

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

Test Report No. : E14DR-090

AGR No. : A14DA-148

Applicant : mondo systems, inc.

Address : 3F, Dongyang Bldg., 128-5, Cheongpa-dong 3-ga, Yongsan-Gu, Seoul, 140-133 Korea

Manufacturer : mondo systems, inc.

Address : 3F, Dongyang Bldg., 128-5, Cheongpa-dong 3-ga, Yongsan-Gu, Seoul, 140-133 Korea

Type of Equipment : Bluetooth Speaker

FCC ID. : VAP-SM-100

IC Certification No. : 9737A-SM100

Model Name : SM-100

Serial number : N/A

Total page of Report : 116 pages (including this page)

Date of Incoming : December 15, 2014

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## SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247 and IC RSS-Gen Issue 4 and RSS 210 Issue 8**

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.

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## CONTENTS

	PAGE
<b>1. VERIFICATION OF COMPLIANCE .....</b>	<b>6</b>
<b>2. TEST SUMMARY.....</b>	<b>7</b>
<b>2.1 TEST ITEMS AND RESULTS .....</b>	<b>7</b>
<b>2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS.....</b>	<b>7</b>
<b>2.3 RELATED SUBMITTAL(S) / GRANT(S) .....</b>	<b>7</b>
<b>2.4 PURPOSE OF THE TEST .....</b>	<b>7</b>
<b>2.5 TEST METHODOLOGY.....</b>	<b>7</b>
<b>2.6 TEST FACILITY.....</b>	<b>8</b>
<b>3. GENERAL INFORMATION .....</b>	<b>9</b>
<b>3.1 PRODUCT DESCRIPTION.....</b>	<b>9</b>
<b>3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT.....</b>	<b>9</b>
<b>4. EUT MODIFICATIONS.....</b>	<b>9</b>
<b>5. SYSTEM TEST CONFIGURATION .....</b>	<b>10</b>
<b>5.1 JUSTIFICATION .....</b>	<b>10</b>
<b>5.2 PERIPHERAL EQUIPMENT .....</b>	<b>10</b>
<b>5.3 MODE OF OPERATION DURING THE TEST .....</b>	<b>10</b>
<b>5.4 CONFIGURATION OF TEST SYSTEM.....</b>	<b>10</b>
<b>5.5 ANTENNA REQUIREMENT .....</b>	<b>11</b>
<b>6. PRELIMINARY TEST .....</b>	<b>11</b>
<b>6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS.....</b>	<b>11</b>
<b>6.2 GENERAL RADIATED EMISSIONS TESTS .....</b>	<b>11</b>
<b>7. MINIMUM 20 DB BANDWIDTH &amp; 99 % OCCUPIED BANDWIDTH .....</b>	<b>12</b>
<b>7.1 OPERATING ENVIRONMENT .....</b>	<b>12</b>
<b>7.2 TEST SET-UP .....</b>	<b>12</b>
<b>7.3 TEST EQUIPMENT USED.....</b>	<b>12</b>
<b>7.4 TEST DATA FOR 1 MBPS .....</b>	<b>13</b>
<b>7.5 TEST DATA FOR 2 MBPS .....</b>	<b>17</b>
<b>7.6 TEST DATA FOR 3 MBPS .....</b>	<b>21</b>
<b>8. HOPPING FREQUENCY SEPARATION.....</b>	<b>25</b>
<b>8.1 OPERATING ENVIRONMENT .....</b>	<b>25</b>
<b>8.2 TEST SET-UP .....</b>	<b>25</b>

<b>8.3 TEST EQUIPMENT USED.....</b>	<b>25</b>
<b>8.4 TEST DATA FOR 1 MBPS .....</b>	<b>26</b>
<b>8.5 TEST DATA FOR 2 MBPS .....</b>	<b>27</b>
<b>8.6 TEST DATA FOR 3 MBPS .....</b>	<b>28</b>
<b>9. NUMBER OF HOPPING CHANNELS .....</b>	<b>29</b>
<b>9.1 OPERATING ENVIRONMENT .....</b>	<b>29</b>
<b>9.2 TEST SET-UP .....</b>	<b>29</b>
<b>9.3 TEST EQUIPMENT USED.....</b>	<b>29</b>
<b>9.4 TEST DATA FOR MBPS 1 .....</b>	<b>30</b>
<b>9.5 TEST DATA FOR MBPS 2 .....</b>	<b>33</b>
<b>9.6 TEST DATA FOR MBPS 3 .....</b>	<b>36</b>
<b>10. TIME OF OCCUPANCY .....</b>	<b>39</b>
<b>10.1 OPERATING ENVIRONMENT .....</b>	<b>39</b>
<b>10.2 TEST SET-UP .....</b>	<b>39</b>
<b>10.3 TEST EQUIPMENT USED.....</b>	<b>39</b>
<b>10.4 TEST DATA FOR 1 MBPS .....</b>	<b>40</b>
<b>10.5 TEST DATA FOR 2 MBPS .....</b>	<b>43</b>
<b>10.6 TEST DATA FOR 3 MBPS .....</b>	<b>46</b>
<b>11. MAXIMUM PEAK OUTPUT POWER.....</b>	<b>49</b>
<b>11.1 OPERATING ENVIRONMENT .....</b>	<b>49</b>
<b>11.2 TEST SET-UP .....</b>	<b>49</b>
<b>11.3 TEST EQUIPMENT USED.....</b>	<b>49</b>
<b>11.4 TEST DATA FOR 1 MBPS .....</b>	<b>50</b>
<b>11.5 TEST DATA FOR 2 MBPS .....</b>	<b>53</b>
<b>11.6 TEST DATA FOR 3 MBPS .....</b>	<b>56</b>
<b>12. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND.....</b>	<b>59</b>
<b>12.1 OPERATING ENVIRONMENT .....</b>	<b>59</b>
<b>12.2 TEST SET-UP FOR CONDUCTED MEASUREMENT .....</b>	<b>59</b>
<b>12.3 TEST SET-UP FOR RADIATED MEASUREMENT.....</b>	<b>59</b>
<b>12.4 TEST EQUIPMENT USED.....</b>	<b>59</b>
<b>12.5 TEST DATA FOR CONDUCTED EMISSION .....</b>	<b>60</b>
<b>12.5.1 Test data for 1 Mbps .....</b>	<b>60</b>
<b>12.5.2 Test data for 2 Mbps .....</b>	<b>65</b>
<b>12.5.3 Test data for 3 Mbps .....</b>	<b>70</b>
<b>12.6 TEST DATA FOR RADIATED EMISSION .....</b>	<b>75</b>

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<b>12.6.1 Radiated Emission which fall in the Restricted Band.....</b>	75
<b>12.6.2 Spurious &amp; Harmonic Radiated Emission above 1 GHz.....</b>	78
<b>12.6.3 Spurious Radiated Emission.....</b>	84
<b>13. SPURIOUS EMISSION - RECEIVER .....</b>	<b>92</b>
<b>13.1 OPERATING ENVIRONMENT .....</b>	<b>92</b>
<b>13.2 TEST SET-UP FOR CONDUCTED MEASUREMENT .....</b>	<b>92</b>
<b>13.3 TEST SET-UP FOR RADIATED MEASUREMENT.....</b>	<b>92</b>
<b>13.4 TEST EQUIPMENT USED .....</b>	<b>92</b>
<b>13.5 TEST DATA FOR 1 MBPS .....</b>	<b>93</b>
<b>    13.5.1 Test data – Conducted.....</b>	<b>93</b>
<b>    13.5.2 Test data - Radiated .....</b>	<b>97</b>
<b>13.6 TEST DATA FOR 2 MBPS .....</b>	<b>100</b>
<b>    13.6.1 Test data – Conducted.....</b>	<b>100</b>
<b>    13.6.2 Test data - Radiated .....</b>	<b>104</b>
<b>13.7 TEST DATA FOR 3 MBPS .....</b>	<b>107</b>
<b>    13.7.1 Test data – Conducted.....</b>	<b>107</b>
<b>    13.7.2 Test data - Radiated .....</b>	<b>111</b>
<b>14. CONDUCTED EMISSION TEST.....</b>	<b>114</b>
<b>14.1 OPERATING ENVIRONMENT .....</b>	<b>114</b>
<b>14.2 TEST SET-UP .....</b>	<b>114</b>
<b>14.3 TEST EQUIPMENT USED .....</b>	<b>114</b>
<b>14.4 TEST DATA FOR CHARGING MODE .....</b>	<b>115</b>

## Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
E14DR-090	December 23, 2014	Initial Issue	All

## 1. VERIFICATION OF COMPLIANCE

APPLICANT : mondo systems, inc.  
ADDRESS : 3F, Dongyang Bldg., 128-5, Cheongpa-dong 3-ga, Yongsan-Gu, Seoul, 140-133 Korea  
CONTACT PERSON : Joel-Lee, Joel / Chief Manager  
TELEPHONE NO : +82-2-3016-3406  
FCC ID : VAP-SM-100  
IC CERTIFICATION NO. : 9737A-SM100  
MODEL NAME : SM-100  
SERIAL NUMBER : N/A  
DATE : December 23, 2014

EQUIPMENT CLASS	<b>FCC: DSS – PART 15 SPREAD SPECTRUM TRANSMITTER</b> <b>IC: Low Power License-Exempt Radio-communication Device</b>
KIND OF EQUIPMENT	Bluetooth Speaker
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2009
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 and RSS 210 Issue 8, RSS-Gen Issue 4.
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& IC 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)	RSS-210 A8.1(b) Carrier Frequency Separation	Met the Limit / PASS
15.247 (a) (1) (iii)	RSS-210 A8.1(d) Minimum Number of Hopping Channels	Met the Limit / PASS
15.247 (a) (1) (iii)	RSS-210 A8.1(d) Average Time of Occupancy	Met the Limit / PASS
15.247 (b) (1)	RSS-210 A8.4(2) Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (b) (5)	RSS-102 Radio Frequency Exposure Level	Met requirement / PASS
15.247 (d)	RSS-210 A8.5 100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	RSS-210 A8.5 Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.209	RSS-210 A8.5 Radiated Emission Limits, General Requirement	Met the Limit / PASS
15.207	RSS-GEN 8.8 Conducted Limits	Met the Limit / PASS
15.203	RSS-GEN, 6.7 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 and IC RSS-Gen Issue 4 and RSS 210 Issue 8

### 2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2009. 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 301-14, Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do, 464-862 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. 85

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

### 3. GENERAL INFORMATION

#### 3.1 Product Description

The mondo systems, inc., Model SM-100 (referred to as the EUT in this report) is a Bluetooth Speaker. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Portable Device	
OPERATING FREQUENCY	2 402 MHz ~ 2 480 MHz	
RF OUTPUT POWER	1 Mbps	-1.38 dBm
	2 Mbps	-0.98 dBm
	3 Mbps	-0.28 dBm
NUMBER OF CHANNEL	79 Channels	
MODULATION TYPE	GFSK for 1 Mbps, DQPSK for 2 Mbps, 8-DPSK for 3 Mbps	
ANTENNA TYPE	Wire Antenna	
ANTENNA GAIN	-2.32 dBi	
LIST OF EACH OSC. OR CRYSTAL. FREQ.(FREQ.>=1 MHz)	26 MHz	
RATED SUPPLY VOLTAGE	DC 3.7 V	

#### 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	mondo systems, inc.	N/A	N/A

### 5.2 Peripheral equipment

- None

### 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 "XZ" 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 mode. The EUT was connected to USB and the power of USB was connected to Notebook PC. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2009 7.3.3 to determine the worse operating conditions.

**Radiated Emission Test:** The EUT was tested in a charging mode and Transmitter mode. Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2009 8.3.1.1 and 13.1.4.1 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m open area test site.

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 transmitter antenna of the EUT is a wire antenna, 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)
Charging 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
Charging Mode	

## 7. MINIMUM 20 dB BANDWIDTH & 99 % OCCUPIED BANDWIDTH

### 7.1 Operating environment

Temperature : 21.4 °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. (Interval)
■ - FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)

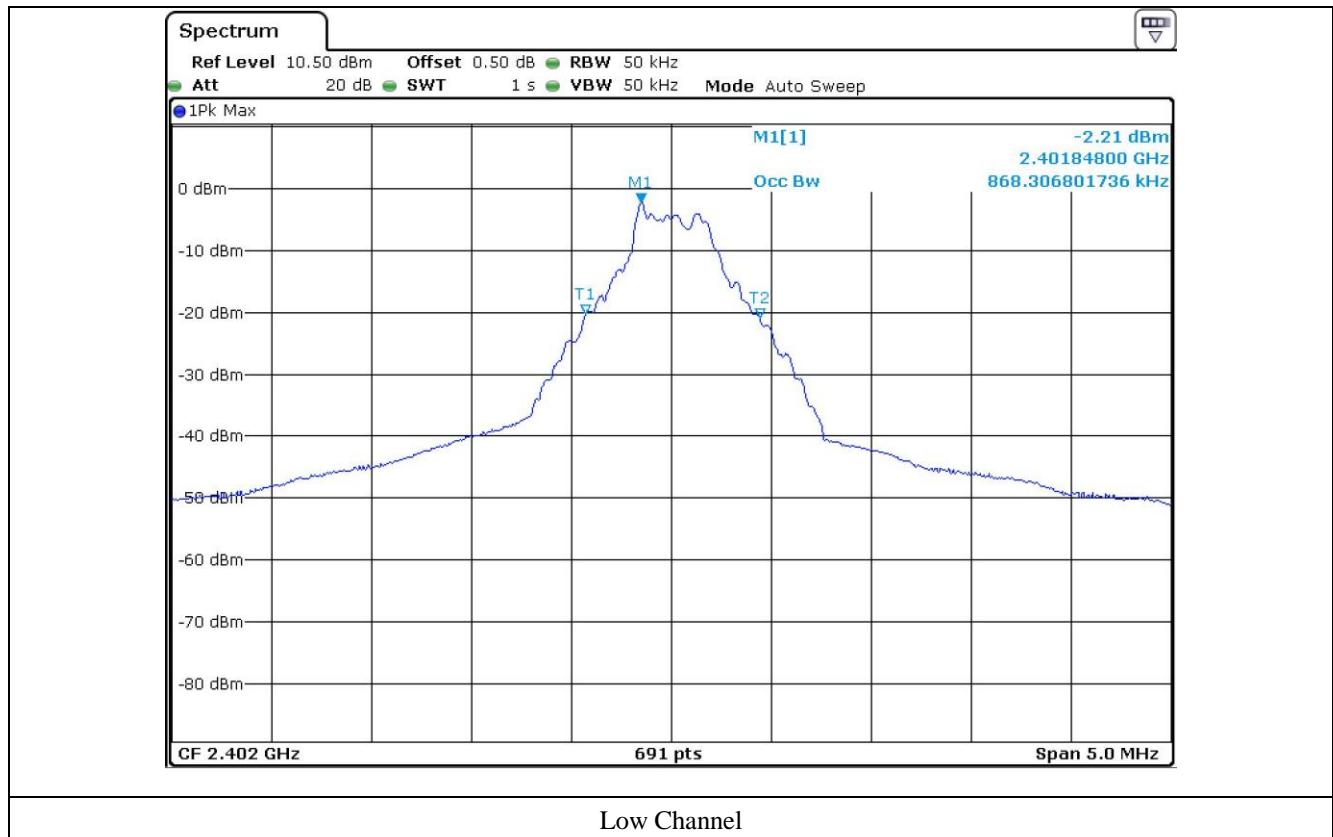
All test equipment used is calibrated on a regular basis.

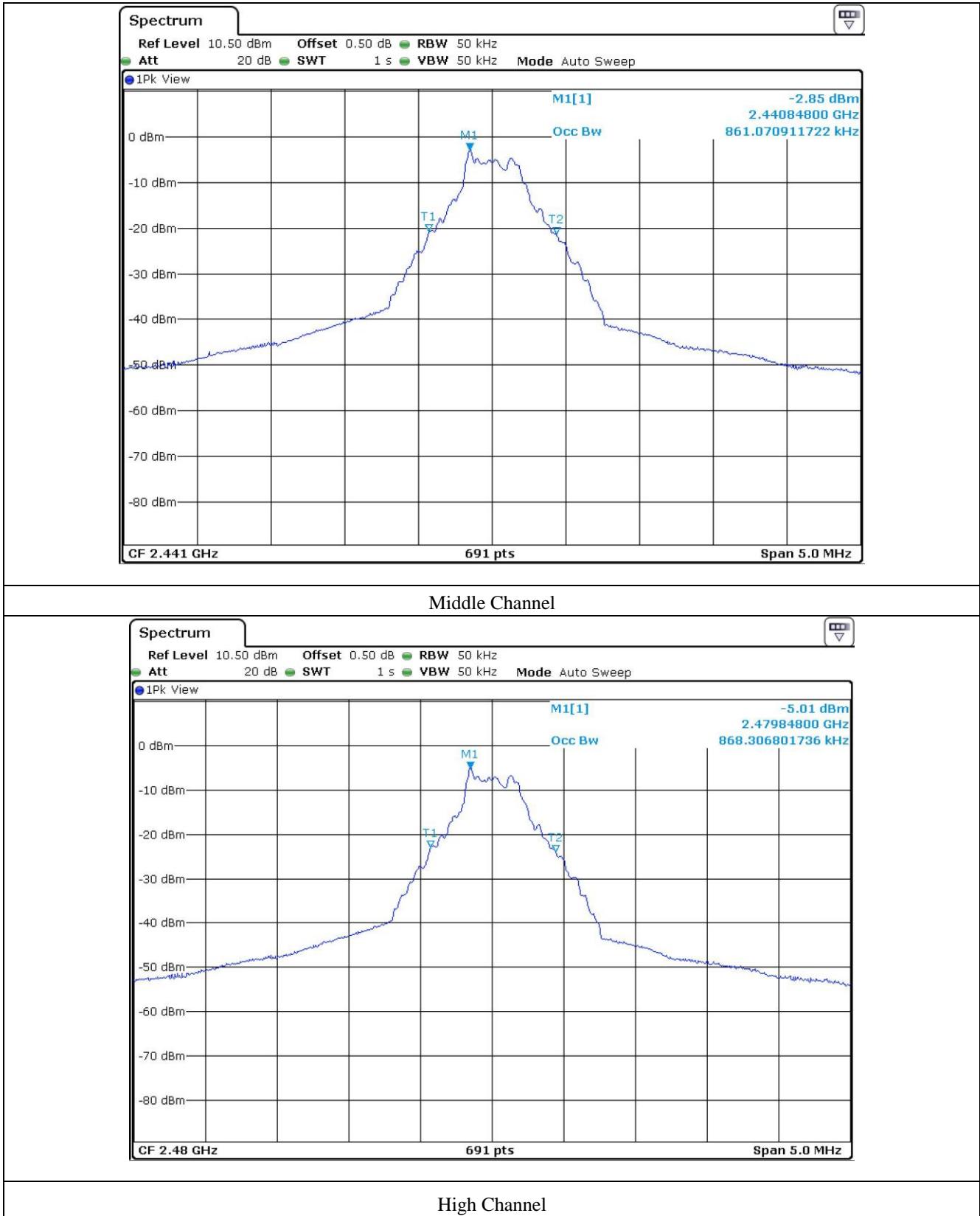
### 7.4 Test data for 1 Mbps

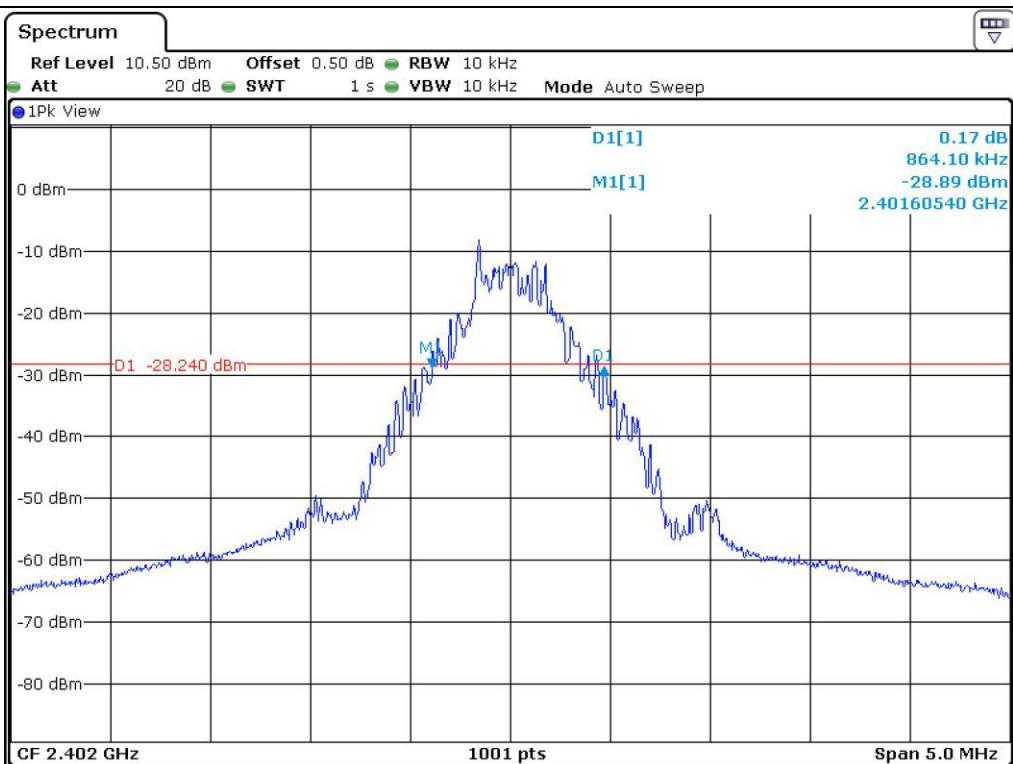
- Test Date : December 19, 2014

CHANNEL	FREQUENCY (MHz)	99% Occupied Bandwidth (kHz)	20 dB Bandwidth (kHz)
Low	2 402	864.10	868.31
Middle	2 441	909.10	861.07
High	2 480	904.10	868.31

