

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

Test Report No. : OT-18N-RWD-030
AGR No. : A18OA-448
Applicant : LG Innotek Co., Ltd.
Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
Manufacturer : LG Innotek Co., Ltd.
Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
Type of Equipment : RF Module
FCC ID. : YZP-TWFMK305D
Model Name : TWFM-K305D
Serial number : N/A
Total page of Report : 74 pages (including this page)
Date of Incoming : October 15, 2018
Date of issue : November 20, 2018

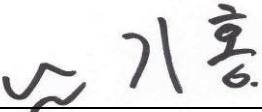
SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247**

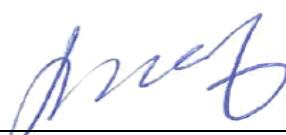
This test report only contains the result of a single test of the sample supplied for the examination.

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

Reviewed by:


Ki-Hong, Nam / Chief Engineer
ONETECH Corp.

Approved by:


Keun-Young, Choi / Vice President
ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-18N-RWD-030	2018.11.20	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Innotek Co., Ltd.

Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea

Contact Person : Jeong, Inchang / Senior Research Engineer

Telephone No. : +82-62-950-0332

FCC ID : YZP-TWFMK305D

Model Name : TWFM-K305D

Brand Name : -

Serial Number : N/A

Date : November 20, 2018

EQUIPMENT CLASS	DTS – DIGITAL TRANSMISSION SYSTEM
E.U.T. DESCRIPTION	Modular Transmitter, RF Module
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 KDB 558074 D01 DTS Meas Guidance v05
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 LG Innotek Co., Ltd., Model TWFM-K305D (referred to as the EUT in this report) is a RF Module. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	RF Module
Temperature Range	-20 °C ~ 80 °C
OPERATING FREQUENCY	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20)) 2 422 MHz ~ 2 452 MHz (802.11n(HT40))
MODULATION TYPE	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK) 802.11g/n(HT20)/n(HT40): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
RF OUTPUT POWER'	17.14 dBm(802.11b) 13.31 dBm(802.11g) 15.74 dBm(802.11n_HT20) 15.91 dBm(802.11n_HT40)
MODULATION TYPE	DSSS Modulation(DBPSK/DQPSK/CCK) OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
ANTENNA TYPE	PCB Antenna
ANTENNA GAIN	1.50 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
TWFM-K305D	LG Innotek Co., Ltd.	RF Module (EUT)	
HP Pavilion g series	HP	Notebook PC	EUT
PPP009C	LIE-ON TECHNOLOGY (CHANGZHOU)CO.,LTD.	AC Adapter	

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	16.51
	2 Mbps	16.43
	5.5 Mbps	16.34
	11 Mbps	16.22
802.11g (Middle Channel)	6 Mbps	12.58
	9 Mbps	12.51
	12 Mbps	12.40
	18 Mbps	12.30
	24 Mbps	12.20
	36 Mbps	12.14
	48 Mbps	12.08
	54 Mbps	11.97
HT 20 (Middle Channel)	6.5 Mbps	12.44
	13 Mbps	12.36
	19.5 Mbps	12.27
	26 Mbps	12.16
	39 Mbps	12.07
	52 Mbps	11.96
	58.5 Mbps	11.86
	65 Mbps	11.75
HT 40 (Middle Channel)	13.5 Mbps	15.57
	27 Mbps	15.50
	40.5 Mbps	15.45
	54 Mbps	15.36
	81 Mbps	15.26
	108 Mbps	15.18
	121.5 Mbps	15.09
	135 Mbps	14.94

- 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, 13.5 Mbps for HT40.
- 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.

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 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 : 41 % 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. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

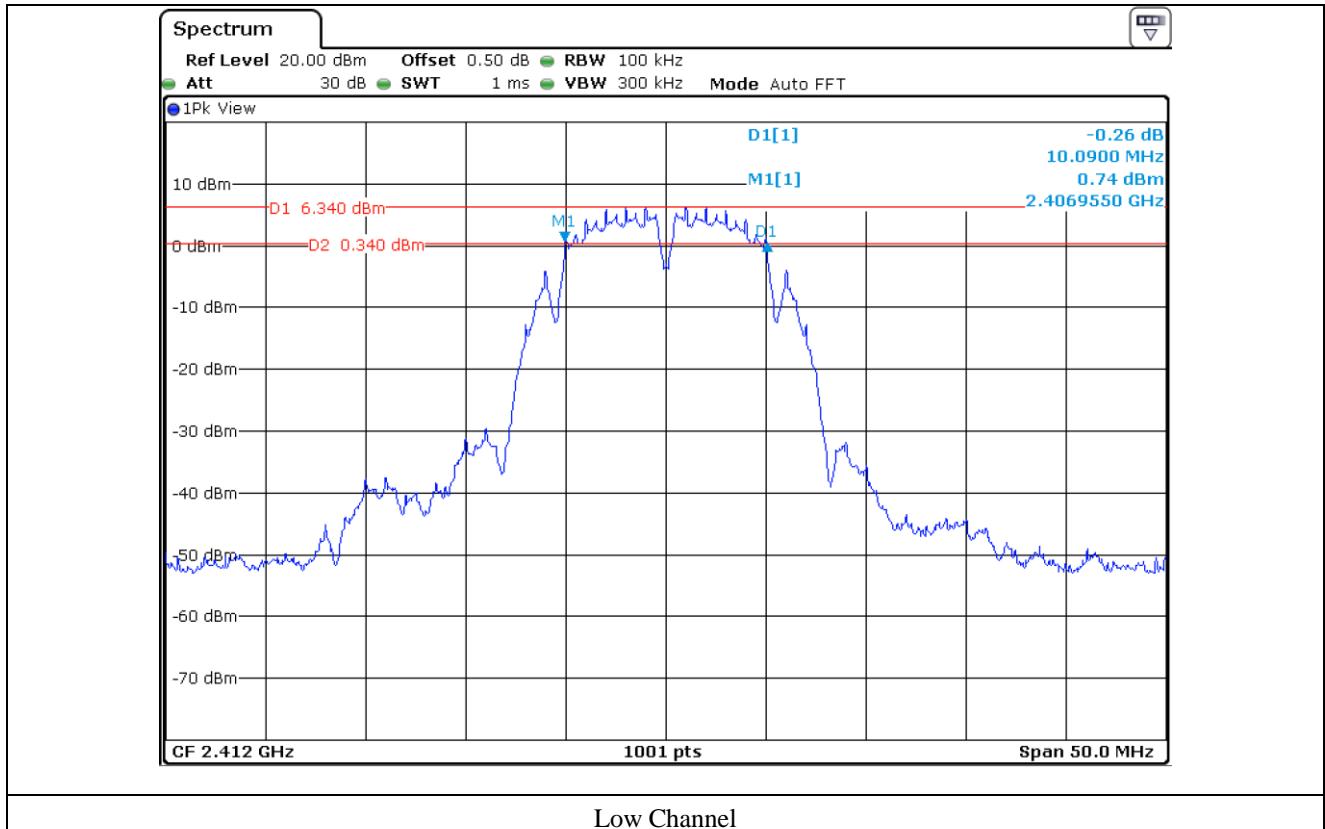
7.4 Test data for 802.11b WLAN Mode

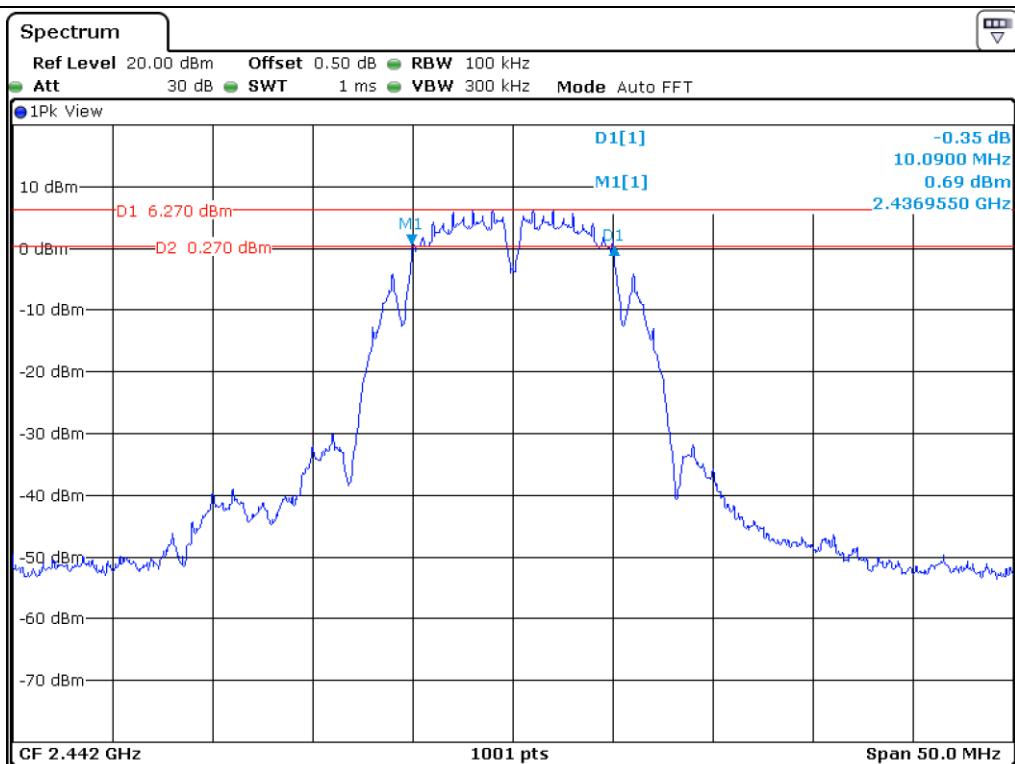
- Test Date : October 16, 2018 ~ October 28, 2018
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	10.09	0.50	9.59
Middle	2 442.00	10.09	0.50	9.59
High	2 462.00	10.09	0.50	9.59

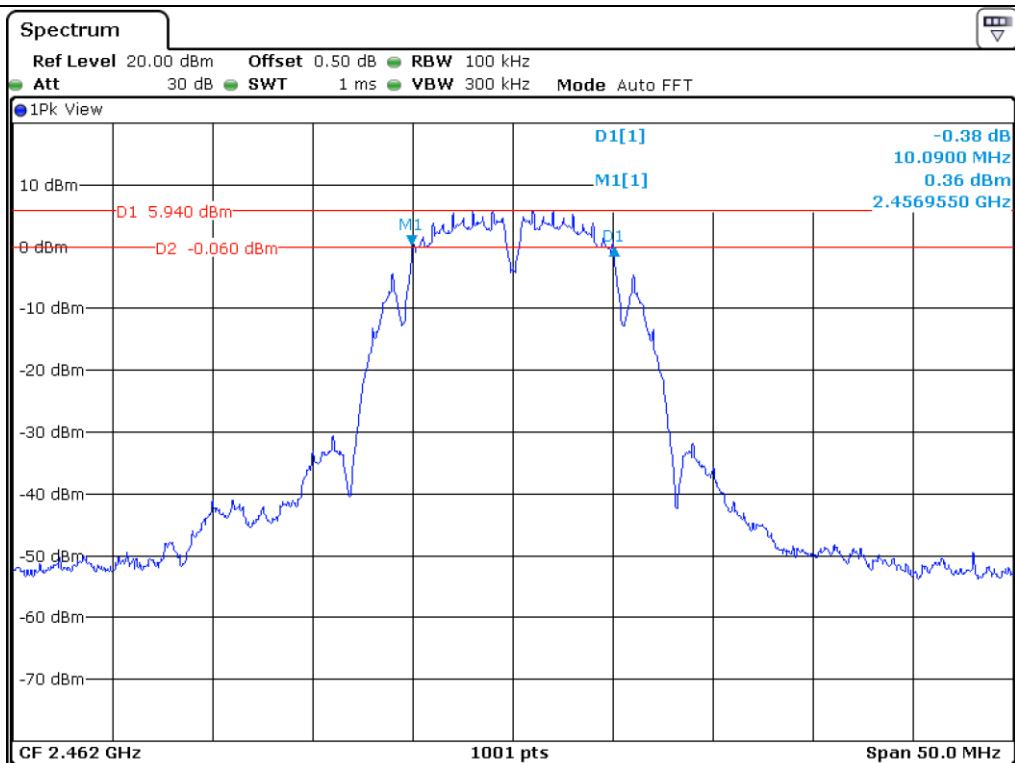
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

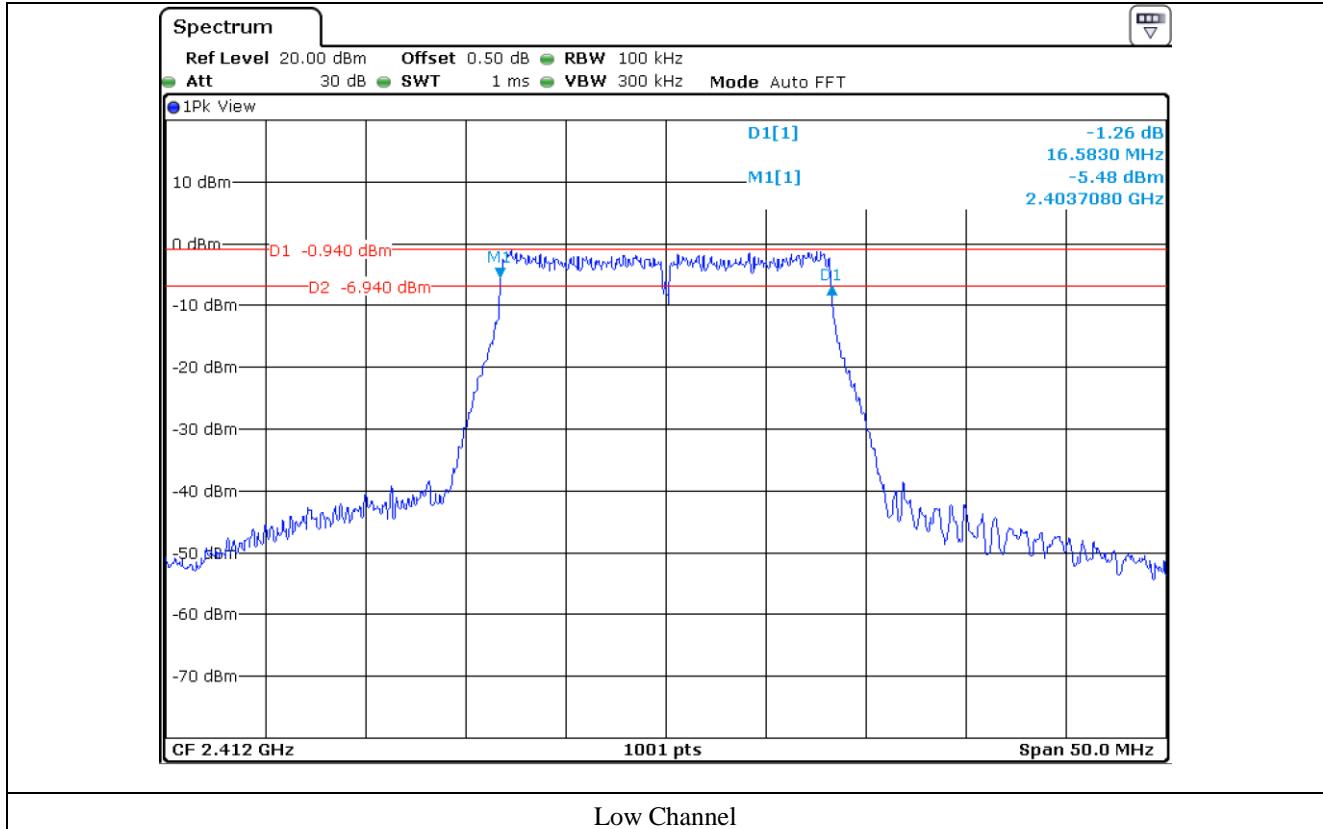
7.5 Test data for 802.11g WLAN Mode

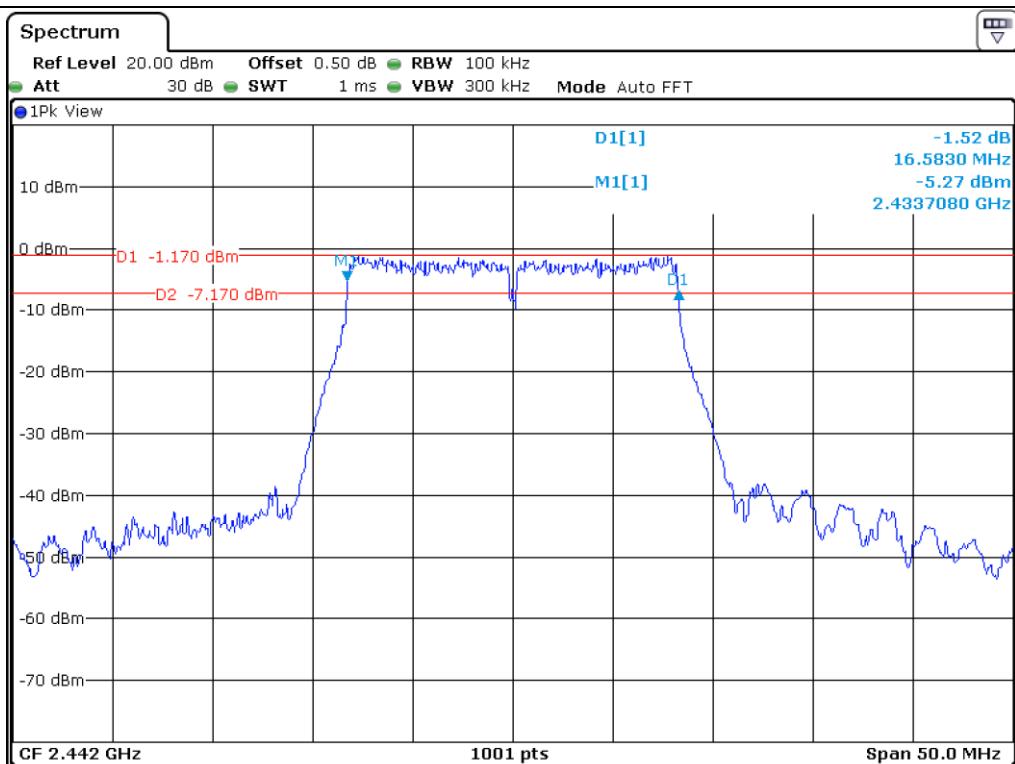
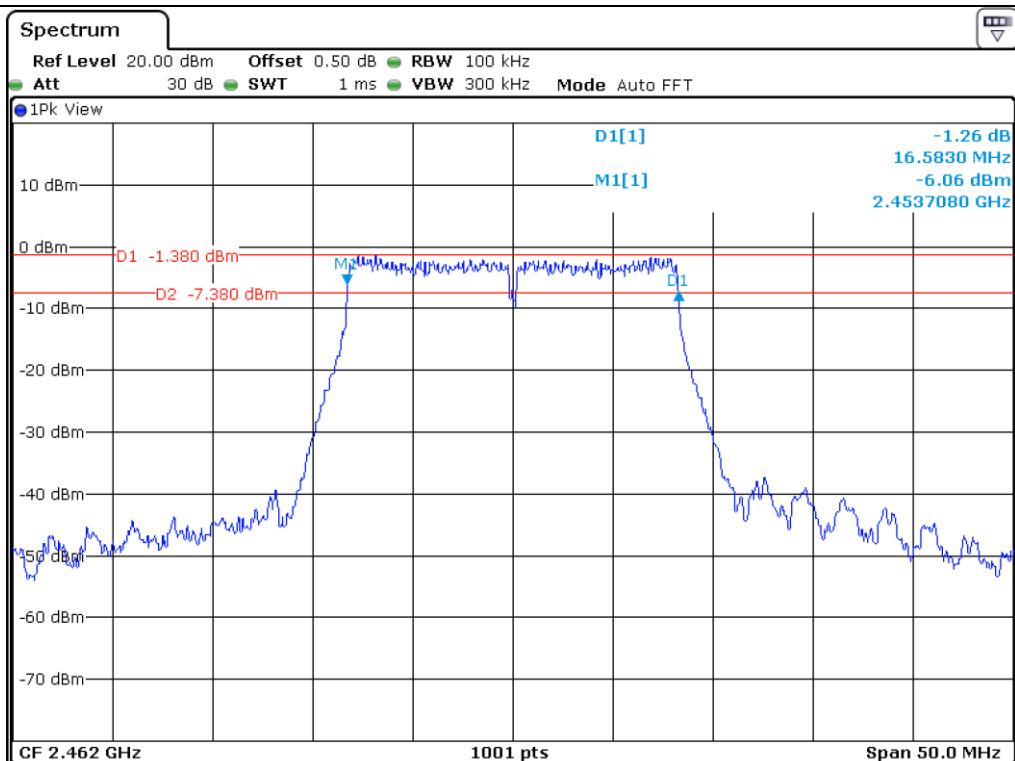
- Test Date : October 16, 2018 ~ October 28, 2018
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	16.58	0.50	16.08
Middle	2 442.00	16.58	0.50	16.08
High	2 462.00	16.58	0.50	16.08

Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager



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

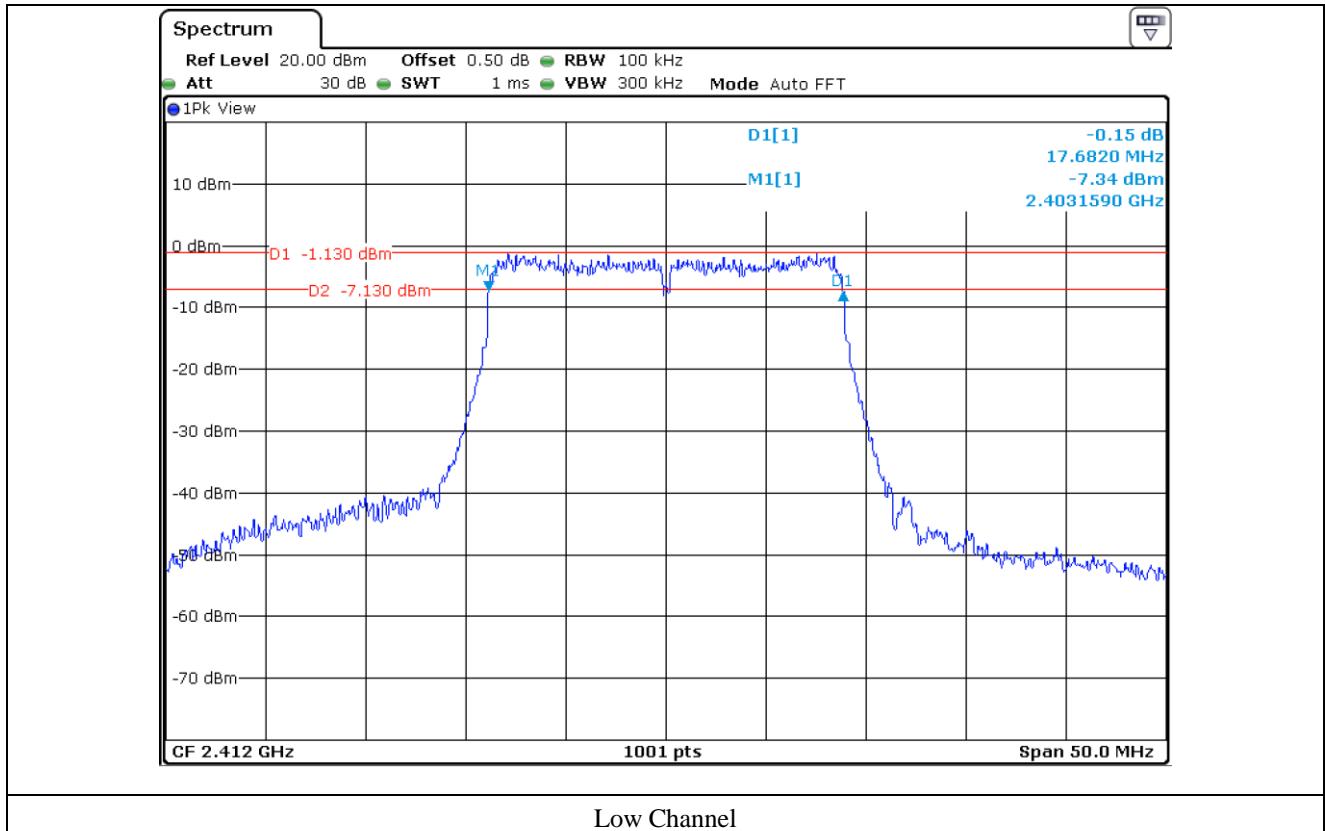
7.6 Test data for 802.11n_HT20 WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Test Result : Pass

