

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

Test Report No. : OT-199-RWD-038
AGR No. : A197A-116
Applicant : BITFINDER, INC.
Address : 40 boardman pl, 2F, San Francisco, California, 94103, United States
Manufacturer : BITFINDER, INC.
Address : 13F WeWork, 343 Samil-daero, Jung-Gu, Seoul, Republic of Korea
Type of Equipment : AWAIR ELEMENT
FCC ID. : 2AF65AWAIR0HD3E
Model Name : AWAIR Rev3E
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 68 pages (including this page)
Date of Incoming : August 02, 2019
Date of issue : September 24, 2019

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.

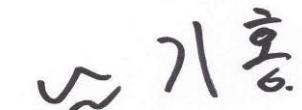
It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by:



Tae-Ho, Kim / Senior Manager
ONETECH Corp.

Approved by:



Ki-Hong, Nam / Chief Engineer
ONETECH Corp.

CONTENTS

	PAGE
1. VERIFICATION OF COMPLIANCE	5
2. TEST SUMMARY.....	6
2.1 TEST ITEMS AND RESULTS	6
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS.....	6
2.3 RELATED SUBMITTAL(S) / GRANT(S)	6
2.4 PURPOSE OF THE TEST	6
2.5 TEST METHODOLOGY.....	6
2.6 TEST FACILITY.....	6
3. GENERAL INFORMATION.....	7
3.1 PRODUCT DESCRIPTION.....	7
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT.....	7
4. EUT MODIFICATIONS.....	7
5. SYSTEM TEST CONFIGURATION	8
5.1 JUSTIFICATION.....	8
5.2 PERIPHERAL EQUIPMENT	8
5.3 MODE OF OPERATION DURING THE TEST	9
5.4 CONFIGURATION OF TEST SYSTEM.....	18
5.5 ANTENNA REQUIREMENT	18
6. PRELIMINARY TEST	19
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS.....	19
6.2 GENERAL RADIATED EMISSIONS TESTS	19
7. MINIMUM 6 DB BANDWIDTH.....	20
7.1 OPERATING ENVIRONMENT	20
7.2 TEST SET-UP	20
7.3 TEST EQUIPMENT USED.....	20
7.4 TEST DATA FOR 802.11B WLAN MODE.....	21
7.5 TEST DATA FOR 802.11G WLAN MODE	23
7.6 TEST DATA FOR 802.11N_HT20 WLAN MODE.....	25
8. MAXIMUM PEAK OUTPUT POWER	27
8.1 OPERATING ENVIRONMENT	27
8.2 TEST SET-UP	27

8.3 TEST EQUIPMENT USED	27
8.4 TEST DATA FOR 802.11B WLAN MODE	28
8.5 TEST DATA FOR 802.11G WLAN MODE	30
9. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND.....	34
9.1 OPERATING ENVIRONMENT	34
9.2 TEST SET-UP FOR CONDUCTED MEASUREMENT	34
9.3 TEST SET-UP FOR RADIATED MEASUREMENT.....	34
9.4 TEST EQUIPMENT USED	34
9.5 TEST DATA FOR CONDUCTED EMISSION	35
<i>9.5.1 Test data for 802.11b WLAN Mode.....</i>	35
<i>9.5.2 Test data for 802.11g WLAN Mode.....</i>	40
<i>9.5.3 Test data for 802.11n_HT20 WLAN Mode</i>	45
9.6 TEST DATA FOR RADIATED EMISSION	50
<i>9.6.1 Radiated Emission which fall in the Restricted Band.....</i>	50
10. PEAK POWER SPECTRUL DENSITY	56
10.1 OPERATING ENVIRONMENT	56
10.2 TEST SET-UP	56
10.3 TEST EQUIPMENT USED	56
10.4 TEST DATA FOR 802.11B WLAN MODE	57
10.5 TEST DATA FOR 802.11G WLAN MODE	59
10.6 TEST DATA FOR 802.11N_HT20 WLAN MODE	61
11. RADIATED EMISSION TEST	63
11.1 OPERATING ENVIRONMENT	63
11.2 TEST SET-UP	63
11.3 TEST EQUIPMENT USED	63
11.4 TEST DATA	64
<i>11.4.1 Test data for 30 MHz ~ 1 GHz</i>	64
<i>11.4.2 Test data for Below 30 MHz</i>	65
<i>11.4.3 Test data for above 1 GHz</i>	65
12. CONDUCTED EMISSION TEST	66
12.1 OPERATING ENVIRONMENT	66
12.2 TEST SET-UP	66
12.3 TEST EQUIPMENT USED	66
12.4 TEST DATA	67

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-199-RWD-038	September 24, 2019	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : BITFINDER, INC.

Address : 40 boardman pl, 2F, San Francisco, California, 94103, United States

Contact Person : Kevin, Cho / CTO

Telephone No. : 408-930-9235

FCC ID : 2AF65AWAIR0HD3E

Model Name : AWAIR Rev3E

Brand Name : -

Serial Number : N/A

Date : September 24, 2019

EQUIPMENT CLASS	DTS – DIGITAL TRANSMISSION SYSTEM
E.U.T. DESCRIPTION	AWAIR ELEMENT
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT	Certification
AUTHORIZATION REQUESTED	
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

- The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

- Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666 / T-1842

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

- Site Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The BITFINDER, INC., Model AWAIR Rev3E (referred to as the EUT in this report) is an AWAIR ELEMENT, Product specification information described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	AWAIR ELEMENT	
Temperature Range	-10 °C ~ 50 °C	
OPERATING FREQUENCY	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
MODULATION TYPE	Bluetooth LE	GFSK
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK) 802.11g/n(HT20): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
RF OUTPUT POWER	Bluetooth LE	-1.05 dBm
	WLAN 2.4 GHz	7.51 dBm(802.11b) 10.75 dBm(802.11g) 9.78 dBm(802.11n_HT20)
ANTENNA TYPE	PCB Antenna	
ANTENNA GAIN	5.049 dBi	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	26 MHz, 37.4 MHz	

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

- None

4. EUT MODIFICATIONS

- None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	BITFINDER, INC.	AWAIR-LITE-MAIN-V2.0	N/A
Sub Board	BITFINDER, INC.	N/A	N/A
LED Board	BITFINDER, INC.	AWAIR-R2-LED-V4.0	N/A
Air Sensor	Honeywell	HPMA 115S0-XXX	N/A
Lithium Battery	N/A	CR2032	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
AWAIR Rev3E	BITFINDER, INC.	AWAIR ELEMENT(EUT)	-
AWAIR Debugger V2.0	Bitfinder, Inc.	Jig Board	EUT / Notebook PC
ST-LINK/V2	STMicroelectronics	Jig Board	EUT / Notebook PC
Ideapad 100-15IBD	LENOVO	Notebook PC	Jig Board

5.3 Mode of operation during the test

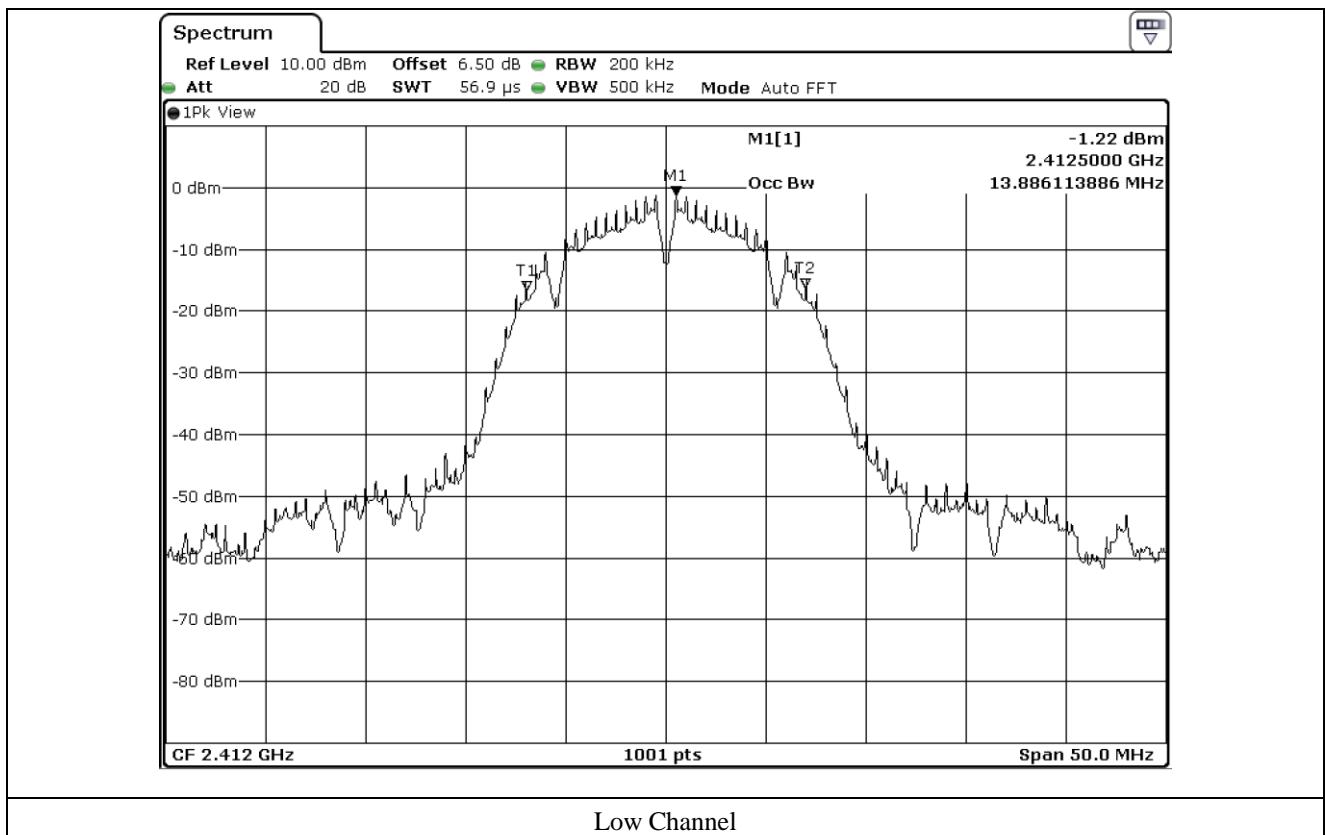
For the testing, software used to control the EUT for staying in continuous transmitting mode is programmed.

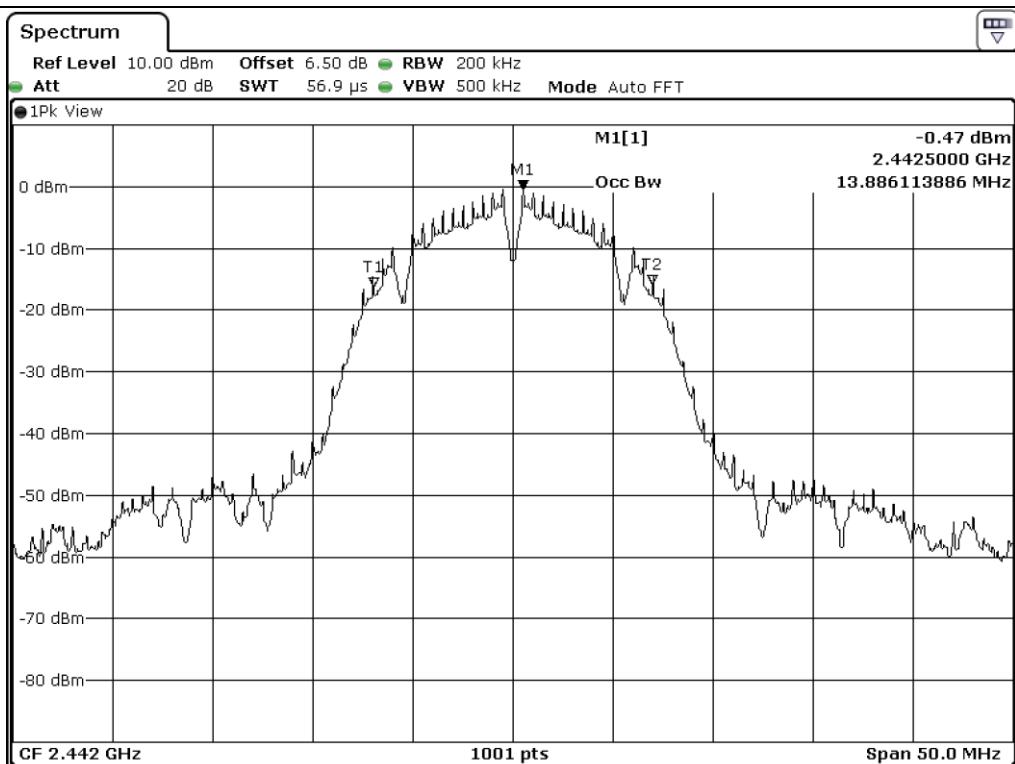
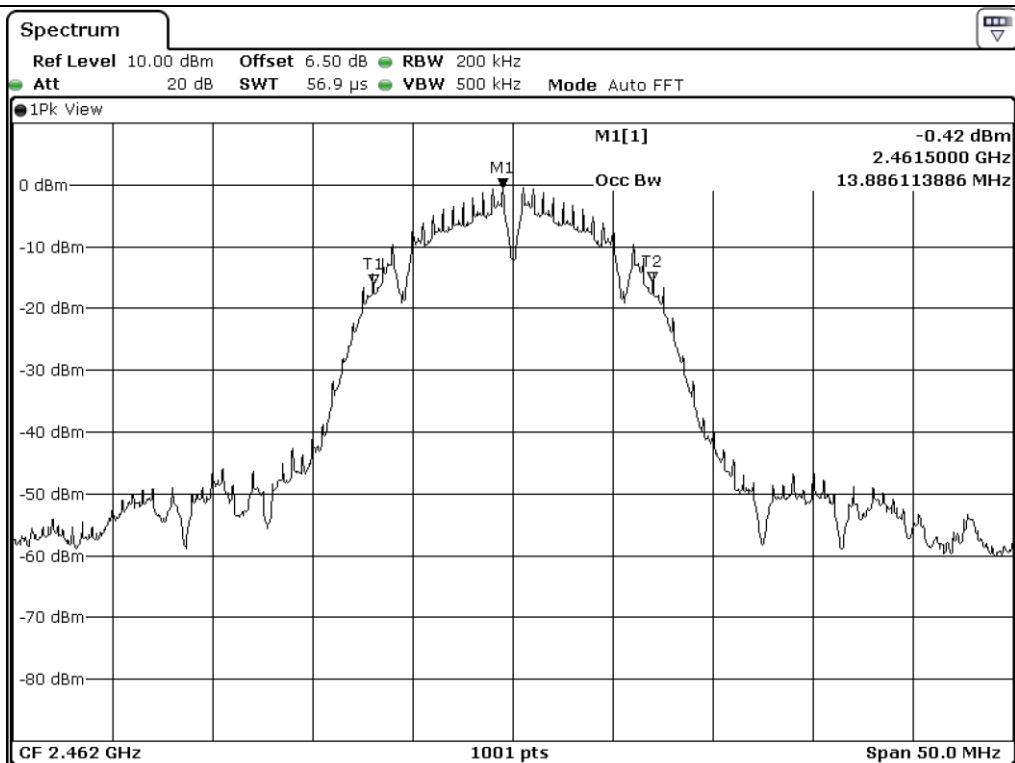
Modulation	DATA RATE	OUTPUT POWER[dBm]
802.11 b (Middle Channel)	1 Mbps	7.27
	2 Mbps	7.22
	5.5 Mbps	7.20
	11 Mbps	7.15
802.11g (Middle Channel)	6 Mbps	9.72
	9 Mbps	9.67
	12 Mbps	9.66
	18 Mbps	9.65
	24 Mbps	9.62
	36 Mbps	9.18
	48 Mbps	9.15
	54 Mbps	9.15
802.11 n(HT 20) (Middle Channel)	6.5 Mbps	8.60
	13 Mbps	8.56
	19.5 Mbps	8.55
	26 Mbps	8.52
	39 Mbps	8.50
	52 Mbps	8.47
	58.5 Mbps	8.46
	65 Mbps	8.45

- The worse case data rate for each modulation is determined 1 Mbps for IEEE 802.11b, 6 Mbps for IEEE 802.11g, 6.5 Mbps for HT20.
- To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis.

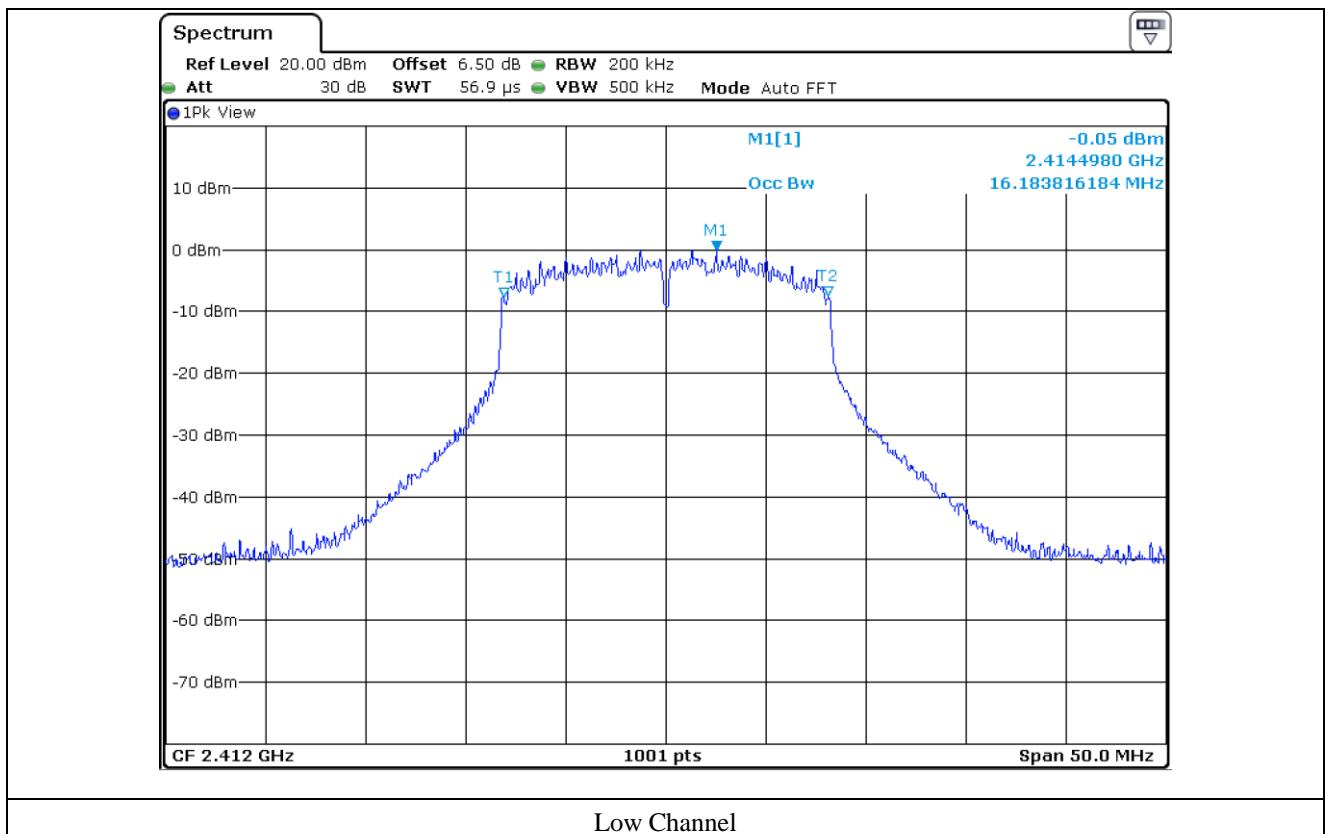
-. Occupied Bandwidth(99 %)

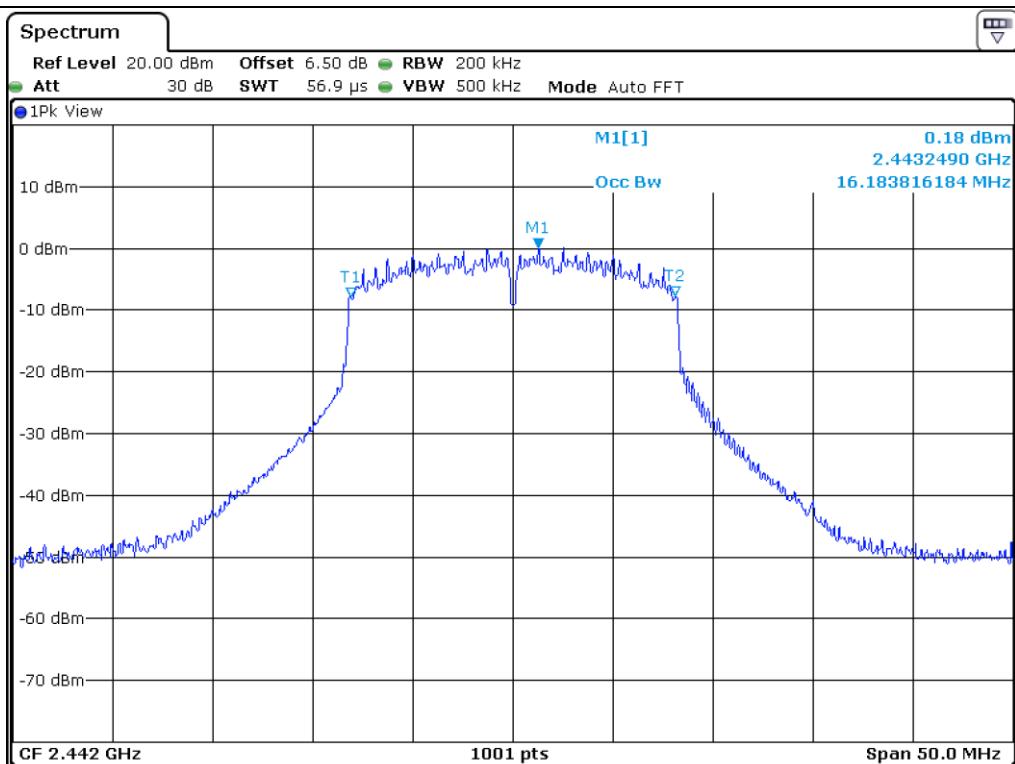
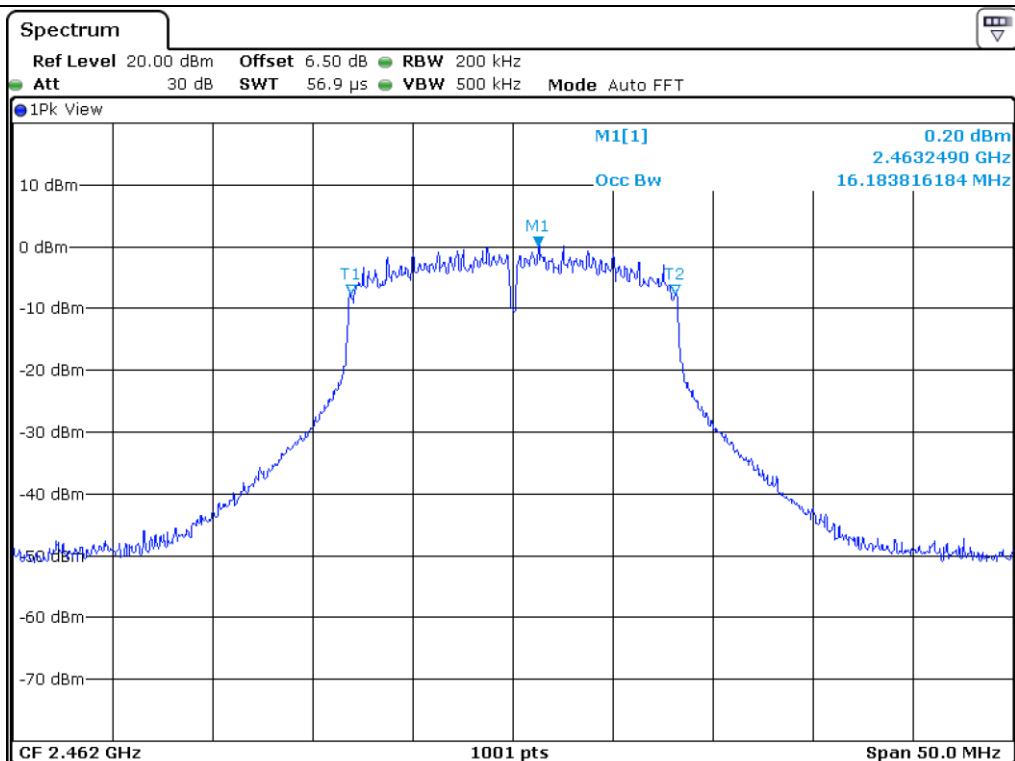
Modulation	CHANNEL	FREQUENCY (MHz)	Occupied Bandwidth(MHz)
802.11 b	Low	2 412	13.89
	Middle	2 442	13.89
	High	2 462	13.89