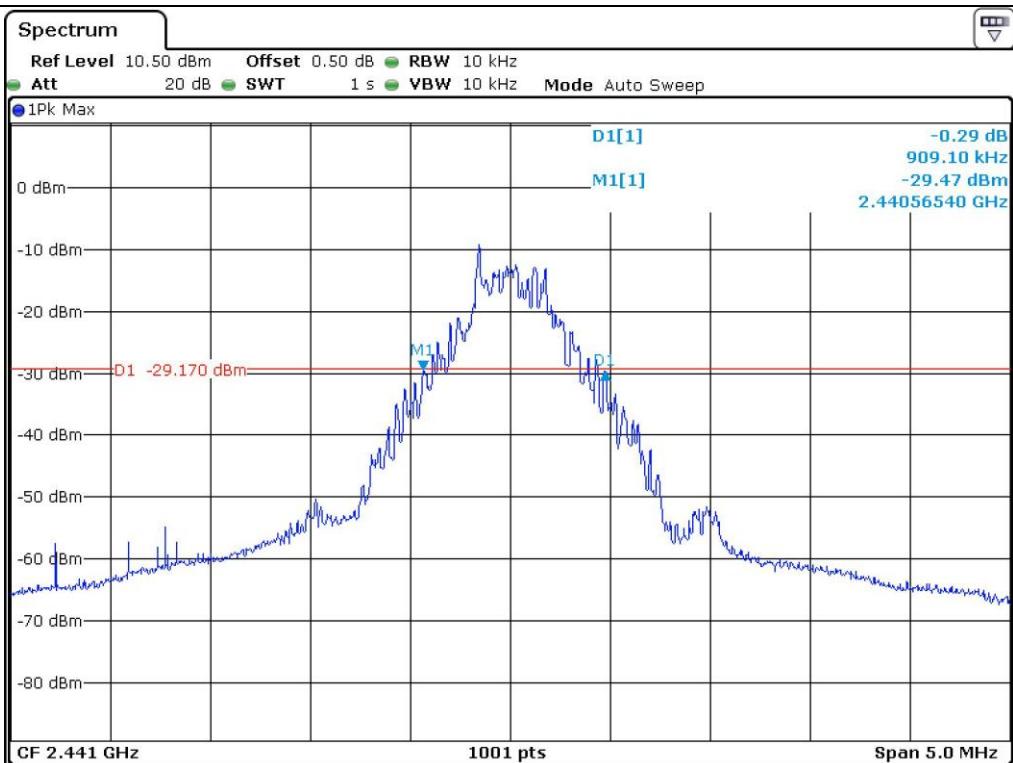
Tested by: Tae-Ho, Kim / Project Engineer



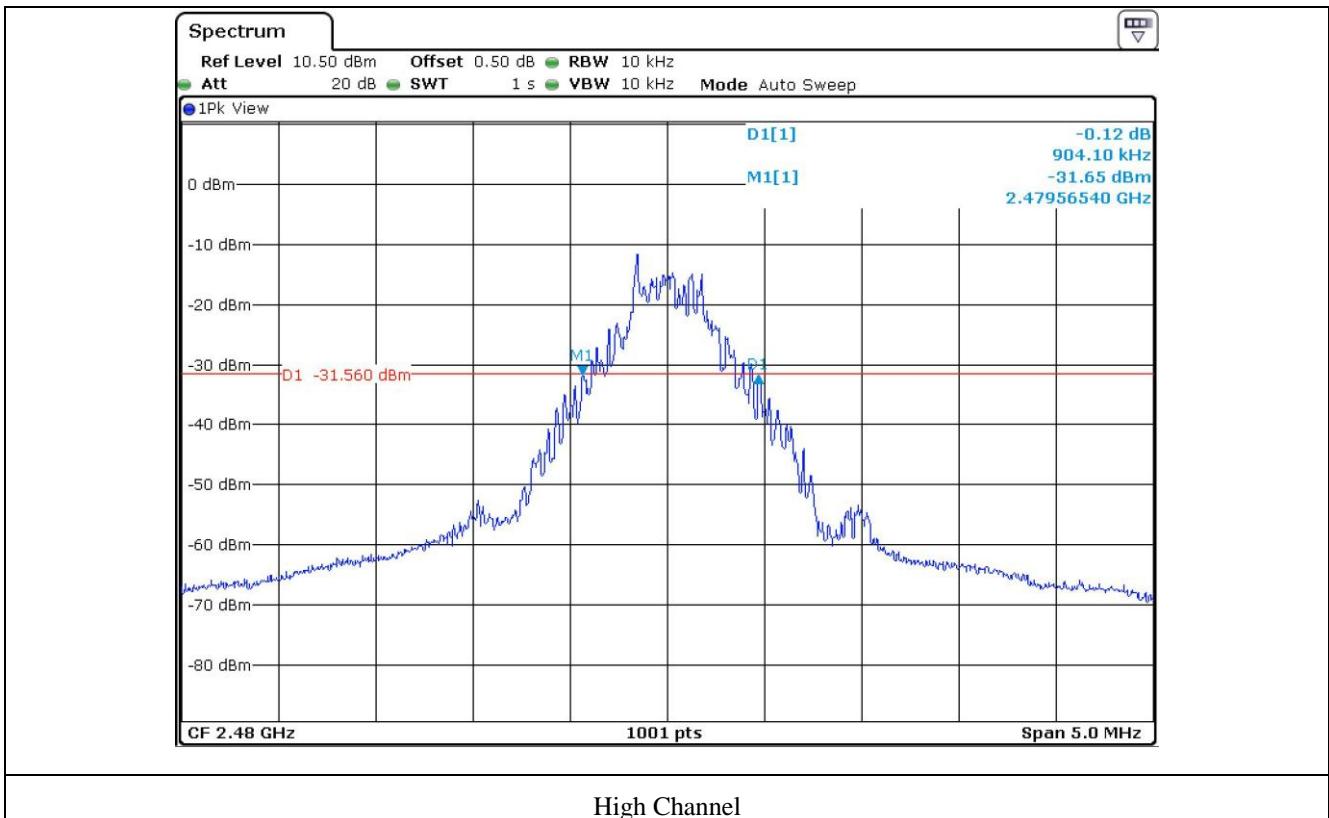




## Low Channel



## Middle Channel

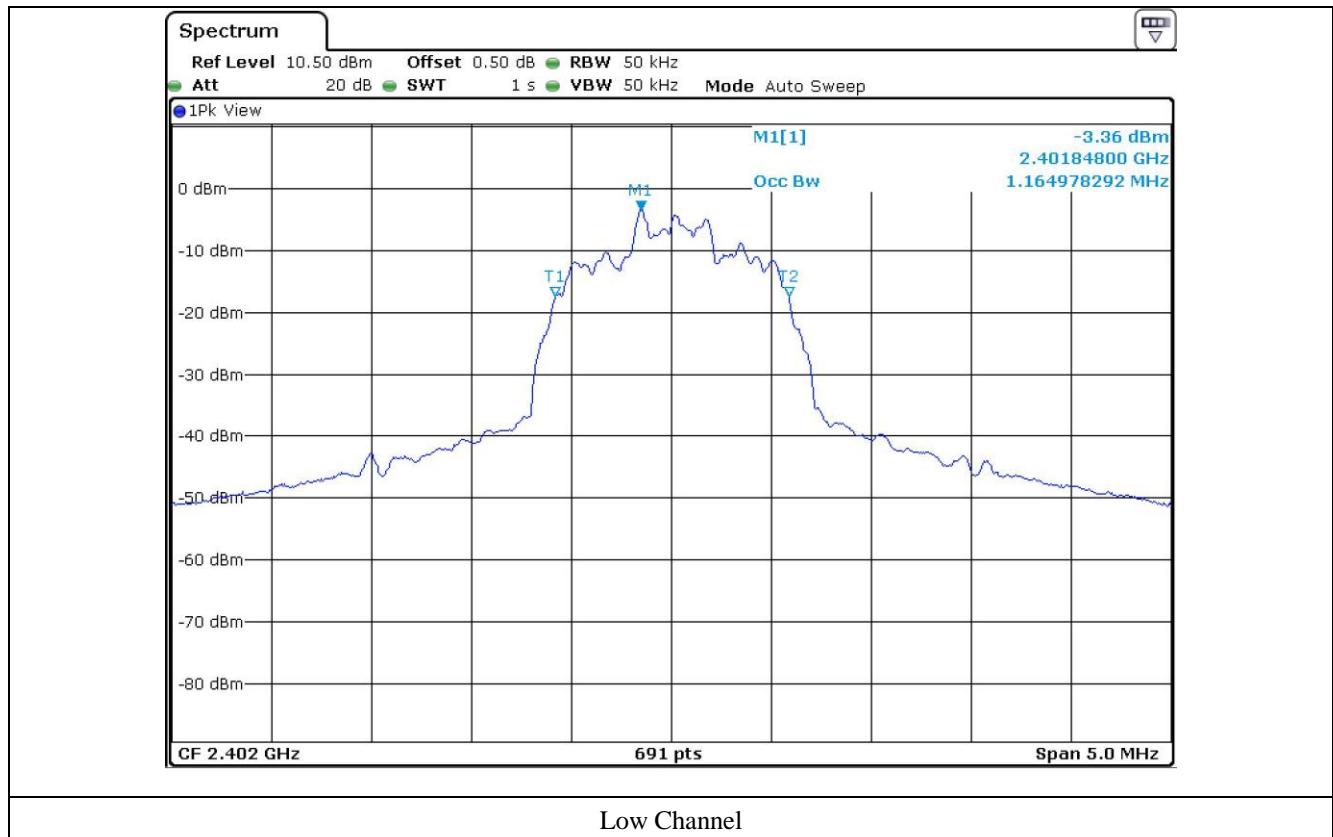


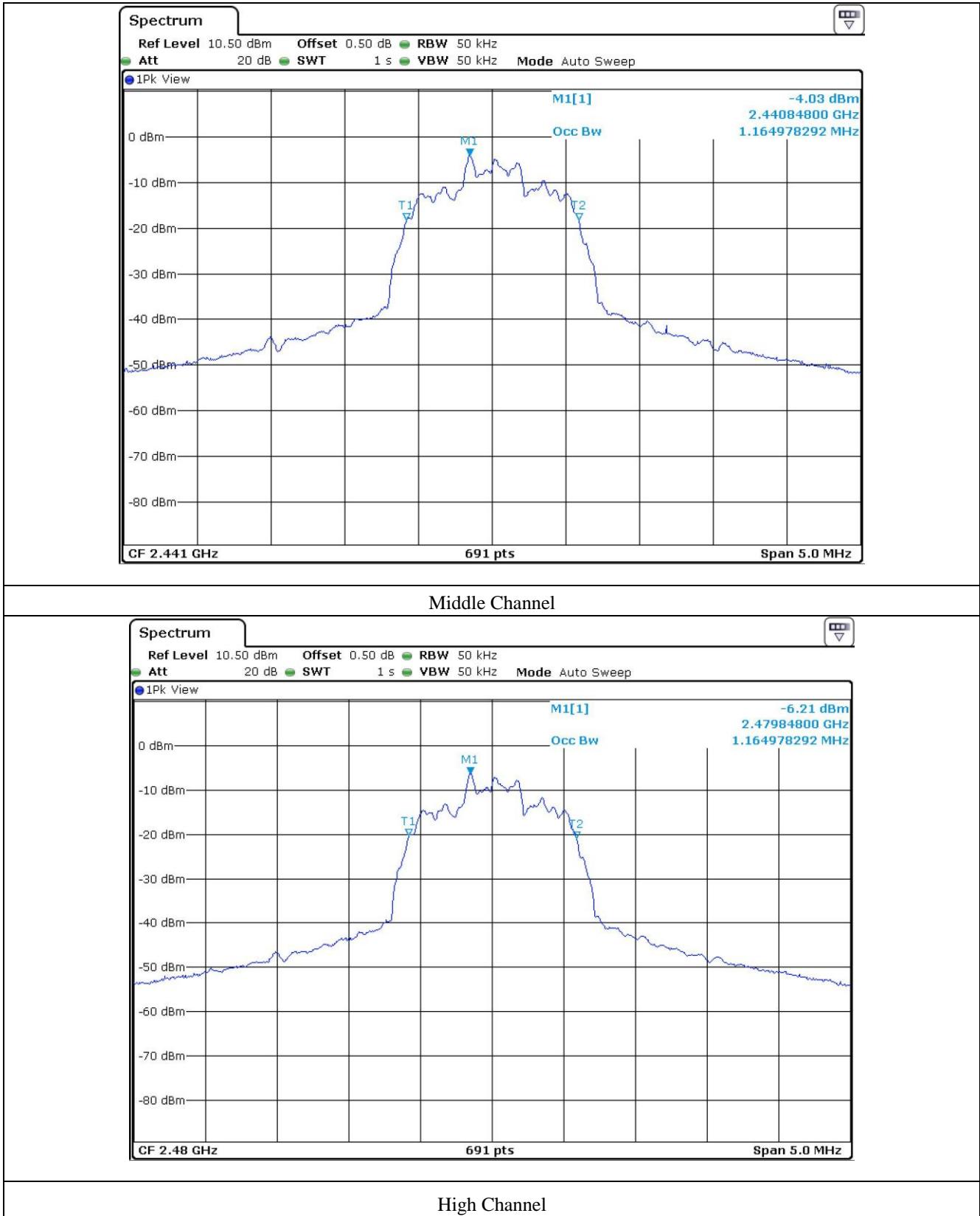
### 7.5 Test data for 2 Mbps

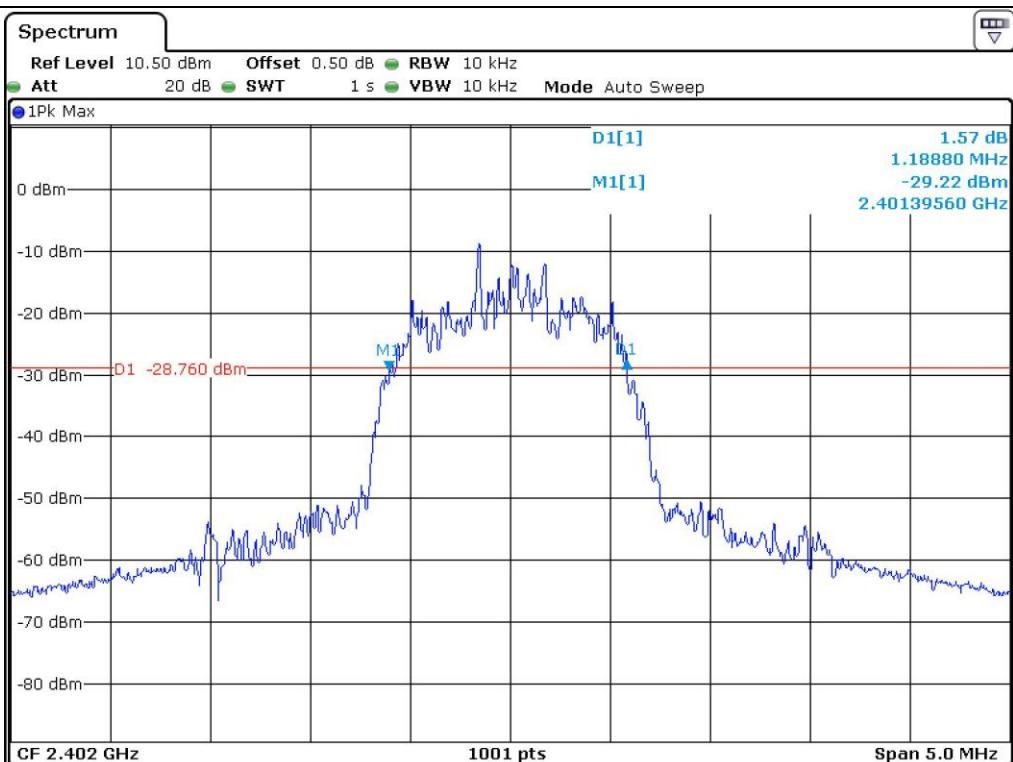
- Test Date : December 19, 2014

CHANNEL	FREQUENCY (MHz)	99% Occupied Bandwidth (kHz)	20 dB Bandwidth (kHz)
Low	2 402	1 188.80	1 164.98
Middle	2 441	1 183.80	1 164.98
High	2 480	1 188.80	1 164.98

