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

Test Report No. : **W161R-D013**

AGR No. : **A15DA-264**

Applicant : **LG Innotek Co., Ltd.**

Address : **978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731 Korea**

Manufacturer : **LG Innotek Co., Ltd.**

Address : **978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731 Korea**

Type of Equipment : **Wi-Fi/BT Combo module**

FCC ID. : **YZP-TWCMK007D**

Model Name : **TWCM-K007D**

Serial number : **N/A**

Total page of Report : **82 pages (including this page)**

Date of Incoming : **December 28, 2015**

Date of issue : **January 25, 2016**

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.

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W161R-D013	January 25, 2016	Initial Issue	All

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1. VERIFICATION OF COMPLIANCE

Applicant	: LG Innotek Co., Ltd.
Address	: 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731 Korea
Contact Person	: Inchang, Jeong / Director
Telephone No.	: +82-62-950-0332
FCC ID	: YZP-TWCMK007D
Model Name	: TWCM-K007D
Serial Number	: N/A
Date	: January 25, 2016

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
E.U.T. DESCRIPTION	Modular Transmitter, Wi-Fi/BT Combo 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.

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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 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. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

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3. GENERAL INFORMATION

3.1 Product Description

The LG Innotek Co., Ltd., Model TWCM-K007D (referred to as the EUT in this report) is a Wi-Fi/BT Combo module. Product specification information described herein was obtained from product data sheet or user's manual.

<table>
<tr><td>DEVICE TYPE</td><td colspan="3">Wi-Fi/BT Combo module</td></tr>
<tr><td rowspan="8">FREQUENCY RANGE</td><td>Bluetooth</td><td colspan="2">2 402 MHz ~ 2 480 MHz</td></tr>
<tr><td>Bluetooth LE</td><td colspan="2">2 402 MHz ~ 2 480 MHz</td></tr>
<tr><td>WLAN 2.4 GHz Band</td><td colspan="2">2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
2 422 MHz ~ 2 452 MHz (802.11n(HT40))</td></tr>
<tr><td rowspan="5">WLAN 5 GHz Band</td><td rowspan="3">5 150 MHz ~ 5 250 MHz Band</td><td>5 180 MHz ~ 5 240 MHz (802.11n(HT20)/ac20)</td></tr>
<tr><td>5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac40)</td></tr>
<tr><td>5 210 MHz (802.11ac80)</td></tr>
<tr><td rowspan="3">5 725 MHz ~ 5 850 MHz Band</td><td>5 745 MHz ~ 5 825 MHz (802.11n(HT20)/ac20)</td></tr>
<tr><td>5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac40)</td></tr>
<tr><td>5 775 MHz (802.11ac80)</td></tr>
</table>

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<table>
<tr><td rowspan="19">MAX. RF OUTPUT POWER</td><td rowspan="3">Bluetooth</td><td colspan="2">1 Mbps</td><td>5.94 dBm</td></tr>
<tr><td colspan="2">2 Mbps</td><td>6.77 dBm</td></tr>
<tr><td colspan="2">3 Mbps</td><td>7.07 dBm</td></tr>
<tr><td>Bluetooth LE</td><td colspan="3">1.43 dBm</td></tr>
<tr><td rowspan="2">WLAN
2.4 GHz Band</td><td>Ant.0</td><td colspan="2">Wi-Fi 802.11b (12.72 dBm)
Wi-Fi 802.11g (11.75 dBm)
Wi-Fi 802.11n_20 MHz (10.54 dBm)
Wi-Fi 802.11n_40 MHz (8.69 dBm)</td></tr>
<tr><td>Ant.1</td><td colspan="2">Wi-Fi 802.11b (12.92 dBm)
Wi-Fi 802.11g (11.75 dBm)
Wi-Fi 802.11n_20 MHz (10.82 dBm)
Wi-Fi 802.11n_40 MHz (8.50 dBm)</td></tr>
<tr><td rowspan="16">WLAN
5 GHz Band</td><td rowspan="8">Ant.0</td><td rowspan="4">5 150 MHz ~
5 250 MHz Band</td><td>Wi-Fi 802.11a (10.00 dBm)
Wi-Fi 802.11n_20 MHz (9.87 dBm)
Wi-Fi 802.11n_40 MHz (8.56 dBm)
Wi-Fi 802.11ac20 MHz (9.77 dBm)
Wi-Fi 802.11ac40 MHz (9.49 dBm)
Wi-Fi 802.11ac80 MHz (8.04 dBm)</td></tr>
<tr><td rowspan="4">5 725 MHz ~
5 850 MHz Band</td><td>Wi-Fi 802.11a (9.22 dBm)
Wi-Fi 802.11n_20 MHz (9.09 dBm)
Wi-Fi 802.11n_40 MHz (7.00 dBm)
Wi-Fi 802.11ac20 MHz (9.31 dBm)
Wi-Fi 802.11ac40 MHz (8.12 dBm)
Wi-Fi 802.11ac80 MHz (7.40 dBm)</td></tr>
<tr><td rowspan="8">Ant.1</td><td rowspan="4">5 150 MHz ~
5 250 MHz Band</td><td>Wi-Fi 802.11a (9.32 dBm)
Wi-Fi 802.11n_20 MHz (9.01 dBm)
Wi-Fi 802.11n_40 MHz (7.57 dBm)
Wi-Fi 802.11ac20 MHz (9.18 dBm)
Wi-Fi 802.11ac40 MHz (8.83 dBm)
Wi-Fi 802.11ac80 MHz (7.16 dBm)</td></tr>
<tr><td rowspan="4">5 725 MHz ~
5 850 MHz Band</td><td>Wi-Fi 802.11a (8.49 dBm)
Wi-Fi 802.11n_20 MHz (8.45 dBm)
Wi-Fi 802.11n_40 MHz (7.12 dBm)
Wi-Fi 802.11ac20 MHz (8.49 dBm)
Wi-Fi 802.11ac40 MHz (7.39 dBm)
Wi-Fi 802.11ac80 MHz (6.54 dBm)</td></tr>
</table>

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MODULATION TYPE	Bluetooth	GFSK for 1 Mbps, DQPSK for 2 Mbps, 8-DPSK for 3 Mbps
	Bluetooth LE	GFSK
	WLAN 2.4 GHz Band	DSSS Modulation(DBPSK/DQPSK/CCK)
	WLAN 5 GHz Band	OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
Antenna Gain	2.4 GHz Band [BT(BDR / EDR / LE)]	0.42 dBi
	2.4 GHz Band [WLAN]	Antenna 0 : 1.23 dBi
		Antenna 1 : 1.21 dBi
	5 GHz Band [5 150 MHz ~ 5 250 MHz Band]	Antenna 0 : 1.71 dBi
		Antenna 1 : 1.39 dBi
	5 GHz Band [5 725 MHz ~ 5 850 MHz Band]	Antenna 0 : 1.10 dBi
		Antenna 1 : 0.71 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	40 MHz	

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

-. None

4. EUT MODIFICATIONS

-. None

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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 Innotek Co., Ltd.	WiFi+BT MODULE	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
TWCM-K007D	LG Innotek Co., Ltd.	Wi-Fi/BT Combo module (EUT)	Notebook PC
PP11L	DELL	Notebook PC	EUT

5.3 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 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.

5.4 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 WLAN PIFA antenna and Bluetooth/BLE PIFA antenna, so no consideration of replacement by the user.

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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

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7. MINIMUM 20 dB BANDWIDTH

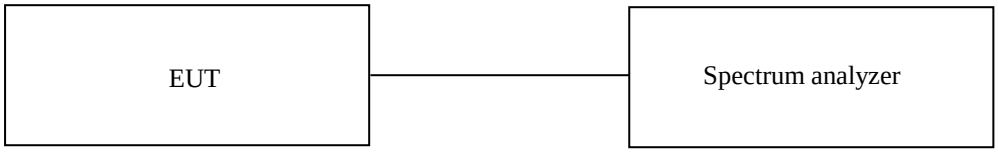
7.1 Operating environment

Temperature : 21.4 ℃

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.

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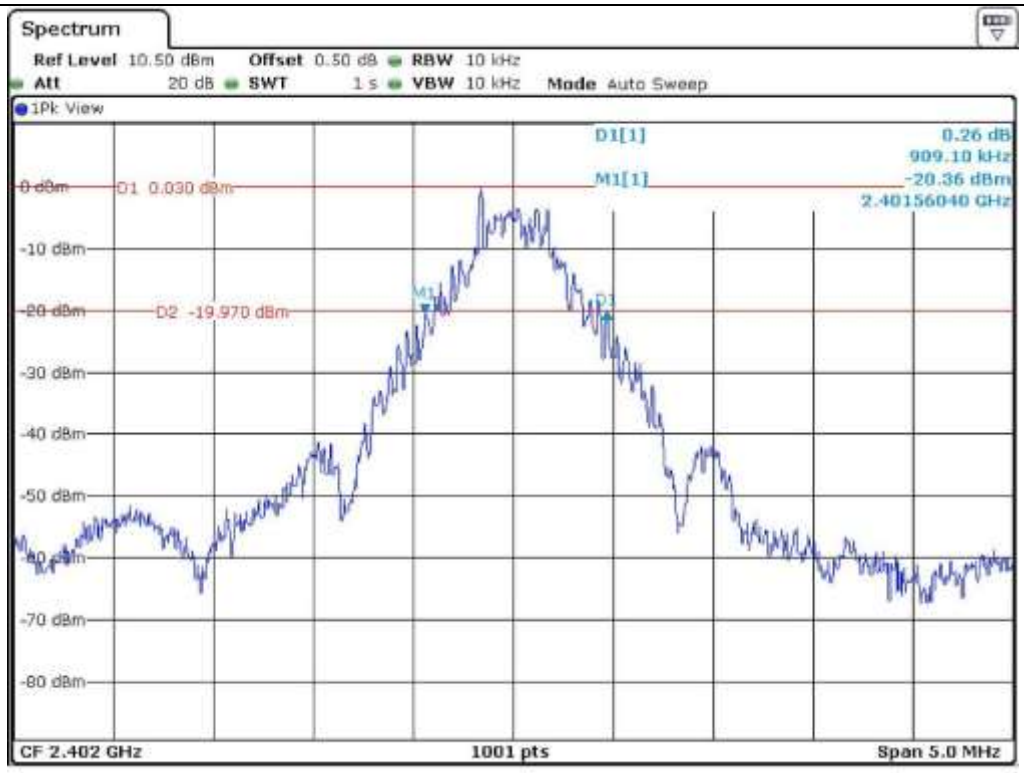
7.4 Test data for 1 Mbps

-. Test Date : January 04, 2016

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	909.10
Middle	2 441	909.10
High	2 480	909.10

Tested by: Tae-Ho, Kim / Senior Engineer



Low Channel

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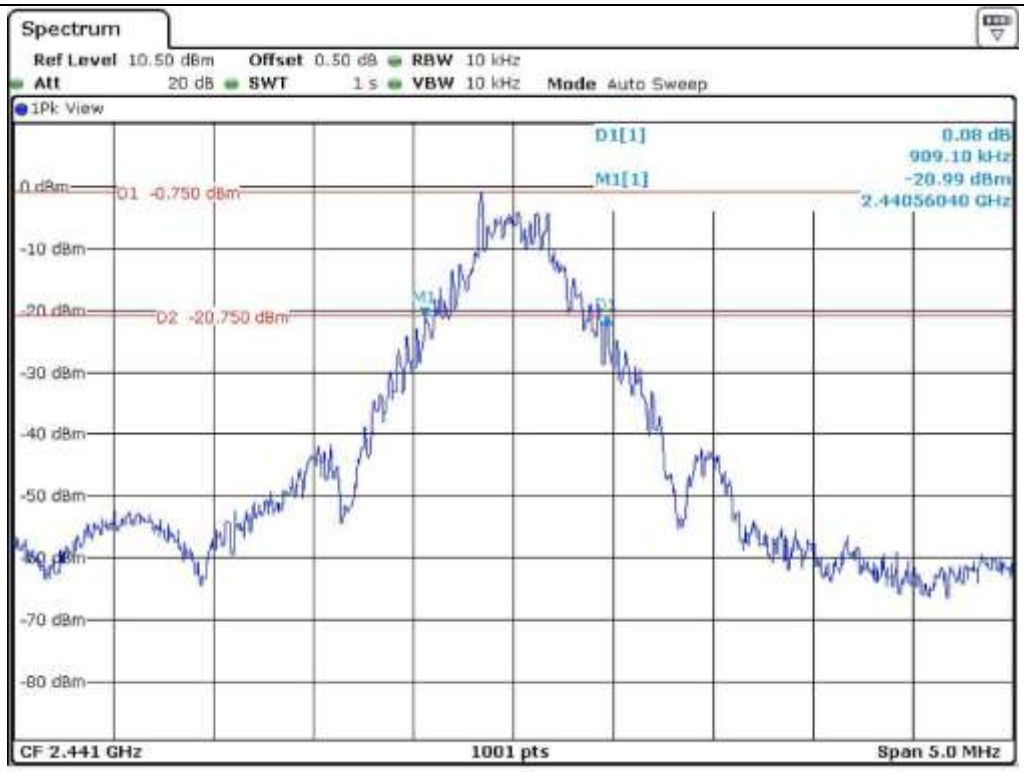
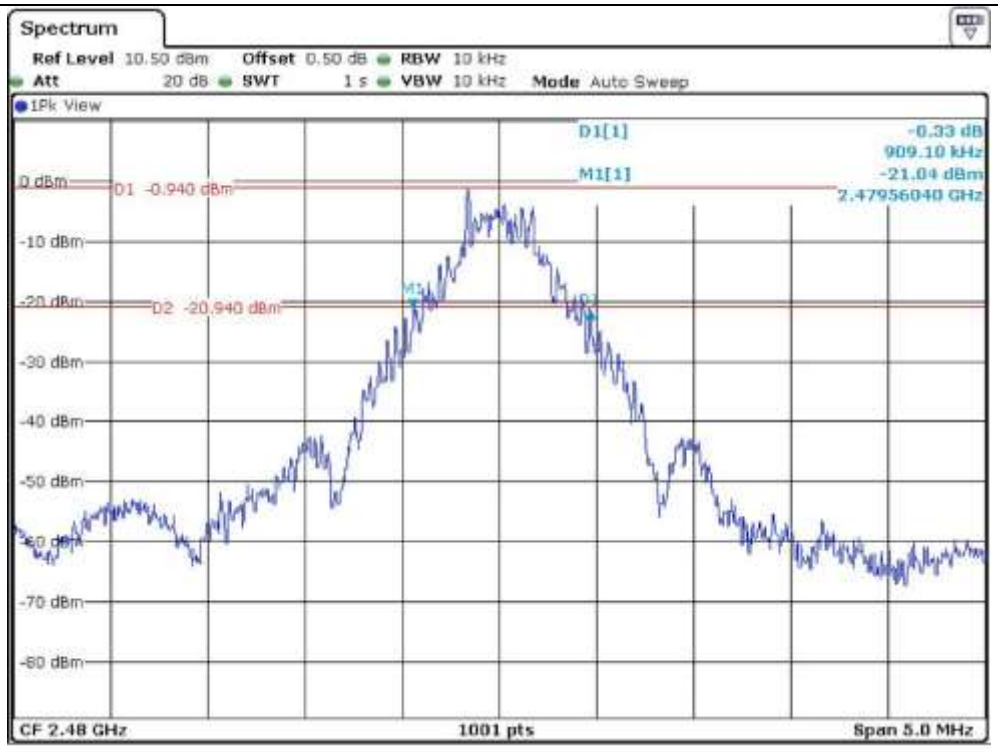


Middle Channel



High Channel

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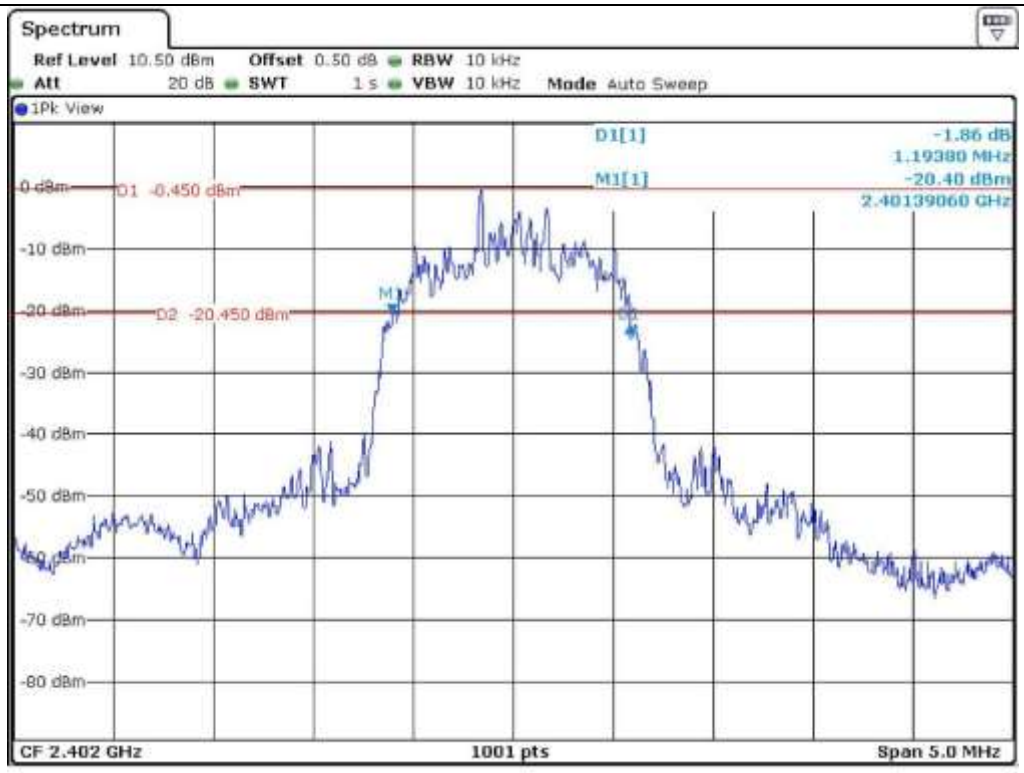
7.5 Test data for 2 Mbps

-. Test Date : January 04, 2016

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	1 193.80
Middle	2 441	1 193.80
High	2 480	1 193.80

Tested by: Tae-Ho, Kim / Senior Engineer



Low Channel

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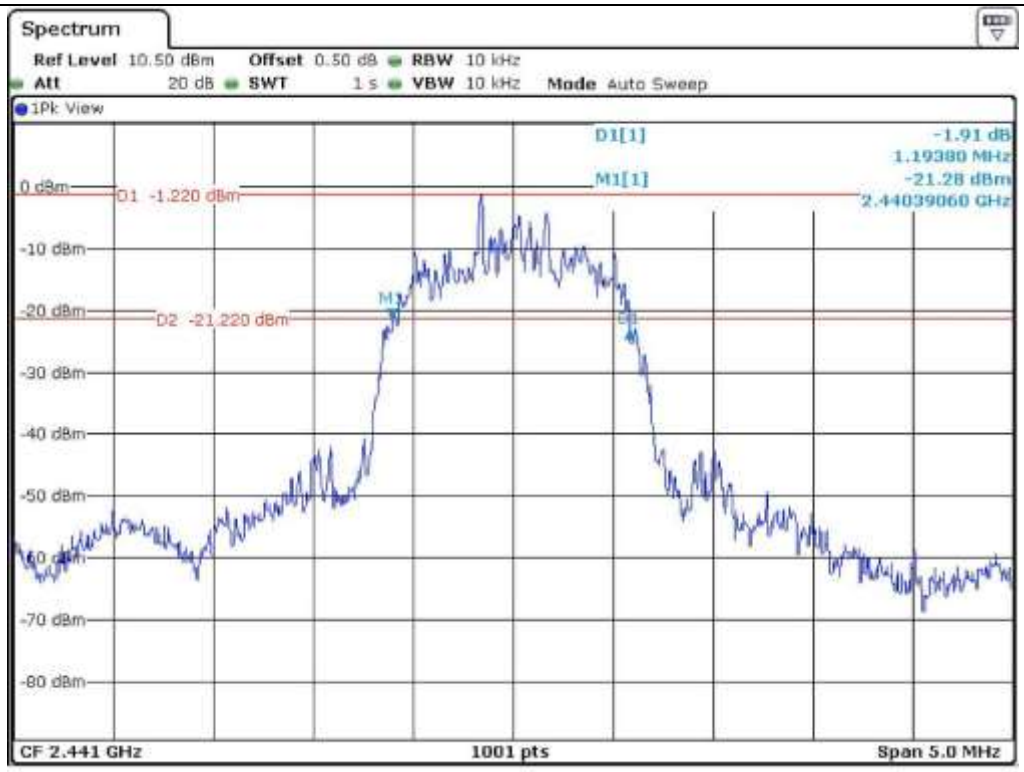
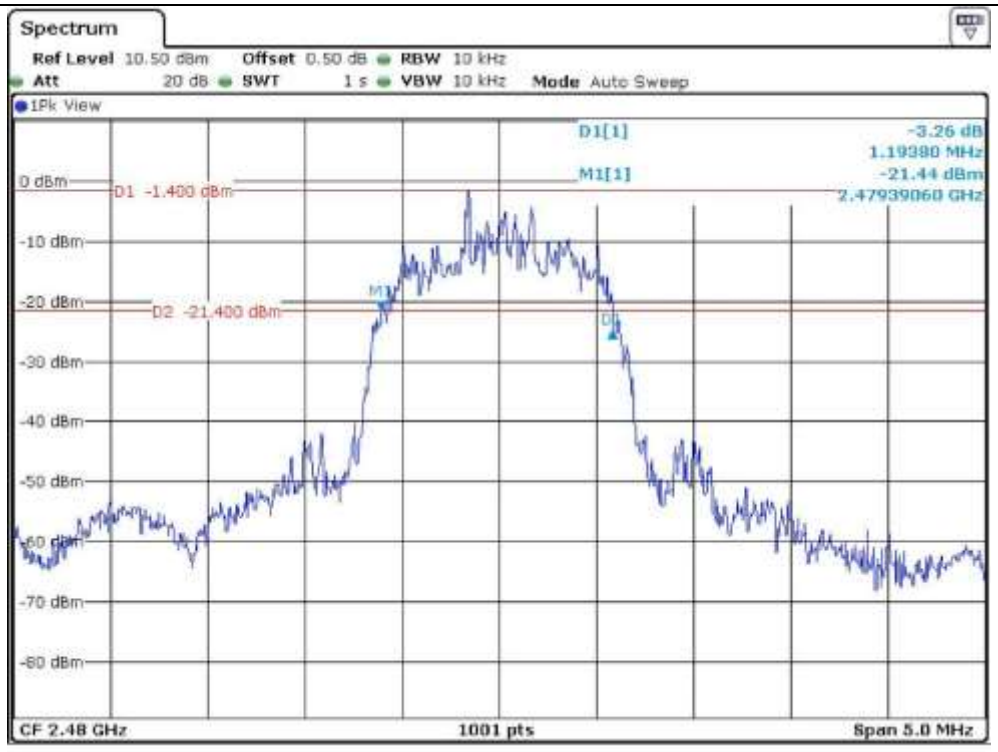


Middle Channel



High Channel

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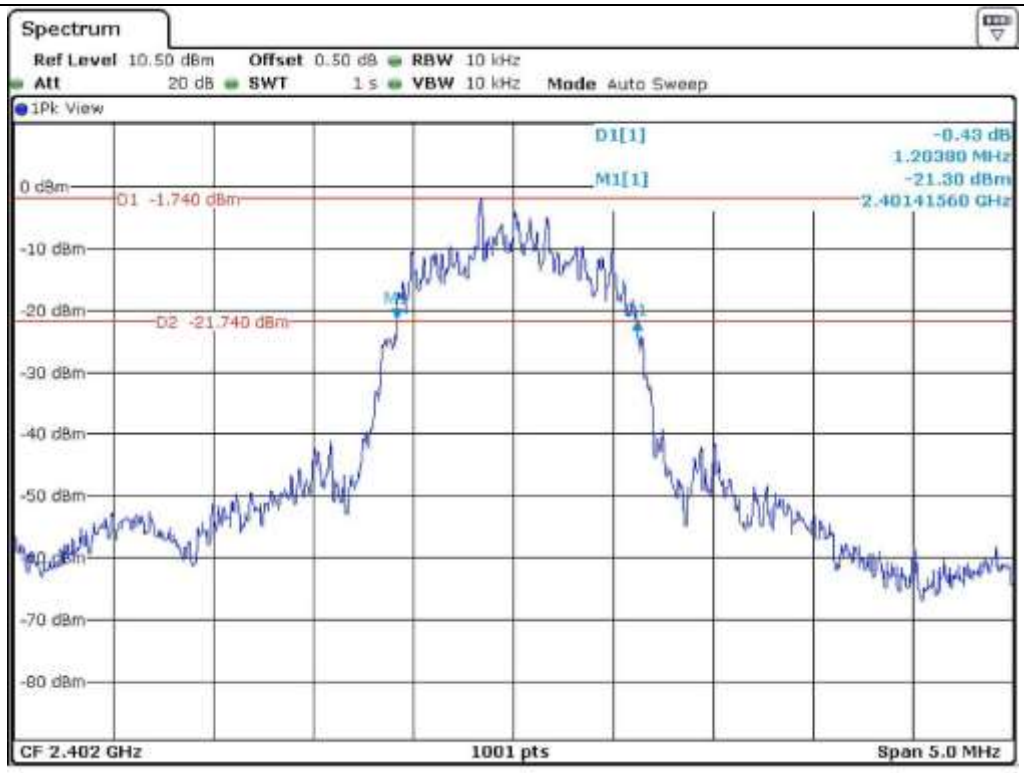
7.6 Test data for 3 Mbps

-. Test Date : January 04, 2016

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	1 203.80
Middle	2 441	1 203.80
High	2 480	1 203.80

