

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

Test Report No. : OT-196-RWD-009
AGR No. : A194A-065
Applicant : AMOSENSE
Address : 56 Naruteo-ro, Seocho-gu, SEOUL, South Korea
Manufacturer : AMOSENSE
Address : 56 Naruteo-ro, Seocho-gu, SEOUL, South Korea
Type of Equipment : ATOZ
FCC ID. : 2AS9T-SB52SW
Model Name : SB52-SW
Serial number : N/A
Total page of Report : 78 pages (including this page)
Date of Incoming : May 21, 2019
Date of issue : June 05, 2019


SUMMARY

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

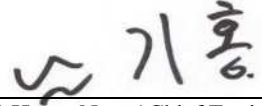
This test report only contains the result of a single test of the sample supplied for the examination.

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.

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ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-196-RWD-009	June 05, 2019	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : AMOSENSE
 Address : 56 Naruteo-ro, Seocho-gu, SEOUL, South Korea
 Manufacturer : AMOSENSE
 Address : 56 Naruteo-ro, Seocho-gu, SEOUL, South Korea
 Factory : AMO VINA CO.,LTD
 Address : Lot CN12, Khai Quang industrial Park, Khai Quang Ward, Vinh Yen City, Vinh Phuc Province, Vietnam
 Contact Person : UIHAN JEONG/Research Engineer
 Telephone No. : +82-010-4948-5676
 FCC ID : 2AS9T-SB52SW
 Model Name : SB52-SW
 Brand Name : -
 Serial Number : N/A
 Date : June 05, 2019

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	ATOZ
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 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 AMOSENSE, Model SB52-SW (referred to as the EUT in this report) is a ATOZ. The product specification described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	ATOZ	
Temperature Range	-20 °C ~ 50 °C	
OPERATING FREQUENCY	NFC	13.56 MHz
	Sig Fox	902.137 5 MHz ~ 904.662 5 MHz
	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	NFC	ASK
	Sig Fox	DBPSK
	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*	NFC	38.11 dBμV/m
	Sig Fox	21.04 dBm
	Bluetooth LE	0.18 dBm
	WLAN 2.4 GHz	2.52 dBm(802.11b) 1.02 dBm(802.11g) 0.84 dBm(802.11n_HT20)
ANTENNA TYPE	NFC: PCB Antenna Sig Fox : Chip Antenna WLAN 2.4 GHz / Bluetooth LE : Chip Antenna	
ANTENNA GAIN	WLAN 2.4 GHz / Bluetooth LE : 3.3 dBi Sig Fox : 0.4 dBi	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	26 MHz, 32 MHz, 50 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	AMONSENSE	ATOZ Rev1.0 / N/A	N/A
Sub Board	AMONSENSE	N/A	N/A
DC Battery	N/A	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
SB52-SW	AMONSENSE	ATOZ (EUT)	-
N/A	N/A	Jig Board	EUT
HP Pavilion g series	HP	Notebook PC	-
PPP009C	LIE-ON TECHNOLOGY (CHANGZHOU)CO.,LTD.	AC Adapter	-
MCS-01KT	Ten Pao Electronics Co., Ltd	DC Adapter	-

5.3 Mode of operation during the test

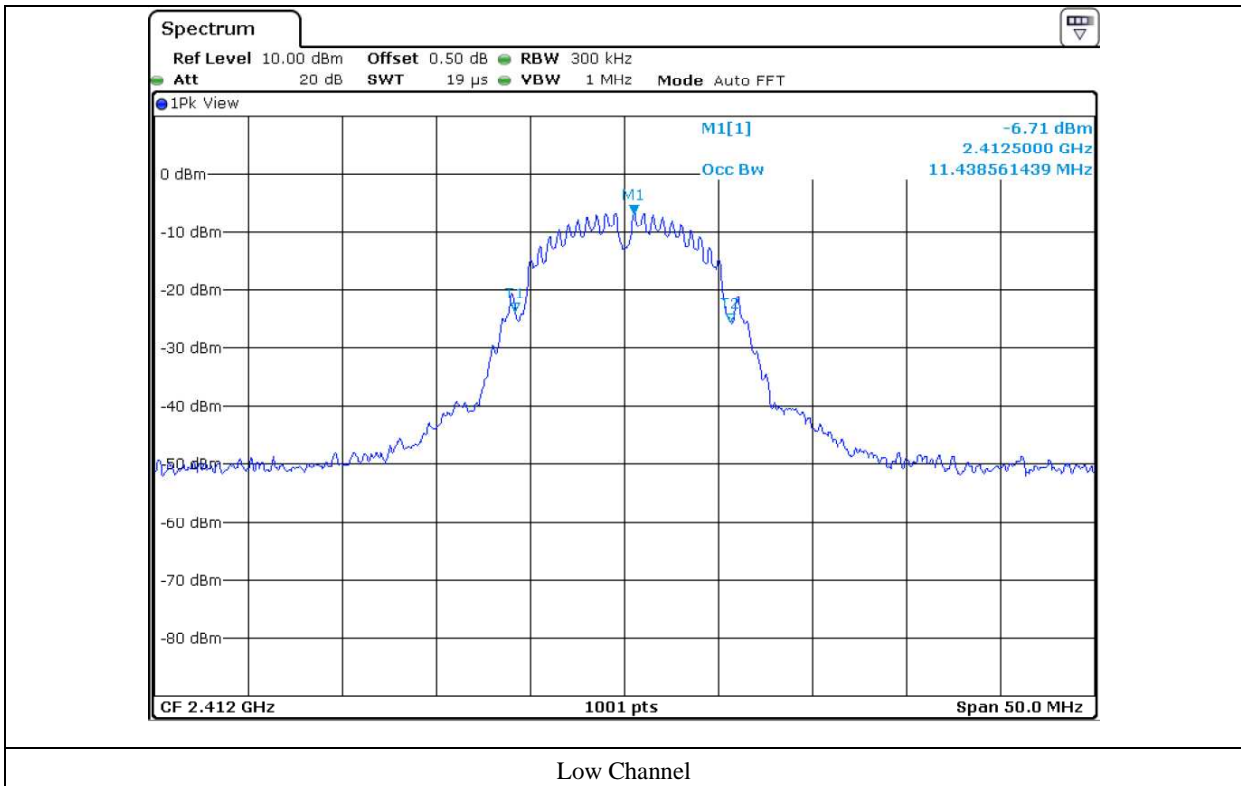
For the testing, software used to control the EUT for staying in continuous transmitting mode is programmed.

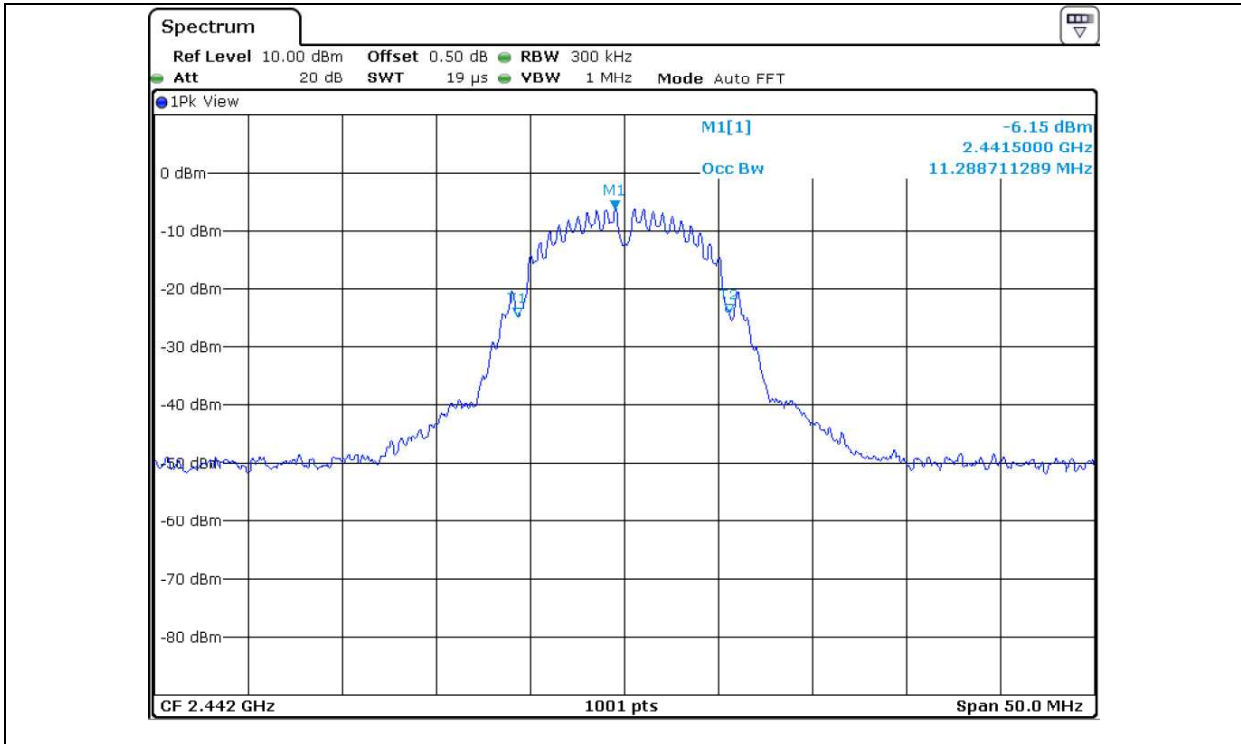
Modulation	DATA RATE	OUTPUT POWER[dBm]
802.11 b (Middle Channel)	1 Mbps	1.25
	2 Mbps	1.22
	5.5 Mbps	1.23
	11 Mbps	1.18
802.11g (Middle Channel)	6 Mbps	-0.67
	9 Mbps	-0.71
	12 Mbps	-0.73
	18 Mbps	-0.74
	24 Mbps	-0.73
	36 Mbps	-0.75
	48 Mbps	-0.74
	54 Mbps	-0.77
802.11 n(HT 20) (Middle Channel)	6.5 Mbps	-0.81
	13 Mbps	-0.83
	19.5 Mbps	-0.85
	26 Mbps	-0.84
	39 Mbps	-0.86
	52 Mbps	-0.85
	58.5 Mbps	-0.87
	65 Mbps	-0.89

- 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.
- The worst case for each modulation is in IEEE 802.11b. So the plot for Radiated Emission which fall in the Restricted Band is provided only in IEEE 802.11b.

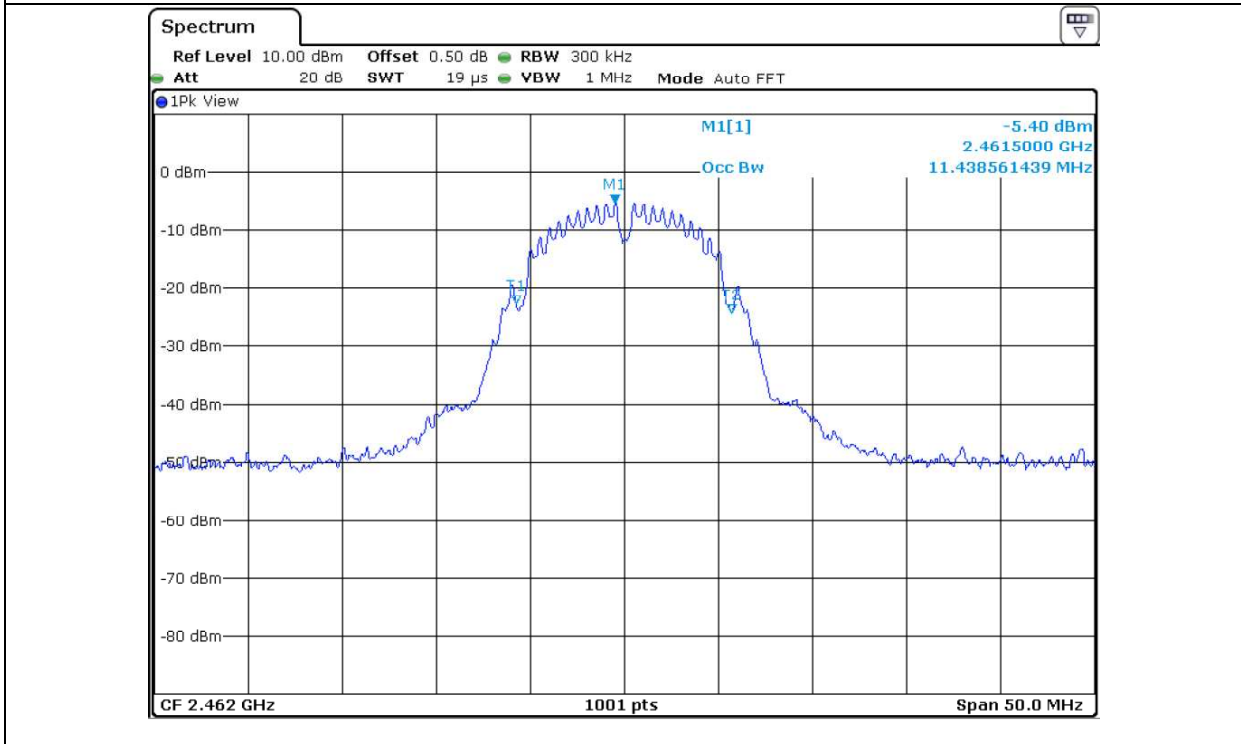
- Occupied Bandwidth(99 %)

Modulation	CHANNEL	FREQUENCY (MHz)	Occupied Bandwidth(MHz)
802.11 b	Low	2 412	11.44
	Middle	2 442	11.29
	High	2 462	11.44



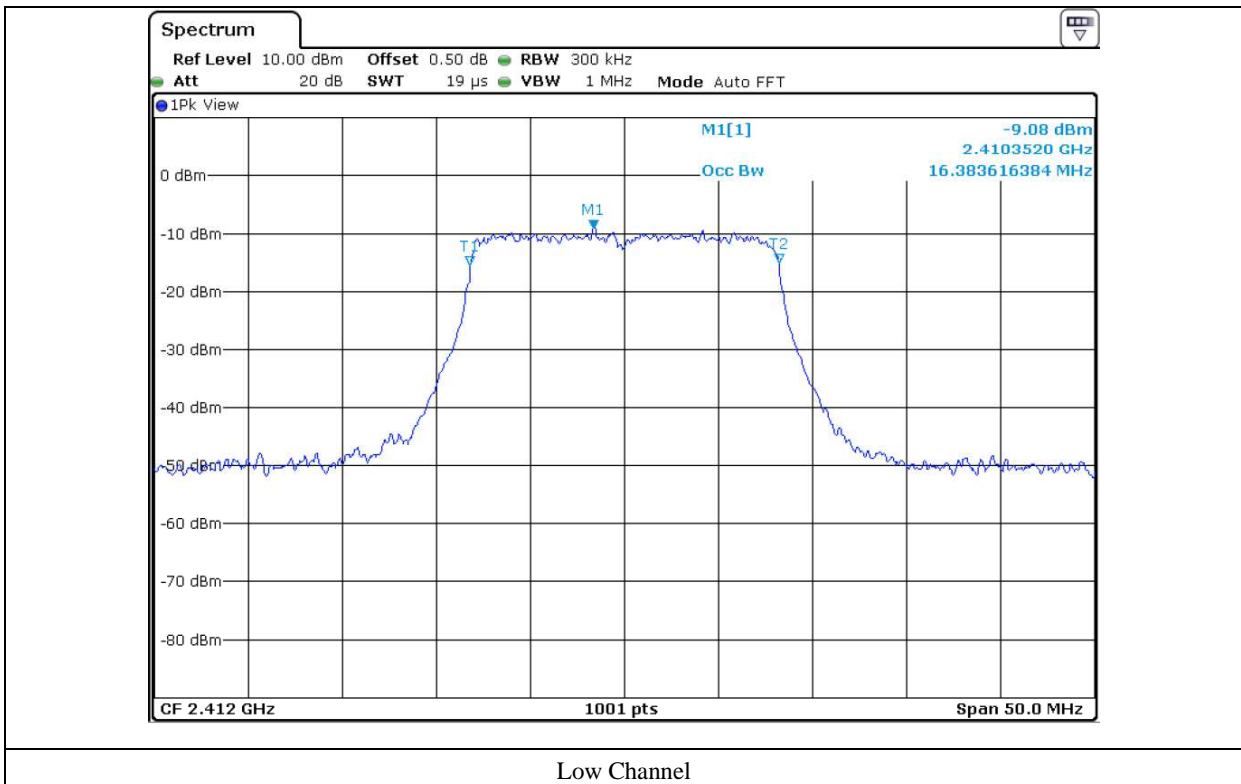


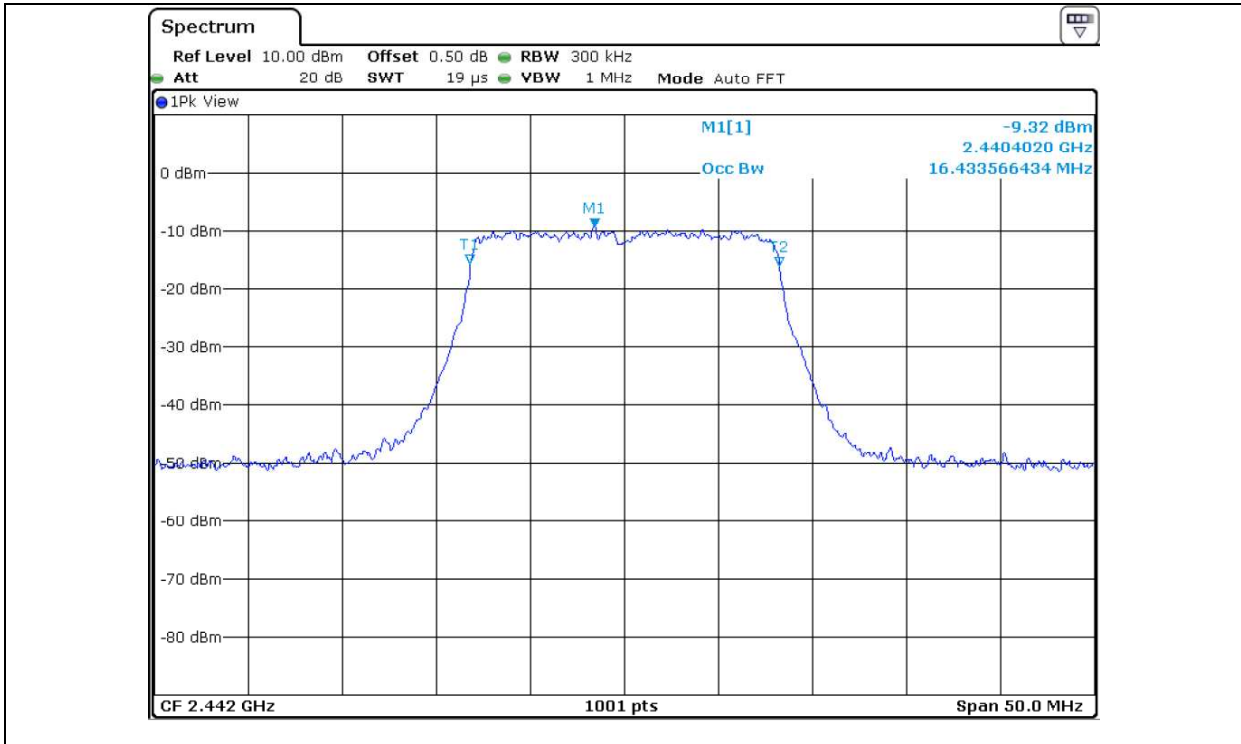
Middle Channel



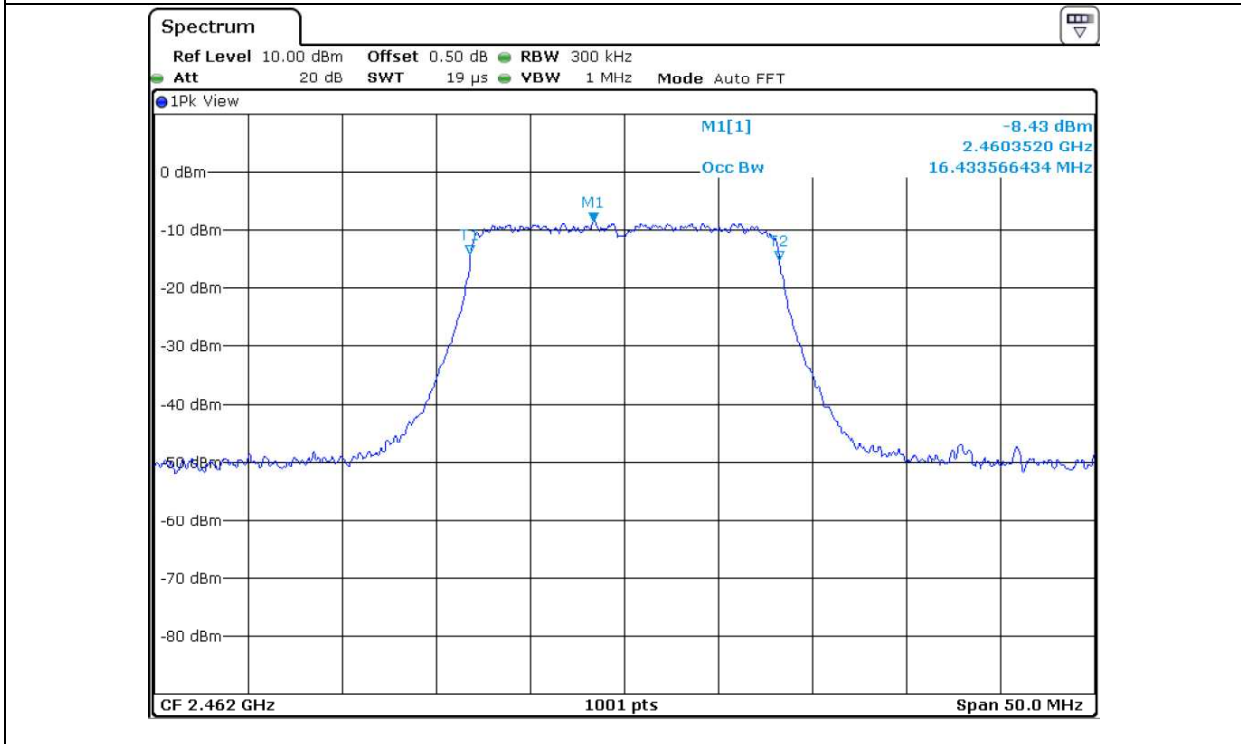
High Channel

Modulation	CHANNEL	FREQUENCY (MHz)	Occupied Bandwidth(MHz)
802.11 g	Low	2 412	16.38
	Middle	2 442	16.43
	High	2 462	16.43



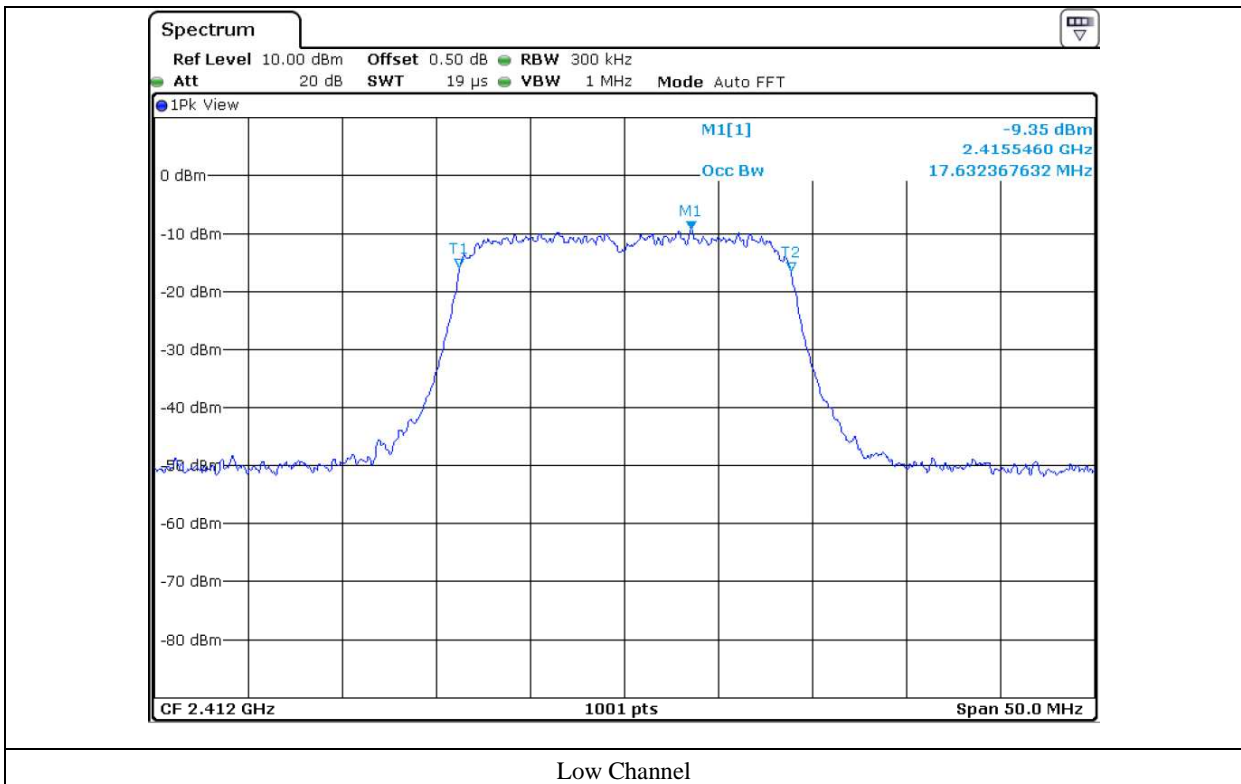


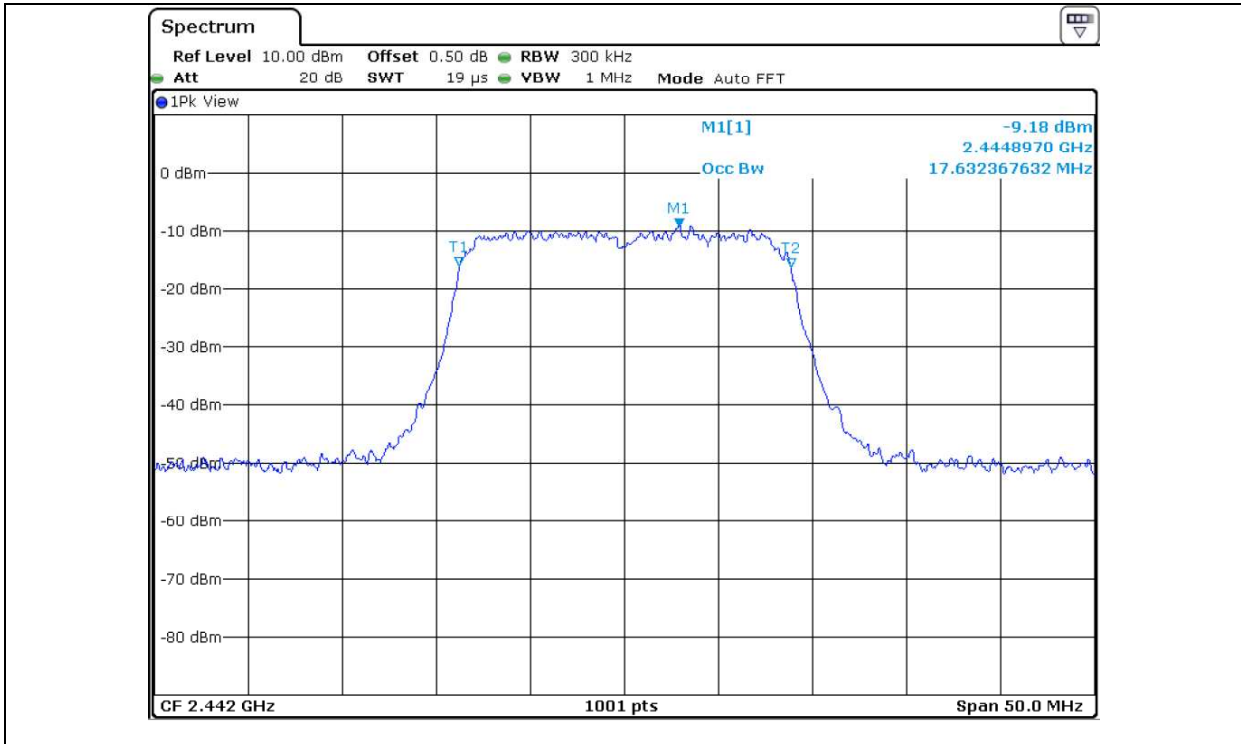
Middle Channel



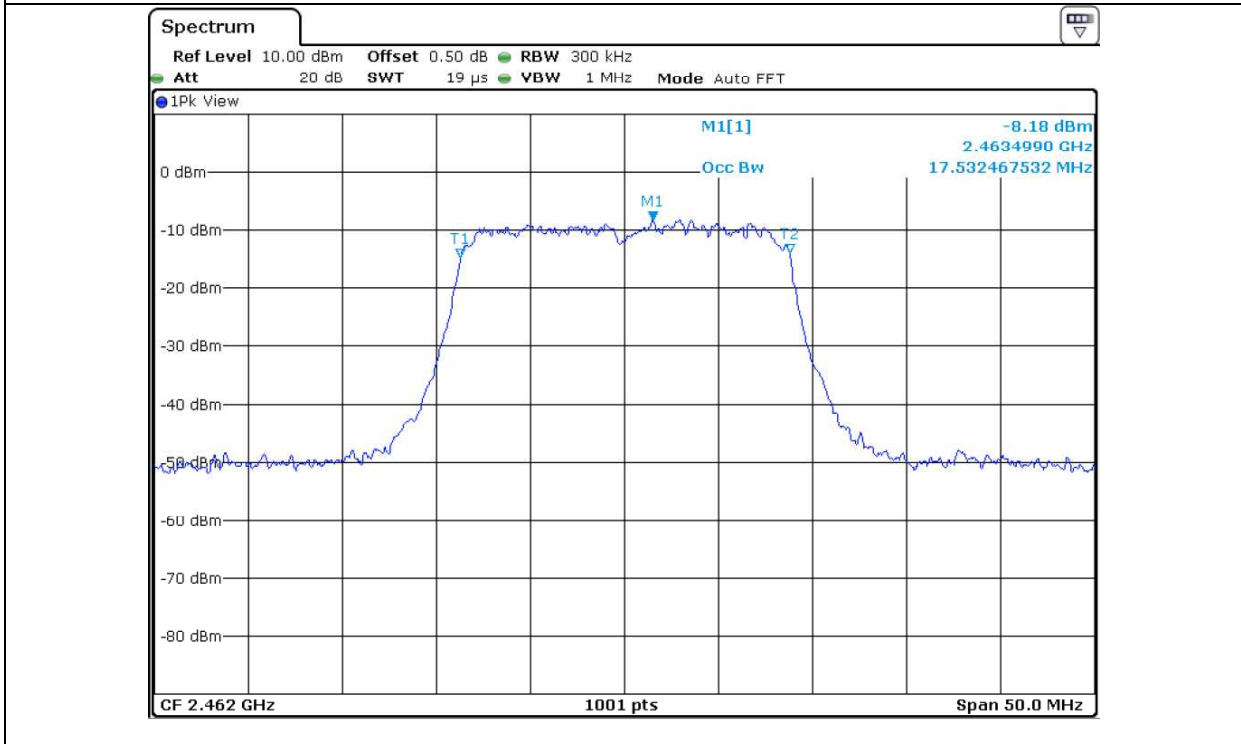
High Channel

Modulation	CHANNEL	FREQUENCY (MHz)	Occupied Bandwidth(MHz)
802.11 n(HT 20)	Low	2 412	17.63
	Middle	2 442	17.63
	High	2 462	17.53





Middle Channel



High Channel

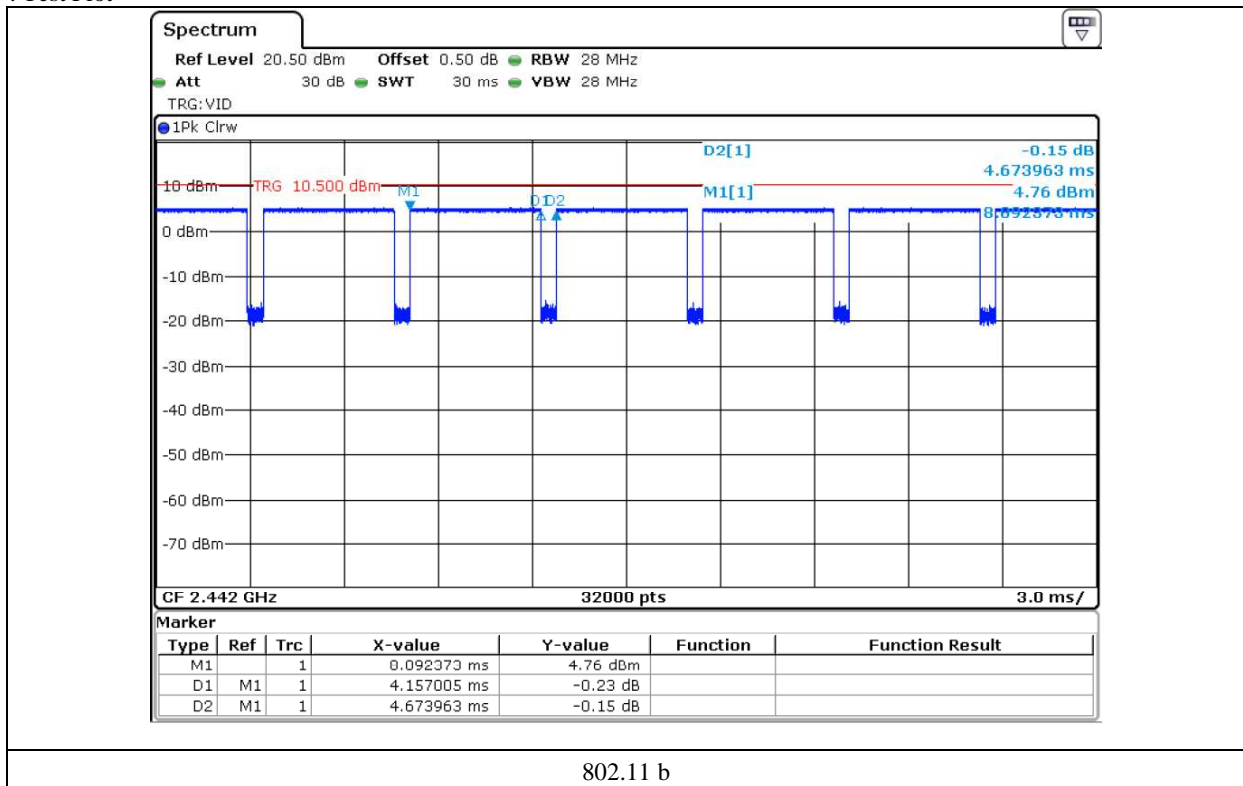
- Duty Cycle

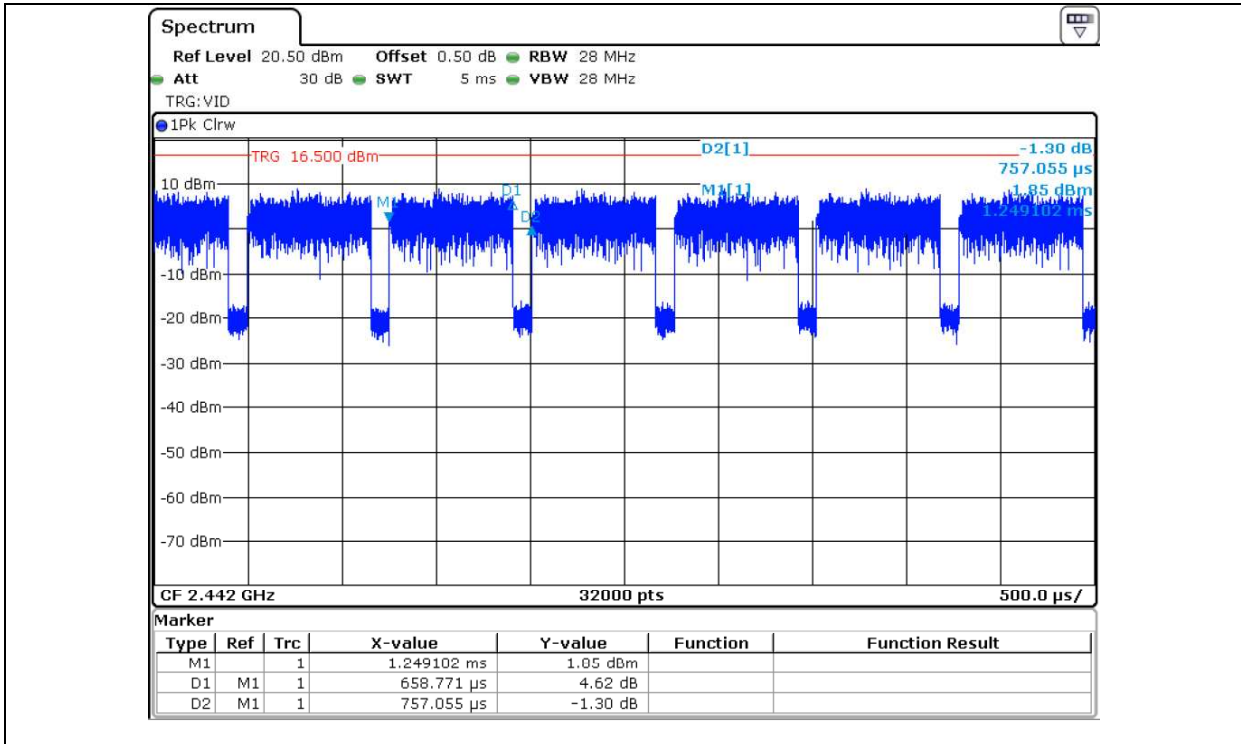
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
802.11 b	4.157	0.517	88.94	0.51
802.11 g	0.757	0.098	87.05	0.60
802.11 n(HT20)	0.624	0.099	86.31	0.64

