

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

Test Report No. : W157R-D003
AGR No. : A154A-165
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 module
FCC ID. : YZP-TWCMB202D
IC Certification No. : 7414C-TWCMB202D
Model Name : TWCM-B202D
Serial number : N/A
Total page of Report : 196 pages (including this page)
Date of Incoming : February 13, 2015
Date of issue : July 14, 2015

SUMMARY

The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247 and IC RSS-Gen Issue 4 Nov 2014 and RSS-247 Issue 1 May 2015*

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by: 

 Ki-Hong, Nam / Asst, Chief Engineer
 ONETECH Corp.

Approved by: 

 Sung-Ik, Han/ Managing Director
 ONETECH Corp.

CONTENTS

	PAGE
1. VERIFICATION OF COMPLIANCE	6
2. TEST SUMMARY.....	7
2.1 TEST ITEMS AND RESULTS	7
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS.....	7
2.3 RELATED SUBMITTAL(S) / GRANT(S)	7
2.4 PURPOSE OF THE TEST	7
2.5 TEST METHODOLOGY.....	7
2.6 TEST FACILITY.....	7
3. GENERAL INFORMATION.....	8
3.1 PRODUCT DESCRIPTION.....	8
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT.....	12
4. EUT MODIFICATIONS.....	12
5. SYSTEM TEST CONFIGURATION	13
5.1 JUSTIFICATION.....	13
5.2 PERIPHERAL EQUIPMENT	13
5.3 MODE OF OPERATION DURING THE TEST	13
5.4 CONFIGURATION OF TEST SYSTEM.....	14
5.5 ANTENNA REQUIREMENT	14
6. PRELIMINARY TEST	15
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS.....	15
6.2 GENERAL RADIATED EMISSIONS TESTS	15
7. WLAN.....	16
7.1 MINIMUM 6 dB BANDWIDTH & 99 % OCCUPIED BANDWIDTH.....	16
7.1.1 Operating environment.....	16
7.1.2 Test set-up	16
7.1.3 Test equipment used.....	16
7.1.4 Test data for 802.11b	17
7.1.5 Test data for 802.11g	25
7.1.6 Test data for 802.11n_HT20.....	33
7.1.7 Test data for 802.11n_HT40.....	41
7.2 MAXIMUM PEAK OUTPUT POWER.....	49

7.2.1 Operating environment 49

7.2.2 Test set-up 49

7.2.3 Test equipment used..... 49

7.2.4 Test data for 802.11b 50

7.2.5 Test data for 802.11g 60

7.2.6 Test data for 802.11n_HT20..... 71

7.2.7 Test data for 802.11n_HT40..... 82

7.3 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND 93

7.3.1 Operating environment..... 93

7.3.2 Test set-up for conducted measurement..... 93

7.3.3 Test set-up for radiated measurement..... 93

7.3.4 Test equipment used..... 93

7.3.5 Test data for conducted emission 94

7.3.6 Test data for radiated emission 134

7.4 SPURIOUS EMISSION - RECEIVER 156

7.4.1 Operating environment..... 156

7.4.2 Test set-up for conducted measurement..... 156

7.4.3 Test set-up for radiated measurement..... 156

7.4.4 Test equipment used..... 156

7.4.5 Test data for 802.11b 157

7.4.6 Test data for 802.11g 159

7.4.7 Test data for 802.11n_HT20..... 161

7.4.8 Test data for 802.11n_HT40..... 163

7.5 PEAK POWER SPECTRUL DENSITY 165

7.5.1 Operating environment..... 165

7.5.2 Test set-up 165

7.5.3 Test equipment used..... 165

7.5.4 Test data for 802.11b 166

7.5.5 Test data for 802.11g 170

7.5.6 Test data for 802.11n_HT20..... 175

7.5.7 Test data for 802.11n_HT40..... 180

7.6 RADIATED EMISSION TEST..... 185

7.6.1 Operating environment..... 185

7.6.2 Test set-up 185

7.6.3 Test equipment used..... 185

7.6.4 Test data for 802.11b 186

7.6.5 Test data for 802.11g 188

<i>7.6.6 Test data for 802.11n_HT20</i>	190
<i>7.6.7 Test data for 802.11n_HT40</i>	192
7.7 CONDUCTED EMISSION TEST	194
<i>7.7.1 Operating environment</i>	194
<i>7.7.2 Test set-up</i>	194
<i>7.7.3 Test equipment used</i>	194
<i>7.7.4 Test data</i>	195

Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W157R-D003	July 14, 2015	Initial Issue	All

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-TWCMB202D
 IC Certification No. : 7414C-TWCMB202D
 Model Name : TWCM-B202D
 Serial Number : N/A
 Date : July 14, 2015

EQUIPMENT CLASS	FCC : DTS – DIGITAL TRNSMISSION SYSTEM IC : Low Power License-Exempt Radio-communication Device
E.U.T. DESCRIPTION	Modular Transmitter, Wi-Fi module
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification, Modular Approval
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247, RSS-Gen Issue 4 Nov 2014, RSS-247 Issue 1 May 2015
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) (2)	RSS-247, 5.2(1) Minimum 6 dB Bandwidth & 99 % Occupied Bandwidth	Met the Limit / PASS
15.247 (b) (3)	RSS-247, 5.4(4) Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	RSS-247, 5.5 100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	RSS-247, 5.5 Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	RSS-247, 5.2(2) Peak Power Spectral Density	Met the Limit / PASS
15.209	RSS-247, 5.5 Radiated Emission Limits	Met the Limit / PASS
15.207	RSS-Gen, Section 7.2.4 Conducted Limits	Met the Limit / PASS
15.203	RSS-Gen, Section 7.1.2 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, IC RSS-Gen Issue 4 Nov 2014 and RSS-247 Issue 1 May 2015

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. 85

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The LG Innotek Co., Ltd., Model TWCM-B202D (referred to as the EUT in this report) is a Wi-Fi module. Product specification information described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	Wi-Fi module		
OPERATING FREQUENCY	WLAN	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))	
		2 422 MHz ~ 2 452 MHz (802.11n(HT40))	
	Bluetooth	2 402 MHz ~ 2 480 MHz	
	Bluetooth LE	2 402 MHz ~ 2 480 MHz	
	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(HT20))	
		5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(HT40))	
		5 210 MHz (802.11n(HT80))	
	5 250 MHz ~ 5 350 MHz Band	5 260 MHz ~ 5 320 MHz (802.11a/n(HT20)/ac(HT20))	
		5 270 MHz ~ 5 310 MHz (802.11n(HT40)/ac(HT40))	
		5 290 MHz (802.11n(HT80))	
	5 470 MHz ~ 5 725 MHz Band	5 500 MHz ~ 5 700 MHz (802.11a/n(HT20)/ac(HT20))	
		5 510 MHz ~ 5 670 MHz (802.11n(HT40)/ac(HT40))	
		5 530 MHz (802.11n(HT80))	
	5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n(HT20)/ac(HT20))	
		5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(HT40))	
		5 775 MHz (802.11n(HT80))	
MAX. RF OUTPUT POWER	WLAN	Antenna 0	Wi-Fi 802.11b (13.85 dBm)
			Wi-Fi 802.11g (13.37 dBm)
			Wi-Fi 802.11n_20 MHz (11.32 dBm)
			Wi-Fi 802.11n_40 MHz (11.52 dBm)
		Antenna 1	Wi-Fi 802.11b (14.08 dBm)
			Wi-Fi 802.11g (13.75 dBm)
			Wi-Fi 802.11n_20 MHz (11.65 dBm)
			Wi-Fi 802.11n_40 MHz (11.86 dBm)
		Multiple transmit	Wi-Fi 802.11g (16.57 dBm)
			Wi-Fi 802.11n_20 MHz (14.50 dBm)
			Wi-Fi 802.11n_40 MHz (14.70 dBm)

MAX. RF OUTPUT POWER	Bluetooth	1 Mbps	4.13 dBm	
		2 Mbps	5.21 dBm	
		3 Mbps	5.86 dBm	
	Bluetooth LE	6.39 dBm		
	Antenna 0	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (12.09 dBm)	
			Wi-Fi 802.11n_20 MHz (12.11 dBm)	
			Wi-Fi 802.11n_40 MHz (12.31 dBm)	
			Wi-Fi 802.11ac_20 MHz (12.15 dBm)	
			Wi-Fi 802.11ac_40 MHz (12.65 dBm)	
			Wi-Fi 802.11ac_80 MHz (9.81 dBm)	
Antenna 0	5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (13.44 dBm)		
		Wi-Fi 802.11n_20 MHz (13.66 dBm)		
		Wi-Fi 802.11n_40 MHz (13.50 dBm)		
		Wi-Fi 802.11ac_20 MHz (13.35 dBm)		
		Wi-Fi 802.11ac_40 MHz (13.82 dBm)		
		Wi-Fi 802.11ac_80 MHz (9.74 dBm)		
Antenna 0	5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (13.94 dBm)		
		Wi-Fi 802.11n_20 MHz (13.73 dBm)		
		Wi-Fi 802.11n_40 MHz (14.06 dBm)		
		Wi-Fi 802.11ac_20 MHz (13.97 dBm)		
		Wi-Fi 802.11ac_40 MHz (14.34 dBm)		
		Wi-Fi 802.11ac_80 MHz (11.40 dBm)		
Antenna 0	5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (12.90 dBm)		
		Wi-Fi 802.11n_20 MHz (12.69 dBm)		
		Wi-Fi 802.11n_40 MHz (13.09 dBm)		
		Wi-Fi 802.11ac_20 MHz (12.74 dBm)		
		Wi-Fi 802.11ac_40 MHz (13.24 dBm)		
		Wi-Fi 802.11ac_80 MHz (10.32 dBm)		

MAX. RF OUTPUT POWER	Antenna 1	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (13.15 dBm) Wi-Fi 802.11n_20 MHz (12.98 dBm) Wi-Fi 802.11n_40 MHz (13.08 dBm) Wi-Fi 802.11ac_20 MHz (12.83 dBm) Wi-Fi 802.11ac_40 MHz (13.37 dBm) Wi-Fi 802.11ac_80 MHz (10.82 dBm)
		5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (12.07 dBm) Wi-Fi 802.11n_20 MHz (12.42 dBm) Wi-Fi 802.11n_40 MHz (12.26 dBm) Wi-Fi 802.11ac_20 MHz (12.14 dBm) Wi-Fi 802.11ac_40 MHz (12.73 dBm) Wi-Fi 802.11ac_80 MHz (10.59 dBm)
		5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (13.60 dBm) Wi-Fi 802.11n_20 MHz (13.22 dBm) Wi-Fi 802.11n_40 MHz (13.44 dBm) Wi-Fi 802.11ac_20 MHz (13.34 dBm) Wi-Fi 802.11ac_40 MHz (13.79 dBm) Wi-Fi 802.11ac_80 MHz (10.59 dBm)
		5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (13.72 dBm) Wi-Fi 802.11n_20 MHz (13.56 dBm) Wi-Fi 802.11n_40 MHz (13.69 dBm) Wi-Fi 802.11ac_20 MHz (13.54 dBm) Wi-Fi 802.11ac_40 MHz (14.22 dBm) Wi-Fi 802.11ac_80 MHz (11.30 dBm)

MAX. RF OUTPUT POWER	Multiple transmit	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (15.63 dBm) Wi-Fi 802.11n_20 MHz (15.52 dBm) Wi-Fi 802.11n_40 MHz (15.68 dBm) Wi-Fi 802.11ac_20 MHz (15.47 dBm) Wi-Fi 802.11ac_40 MHz (16.04 dBm) Wi-Fi 802.11ac_80 MHz (13.35 dBm)
		5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (15.82 dBm) Wi-Fi 802.11n_20 MHz (16.09 dBm) Wi-Fi 802.11n_40 MHz (15.93 dBm) Wi-Fi 802.11ac_20 MHz (15.80 dBm) Wi-Fi 802.11ac_40 MHz (16.26 dBm) Wi-Fi 802.11ac_80 MHz (13.20 dBm)
		5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (16.78 dBm) Wi-Fi 802.11n_20 MHz (16.49 dBm) Wi-Fi 802.11n_40 MHz (16.77 dBm) Wi-Fi 802.11ac_20 MHz (16.68 dBm) Wi-Fi 802.11ac_40 MHz (17.08 dBm) Wi-Fi 802.11ac_80 MHz (14.02 dBm)
		5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (16.34 dBm) Wi-Fi 802.11n_20 MHz (16.16 dBm) Wi-Fi 802.11n_40 MHz (16.41 dBm) Wi-Fi 802.11ac_20 MHz (16.17 dBm) Wi-Fi 802.11ac_40 MHz (16.77 dBm) Wi-Fi 802.11ac_80 MHz (13.85 dBm)
MODULATION TYPE	WLAN 2.4 G	DSSS Modulation(DBPSK/DQPSK/CCK)	
	WLAN 5 G	OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
	Bluetooth	GFSK for 1 Mbps, DQPSK for 2 Mbps, 8-DPSK for 3 Mbps	
	Bluetooth LE	GFSK	
ANTENNA TYPE	WLAN : PIFA Antenna		
	Bluetooth / Bluetooth LE : PIFA Antenna		
ANTENNA GAIN	WLAN : 2.9 dBi		
	Bluetooth / Bluetooth LE : 0.42 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

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.	N/A	N/A

5.2 Peripheral equipment

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

Model	Manufacturer	Description	Connected to
TWCM-B202D	LG Innotek Co., Ltd.	Wi-Fi module (EUT)	Notebook PC
LGR51	LG Electronics	Notebook PC	EUT

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting mode is programmed.

The worse case data rate for each modulation is determined 1 Mbps(Ant.0) / 1 Mbps(Ant.1) for IEEE 802.11b, 6 Mbps(Ant.0) / 6 Mbps(Ant.1) for IEEE 802.11g, 6.5 Mbps(Ant.0) / 6.5 Mbps(Ant.1) for HT20, 13 Mbps(Ant.0)/ 13 Mbps(Ant1) for HT40.

5.4 Configuration of Test System

Line Conducted Test: 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: 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.

5.5 Antenna Requirement

For intentional device, according to section 15.203 and RSS-Gen Issue 4 November 2014 Section 8.3, 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.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

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

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

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

7. WLAN

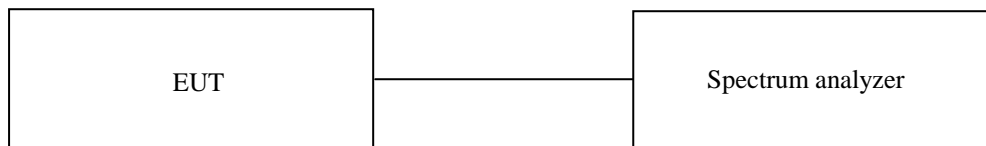
7.1 MINIMUM 6 dB BANDWIDTH & 99 % OCCUPIED BANDWIDTH

7.1.1 Operating environment

Temperature : 21.4 °C
 Relative humidity : 45.1 % R.H.

7.1.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.1.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 30, 2014 (1Y)

All test equipment used is calibrated on a regular basis.

7.1.4 Test data for 802.11b

7.1.4.1 Test data for Antenna 0

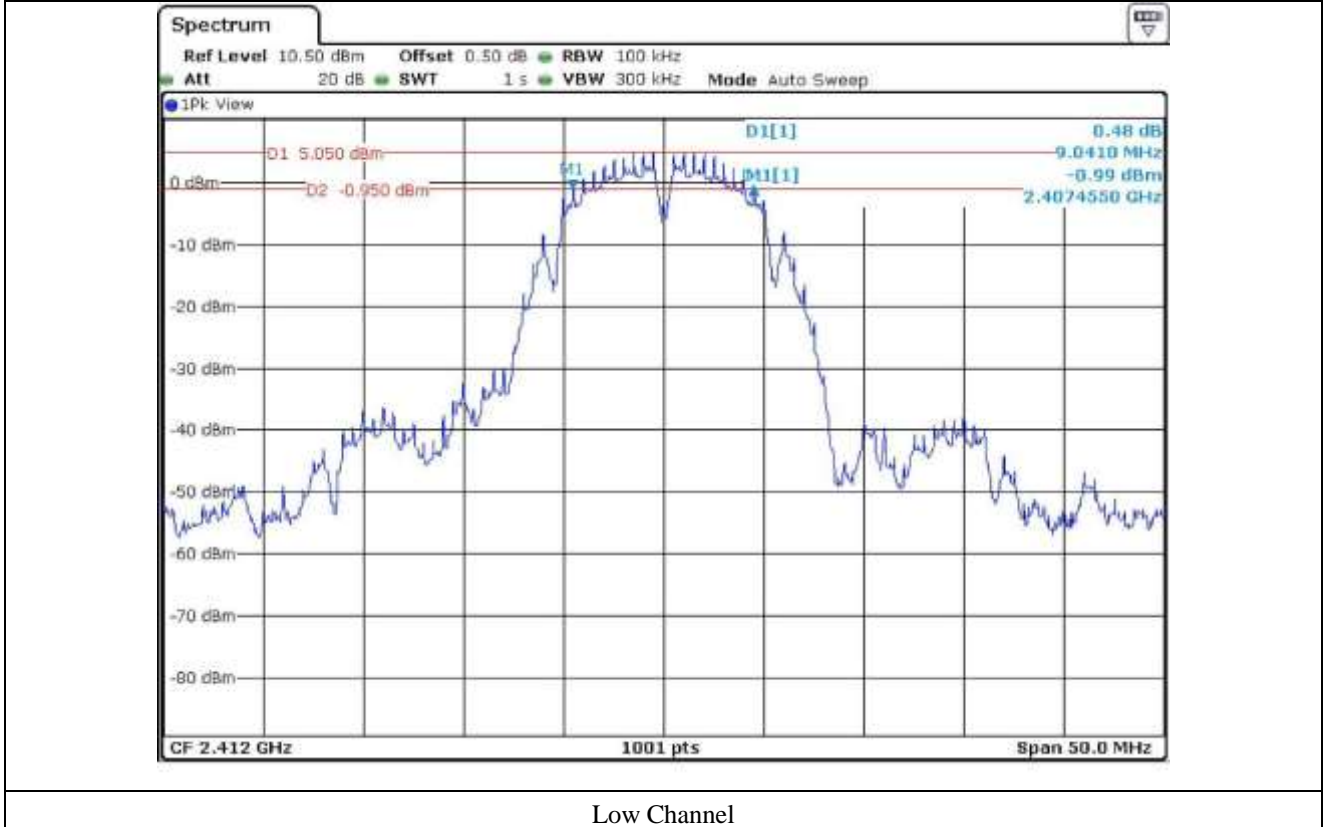
-. Test Date : May 20, 2015

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	9.04	11.59	0.5	-8.54
Middle	2 442	9.04	11.34	0.5	-8.54
High	2 462	9.04	11.49	0.5	-8.54

Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Engineer



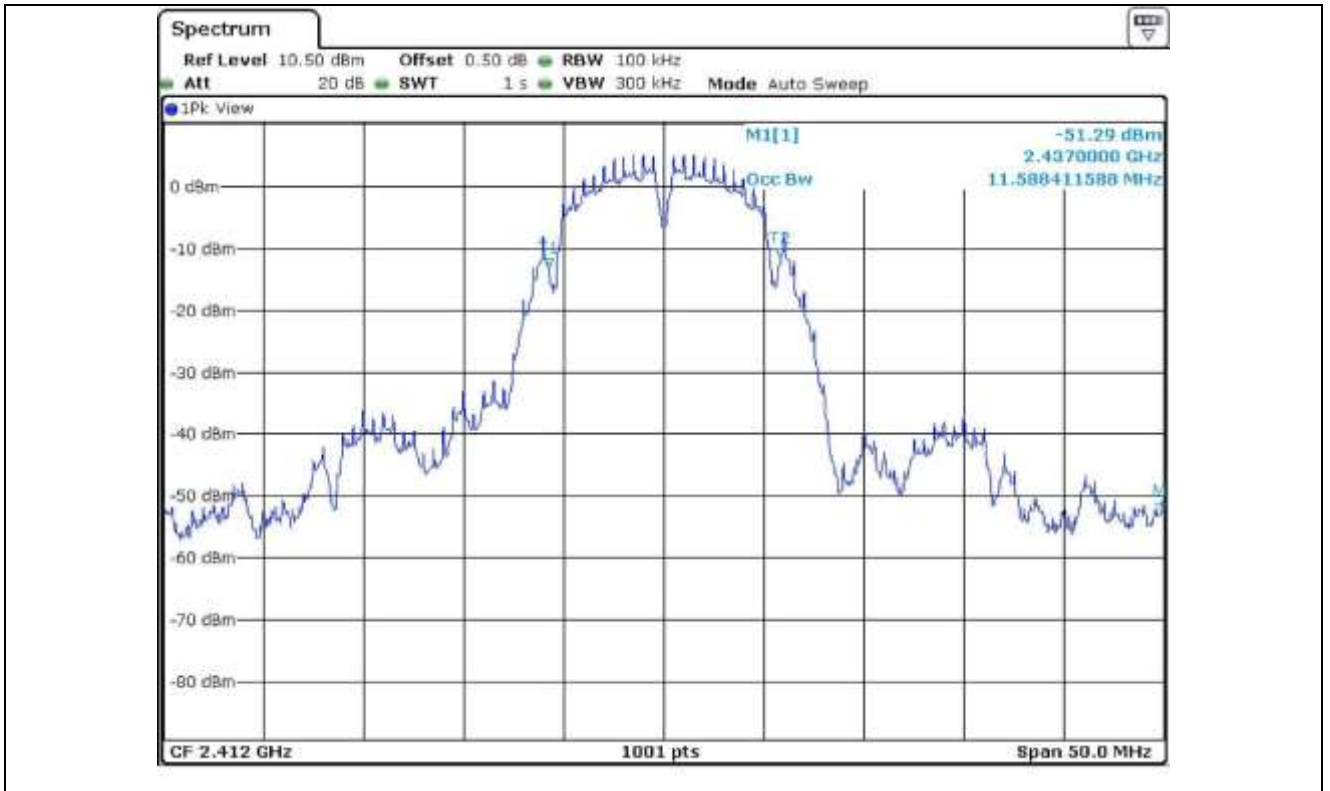
Low Channel



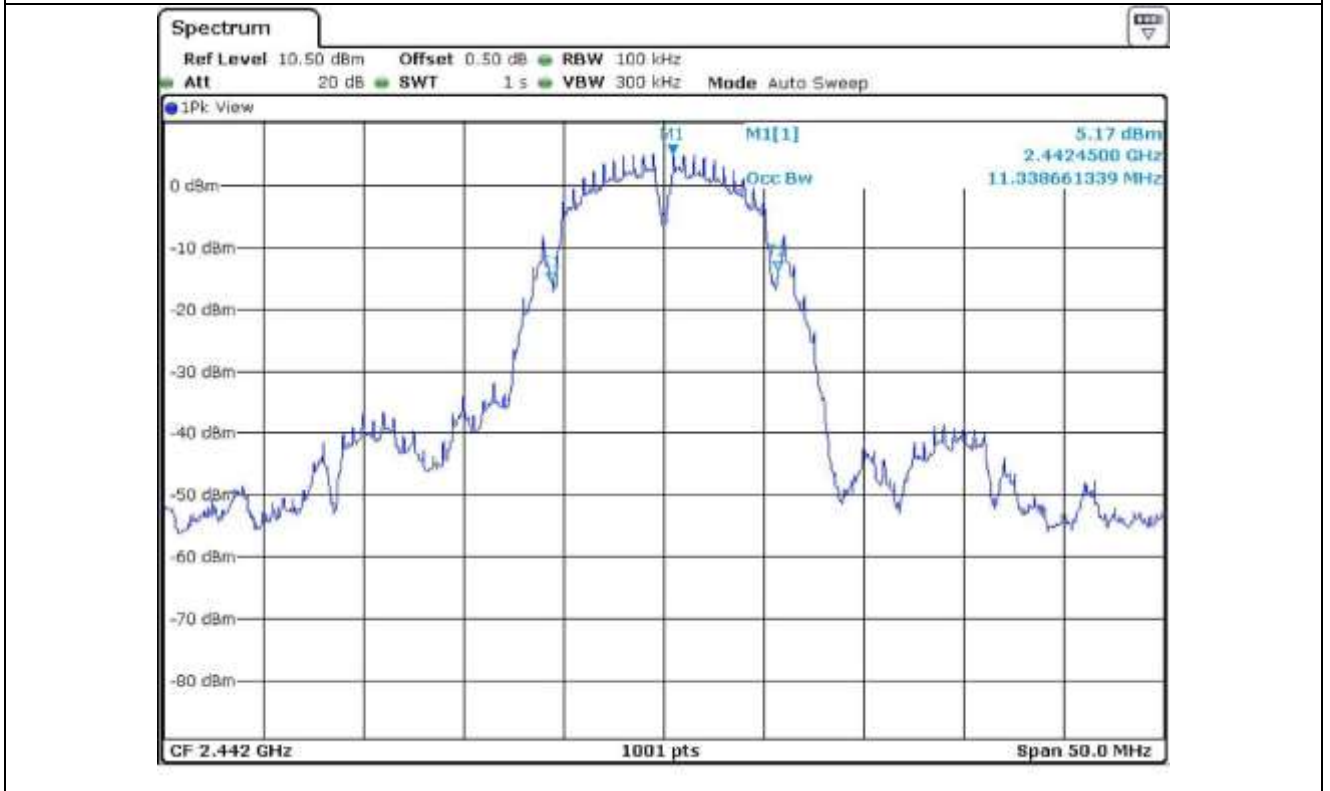
Middle Channel



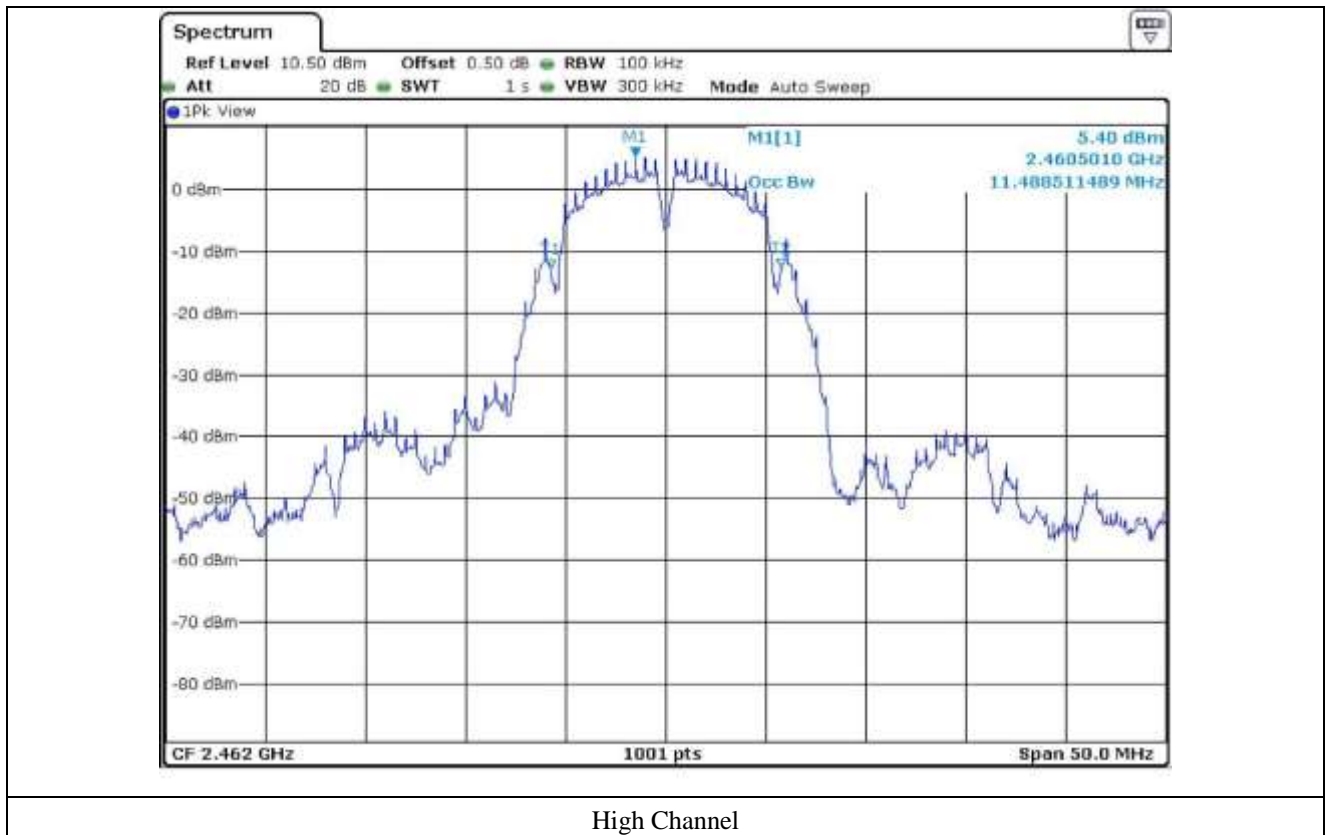
High Channel



Low Channel



Middle Channel



High Channel

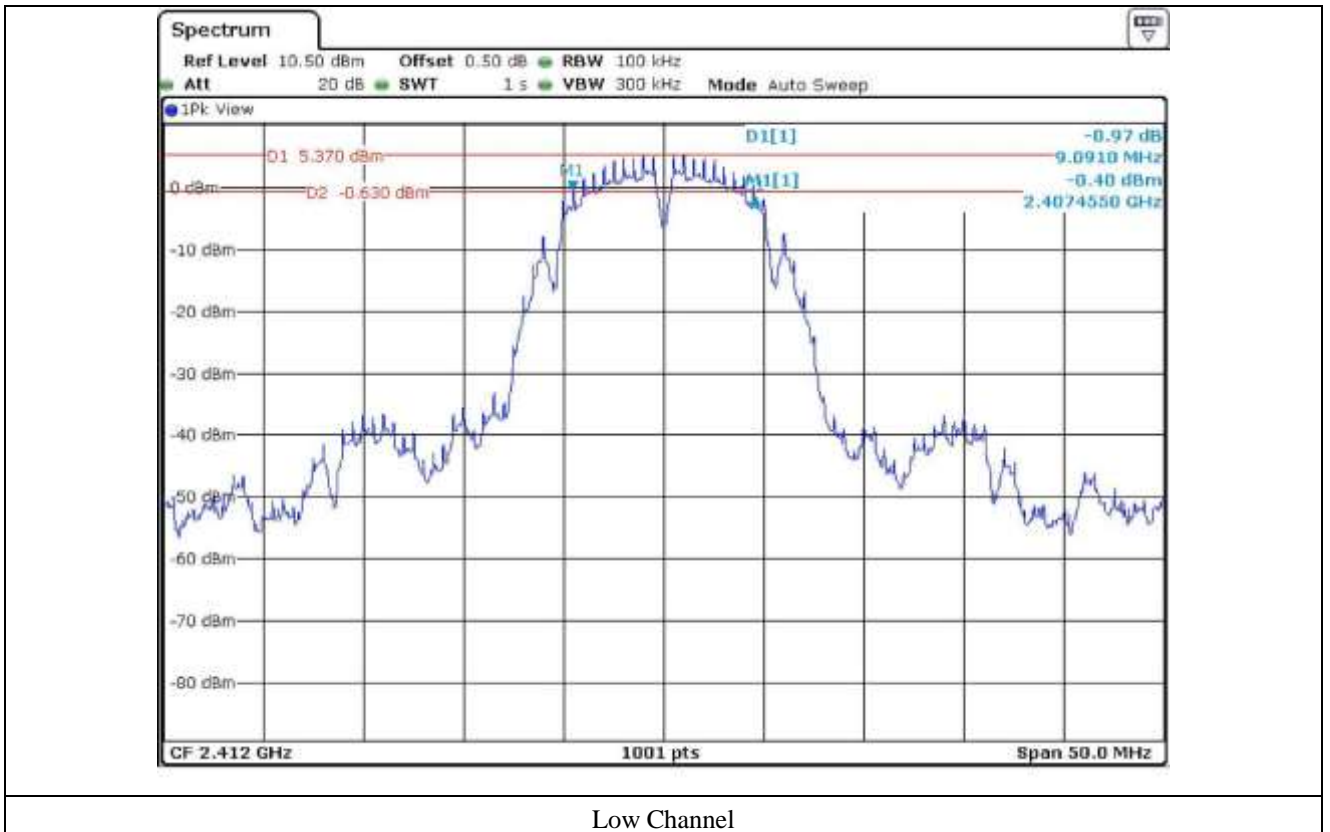
7.1.4.2 Test data for Antenna 1

- Test Date : May 20, 2015
 - Test Result : Pass

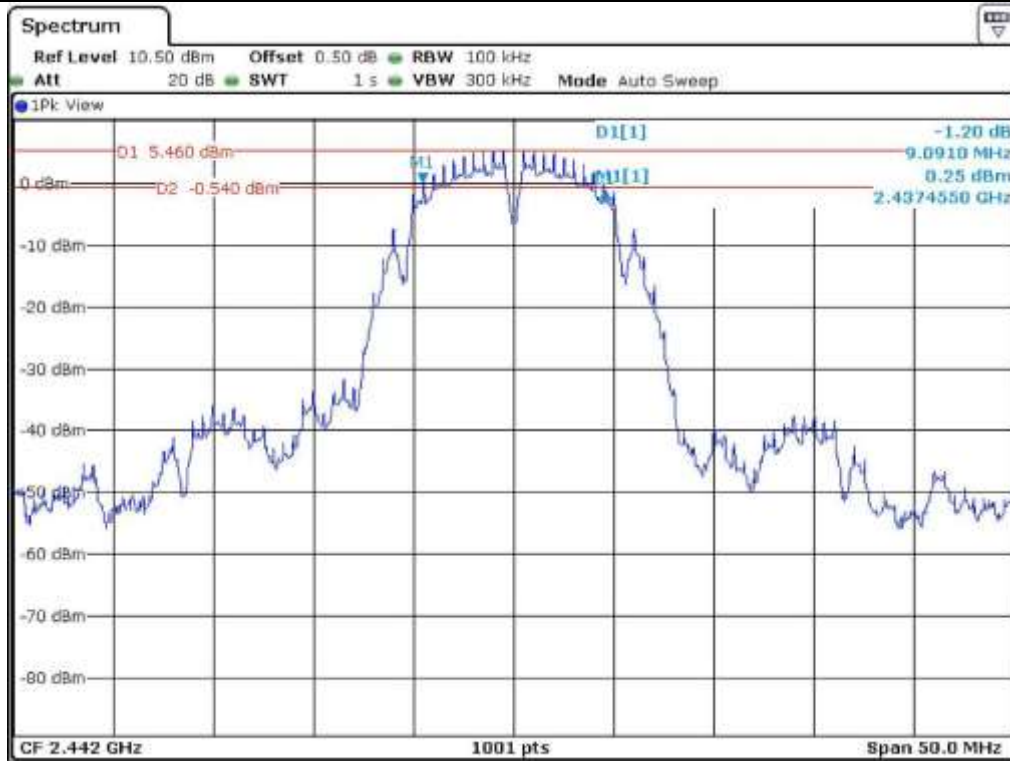
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	9.09	11.69	0.5	-8.59
Middle	2 442	9.09	11.69	0.5	-8.59
High	2 462	9.09	11.69	0.5	-8.59

Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Engineer



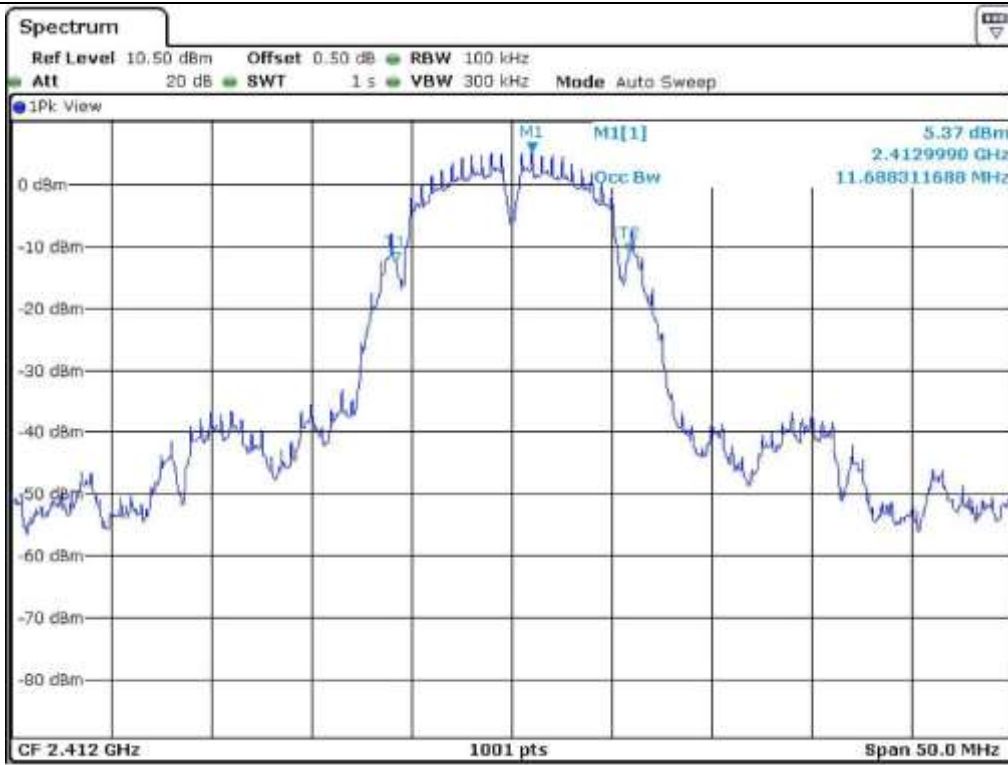
Low Channel



Middle Channel



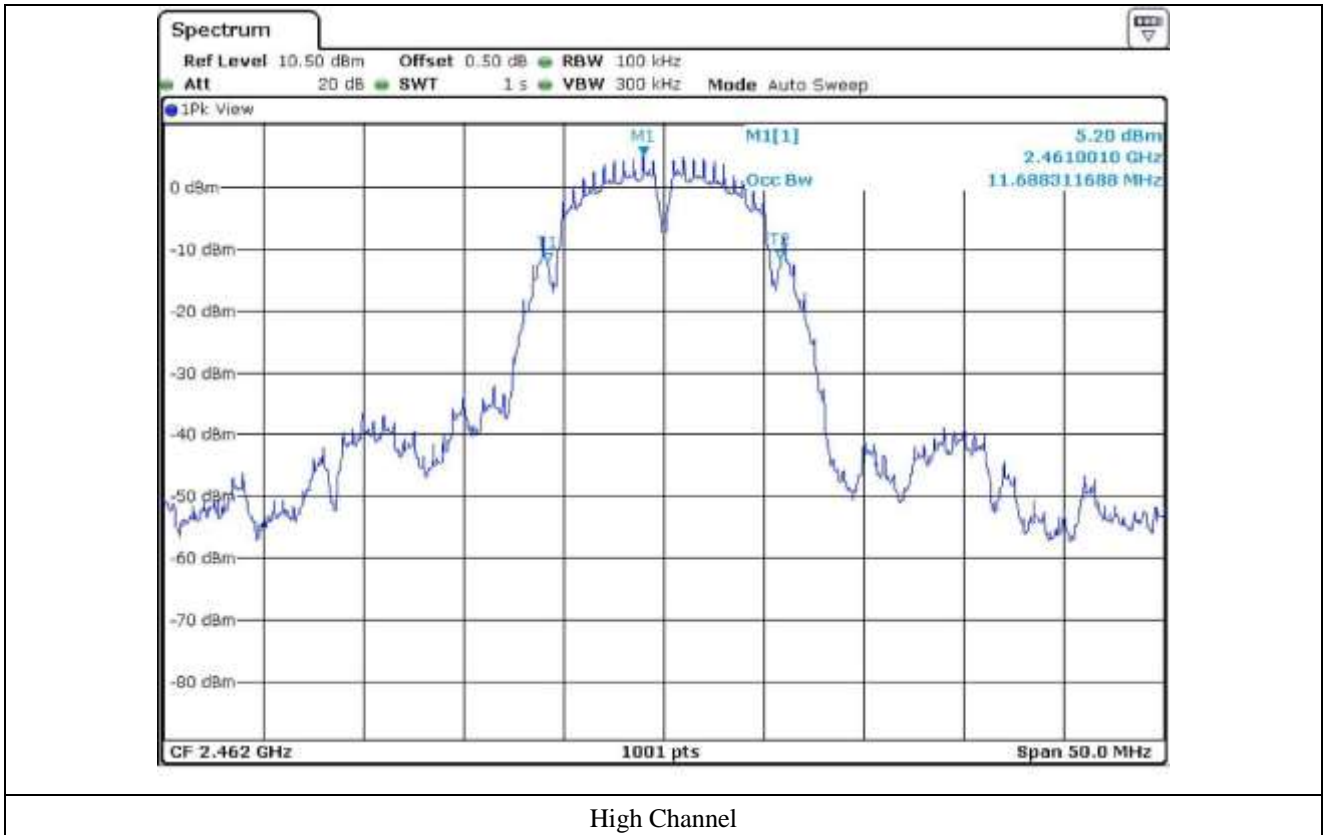
High Channel



Low Channel



Middle Channel



7.1.5 Test data for 802.11g

7.1.5.1 Test data for Antenna 0

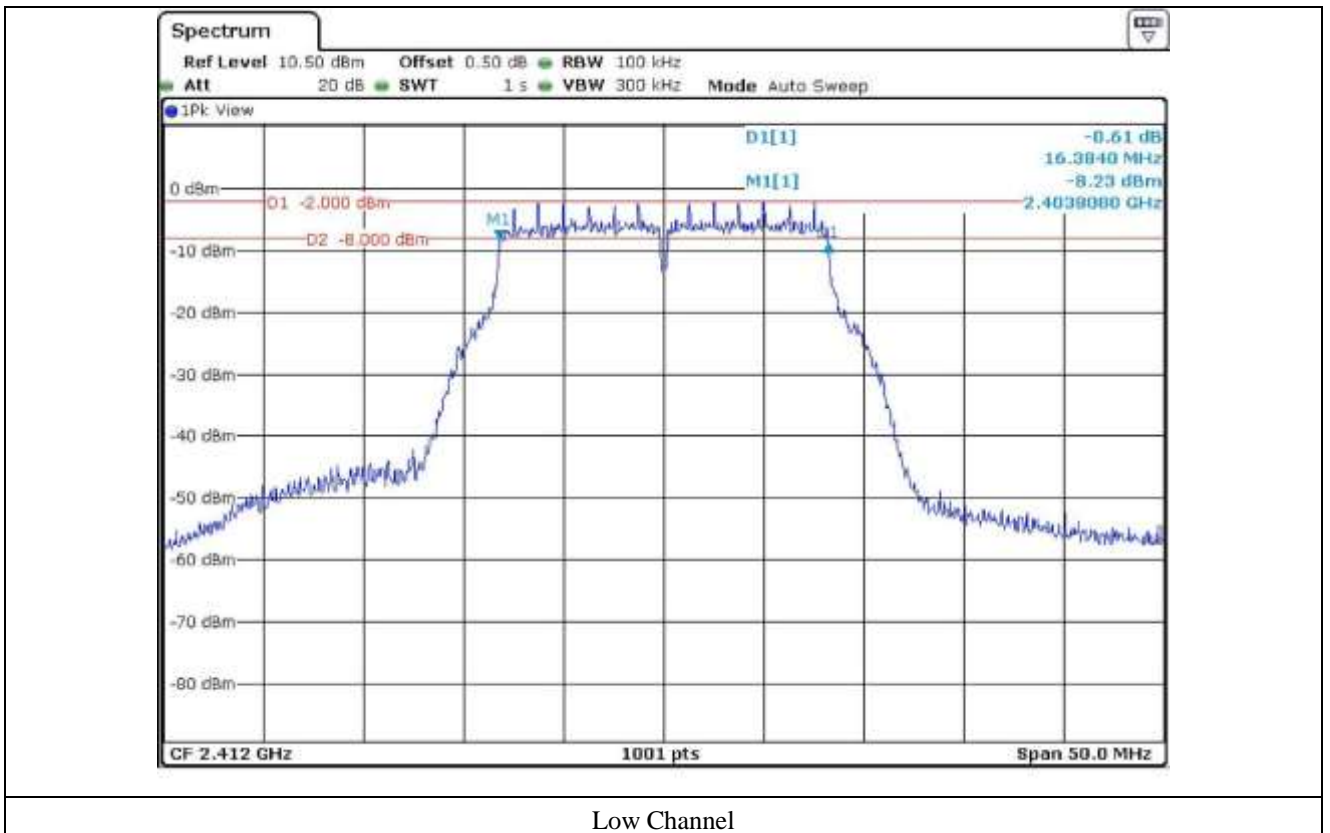
- Test Date : May 20, 2015

- Test Result : Pass

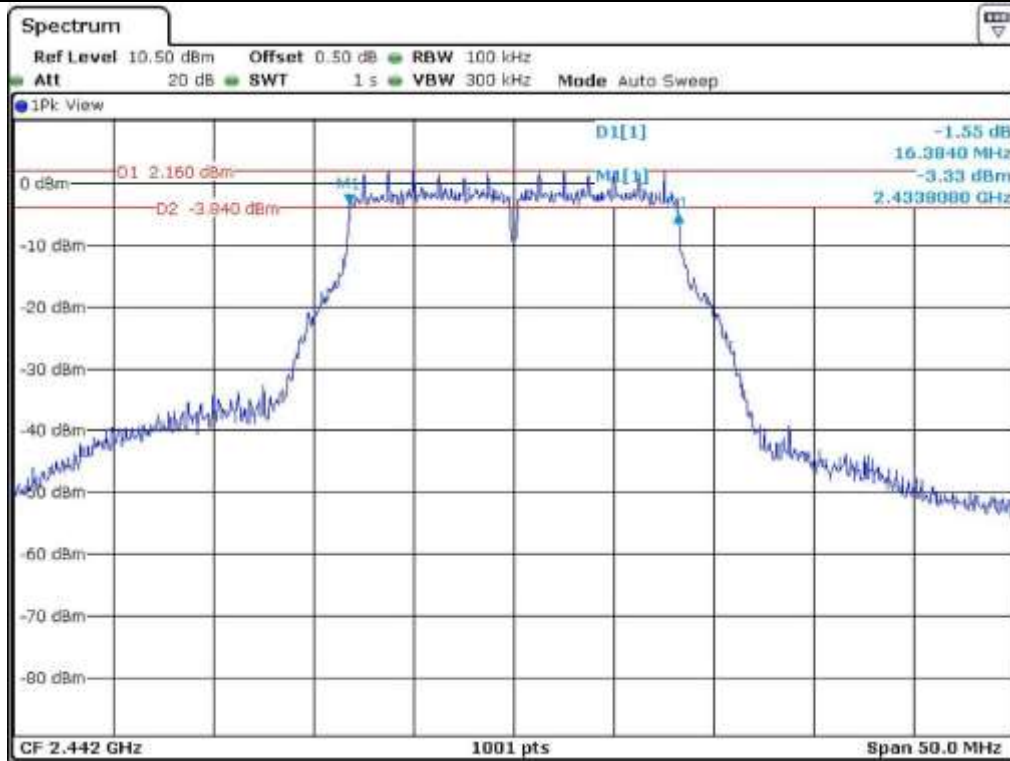
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	16.38	16.58	0.5	-15.88
Middle	2 442	16.38	16.58	0.5	-15.88
High	2 462	16.38	16.58	0.5	-15.88

Remark. Margin = Measured Value - Limit

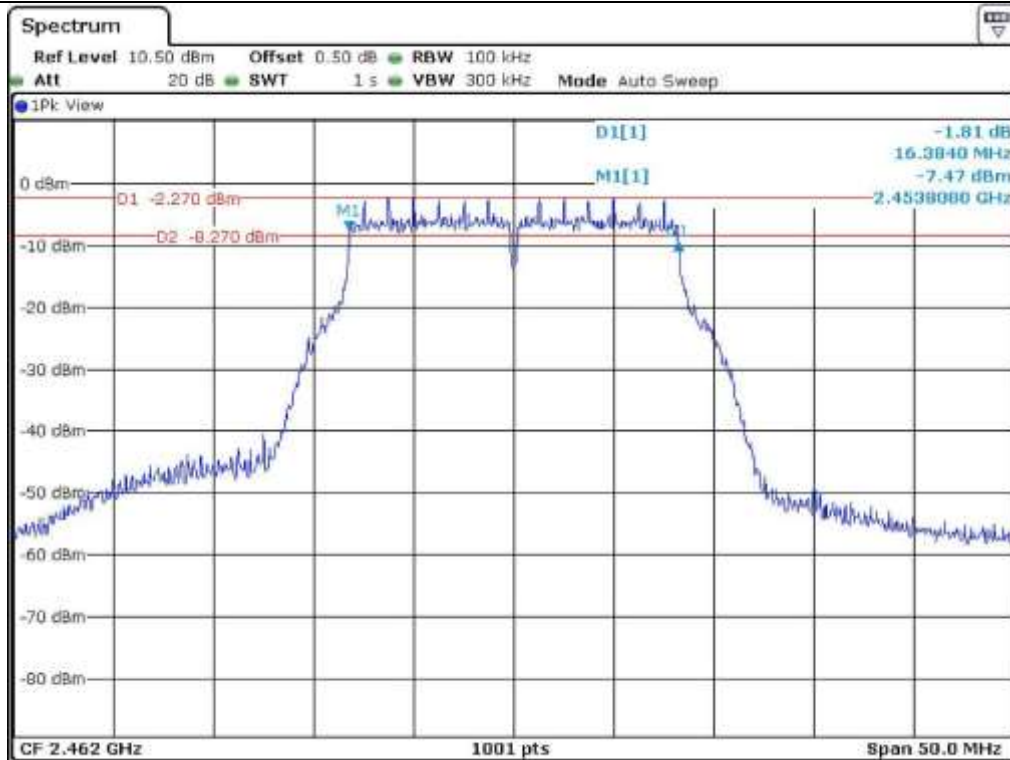
Tested by: Tae-Ho, Kim / Senior Engineer



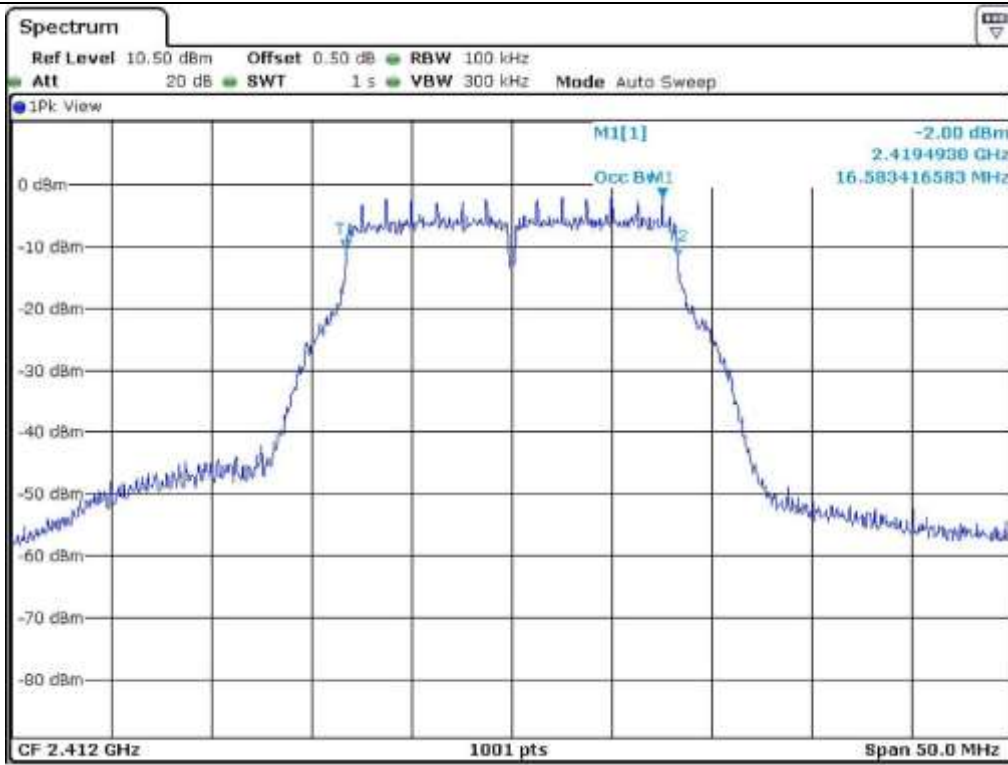
Low Channel



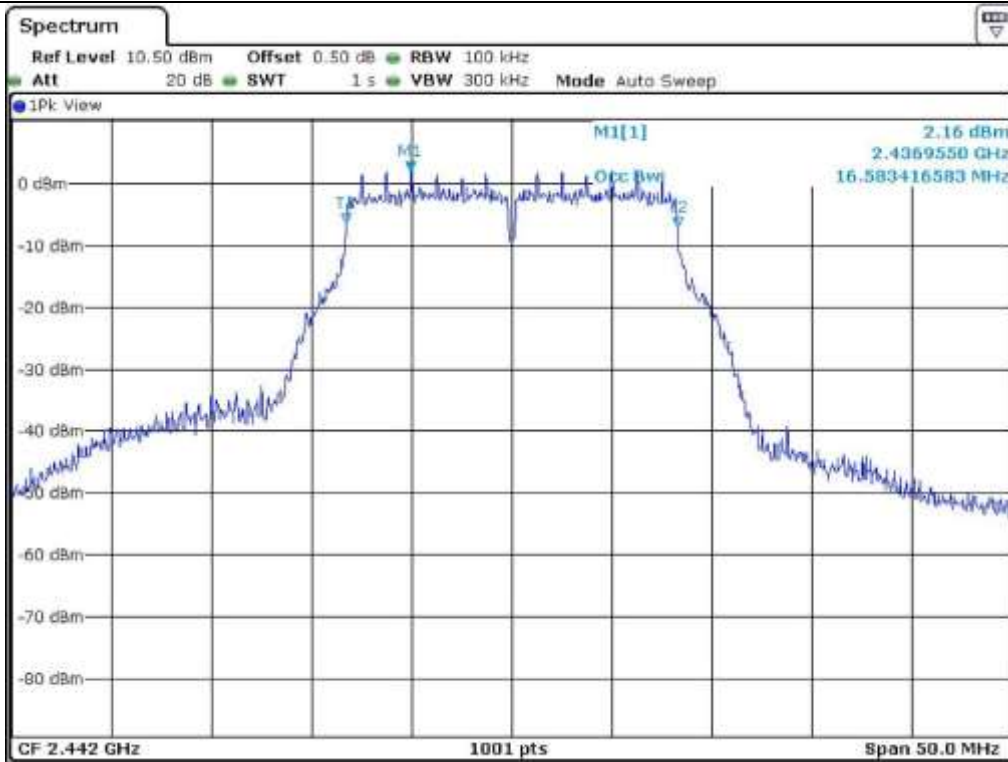
Middle Channel



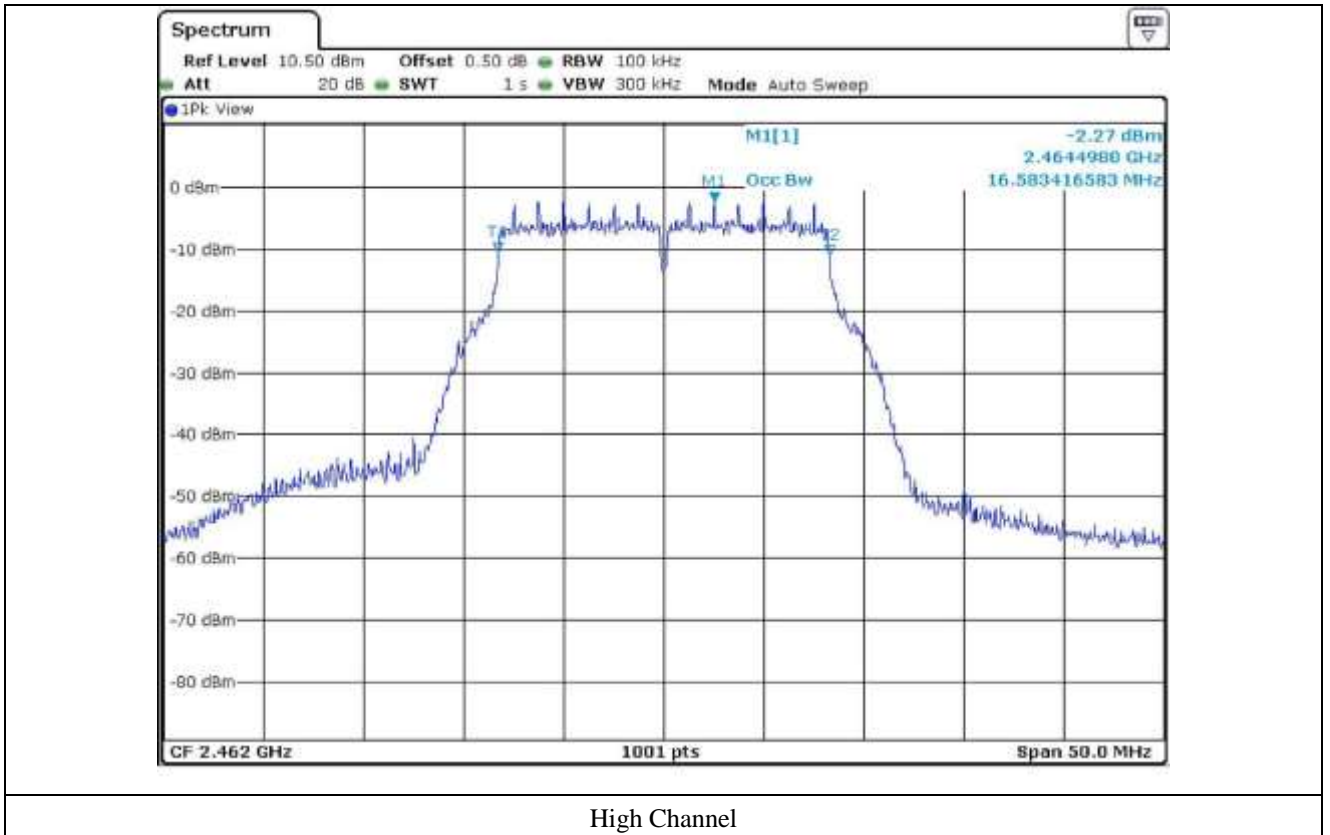
High Channel



Low Channel



Middle Channel



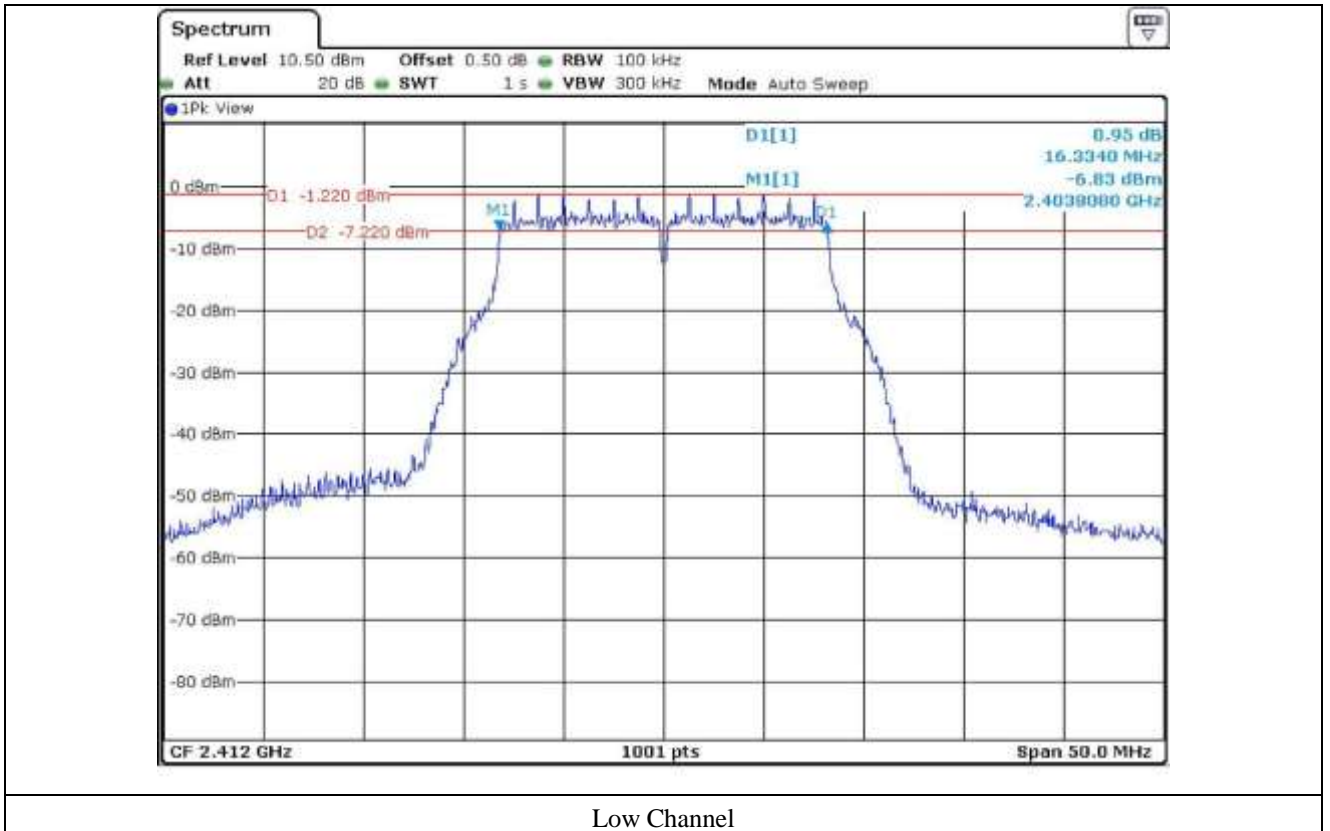
7.1.5.2 Test data for Antenna 1

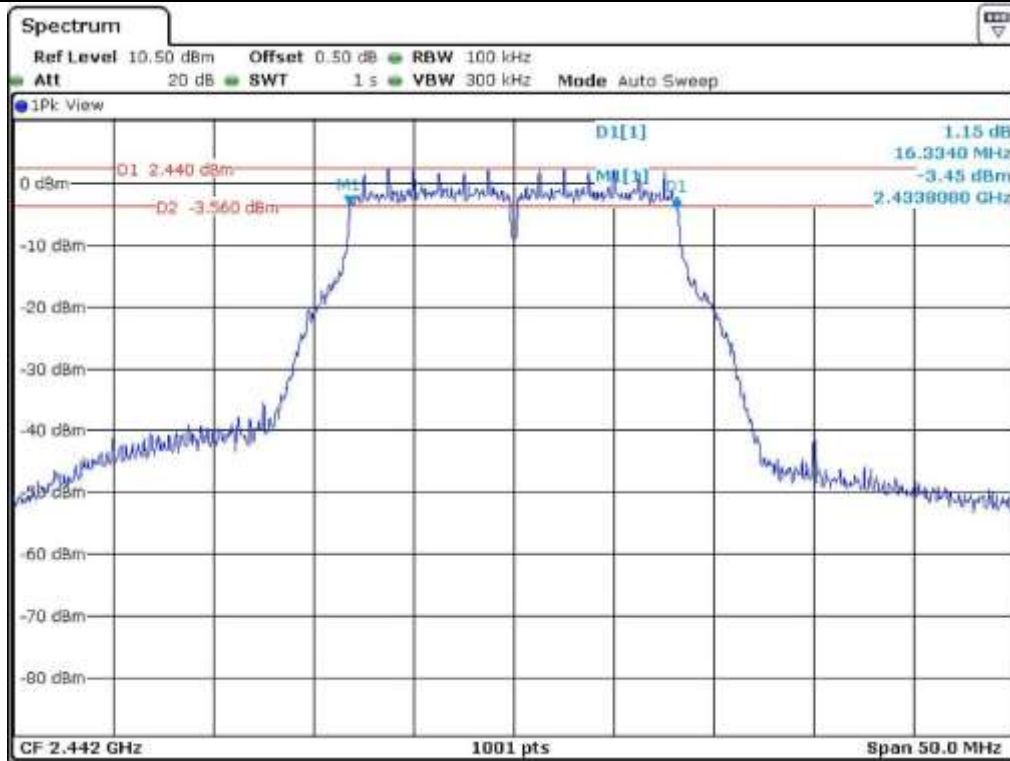
- Test Date : May 20, 2015
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	16.33	16.58	0.5	-15.83
Middle	2 442	16.33	16.53	0.5	-15.83
High	2 462	16.33	16.53	0.5	-15.83

Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Engineer

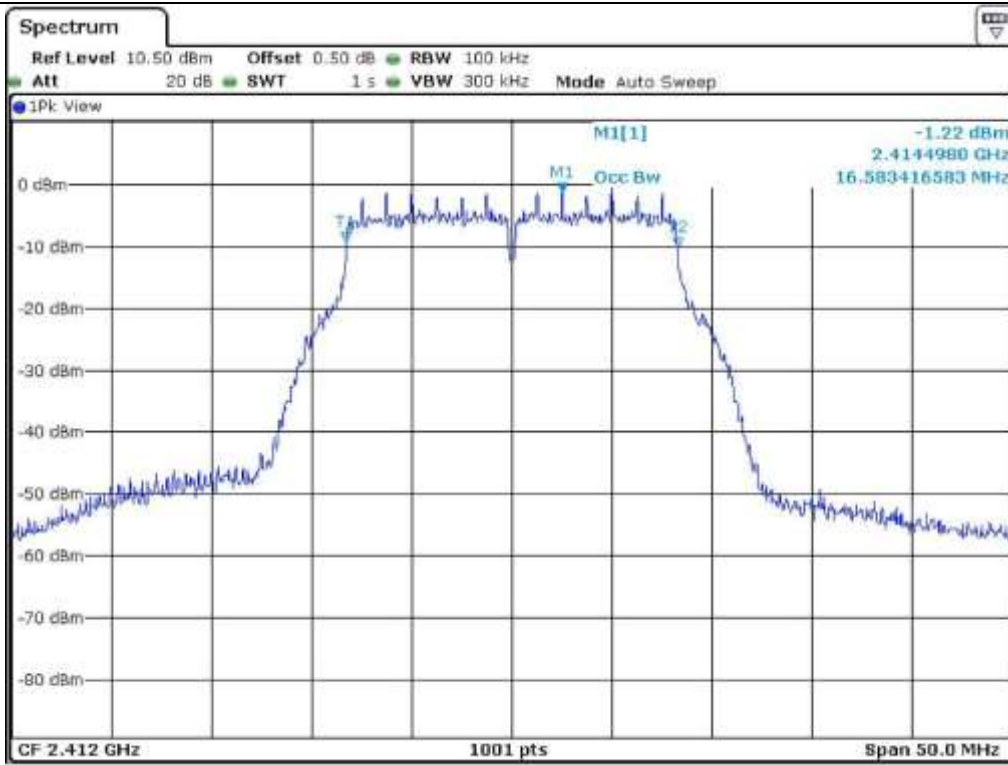




Middle Channel



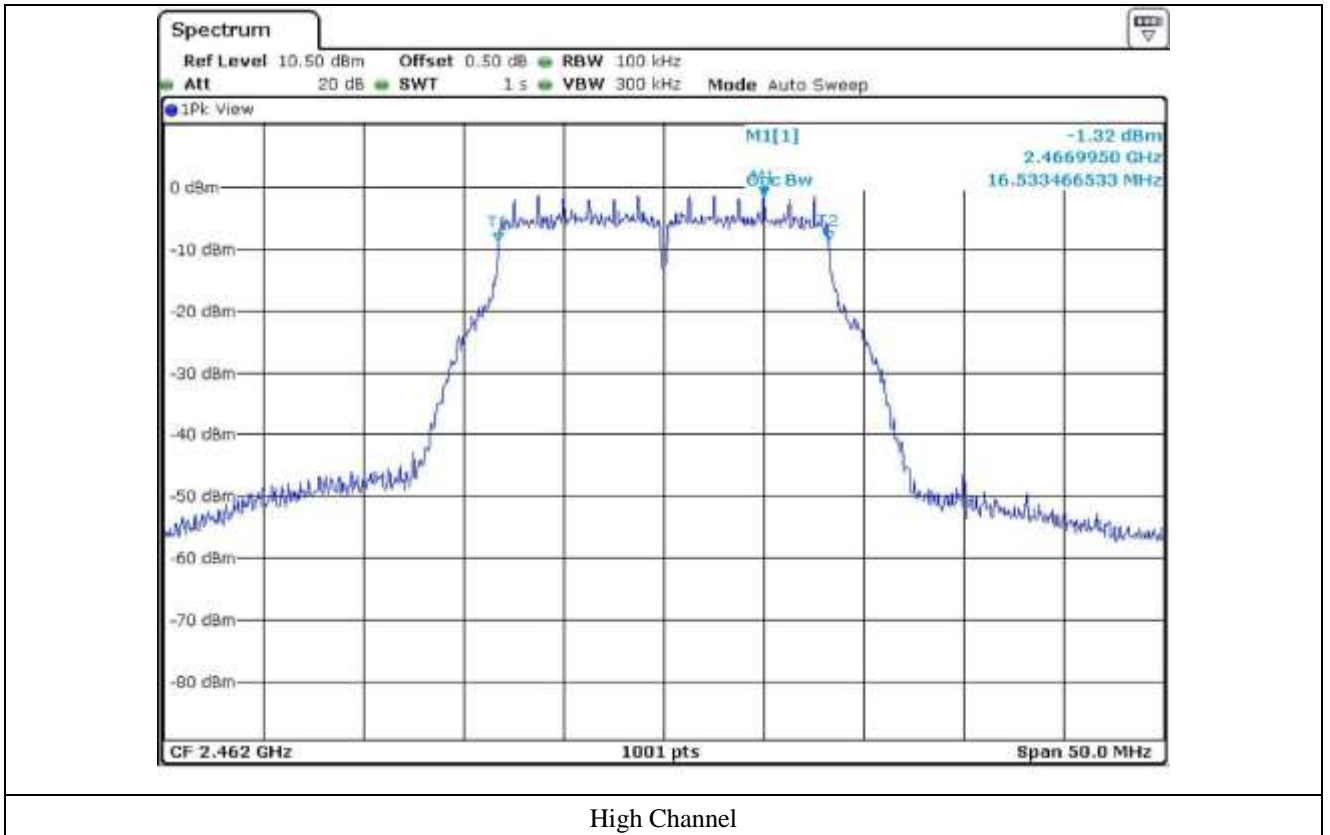
High Channel



Low Channel



Middle Channel



High Channel

7.1.6 Test data for 802.11n_HT20

7.1.6.1 Test data for Antenna 0

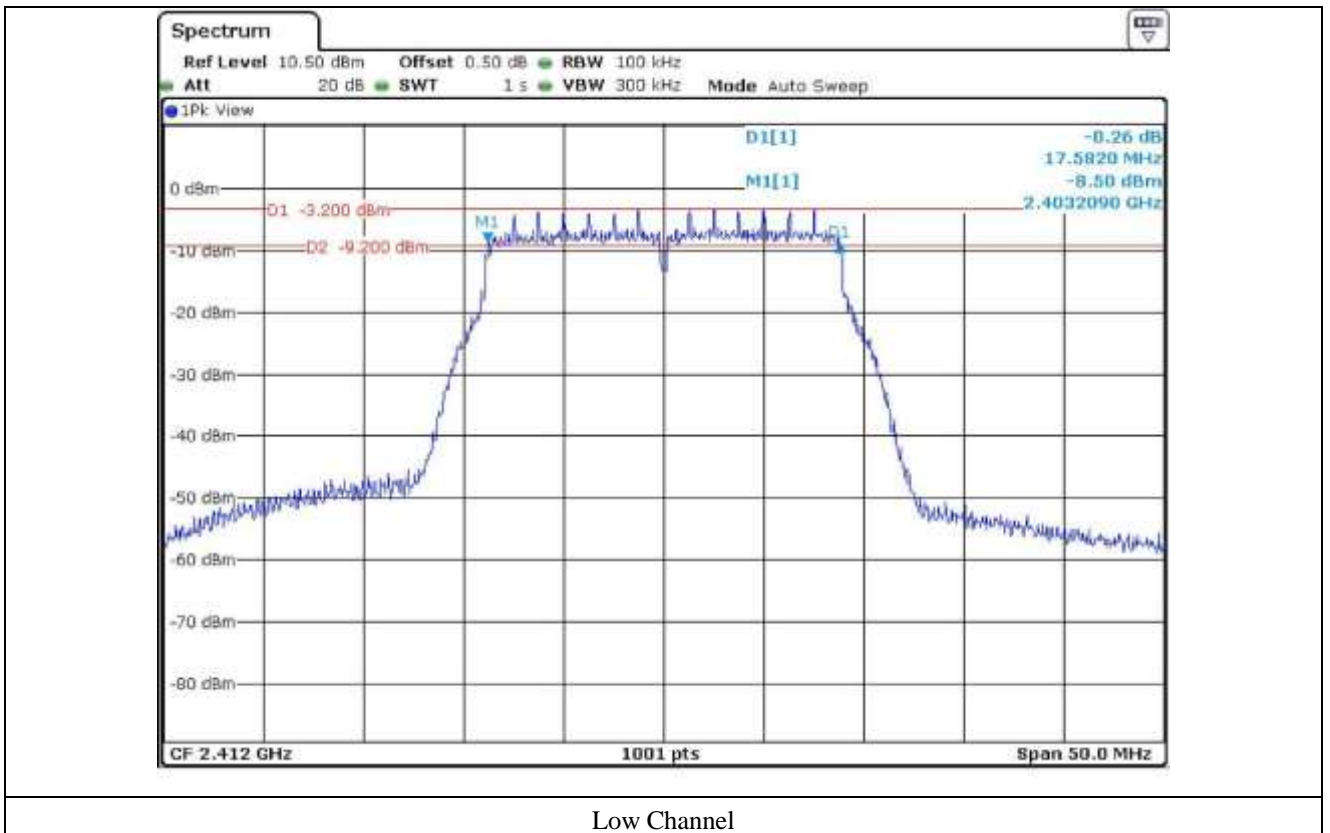
- Test Date : May 20, 2015
- Test Result : Pass

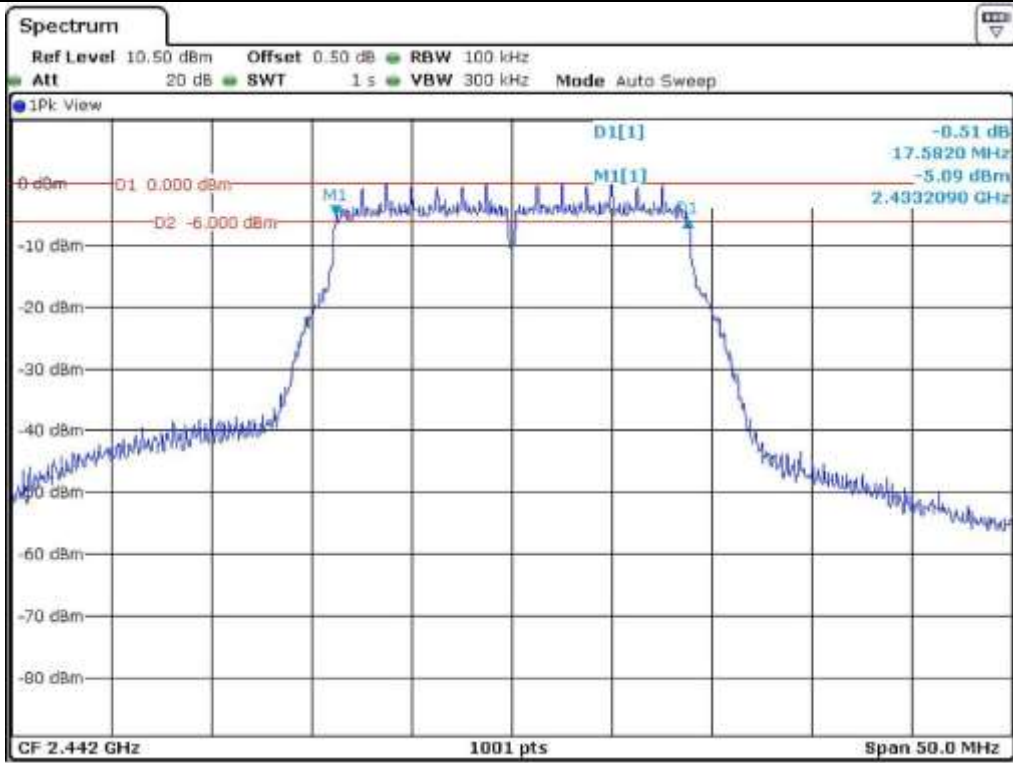
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	17.58	17.78	0.5	-17.08
Middle	2 442	17.58	17.78	0.5	-17.08
High	2 462	17.58	17.78	0.5	-17.08

Remark. Margin = Measured Value - Limit

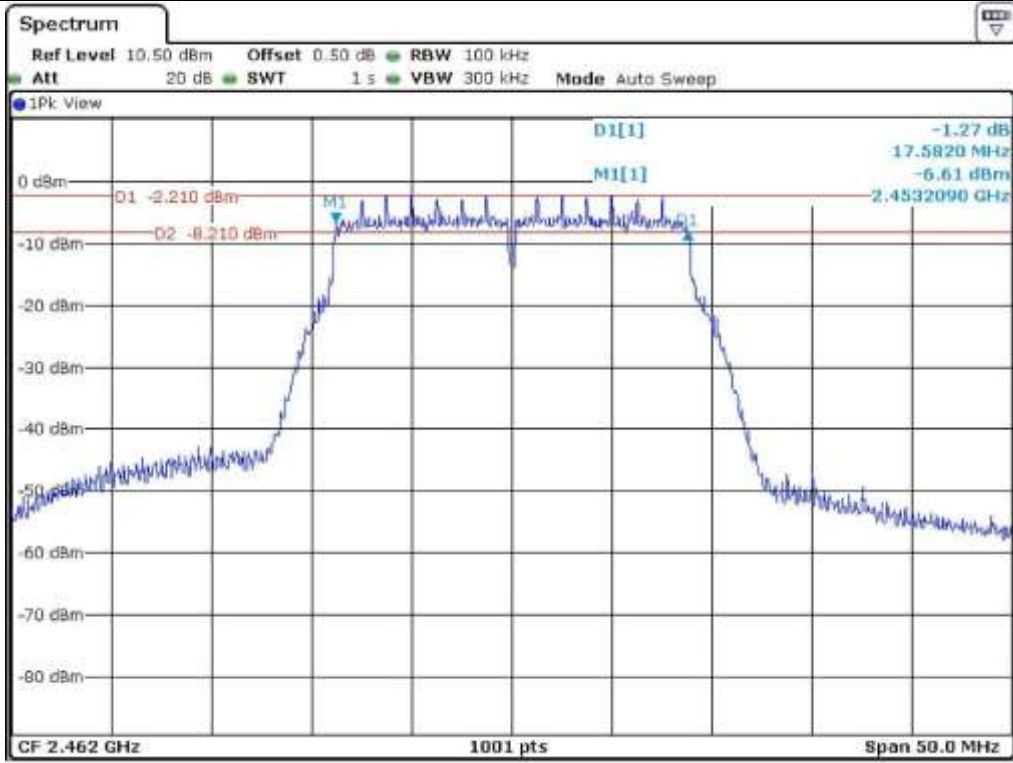


Tested by: Tae-Ho, Kim / Senior Engineer

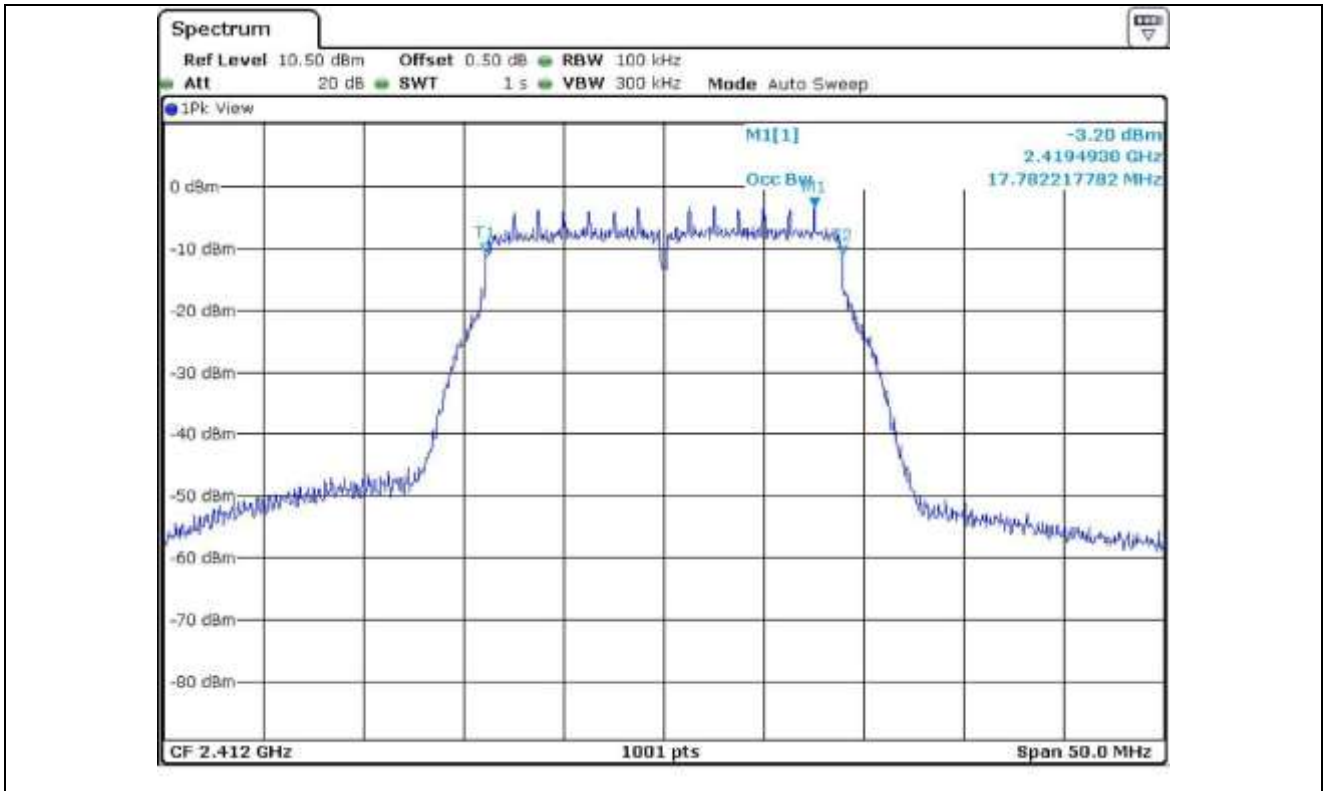




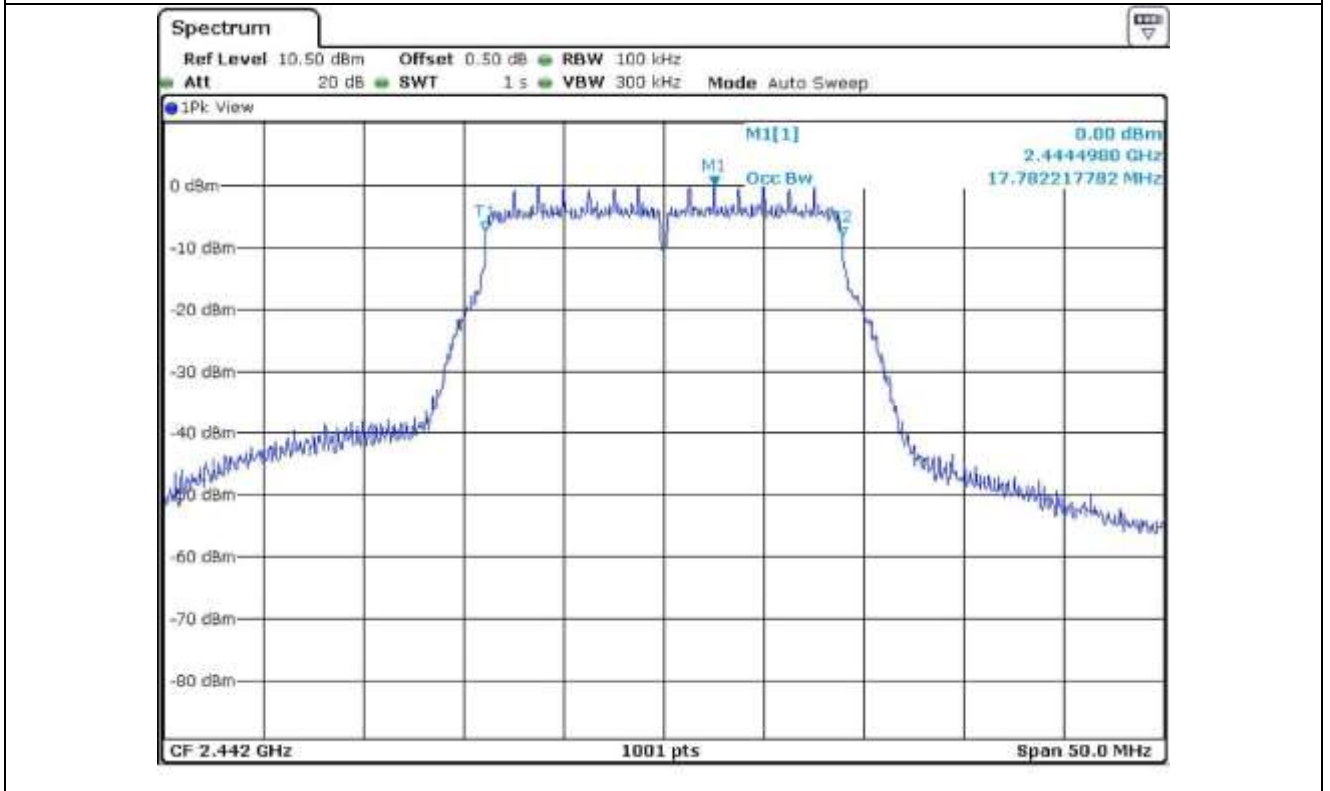
Middle Channel



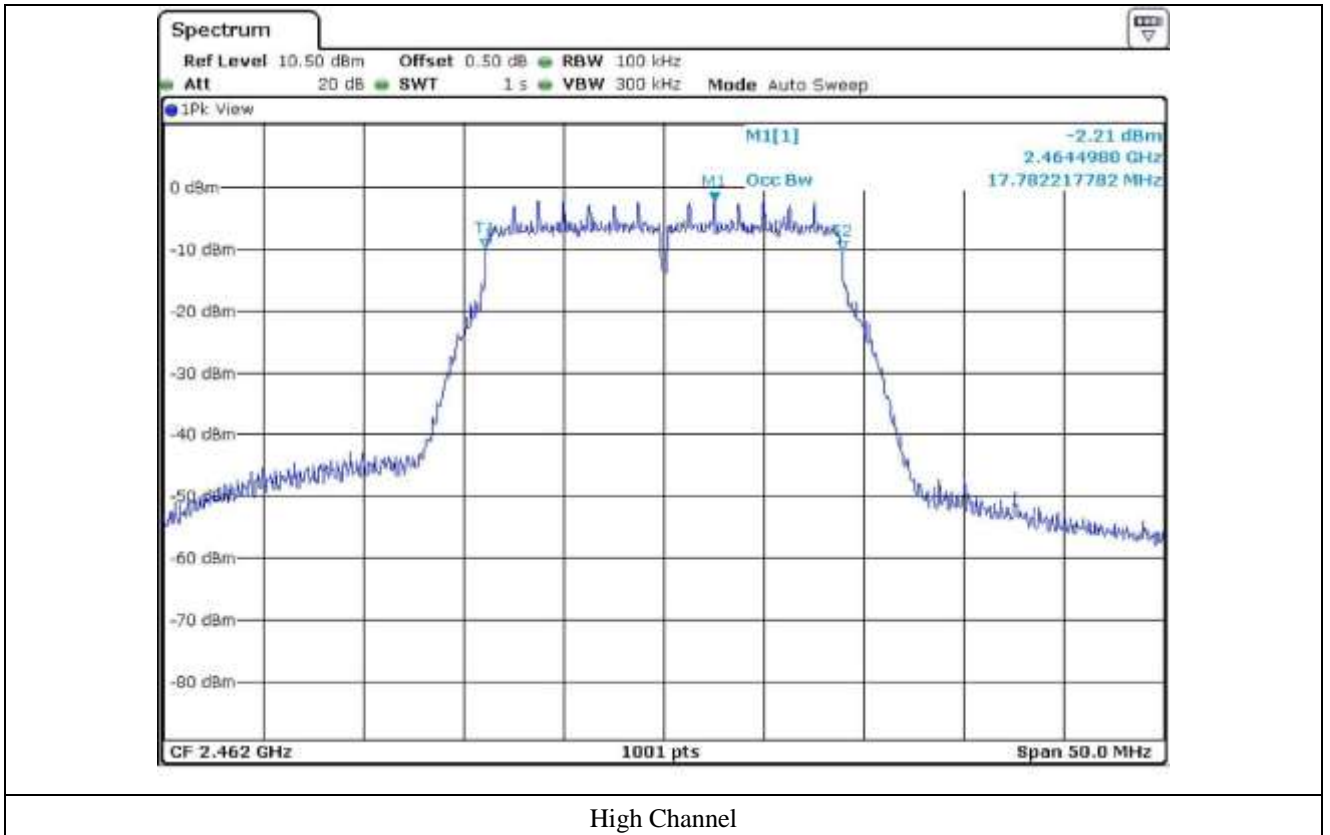
High Channel



Low Channel



Middle Channel



7.1.6.2 Test data for Antenna 1

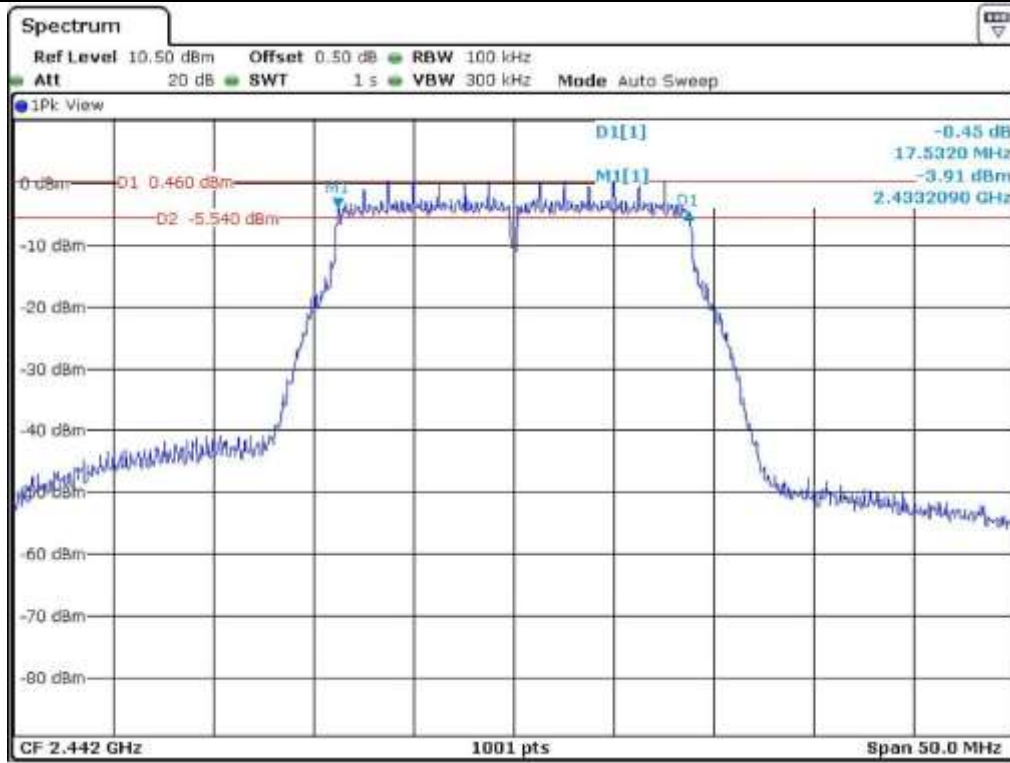
- Test Date : May 20, 2015
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	17.53	17.78	0.5	-17.03
Middle	2 442	17.53	17.78	0.5	-17.03
High	2 462	17.53	17.78	0.5	-17.03

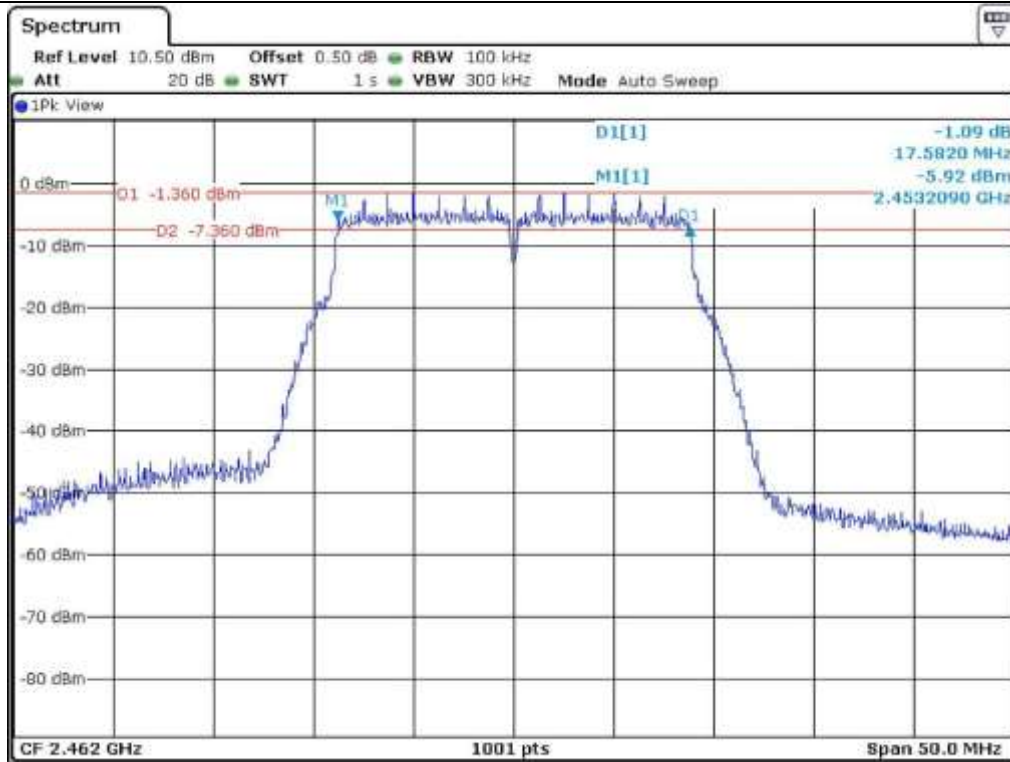
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Engineer

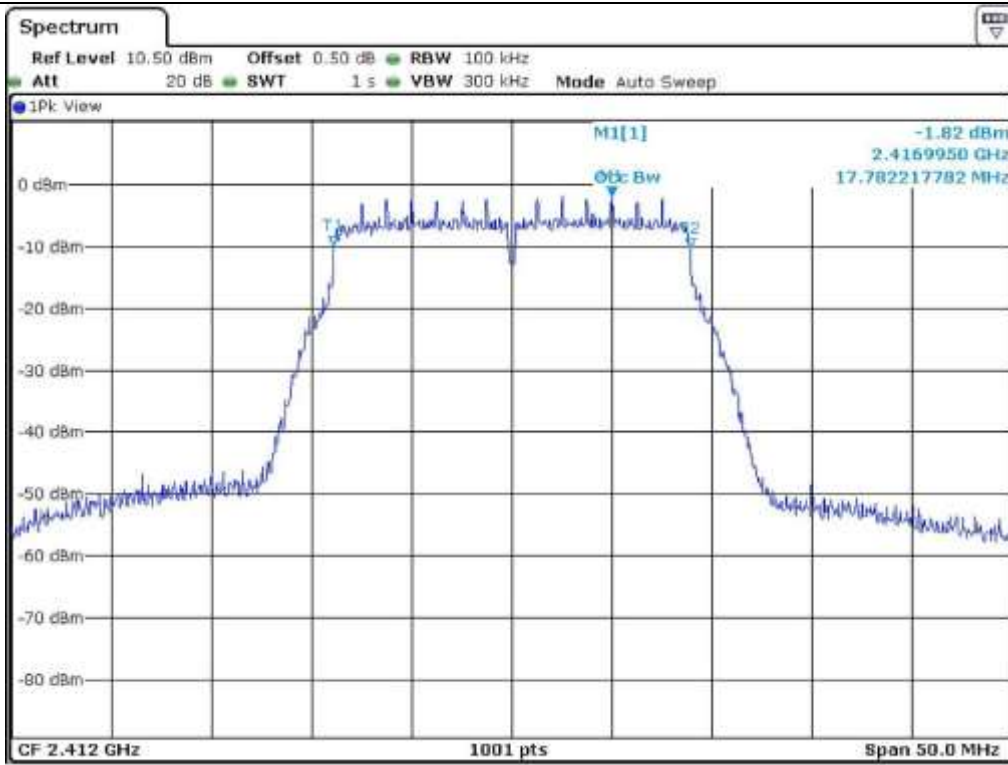




Middle Channel



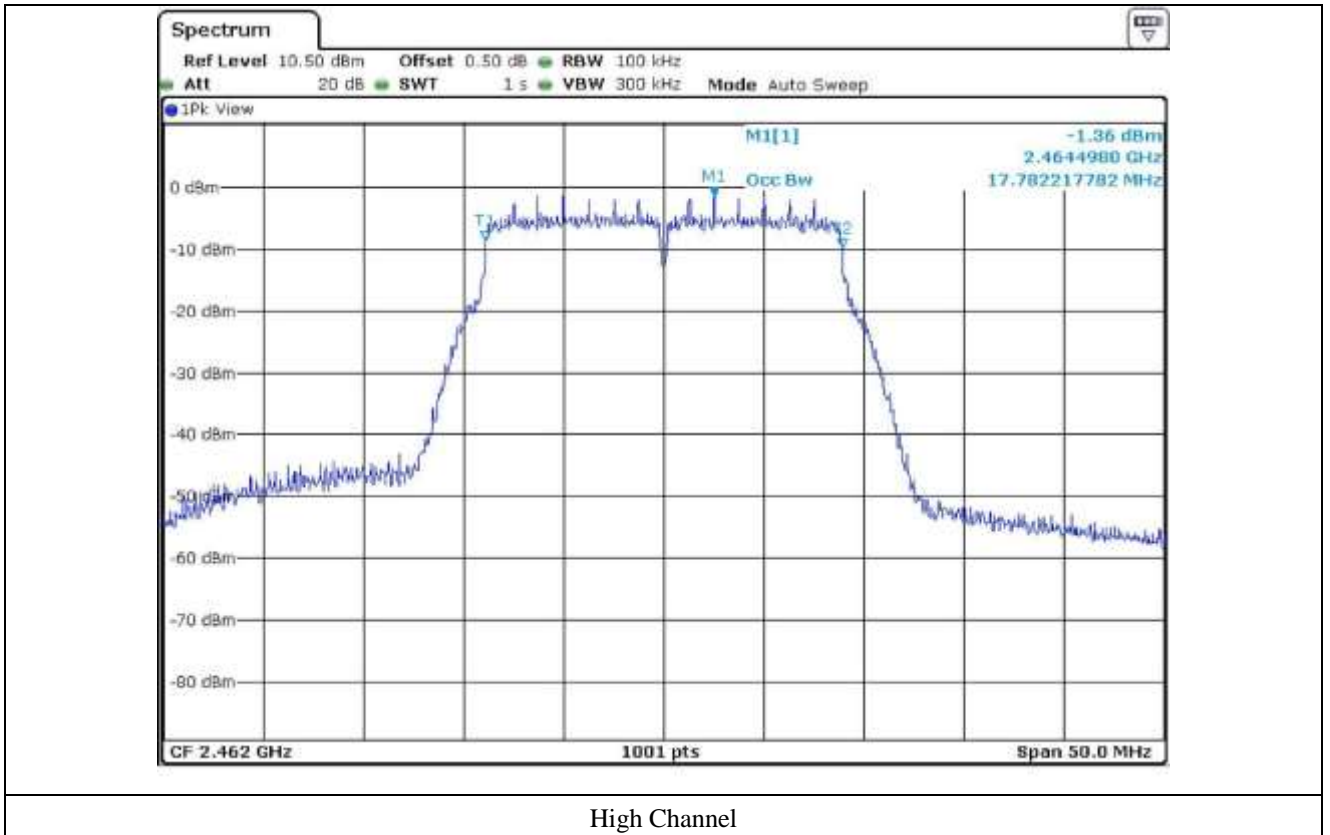
High Channel



Low Channel



Middle Channel



7.1.7 Test data for 802.11n_HT40

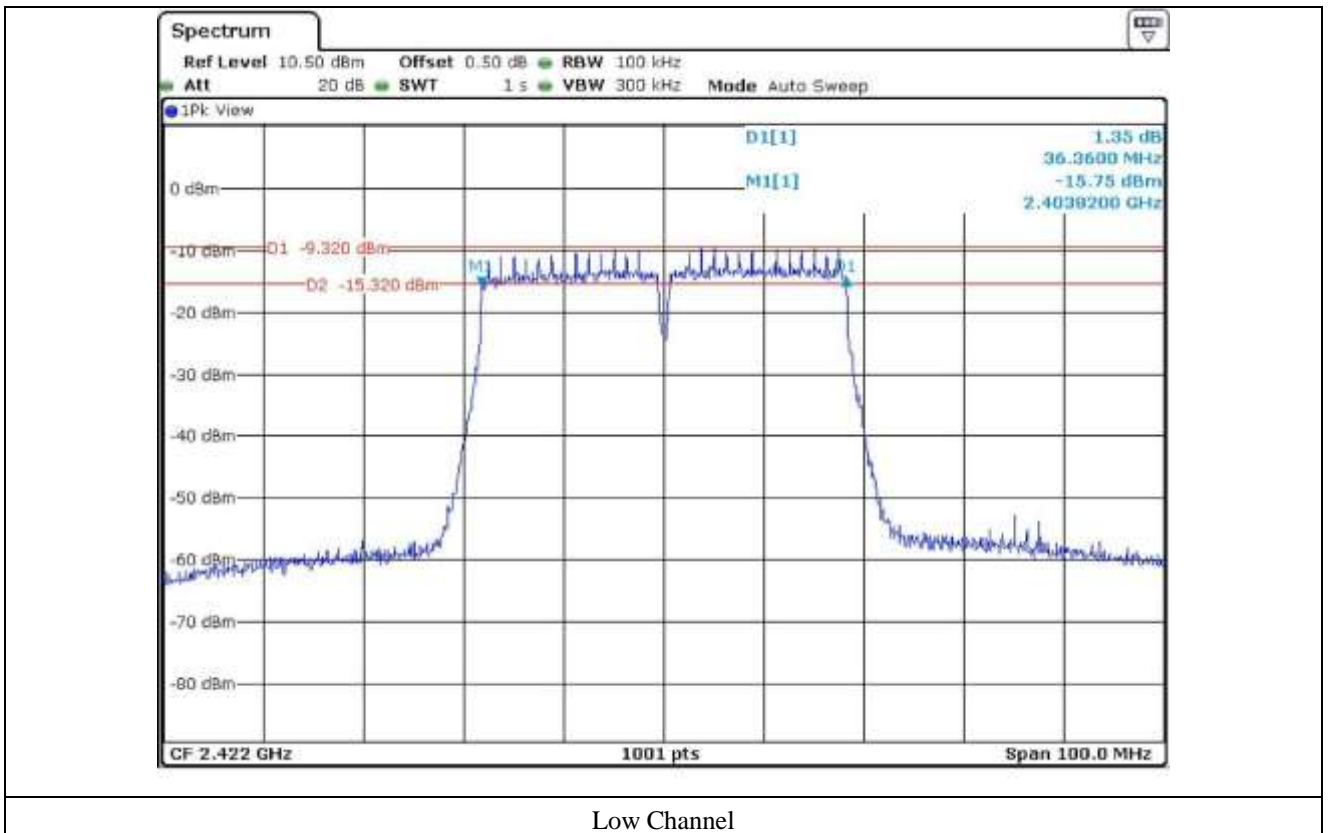
7.1.7.1 Test data for Antenna 0

- Test Date : May 20, 2015
- Test Result : Pass

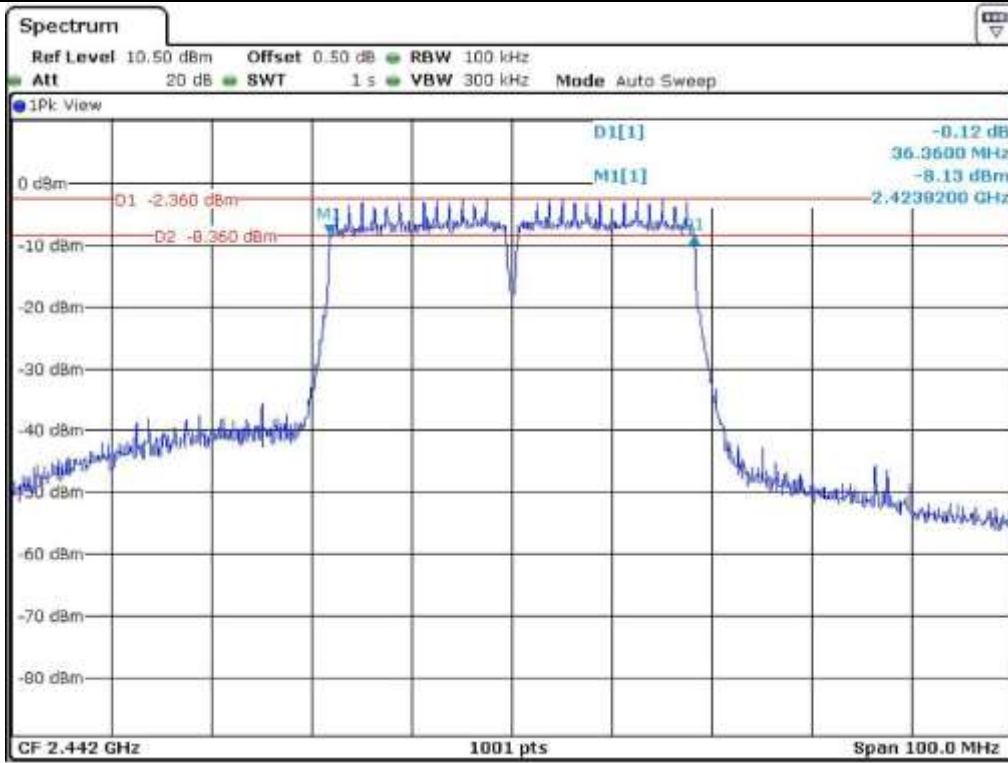
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	36.36	36.16	0.5	-35.86
Middle	2 442	36.36	36.16	0.5	-35.86
High	2 462	36.36	36.16	0.5	-35.86

