



# FCC RF Test Report

**APPLICANT** : Ubiquiti Networks, Inc.  
**EQUIPMENT** : BULLET M2  
**BRAND NAME** : UBIQUITI  
**MODEL NAME** : BulletM2-HP, BM2-Ti  
**FCC ID** : SWX-M2BW  
**STANDARD** : FCC Part 15 Subpart C §15.247  
**CLASSIFICATION** : (DTS) Digital Transmission System

The product was received on Dec. 19, 2017 and testing was completed on Feb. 08, 2018. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

Reviewed by: Anderson Chiu / Manager

Approved by: Jones Tsai / Manager



## **SPORTON INTERNATIONAL INC.**

**No. 52, Hwa Ya 1<sup>st</sup> Rd., Hwa Ya Technology Park, Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C.**

SPORTON INTERNATIONAL INC.

TEL : 886-3-327-3456

FAX : 886-3-328-4978

FCC ID: SWX-M2BW

Page Number : 1 of 154

Report Issued Date : Feb. 14, 2018

Report Version : Rev. 01

Report Template No.: BU5-FR15CWLAC MA Version 2.0



# TABLE OF CONTENTS

**REVISION HISTORY..... 3**

**SUMMARY OF TEST RESULT ..... 4**

**1 GENERAL DESCRIPTION ..... 5**

    1.1 Applicant ..... 5

    1.2 Manufacturer ..... 5

    1.3 Product Feature of Equipment Under Test..... 5

    1.4 Modification of EUT ..... 5

    1.5 Testing Location ..... 6

    1.6 Applicable Standards ..... 6

**2 TEST CONFIGURATION OF EQUIPMENT UNDER TEST ..... 7**

    2.1 Carrier Frequency and Channel ..... 7

    2.2 Test Mode ..... 8

    2.3 Connection Diagram of Test System ..... 8

    2.4 Support Unit used in test configuration and system ..... 9

    2.5 EUT Operation Test Setup ..... 9

    2.6 Measurement Results Explanation Example ..... 9

**3 TEST RESULT ..... 10**

    3.1 6dB and 99% Bandwidth Measurement ..... 10

    3.2 Output Power Measurement ..... 13

    3.3 Power Spectral Density Measurement ..... 15

    3.4 Conducted Band Edges and Spurious Emission Measurement ..... 18

    3.5 Radiated Band Edges and Spurious Emission Measurement ..... 145

    3.6 AC Conducted Emission Measurement ..... 149

    3.7 Antenna Requirements ..... 151

**4 LIST OF MEASURING EQUIPMENT ..... 153**

**5 UNCERTAINTY OF EVALUATION ..... 154**

**APPENDIX A. CONDUCTED TEST RESULTS**

**APPENDIX B. AC CONDUCTED EMISSION TEST RESULT**

**APPENDIX C. RADIATED SPURIOUS EMISSION**

**APPENDIX D. RADIATED SPURIOUS EMISSION PLOTS**

**APPENDIX E. DUTY CYCLE PLOTS**

**APPENDIX F. SETUP PHOTOGRAPHS**





### SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Pass	-
3.2	15.247(b)	Power Output Measurement	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	-
		Conducted Spurious Emission		Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 1.06 dB at 145.020 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 5.00 dB at 0.150 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-



# 1 General Description

## 1.1 Applicant

Ubiquiti Networks, Inc.  
685 Third Avenue, 27th Floor New York, New York 10017 USA

## 1.2 Manufacturer

Ubiquiti Networks, Inc.  
685 Third Avenue, 27th Floor New York, New York 10017 USA

## 1.3 Product Feature of Equipment Under Test

Wi-Fi 2.4GHz 802.11b/g/n

Product Specification subjective to this standard	
Sample 1	EUT in Gray Case and Model Name: BM2-Ti
Sample 2	EUT in White Case and Model Name: BulletM2-HP

Antenna Information			
	Model Name	Type	Gain
Ant. 1	AMO-2G10	Omni Antenna	10dBi
Ant. 2	AMO-2G13	Omni Antenna	13dBi
Ant. 3	AM-V2G-Ti	Sector Antenna	15~17dBi
Ant. 4	RD-2G24	Dish Antenna	24dBi

## 1.4 Modification of EUT

No modifications are made to the EUT during all test items.



### 1.5 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1190 and TW0007 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

<b>Test Site</b>	SPORTON INTERNATIONAL INC.
<b>Test Site Location</b>	No. 52, Hwa Ya 1 <sup>st</sup> Rd., Hwa Ya Technology Park, Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978
<b>Test Site No.</b>	<b>Sporton Site No.</b> CO05-HY

**Note:** The test site complies with ANSI C63.4 2014 requirement.

<b>Test Site</b>	SPORTON INTERNATIONAL INC.
<b>Test Site Location</b>	No.58, Aly. 75, Ln. 564, Wenhua 3rd Rd. Guishan Dist, Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
<b>Test Site No.</b>	<b>Sporton Site No.</b> 03CH15-HY

**Note:** The test site complies with ANSI C63.4 2014 requirement.

### 1.6 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ♦ ANSI C63.10-2013

**Remark:**

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



## 2 Test Configuration of Equipment Under Test

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower)..
  
- b. AC power line Conducted Emission was tested under maximum output power.

### 2.1 Carrier Frequency and Channel

Frequency Band	Freq. (MHz)	Freq. (MHz)	Freq. (MHz)	Freq. (MHz)
2400-2483.5 MHz	2412	2427	2442	2457
	2414	2429	2444	2459
	2417	2432	2447	2462
	2419	2434	2449	
	2422	2437	2452	
	2424	2439	2454	

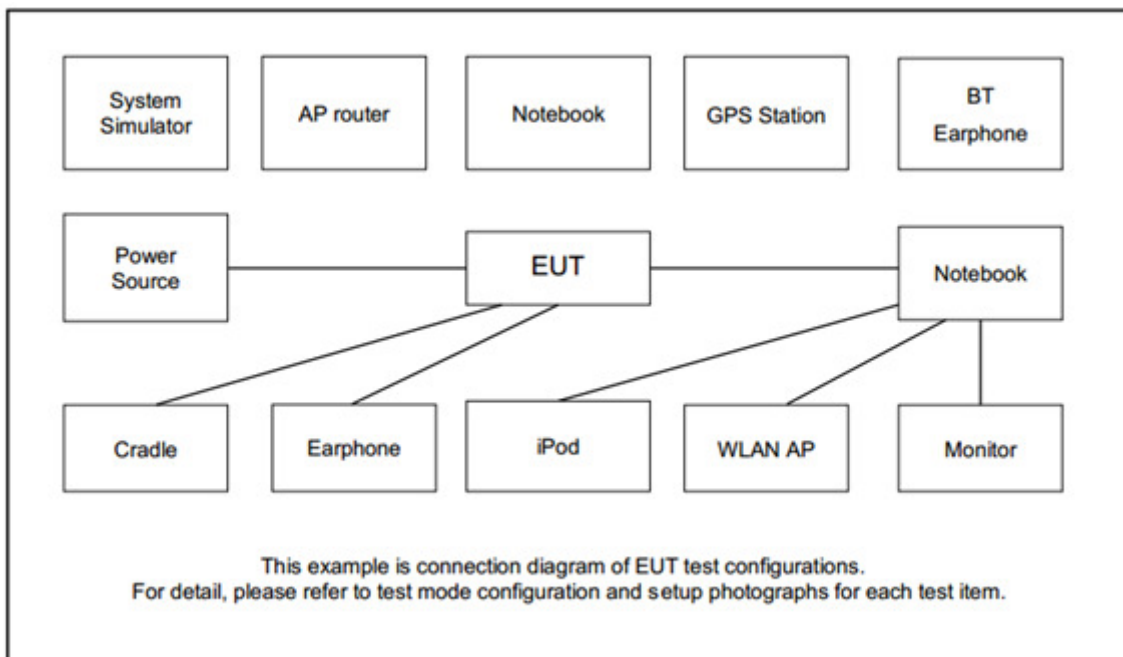
## 2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

Modulation	Bandwidth	Data Rate
802.11b	(5, 8, 10, 20) MHz	1 Mbps
802.11g	(5, 8, 10, 20) MHz	6 Mbps
802.11n	HT (5, 8, 10, 20, 30, 40) MHz	MCS0

Test Cases	
<b>AC Conducted Emission</b>	Mode 1 :WLAN (2.4GHz) Tx + LAN Link + PoE + Omni Antenna for Sample 1
	Mode 2 WLAN (2.4GHz) Tx + LAN Link + PoE + AM-V2G-Ti Antenna for Sample 1
	Mode 3 :WLAN (2.4GHz) Tx + LAN Link + PoE + RD-2G24 Antenna for Sample 1
	Mode 4 :WLAN (2.4GHz) Tx + LAN Link + PoE + AM-V2G-Ti Antenna for Sample 2
<b>Remark:</b> The worst case of conducted emission is mode 2; only the test data of it was reported.	

## 2.3 Connection Diagram of Test System







## 2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Notebook	DELL	Latitude E6320	FCC DoC/ Contains FCC ID: QDS-BRCM1054	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
2.	POE	Ubiquiti	GP-A240-050G	FCC DoC	N/A	N/A

## 2.5 EUT Operation Test Setup

The RF test items, utility “Putty” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

## 2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

$$\text{Offset} = \text{RF cable loss} + \text{attenuator factor}.$$

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 4.2 + 10 = 14.2 \text{ (dB)} \end{aligned}$$

### 3 Test Result

#### 3.1 6dB and 99% Bandwidth Measurement

##### 3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

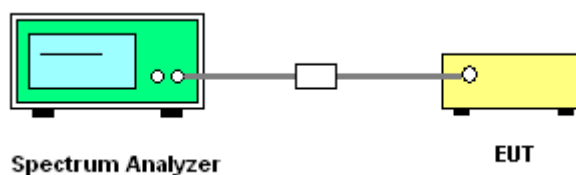
##### 3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

##### 3.1.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 DTS D01 Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) = 1MHz and set the Video bandwidth (VBW) = 3MHz.
6. Measure and record the results in the test report.

##### 3.1.4 Test Setup

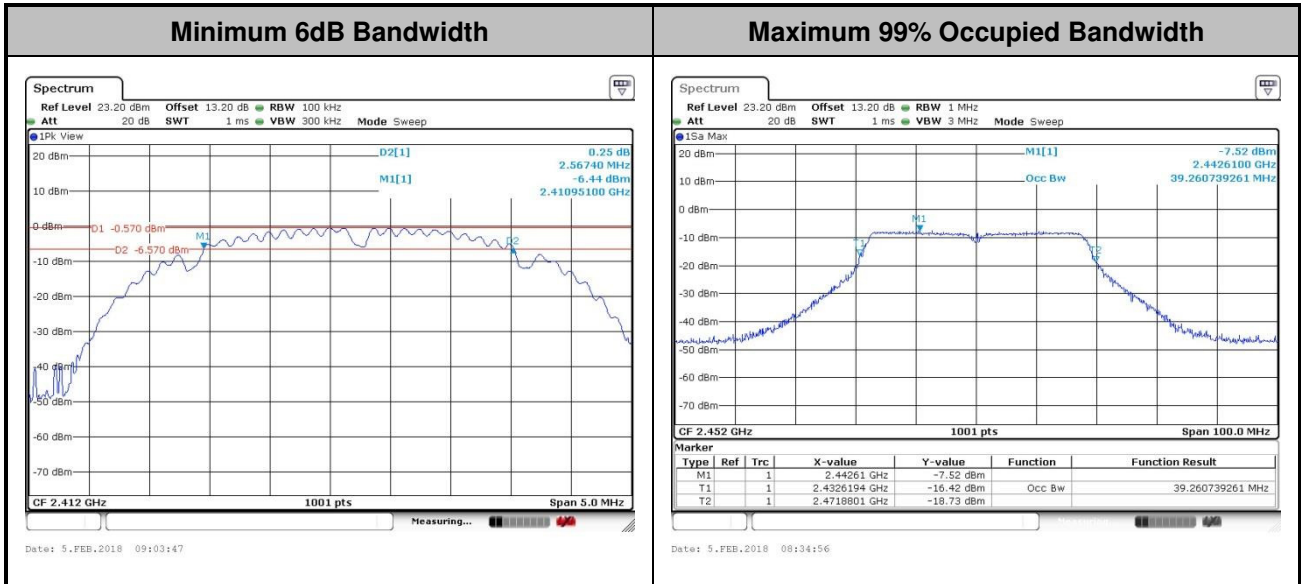




### 3.1.5 Test Result of 6dB and 99% Occupied Bandwidth

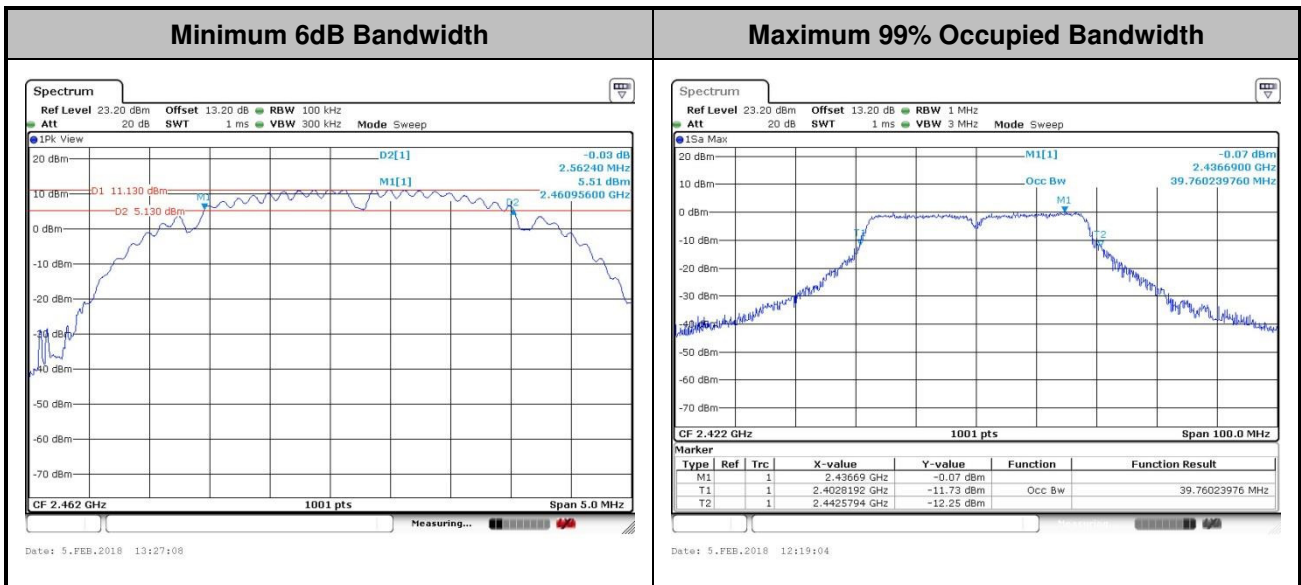
Please refer to Appendix A.