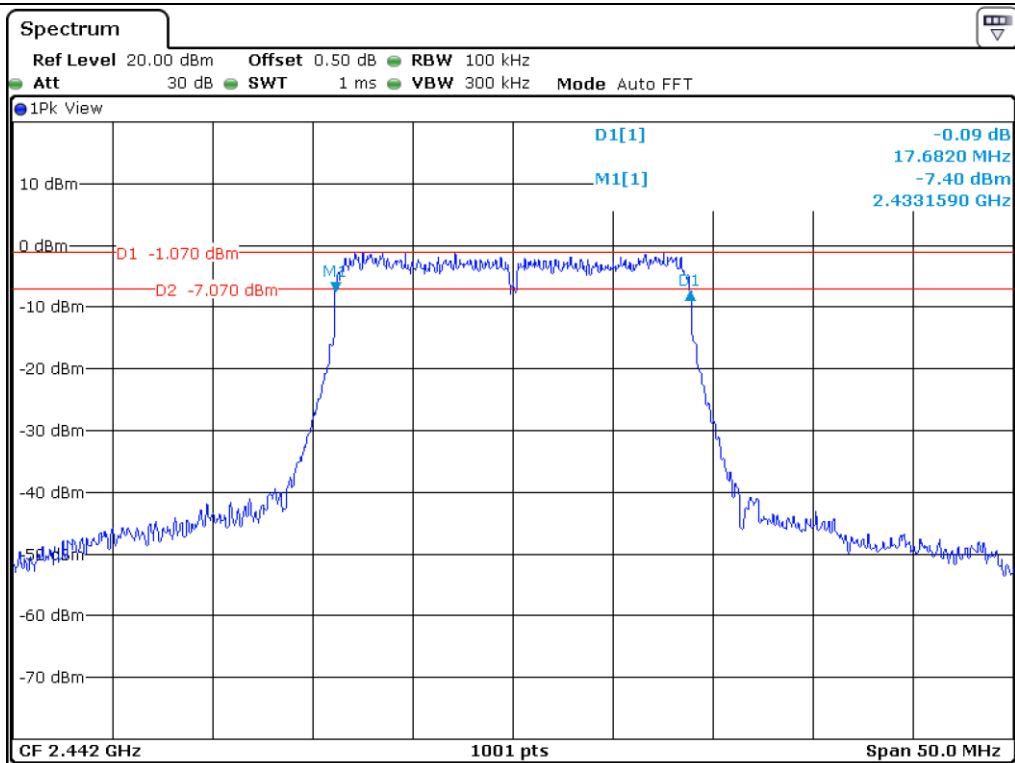
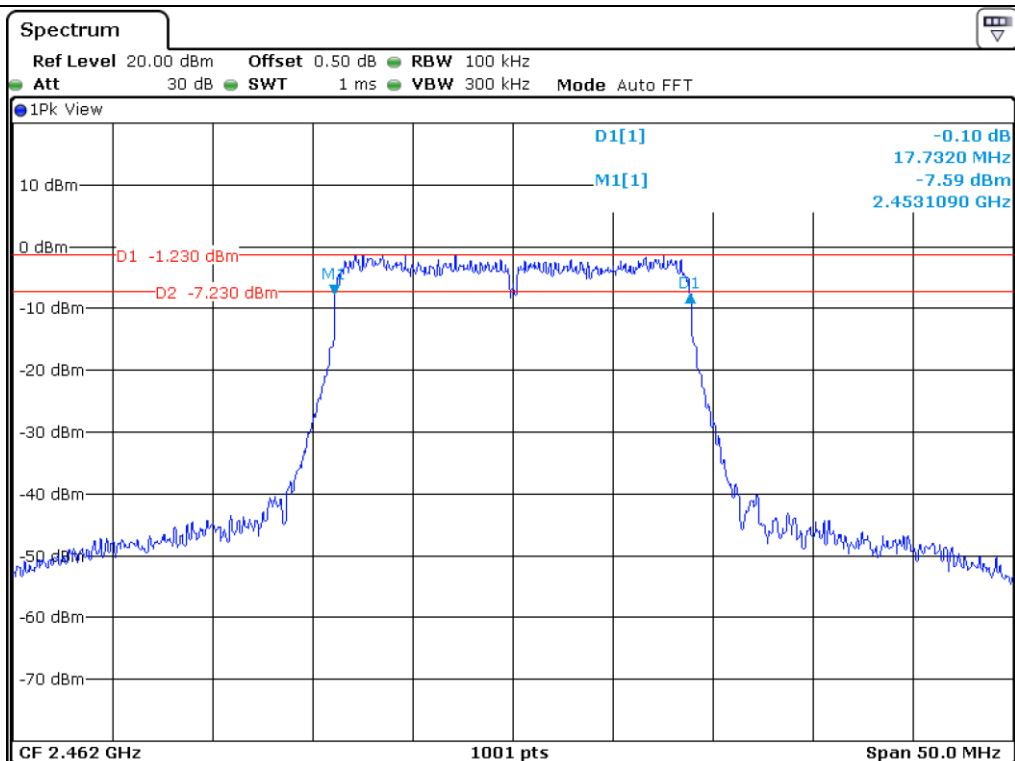
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	17.68	0.50	17.18
Middle	2 442.00	17.68	0.50	17.18
High	2 462.00	17.73	0.50	17.23

Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager



Low Channel

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

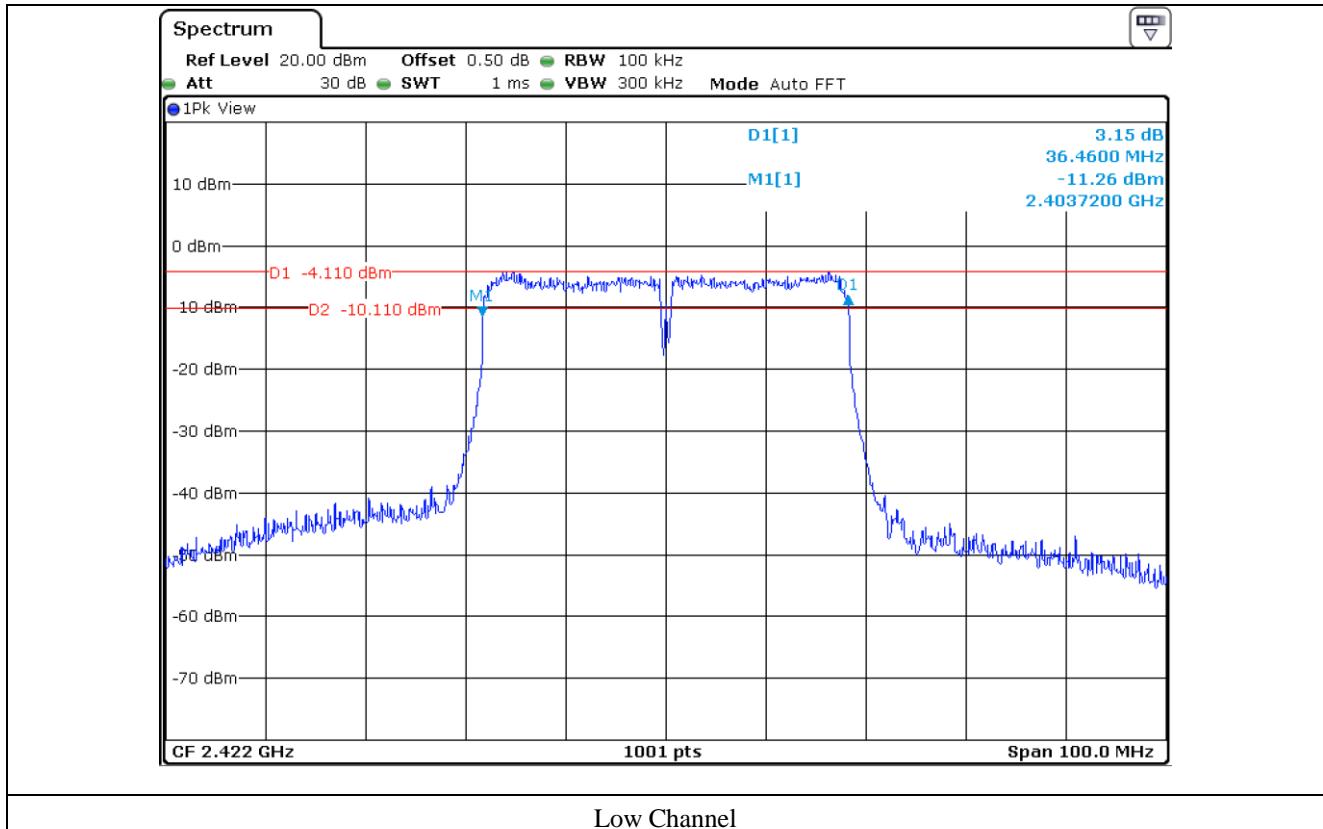
7.7 Test data for 802.11n_HT40 WLAN Mode

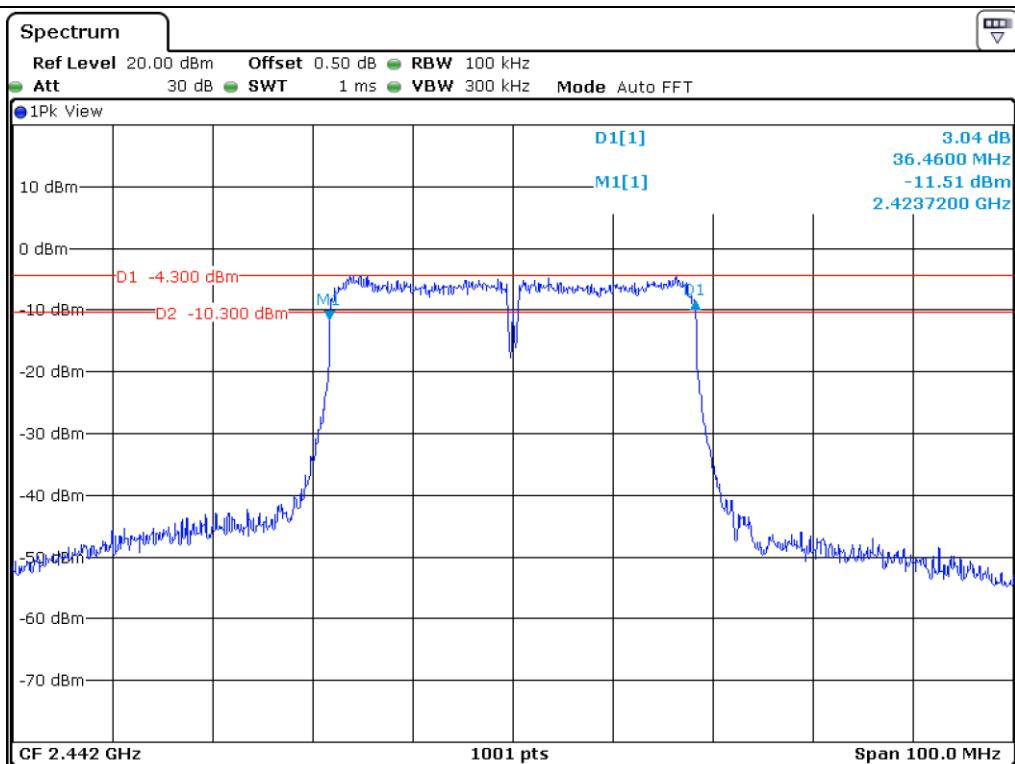
- Test Date : October 16, 2018 ~ October 28, 2018
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 422.00	36.46	0.50	35.96
Middle	2 442.00	36.46	0.50	35.96
High	2 452.00	36.46	0.50	35.96

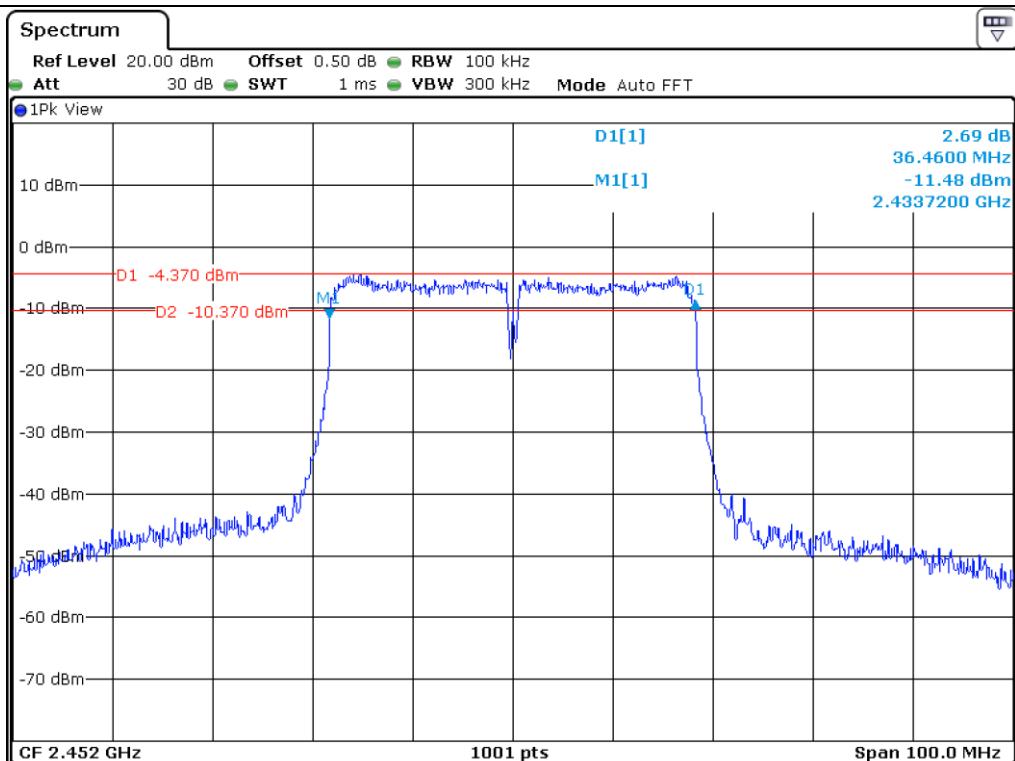
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

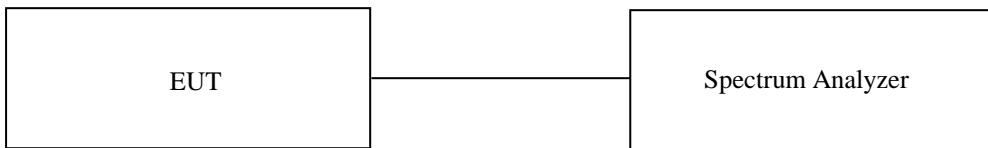
Temperature : 23 °C

Relative humidity : 41 % R.H.

8.2 Test set-up

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

The resolution bandwidth is set to \geq DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 802.11b WLAN Mode

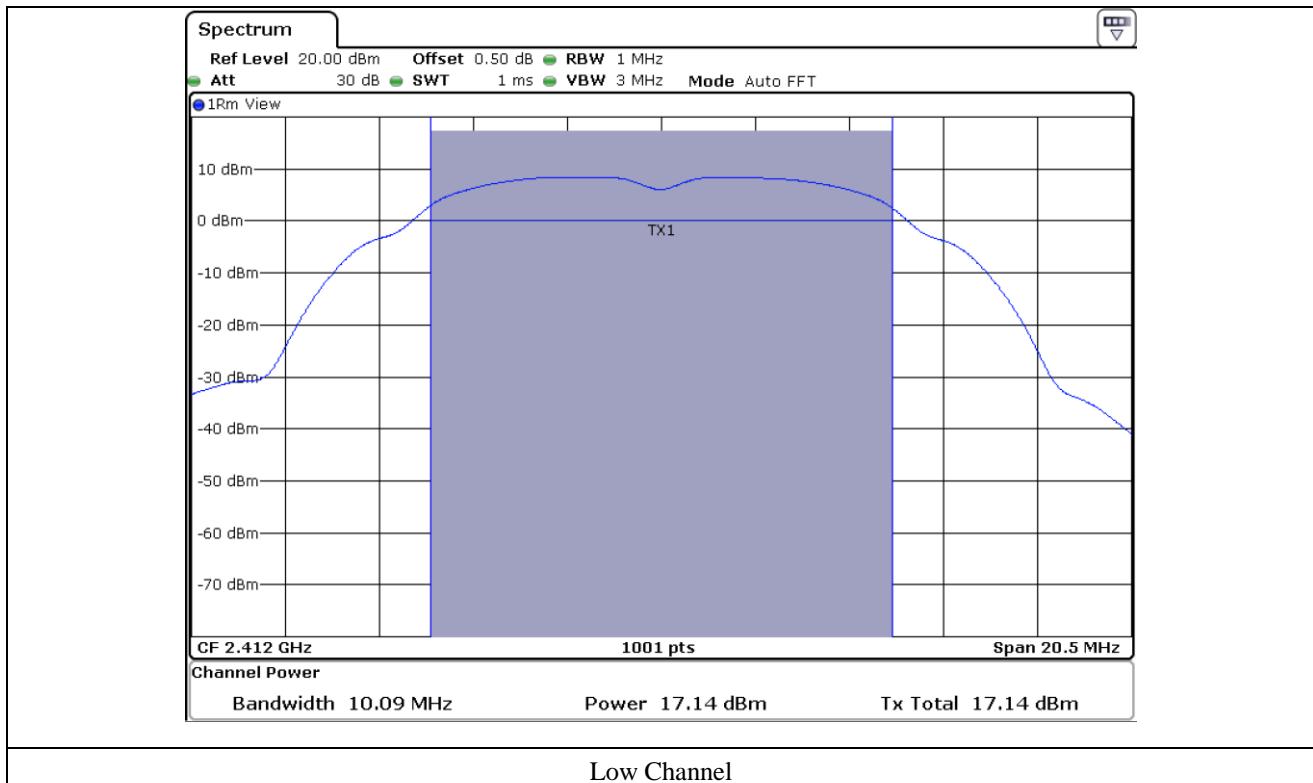
- Test Date : October 16, 2018 ~ October 28, 2018

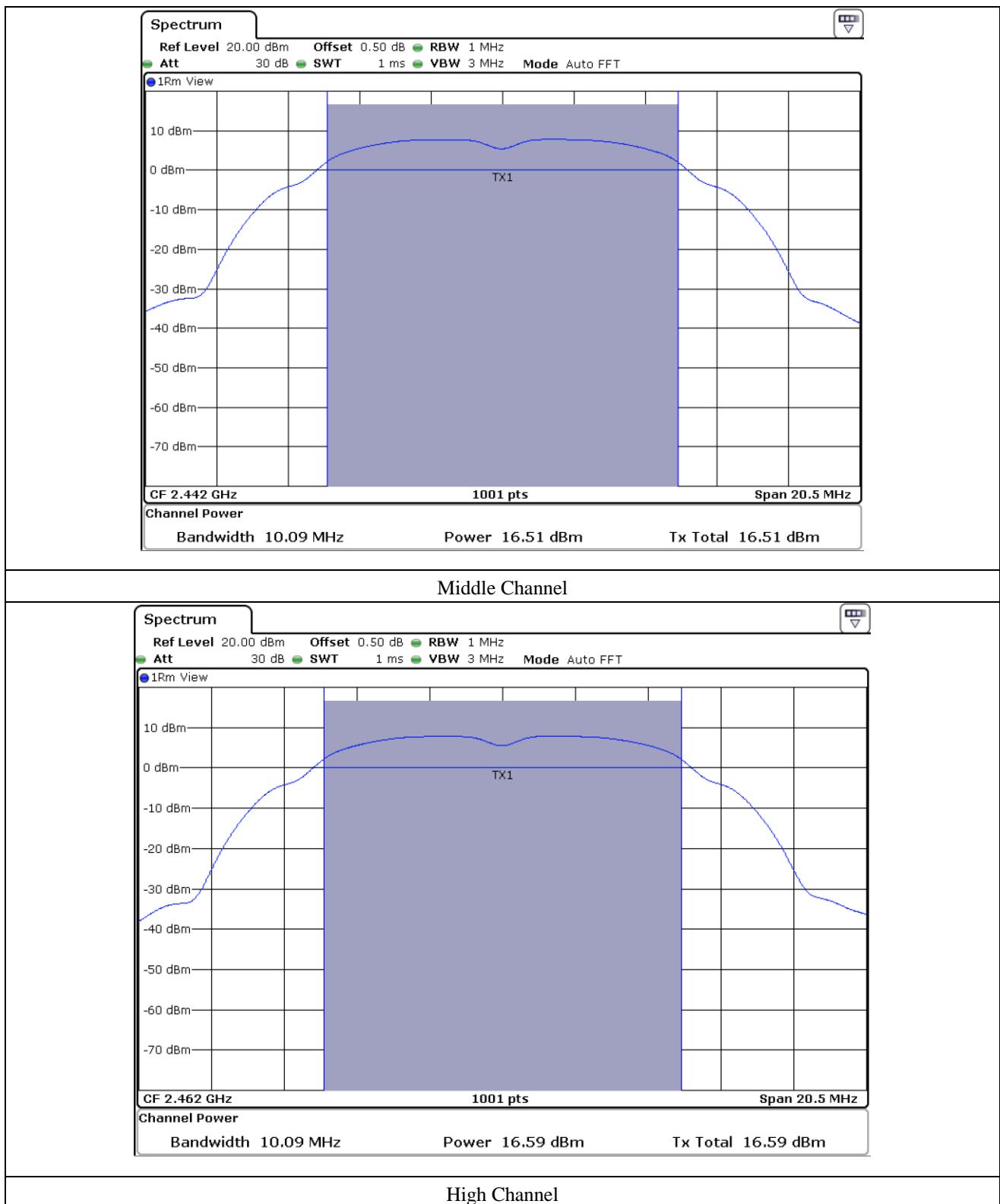
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	17.14	30.00	12.86
MIDDLE	2 442.00	16.51	30.00	13.49
HIGH	2 462.00	16.59	30.00	13.41

Remark : Margin = Limit – Measured Value (=Power Sensor Reading - Cable Loss)

Tested by: Tae-Ho, Kim / Senior Manager





8.5 Test data for 802.11g WLAN Mode

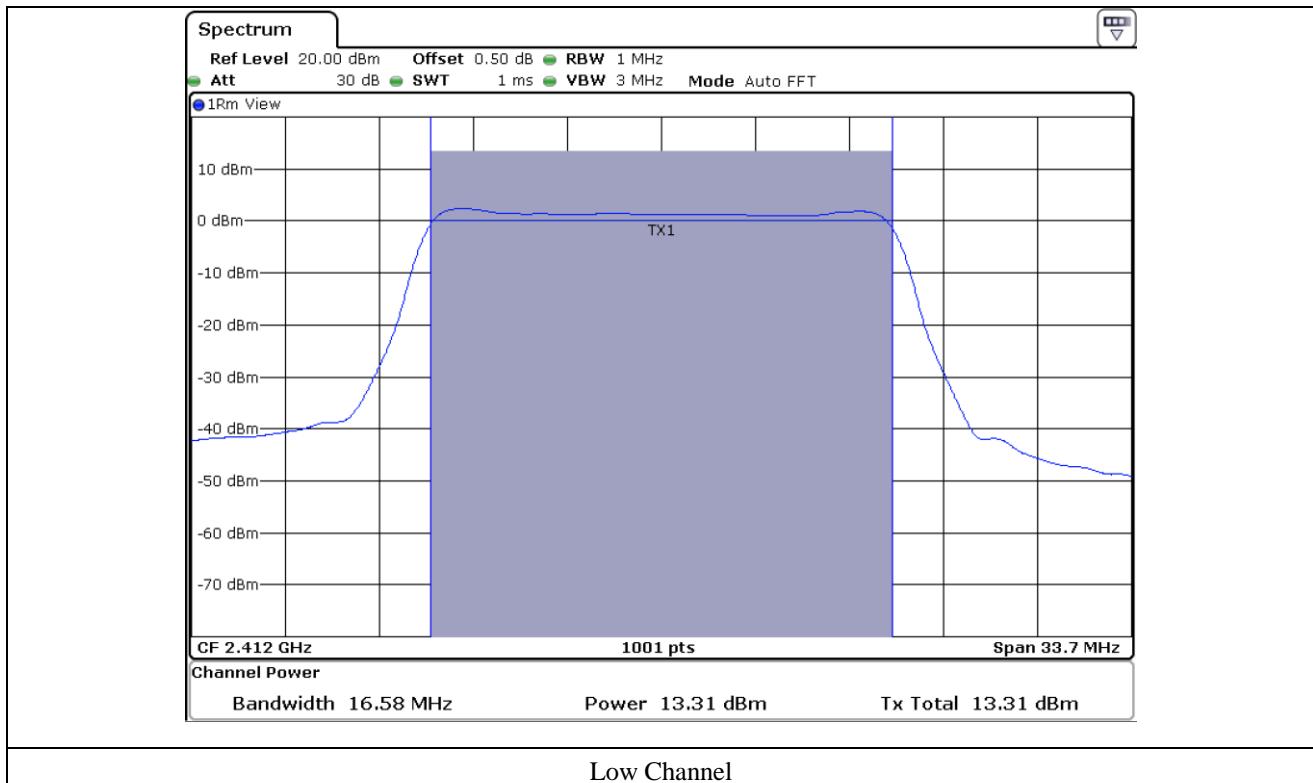
- Test Date : October 16, 2018 ~ October 28, 2018

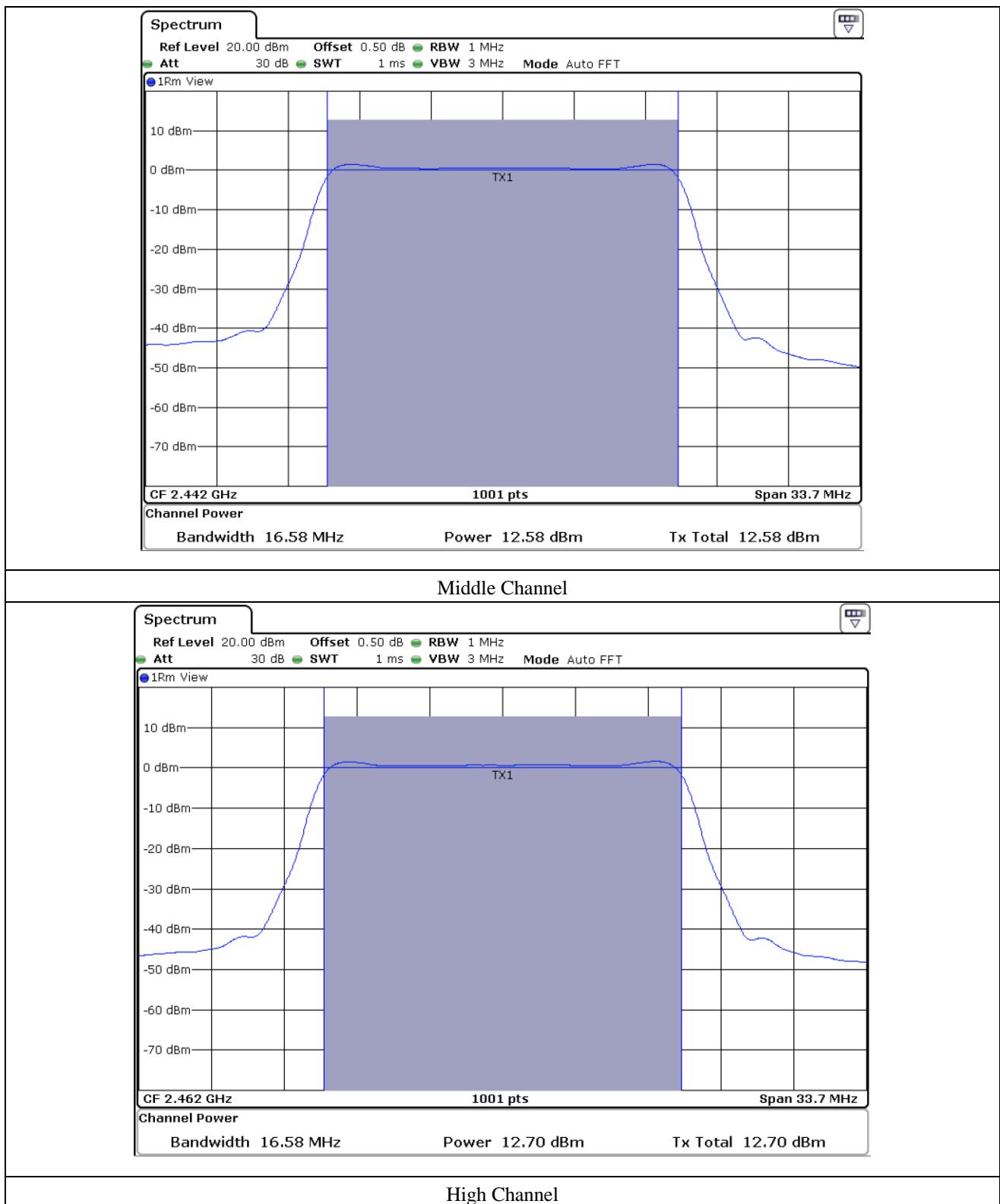
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	13.31	30.00	16.69
MIDDLE	2 442.00	12.58	30.00	17.42
HIGH	2 462.00	12.70	30.00	17.30

Remark : Margin = Limit – Measured Value (=Power Sensor Reading - Cable Loss)

