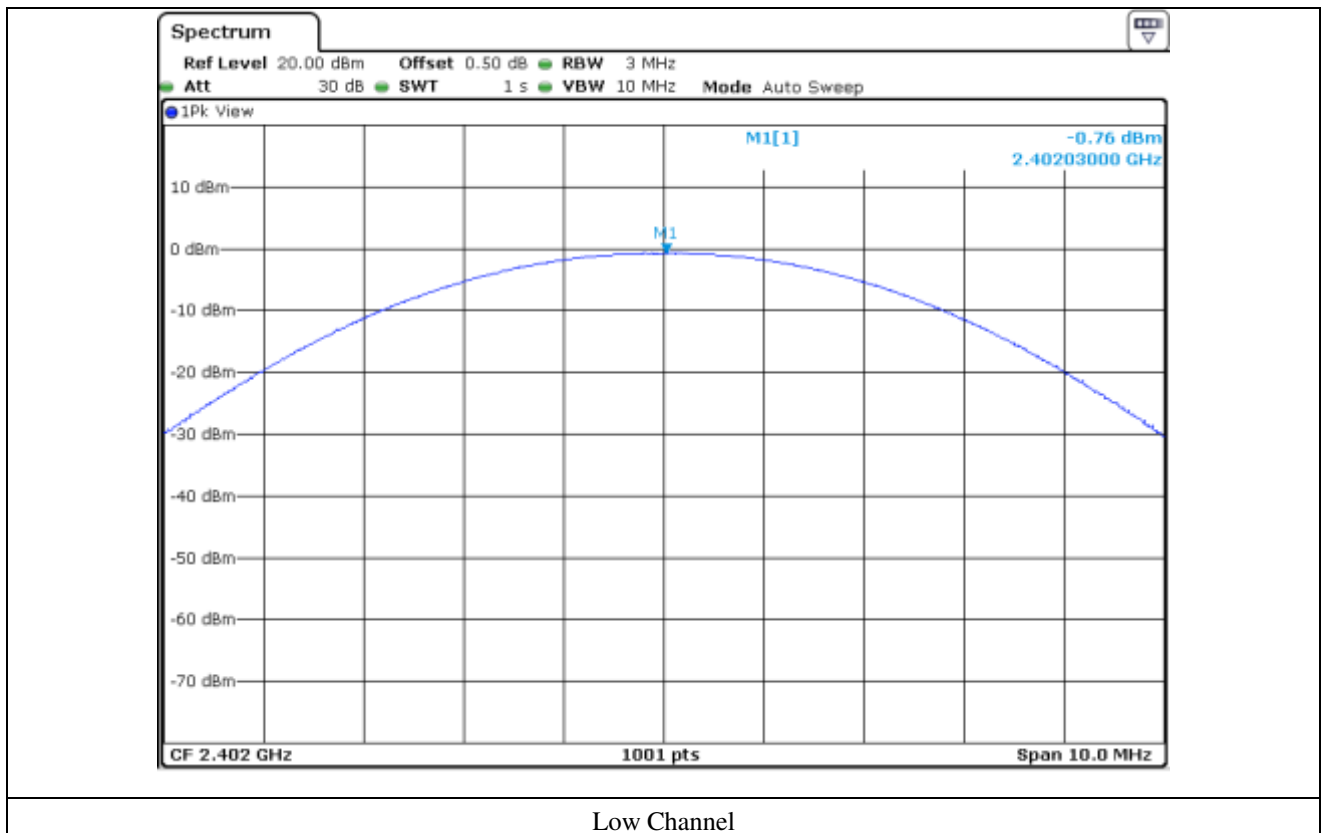
-. Test Result : Pass

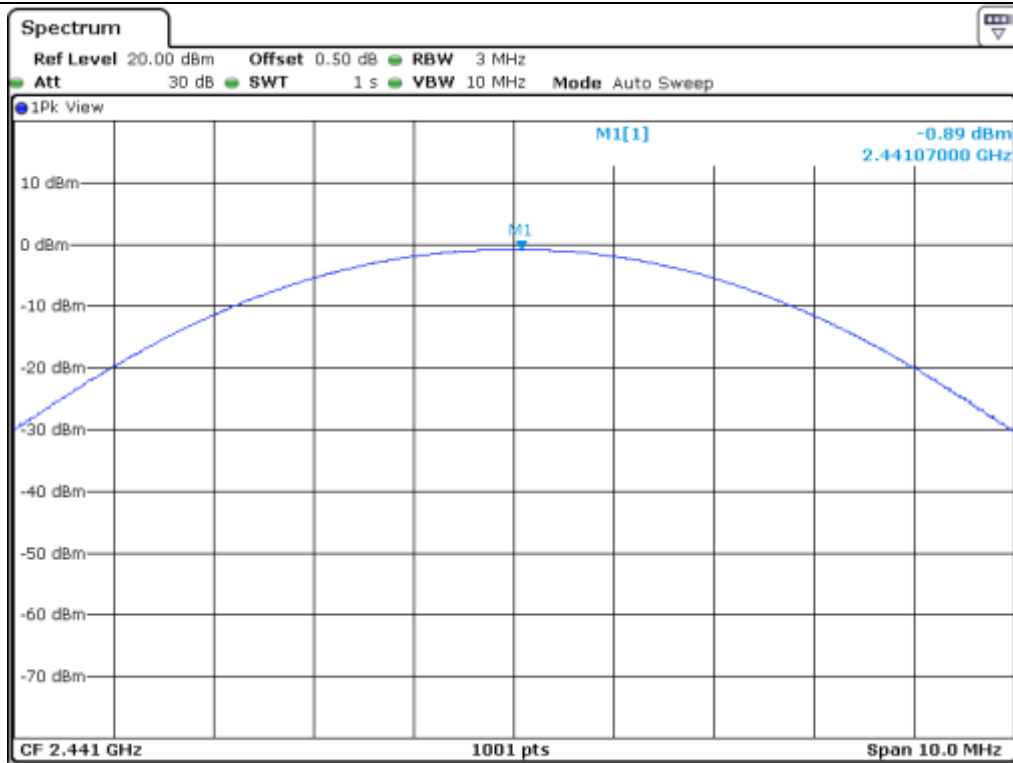
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-0.76	21.00	21.76
MIDDLE	2 441	-0.89	21.00	21.89
HIGH	2 480	-0.78	21.00	21.78

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

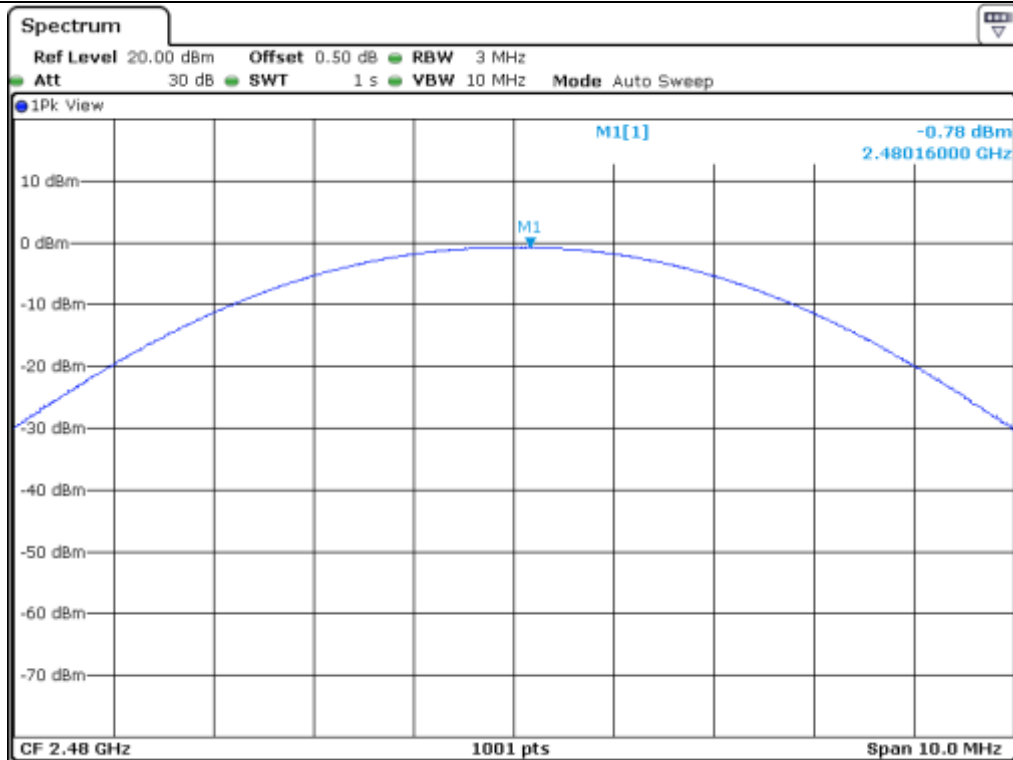


Tested by: Hyung-Kwon, Oh / Engineer





Middle Channel



High Channel

11.6 Test data for 3 Mbps

-. Test Date : May 02, 2016

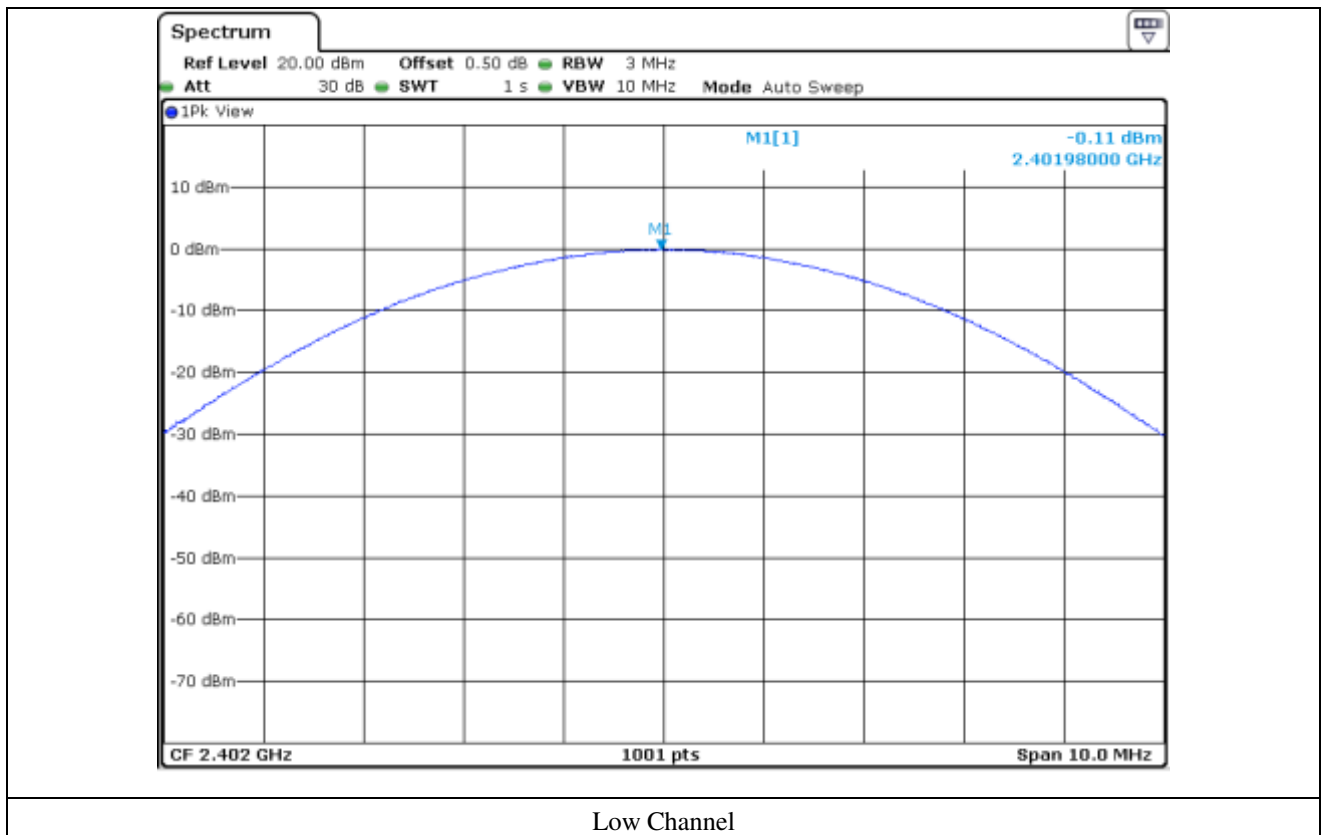
-. Test Result : Pass

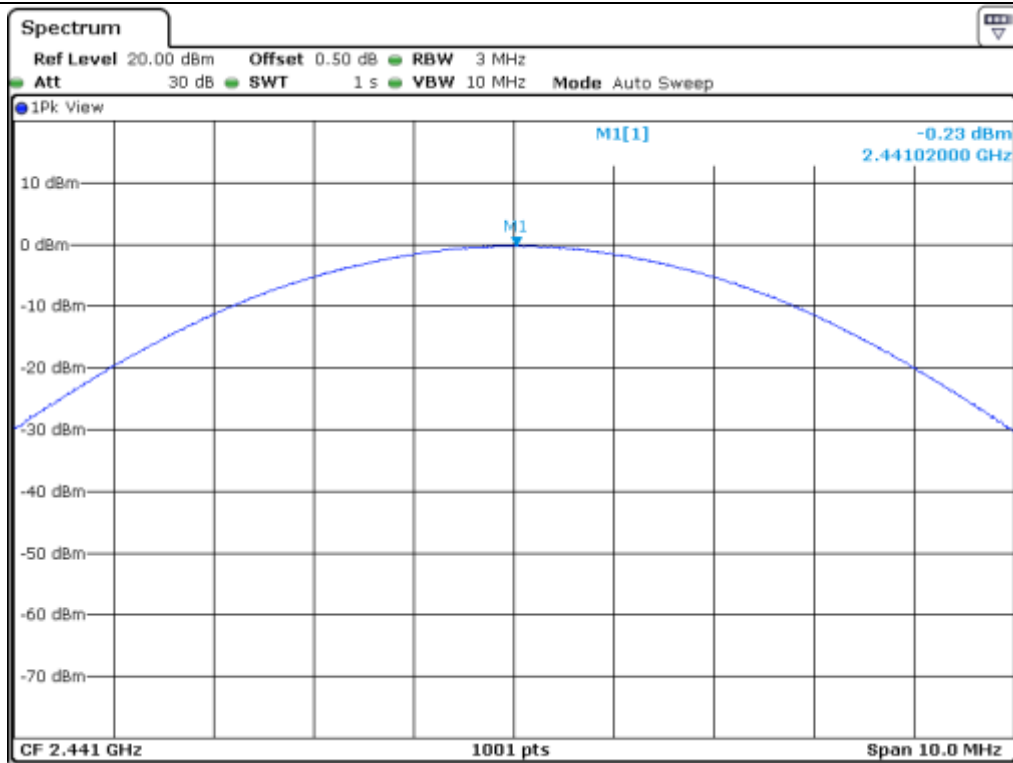
CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-0.11	21.00	21.11
MIDDLE	2 441	-0.23	21.00	21.23
HIGH	2 480	-0.15	21.00	21.15

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

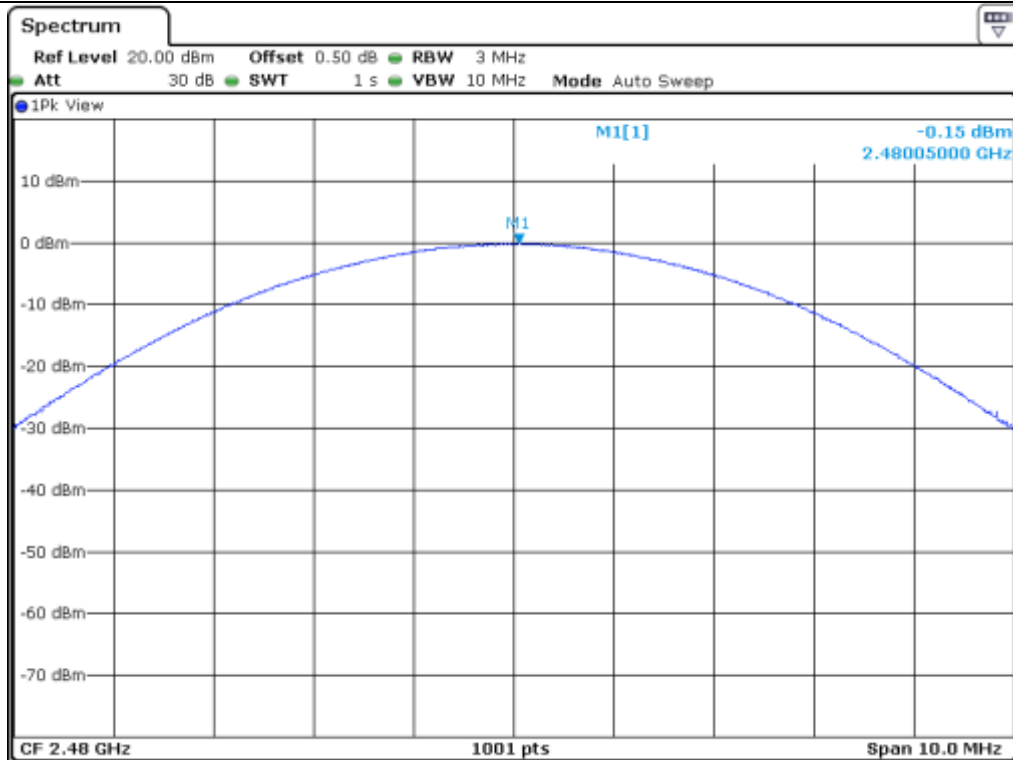


Tested by: Hyung-Kwon, Oh / Engineer





Middle Channel



High Channel

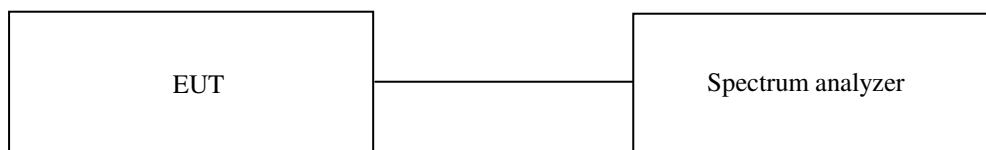
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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.