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

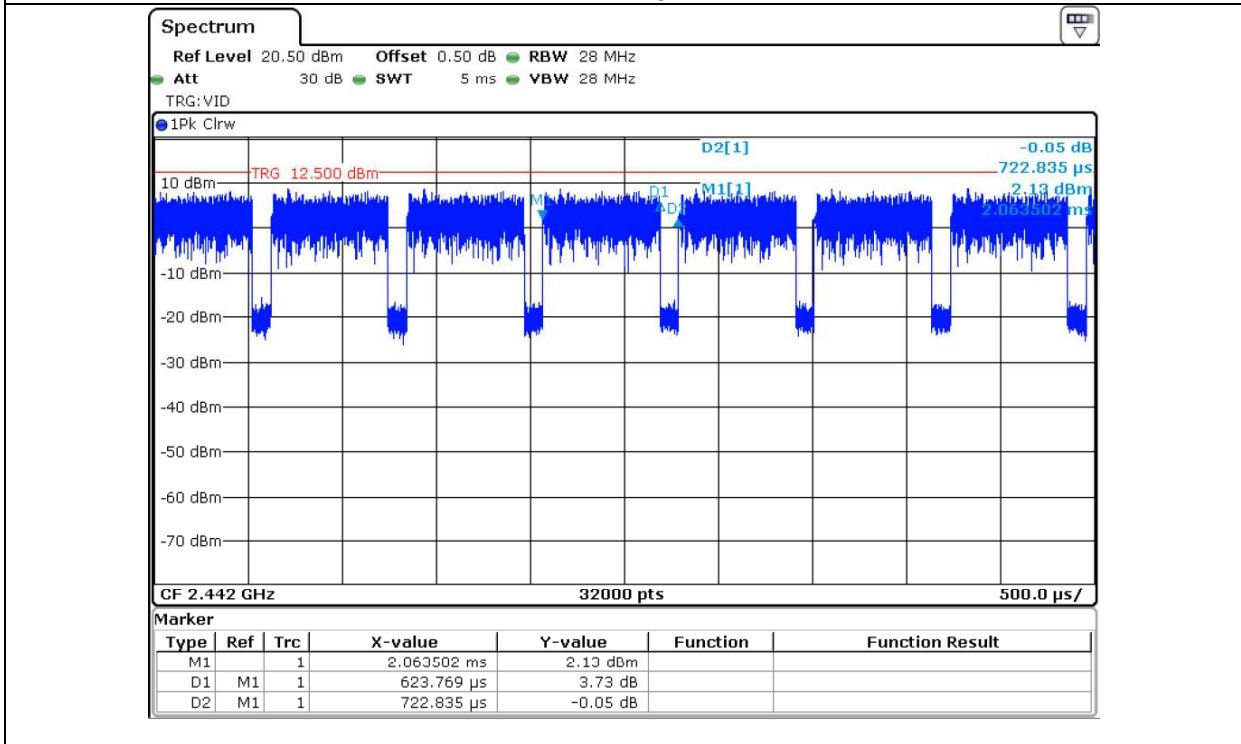
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

- Test Plot





802.11 g



802.11 n(HT20)

5.4 Configuration of Test System

Line Conducted Test: The EUT was tested in a Charging mode. The EUT was connected to USB and the Power of USB was Connected to DC Adaptor. 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 Chip 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)
Charging 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. MIMIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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

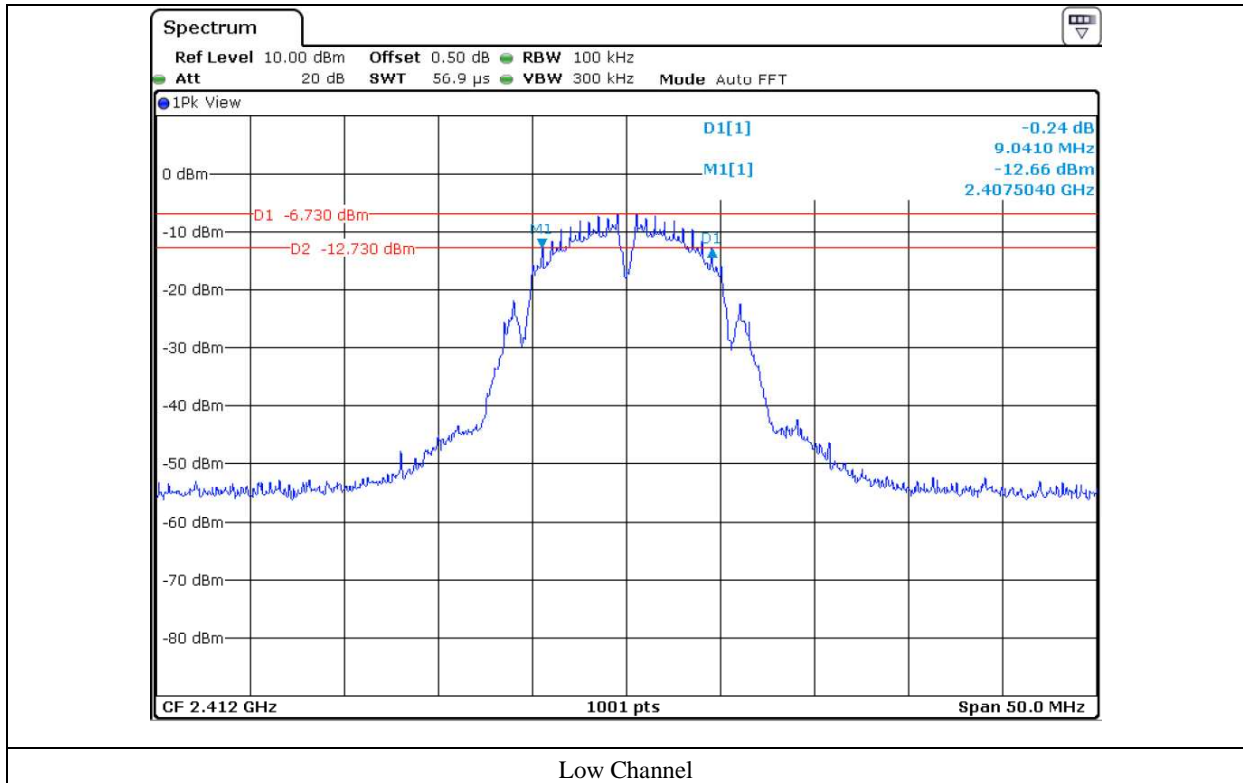
- Test Date : May 22, 2019 ~ May 30, 2019

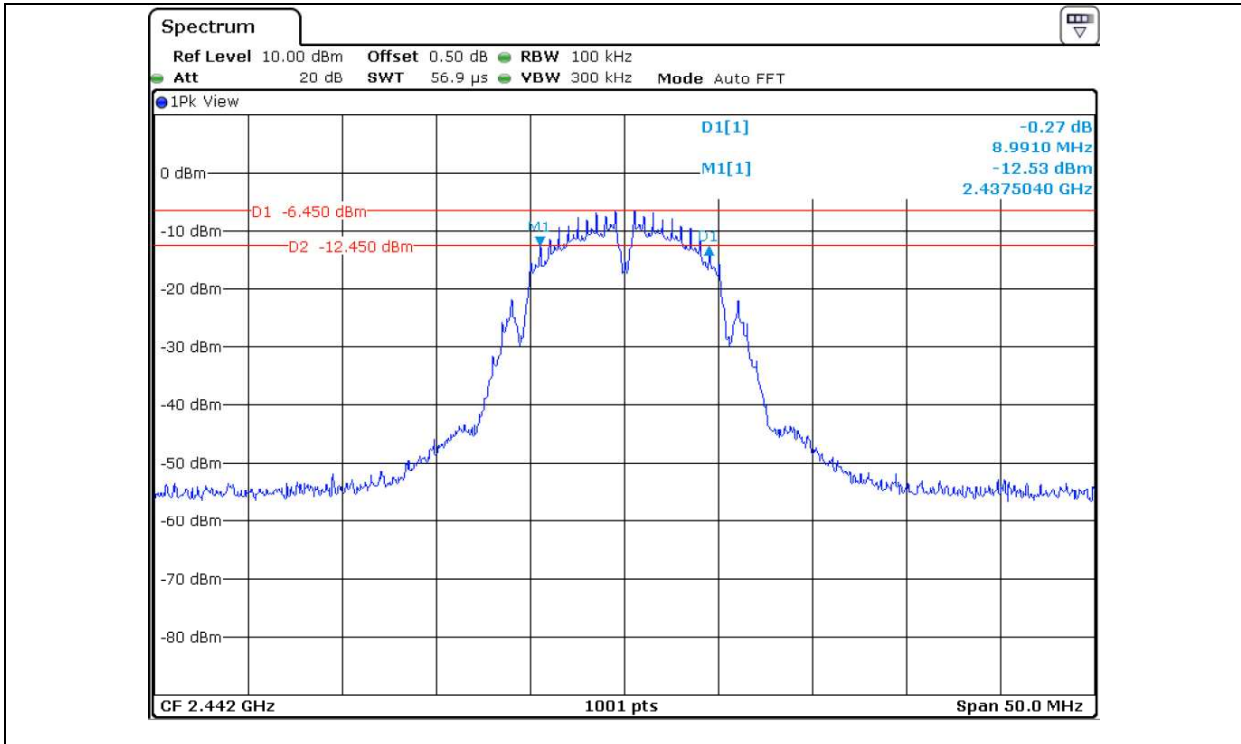
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
LOW	2 412.00	9.04	0.50	8.54
MIDDLE	2 442.00	8.99	0.50	8.49
HIGH	2 462.00	9.04	0.50	8.54

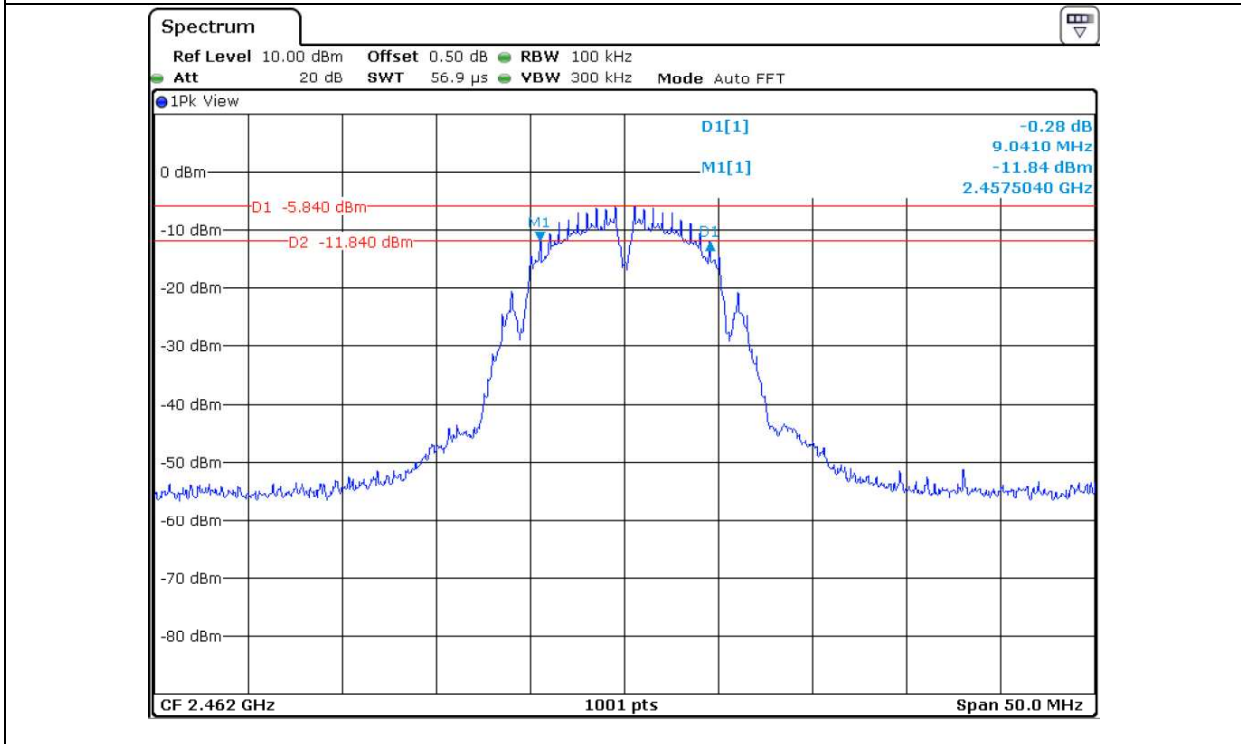
Remark. Margin = Measured Value - Limit

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

7.5 Test data for 802.11g WLAN Mode

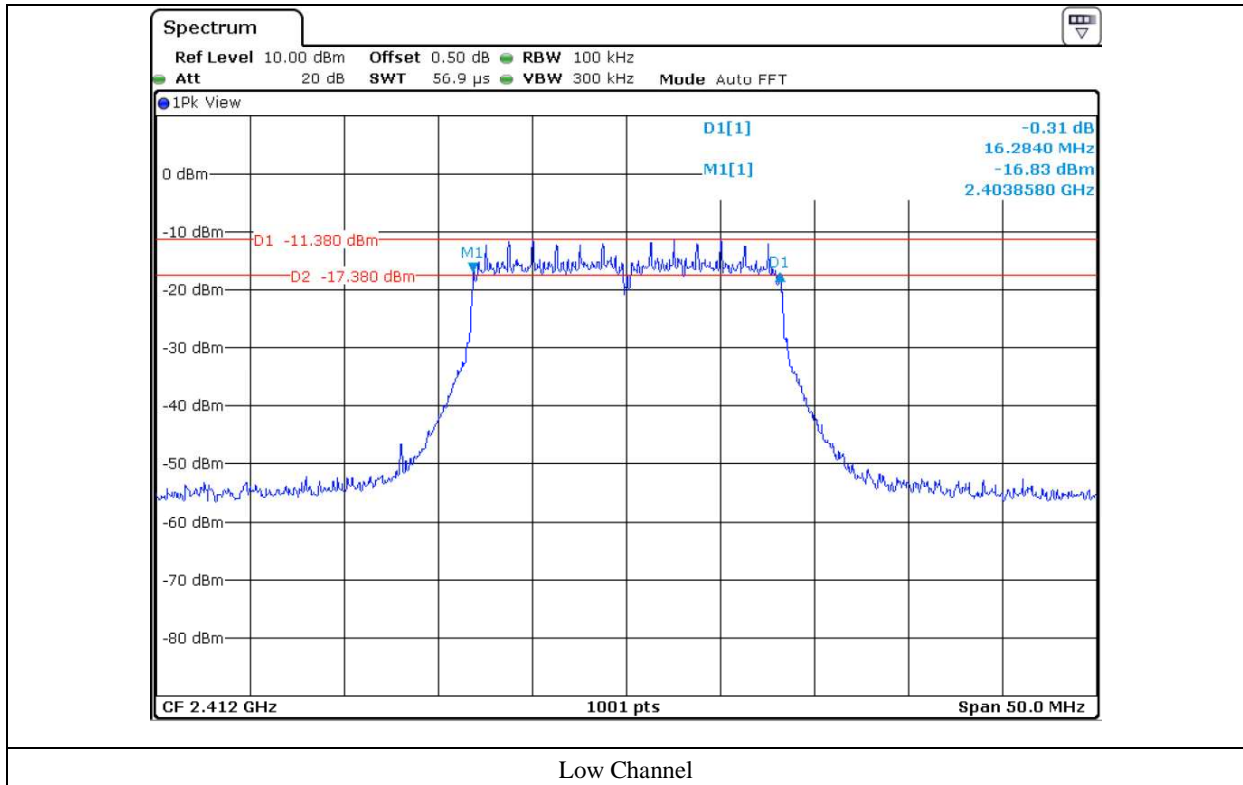
- Test Date : May 22, 2019 ~ May 30, 2019

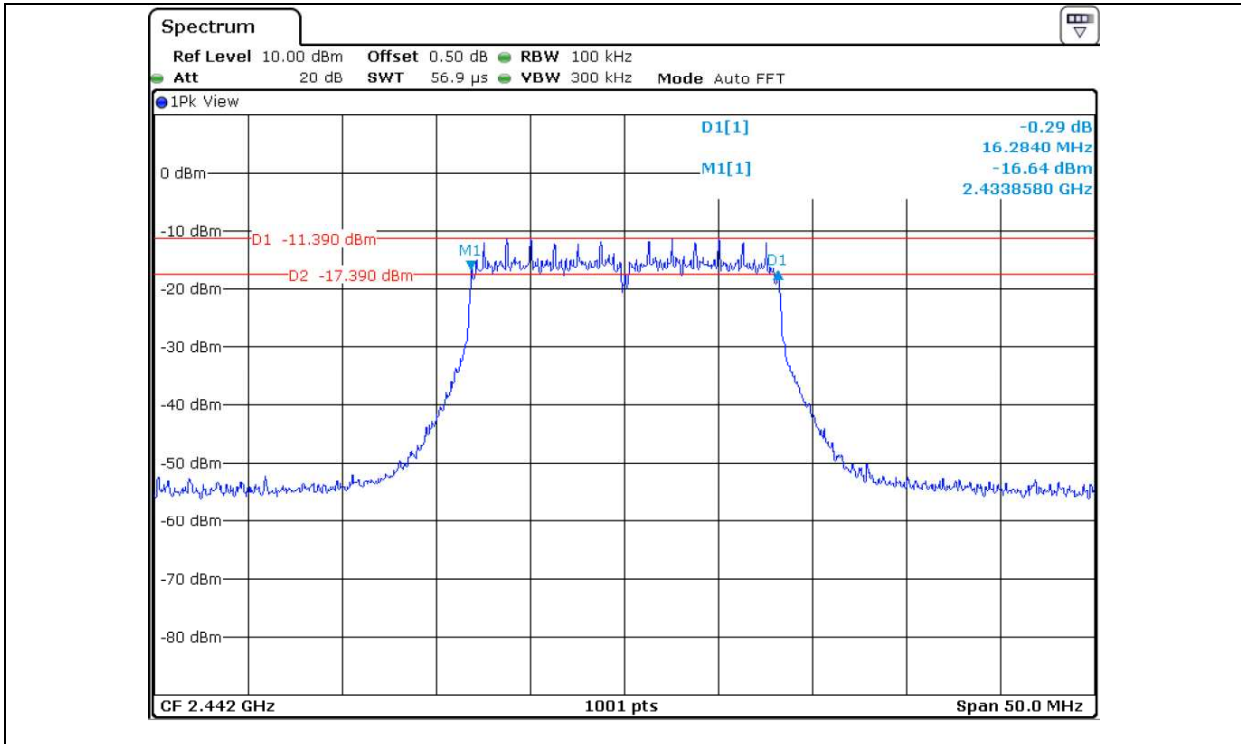
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
LOW	2 412.00	16.28	0.50	15.78
MIDDLE	2 442.00	16.28	0.50	15.78
HIGH	2 462.00	16.28	0.50	15.78

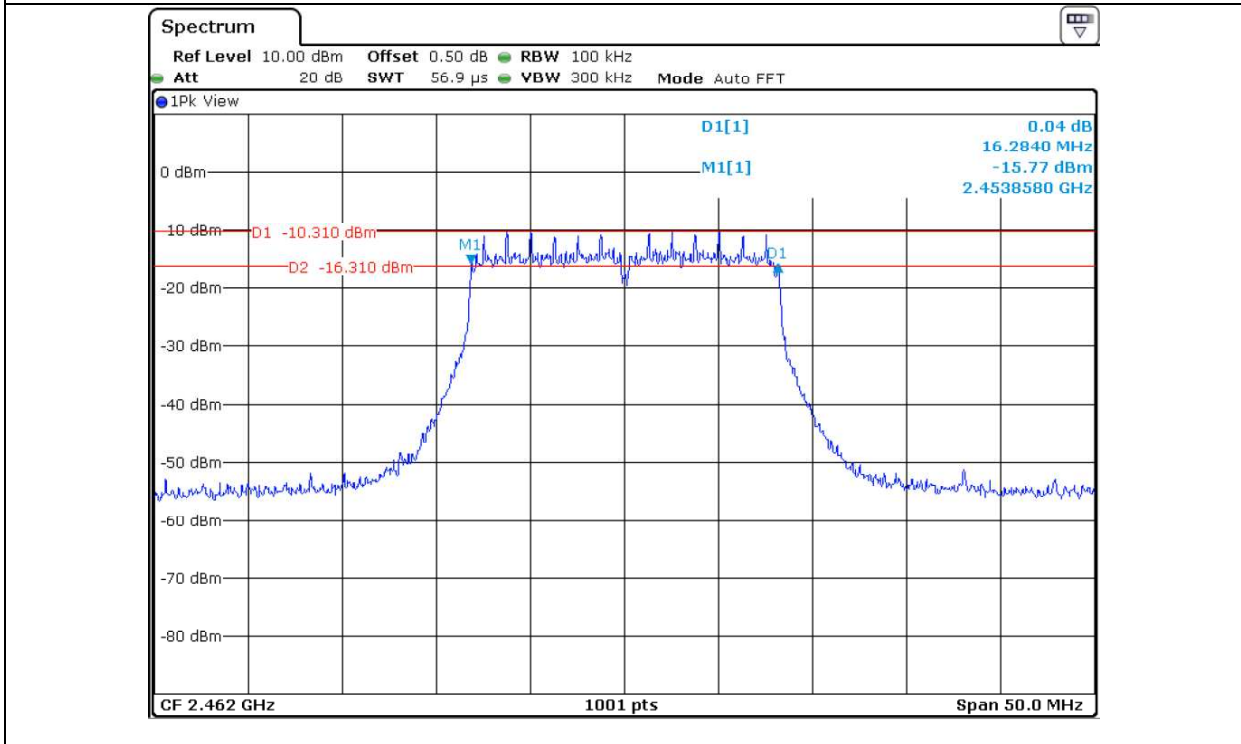
Remark. Margin = Measured Value - Limit

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

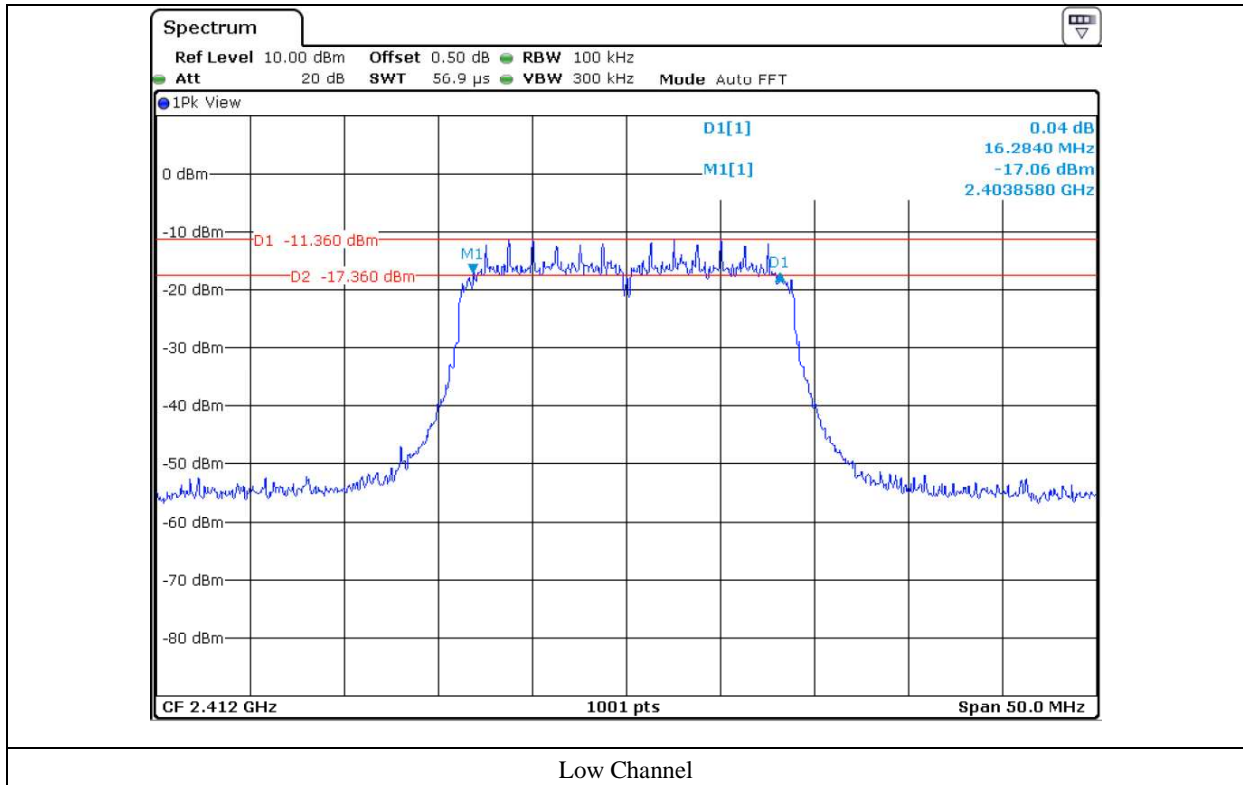
7.6 Test data for 802.11n_HT20 WLAN Mode

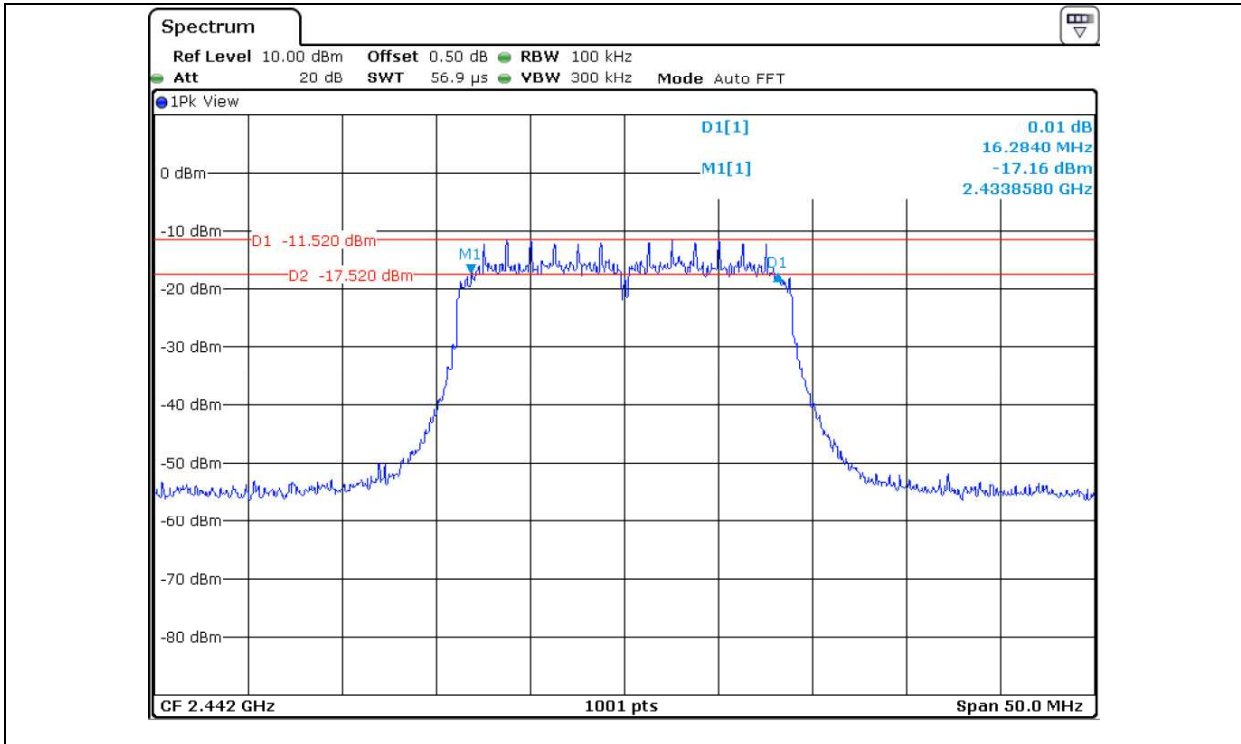
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
LOW	2 412.00	16.28	0.50	15.78
MIDDLE	2 442.00	16.28	0.50	15.78
HIGH	2 462.00	16.28	0.50	15.78

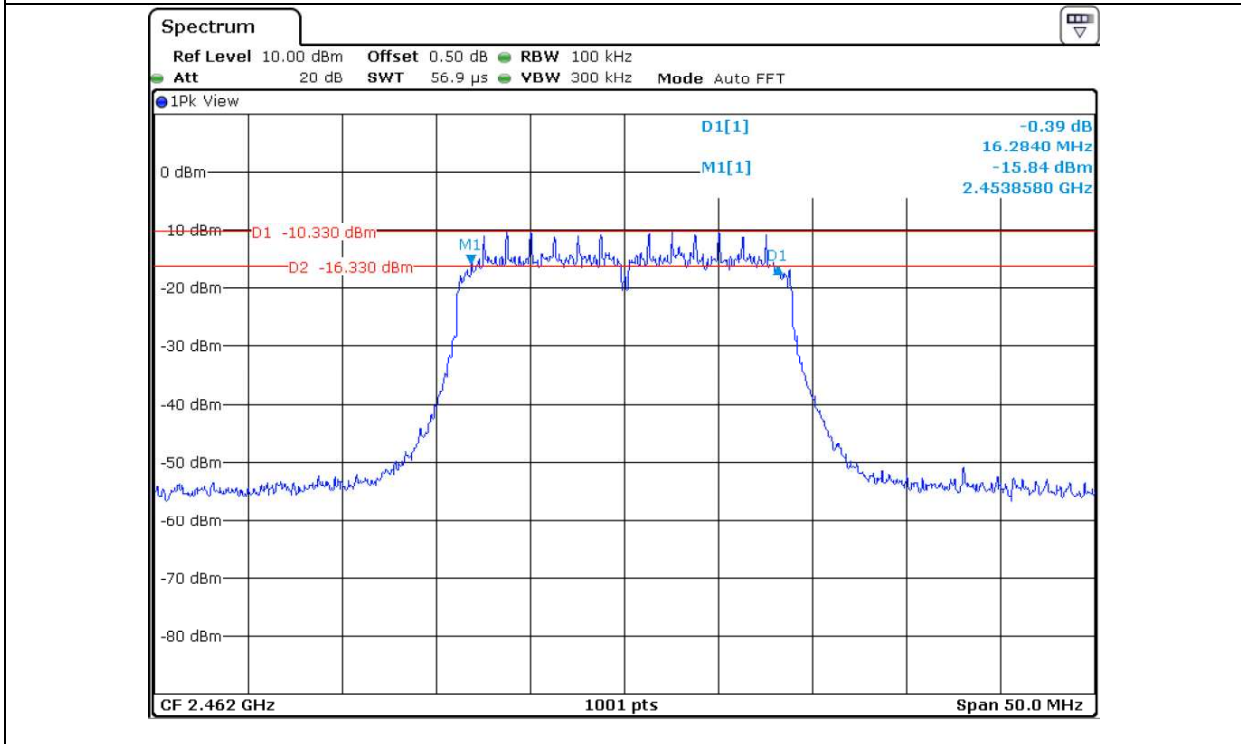
Remark. Margin = Measured Value - Limit

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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.