#### <Dish Antenna>



Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

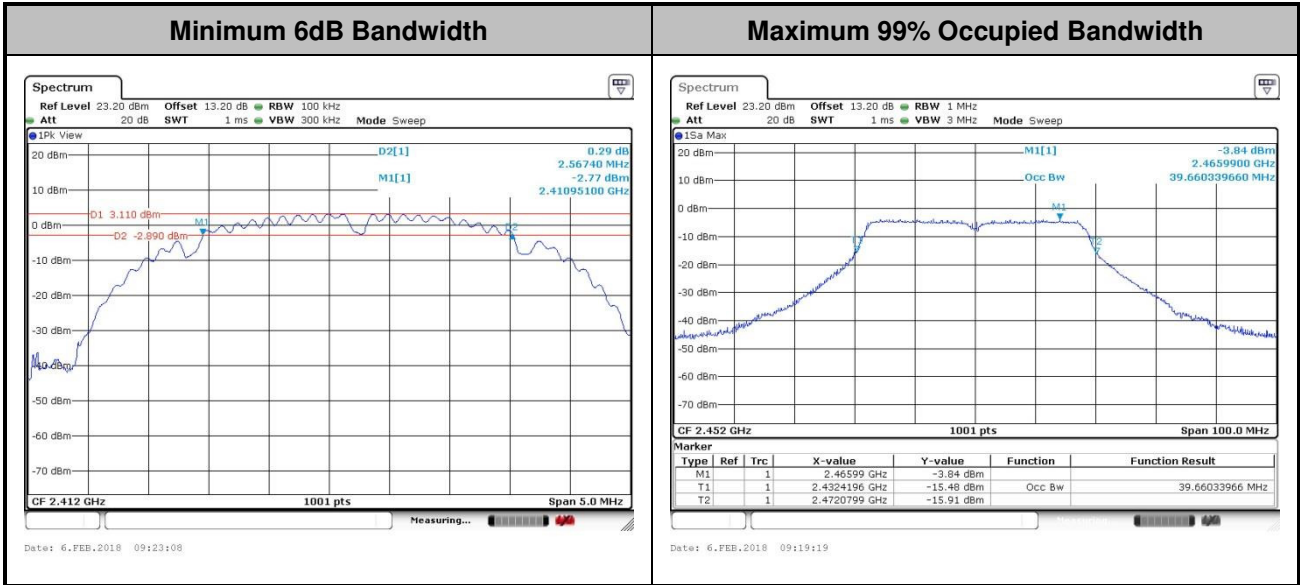
#### <Omni Antenna>



Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations



<Sector Antenna>



Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations

## 3.2 Output Power Measurement

### 3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

### 3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

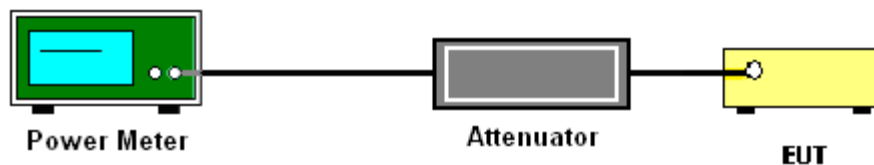
### 3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.3 PKPM1 Peak power meter method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

<Average output power>

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 D01 DTS Meas. Guidance v04 section 9.3.2 AVGPM-G Method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.
4. Record the test results in the test report.

### 3.2.4 Test Setup





### **3.2.5 Test Result of Peak Output Power**

Please refer to Appendix A.

### **3.2.6 Test Result of Average output Power (Reporting Only)**

Please refer to Appendix A.



### **3.3 Power Spectral Density Measurement**

#### **3.3.1 Limit of Power Spectral Density**

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

#### **3.3.2 Measuring Instruments**

The measuring equipment is listed in the section 4 of this test report.

#### **3.3.3 Test Procedures**

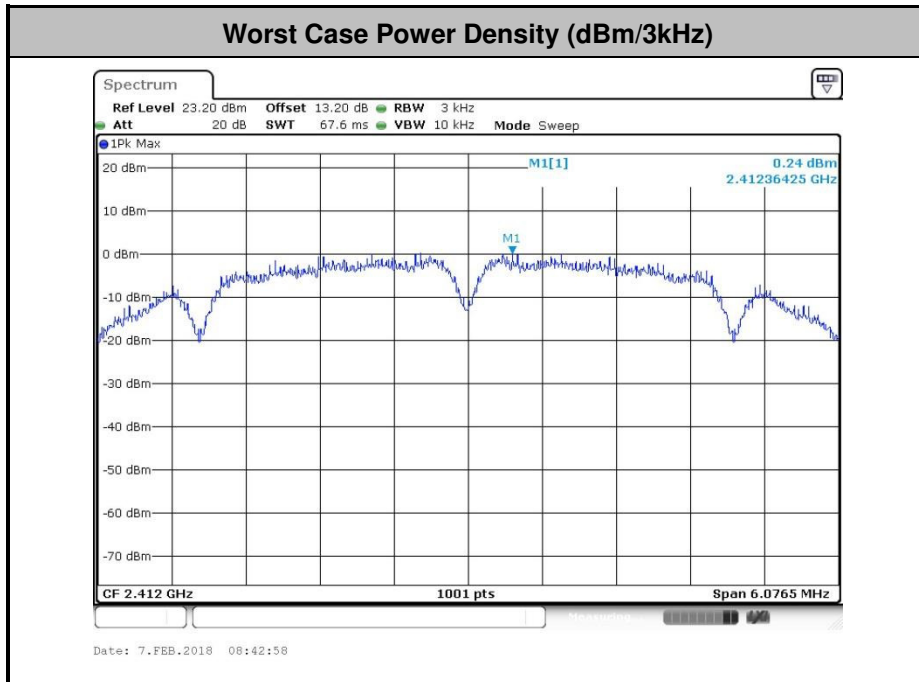
1. The testing follows Measurement Procedure 10.2 Method PKPSD of FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.



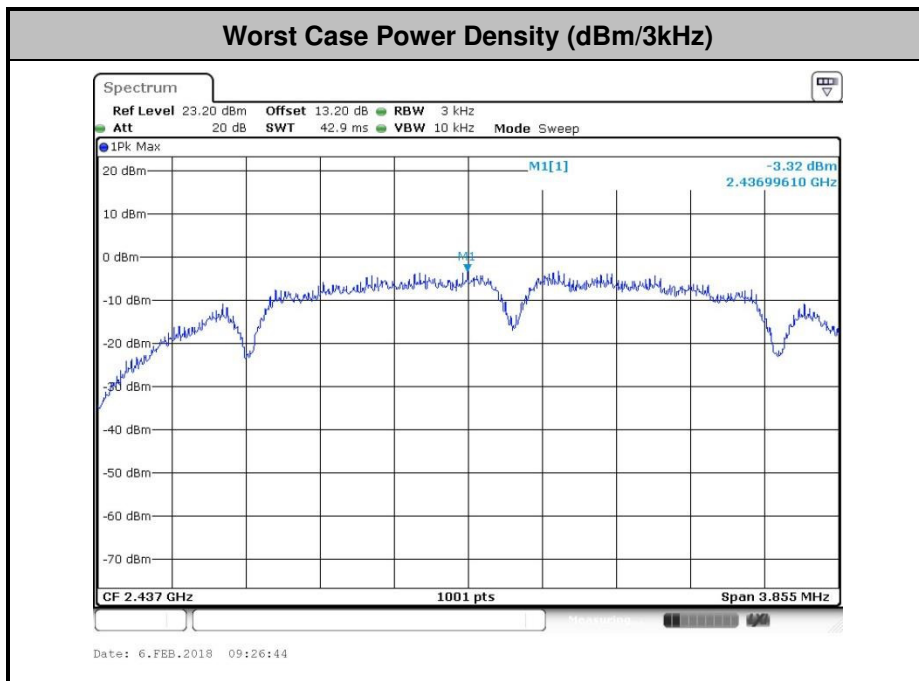




<Omni Antenna>



<Sector Antenna>



## 3.4 Conducted Band Edges and Spurious Emission Measurement

### 3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

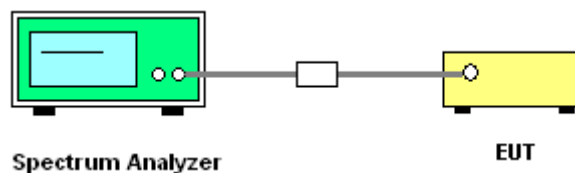
### 3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

### 3.4.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

### 3.4.4 Test Setup





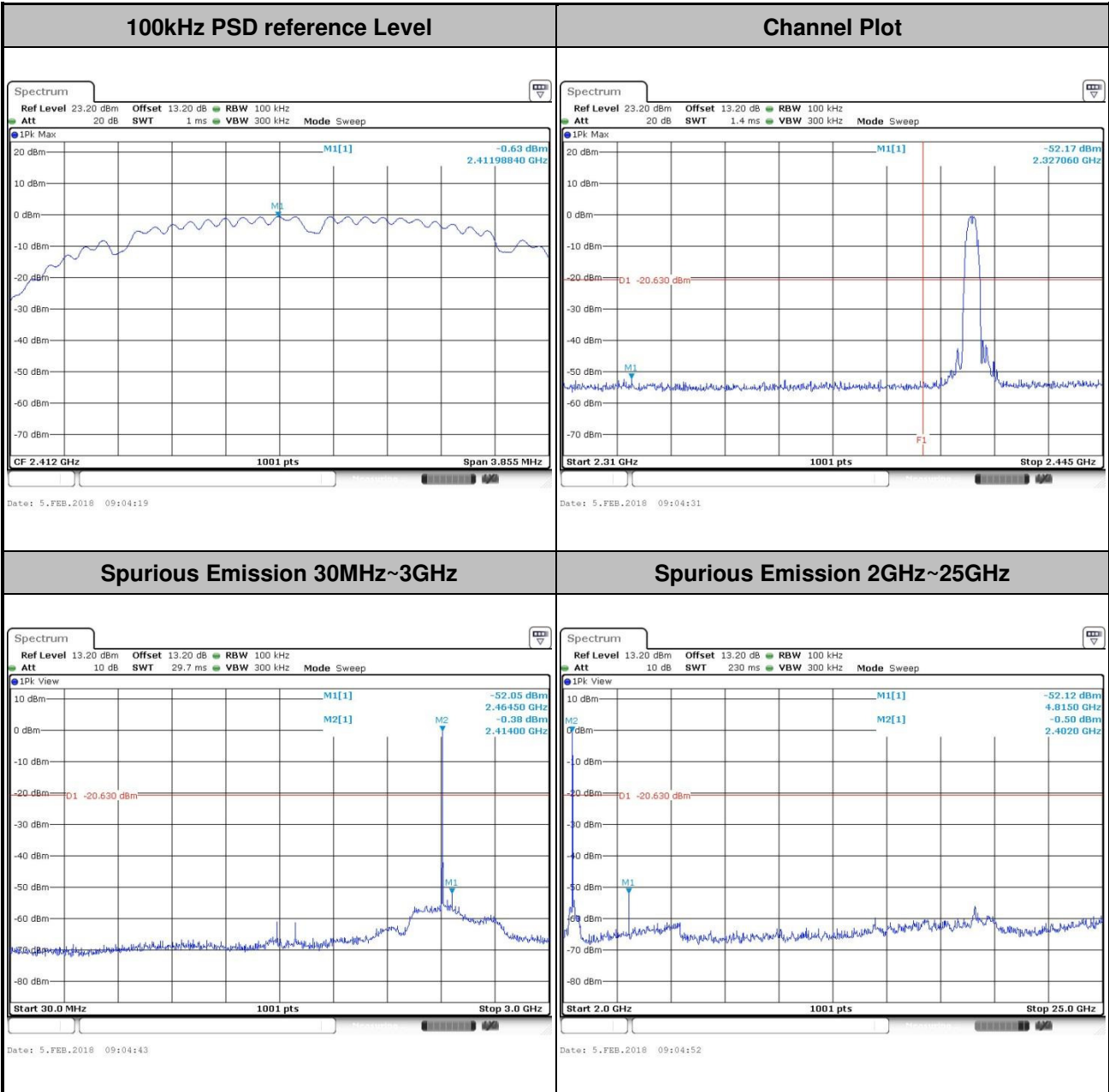
### 3.4.5 Test Result of Conducted Band Edges and Spurious Emission