Tested by: Tae-Ho, Kim / Senior Engineer



Low Channel

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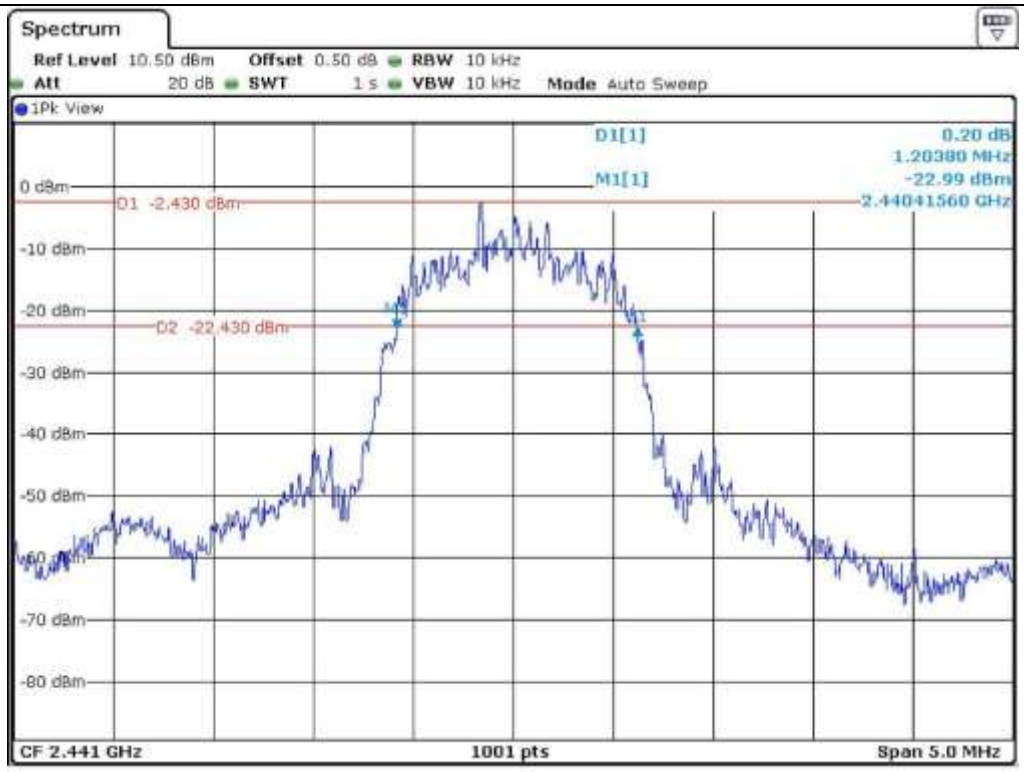
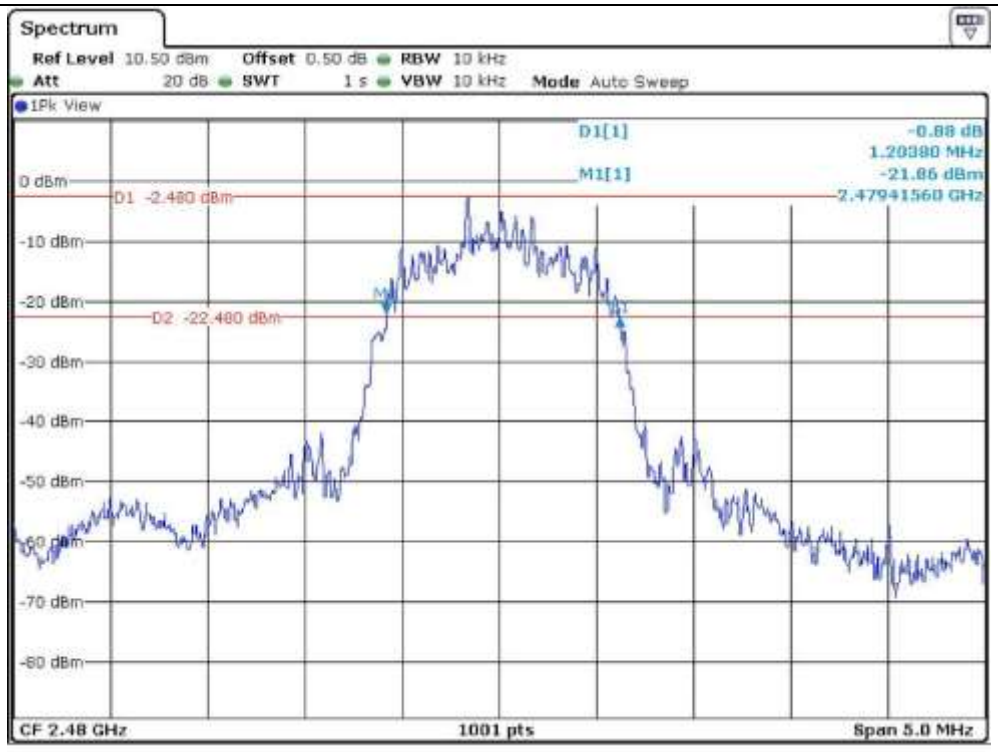


Middle Channel



High Channel

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8. HOPPING FREQUENCY SEPARATION

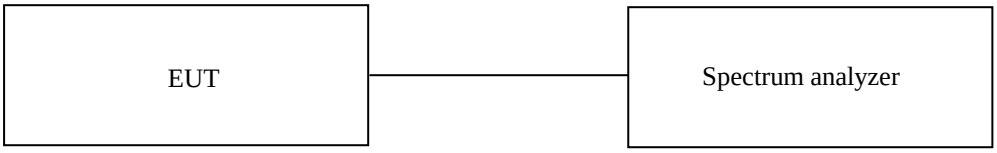
8.1 Operating environment

Temperature : 21.4 ℃

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.

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

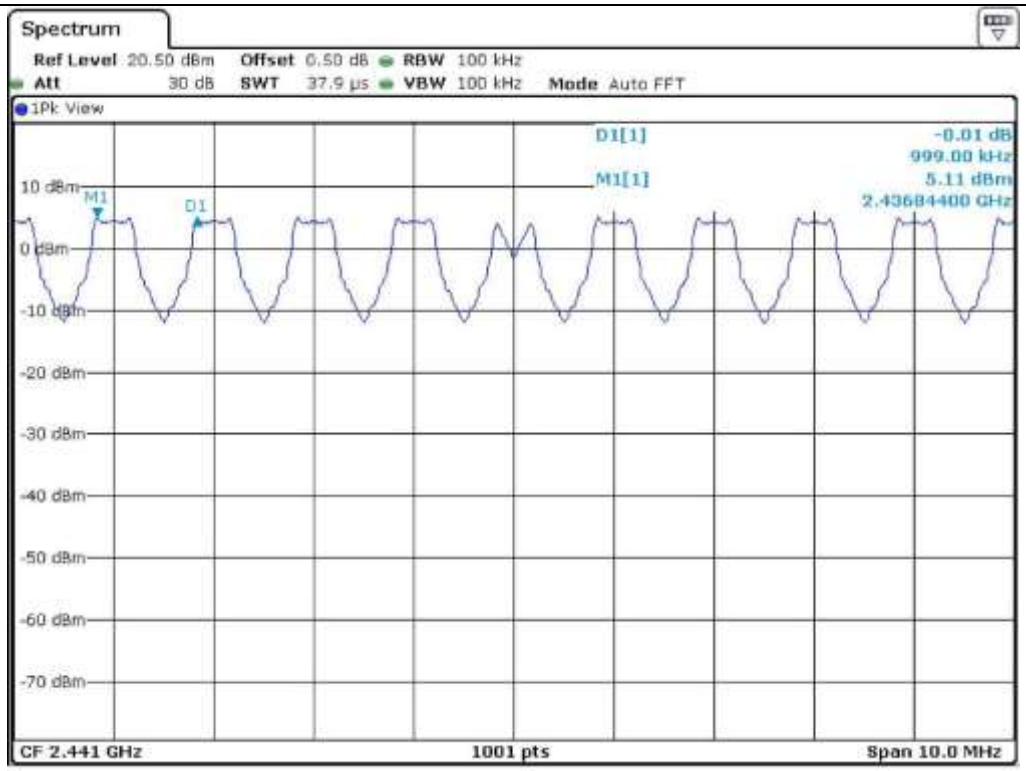
8.4 Test data for 1 Mbps

-. Test Date : January 04, 2016

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 009.00	606.07	Separated by a minimum of 25 kHz

Tested by: Tae-Ho, Kim / Senior Engineer



HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

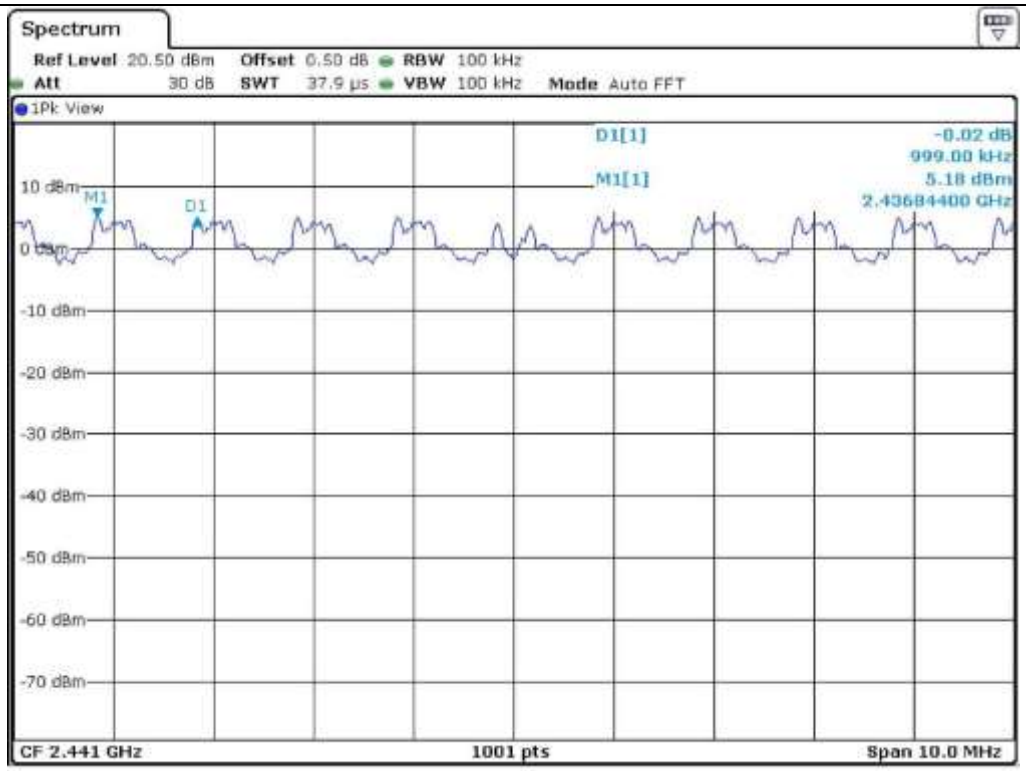
8.5 Test data for 2 Mbps

-. Test Date : January 04, 2016

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 009.00	795.87	Separated by a minimum of 25 kHz

Tested by: Tae-Ho, Kim / Senior Engineer



HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

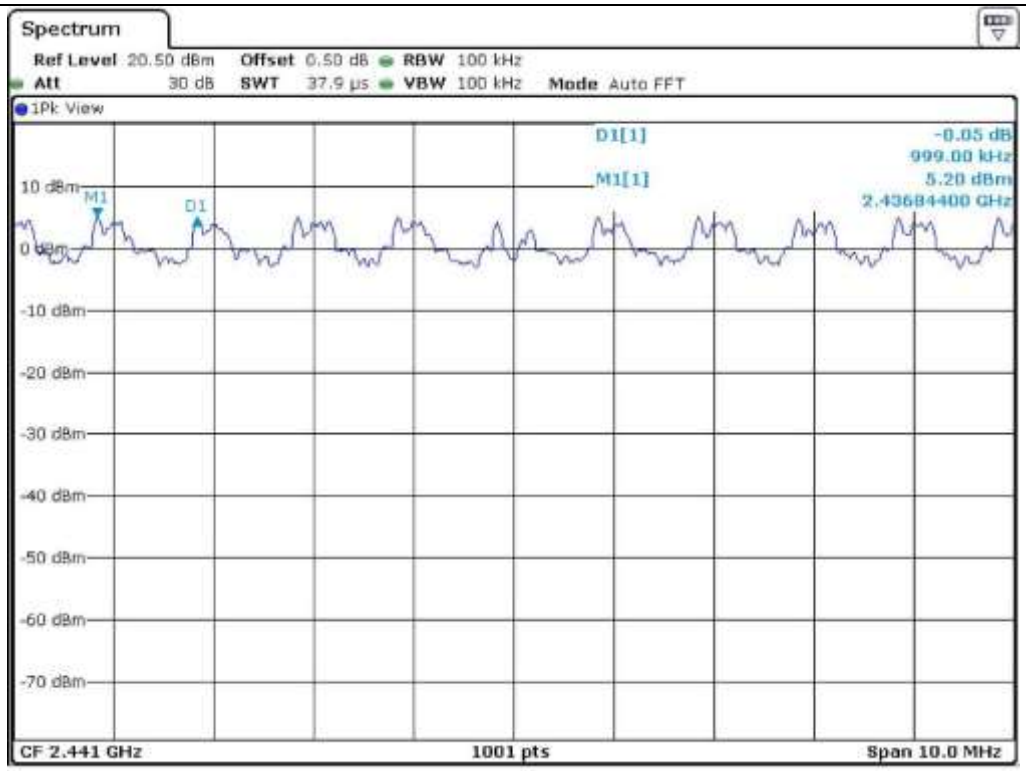
8.6 Test data for 3 Mbps

-. Test Date : January 04, 2016

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 009.00	802.53	Separated by a minimum of 25 kHz

Tested by: Tae-Ho, Kim / Senior Engineer



HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

9. NUMBER OF HOPPING CHANNELS

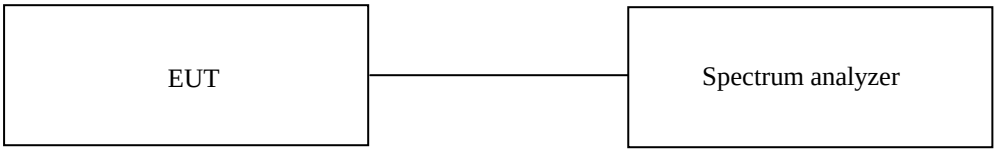
9.1 Operating environment

Temperature : 21.4 ℃

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.

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

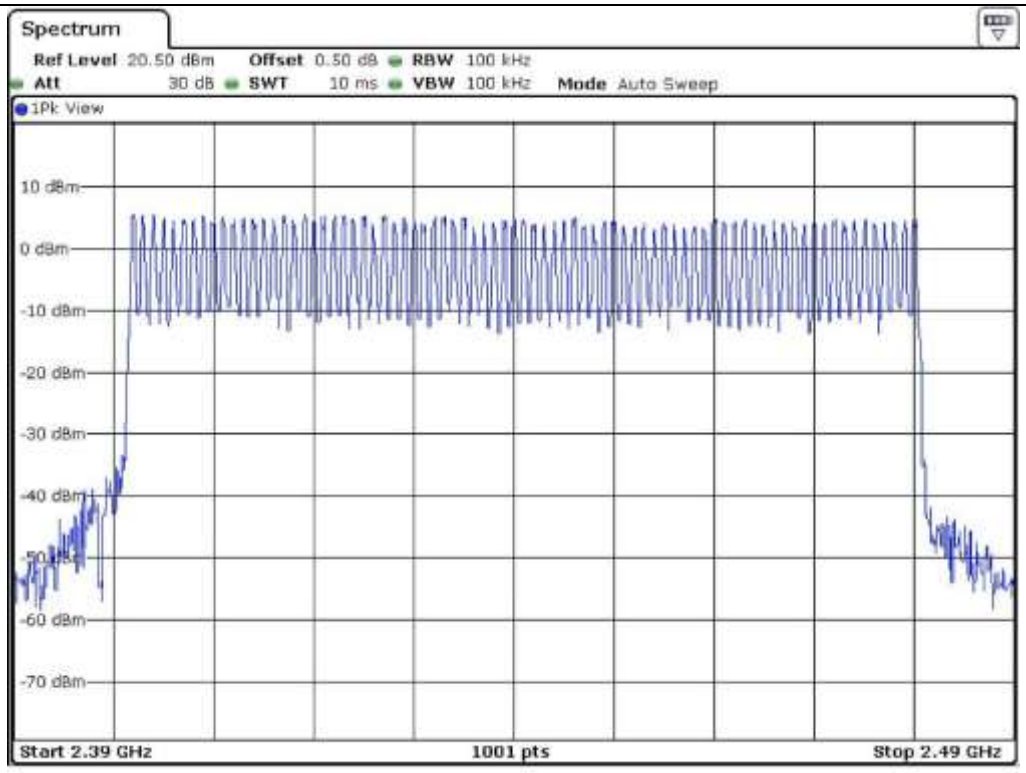
9.4 Test data for 1 Mbps

-. Test Date : January 04, 2016

-. Test Result : Pass

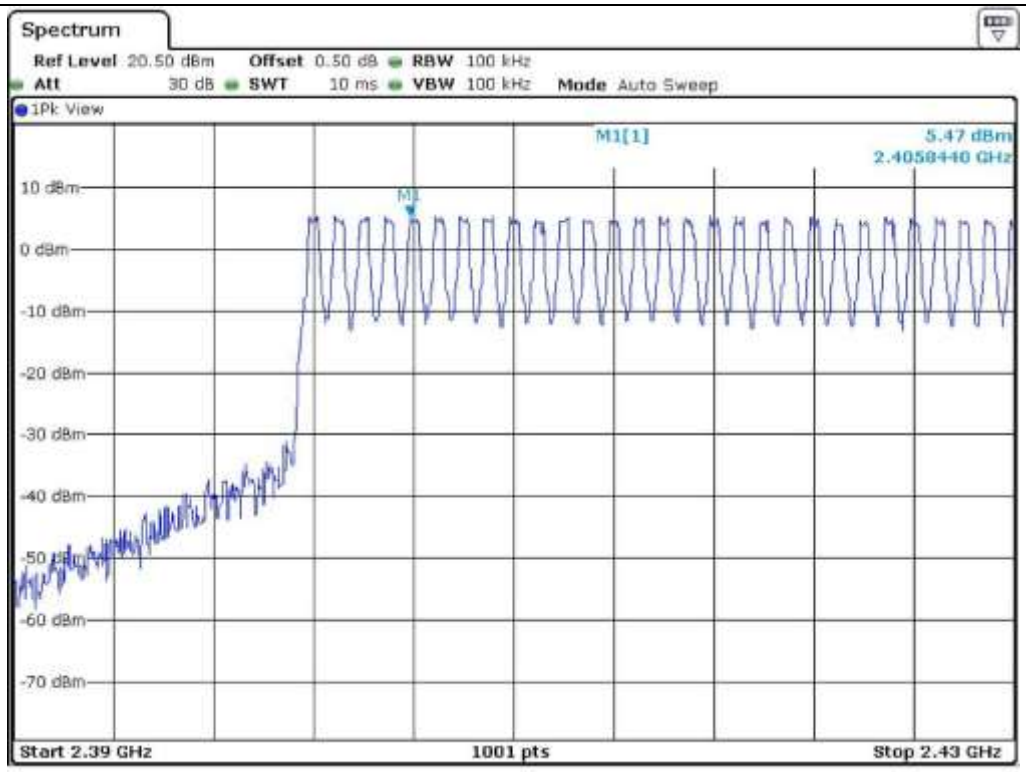
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
1 Mbps	79	Minimum of 15	64

Tested by: Tae-Ho, Kim / Senior Engineer

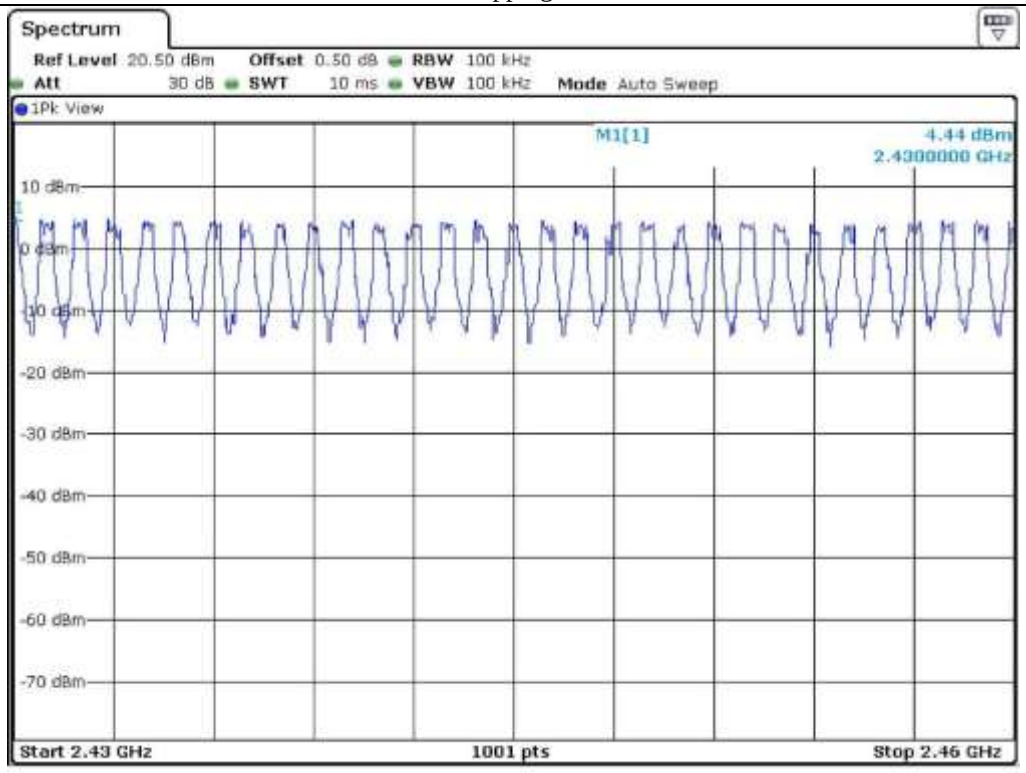


Total number of hopping channel: 28+30+21 = 79

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

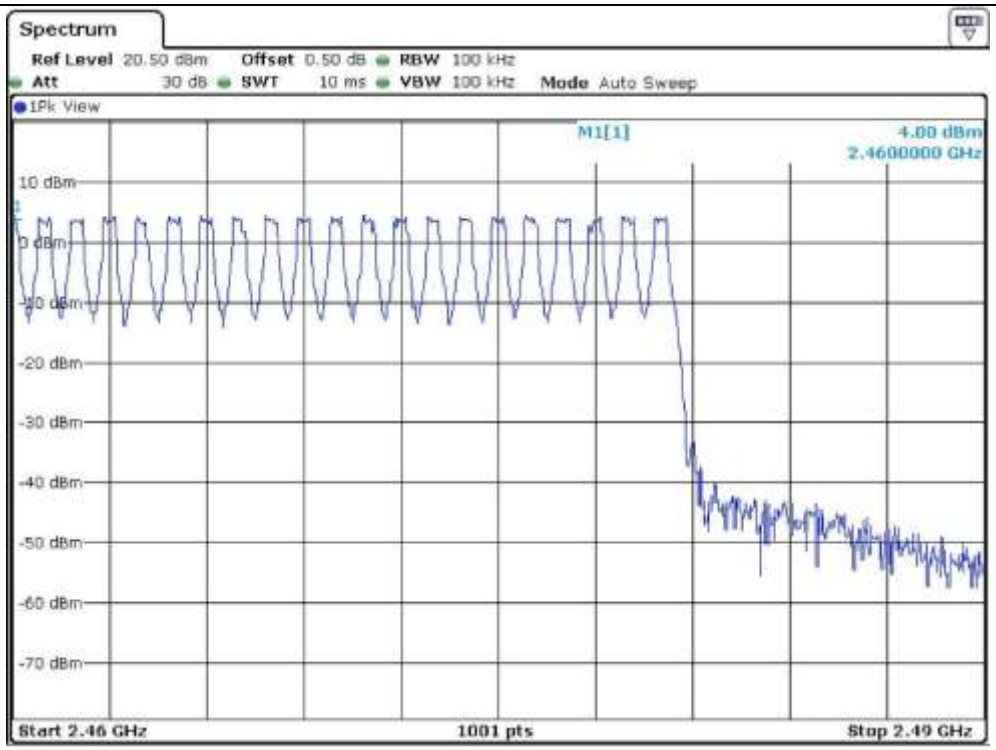


Number of hopping channel: 28



Number of hopping channel: 30

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



Number of hopping channel: 21

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

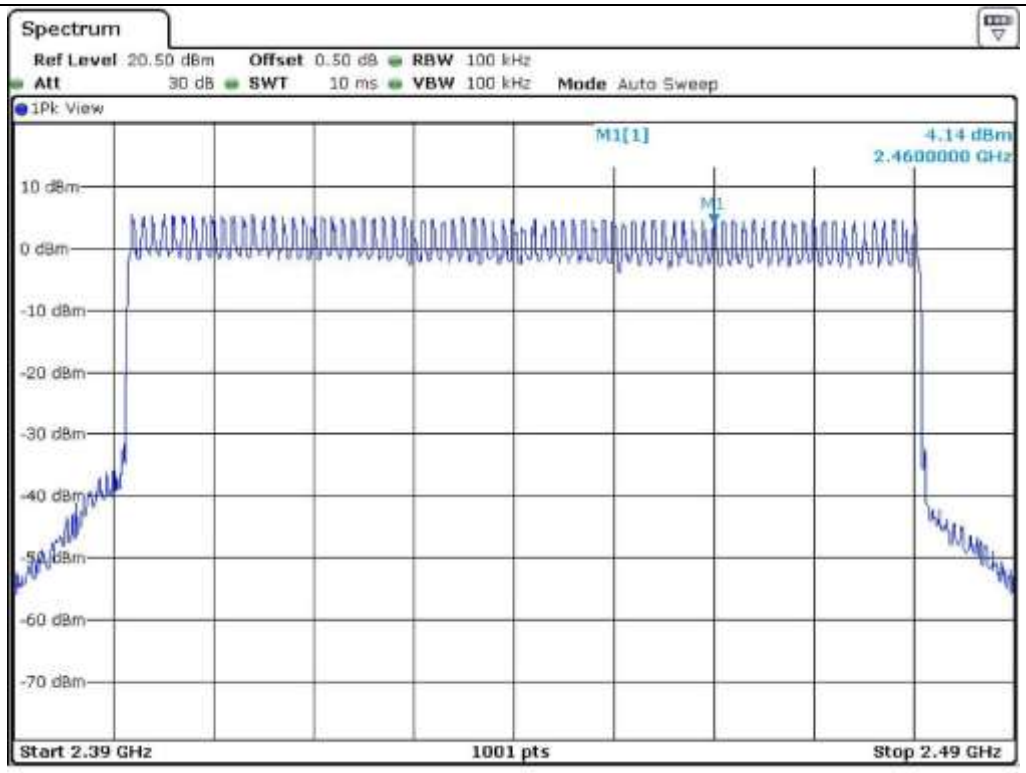
9.5 Test data for 2 Mbps

-. Test Date : January 04, 2016

-. Test Result : Pass

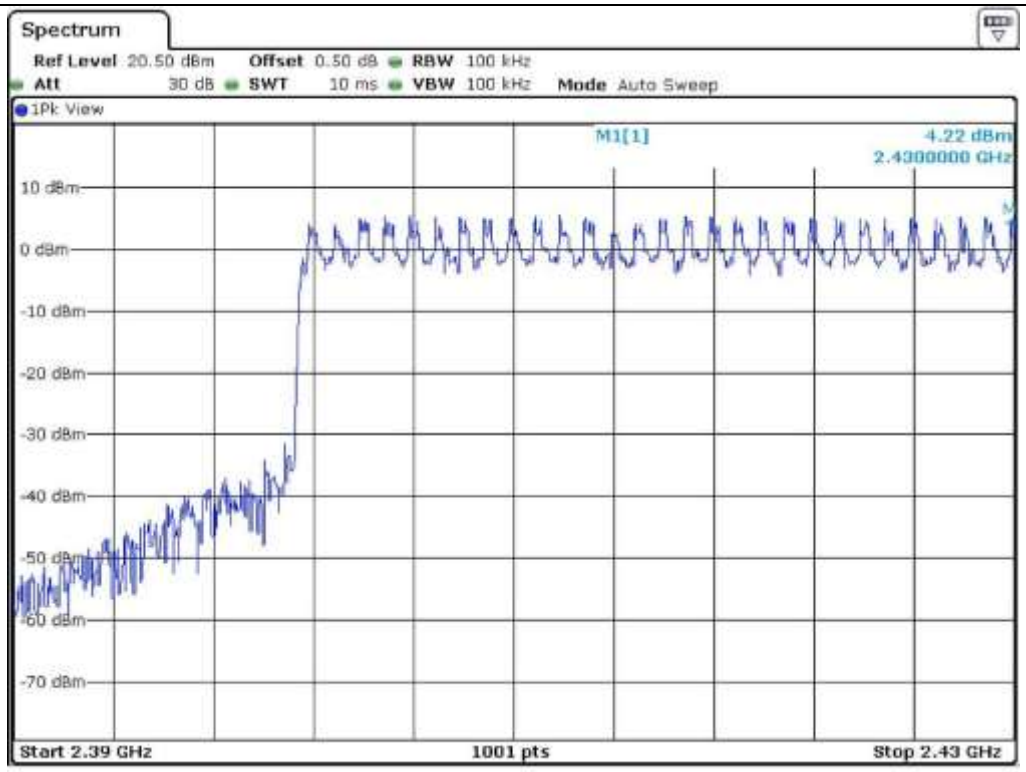
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
2 Mbps	79	Minimum of 15	64