Tested by: Tae-Ho, Kim / Senior Manager





8.6 Test data for 802.11n_HT20 WLAN Mode

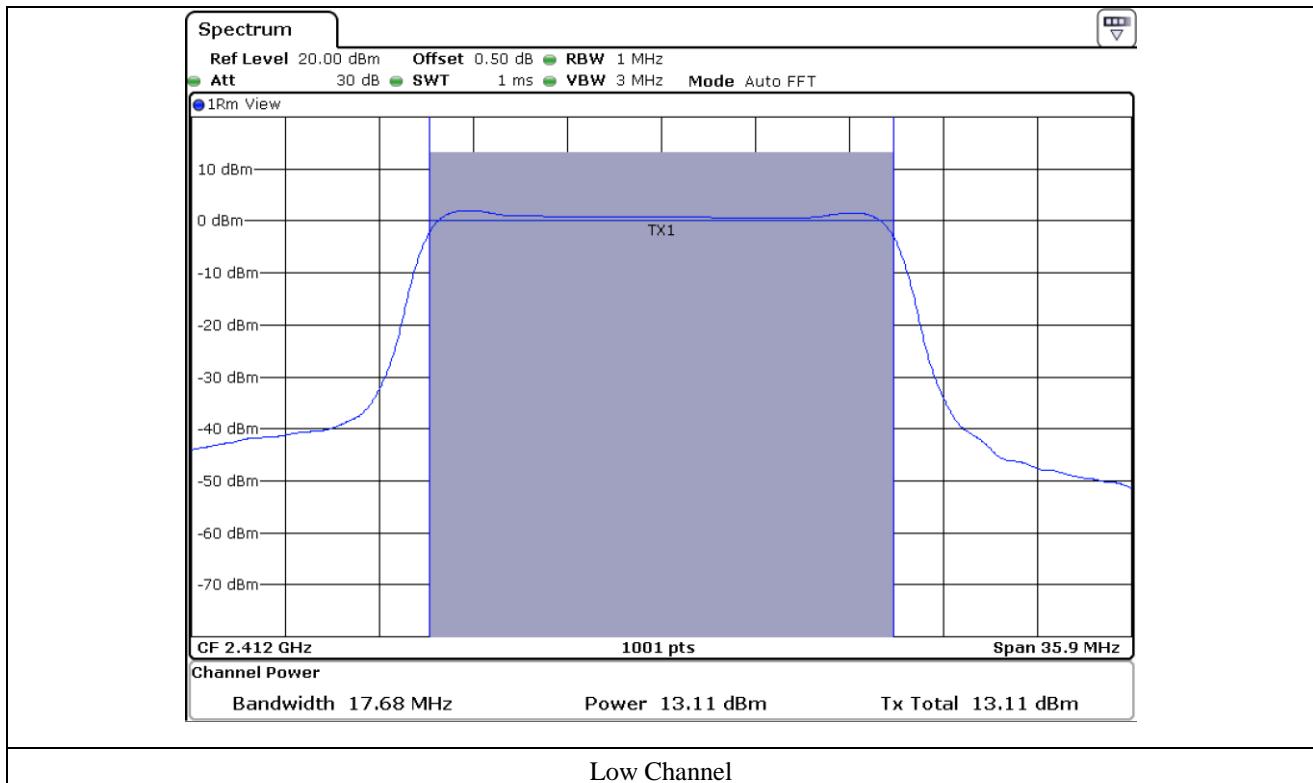
- Test Date : October 16, 2018 ~ October 28, 2018

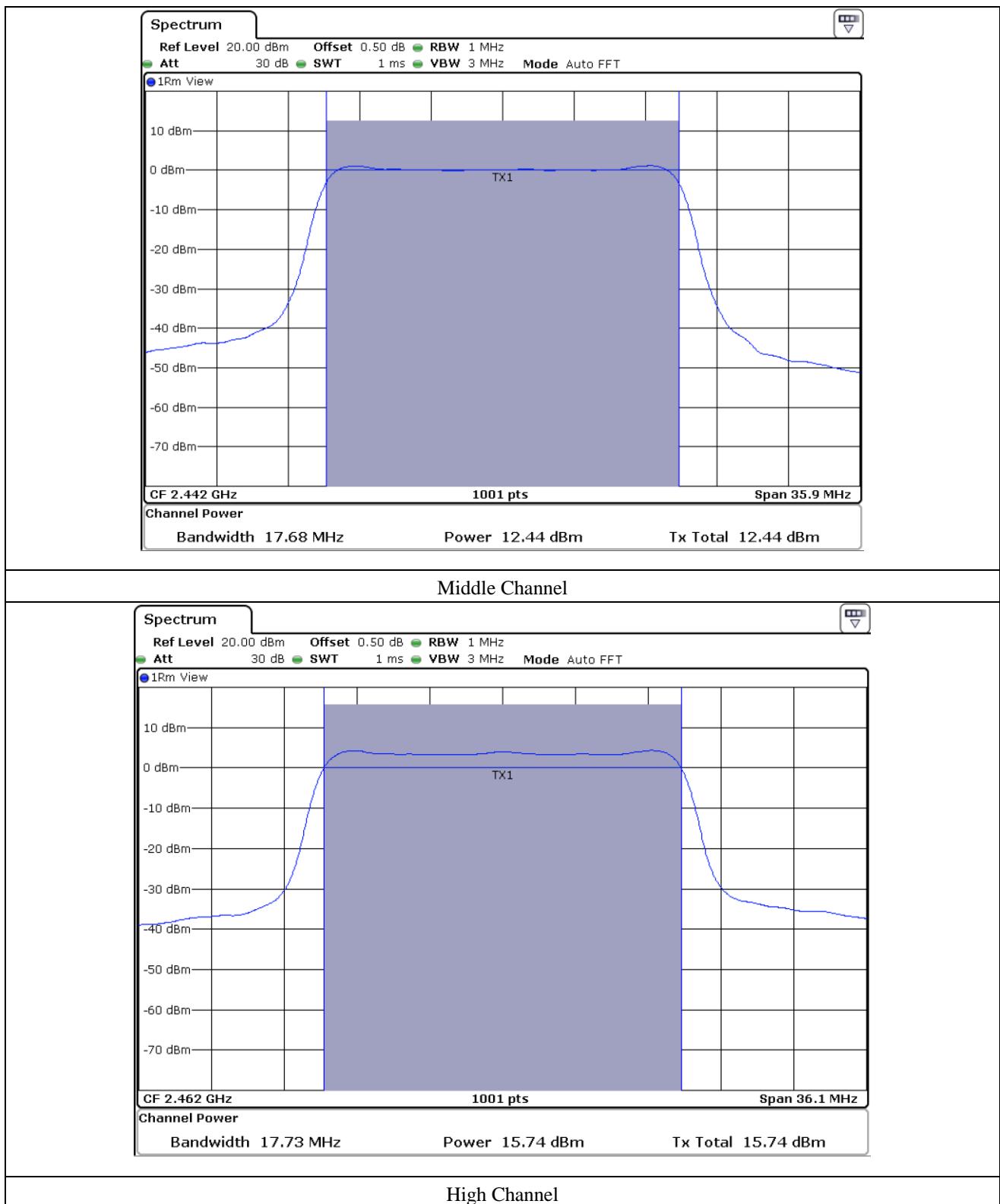
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	13.11	30.00	16.89
MIDDLE	2 442.00	12.44	30.00	17.56
HIGH	2 462.00	15.74	30.00	14.26

Remark : Margin = Limit – Measured Value (=Power Sensor Reading - Cable Loss)

Tested by: Tae-Ho, Kim / Senior Manager





8.7 Test data for 802.11n_HT40 WLAN Mode

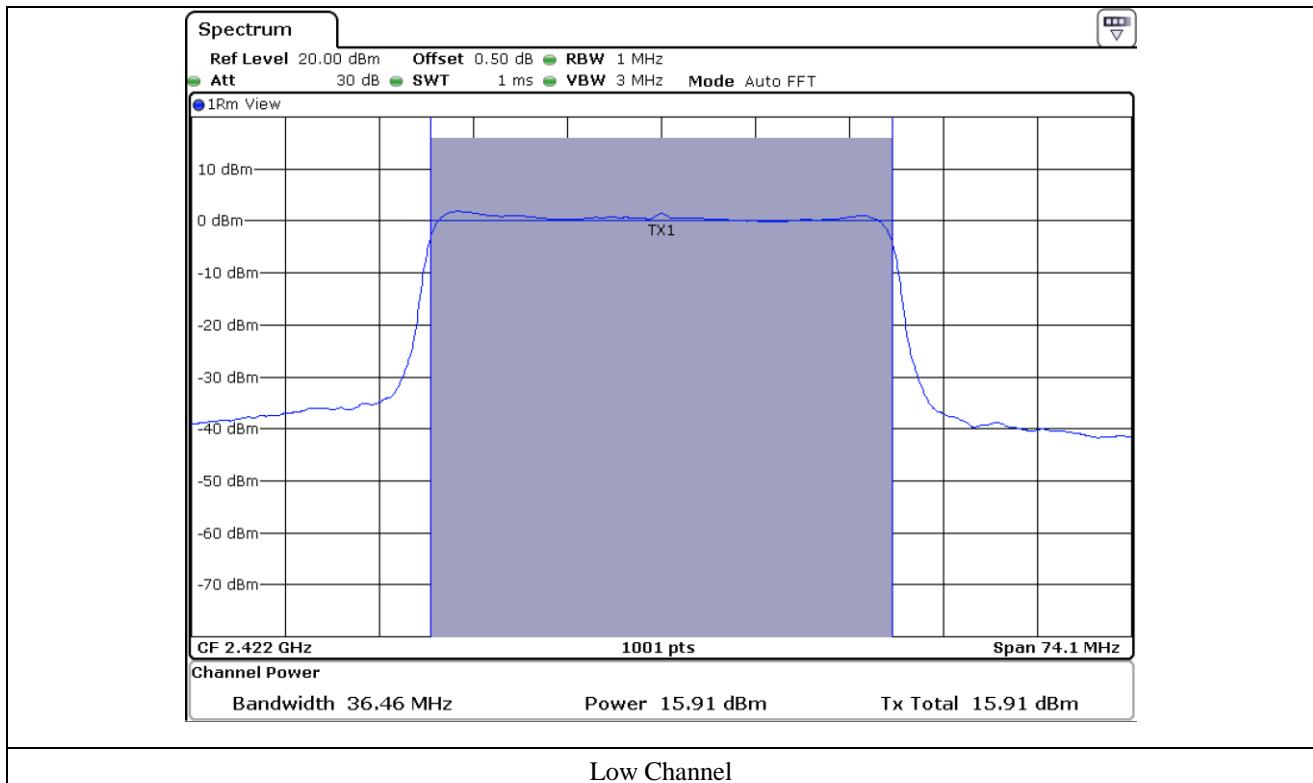
- Test Date : October 16, 2018 ~ October 28, 2018

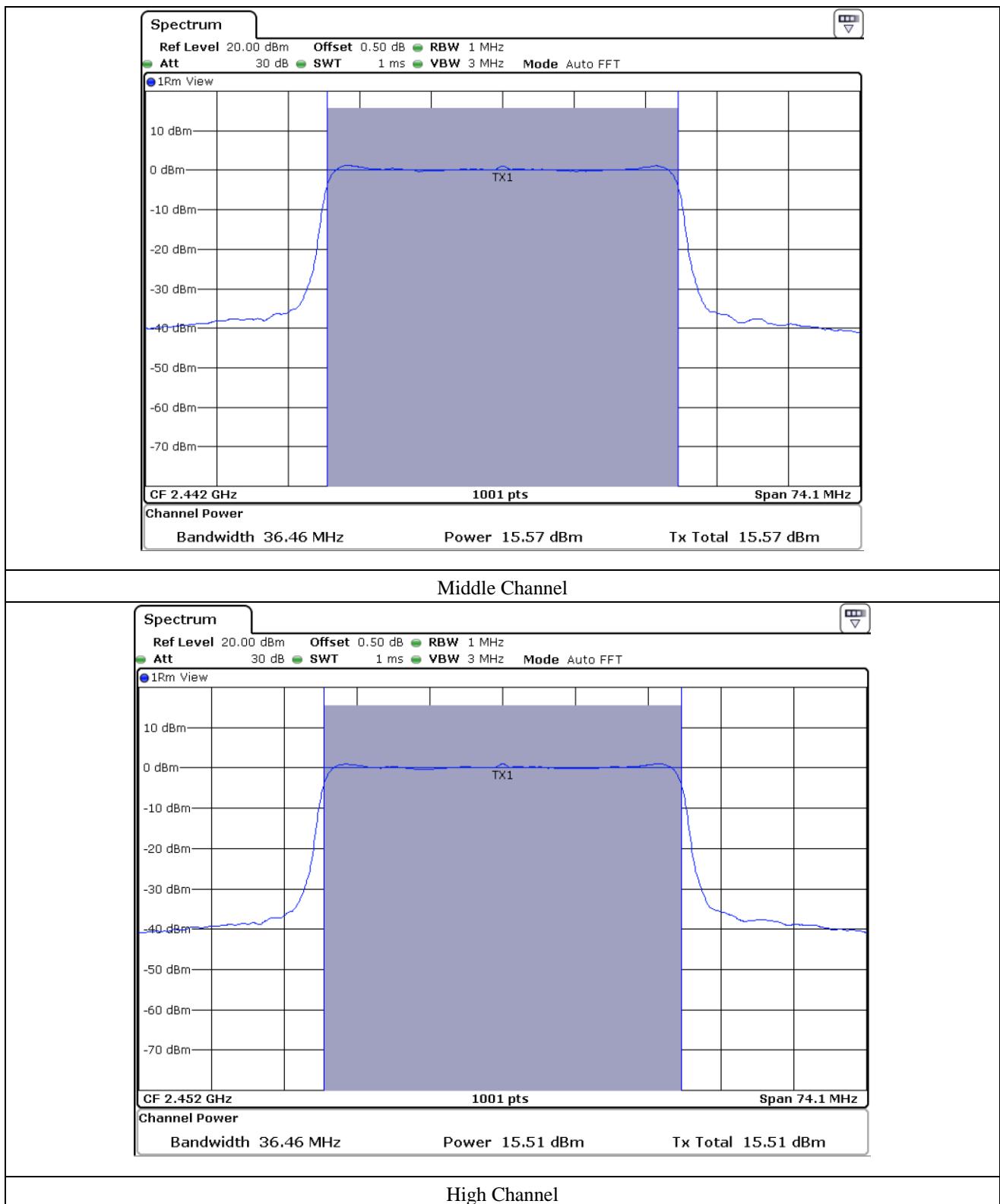
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422.00	15.91	30.00	14.09
MIDDLE	2 442.00	15.57	30.00	14.43
HIGH	2 452.00	15.51	30.00	14.49

Remark : Margin = Limit – Measured Value (=Power Sensor Reading - Cable Loss)

Tested by: Tae-Ho, Kim / Senior Manager





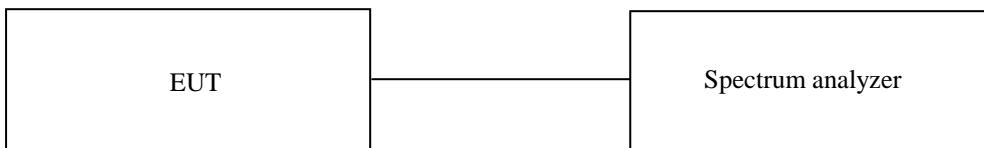
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 23 °C
Relative humidity : 41 % 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.

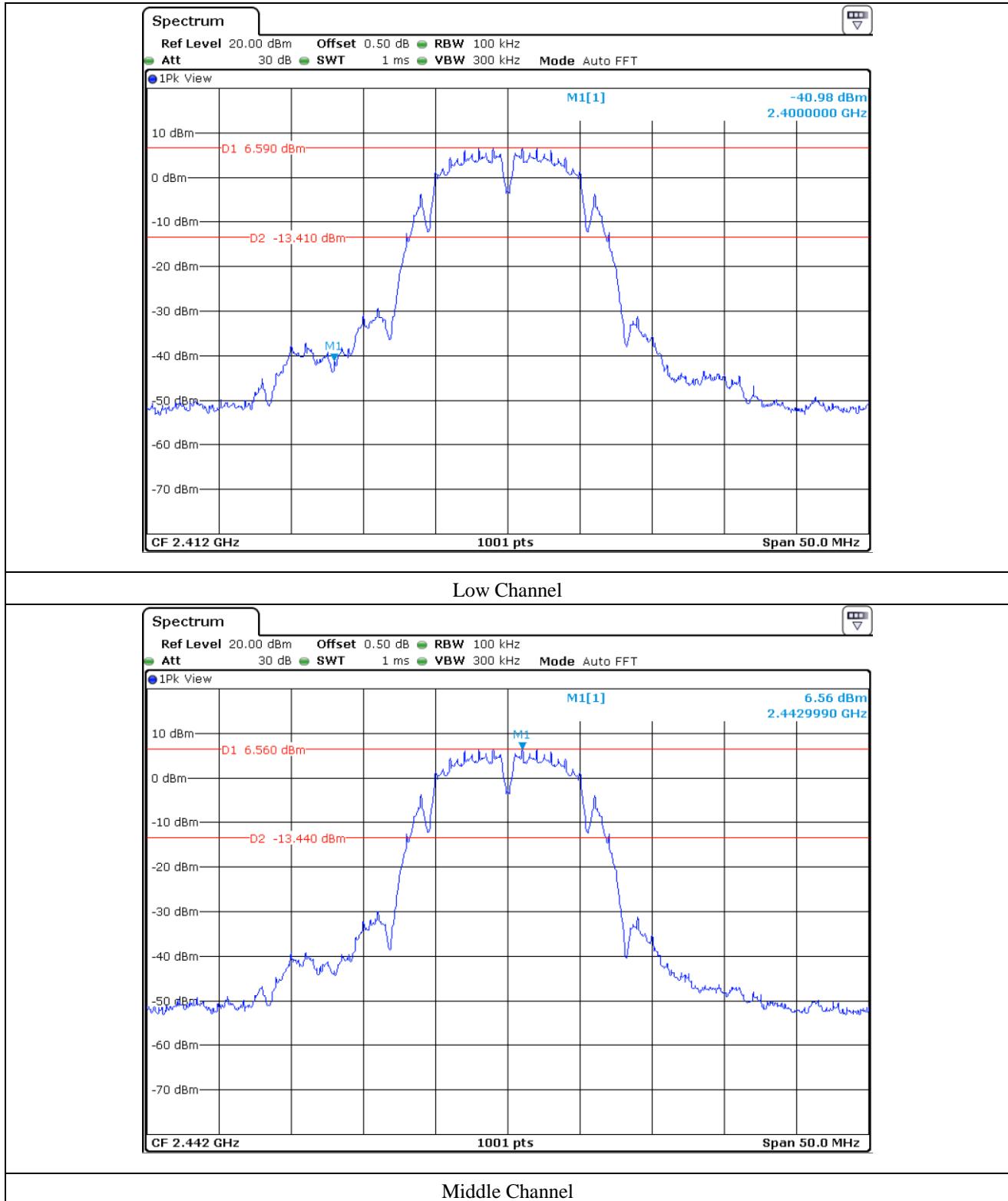
9.4 Test equipment used

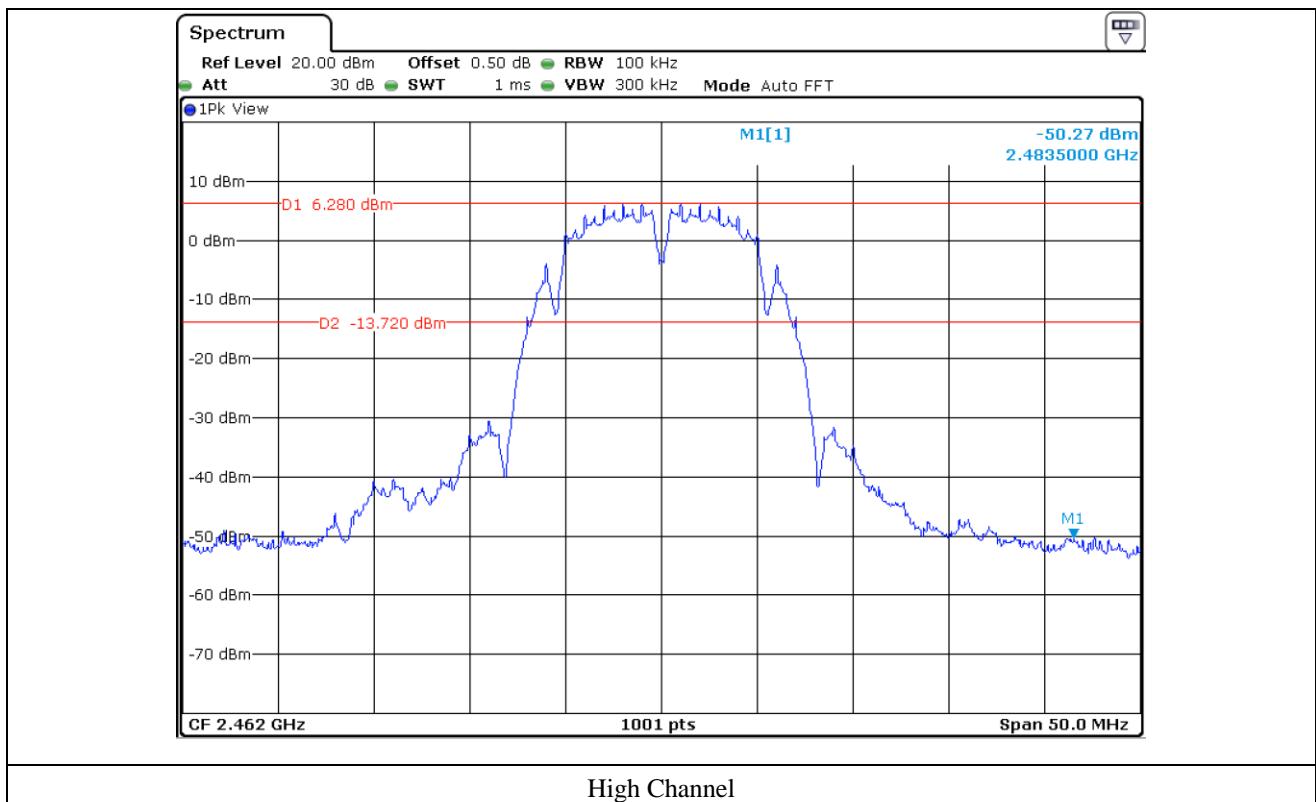
Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)
■ - ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 29, 2018 (1Y)
■ - 310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 28, 2018 (1Y)
■ - BBV 9718 B	Schwarzbeck	Amplifier	009	Mar. 16, 2018 (1Y)
■ - SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Mar. 15, 2018 (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	BBHA9120D295	Aug. 16, 2017 (2Y)
■ - BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jul. 28, 2017 (2Y)

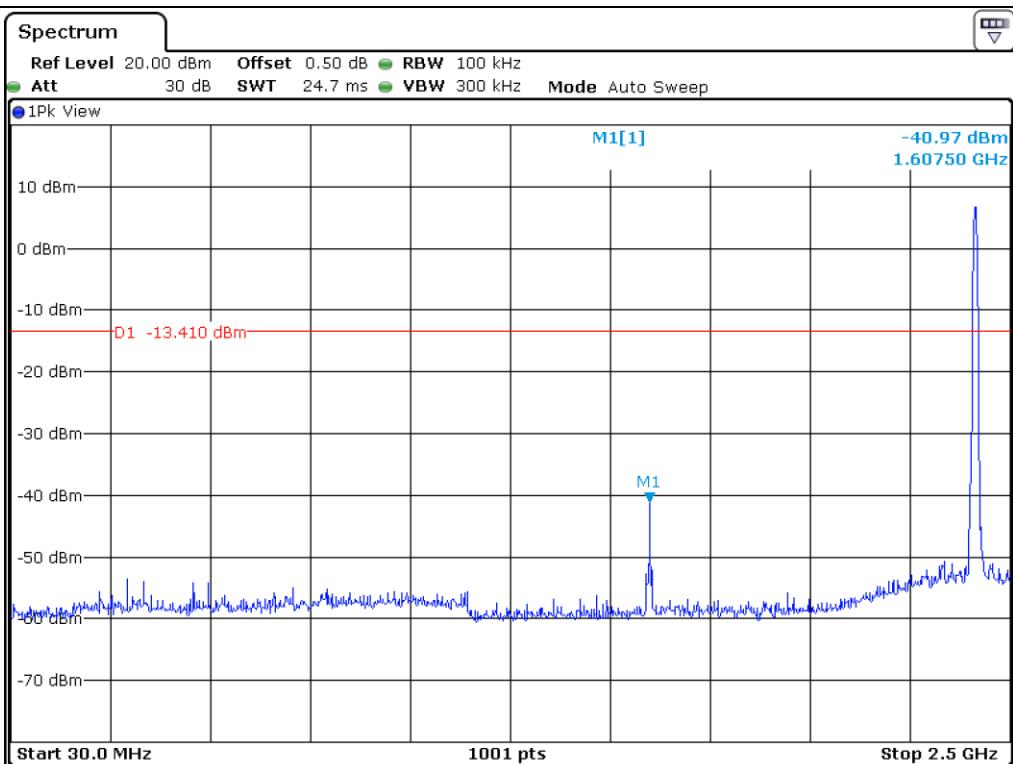
All test equipment used is calibrated on a regular basis.