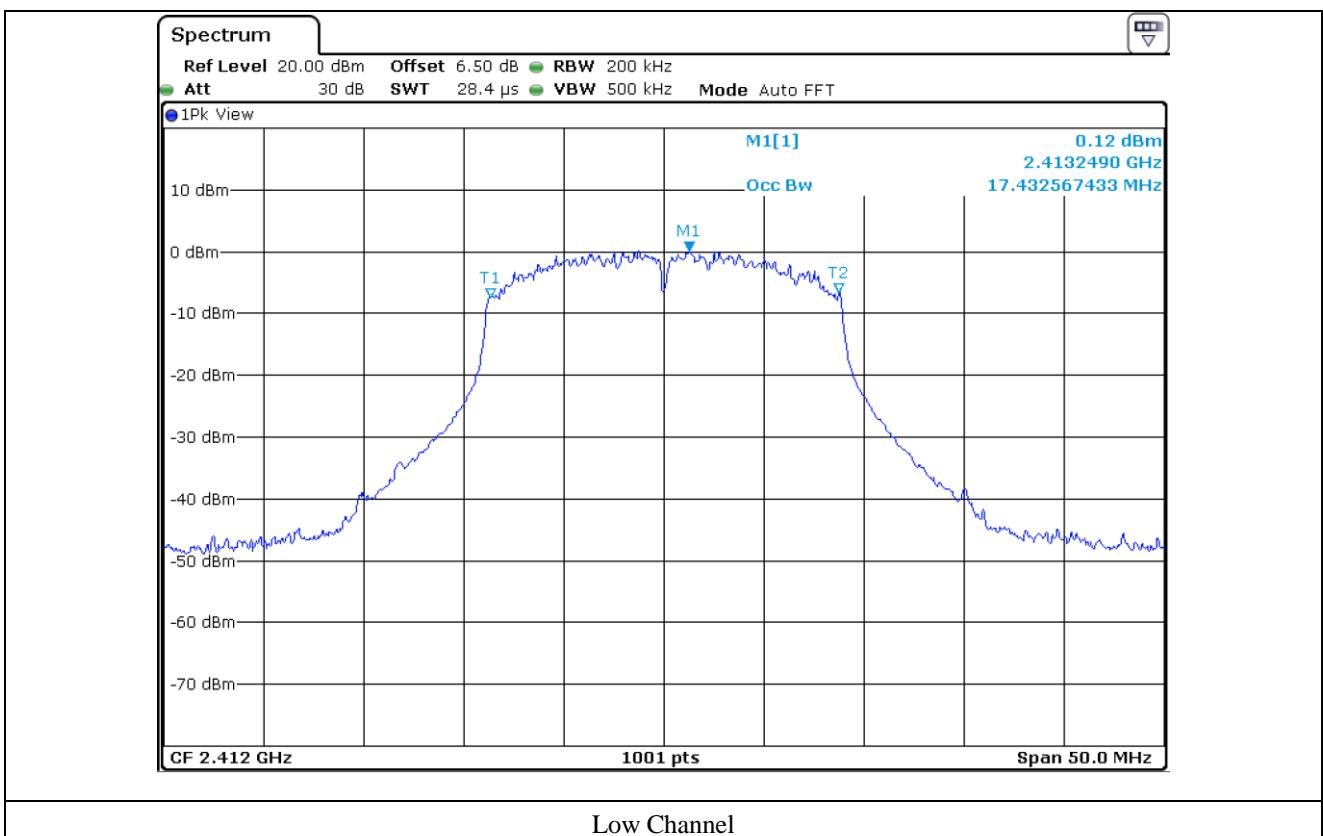
**Middle Channel****High Channel**

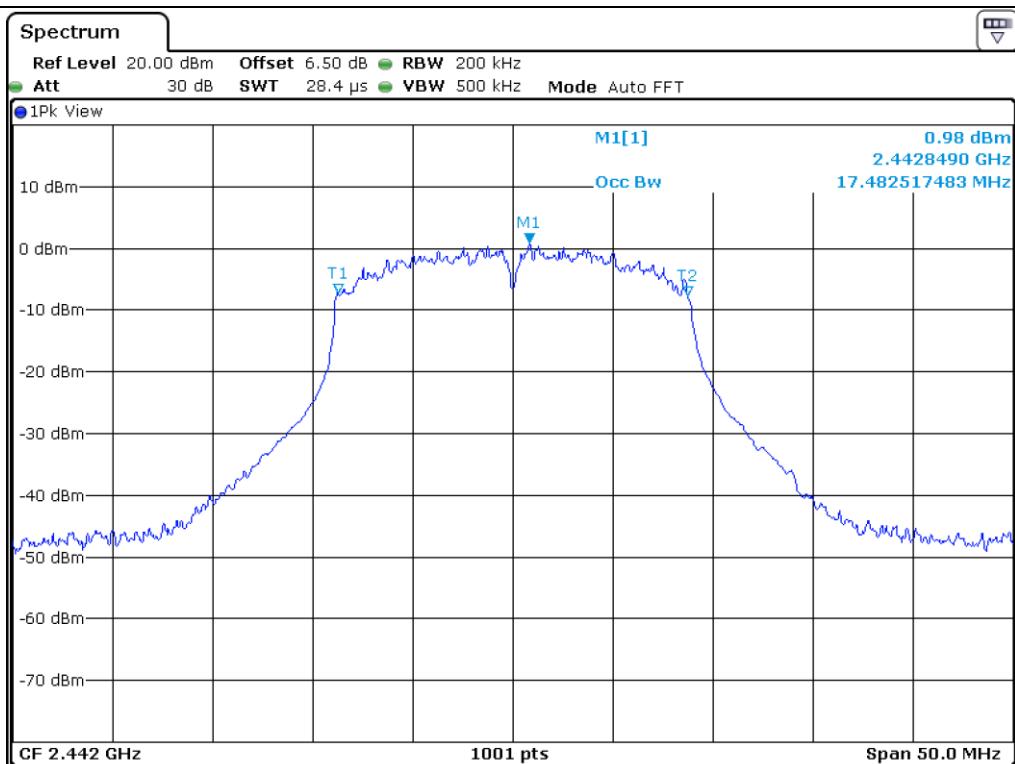
Modulation	CHANNEL	FREQUENCY (MHz)	Occupied Bandwidth(MHz)
802.11 g	Low	2 412	16.18
	Middle	2 442	16.18
	High	2 462	16.18



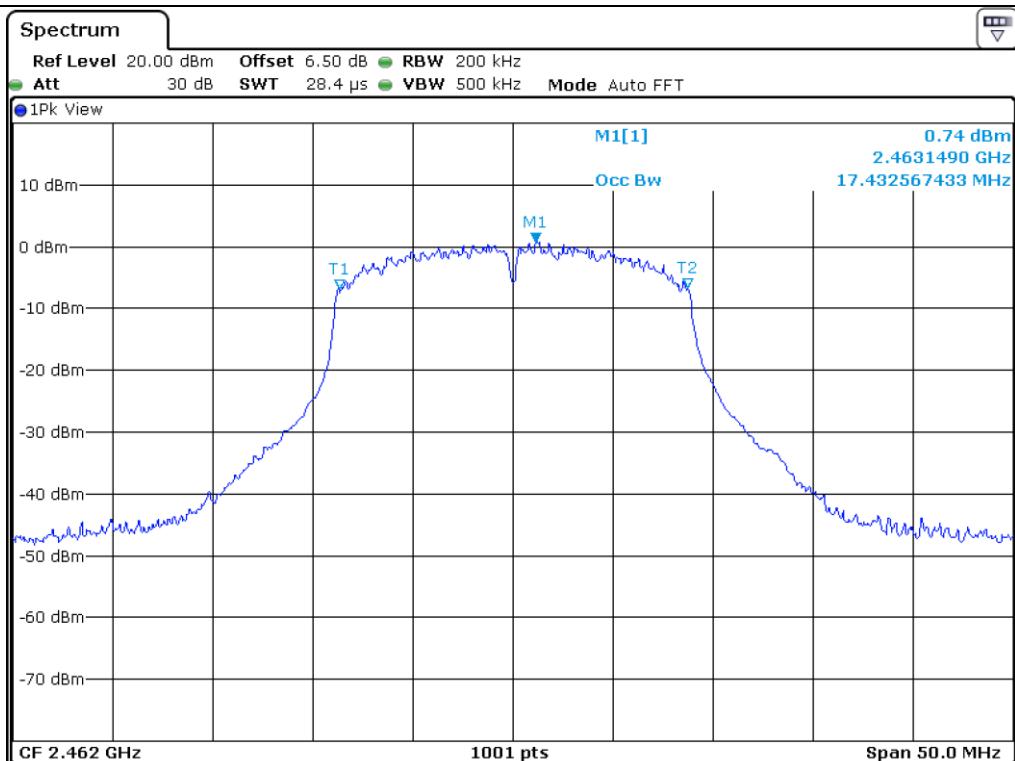
**Middle Channel****High Channel**

Modulation	CHANNEL	FREQUENCY (MHz)	Occupied Bandwidth(MHz)
802.11 n(HT 20)	Low	2 412	17.43
	Middle	2 442	17.48
	High	2 462	17.43





Middle Channel



High Channel

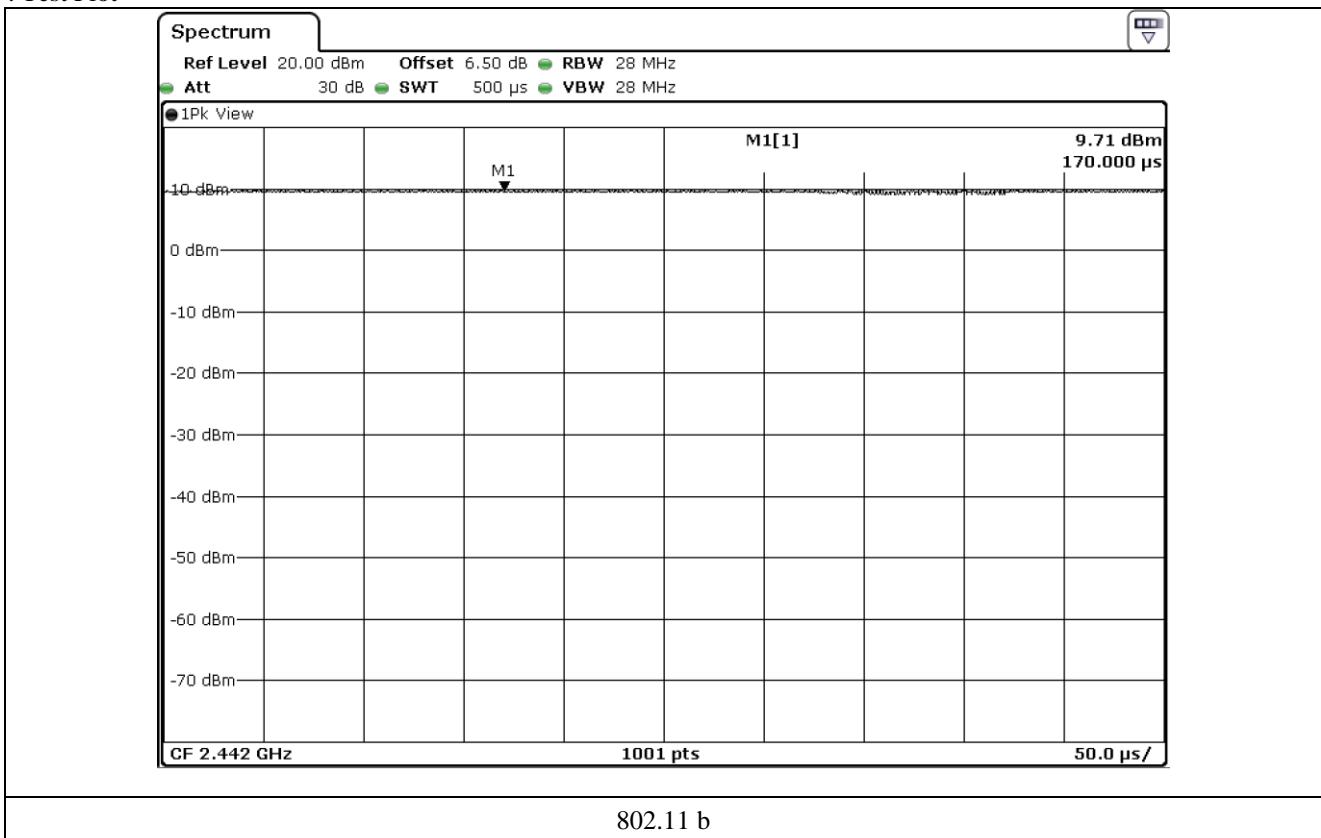
- Duty Cycle

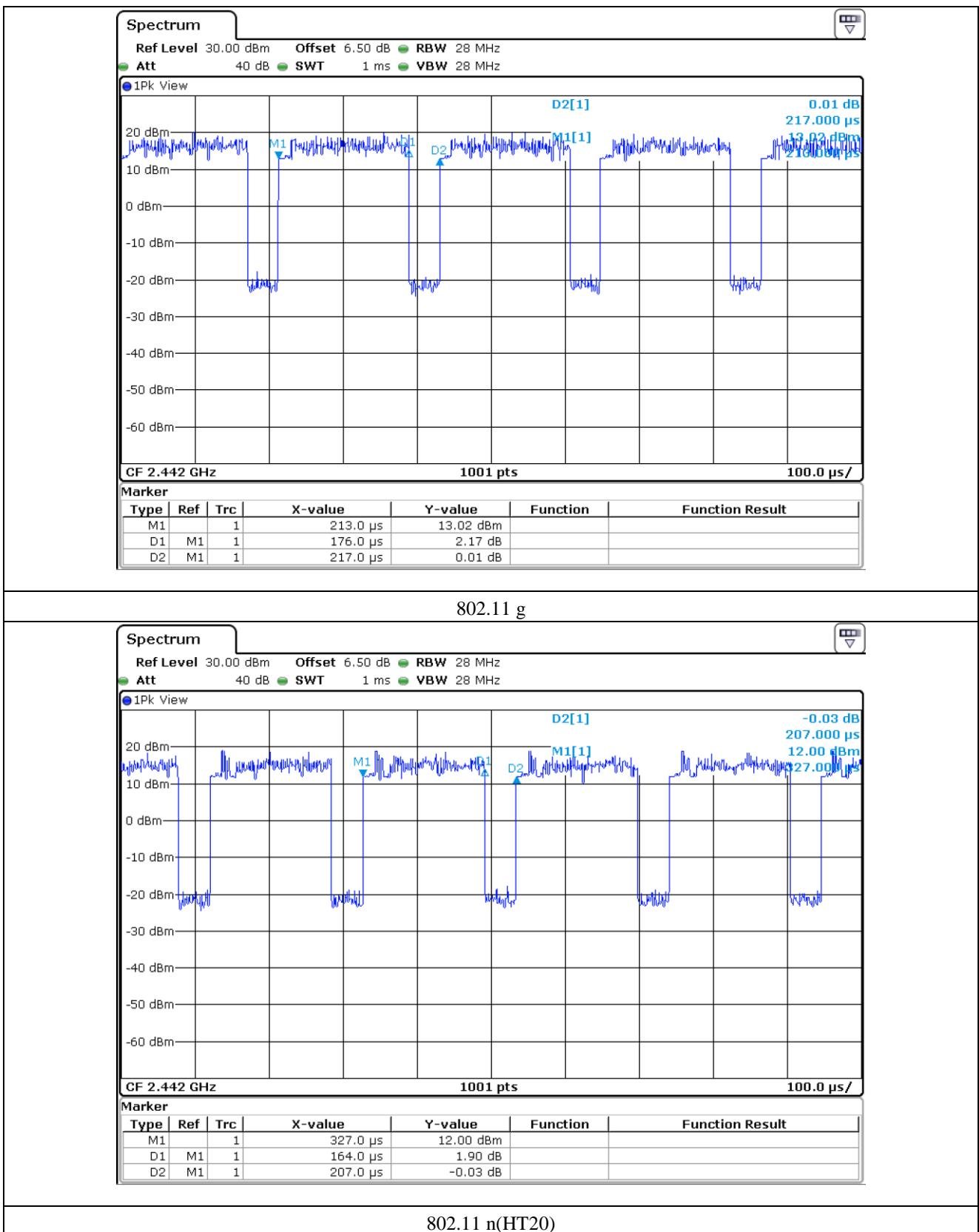
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
802.11 b	-	-	100.00	-
802.11 g	0.176	0.041	81.11	0.91
802.11 n(HT20)	0.164	0.043	79.23	1.01

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : $10 * \log(1 / (\text{Duty Cycle} / 100))$

- Test Plot





5.4 Configuration of Test System

- Line Conducted Test:** The EUT was connected to LISN. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.
- Radiated Emission Test:** Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber. The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is PCB Antenna on the main board in the EUT, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

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

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

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

7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 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.



7.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

7.4 Test data for 802.11b WLAN Mode

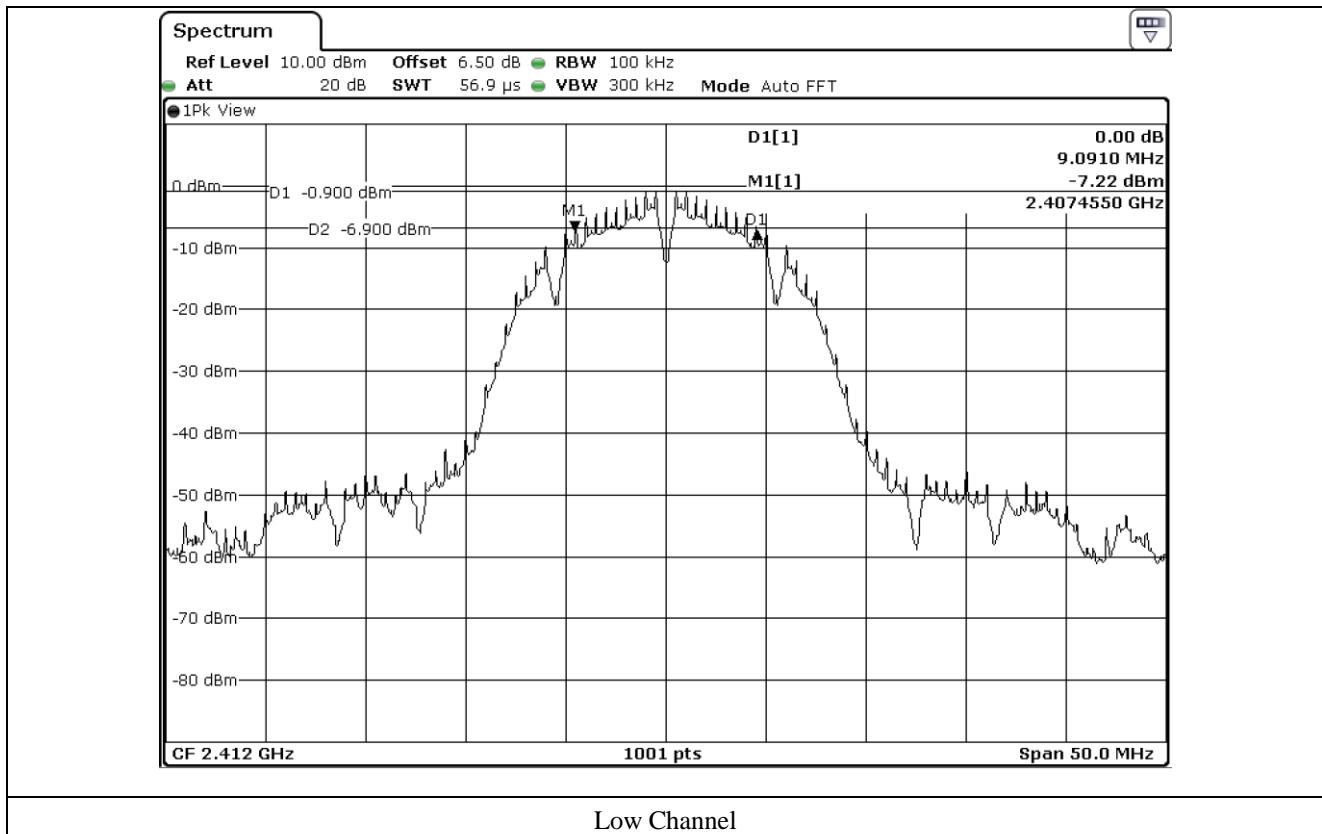
- Test Date : August 08, 2019 ~ August 16, 2019

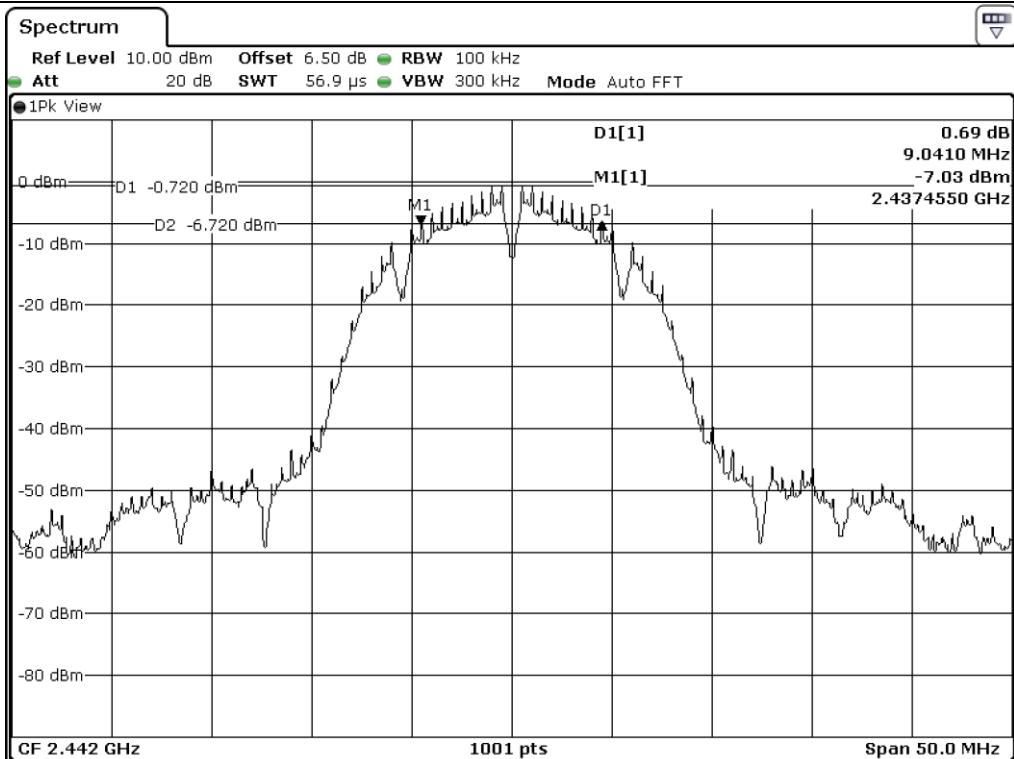
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
LOW	2 412.00	9.09	0.50	8.59
MIDDLE	2 442.00	9.04	0.50	8.54
HIGH	2 462.00	9.09	0.50	8.59

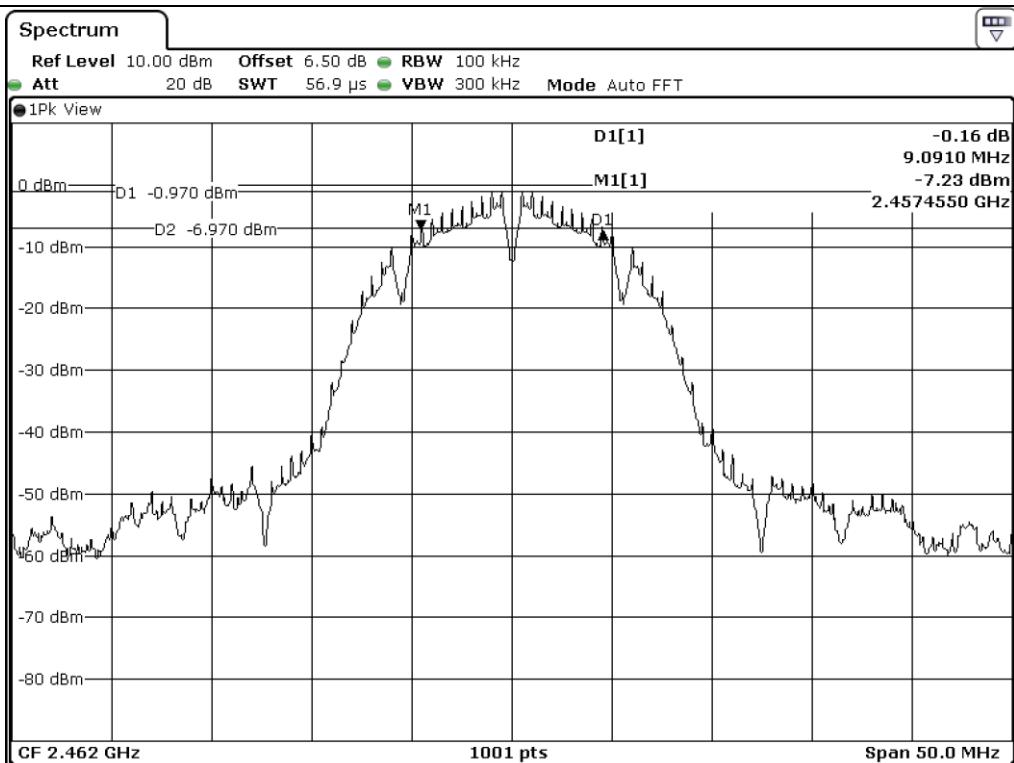
Remark. Margin = Measured Value - Limit

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

7.5 Test data for 802.11g WLAN Mode

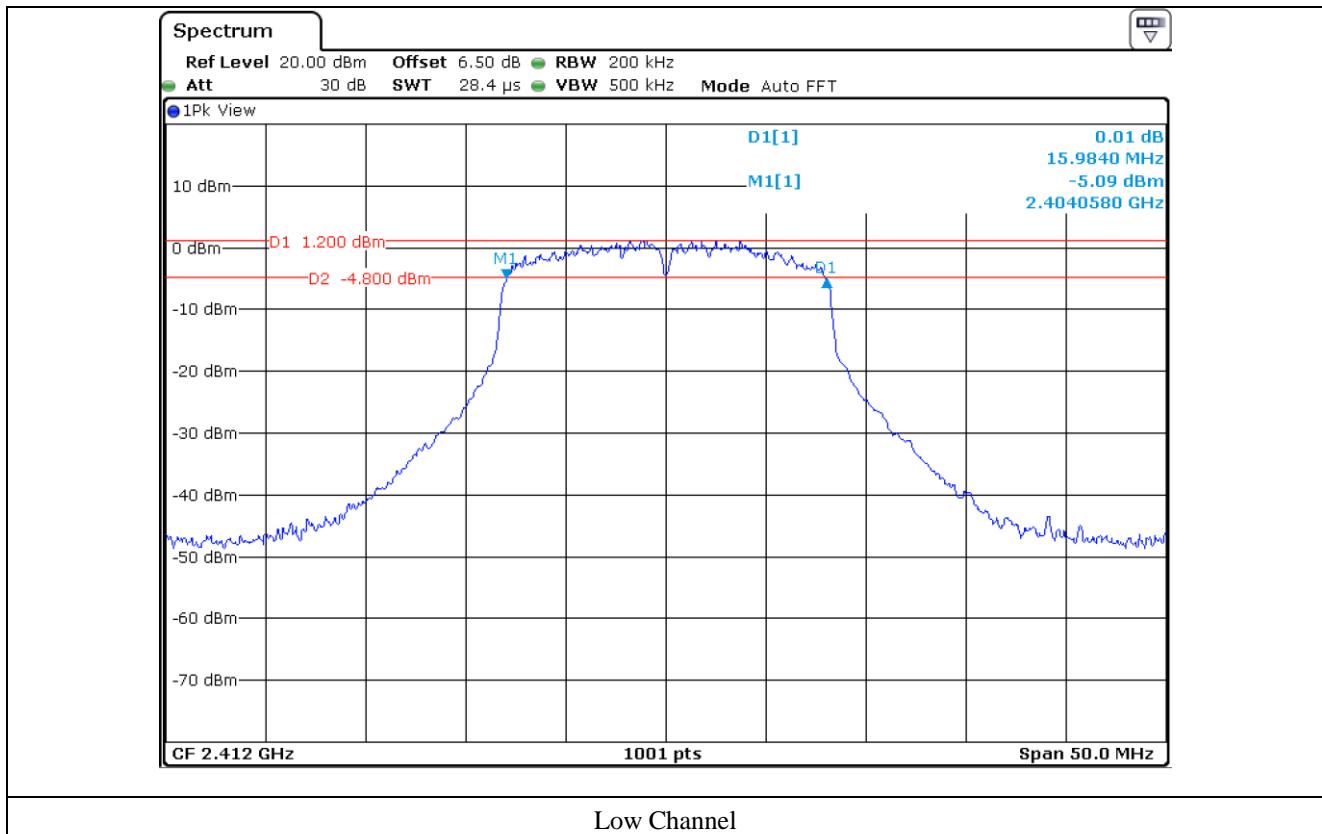
- Test Date : August 08, 2019 ~ August 16, 2019