Tested by: Tae-Ho, Kim / Senior Engineer

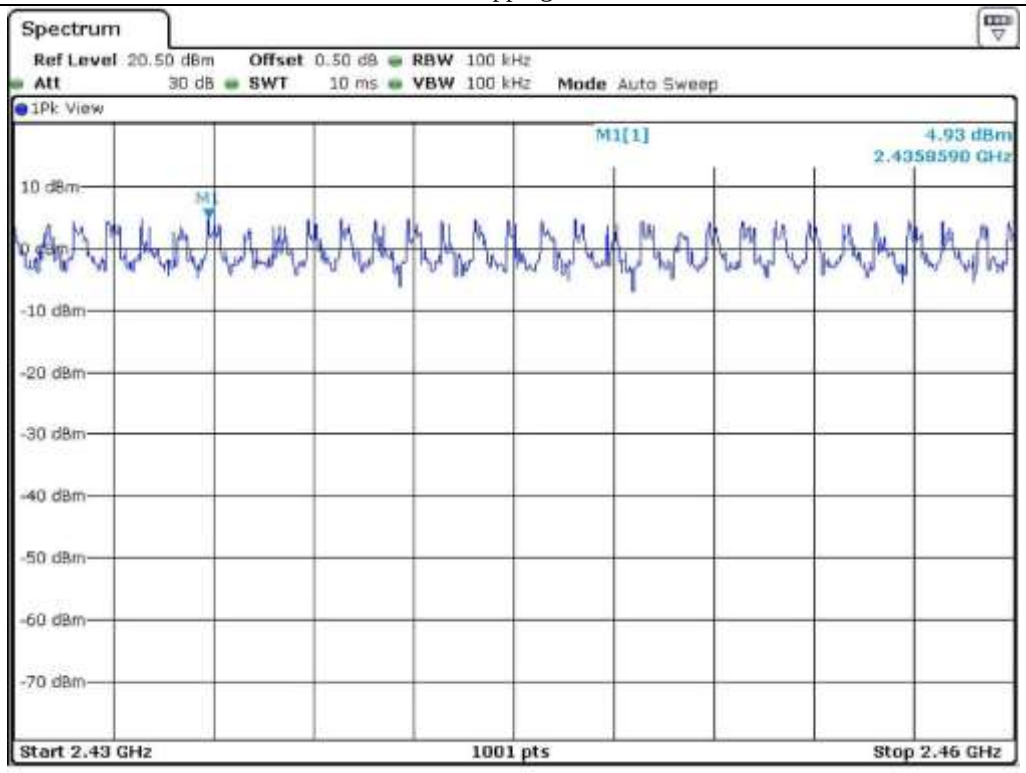


Total number of hopping channel: 28+30+21 = 79

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

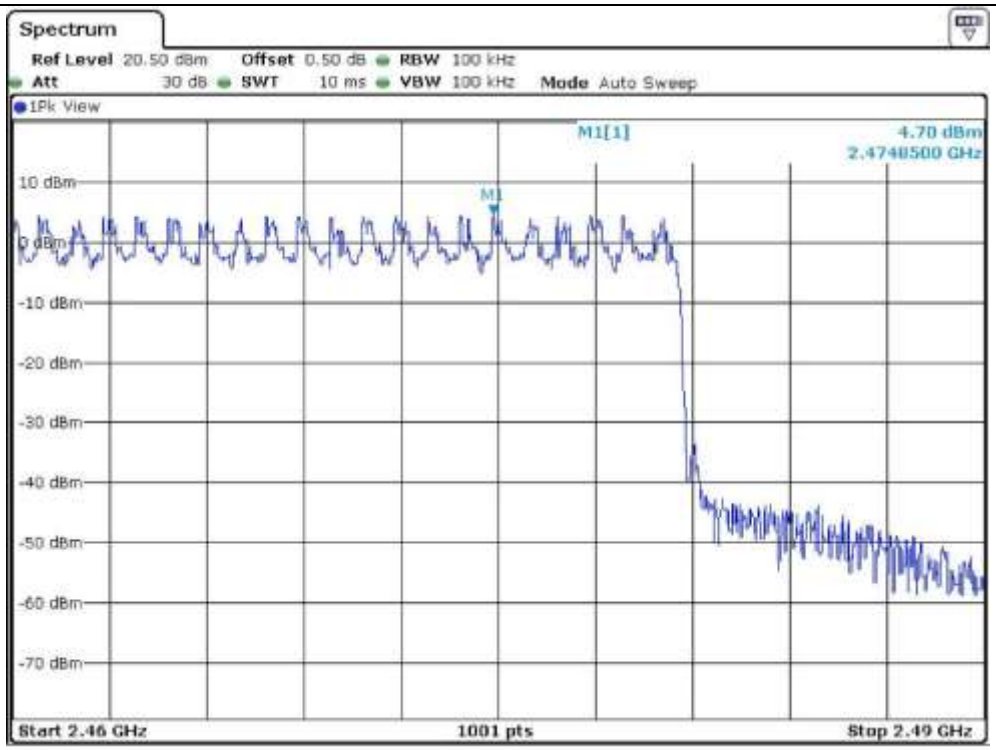


Number of hopping channel: 28



Number of hopping channel: 30

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



Number of hopping channel: 21

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

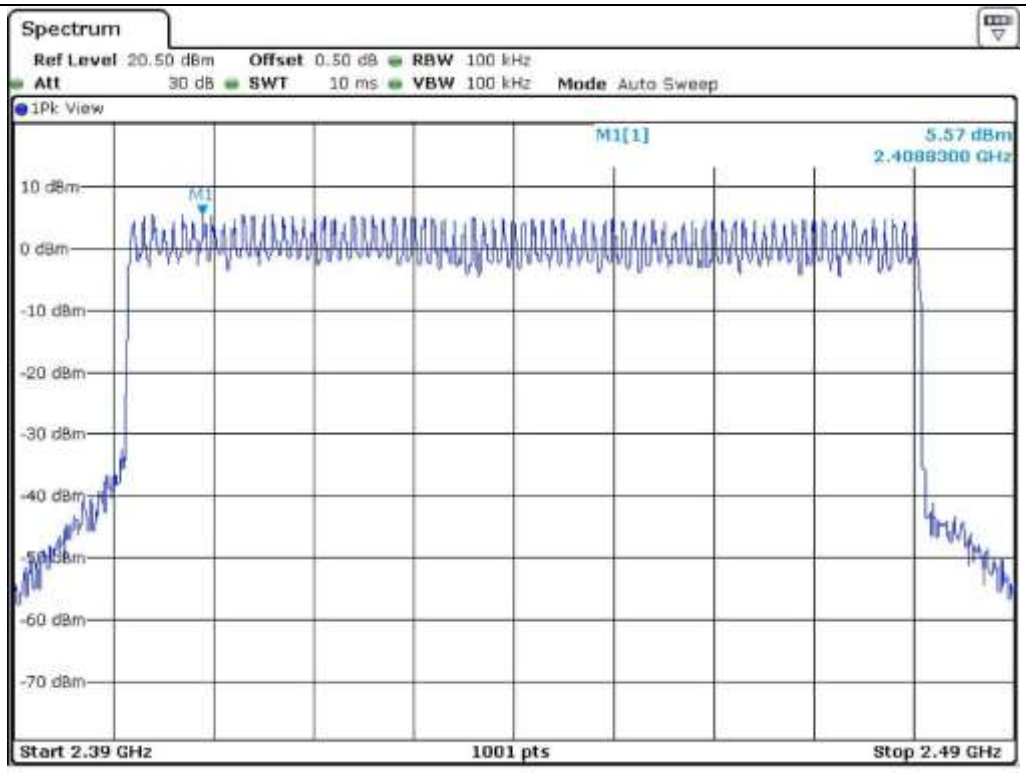
9.6 Test data for 3 Mbps

-. Test Date : January 04, 2016

-. Test Result : Pass

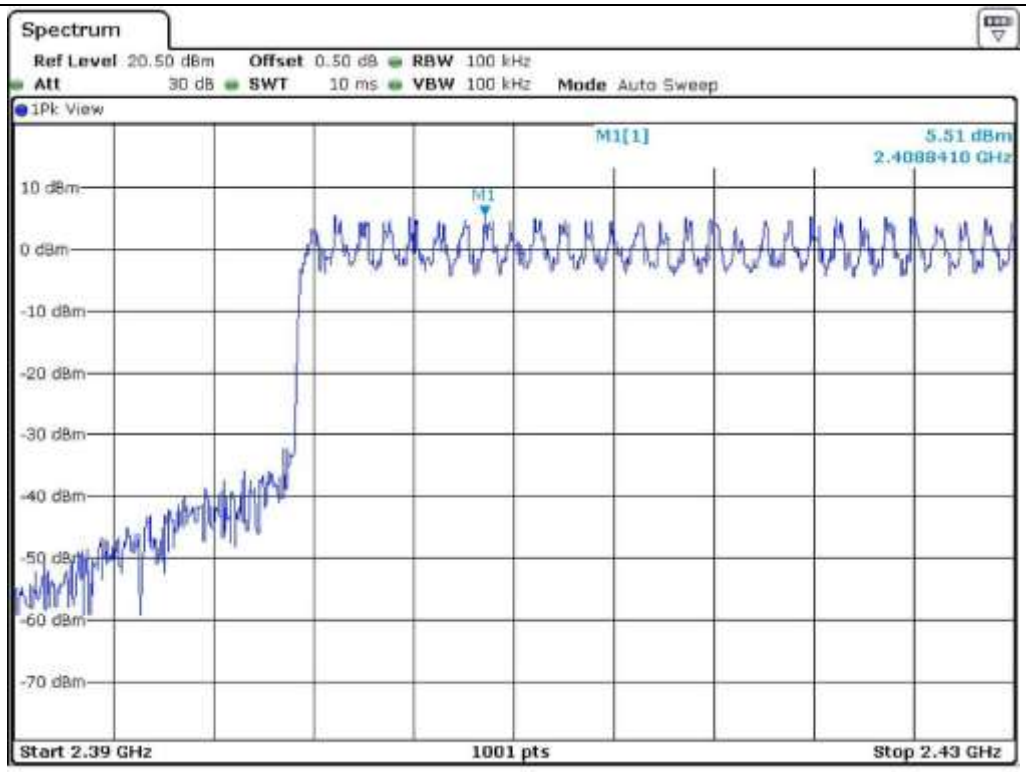
Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
3 Mbps	79	Minimum of 15	64

Tested by: Tae-Ho, Kim / Senior Engineer

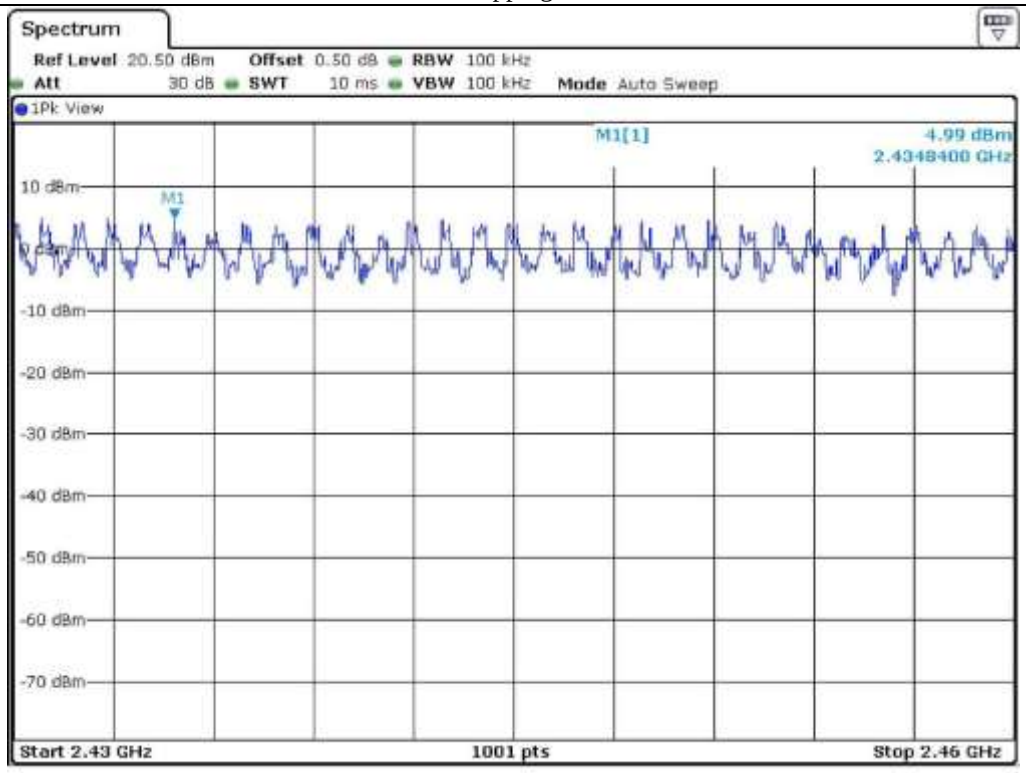


Total number of hopping channel: 28+30+21 = 79

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

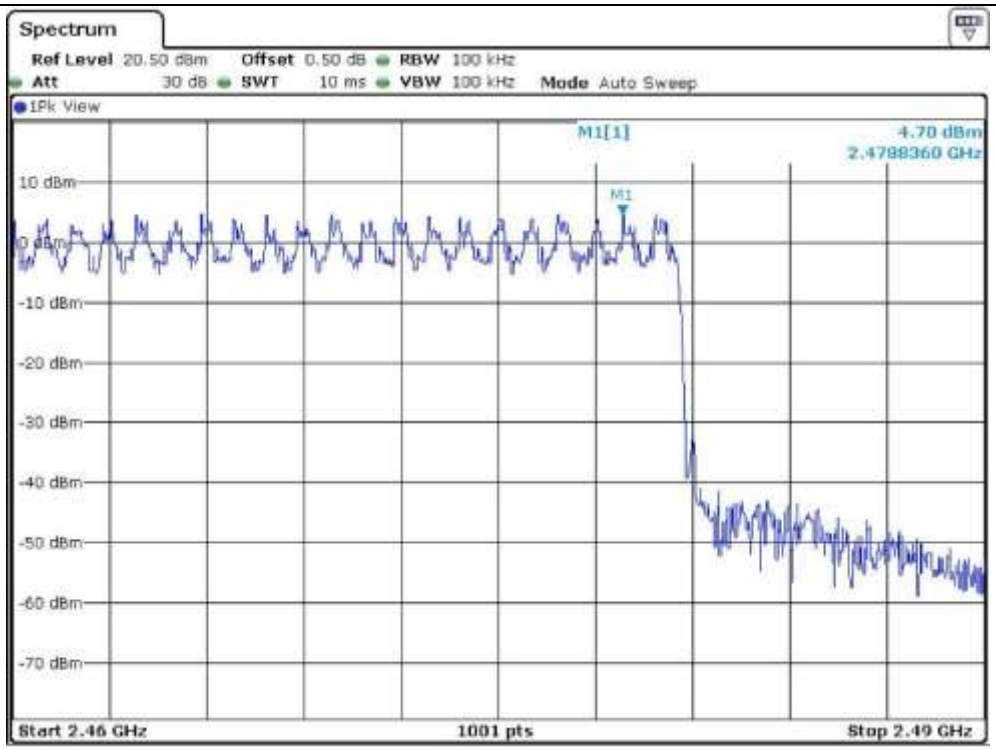


Number of hopping channel: 28



Number of hopping channel: 30

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



Number of hopping channel: 21

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

10. TIME OF OCCUPANCY

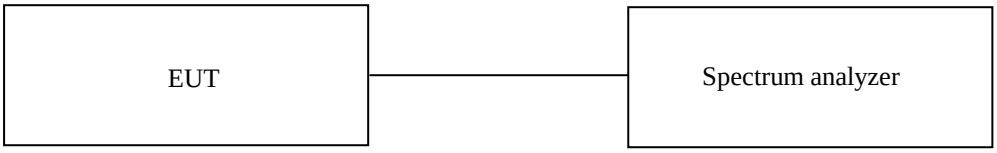
10.1 Operating environment

Temperature : 21.4 ℃

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.

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

10.4 Test data for 1 Mbps

-. Test Date : January 04, 2016

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	0.370	10.13	31.6	118.44	400	PASS
DH3	1.630	5.06	31.6	260.63	400	
DH5	2.880	3.38	31.6	307.61	400	

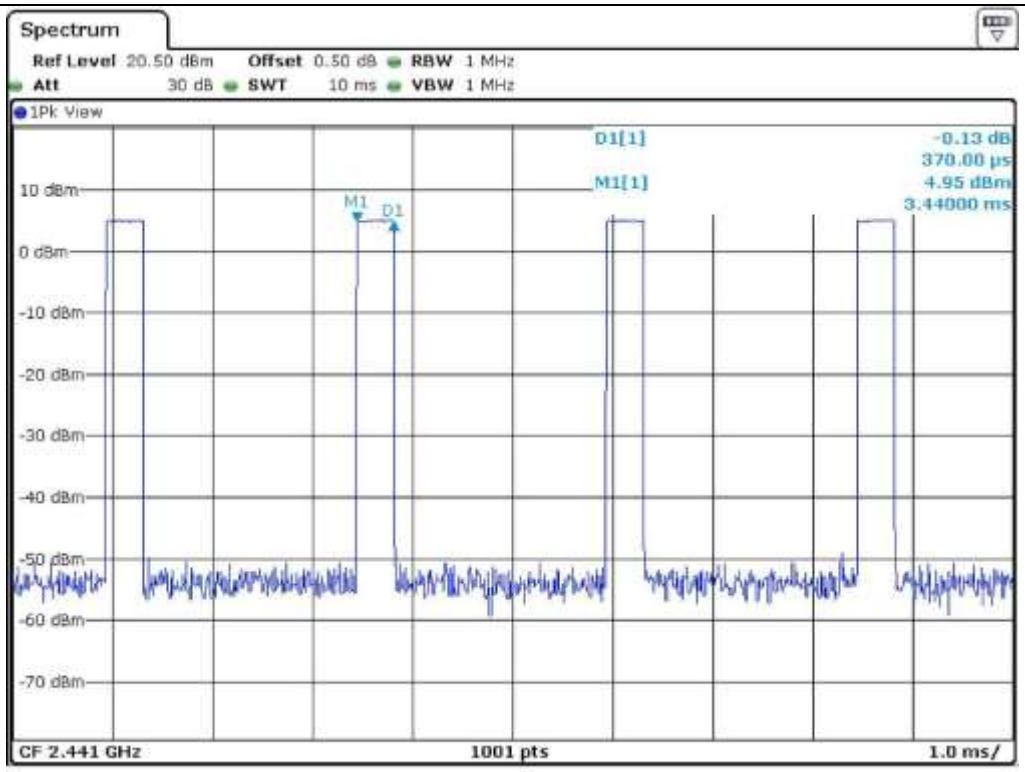
Total dwell time is calculated as following.

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

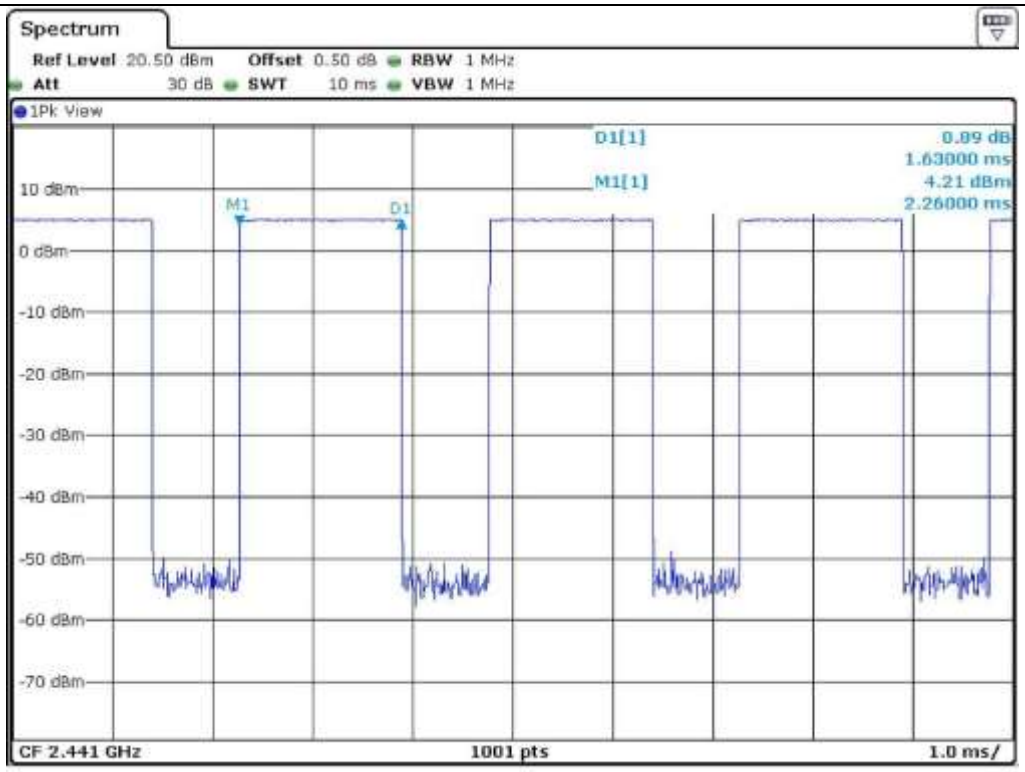
Remark: See next page for an overview sweep performed with peak detector.

Tested by: Tae-Ho, Kim / Senior Engineer

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

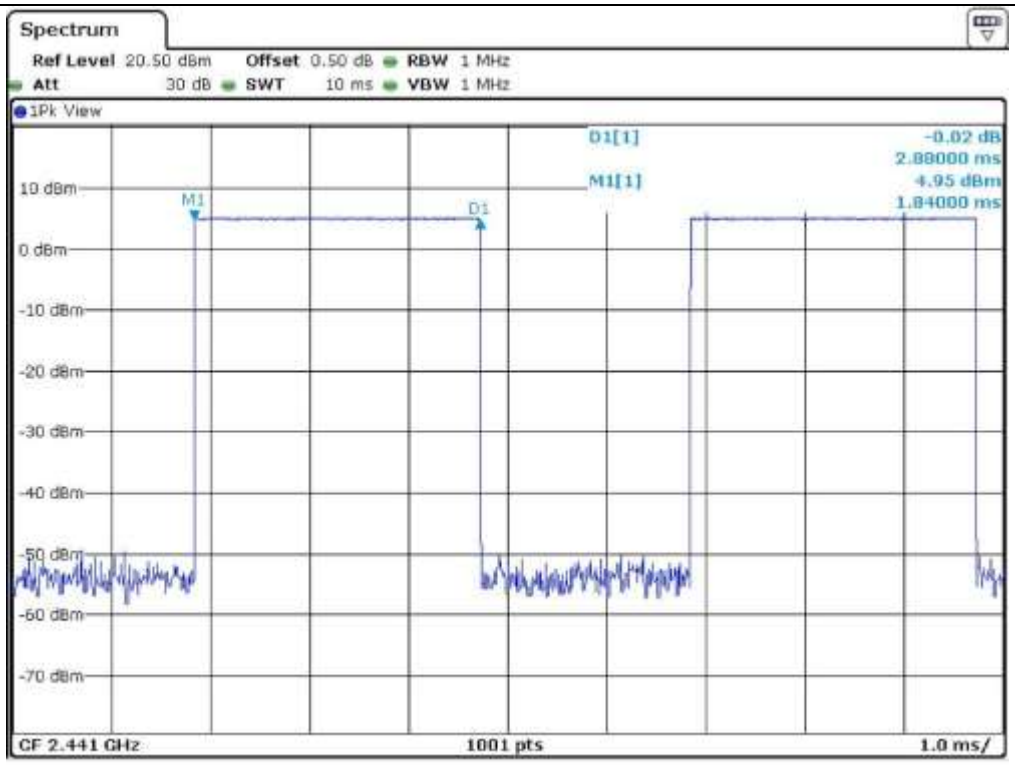


DH1



DH3

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



DH5

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

10.5 Test data for 2 Mbps

-. Test Date : January 04, 2016

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	1.620	5.06	31.6	259.03	400	
DH5	2.880	3.38	31.6	307.61	400	

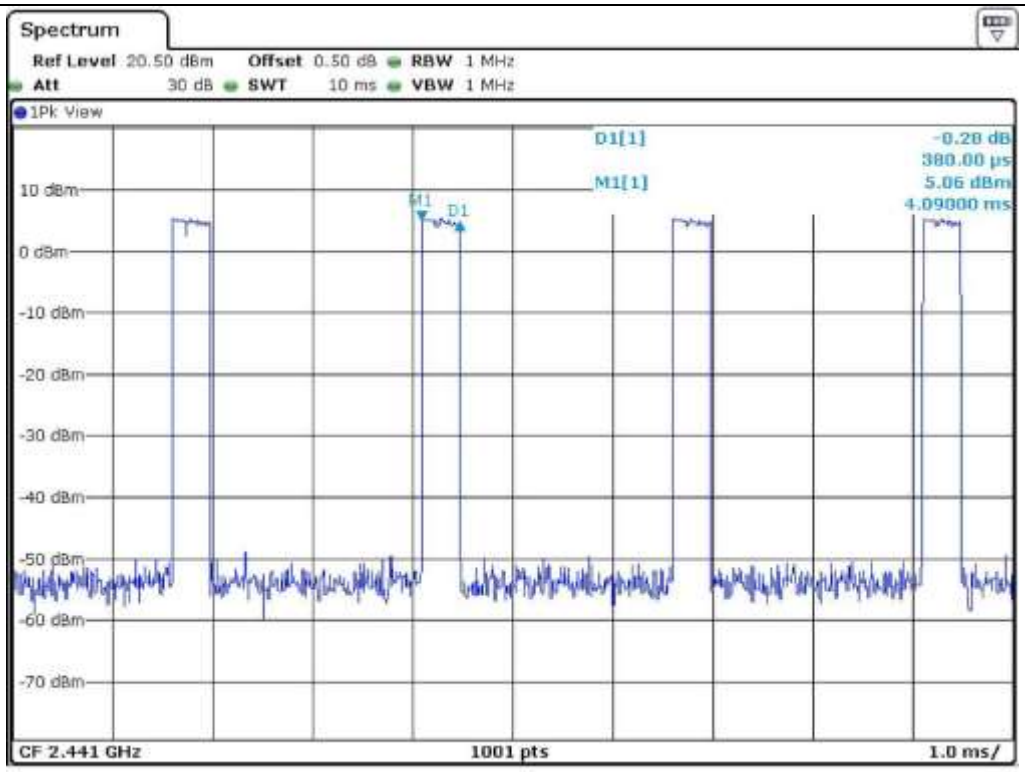
Total dwell time is calculated as following.