9.5 Test data for conducted emission

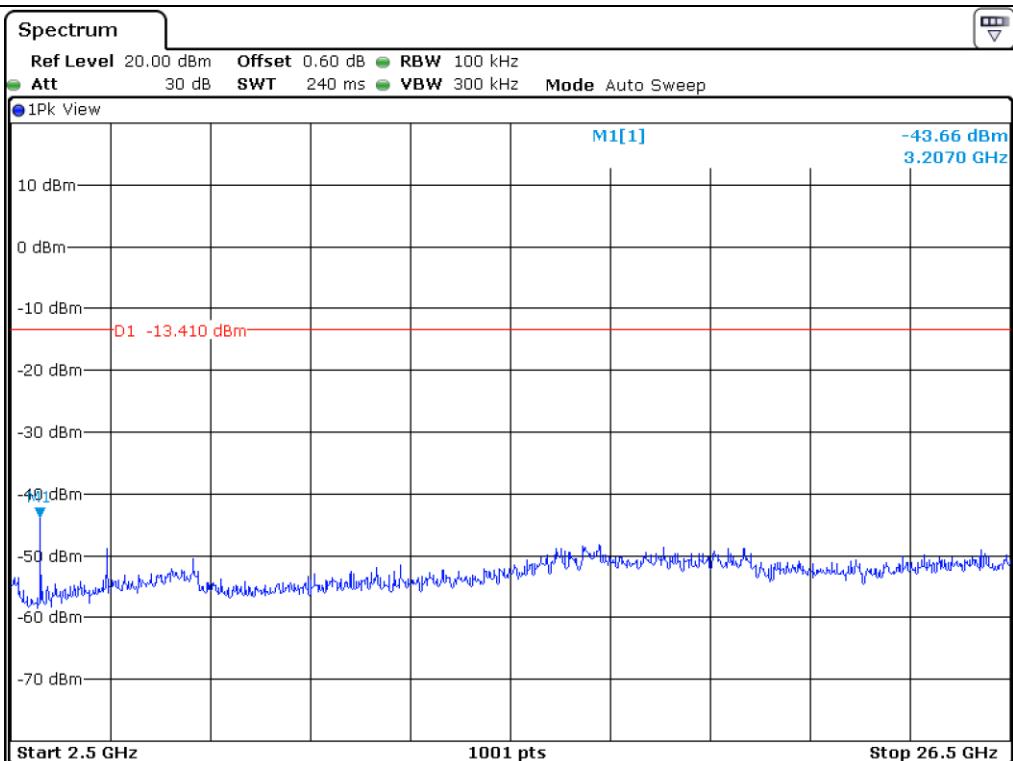
9.5.1 Test data for 802.11b WLAN Mode



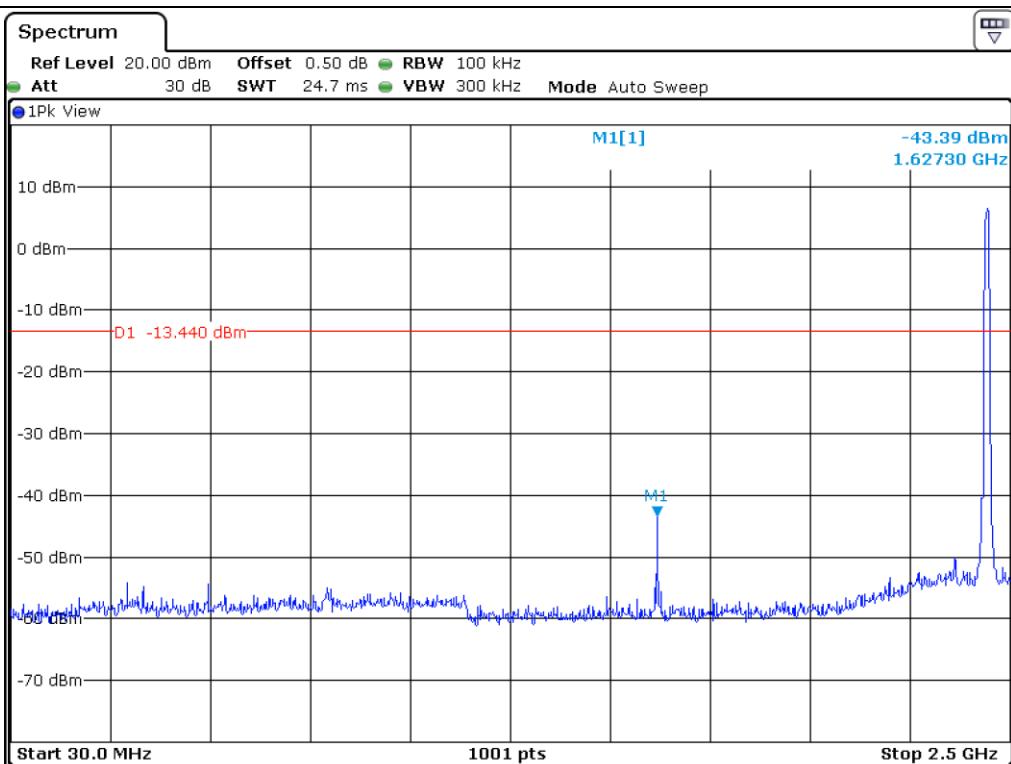
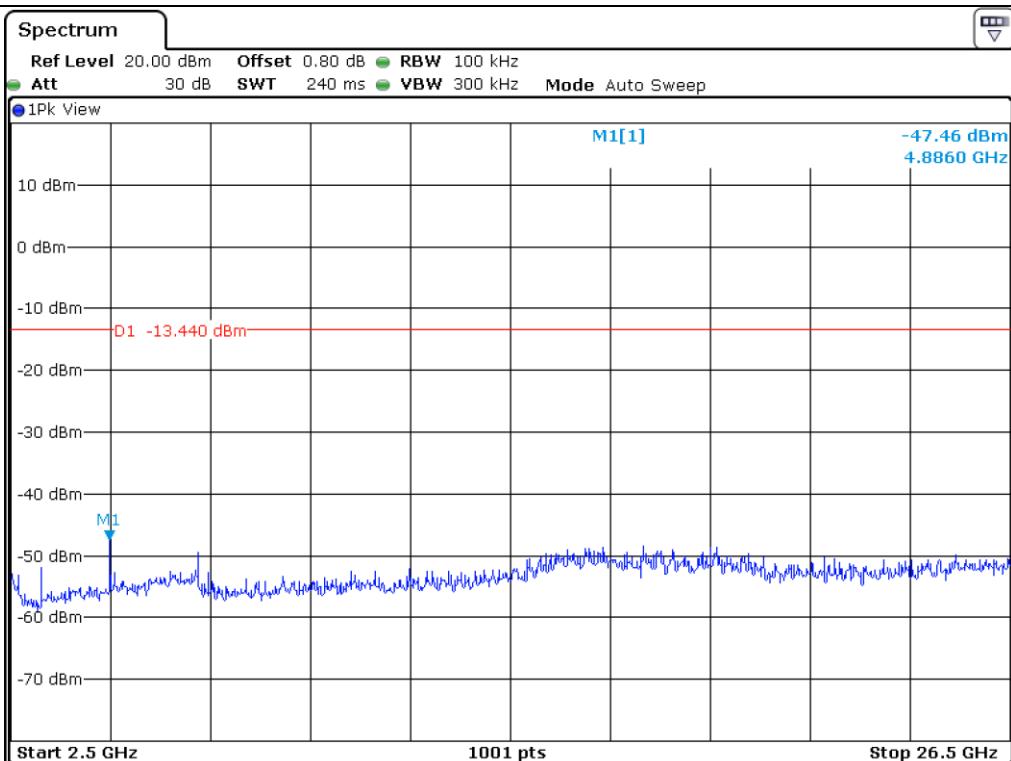