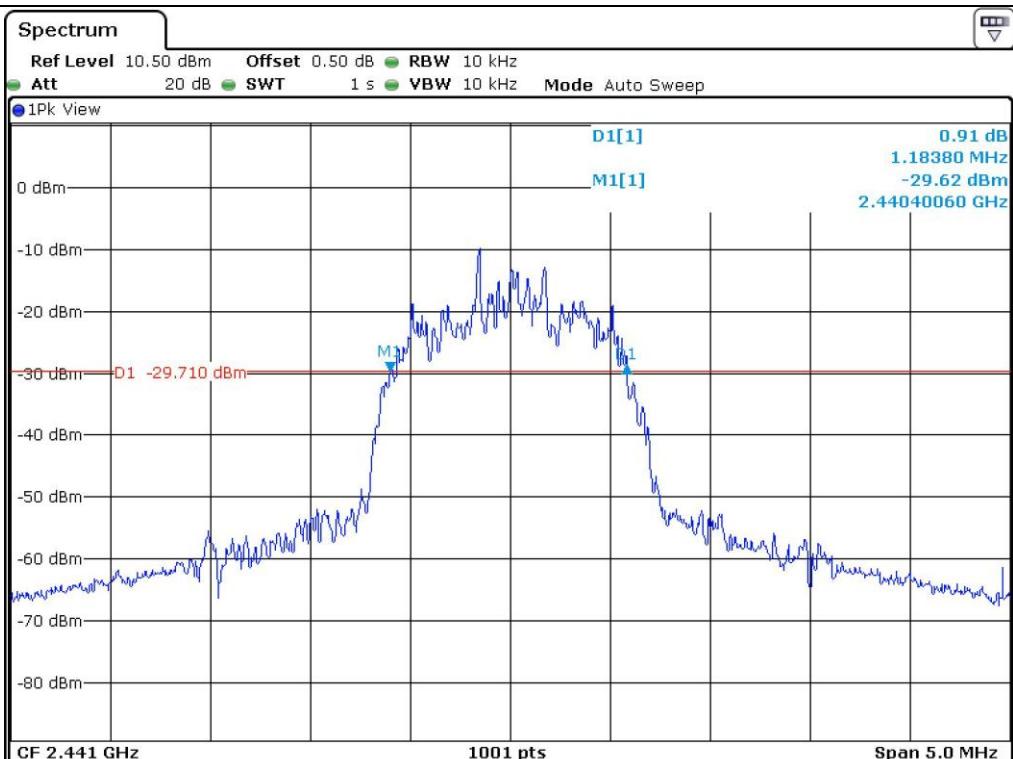
Tested by: Tae-Ho, Kim / Project Engineer



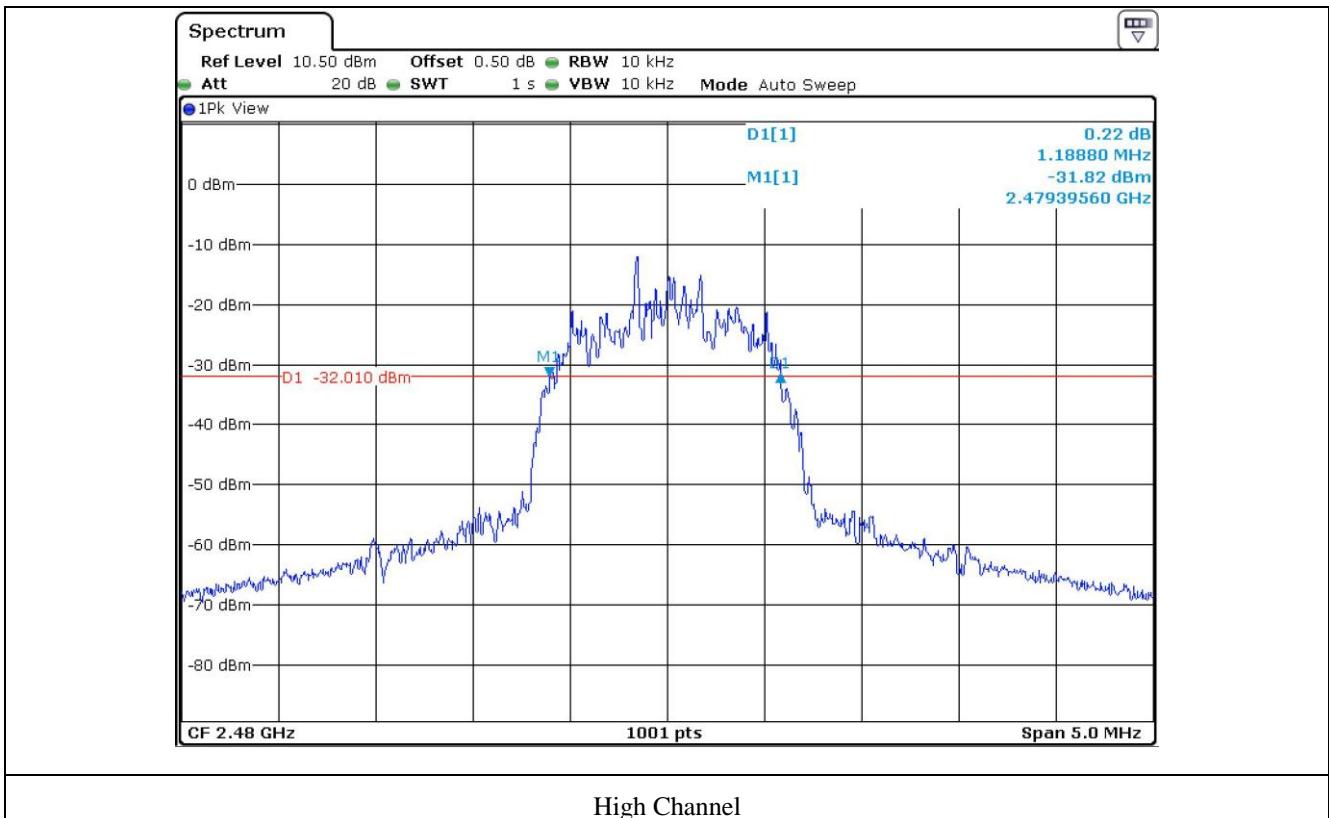




## Low Channel



## Middle Channel

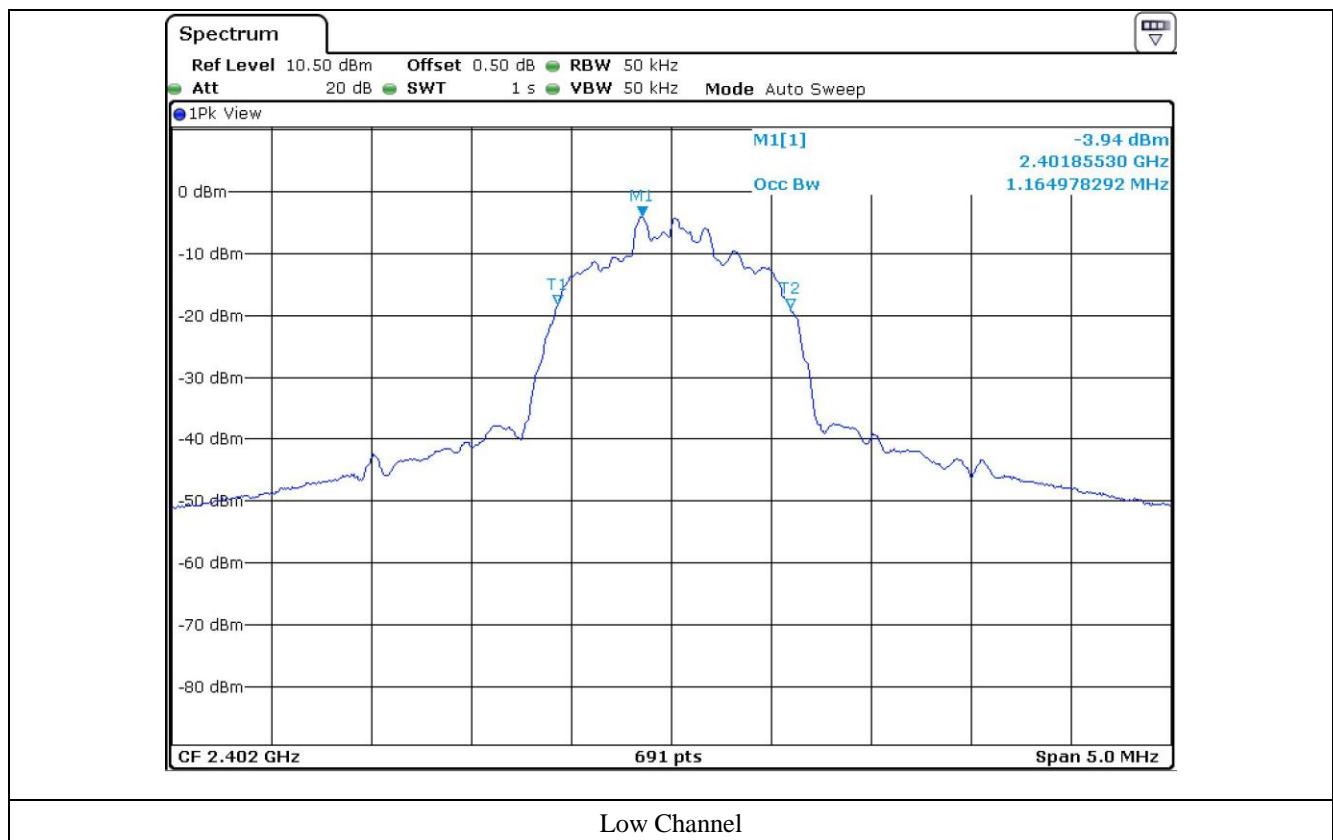


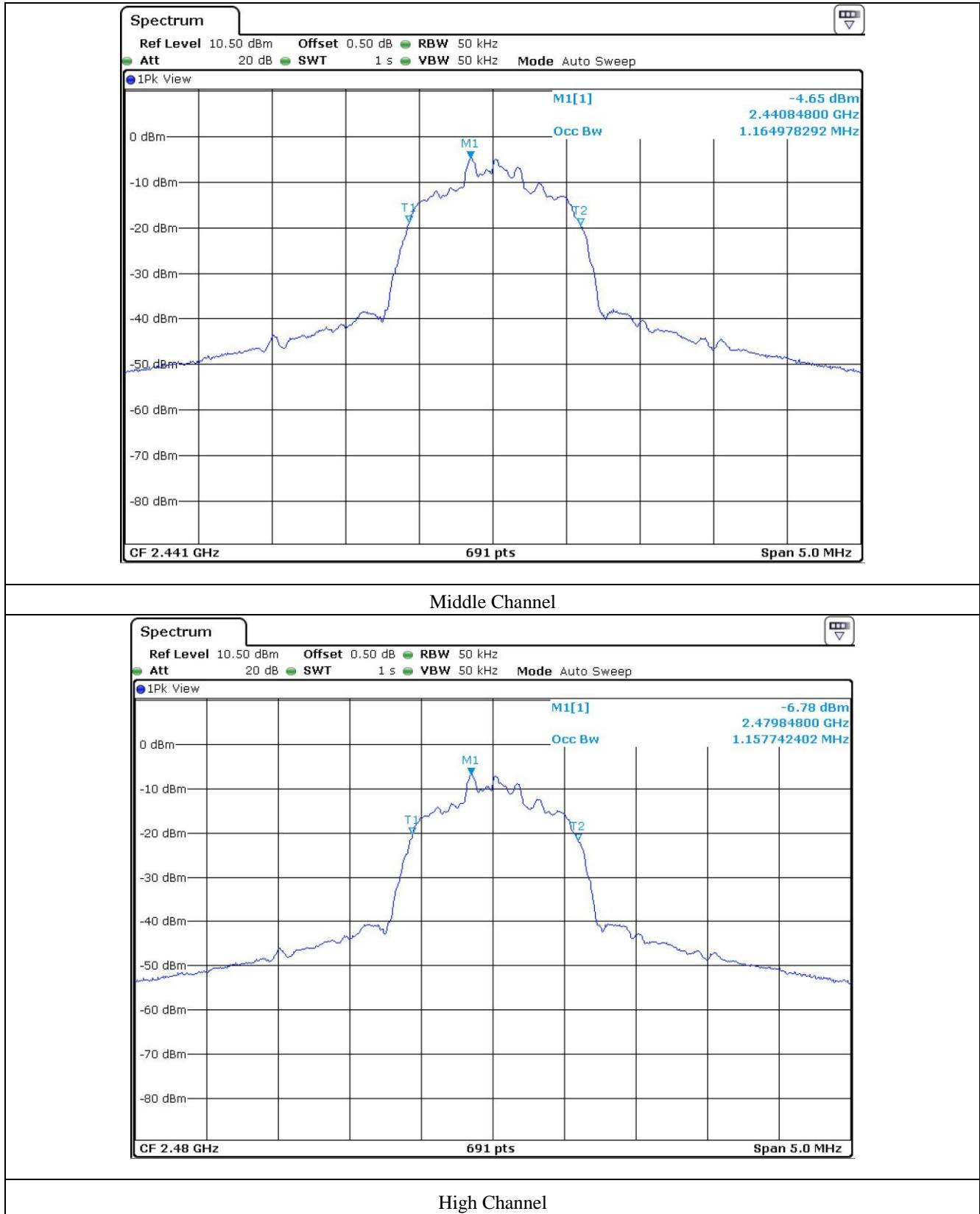
## 7.6 Test data for 3 Mbps

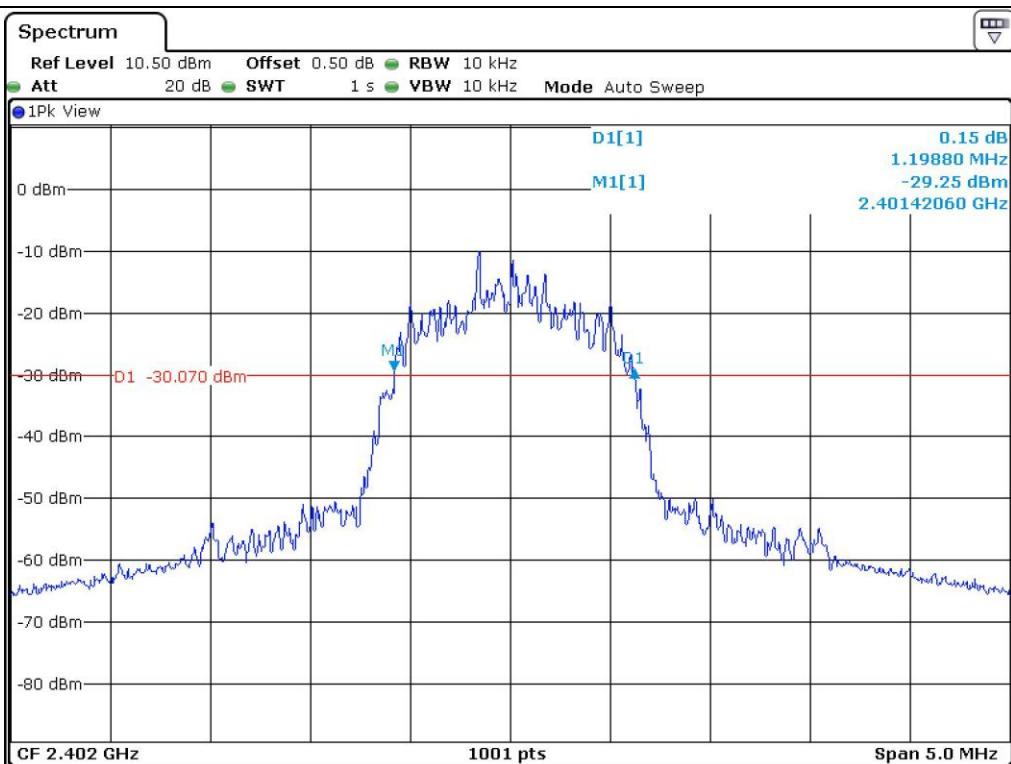
- Test Date : December 19, 2014

CHANNEL	FREQUENCY (MHz)	99% Occupied Bandwidth (kHz)	20 dB Bandwidth (kHz)
Low	2 402	1 198.80	1 164.98
Middle	2 441	1 198.80	1 164.98
High	2 480	1 198.80	1 157.74

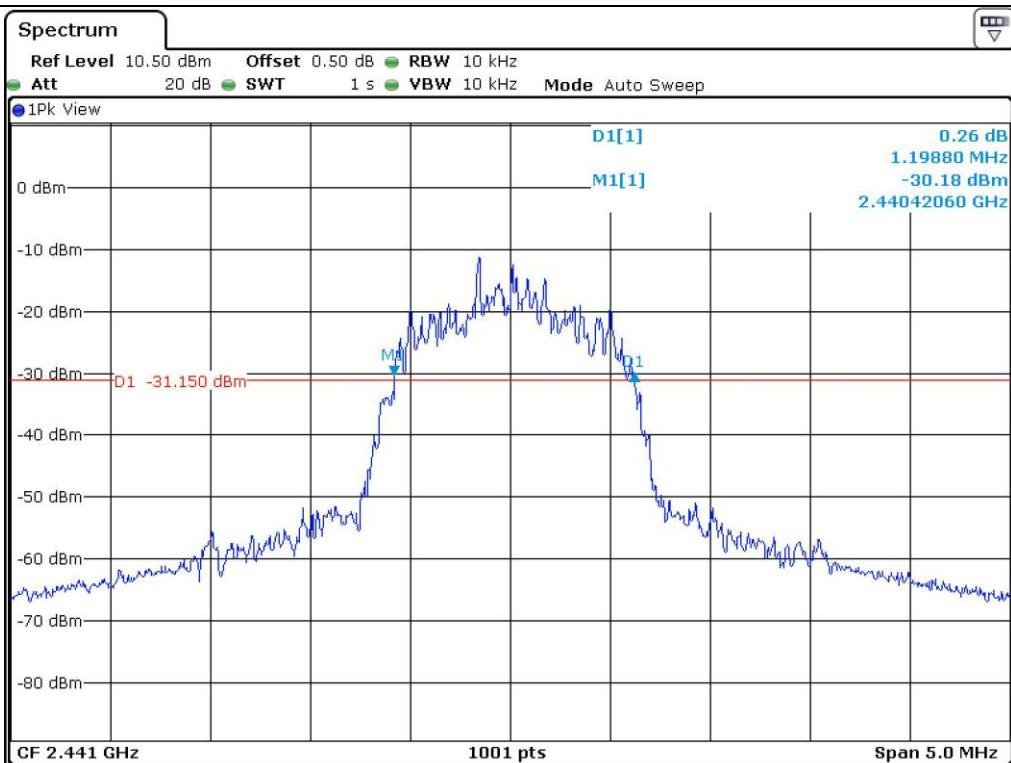
Tested by: Tae-Ho, Kim / Project Engineer



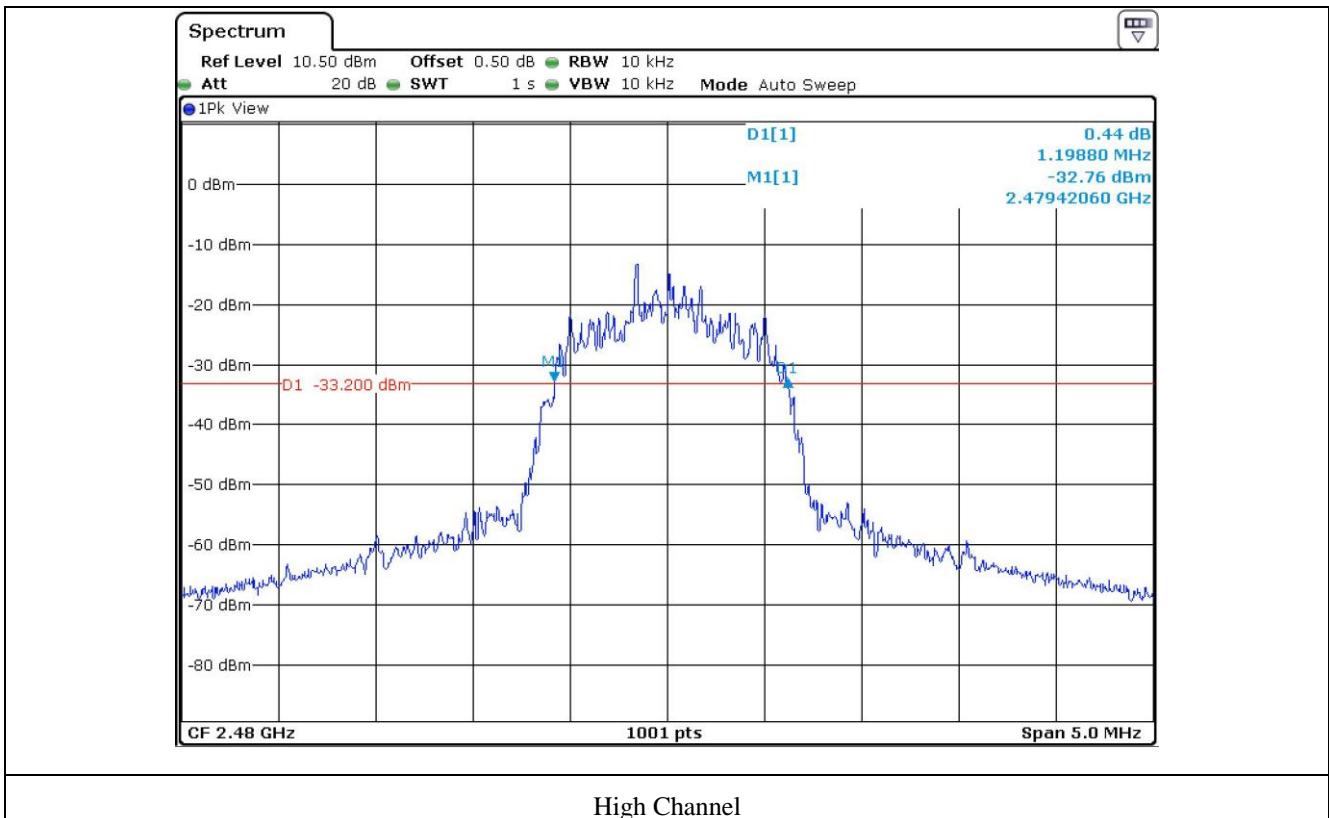




## Low Channel



## Middle Channel



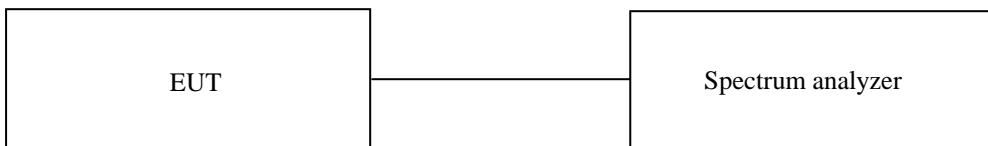
## 8. HOPPING FREQUENCY SEPARATION

### 8.1 Operating environment

Temperature : 21.4 °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. (Interval)
■ - FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)

All test equipment used is calibrated on a regular basis.