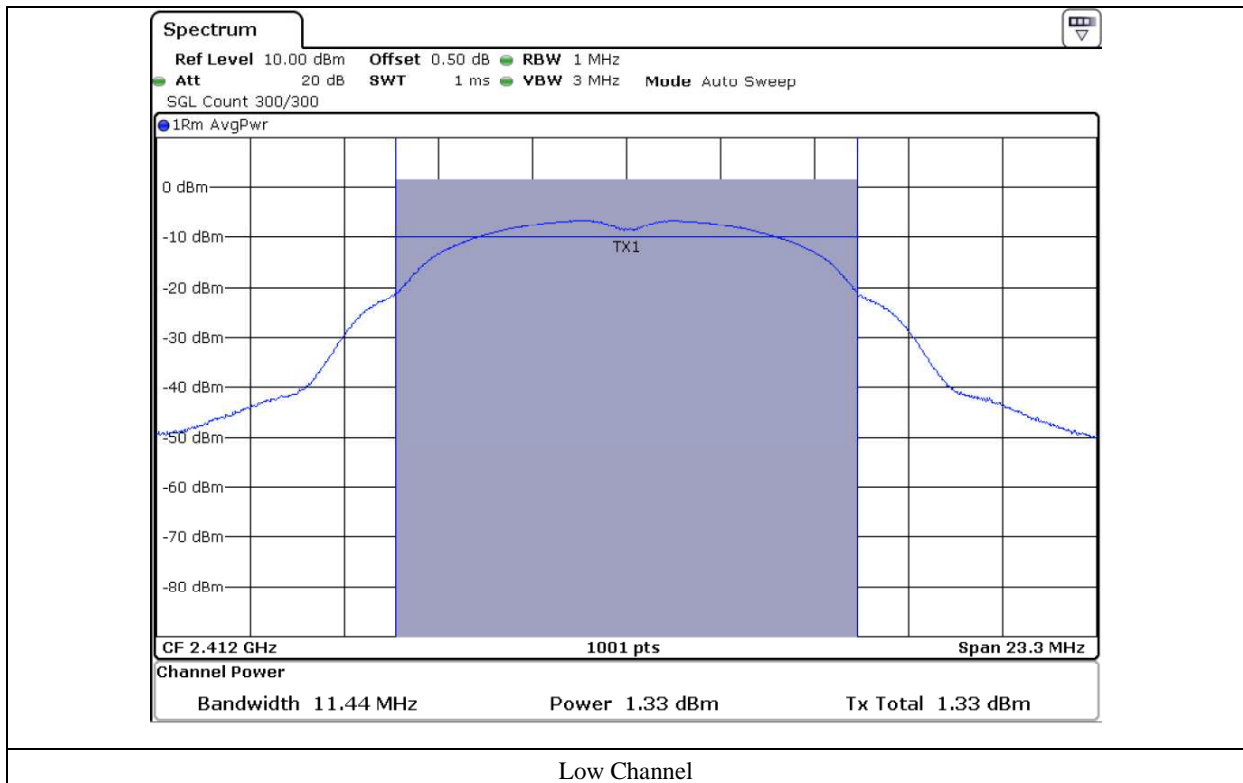
8.4 Test data for 802.11b WLAN Mode

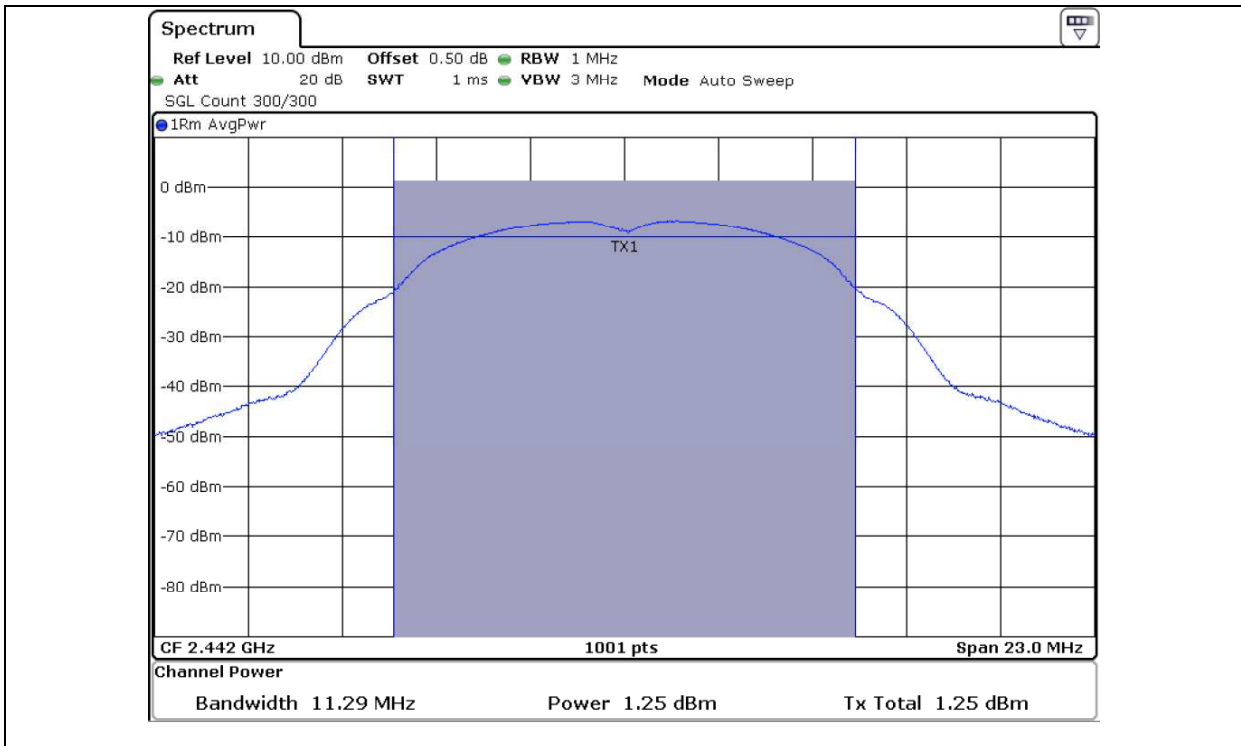
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass
- Duty Cycle : 88.94 %

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Correction Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	1.33	0.51	1.84	30.00	28.16
MIDDLE	2 442.00	1.25	0.51	1.76	30.00	28.24
HIGH	2 462.00	2.01	0.51	2.52	30.00	27.48

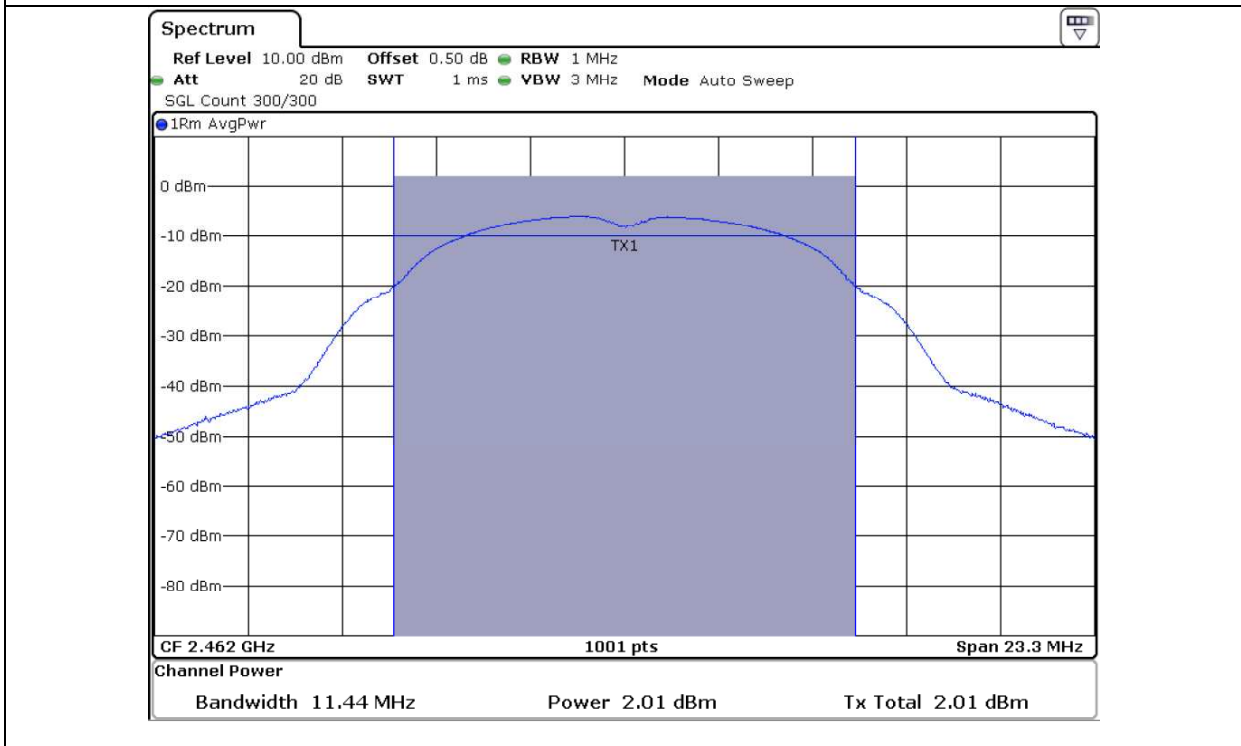
Remark : Margin = Limit – Result (= Measured Vlaue + Correction Factor)

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

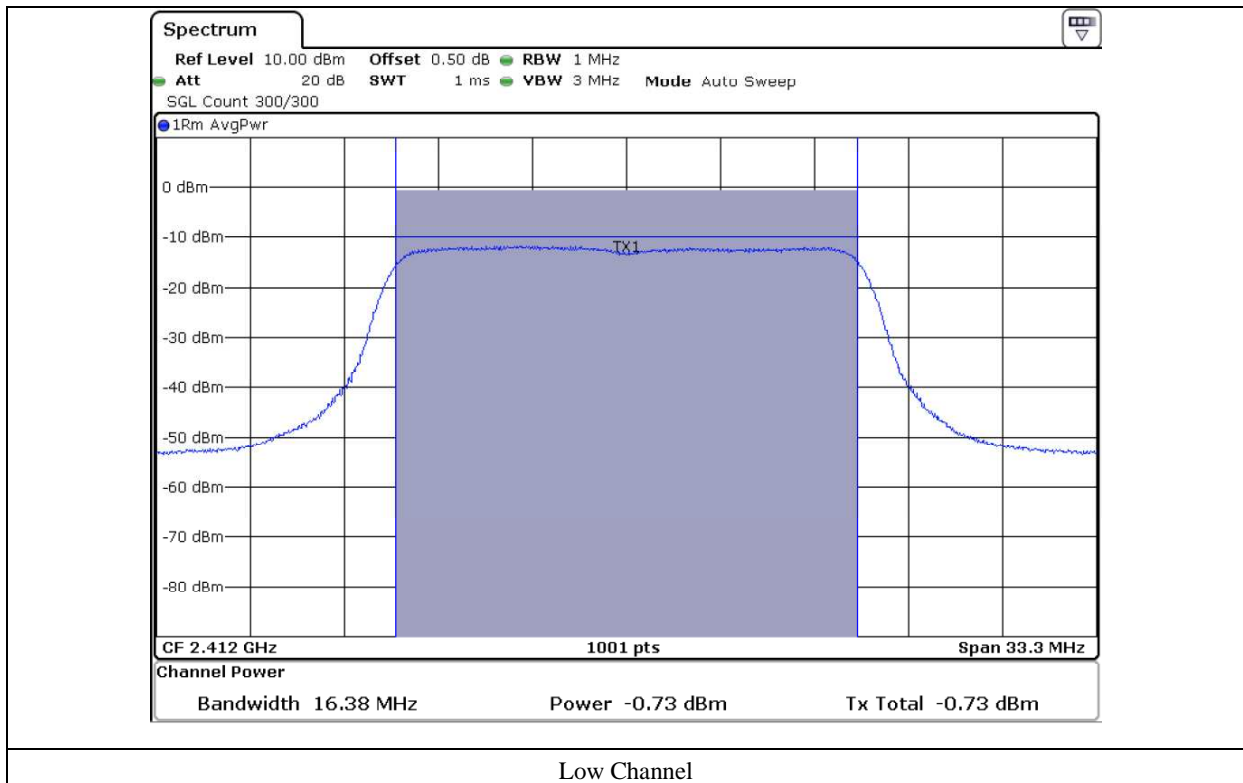
8.5 Test data for 802.11g WLAN Mode

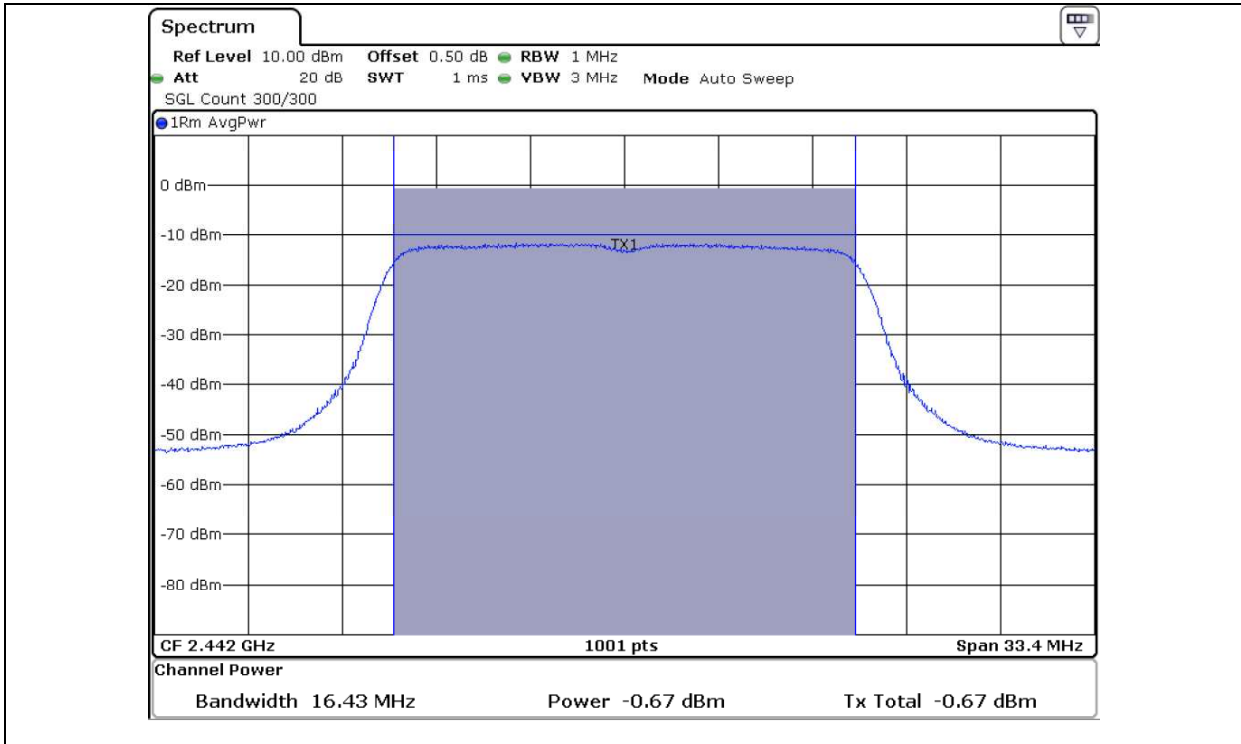
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass
- Duty Cycle : 87.05 %

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Correction Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	-0.73	0.60	-0.13	30.00	30.13
MIDDLE	2 442.00	-0.67	0.60	-0.07	30.00	30.07
HIGH	2 462.00	0.42	0.60	1.02	30.00	28.98

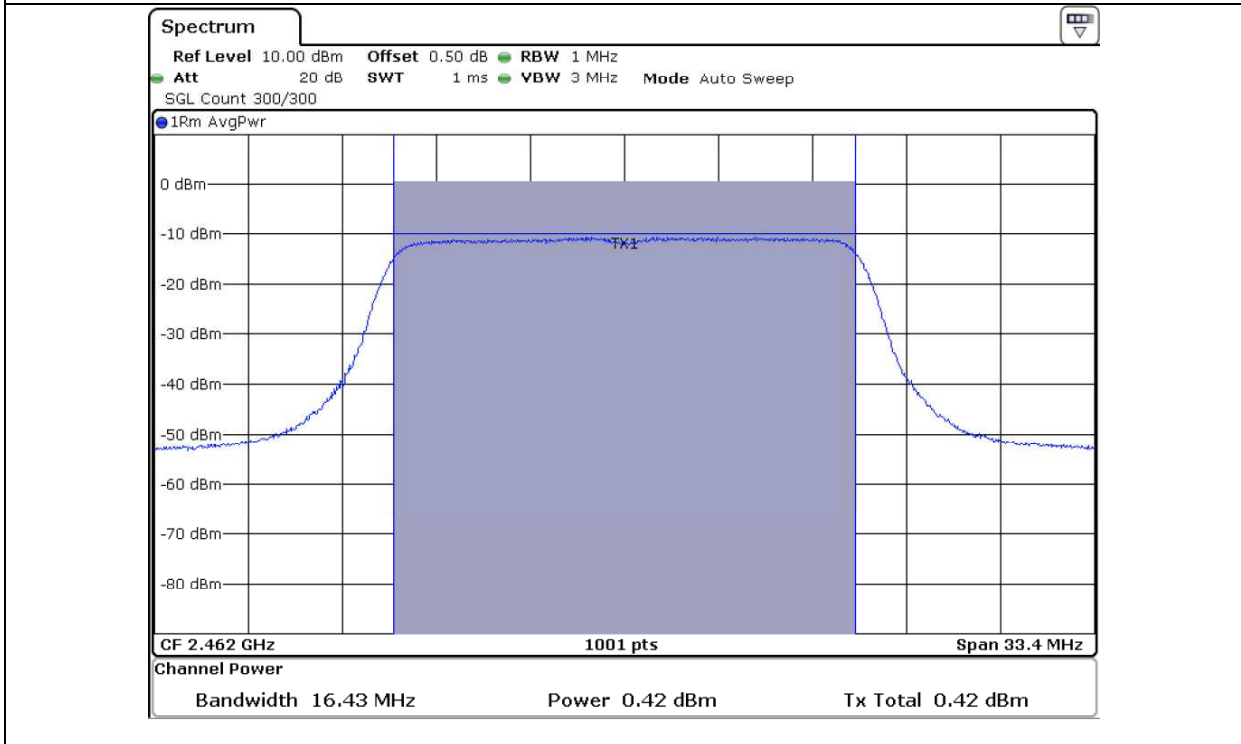
Remark : Margin = Limit – Result (= Measured Vlaue + Correction Factor)

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

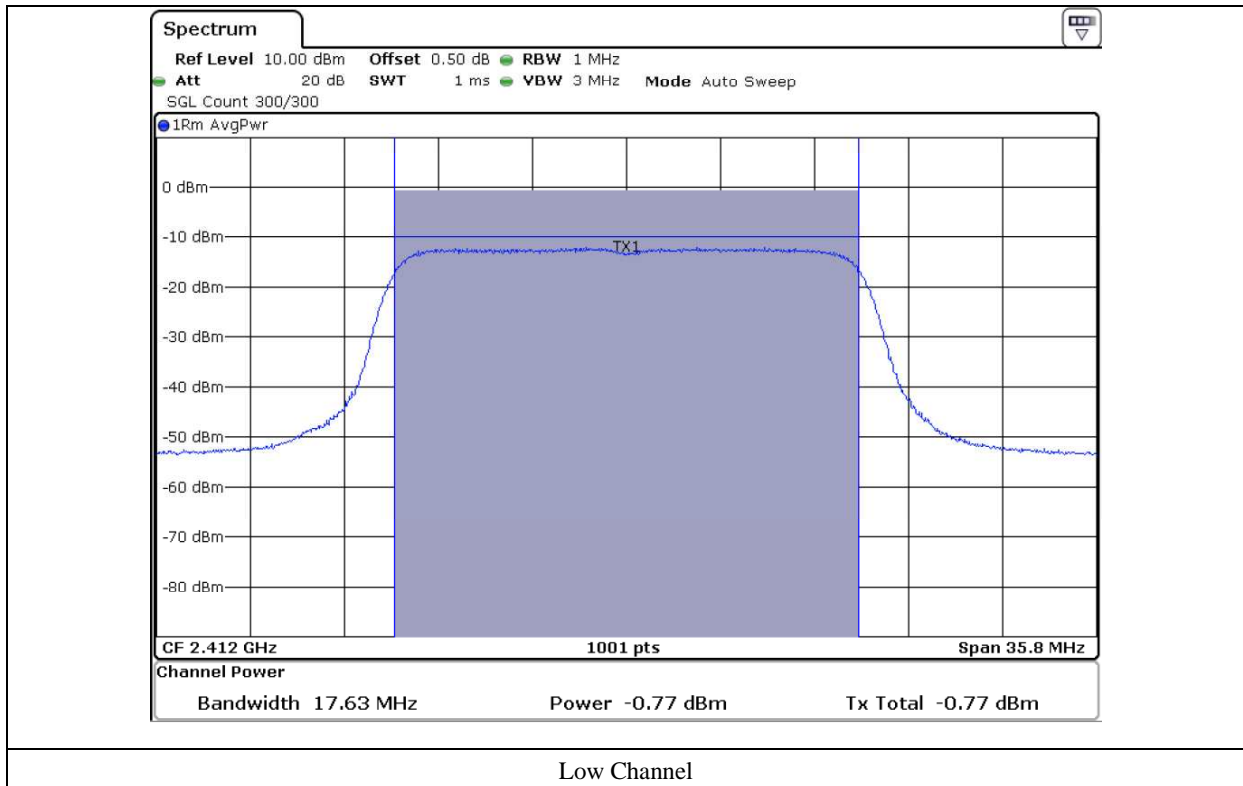
8.6 Test data for 802.11n_HT20 WLAN Mode

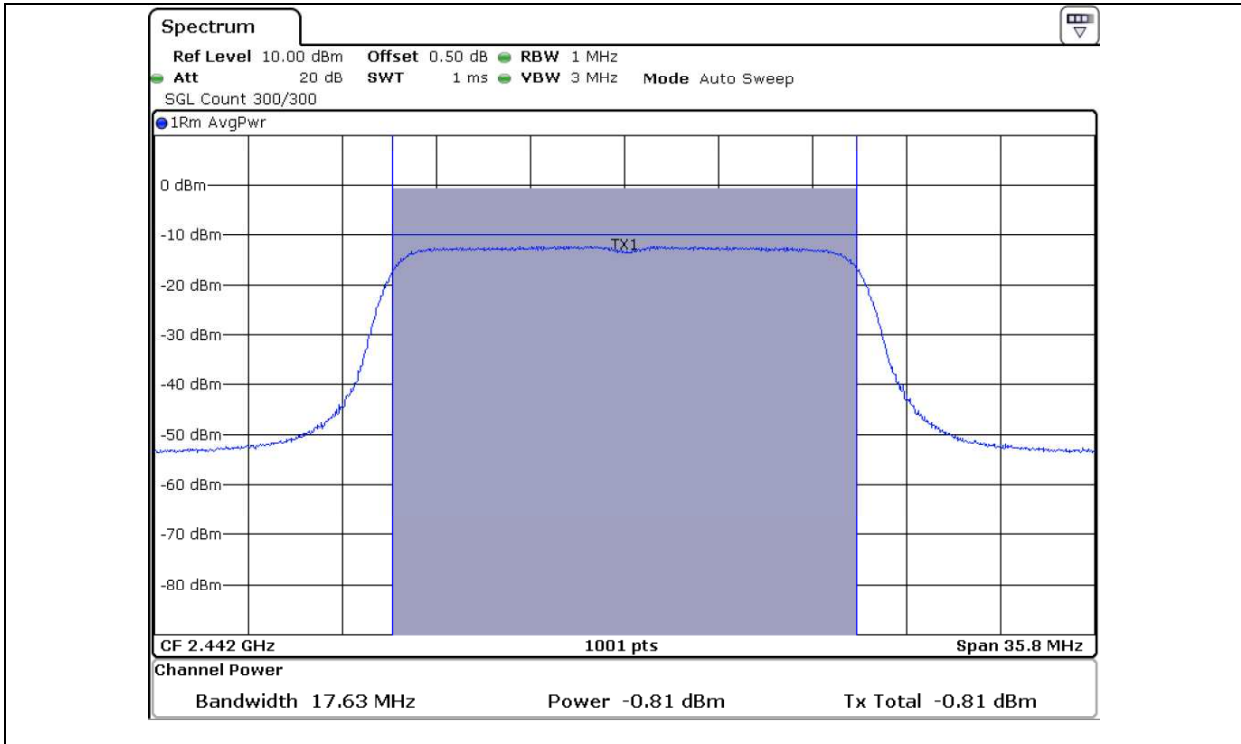
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass
- Duty Cycle : 86.31 %

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Correction Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	-0.77	0.64	-0.13	30.00	30.13
MIDDLE	2 442.00	-0.81	0.64	-0.17	30.00	30.17
HIGH	2 462.00	0.20	0.64	0.84	30.00	29.16

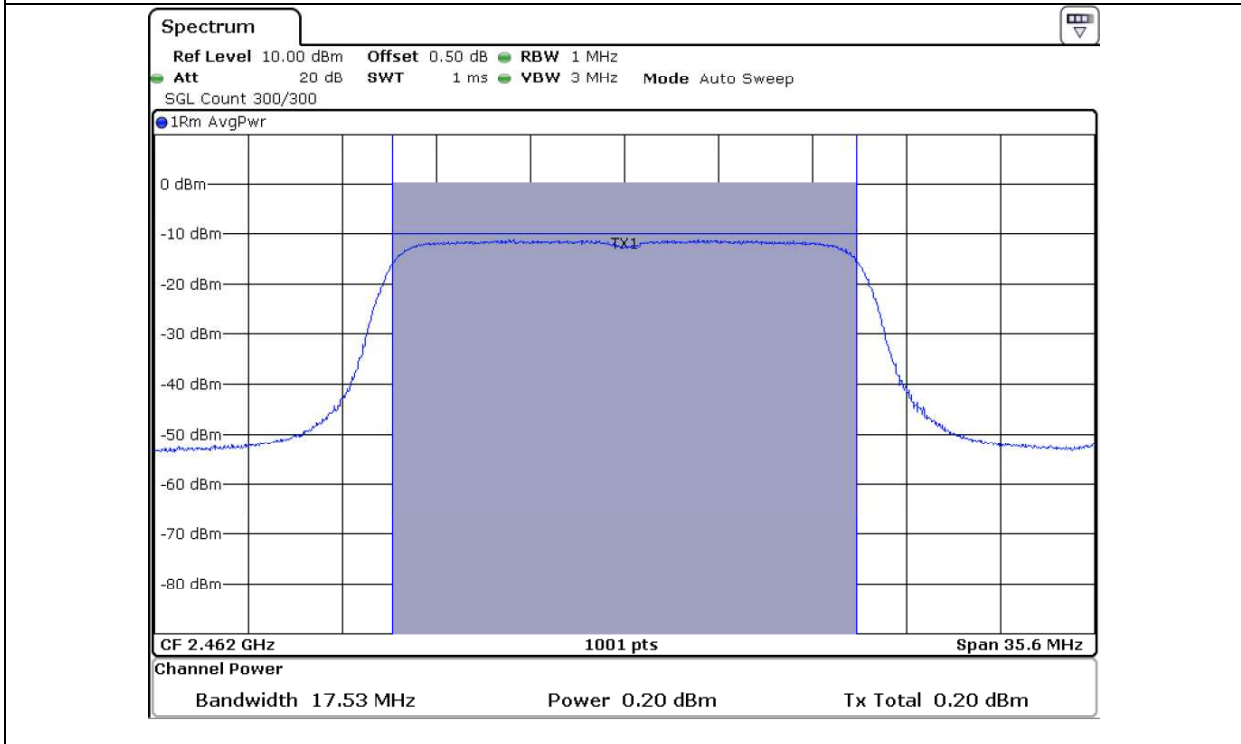
Remark : Margin = Limit – Result (= Measured Vlaue + Correction Factor)

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

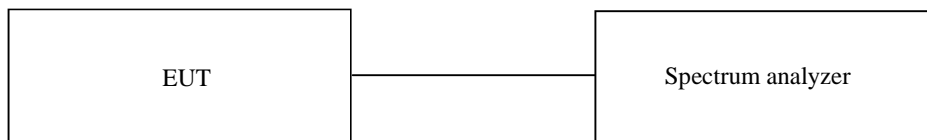
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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.

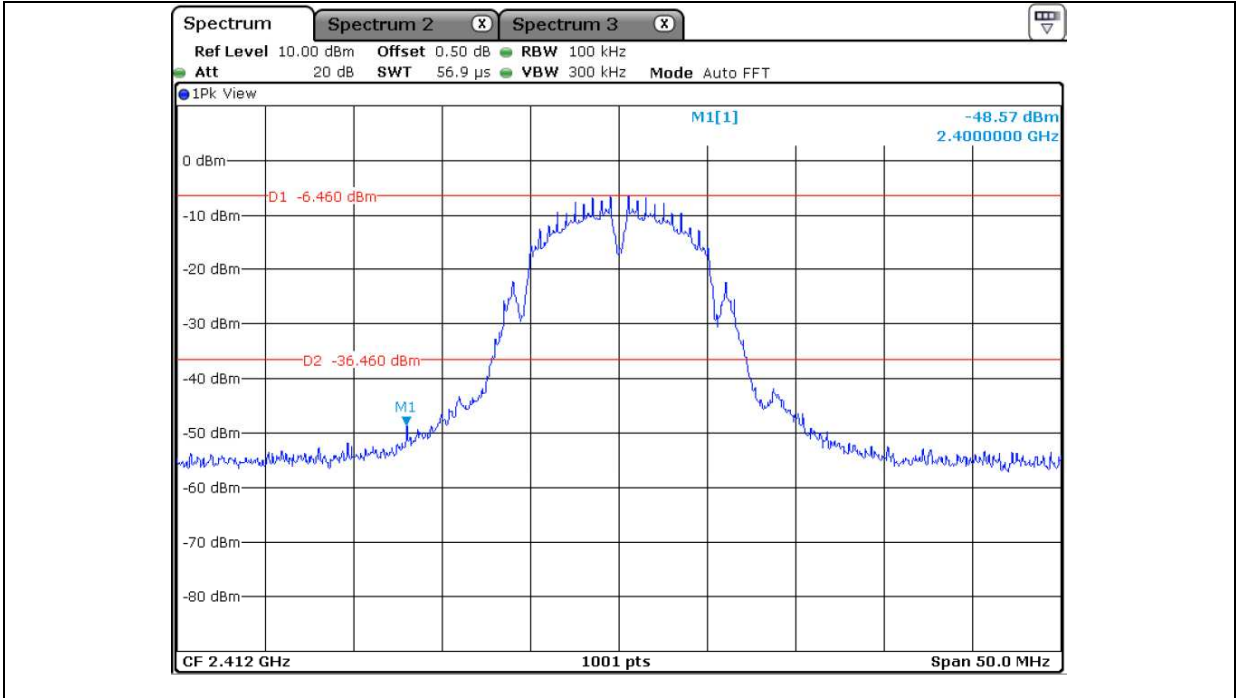
9.4 Test equipment used

	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	312545	Mar. 18, 2019 (1Y)
■ -	BBV9718	Schwarzbeck	Amplifier	310	Mar. 28, 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)
■ -	BBHA 9120D	Schwarzbeck	Horn Antenna	9120D-1366	Aug. 02, 2017 (2Y)
■ -	BBHA 9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jan. 16, 2019 (1Y)

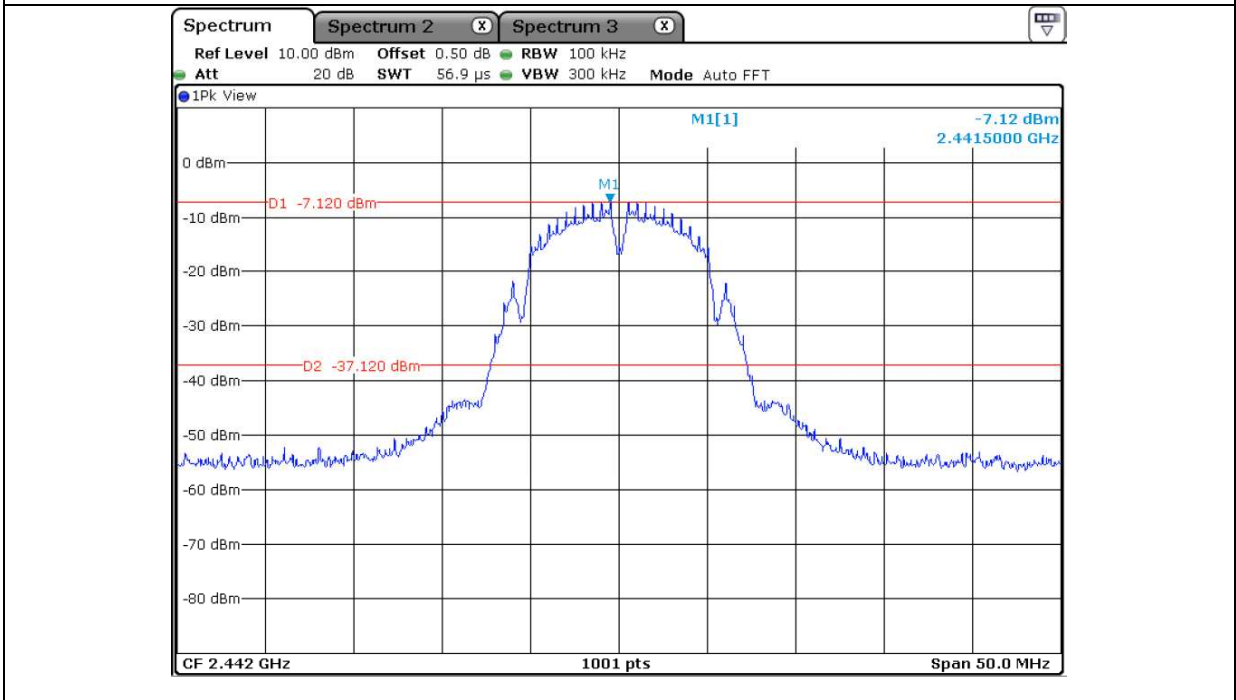
All test equipment used is calibrated on a regular basis.