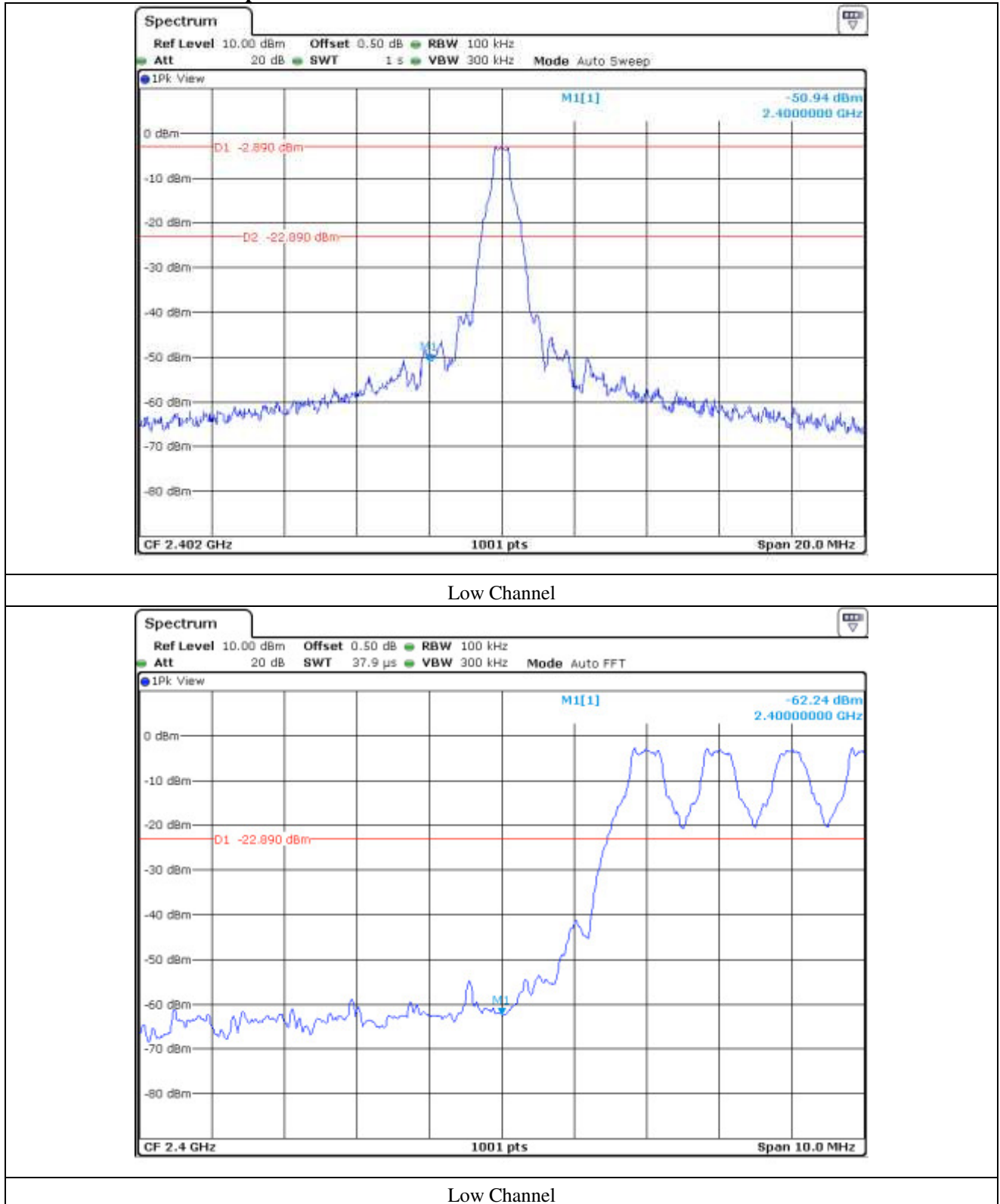
12.4 Test equipment used

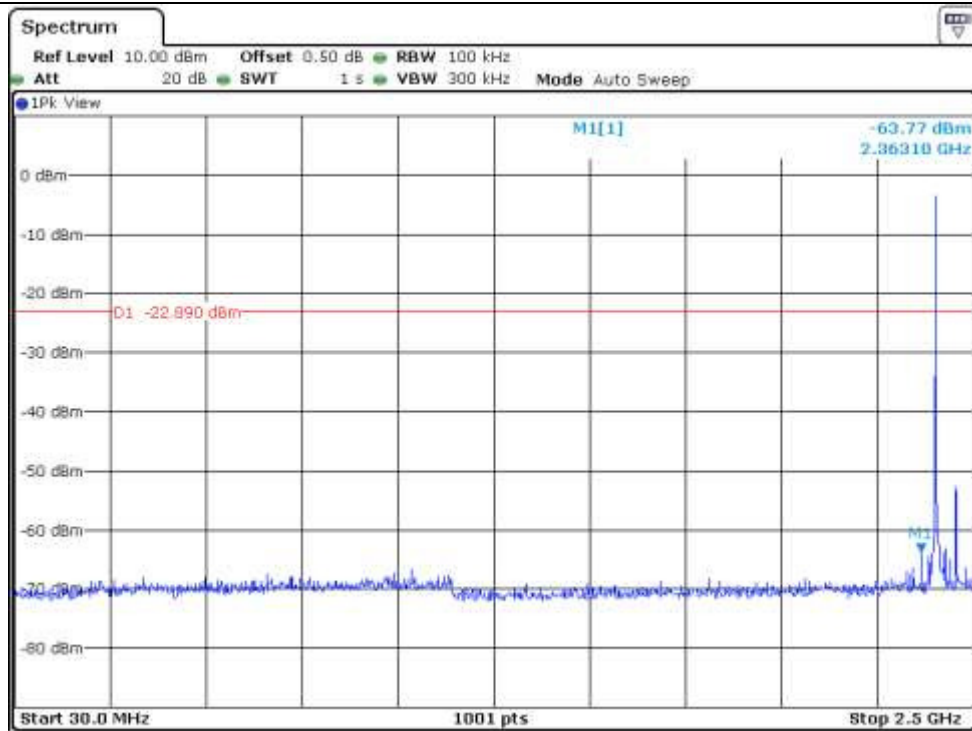
	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 22, 2015 (1Y)
■ -	ESU	Rohde & Schwarz	EMI Test Receiver	100261	Apr. 06, 2016 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Apr. 05, 2016 (1Y)
■ -	SCU-18	Rohde & Schwarz	Pre-Amplifier	10041	Nov. 23, 2015 (1Y)
■ -	DT3000	Innco System	Turn Table	930611	N/A
■ -	MA4000-EP	Innco System	Antenna Master	3320611	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-421	Apr. 15, 2016 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 31, 2015 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Apr. 31, 2015 (2Y)

All test equipment used is calibrated on a regular basis.