Test Engineer : Howard Kao	Temperature : 26°C
	Relative Humidity : 66%

<Dish Antenna>

Number of TX = 1, Ant. 1 (Measured)

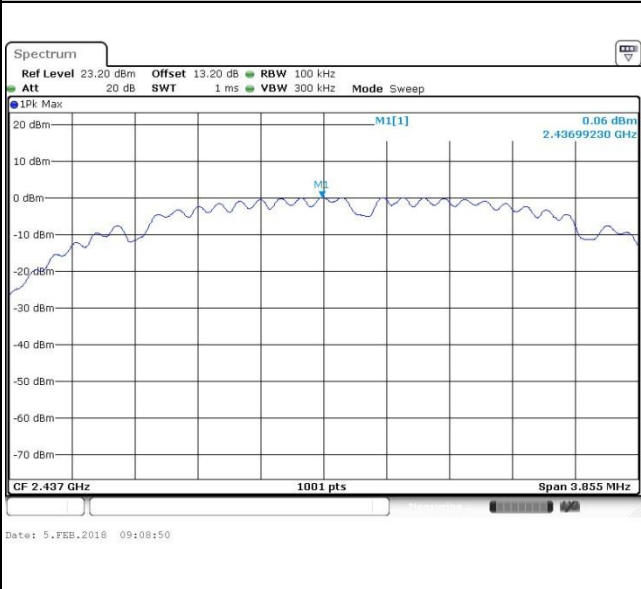
Test Mode : 802.11b (5MHz)	Test Channel : 01
----------------------------	-------------------



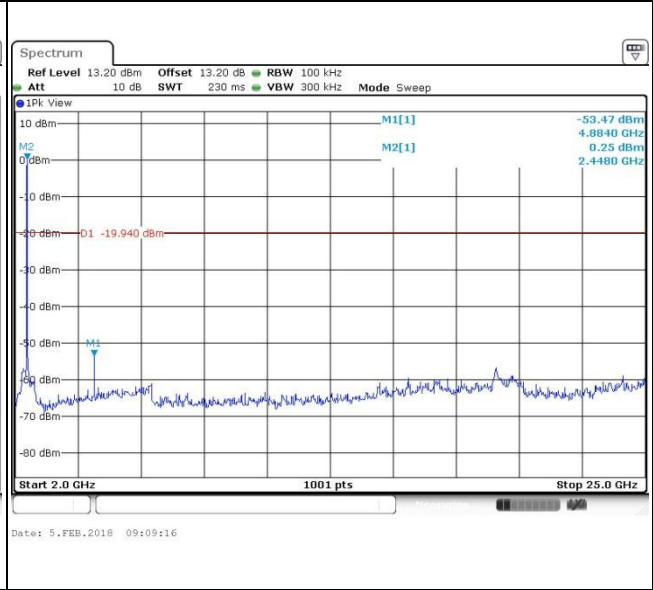
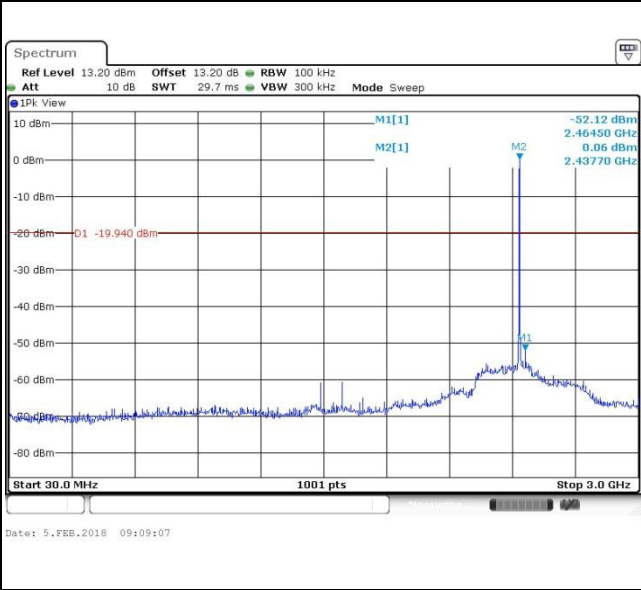


Test Mode :	802.11b (5MHz)	Test Channel :	06
-------------	----------------	----------------	----

<b>100kHz PSD reference Level</b>	<b>Channel Plot</b>
-----------------------------------	---------------------

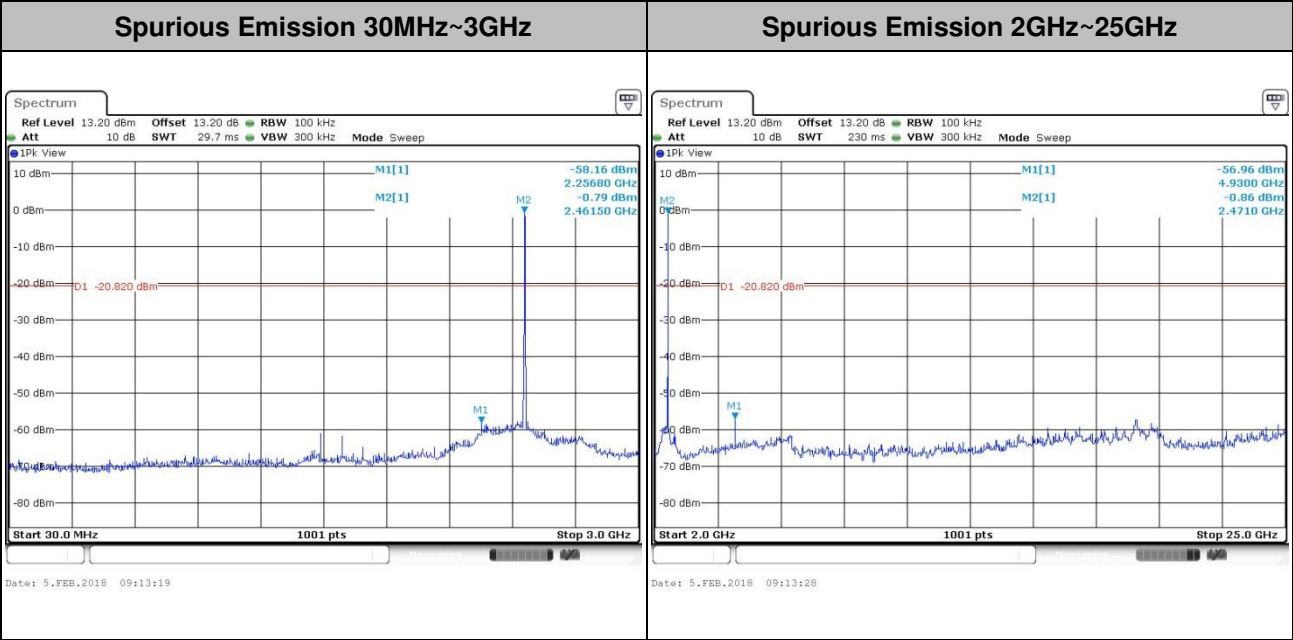
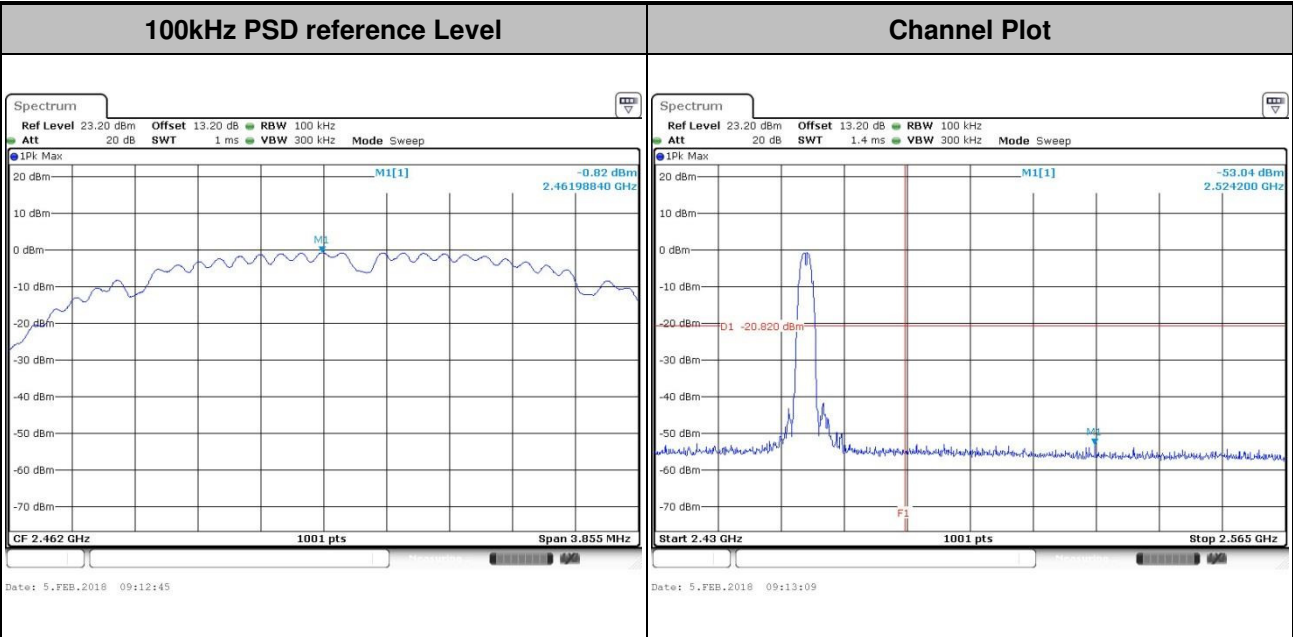


<b>Spurious Emission 30MHz~3GHz</b>	<b>Spurious Emission 2GHz~25GHz</b>
-------------------------------------	-------------------------------------



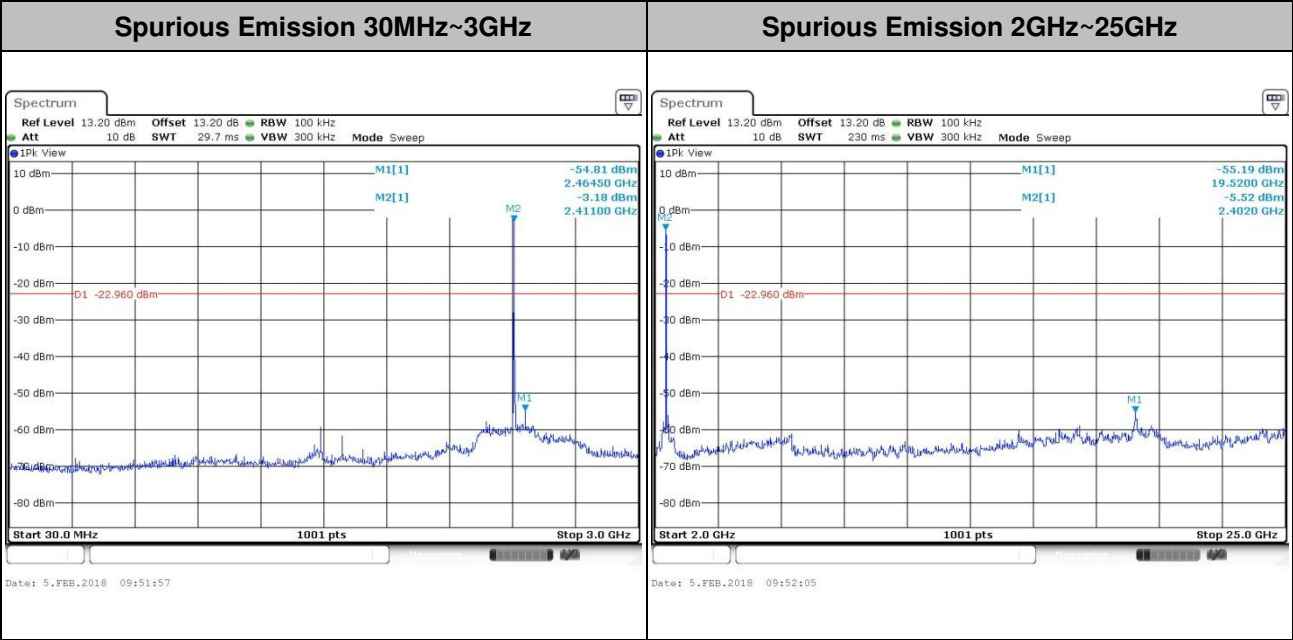
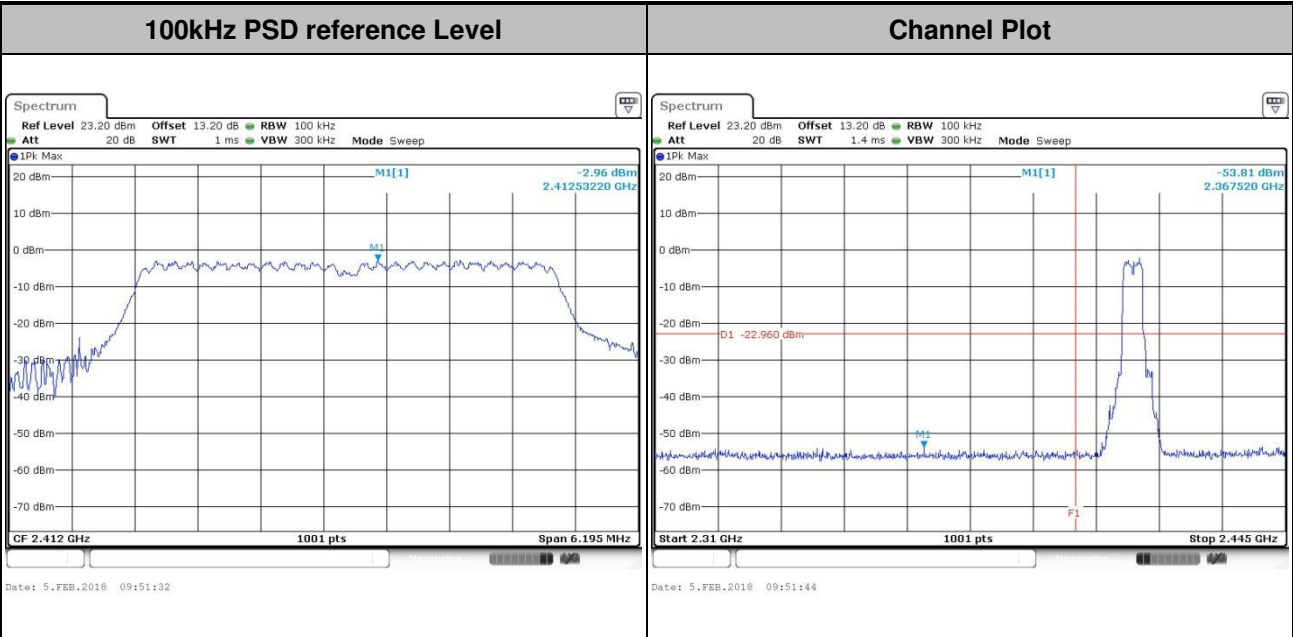