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

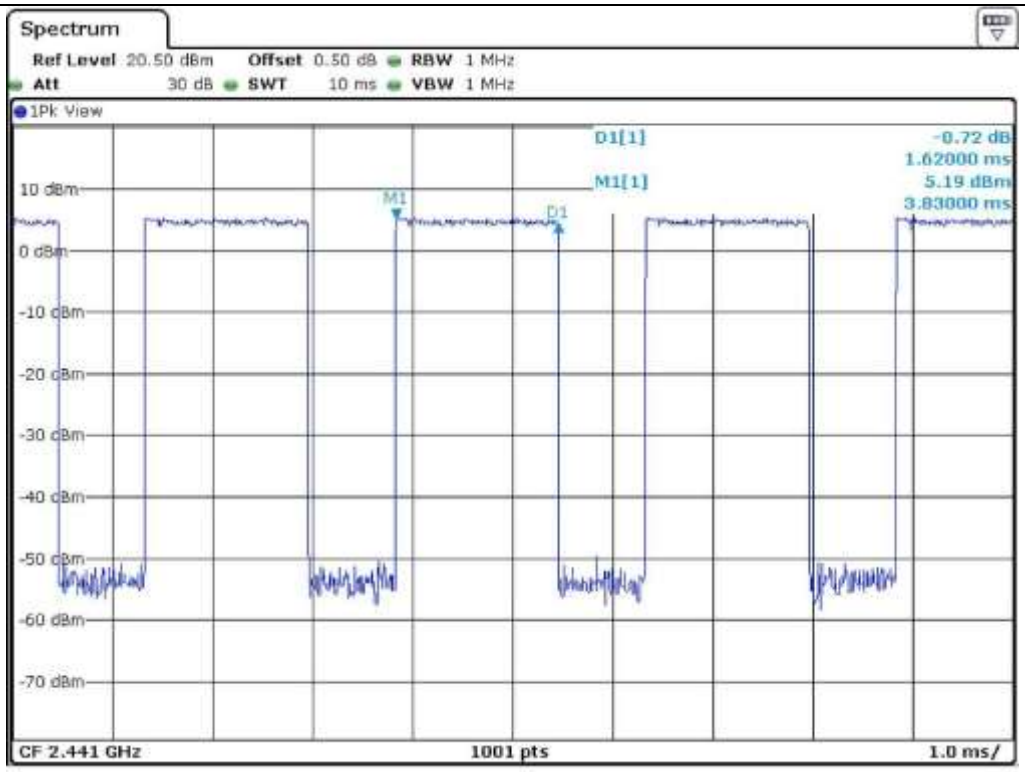
Remark: See next page for an overview sweep performed with peak detector.

Tested by: Tae-Ho, Kim / Senior Engineer

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

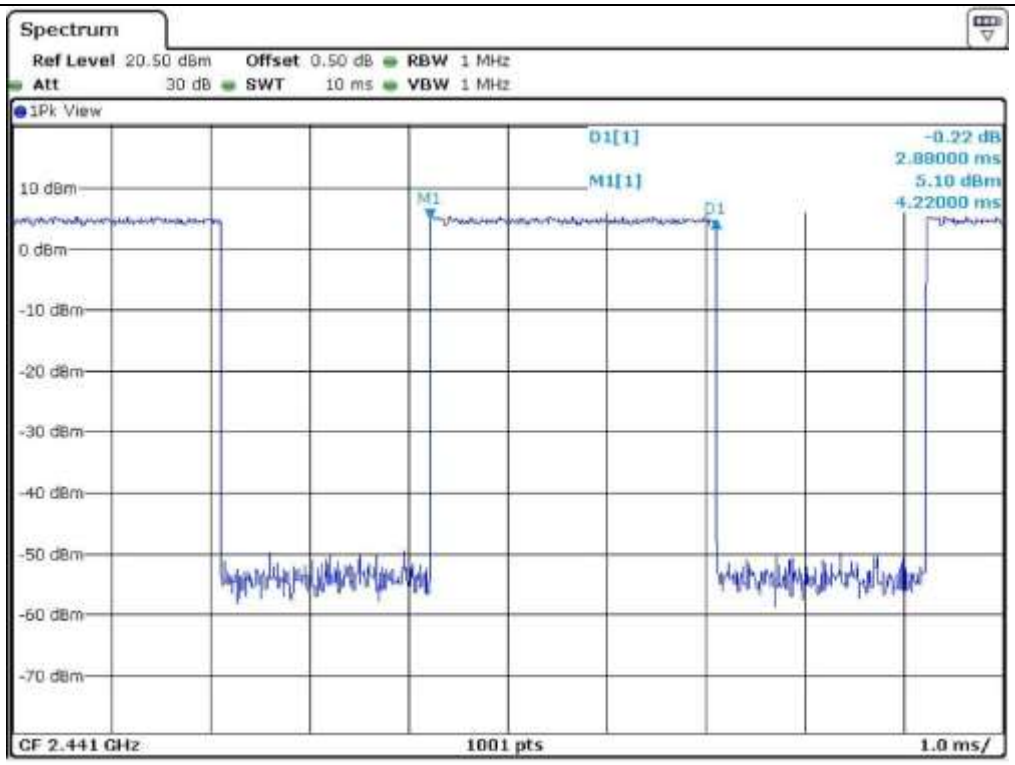


DH1



DH3

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



DH5

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

10.6 Test data for 3 Mbps

-. Test Date : January 04, 2016

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	0.370	10.13	31.6	118.44	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 / Senior Engineer

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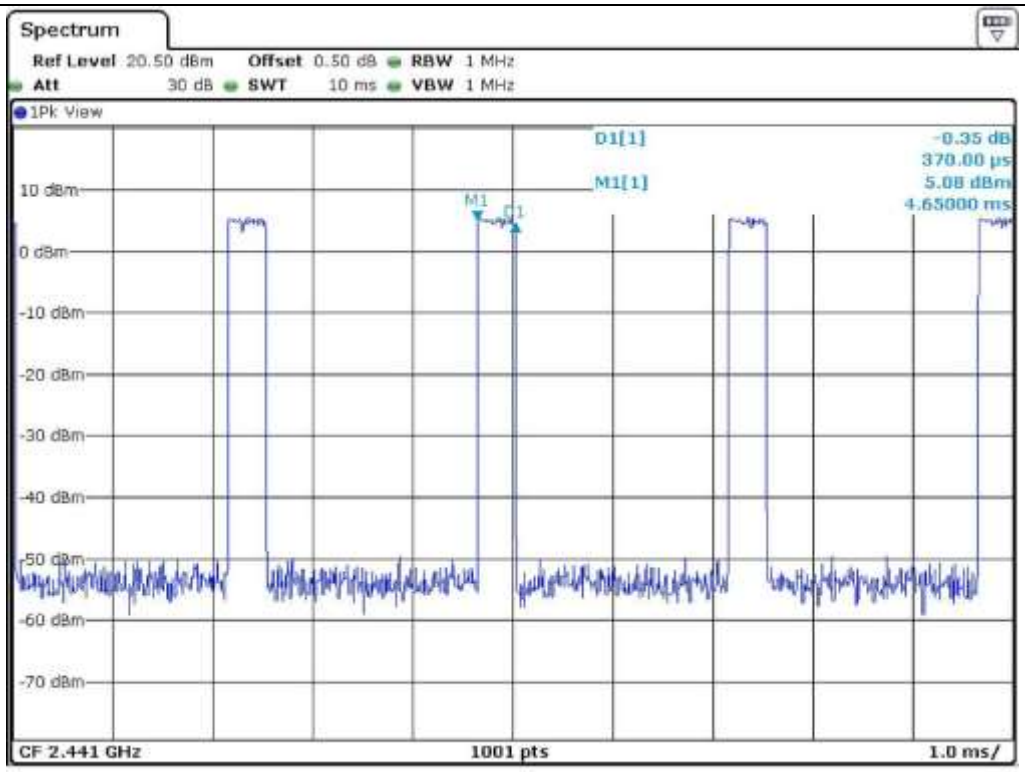
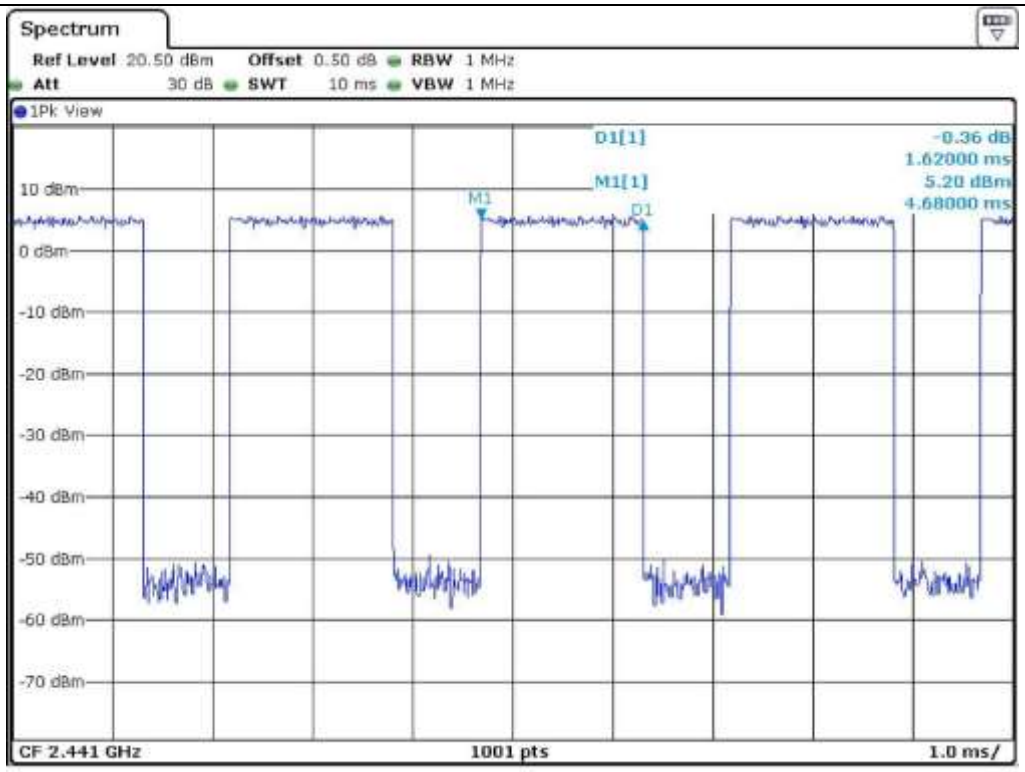


DH1



DH3

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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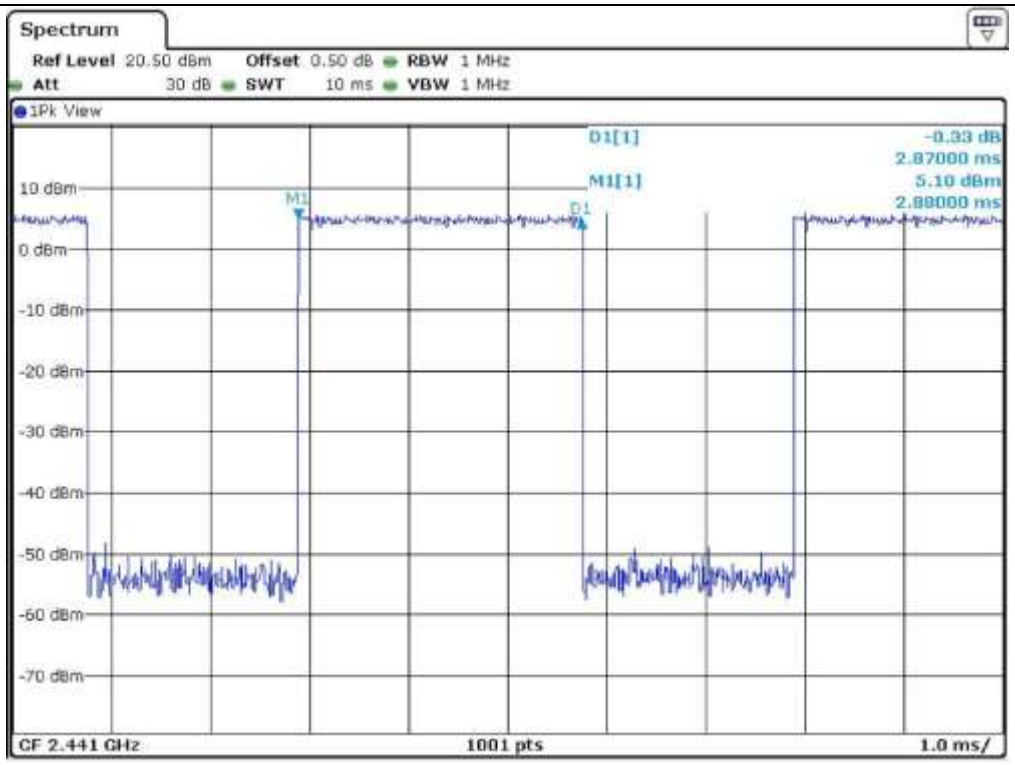

DH5

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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11. MAXIMUM PEAK OUTPUT POWER

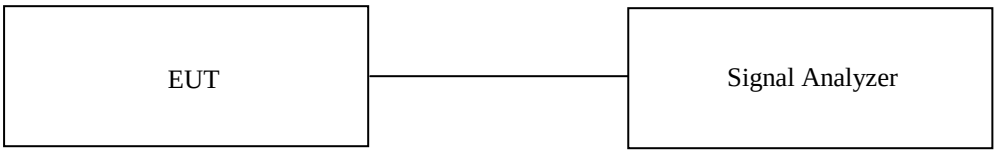
11.1 Operating environment

Temperature : 21.4 ℃

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.

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11.4 Test data for 1 Mbps

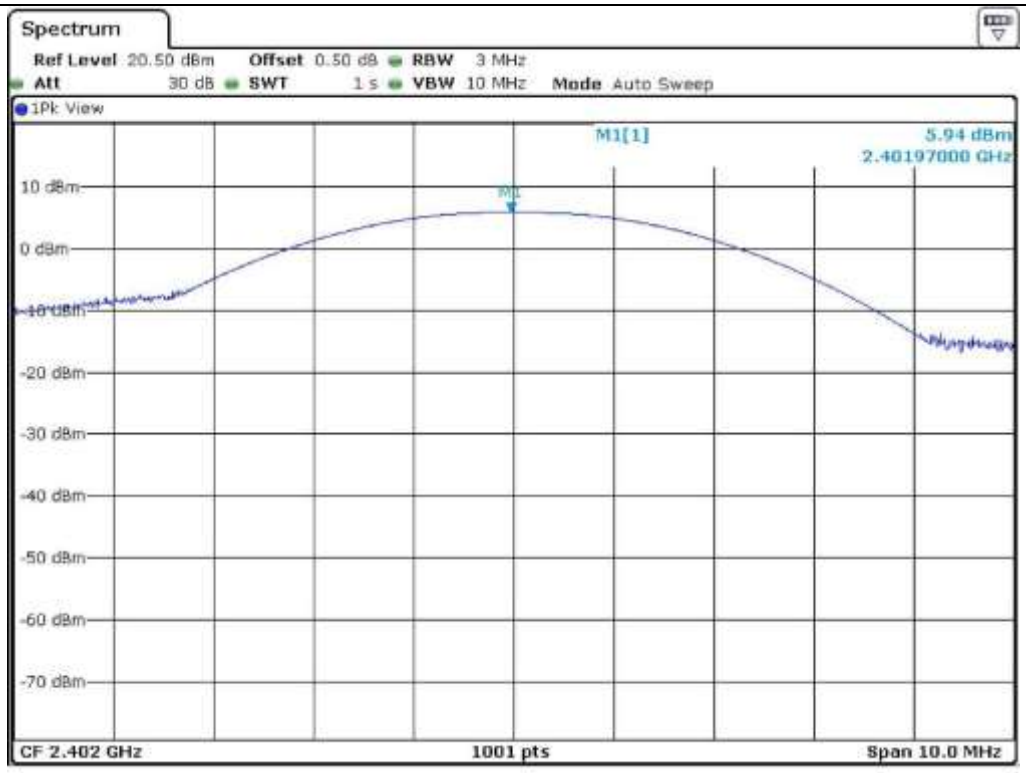
-. Test Date : January 04, 2016

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	5.94	21.00	15.06
MIDDLE	2 441	5.19	21.00	15.81
HIGH	2 480	5.09	21.00	15.91

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

Tested by: Tae-Ho, Kim / Senior Engineer



Low Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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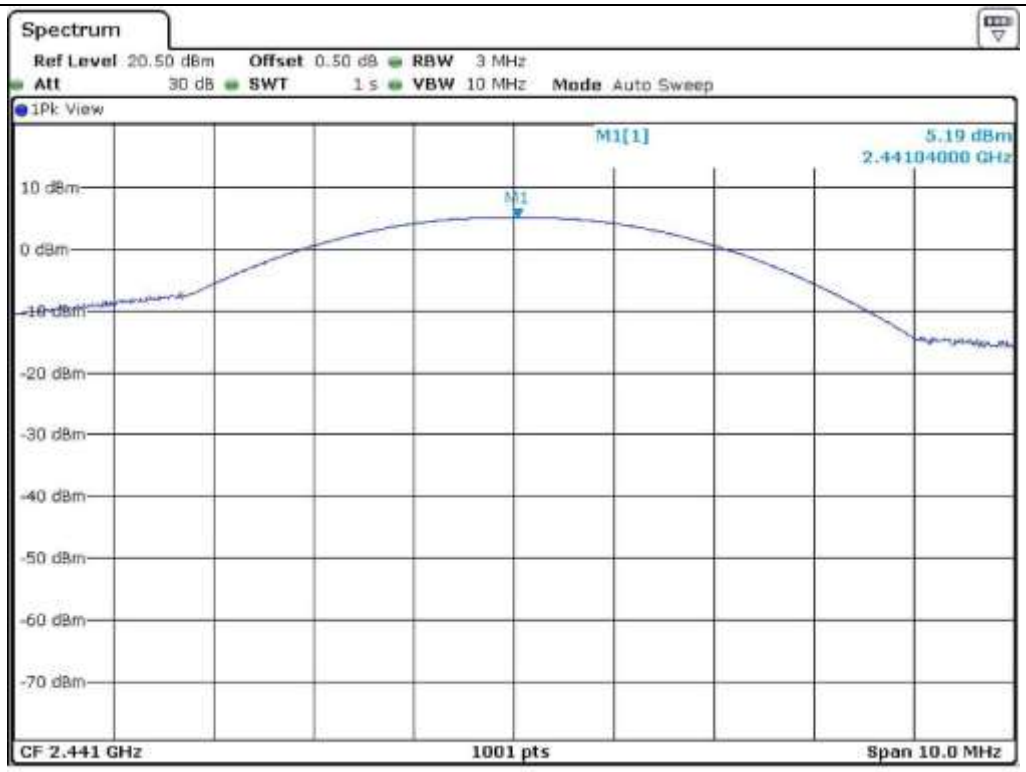
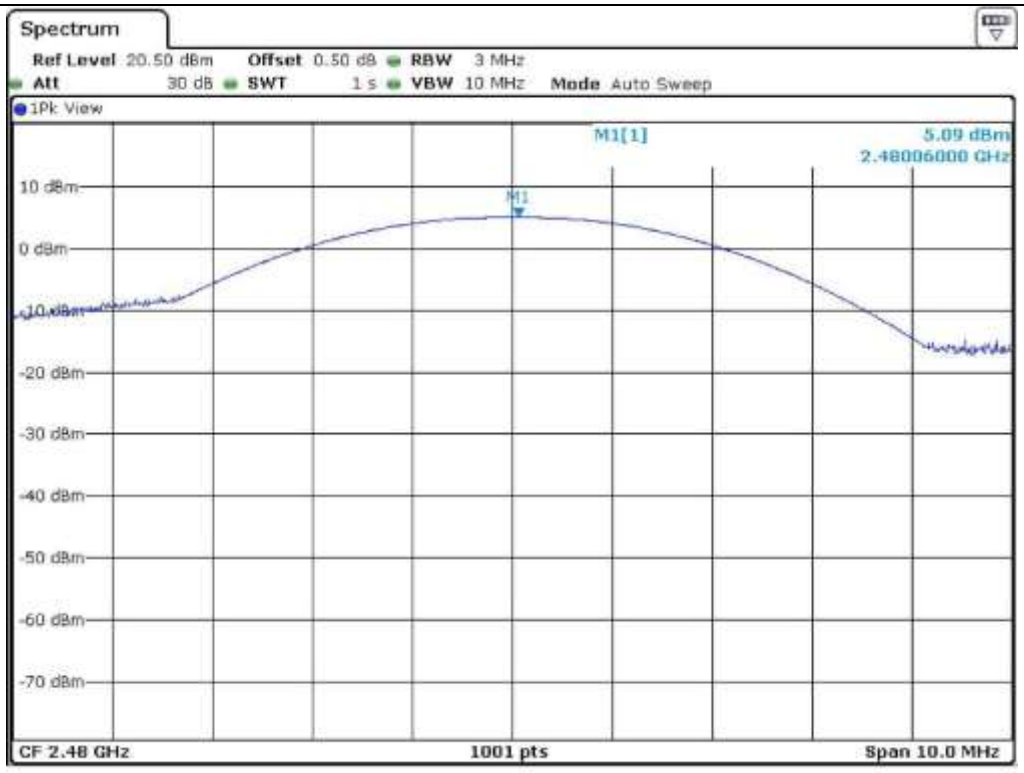


Middle Channel



High Channel

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

11.5 Test data for 2 Mbps

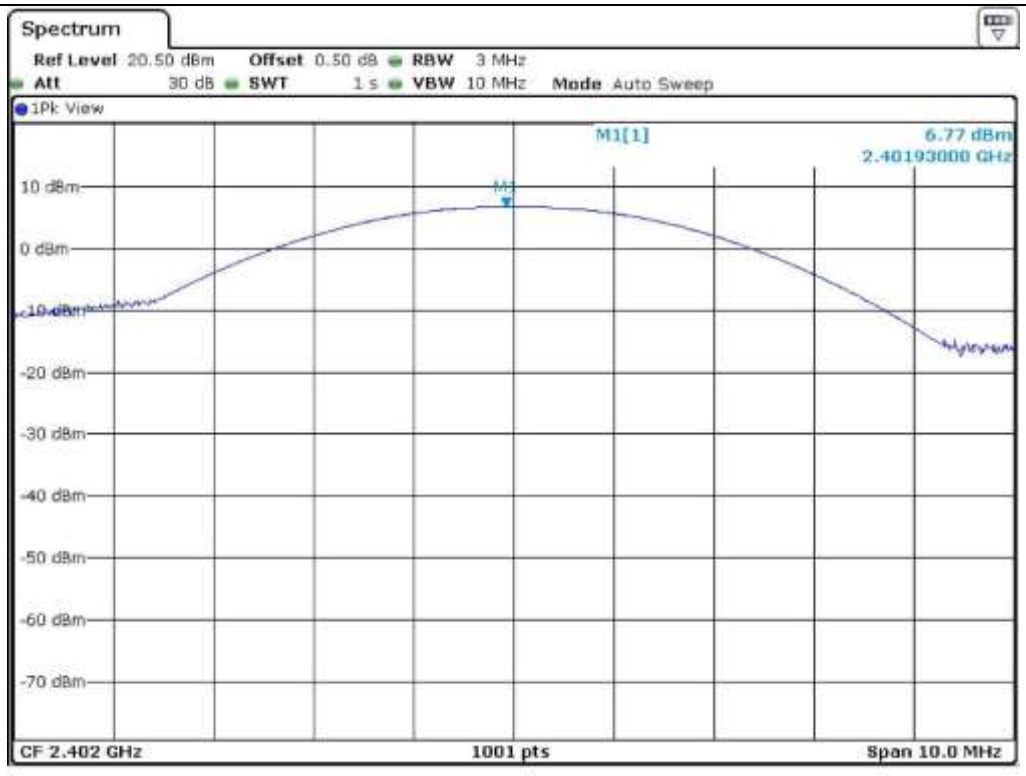
-. Test Date : January 04, 2016

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	6.77	21.00	14.23
MIDDLE	2 441	6.07	21.00	14.93
HIGH	2 480	6.01	21.00	14.99