Remark. Margin = Measured Value - Limit

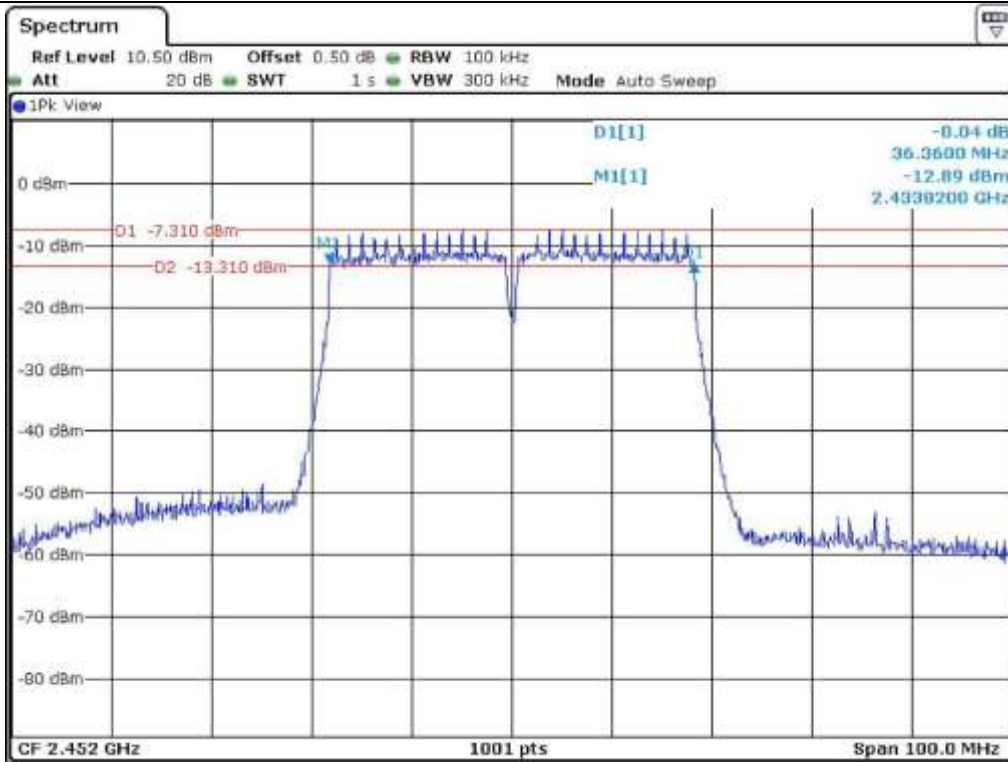
Tested by: Tae-Ho, Kim / Senior Engineer



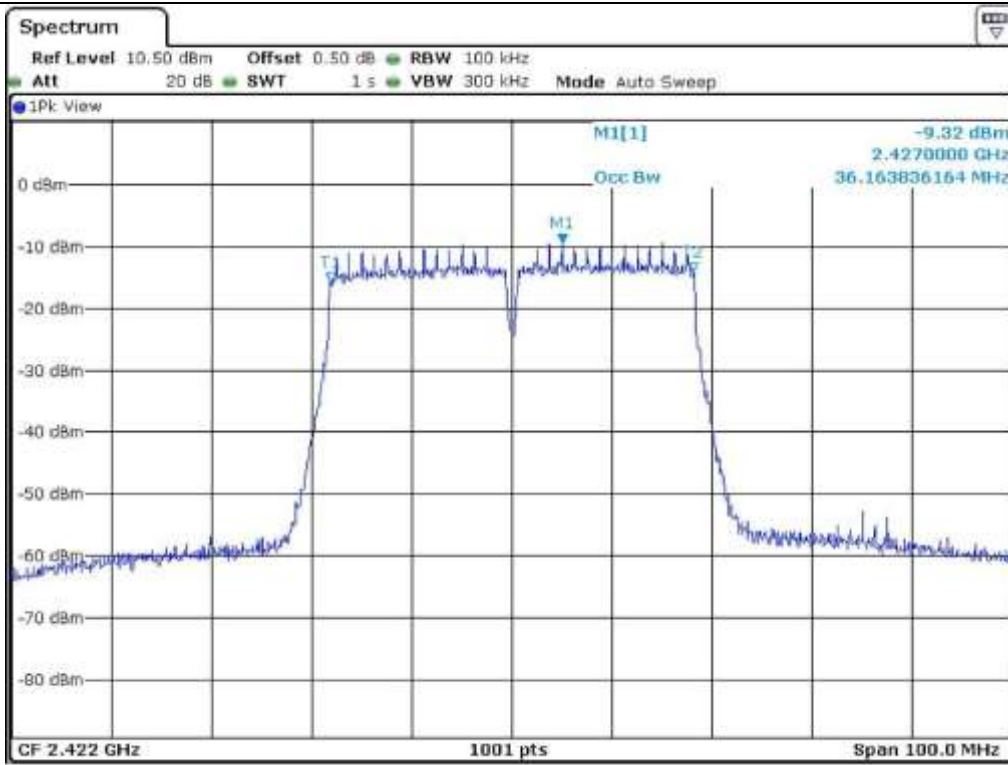
Low Channel



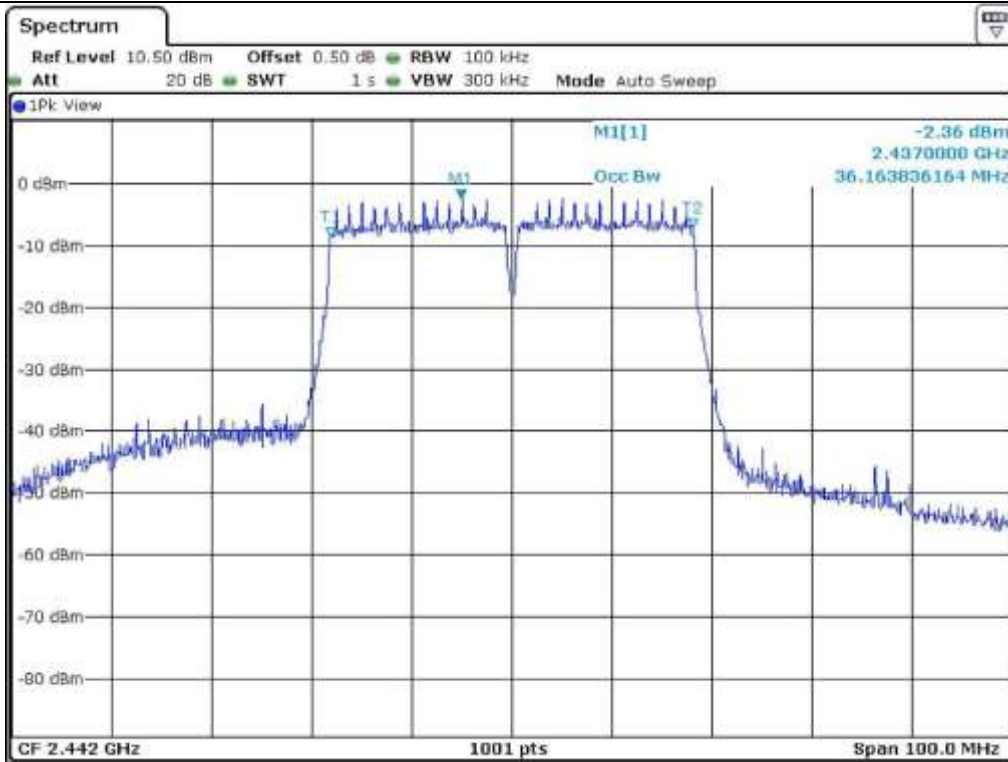
Middle Channel



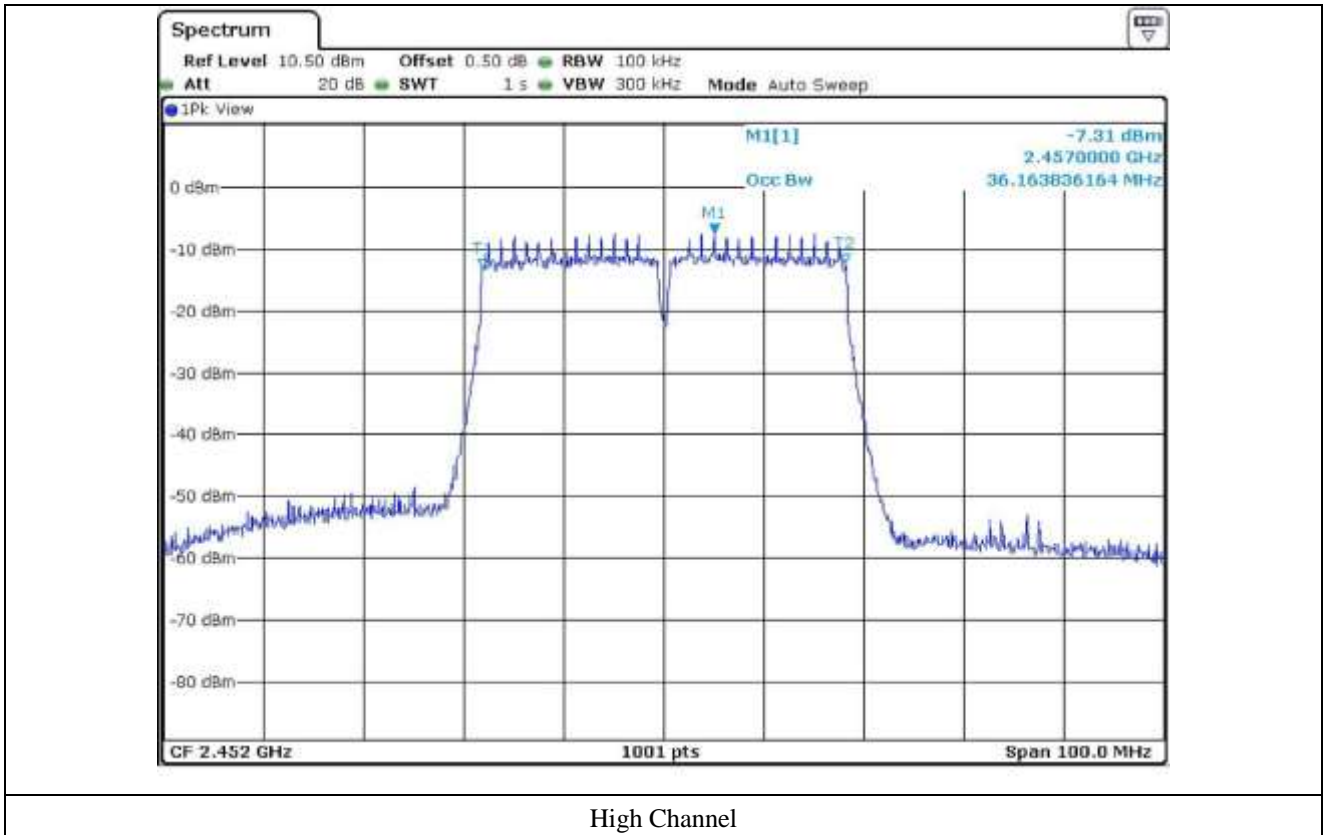
High Channel



Low Channel



Middle Channel



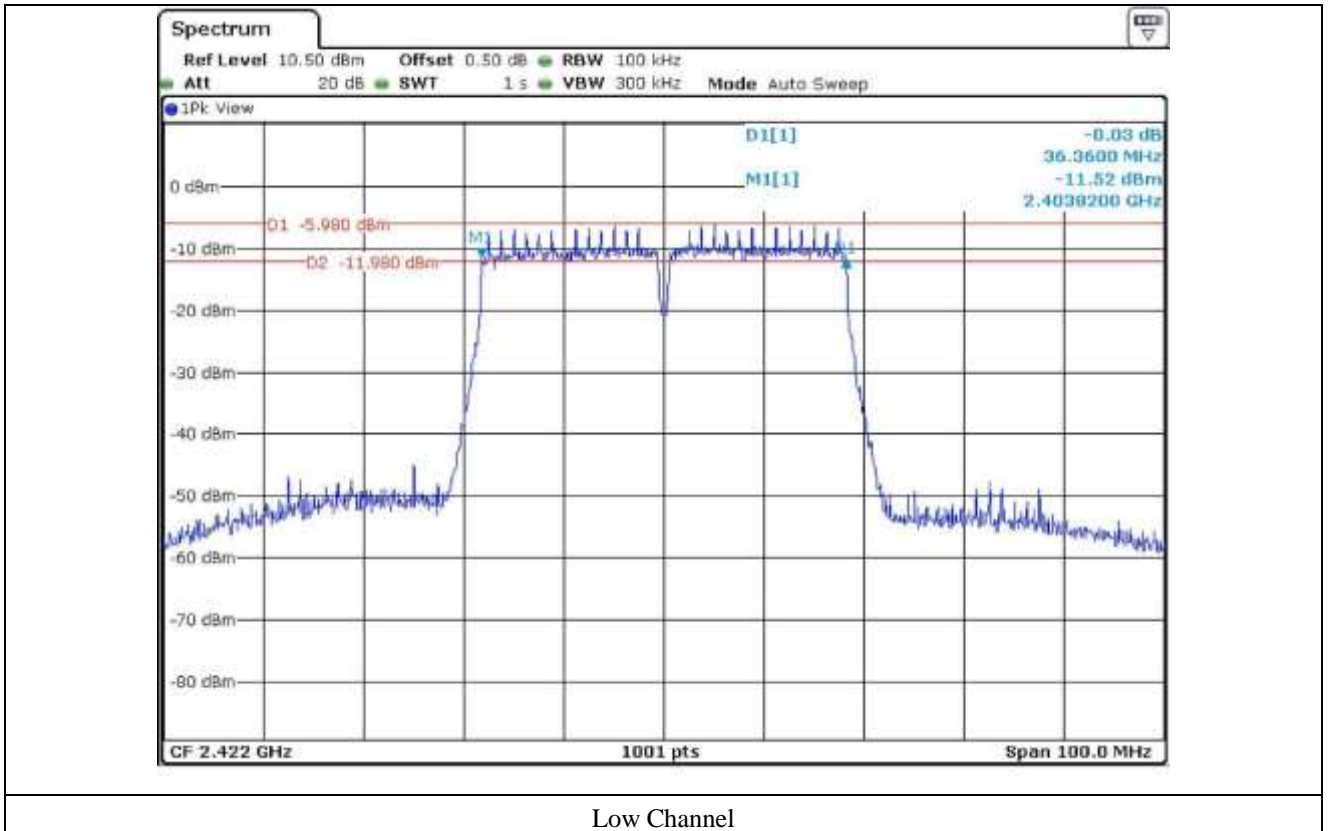
7.1.7.2 Test data for Antenna 1

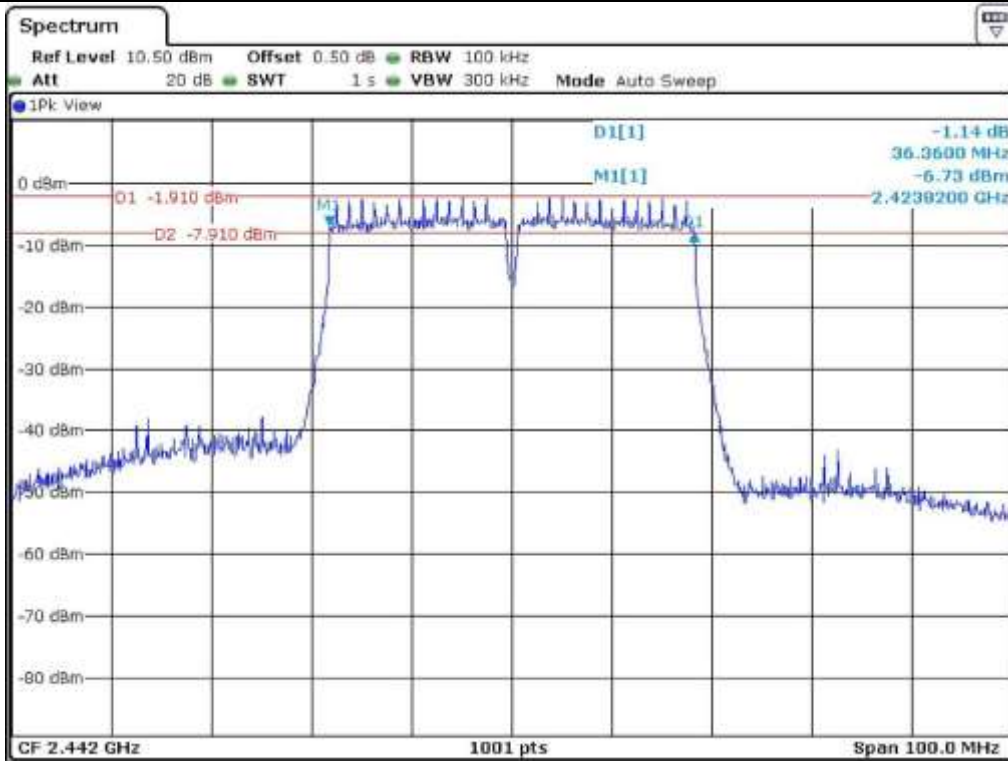
- Test Date : May 20, 2015
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412	36.36	36.16	0.5	-35.86
Middle	2 442	36.36	36.16	0.5	-35.86
High	2 462	36.36	36.16	0.5	-35.86

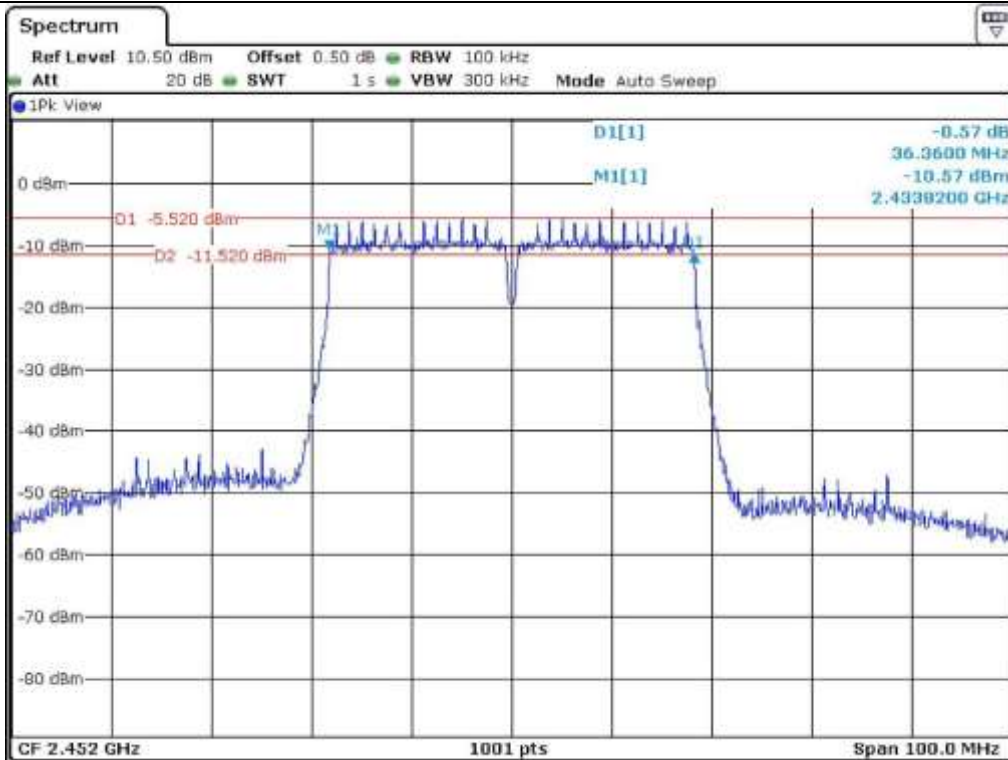
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Engineer





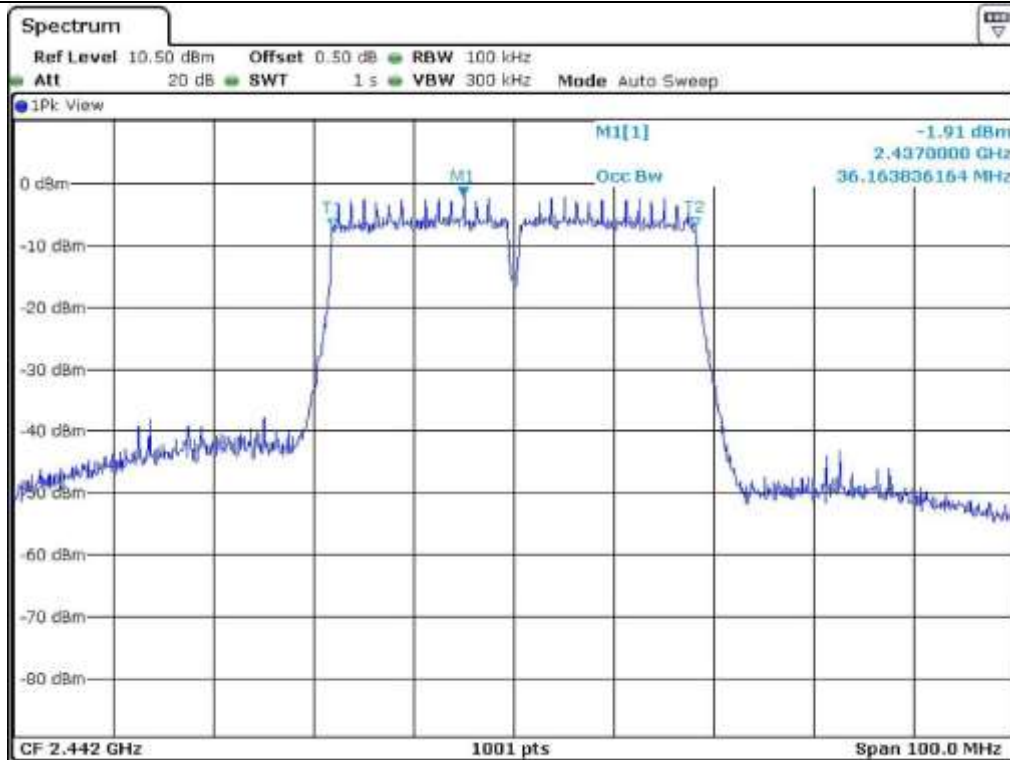
Middle Channel



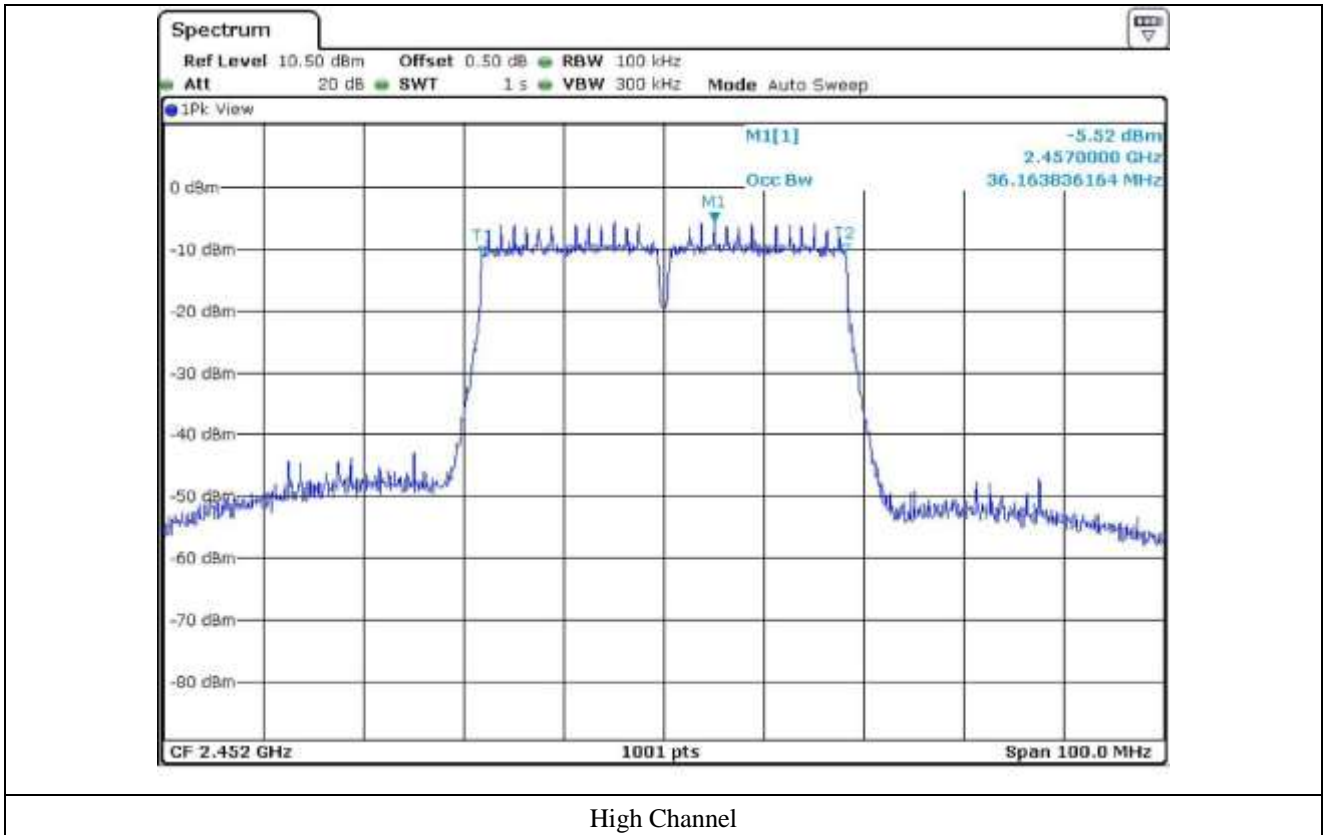
High Channel



Low Channel



Middle Channel



High Channel

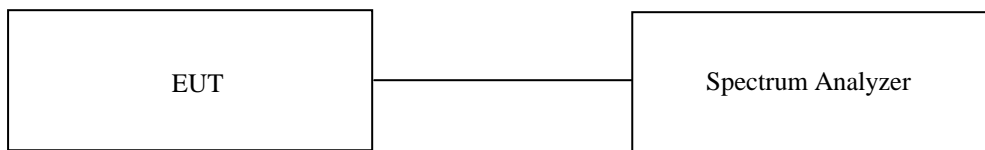
7.2 MAXIMUM PEAK OUTPUT POWER

7.2.1 Operating environment

Temperature : 21.4 °C
 Relative humidity : 45.1 % R.H.

7.2.2 Test set-up

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The spectrum analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99 % bandwidth. The EUT was operating in transmit mode at the appropriate center frequency.



7.2.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Jul. 30, 2014 (1Y)

All test equipment used is calibrated on a regular basis.