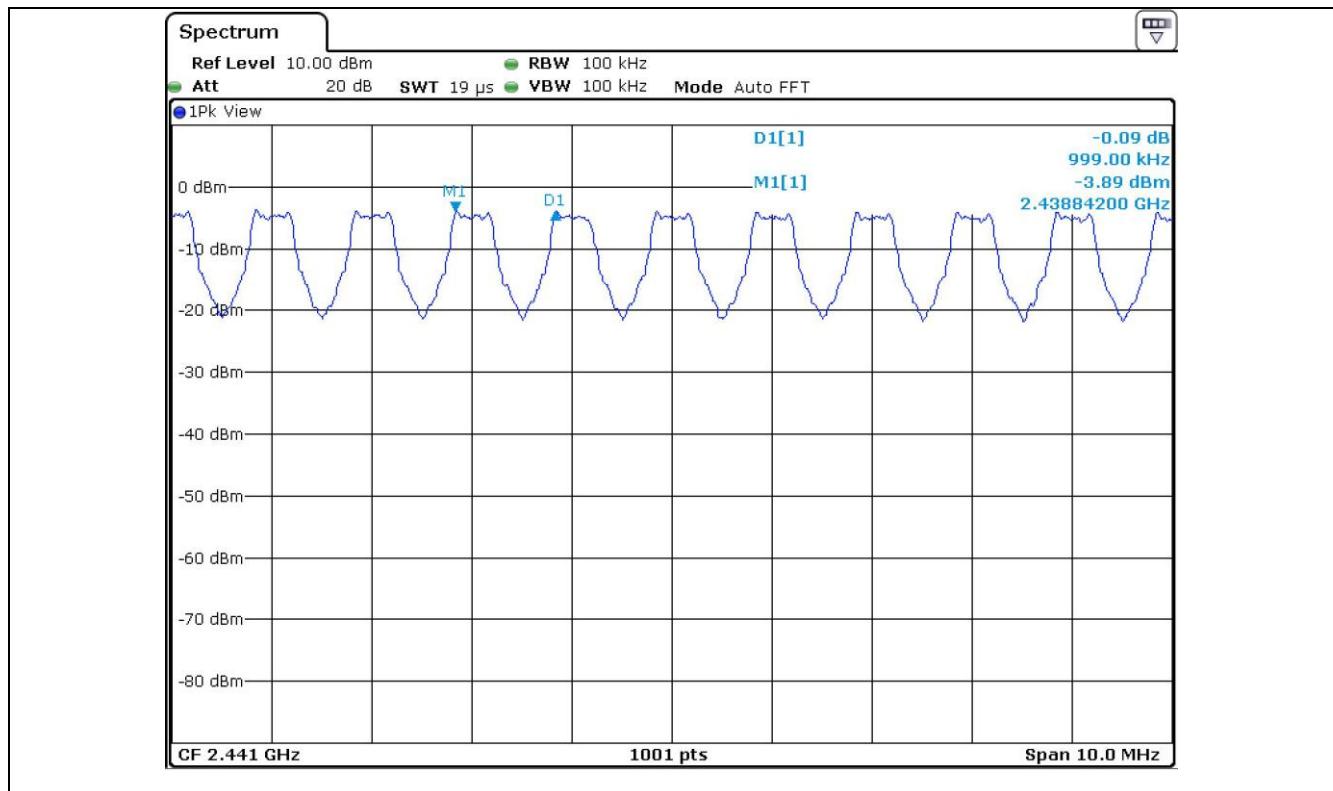
#### 8.4 Test data for 1 Mbps

- Test Date : December 18, 2014

- Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	574.0	Separated by a minimum of 25 kHz

Tested by: Tae-Ho, Kim / Project Engineer



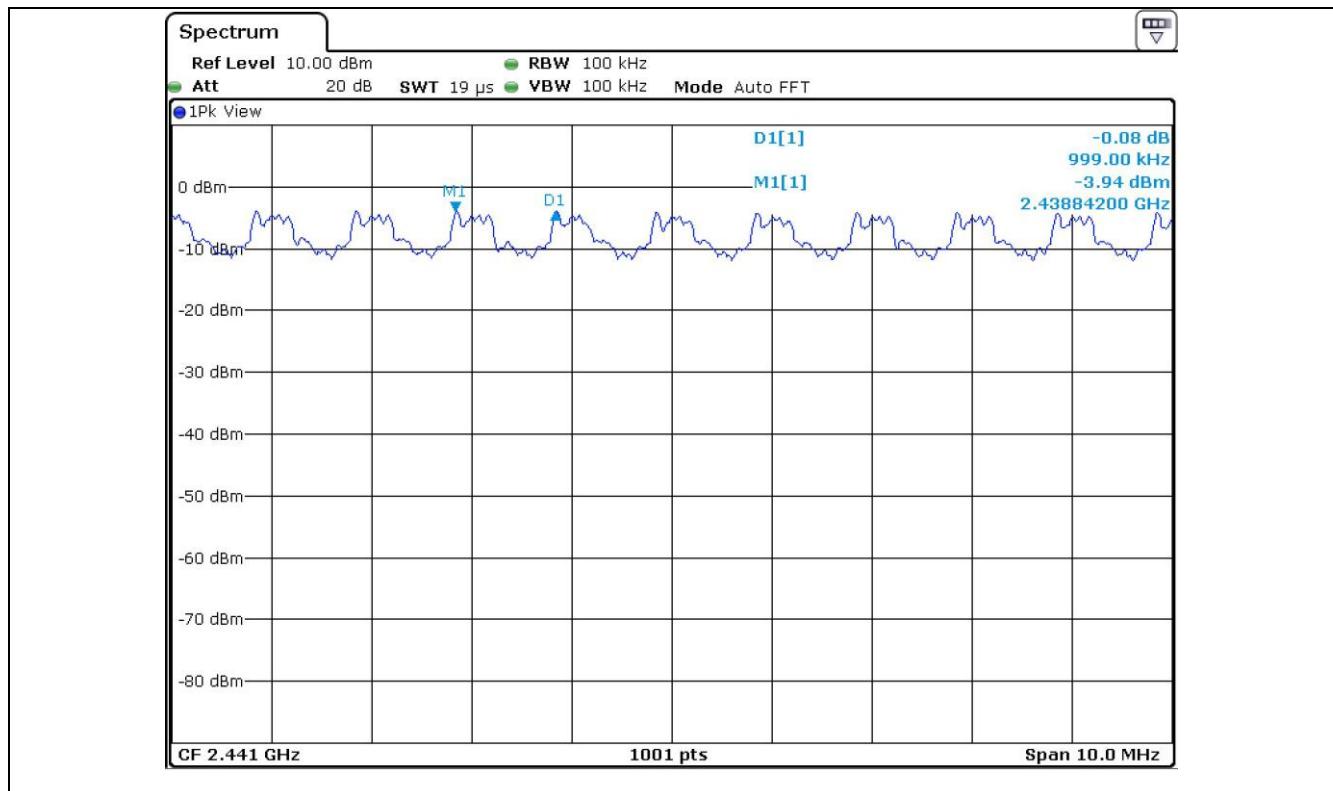
### 8.5 Test data for 2 Mbps

- Test Date : December 18, 2014

- Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	776.7	Separated by a minimum of 25 kHz

Tested by: Tae-Ho, Kim / Project Engineer



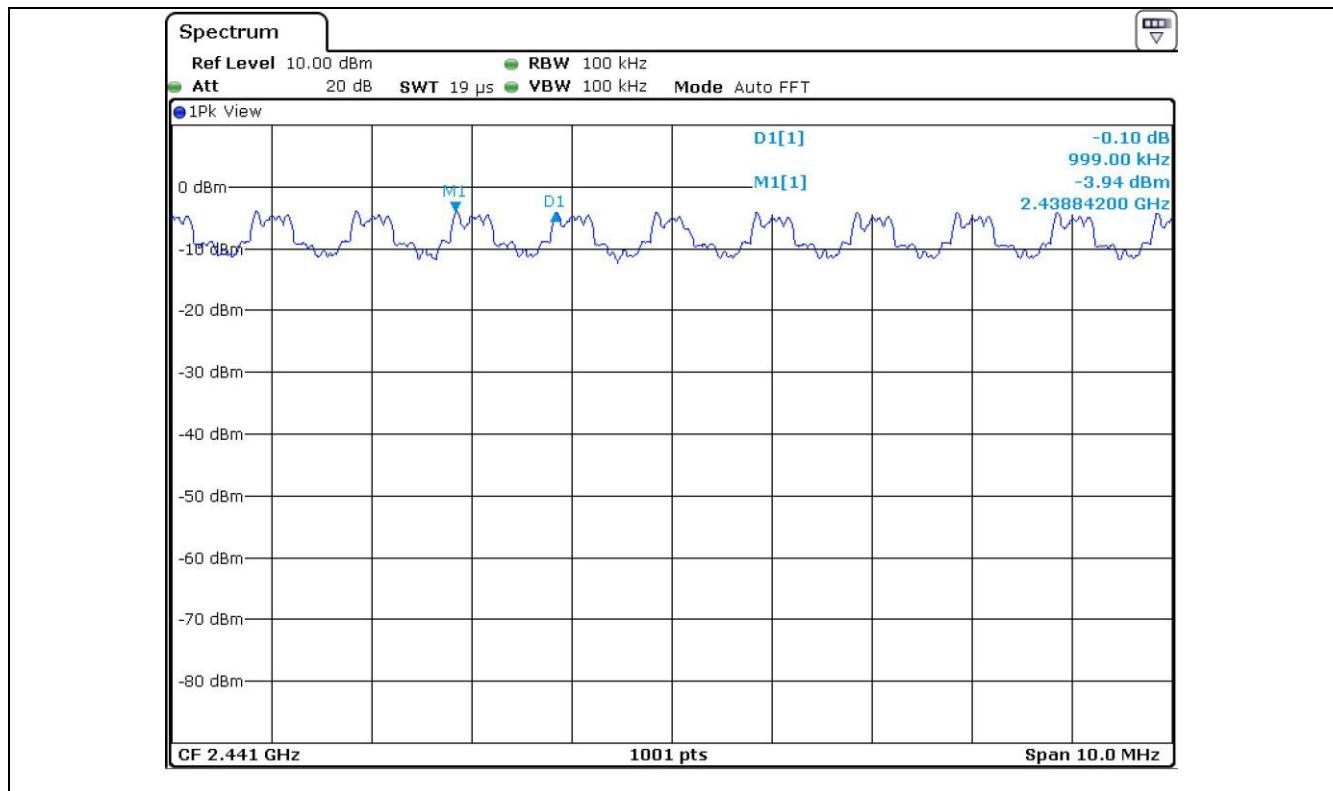
### 8.6 Test data for 3 Mbps

- Test Date : December 18, 2014

- Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	776.7	Separated by a minimum of 25 kHz

Tested by: Tae-Ho, Kim / Project Engineer



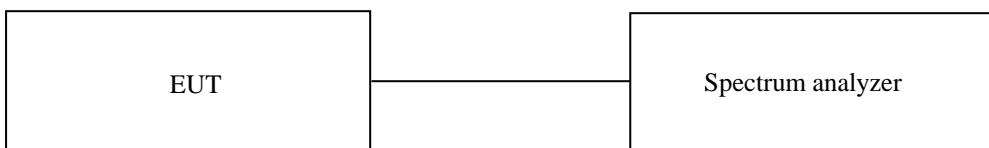
## 9. NUMBER OF HOPPING CHANNELS

### 9.1 Operating environment

Temperature : 21.4 °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. (Interval)
■ - FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)

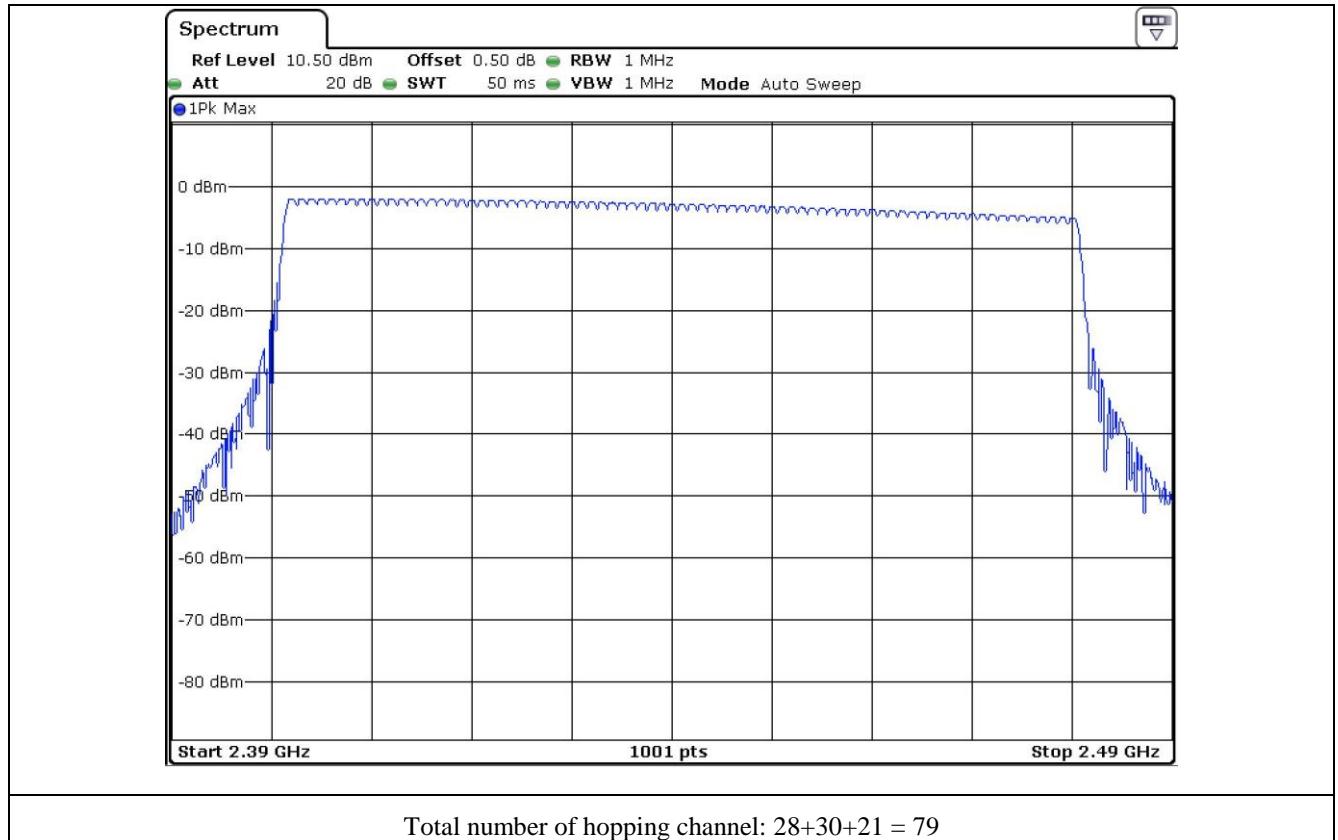
All test equipment used is calibrated on a regular basis.