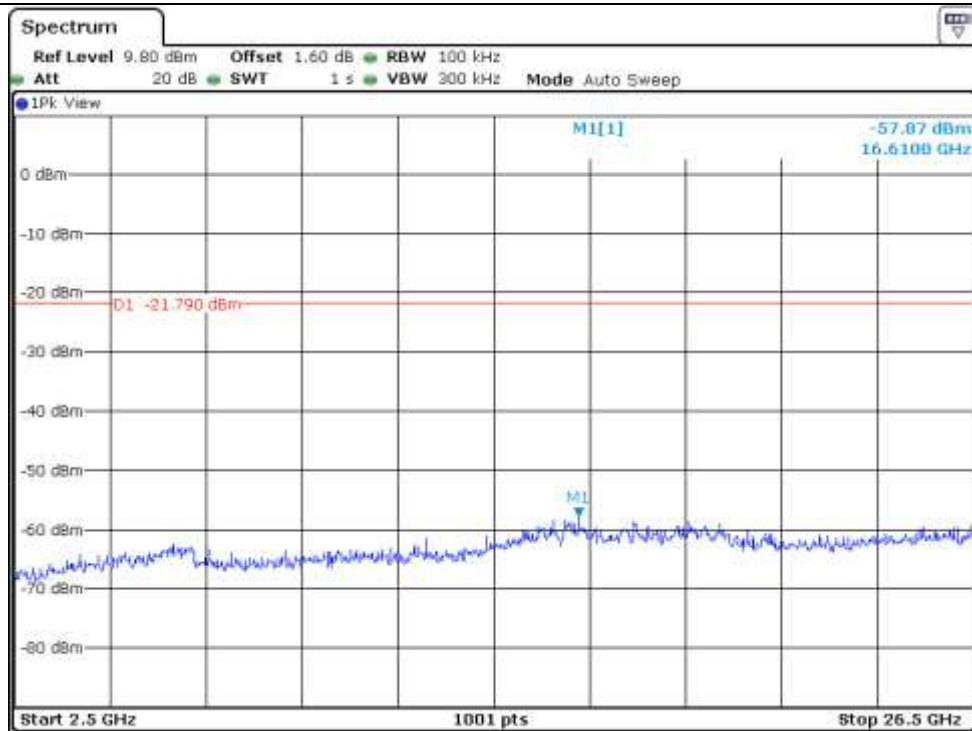
12.5 Test data for conducted emission

12.5.1 Test data for 1 Mbps

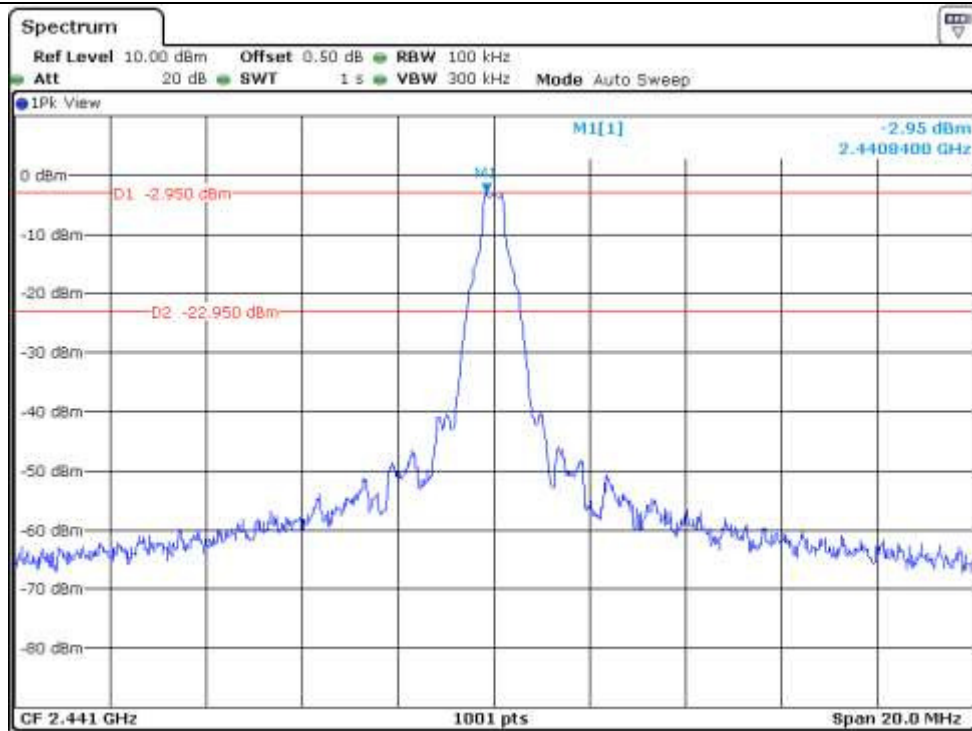




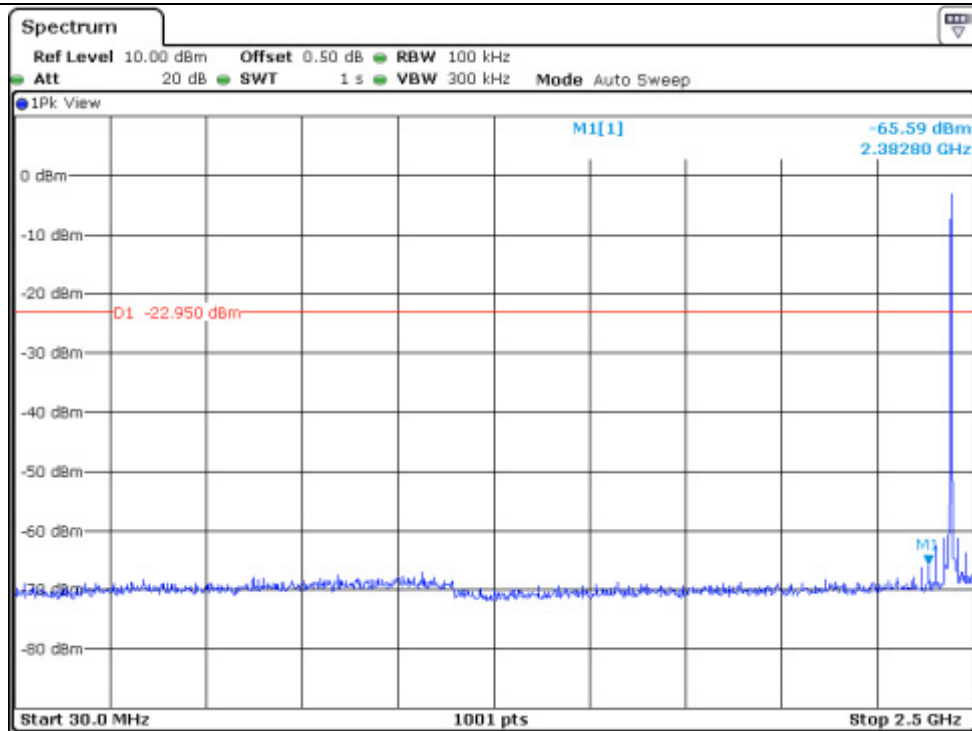
Low Channel



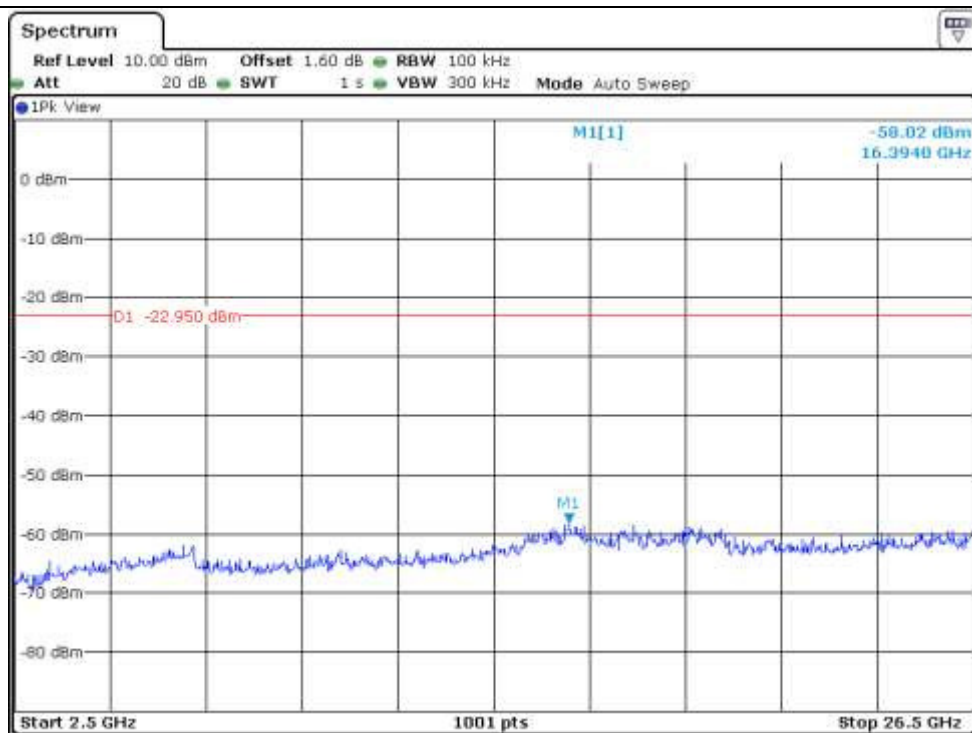
Low Channel



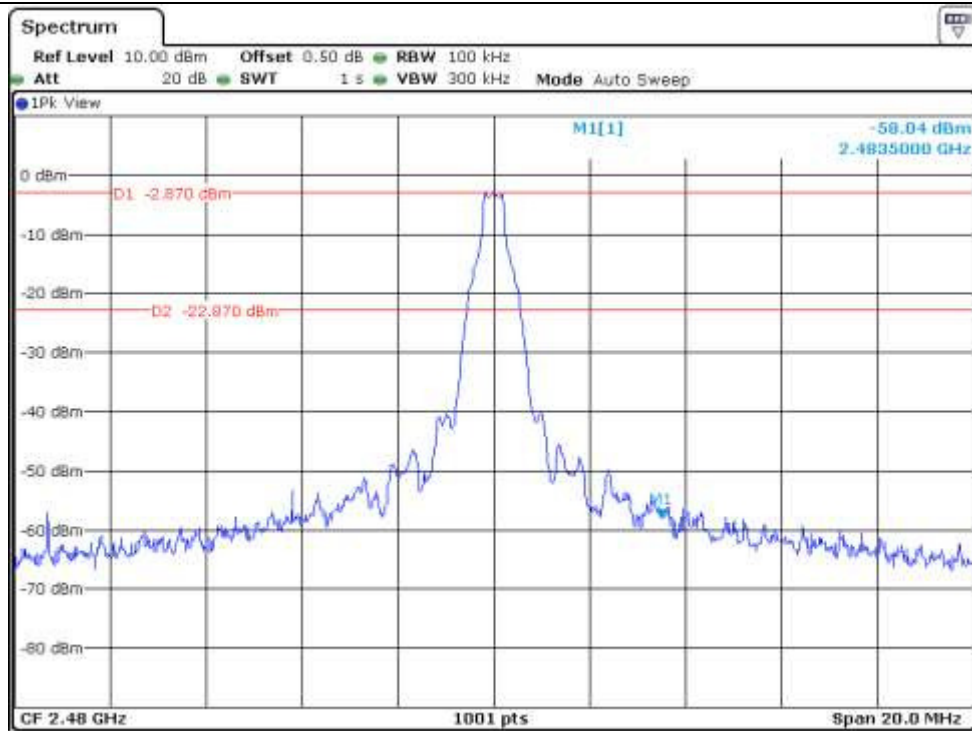
Middle Channel



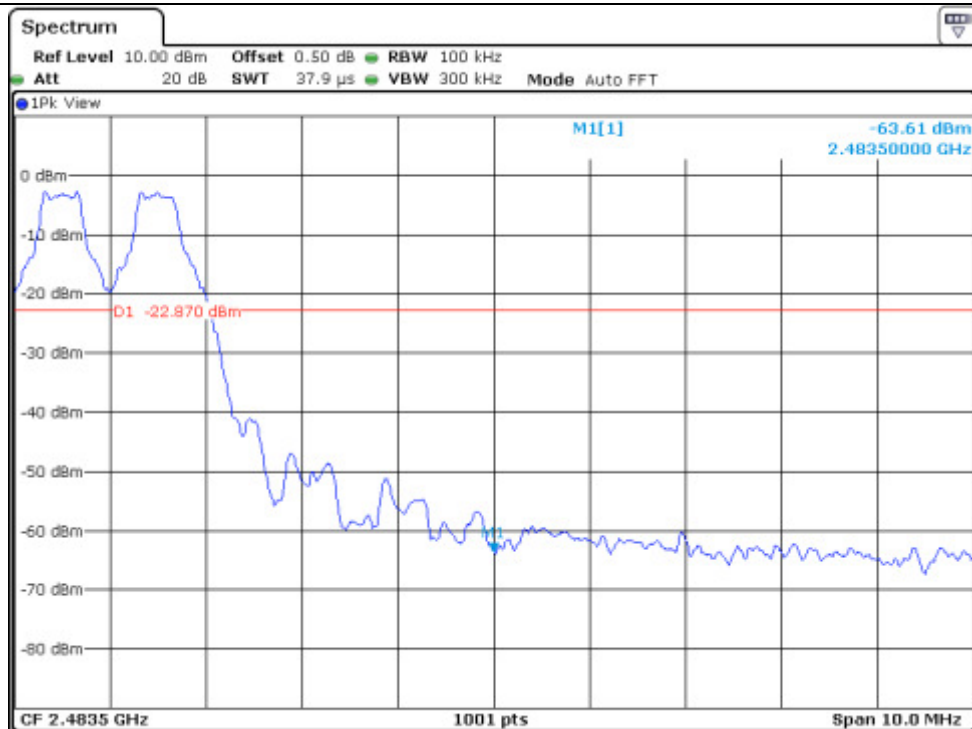
Middle Channel



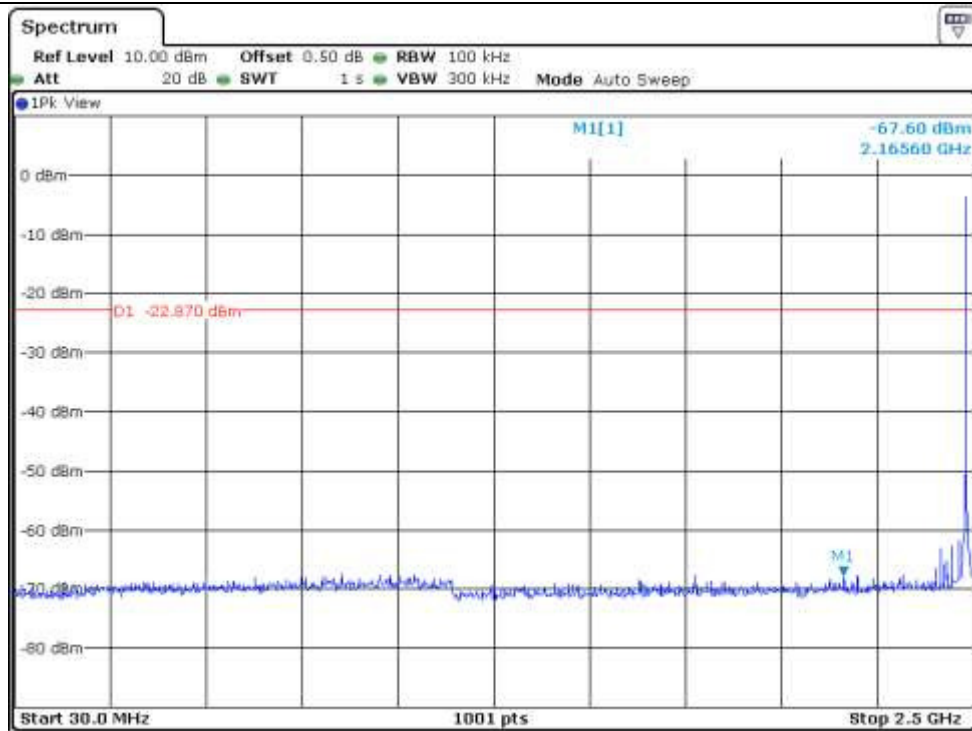
Middle Channel



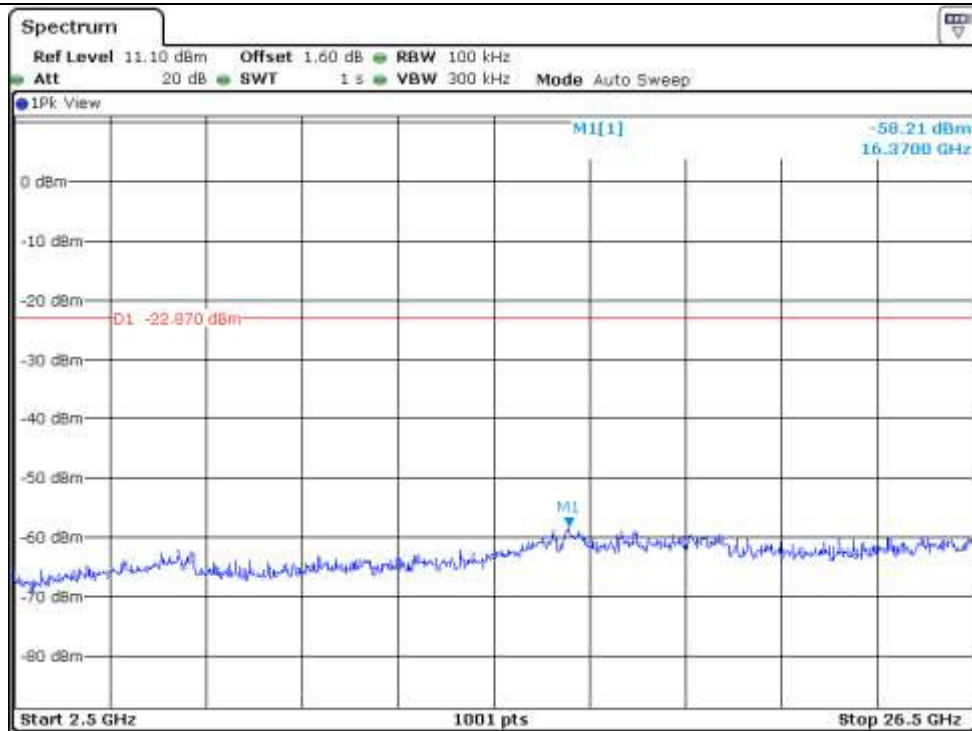
High Channel



High Channel

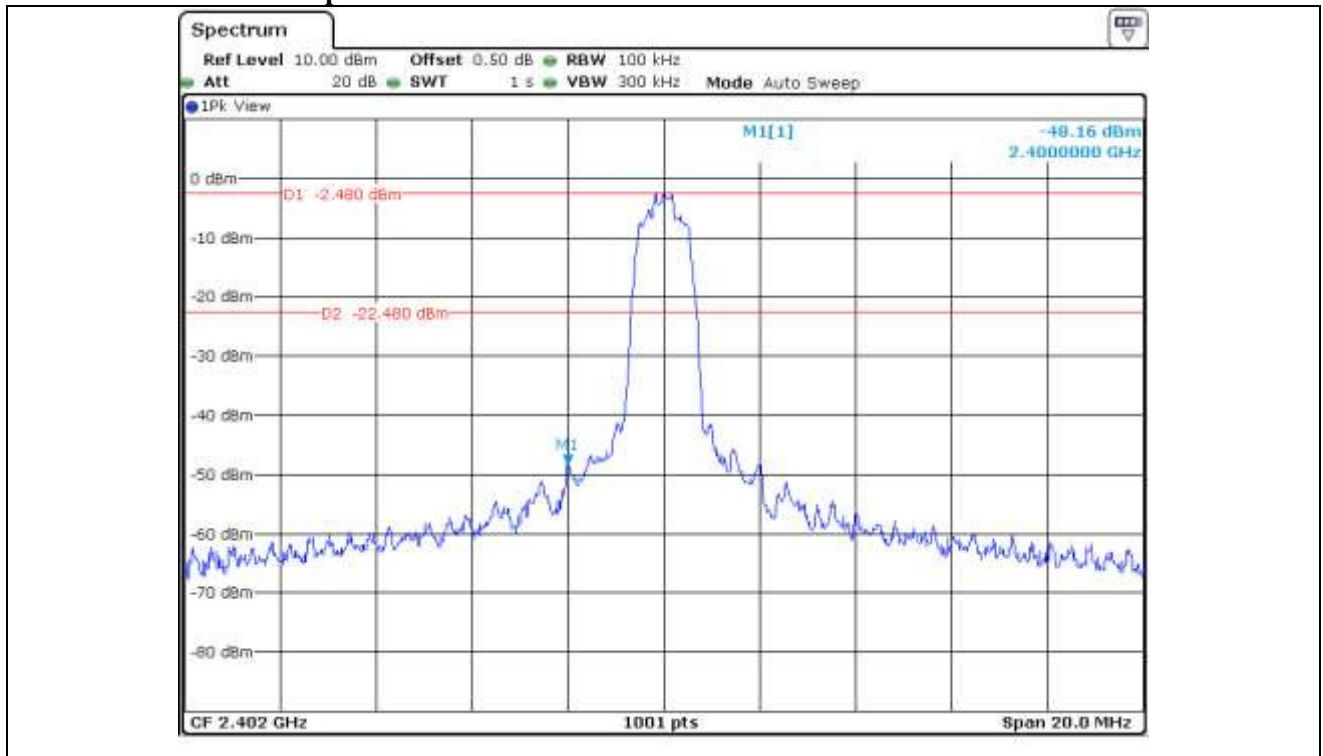


High Channel

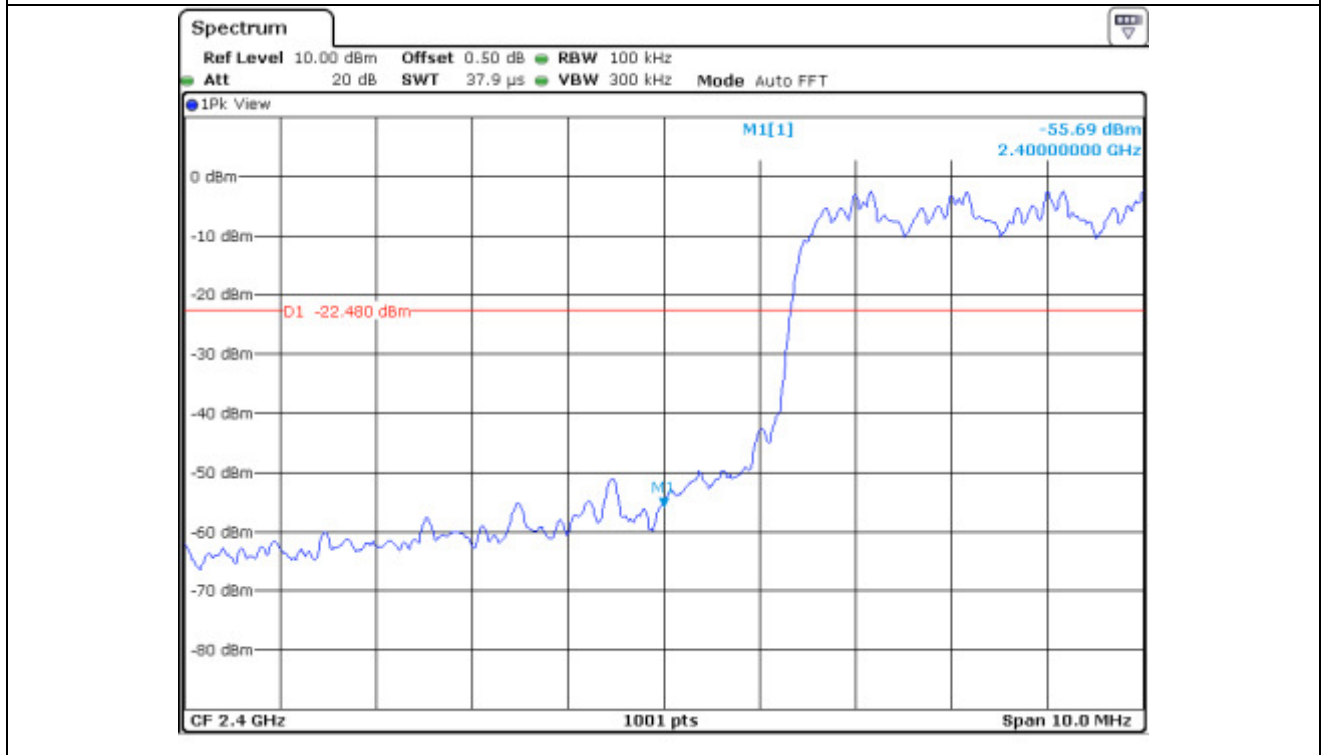


High Channel

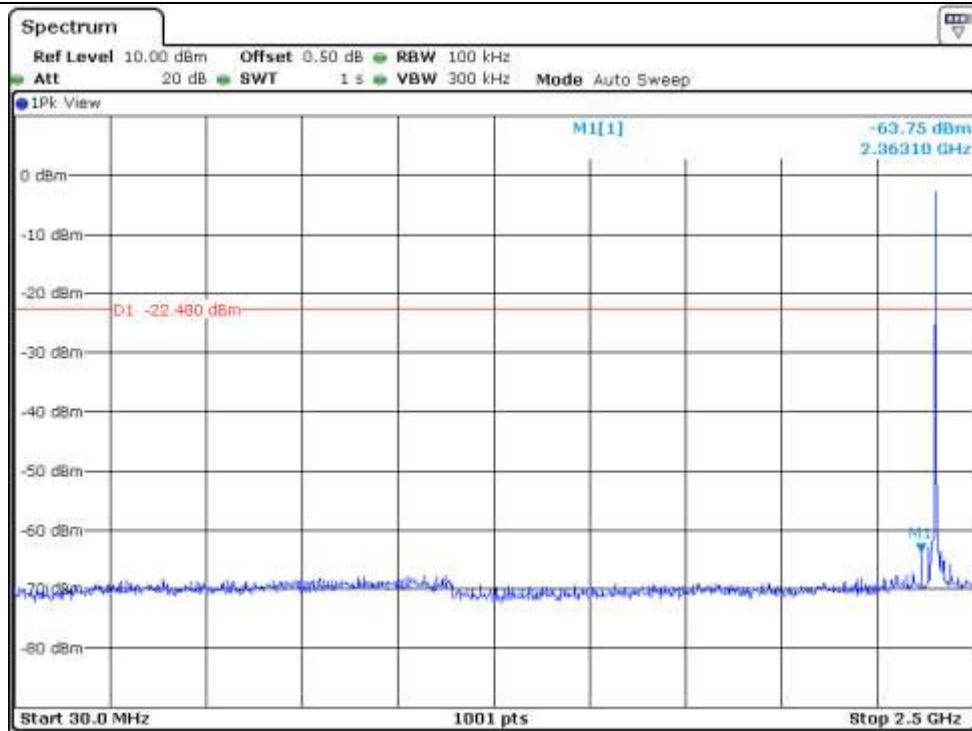
12.5.2 Test data for 2 Mbps



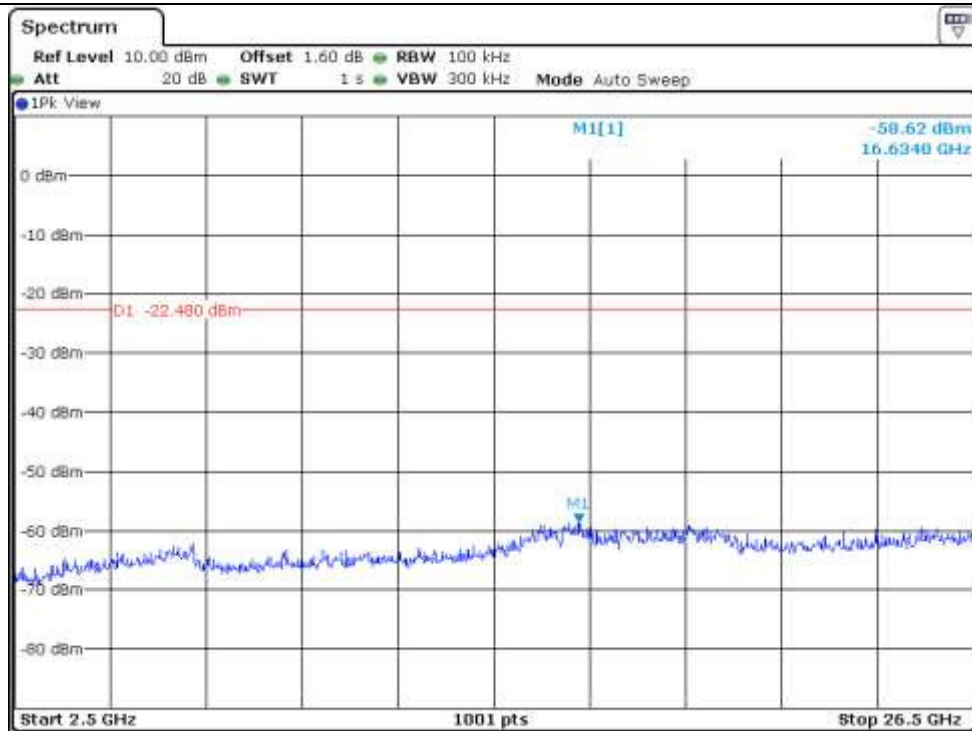
Low Channel



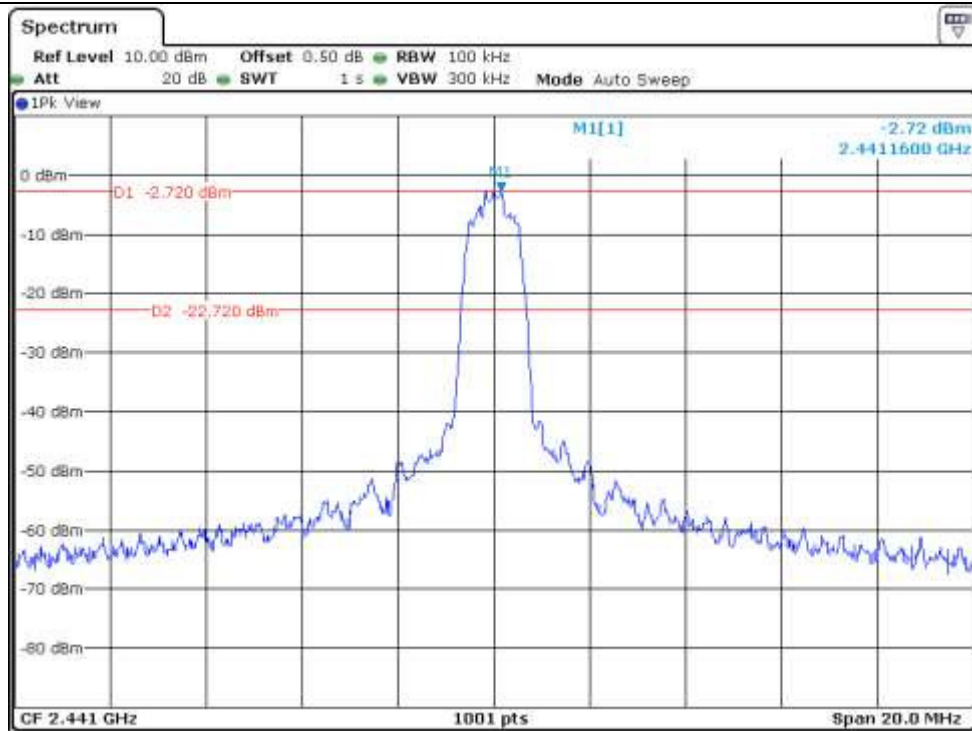
Low Channel



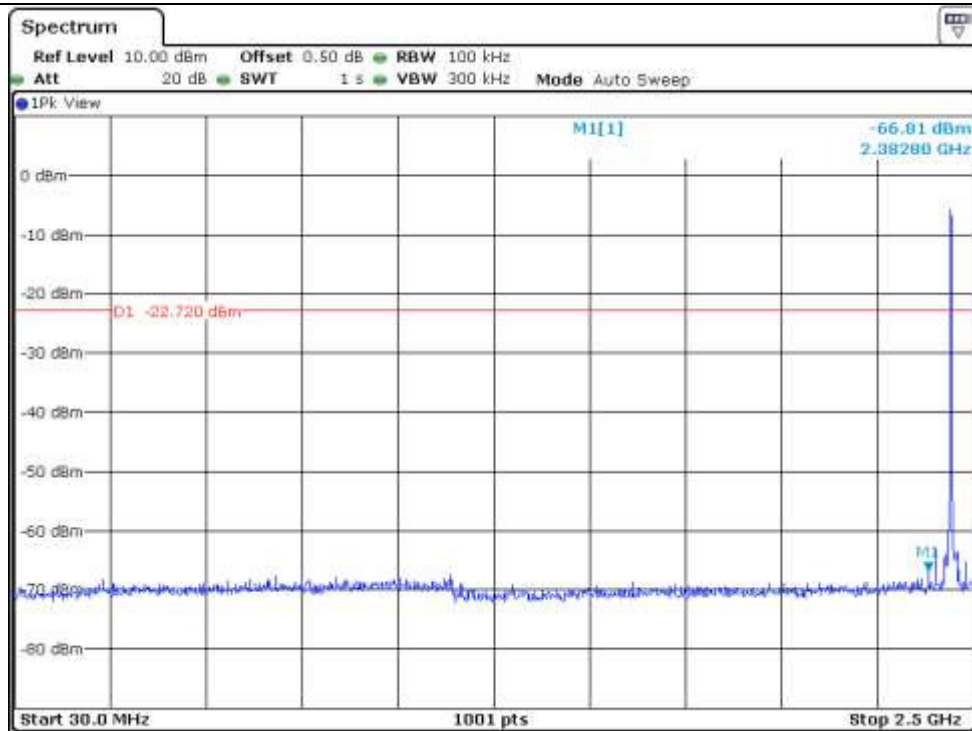
Low Channel



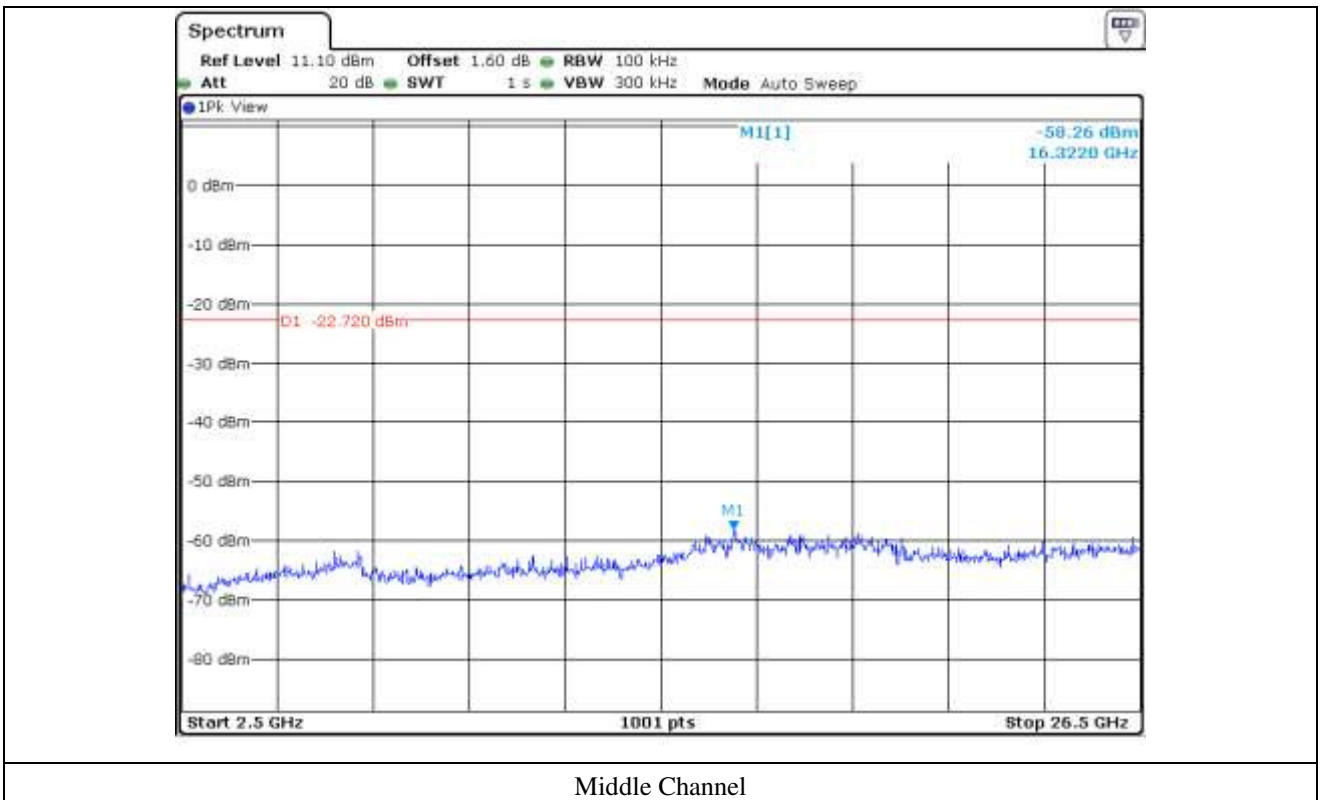
Low Channel

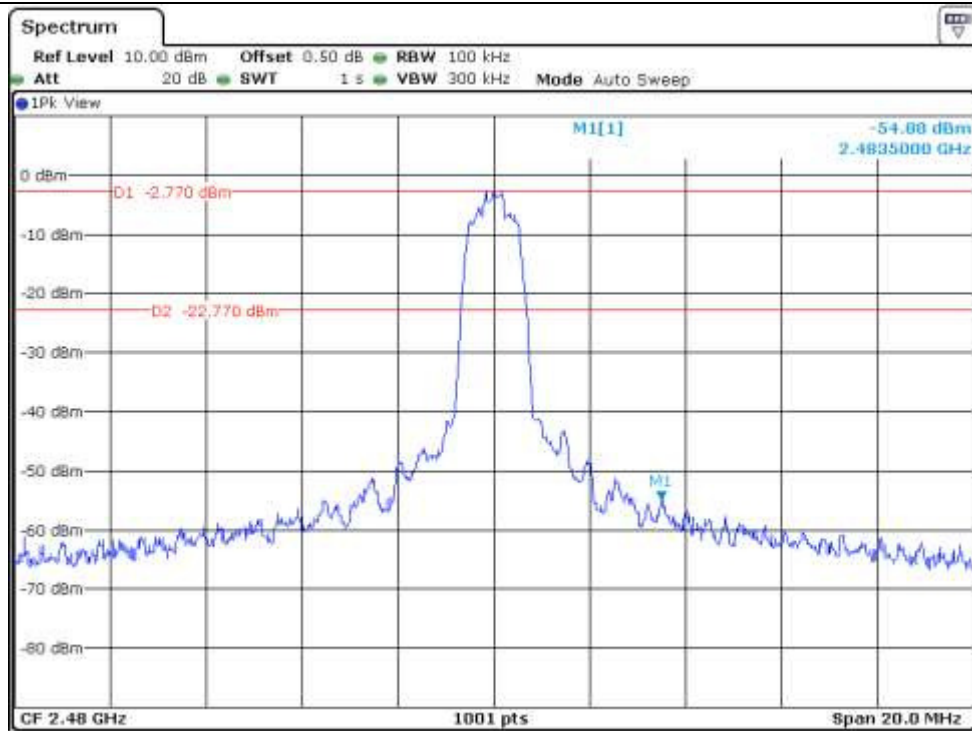


Middle Channel

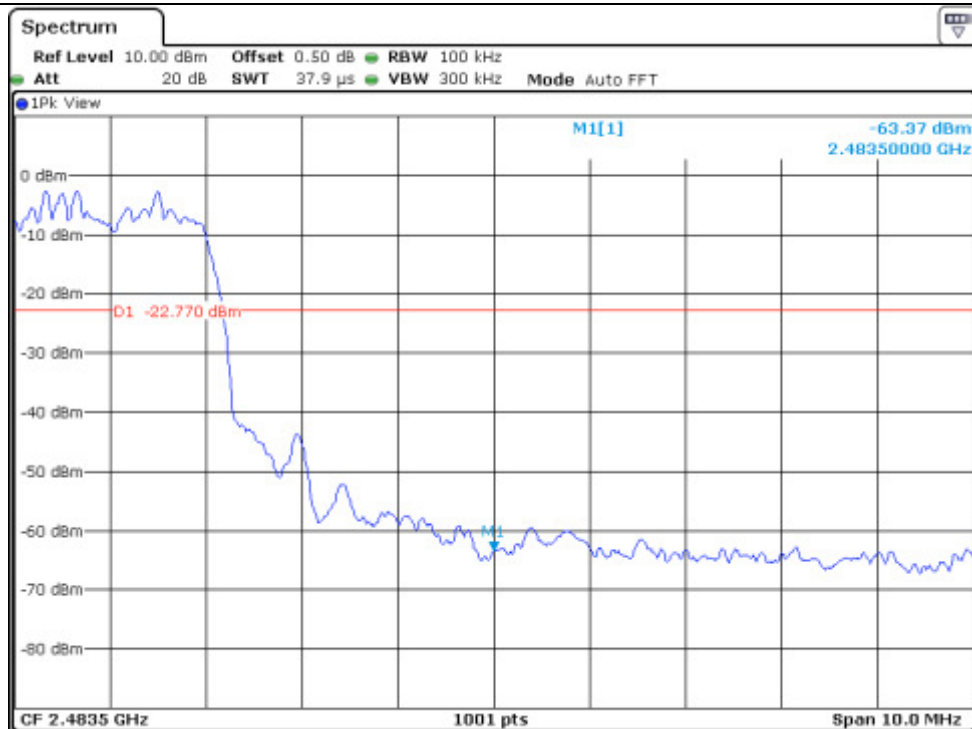


Middle Channel

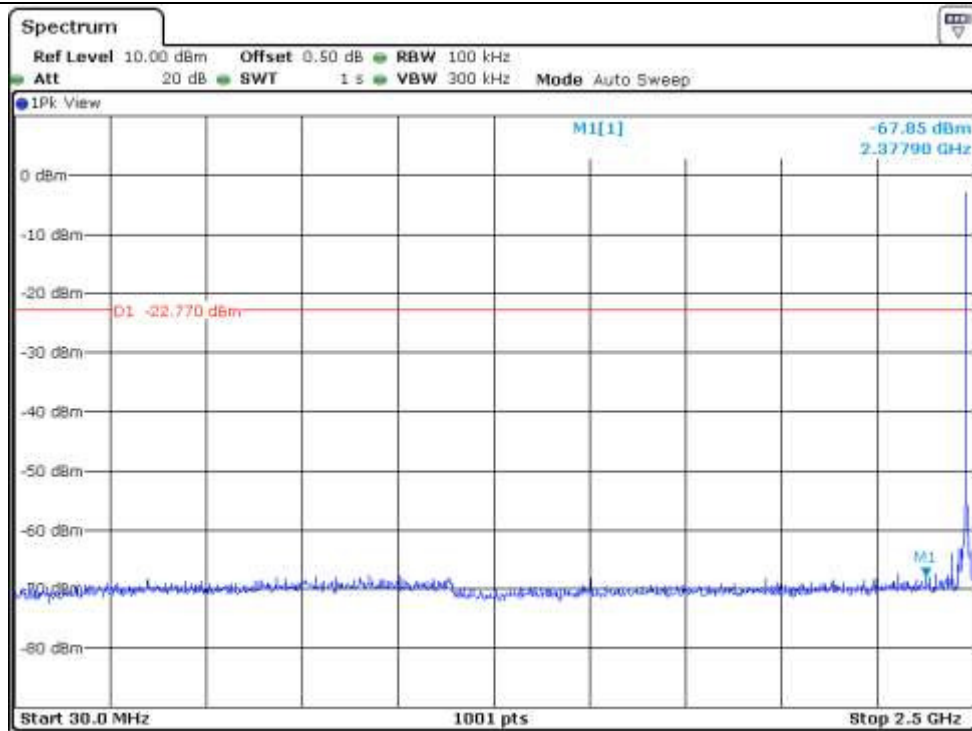




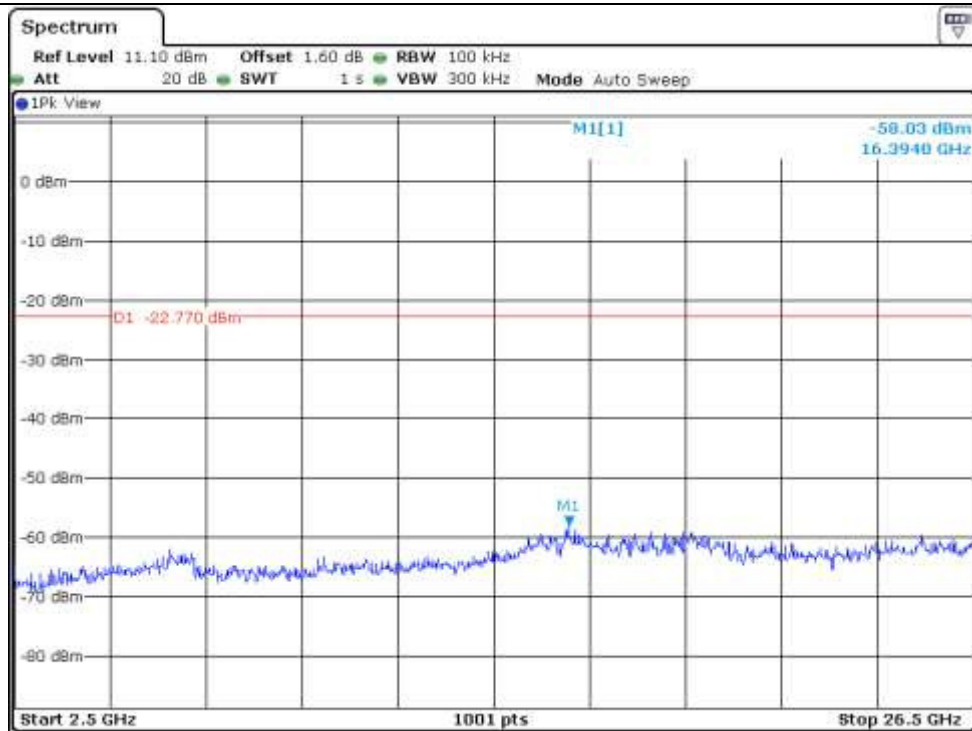
High Channel



High Channel

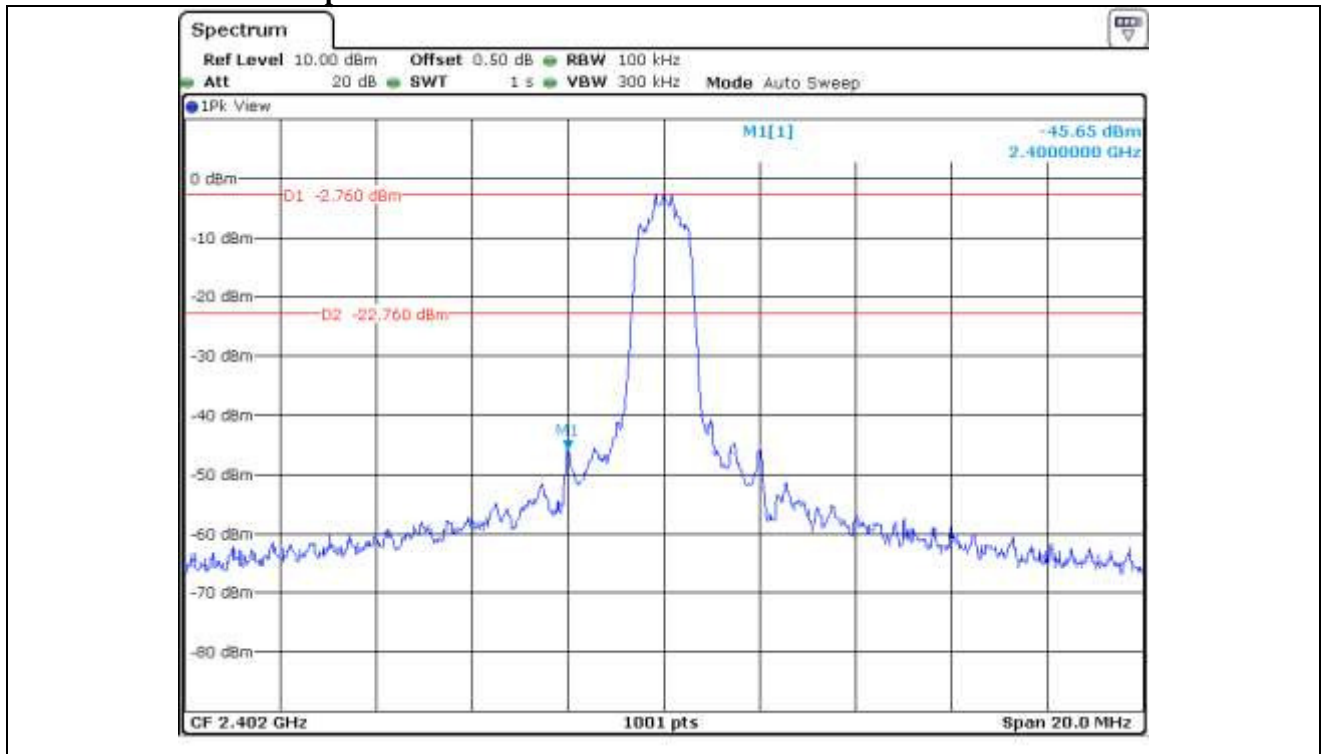


High Channel

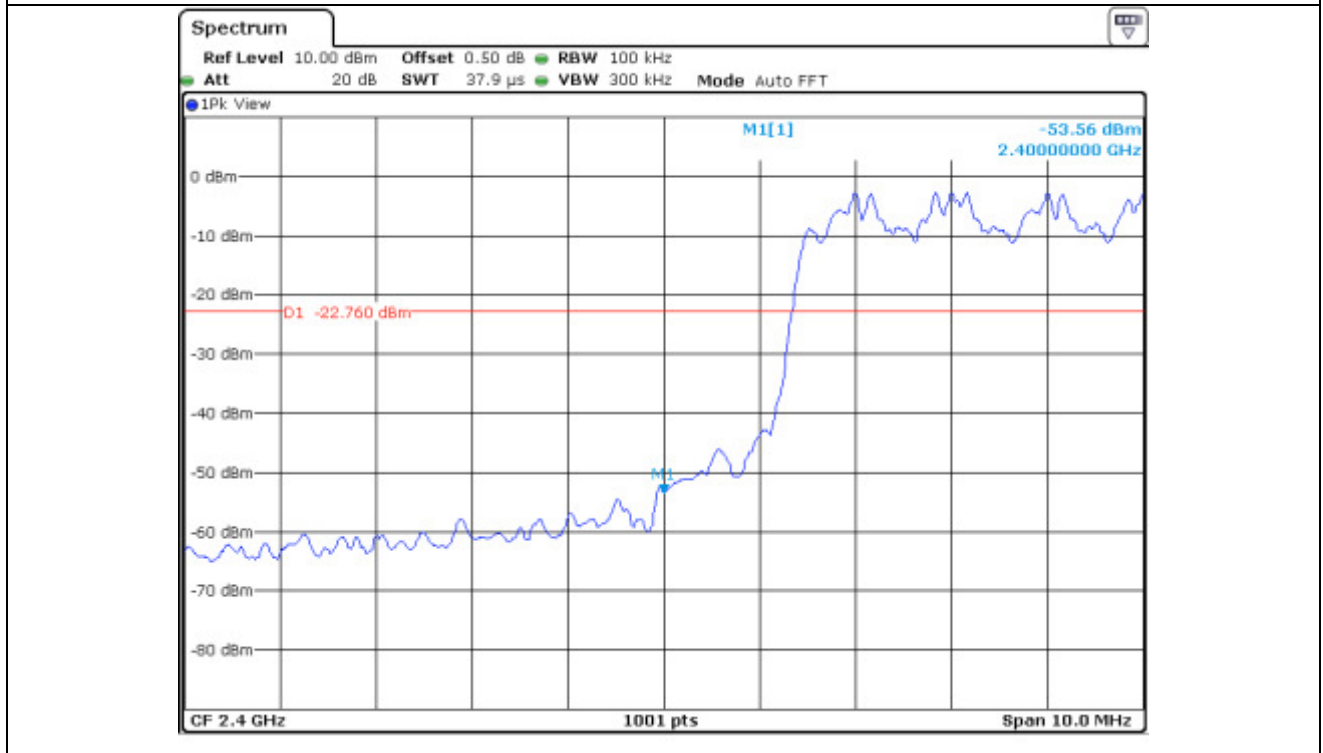


High Channel

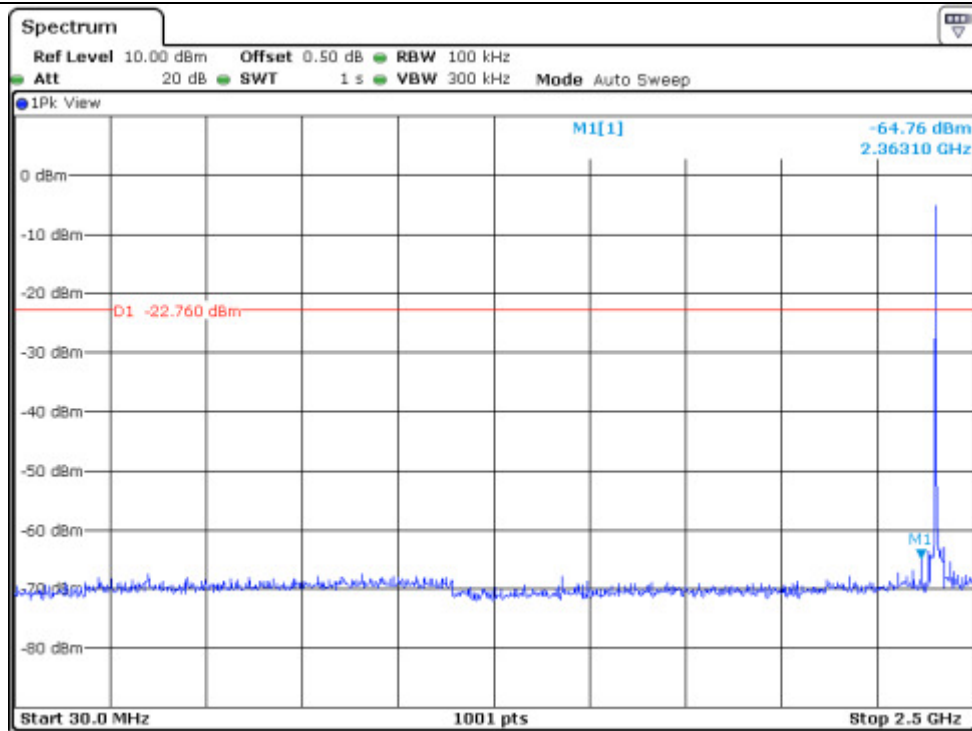
12.5.3 Test data for 3 Mbps



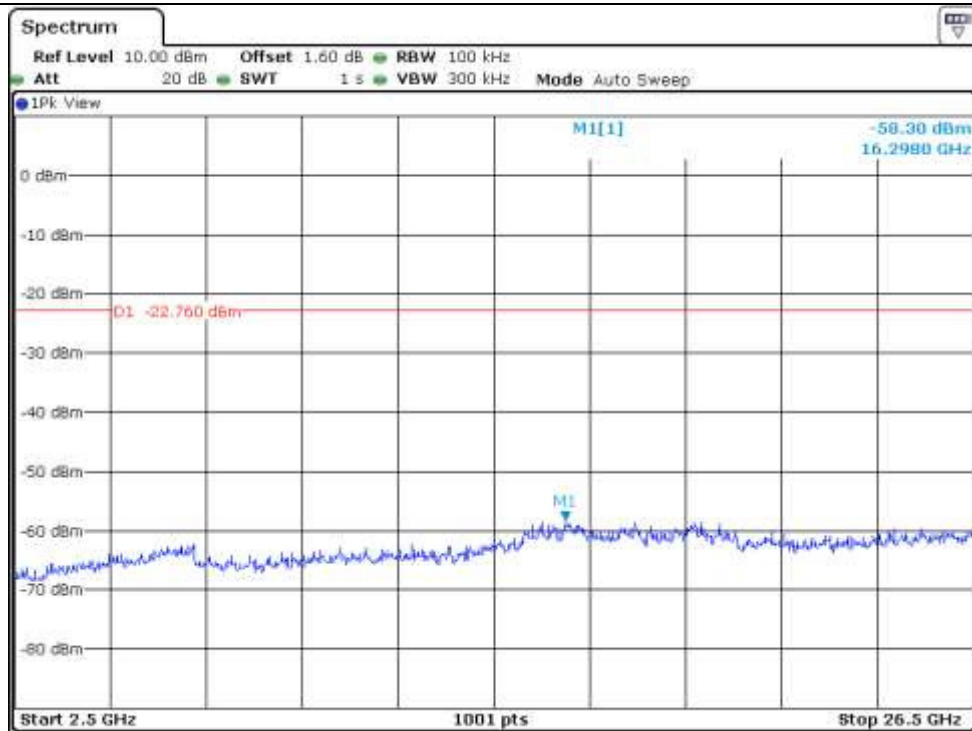
Low Channel



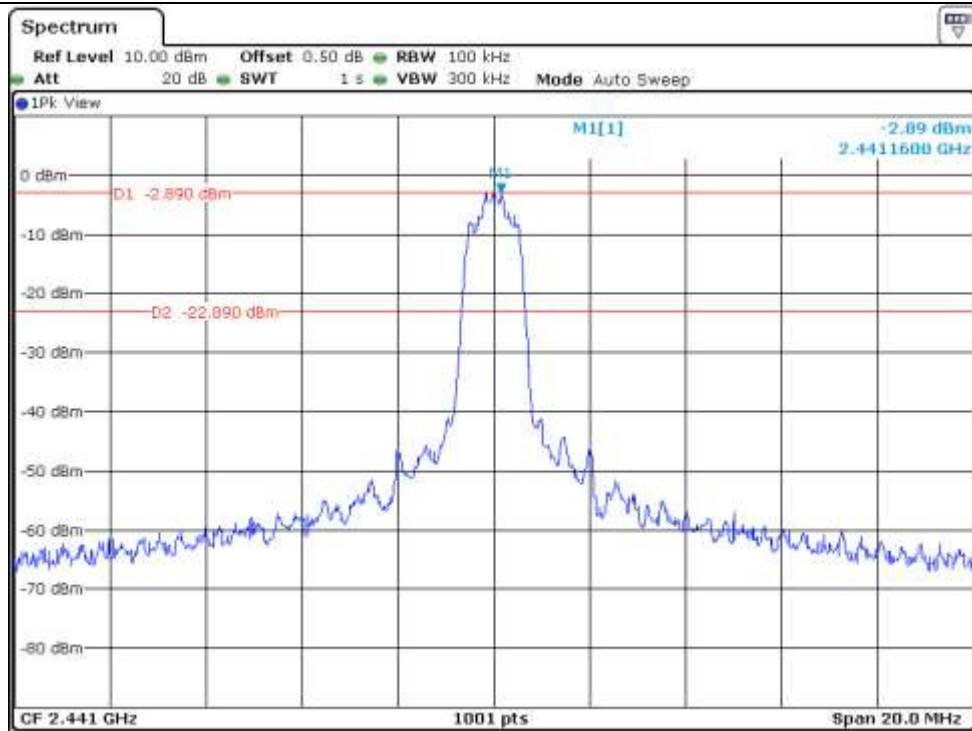
Low Channel



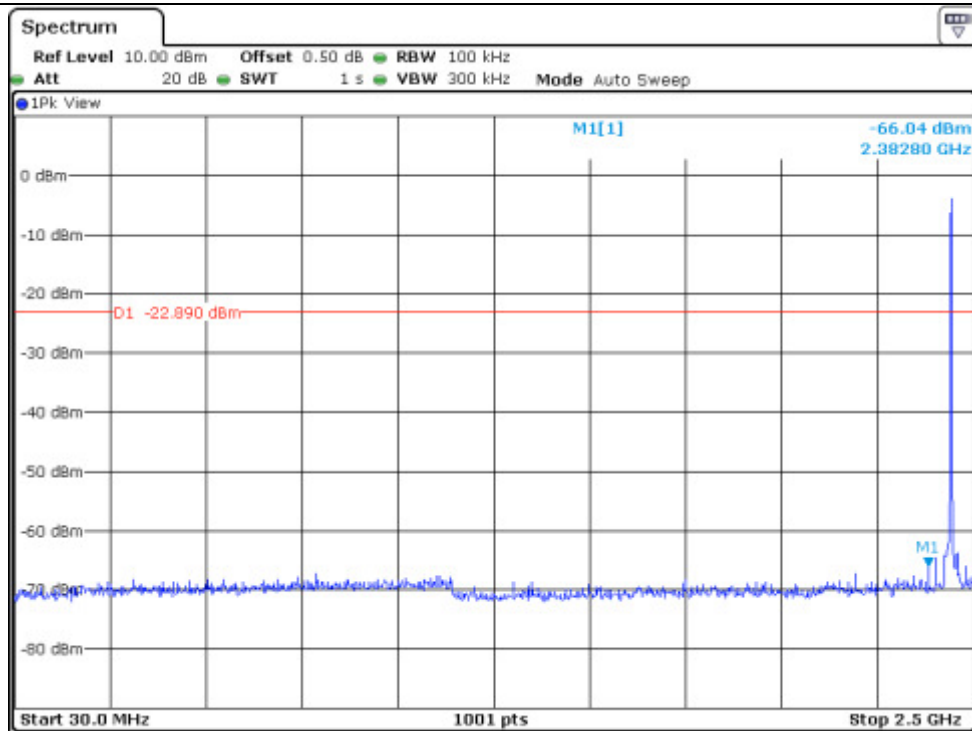
Low Channel



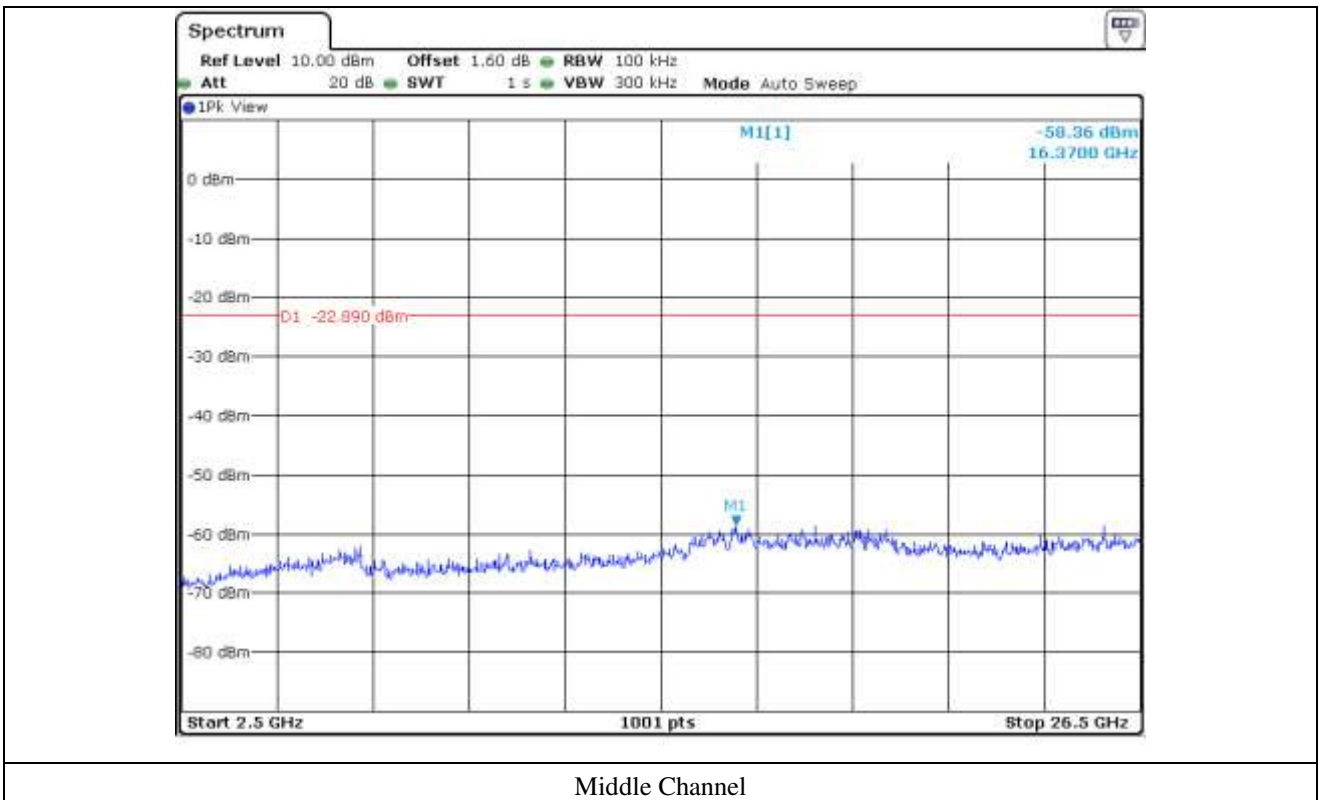
Low Channel

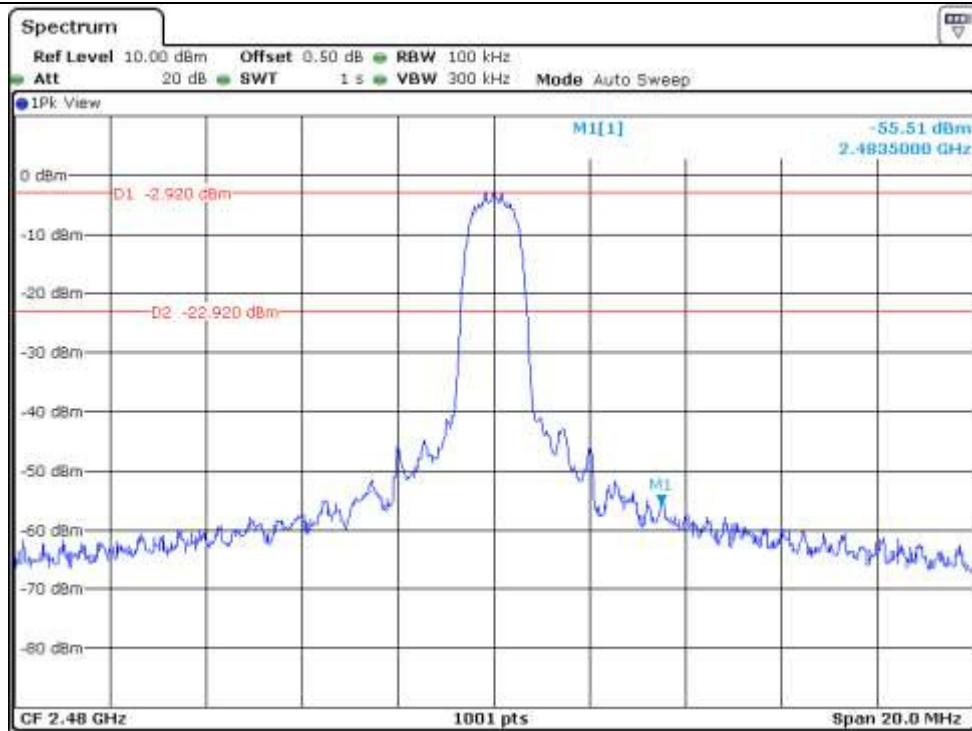


Middle Channel

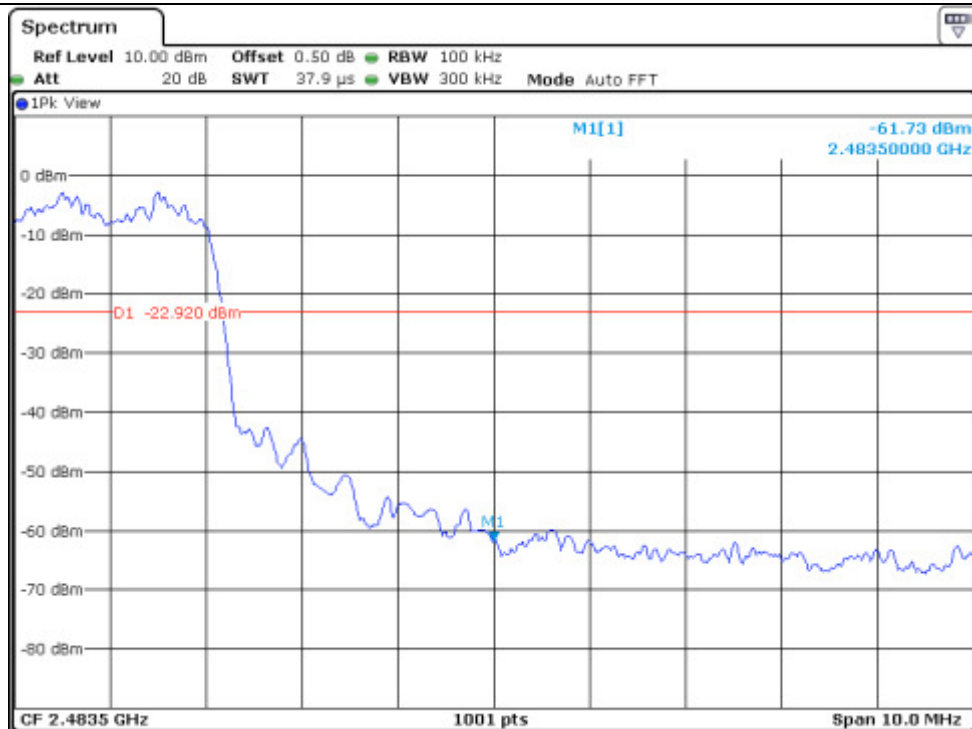


Middle Channel

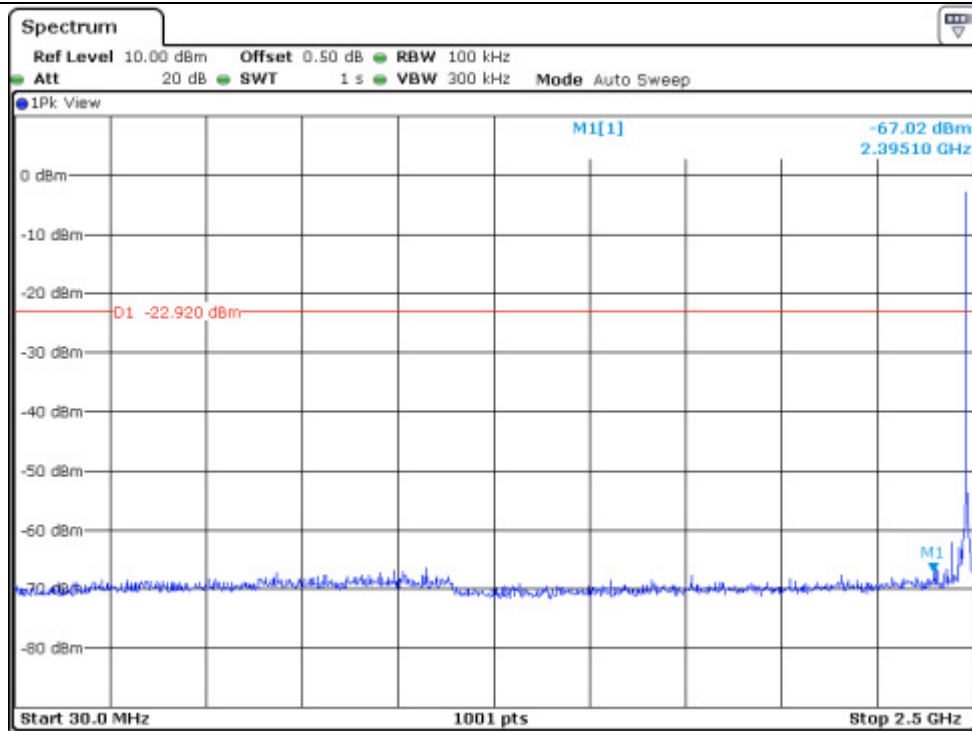