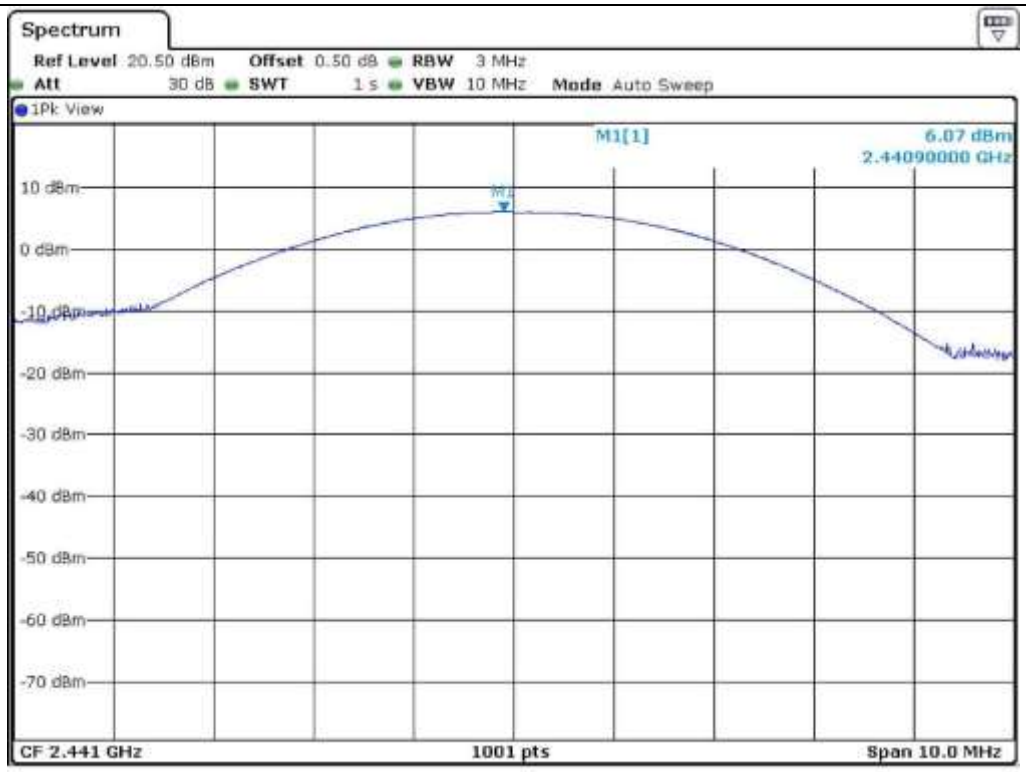
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Tested by: Tae-Ho, Kim / Senior Engineer

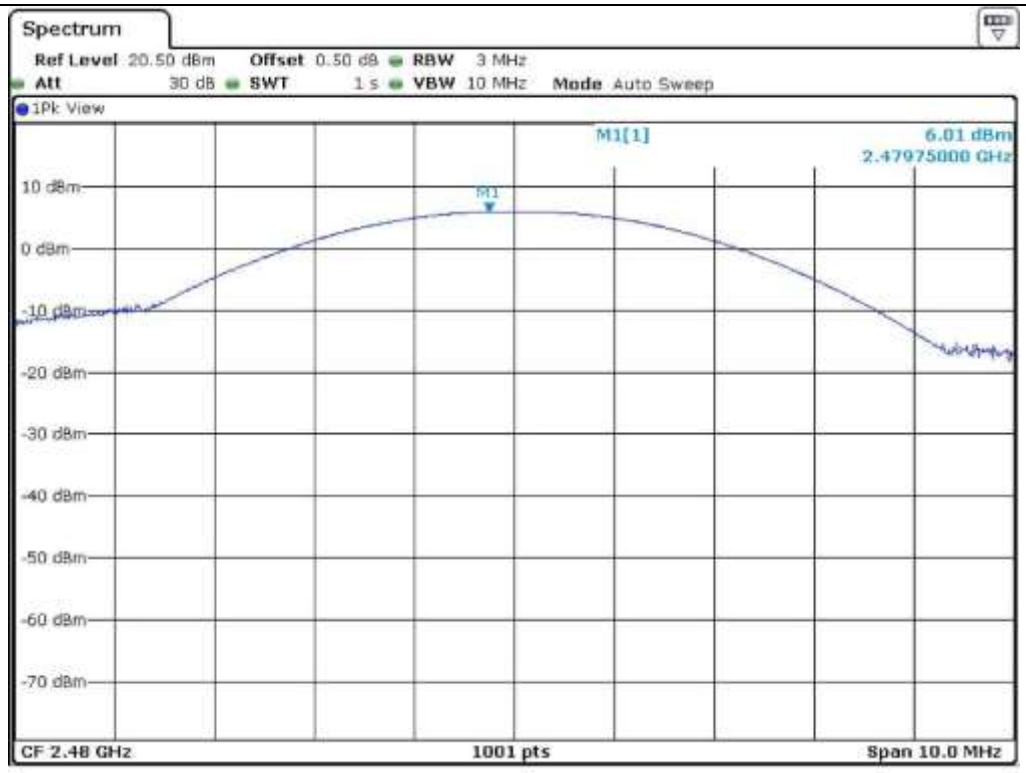


Low Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



Middle Channel



High Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

11.6 Test data for 3 Mbps

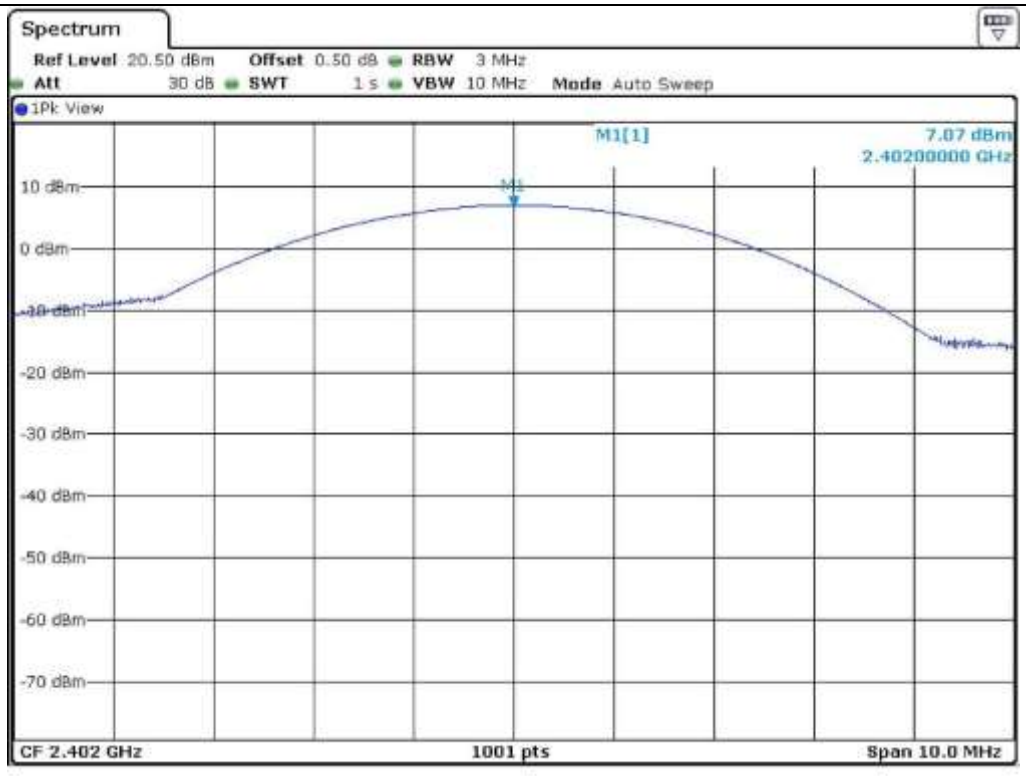
-. Test Date : January 04, 2016

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	7.07	21.00	13.93
MIDDLE	2 441	6.34	21.00	14.66
HIGH	2 480	6.23	21.00	14.77

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

Tested by: Tae-Ho, Kim / Senior Engineer



Low Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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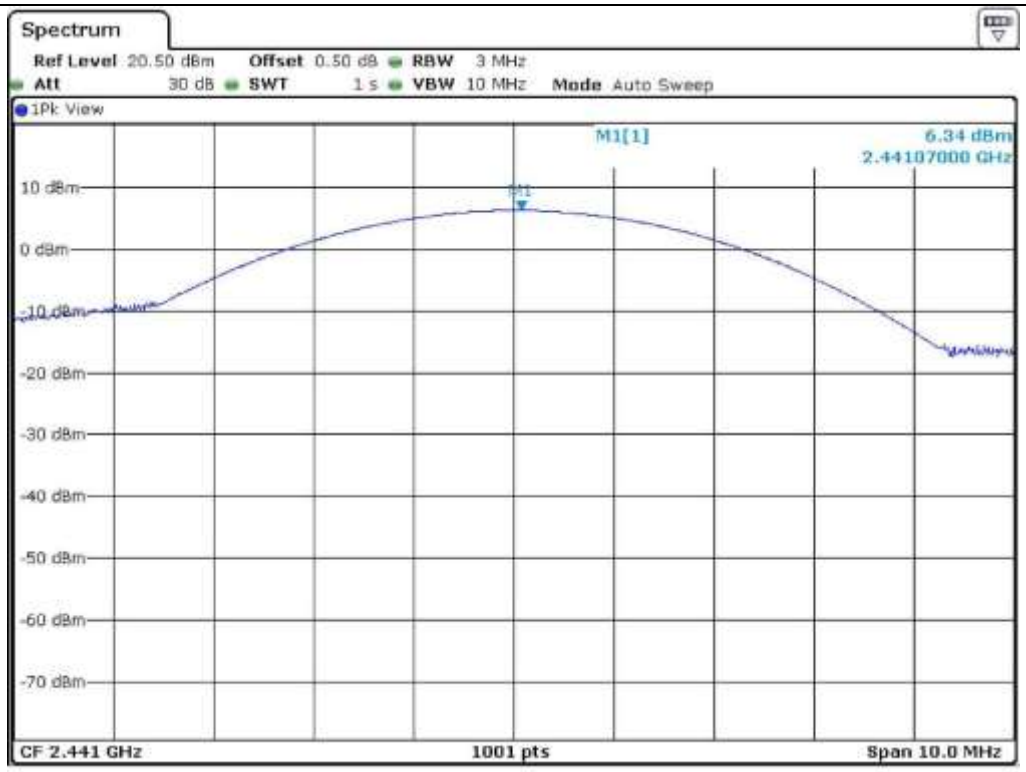
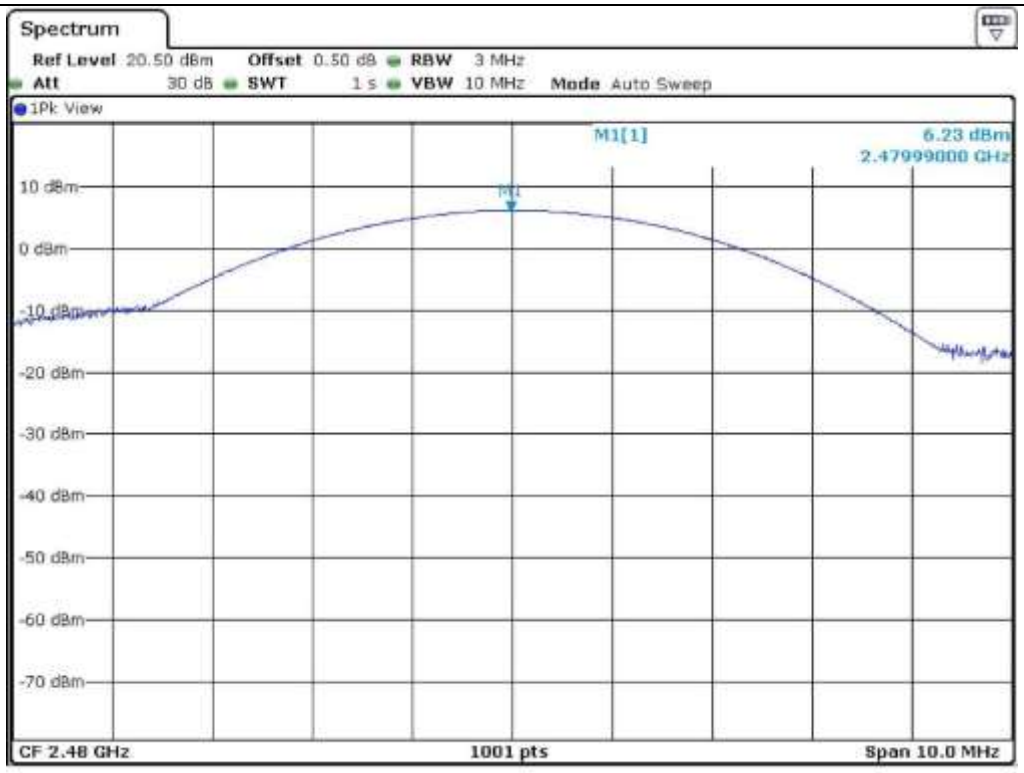


Middle Channel



High Channel

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12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

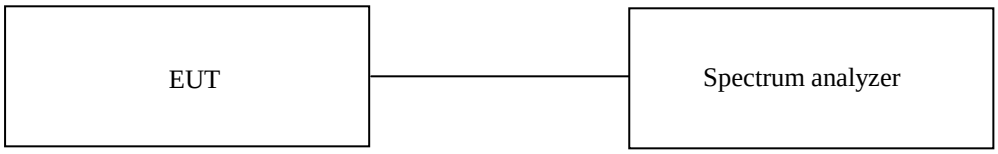
12.1 Operating environment

Temperature : 21.4 ℃

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

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

12.4 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 22, 2015 (1Y)
■ -	ESU	Rohde & Schwarz	EMI Test Receiver	100261	Apr. 29, 2015 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Apr. 29, 2015 (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	Jul. 10, 2014 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 31, 2015 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Apr. 30, 2015 (2Y)

All test equipment used is calibrated on a regular basis.

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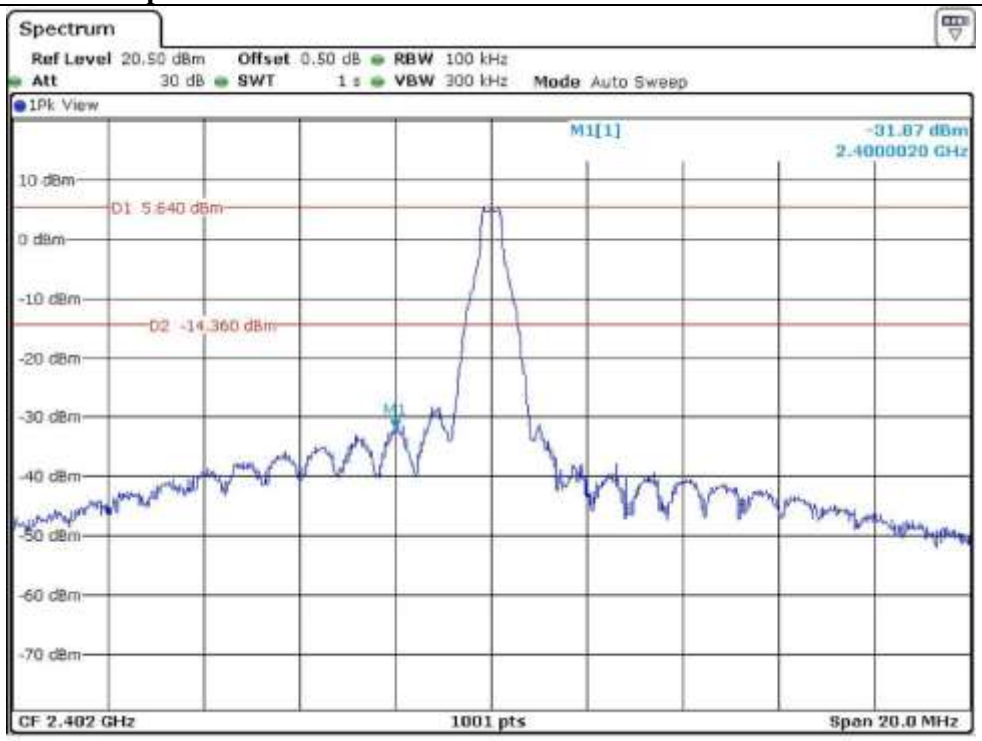
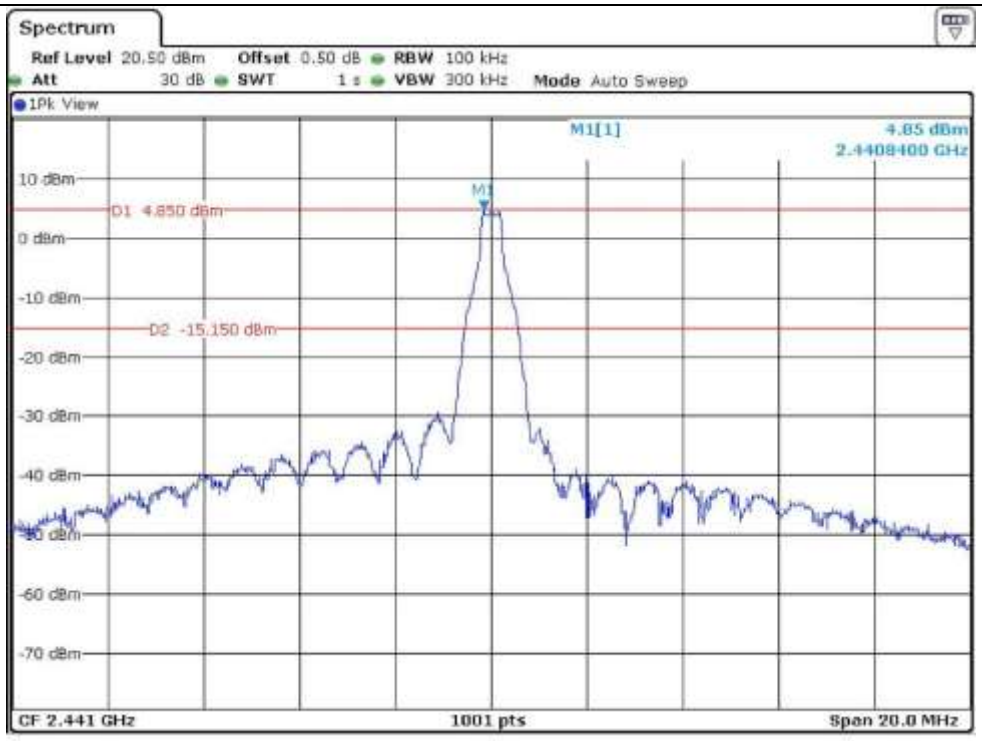
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

12.5 Test data for conducted emission

12.5.1 Test data for 1 Mbps



Low Channel



Middle Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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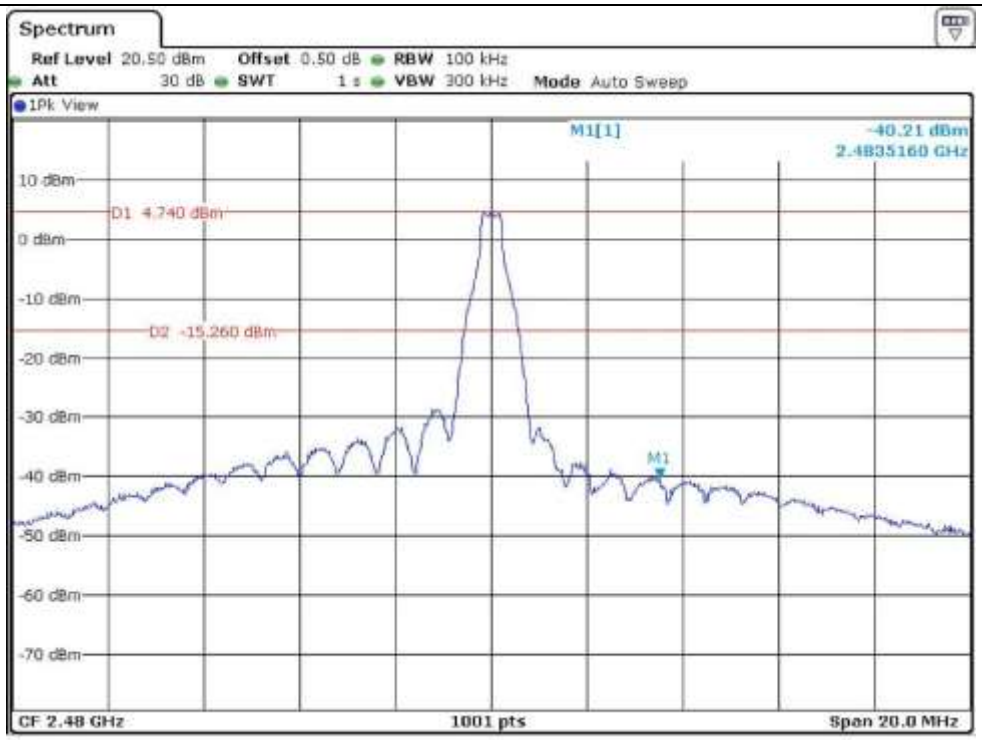

High Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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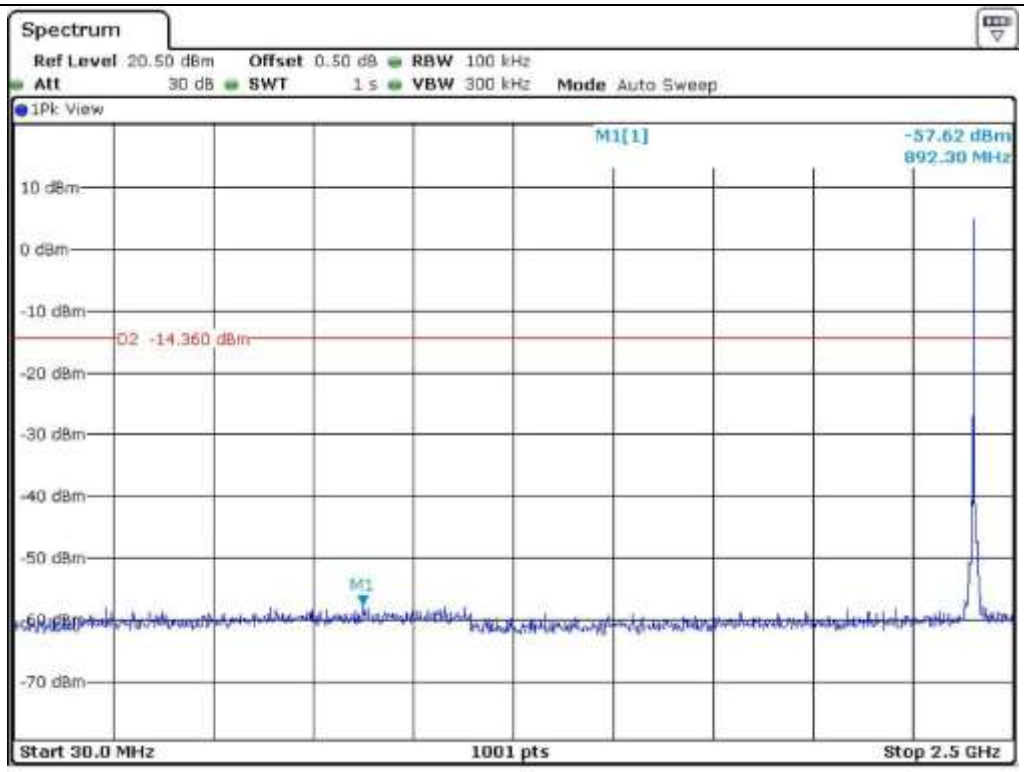
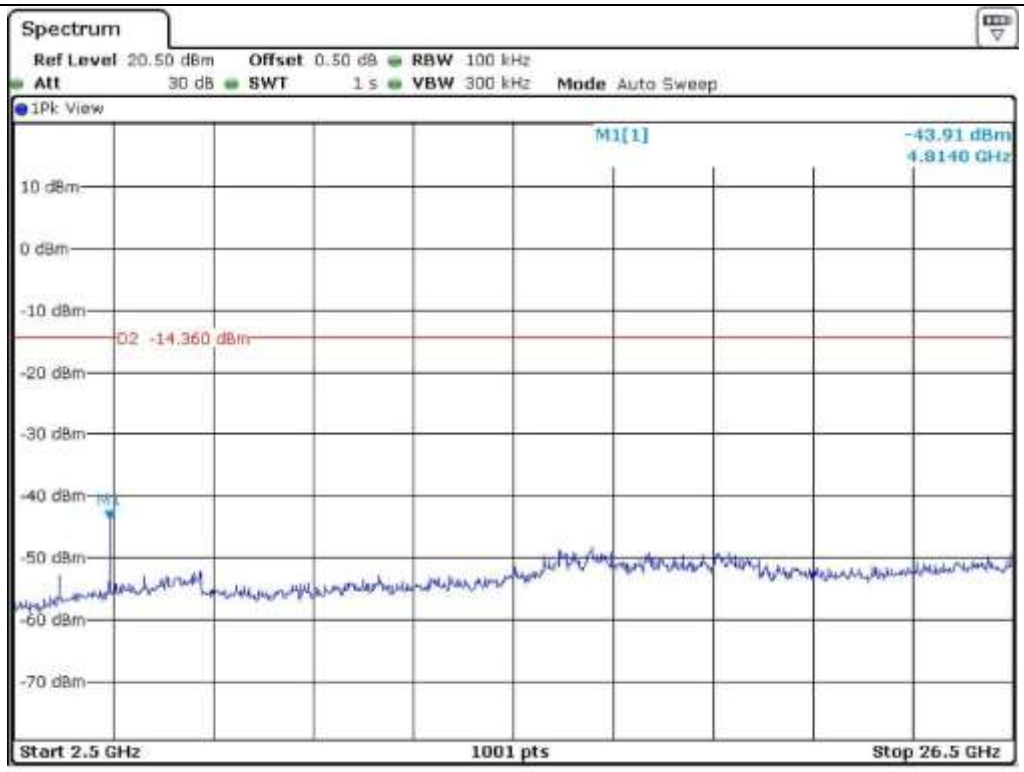