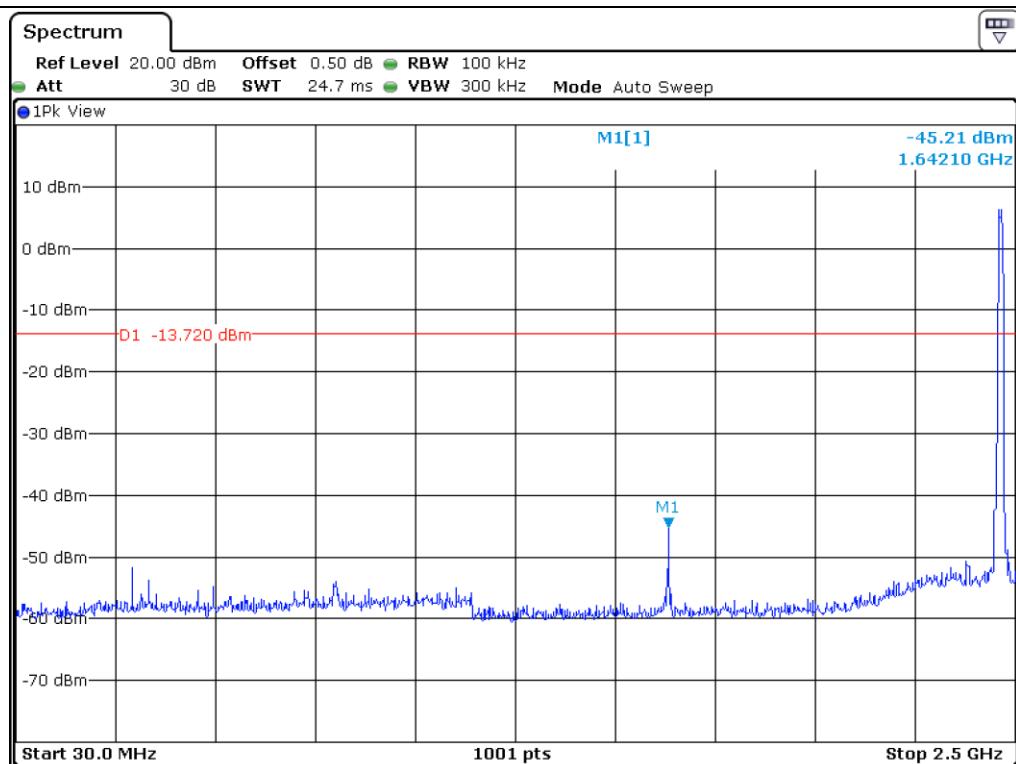


Low Channel

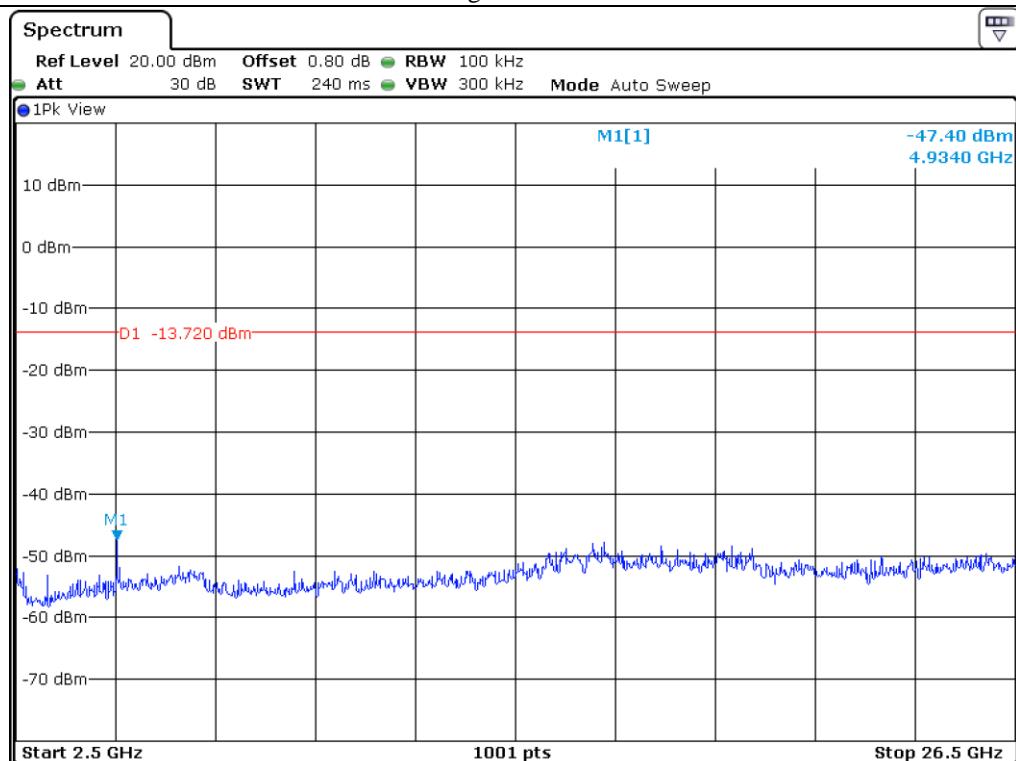


Low Channel

**Middle Channel****Middle Channel**

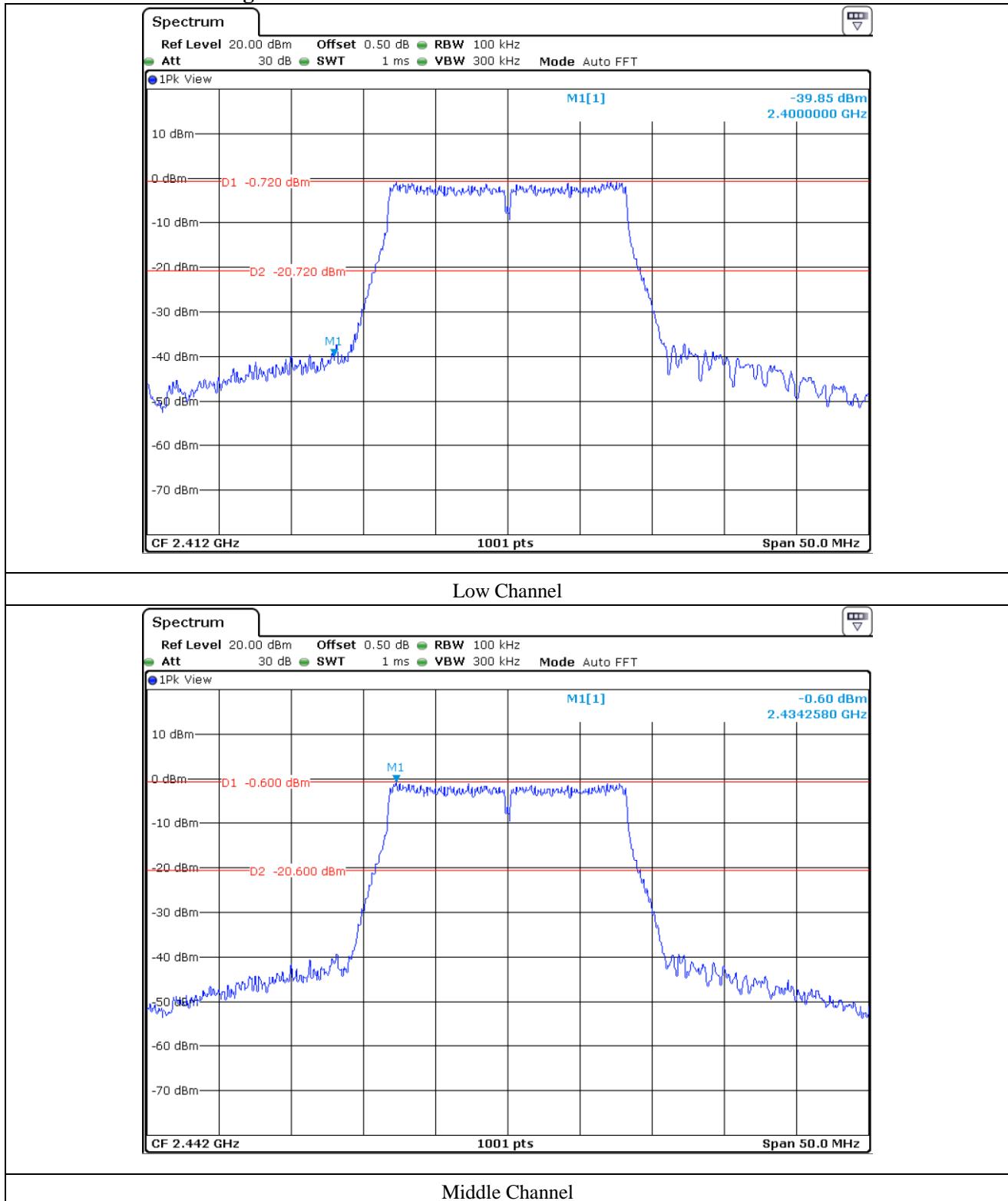


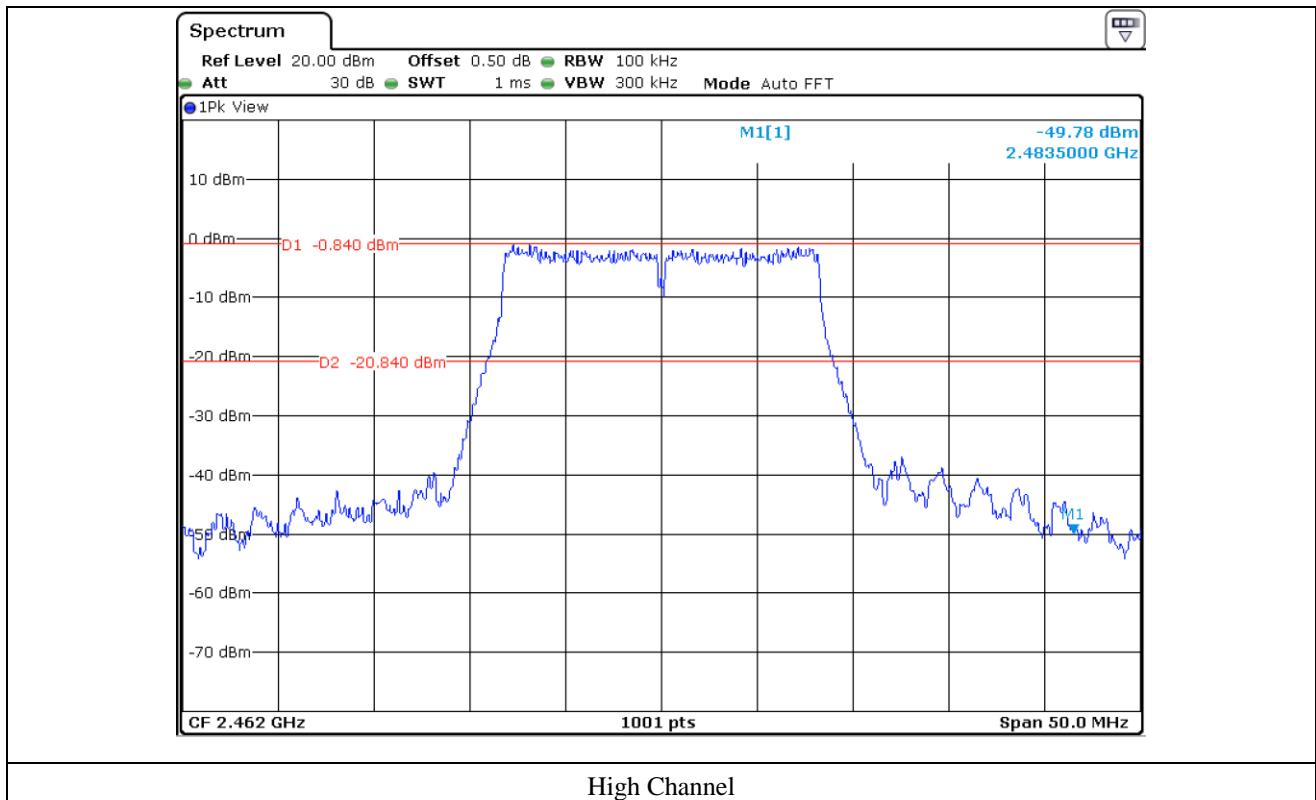
High Channel

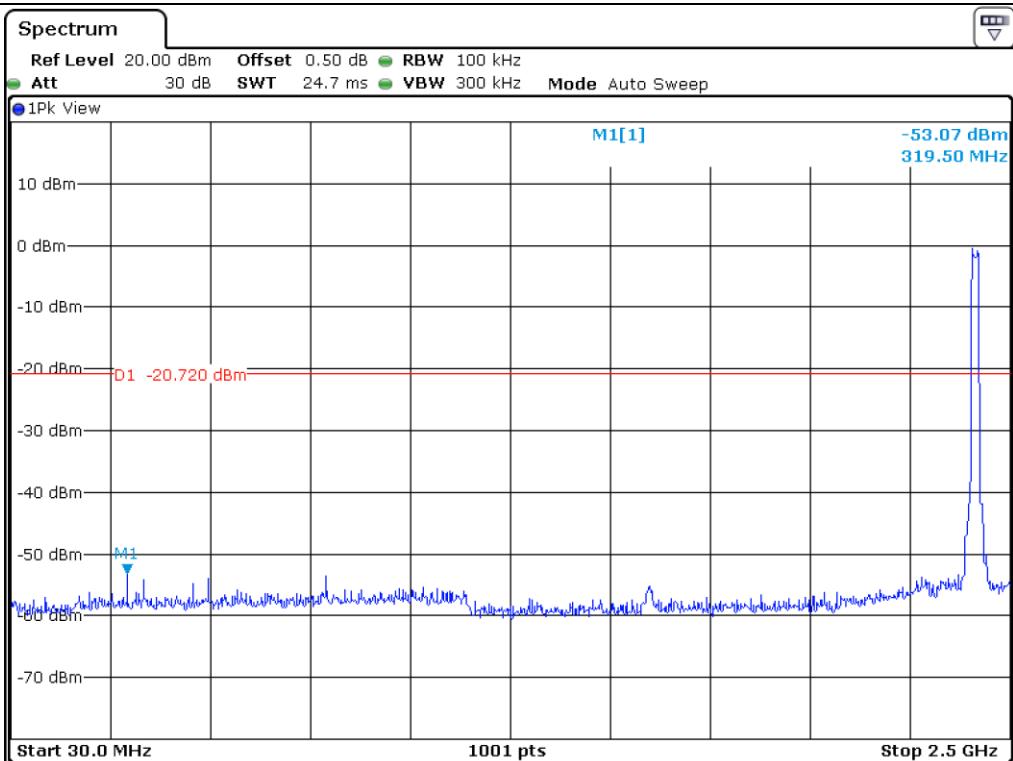


High Channel

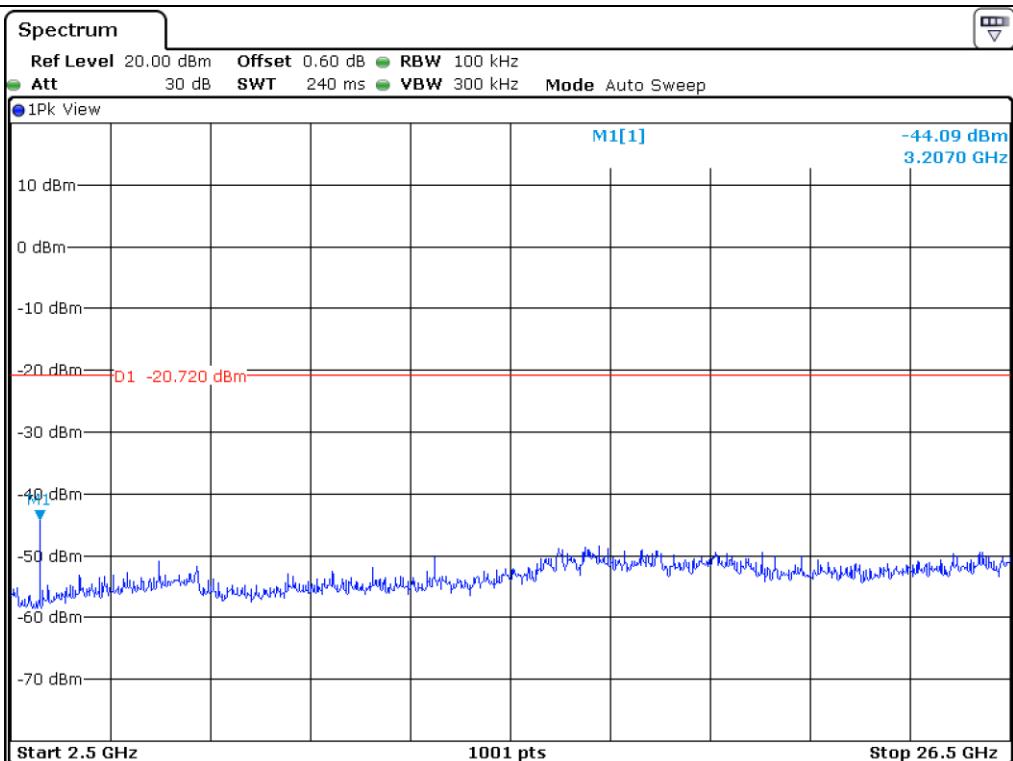
9.5.2 Test data for 802.11g WLAN Mode



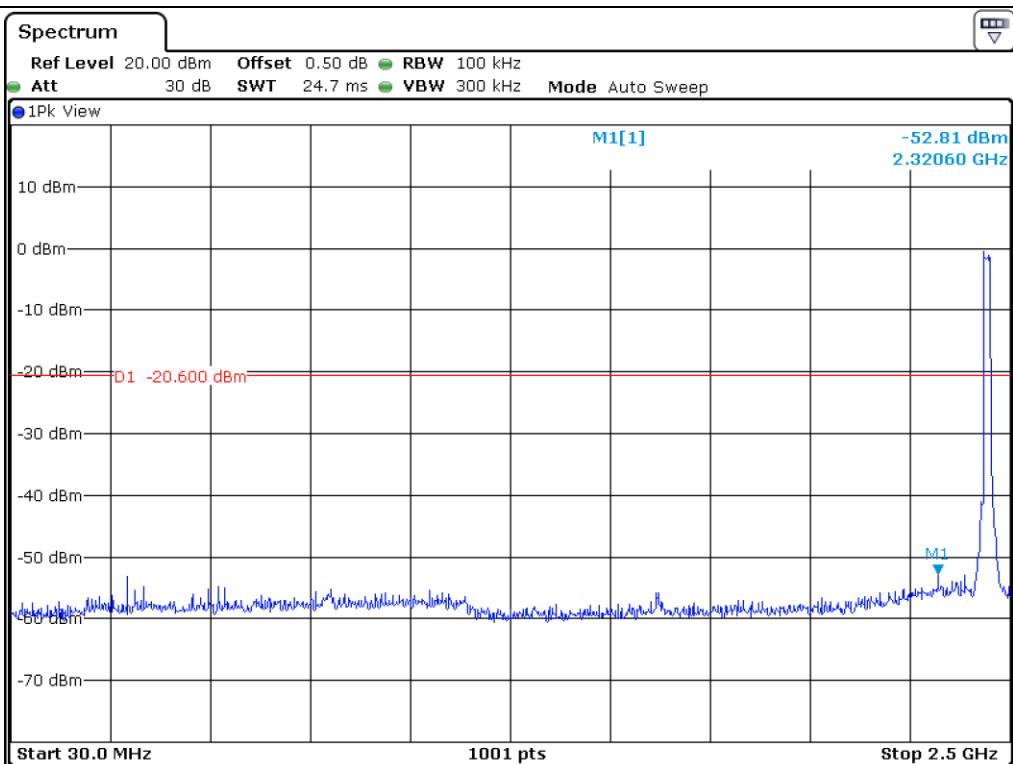




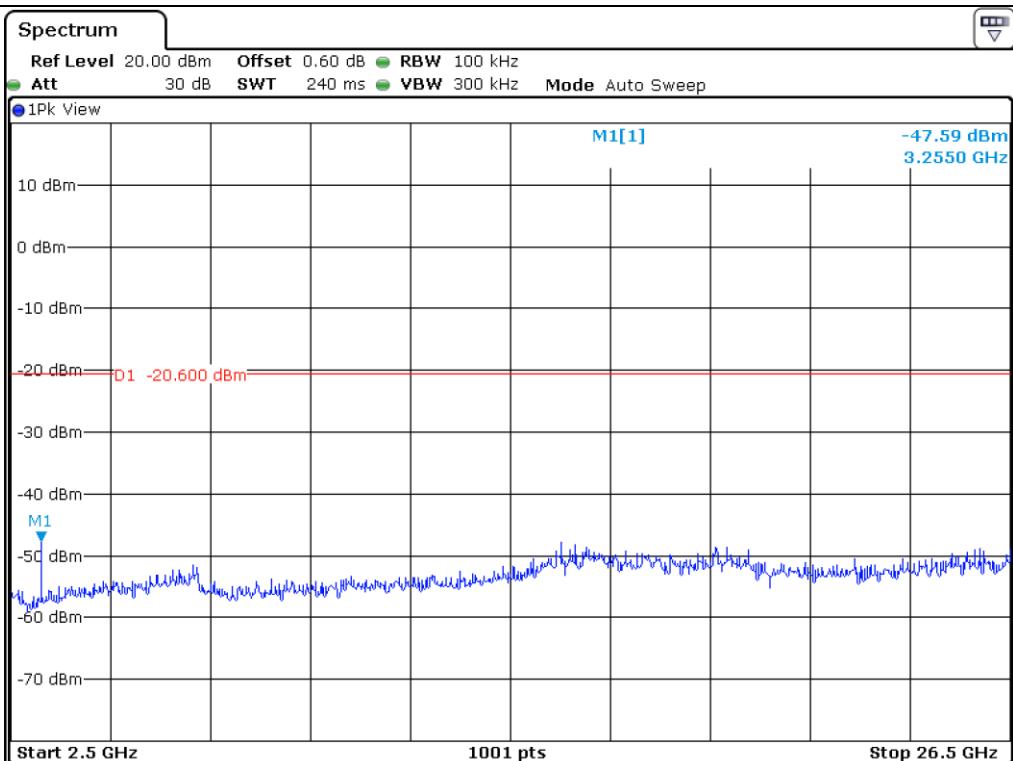
Low Channel



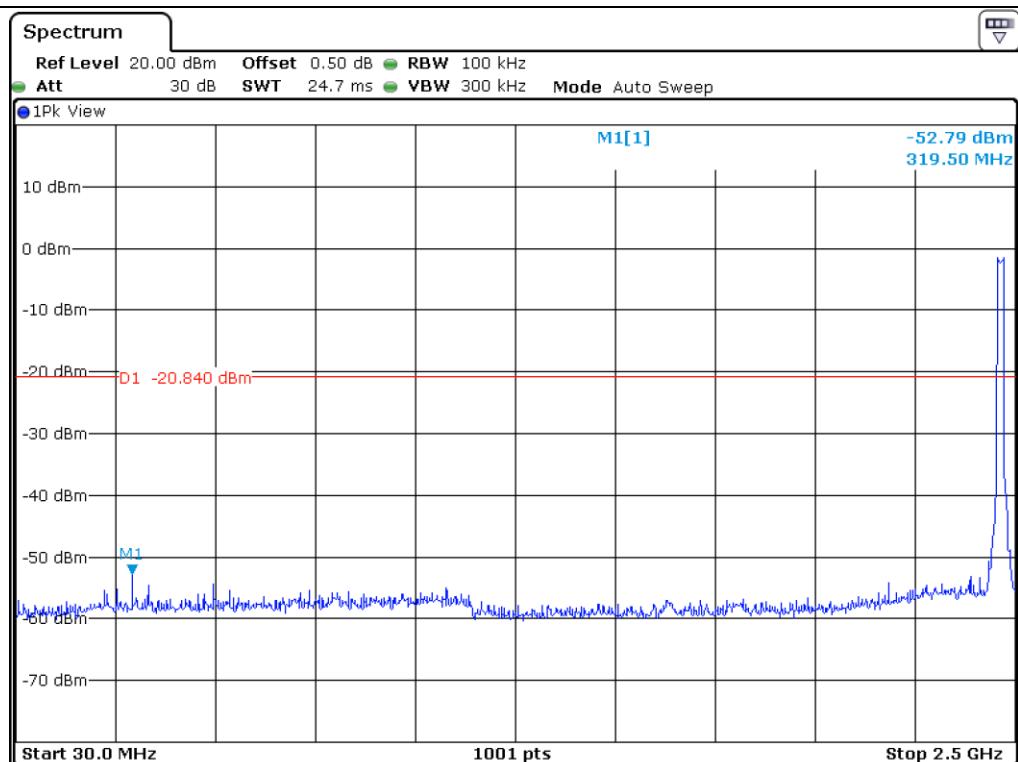
Low Channel



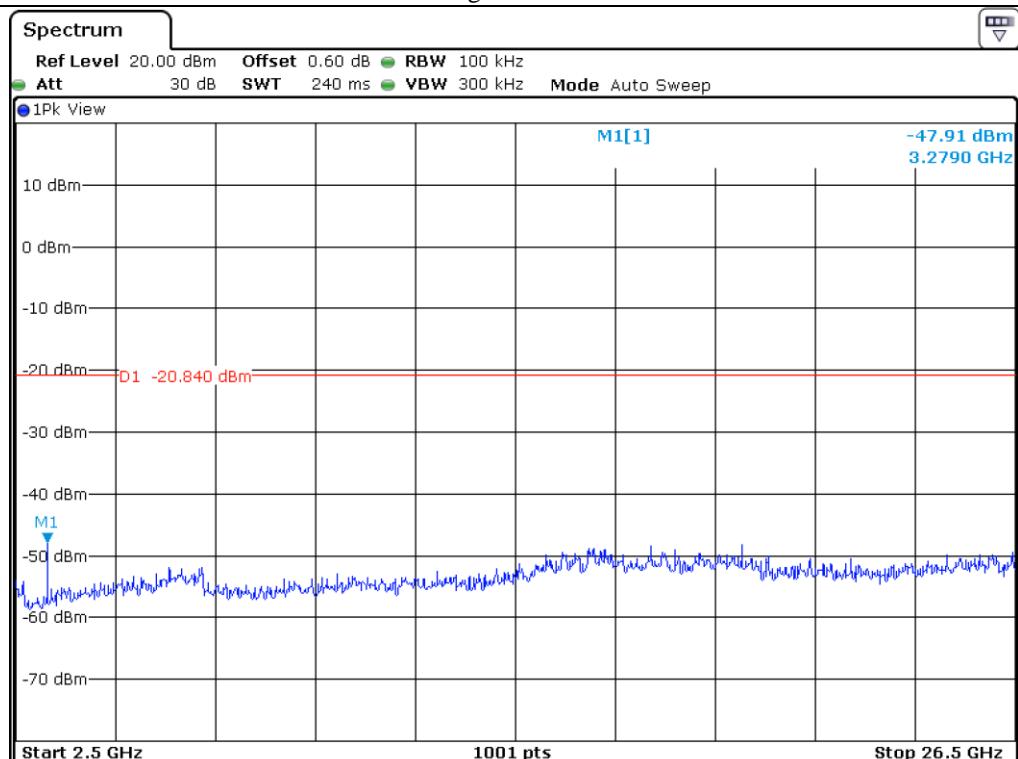
Middle Channel



Middle Channel

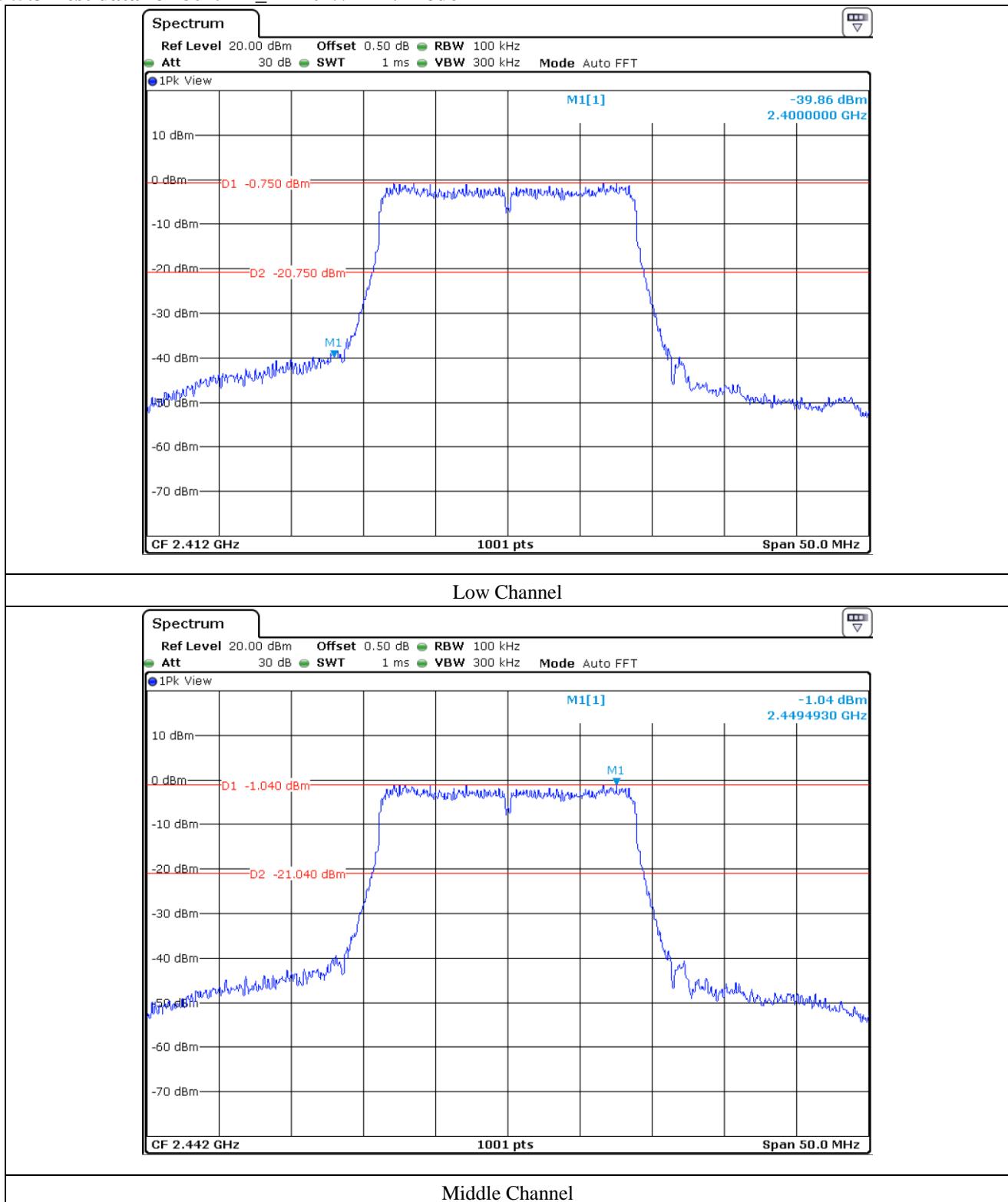


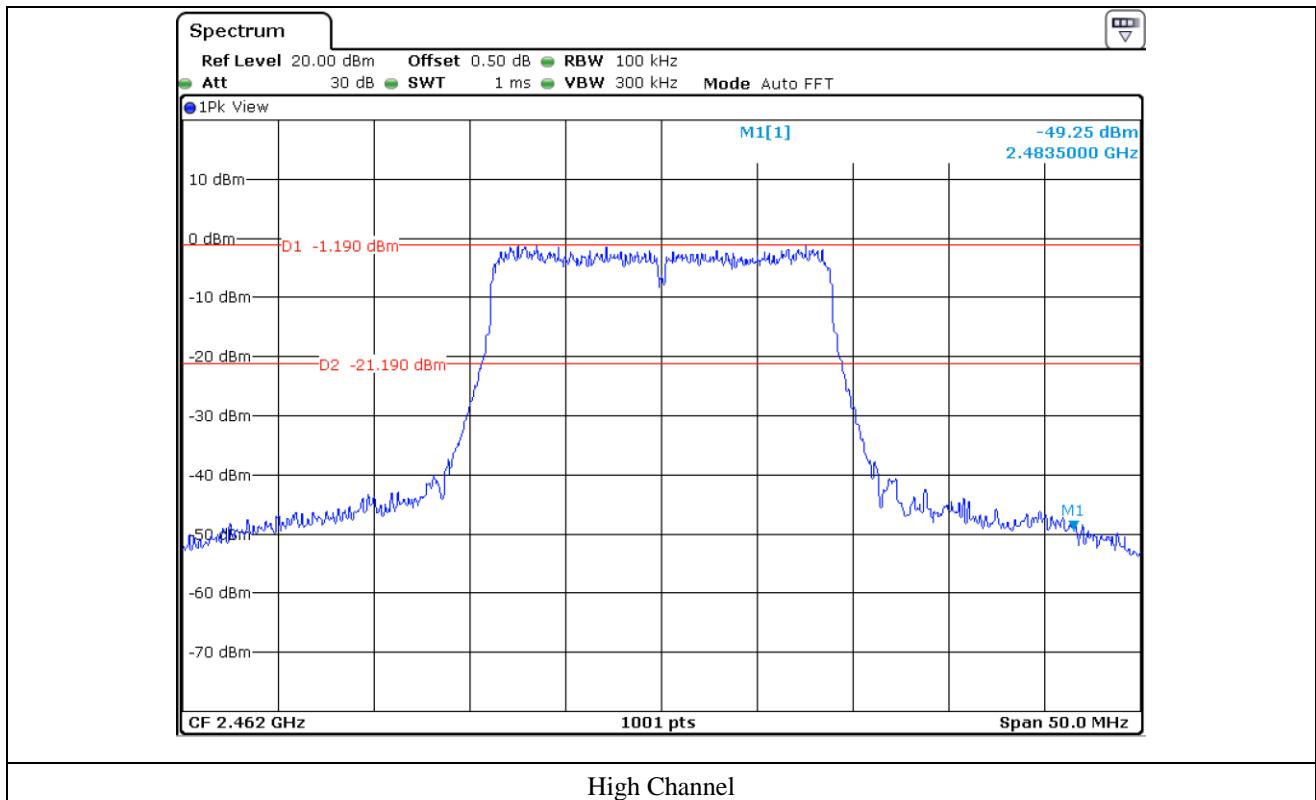
High Channel

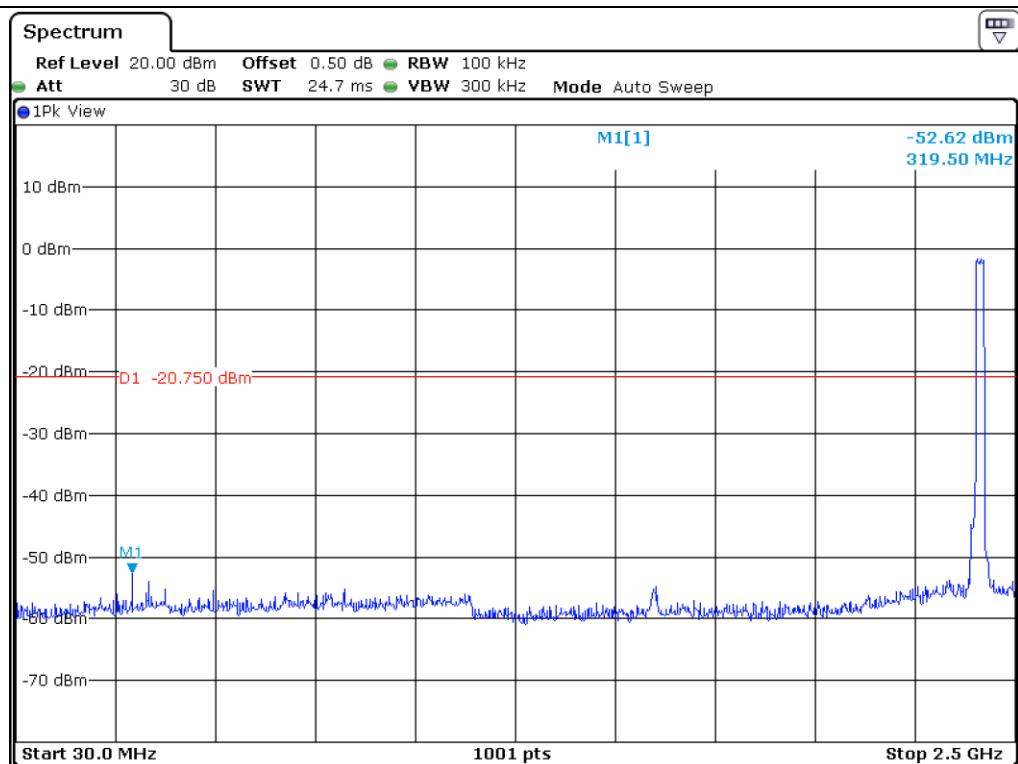


High Channel

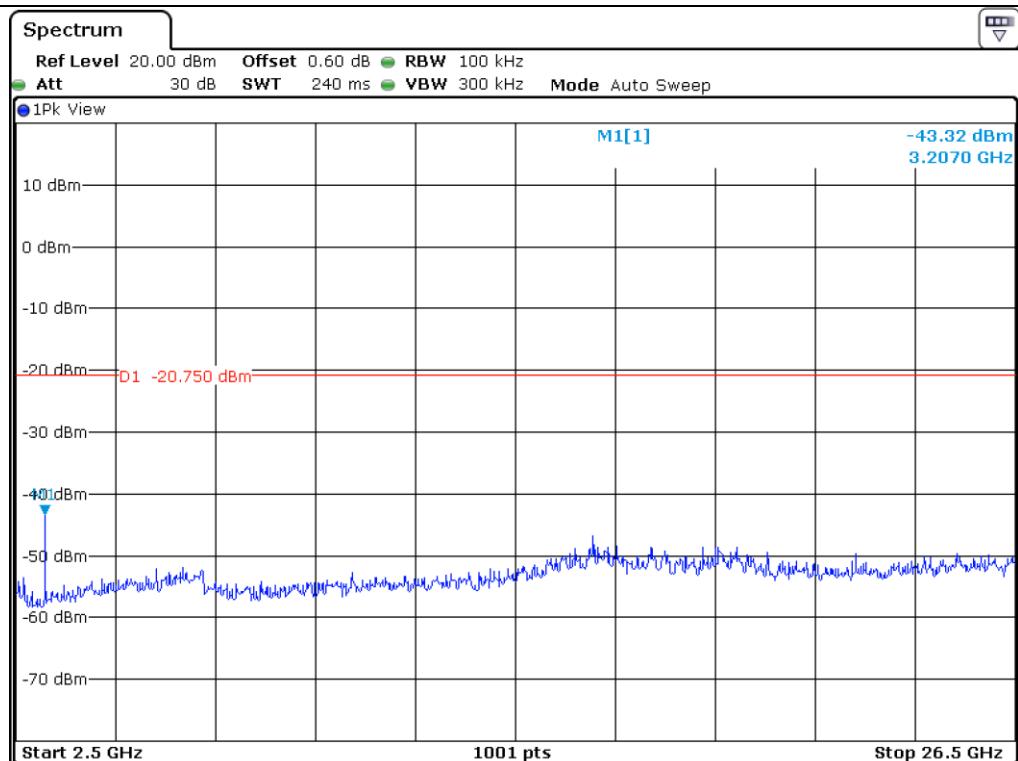
9.5.3 Test data for 802.11n_HT20 WLAN Mode