Test Mode :	802.11b (5MHz)	Test Channel :	11
-------------	----------------	----------------	----



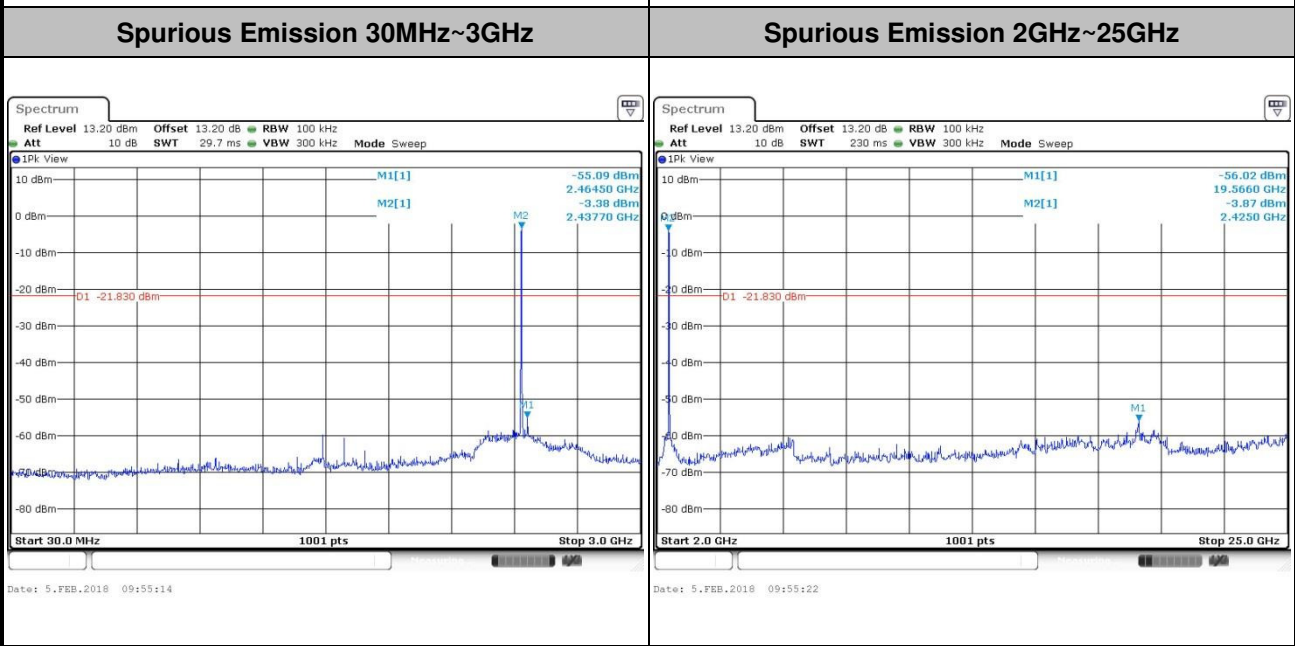
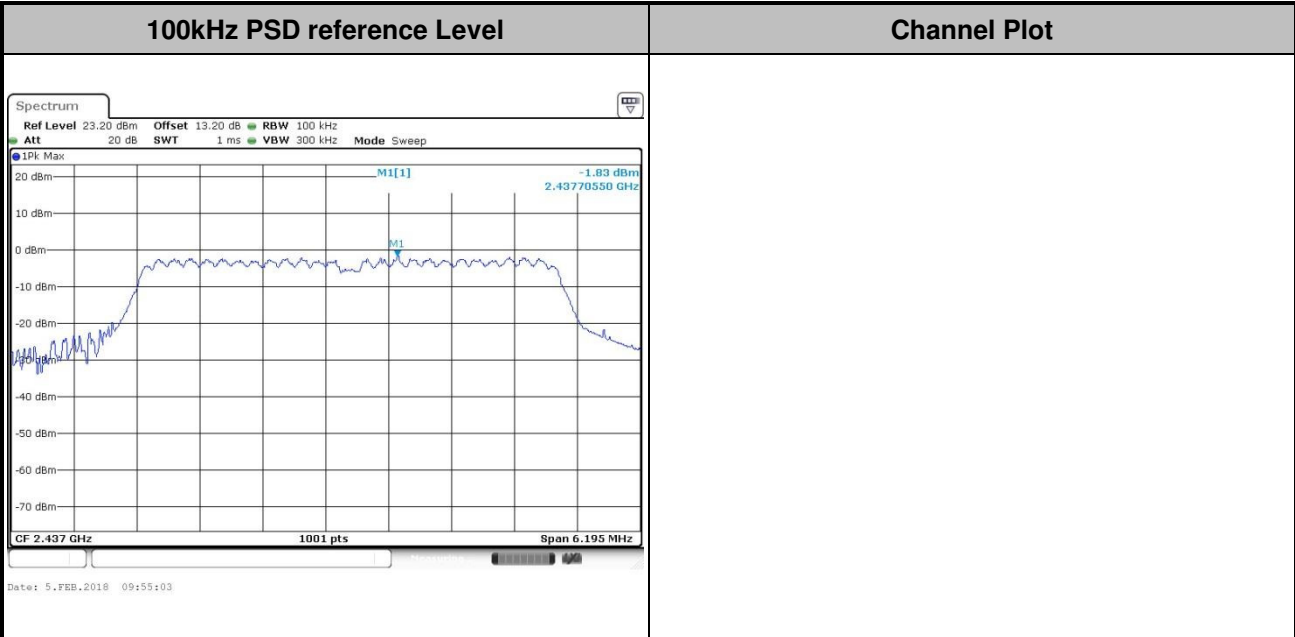


Test Mode :	802.11g (5MHz)	Test Channel :	01
-------------	----------------	----------------	----



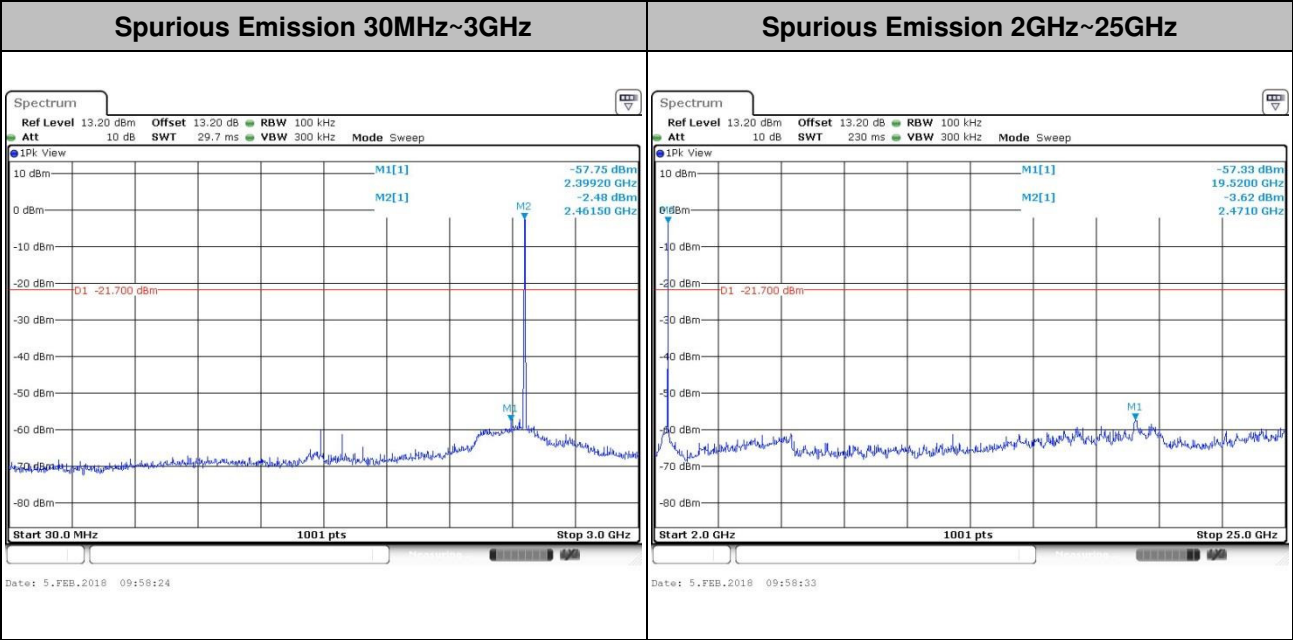
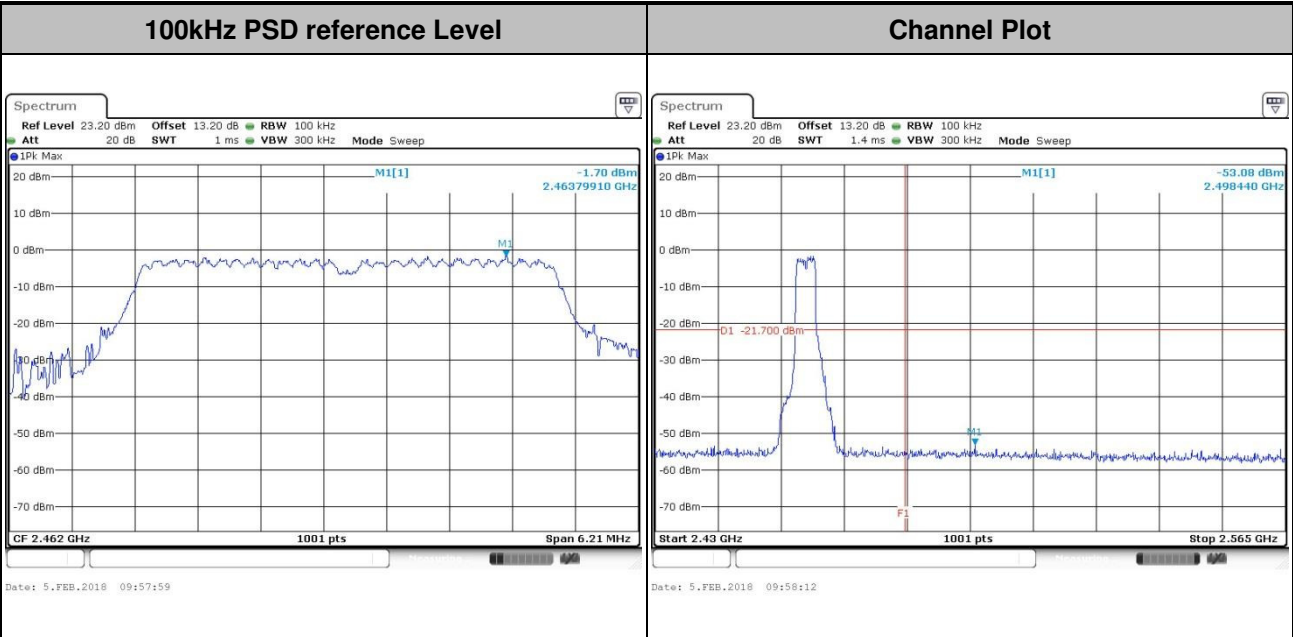