Low Channel



Low Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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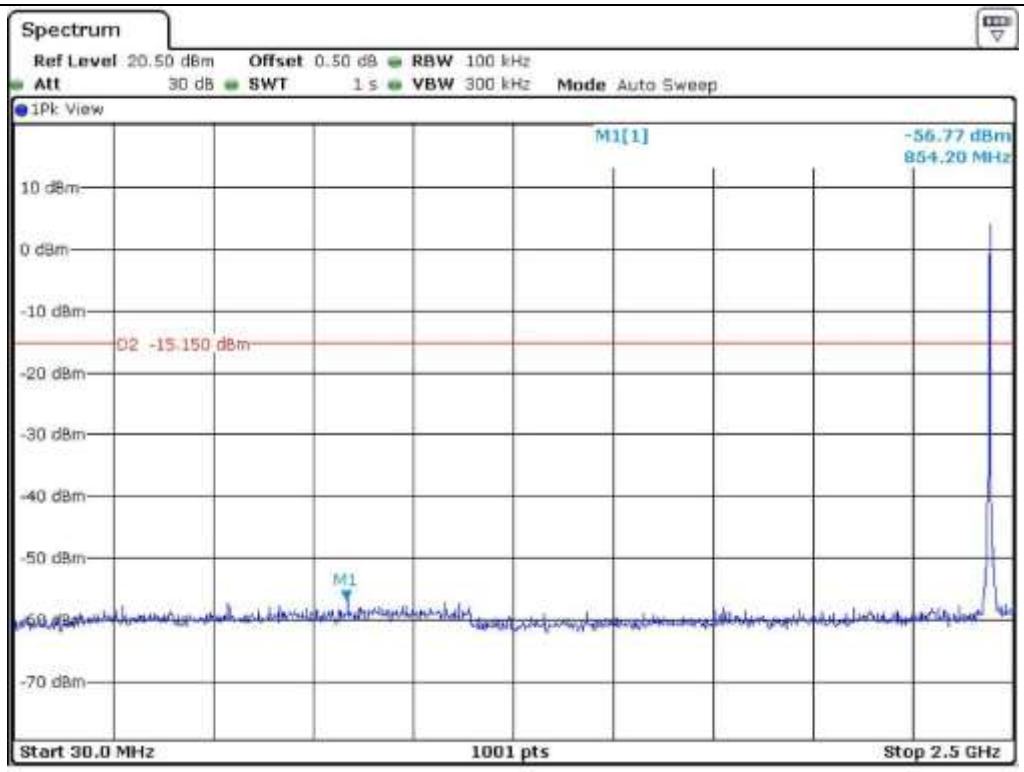
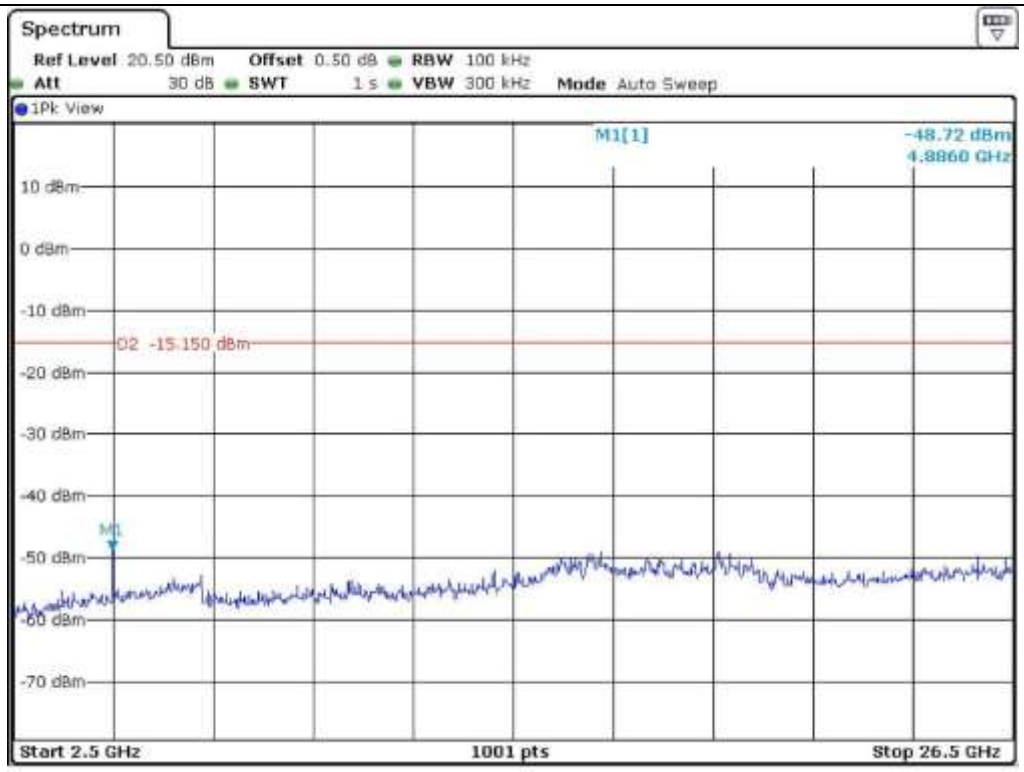


Middle Channel



Middle Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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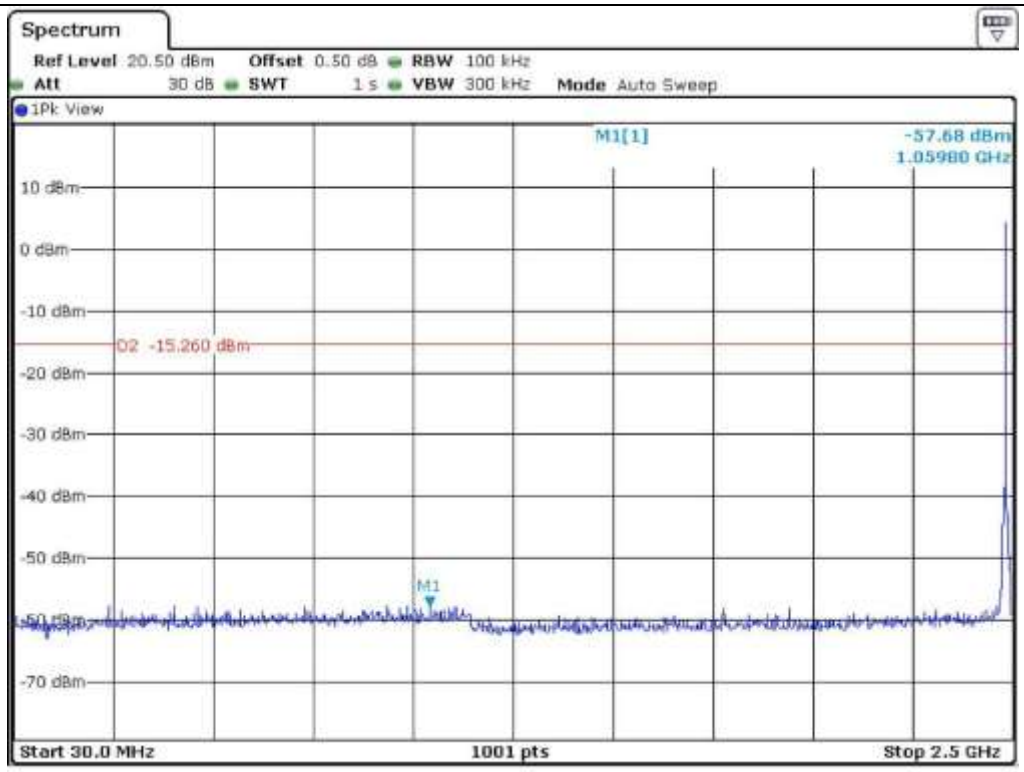
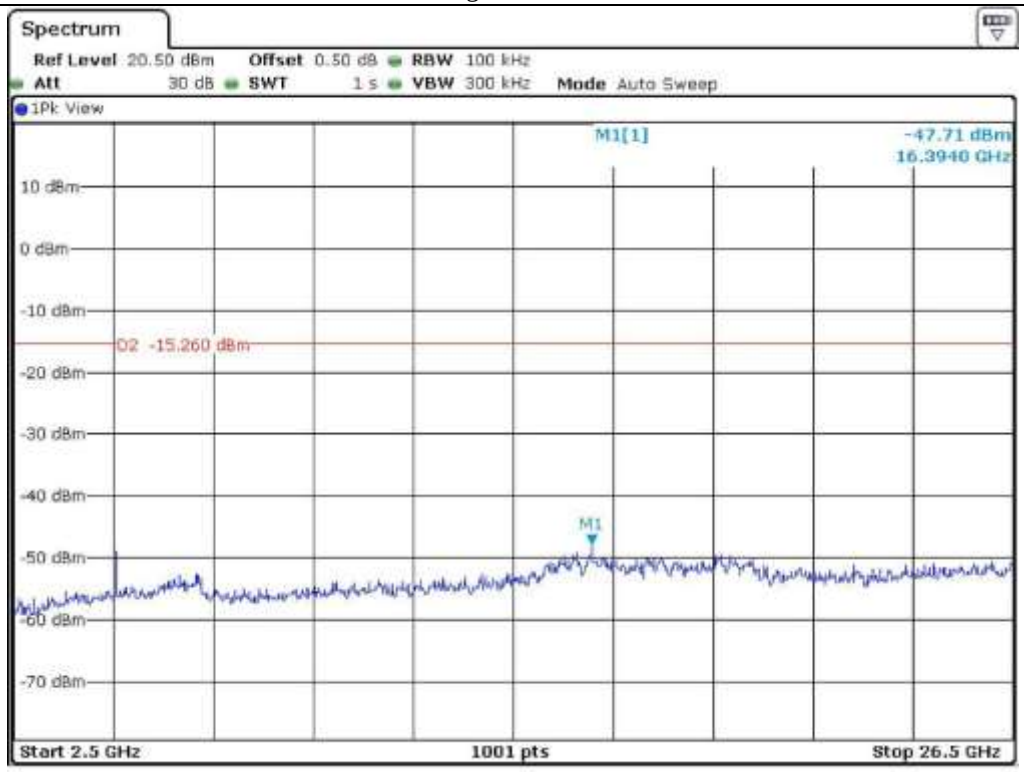


High Channel



High Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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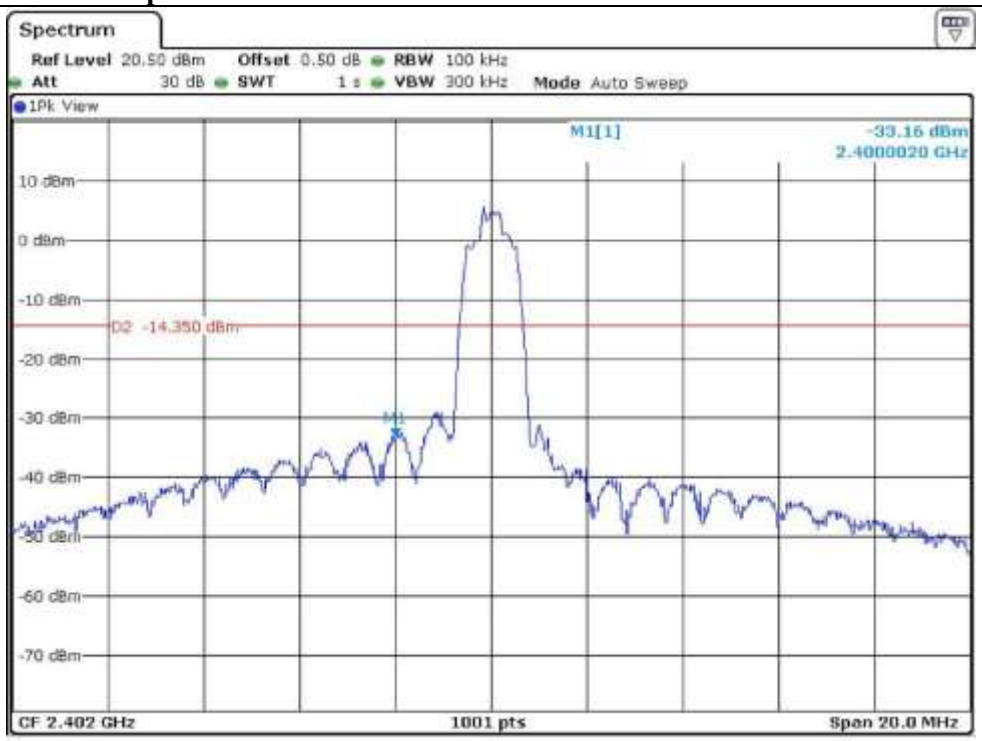
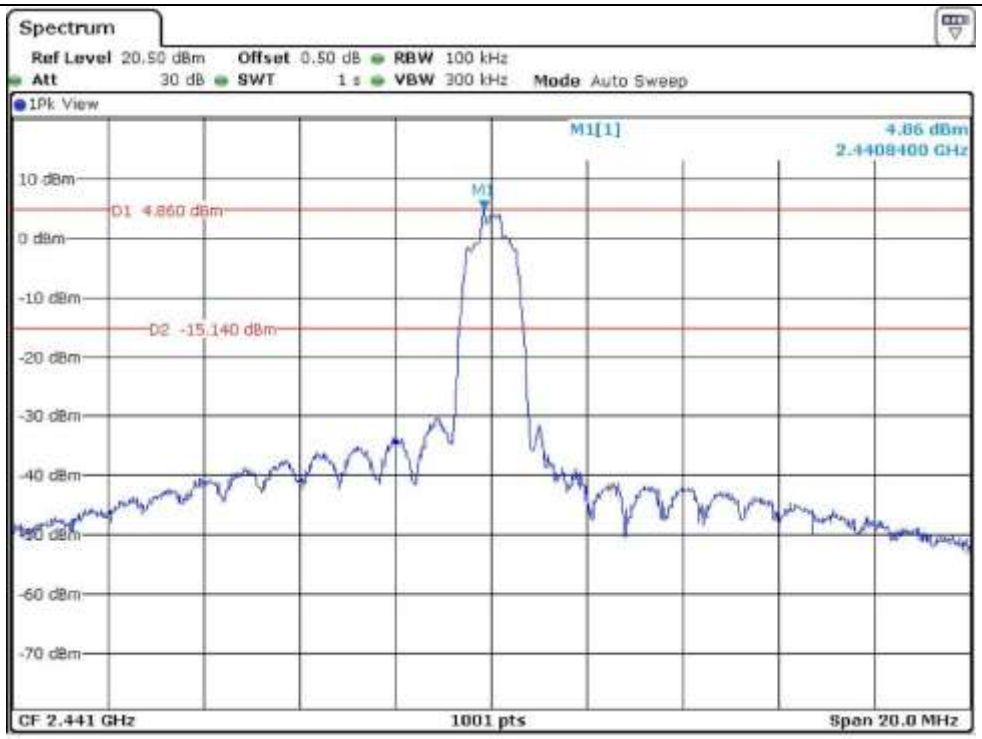
12.5.2 Test data for 2 Mbps



Low Channel



Middle Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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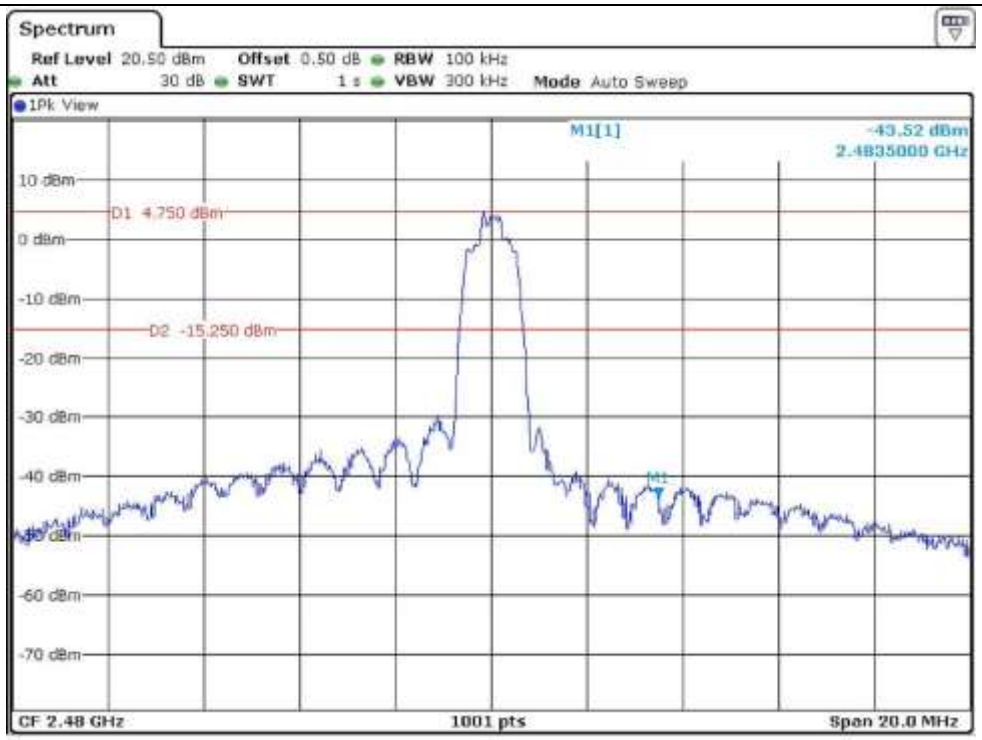
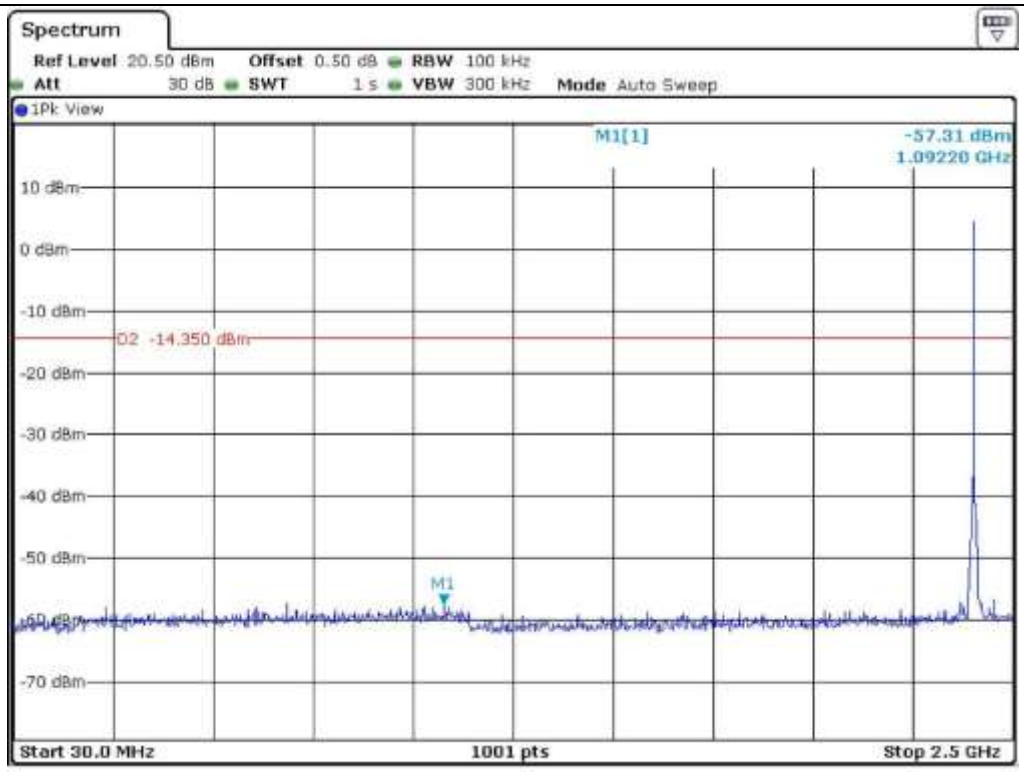
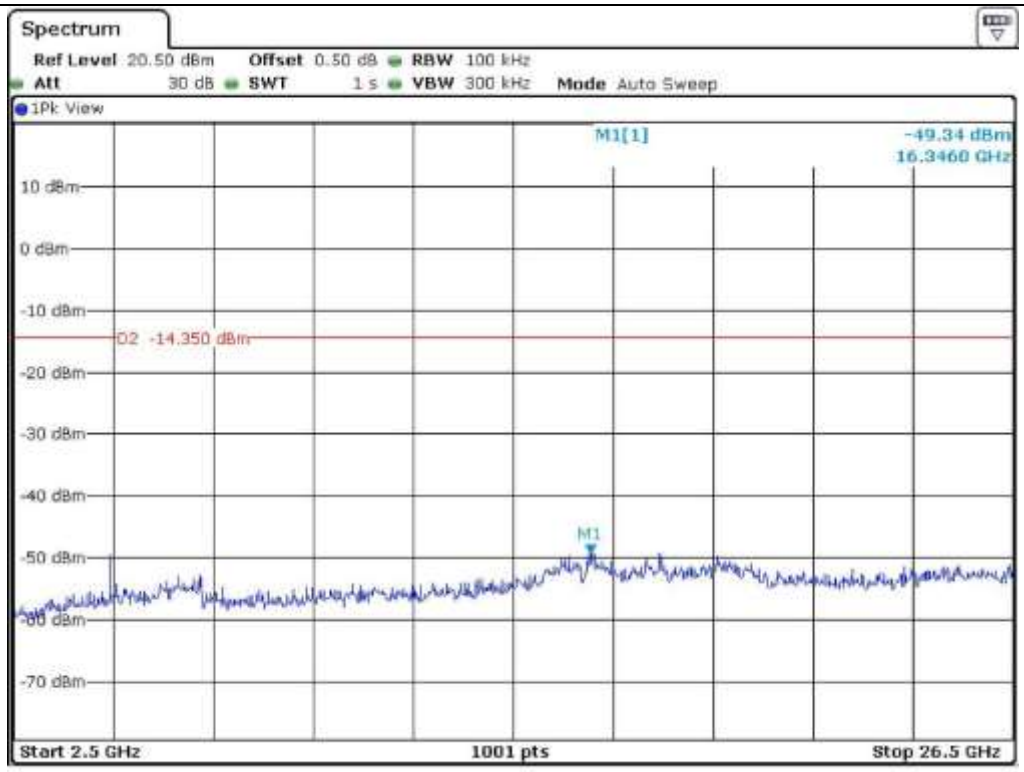


High Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)



Low Channel



Low Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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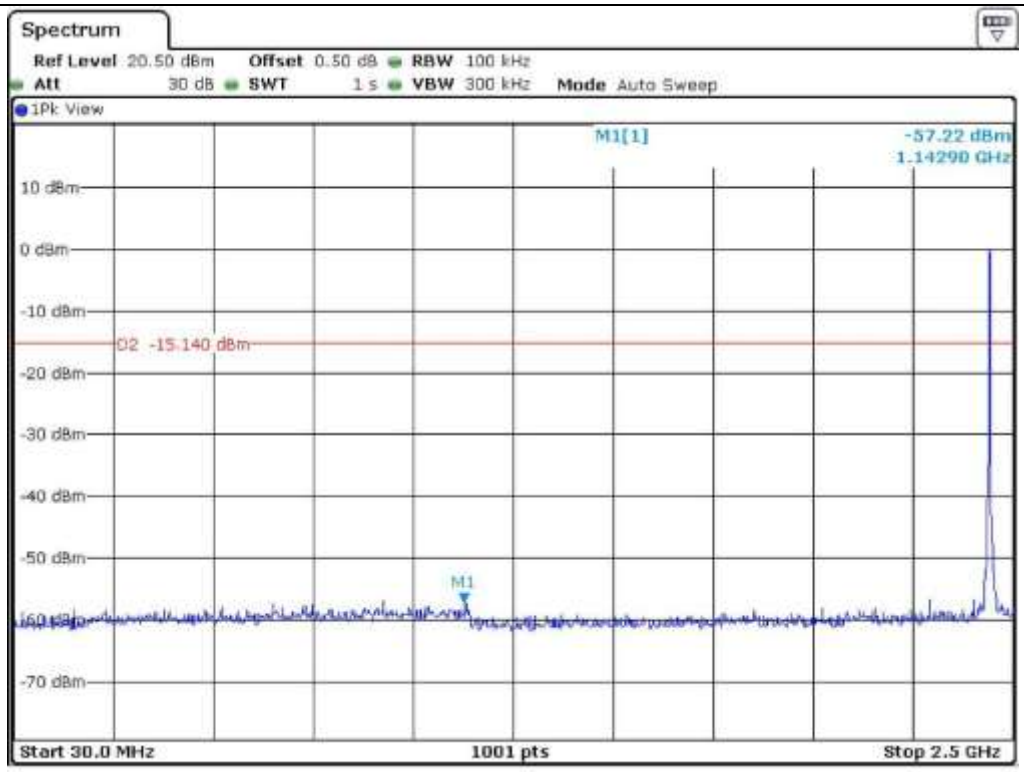
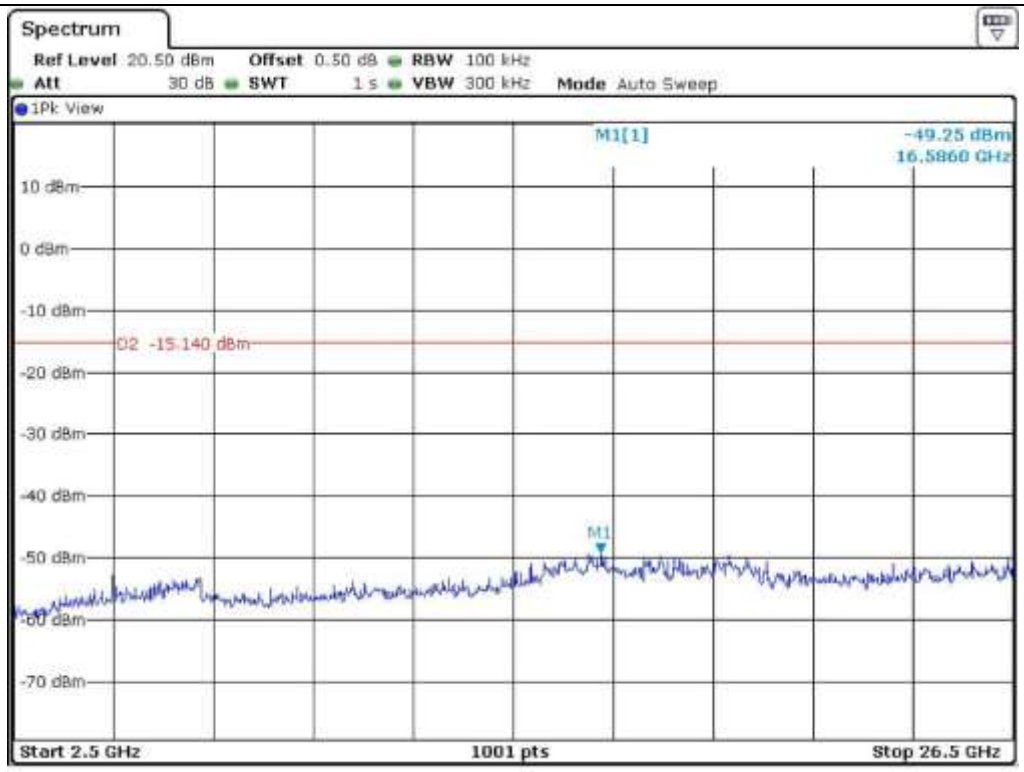