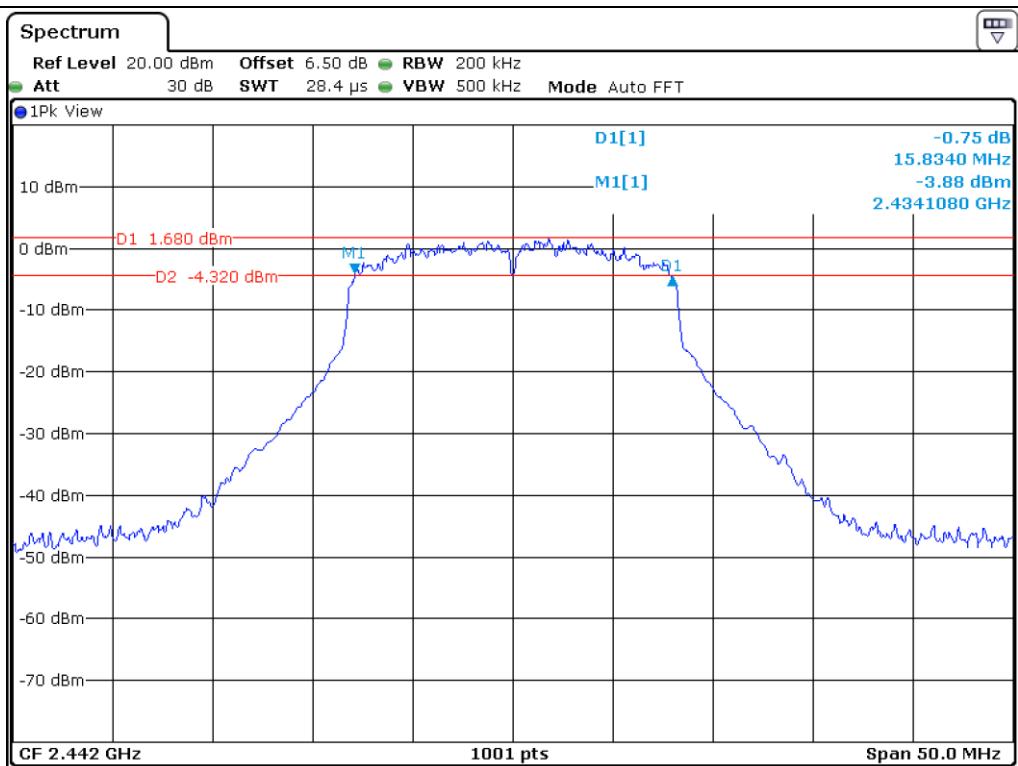
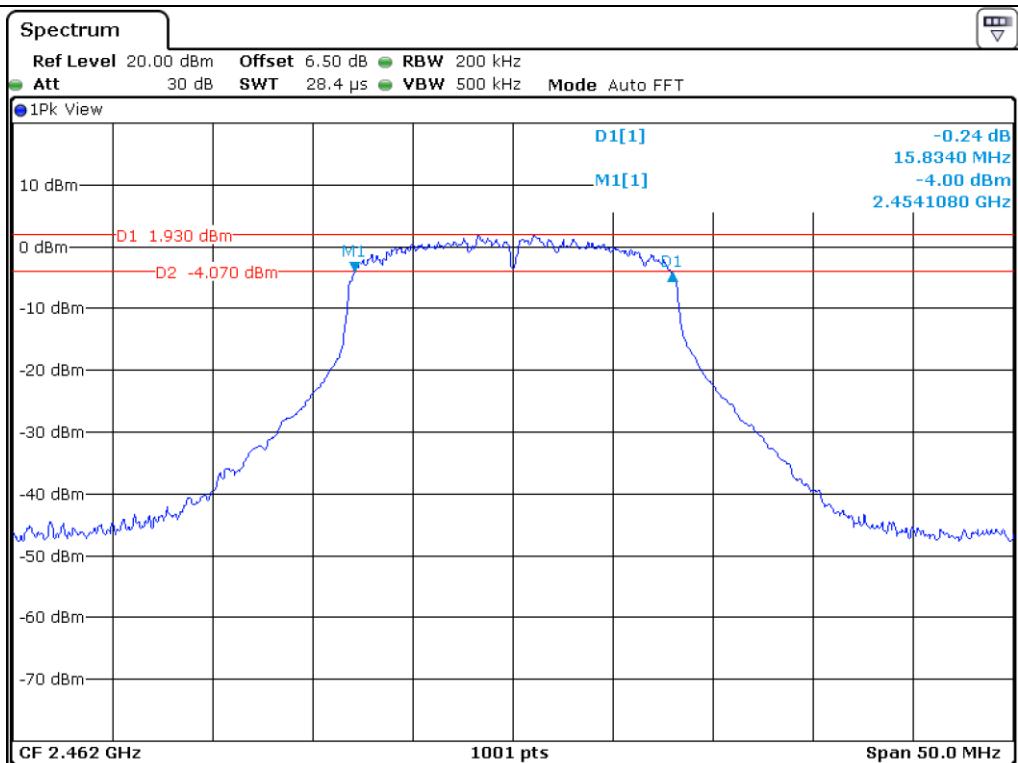
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
LOW	2 412.00	15.98	0.50	15.48
MIDDLE	2 442.00	15.83	0.50	15.33
HIGH	2 462.00	15.83	0.50	15.33

Remark. Margin = Measured Value - Limit

Tested by: Hyung-Kwon, Oh / Assistant Manager



**Middle Channel****High Channel**

7.6 Test data for 802.11n_HT20 WLAN Mode

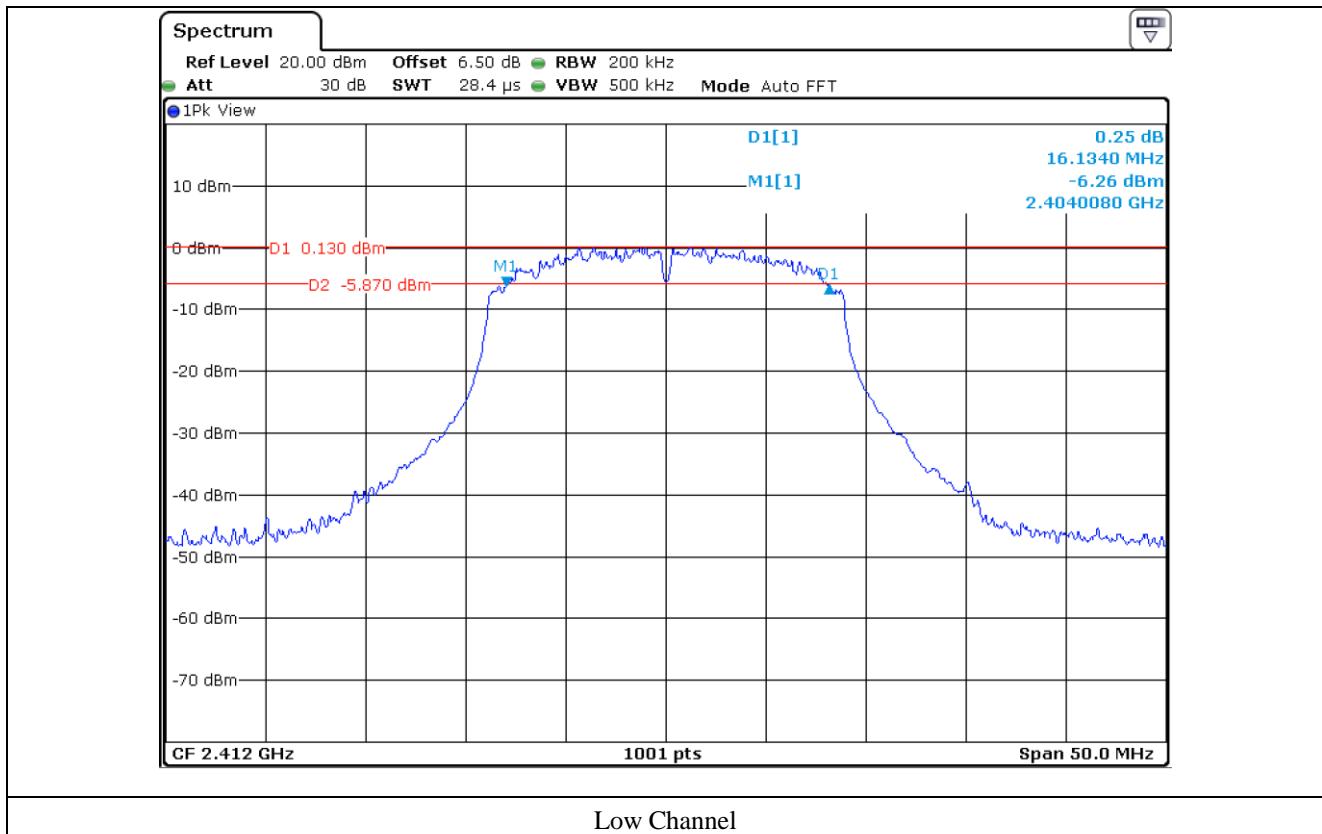
- Test Date : August 08, 2019 ~ August 16, 2019

- Test Result : Pass

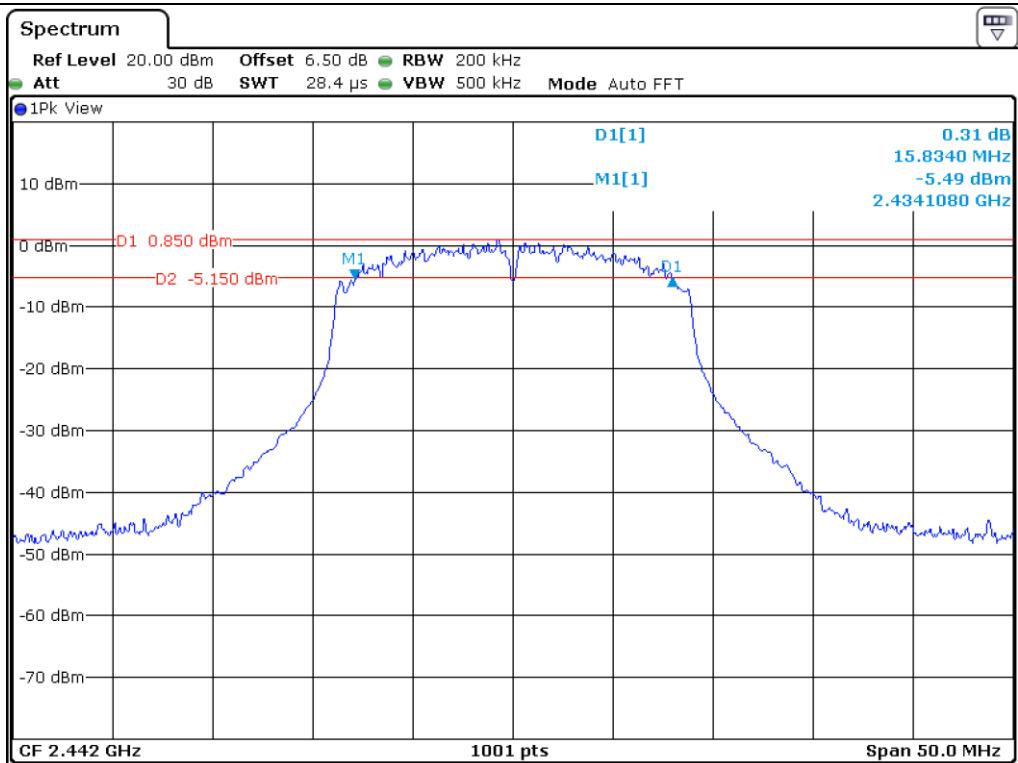
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
LOW	2 412.00	16.13	0.50	15.63
MIDDLE	2 442.00	15.83	0.50	15.33
HIGH	2 462.00	16.13	0.50	15.63

Remark. Margin = Measured Value - Limit

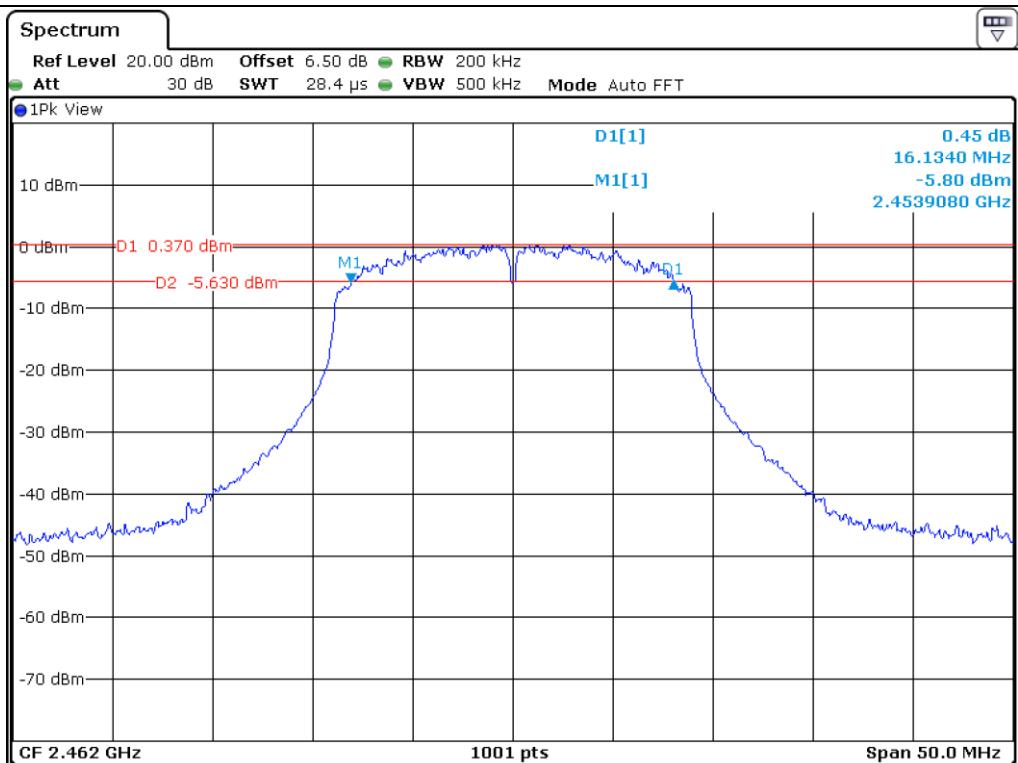
Tested by: Hyung-Kwon, Oh / Assistant Manager



Low Channel



Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

Temperature : 23 °C

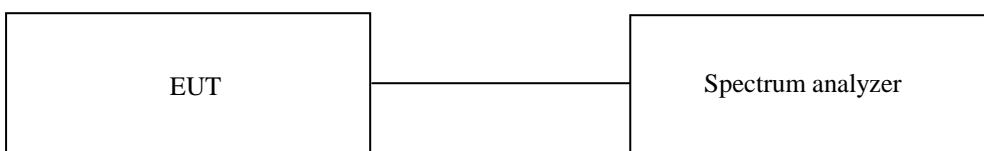
Relative humidity : 45 % R.H.

8.2 Test set-up

The maximum peak output power was measured with the wide band sensor connected to the antenna output of the EUT.

The Wide Band Sensor is measured when the EUT is transmitting at the appropriate center frequency its maximum power control level as described in Section 8.3.2(558074 D01 15.247 Meas Guidance v05r02).

Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.



8.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 802.11b WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019

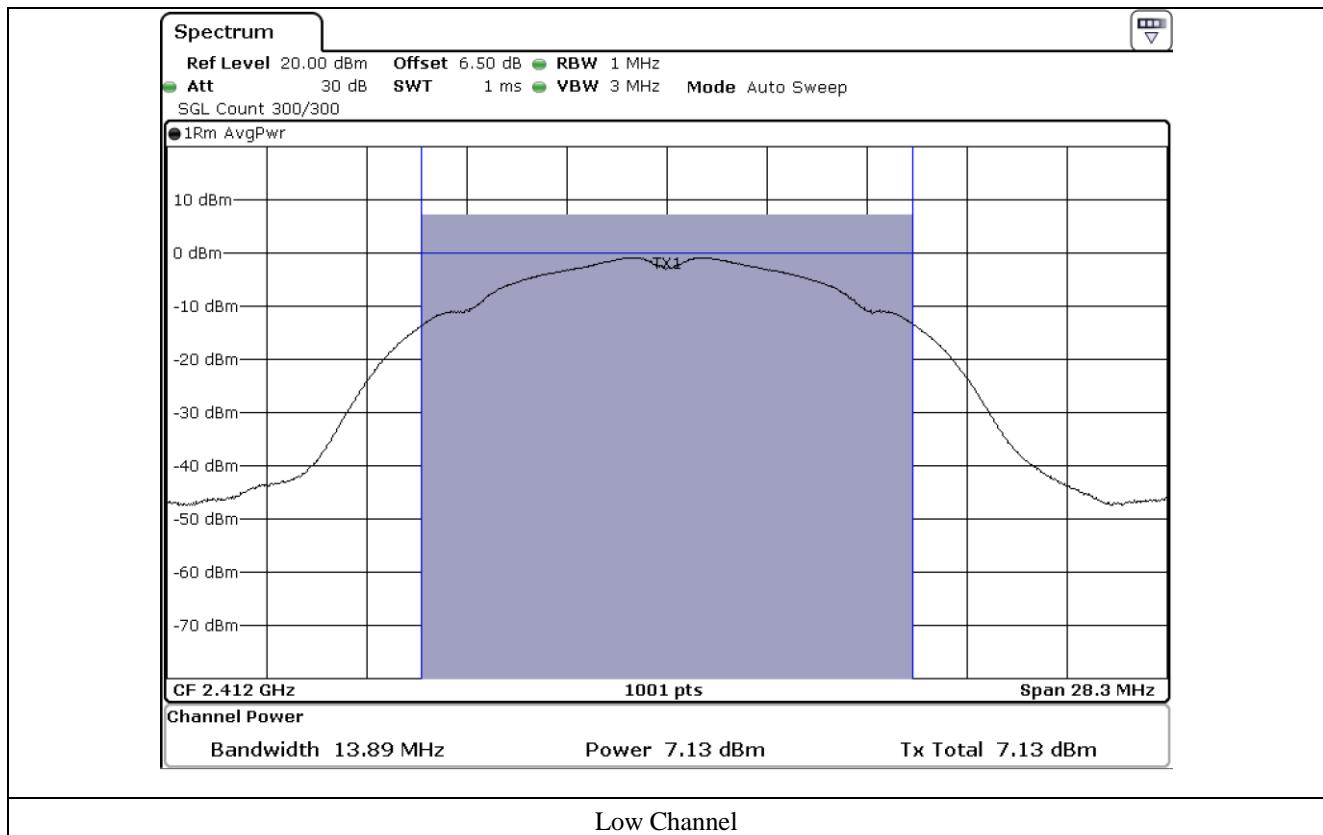
- Test Result : Pass

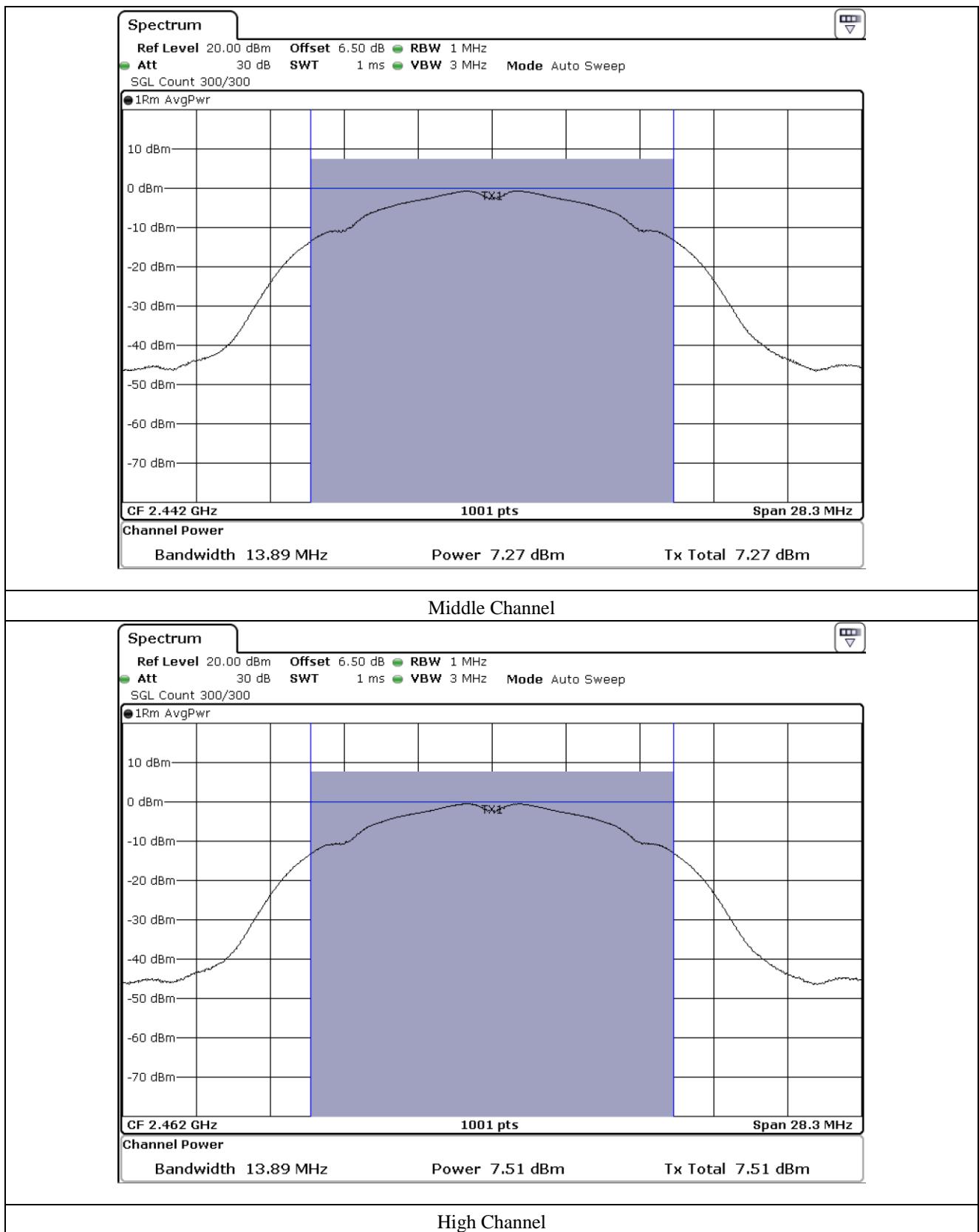
- Duty Cycle : 100.00 %

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Correction Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	7.13	-	7.13	30.00	22.87
MIDDLE	2 442.00	7.27	-	7.27	30.00	22.73
HIGH	2 462.00	7.51	-	7.51	30.00	22.49

Remark : Margin = Limit – Result (= Measured Vlaue + Correction Factor)