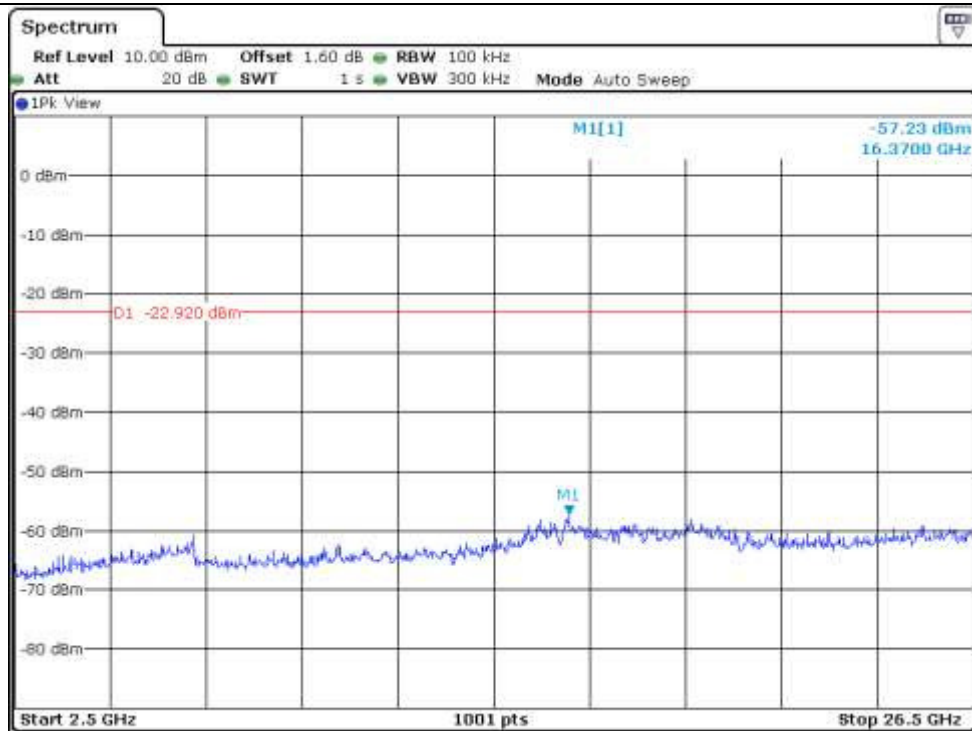
High Channel



High 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 : May 02, 2016
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- 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									
2 390.00	47.66	Peak	H	27.10	7.50	43.00	39.26	74.00	34.74
	37.94	Average	H				29.54	54.00	24.46
	47.26	Peak	V				38.86	74.00	35.14
	38.21	Average	V				29.81	54.00	24.19
Test Data for Low Channel									
2 400.00	58.92	Peak	H	27.10	7.50	43.00	50.52	74.00	23.48
	41.26	Average	H				32.86	54.00	21.14
	48.61	Peak	V				40.21	74.00	33.79
	37.65	Average	V				29.25	54.00	24.75
Test Data for High Channel									
2 483.50	49.64	Peak	H	27.10	7.50	43.00	41.24	74.00	32.76
	39.21	Average	H				30.81	54.00	23.19
	47.51	Peak	V				39.11	74.00	34.89
	37.84	Average	V				29.44	54.00	24.56

Tabulated test data for Restricted Band

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


Tested by: Hyung-Kwon, Oh / Engineer

12.6.1.2 Test data for 2 Mbps

- Test Date : May 02, 2016
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- 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									
2 390.00	47.18	Peak	H	27.10	7.50	43.00	38.78	74.00	35.22
	38.12	Average	H				29.72	54.00	24.28
	47.52	Peak	V				39.12	74.00	34.88
	38.27	Average	V				29.87	54.00	24.13
Test Data for Low Channel									
2 400.00	58.33	Peak	H	27.10	7.50	43.00	49.93	74.00	24.07
	40.45	Average	H				32.05	54.00	21.95
	48.75	Peak	V				40.35	74.00	33.65
	38.35	Average	V				29.95	54.00	24.05
Test Data for High Channel									
2 483.50	49.22	Peak	H	27.10	7.50	43.00	40.82	74.00	33.18
	39.06	Average	H				30.66	54.00	23.34
	47.32	Peak	V				38.92	74.00	35.08
	38.14	Average	V				29.74	54.00	24.26

Tabulated test data for Restricted Band