7.2.4 Test data for 802.11b

7.2.4.1 Test data for Antenna 0

- Test Date : May 20, 2015

- Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	9.04	13.85	30	16.15
MIDDLE	2 442	9.04	13.66	30	16.34
HIGH	2 462	9.04	13.60	30	16.40

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

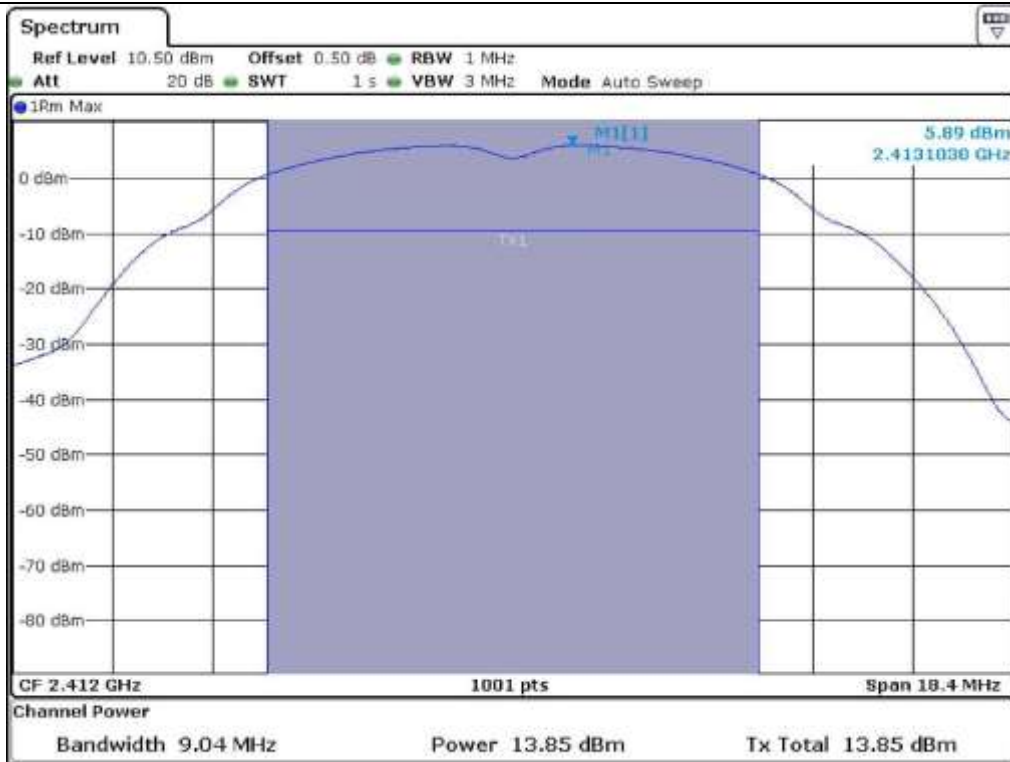
- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	11.59	14.05	30	15.95
MIDDLE	2 442	11.34	13.87	30	16.13
HIGH	2 462	11.49	13.91	30	16.09

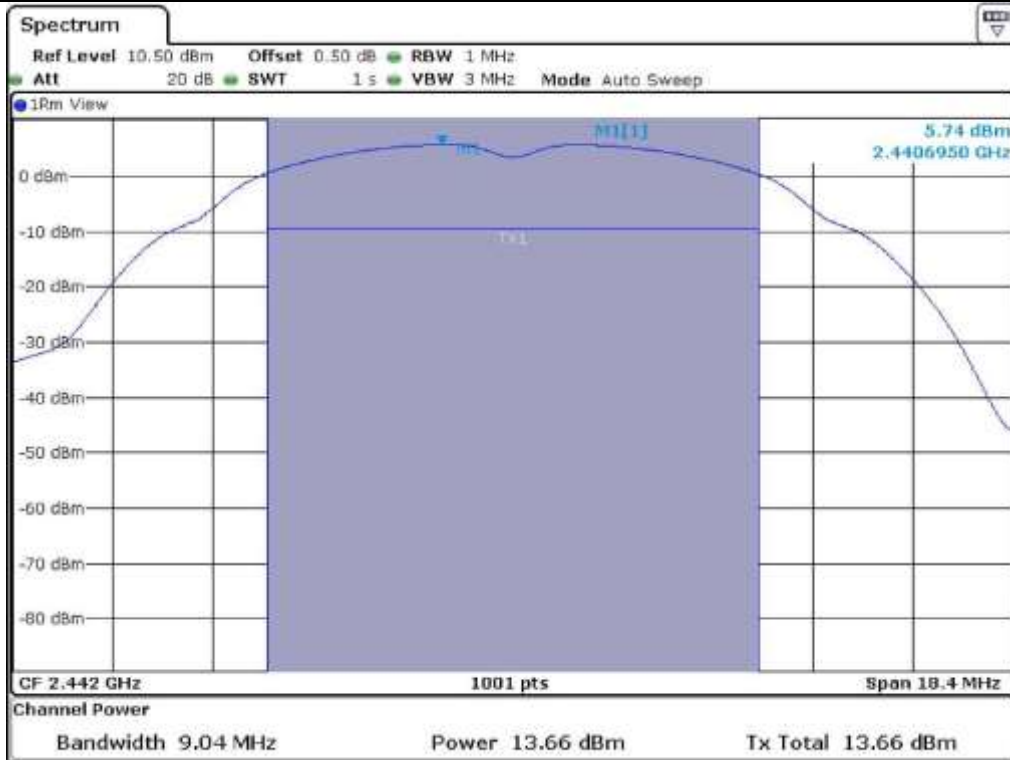
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



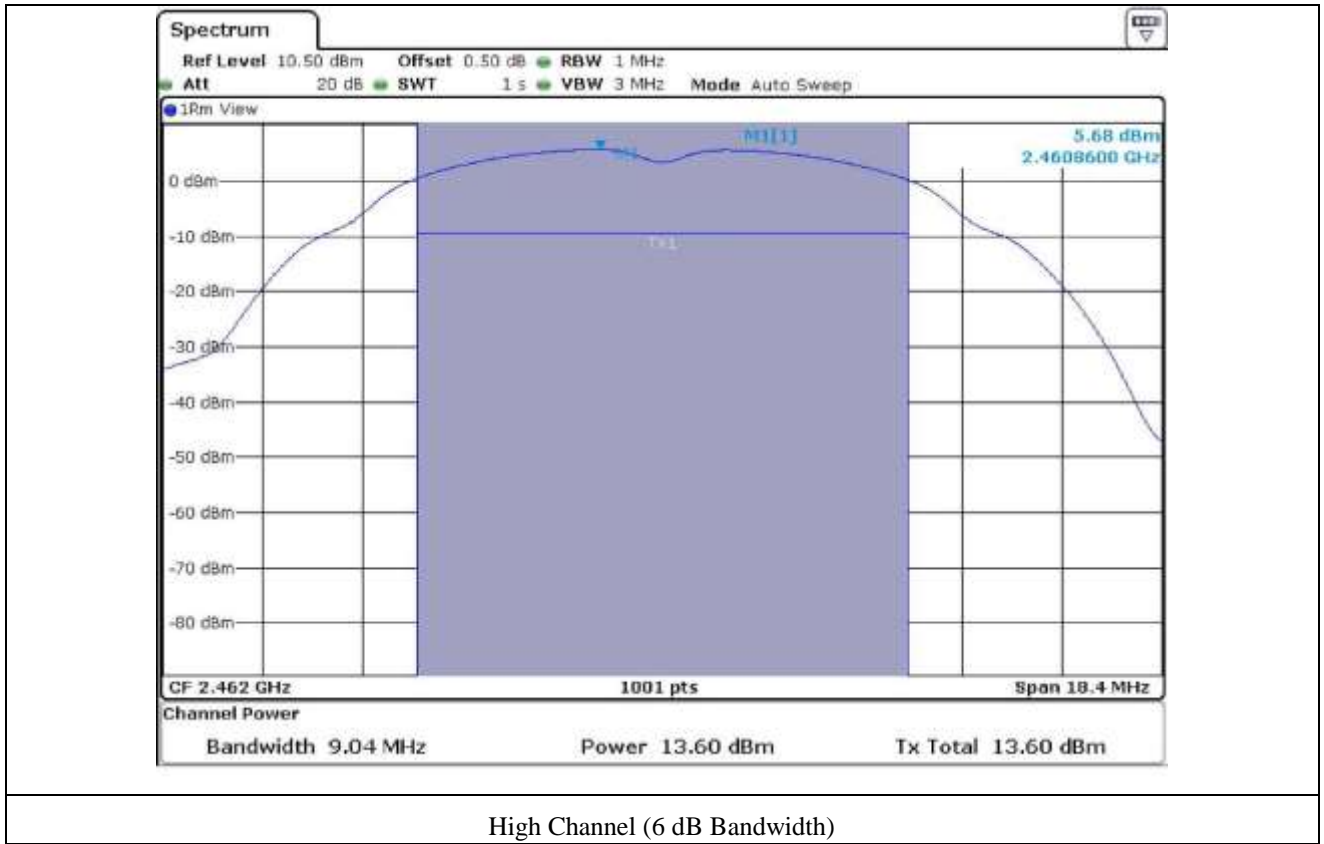
Tested by: Tae-Ho, Kim / Senior Engineer

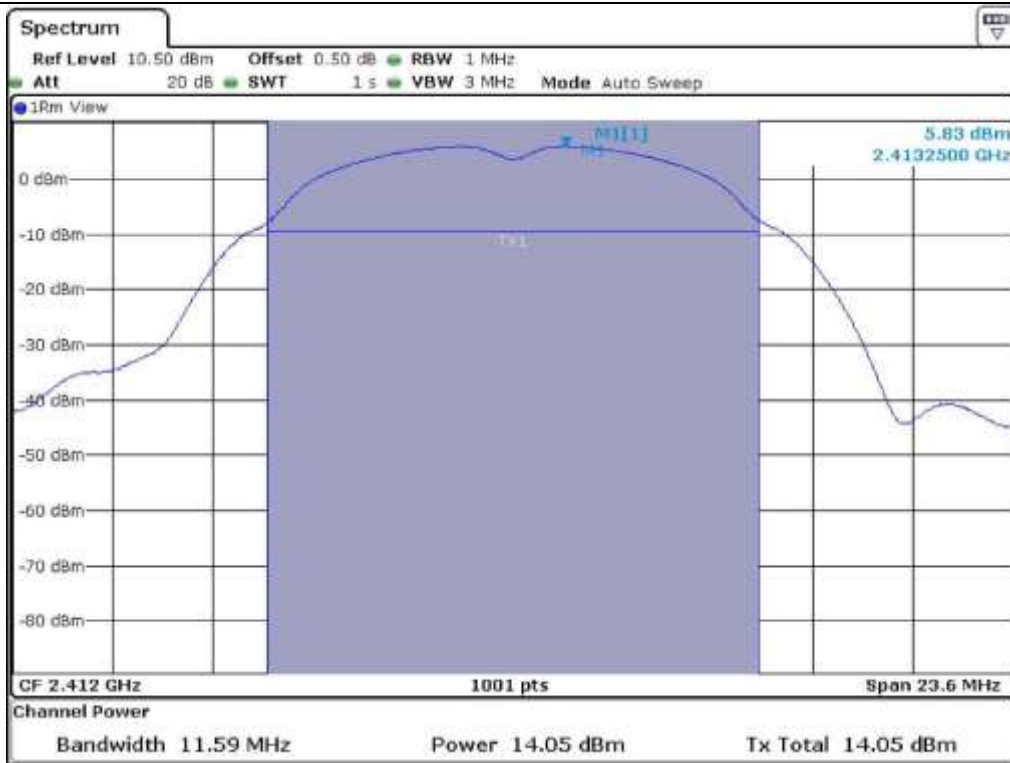


Low Channel (6 dB Bandwidth)

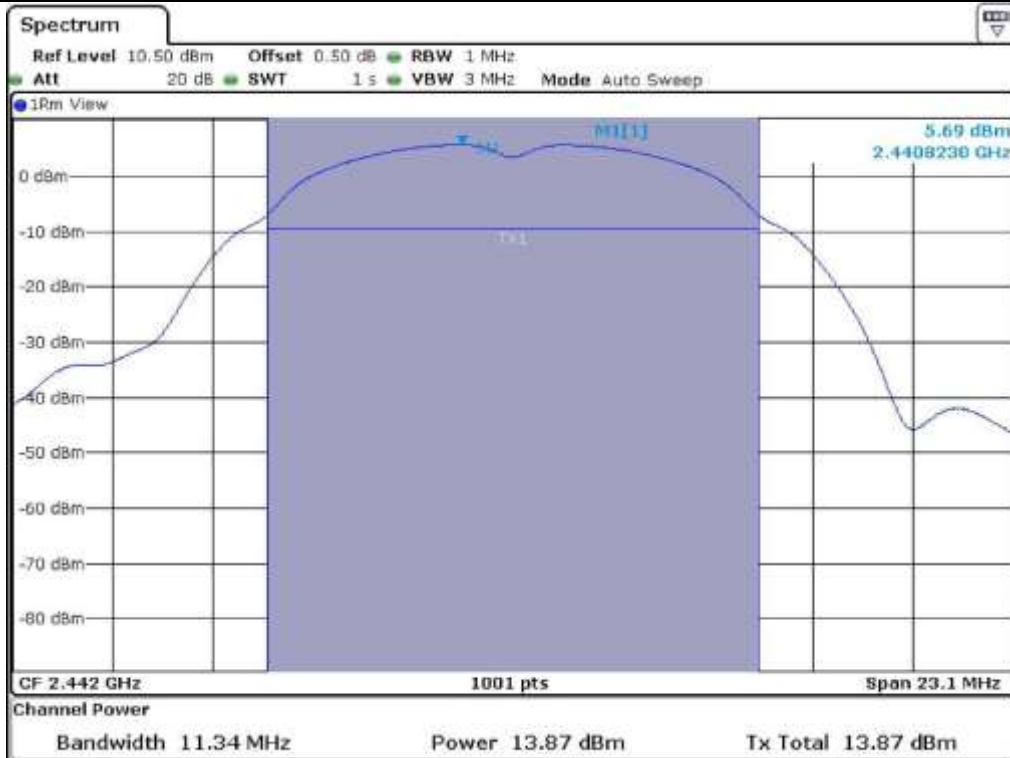


Middle Channel (6 dB Bandwidth)

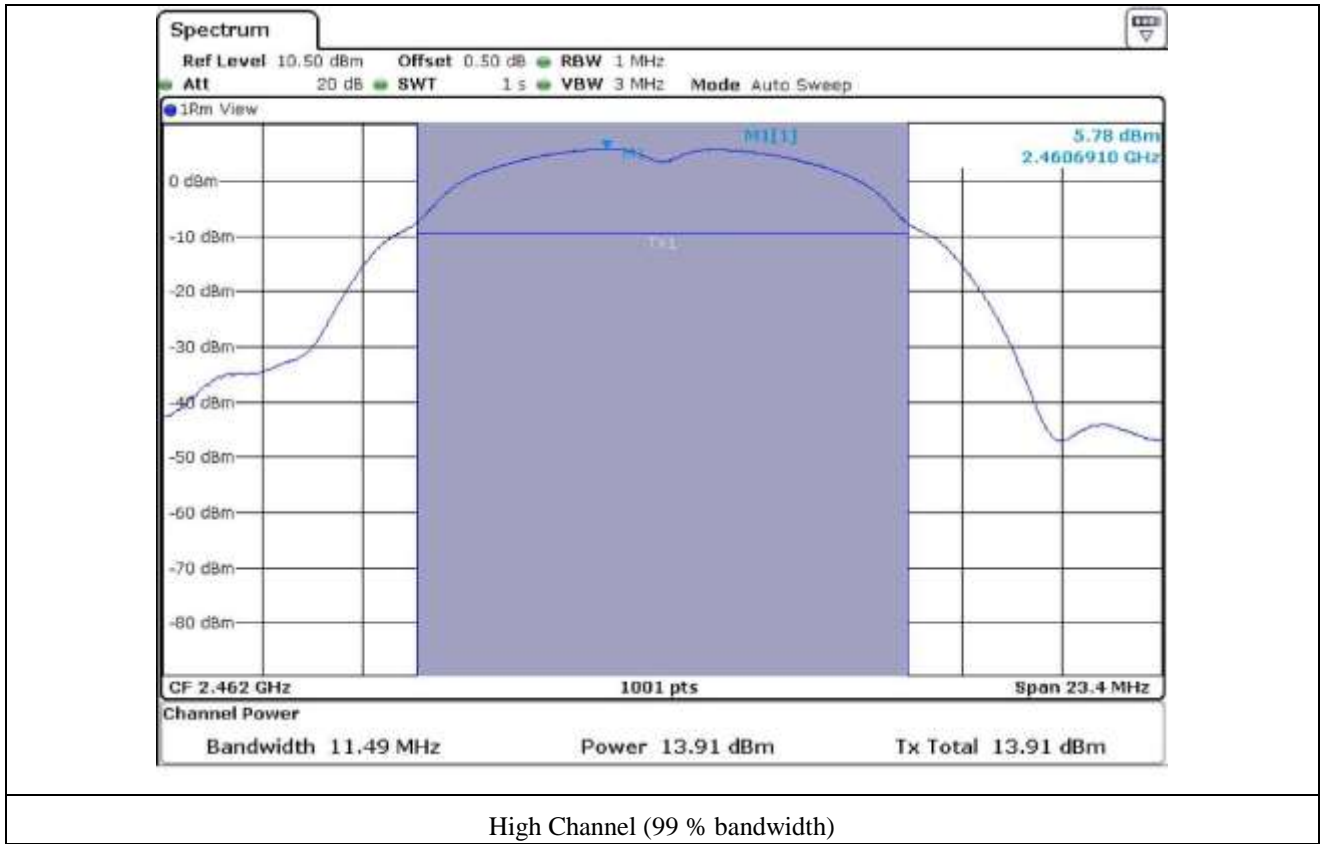




Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.4.2 Test data for Antenna 1

- Test Date : May 20, 2015
 - Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	9.09	14.08	30	15.92
MIDDLE	2 442	9.09	13.77	30	16.23
HIGH	2 462	9.09	13.71	30	16.29

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

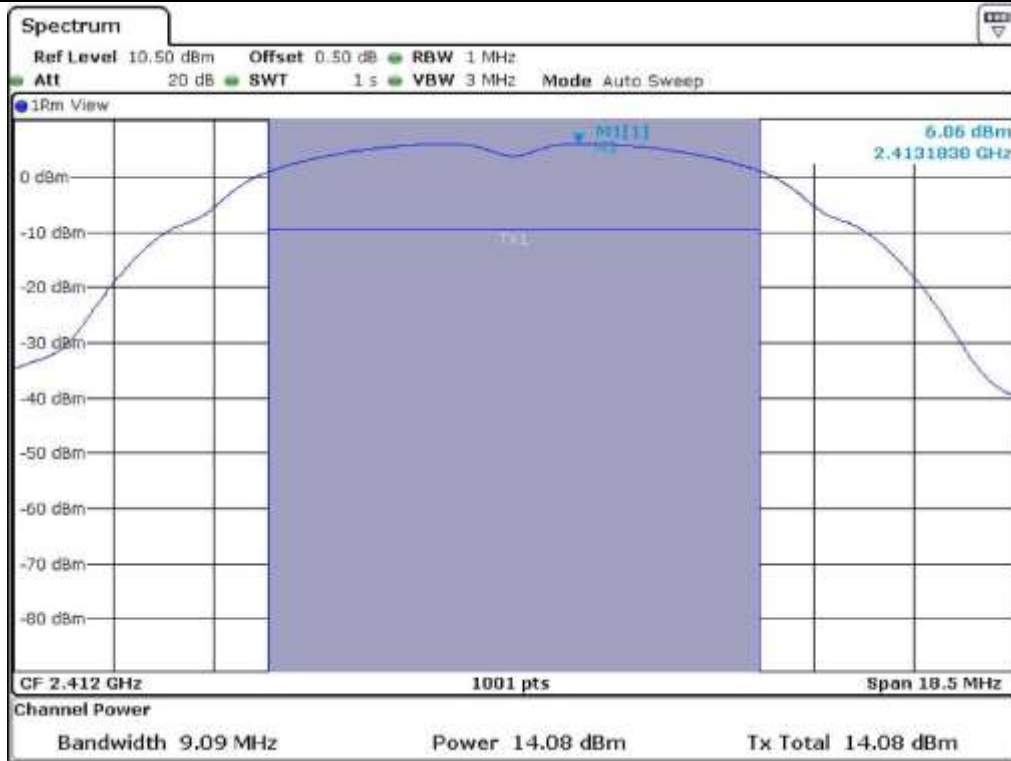
- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	11.69	14.11	30	15.89
MIDDLE	2 442	11.69	14.09	30	15.91
HIGH	2 462	11.69	13.98	30	16.02

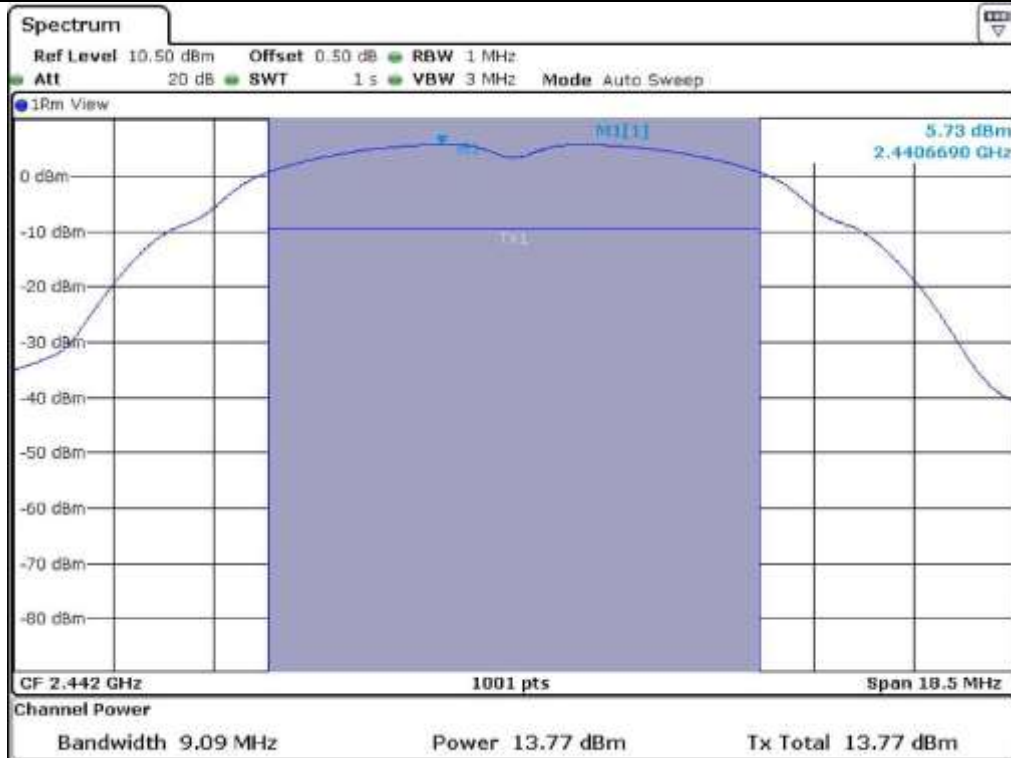
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



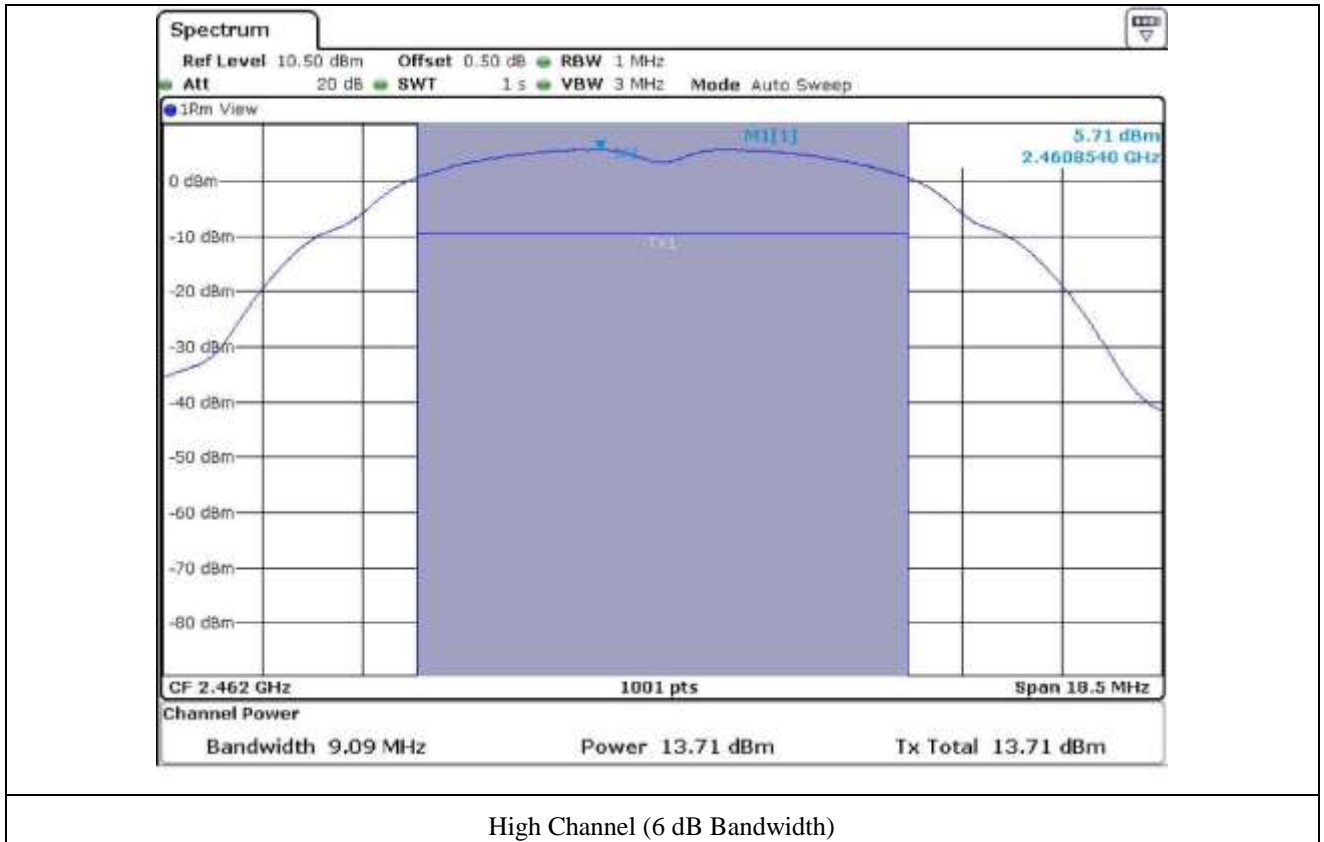
Tested by: Tae-Ho, Kim / Senior Engineer



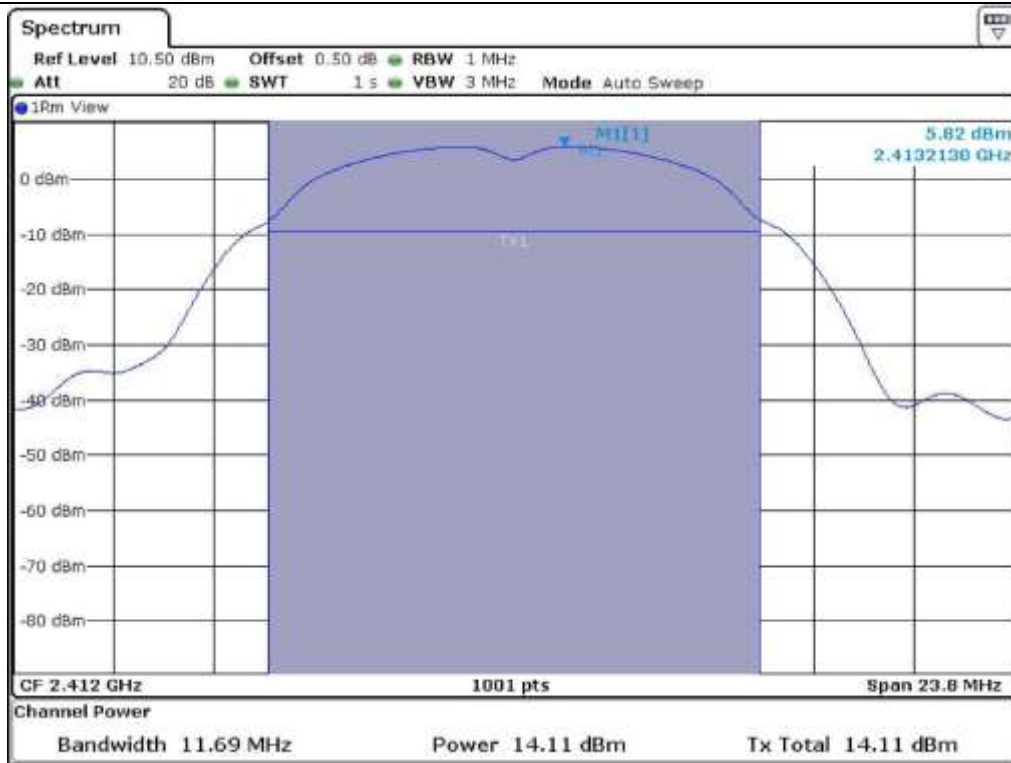
Low Channel (6 dB Bandwidth)



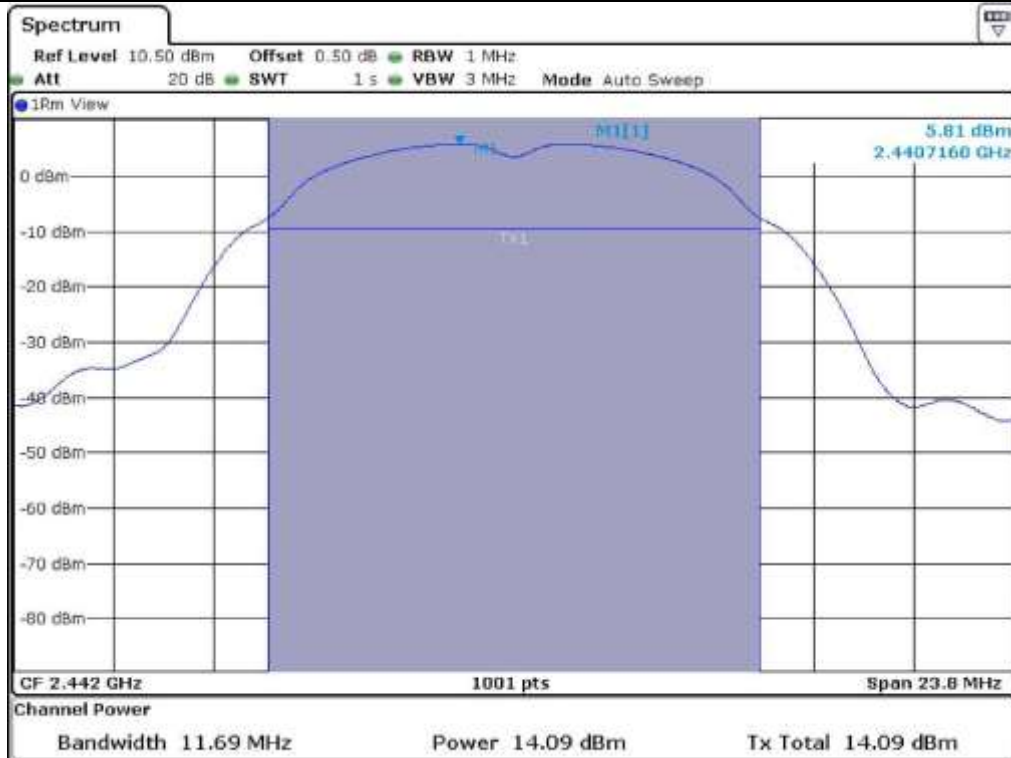
Middle Channel (6 dB Bandwidth)



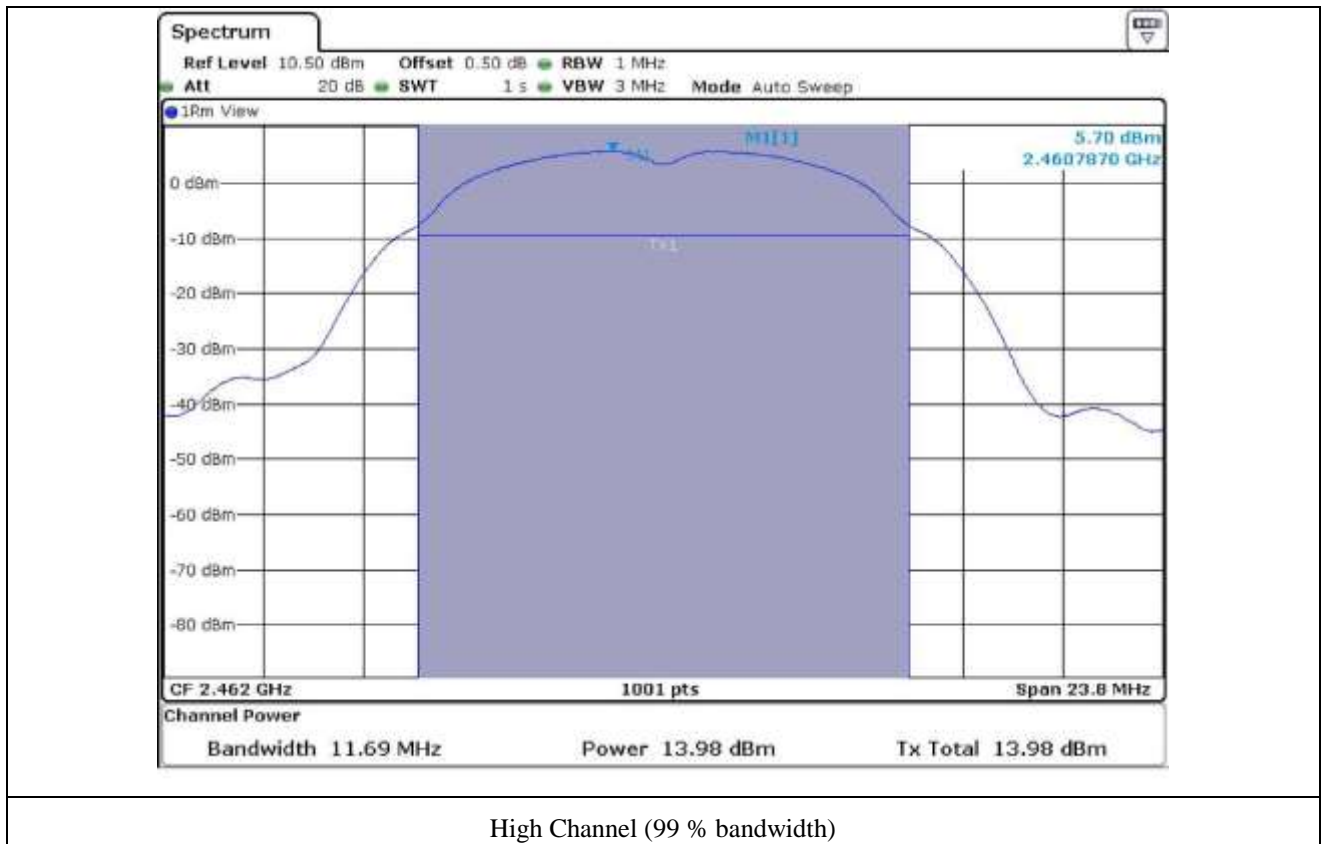
High Channel (6 dB Bandwidth)



Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.5 Test data for 802.11g

7.2.5.1 Test data for Antenna 0

-. Test Date : May 20, 2015

-. Test Result : Pass

-. FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	16.38	9.14	30	20.86
MIDDLE	2 442	16.38	13.37	30	16.63
HIGH	2 462	16.38	9.03	30	20.97

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

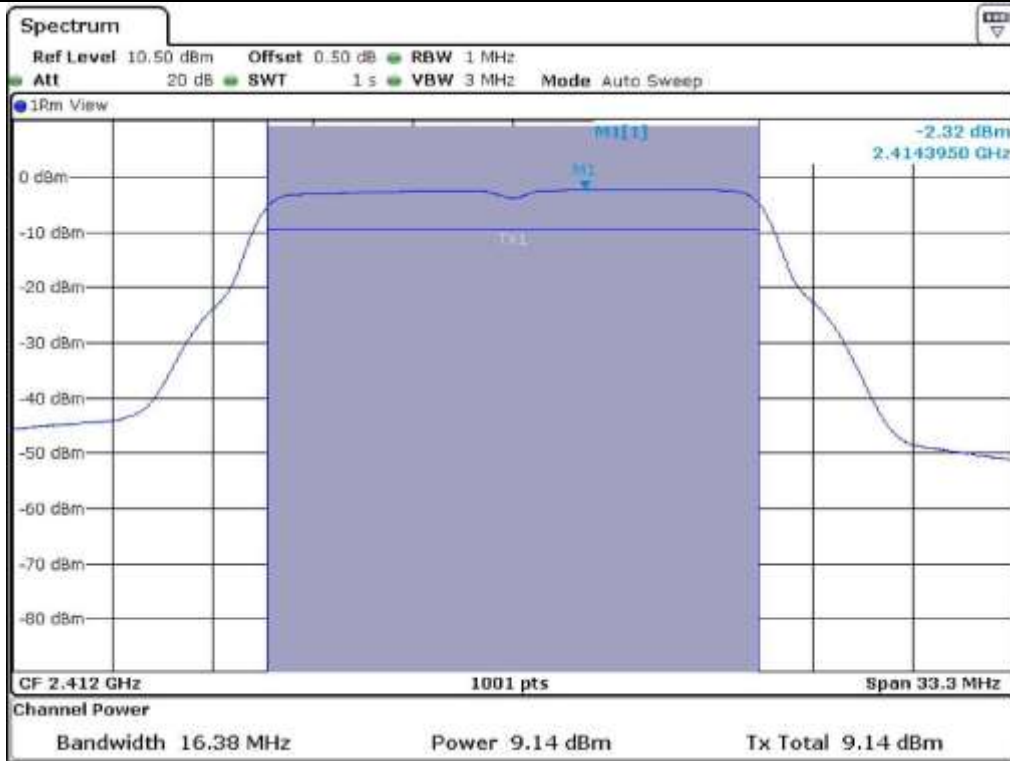
-. IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	16.58	9.11	30	20.89
MIDDLE	2 442	16.58	13.46	30	16.54
HIGH	2 462	16.58	9.11	30	20.89