Tested by: Hyung-Kwon, Oh / Assistant Manager





8.5 Test data for 802.11g WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019

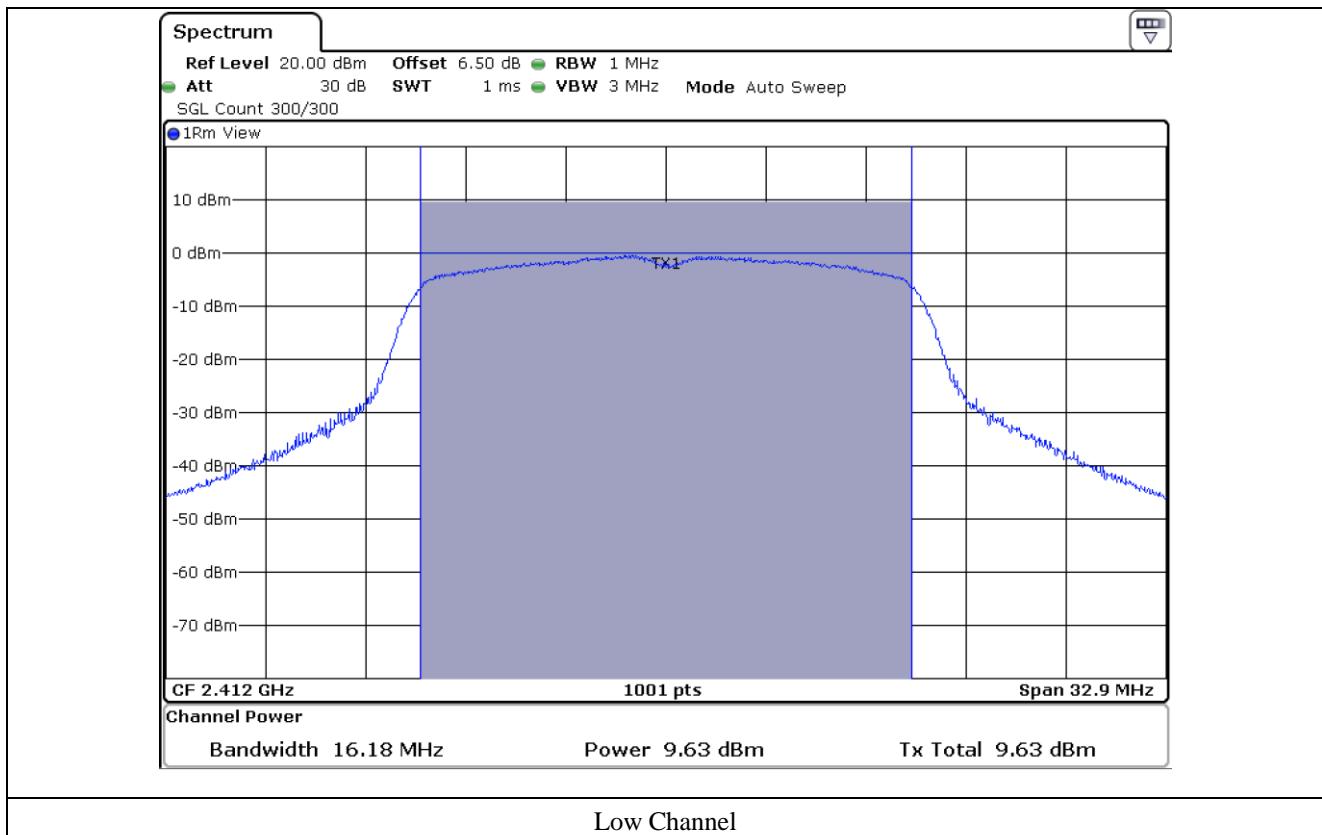
- Test Result : Pass

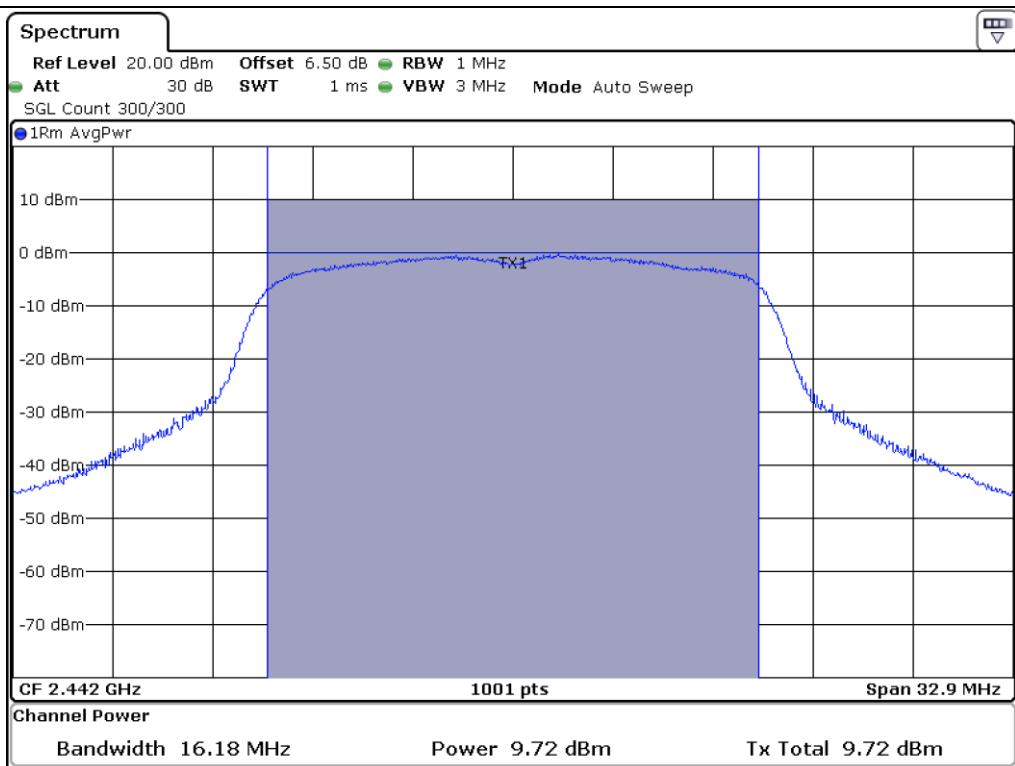
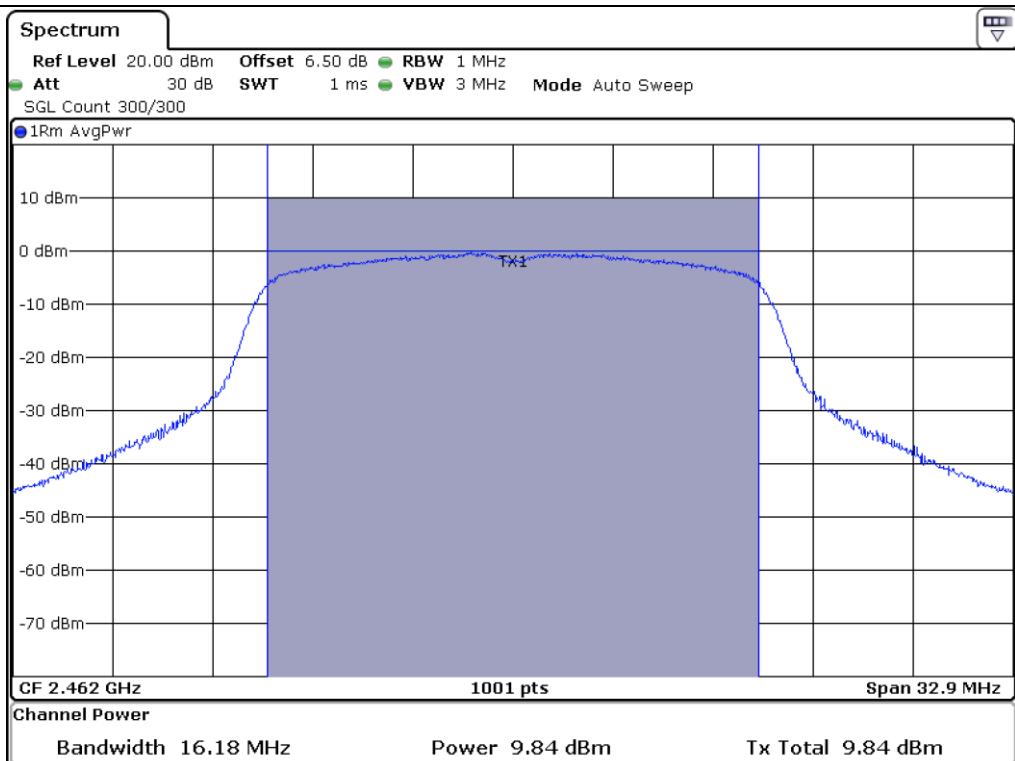
- Duty Cycle : 81.11 %

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Correction Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	9.63	0.91	10.54	30.00	19.46
MIDDLE	2 442.00	9.72	0.91	10.63	30.00	19.37
HIGH	2 462.00	9.84	0.91	10.75	30.00	19.25

Remark : Margin = Limit – Result (= Measured Vlaue + Correction Factor)

Tested by: Hyung-Kwon, Oh / Assistant Manager



**Middle Channel****High Channel**

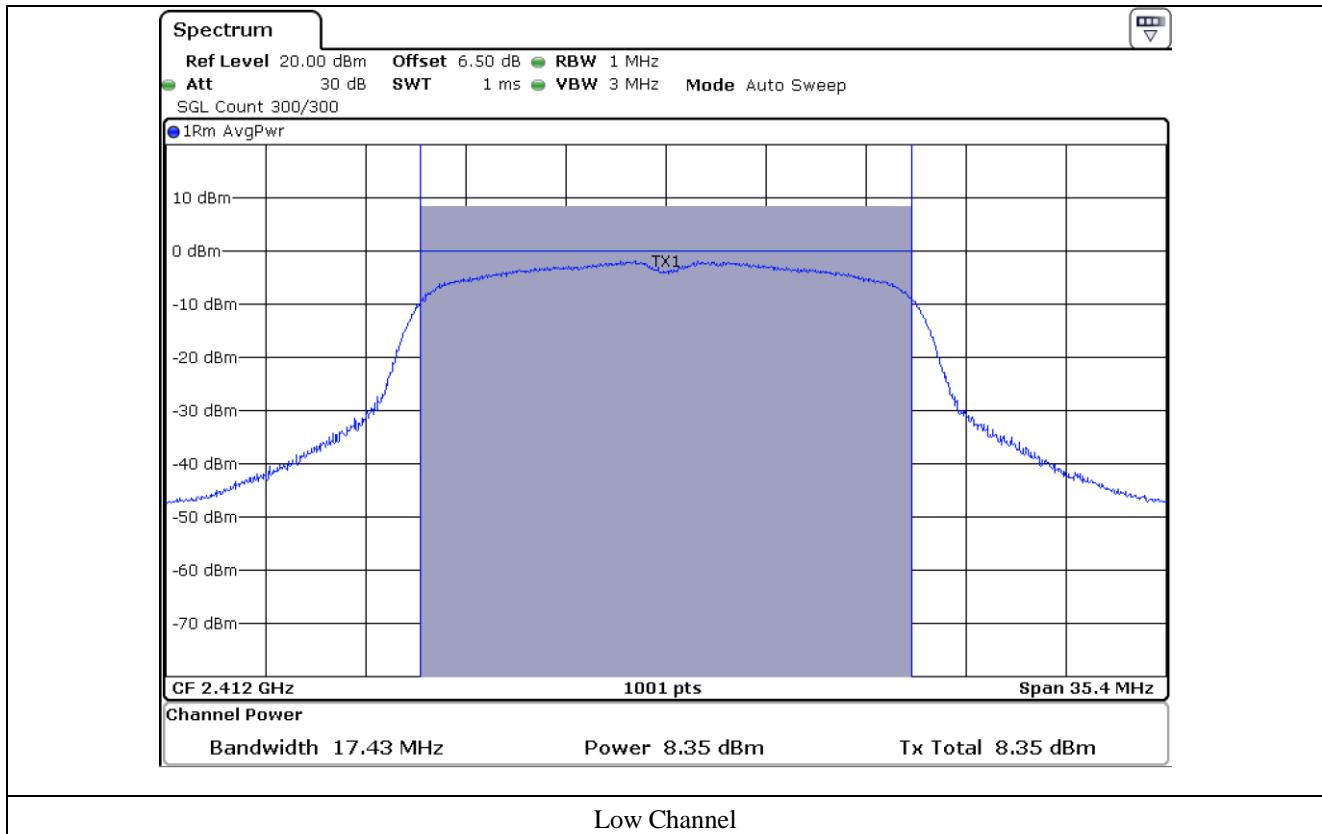
8.6 Test data for 802.11n_HT20 WLAN Mode

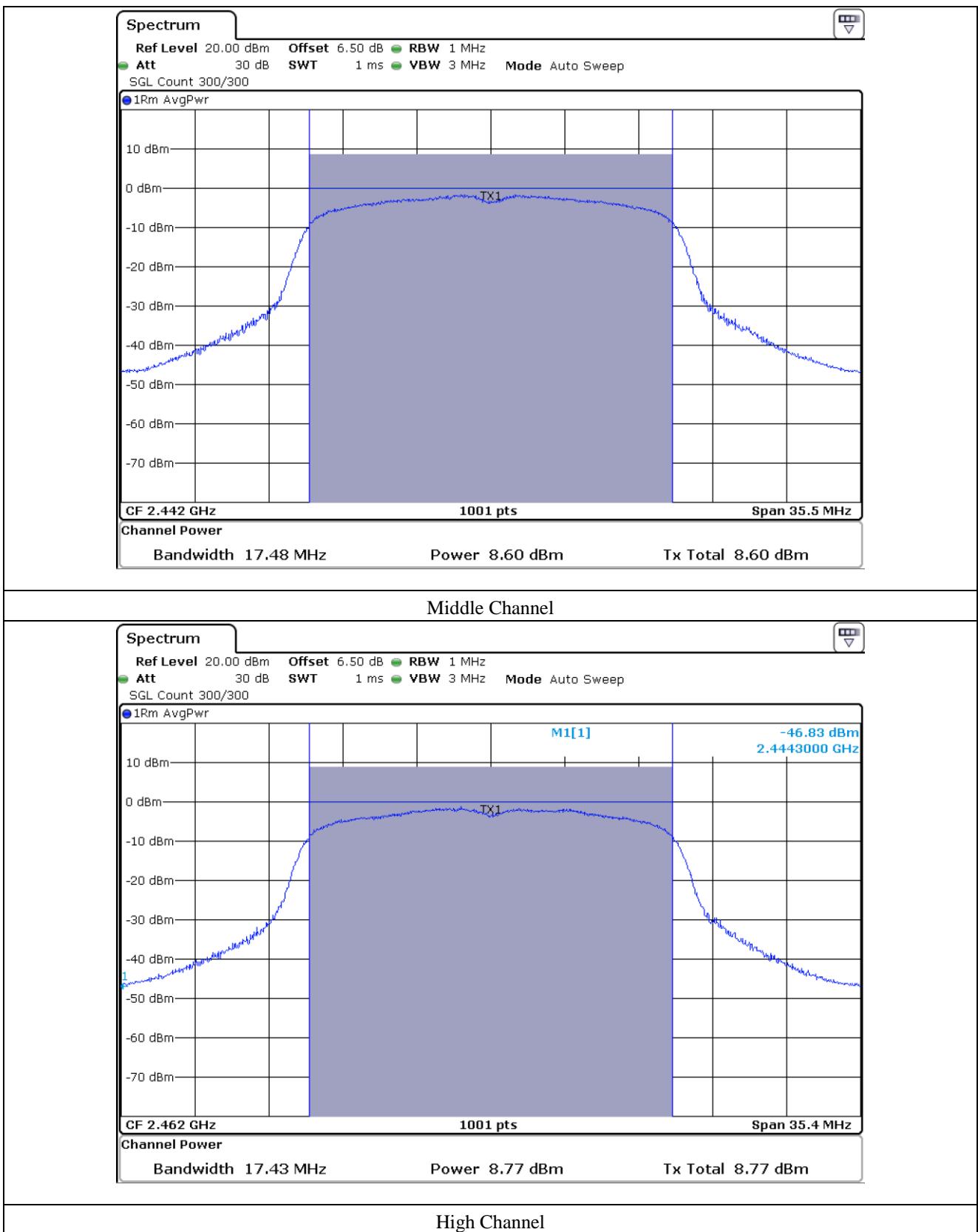
- Test Date : August 08, 2019 ~ August 16, 2019
- Test Result : Pass
- Duty Cycle : 79.23 %

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Correction Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	8.35	1.01	9.36	30.00	20.64
MIDDLE	2 442.00	8.60	1.01	9.61	30.00	20.39
HIGH	2 462.00	8.77	1.01	9.78	30.00	20.22

Remark : Margin = Limit – Result (= Measured Vlaue + Correction Factor)

Tested by: Hyung-Kwon, Oh / Assistant Manager





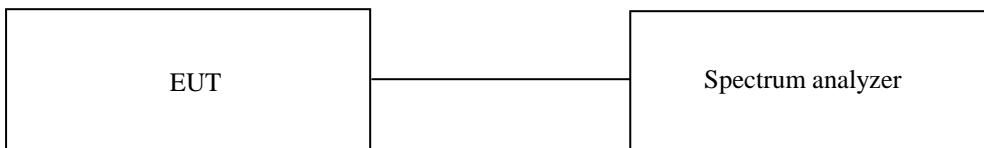
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 23 °C
 Relative humidity : 45 % R.H.

9.2 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.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

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

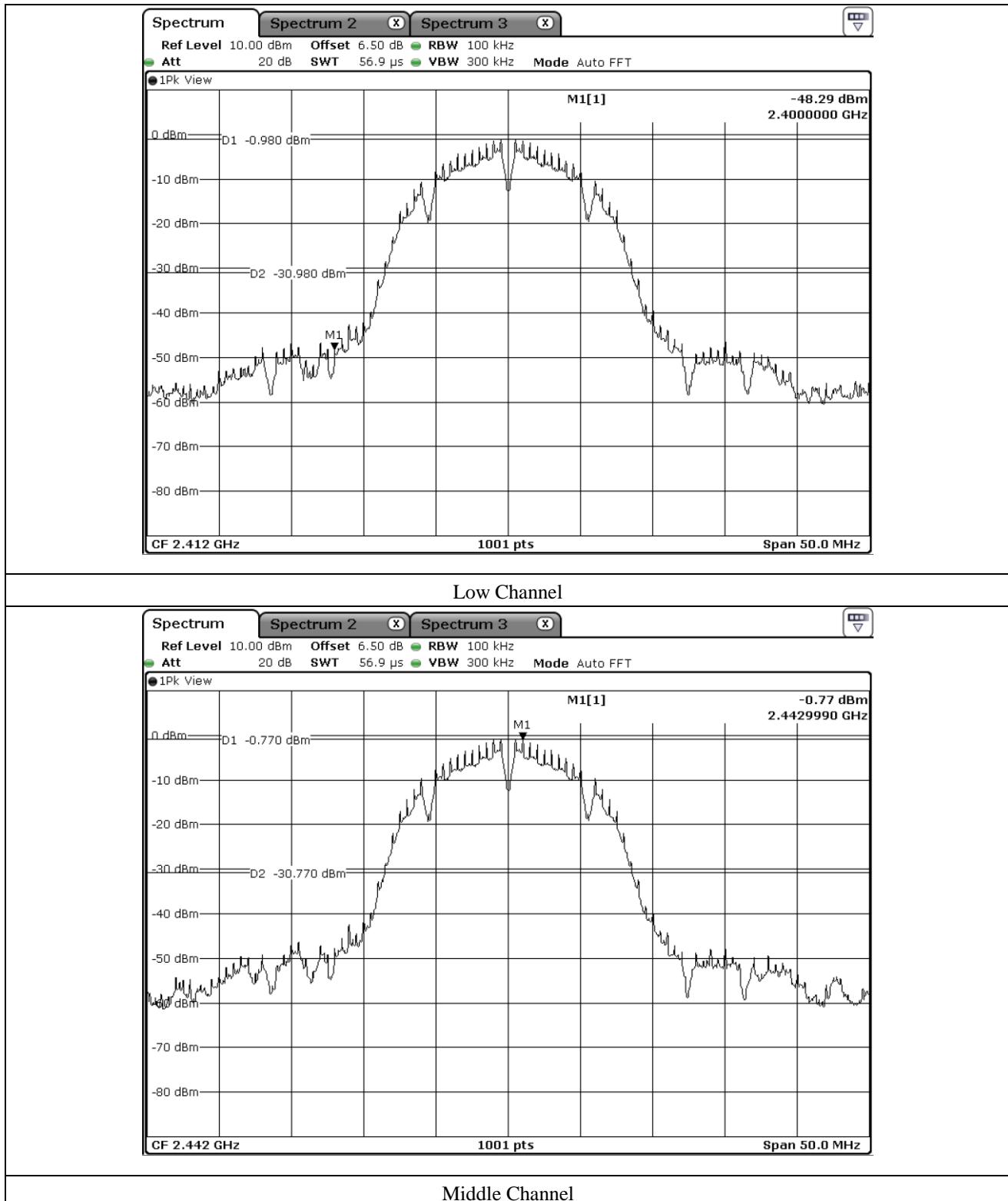
9.4 Test equipment used

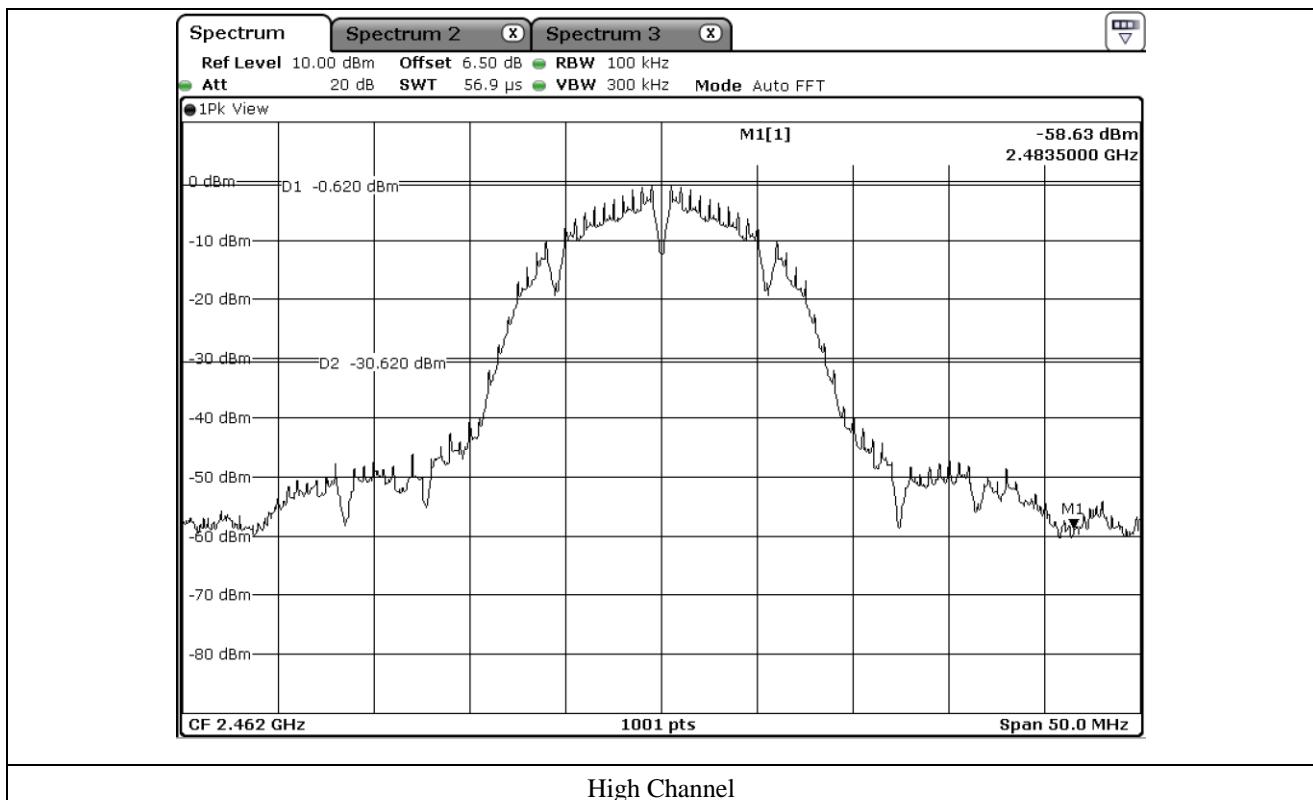
Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 11, 2019 (1Y)
■ - ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 28, 2019 (1Y)
■ - 310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 18, 2019 (1Y)
■ - BBV 9718B	Schwarzbeck	Amplifier	009	Mar. 20, 2019 (1Y)
■ - SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Mar. 11, 2019 (1Y)
■ - DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ - MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ - VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 13, 2018 (2Y)
■ - BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 16, 2019 (1Y)
■ - BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jan. 16, 2019 (1Y)
■ - VAMP9243	Schwarzbeck	ROD ANTENNA	VAMP9243	Mar. 14, 2019 (2Y)

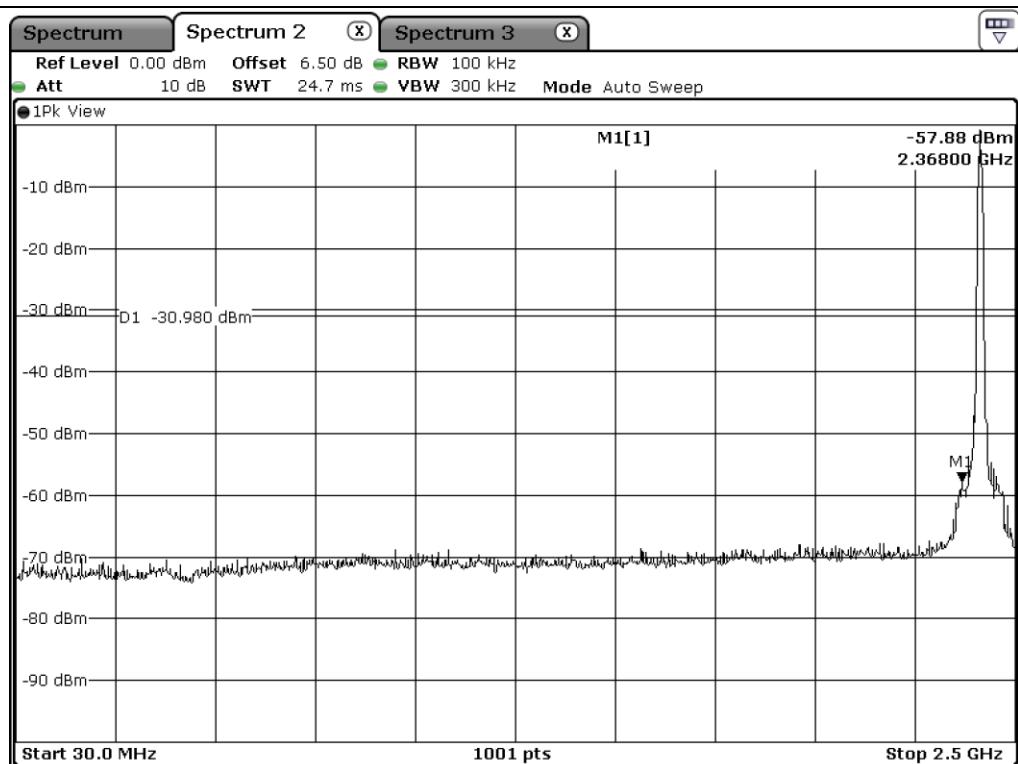
All test equipment used is calibrated on a regular basis.