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



Tested by: Hyung-Kwon, Oh / Engineer

12.6.1.3 Test data for 3 Mbps

- Test Date : May 02, 2016
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- 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									
2 390.00	46.84	Peak	H	27.10	7.50	43.00	38.44	74.00	35.56
	36.99	Average	H				28.59	54.00	25.41
	47.08	Peak	V				38.68	74.00	35.32
	37.19	Average	V				28.79	54.00	25.21
Test Data for Low Channel									
2 400.00	58.29	Peak	H	27.10	7.50	43.00	49.89	74.00	24.11
	41.03	Average	H				32.63	54.00	21.37
	48.29	Peak	V				39.89	74.00	34.11
	38.06	Average	V				29.66	54.00	24.34
Test Data for High Channel									
2 483.50	48.84	Peak	H	27.10	7.50	43.00	40.44	74.00	33.56
	37.66	Average	H				29.26	54.00	24.74
	47.06	Peak	V				38.66	74.00	35.34
	37.20	Average	V				28.80	54.00	25.20

Tabulated test data for Restricted Band

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



Tested by: Hyung-Kwon, Oh / Engineer

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data for 1 Mbps

- Test Date : May 02, 2016
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- 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	47.56	Peak	H	30.60	11.10	42.50	46.76	74.00	27.24
	38.53	Average	H				37.73	54.00	16.27
	46.98	Peak	V				46.18	74.00	27.82
	38.20	Average	V				37.40	54.00	16.60
Test Data for Middle Channel									
4 882.00	47.26	Peak	H	30.70	11.20	42.50	46.66	74.00	27.34
	38.06	Average	H				37.46	54.00	16.54
	47.95	Peak	V				47.35	74.00	26.65
	38.33	Average	V				37.73	54.00	16.27
Test Data for High Channel									
4 960.00	47.65	Peak	H	30.80	11.30	42.50	47.25	74.00	26.75
	38.68	Average	H				38.28	54.00	15.72
	46.79	Peak	V				46.39	74.00	27.61