Middle Channel



Middle Channel

HEAD OFFICE : 301-14 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)
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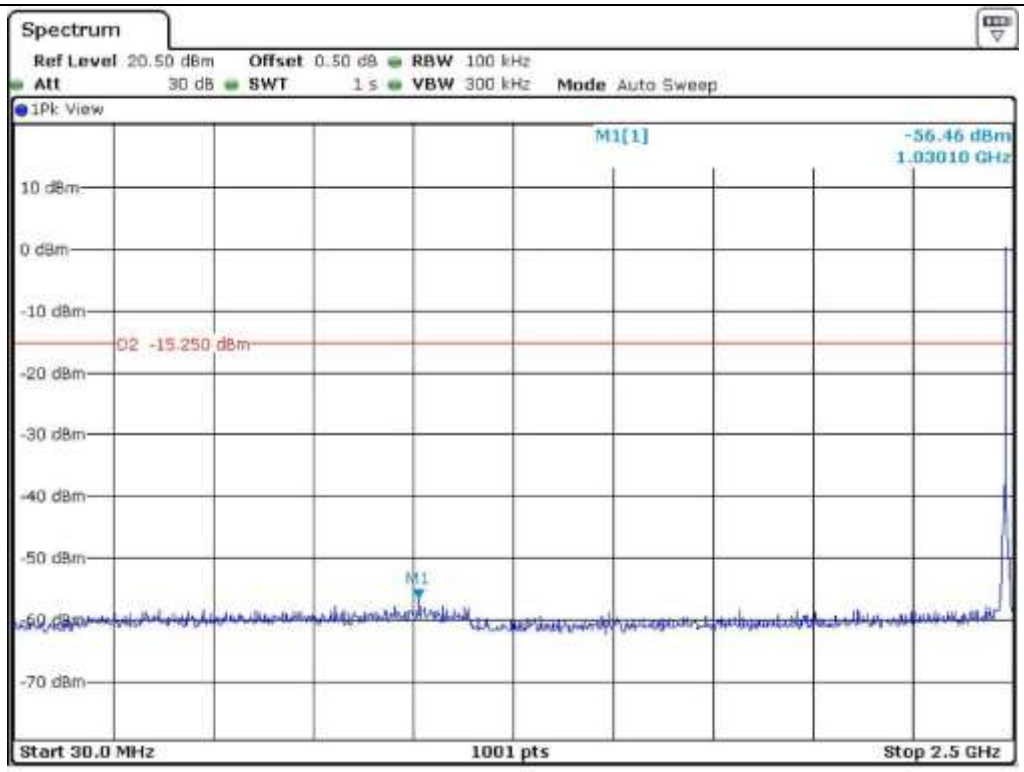
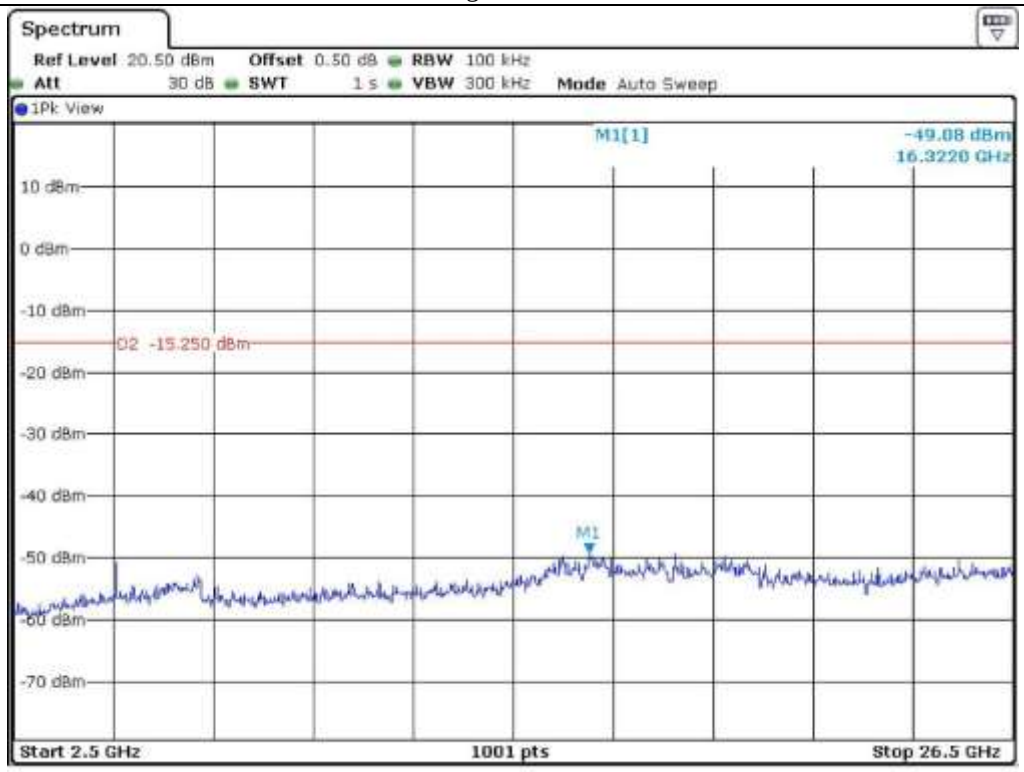


High Channel



High Channel

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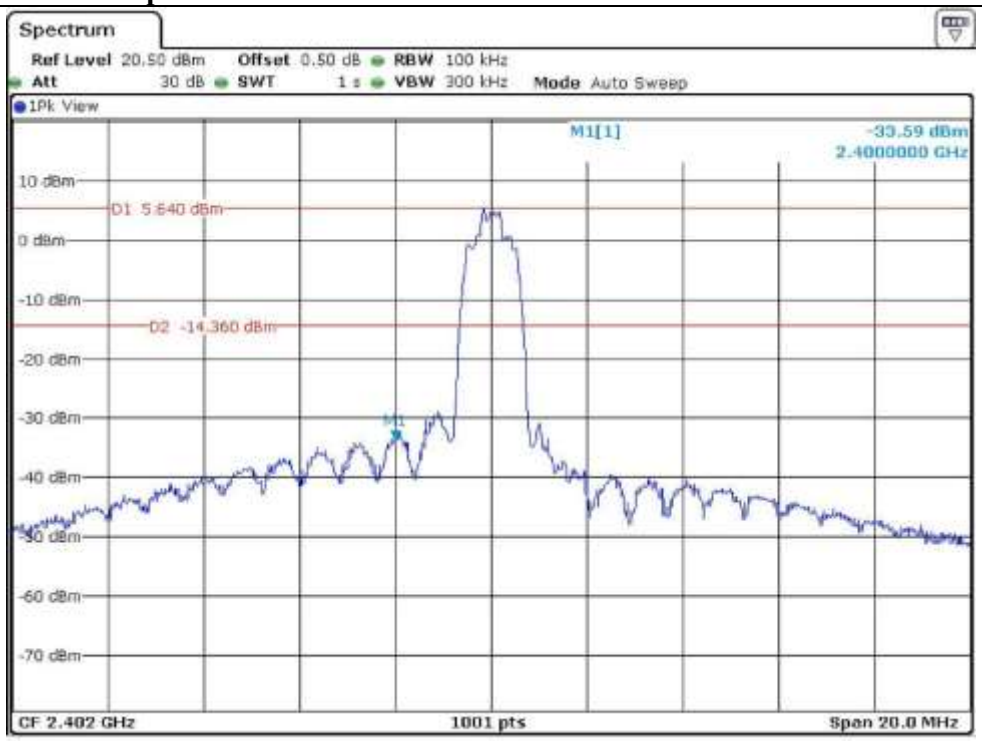
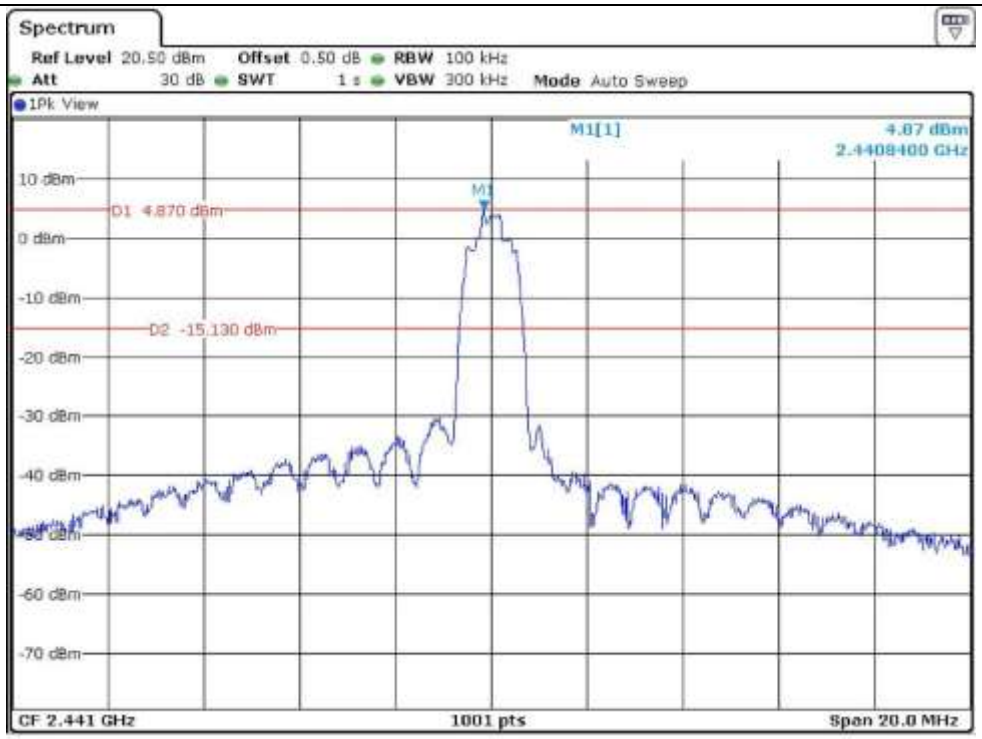
12.5.3 Test data for 3 Mbps



Low Channel



Middle Channel

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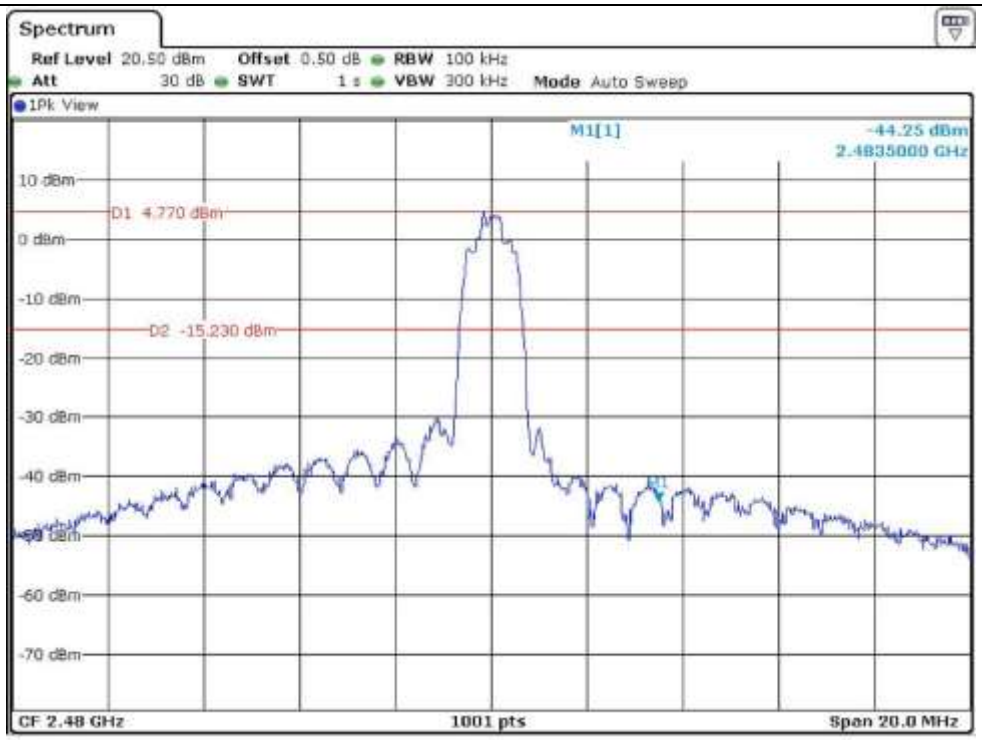

High Channel

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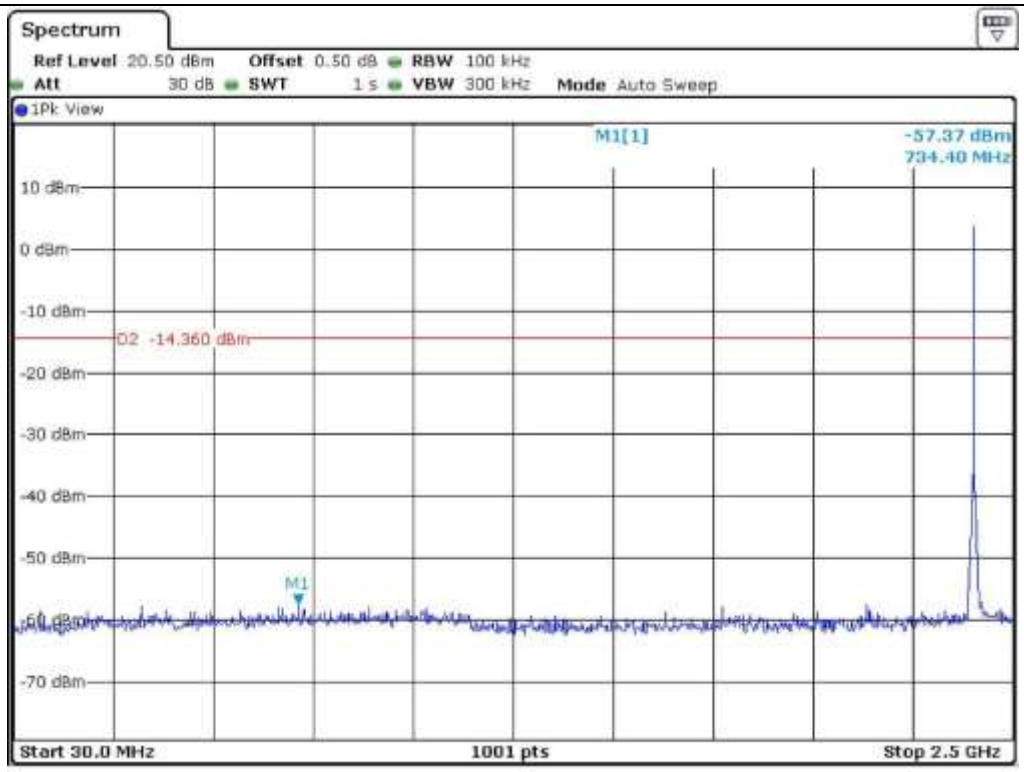
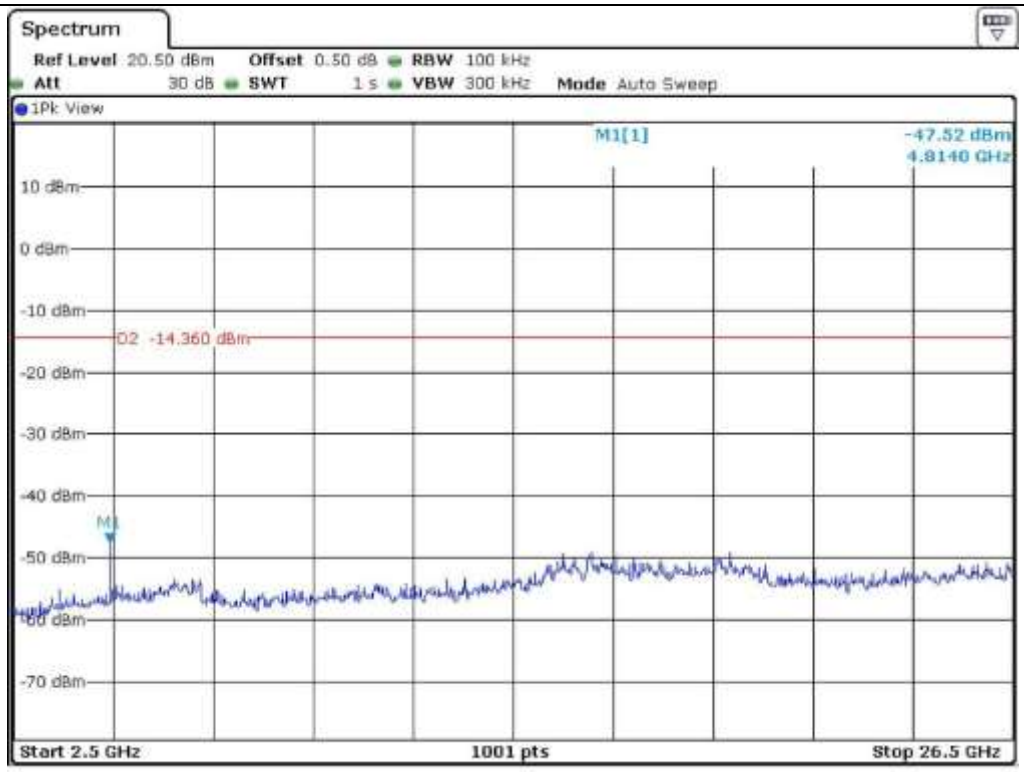


Low Channel



Low Channel

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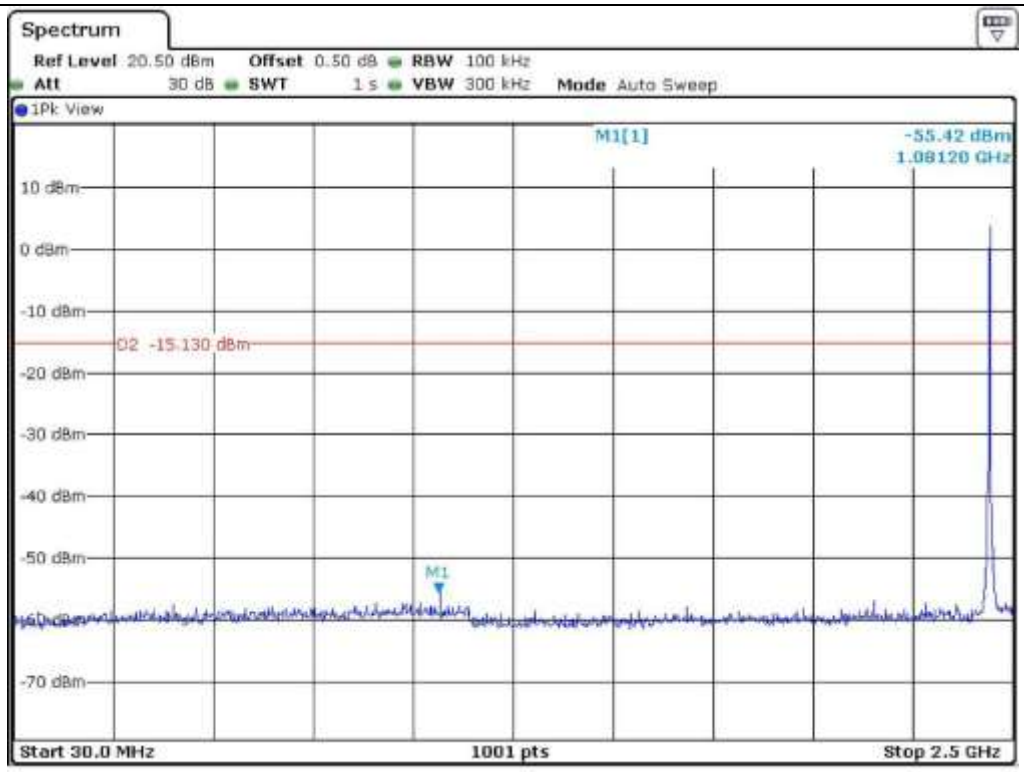
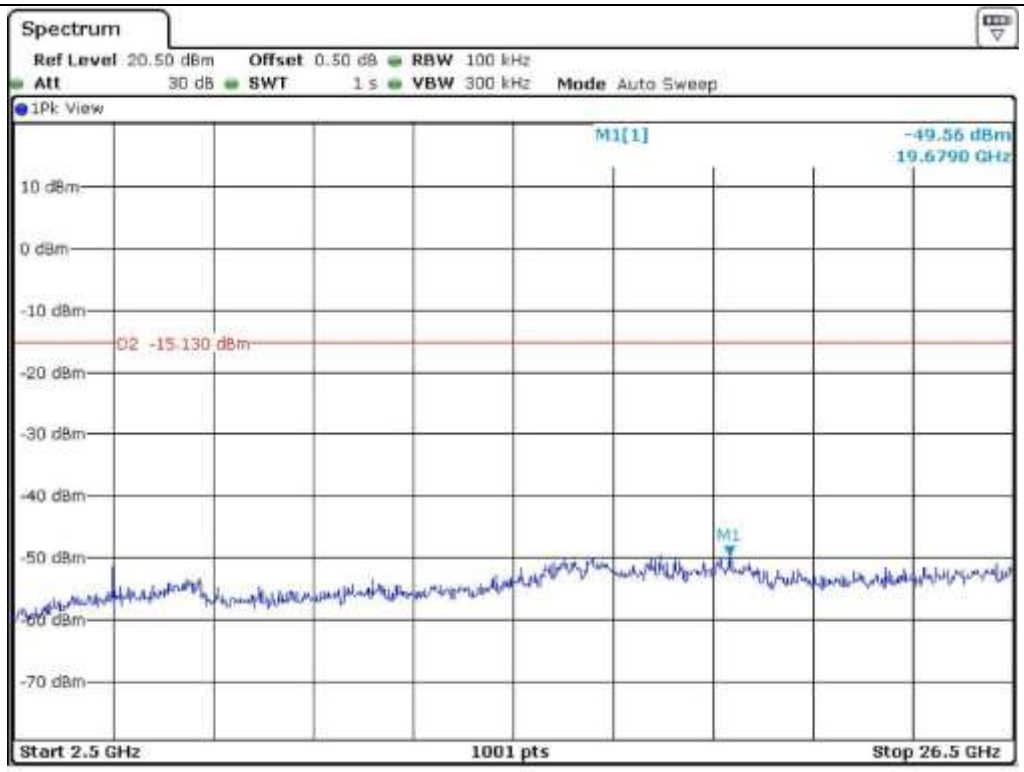


Middle Channel



Middle Channel

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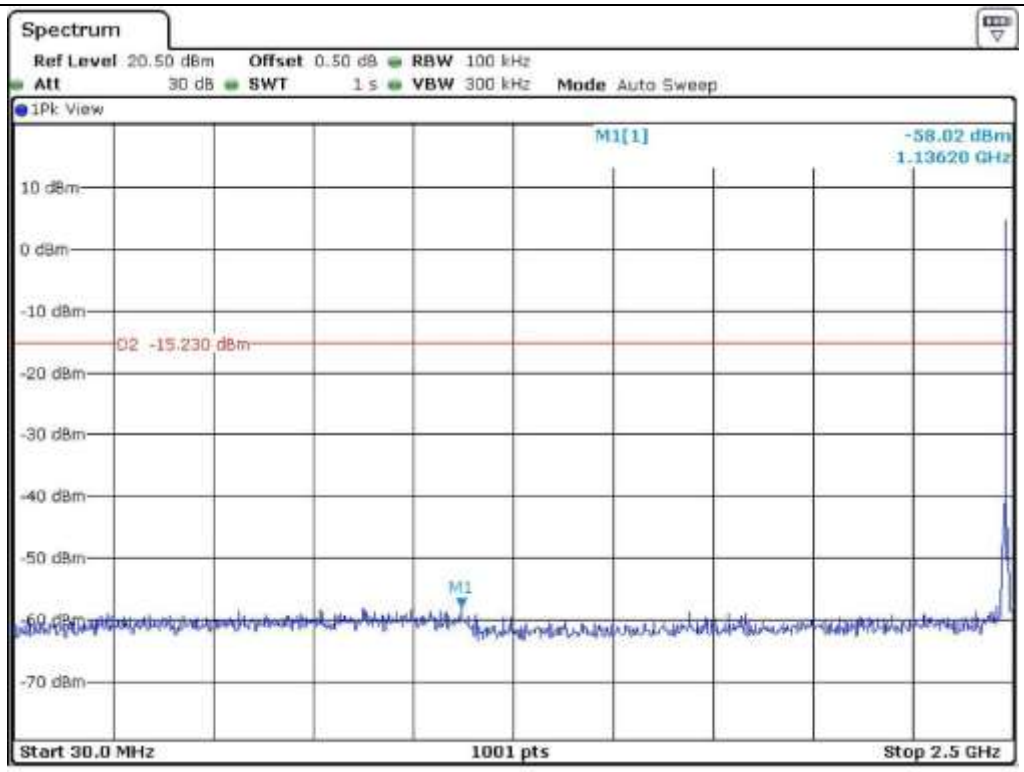
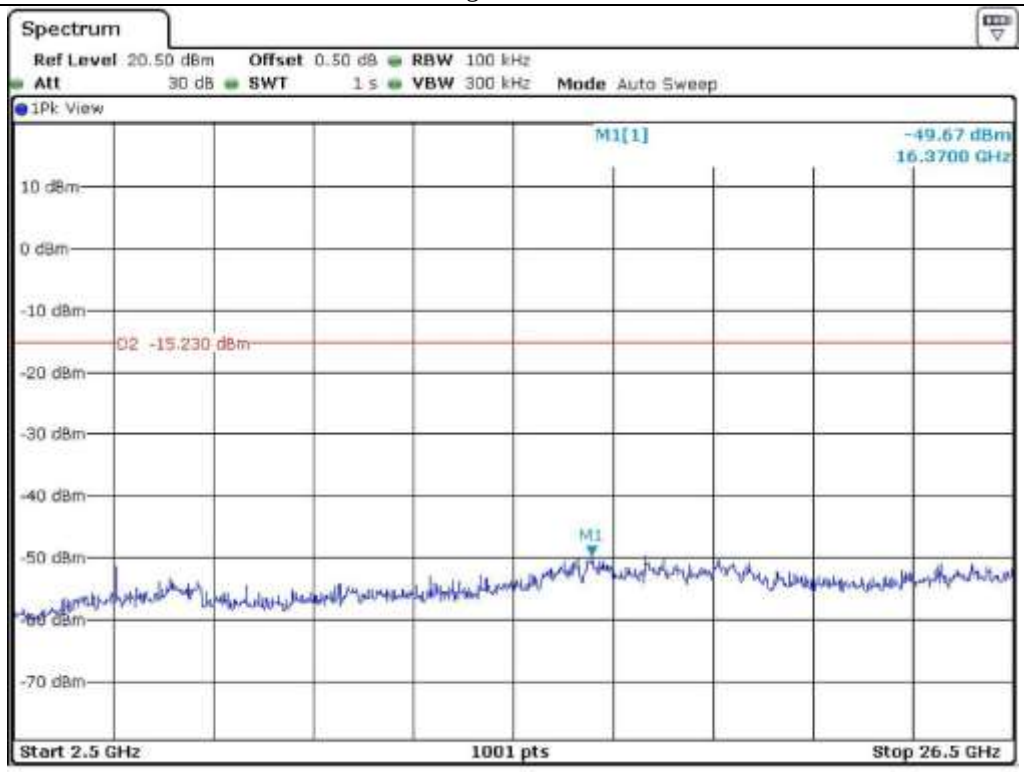


High Channel



High Channel

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12.6 Test data for Transmitting mode radiated emission