9.5 Test data for conducted emission

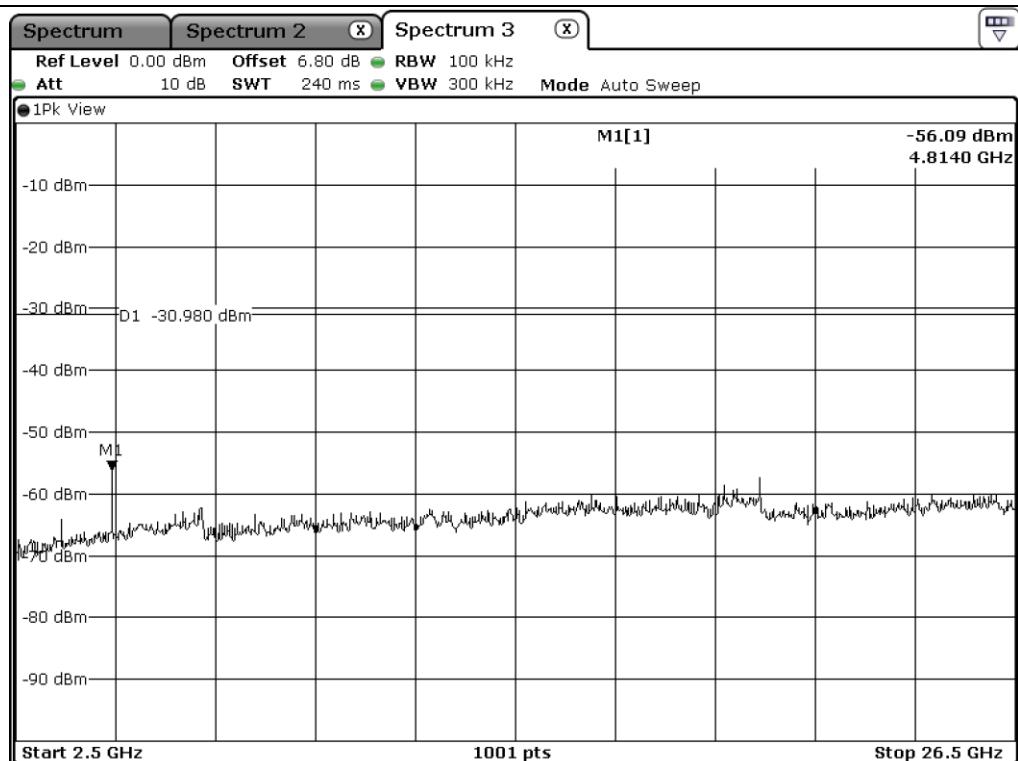
9.5.1 Test data for 802.11b WLAN Mode



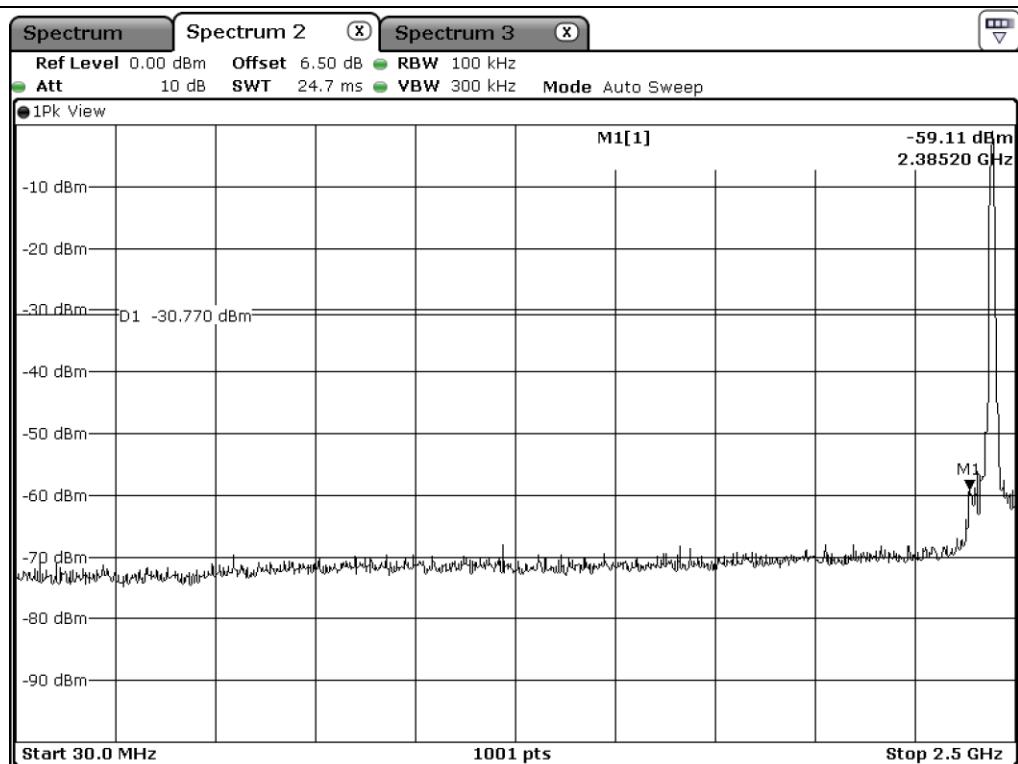




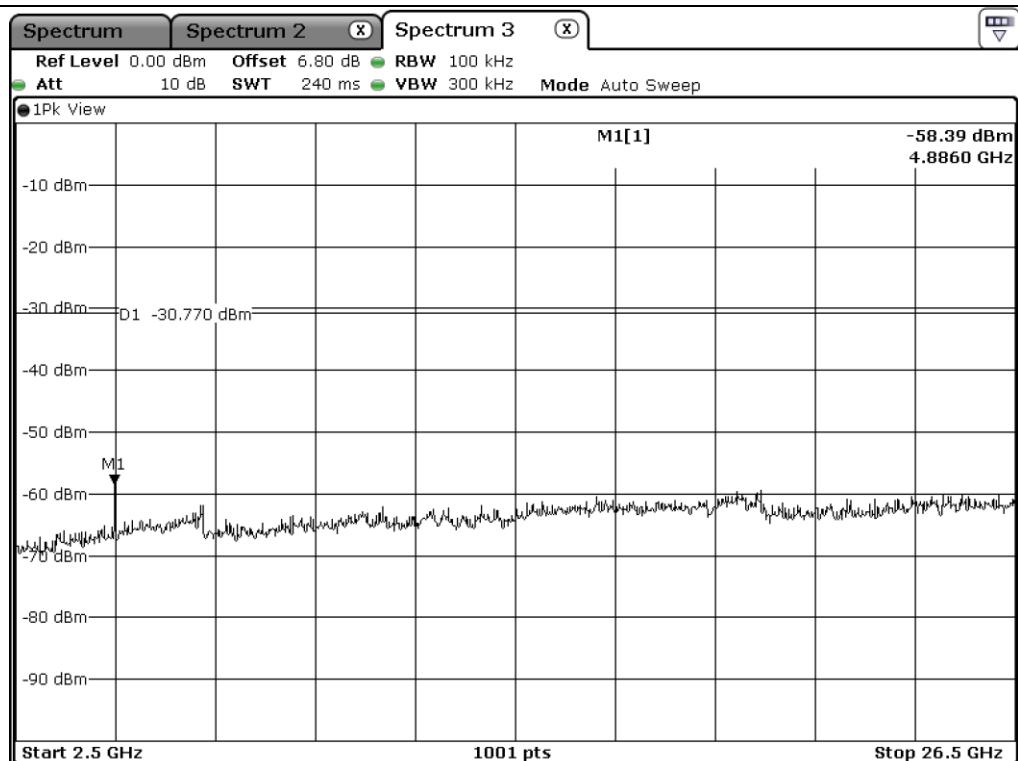
Low Channel



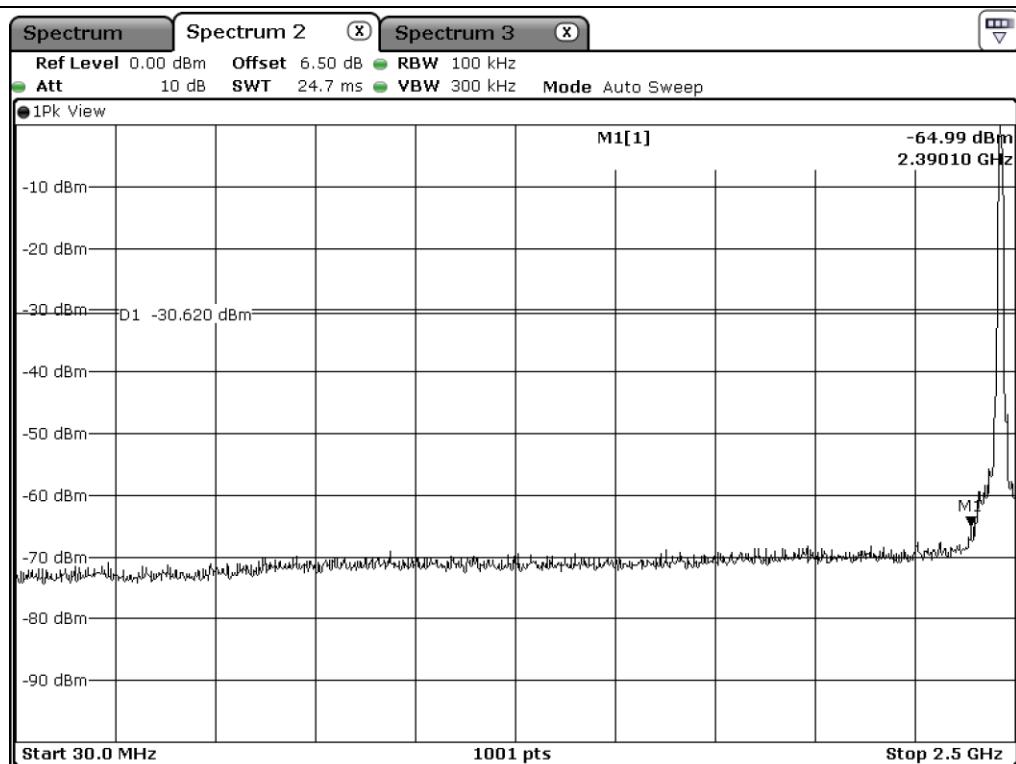
Low Channel



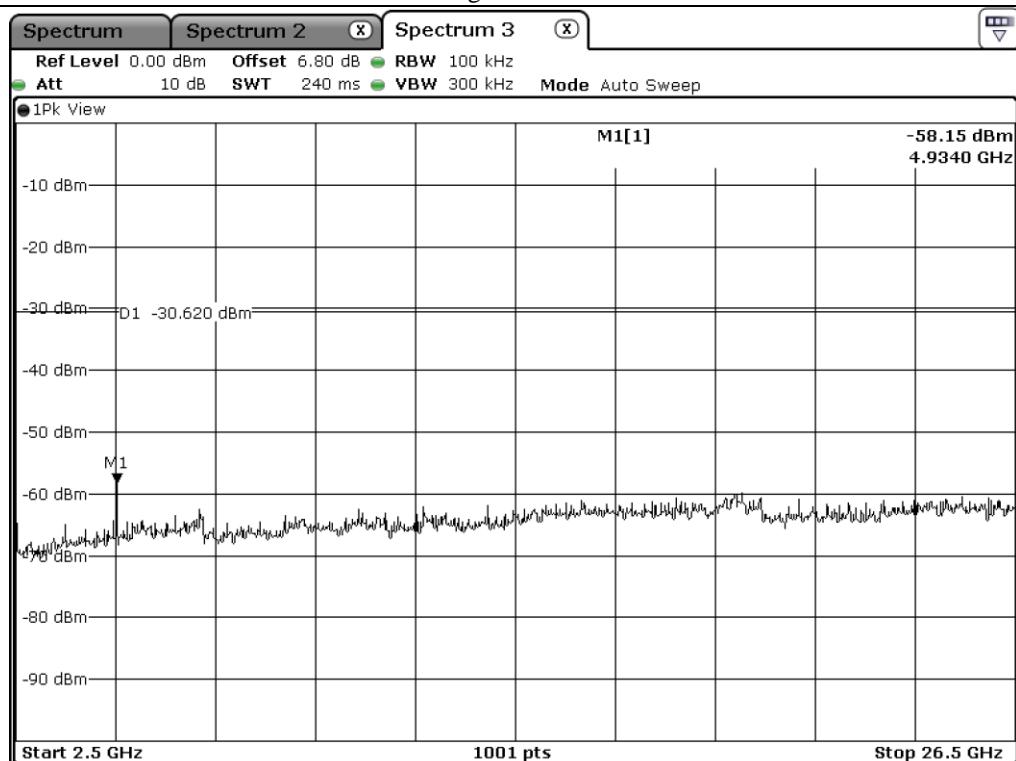
Middle Channel



Middle Channel

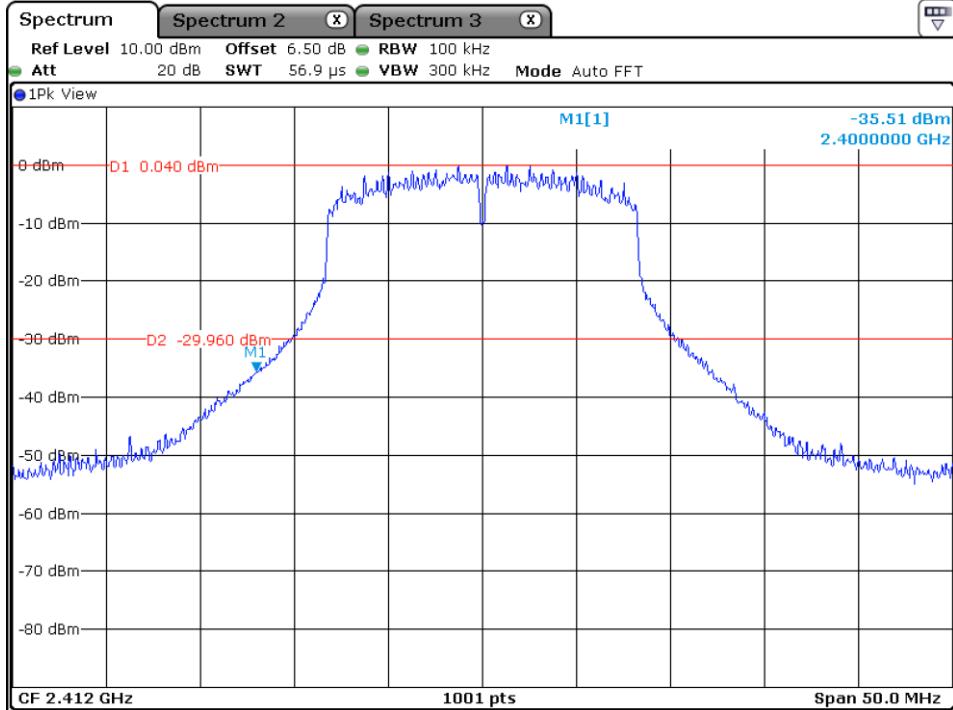


High Channel

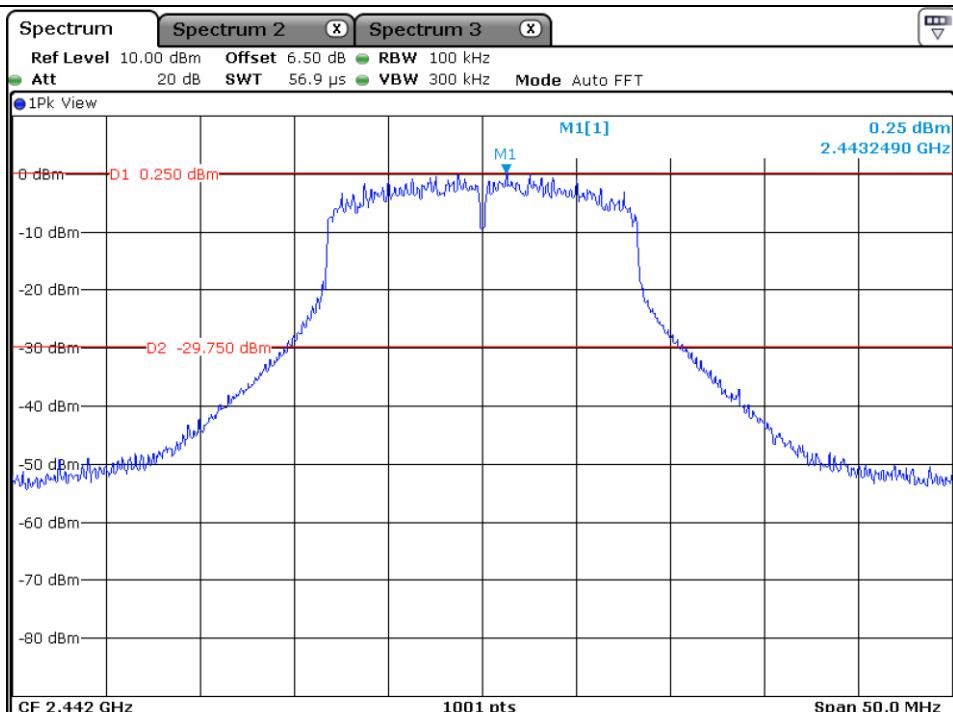


High Channel

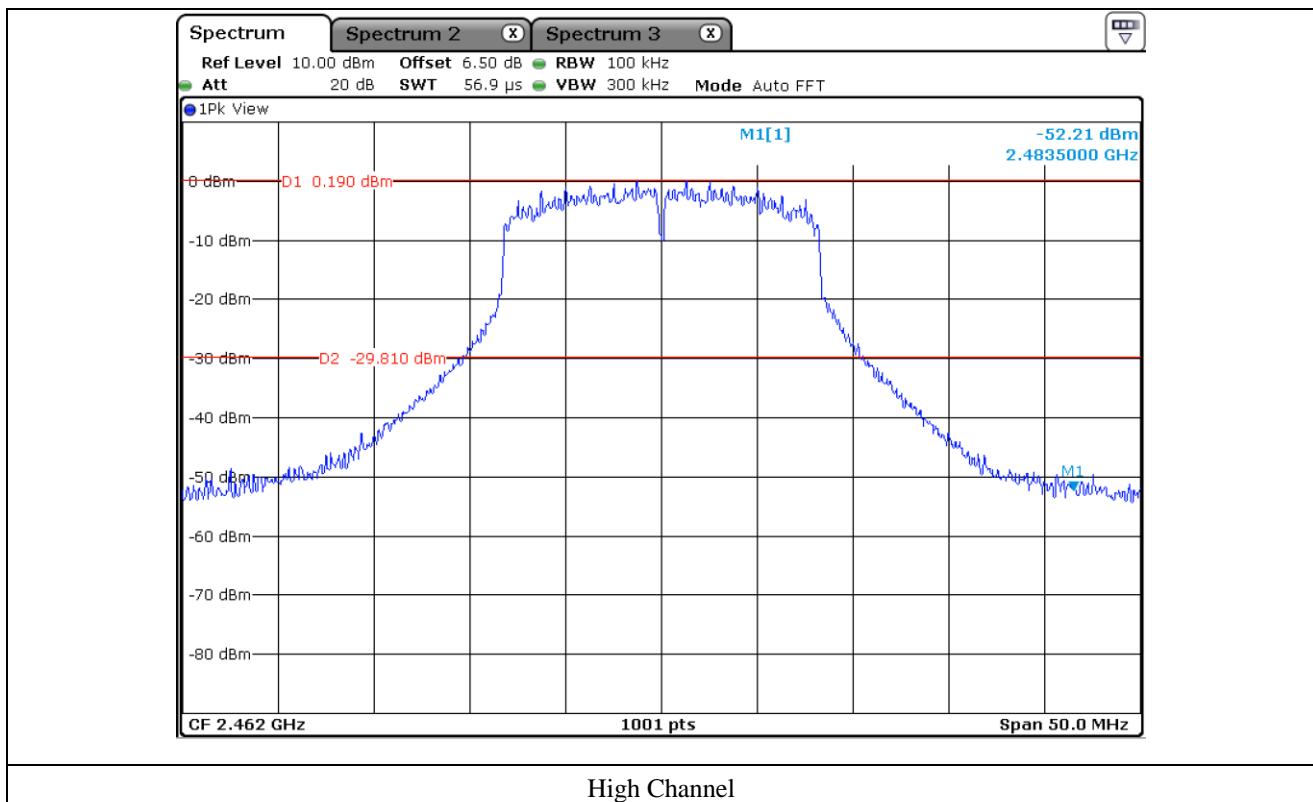
9.5.2 Test data for 802.11g WLAN Mode