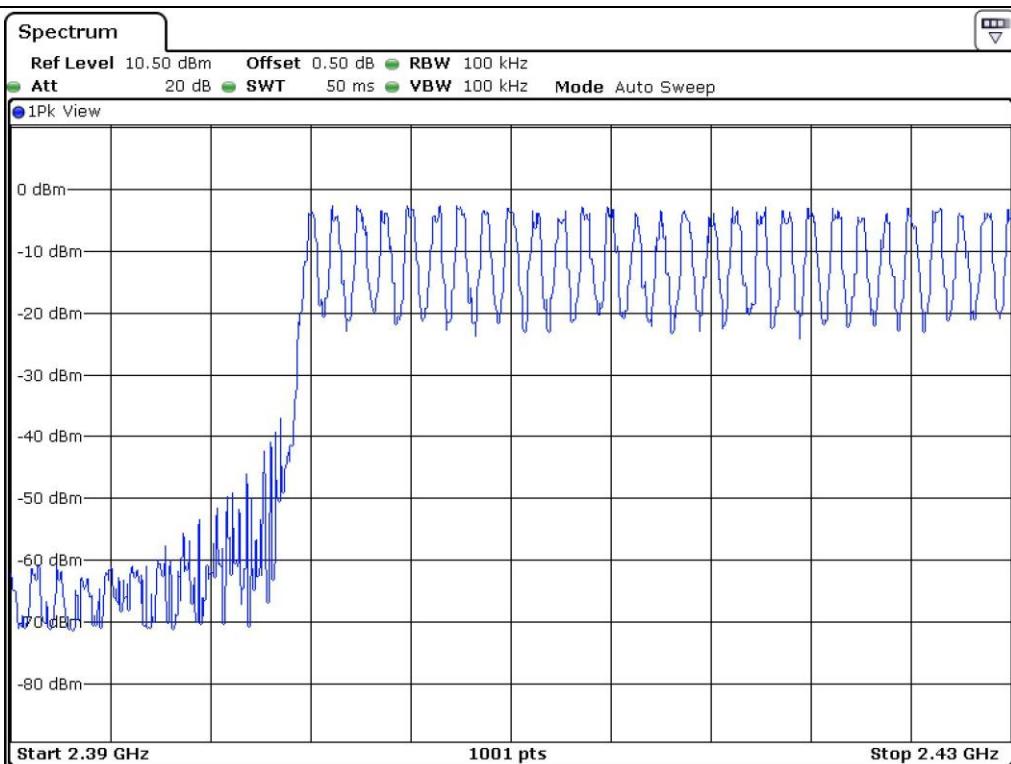
#### 9.4 Test data for Mbps 1

- Test Date : December 19, 2014  
- Test Result : Pass

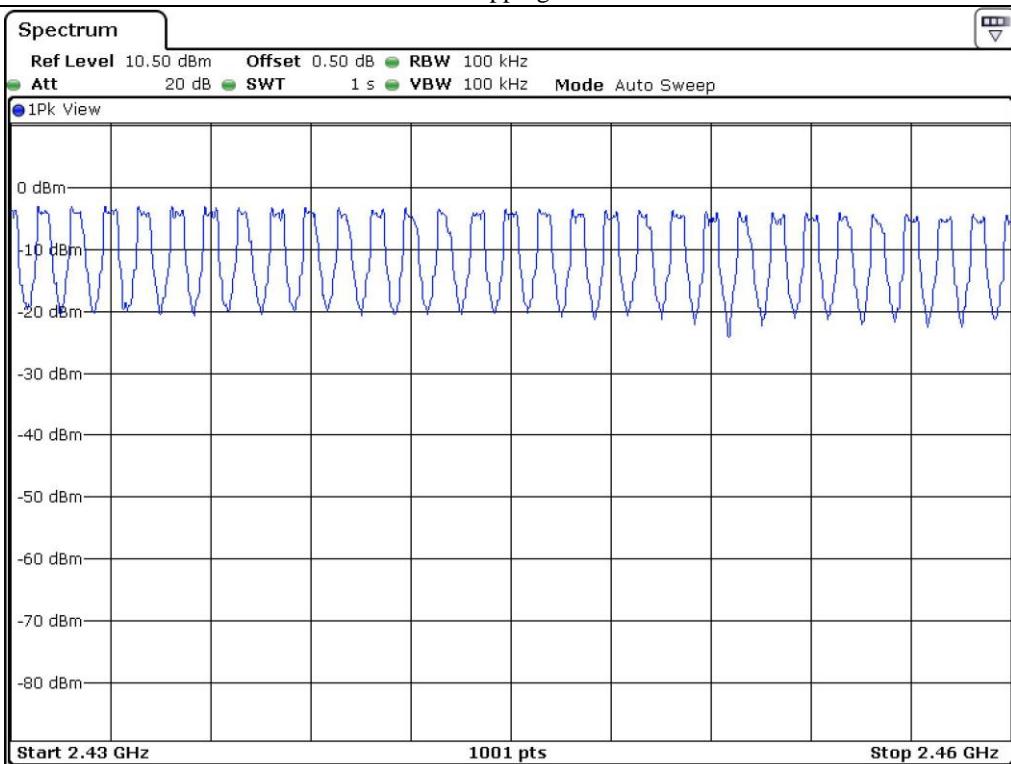
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
1 Mbps	79	Minimum of 15	64

Tested by: Tae-Ho, Kim / Project Engineer

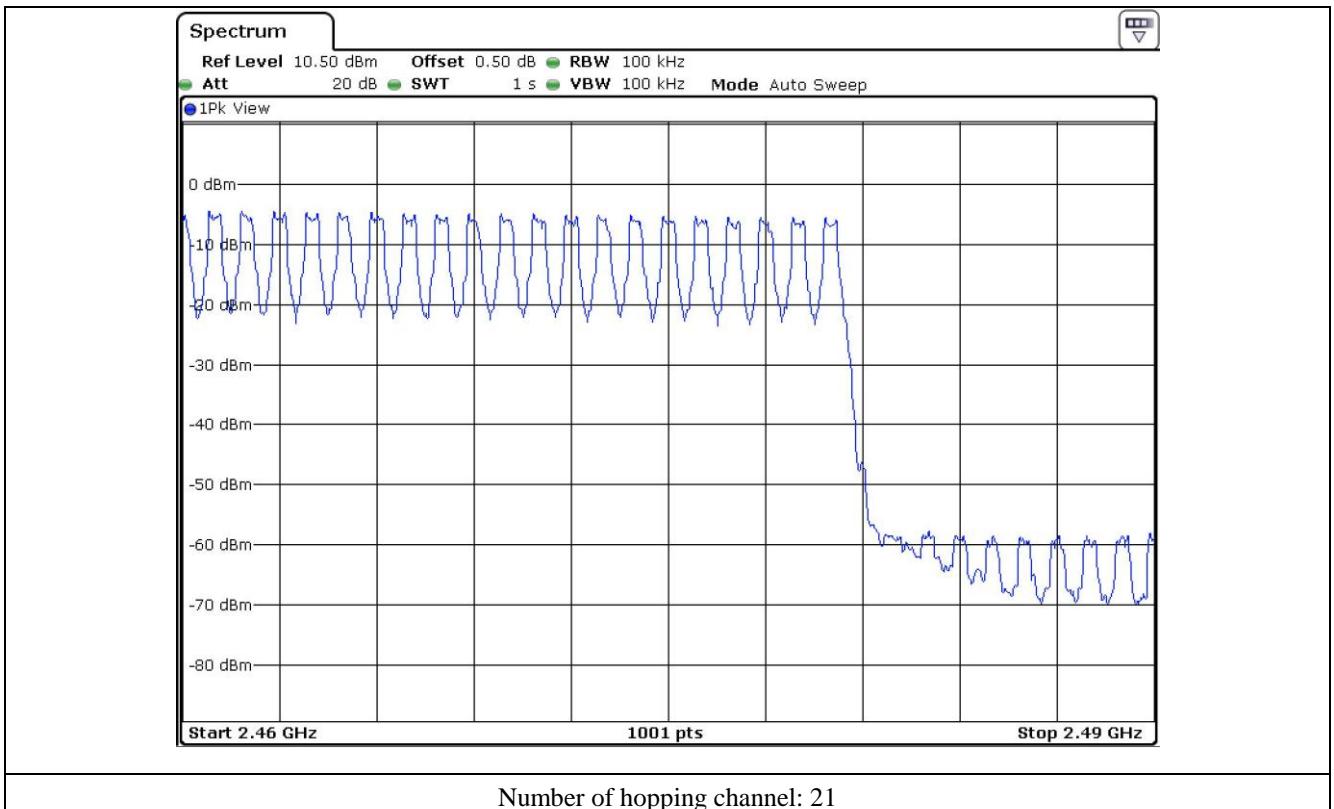




Number of hopping channel: 28



Number of hopping channel: 30

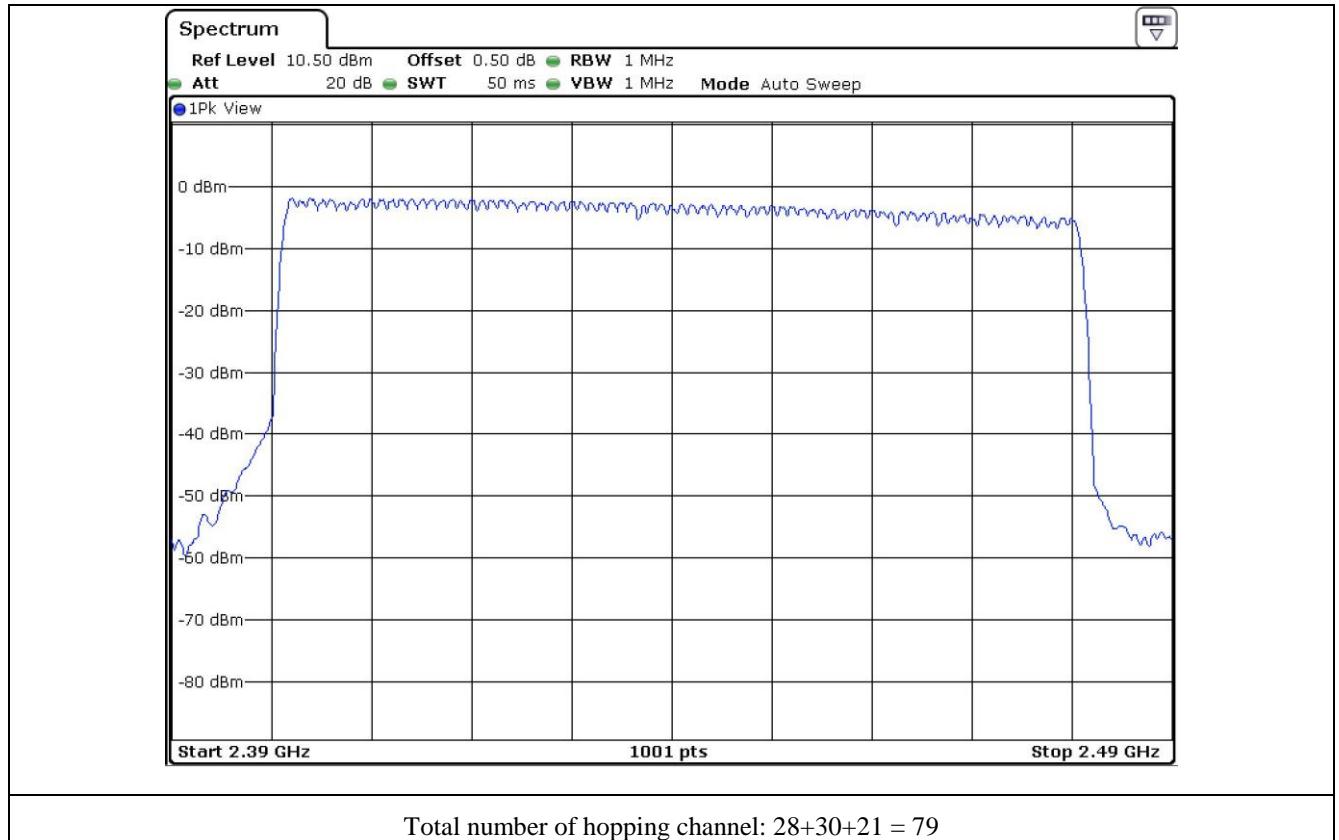


## 9.5 Test data for Mbps 2

- Test Date : December 19, 2014  
- Test Result : Pass

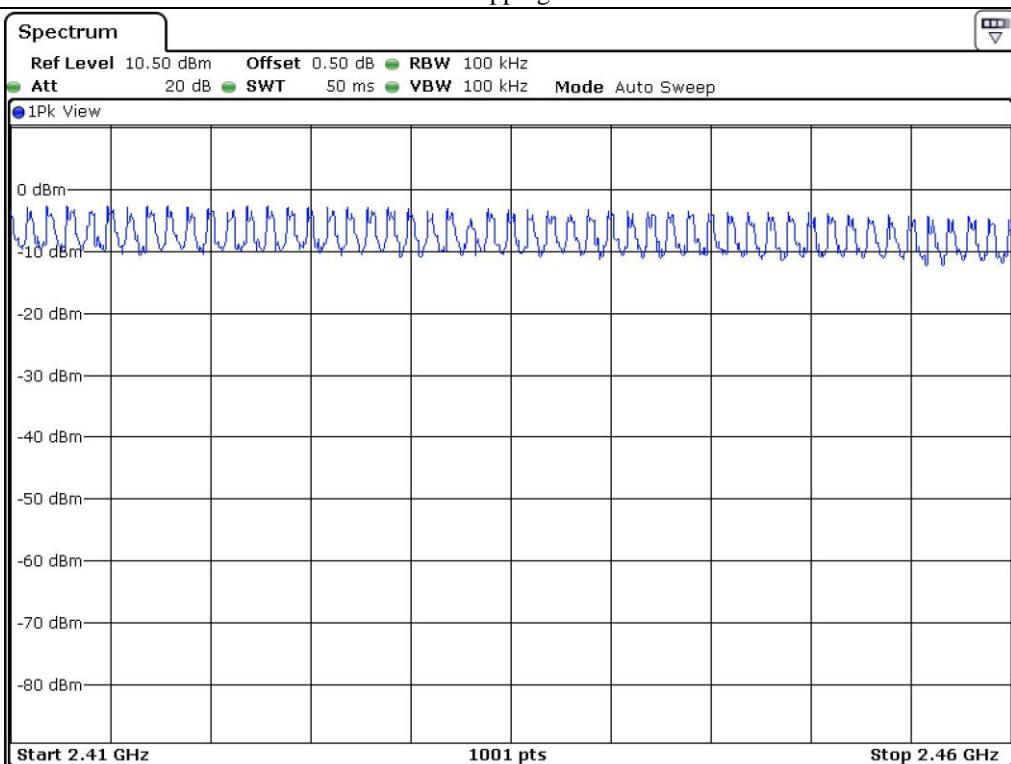
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
2 Mbps	79	Minimum of 15	64

Tested by: Tae-Ho, Kim / Project Engineer

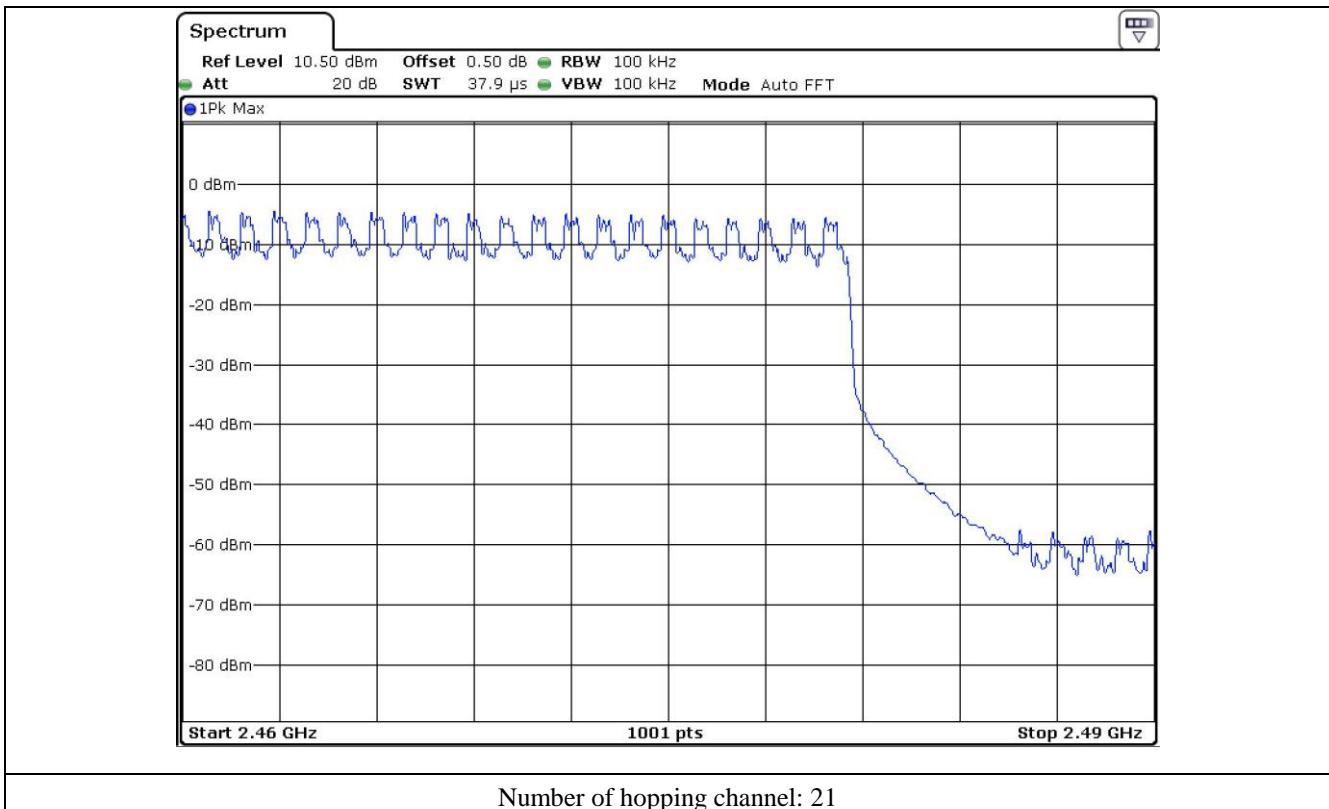




Number of hopping channel: 28



Number of hopping channel: 30



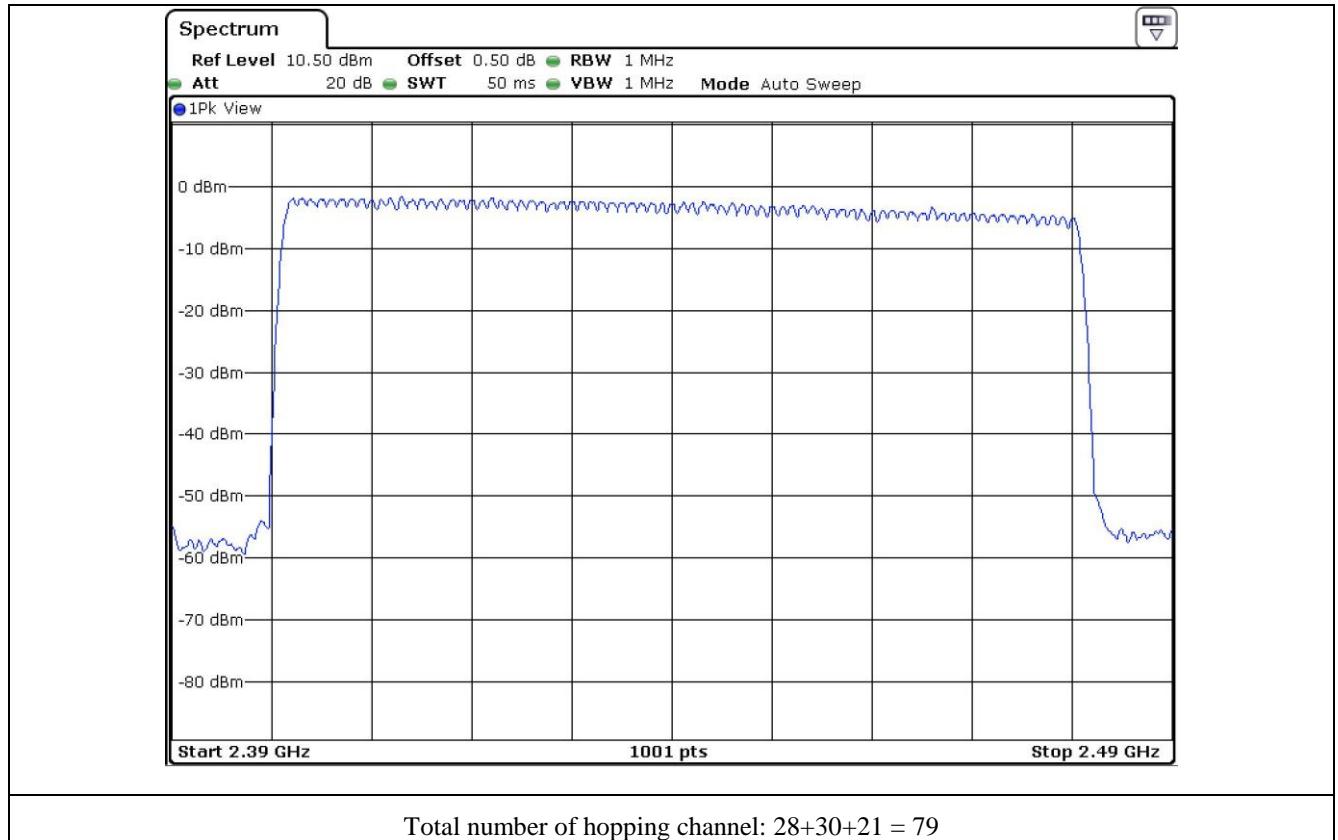
### 9.6 Test data for Mbps 3

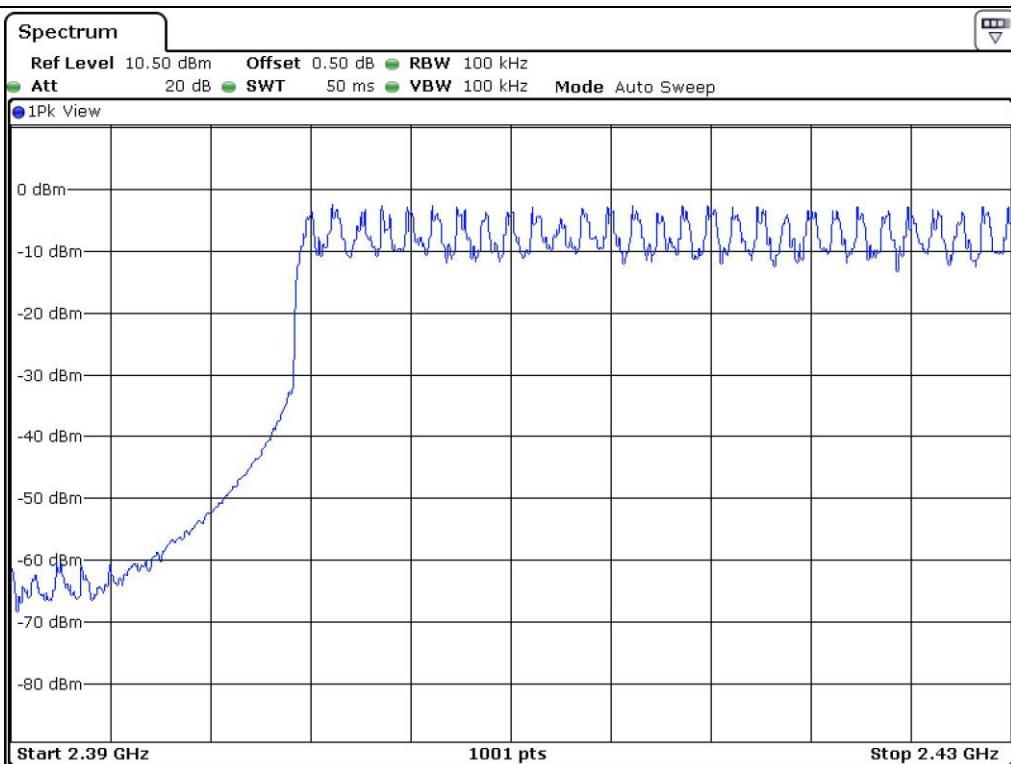
- Test Date : December 19, 2014  
- Test Result : Pass