9.5 Test data for conducted emission

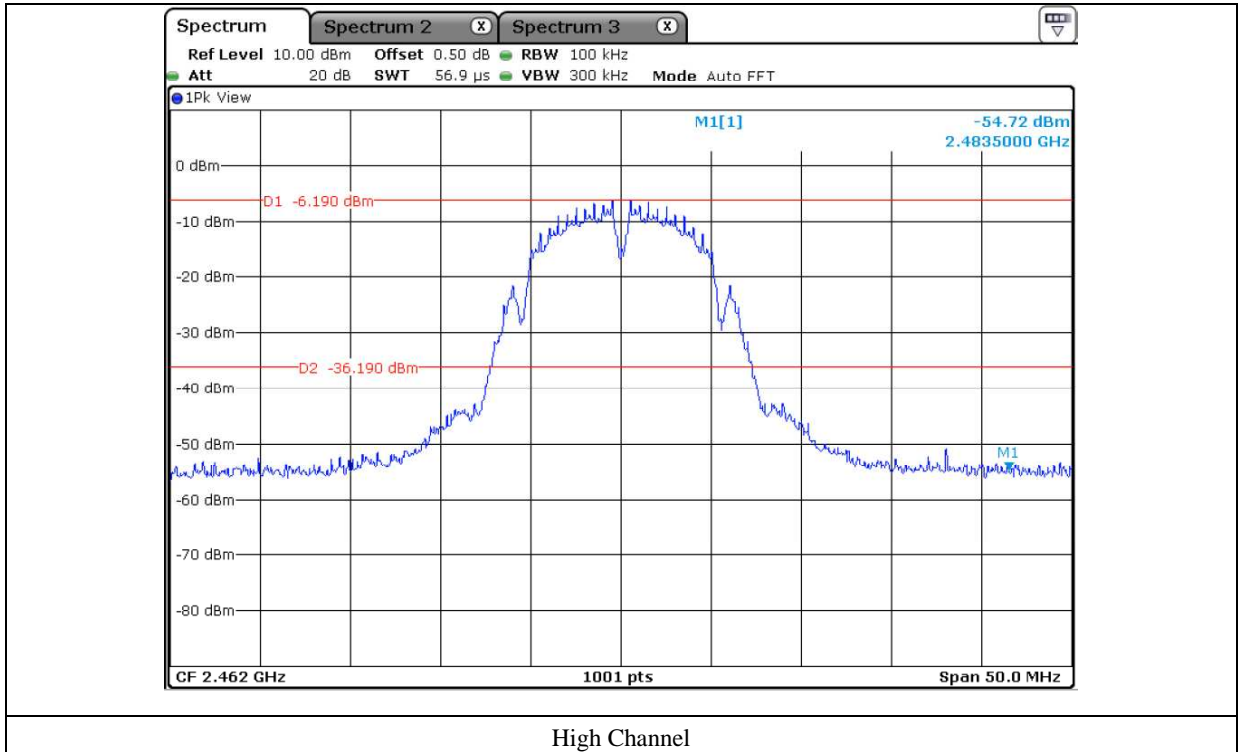
9.5.1 Test data for 802.11b WLAN Mode



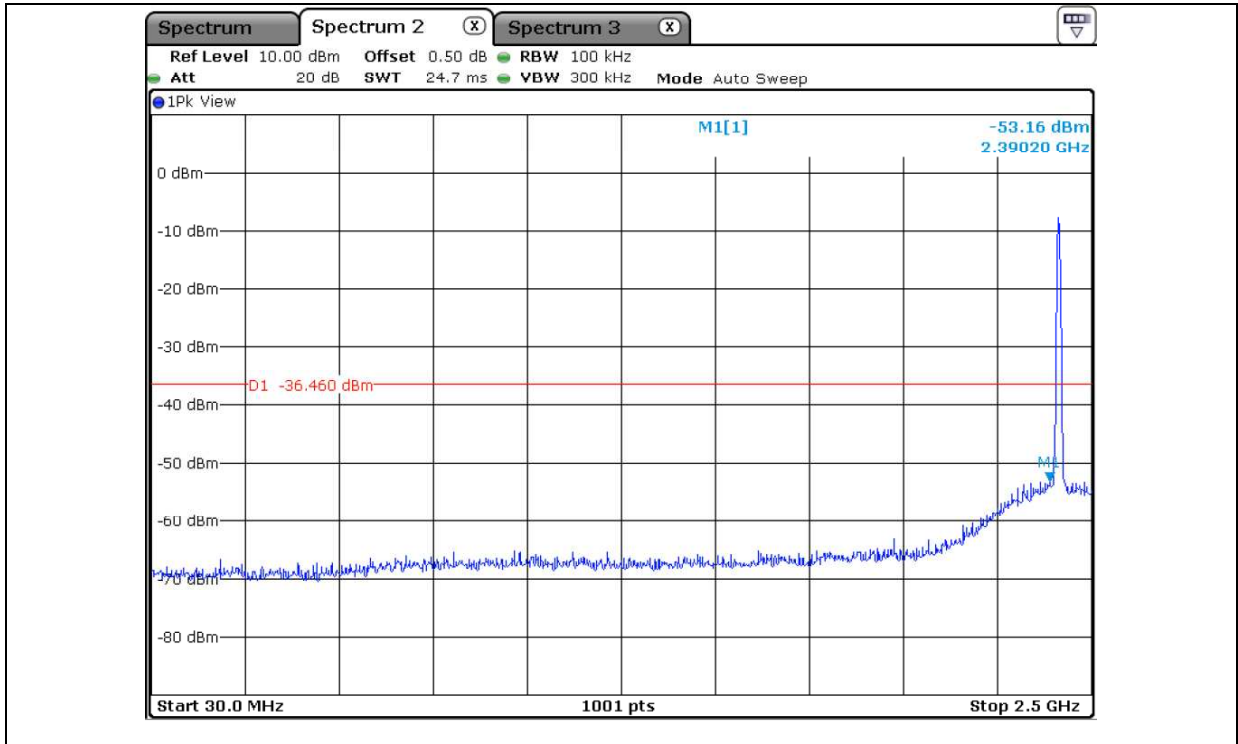
Low Channel



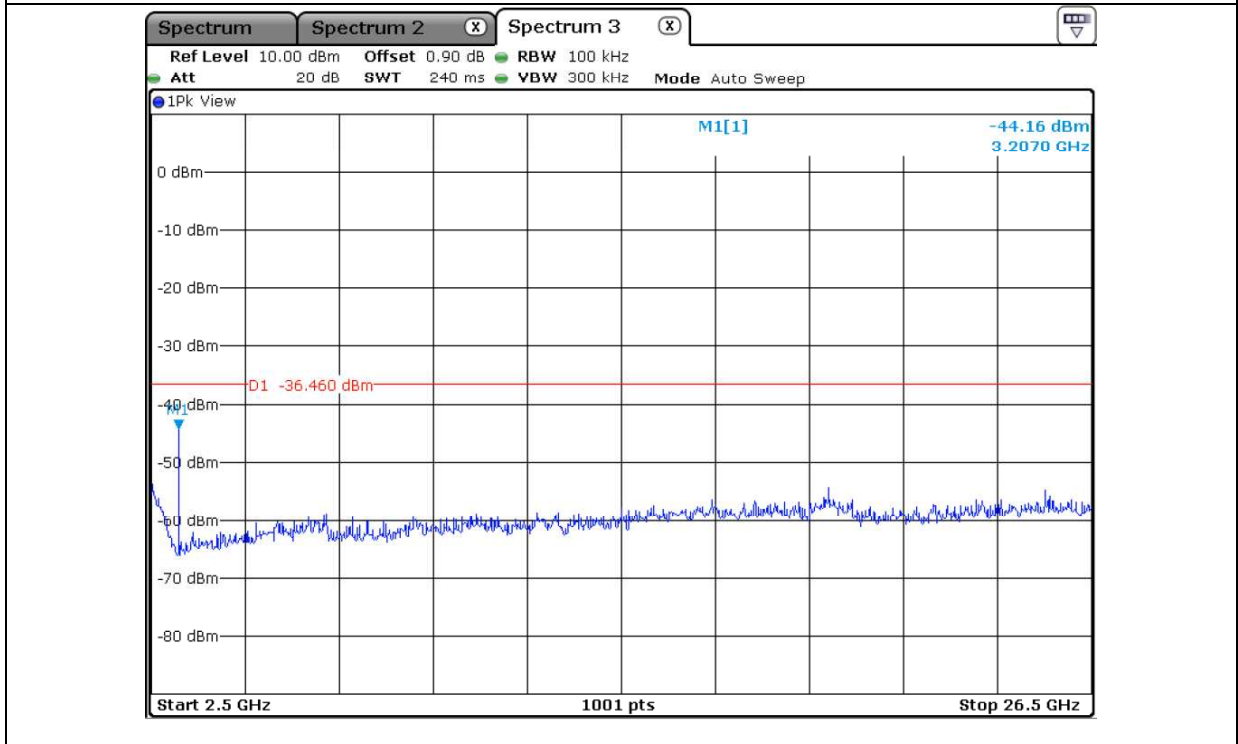
Middle Channel



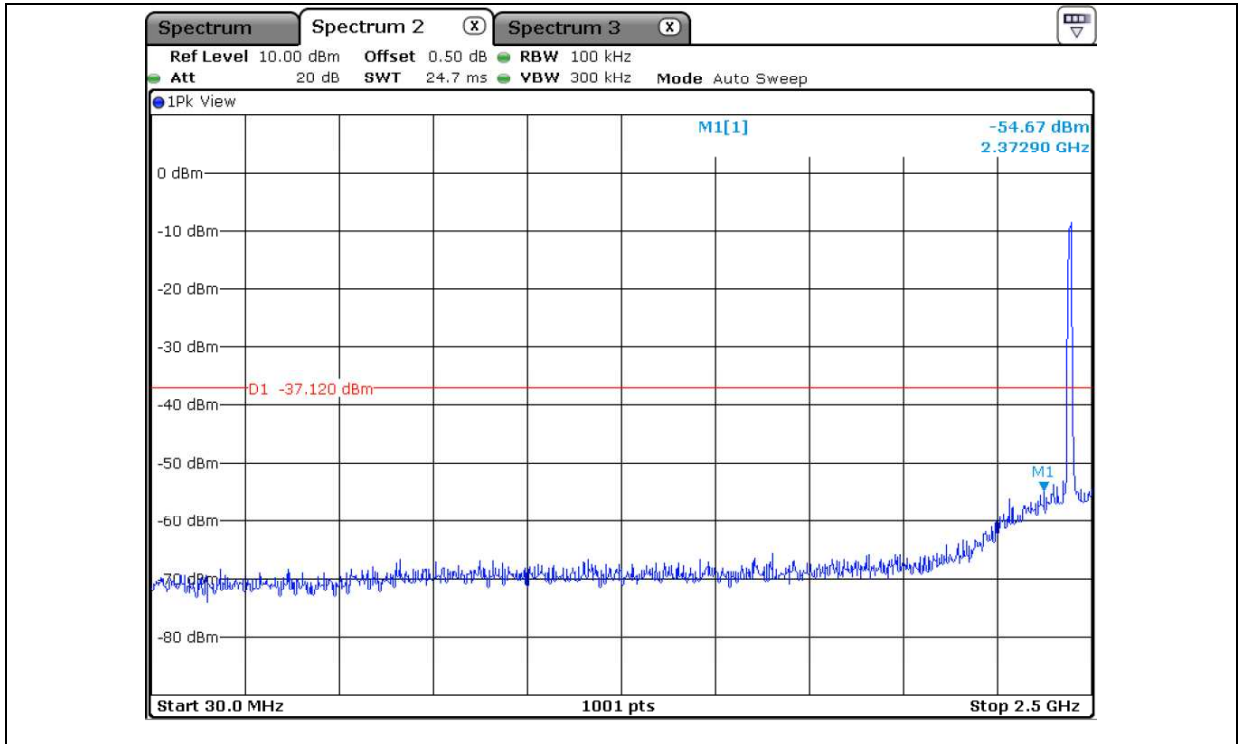
High Channel



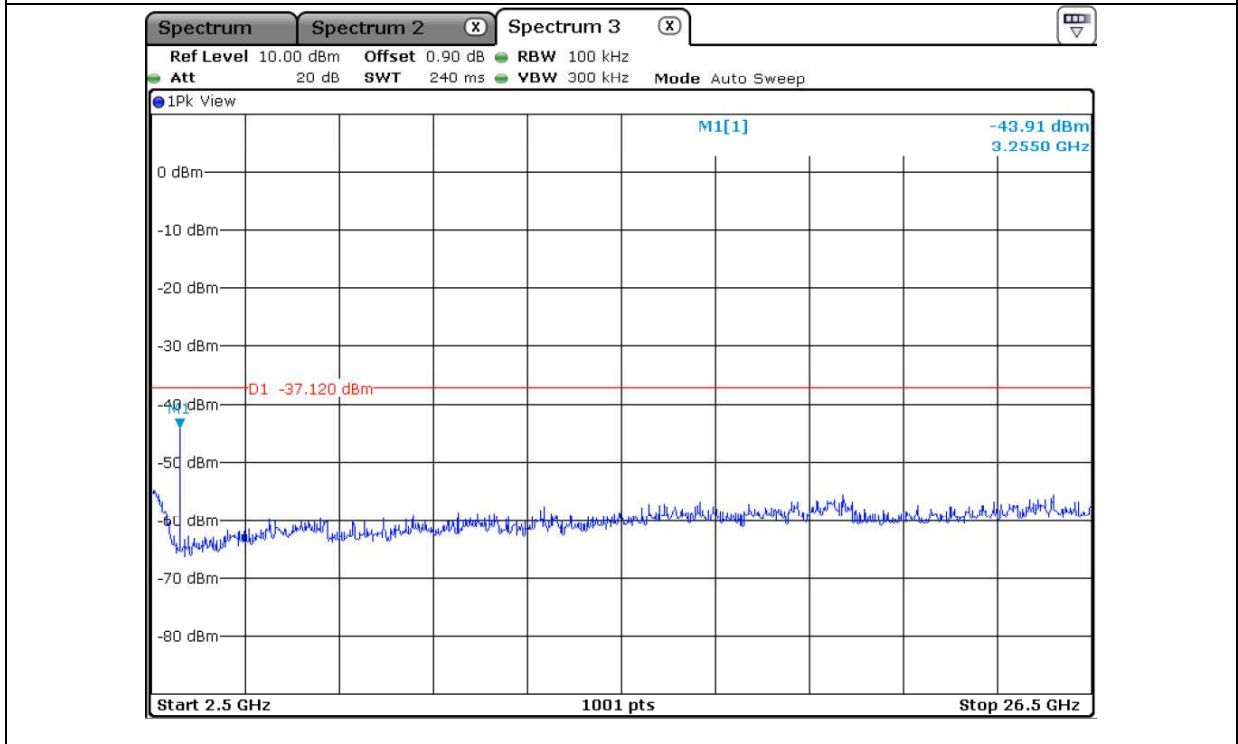
Low Channel



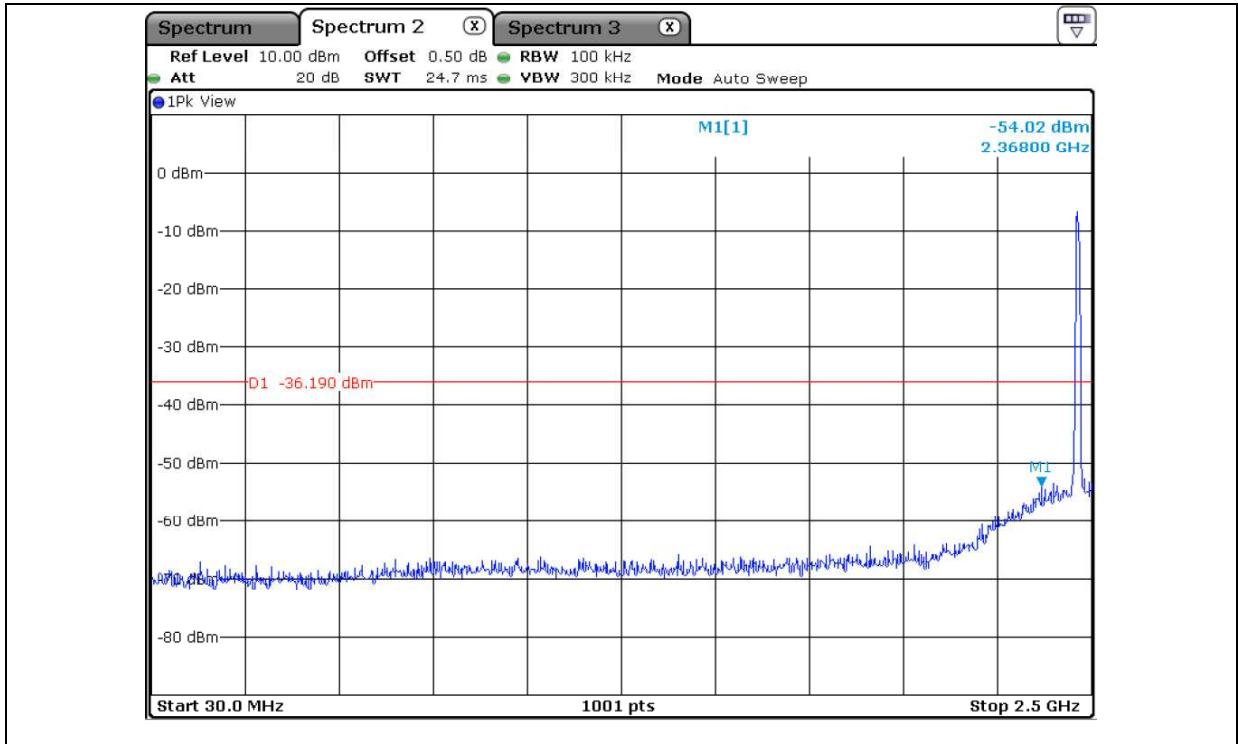
Low Channel



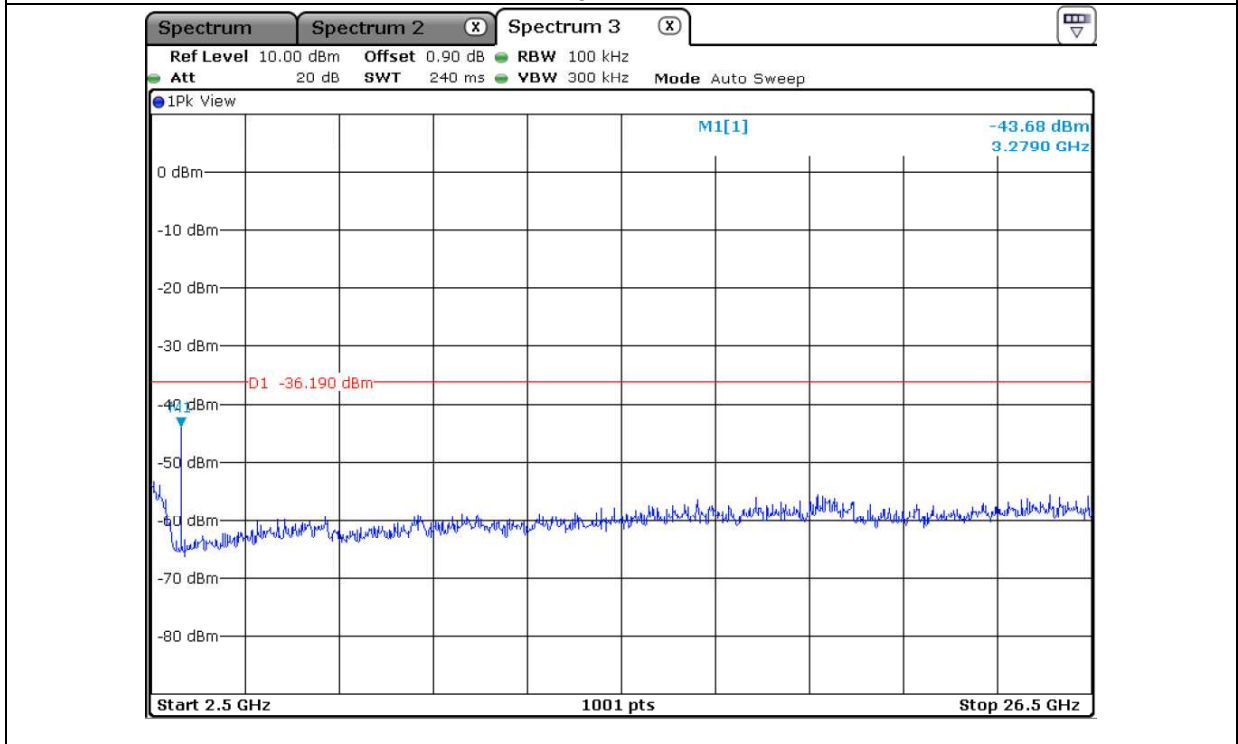
Middle Channel



Middle Channel

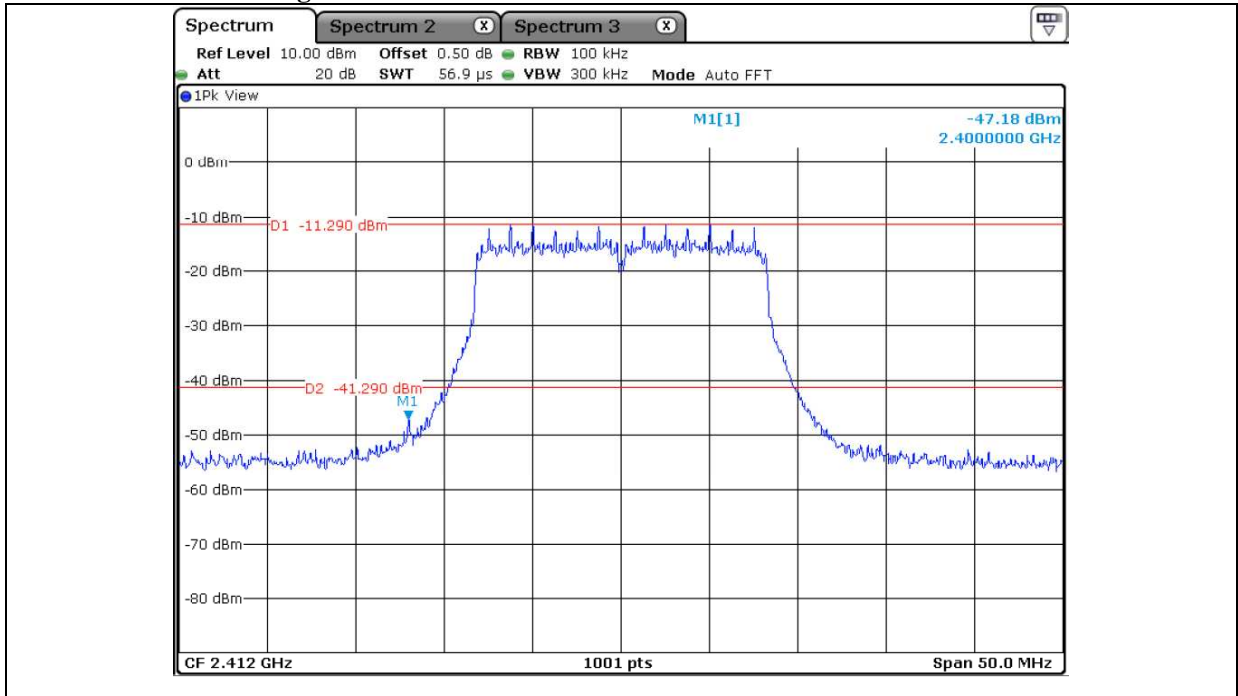


High Channel

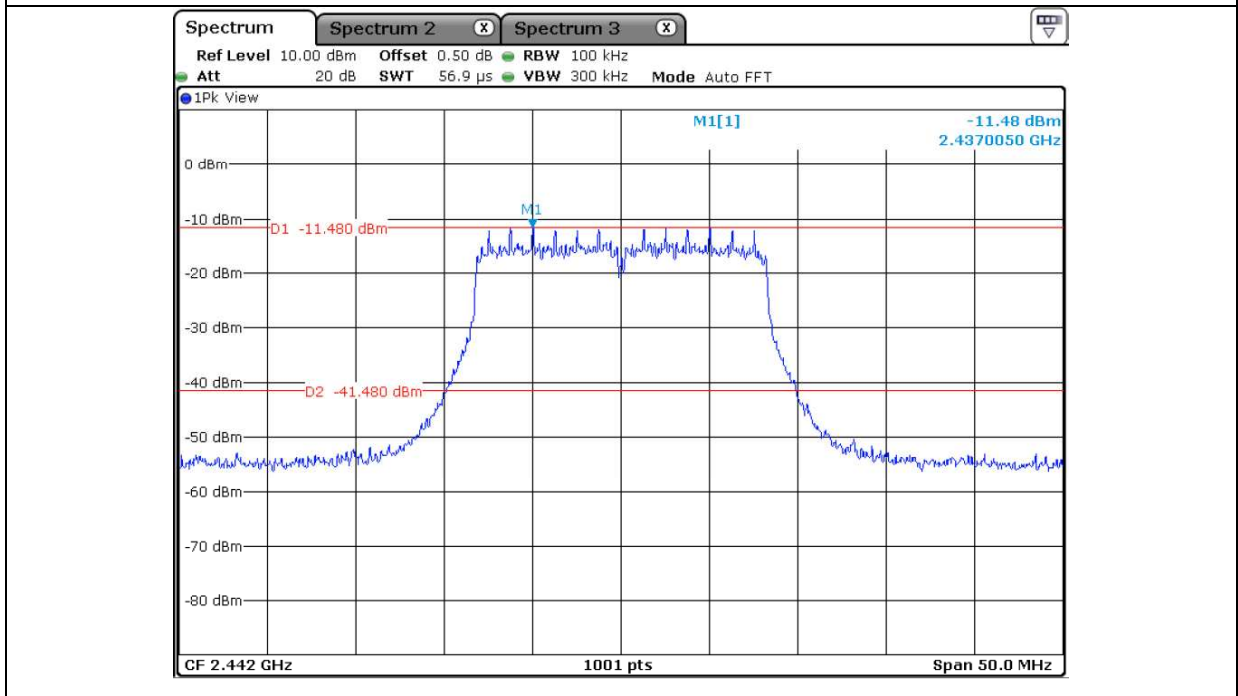


High Channel

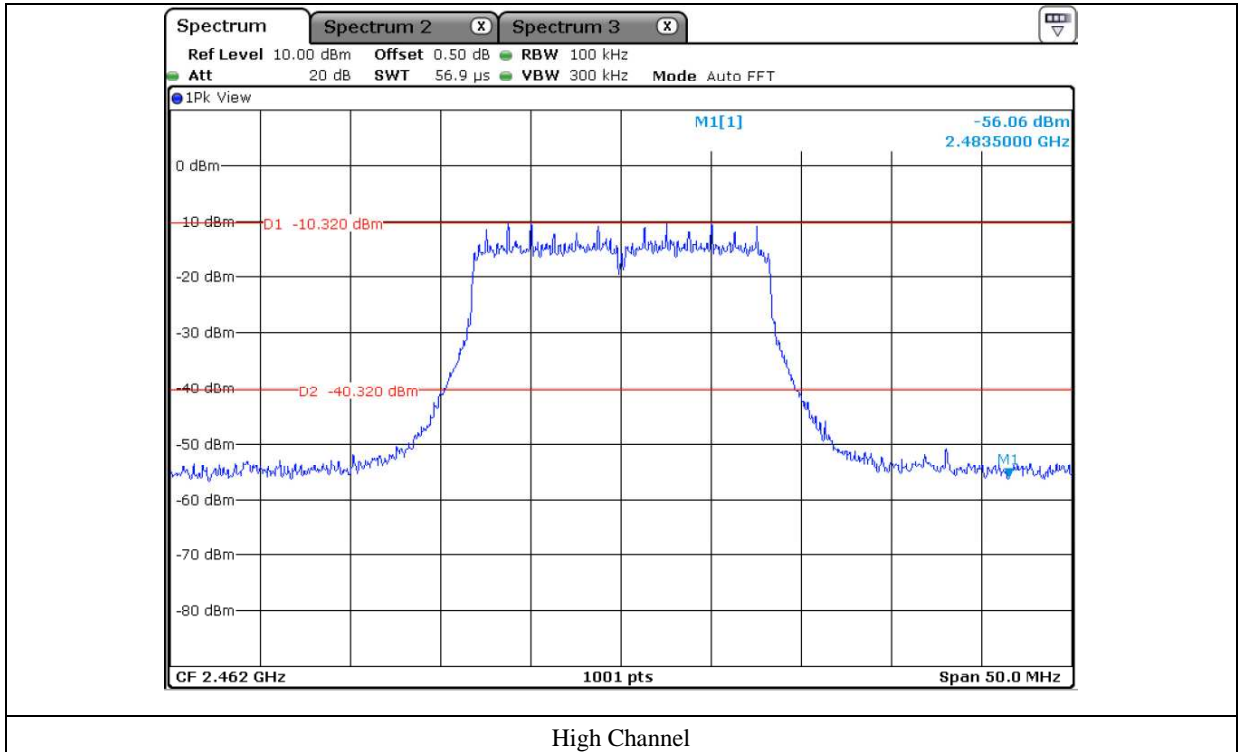
9.5.2 Test data for 802.11g WLAN Mode

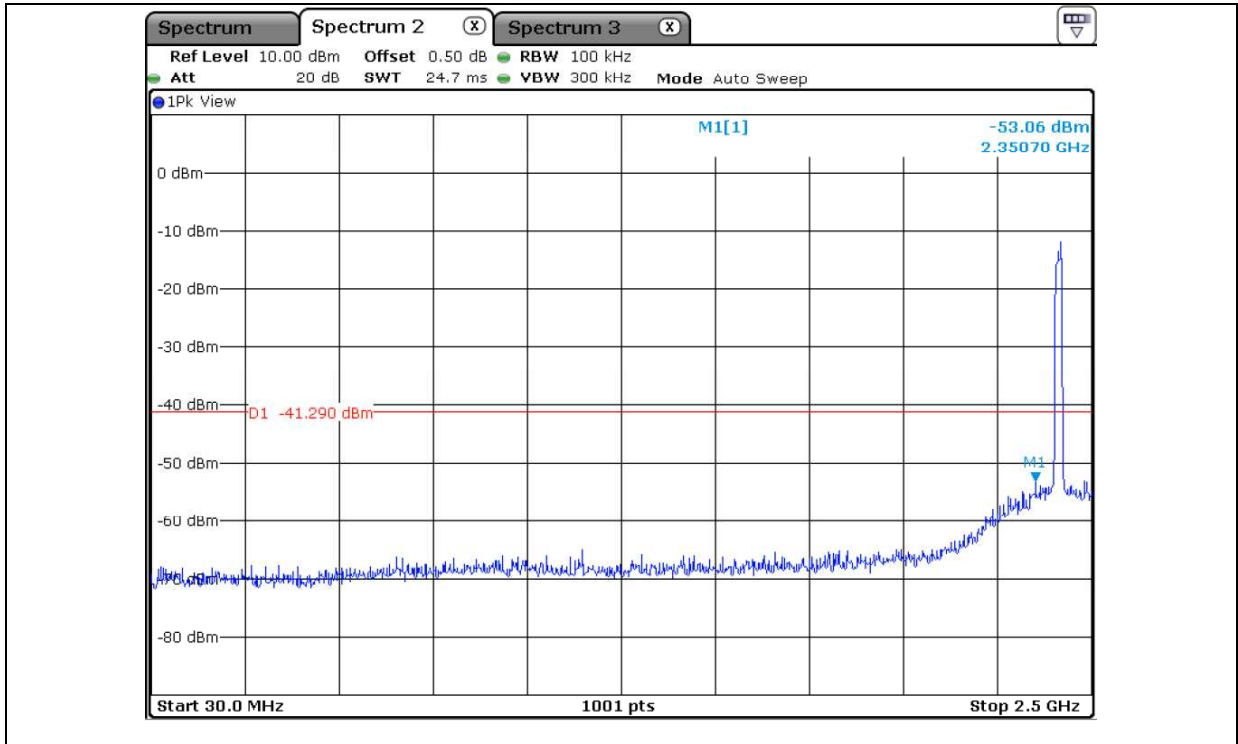


Low Channel

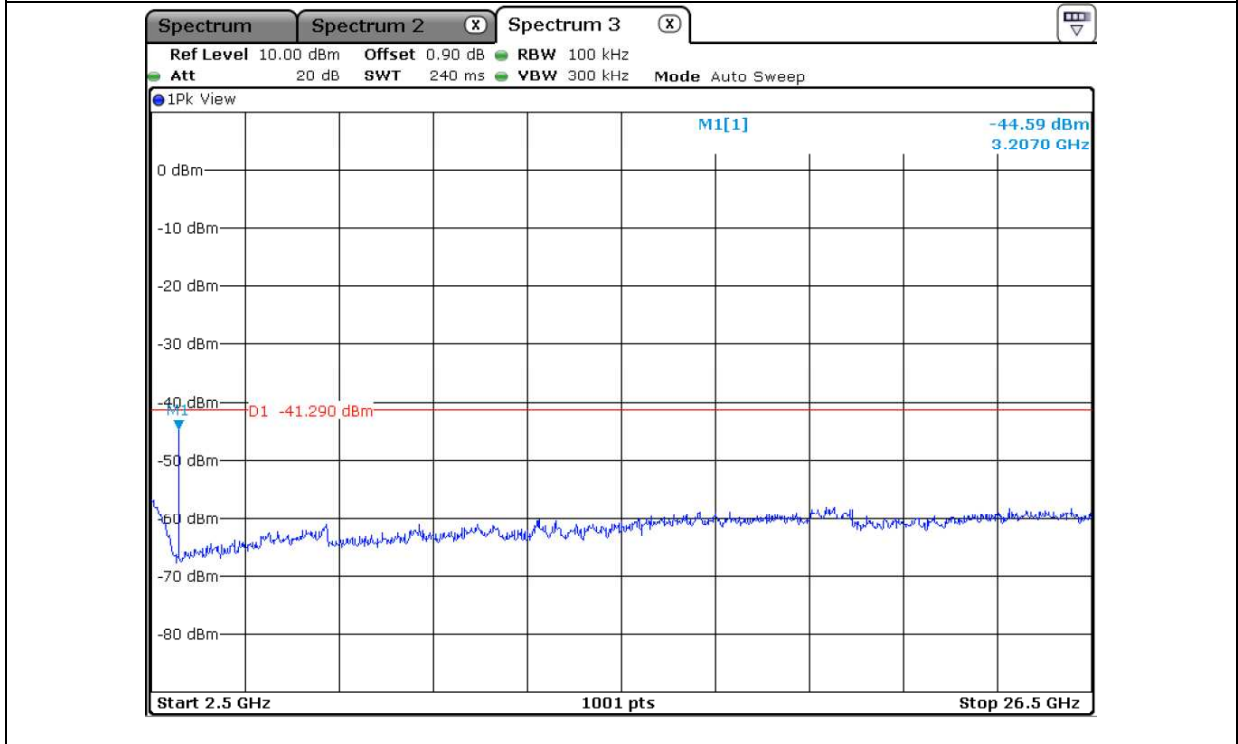


Middle Channel

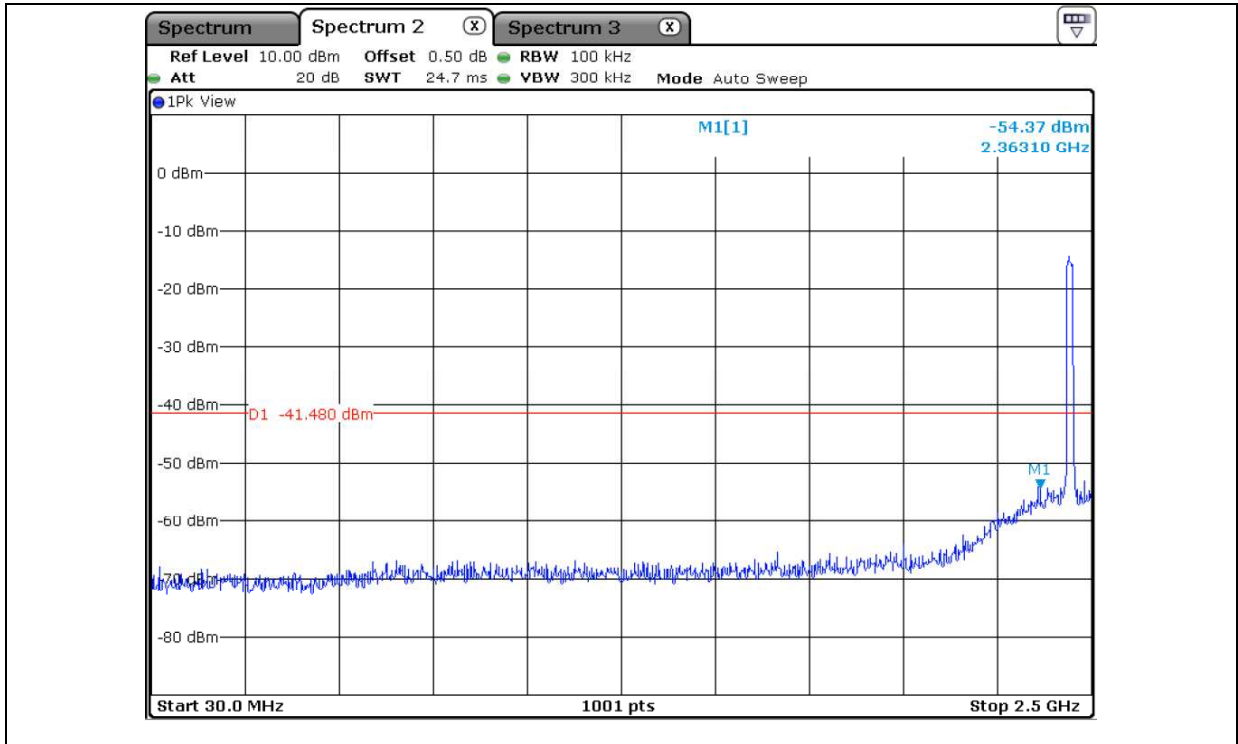




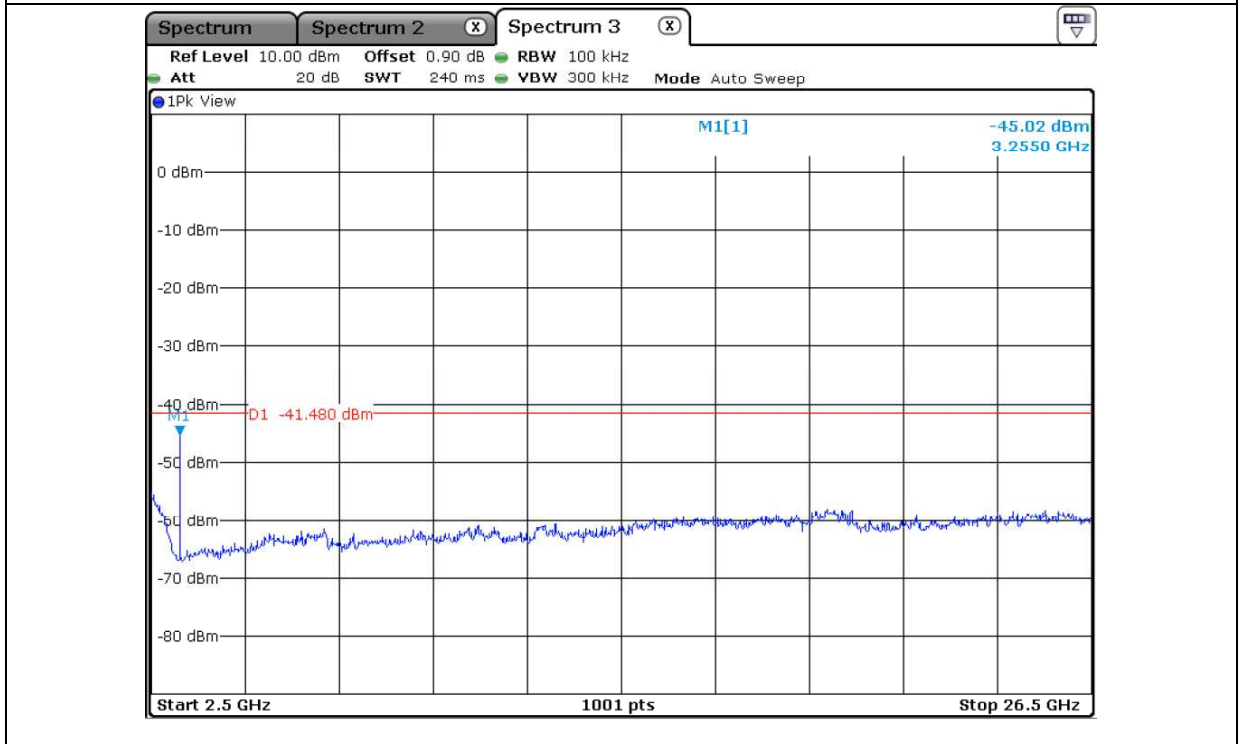
Low Channel



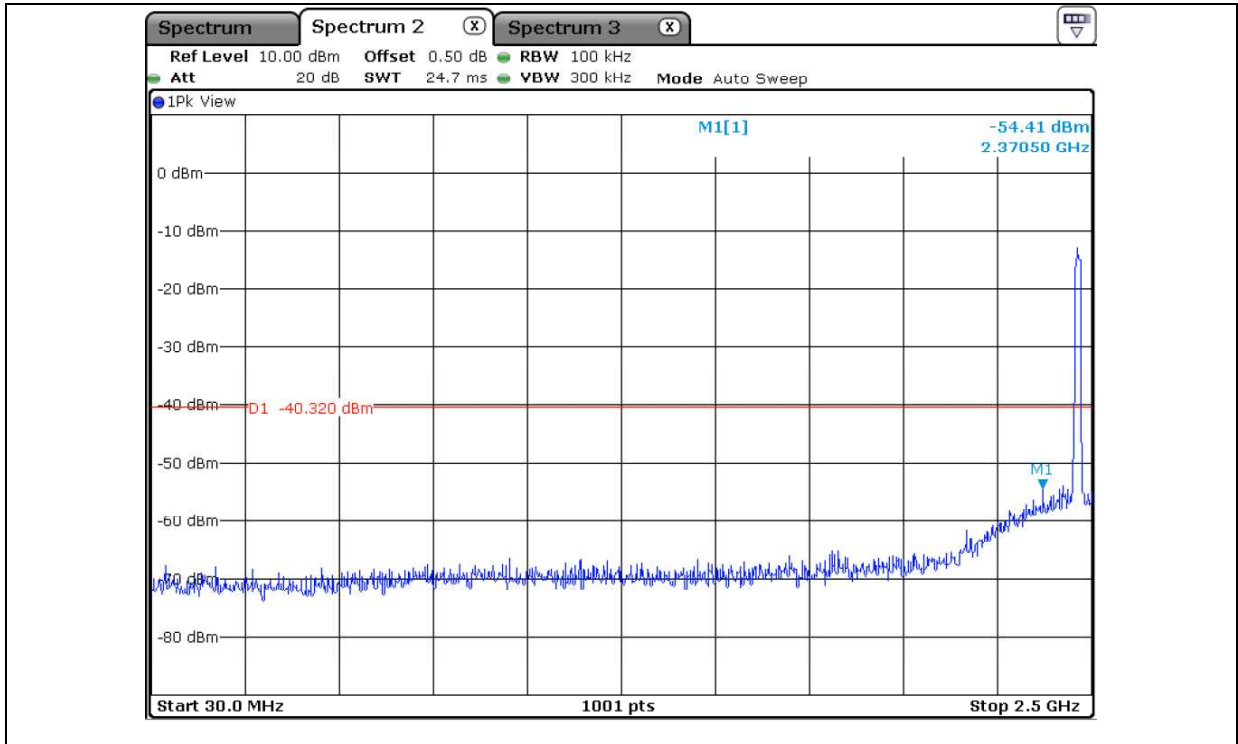
Low Channel



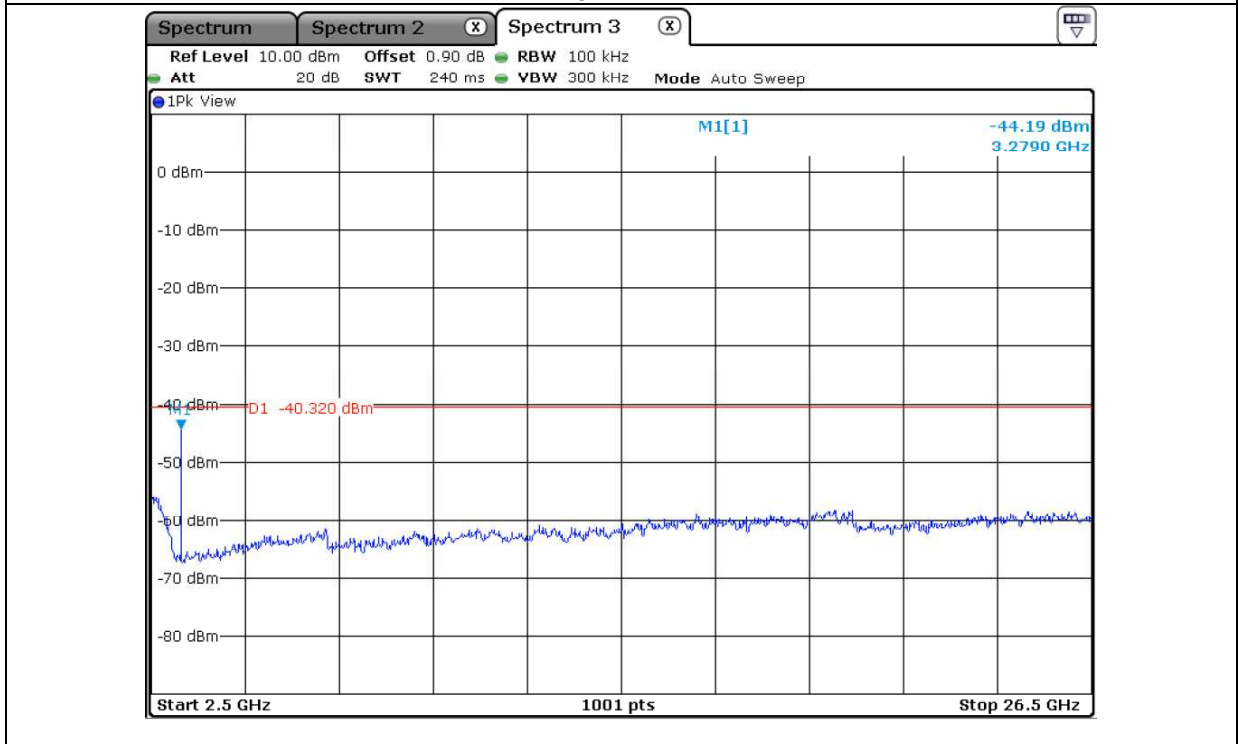
Middle Channel



Middle Channel

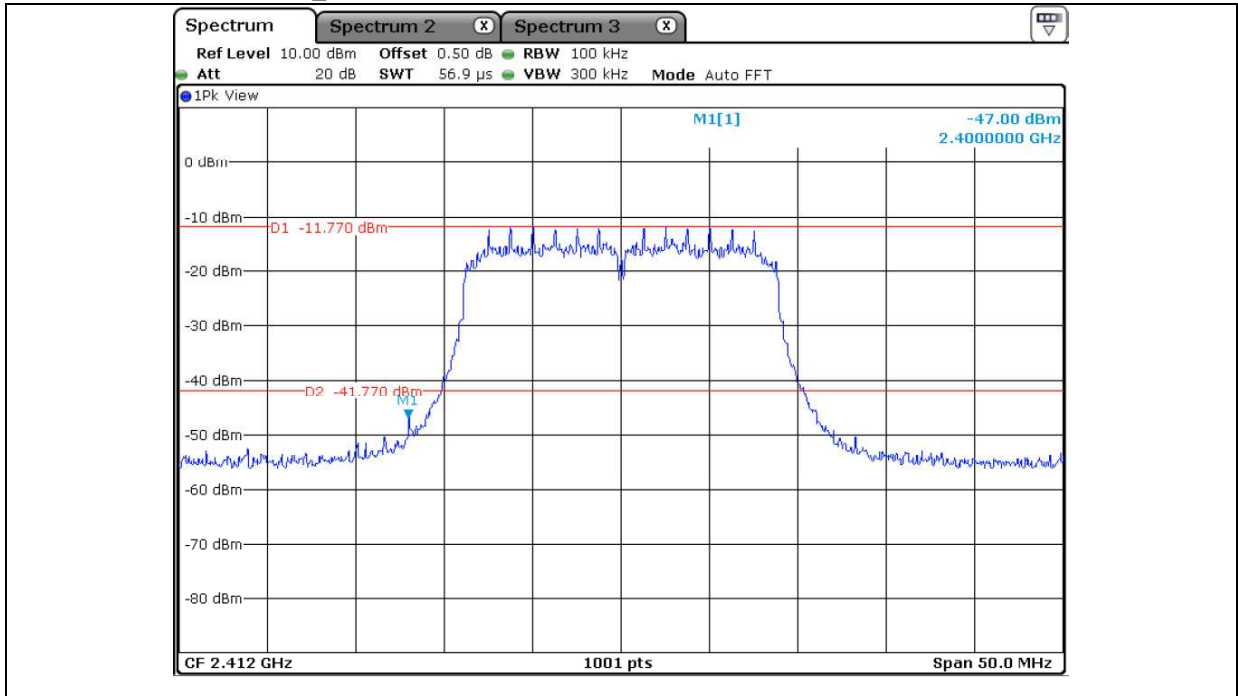


High Channel

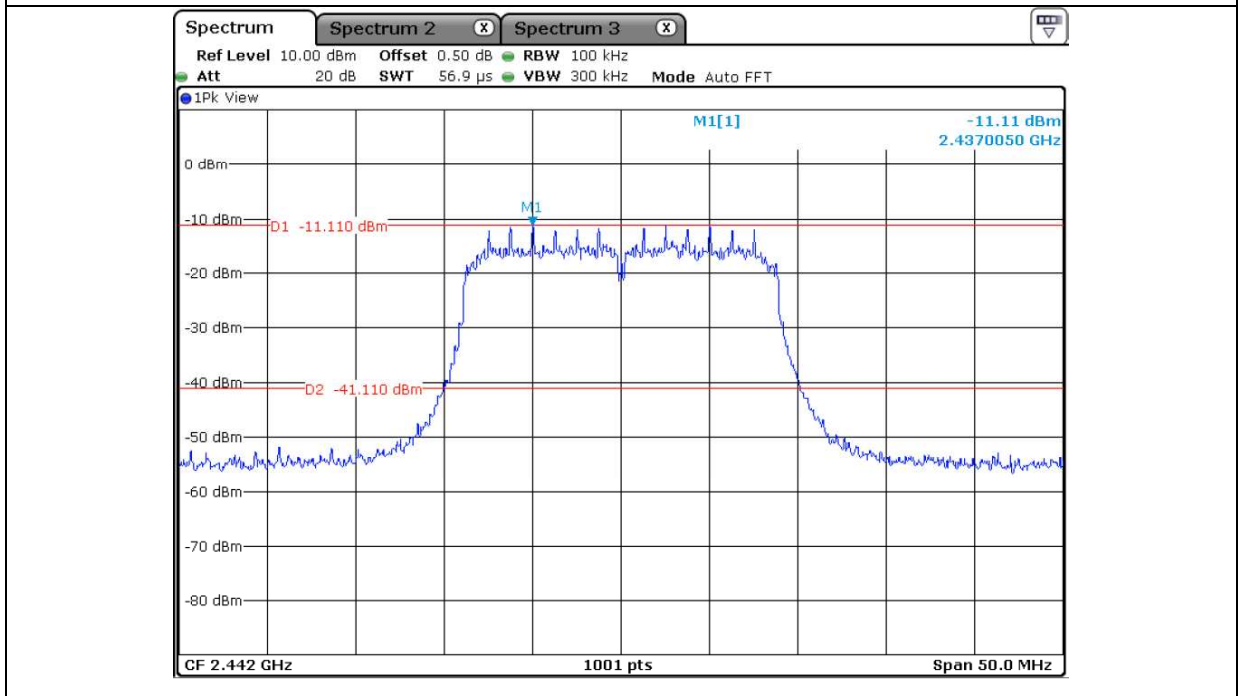