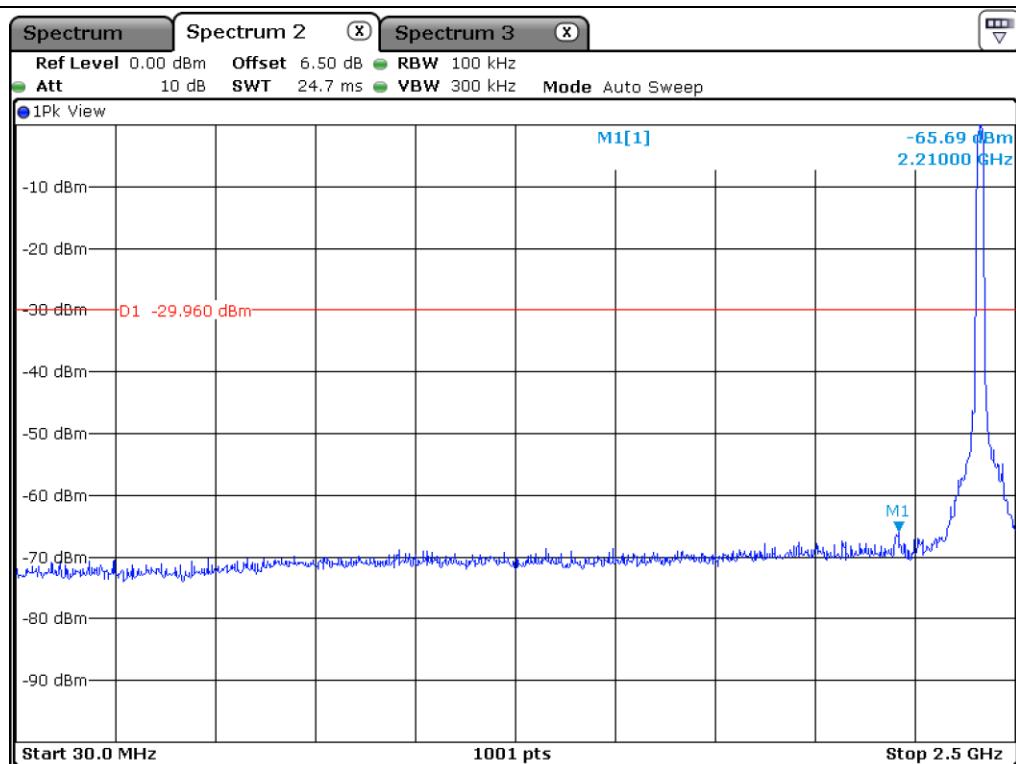


Low Channel

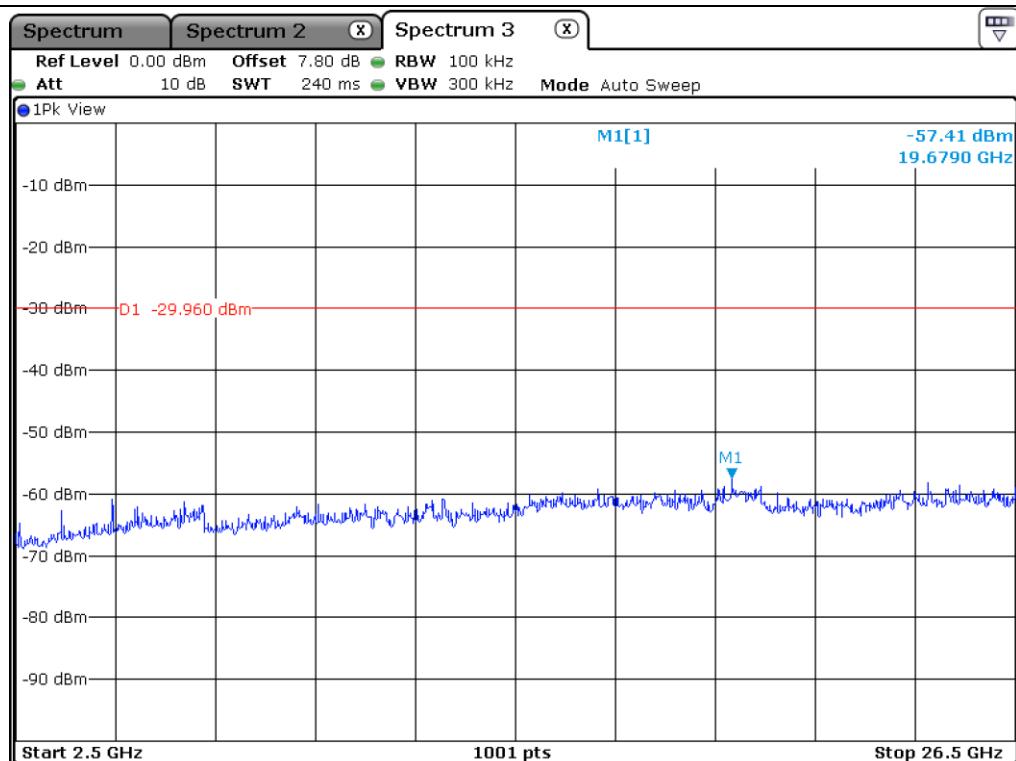


Middle Channel

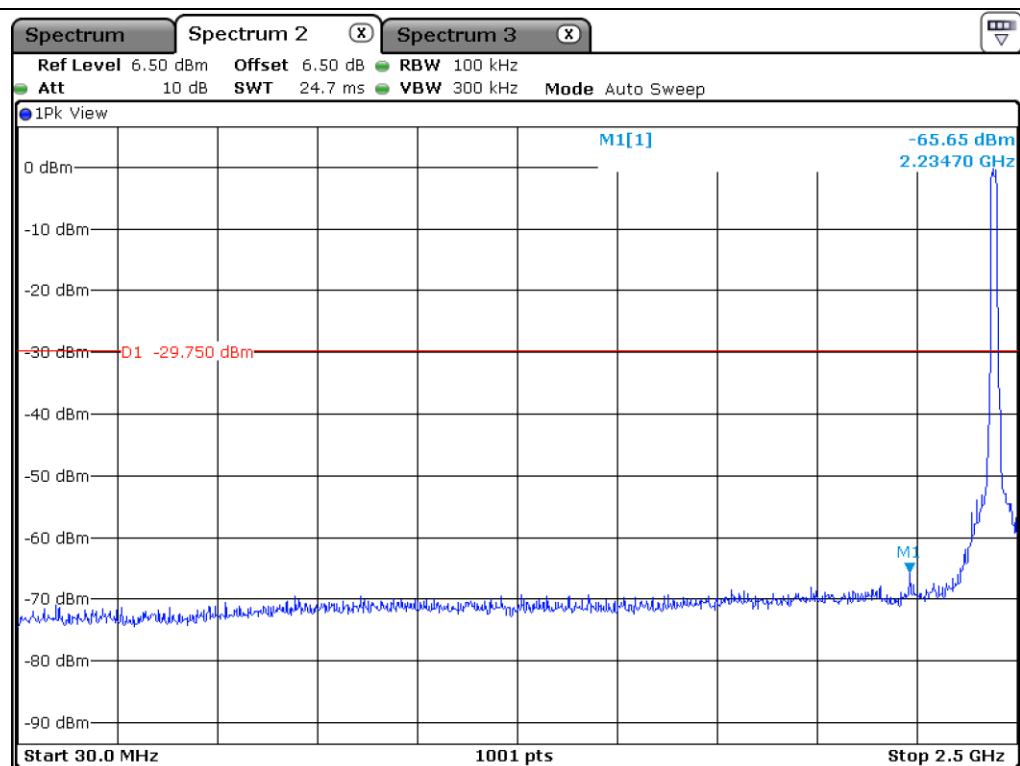




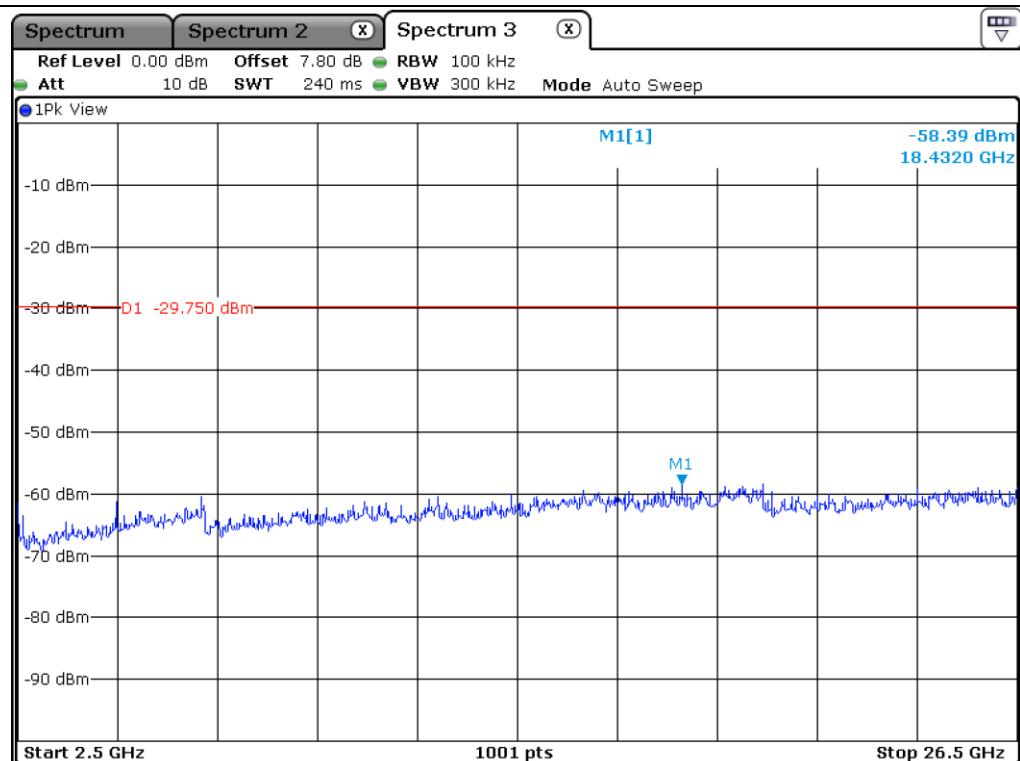
Low Channel



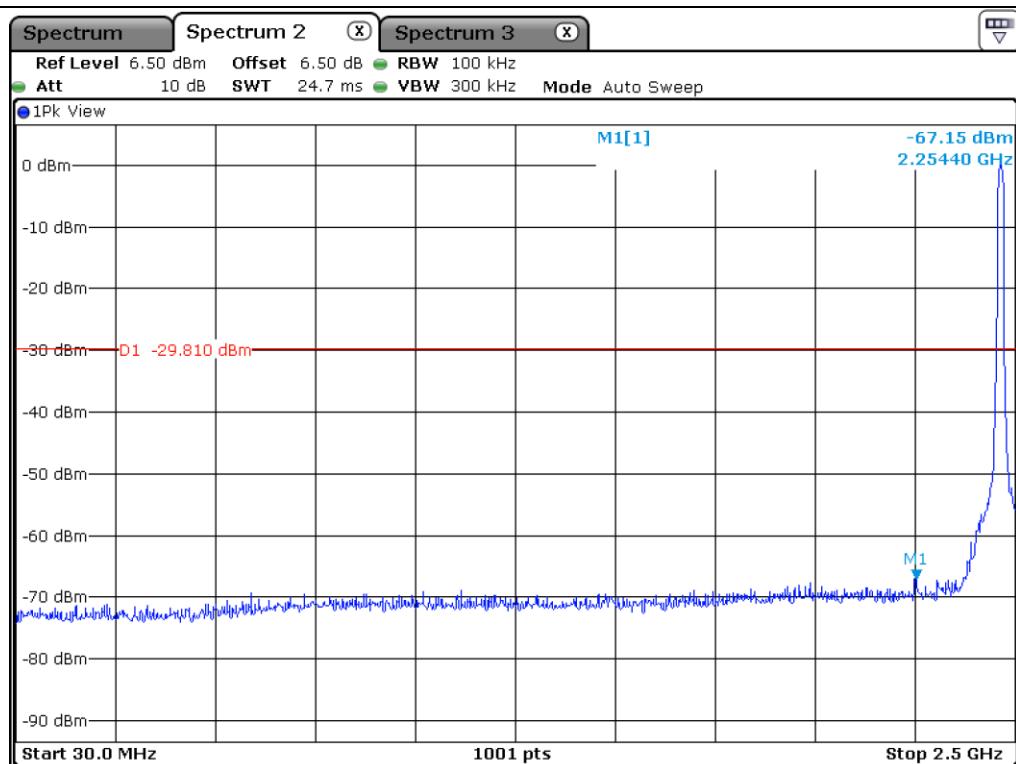
Low Channel



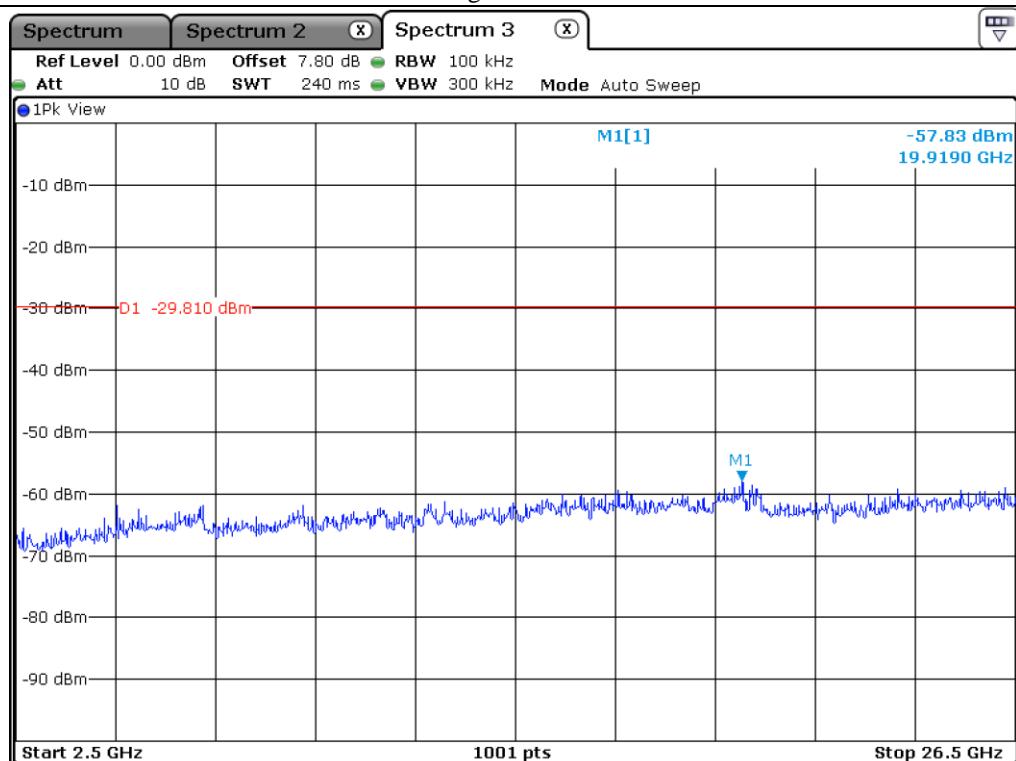
Middle Channel



Middle Channel

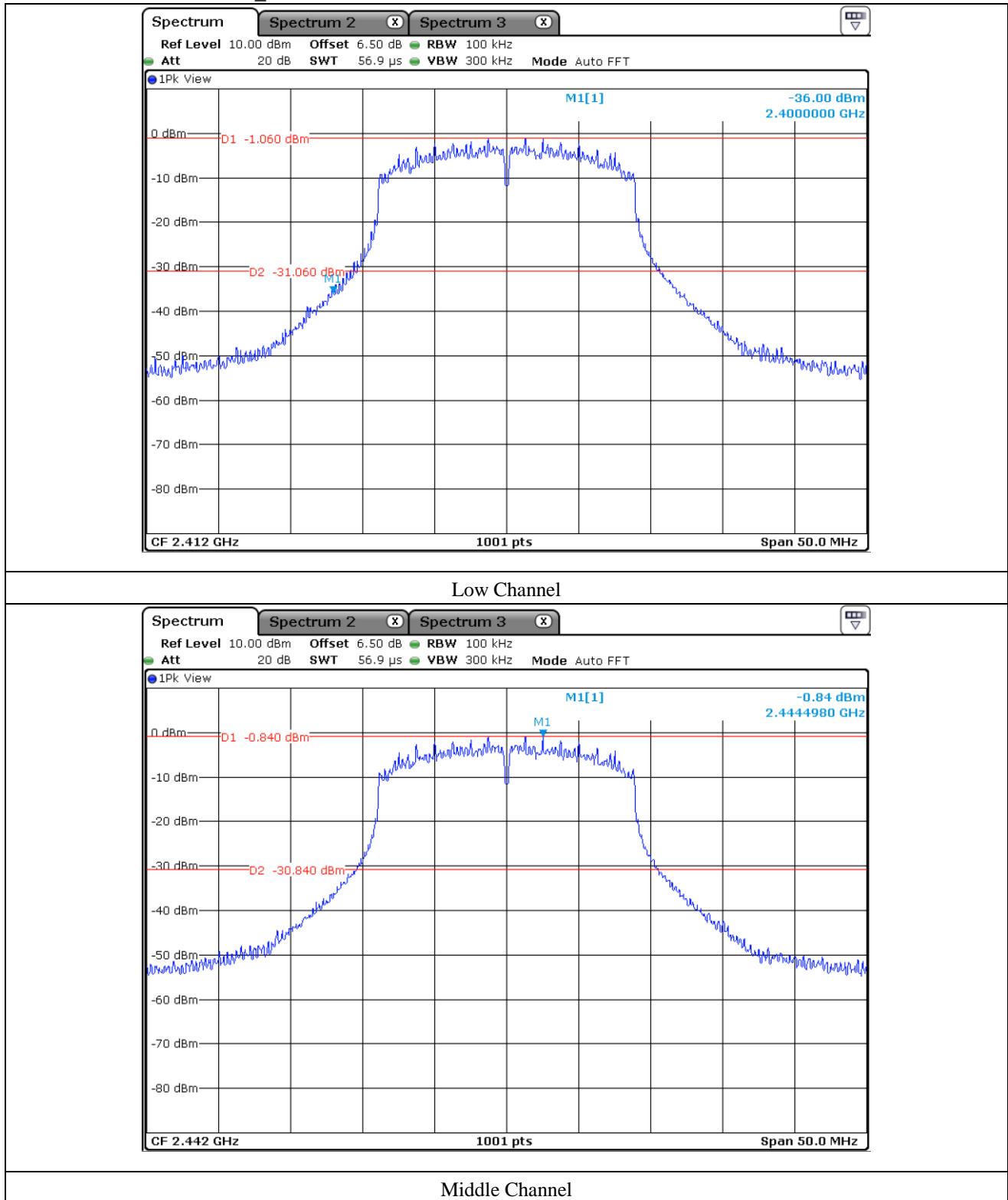


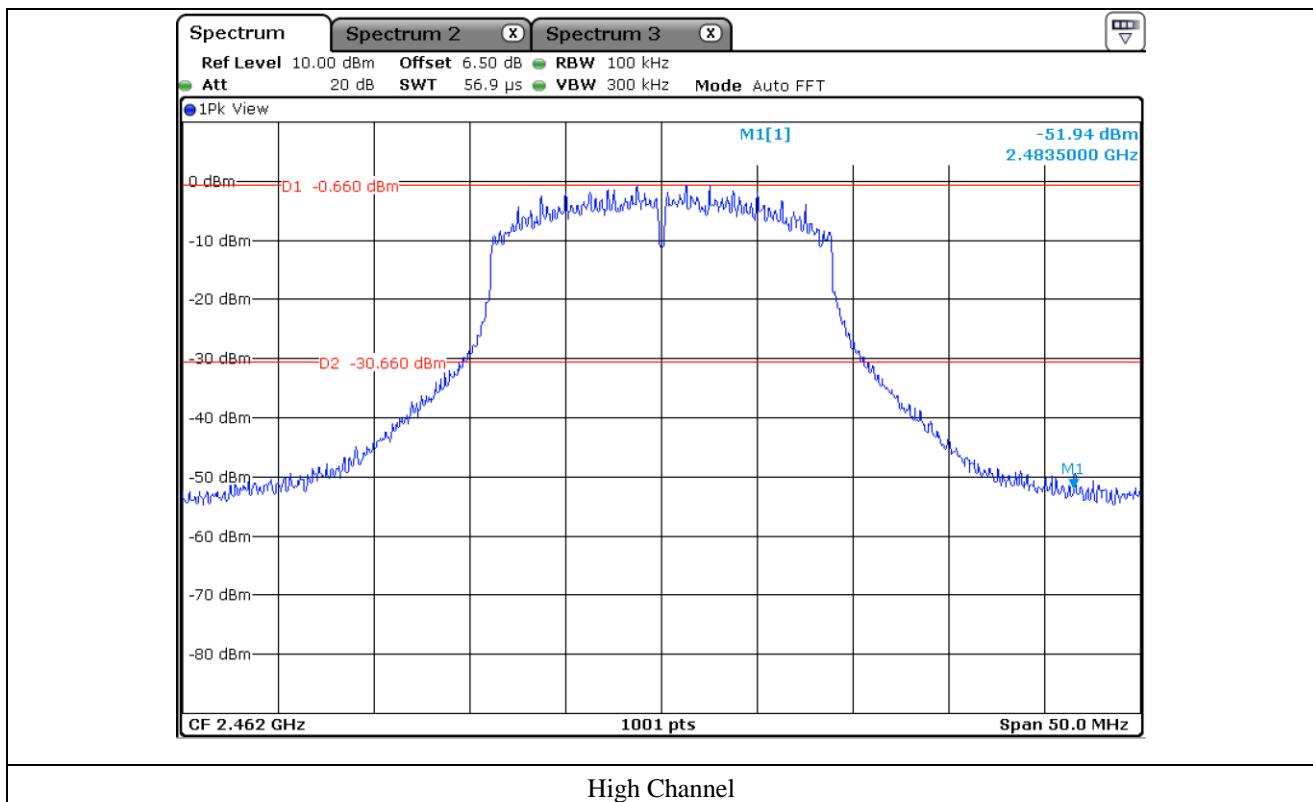
High Channel

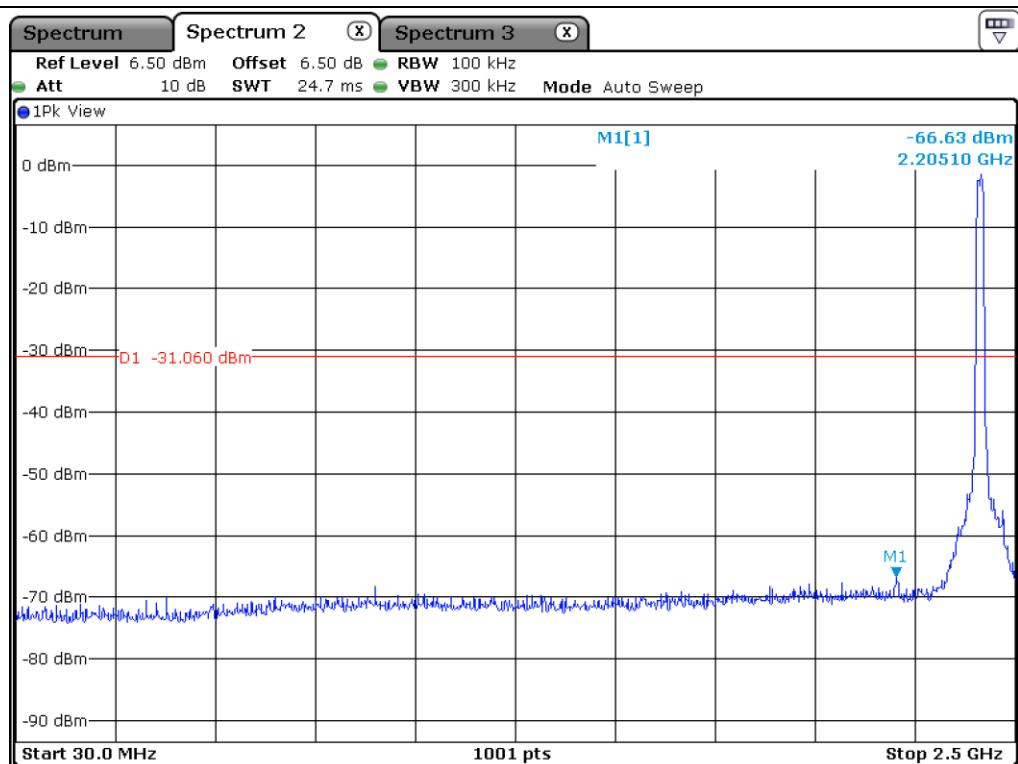


High Channel

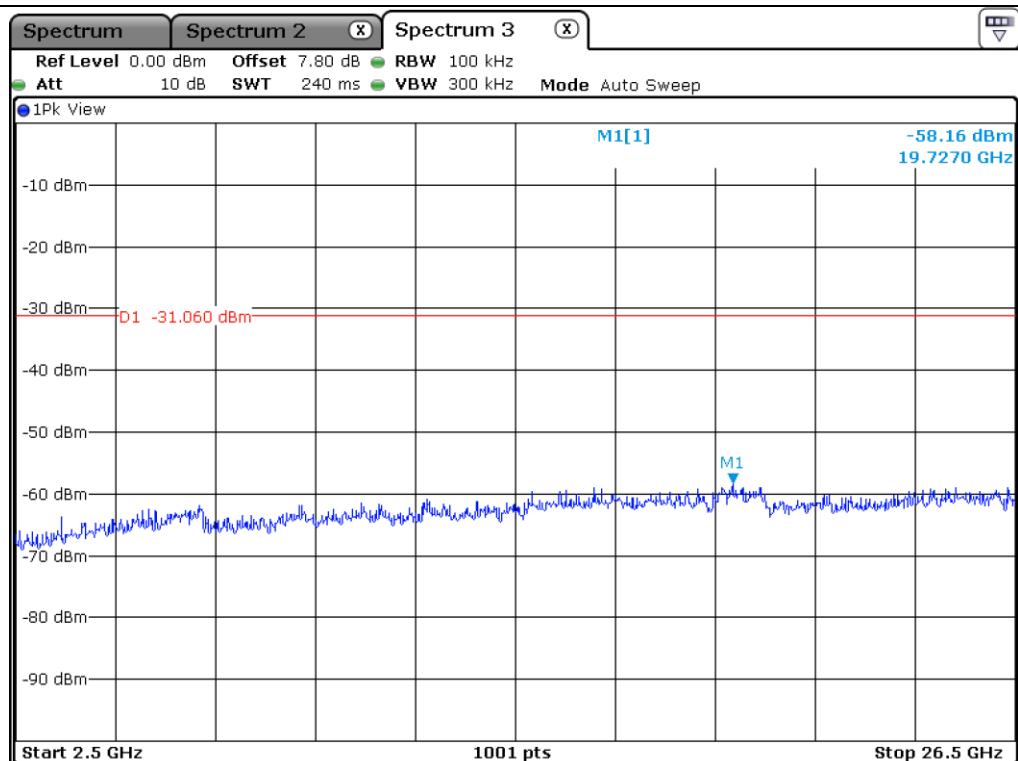
9.5.3 Test data for 802.11n HT20 WLAN Mode