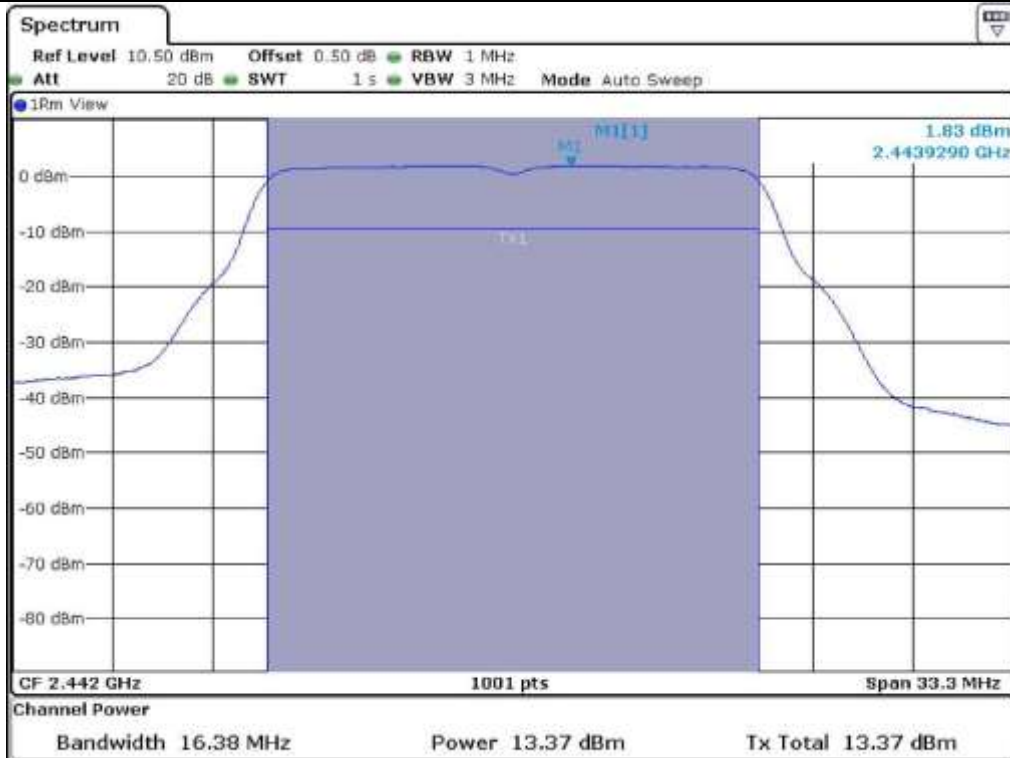
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



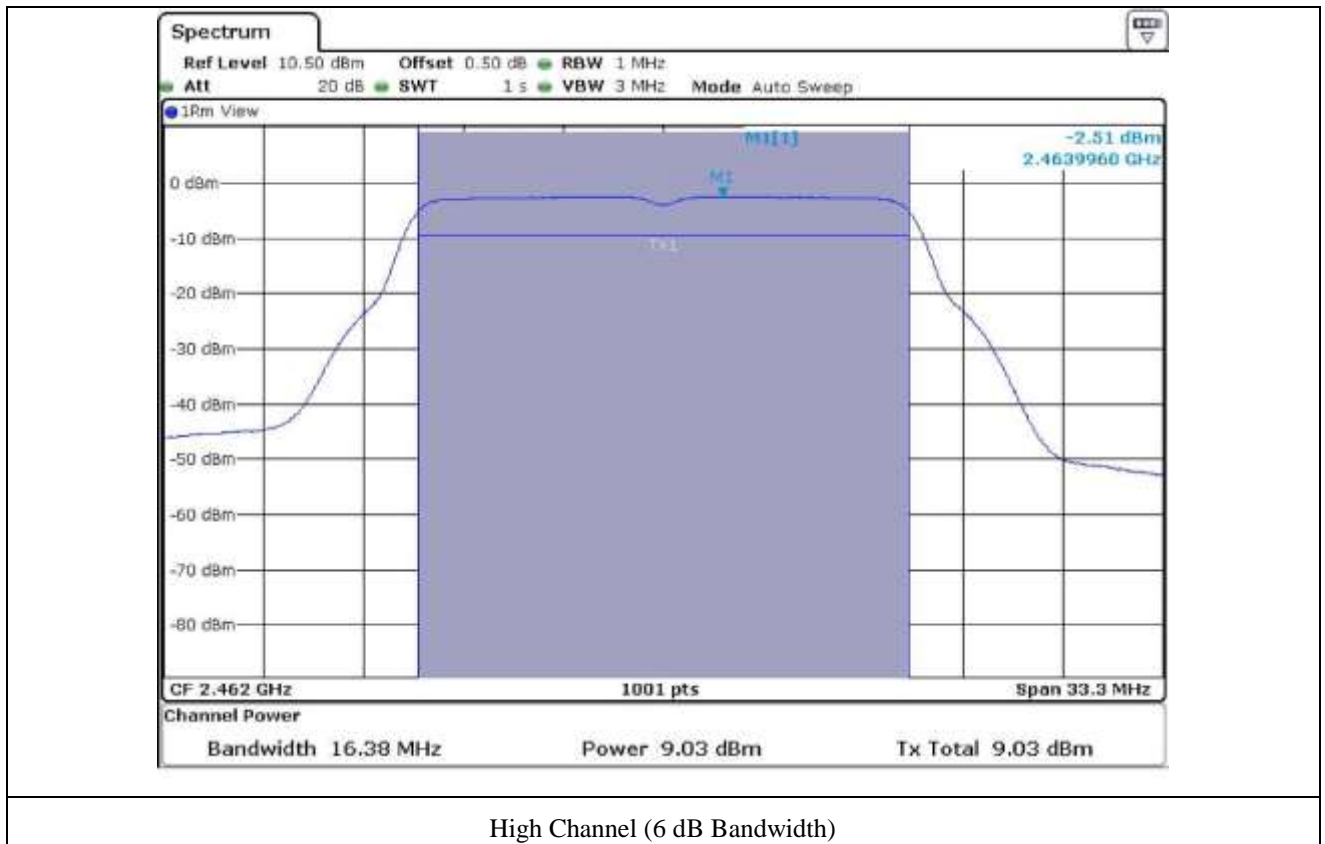
Tested by: Tae-Ho, Kim / Senior Engineer

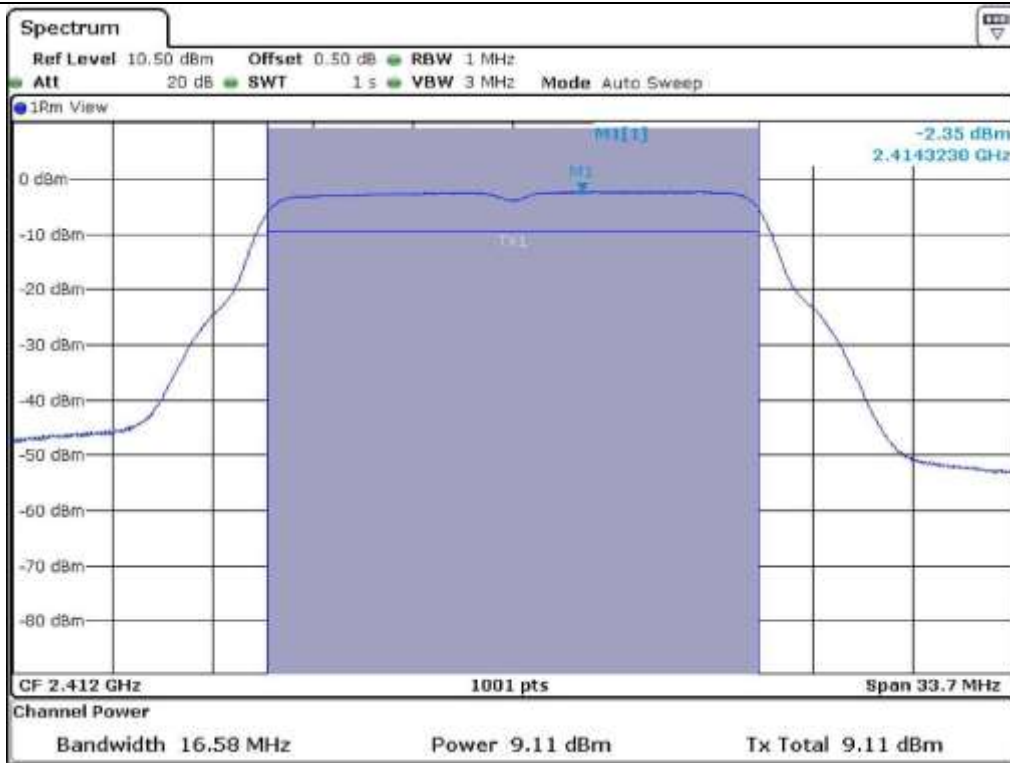


Low Channel (6 dB Bandwidth)

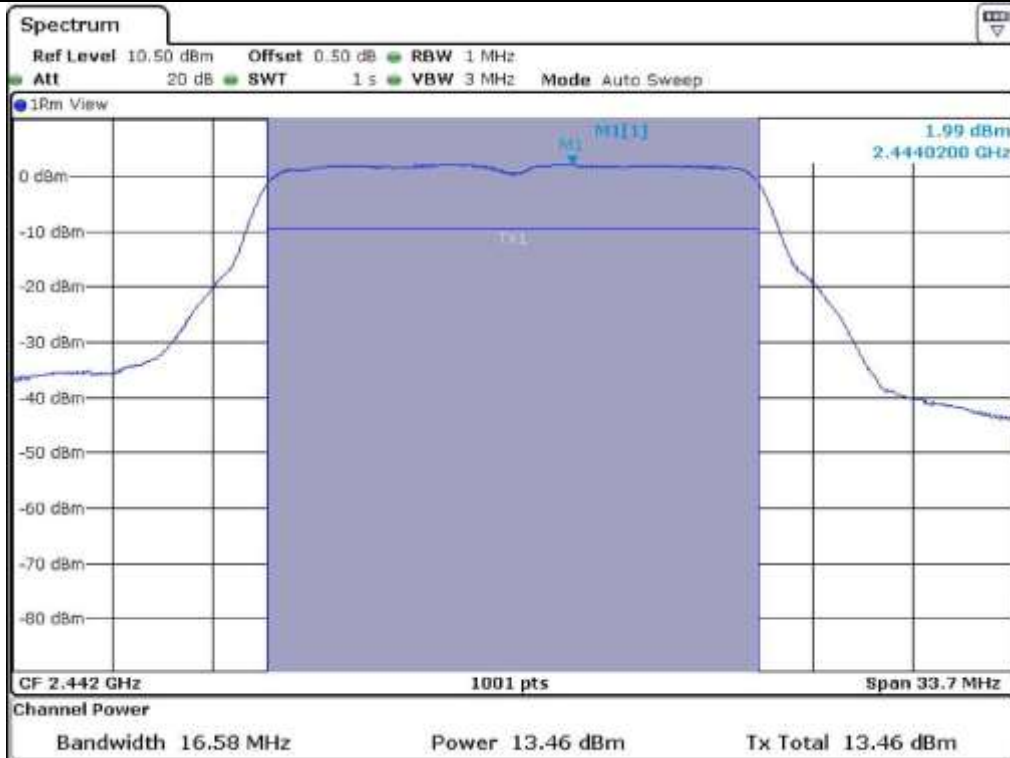


Middle Channel (6 dB Bandwidth)

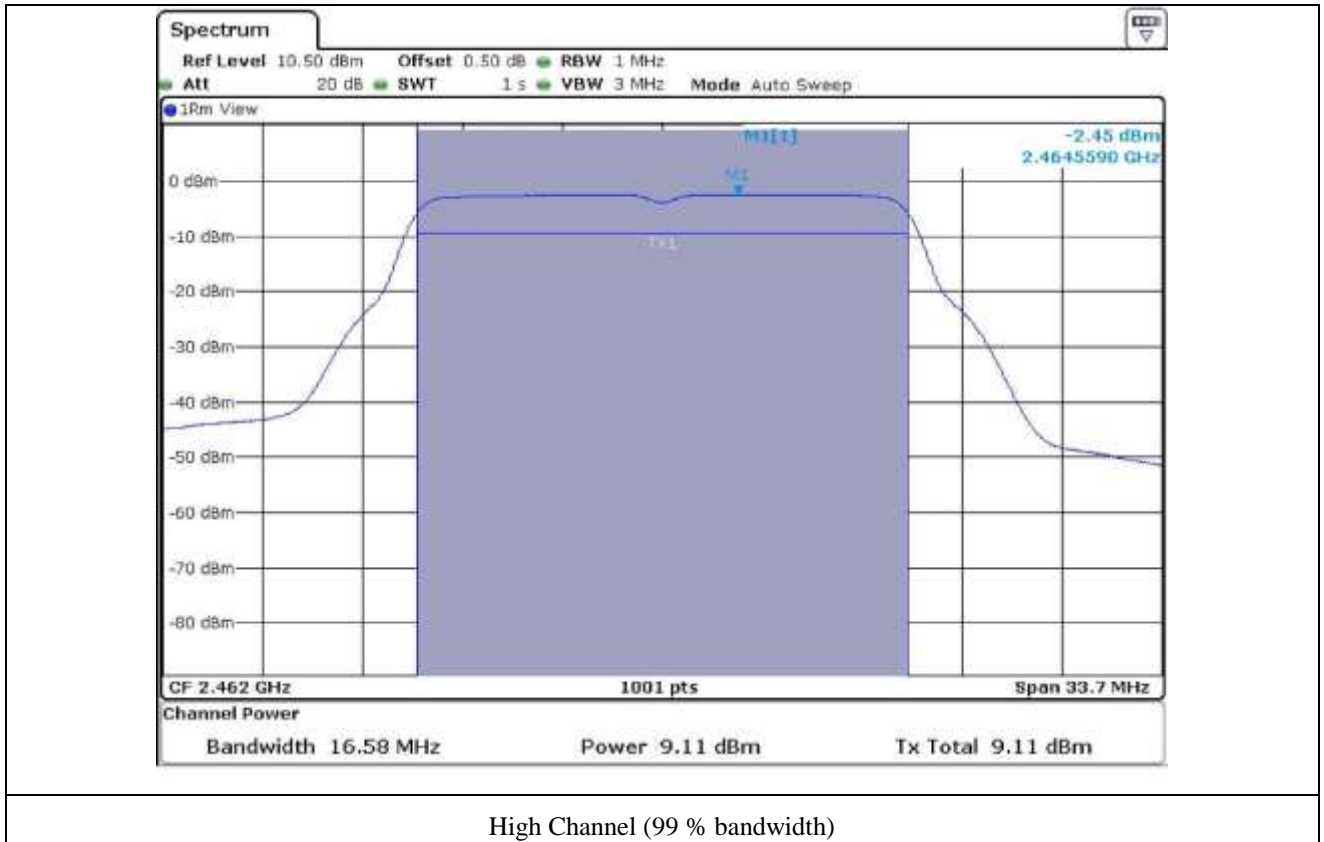




Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.5.2 Test data for Antenna 1

- Test Date : May 20, 2015
 - Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	16.33	10.28	30	19.72
MIDDLE	2 442	16.33	13.75	30	16.25
HIGH	2 462	16.33	10.17	30	19.83

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

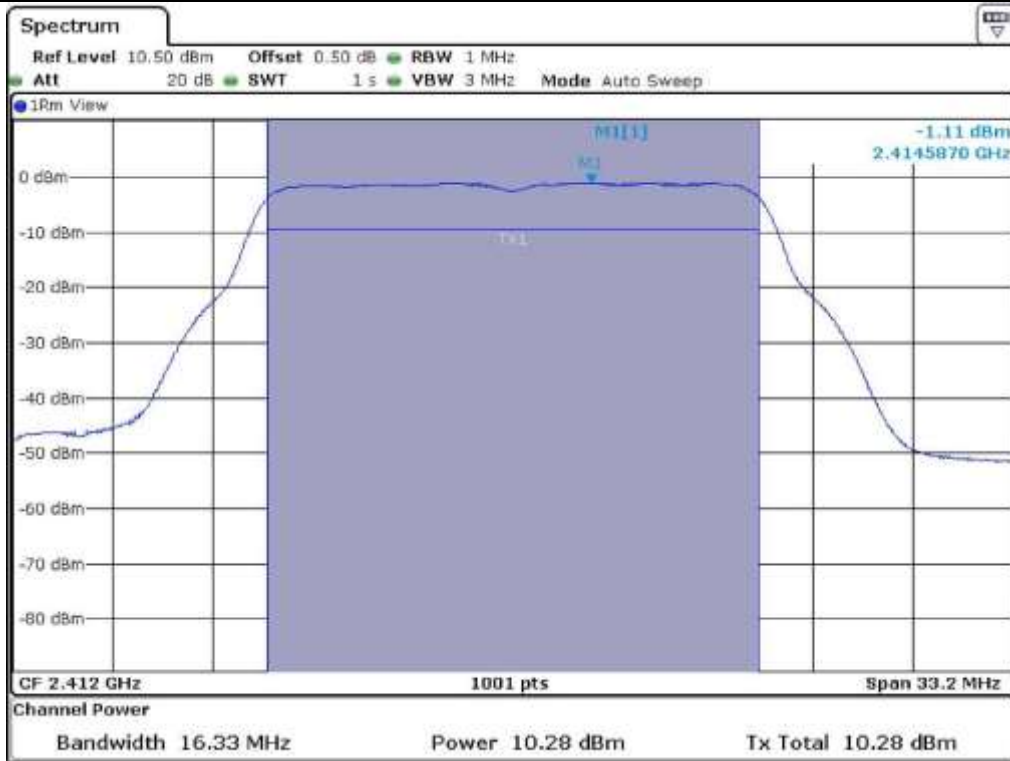
- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	16.58	10.13	30	19.87
MIDDLE	2 442	16.53	13.52	30	16.48
HIGH	2 462	16.53	10.16	30	19.84

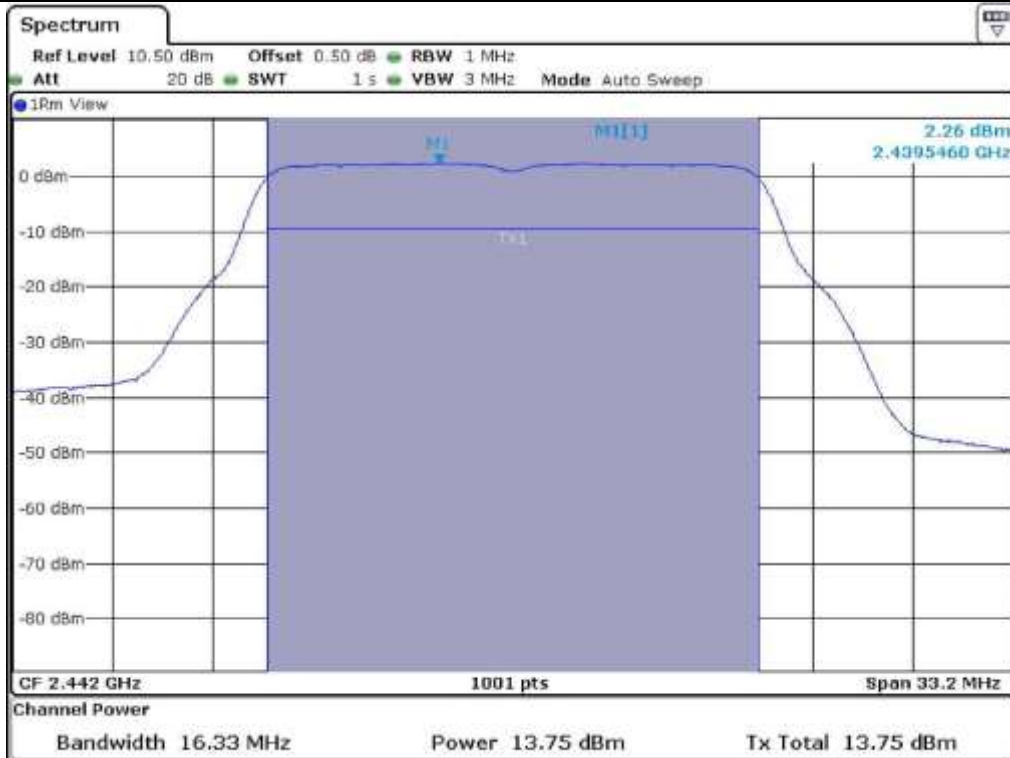
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



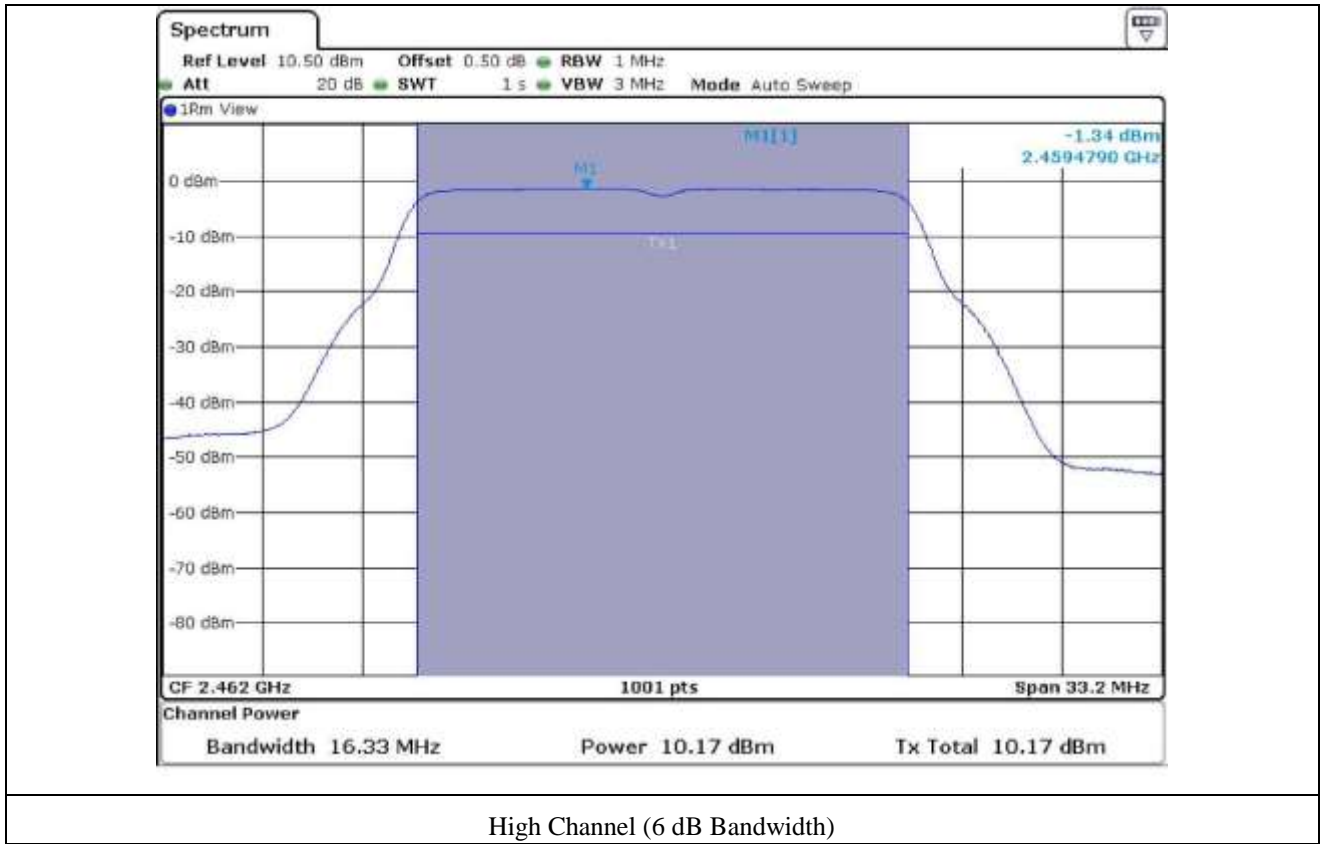
Tested by: Tae-Ho, Kim / Senior Engineer



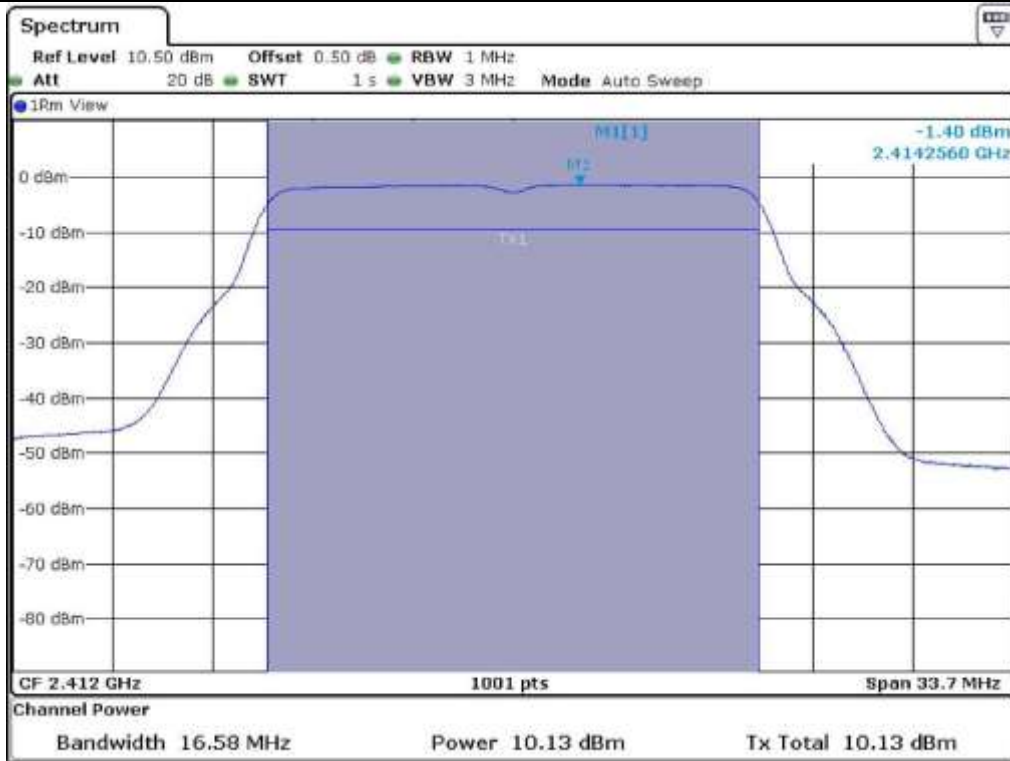
Low Channel (6 dB Bandwidth)



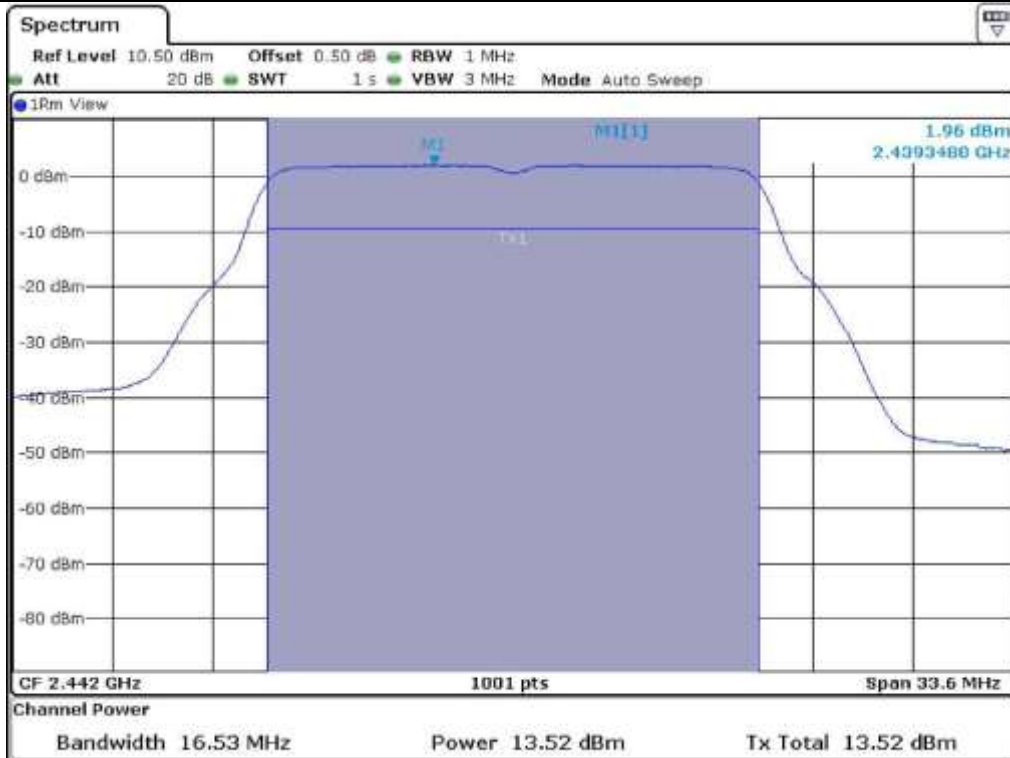
Middle Channel (6 dB Bandwidth)



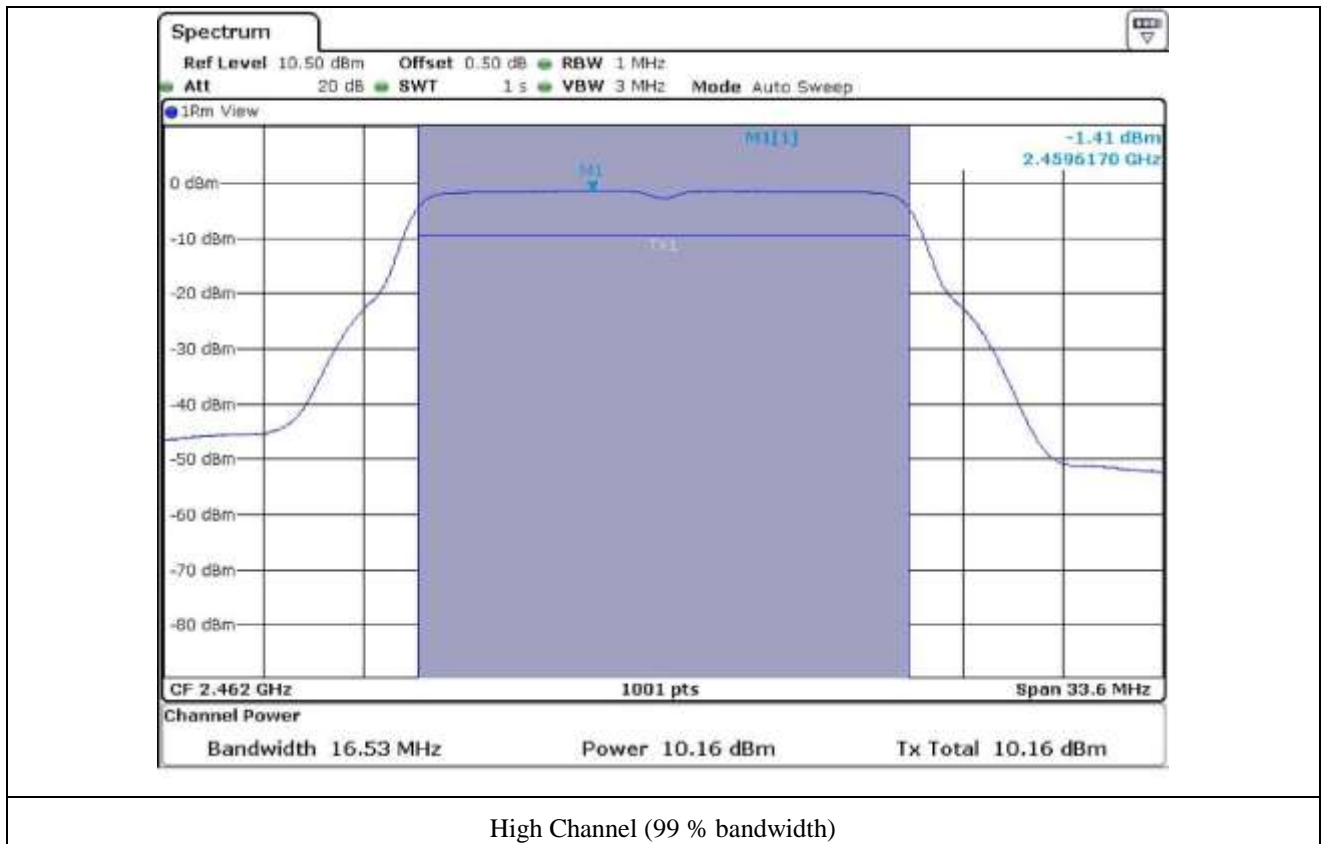
High Channel (6 dB Bandwidth)



Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.5.3 Test data for Multiple transmit

-. Test Date : May 20, 2015
 -. Test Result : Pass

-. FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	CALCULATED OUTPUT POWER (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	16.38	12.76	30	17.24
MIDDLE	2 442	16.38	16.57	30	13.43
HIGH	2 462	16.38	12.65	30	17.35

Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log(10^{(\text{Antenna1 Output Power}/10)} + 10^{(\text{Antenna2 Output Power}/10)})$

-. IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	CALCULATED OUTPUT POWER (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	16.43	12.66	30	17.34
MIDDLE	2 442	16.43	16.50	30	13.50
HIGH	2 462	16.43	12.68	30	17.32

Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log(10^{(\text{Antenna1 Output Power}/10)} + 10^{(\text{Antenna2 Output Power}/10)})$



Tested by: Tae-Ho, Kim / Senior Engineer

7.2.6 Test data for 802.11n_HT20

7.2.6.1 Test data for Antenna 0

- Test Date : May 20, 2015
 - Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	17.58	7.93	30	22.07
MIDDLE	2 442	17.58	11.32	30	18.68
HIGH	2 462	17.58	9.10	30	20.90

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

- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	17.78	7.80	30	22.20
MIDDLE	2 442	17.78	11.32	30	18.68
HIGH	2 462	17.78	8.81	30	21.19