	38.11	Average	V				37.71	54.00	16.29

Tabulated test data for Restricted Band

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


Tested by: Hyung-Kwon, Oh / Engineer

12.6.2.2 Test data for 2 Mbps

- Test Date : May 02, 2016
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- 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	47.26	Peak	H	30.60	11.10	42.50	46.46	74.00	27.54
	38.24	Average	H				37.44	54.00	16.56
	47.39	Peak	V				46.59	74.00	27.41
	38.29	Average	V				37.49	54.00	16.51
Test Data for Middle Channel									
4 882.00	46.96	Peak	H	30.70	11.20	42.50	46.36	74.00	27.64
	37.88	Average	H				37.28	54.00	16.72
	47.84	Peak	V				47.24	74.00	26.76
	38.26	Average	V				37.66	54.00	16.34
Test Data for High Channel									
4 960.00	47.62	Peak	H	30.80	11.30	42.50	47.22	74.00	26.78
	38.44	Average	H				38.04	54.00	15.96
	47.48	Peak	V				47.08	74.00	26.92
	38.26	Average	V				37.86	54.00	16.14

Tabulated test data for Restricted Band

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


Tested by: Hyung-Kwon, Oh / Engineer

12.6.2.3 Test data for 3 Mbps

- Test Date : May 02, 2016
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- 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	47.56	Peak	H	30.60	11.10	42.50	46.76	74.00	27.24
	38.84	Average	H				38.04	54.00	15.96
	47.25	Peak	V				46.45	74.00	27.55
	38.65	Average	V				37.85	54.00	16.15
Test Data for Middle Channel									
4 882.00	47.77	Peak	H	30.70	11.20	42.50	47.17	74.00	26.83
	38.36	Average	H				37.76	54.00	16.24
	46.98	Peak	V				46.38	74.00	27.62
	38.51	Average	V				37.91	54.00	16.09
Test Data for High Channel									
4 960.00	47.76	Peak	H	30.80	11.30	42.50	47.36	74.00	26.64
	38.25	Average	H				37.85	54.00	16.15
	47.66	Peak	V				47.26	74.00	26.74