12.6.1 Radiated Emission which fall in the Restricted Band

12.6.1.1 Test data for 1 Mbps

-. Test Date : January 04, 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	40.88	Peak	H	27.10	7.50	43.00	32.28	74.00	41.72
	28.72	Average	H				19.82	54.00	34.18
	41.81	Peak	V				32.01	74.00	41.99
	26.93	Average	V				19.73	54.00	34.27
Test Data for Low Channel									
2 400.00	57.11	Peak	H	27.10	7.50	43.00	50.21	74.00	23.79
	44.07	Average	H				36.77	54.00	17.23
	57.86	Peak	V				50.86	74.00	23.14
	48.11	Average	V				38.41	54.00	15.59
Test Data for High Channel									
2 483.50	59.68	Peak	H	27.10	7.50	43.00	50.28	74.00	23.72
	30.44	Average	H				21.84	54.00	32.16
	58.11	Peak	V				50.31	74.00	23.69
	28.71	Average	V				21.71	54.00	32.29

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

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12.6.1.2 Test data for 2 Mbps

-. Test Date : January 04, 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

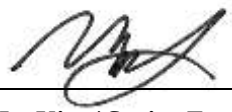
-. Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)

-. 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	39.68	Peak	H	27.10	7.50	43.00	29.87	74.00	44.13
	27.92	Average	H				20.90	54.00	33.10
	41.21	Peak	V				30.71	74.00	43.29
	28.13	Average	V				20.34	54.00	33.66
Test Data for Low Channel									
2 400.00	58.48	Peak	H	27.10	7.50	43.00	49.15	74.00	24.85
	30.74	Average	H				36.96	54.00	17.04
	57.41	Peak	V				49.20	74.00	24.80
	29.01	Average	V				37.67	54.00	16.33
Test Data for High Channel									
2 483.50	59.51	Peak	H	27.10	7.50	43.00	48.86	74.00	25.14
	46.17	Average	H				36.26	54.00	17.74
	59.96	Peak	V				49.52	74.00	24.48
	45.91	Average	V				37.30	54.00	16.70

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical



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12.6.1.3 Test data for 3 Mbps

-. Test Date : January 04, 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

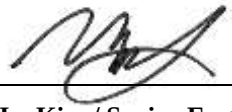
-. Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)

-. 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	40.78	Peak	H	27.10	7.50	43.00	31.93	74.00	42.07
	28.02	Average	H				20.67	54.00	33.33
	39.01	Peak	V				31.80	74.00	42.20
	28.33	Average	V				20.47	54.00	33.53
Test Data for Low Channel									
2 400.00	59.78	Peak	H	27.10	7.50	43.00	49.00	74.00	25.00
	30.54	Average	H				37.68	54.00	16.32
	59.81	Peak	V				49.98	74.00	24.02
	31.51	Average	V				37.93	54.00	16.07
Test Data for High Channel									
2 483.50	58.21	Peak	H	27.10	7.50	43.00	48.32	74.00	25.68
	46.47	Average	H				36.63	54.00	17.37
	58.46	Peak	V				50.62	74.00	23.38
	45.71	Average	V				37.78	54.00	16.22

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical



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12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data for 1 Mbps

-. Test Date : January 04, 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

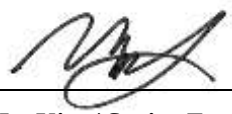
-. Operating Condition : Highest Output Power Transmitting Mode

-. 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	43.96	Peak	H	30.60	11.10	42.50	41.44	74.00	32.56
	32.28	Average	H				33.39	54.00	20.61
	41.84	Peak	V				41.56	74.00	32.44
	32.03	Average	V				33.60	54.00	20.40
Test Data for Middle Channel									
4 882.00	44.91	Peak	H	30.70	11.20	42.50	41.70	74.00	32.30
	32.76	Average	H				33.66	54.00	20.34
	43.62	Peak	V				41.81	74.00	32.19
	32.72	Average	V				34.09	54.00	19.91
Test Data for High Channel									
4 960.00	43.59	Peak	H	30.80	11.30	42.50	42.17	74.00	31.83
	34.02	Average	H				33.92	54.00	20.08
	41.66	Peak	V				42.05	74.00	31.95
	32.84	Average	V				34.18	54.00	19.82

Tabulated test data for Restricted Band

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



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12.6.2.2 Test data for 2 Mbps

-. Test Date : January 04, 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	42.66	Peak	H	30.60	11.10	42.50	42.00	74.00	32.00
	32.68	Average	H				34.07	54.00	19.93
	42.94	Peak	V				41.90	74.00	32.10
	32.33	Average	V				33.97	54.00	20.03
Test Data for Middle Channel									
4 882.00	45.11	Peak	H	30.70	11.20	42.50	42.65	74.00	31.35
	35.06	Average	H				34.20	54.00	19.80
	42.12	Peak	V				42.32	74.00	31.68
	33.62	Average	V				34.15	54.00	19.85
Test Data for High Channel									
4 960.00	41.99	Peak	H	30.80	11.30	42.50	43.31	74.00	30.69
	33.72	Average	H				34.37	54.00	19.63
	42.56	Peak	V				43.95	74.00	30.05
	32.84	Average	V				34.29	54.00	19.71

Tabulated test data for Restricted Band

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

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12.6.2.3 Test data for 3 Mbps

-. Test Date : January 04, 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	44.26	Peak	H	30.60	11.10	42.50	43.25	74.00	30.75
	32.58	Average	H				34.01	54.00	19.99
	43.24	Peak	V				42.94	74.00	31.06
	32.43	Average	V				33.70	54.00	20.30
Test Data for Middle Channel									
4 882.00	43.31	Peak	H	30.70	11.20	42.50	43.32	74.00	30.68
	33.36	Average	H				34.17	54.00	19.83
	43.52	Peak	V				42.90	74.00	31.10
	34.52	Average	V				33.79	54.00	20.21
Test Data for High Channel									
4 960.00	44.09	Peak	H	30.80	11.30	42.50	43.93	74.00	30.07
	32.52	Average	H				34.26	54.00	19.74
	44.36	Peak	V				43.67	74.00	30.33
	34.54	Average	V				34.35	54.00	19.65

Tabulated test data for Restricted Band

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

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13. RADIATED EMISSION TEST

13.1 Operating environment

Temperature : 21.6 ℃

Relative humidity : 43.0 % R.H.

13.2 Test set-up

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

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

13.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 22, 2015 (1Y)
■ -	ESCI	Rohde & Schwarz	Test Receiver	101012	Nov. 02, 2015 (1Y)
■ -	310N	Sonoma Instrument	Pre-Amplifier	312544	Apr. 29, 2015 (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	Jul. 10, 2014 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 31, 2015 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Apr. 30, 2015 (2Y)

All test equipment used is calibrated on a regular basis.

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13.4 Test data for 1 Mbps

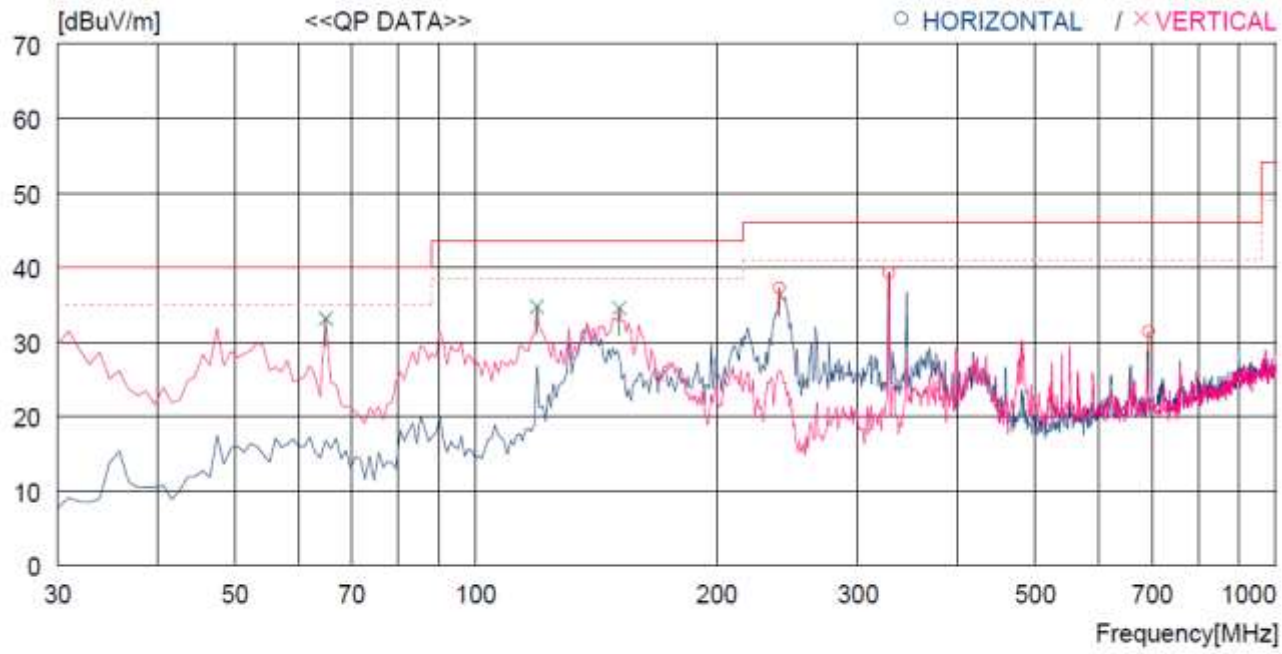
13.4.1 Test data for 30 MHz ~ 1 000 MHz

-. Test Date : January 04, 2016

-. Resolution bandwidth : 120 kHz

-. Frequency range : 30 MHz ~ 1 000 MHz

-. Measurement distance : 3 m



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	239.520	53.8	12.1	4.1	32.8	37.2	46.0	8.8	100	97
2	328.760	52.9	14.2	4.8	32.6	39.3	46.0	6.7	100	97
3	692.505	38.2	19.6	7.2	33.6	31.4	46.0	14.6	100	97
----- Vertical ------										
4	64.920	52.5	11.5	2.2	33.1	33.1	40.0	6.9	100	47
5	119.240	54.1	10.3	3.5	33.2	34.7	43.5	8.8	100	26
6	151.250	55.8	8.4	3.3	33.0	34.5	43.5	9.0	100	7

Tested by: Tae-Ho, Kim / Senior Engineer

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13.4.2 Test data for Below 30 MHz

-. Test Date : January 04, 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 : January 04, 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: Tae-Ho, Kim / Senior Engineer

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13.5 Test data for 2 Mbps

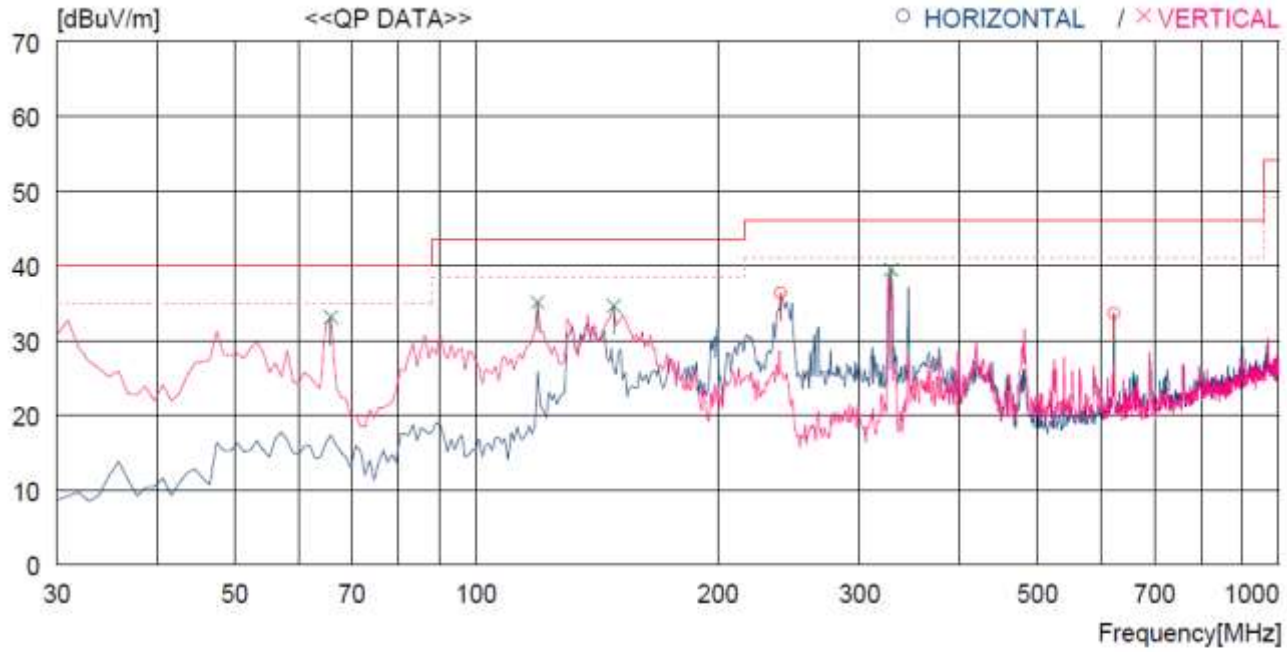
13.5.1 Test data for 30 MHz ~ 1 000 MHz

-. Test Date : January 04, 2016

-. Resolution bandwidth : 120 kHz

-. Frequency range : 30 MHz ~ 1 000 MHz

-. Measurement distance : 3 m



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	239.520	52.9	12.1	4.1	32.8	36.3	46.0	9.7	100	2
2	623.637	40.9	19.3	6.8	33.4	33.6	46.0	12.4	100	12
----- Vertical ------										
3	65.890	52.7	11.2	2.3	33.1	33.1	40.0	6.9	100	69
4	119.240	54.5	10.3	3.5	33.2	35.1	43.5	8.4	100	33
5	148.340	56.0	8.3	3.3	33.0	34.6	43.5	8.9	100	69
6	328.760	53.1	14.2	4.8	32.6	39.5	46.0	6.5	100	69

Tested by: Tae-Ho, Kim / Senior Engineer

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13.5.2 Test data for Below 30 MHz

-. Test Date : January 04, 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 : January 04, 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: Tae-Ho, Kim / Senior Engineer

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13.6 Test data for 3 Mbps

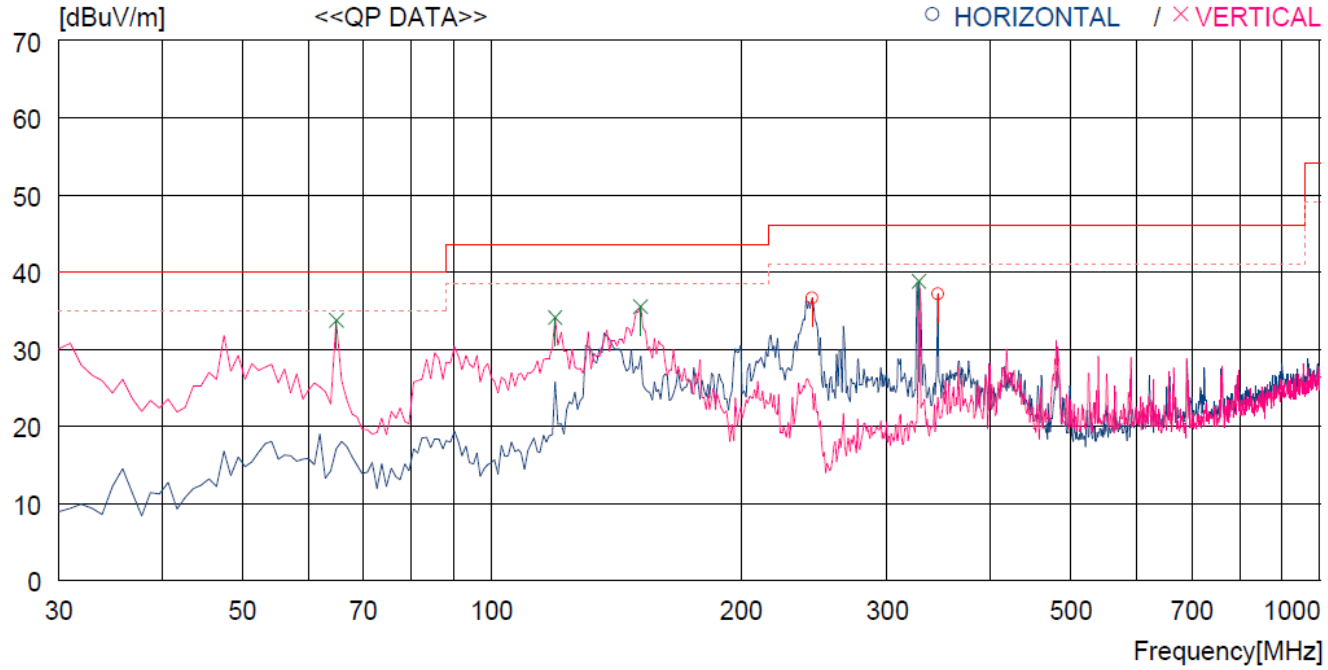
13.6.1 Test data for 30 MHz ~ 1 000 MHz

-. Test Date : January 04, 2016

-. Resolution bandwidth : 120 kHz

-. Frequency range : 30 MHz ~ 1 000 MHz

-. Measurement distance : 3 m



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	243.400	53.0	12.2	4.2	32.8	36.6	46.0	9.4	100	2
2	345.250	50.1	14.6	5.0	32.6	37.1	46.0	8.9	100	139
----- Vertical ------										
3	64.920	53.1	11.5	2.2	33.1	33.7	40.0	6.3	100	2
4	119.240	53.5	10.3	3.5	33.2	34.1	43.5	9.4	100	26
5	151.250	56.8	8.4	3.3	33.0	35.5	43.5	8.0	100	2
6	327.790	52.4	14.2	4.8	32.6	38.8	46.0	7.2	100	26

Tested by: Tae-Ho, Kim / Senior Engineer

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13.6.2 Test data for Below 30 MHz

-. Test Date : January 04, 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 : January 04, 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: Tae-Ho, Kim / Senior Engineer

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14. CONDUCTED EMISSION TEST

14.1 Operating environment

Temperature : 21.6 ℃

Relative humidity : 43.0 % 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 μH + 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	Test Receiver	101012	Nov. 02, 2015 (1Y)
□ -	ESHS10	Rohde & Schwarz	Test Receiver	834467/007	Apr. 29, 2015 (1Y)
□ -	NSLK8128	Schwarzbeck	AMN	8128-216	Apr. 06, 2015 (1Y)
■ -	NSLK8126	Schwarzbeck	AMN	8126-404	Apr. 29, 2015 (1Y)
□ -	3825/2	EMCO	AMN	9109-1869	Apr. 29, 2015 (1Y)
■ -	3825/2	EMCO	AMN	9109-1867	Apr. 29, 2015 (1Y)

All test equipment used is calibrated on a regular basis.

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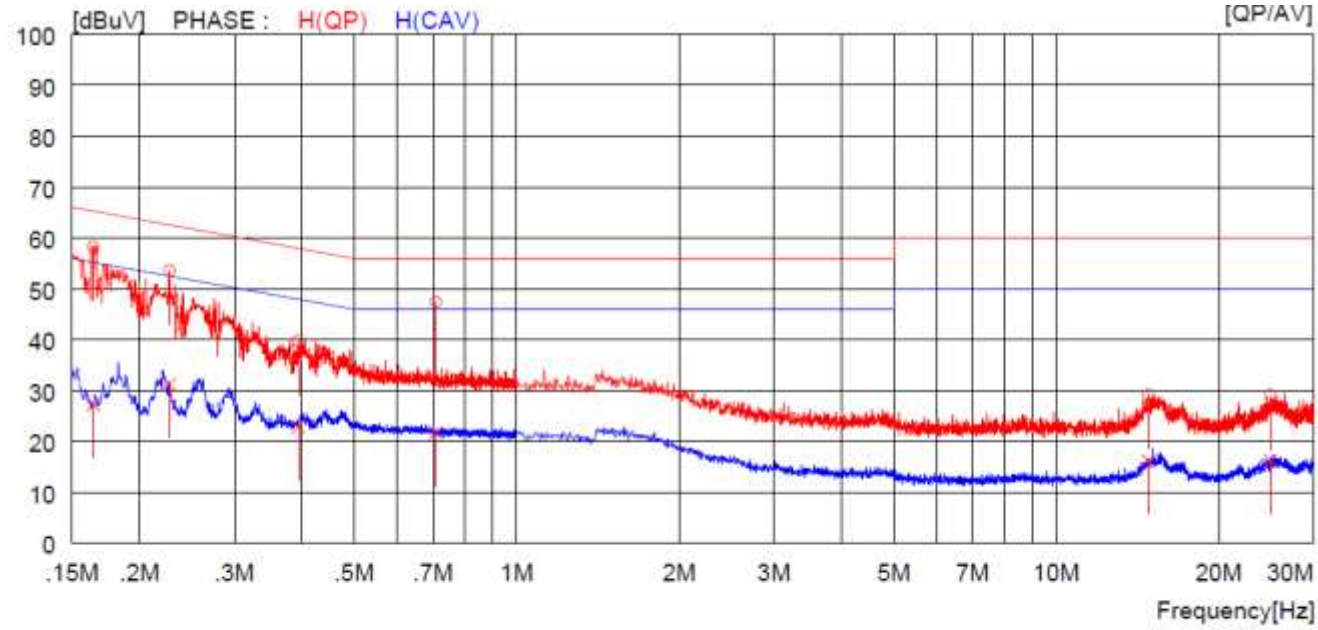
14.4 Test data

-. Test Date : January 04, 2016

-. Resolution bandwidth : 9 kHz

-. Frequency range : 0.15 MHz ~ 30 MHz

-. Tested Line : HOT LINE



NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.16400	48.3	----	9.9	58.2	----	65.3	----	7.1	----	H(QP)
2	0.22700	43.6	----	10.0	53.6	----	62.6	----	9.0	----	H(QP)
3	0.39400	29.8	----	10.0	39.8	----	58.0	----	18.2	----	H(QP)
4	0.70800	37.3	----	10.1	47.4	----	56.0	----	8.6	----	H(QP)
5	14.81000	18.7	----	10.5	29.2	----	60.0	----	30.8	----	H(QP)
6	24.94000	18.5	----	10.5	29.0	----	60.0	----	31.0	----	H(QP)
7	0.16400	----	17.4	9.9	----	27.3	----	55.3	----	28.0	H(CAV)
8	0.22700	----	21.3	10.0	----	31.3	----	52.6	----	21.3	H(CAV)
9	0.39400	----	12.9	10.0	----	22.9	----	48.0	----	25.1	H(CAV)
10	0.70800	----	11.6	10.1	----	21.7	----	46.0	----	24.3	H(CAV)
11	14.81000	----	5.8	10.5	----	16.3	----	50.0	----	33.7	H(CAV)
12	24.94000	----	5.7	10.5	----	16.2	----	50.0	----	33.8	H(CAV)

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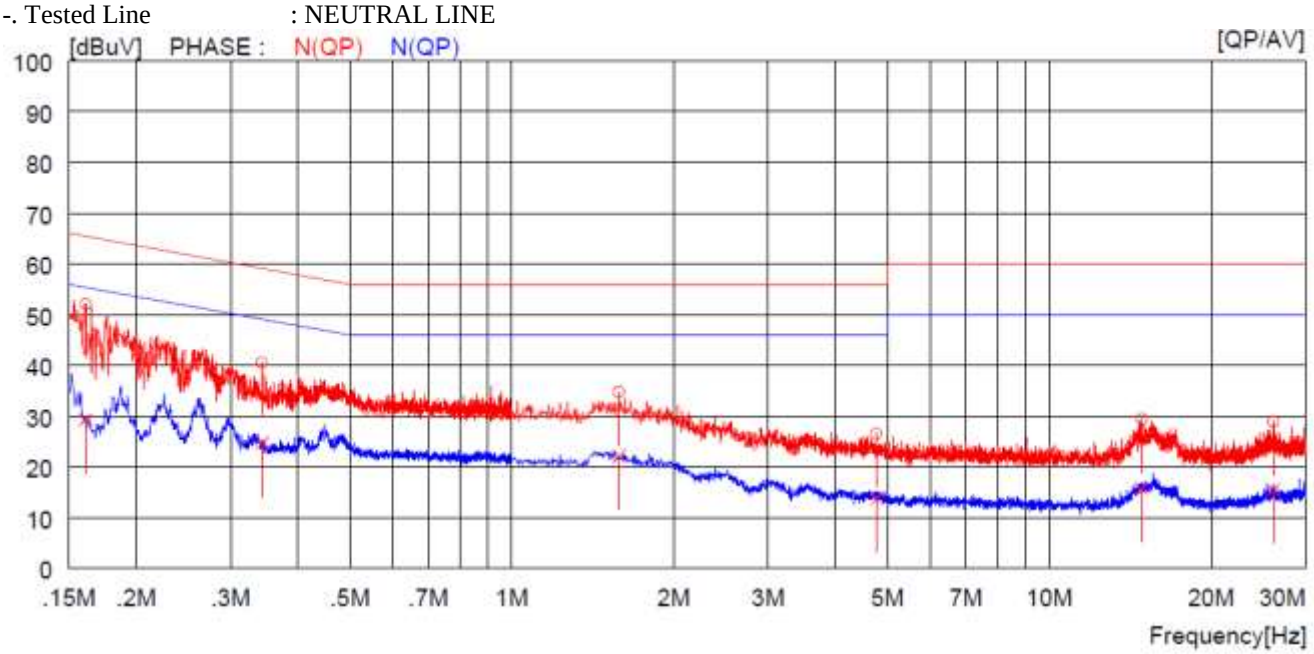
-. Tested Line : NEUTRAL LINE



NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.16100	42.1	----	9.9	52.0	----	65.4	----	13.4	----	N(QP)
2	0.34300	30.5	----	10.0	40.5	----	59.1	----	18.6	----	N(QP)
3	1.58400	24.7	----	10.1	34.8	----	56.0	----	21.2	----	N(QP)
4	4.77200	16.4	----	10.1	26.5	----	56.0	----	29.5	----	N(QP)
5	14.85000	18.9	----	10.5	29.4	----	60.0	----	30.6	----	N(QP)
6	26.11000	18.4	----	10.5	28.9	----	60.0	----	31.1	----	N(QP)
7	0.16100	----	19.4	9.9	----	29.3	----	55.4	----	26.1	N(CAV)
8	0.34300	----	14.7	10.0	----	24.7	----	49.1	----	24.4	N(CAV)
9	1.58400	----	12.1	10.1	----	22.2	----	46.0	----	23.8	N(CAV)
10	4.77200	----	3.7	10.1	----	13.8	----	46.0	----	32.2	N(CAV)
11	14.85000	----	5.3	10.5	----	15.8	----	50.0	----	34.2	N(CAV)
12	26.11000	----	5.0	10.5	----	15.5	----	50.0	----	34.5	N(CAV)

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

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