Test Mode :	802.11g (5MHz)	Test Channel :	06
-------------	----------------	----------------	----





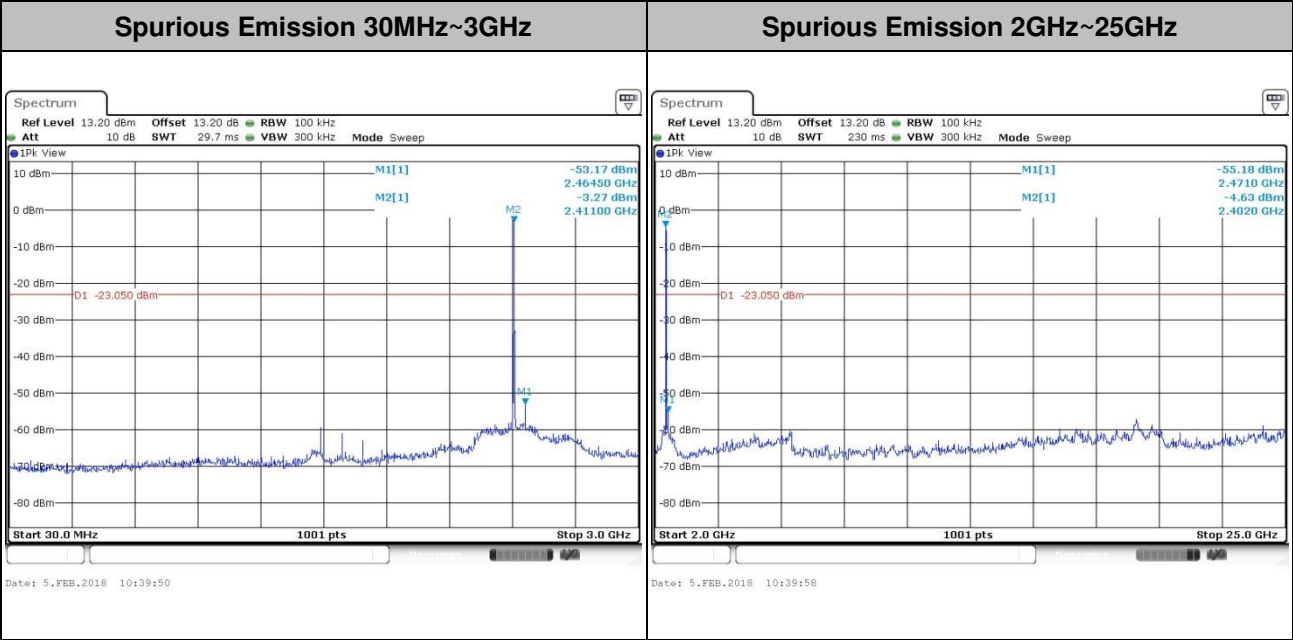
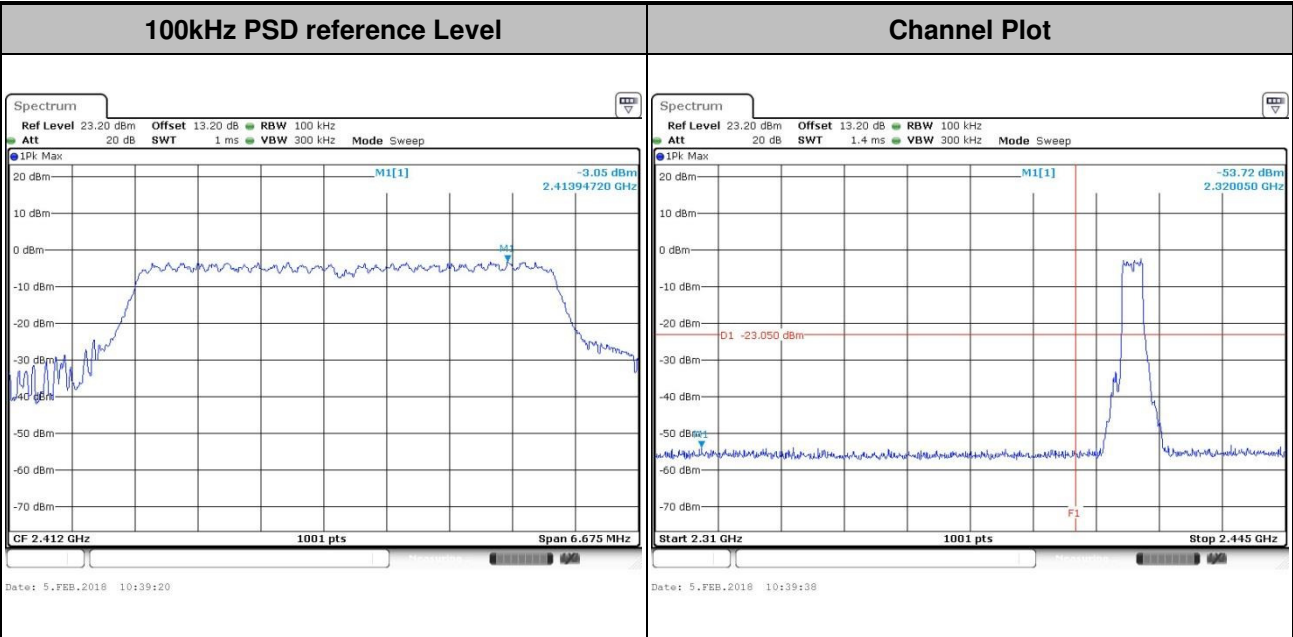
Test Mode :	802.11g (5MHz)	Test Channel :	11
-------------	----------------	----------------	----





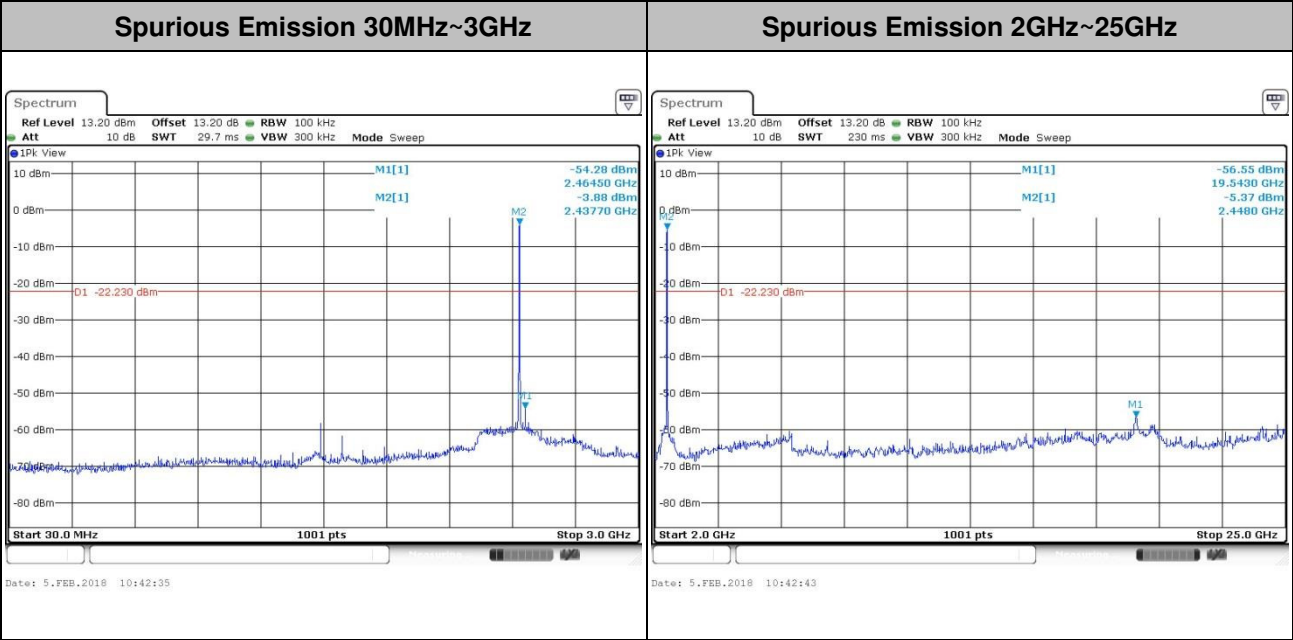
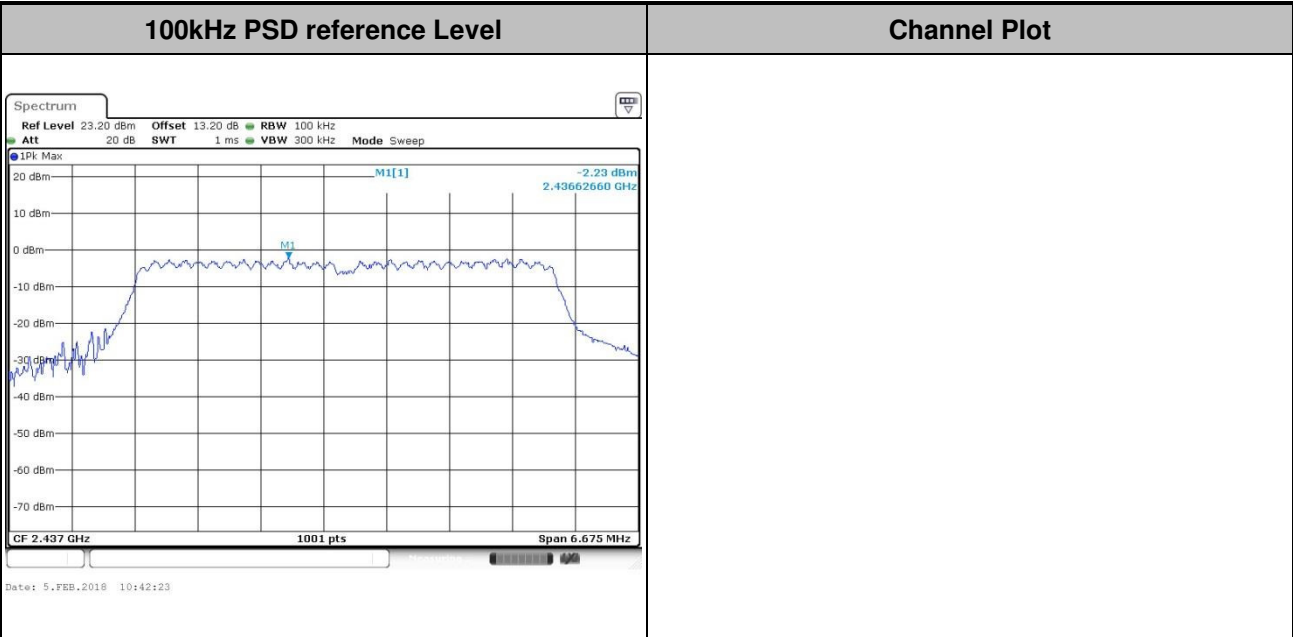


<b>Test Mode :</b>	802.11n HT (5MHz)	<b>Test Channel :</b>	01
--------------------	-------------------	-----------------------	----



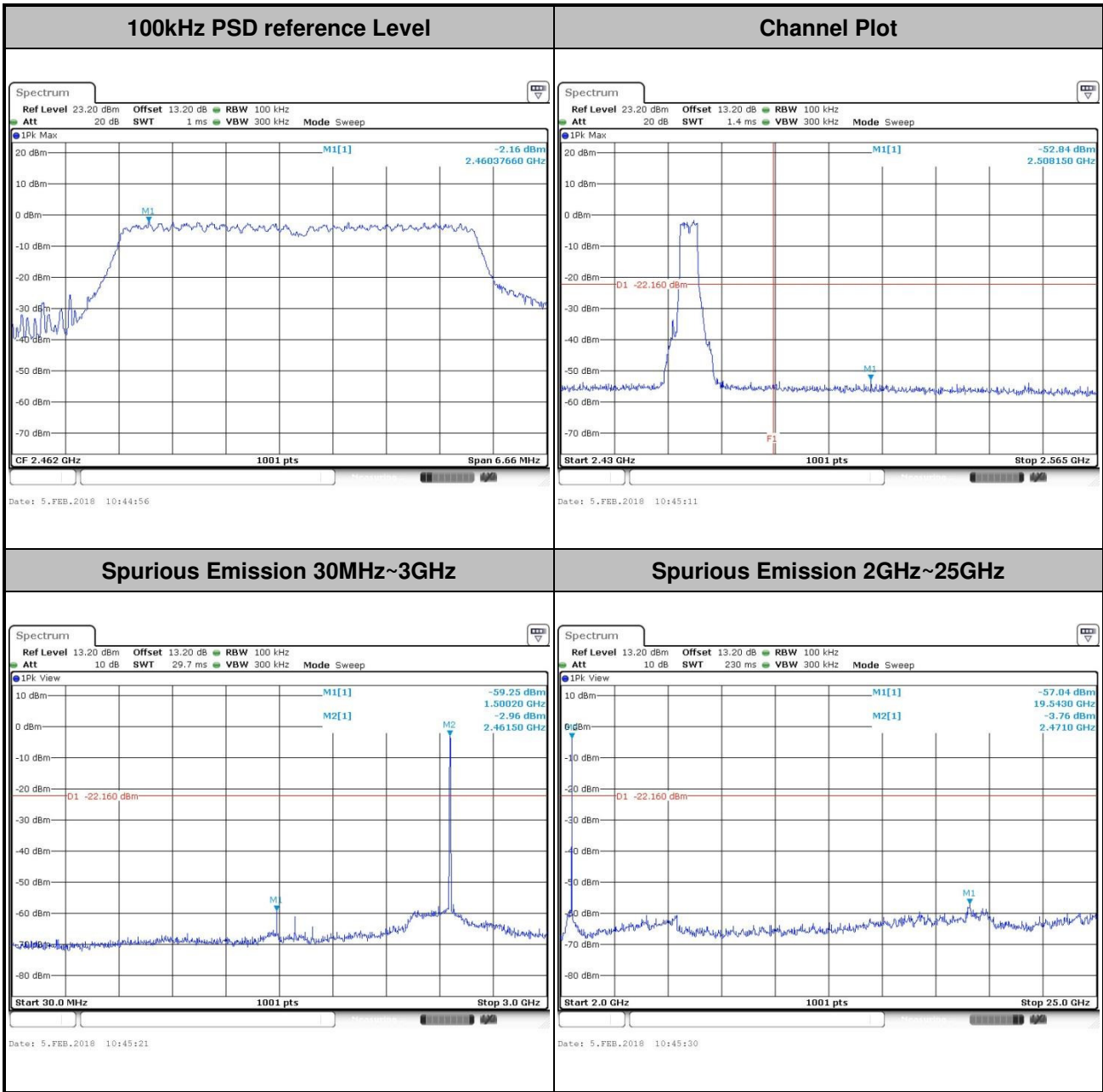


Test Mode :	802.11n HT (5MHz)	Test Channel :	06
-------------	-------------------	----------------	----