	38.64	Average	V				38.24	54.00	15.76

Tabulated test data for Restricted Band

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

Tested by: Hyung-Kwon, Oh / Engineer

13. RADIATED EMISSION TEST

13.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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 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

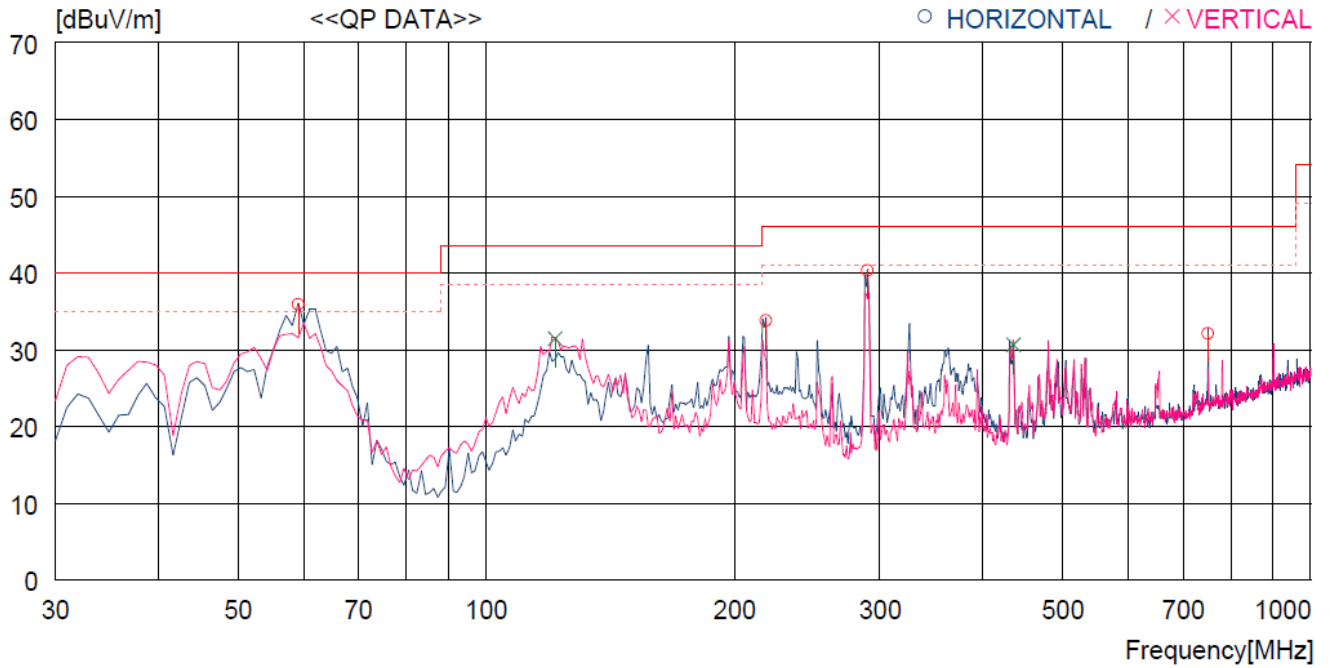
	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 22, 2015 (1Y)
■ -	ESU	Rohde & Schwarz	EMI Test Receiver	100261	Apr. 06, 2016 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Apr. 05, 2016 (1Y)
■ -	SCU-18	Rohde & Schwarz	Pre-Amplifier	10041	Nov. 23, 2015 (1Y)
■ -	DT3000	Innco System	Turn Table	930611	N/A
■ -	MA4000-EP	Innco System	Antenna Master	3320611	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-421	Apr. 15, 2016 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 31, 2015 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Apr. 31, 2015 (2Y)

All test equipment used is calibrated on a regular basis.

13.4 Test data for 1 Mbps

13.4.1 Test data for 30 MHz ~ 1 000 MHz

- Test Date : May 02, 2016
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	59.100	53.5	13.3	2.1	33.0	35.9	40.0	4.1	400	359
2	218.180	51.3	11.4	3.9	32.8	33.8	46.0	12.2	200	243
3	289.960	55.2	13.3	4.5	32.7	40.3	46.0	5.7	100	0
4	750.703	37.9	20.3	7.6	33.7	32.1	46.0	13.9	100	3
----- Vertical -----										
5	121.180	51.0	10.1	3.5	33.2	31.4	43.5	12.1	100	359
6	435.461	41.3	16.4	5.6	32.7	30.6	46.0	15.4	200	6

Tested by: Hyung-Kwon, Oh / Engineer

13.4.2 Test data for Below 30 MHz

- . Test Date : May 02, 2016
- . 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)
It was not observed any emissions from the EUT.								