High Channel

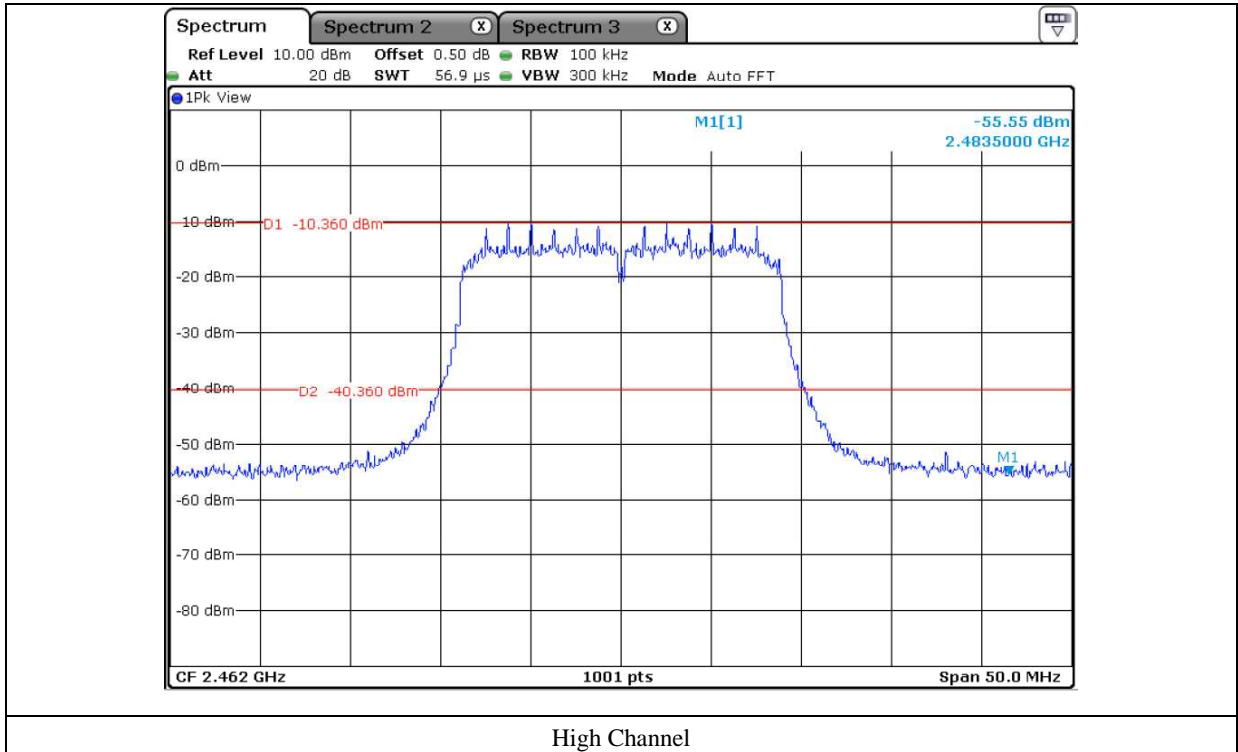
9.5.3 Test data for 802.11n_HT20 WLAN Mode



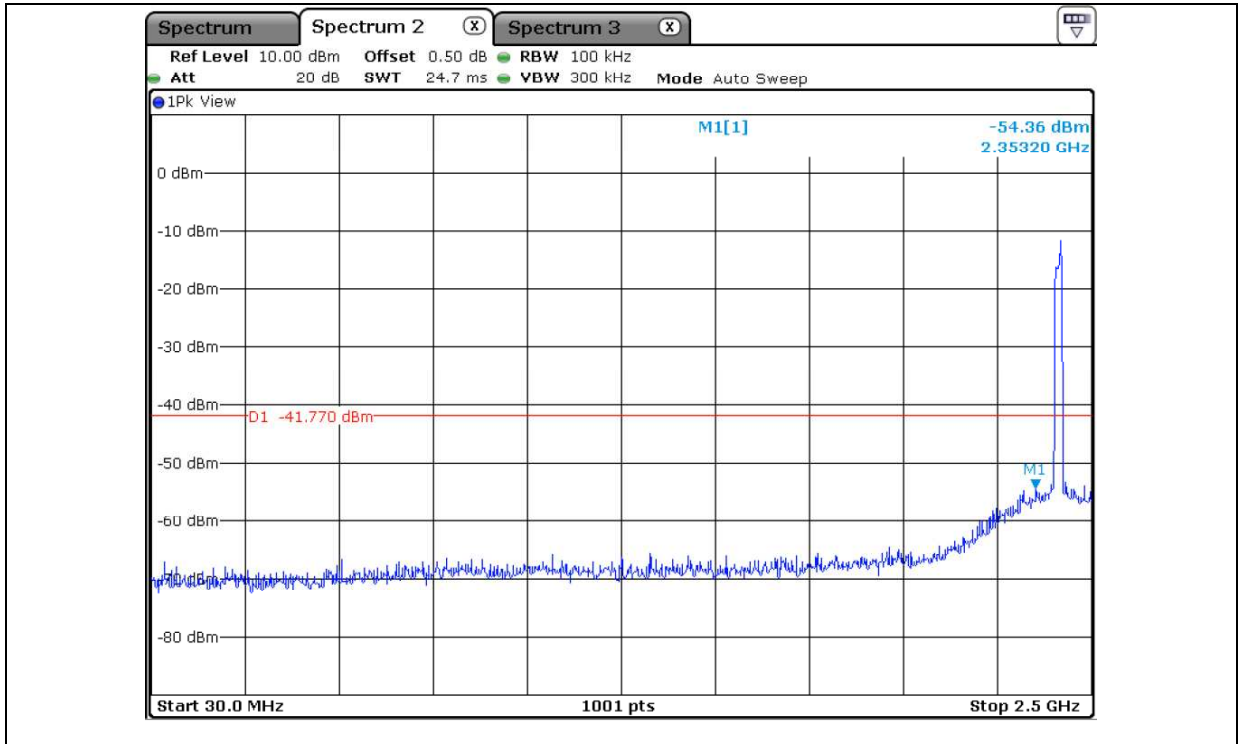
Low Channel



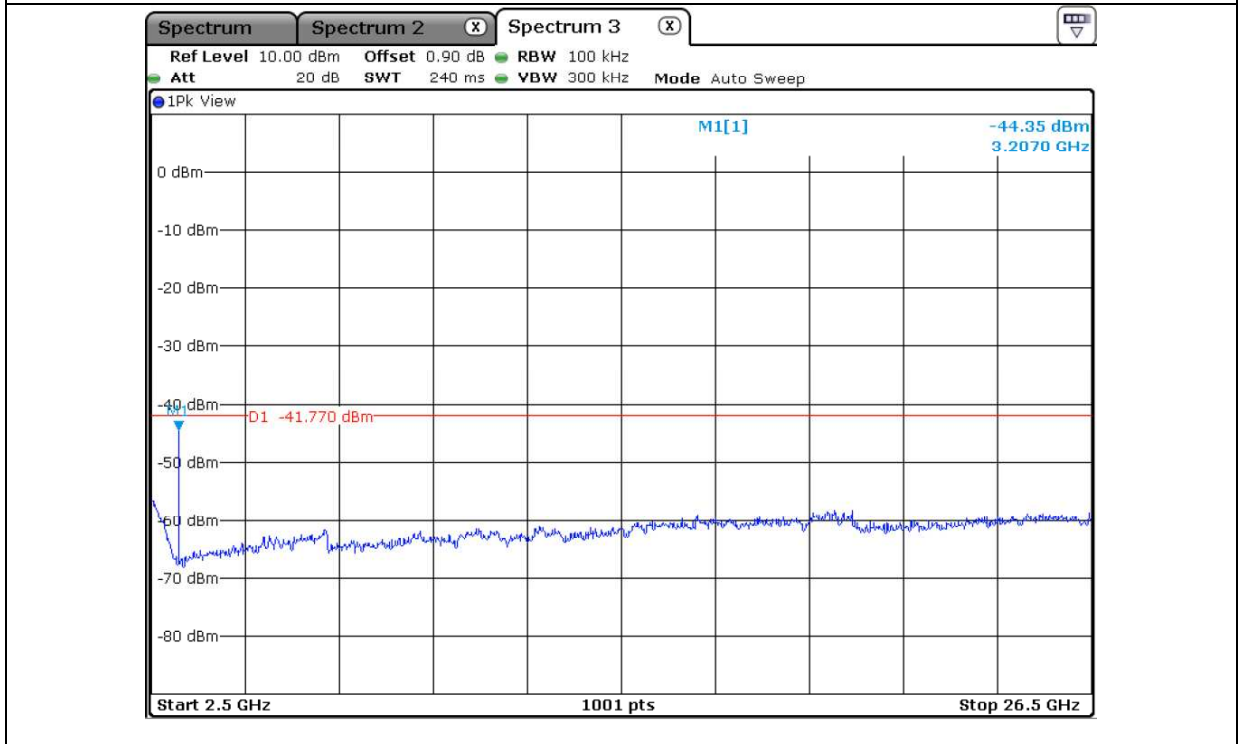
Middle Channel



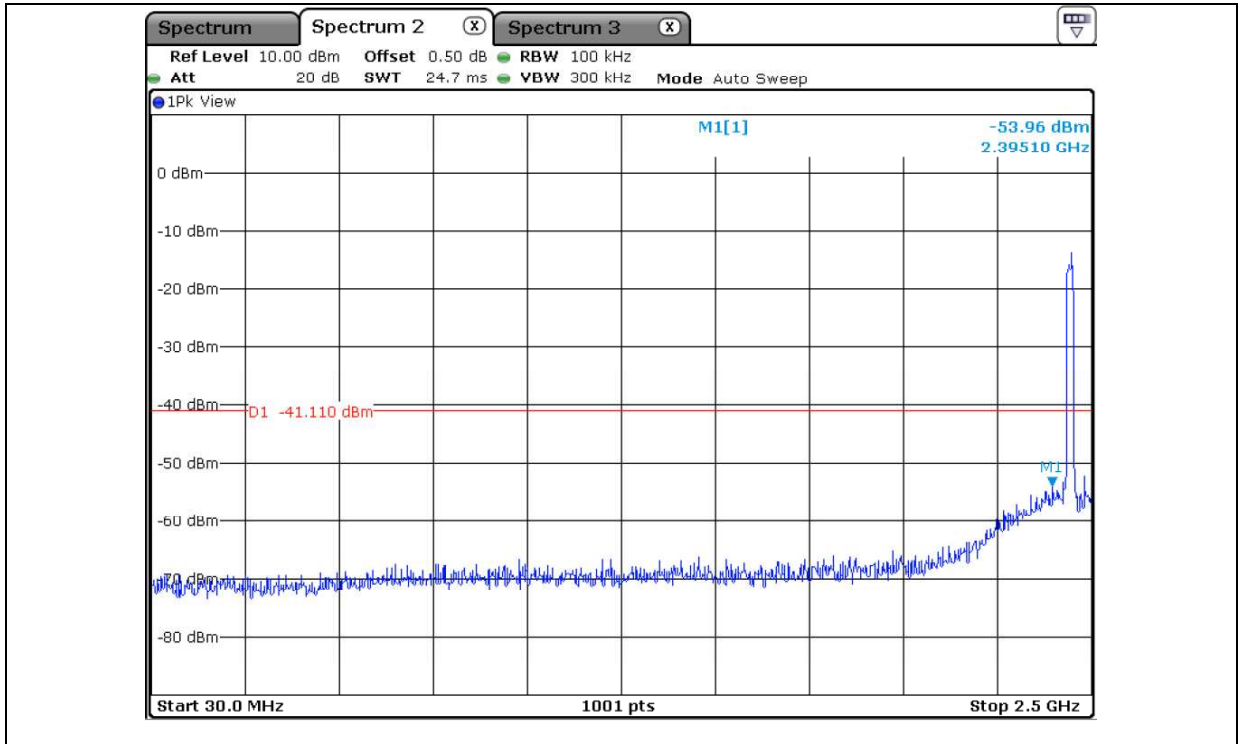
High Channel



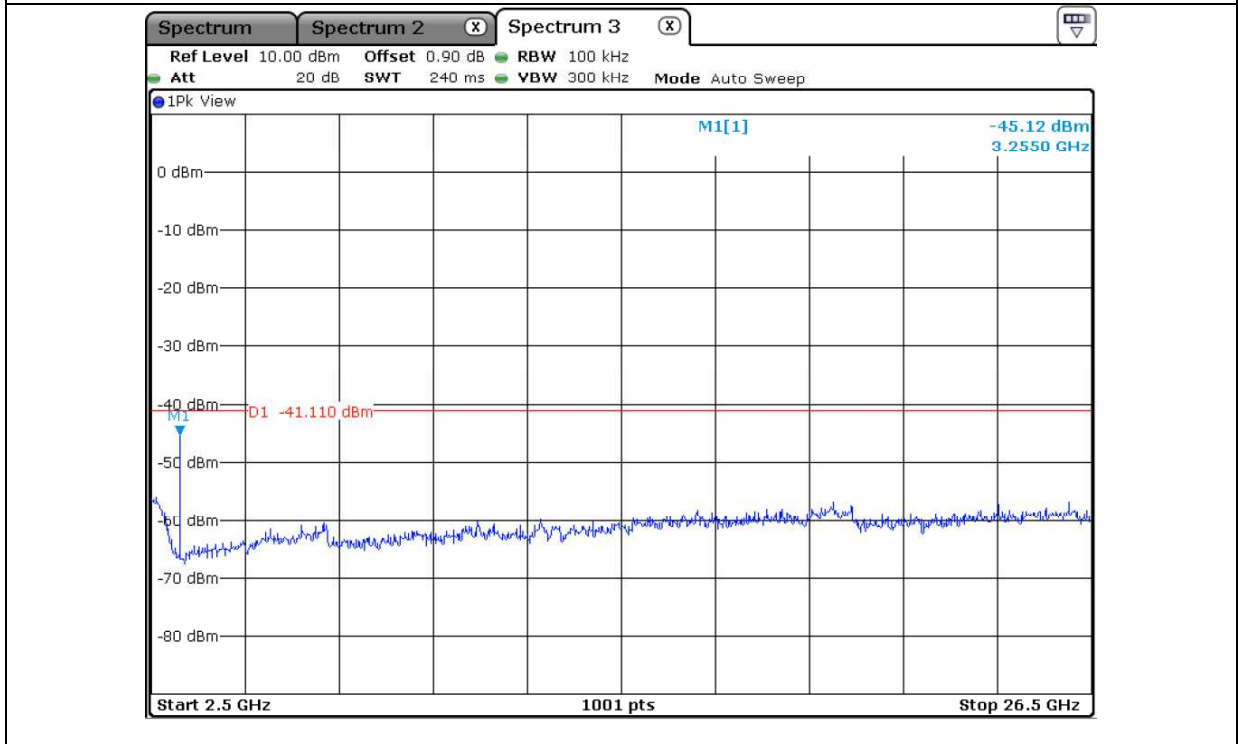
Low Channel



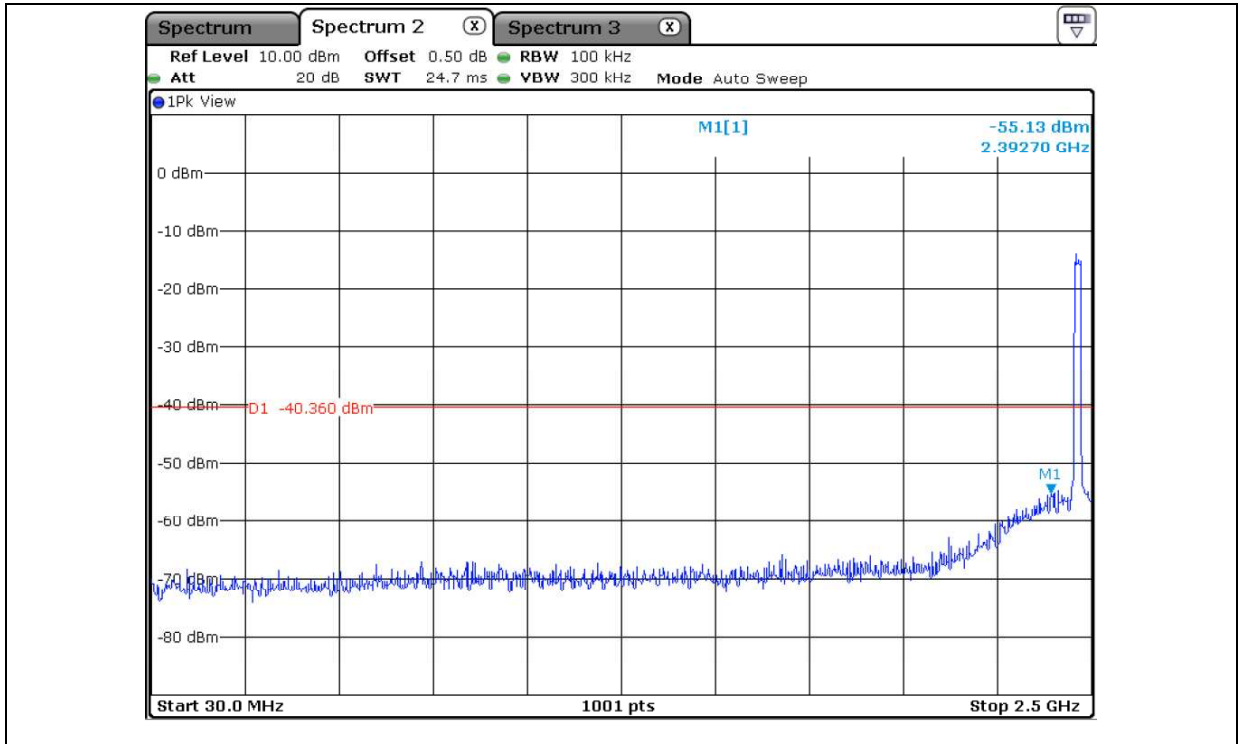
Low Channel



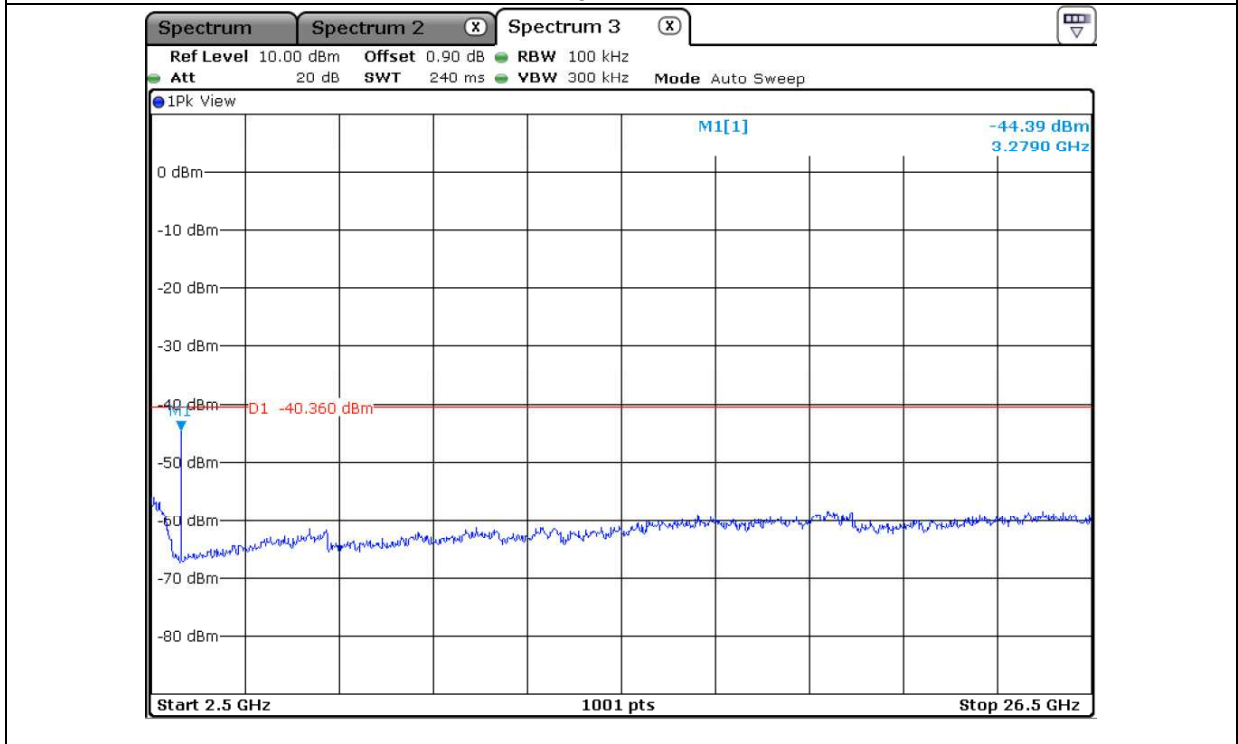
Middle Channel



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 : May 22, 2019 ~ May 30, 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 : 88.94 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 329.860	20.81	Peak	H	26.94	9.20	-	56.95	74.00	17.05
2 347.283	9.71	Average	H	26.94	9.20	0.51	46.36	54.00	7.64
2 330.739	18.04	Peak	V	26.94	9.20	-	54.18	74.00	19.82
2 337.373	7.68	Average	V	26.94	9.20	0.51	44.33	54.00	9.67
Test Data for High Channel									
2 493.514	18.21	Peak	H	27.47	9.49	-	55.17	74.00	18.83
2 489.788	6.66	Average	H	27.47	9.49	0.51	44.13	54.00	9.87
2 484.580	18.07	Peak	V	27.47	9.49	-	55.03	74.00	18.97
2 483.525	6.59	Average	V	27.47	9.49	0.51	44.06	54.00	9.94