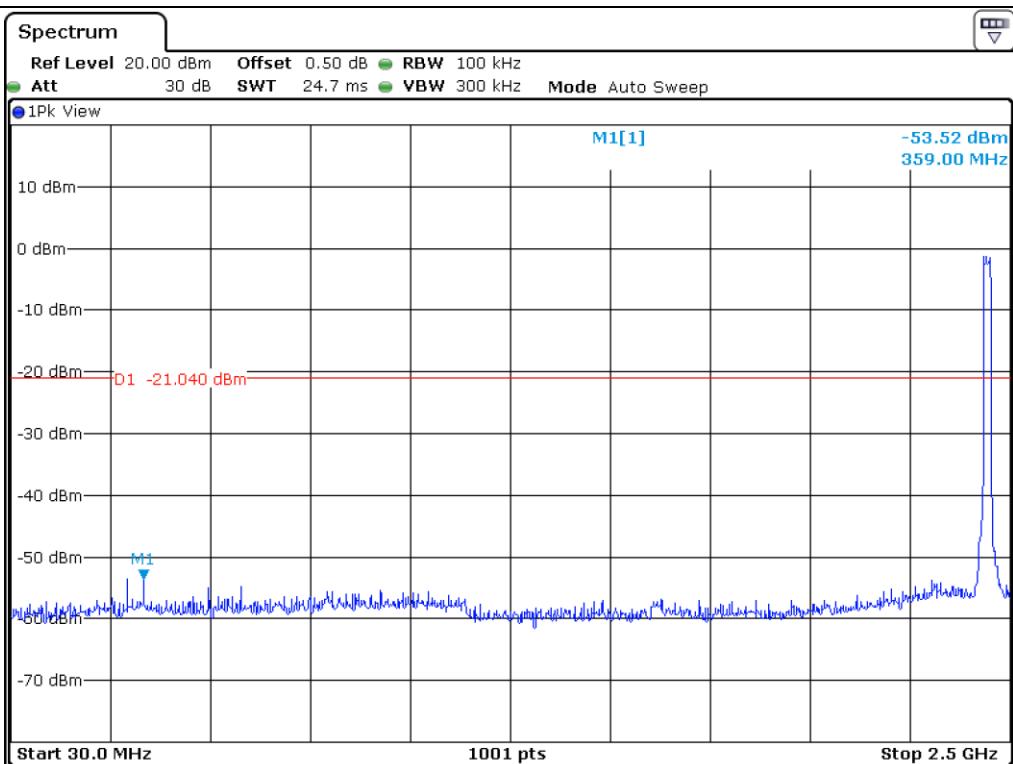




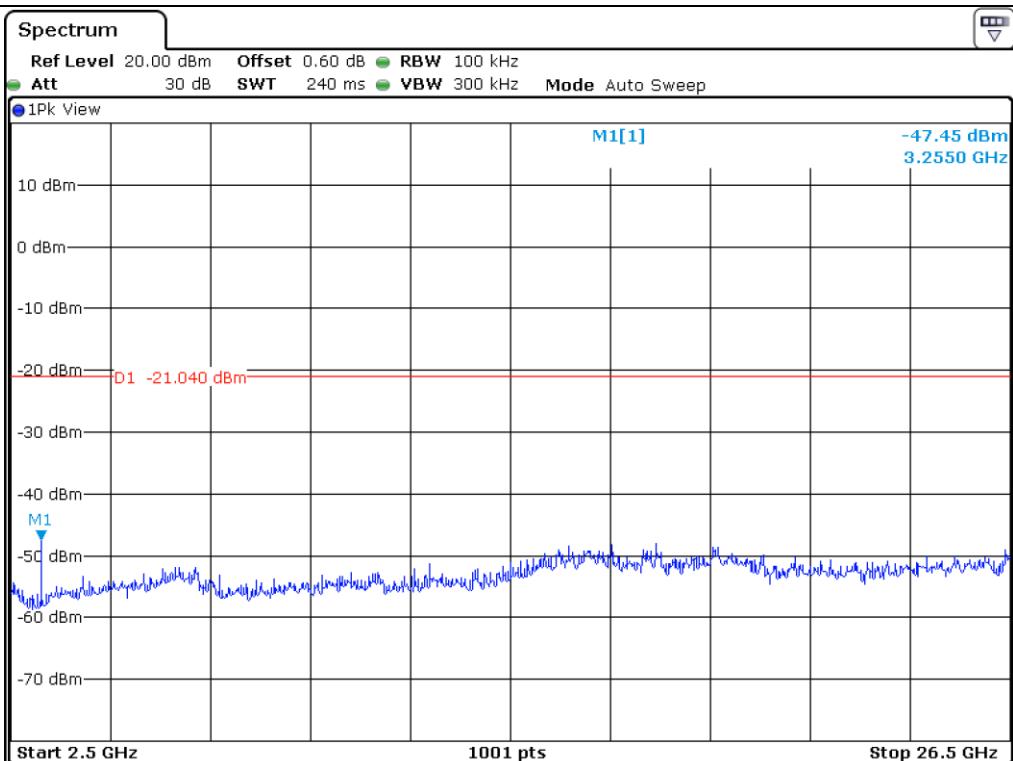
Low Channel



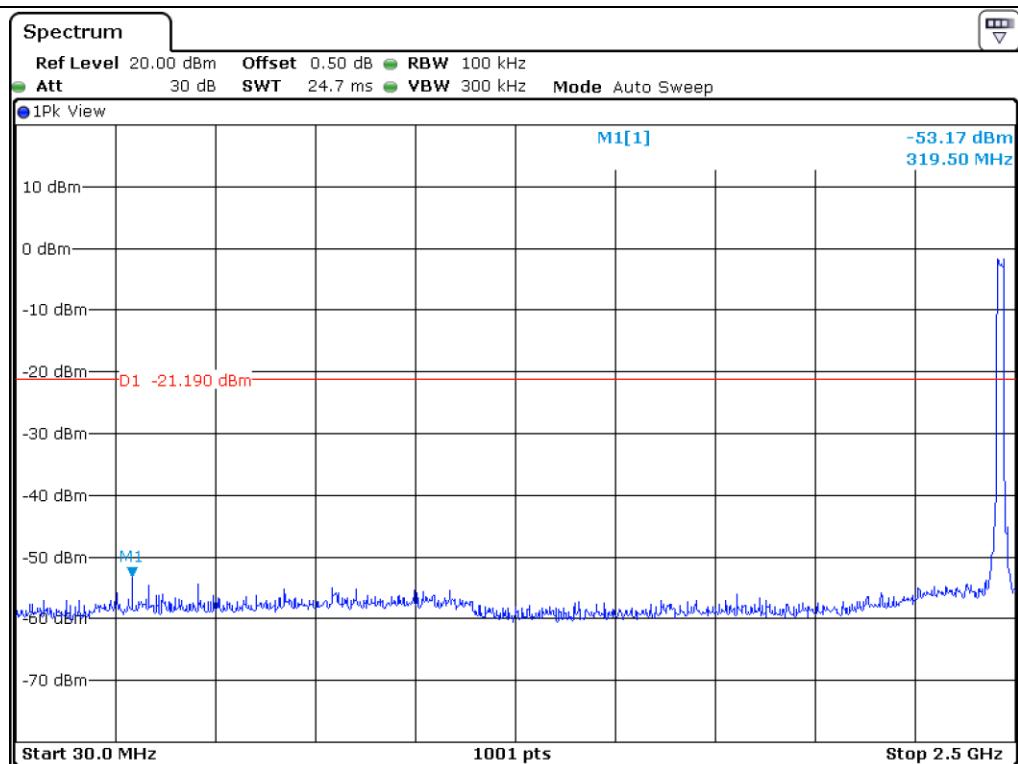
Low Channel



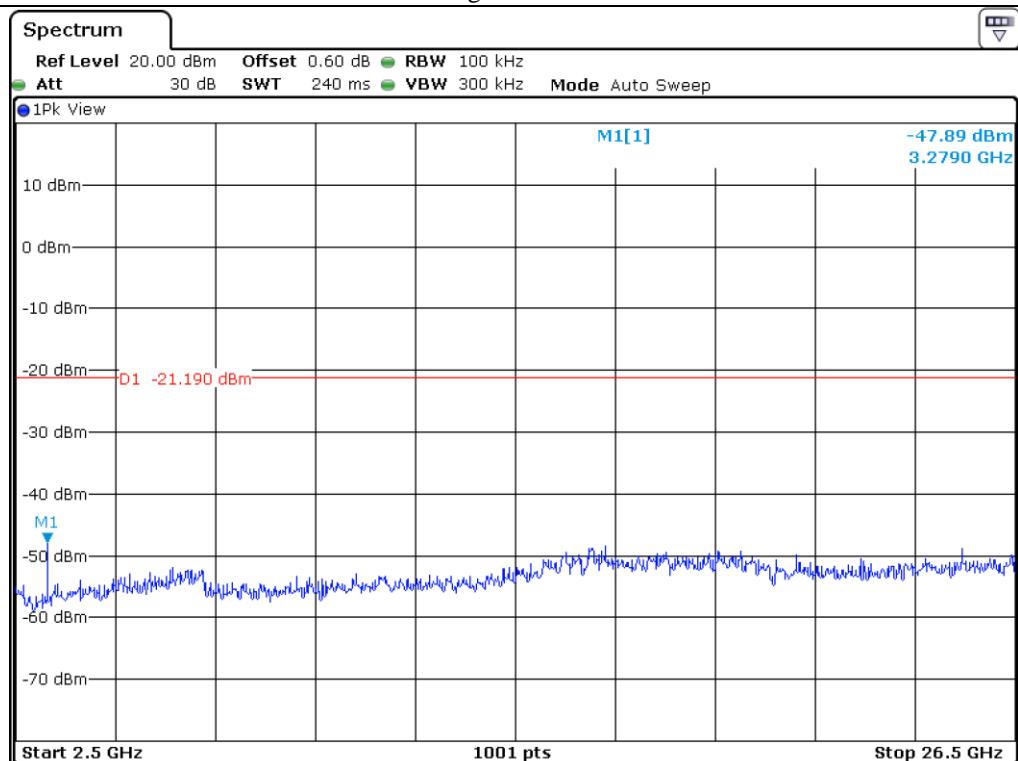
Middle Channel



Middle Channel

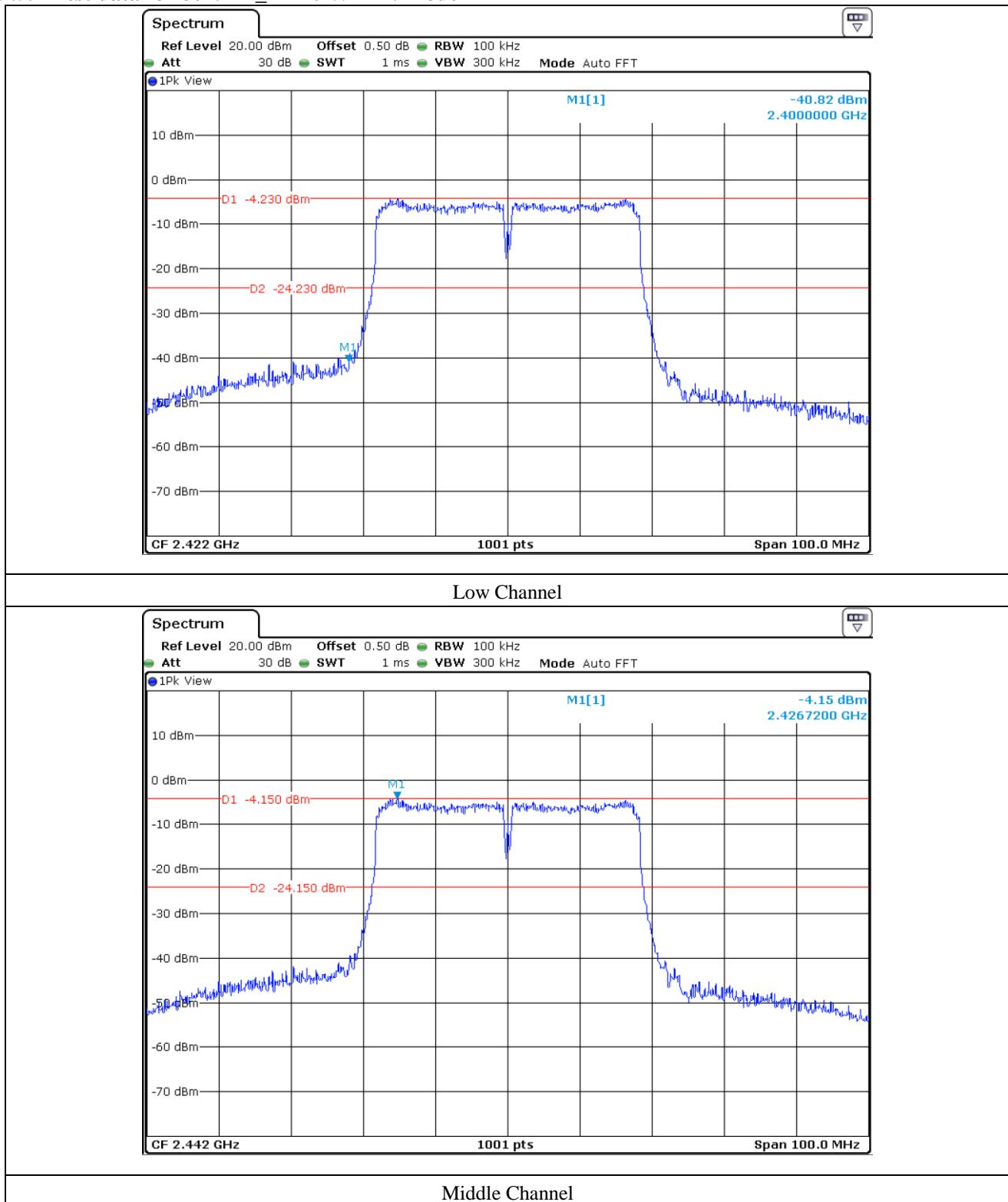


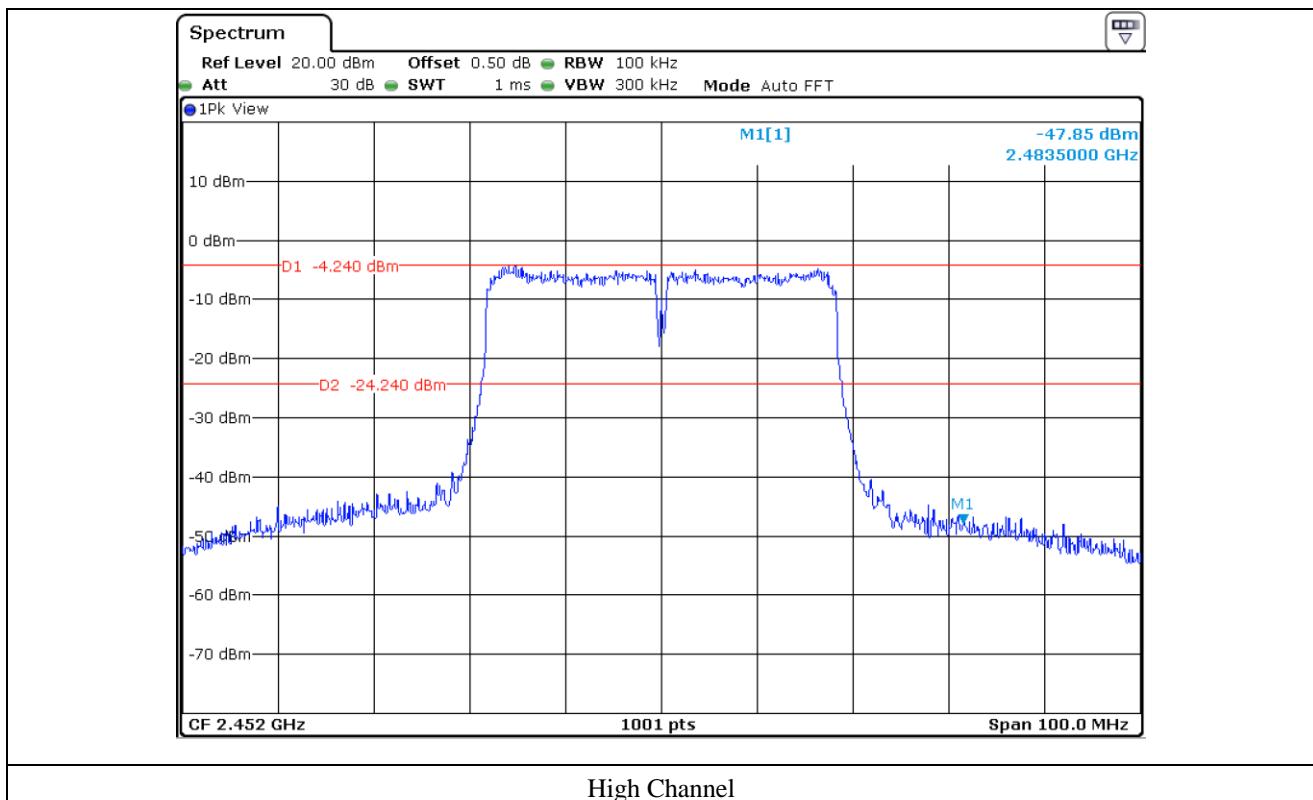
High Channel

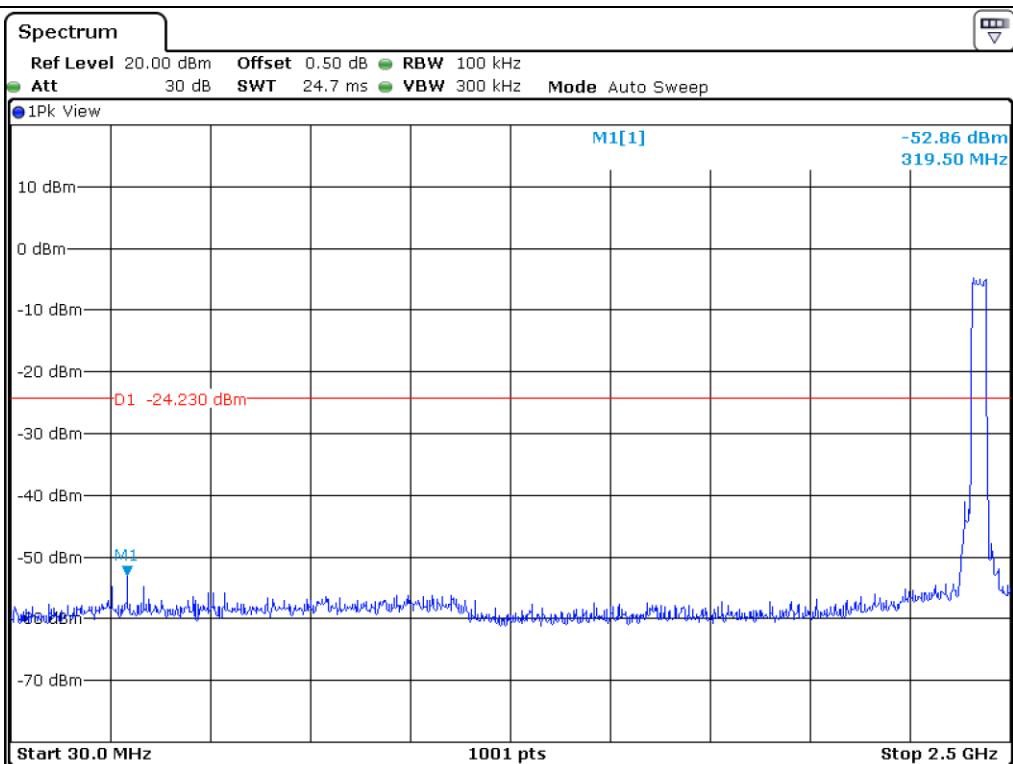


High Channel

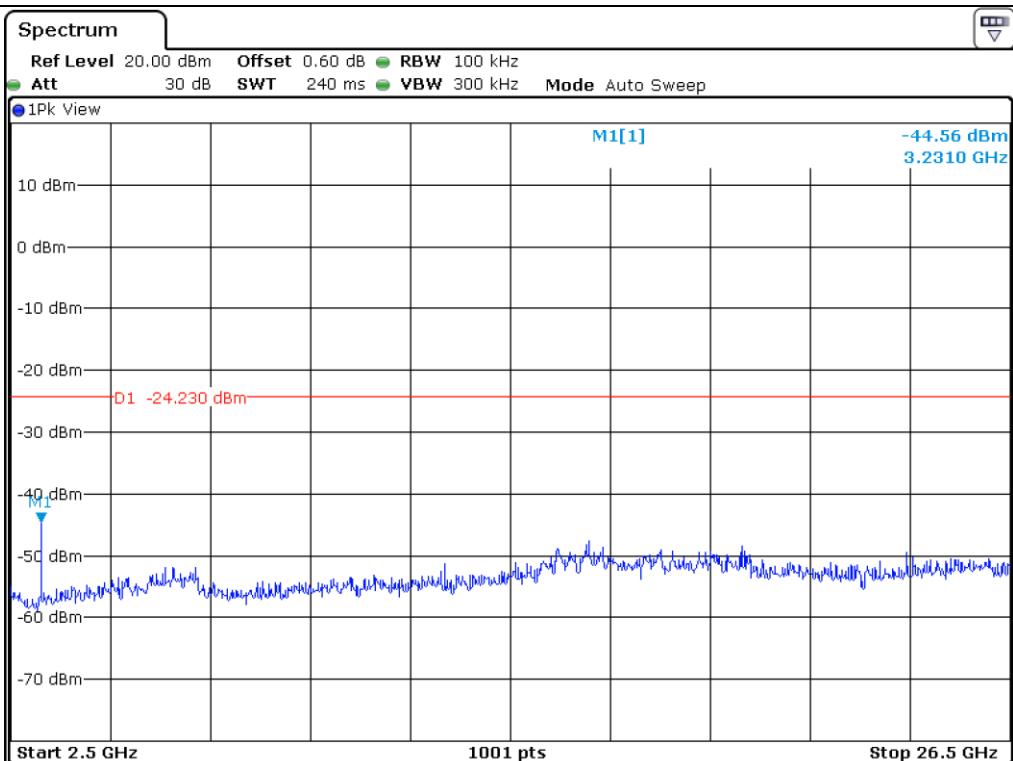
9.5.4 Test data for 802.11n_HT40 WLAN Mode



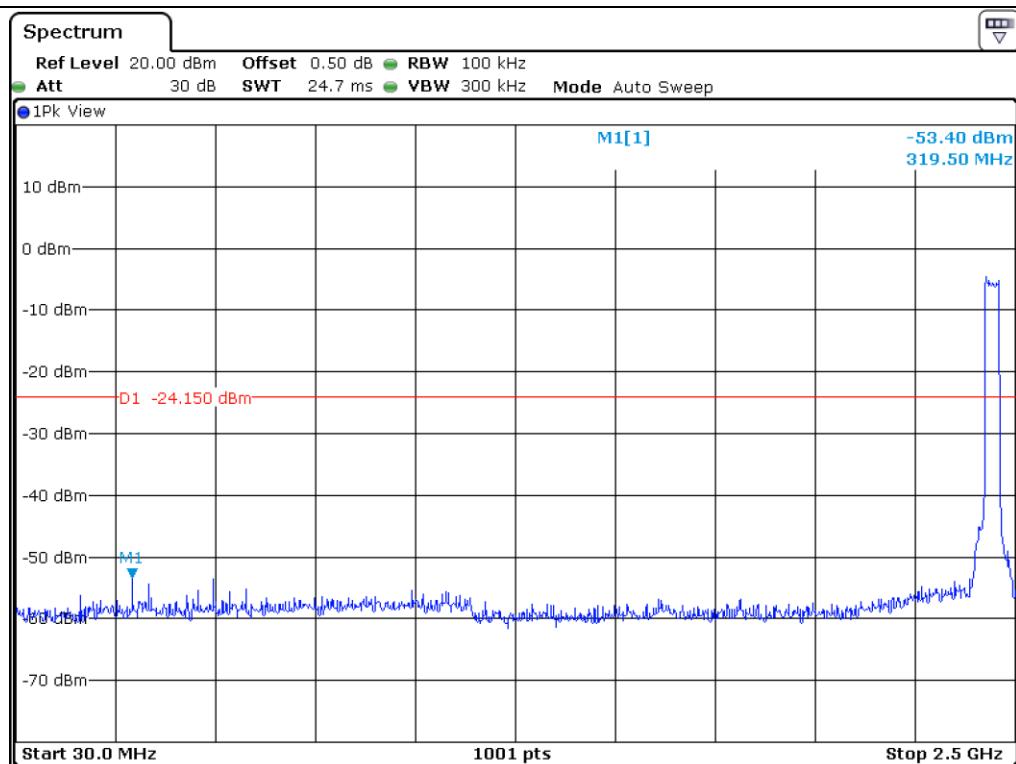




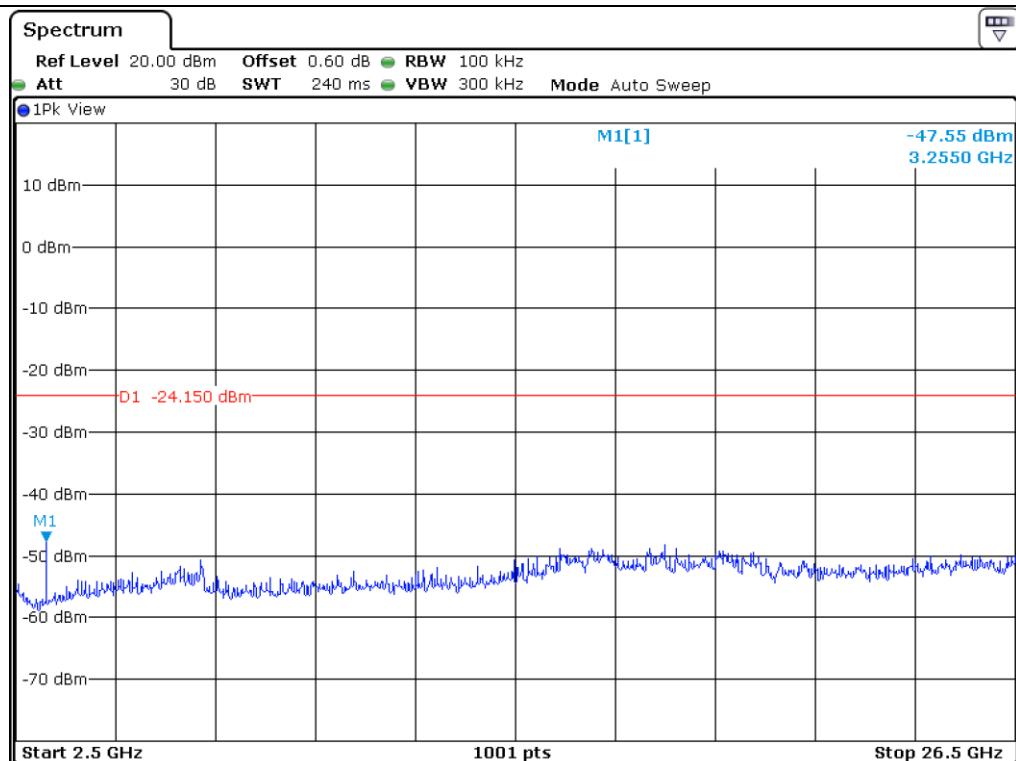
Low Channel



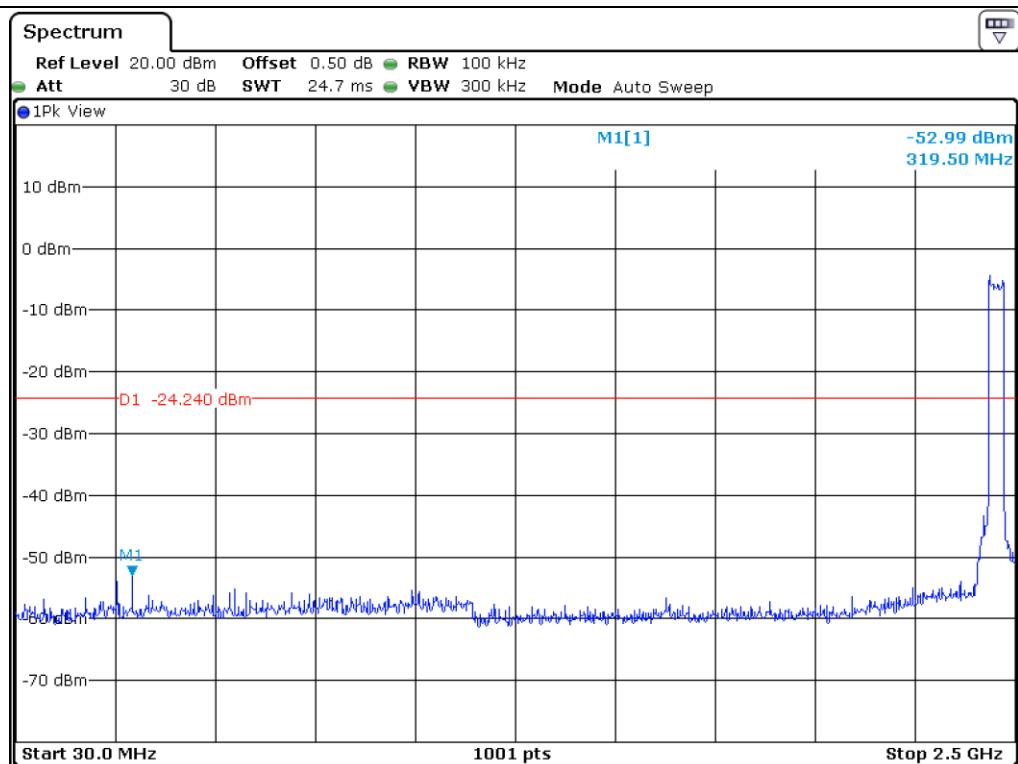
Low Channel



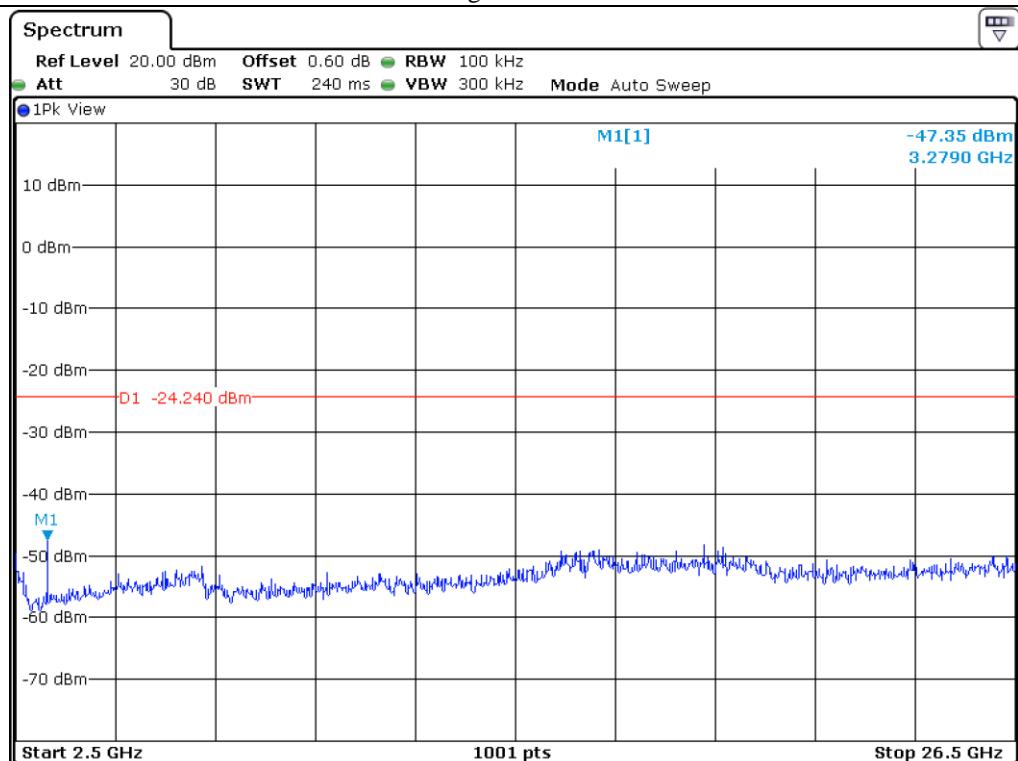
Middle Channel



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 : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Measurement distance : 3 m
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
2 389.880	56.22	Peak	H	26.94	9.20	34.76	57.60	74.00	16.40
2 389.960	50.14	Average	H	26.94	9.20	34.76	51.52	54.00	2.48
2 389.960	54.50	Peak	V	26.94	9.20	34.76	55.88	74.00	18.12
2 389.960	48.33	Average	V	26.94	9.20	34.76	49.71	54.00	4.29
Test Data for High Channel									
2 483.591	50.91	Peak	H	27.47	9.49	35.51	52.36	74.00	21.64
2 483.508	41.03	Average	H	27.47	9.49	35.51	42.48	54.00	11.52
2 483.541	47.89	Peak	V	27.47	9.49	35.51	49.34	74.00	24.66
2 483.508	38.99	Average	V	27.47	9.49	35.51	40.44	54.00	13.56

Tabulated test data for Restricted Band

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

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

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$

Tested by: Tae-Ho, Kim / Senior Manager

9.6.1.2 Test data for 802.11g WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Measurement distance : 3 m
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
2 389.960	66.87	Peak	H	26.94	9.20	34.76	68.25	74.00	5.75
2 389.960	51.29	Average	H	26.94	9.20	34.76	52.67	54.00	1.33
2 389.960	64.80	Peak	V	26.94	9.20	34.76	66.18	74.00	7.82
2 389.960	49.16	Average	V	26.94	9.20	34.76	50.54	54.00	3.46
Test Data for High Channel									
2 483.508	56.06	Peak	H	27.47	9.49	35.51	57.51	74.00	16.49
2 483.508	40.91	Average	H	27.47	9.49	35.51	42.36	54.00	11.64
2 483.508	53.27	Peak	V	27.47	9.49	35.51	54.72	74.00	19.28
2 483.508	38.87	Average	V	27.47	9.49	35.51	40.32	54.00	13.68

Tabulated test data for Restricted Band

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

Margin (dB) = Limits (dB μ V/m) - Total Level (dB μ V/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain


Tested by: Tae-Ho, Kim / Senior Manager

9.6.1.3 Test data for 802.11n_HT20 WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Measurement distance : 3 m
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
2 389.960	69.49	Peak	H	26.94	9.20	34.76	70.87	74.00	3.13
2 389.960	51.40	Average	H	26.94	9.20	34.76	52.78	54.00	1.22
2 389.960	68.00	Peak	V	26.94	9.20	34.76	69.38	74.00	4.62
2 389.960	49.73	Average	V	26.94	9.20	34.76	51.11	54.00	2.89
Test Data for High Channel									
2 485.552	57.15	Peak	H	27.47	9.49	35.51	58.60	74.00	15.40
2 483.508	40.66	Average	H	27.47	9.49	35.51	42.11	54.00	11.89
2 485.338	55.95	Peak	V	27.47	9.49	35.51	57.40	74.00	16.60
2 483.508	39.01	Average	V	27.47	9.49	35.51	40.46	54.00	13.54

Tabulated test data for Restricted Band

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

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

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



Tested by: Tae-Ho, Kim / Senior Manager

9.6.1.4 Test data for 802.11n_HT40 WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Measurement distance : 3 m
- Result : PASSED