13.4.3 Test data for above 1 GHz

- . Test Date : May 02, 2016
- . 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

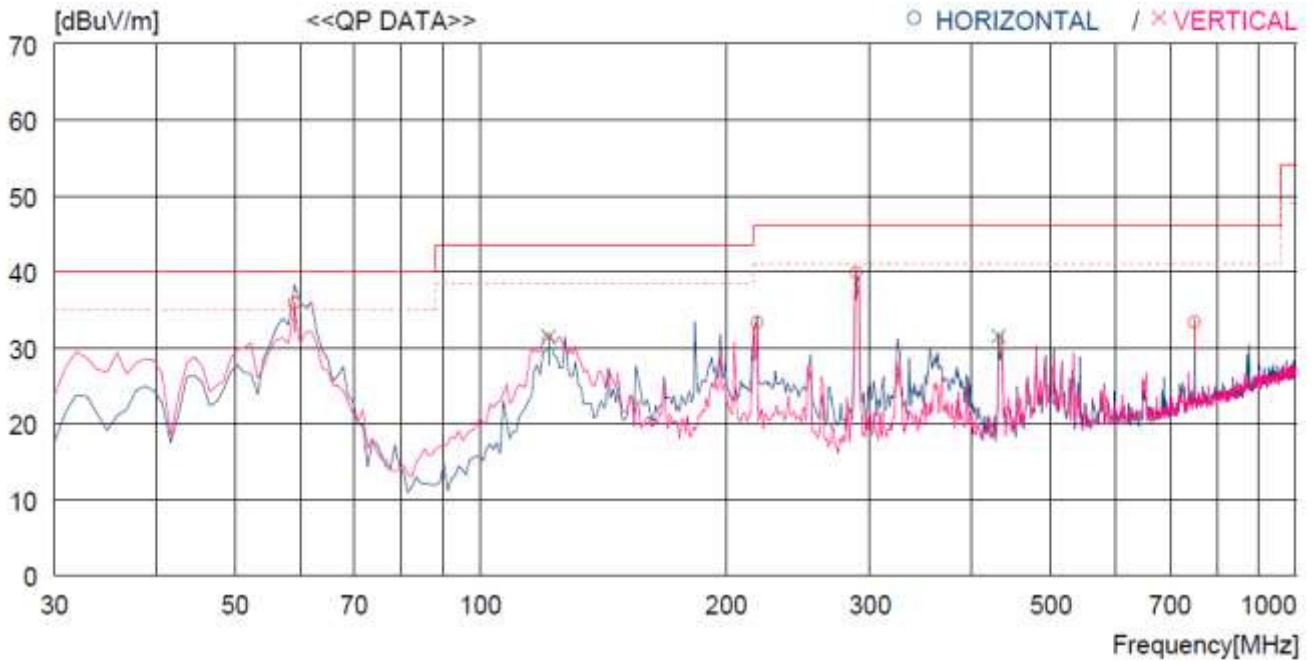
Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
It was not observed any emissions from the EUT.								


Tested by: Hyung-Kwon, Oh / Engineer

13.5 Test data for 2 Mbps

13.5.1 Test data for 30 MHz ~ 1 000 MHz

- Test Date : May 02, 2016
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	59.100	53.5	13.3	2.1	33.0	35.9	40.0	4.1	400	359
2	218.180	50.8	11.4	3.9	32.8	33.3	46.0	12.7	100	243
3	288.990	54.8	13.3	4.5	32.7	39.9	46.0	6.1	100	281
4	750.703	39.1	20.3	7.6	33.7	33.3	46.0	12.7	100	0
----- Vertical -----										
5	121.180	51.0	10.1	3.5	33.2	31.4	43.5	12.1	100	354
6	431.581	42.3	16.3	5.6	32.7	31.5	46.0	14.5	100	359

Tested by: Hyung-Kwon, Oh / Engineer

13.5.2 Test data for Below 30 MHz

- . Test Date : May 02, 2016
- . 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)
It was not observed any emissions from the EUT.								

13.5.3 Test data for above 1 GHz

- . Test Date : May 02, 2016
- . 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

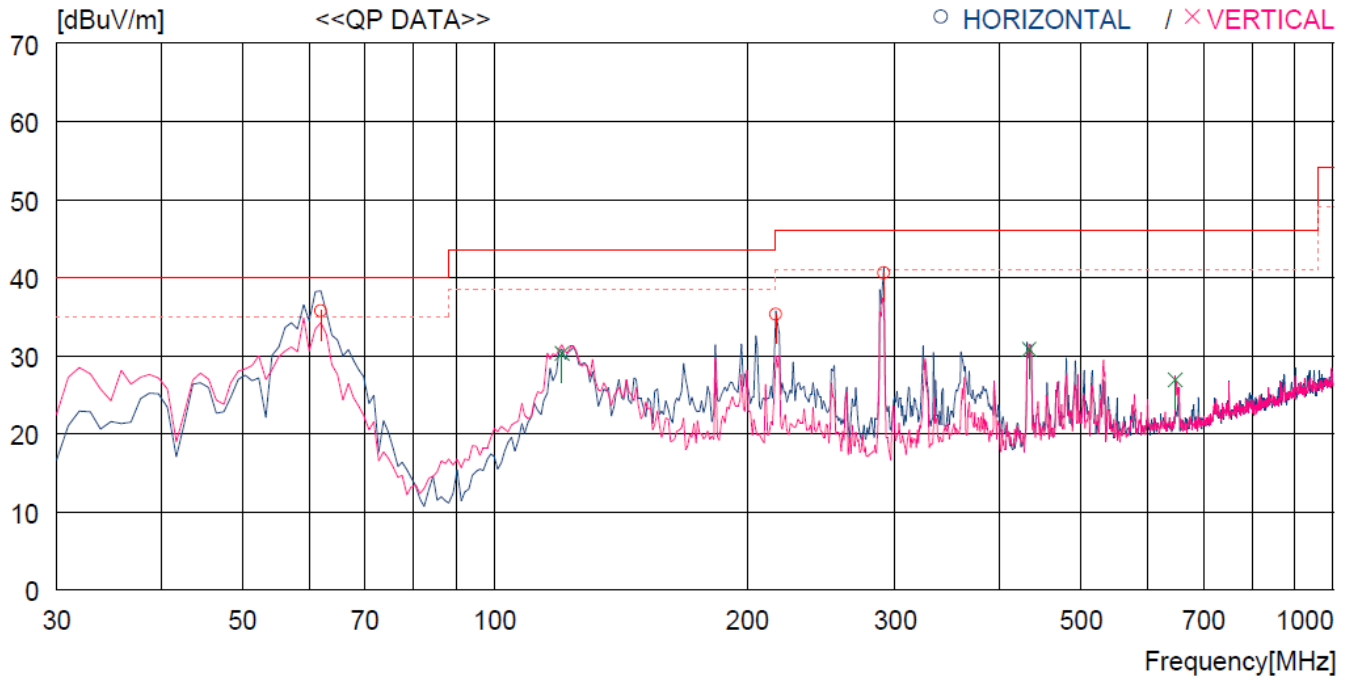
Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
It was not observed any emissions from the EUT.								


 Tested by: Hyung-Kwon, Oh / Engineer

13.6 Test data for 3 Mbps

13.6.1 Test data for 30 MHz ~ 1 000 MHz

- Test Date : May 02, 2016
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	62.010	54.0	12.6	2.2	33.1	35.7	40.0	4.3	300	170
2	216.240	52.9	11.3	3.9	32.8	35.3	46.0	10.7	100	212
3	290.930	55.3	13.4	4.6	32.7	40.6	46.0	5.4	100	271
----- Vertical -----										
4	120.210	49.8	10.2	3.5	33.2	30.3	43.5	13.2	100	2
5	433.521	41.5	16.4	5.6	32.7	30.8	46.0	15.2	100	140
6	647.887	34.0	19.4	6.9	33.4	26.9	46.0	19.1	100	359

Tested by: Hyung-Kwon, Oh / Engineer

13.6.2 Test data for Below 30 MHz

- . Test Date : May 02, 2016
- . 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)
It was not observed any emissions from the EUT.								

13.6.3 Test data for above 1 GHz

- . Test Date : May 02, 2016
- . 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)
It was not observed any emissions from the EUT.								


 Tested by: Hyung-Kwon, Oh / Engineer

14. CONDUCTED EMISSION TEST

14.1 Operating environment

Temperature : 21.4 °C
Relative humidity : 45.1 % 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.

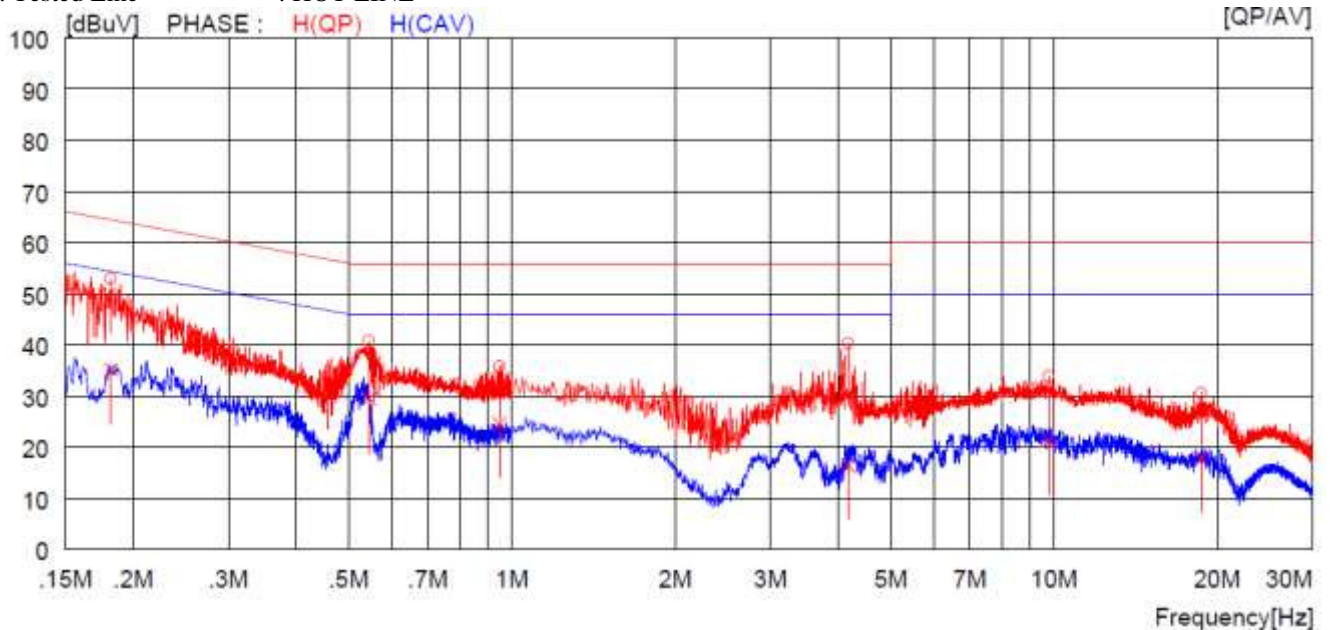
14.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESPI	Rohde & Schwarz	EMI Test Receiver	101278	Nov. 02, 2015 (1Y)
□ -	ESHS10	Rohde & Schwarz	EMI Test Receiver	834467/007	Apr. 05, 2016 (1Y)
□ -	NSLK8128	Schwarzbeck	AMN	8128-216	Apr. 06, 2016 (1Y)
■ -	NSLK8126	Schwarzbeck	AMN	8126-404	Apr. 05, 2016 (1Y)
□ -	3825/2	EMCO	AMN	9109-1869	Apr. 06, 2016 (1Y)
■ -	3825/2	EMCO	AMN	9109-1867	Apr. 06, 2016 (1Y)

All test equipment used is calibrated on a regular basis.

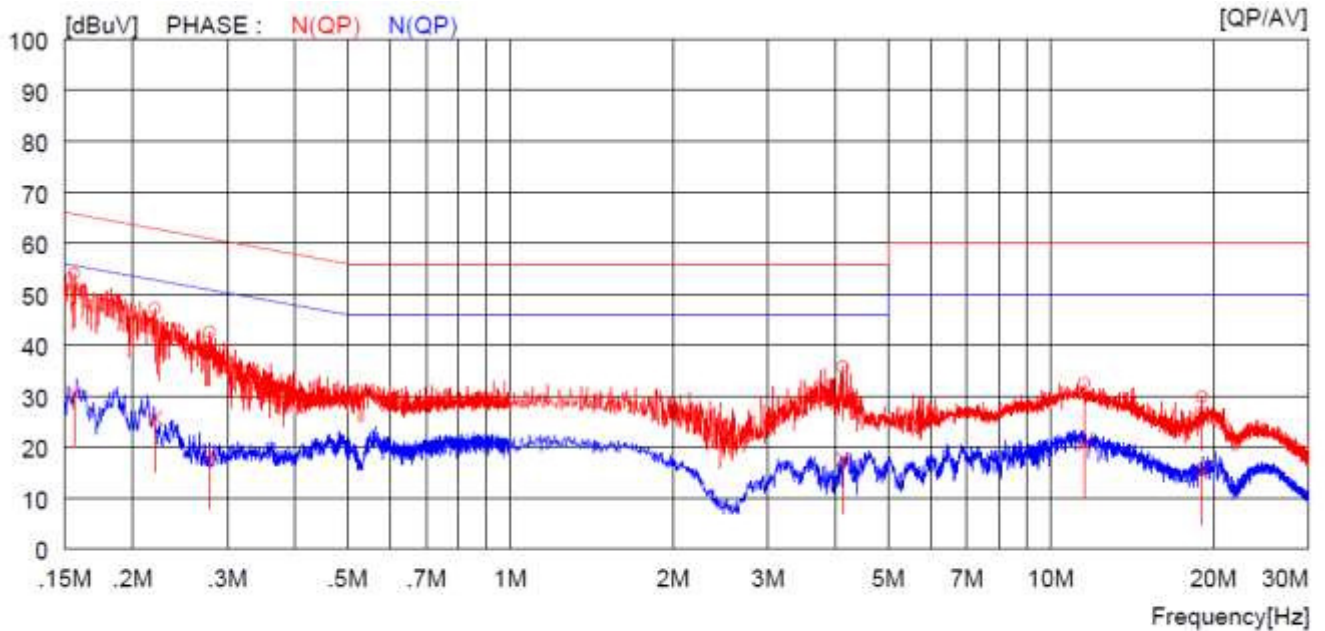
14.4 Test data

- Test Date : May 02, 2016
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



NO	FREQ		READING		C.FACTOR		RESULT		LIMIT		MARGIN		PHASE
	QP	AV	QP	AV	QP	AV	QP	AV	QP	AV	QP	AV	
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	
1	0.18200	52.8	----	0.1	52.9	----	64.4	----	11.5	----	H(QP)		
2	0.54400	40.7	----	0.1	40.8	----	56.0	----	15.2	----	H(QP)		
3	0.94700	35.6	----	0.1	35.7	----	56.0	----	20.3	----	H(QP)		
4	4.17200	40.1	----	0.2	40.3	----	56.0	----	15.7	----	H(QP)		
5	9.78000	33.5	----	0.4	33.9	----	60.0	----	26.1	----	H(QP)		
6	18.68000	29.9	----	0.7	30.6	----	60.0	----	29.4	----	H(QP)		
7	0.18200	----	35.0	0.1	----	35.1	----	54.4	----	19.3	H(CAV)		
8	0.54400	----	29.4	0.1	----	29.5	----	46.0	----	16.5	H(CAV)		
9	0.94700	----	24.5	0.1	----	24.6	----	46.0	----	21.4	H(CAV)		
10	4.17200	----	16.2	0.2	----	16.4	----	46.0	----	29.6	H(CAV)		
11	9.78000	----	20.8	0.4	----	21.2	----	50.0	----	28.8	H(CAV)		
12	18.68000	----	17.2	0.7	----	17.9	----	50.0	----	32.1	H(CAV)		

-. Tested Line : NEUTRAL LINE



NO	FREQ	READING	C.FACTOR	RESULT	LIMIT	MARGIN	PHASE	
	QP	AV	QP	AV	QP	AV	QP	AV
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]
1	0.15600	53.9	---	0.1	54.0	---	65.7	---
2	0.22000	47.1	---	0.1	47.2	---	62.8	---
3	0.27800	42.5	---	0.1	42.6	---	60.9	---
4	4.12800	35.6	---	0.2	35.8	---	56.0	---
5	11.55000	32.1	---	0.4	32.5	---	60.0	---
6	19.07000	29.1	---	0.7	29.8	---	60.0	---
7	0.15600	---	30.4	0.1	---	30.5	---	55.7
8	0.22000	---	25.6	0.1	---	25.7	---	52.8
9	0.27800	---	18.4	0.1	---	18.5	---	50.9
10	4.12800	---	17.4	0.2	---	17.6	---	46.0
11	11.55000	---	20.1	0.4	---	20.5	---	50.0
12	19.07000	---	14.6	0.7	---	15.3	---	50.0

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.

Tested by: Hyung-Kwon, Oh / Engineer