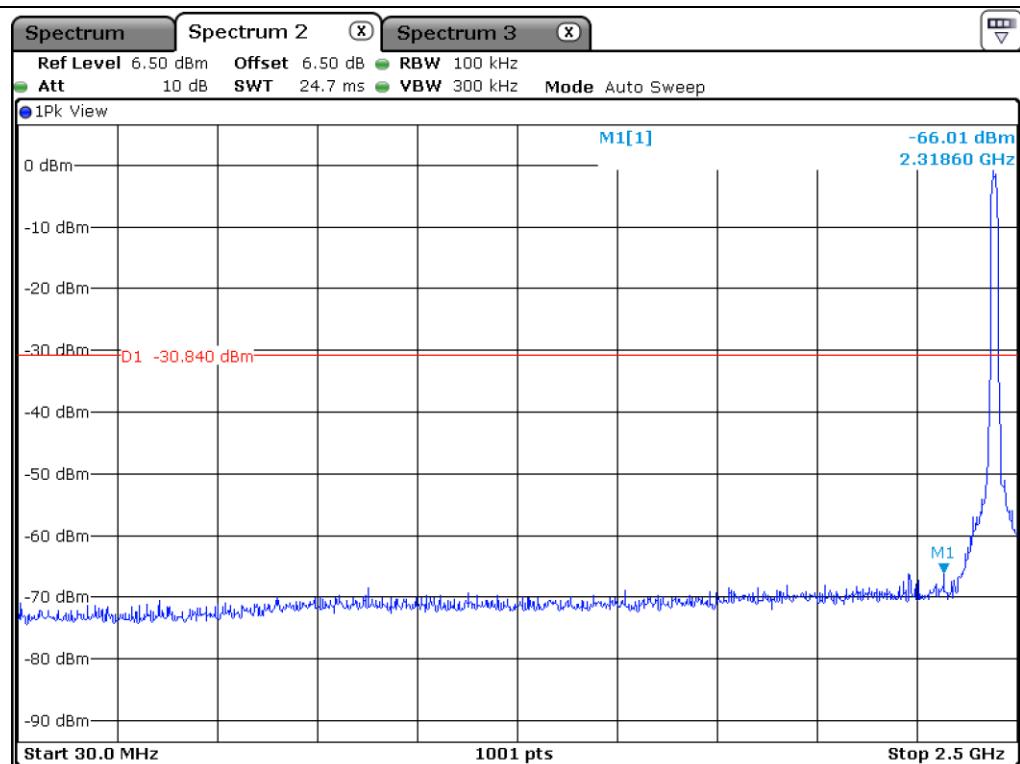




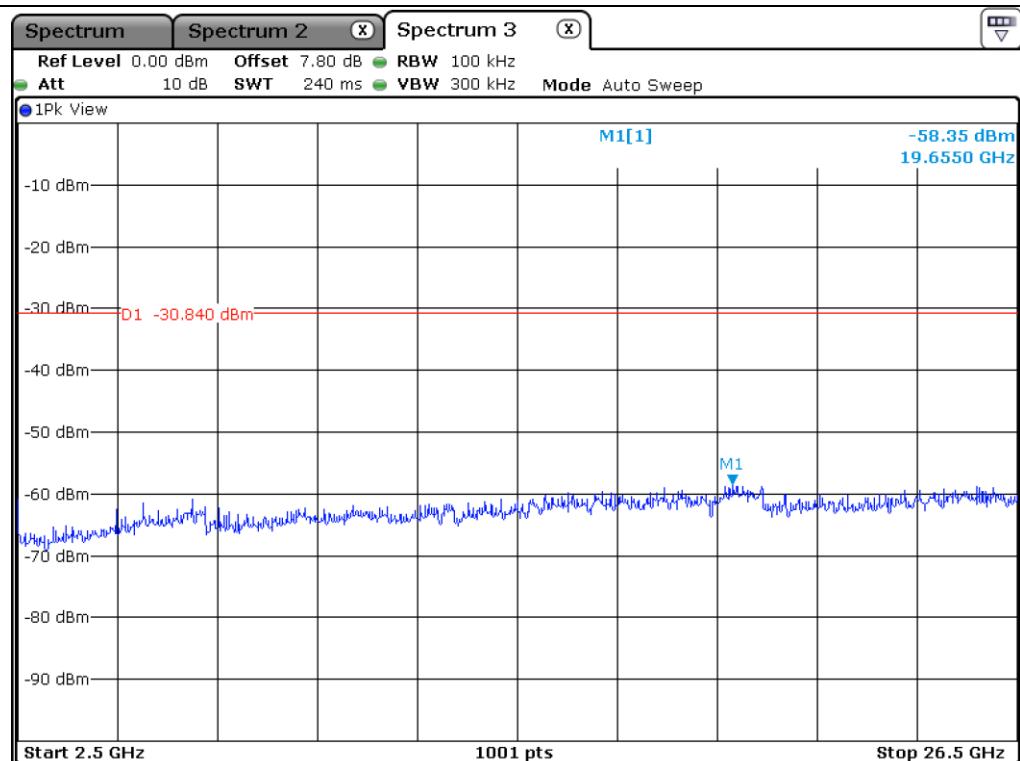
Low Channel



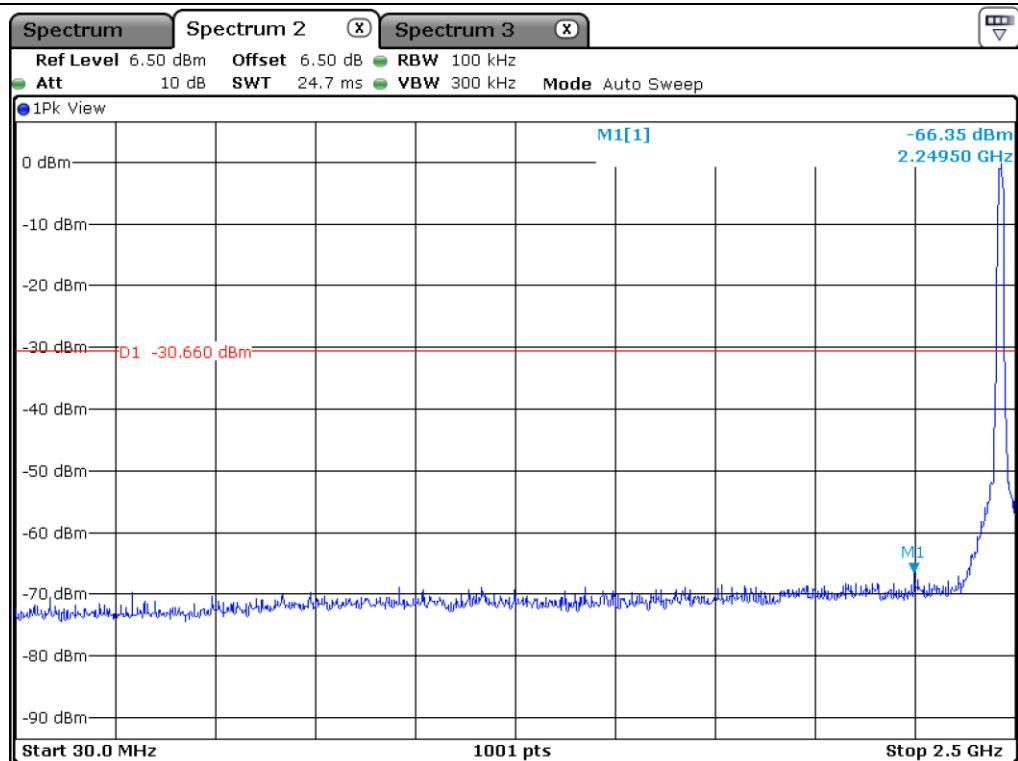
Low Channel



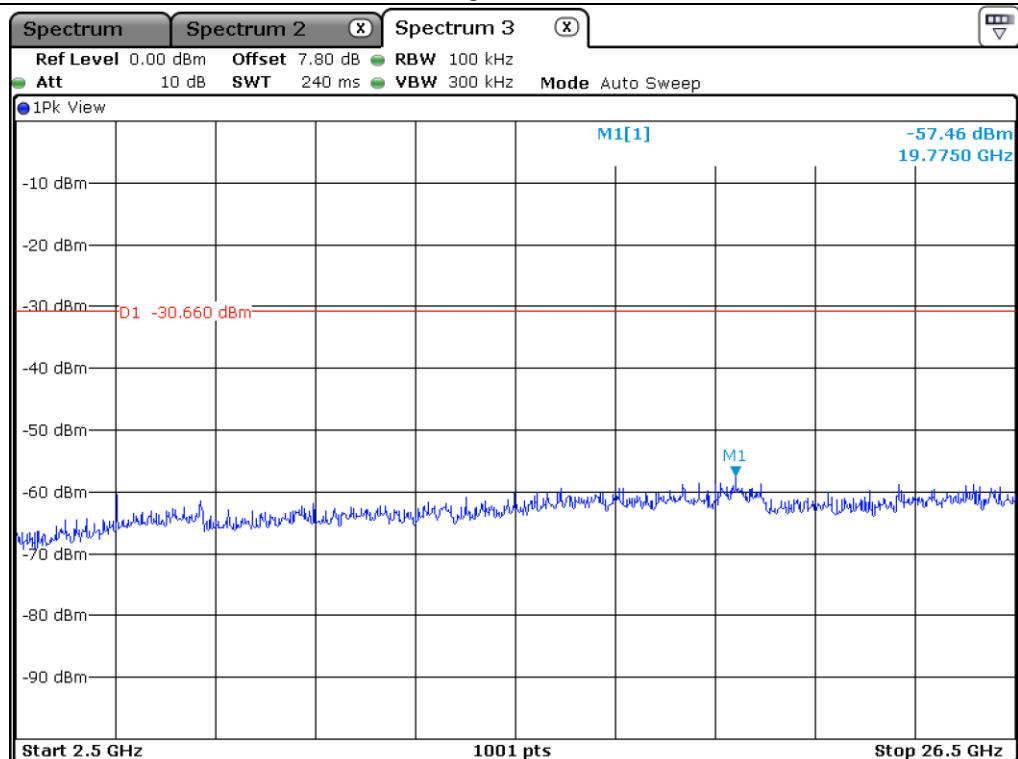
Middle Channel



Middle Channel



High Channel



High Channel

9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

9.6.1.1 Test data for 802.11b WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 100.00 %
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
2 315.382	19.24	Peak	H	25.94	2.75	-	47.93	74.00	26.07
2 380.576	8.17	Average	H				36.86	54.00	17.14
2 381.058	19.38	Peak	V				48.07	74.00	25.93
2 381.576	11.05	Average	V				39.74	54.00	14.26
Test Data for High Channel									
2 486.556	19.74	Peak	H	26.47	2.39	-	48.60	74.00	25.40
2 485.735	8.03	Average	H				36.89	54.00	17.11
2 490.117	19.55	Peak	V				48.41	74.00	25.59
2 486.250	9.20	Average	V				38.06	54.00	15.94

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.1.2 Test data for 802.11g WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 81.11 %
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
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Test Data for Low Channel

2 339.117	18.77	Peak	H	25.94	2.75	-	47.46	74.00	26.54
2 389.550	8.24	Average	H			0.91	37.84	54.00	16.16
2 388.776	22.11	Peak	V			-	50.80	74.00	23.20
2 389.568	11.35	Average	V			0.91	40.95	54.00	13.05

Test Data for High Channel

2 483.508	20.17	Peak	H	26.47	2.39	-	49.03	74.00	24.97
2 483.508	8.56	Average	H			0.91	38.33	54.00	15.67
2 491.225	22.03	Peak	V			-	50.89	74.00	23.11
2 484.339	10.59	Average	V			0.91	40.36	54.00	13.64

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.1.3 Test data for 802.11n_HT20 WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 79.23 %
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
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Test Data for Low Channel

2 385.417	18.51	Peak	H	25.94	2.75	-	47.20	74.00	26.80
2 389.880	8.24	Average	H			1.01	37.94	54.00	16.06
2 389.264	21.50	Peak	V			-	50.19	74.00	23.81
2 389.990	11.30	Average	V			1.01	41.00	54.00	13.00

Test Data for High Channel

2 484.580	19.99	Peak	H	26.47	2.39	-	48.85	74.00	25.15
2 483.539	8.49	Average	H			1.01	38.36	54.00	15.64
2 483.517	21.56	Peak	V			-	50.42	74.00	23.58
2 484.560	10.10	Average	V			1.01	39.97	54.00	14.03

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for 802.11b WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 100.00 %
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4824.00	20.04	Peak	H	27.84	5.28	-	53.16	74.00	20.84
4824.00	9.72	Average	H				42.84	54.00	11.16
4824.00	22.92	Peak	V				56.04	74.00	17.96
4824.00	16.86	Average	V				46.98	54.00	7.02
Test Data for Middle Channel									
4884.00	21.01	Peak	H	27.01	5.42	-	53.44	74.00	20.56
4884.00	8.85	Average	H				41.28	54.00	12.72
4884.00	21.45	Peak	V				53.88	74.00	20.12
4884.00	13.84	Average	V				46.27	54.00	7.73
Test Data for High Channel									
4924.00	19.22	Peak	H	28.15	5.40	-	52.77	74.00	21.23
4924.00	10.31	Average	H				43.86	54.00	10.14
4924.00	21.30	Peak	V				54.85	74.00	19.15
4924.00	14.66	Average	V				48.21	54.00	5.79

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.2.2 Test data for 802.11g WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 81.11 %
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	20.61	Peak	H	27.84	5.28	-	53.73	74.00	20.27
4 824.00	10.37	Average	H			0.91	44.40	54.00	9.60
4 824.00	22.76	Peak	V			-	55.88	74.00	18.12
4 824.00	17.96	Average	V			0.91	48.99	54.00	5.01
Test Data for Middle Channel									
4 884.00	21.38	Peak	H	27.01	5.42	-	53.81	74.00	20.19
4 884.00	8.64	Average	H			0.91	41.98	54.00	12.02
4 884.00	20.00	Peak	V			-	52.43	74.00	21.57
4 884.00	12.52	Average	V			0.91	45.86	54.00	8.14
Test Data for High Channel									
4 924.00	21.14	Peak	H	28.15	5.40	-	54.69	74.00	19.31
4 924.00	9.97	Average	H			0.91	44.43	54.00	9.57
4 924.00	21.39	Peak	V			-	54.94	74.00	19.06
4 924.00	13.81	Average	V			0.91	48.27	54.00	5.73

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.2.3 Test data for 802.11n_HT20 WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 79.23 %
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	20.77	Peak	H	27.84	5.28	-	53.89	74.00	20.11
4 824.00	9.72	Average	H			1.01	43.85	54.00	10.15
4 824.00	22.90	Peak	V			-	56.02	74.00	17.98
4 824.00	16.33	Average	V			1.01	47.46	54.00	6.54
Test Data for Middle Channel									
4 884.00	20.64	Peak	H	27.01	5.42	-	53.07	74.00	20.93
4 884.00	9.30	Average	H			1.01	42.74	54.00	11.26
4 884.00	20.27	Peak	V			-	52.70	74.00	21.30
4 884.00	12.65	Average	V			1.01	46.09	54.00	7.91
Test Data for High Channel									
4 924.00	19.88	Peak	H	28.15	5.40	-	53.43	74.00	20.57
4 924.00	9.81	Average	H			1.01	44.37	54.00	9.63
4 924.00	21.88	Peak	V			-	55.43	74.00	18.57
4 924.00	13.52	Average	V			1.01	48.08	54.00	5.92

Tabulated test data for Restricted Band

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

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor}$$

Tested by: Hyung-Kwon, Oh / Assistant Manager

10. PEAK POWER SPECTRUL DENSITY

10.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 11, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for 802.11b WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019

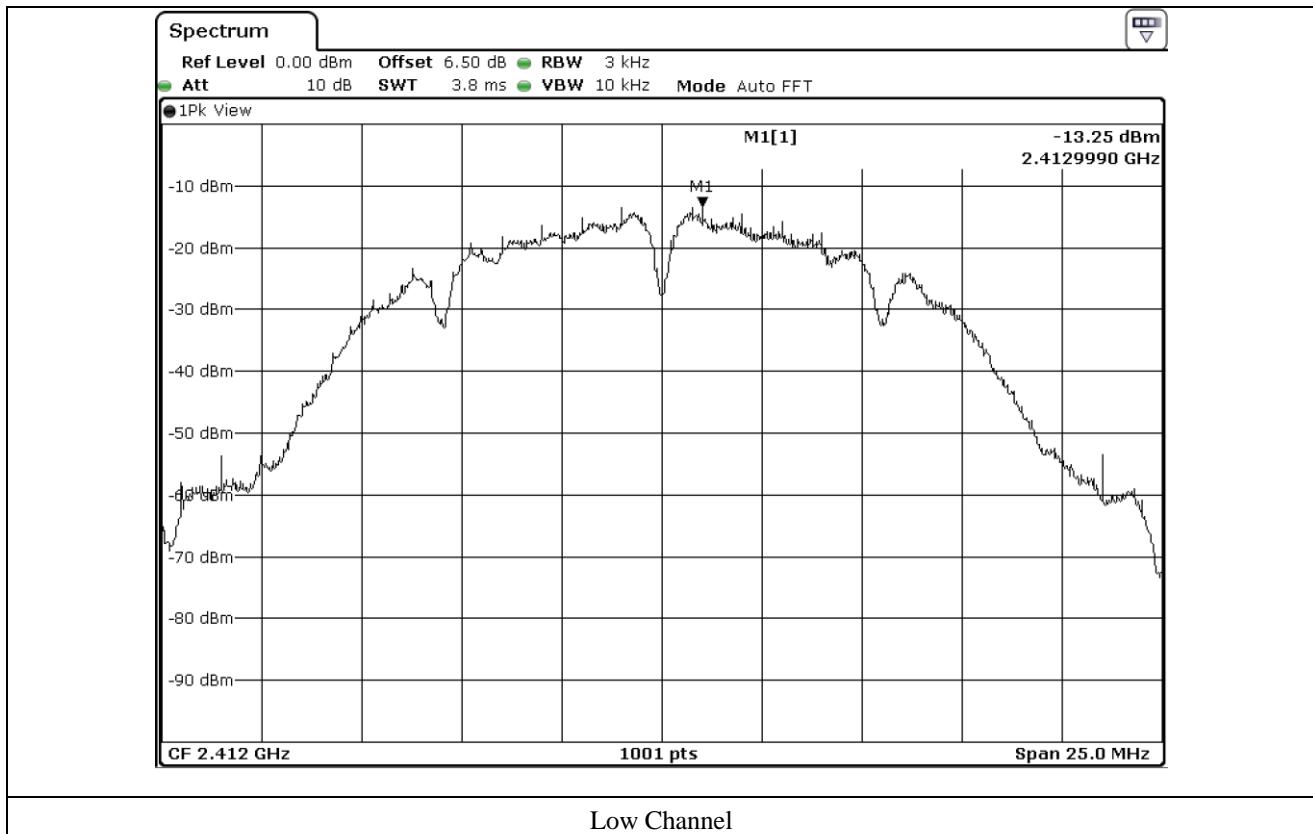
- Test Result : Pass

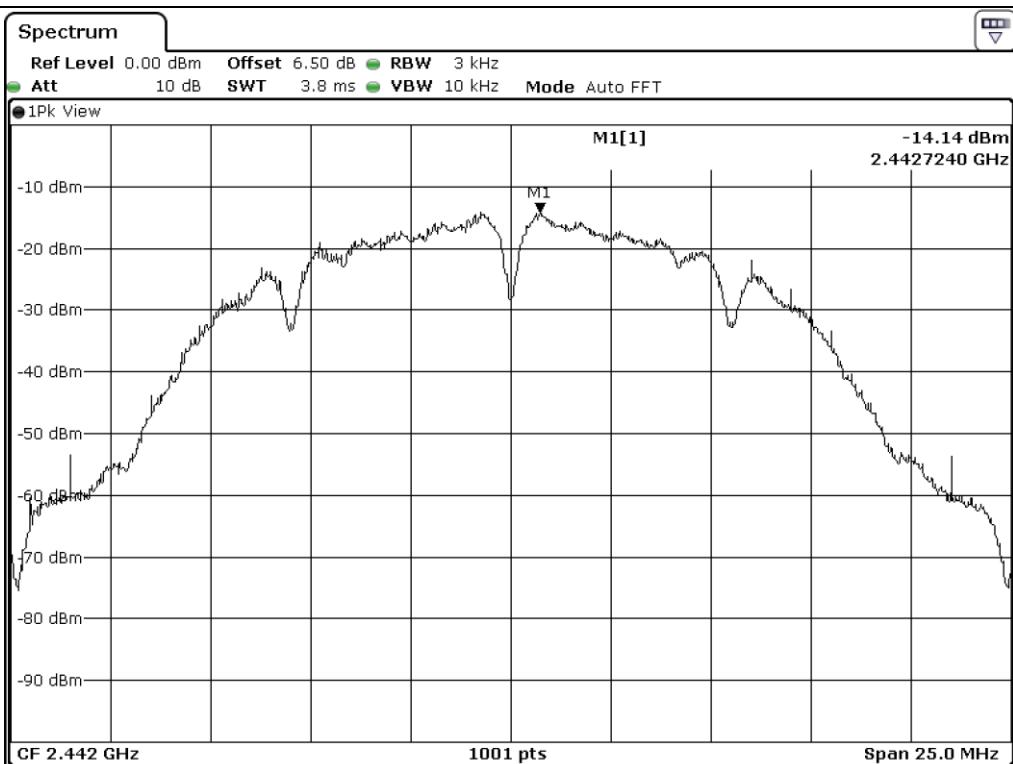
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-13.25	8.00	21.25
Middle	2 442.00	-14.14	8.00	22.14
High	2 462.00	-12.31	8.00	20.31

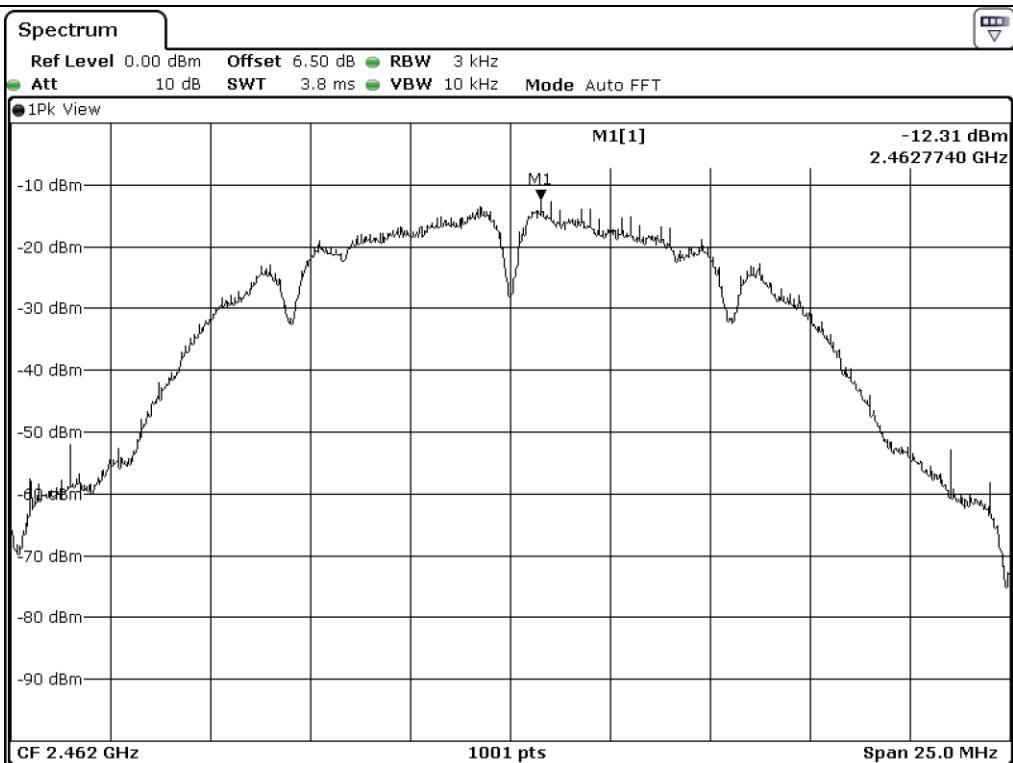
Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

10.5 Test data for 802.11g WLAN Mode

- . Test Date : August 08, 2019 ~ August 16, 2019

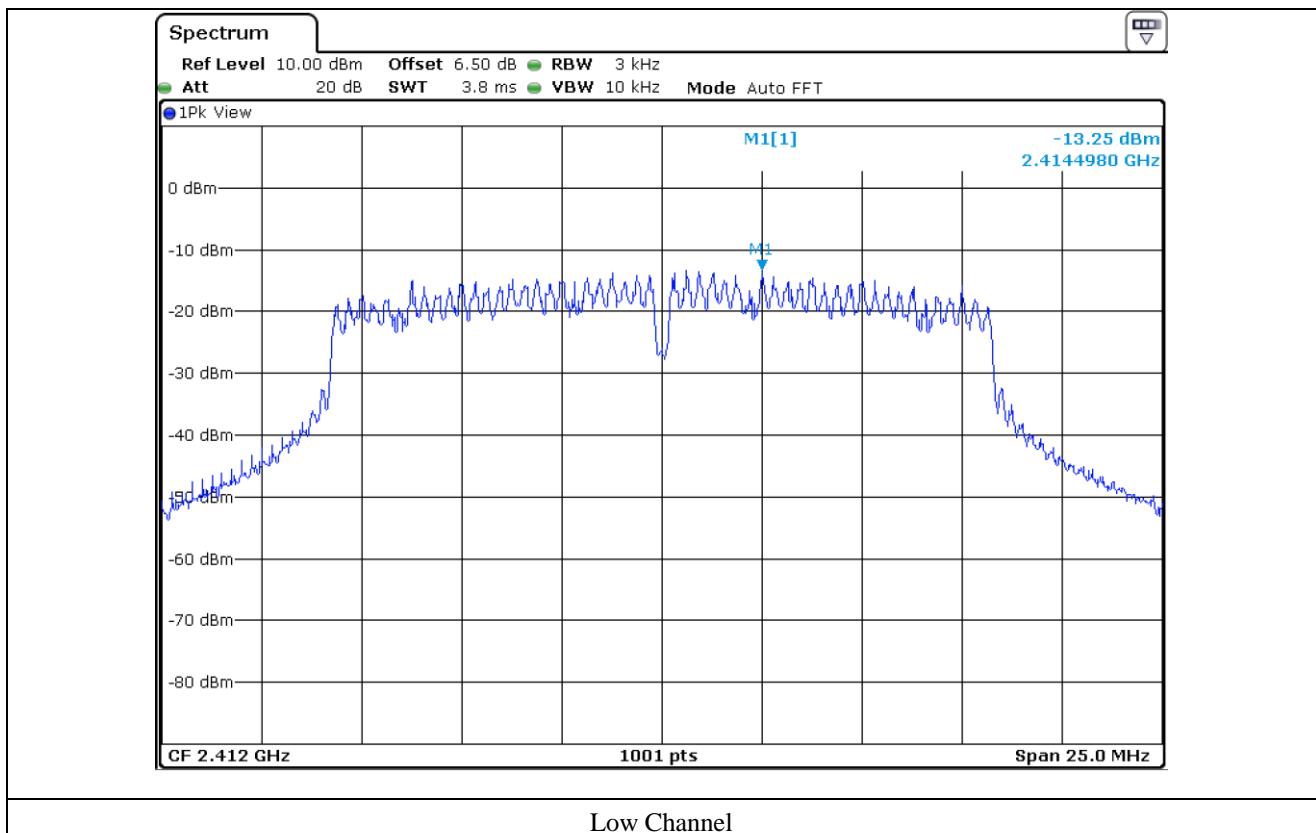
- . Test Result : Pass

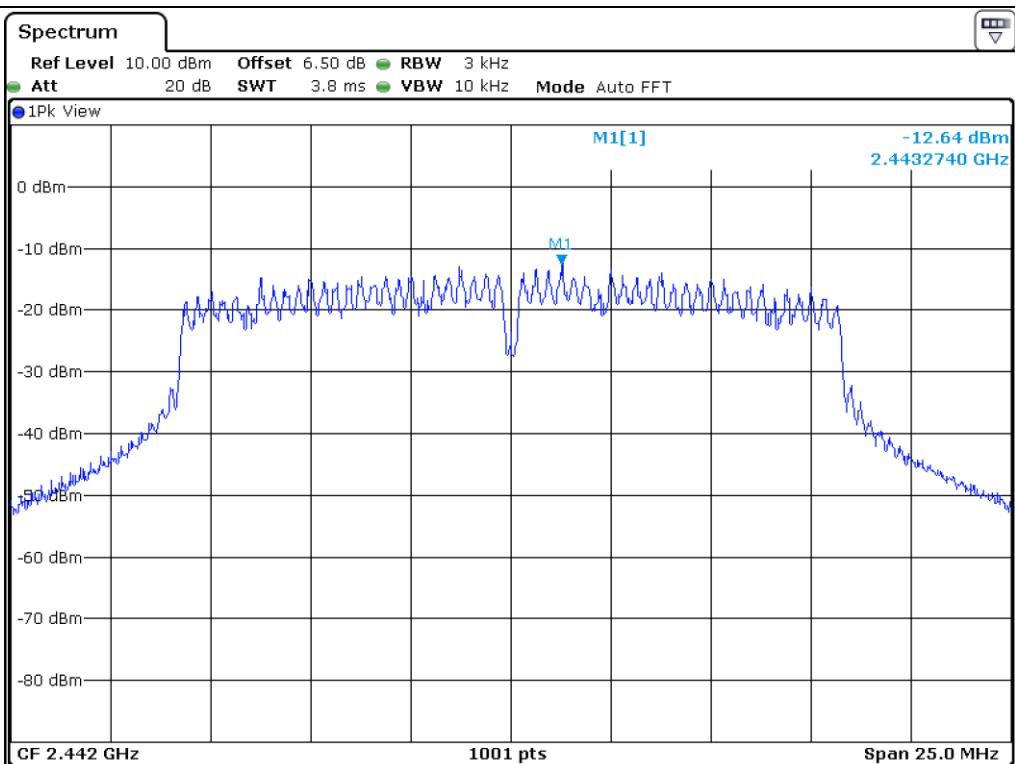
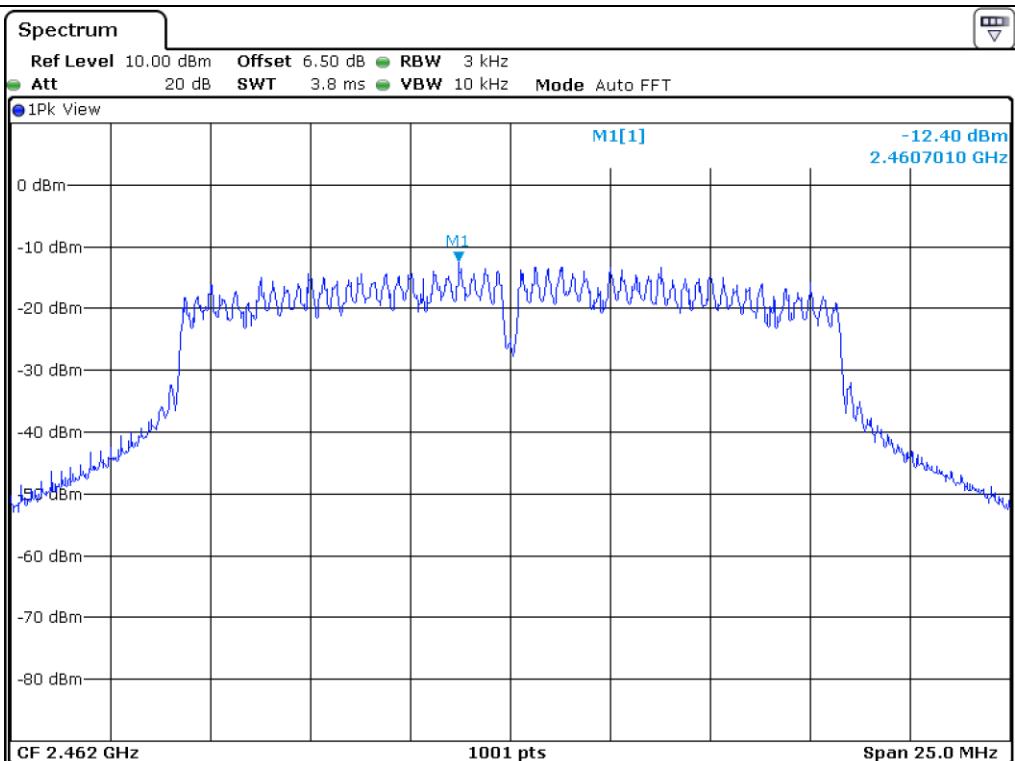
- . Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-13.25	8.00	21.25
Middle	2 442.00	-12.64	8.00	20.64
High	2 462.00	-12.40	8.00	20.40

Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager



**Middle Channel****High Channel**

10.6 Test data for 802.11n_HT20 WLAN Mode

- Test Date : August 08, 2019 ~ August 16, 2019

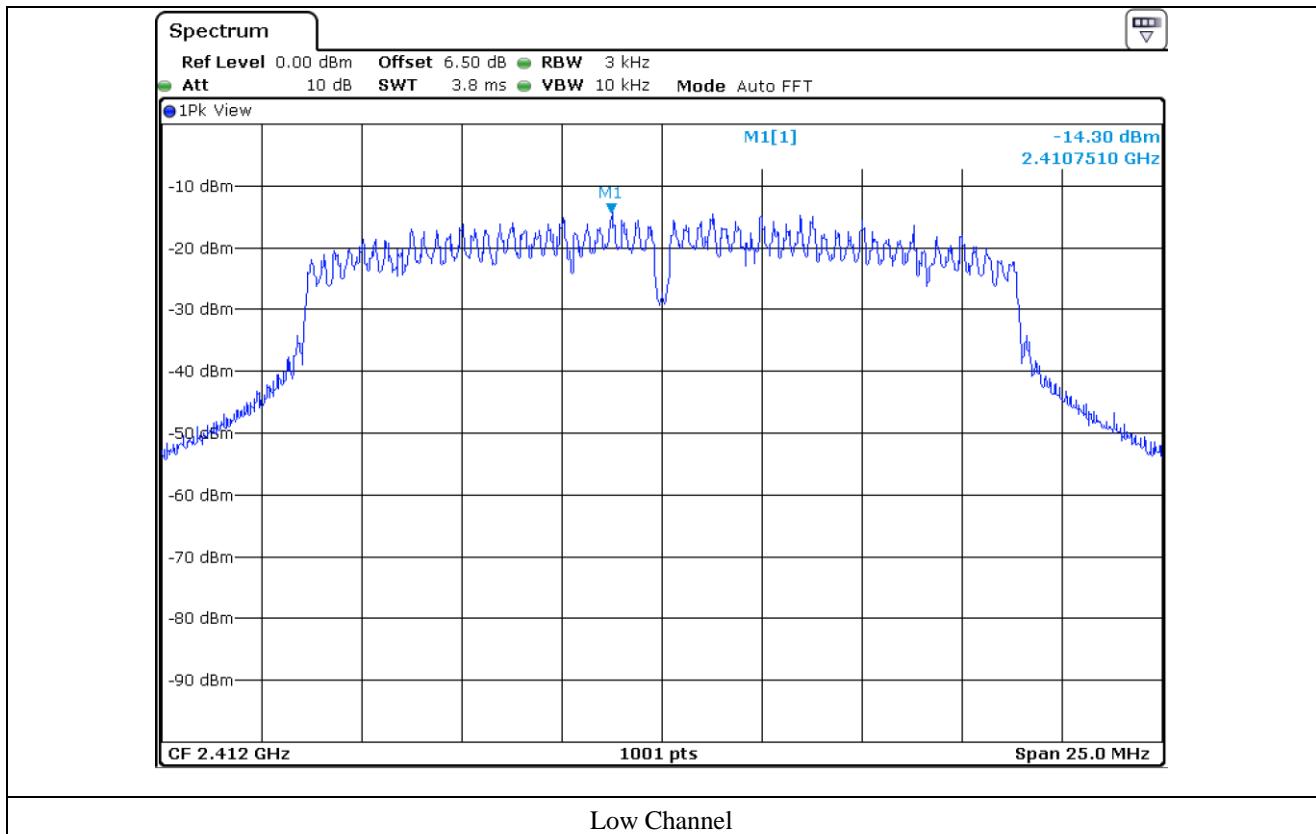
- Test Result : Pass

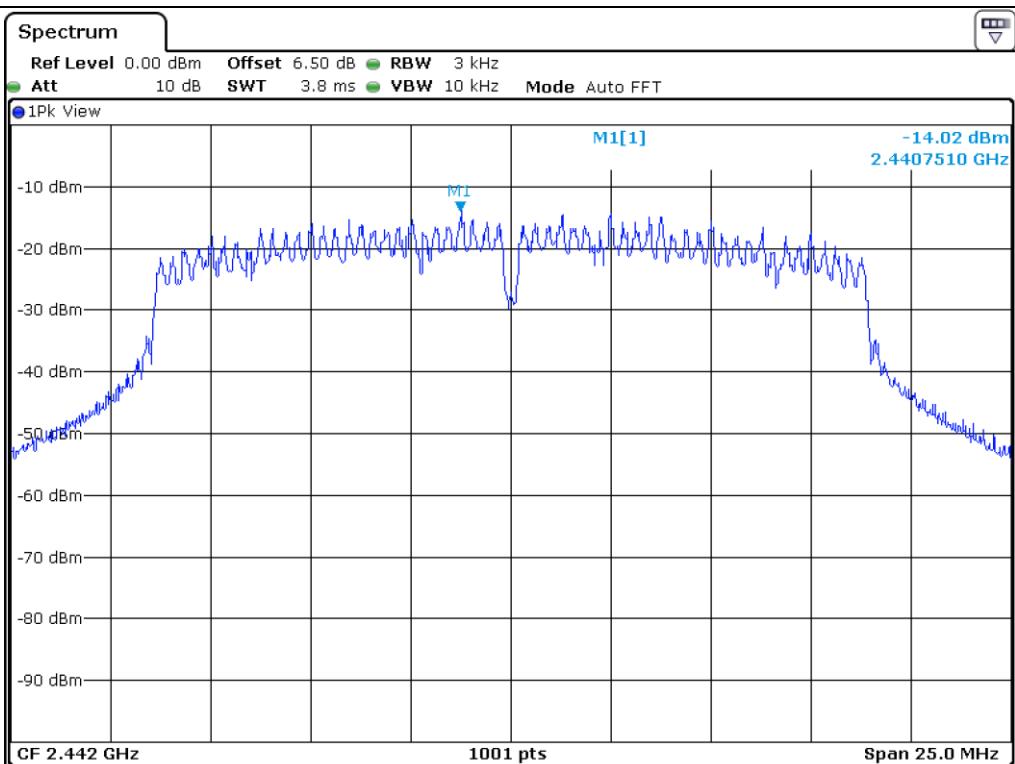
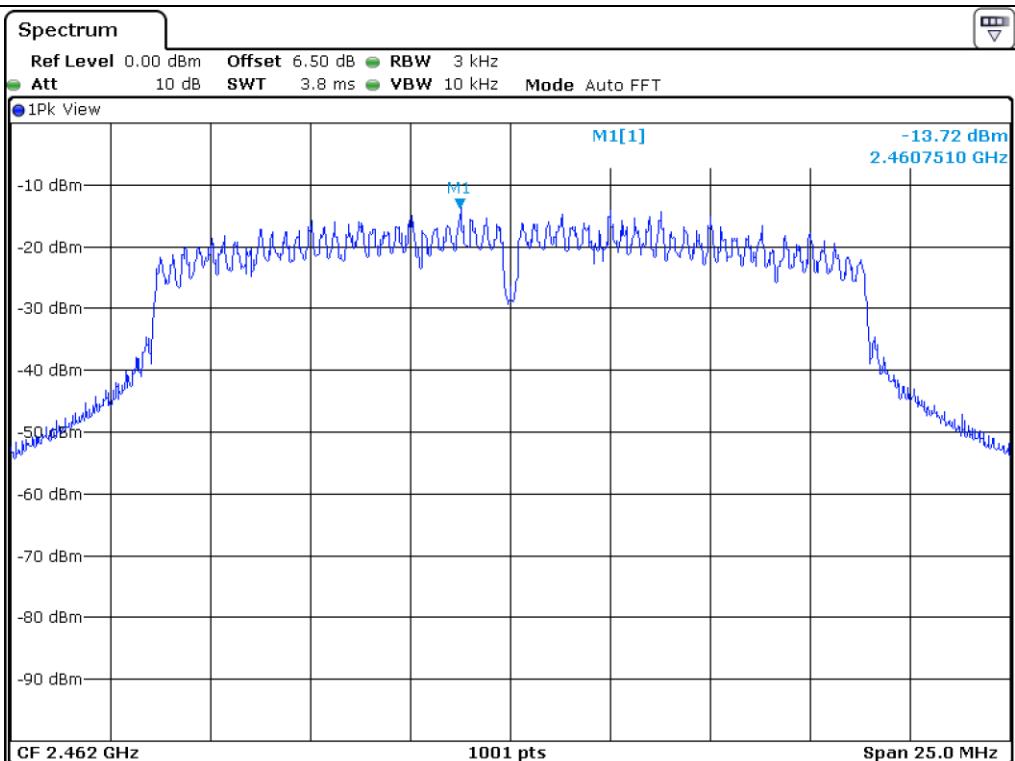
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-14.30	8.00	22.30
Middle	2 442.00	-14.02	8.00	22.02
High	2 462.00	-13.72	8.00	21.72

Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager



**Middle Channel****High Channel**

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

11.2 Test set-up

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

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

11.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 11, 2019 (1Y)
■ - ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 28, 2019 (1Y)
■ - 310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 18, 2019 (1Y)
■ - BBV 9718B	Schwarzbeck	Amplifier	009	Mar. 20, 2019 (1Y)
■ - SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Mar. 11, 2019 (1Y)
■ - DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ - MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ - VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 13, 2018 (2Y)
■ - BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jul. 16, 2019 (1Y)
■ - BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jan. 16, 2019 (1Y)
■ - VAMP9243	Schwarzbeck	ROD ANTENNA	VAMP9243	Mar. 14, 2019 (2Y)

All test equipment used is calibrated on a regular basis.

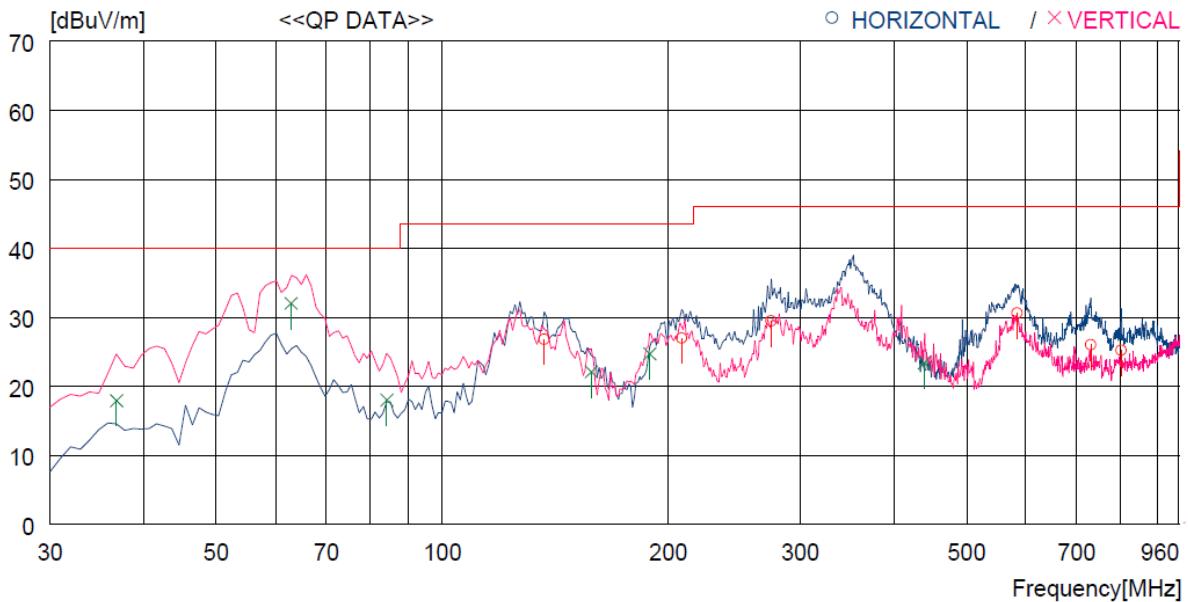
11.4 Test data

11.4.1 Test data for 30 MHz ~ 1 GHz

Humidity Level : 45 % R.H. Temperature: 23 °C
 Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247
 Result : PASSED

EUT : AWAIR ELEMENT Date: August 08, 2019 ~ August 16, 2019

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	QP	FACTOR			[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]

----- Horizontal -----

1	274.440	46.2	13.0	3.2	33.0	29.4	46.0	16.6	100	359
2	732.274	33.5	20.4	5.3	33.2	26.0	46.0	20.0	100	359
3	804.052	31.5	21.3	5.4	33.0	25.2	46.0	20.8	100	285
4	583.868	40.1	19.2	4.6	33.3	30.6	46.0	15.4	300	129
5	136.700	48.9	8.6	2.3	33.0	26.8	43.5	16.7	200	0
6	208.480	46.2	11.0	2.8	33.0	27.0	43.5	16.5	100	218

----- Vertical -----

7	36.790	36.1	13.6	1.3	33.1	17.9	40.0	22.1	100	0
8	84.320	40.0	9.1	1.9	33.0	18.0	40.0	22.0	100	0
9	62.980	51.4	12.0	1.7	33.1	32.0	40.0	8.0	100	0
10	158.040	44.0	8.7	2.4	33.0	22.1	43.5	21.4	100	282
11	189.080	44.1	10.9	2.7	33.0	24.7	43.5	18.8	100	258
12	439.341	36.4	16.0	4.1	33.1	23.4	46.0	22.6	100	0

Tested by: Hyung-Kwon, Oh / Assistant Manager

11.4.2 Test data for Below 30 MHz

- Test Date : August 08, 2019 ~ August 16, 2019
- 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
- Operating mode : Transmitting mode

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

11.4.3 Test data for above 1 GHz

- Test Date : August 08, 2019 ~ August 16, 2019
- 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
- Operating mode : Transmitting mode

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

Tested by: Hyung-Kwon, Oh / Assistant Manager

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

12.2 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 $50 \Omega / 50 \mu\text{H} + 5 \Omega$ Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

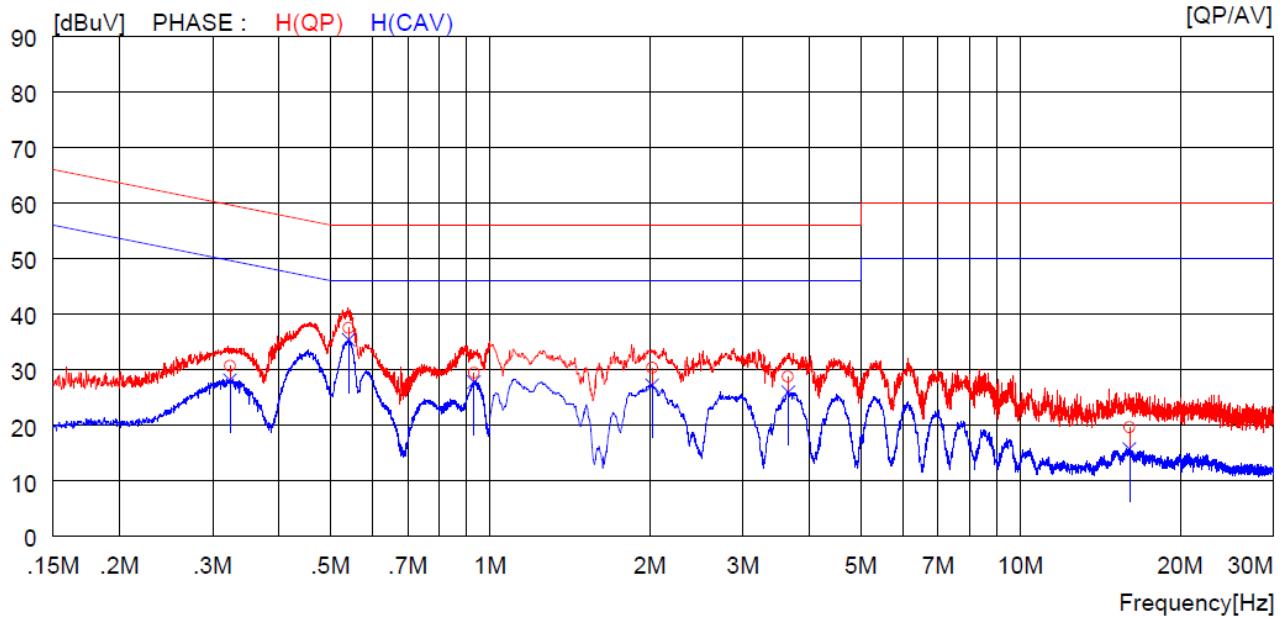
12.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ - ESCI	Rohde & Schwarz	Test Receiver	101012	Oct. 22, 2018 (1Y)
□ - NSLK8128	Schwarzbeck	AMN	8128-216	Mar. 20, 2019 (1Y)
■ - NSLK8126	Schwarzbeck	AMN	8126-404	Mar. 19, 2019 (1Y)
□ - 3825/2	EMCO	AMN	9109-1869	Mar. 19, 2019 (1Y)
■ - 3825/2	EMCO	AMN	9109-1867	Mar. 27, 2019 (1Y)

All test equipment used is calibrated on a regular basis.

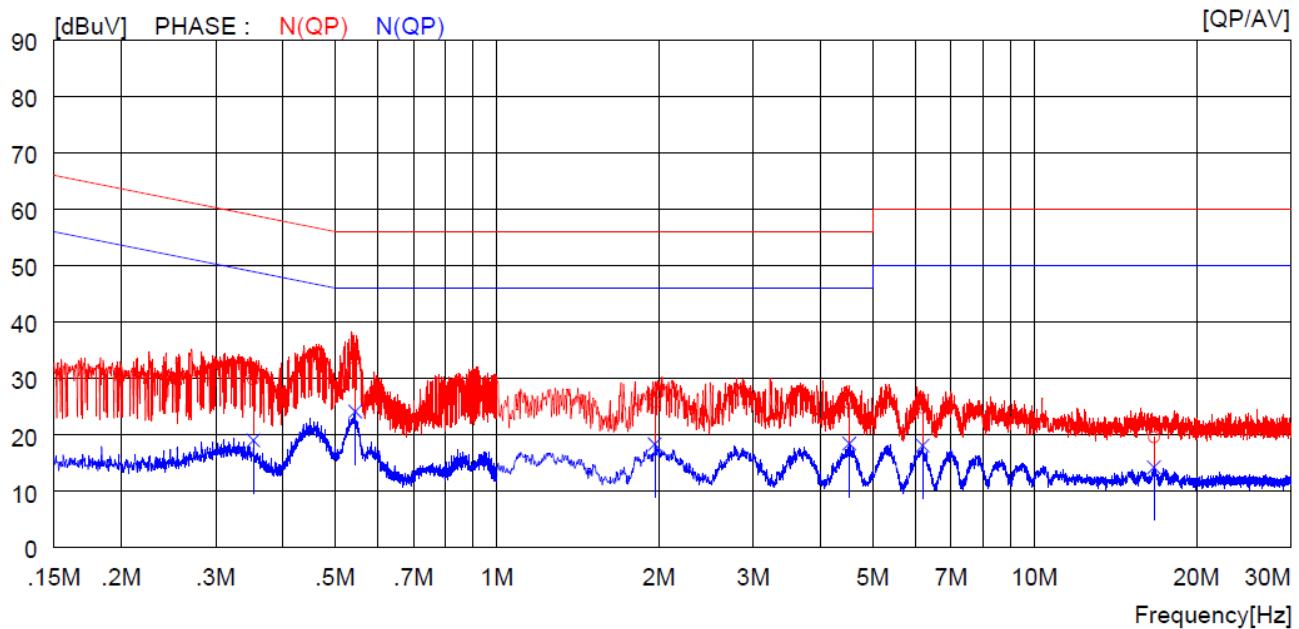
12.4 Test data

- Test Date : August 08, 2019 ~ August 16, 2019
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.32300	20.7	----	10.0	30.7	----	59.6	----	28.9	----	H (QP)
2	0.54100	27.5	----	10.0	37.5	----	56.0	----	18.5	----	H (QP)
3	0.93200	19.4	----	10.0	29.4	----	56.0	----	26.6	----	H (QP)
4	2.02000	20.2	----	10.1	30.3	----	56.0	----	25.7	----	H (QP)
5	3.64800	18.6	----	10.1	28.7	----	56.0	----	27.3	----	H (QP)
6	16.05000	9.1	----	10.6	19.7	----	60.0	----	40.3	----	H (QP)
7	0.32300	----	18.1	10.0	----	28.1	----	49.6	----	21.5	H (CAV)
8	0.54100	----	25.4	10.0	----	35.4	----	46.0	----	10.6	H (CAV)
9	0.93200	----	17.8	10.0	----	27.8	----	46.0	----	18.2	H (CAV)
10	2.02000	----	17.1	10.1	----	27.2	----	46.0	----	18.8	H (CAV)
11	3.64800	----	15.9	10.1	----	26.0	----	46.0	----	20.0	H (CAV)
12	16.05000	----	5.2	10.6	----	15.8	----	50.0	----	34.2	H (CAV)

- Tested Line : NEUTRAL LINE



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.35200	19.8	----	10.0	29.8	----	58.9	----	29.1	----	N (QP)
2	0.54500	23.4	----	10.0	33.4	----	56.0	----	22.6	----	N (QP)
3	1.96400	15.7	----	10.1	25.8	----	56.0	----	30.2	----	N (QP)
4	4.52400	15.5	----	10.1	25.6	----	56.0	----	30.4	----	N (QP)
5	6.19000	14.6	----	10.2	24.8	----	60.0	----	35.2	----	N (QP)
6	16.69000	8.9	----	10.6	19.5	----	60.0	----	40.5	----	N (QP)
7	0.35200	---	9.0	10.0	---	19.0	----	48.9	----	29.9	N (CAV)
8	0.54500	---	14.1	10.0	---	24.1	----	46.0	----	21.9	N (CAV)
9	1.96400	---	8.2	10.1	---	18.3	----	46.0	----	27.7	N (CAV)
10	4.52400	---	8.4	10.1	---	18.5	----	46.0	----	27.5	N (CAV)
11	6.19000	---	7.9	10.2	---	18.1	----	50.0	----	31.9	N (CAV)
12	16.69000	---	3.7	10.6	---	14.3	----	50.0	----	35.7	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.

Tested by: Hyung-Kwon, Oh / Assistant Manager