Tabulated test data for Restricted Band

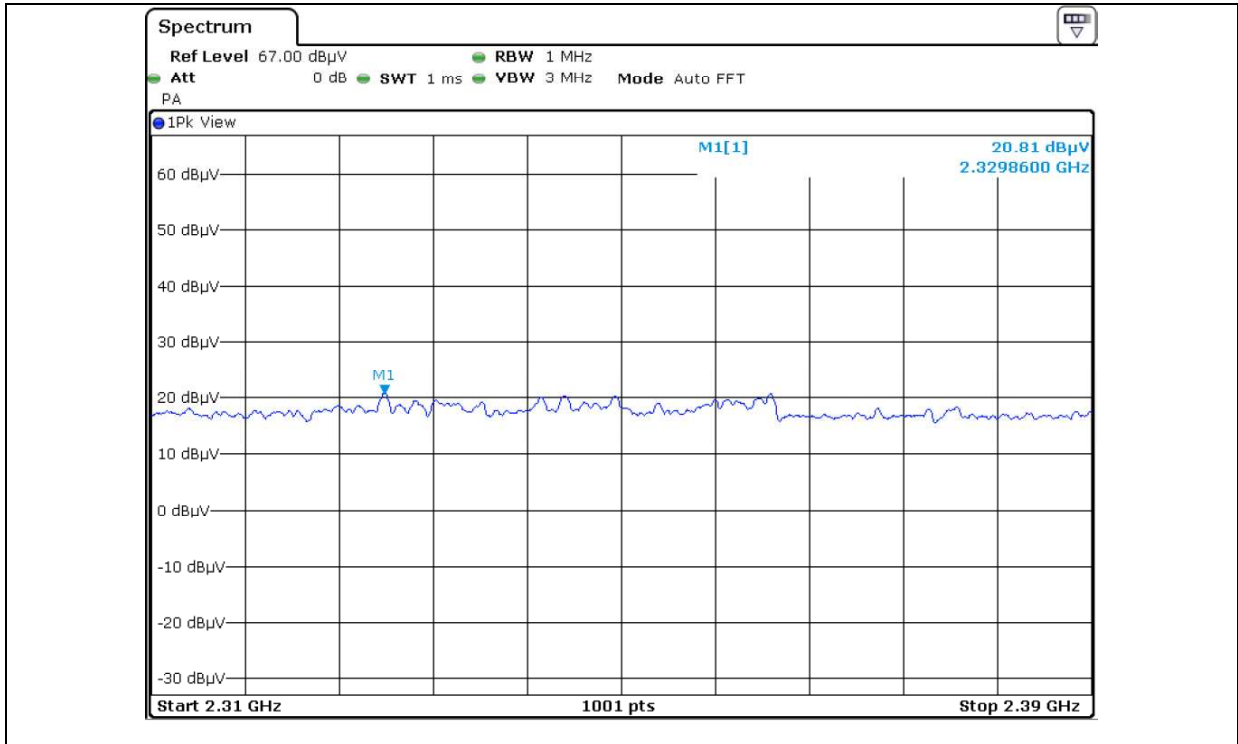
Remark: “H”: Horizontal, “V”: Vertical

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

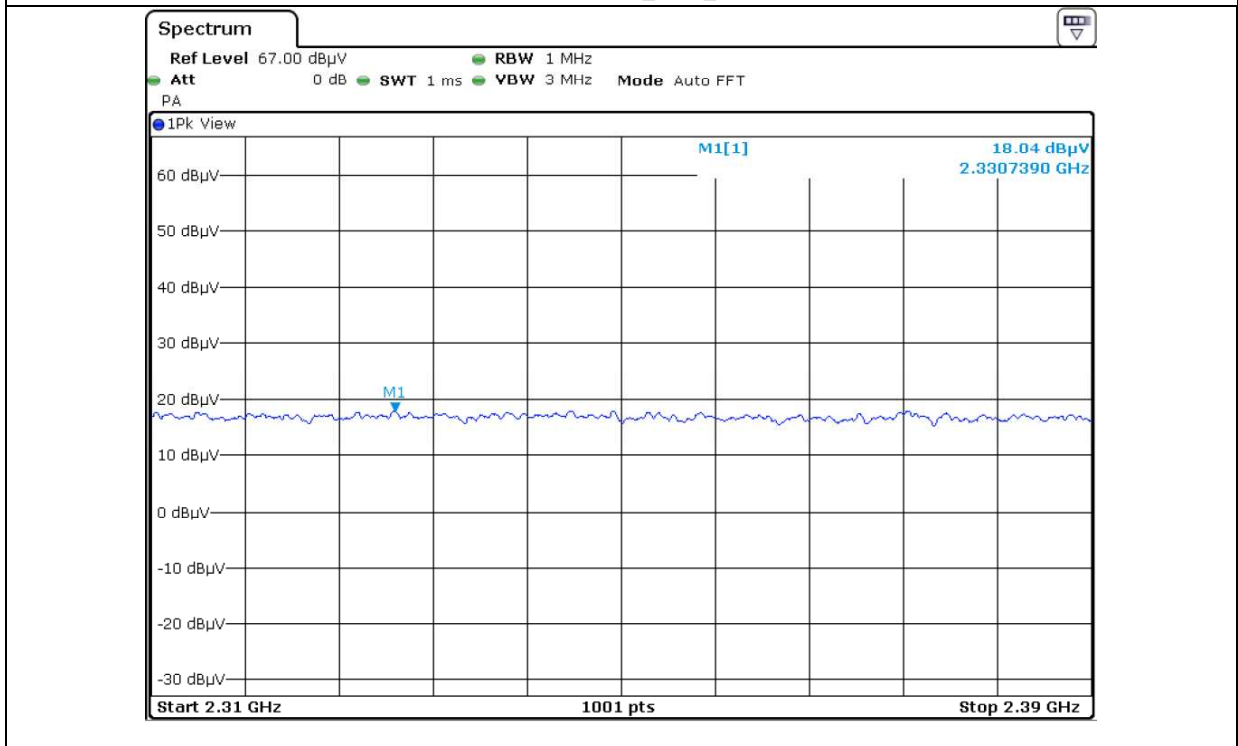
$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Correction Factor} - \text{Pre-Amplifier Gain}$$



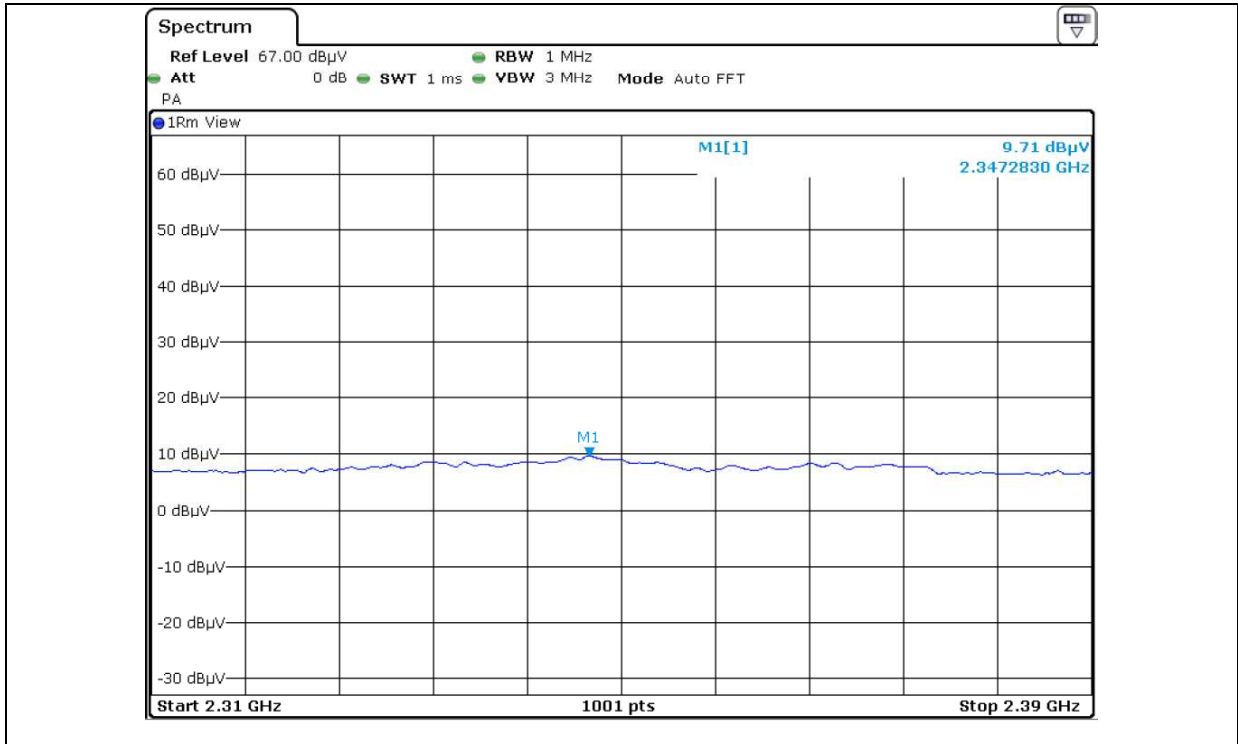
Tested by: Hyung-Kwon, Oh / Assistant Manager



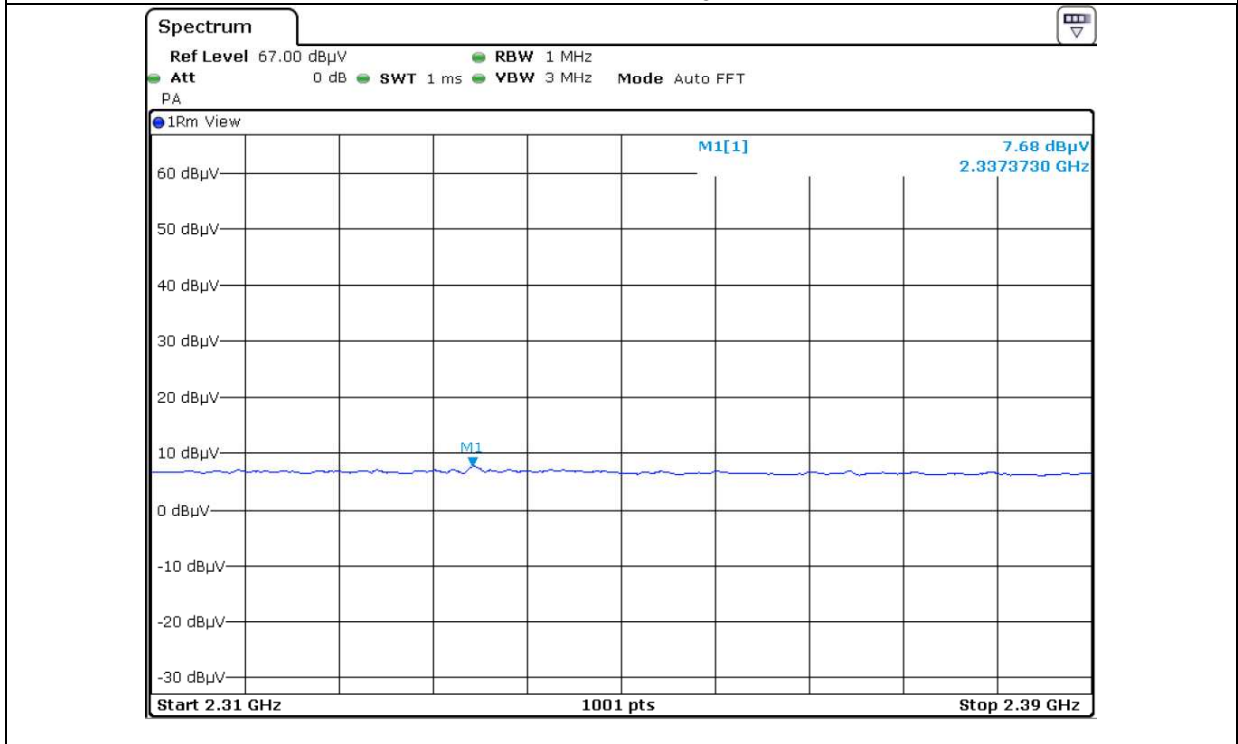
Low Channel_Peak_H



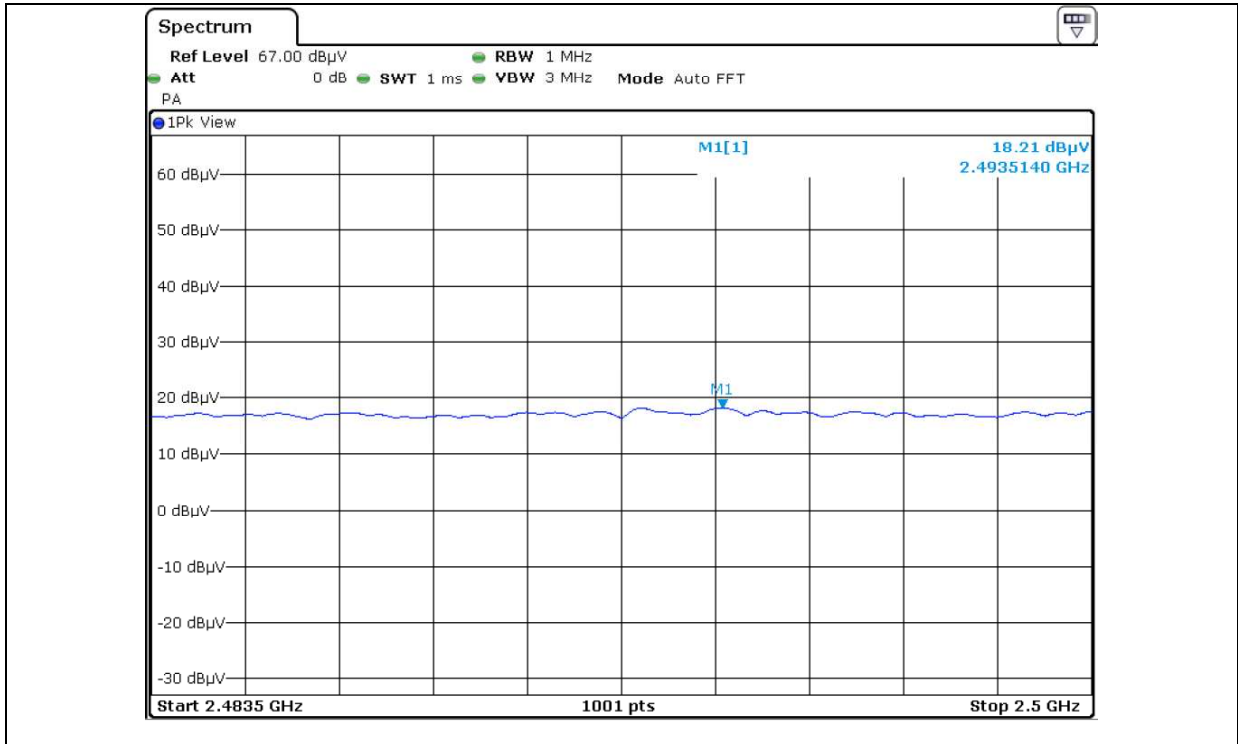
Low Channel_Peak_V



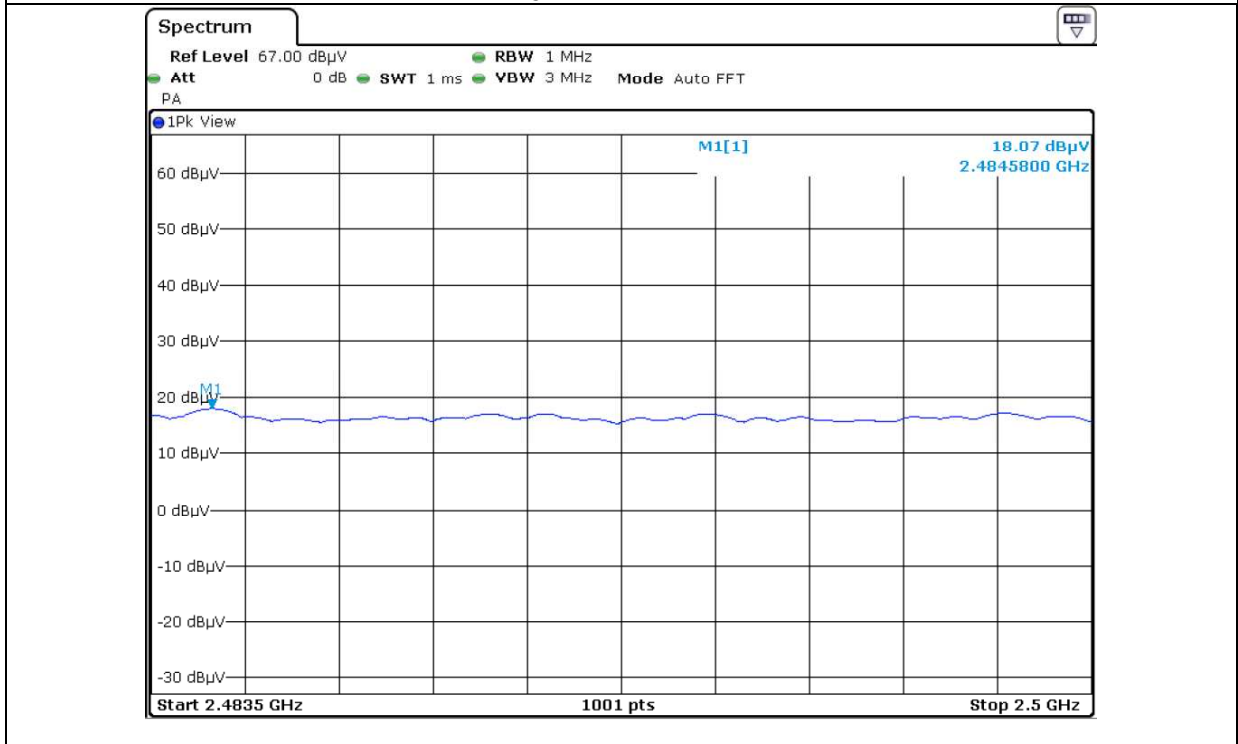
Low Channel_Average_H



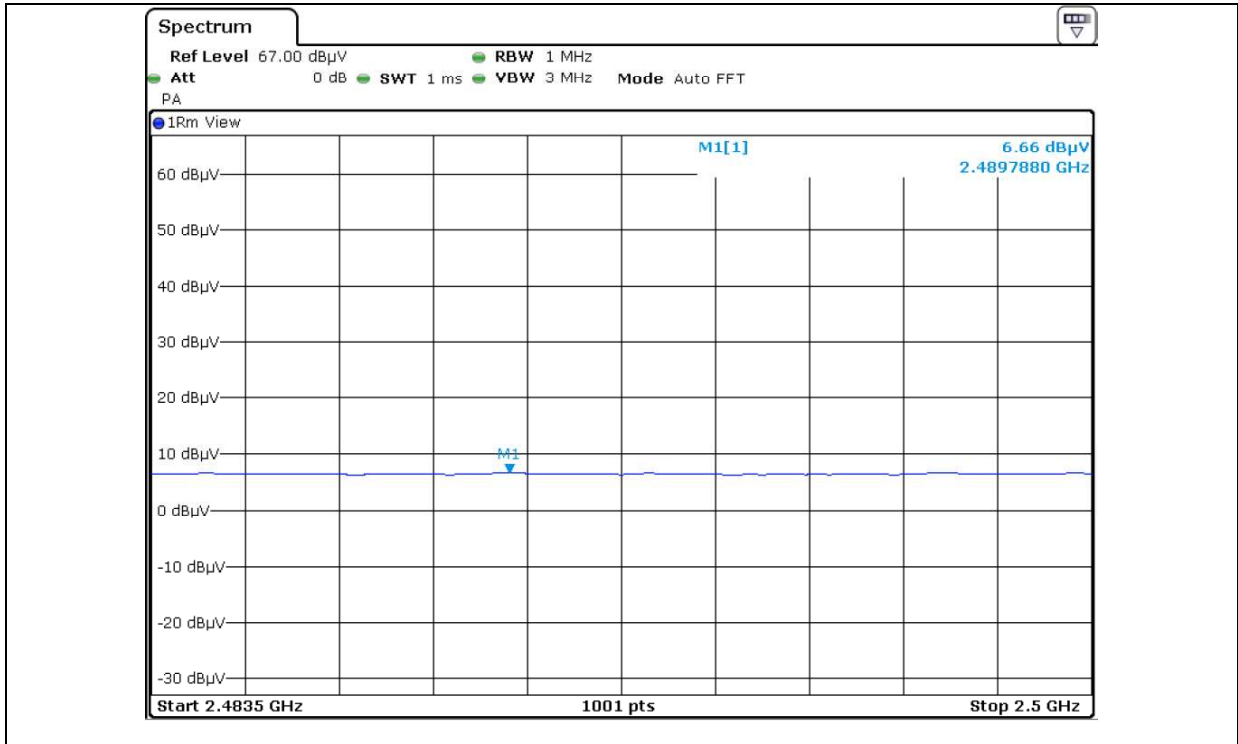
Low Channel_Average_V



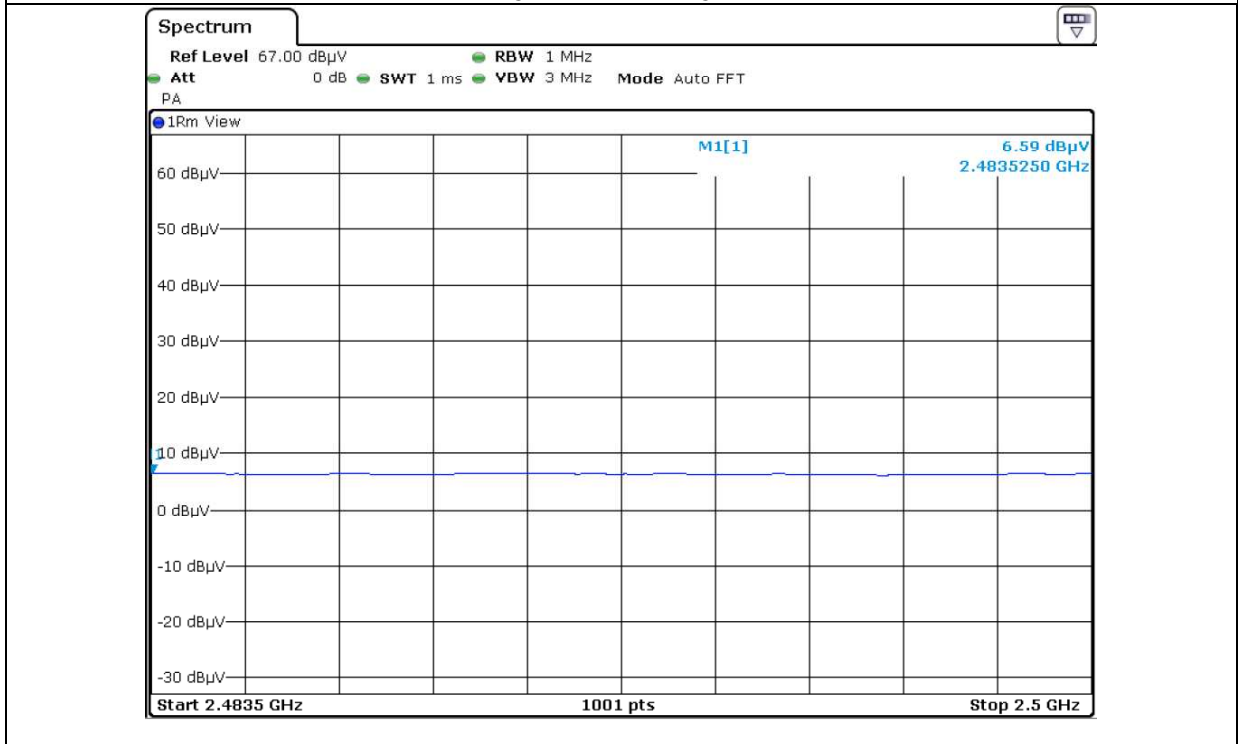
High Channel_Peak_H



High Channel_Peak_V



High Channel_Average_H



High Channel_Average_V

9.6.1.2 Test data for 802.11g WLAN Mode

- Test Date : May 22, 2019 ~ May 30, 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 : 87.05 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 329.810	21.63	Peak	H	26.94	9.20	-	57.77	74.00	16.23
2 347.283	9.68	Average	H	26.94	9.20	0.60	46.42	54.00	7.58
2 330.711	18.66	Peak	V	26.94	9.20	-	54.80	74.00	19.20
2 337.370	8.06	Average	V	26.94	9.20	0.60	44.80	54.00	9.20
Test Data for High Channel									
2 493.522	18.79	Peak	H	27.47	9.49	-	55.75	74.00	18.25
2 489.780	7.63	Average	H	27.47	9.49	0.60	45.19	54.00	8.81
2 484.577	18.85	Peak	V	27.47	9.49	-	55.81	74.00	18.19
2 483.600	7.34	Average	V	27.47	9.49	0.60	44.90	54.00	9.10

Tabulated test data for Restricted Band

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

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

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



Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.1.3 Test data for 802.11n_HT20 WLAN Mode

- Test Date : May 22, 2019 ~ May 30, 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 : 86.31 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 329.851	20.11	Peak	H	26.94	9.20	-	56.25	74.00	17.75
2 347.290	9.26	Average	H	26.94	9.20	0.64	46.04	54.00	7.96
2 330.747	17.61	Peak	V	26.94	9.20	-	53.75	74.00	20.25
2 337.370	8.61	Average	V	26.94	9.20	0.64	45.39	54.00	8.61
Test Data for High Channel									
2 493.524	17.69	Peak	H	27.47	9.49	-	54.65	74.00	19.35
2 489.790	6.83	Average	H	27.47	9.49	0.64	44.43	54.00	9.57
2 484.370	18.69	Peak	V	27.47	9.49	-	55.65	74.00	18.35
2 483.520	7.05	Average	V	27.47	9.49	0.64	44.65	54.00	9.35

Tabulated test data for Restricted Band

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

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

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



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 : May 22, 2019 ~ May 30, 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 : 88.94 %
- Result : PASSED


Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	19.93	Peak	H	28.84	10.31	-	59.08	74.00	14.92
4 824.00	9.25	Average	H	28.84	10.31	0.51	48.91	54.00	5.09
4 824.00	20.08	Peak	V	28.84	10.31	-	59.23	74.00	14.77
4 824.00	9.32	Average	V	28.84	10.31	0.51	48.98	54.00	5.02
Test Data for Middle Channel									
4 884.00	19.71	Peak	H	28.01	10.43	-	58.15	74.00	15.85
4 884.00	8.67	Average	H	28.01	10.43	0.51	47.62	54.00	6.38
4 884.00	20.20	Peak	V	28.01	10.43	-	58.64	74.00	15.36
4 884.00	8.66	Average	V	28.01	10.43	0.51	47.61	54.00	6.39
Test Data for High Channel									
4 924.00	19.91	Peak	H	29.15	10.81	-	59.87	74.00	14.13
4 924.00	8.79	Average	H	29.15	10.81	0.51	49.26	54.00	4.74
4 924.00	19.28	Peak	V	29.15	10.81	-	59.24	74.00	14.76
4 924.00	8.73	Average	V	29.15	10.81	0.51	49.20	54.00	4.80

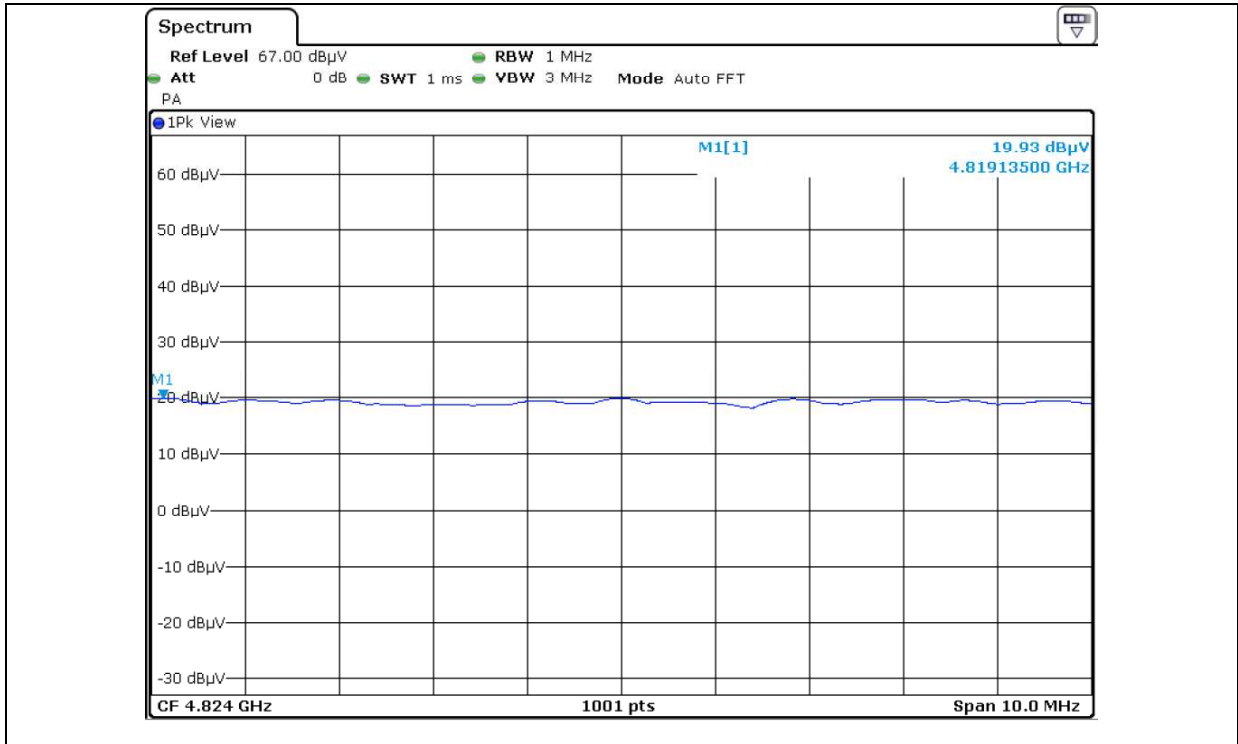
Tabulated test data for Restricted Band

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

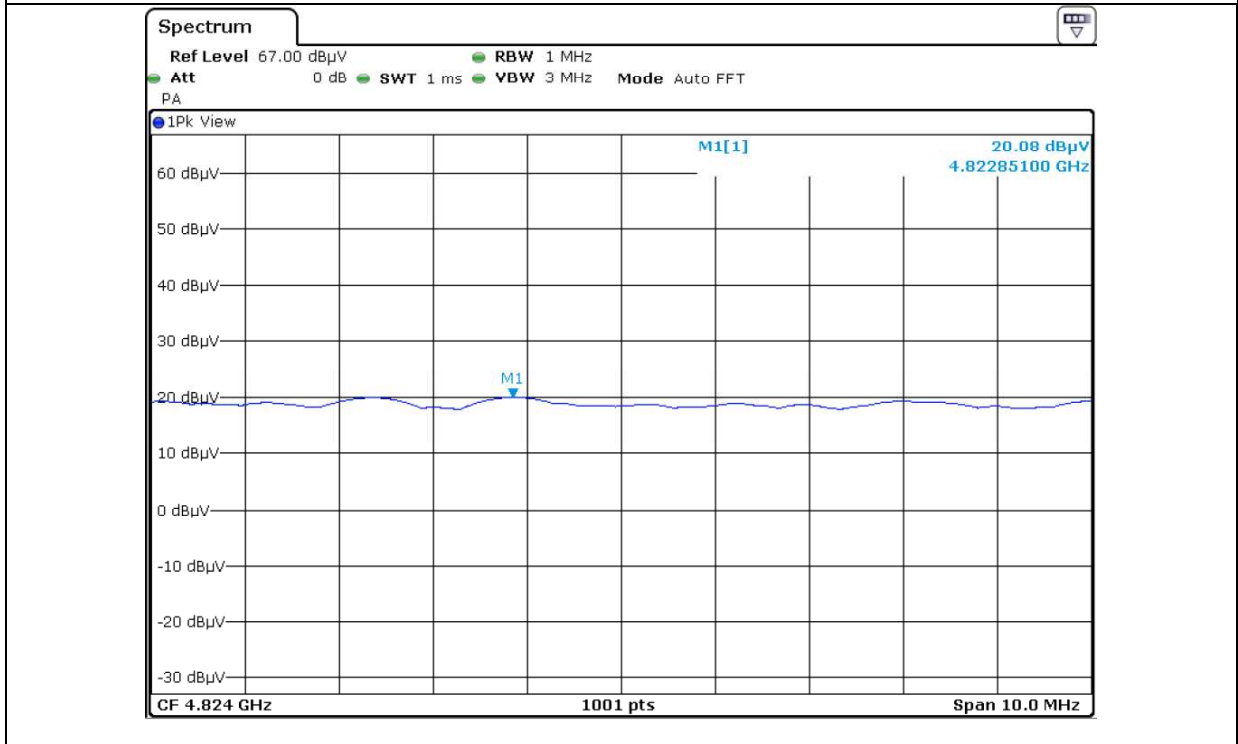
$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