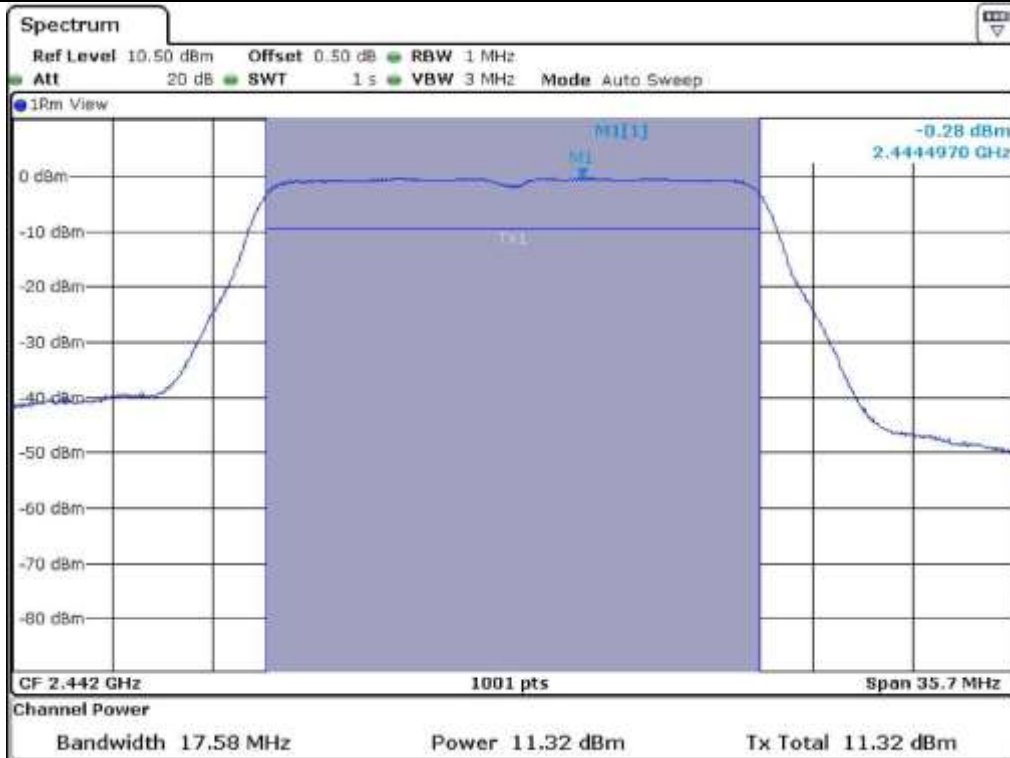
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



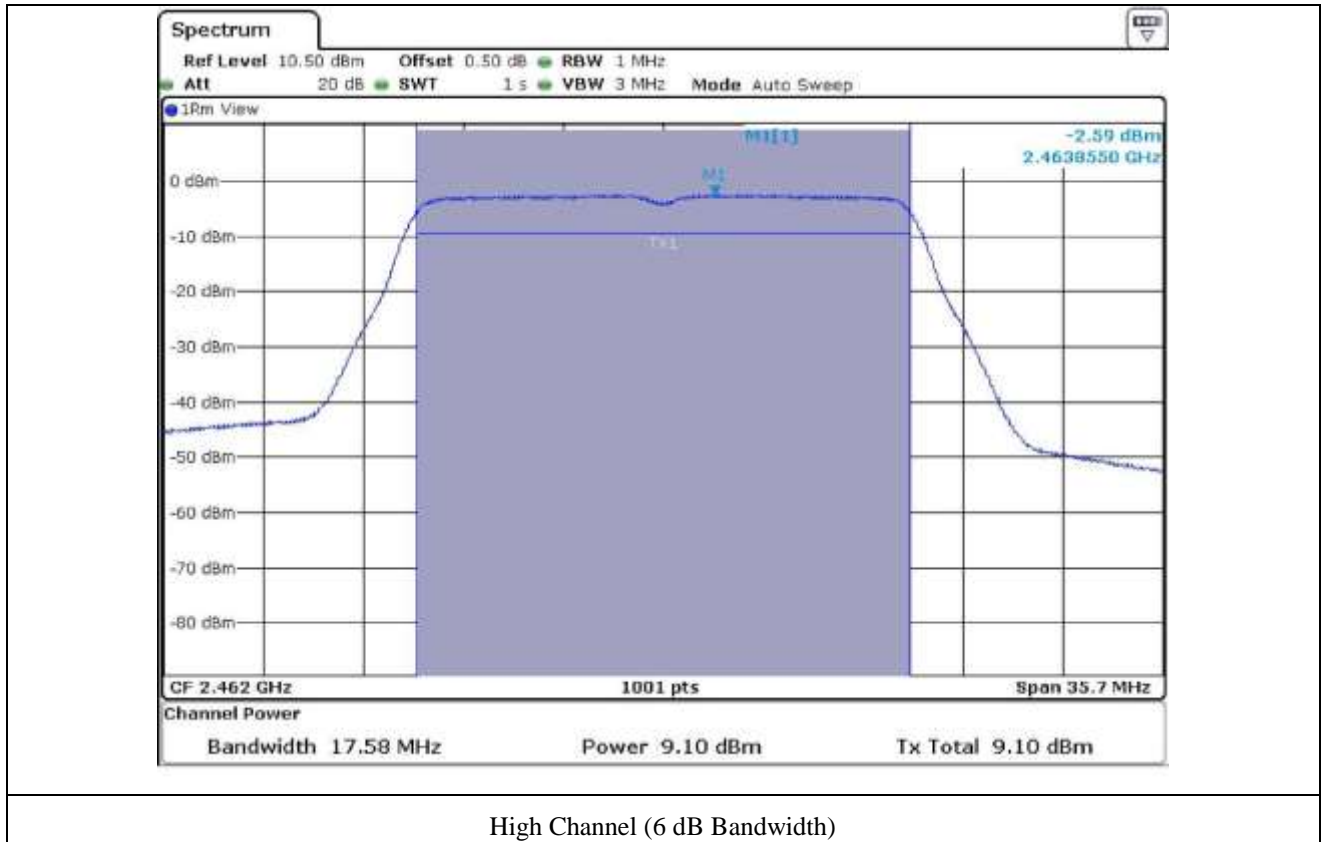
Tested by: Tae-Ho, Kim / Senior Engineer

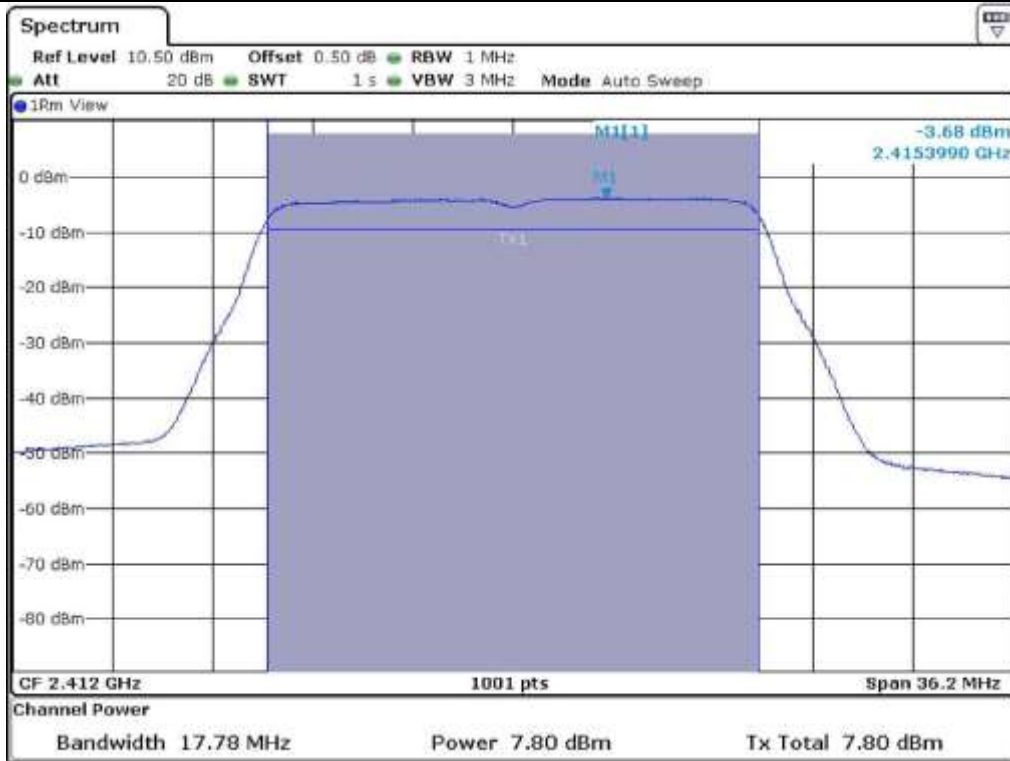


Low Channel (6 dB Bandwidth)

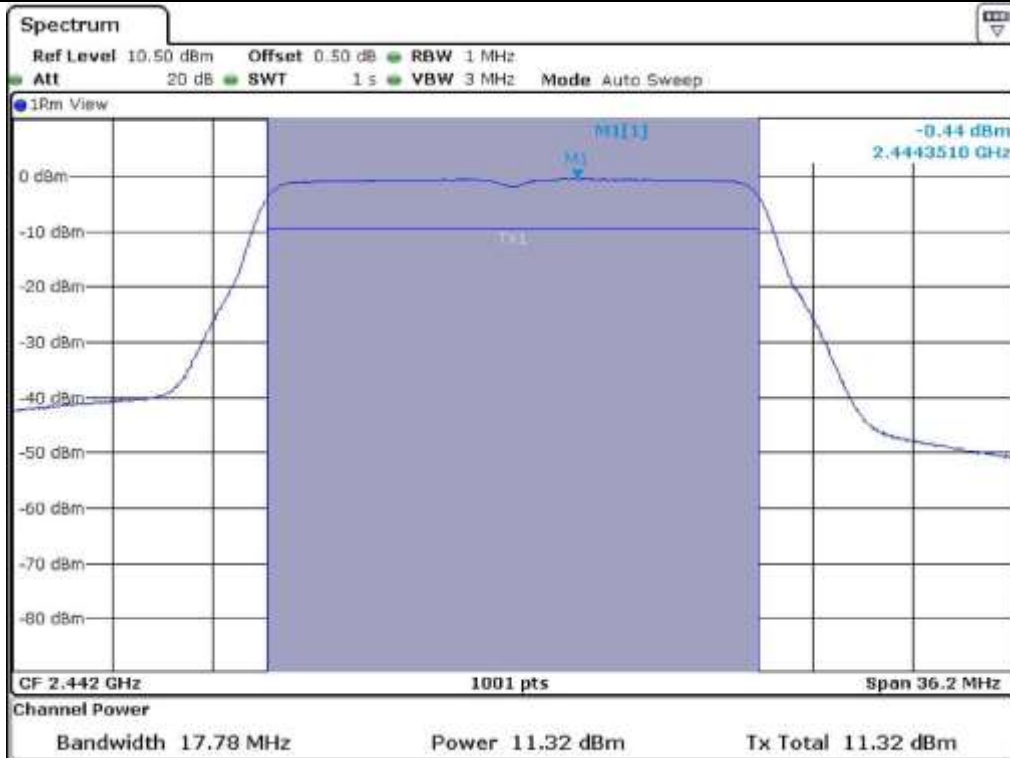


Middle Channel (6 dB Bandwidth)

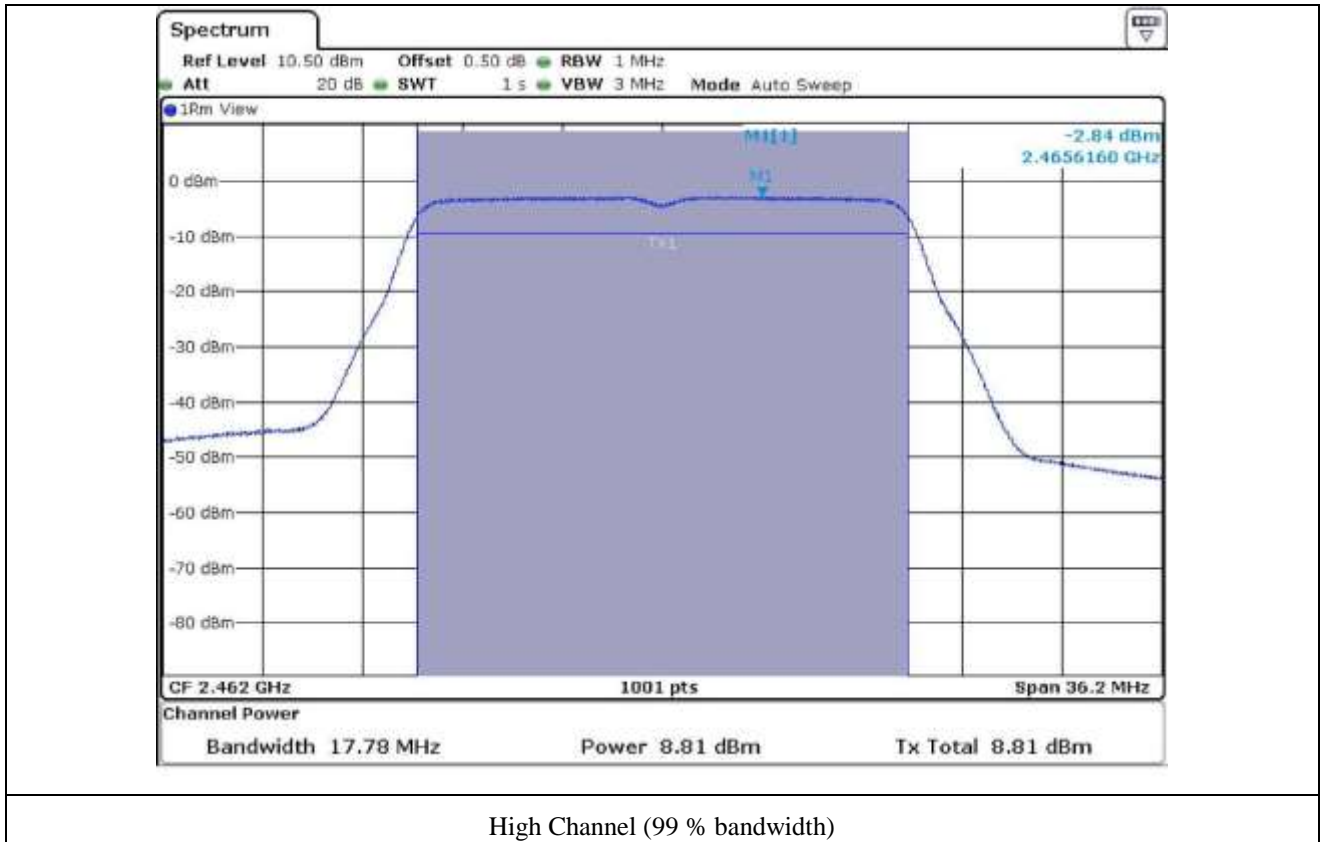




Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.6.2 Test data for Antenna 1

- Test Date : May 20, 2015
- Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	17.53	9.18	30	20.82
MIDDLE	2 442	17.53	11.65	30	18.35
HIGH	2 462	17.53	9.96	30	20.04

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

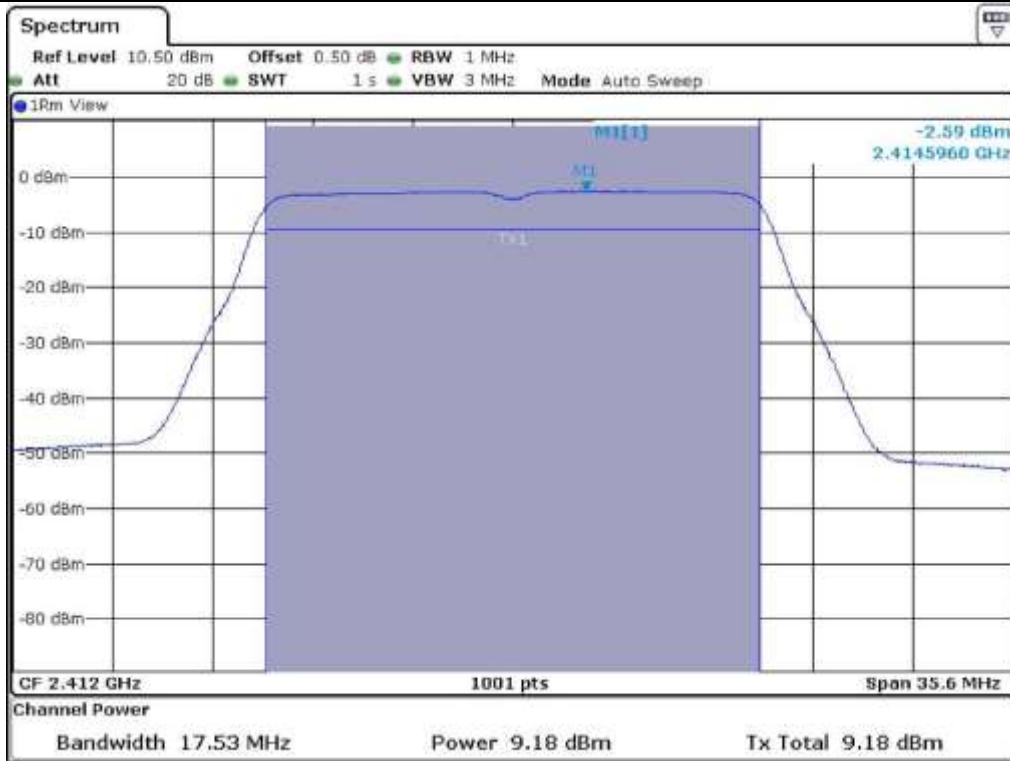
- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	17.78	9.23	30	20.77
MIDDLE	2 442	17.78	11.77	30	18.23
HIGH	2 462	17.78	9.95	30	20.05

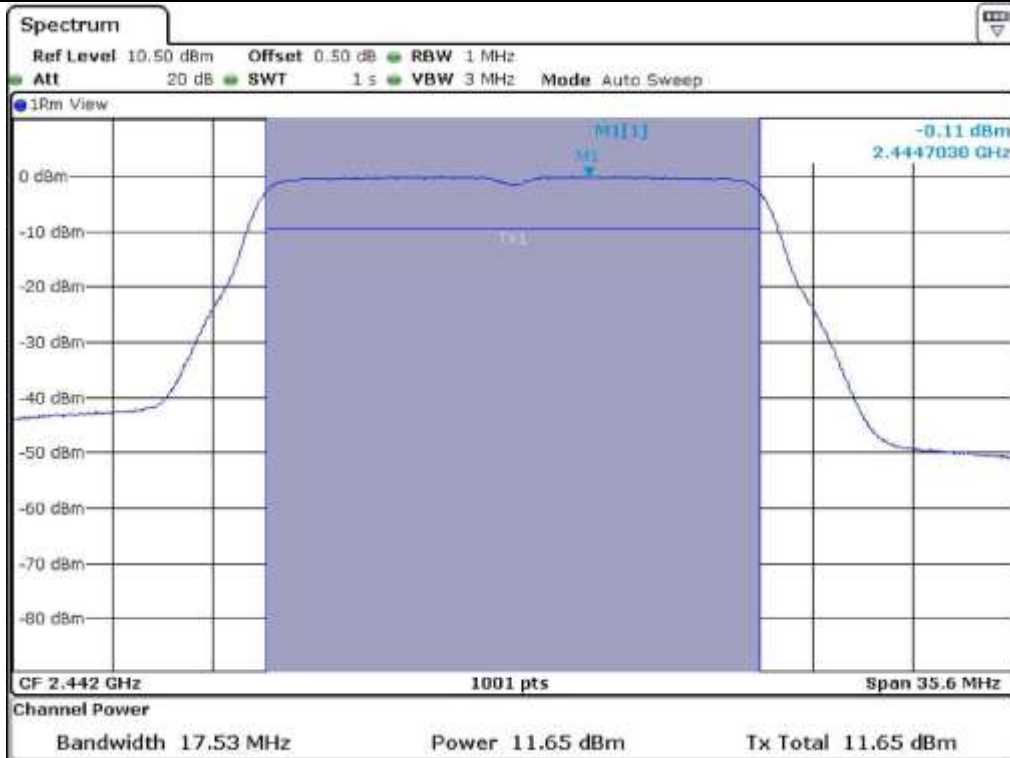
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



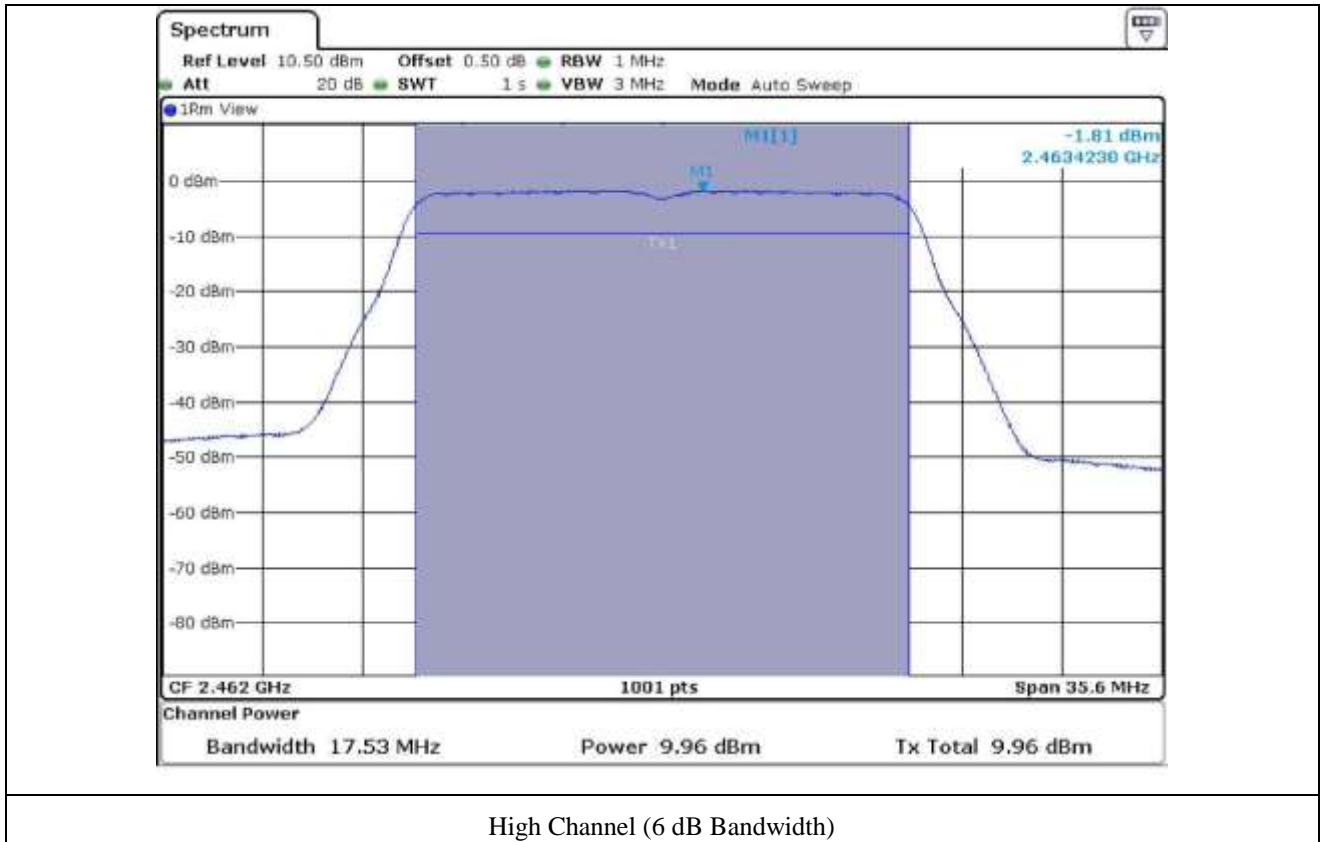
Tested by: Tae-Ho, Kim / Senior Engineer



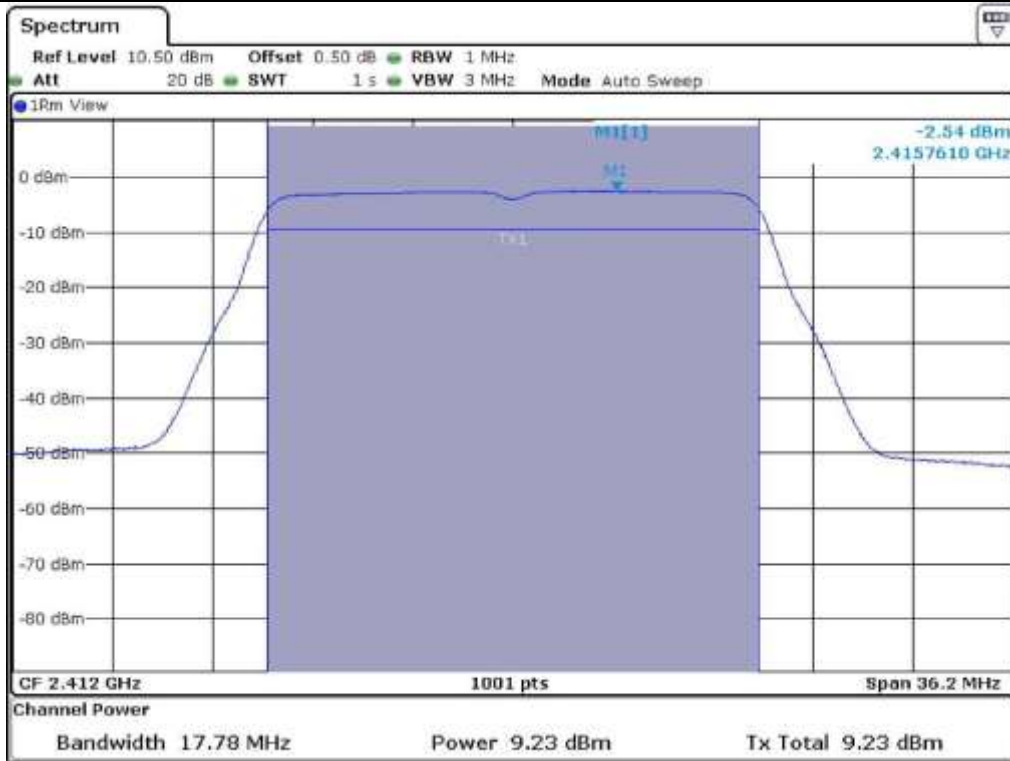
Low Channel (6 dB Bandwidth)



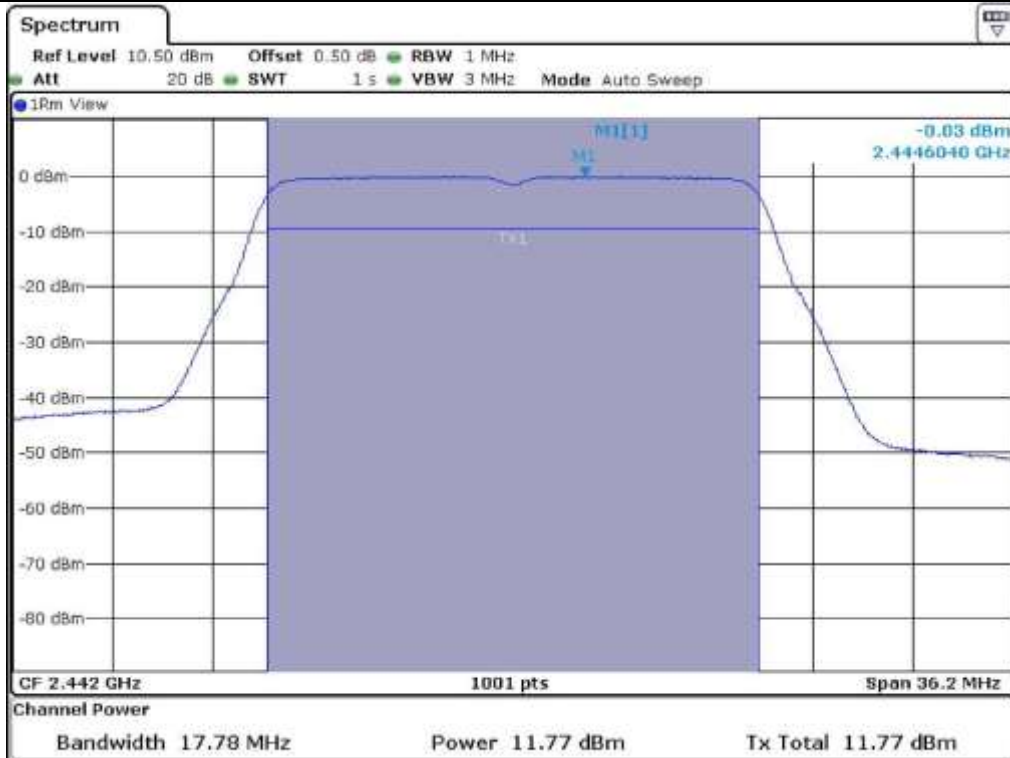
Middle Channel (6 dB Bandwidth)



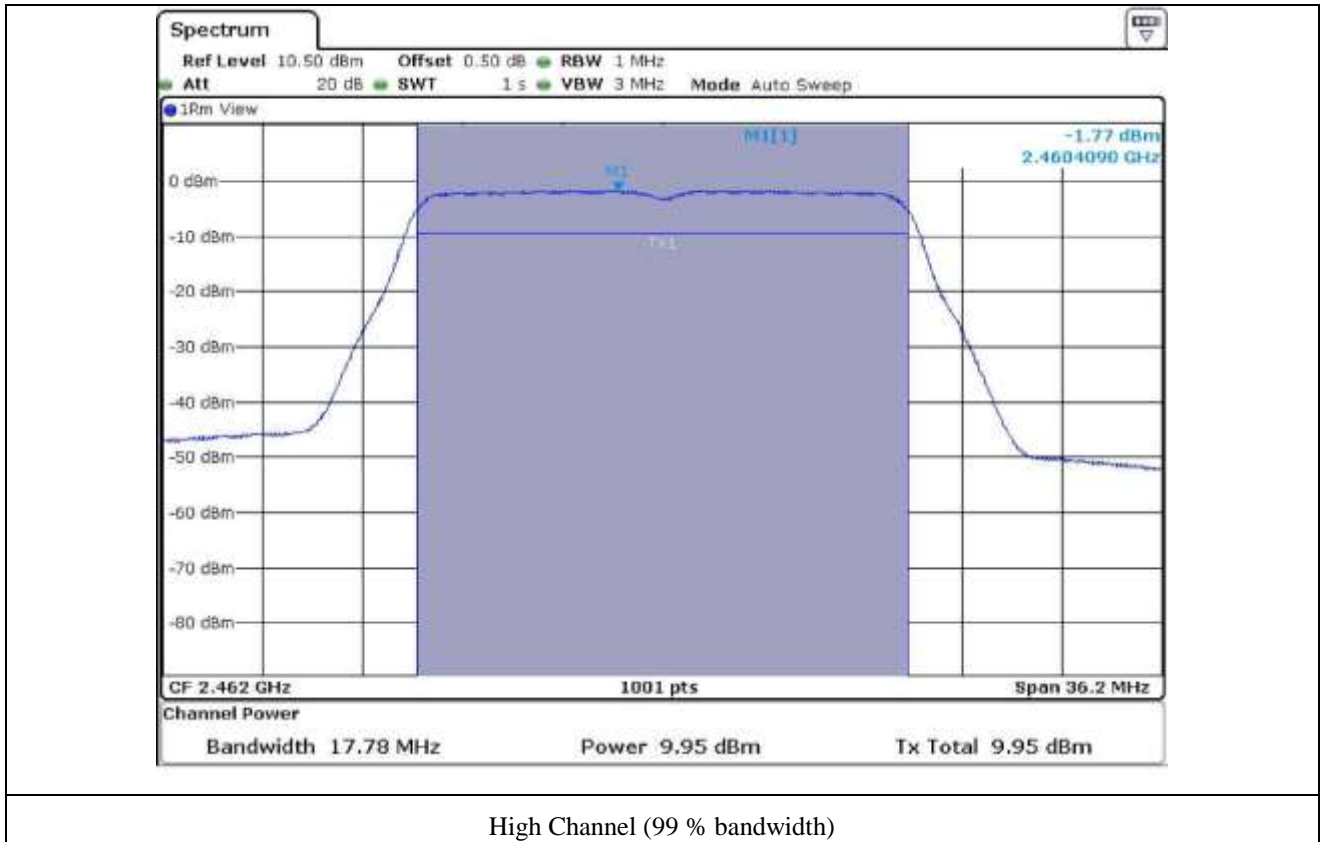
High Channel (6 dB Bandwidth)



Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.6.3 Test data for Multiple transmit

- Test Date : May 20, 2015
 - Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	CALCULATED OUTPUT POWER (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	17.58	11.61	30	18.39
MIDDLE	2 442	17.58	14.50	30	15.50
HIGH	2 462	17.58	12.56	30	17.44

Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log(10^{(\text{Antenna1 Output Power}/10)}+10^{(\text{Antenna2 Output Power}/10)})$

- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	CALCULATED OUTPUT POWER (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	17.53	11.58	30	18.42
MIDDLE	2 442	17.53	14.56	30	15.44
HIGH	2 462	17.53	12.43	30	17.57

Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log(10^{(\text{Antenna1 Output Power}/10)}+10^{(\text{Antenna2 Output Power}/10)})$



Tested by: Tae-Ho, Kim / Senior Engineer

7.2.7 Test data for 802.11n_HT40

7.2.7.1 Test data for Antenna 0

- Test Date : May 20, 2015
 - Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	36.36	4.42	30	25.58
MIDDLE	2 442	36.36	11.52	30	18.48
HIGH	2 462	36.36	6.32	30	23.68

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

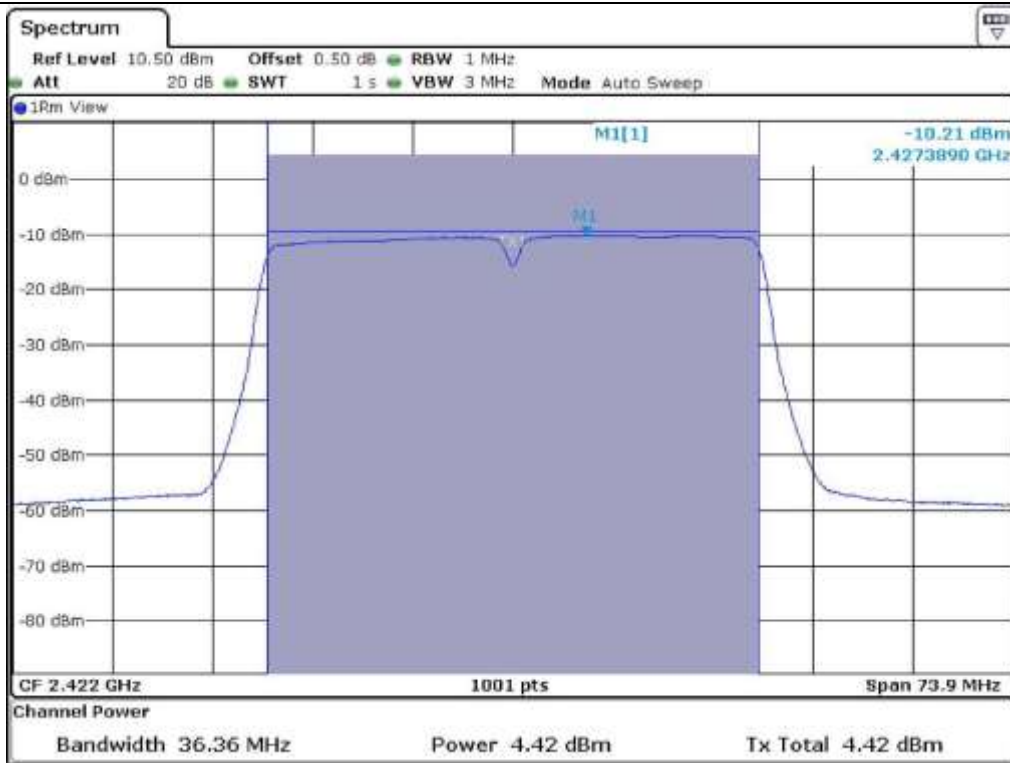
- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	36.16	4.19	30	25.81
MIDDLE	2 442	36.16	11.49	30	18.51
HIGH	2 462	36.16	6.33	30	23.67