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

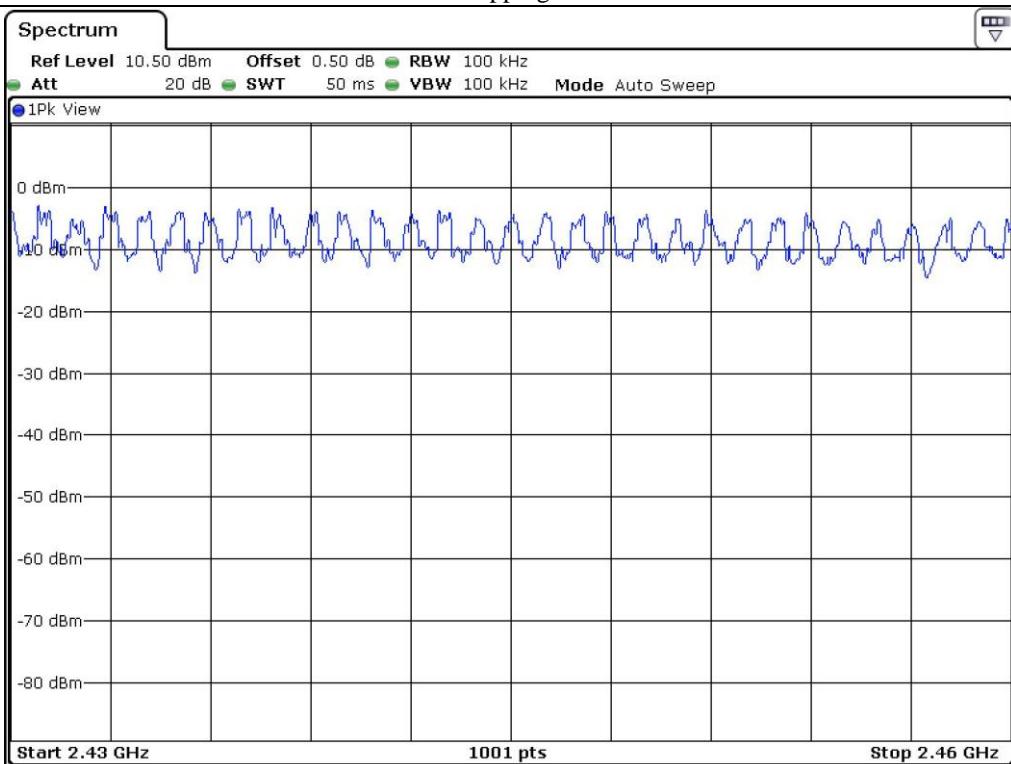


Tested by: Tae-Ho, Kim / Project Engineer

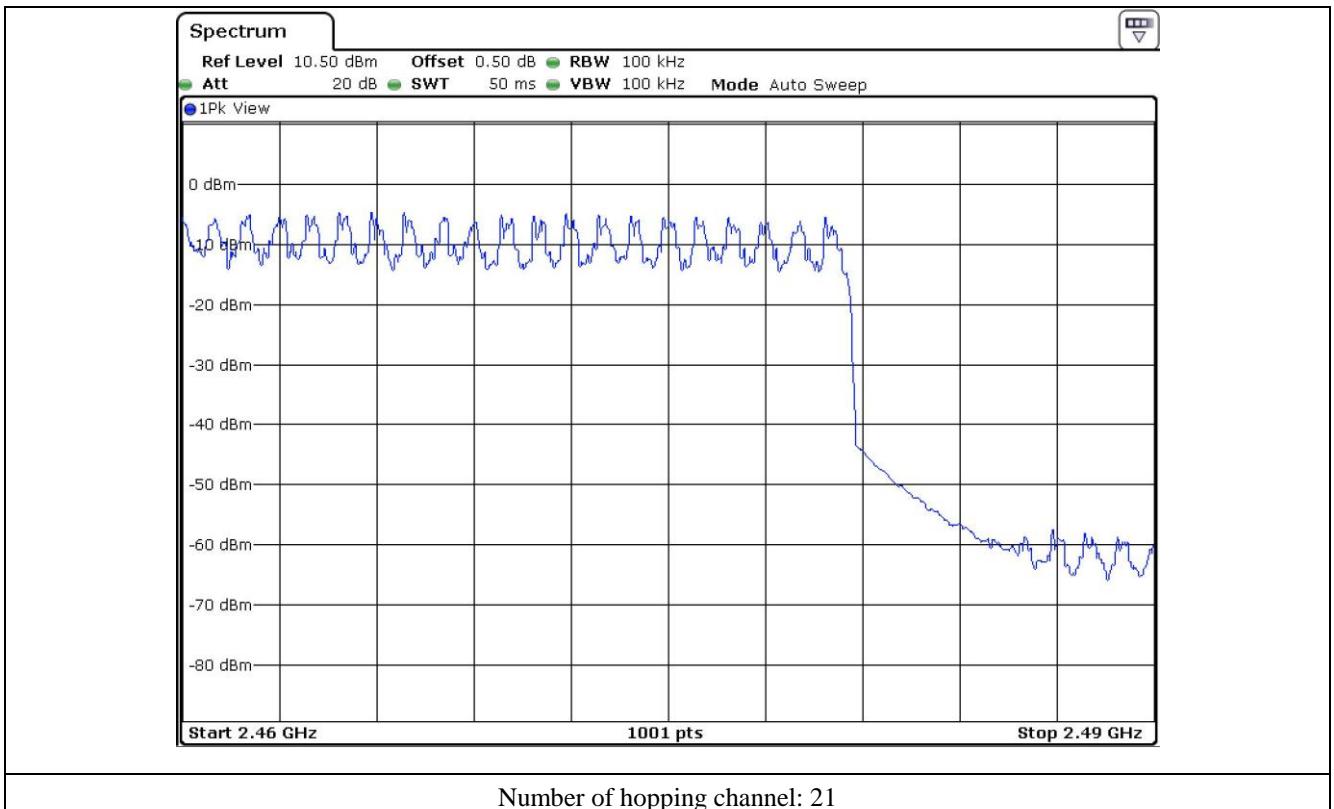




Number of hopping channel: 28



Number of hopping channel: 30



## 10. TIME OF OCCUPANCY

### 10.1 Operating environment

Temperature : 21.4 °C  
Relative humidity : 45 % 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. (Interval)
■ - FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)

All test equipment used is calibrated on a regular basis.

#### 10.4 Test data for 1 Mbps

- Test Date : December 19, 2014

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625  $\mu$ 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	0.390	10.13	31.6	124.84	400	PASS
DH3	1.650	5.06	31.6	263.83	400	
DH5	2.900	3.38	31.6	309.74	400	

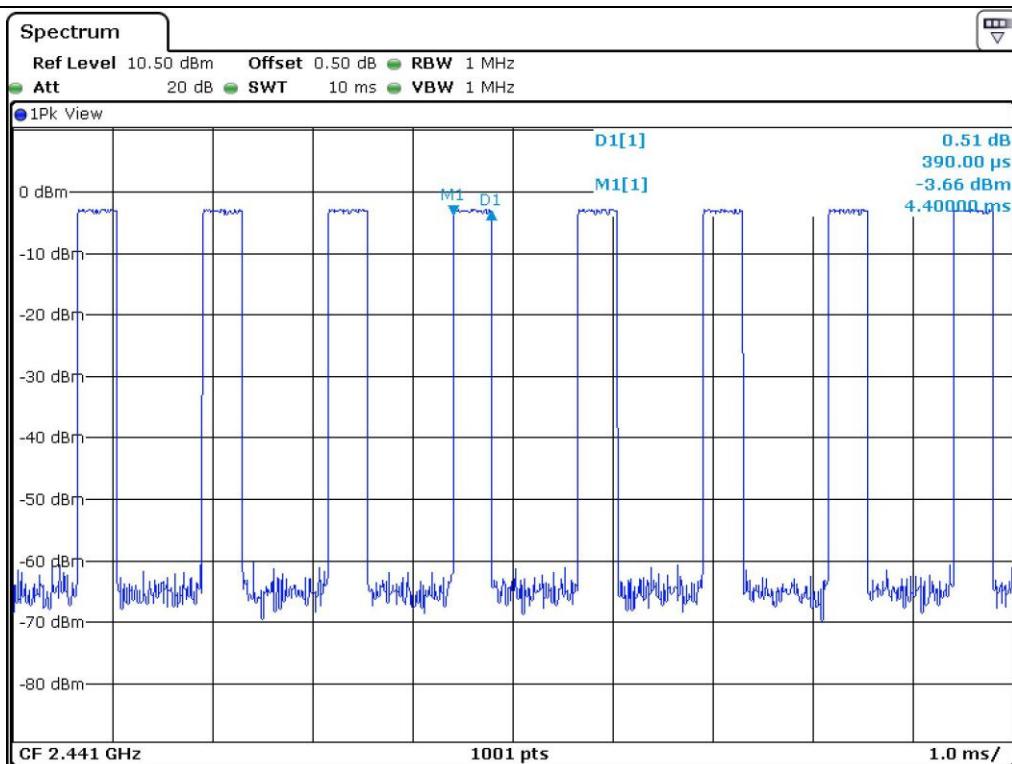
Total dwell time is calculated as following.

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

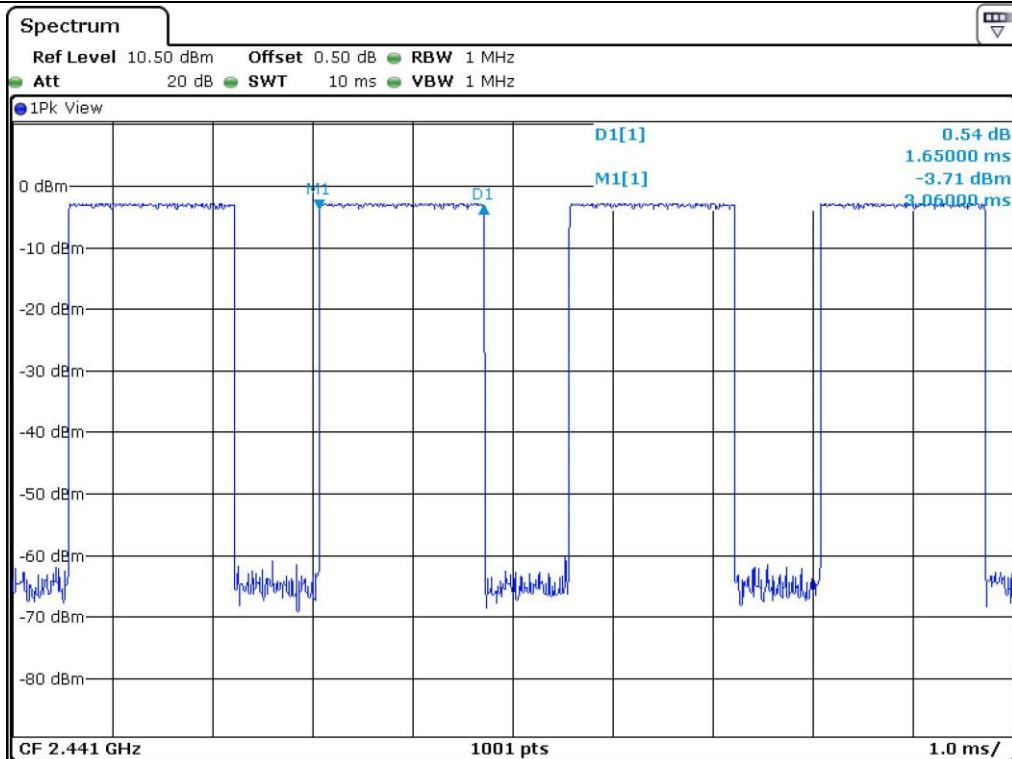
Remark: See next page for an overview sweep performed with peak detector.



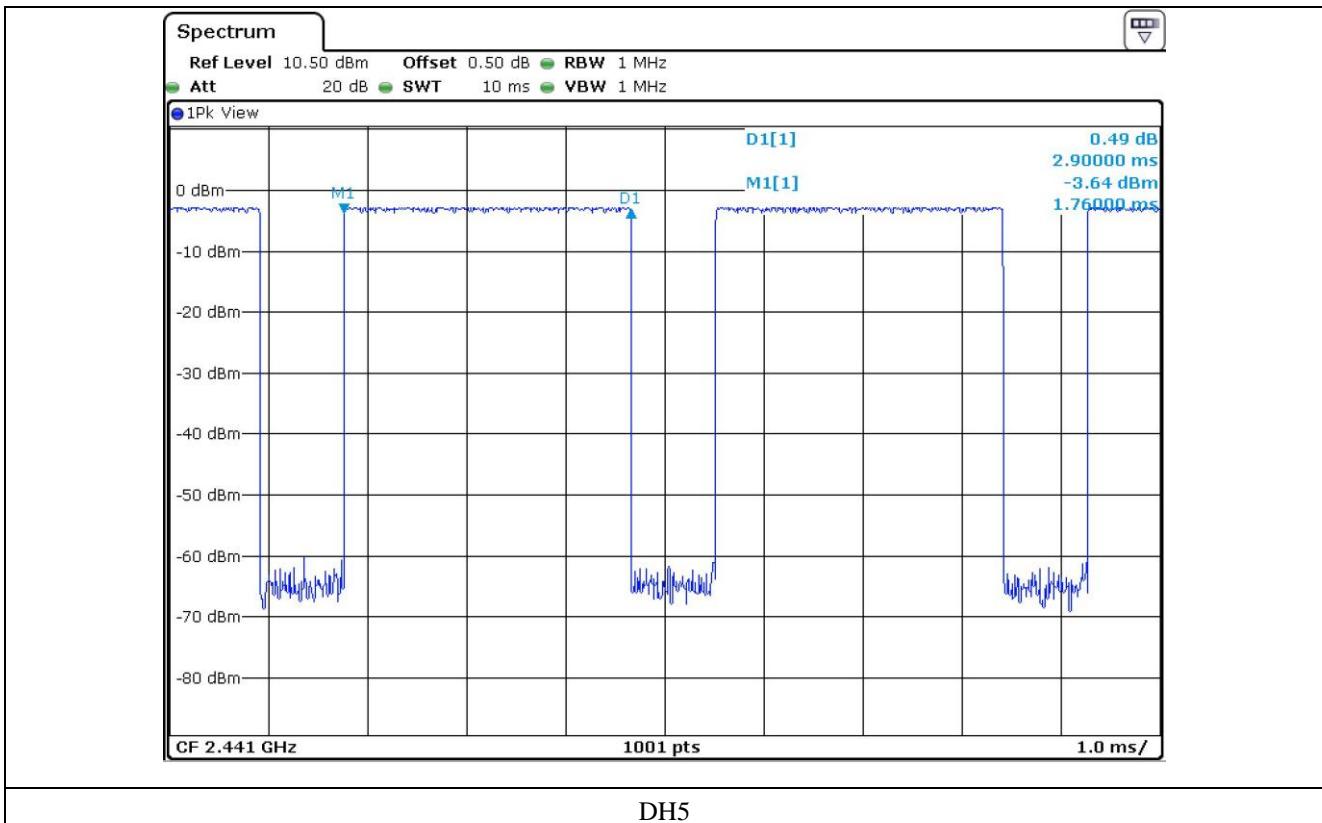
Tested by: Tae-Ho, Kim / Project Engineer



DH1



DH3



## 10.5 Test data for 2 Mbps

- Test Date : December 19, 2014

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	0.380	10.13	31.6	121.64	400	PASS
DH3	1.640	5.06	31.6	262.23	400	
DH5	2.890	3.38	31.6	308.68	400	

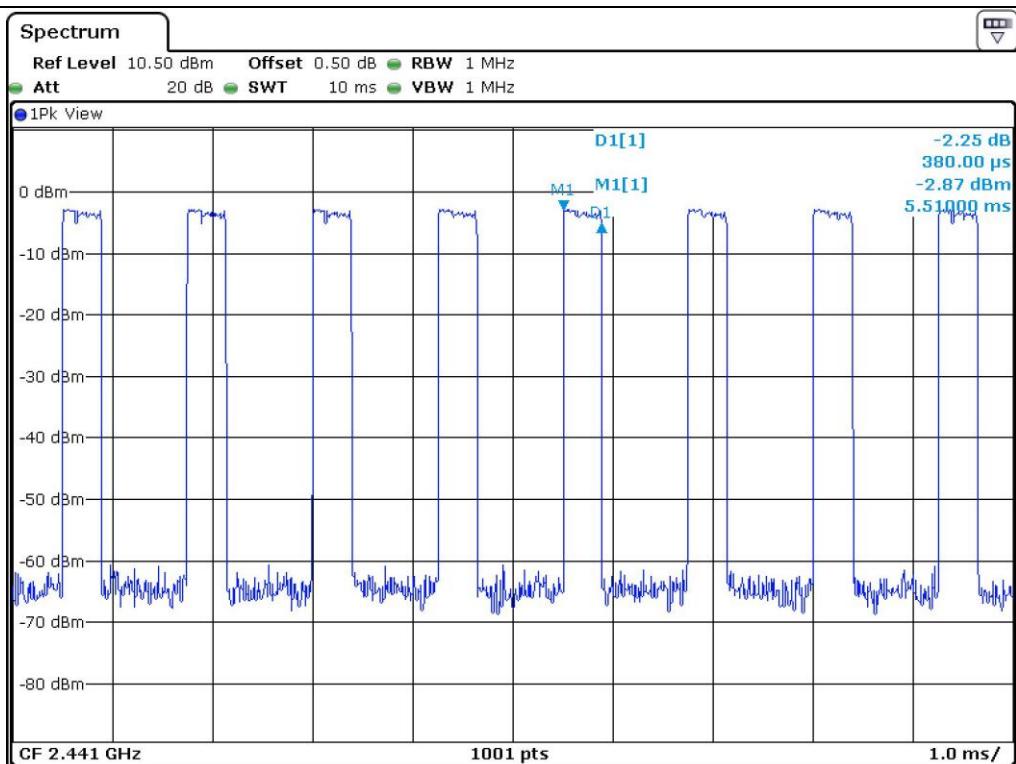
Total dwell time is calculated as following.