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
2 387.962	65.59	Peak	H	26.94	9.20	34.76	66.97	74.00	7.03
2 387.962	51.00	Average	H	26.94	9.20	34.76	52.38	54.00	1.62
2 388.042	63.58	Peak	V	26.94	9.20	34.76	64.96	74.00	9.04
2 389.960	49.15	Average	V	26.94	9.20	34.76	50.53	54.00	3.47
Test Data for High Channel									
2 484.975	56.07	Peak	H	27.47	9.49	35.51	57.52	74.00	16.48
2 483.508	40.55	Average	H	27.47	9.49	35.51	42.00	54.00	12.00
2 484.695	53.78	Peak	V	27.47	9.49	35.51	55.23	74.00	18.77
2 483.508	38.98	Average	V	27.47	9.49	35.51	40.43	54.00	13.57

Tabulated test data for Restricted Band

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

Margin (dB) = Limits (dB μ V/m) - Total Level (dB μ V/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain


Tested by: Tae-Ho, Kim / Senior Manager

9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for 802.11b WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	33.39	Peak	H	30.84	12.31	35.74	40.80	74.00	33.20
	26.48	Average	H				33.89	54.00	20.11
	32.39	Peak	V				39.80	74.00	34.20
	27.76	Average	V				35.17	54.00	18.83
Test Data for Middle Channel									
4 884.00	33.09	Peak	H	30.01	12.43	35.80	39.73	74.00	34.27
	25.96	Average	H				32.60	54.00	21.40
	32.68	Peak	V				39.32	74.00	34.68
	26.99	Average	V				33.63	54.00	20.37
	Test Data for High Channel								
4 924.00	33.19	Peak	H	31.15	12.81	35.96	41.19	74.00	32.81
	26.13	Average	H				34.13	54.00	19.87
	32.34	Peak	V				40.34	74.00	33.66
	26.51	Average	V				34.51	54.00	19.49

Tabulated test data for Restricted Band

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

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

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



Tested by: Tae-Ho, Kim / Senior Manager

9.6.2.2 Test data for 802.11g WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	33.72	Peak	H	30.84	12.31	35.74	41.13	74.00	32.87
	26.85	Average	H				34.26	54.00	19.74
	34.15	Peak	V				41.56	74.00	32.44
	27.51	Average	V				34.92	54.00	19.08
Test Data for Middle Channel									
4 884.00	33.27	Peak	H	30.01	12.43	35.80	39.91	74.00	34.09
	25.35	Average	H				31.99	54.00	22.01
	33.27	Peak	V				39.91	74.00	34.09
	26.62	Average	V				33.26	54.00	20.74
Test Data for High Channel									
4 924.00	32.41	Peak	H	31.15	12.81	35.96	40.41	74.00	33.59
	26.81	Average	H				34.81	54.00	19.19
	32.40	Peak	V				40.40	74.00	33.60
	27.36	Average	V				35.36	54.00	18.64

Tabulated test data for Restricted Band

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

Margin (dB) = Limits (dB μ V/m) - Total Level (dB μ V/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain

Tested by: Tae-Ho, Kim / Senior Manager

9.6.2.3 Test data for 802.11n_HT20 WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	33.63	Peak	H	30.84	12.31	35.74	41.04	74.00	32.96
	27.32	Average	H				34.73	54.00	19.27
	32.22	Peak	V				39.63	74.00	34.37
	28.01	Average	V				35.42	54.00	18.58
Test Data for Middle Channel									
4 884.00	32.25	Peak	H	30.01	12.43	35.80	38.89	74.00	35.11
	24.94	Average	H				31.58	54.00	22.42
	33.39	Peak	V				40.03	74.00	33.97
	27.32	Average	V				33.96	54.00	20.04
Test Data for High Channel									
4 924.00	32.20	Peak	H	31.15	12.81	35.96	40.20	74.00	33.80
	26.53	Average	H				34.53	54.00	19.47
	31.07	Peak	V				39.07	74.00	34.93
	27.65	Average	V				35.65	54.00	18.35

Tabulated test data for Restricted Band

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

Margin (dB) = Limits (dB μ V/m) - Total Level (dB μ V/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain

Tested by: Tae-Ho, Kim / Senior Manager

9.6.2.4 Test data for 802.11n_HT40 WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Test Data for Low Channel									
4 844.00	33.67	Peak	H	30.84	12.31	35.74	41.08	74.00	32.92
	25.51	Average	H				32.92	54.00	21.08
	33.10	Peak	V				40.51	74.00	33.49
	27.38	Average	V				34.79	54.00	19.21
Test Data for Middle Channel									
4 884.00	32.71	Peak	H	30.01	12.43	35.80	39.35	74.00	34.65
	25.49	Average	H				32.13	54.00	21.87
	34.13	Peak	V				40.77	74.00	33.23
	27.06	Average	V				33.70	54.00	20.30
Test Data for High Channel									
4 904.00	32.92	Peak	H	31.15	12.81	35.96	40.92	74.00	33.08
	25.78	Average	H				33.78	54.00	20.22
	31.55	Peak	V				39.55	74.00	34.45
	26.55	Average	V				34.55	54.00	19.45

Tabulated test data for Restricted Band

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

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

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$

Tested by: Tae-Ho, Kim / Senior Manager

10. PEAK POWER SPECTRUL DENSITY

10.1 Operating environment

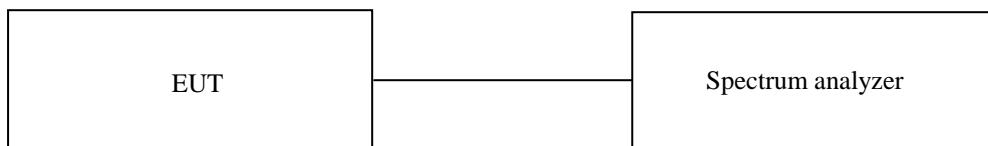
Temperature : 23 °C

Relative humidity : 41 % 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. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for 802.11b WLAN Mode

- Test Date : September 28, 2018 ~ October 24, 2018

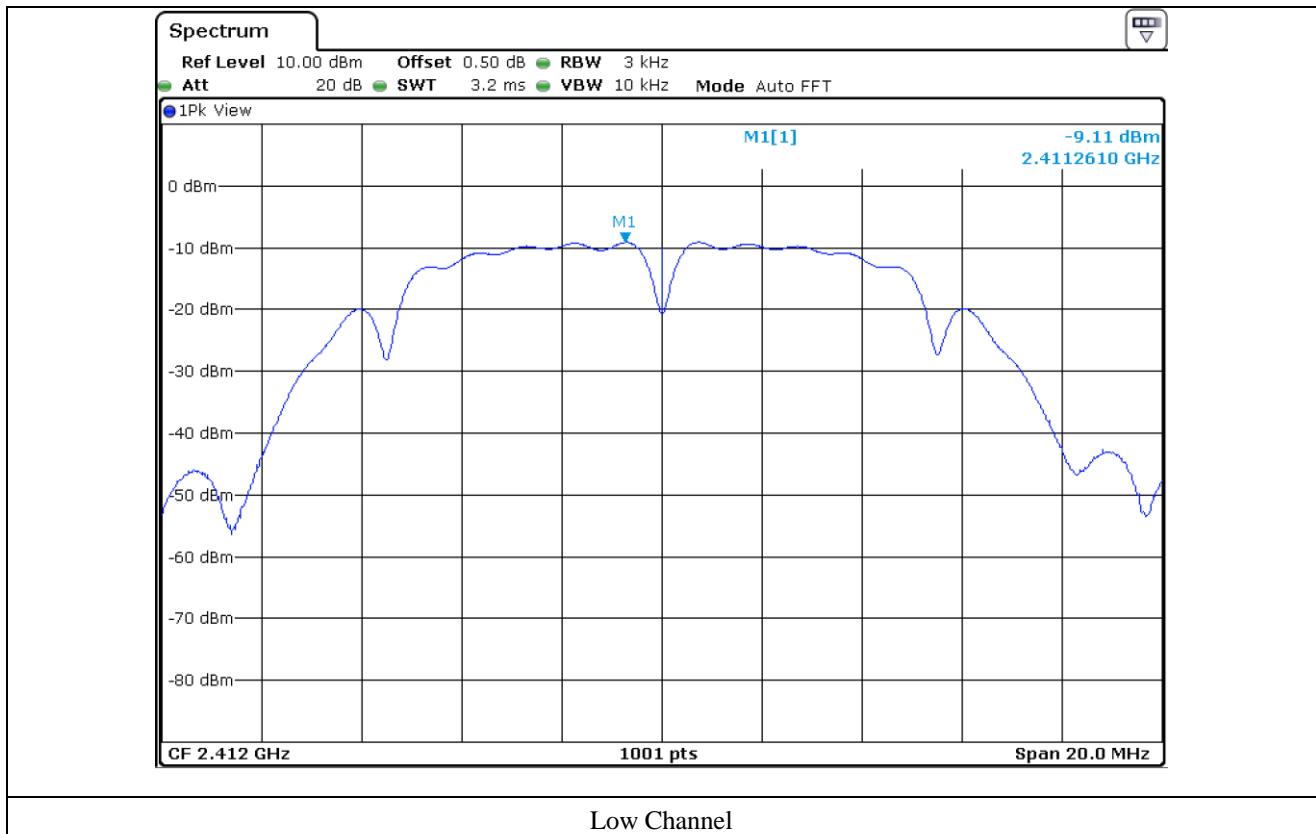
- Test Result : Pass

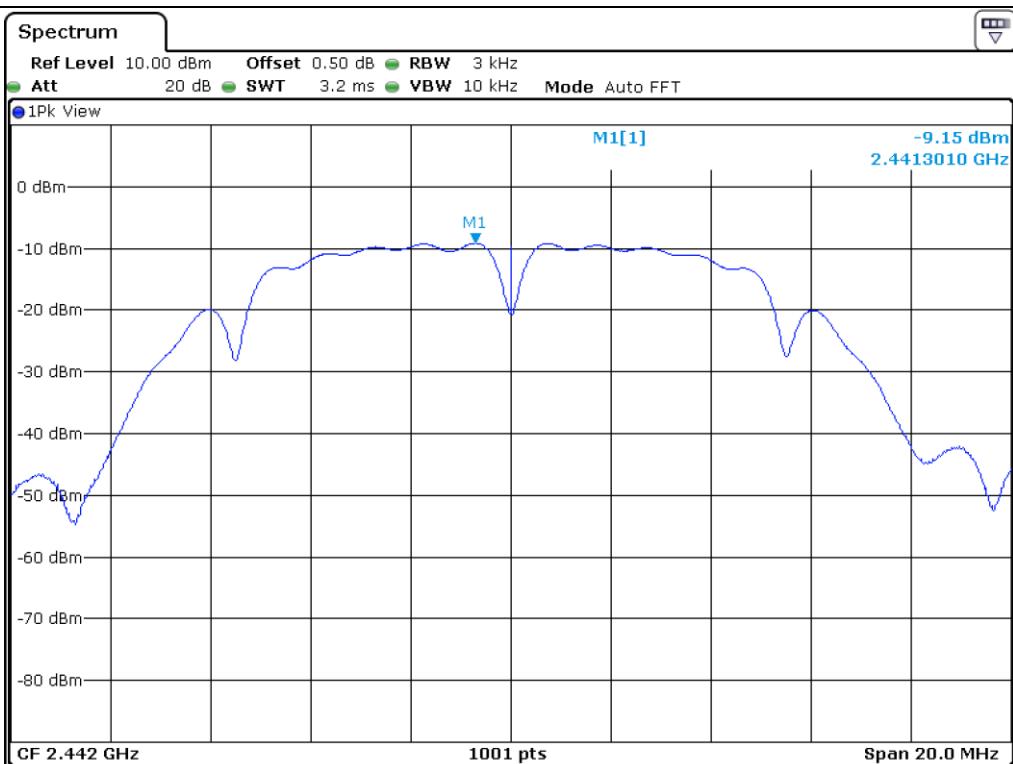
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-9.11	8.00	17.11
Middle	2 442.00	-9.15	8.00	17.15
High	2 462.00	-9.40	8.00	17.40

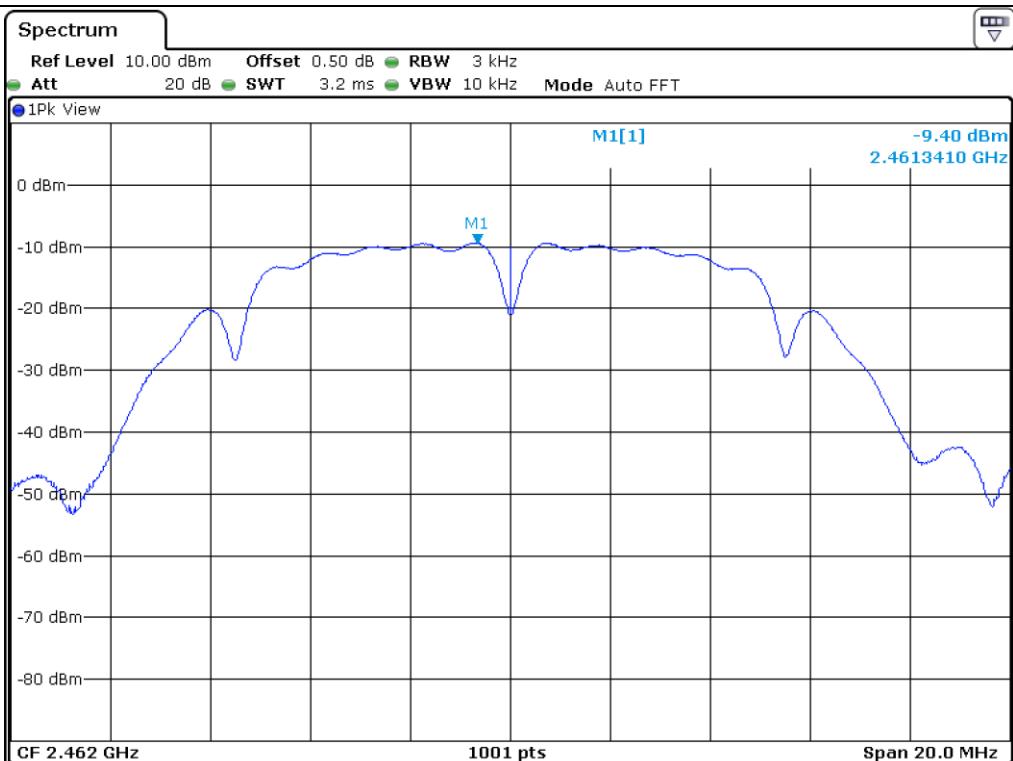
Remark. Margin = Limit – Measured value

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

10.5 Test data for 802.11g WLAN Mode

- Test Date : October 16, 2018 ~ October 28, 2018

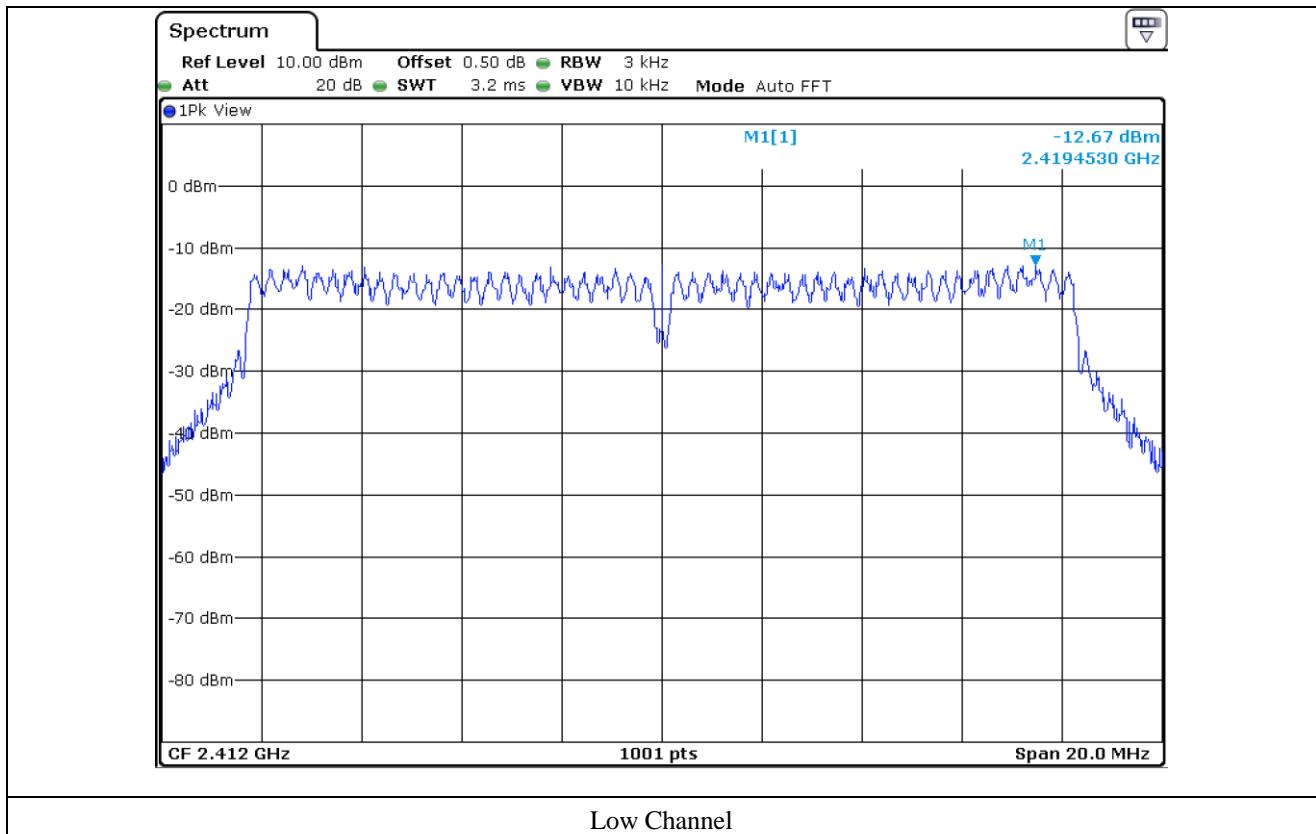
- Test Result : Pass

- Operating Condition : Continuous transmitting mode

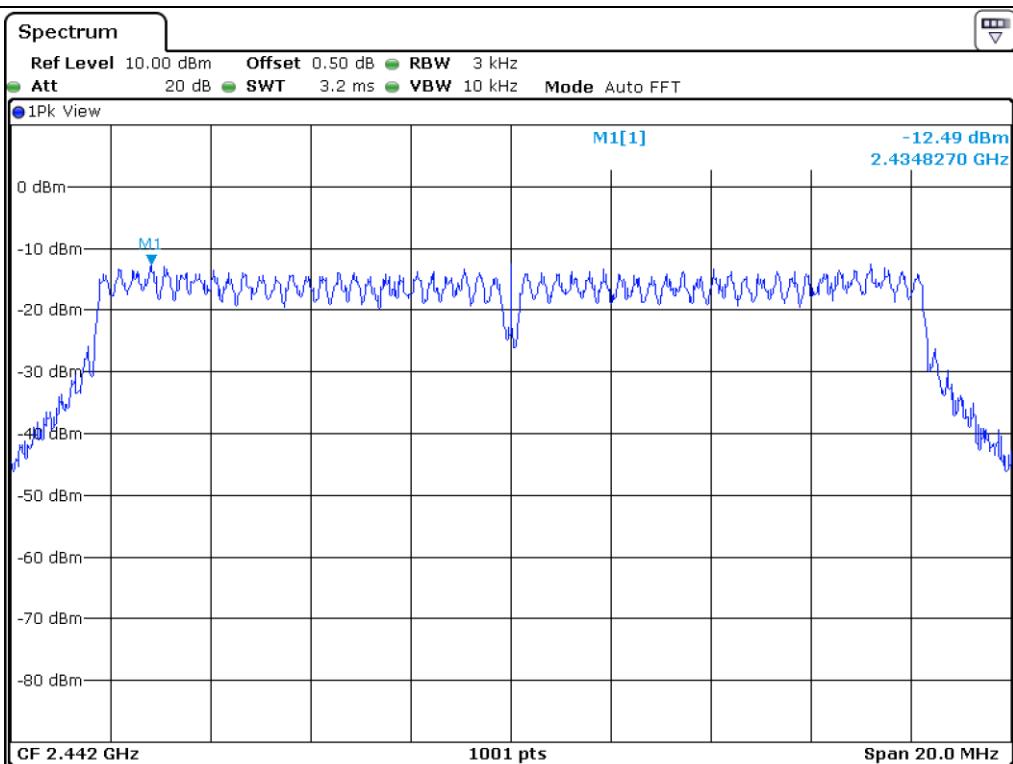
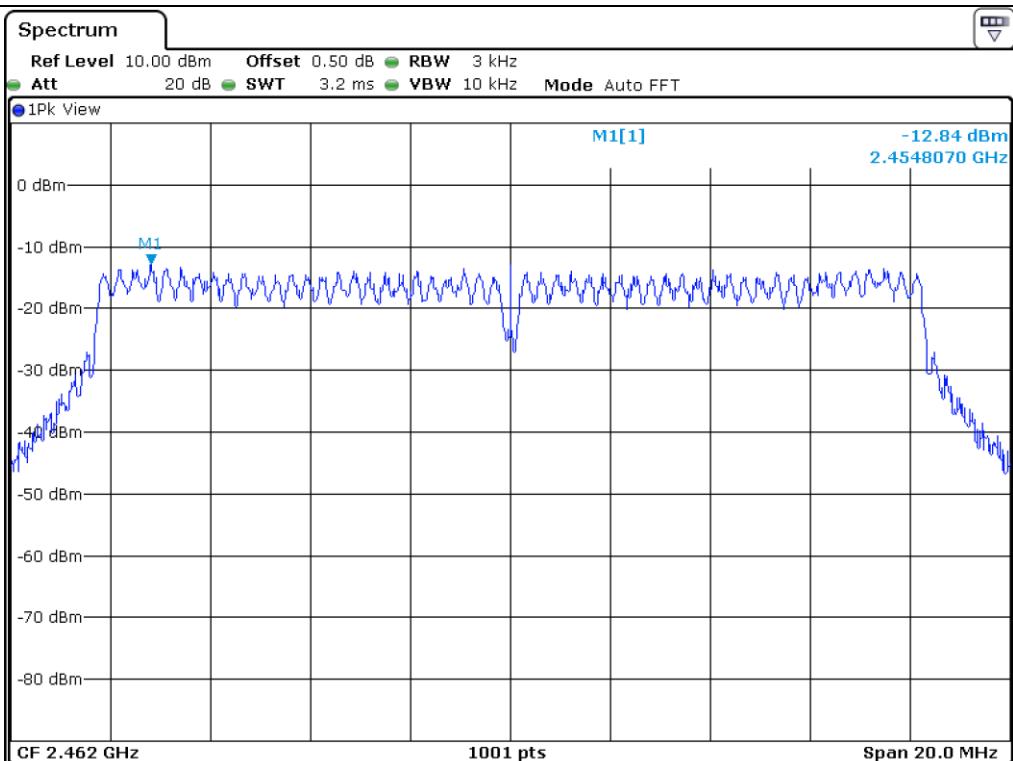
CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-12.67	8.00	20.67
Middle	2 442.00	-12.49	8.00	20.49
High	2 462.00	-12.84	8.00	20.84