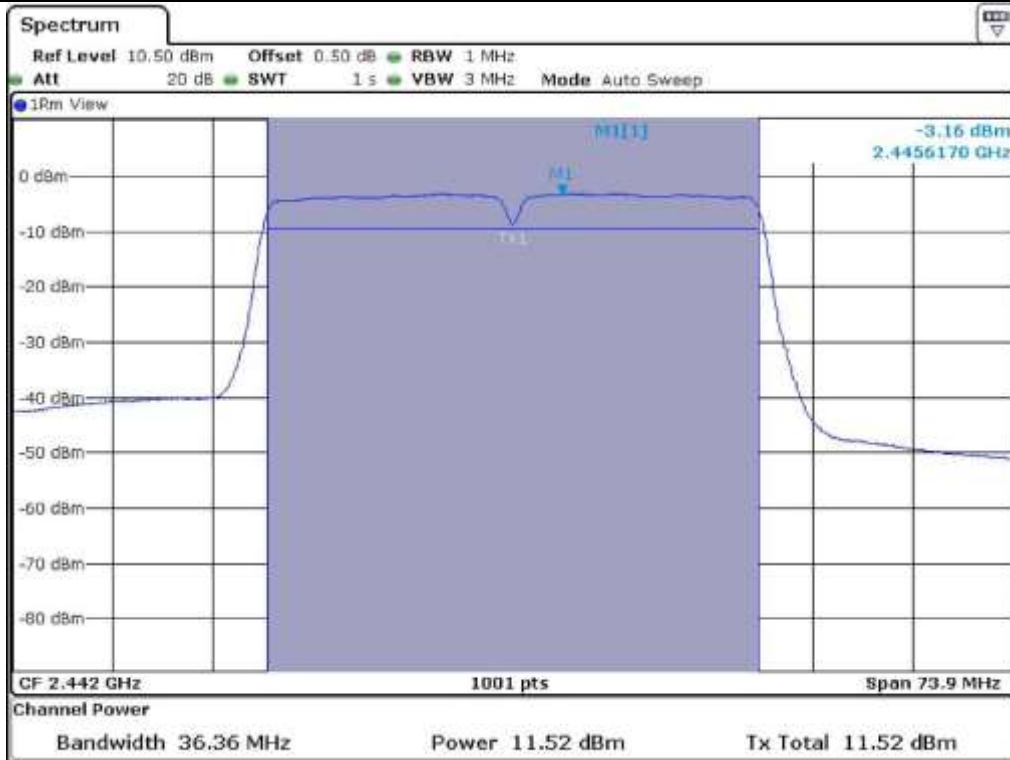
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



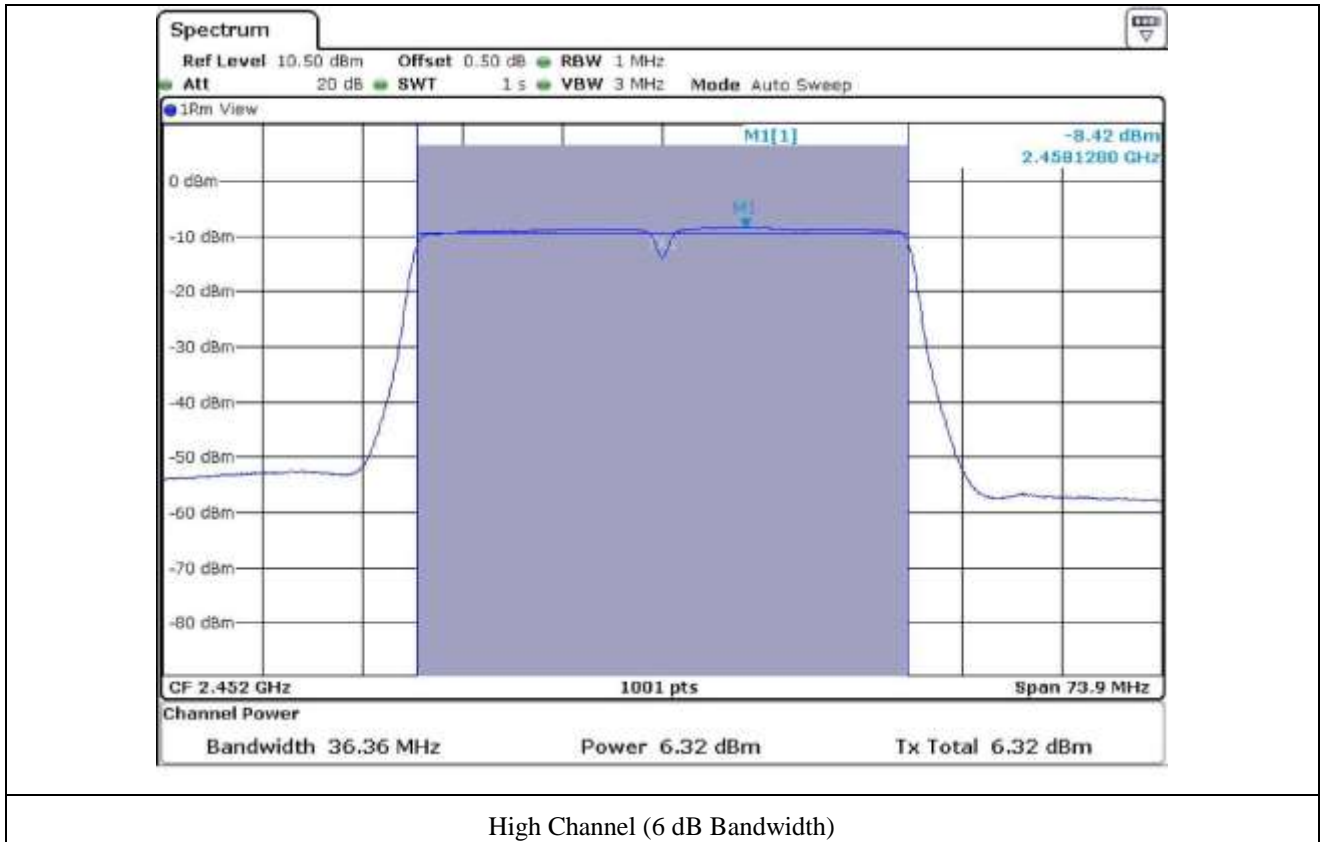
Tested by: Tae-Ho, Kim / Senior Engineer



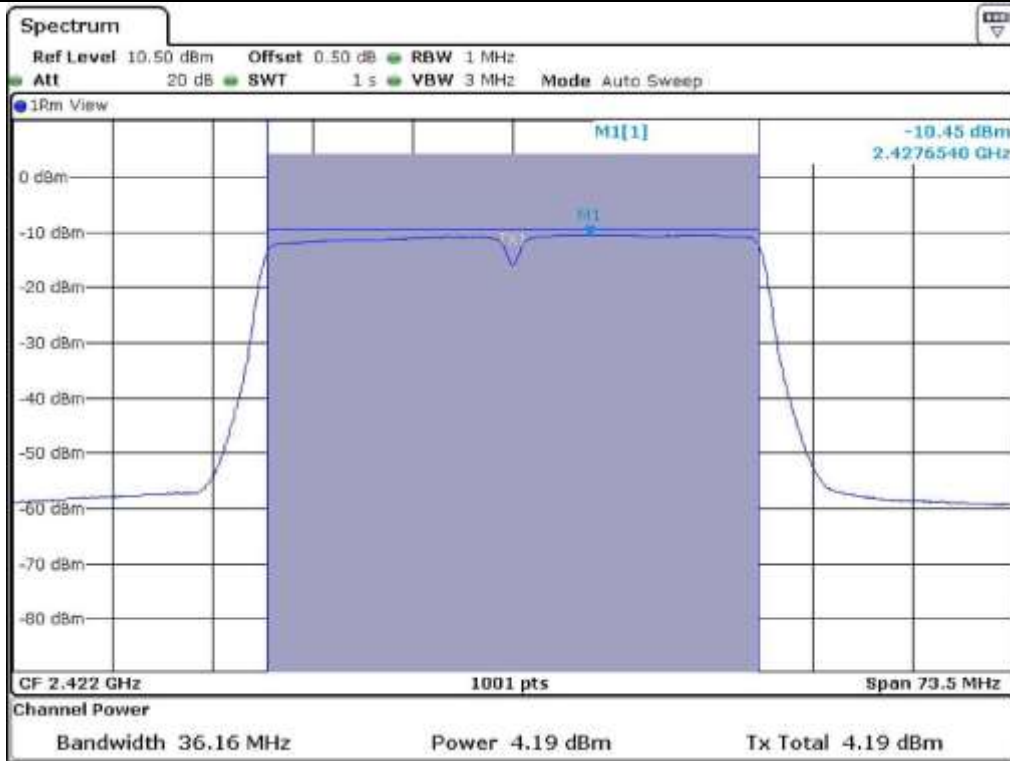
Low Channel (6 dB Bandwidth)



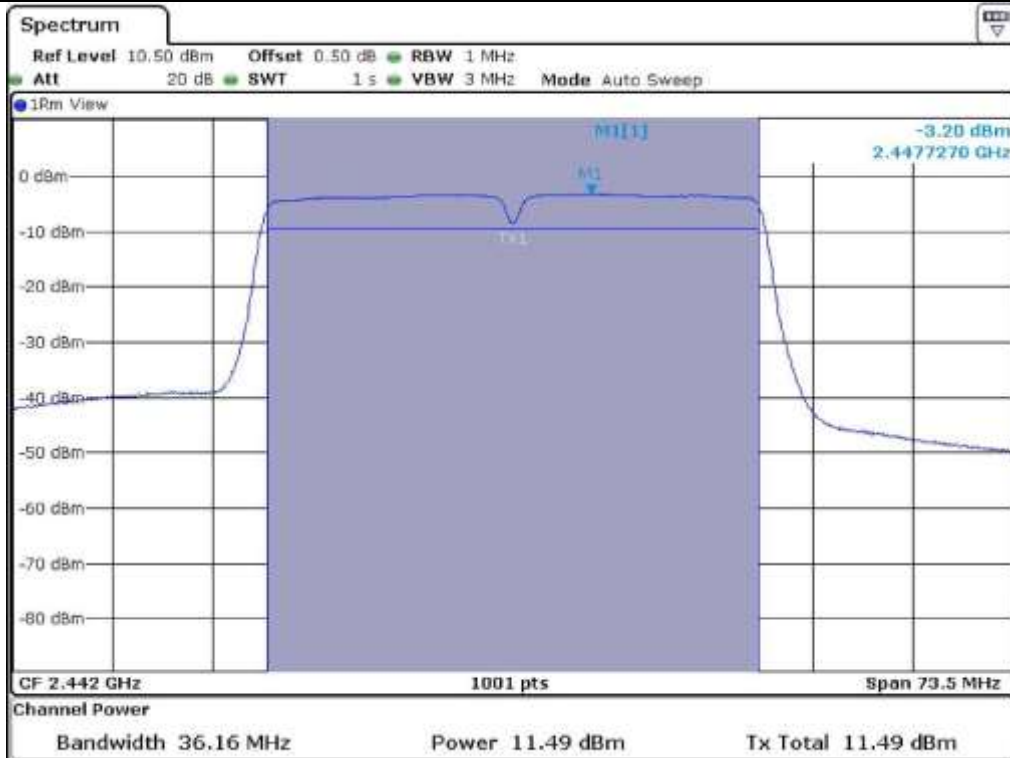
Middle Channel (6 dB Bandwidth)



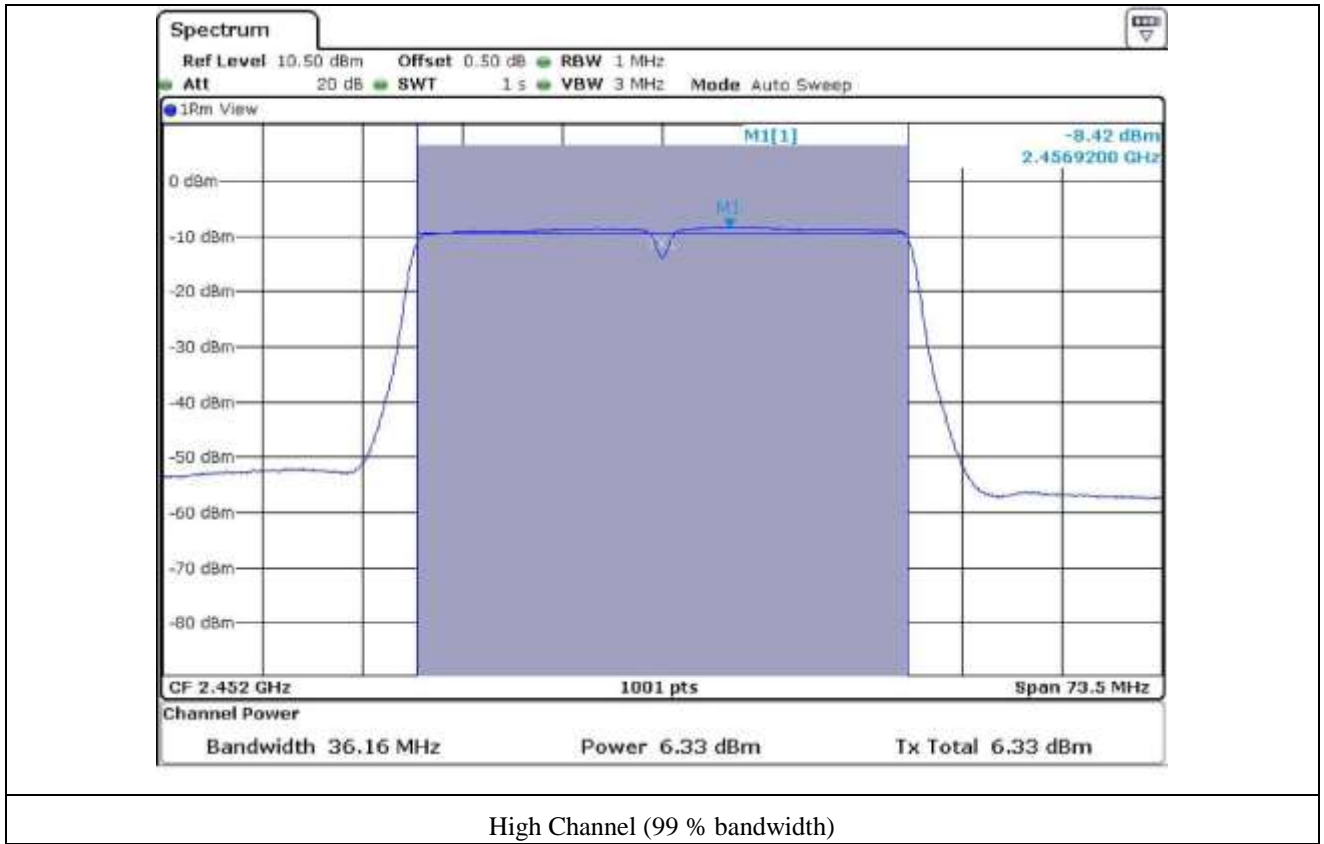
High Channel (6 dB Bandwidth)



Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.7.2 Test data for Antenna 1

- Test Date : March 11, 2015
- Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	36.36	7.39	30	22.61
MIDDLE	2 442	36.36	11.86	30	18.14
HIGH	2 462	36.36	8.40	30	21.60

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

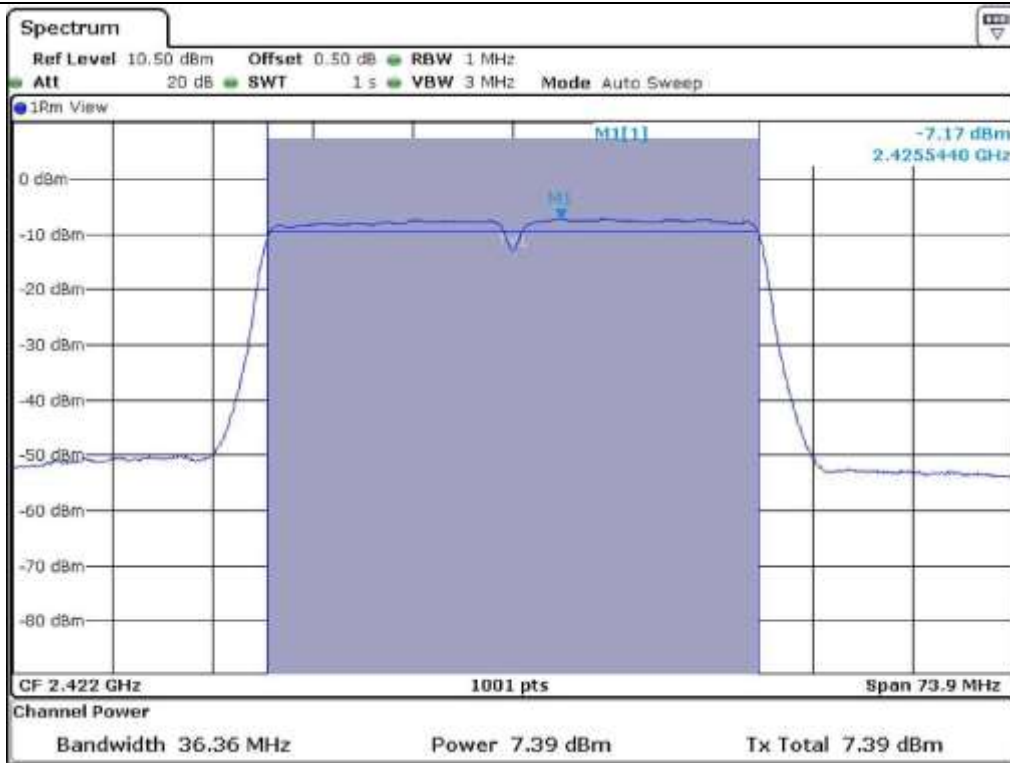
- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412	36.16	7.39	30	22.61
MIDDLE	2 442	36.16	11.79	30	18.21
HIGH	2 462	36.16	8.34	30	21.66

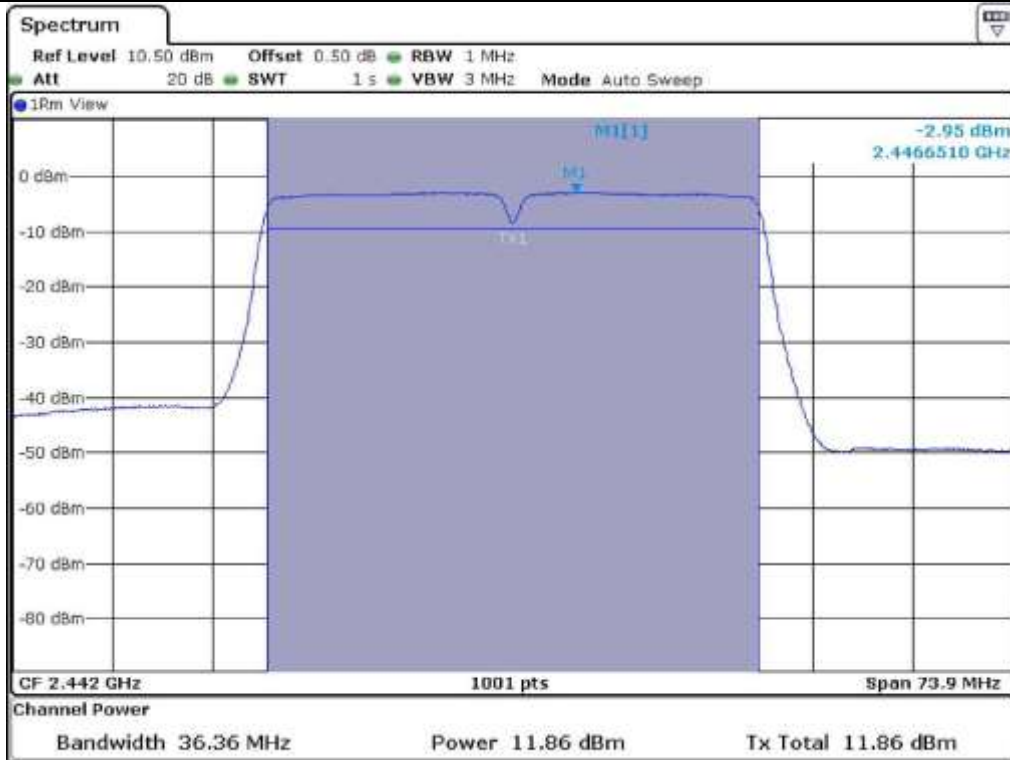
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



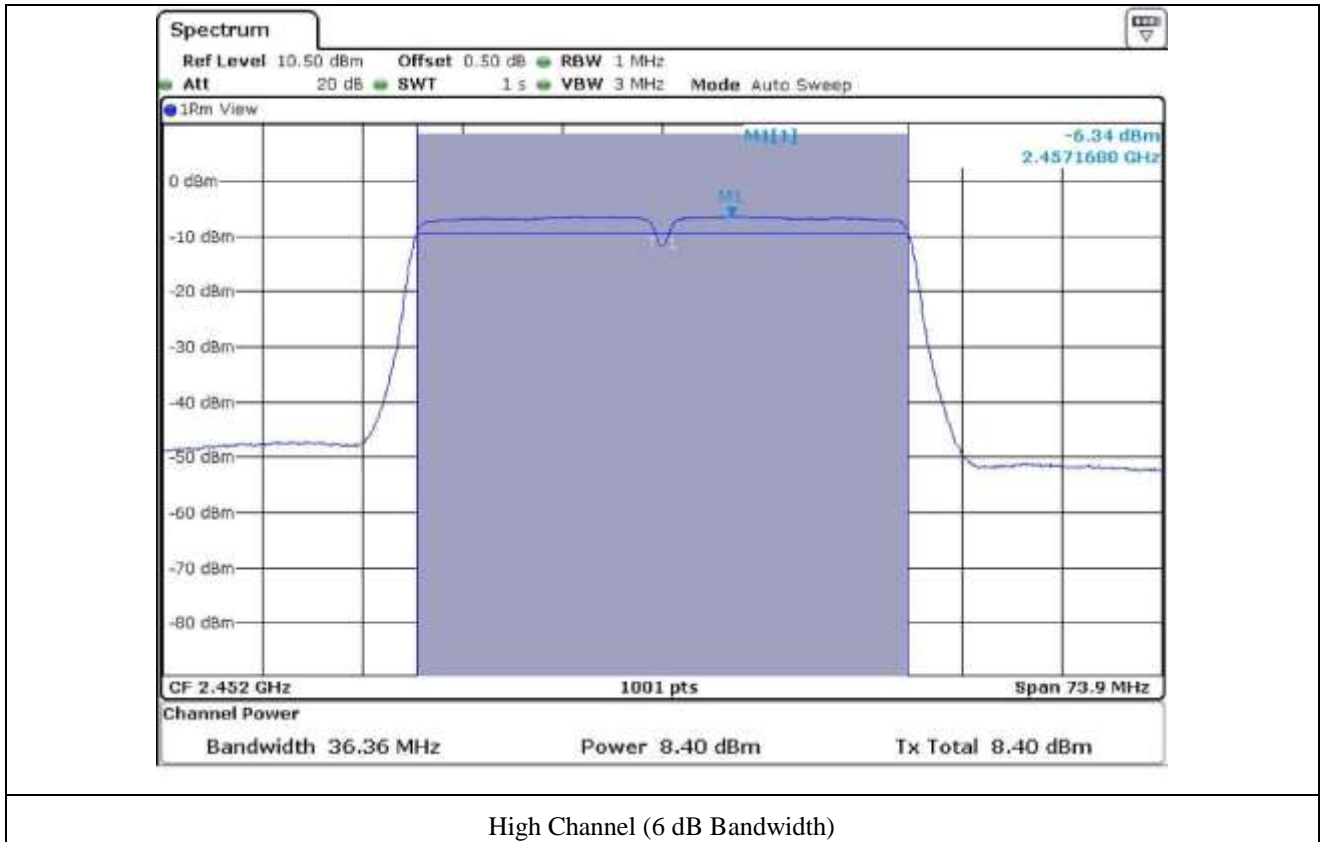
Tested by: Tae-Ho, Kim / Senior Engineer



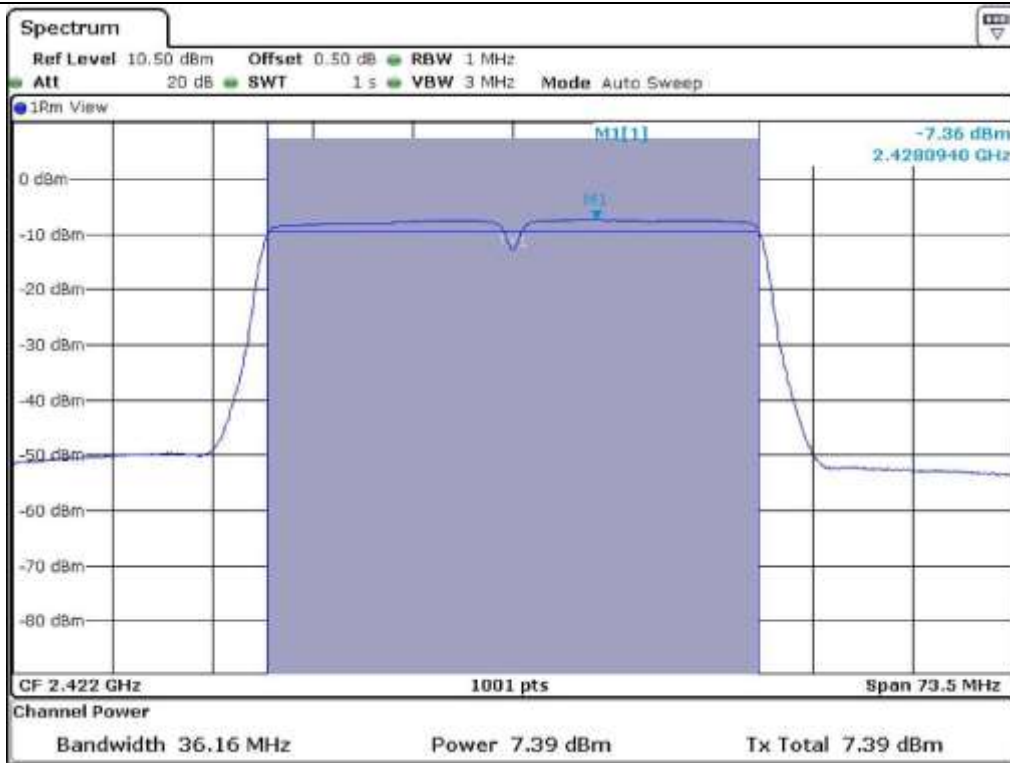
Low Channel (6 dB Bandwidth)



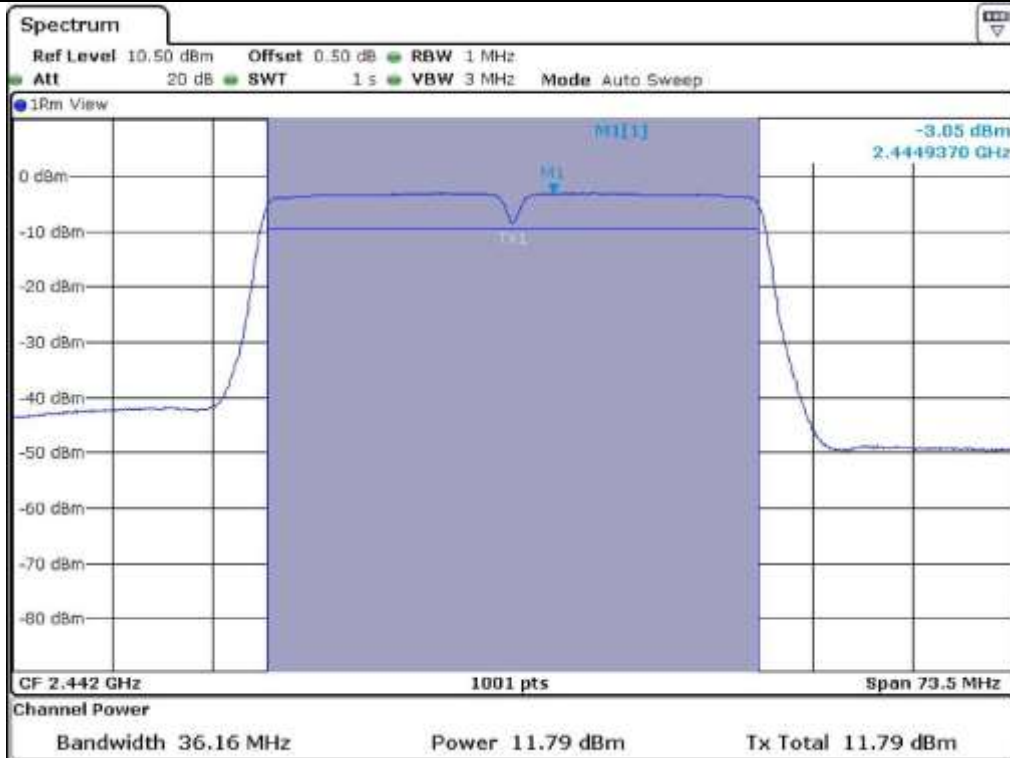
Middle Channel (6 dB Bandwidth)



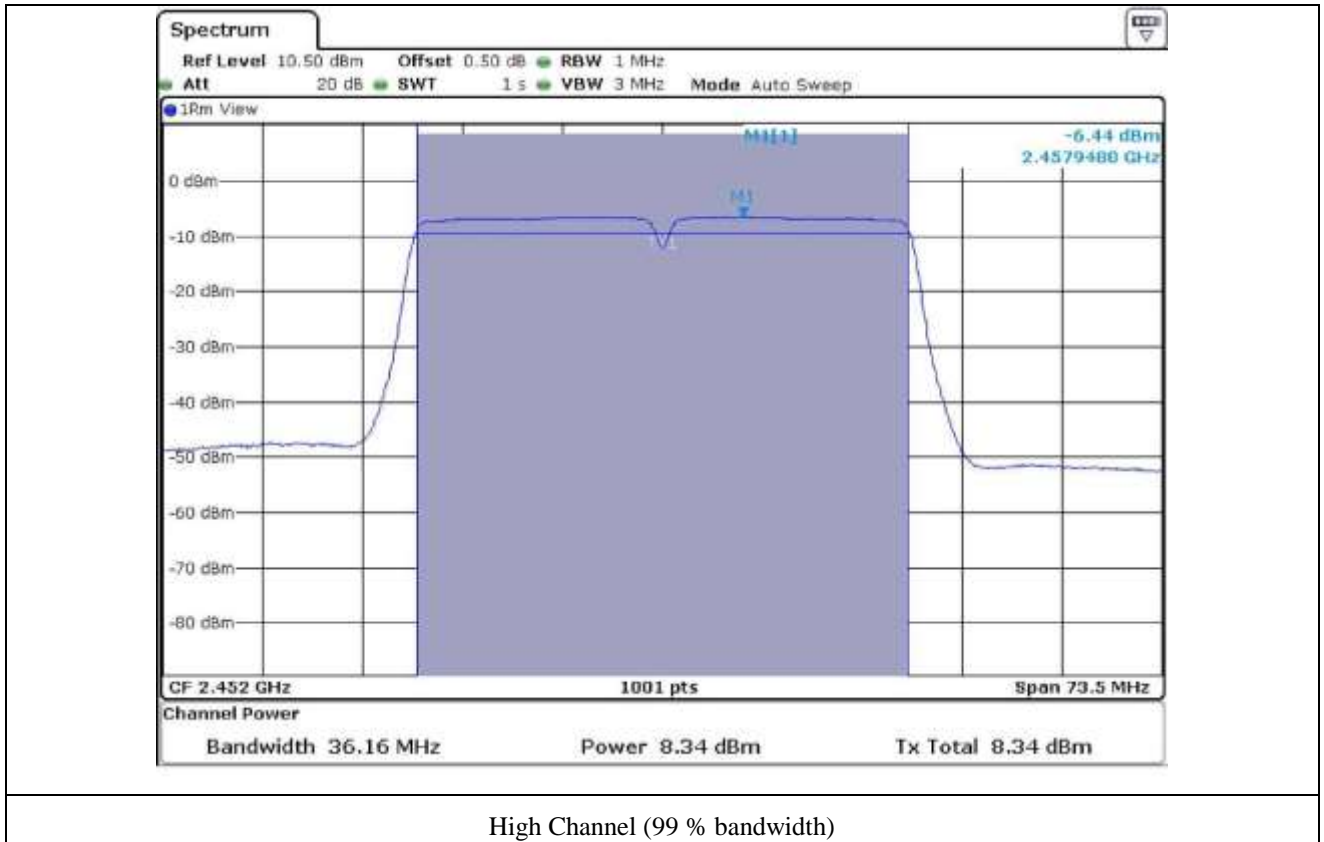
High Channel (6 dB Bandwidth)



Low Channel (99 % bandwidth)



Middle Channel (99 % bandwidth)



7.2.7.3 Test data for Multiple transmit

- Test Date : May 20, 2015
 - Test Result : Pass

- FCC Test data

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	CALCULATED OUTPUT POWER (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422	36.36	9.16	30	20.84
MIDDLE	2 442	36.36	14.70	30	15.30
HIGH	2 452	36.36	10.49	30	19.51

Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log (10^{(\text{Antenna1 Output Power}/10)}+10^{(\text{Antenna2 Output Power}/10)})$

- IC Test data

CHANNEL	FREQUENCY (MHz)	99 % bandwidth (MHz)	CALCULATED OUTPUT POWER (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422	35.88	9.09	30	20.91
MIDDLE	2 442	35.88	14.65	30	15.35
HIGH	2 452	35.88	10.46	30	19.54

Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log (10^{(\text{Antenna1 Output Power}/10)}+10^{(\text{Antenna2 Output Power}/10)})$



Tested by: Tae-Ho, Kim / Senior Engineer