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

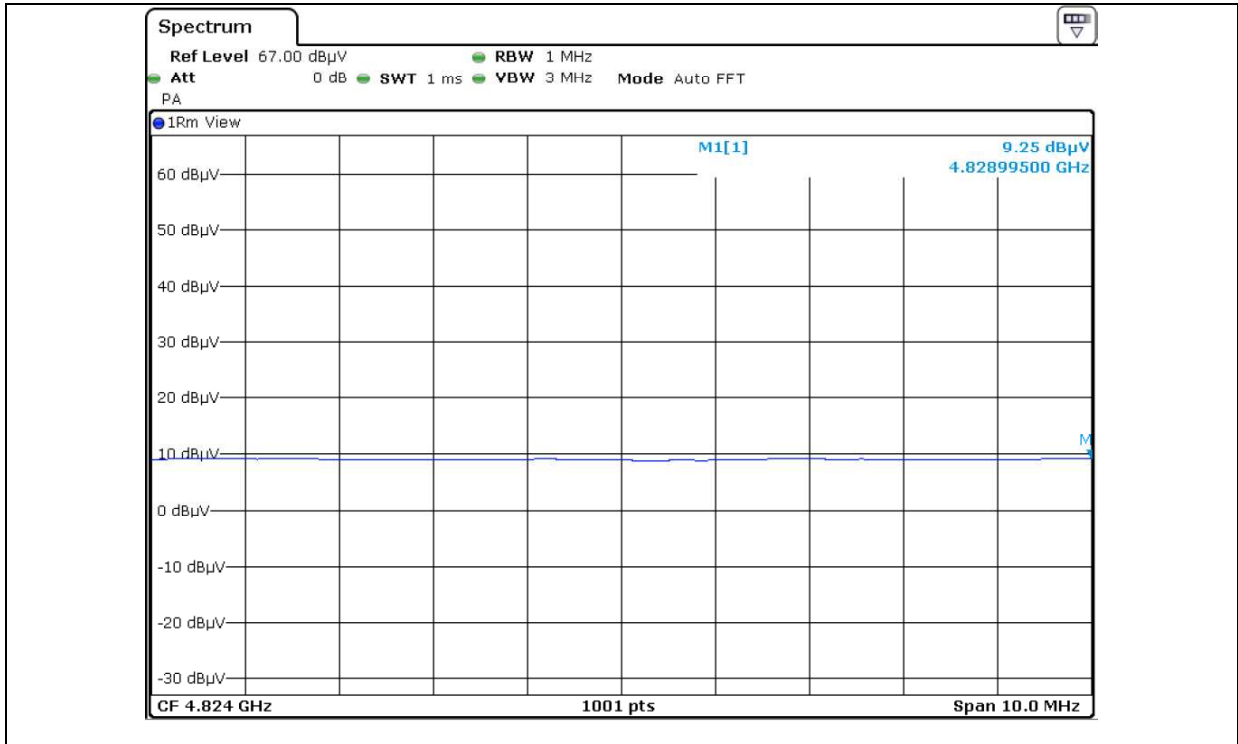

Tested by: Hyung-Kwon, Oh / Assistant Manager



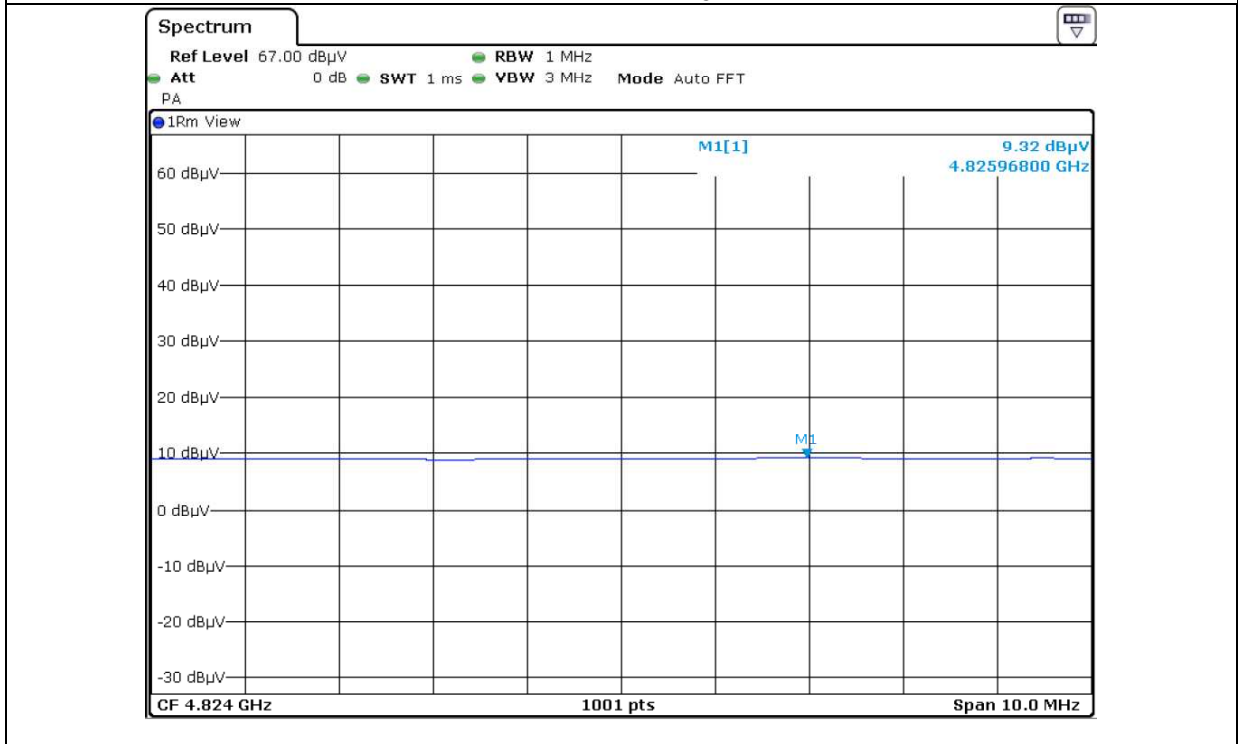
Low Channel_Peak_H



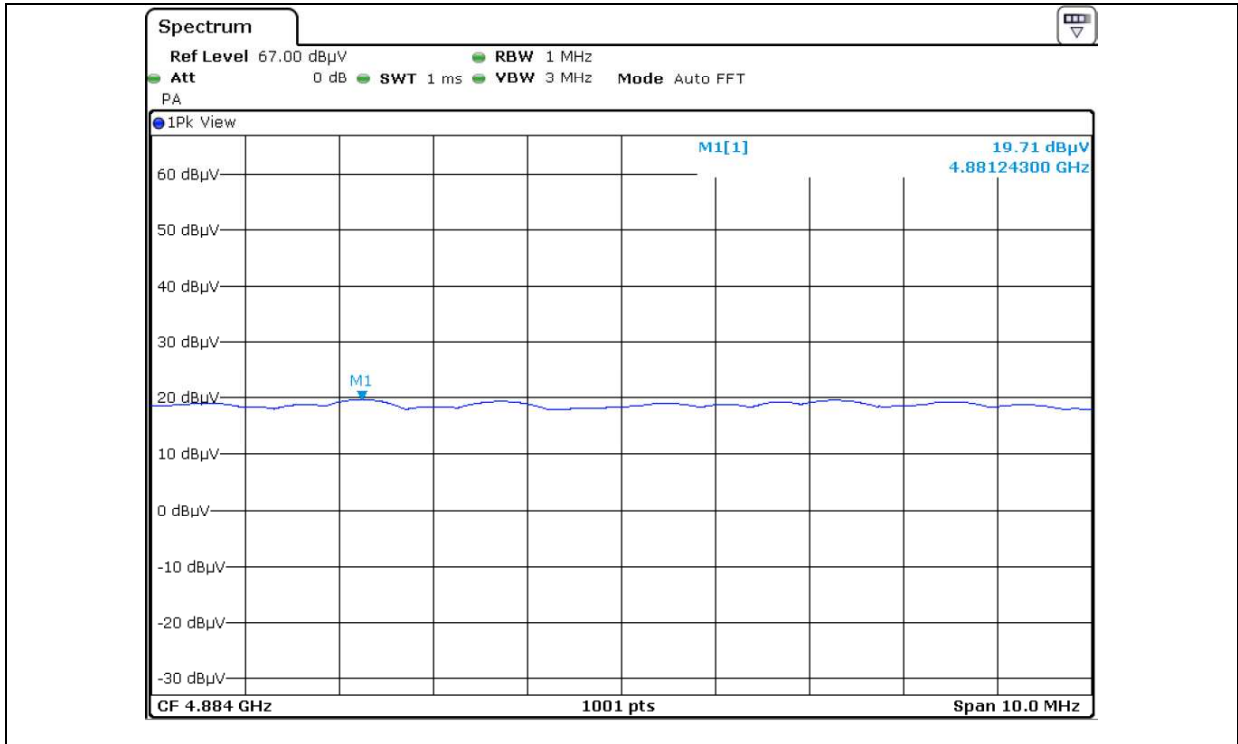
Low Channel_Peak_V



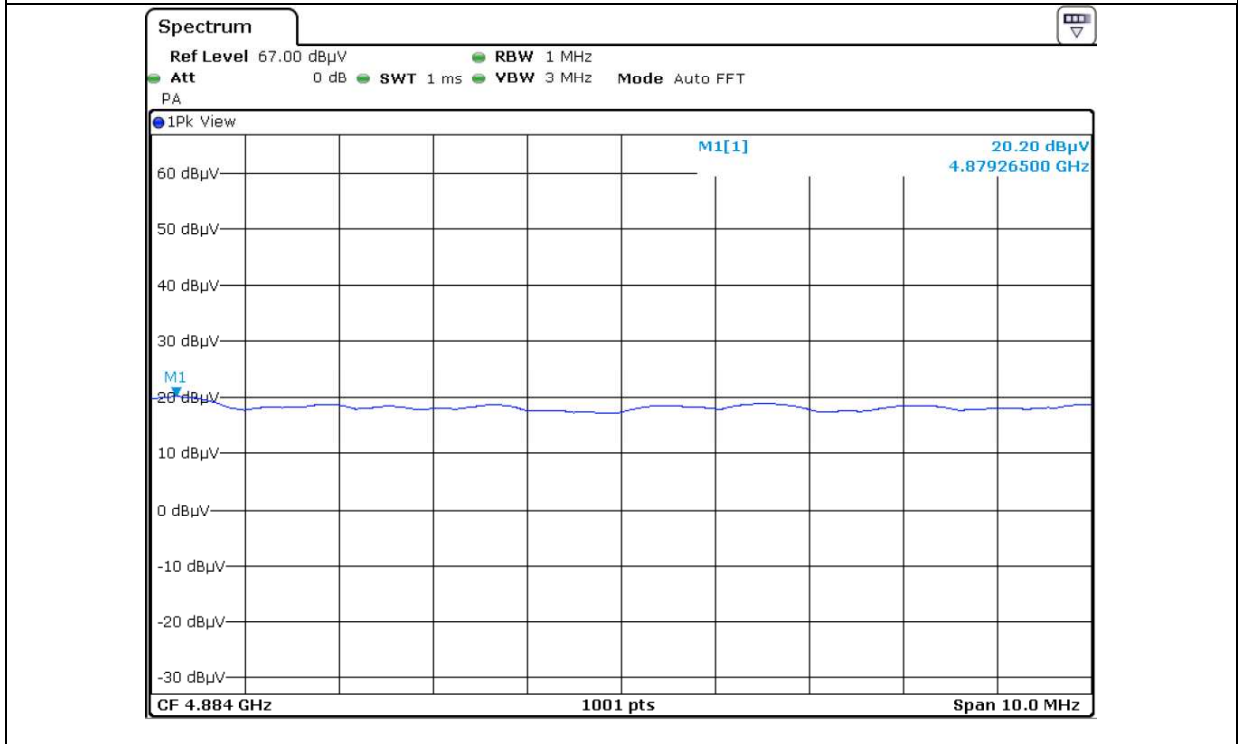
Low Channel_Average_H



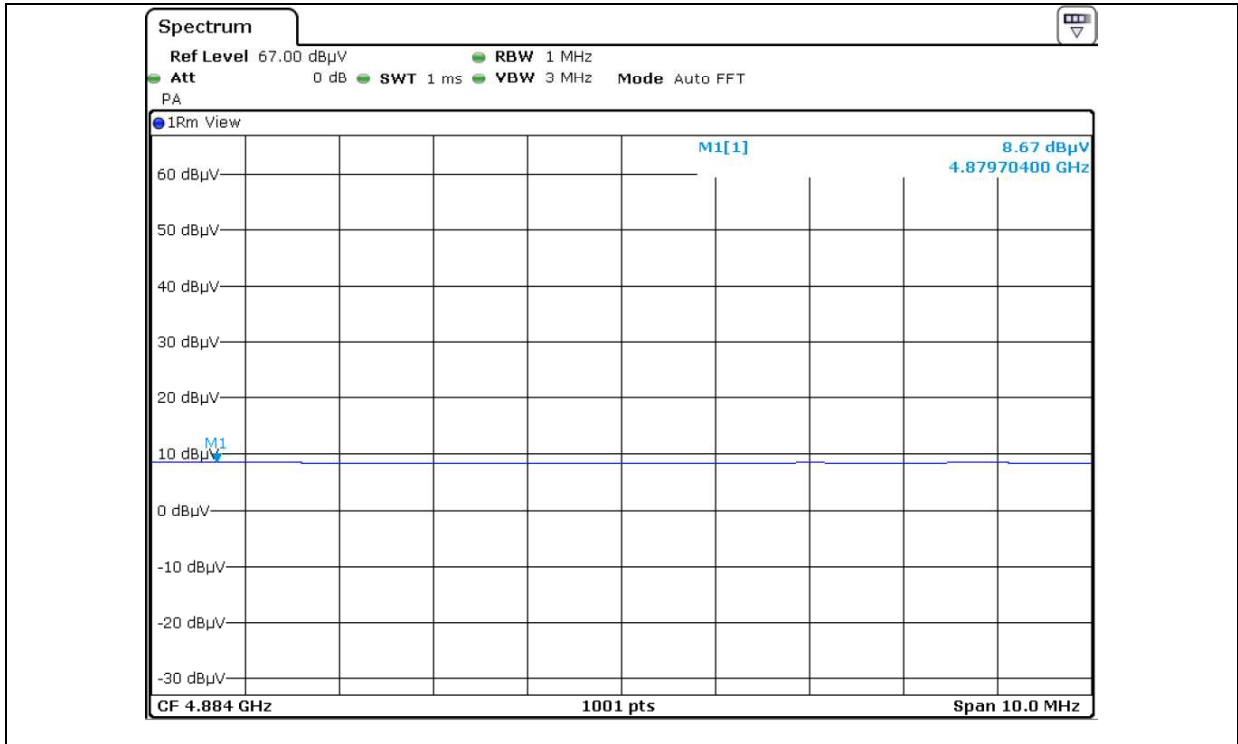
Low Channel_Average_V



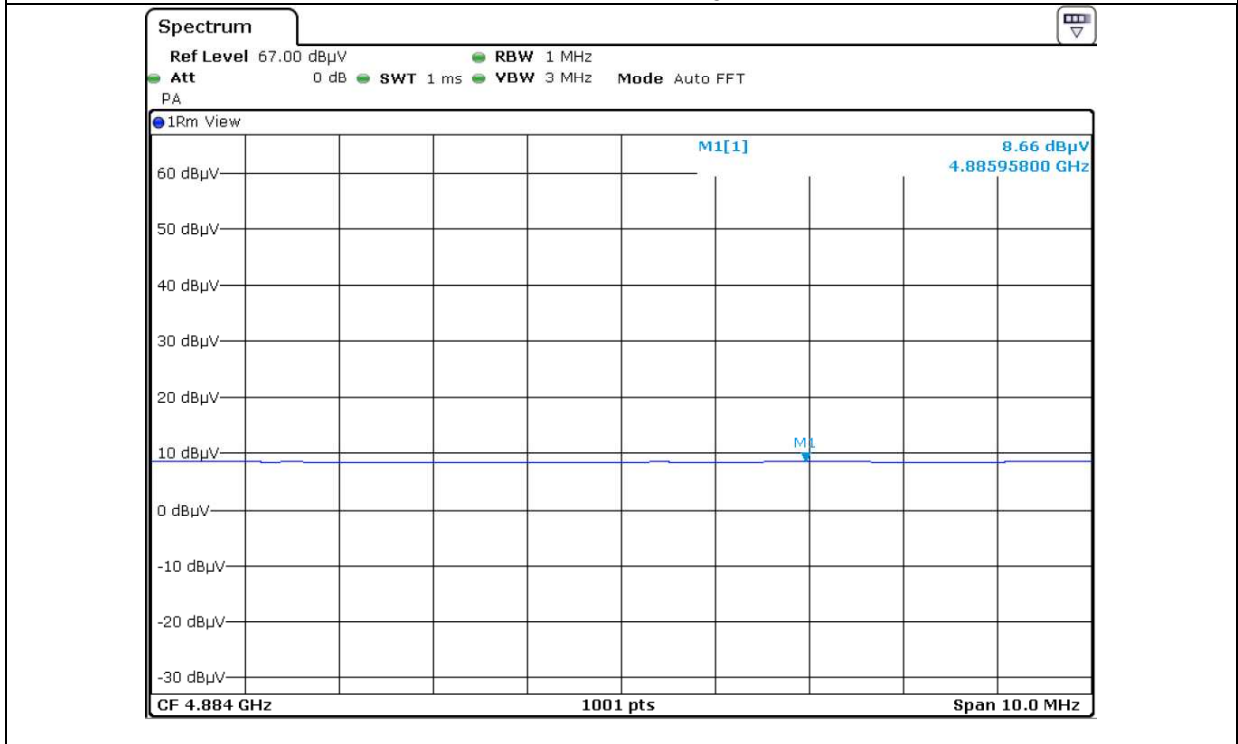
Middle Channel_Peak_H



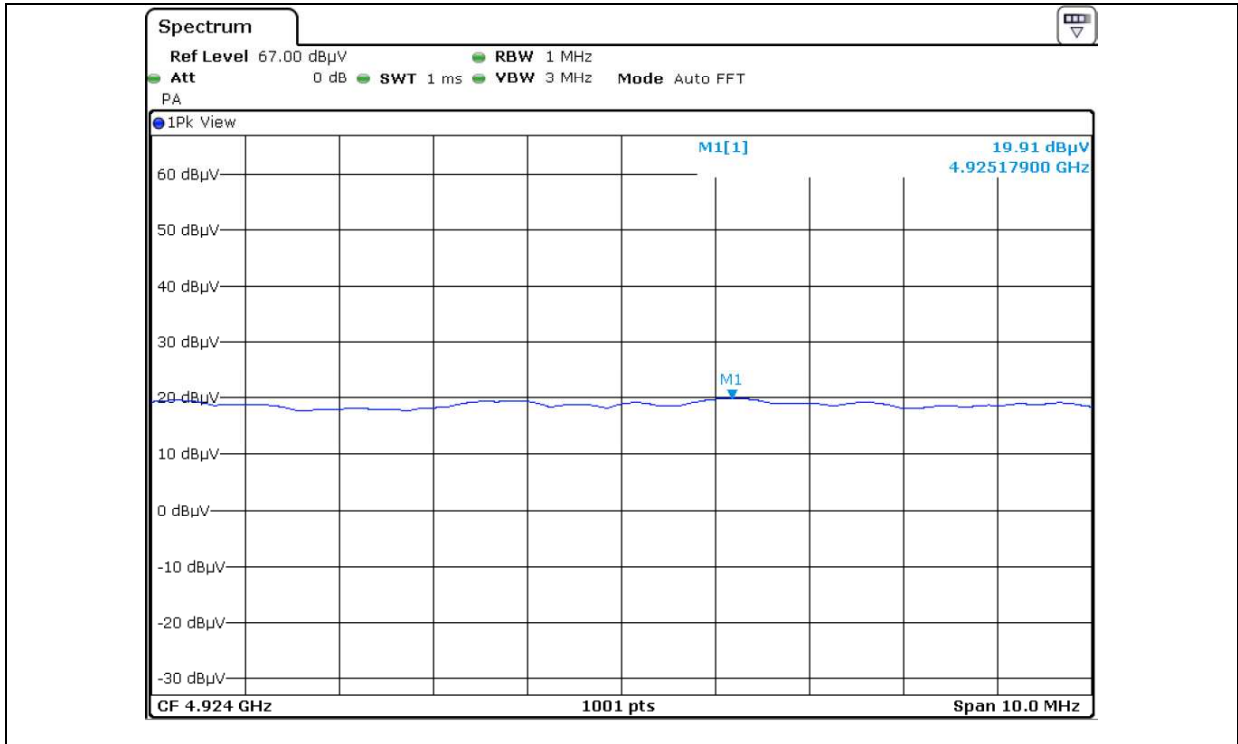
Middle Channel_Peak_V



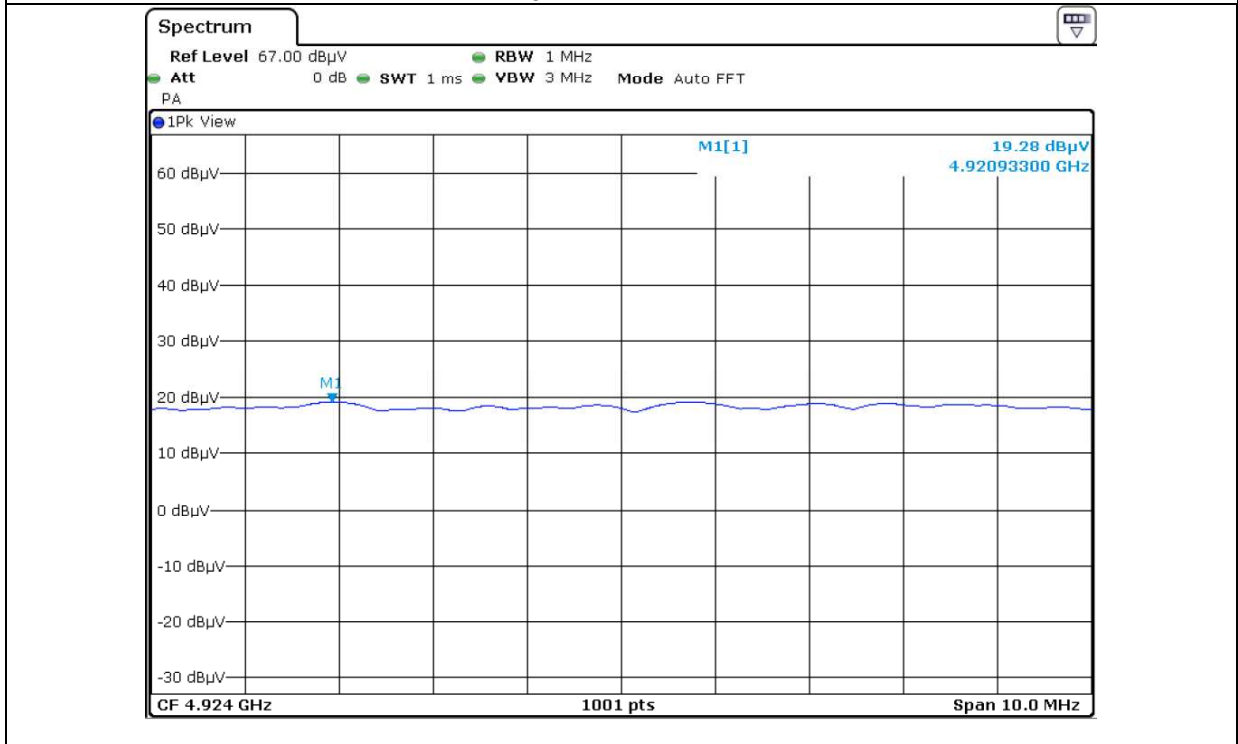
Middle Channel_Average_H



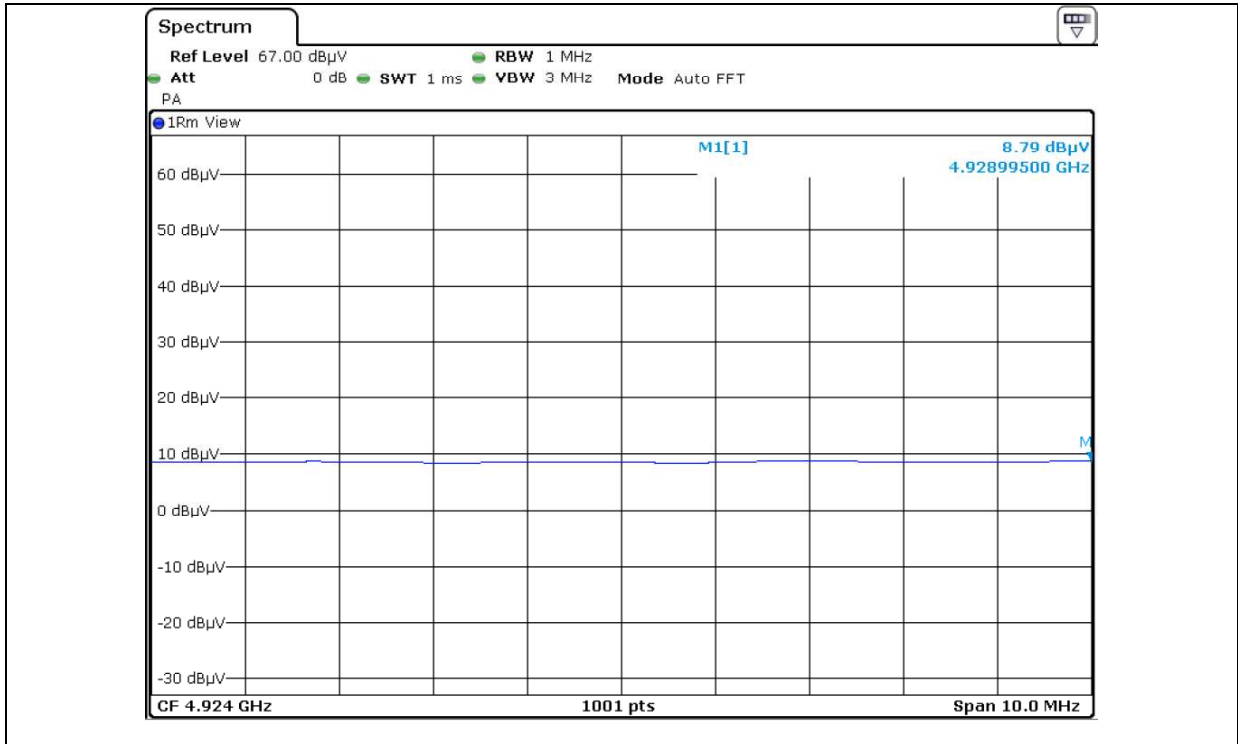
Middle Channel_Average_V



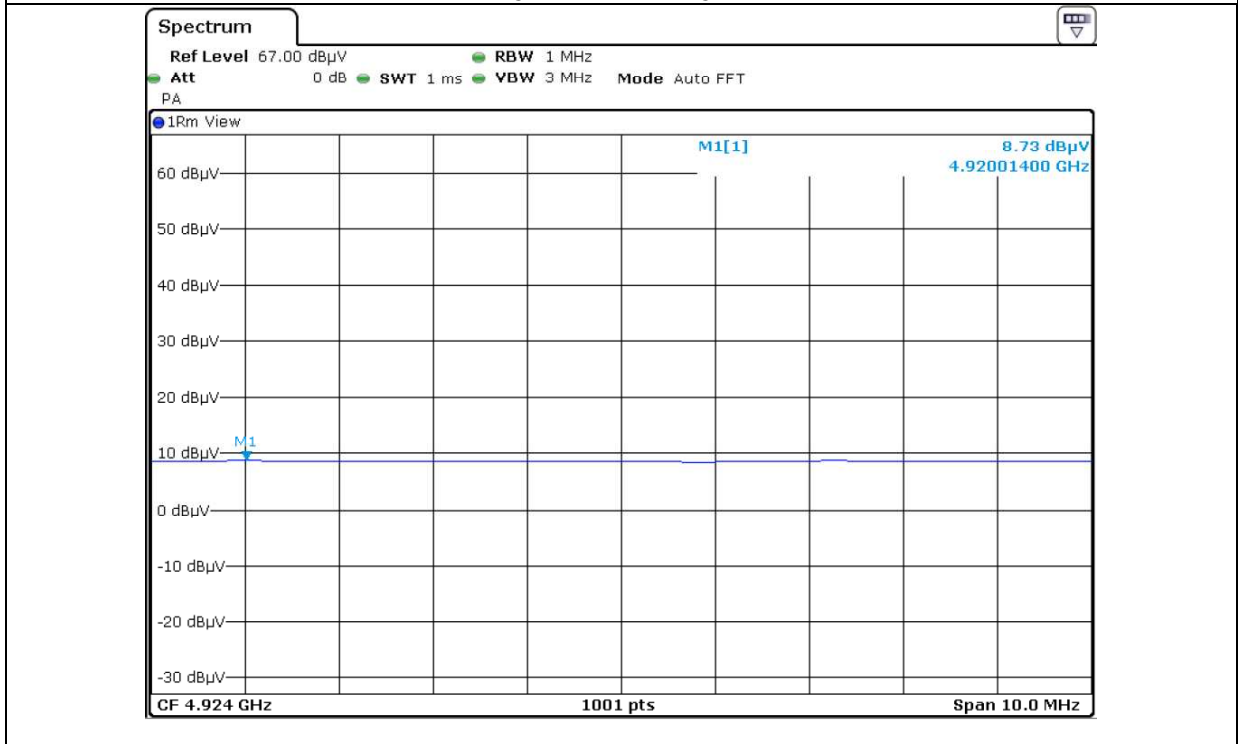
High Channel_Peak_H



High Channel_Peak_V



High Channel_Average_H



High Channel_Average_V

9.6.2.2 Test data for 802.11g WLAN Mode

- Test Date : May 22, 2019 ~ May 30, 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 : 87.05 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	20.76	Peak	H	28.84	10.31	-	59.91	74.00	14.09
4 824.00	9.80	Average	H	28.84	10.31	0.60	49.55	54.00	4.45
4 824.00	19.85	Peak	V	28.84	10.31	-	59.00	74.00	15.00
4 824.00	8.74	Average	V	28.84	10.31	0.60	48.49	54.00	5.51
Test Data for Middle Channel									
4 884.00	19.89	Peak	H	28.01	10.43	-	58.33	74.00	15.67
4 884.00	8.67	Average	H	28.01	10.43	0.60	47.71	54.00	6.29
4 884.00	20.00	Peak	V	28.01	10.43	-	58.44	74.00	15.56
4 884.00	9.43	Average	V	28.01	10.43	0.60	48.47	54.00	5.53
Test Data for High Channel									
4 924.00	19.46	Peak	H	29.15	10.81	-	59.42	74.00	14.58
4 924.00	9.33	Average	H	29.15	10.81	0.60	49.89	54.00	4.11
4 924.00	20.19	Peak	V	29.15	10.81	-	60.15	74.00	13.85
4 924.00	9.63	Average	V	29.15	10.81	0.60	50.19	54.00	3.81

Tabulated test data for Restricted Band

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

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

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



Tested by: Hyung-Kwon, Oh / Assistant Manager

9.6.2.3 Test data for 802.11n_HT20 WLAN Mode

- Test Date : May 22, 2019 ~ May 30, 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 : 86.31 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Correction Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 824.00	20.06	Peak	H	28.84	10.31	-	59.21	74.00	14.79
4 824.00	8.30	Average	H	28.84	10.31	0.64	48.09	54.00	5.91
4 824.00	20.63	Peak	V	28.84	10.31	-	59.78	74.00	14.22
4 824.00	9.88	Average	V	28.84	10.31	0.64	49.67	54.00	4.33
Test Data for Middle Channel									
4 884.00	19.74	Peak	H	28.01	10.43	-	58.18	74.00	15.82
4 884.00	8.95	Average	H	28.01	10.43	0.64	48.03	54.00	5.97
4 884.00	20.19	Peak	V	28.01	10.43	-	58.63	74.00	15.37
4 884.00	8.30	Average	V	28.01	10.43	0.64	47.38	54.00	6.62
Test Data for High Channel									
4 924.00	20.37	Peak	H	29.15	10.81	-	60.33	74.00	13.67
4 924.00	8.85	Average	H	29.15	10.81	0.64	49.45	54.00	4.55
4 924.00	19.95	Peak	V	29.15	10.81	-	59.91	74.00	14.09
4 924.00	9.69	Average	V	29.15	10.81	0.64	50.29	54.00	3.71

Tabulated test data for Restricted Band

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

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

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



Tested by: Hyung-Kwon, Oh / Assistant Manager

10. PEAK POWER SPECTRUL DENSITY

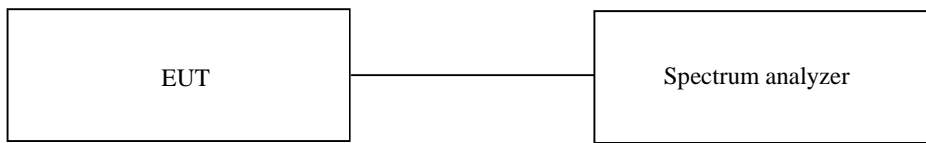
10.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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.