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

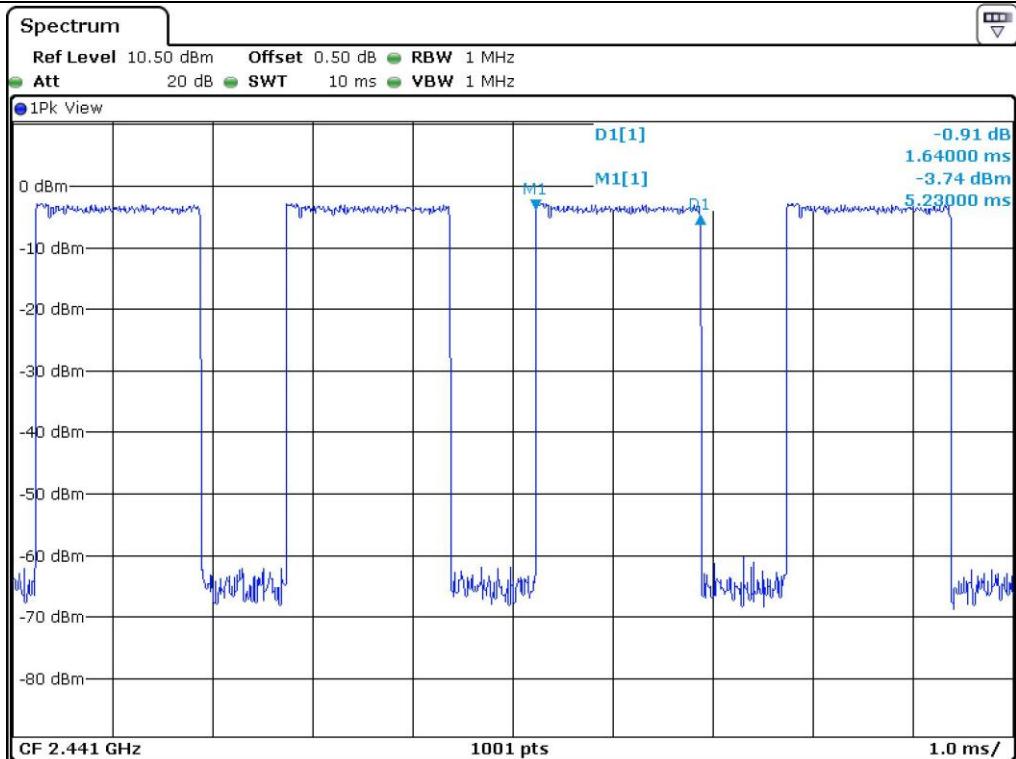
Remark: See next page for an overview sweep performed with peak detector.



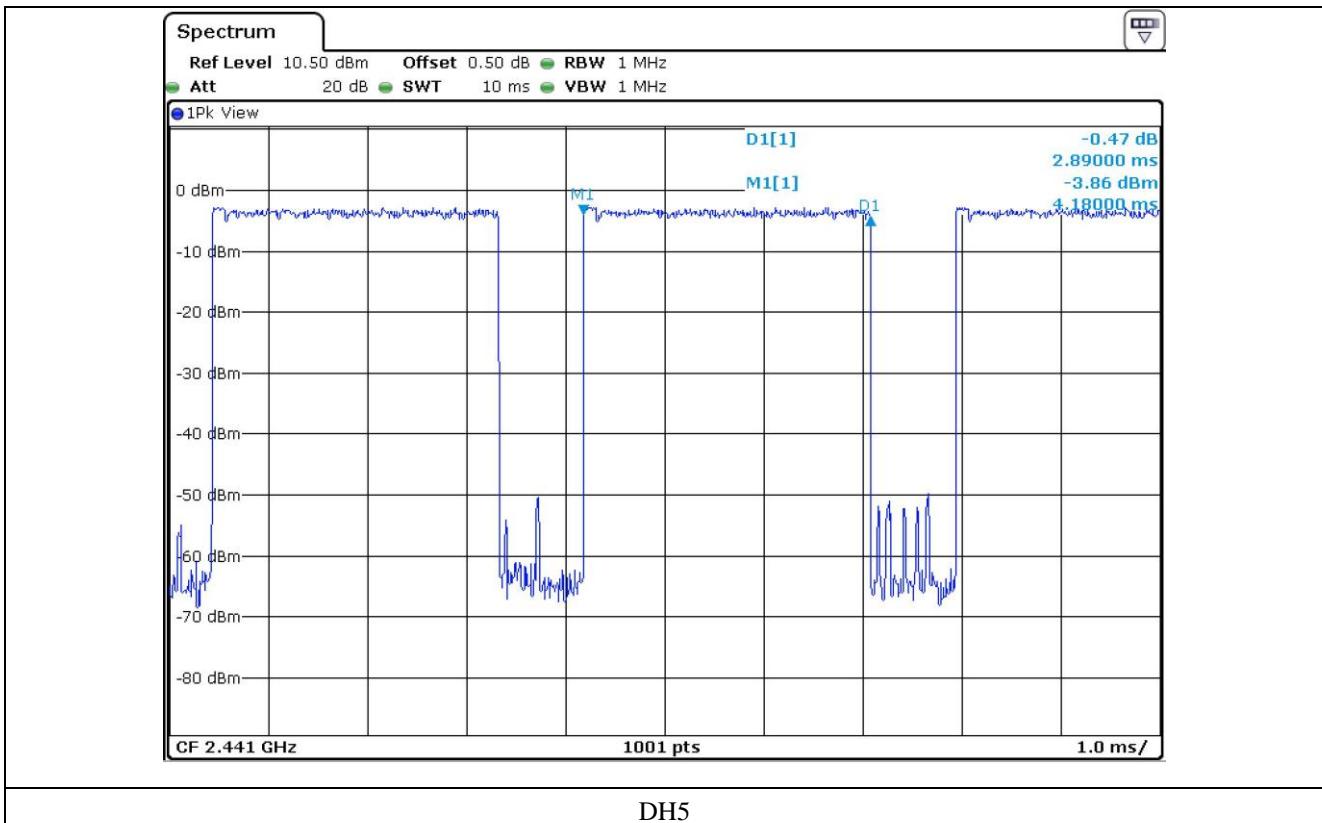
Tested by: Tae-Ho, Kim / Project Engineer



DH1



DH3



## 10.6 Test data for 3 Mbps

- Test Date : December 19, 2014

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.

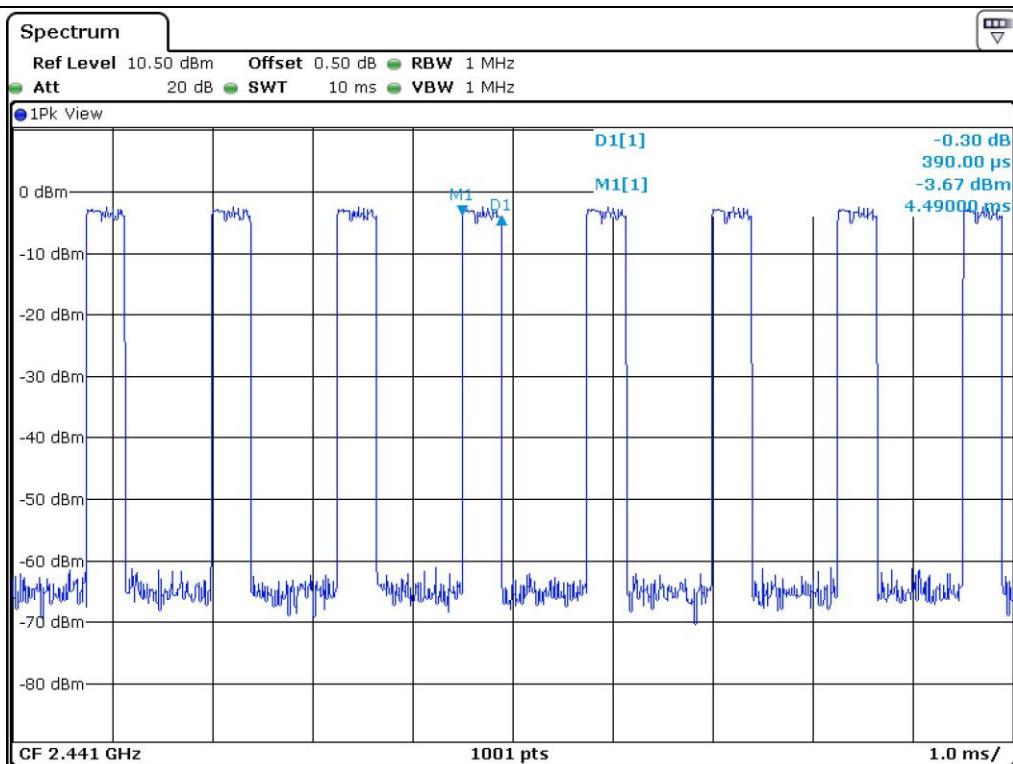
Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.390	10.13	31.6	124.84	400	PASS
DH3	1.620	5.06	31.6	259.03	400	
DH5	2.880	3.38	31.6	307.61	400	

Total dwell time is calculated as following.

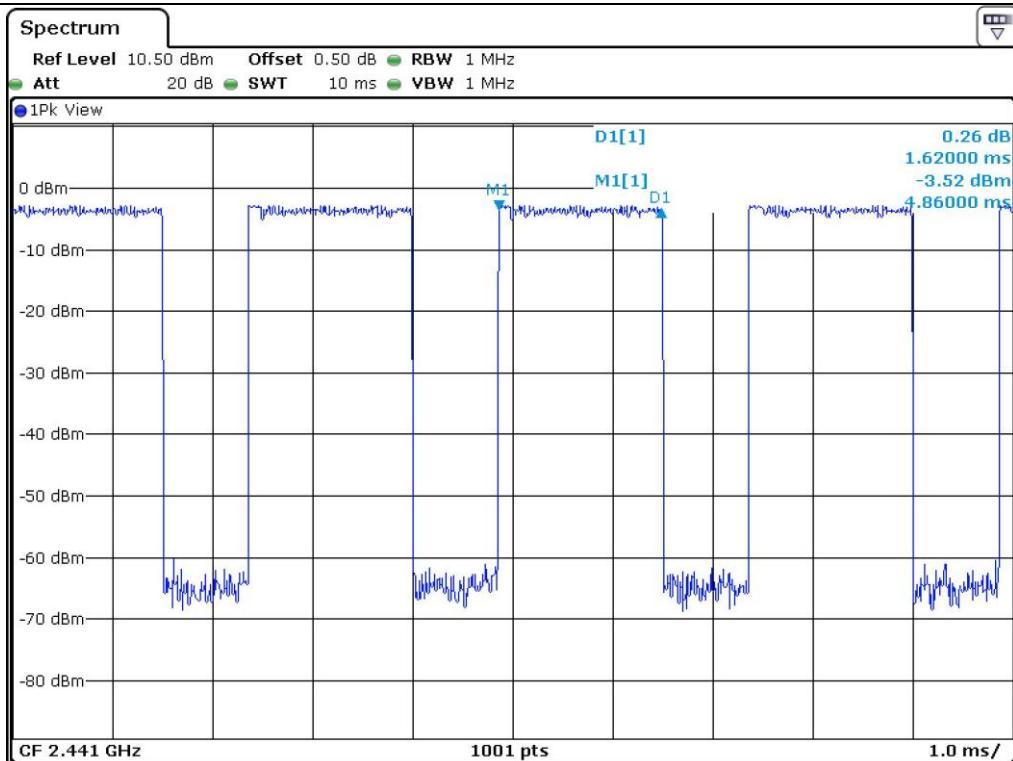
Total Dwell Time = Pulse time \* Hops per second with channels \* period time

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

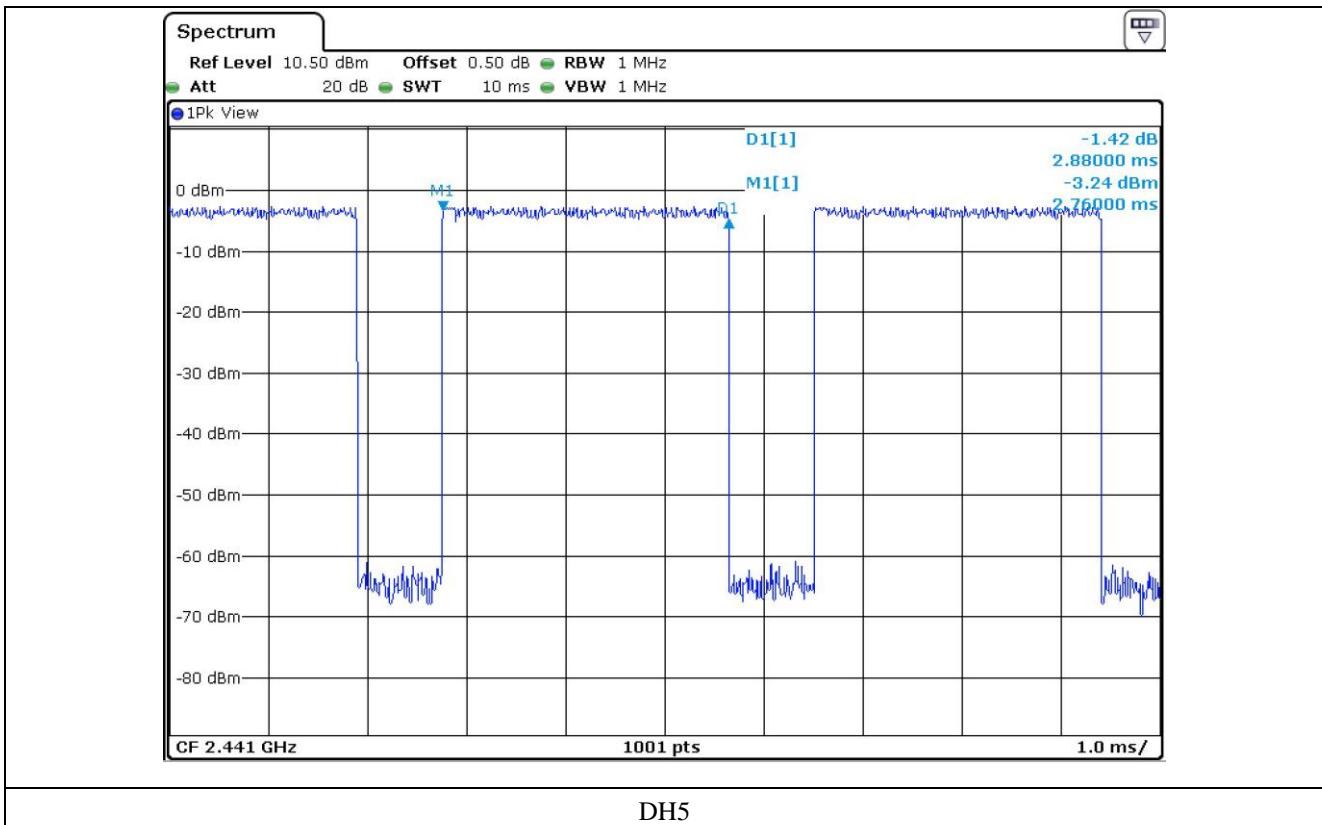
Tested by: Tae-Ho, Kim / Project Engineer



DH1



DH3



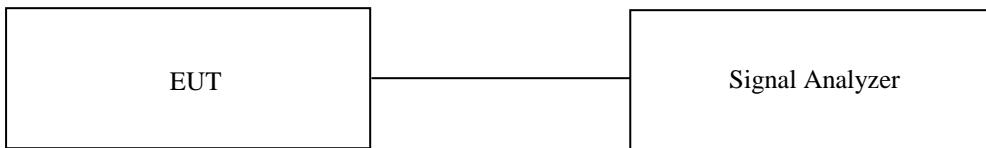
## 11. MAXIMUM PEAK OUTPUT POWER

### 11.1 Operating environment

Temperature : 21.4 °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. (Interval)
■ - FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)

All test equipment used is calibrated on a regular basis.

**11.4 Test data for 1 Mbps**

- . Test Date : December 22, 2014

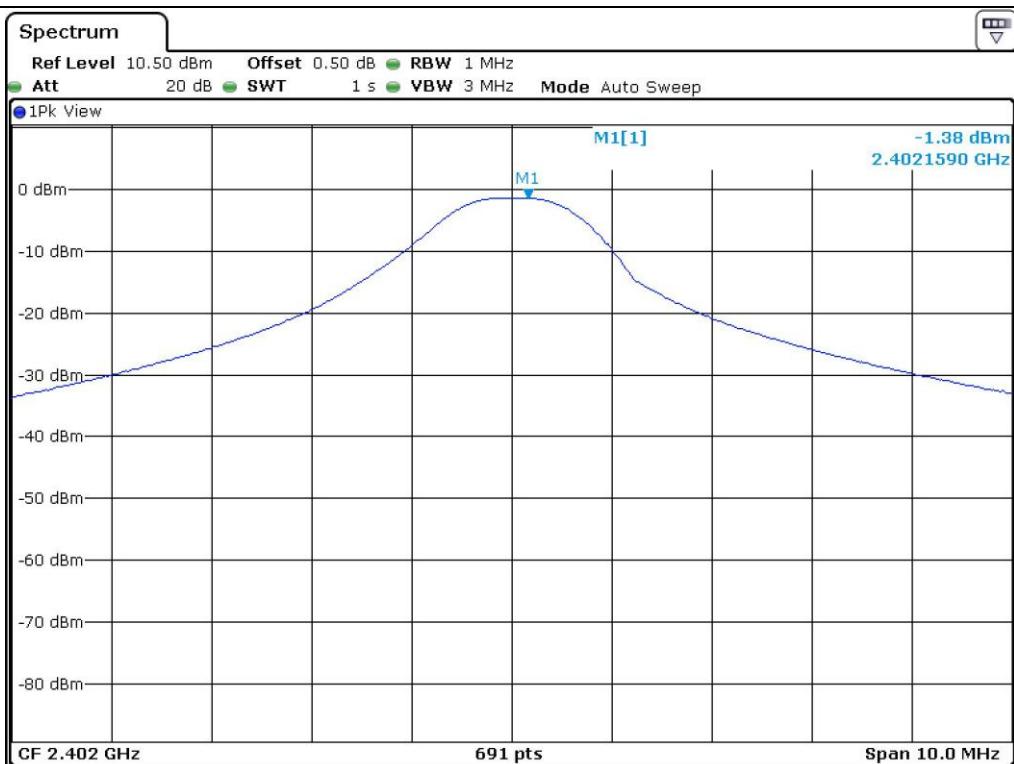
- . Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-1.38	30	31.38
MIDDLE	2 441	-2.14	30	32.14
HIGH	2 480	-4.24	30	34.24