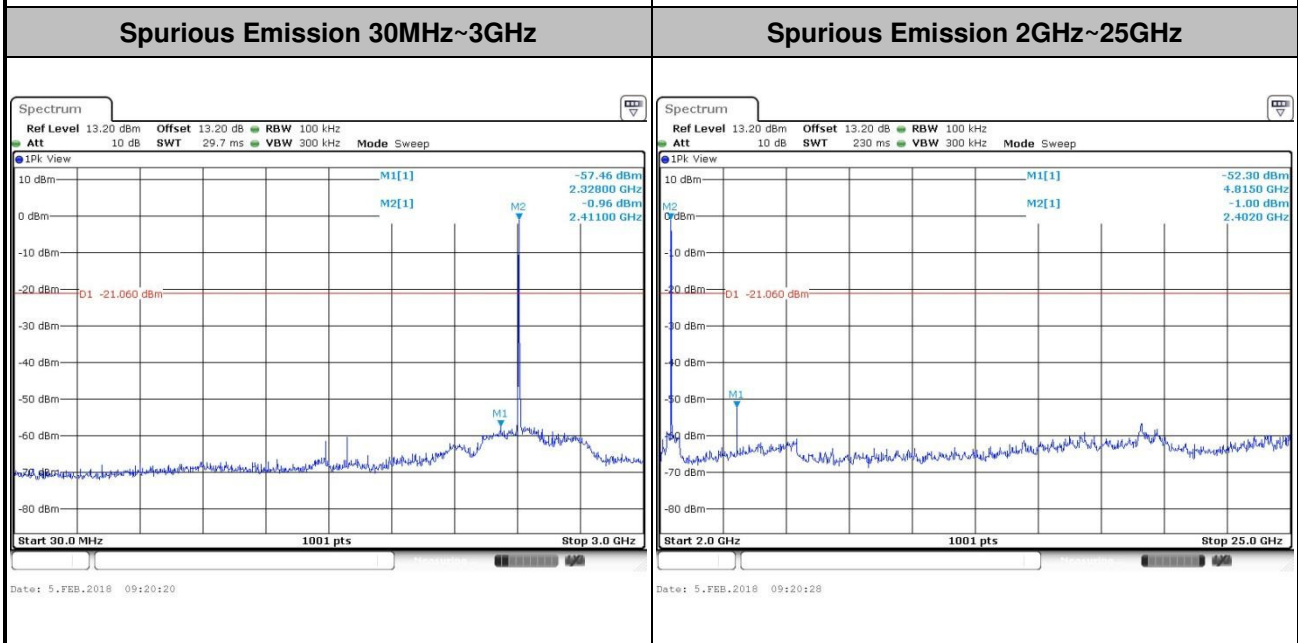
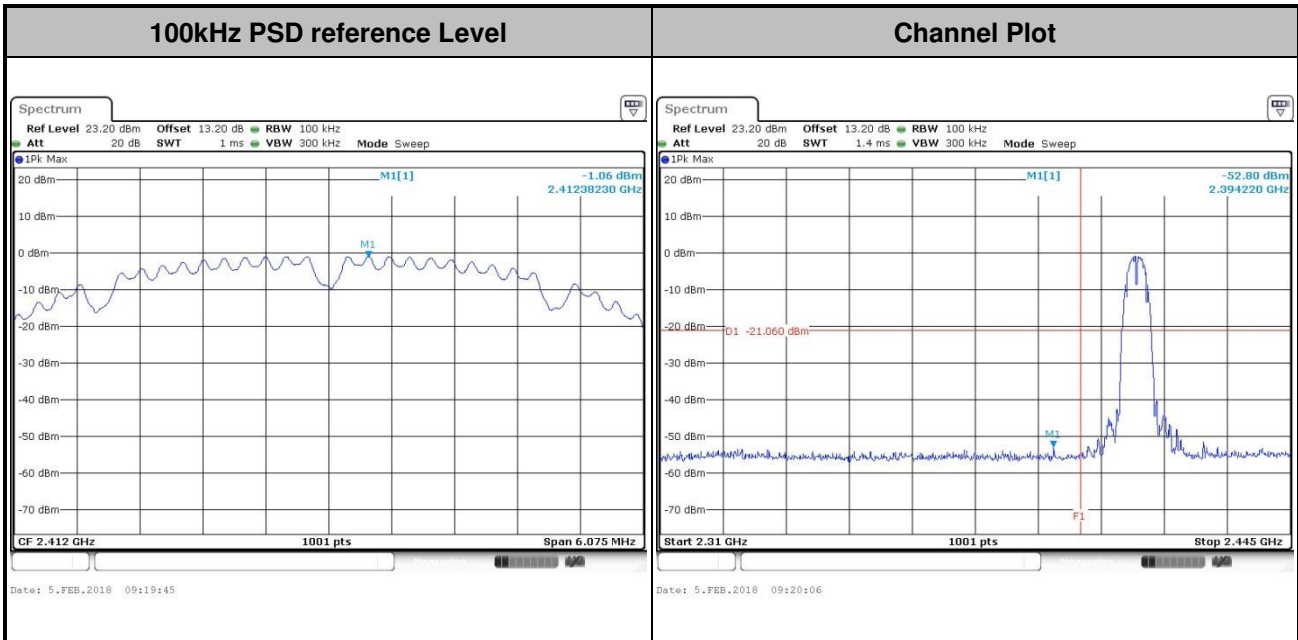


Test Mode :	802.11n HT (5MHz)	Test Channel :	11
-------------	-------------------	----------------	----





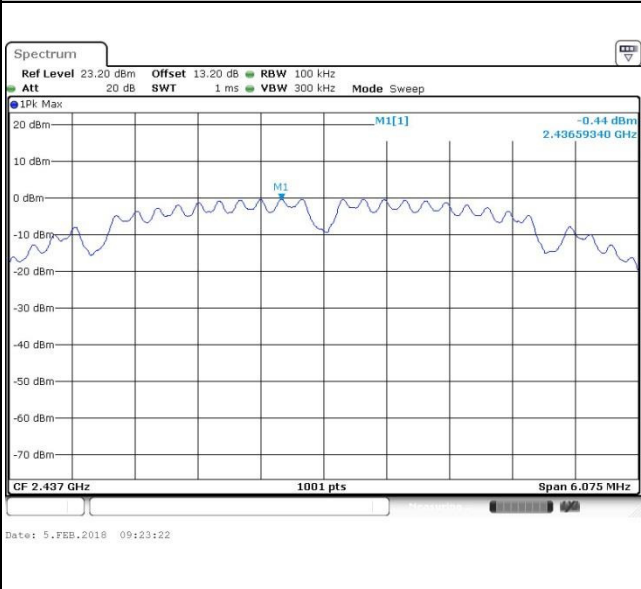
Test Mode :	802.11b (8MHz)	Test Channel :	01
-------------	----------------	----------------	----



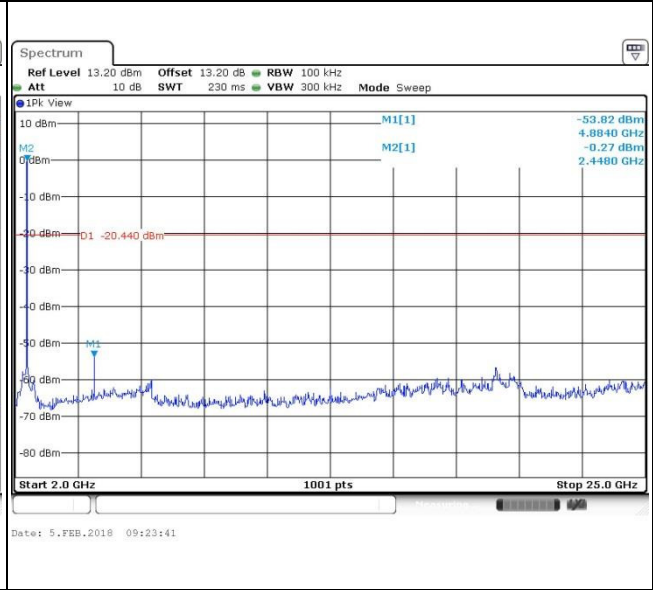
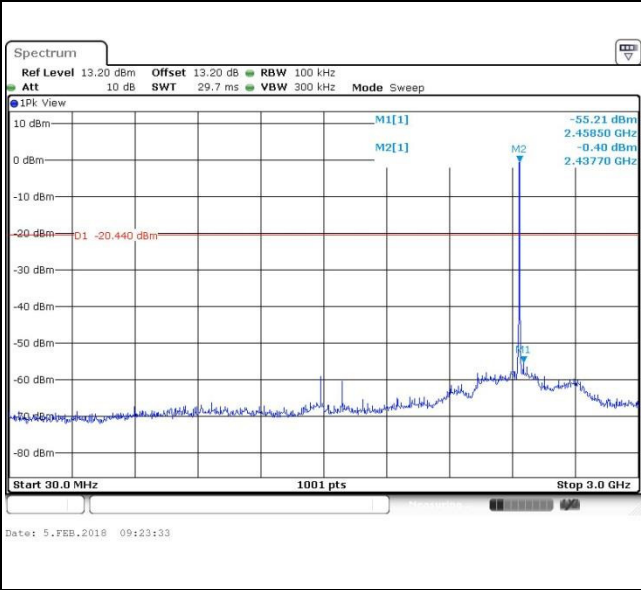


Test Mode :	802.11b (8MHz)	Test Channel :	06
-------------	----------------	----------------	----

<b>100kHz PSD reference Level</b>	<b>Channel Plot</b>
-----------------------------------	---------------------