Remark. Margin = Limit – Measured value

Tested by: Tae-Ho, Kim / Senior Manager



Low Channel

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

10.6 Test data for 802.11n_HT20 WLAN Mode

- . Test Date : October 16, 2018 ~ October 28, 2018

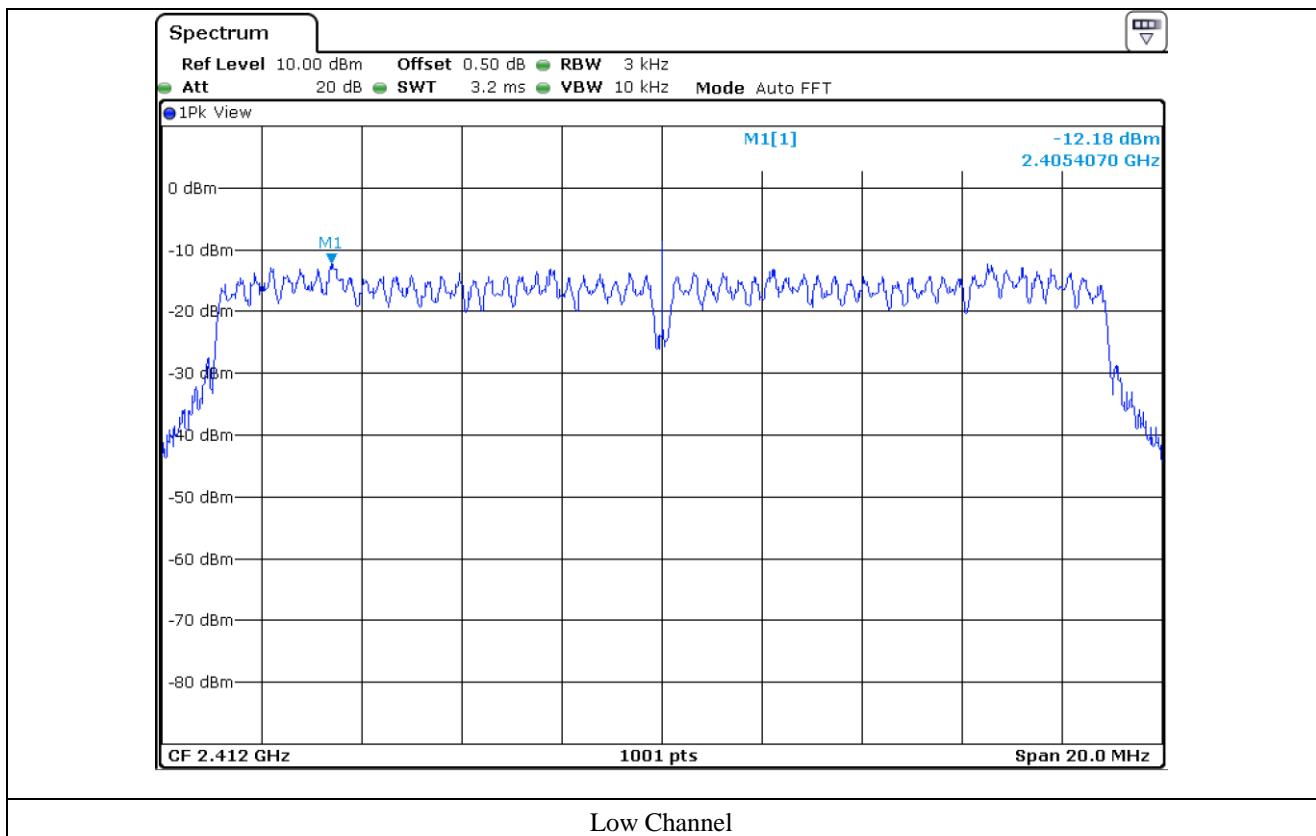
- . Test Result : Pass

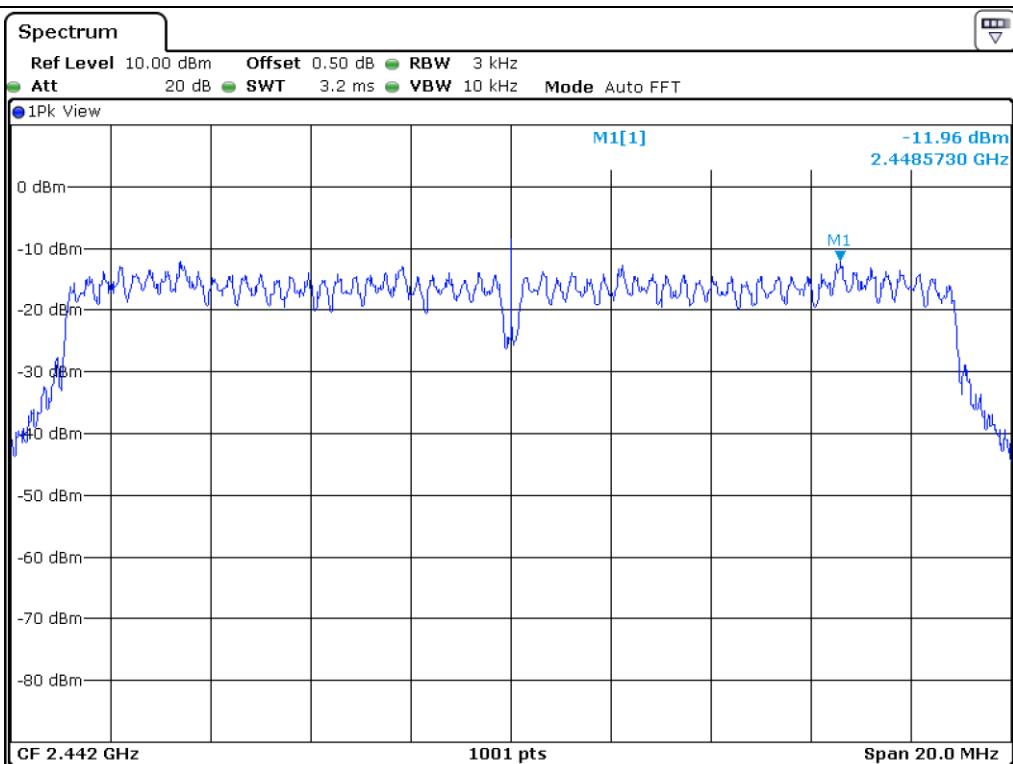
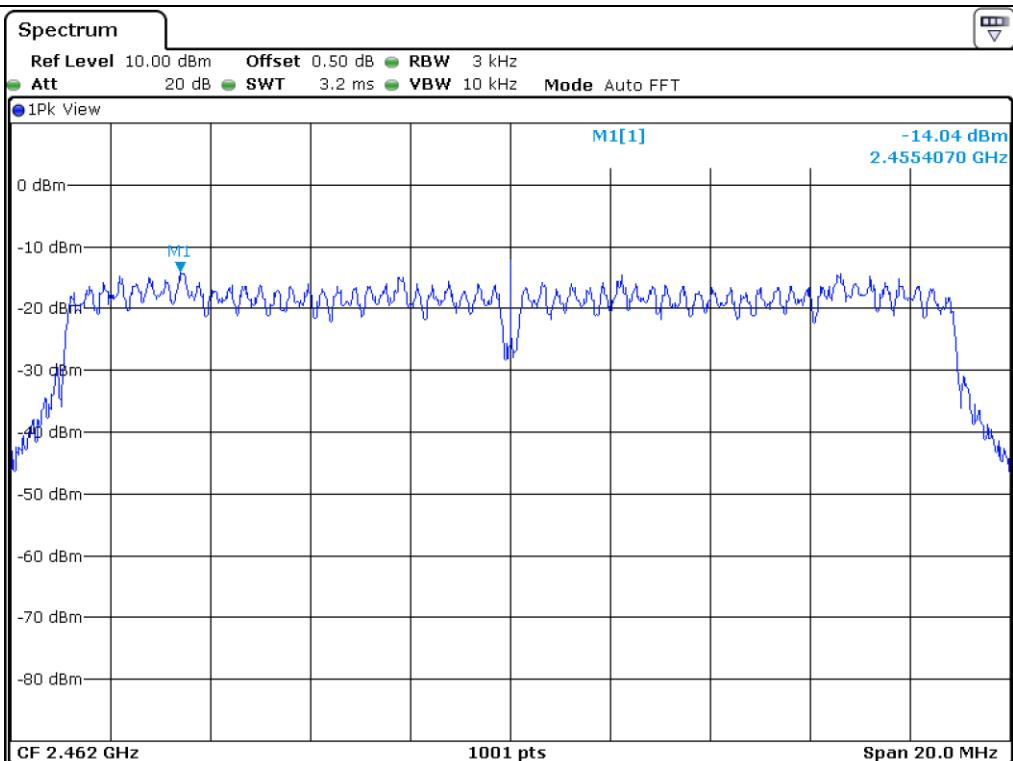
- . Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-12.18	8.00	20.18
Middle	2 442.00	-11.96	8.00	19.96
High	2 462.00	-14.04	8.00	22.04

Remark. Margin = Limit – Measured value

Tested by: Tae-Ho, Kim / Senior Manager



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

10.7 Test data for 802.11n_HT40 WLAN Mode

- Test Date : September 28, 2018 ~ October 24, 2018

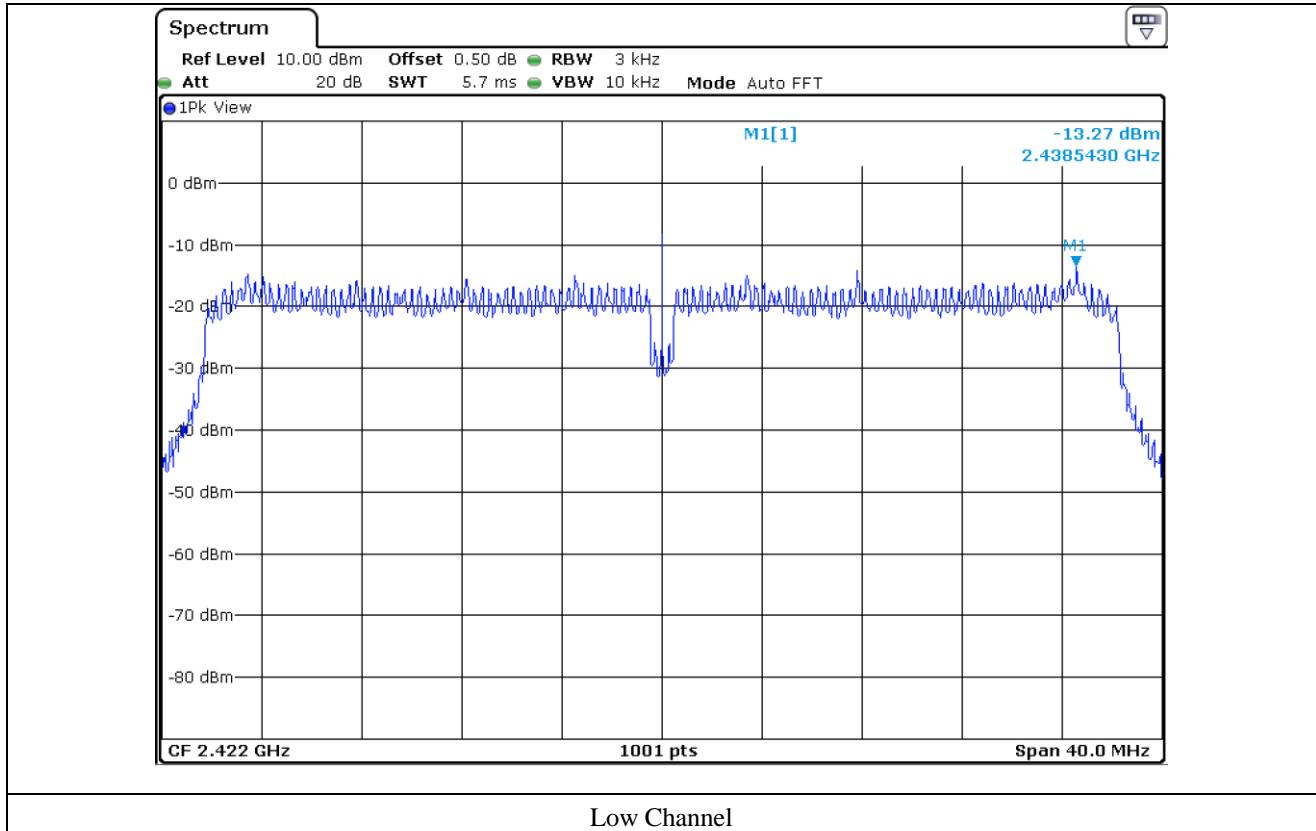
- Test Result : Pass

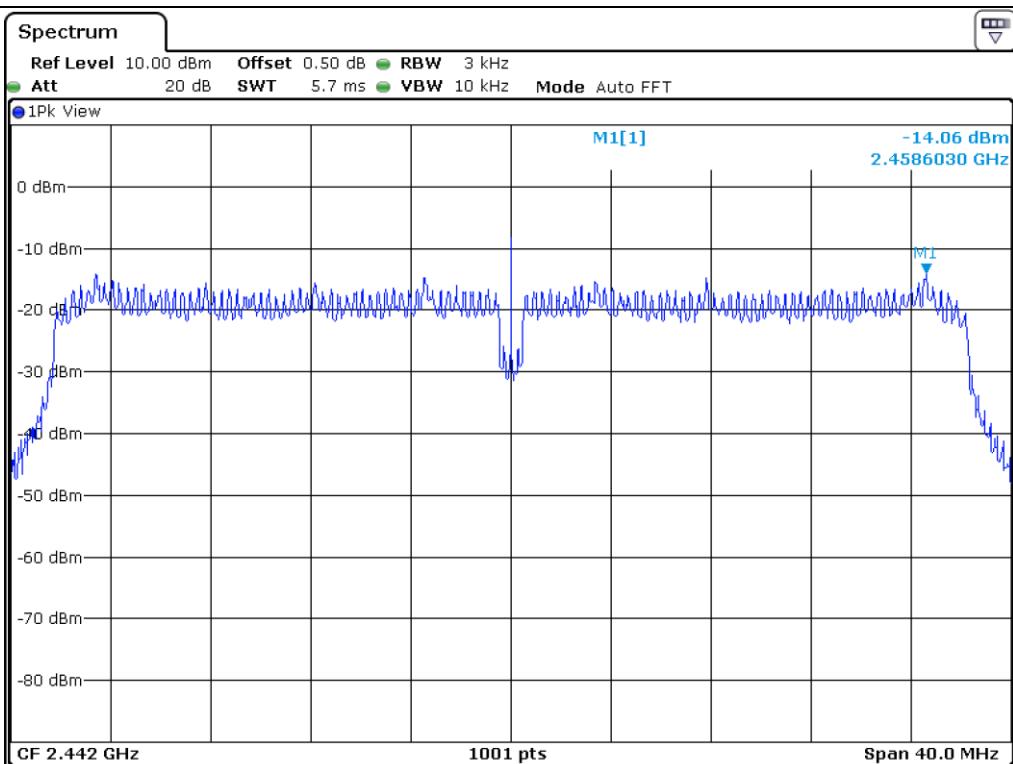
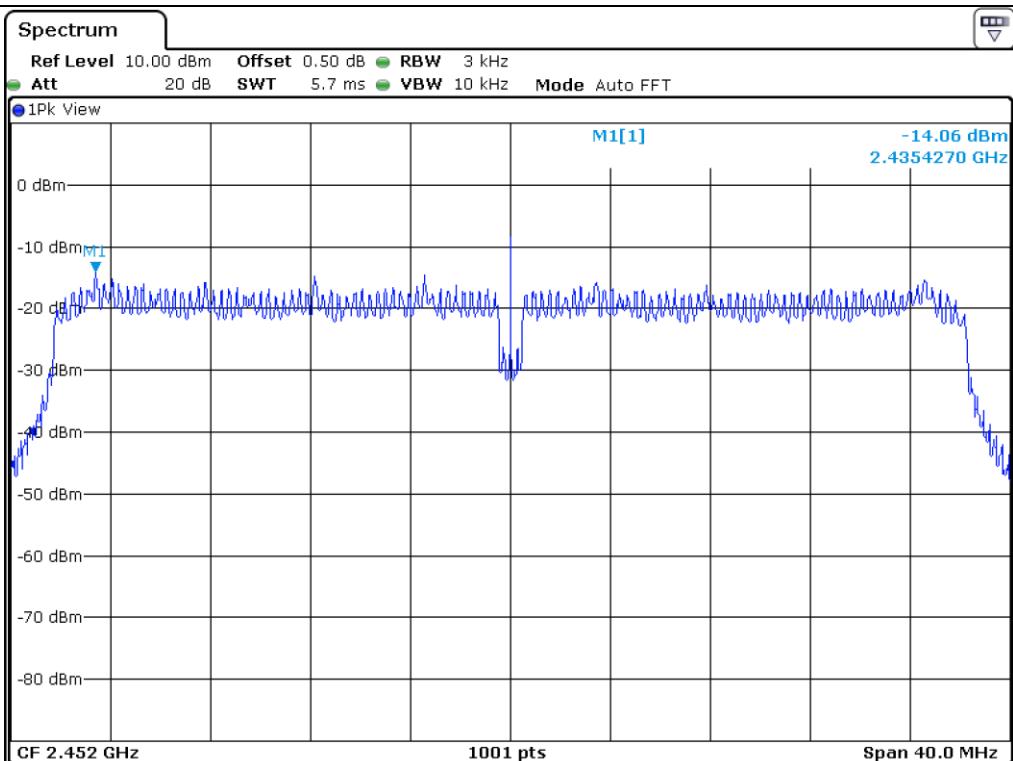
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 422.00	-13.27	8.00	21.27
Middle	2 442.00	-14.06	8.00	22.06
High	2 452.00	-14.06	8.00	22.06

Remark. Margin = Limit – Measured value

Tested by: Tae-Ho, Kim / Senior Manager



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

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 23 °C

Relative humidity : 41 % 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. 14, 2018 (1Y)
■ - ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 29, 2018 (1Y)
■ - 310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 28, 2018 (1Y)
■ - BBV 9718 B	Schwarzbeck	Amplifier	009	Mar. 16, 2018 (1Y)
■ - SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Mar. 15, 2018 (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	BBHA9120D295	Aug. 16, 2017 (2Y)

All test equipment used is calibrated on a regular basis.

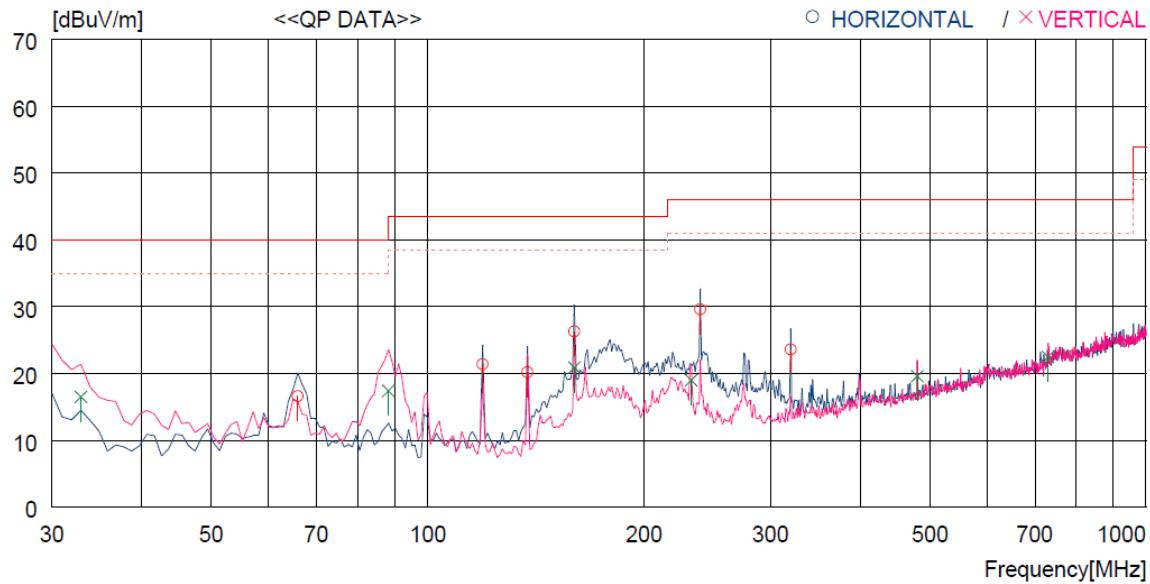
11.4 Test data

11.4.1 Test data for 30 MHz ~ 1 000 MHz

Humidity Level : 41 % R.H. Temperature: 23 °C
 Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247
 Result : PASSED

EUT : RF Module Date: October 16, 2018 ~ October 28, 2018

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



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA TABLE	
									[dB]	[cm]
----- Horizontal -----										
1	65.890	36.4	11.2	2.1	33.1	16.6	40.0	23.4	400	186
2	159.980	47.6	8.4	3.3	33.0	26.3	43.5	17.2	200	115
3	239.520	46.7	12.0	4.0	33.1	29.6	46.0	16.4	100	359
4	320.030	38.4	13.6	4.7	33.1	23.6	46.0	22.4	100	112
5	119.240	41.3	10.2	2.9	33.0	21.4	43.5	22.1	300	134
6	137.670	41.8	8.2	3.1	32.9	20.2	43.5	23.3	200	108
----- Vertical -----										
7	88.200	38.1	9.9	2.4	33.0	17.4	43.5	26.1	200	359
8	730.334	28.8	19.9	7.2	33.4	22.5	46.0	23.5	300	0
9	32.910	36.2	11.9	1.5	33.1	16.5	40.0	23.5	100	0
10	159.980	42.2	8.4	3.3	33.0	20.9	43.5	22.6	100	0
11	232.730	36.4	11.7	4.0	33.1	19.0	46.0	27.0	100	0
12	480.081	30.4	16.8	5.7	33.3	19.6	46.0	26.4	100	0


Tested by: Tae-Ho, Kim / Senior Manager

11.4.2 Test data for Below 30 MHz

- . Test Date : October 16, 2018 ~ October 28, 2018
- . 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 : October 16, 2018 ~ October 28, 2018
- . 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: Tae-Ho, Kim / Senior Manager**

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 23 °C

Relative humidity : 41 % 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.

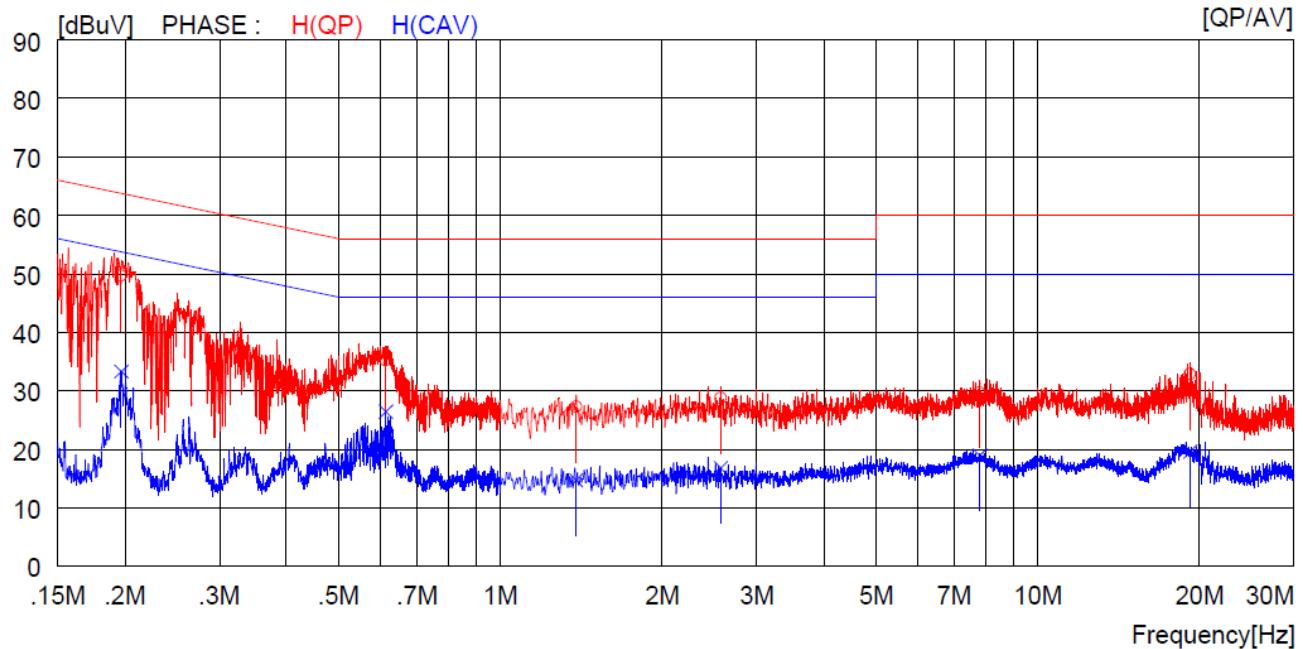
12.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ - ESCI	Rohde & Schwarz	Test Receiver	101012	Oct. 22, 2018 (1Y)
□ - ESHS10	Rohde & Schwarz	Test Receiver	834467/007	Mar. 29, 2018 (1Y)
□ - NSLK8128	Schwarzbeck	AMN	8128-216	Mar. 29, 2018 (1Y)
■ - NSLK8126	Schwarzbeck	AMN	8126-404	Apr. 04, 2018 (1Y)
□ - 3825/2	EMCO	AMN	9109-1869	Apr. 11, 2018 (1Y)
■ - 3825/2	EMCO	AMN	9109-1867	Mar. 28, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

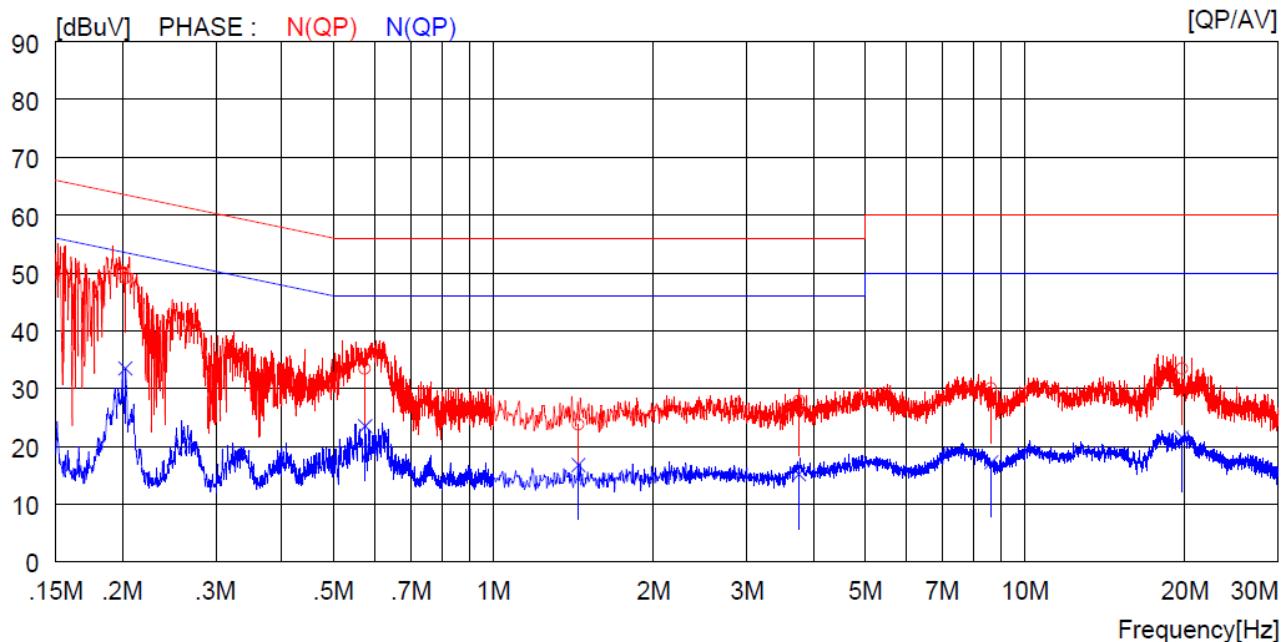
12.4 Test data

- Test Date : October 16, 2018 ~ October 28, 2018
- 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	0.19700	39.7	----	10.0	49.7	----	63.7	----	14.0	----	H (QP)
2	0.61200	25.2	----	10.0	35.2	----	56.0	----	20.8	----	H (QP)
3	1.38400	17.3	----	10.0	27.3	----	56.0	----	28.7	----	H (QP)
4	2.57200	18.7	----	10.0	28.7	----	56.0	----	27.3	----	H (QP)
5	7.79500	19.5	----	10.2	29.7	----	60.0	----	30.3	----	H (QP)
6	19.22000	22.5	----	10.4	32.9	----	60.0	----	27.1	----	H (QP)
7	0.19700	23.3	10.0	----	33.3	----	53.7	----	20.4	----	H (CAV)
8	0.61200	16.4	10.0	----	26.4	----	46.0	----	19.6	----	H (CAV)
9	1.38400	4.7	10.0	----	14.7	----	46.0	----	31.3	----	H (CAV)
10	2.57200	6.8	10.0	----	16.8	----	46.0	----	29.2	----	H (CAV)
11	7.79500	8.7	10.2	----	18.9	----	50.0	----	31.1	----	H (CAV)
12	19.22000	9.2	10.4	----	19.6	----	50.0	----	30.4	----	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	0.20300	39.1	----	10.0	49.1	----	63.5	----	14.4	----	N (QP)
2	0.57300	23.4	----	10.0	33.4	----	56.0	----	22.6	----	N (QP)
3	1.44400	13.7	----	10.0	23.7	----	56.0	----	32.3	----	N (QP)
4	3.75600	17.8	----	10.1	27.9	----	56.0	----	28.1	----	N (QP)
5	8.64000	19.8	----	10.2	30.0	----	60.0	----	30.0	----	N (QP)
6	19.74000	23.0	----	10.4	33.4	----	60.0	----	26.6	----	N (QP)
7	0.20300	----	23.5	10.0	----	33.5	----	53.5	----	20.0	N (CAV)
8	0.57300	----	13.5	10.0	----	23.5	----	46.0	----	22.5	N (CAV)
9	1.44400	----	6.8	10.0	----	16.8	----	46.0	----	29.2	N (CAV)
10	3.75600	----	5.1	10.1	----	15.2	----	46.0	----	30.8	N (CAV)
11	8.64000	----	7.0	10.2	----	17.2	----	50.0	----	32.8	N (CAV)
12	19.74000	----	11.1	10.4	----	21.5	----	50.0	----	28.5	N (CAV)

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

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

Tested by: Tae-Ho, Kim / Senior Manager