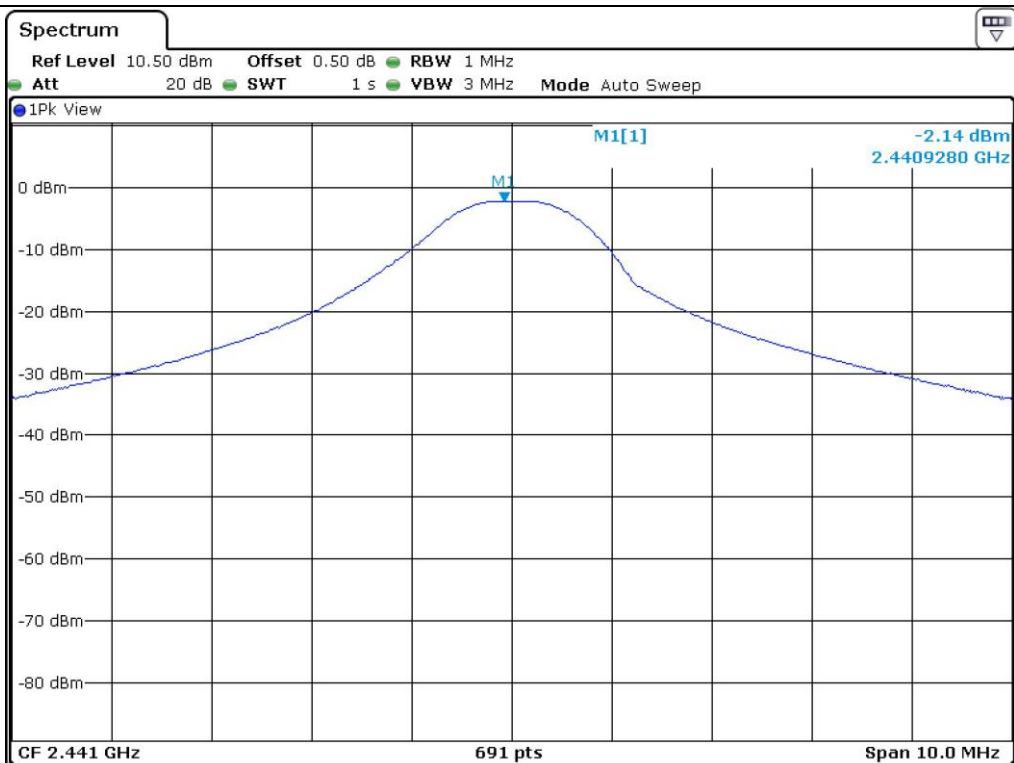
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



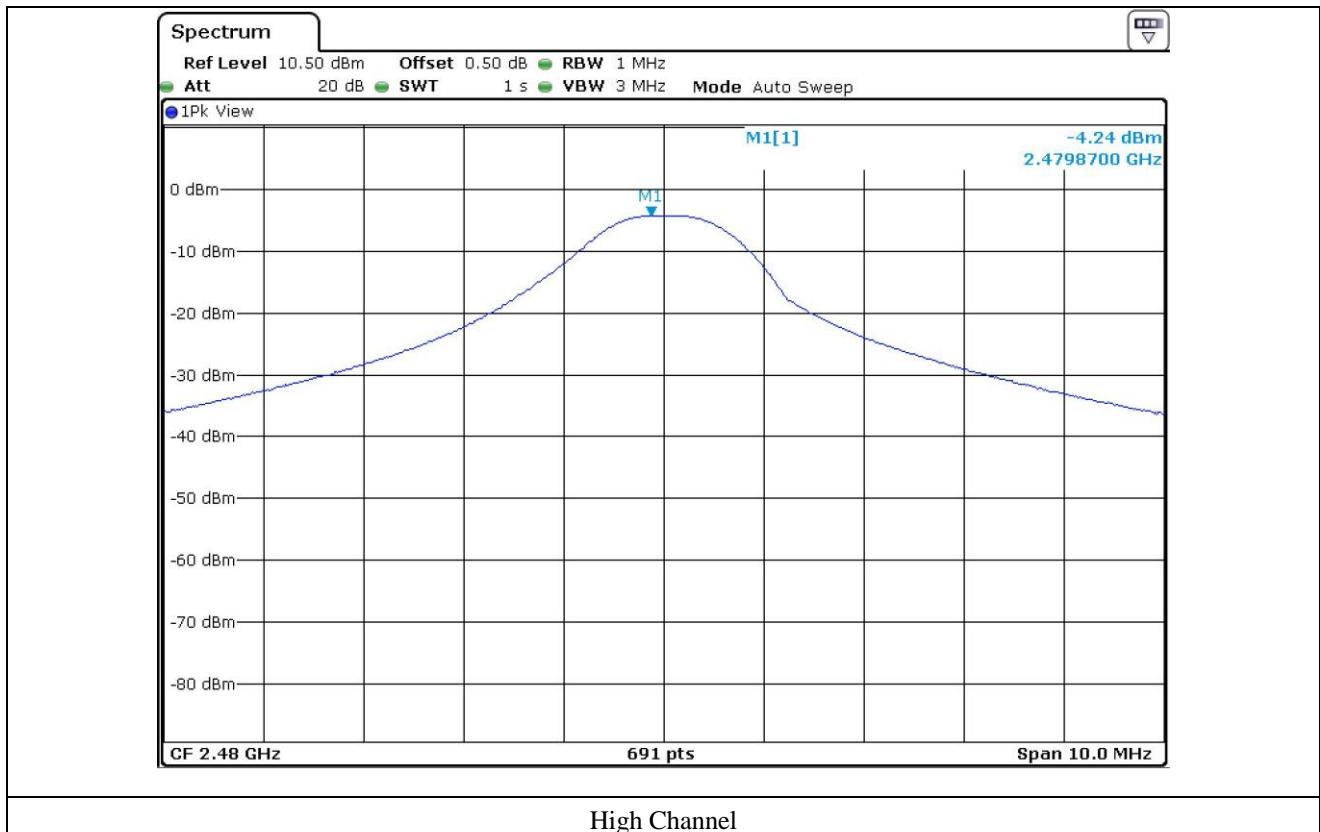
Tested by: Tae-Ho, Kim / Project Engineer



## Low Channel



## Middle Channel



**11.5 Test data for 2 Mbps**

- . Test Date : December 22, 2014

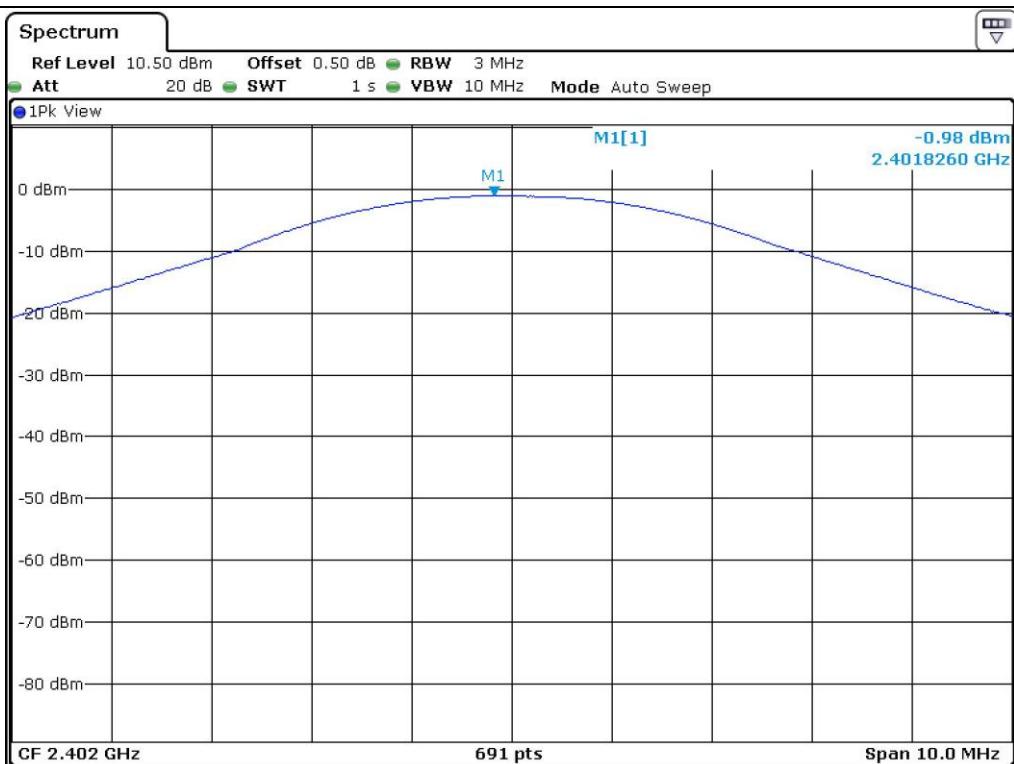
- . Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-0.98	30	30.98
MIDDLE	2 441	-1.67	30	31.67
HIGH	2 480	-3.75	30	33.75

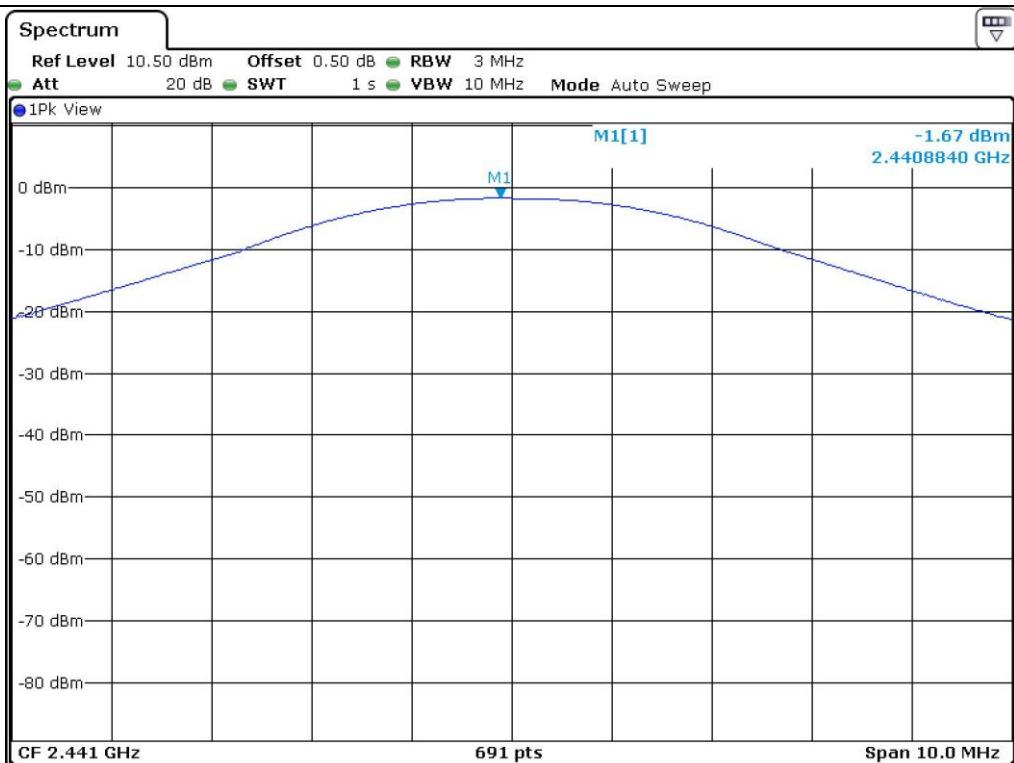
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



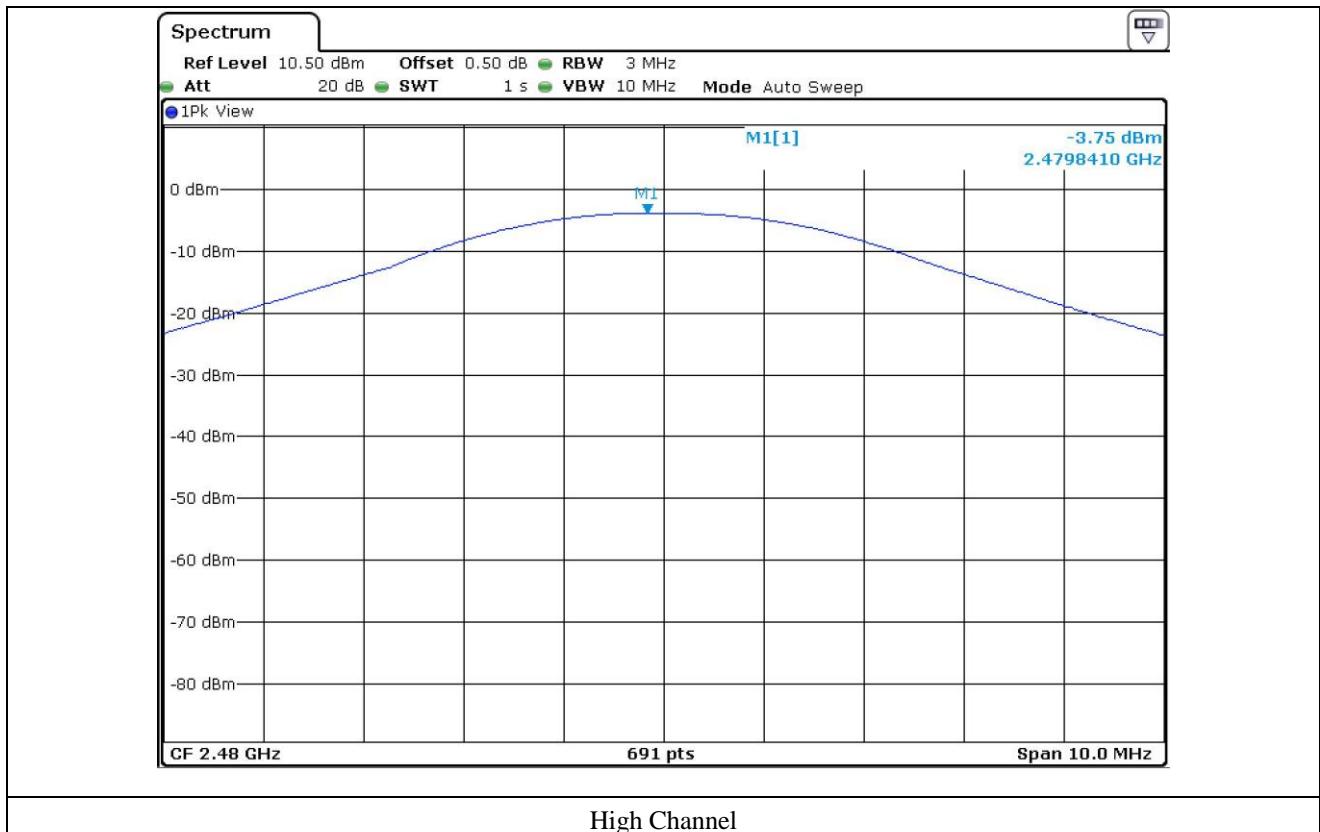
Tested by: Tae-Ho, Kim / Project Engineer



## Low Channel



## Middle Channel



**11.6 Test data for 3 Mbps**

- . Test Date : December 22, 2014

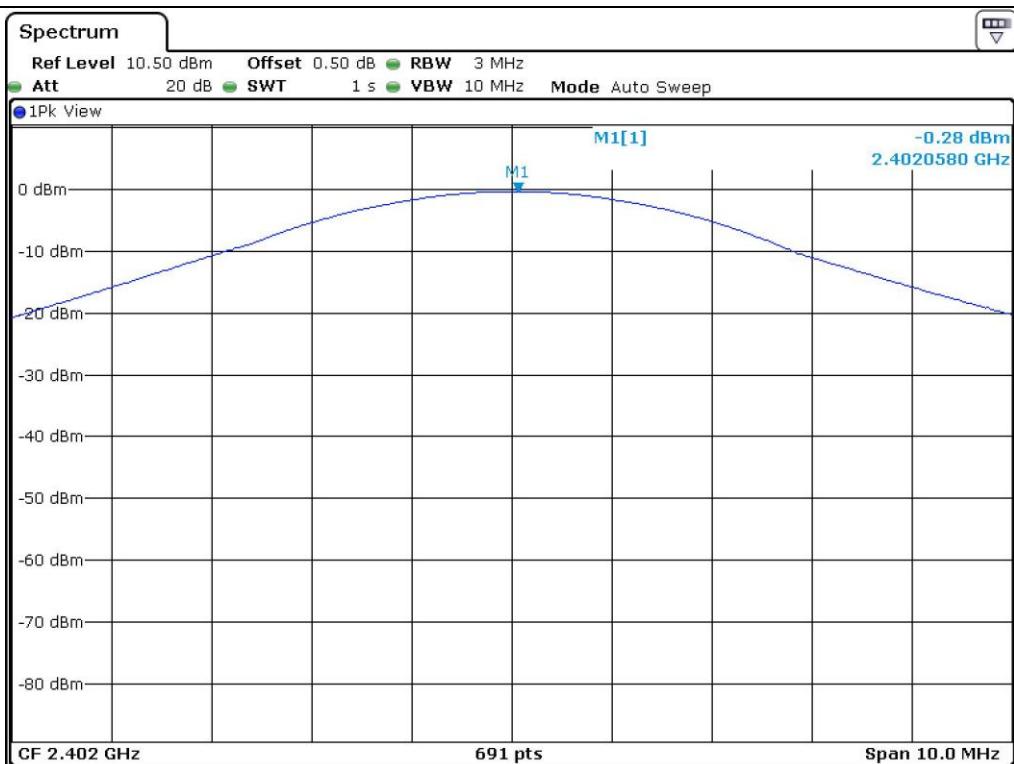
- . Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	-0.28	30	30.28
MIDDLE	2 441	-0.93	30	30.93
HIGH	2 480	-3.01	30	33.01

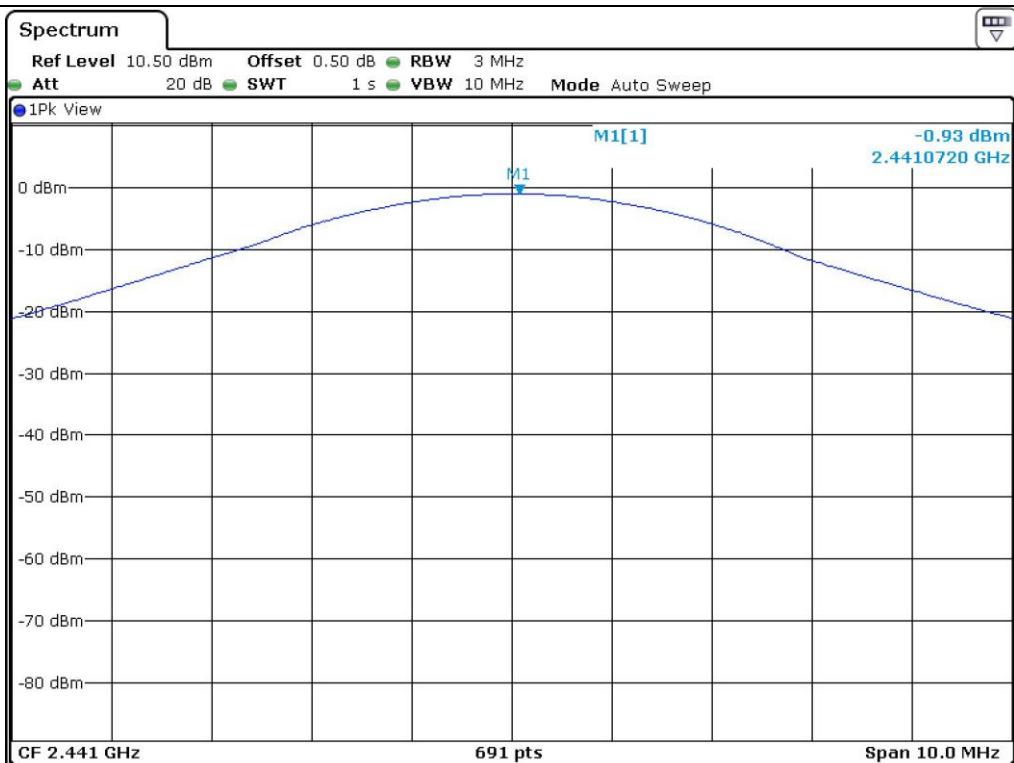
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



Tested by: Tae-Ho, Kim / Project Engineer



### Low Channel



### Middle Channel