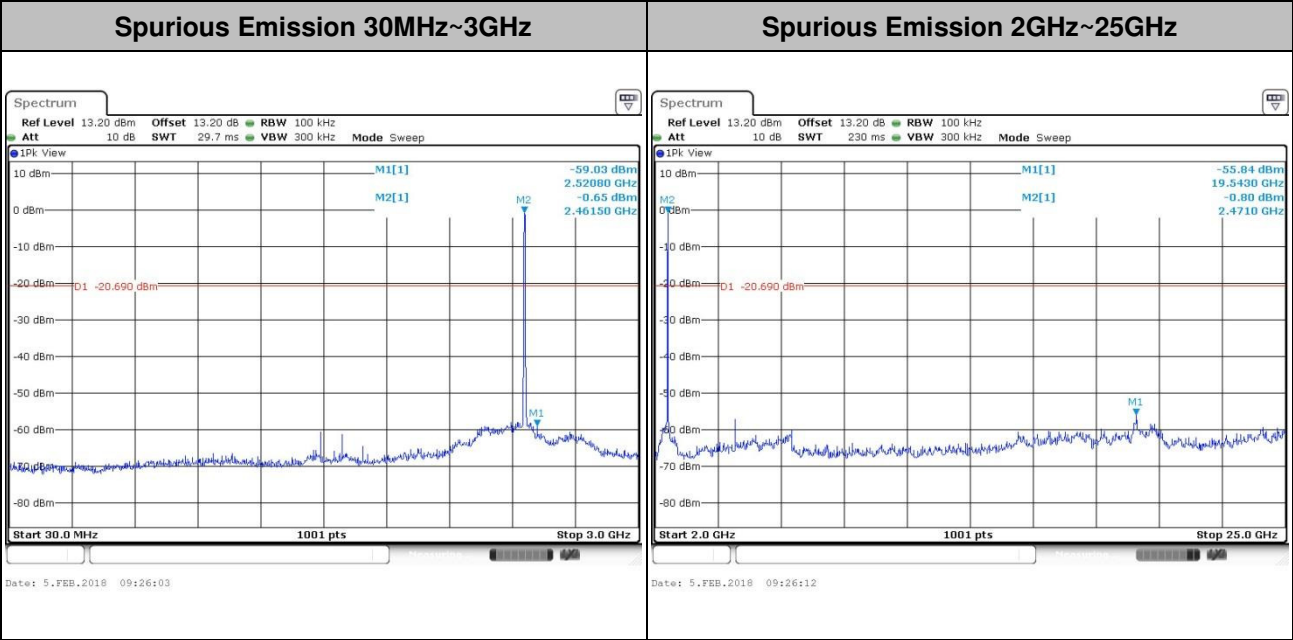
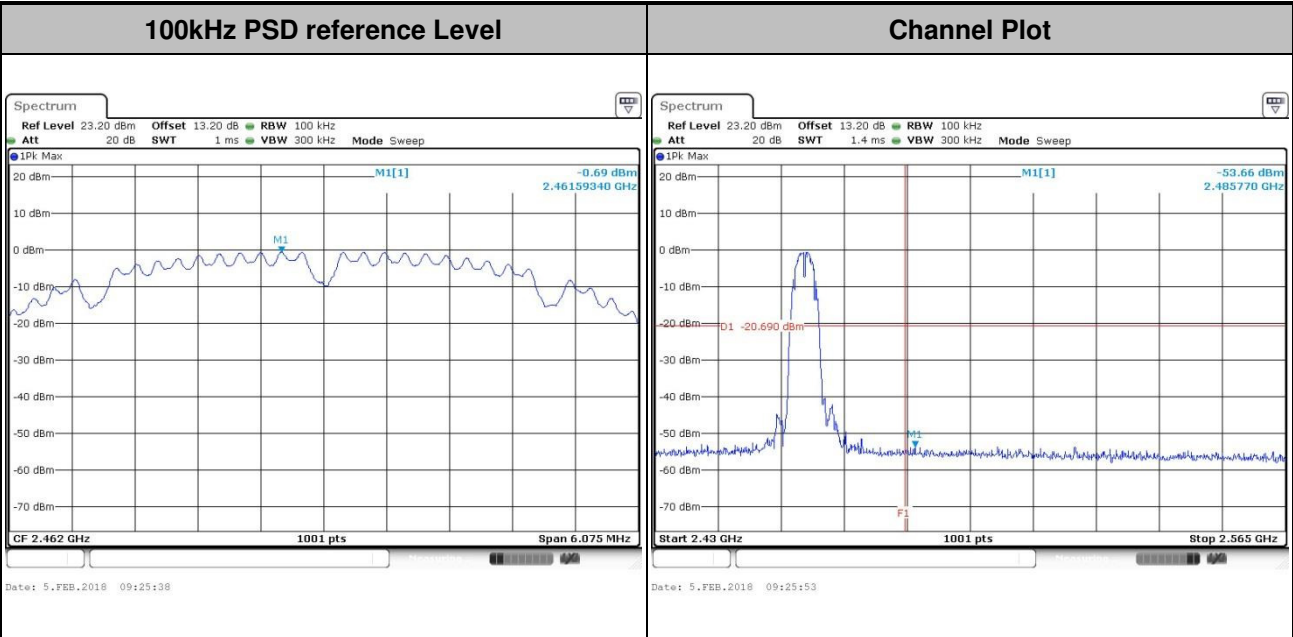


<b>Spurious Emission 30MHz~3GHz</b>	<b>Spurious Emission 2GHz~25GHz</b>
-------------------------------------	-------------------------------------



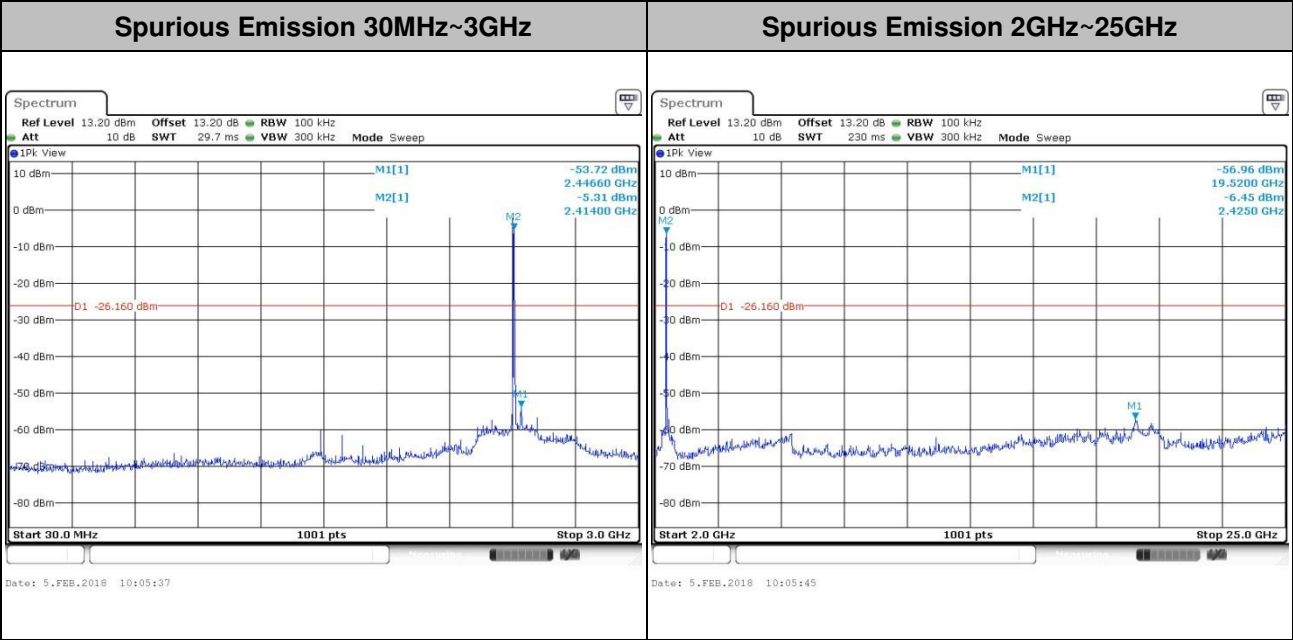
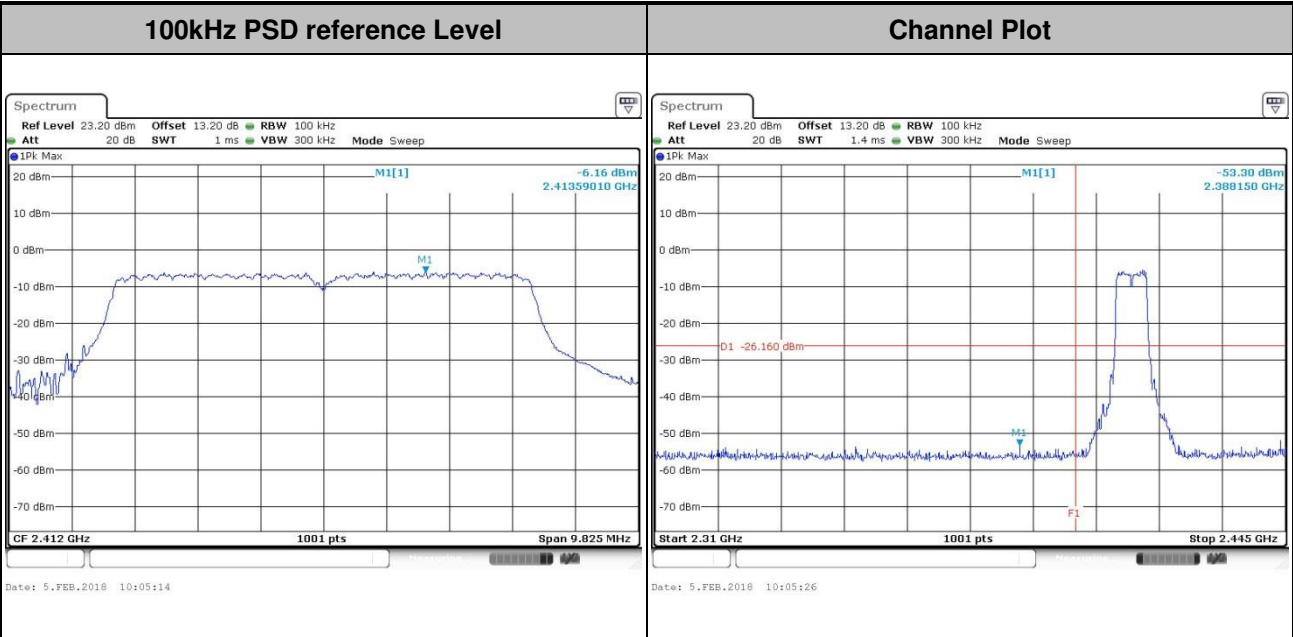


Test Mode :	802.11b (8MHz)	Test Channel :	11
-------------	----------------	----------------	----





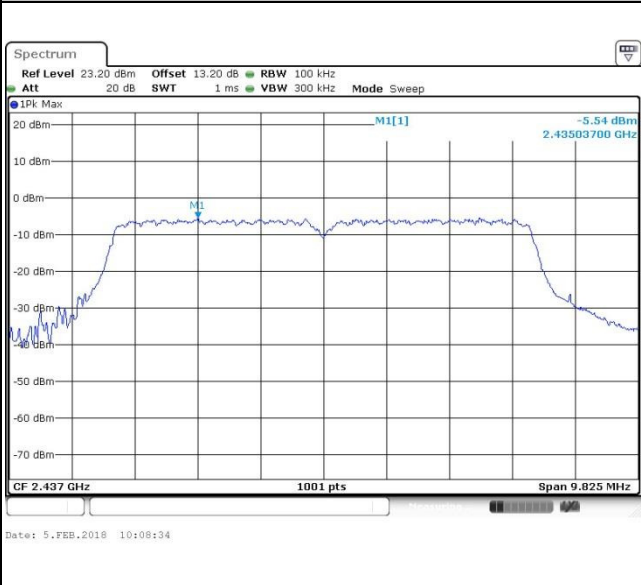
Test Mode :	802.11g (8MHz)	Test Channel :	01
-------------	----------------	----------------	----



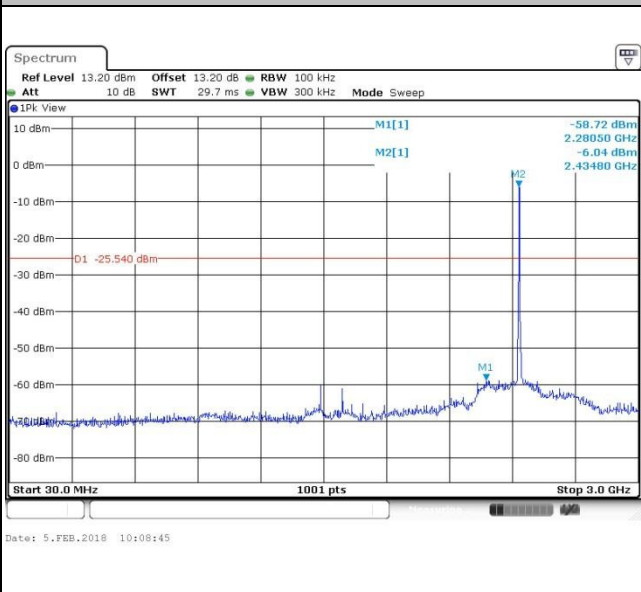


Test Mode :	802.11g (8MHz)	Test Channel :	06
-------------	----------------	----------------	----

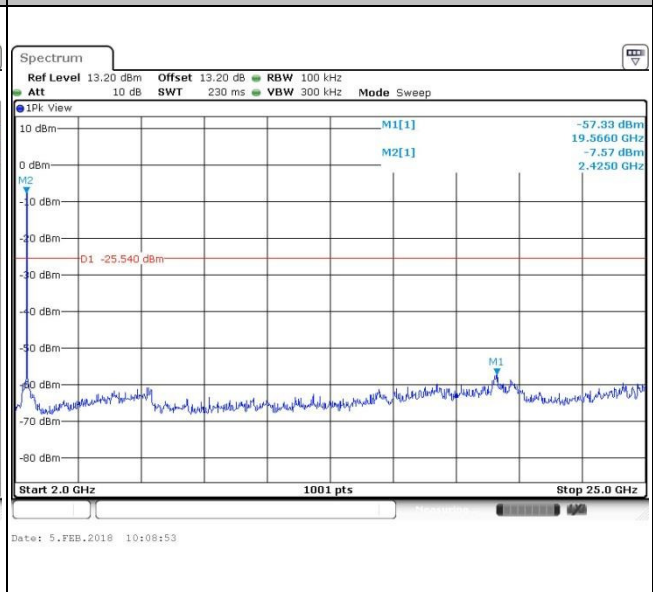
<b>100kHz PSD reference Level</b>	<b>Channel Plot</b>
-----------------------------------	---------------------