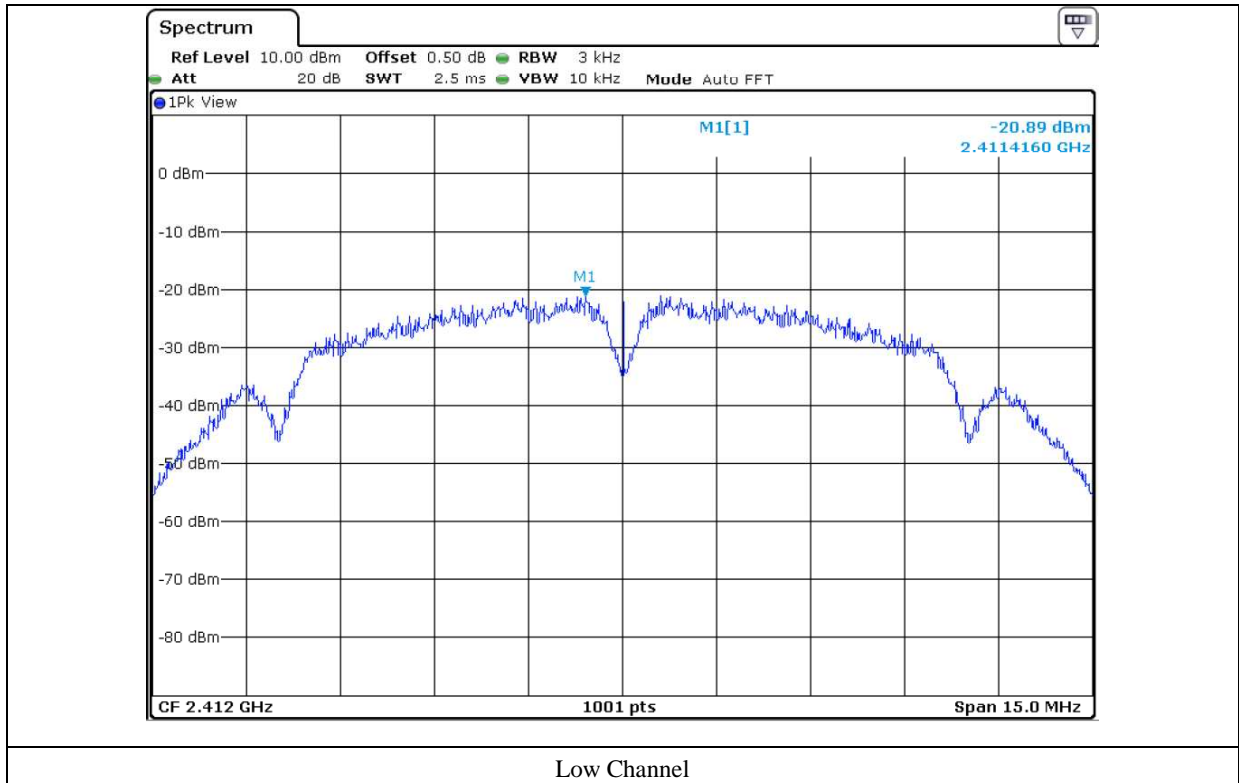
10.4 Test data for 802.11b WLAN Mode

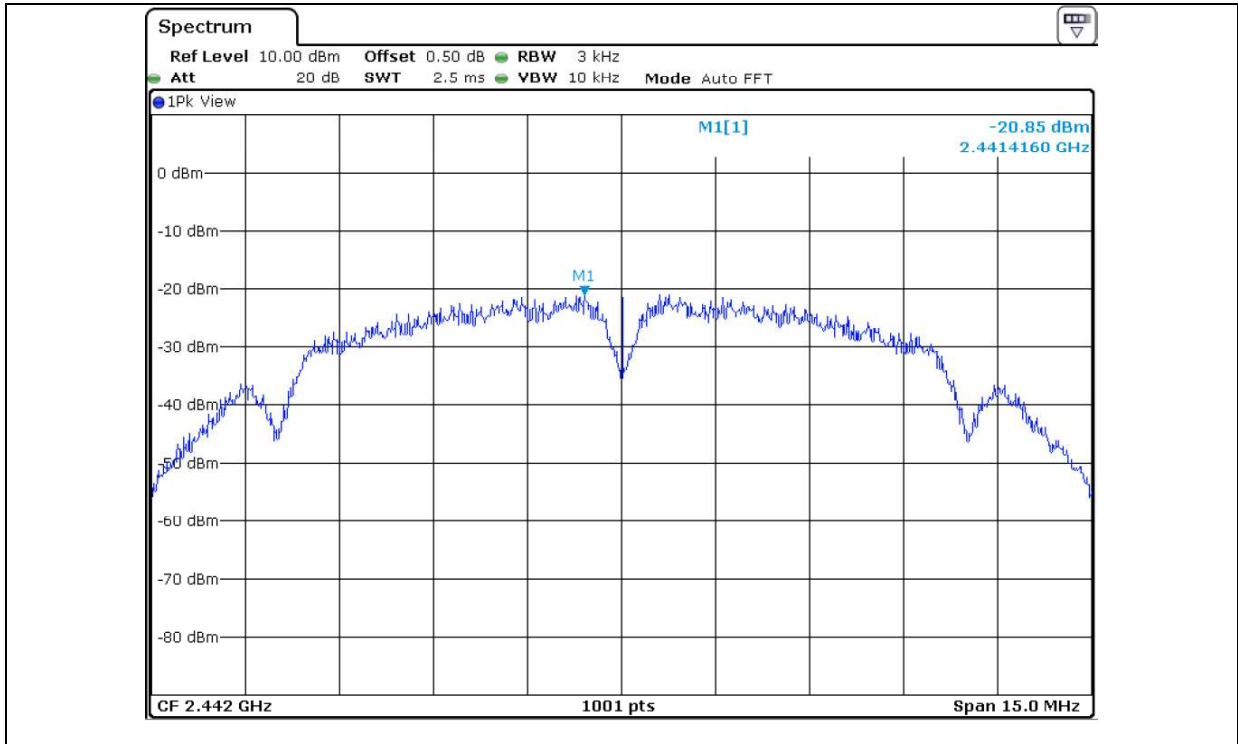
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-20.89	8.00	28.89
Middle	2 442.00	-20.85	8.00	28.85
High	2 462.00	-20.02	8.00	28.02

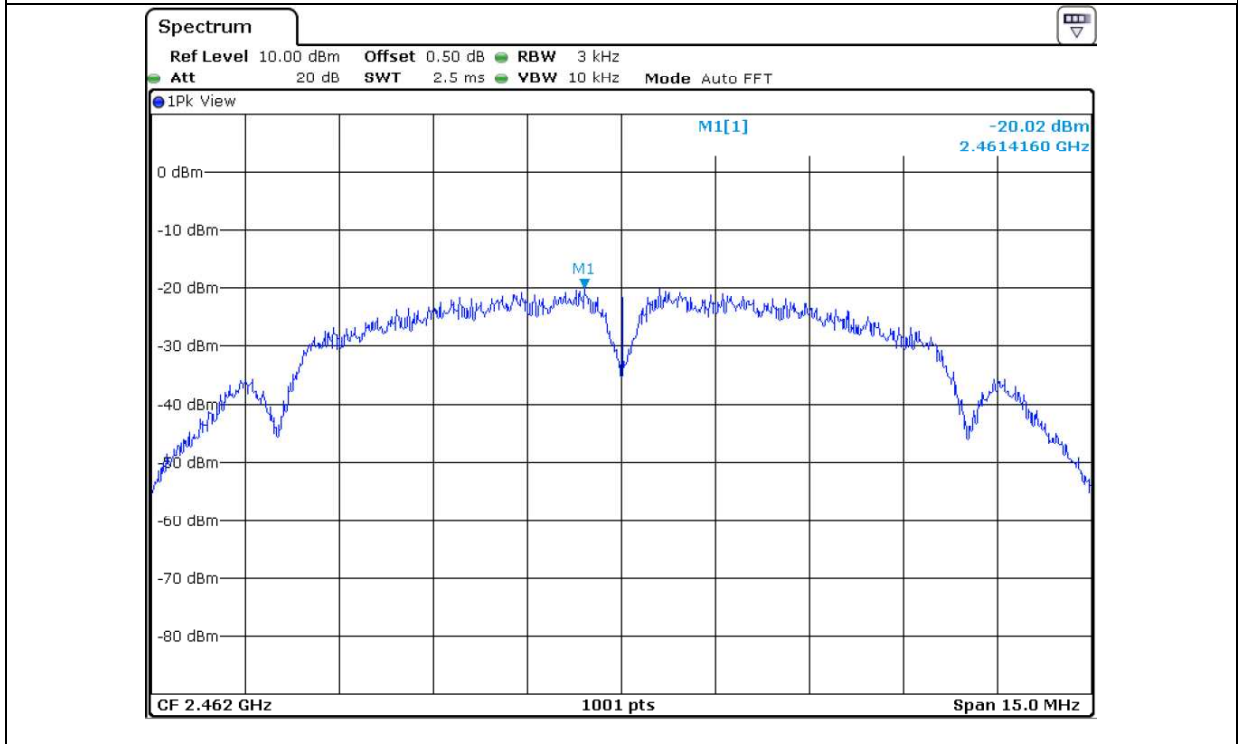
Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

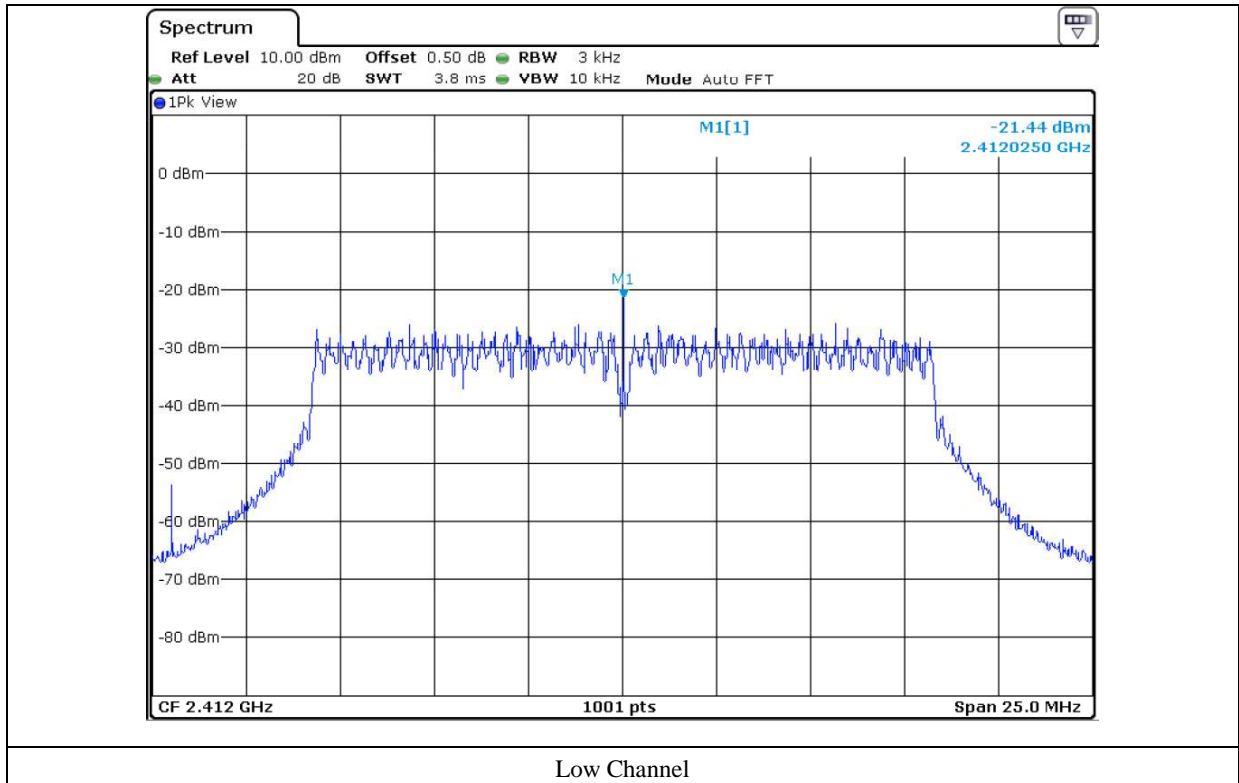
10.5 Test data for 802.11g WLAN Mode

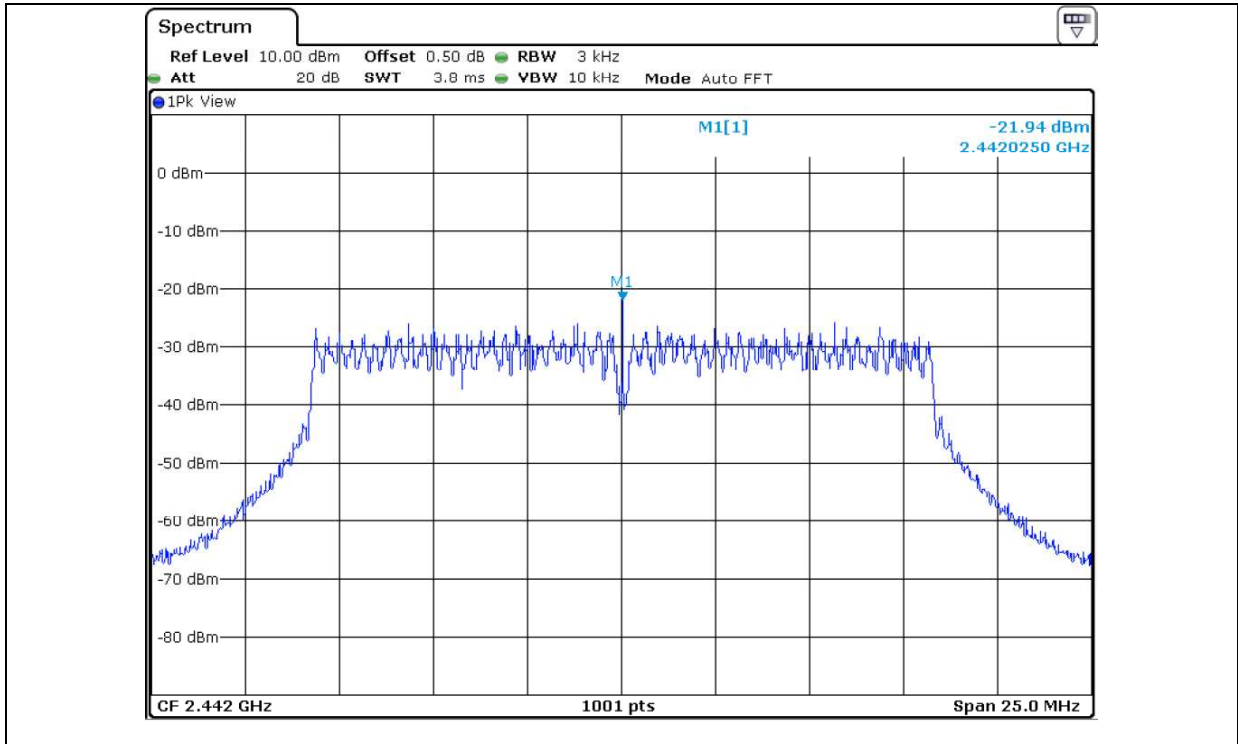
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-21.44	8.00	29.44
Middle	2 442.00	-21.94	8.00	29.94
High	2 462.00	-21.61	8.00	29.61

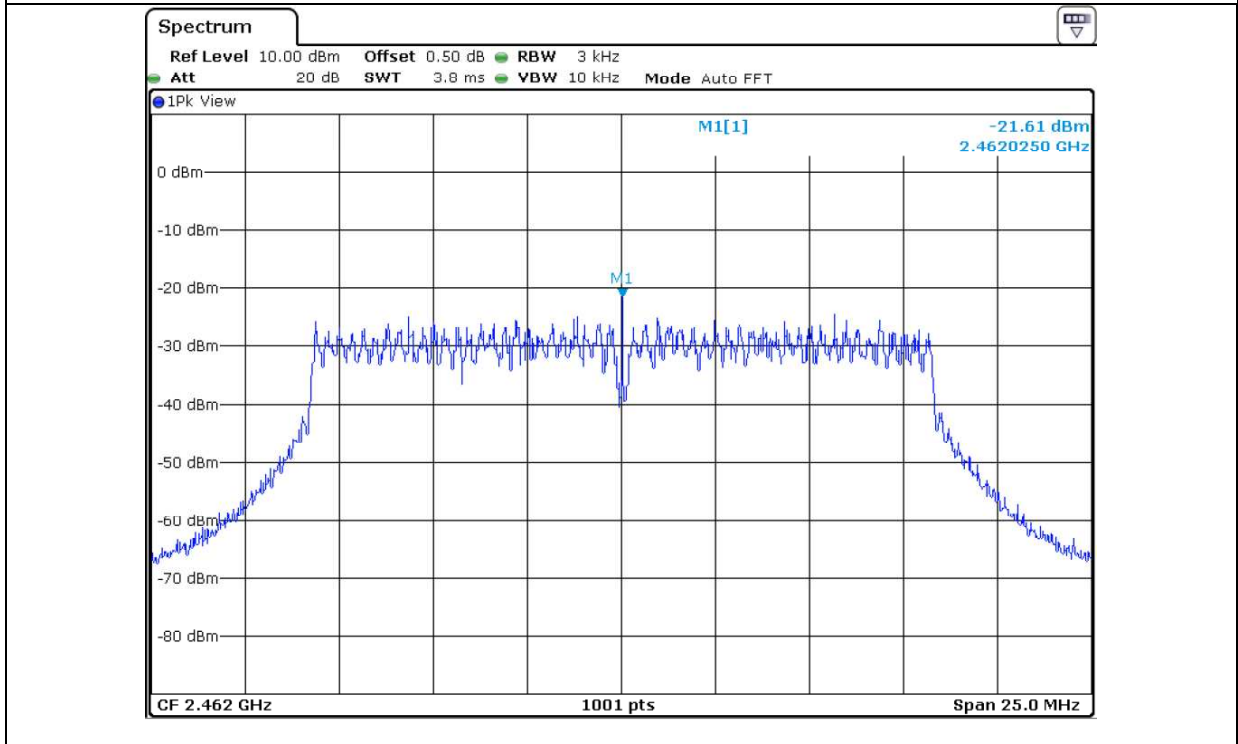
Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

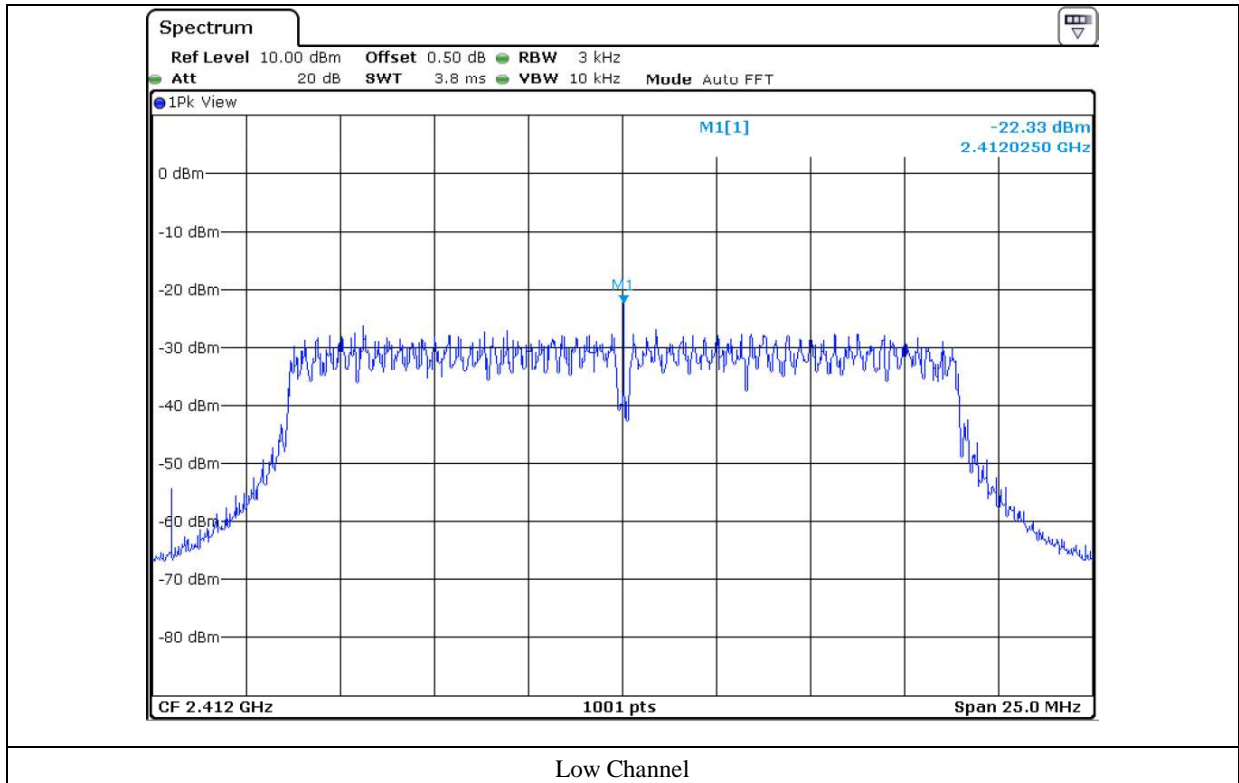
10.6 Test data for 802.11n_HT20 WLAN Mode

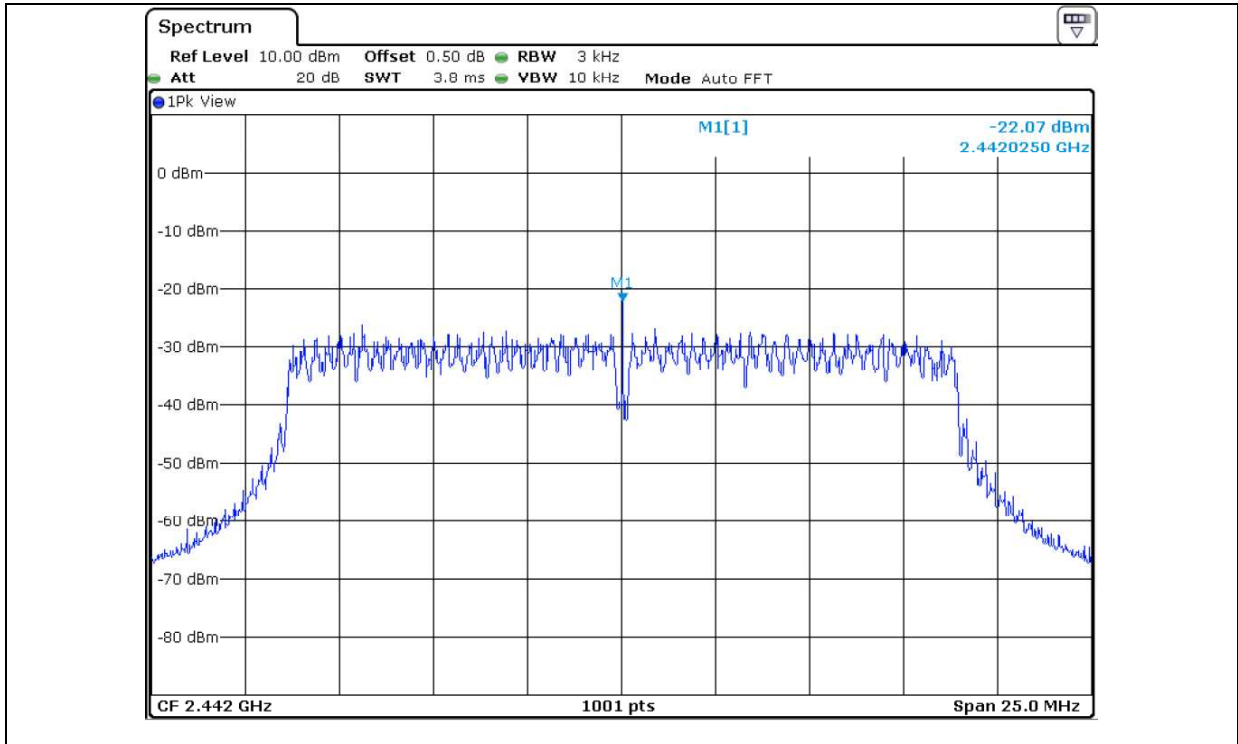
- Test Date : May 22, 2019 ~ May 30, 2019
- Test Result : Pass
- Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 412.00	-22.33	8.00	30.33
Middle	2 442.00	-22.07	8.00	30.07
High	2 462.00	-21.13	8.00	29.13

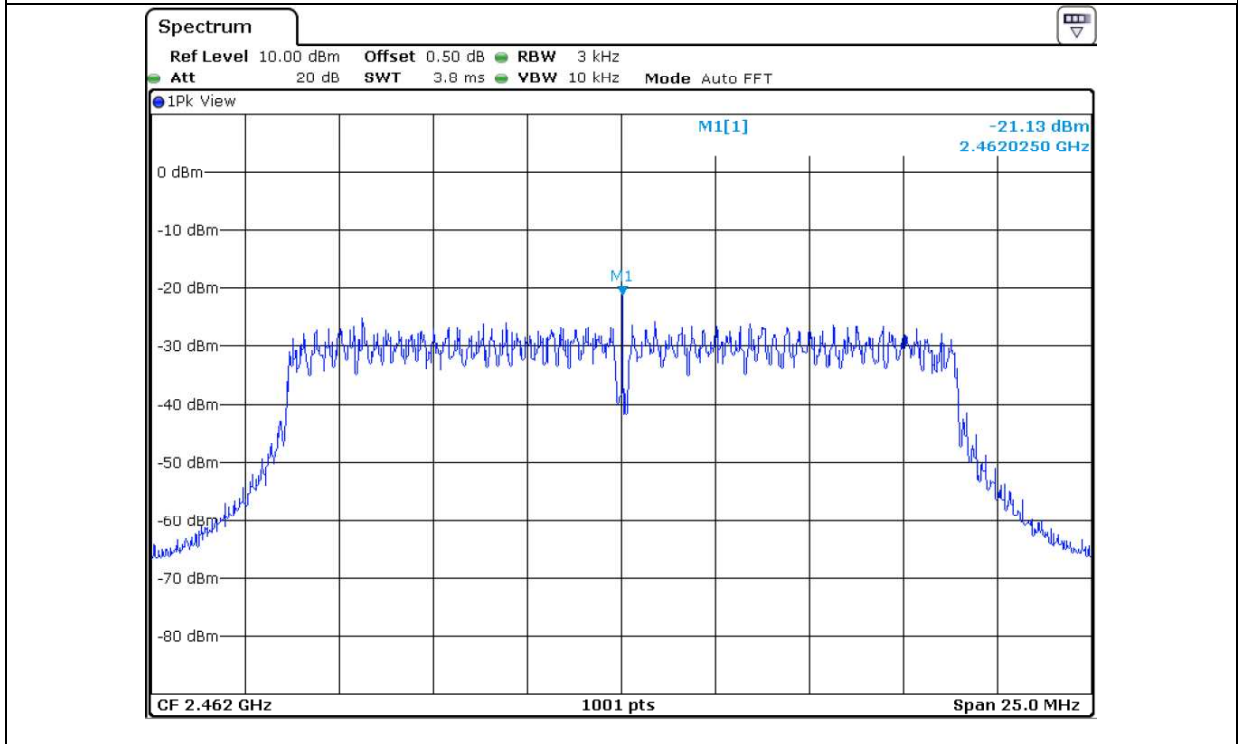
Remark. Margin = Limit – Measured value

Tested by: Hyung-Kwon, Oh / Assistant Manager





Middle Channel



High Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 24 °C
 Relative humidity : 43 % 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	312545	Mar. 18, 2019 (1Y)
■ - BBV9718	Schwarzbeck	Amplifier	310	Mar. 28, 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)
■ - BBHA 9120D	Schwarzbeck	Horn Antenna	9120D-1366	Aug. 02, 2017 (2Y)
■ - BBHA 9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jan. 16, 2019 (1Y)

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 : 43 % R.H.

Temperature: 24 °C

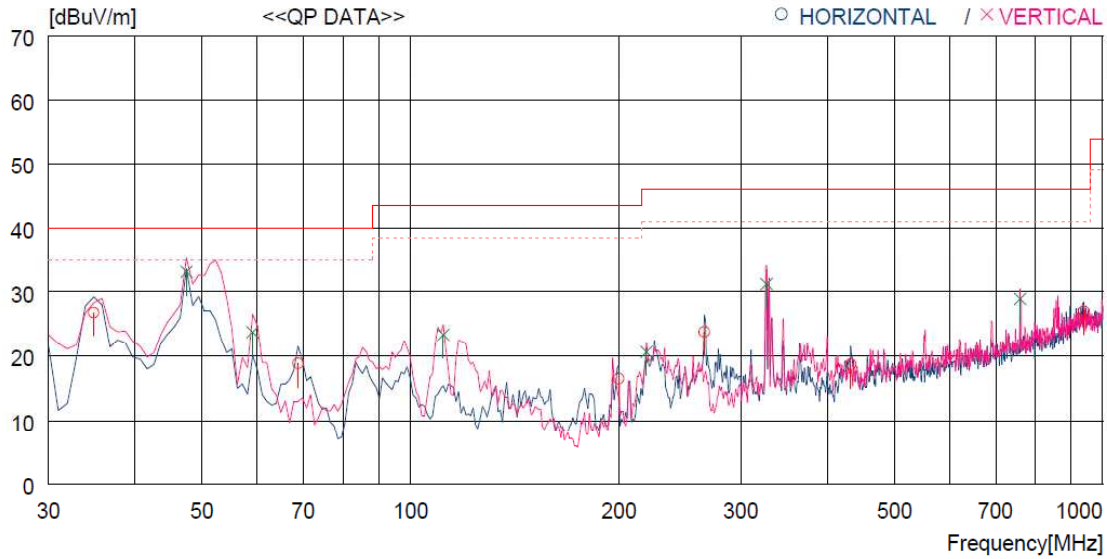
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : ATOZ

Date: May 22, 2019 ~ May 30, 2019

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



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	34.850	45.2	13.3	1.4	33.1	26.8	40.0	13.2	100	138
2	68.800	40.1	9.8	2.0	33.1	18.8	40.0	21.2	100	5
3	199.750	35.5	10.7	3.3	33.0	16.5	43.5	27.0	100	138
4	265.710	40.1	12.9	3.8	33.0	23.8	46.0	22.2	100	2
5	432.551	31.0	16.0	4.8	33.1	18.7	46.0	27.3	100	111
6	938.878	28.7	23.1	7.2	32.0	27.0	46.0	19.0	100	2
----- Vertical -----										
7	47.460	50.3	14.3	1.6	33.1	33.1	40.0	6.9	100	227
8	59.100	41.7	13.3	1.8	33.1	23.7	40.0	16.3	100	246
9	111.480	42.6	11.3	2.4	33.0	23.3	43.5	20.2	100	338
10	219.150	38.6	11.5	3.4	32.9	20.6	46.0	25.4	100	338
11	326.820	45.8	14.2	4.2	33.0	31.2	46.0	14.8	100	338
12	759.433	34.9	20.8	6.4	33.2	28.9	46.0	17.1	100	254

Tested by: Hyung-Kwon, Oh / Assistant Manager

11.4.2 Test data for Below 30 MHz

- Test Date : May 22, 2019 ~ May 30, 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 (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
It was not observed any emissions from the EUT.									

11.4.3 Test data for above 1 GHz

- Test Date : May 22, 2019 ~ May 30, 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 (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/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 : 24 °C
 Relative humidity : 43 % 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 Ω / 50 μH + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

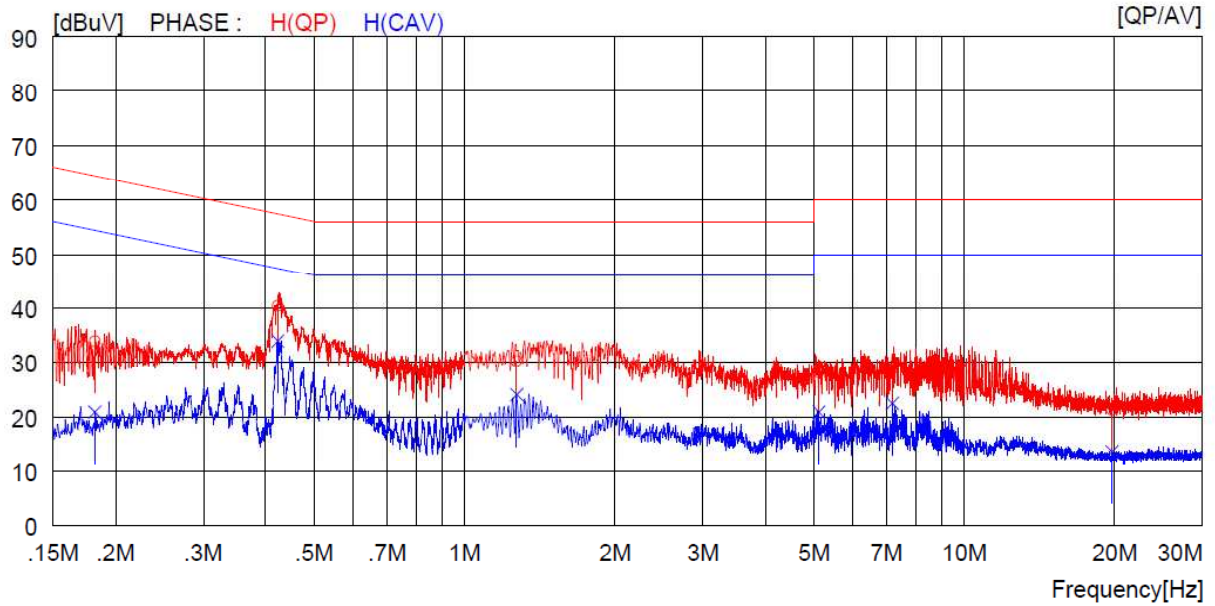
12.3 Test equipment used

	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.

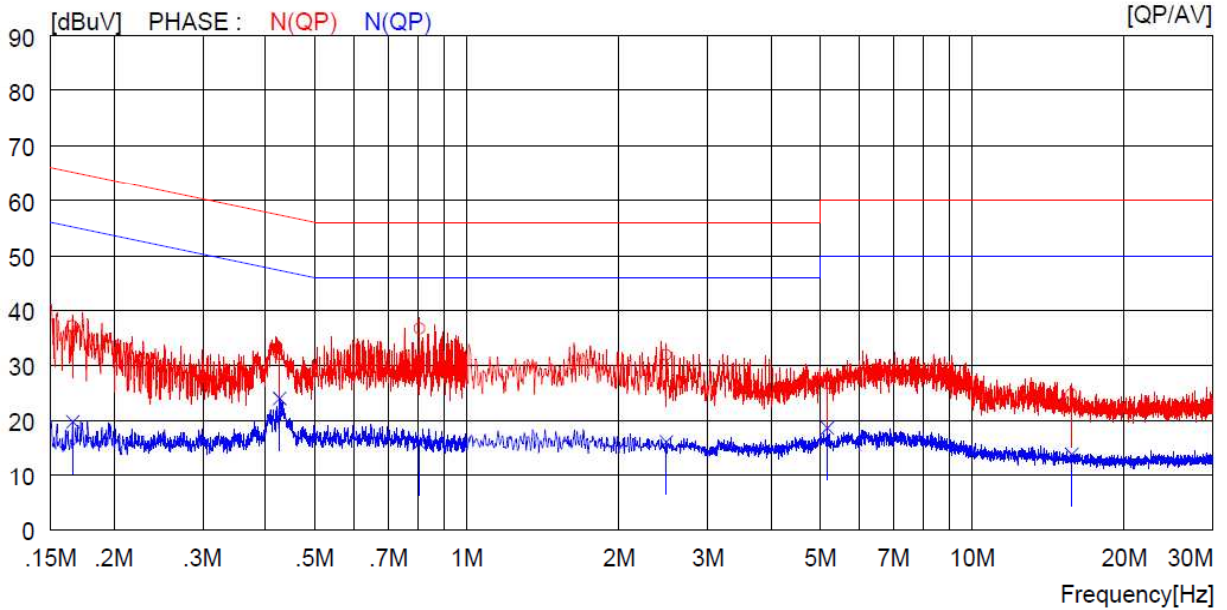
12.4 Test data

- Test Date : May 22, 2019 ~ May 30, 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	0.18200	23.8	----	10.1	33.9	----	64.4	----	30.5	----	H(QP)
2	0.42300	30.2	----	10.1	40.3	----	57.4	----	17.1	----	H(QP)
3	1.27200	20.1	----	10.1	30.2	----	56.0	----	25.8	----	H(QP)
4	5.12000	18.1	----	10.1	28.2	----	60.0	----	31.8	----	H(QP)
5	7.17500	18.6	----	10.2	28.8	----	60.0	----	31.2	----	H(QP)
6	19.77000	10.9	----	10.4	21.3	----	60.0	----	38.7	----	H(QP)
7	0.18200	----	10.8	10.1	----	20.9	----	54.4	----	33.5	H(CAV)
8	0.42300	----	23.8	10.1	----	33.9	----	47.4	----	13.5	H(CAV)
9	1.27200	----	13.9	10.1	----	24.0	----	46.0	----	22.0	H(CAV)
10	5.12000	----	10.8	10.1	----	20.9	----	50.0	----	29.1	H(CAV)
11	7.17500	----	12.2	10.2	----	22.4	----	50.0	----	27.6	H(CAV)
12	19.77000	----	3.2	10.4	----	13.6	----	50.0	----	36.4	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	0.16600	27.1	----	10.1	37.2	----	65.2	----	28.0	----	N (QP)
2	0.42600	22.0	----	10.1	32.1	----	57.3	----	25.2	----	N (QP)
3	0.80600	26.6	----	10.1	36.7	----	56.0	----	19.3	----	N (QP)
4	2.48000	21.8	----	10.1	31.9	----	56.0	----	24.1	----	N (QP)
5	5.17000	16.5	----	10.1	26.6	----	60.0	----	33.4	----	N (QP)
6	15.74000	14.3	----	10.4	24.7	----	60.0	----	35.3	----	N (QP)
7	0.16600	----	9.6	10.1	----	19.7	----	55.2	----	35.5	NCAV)
8	0.42600	----	13.8	10.1	----	23.9	----	47.3	----	23.4	NCAV)
9	0.80600	----	5.7	10.1	----	15.8	----	46.0	----	30.2	NCAV)
10	2.48000	----	6.0	10.1	----	16.1	----	46.0	----	29.9	NCAV)
11	5.17000	----	8.5	10.1	----	18.6	----	50.0	----	31.4	NCAV)
12	15.74000	----	3.4	10.4	----	13.8	----	50.0	----	36.2	NCAV)

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