**Spurious Emission 30MHz~3GHz**



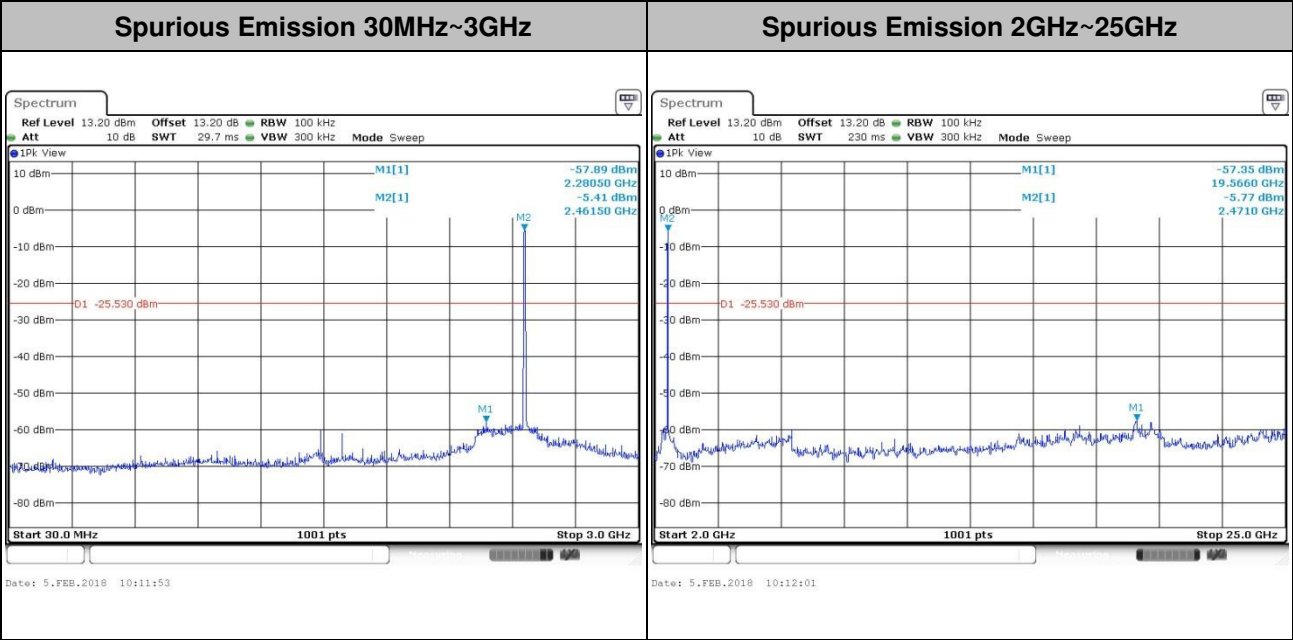
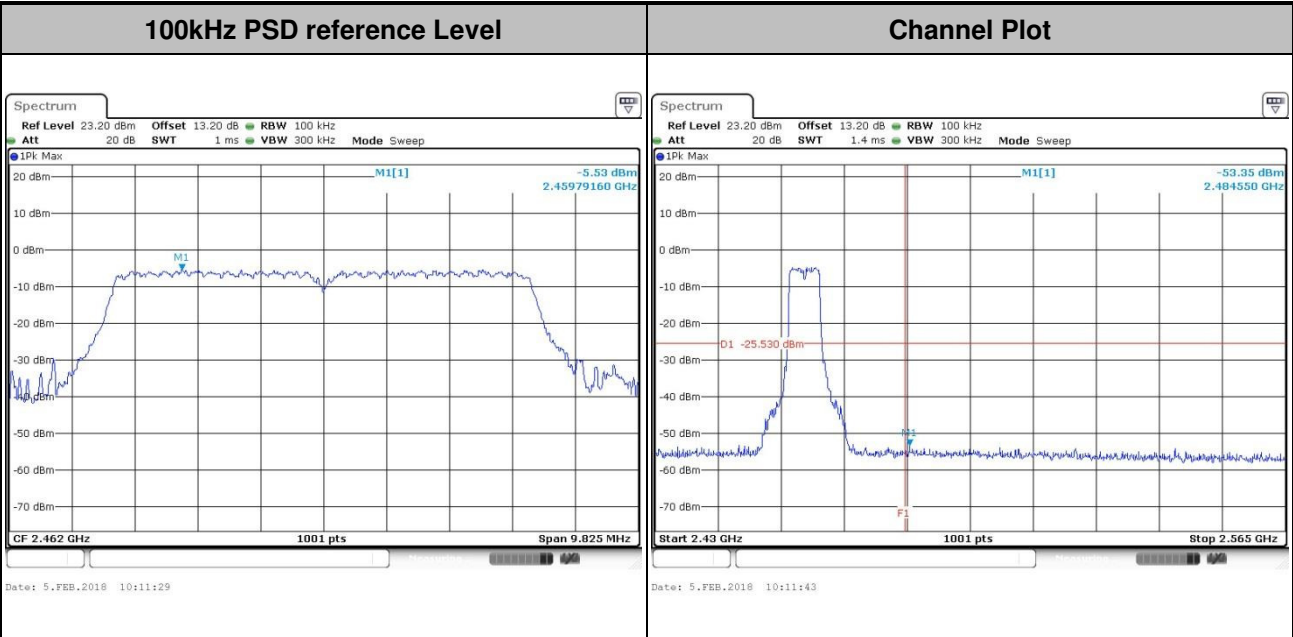
**Spurious Emission 2GHz~25GHz**





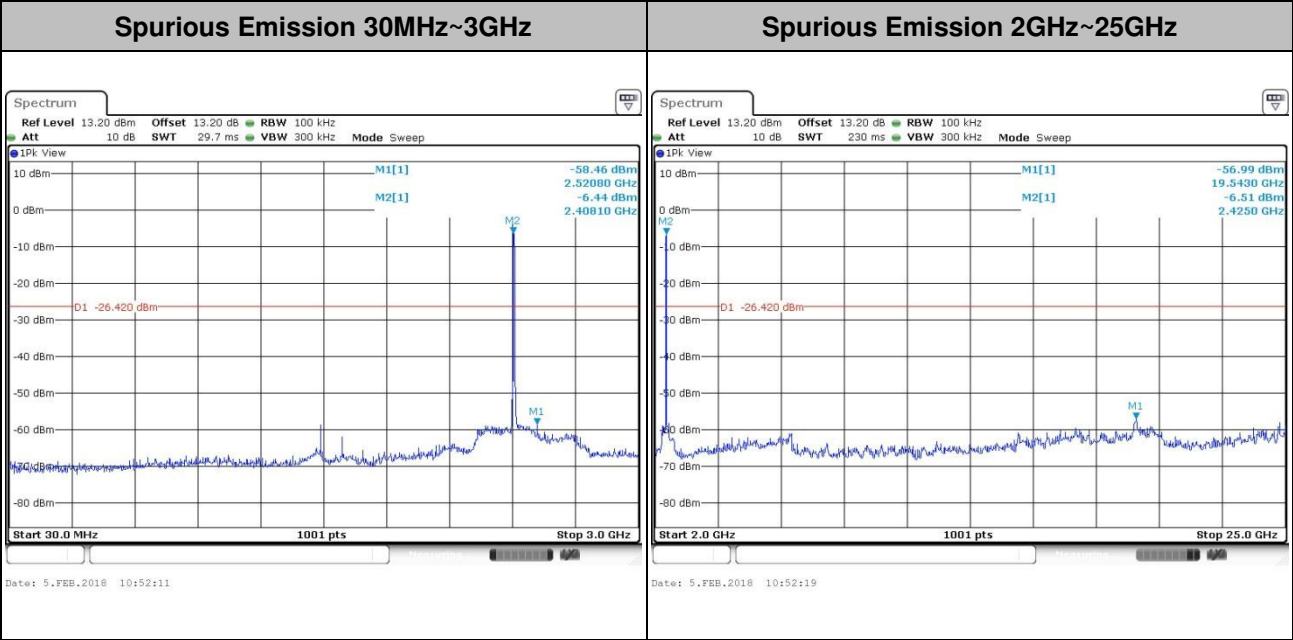
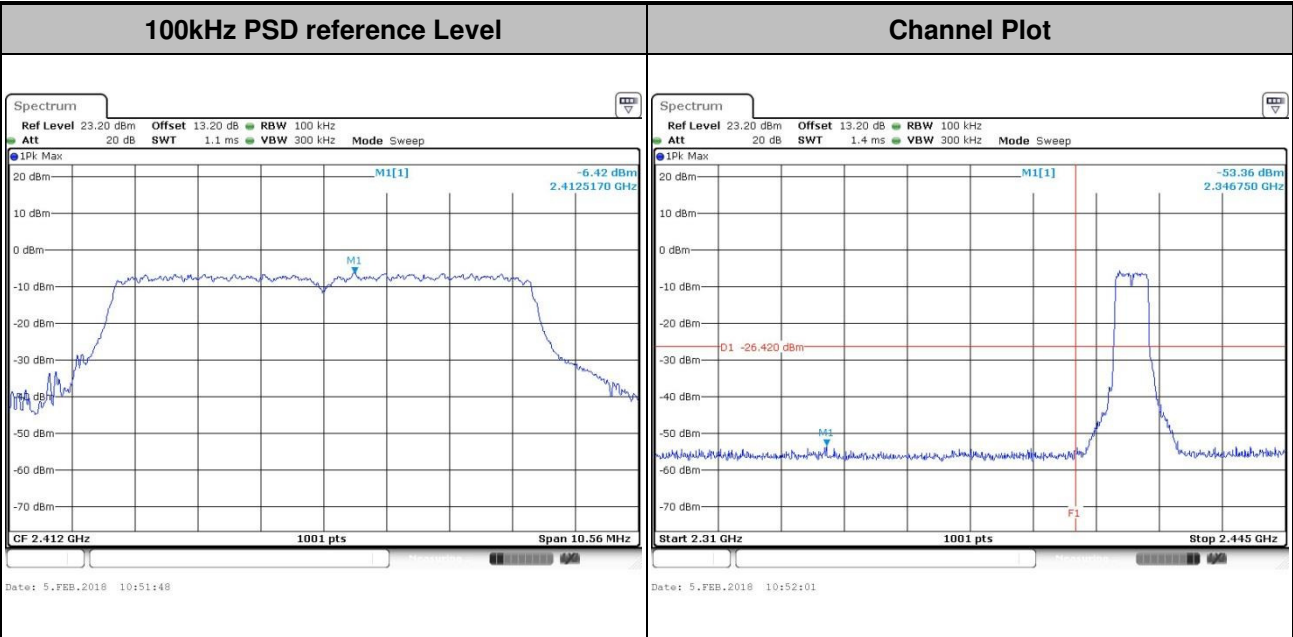


Test Mode :	802.11g (8MHz)	Test Channel :	11
-------------	----------------	----------------	----



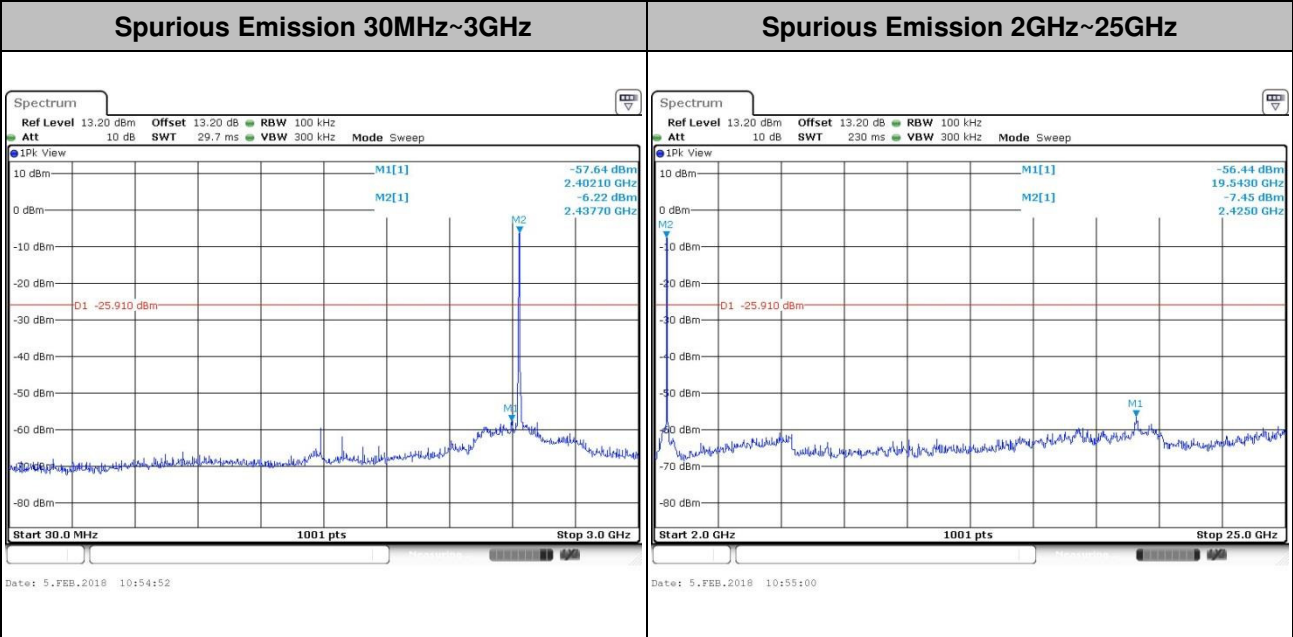
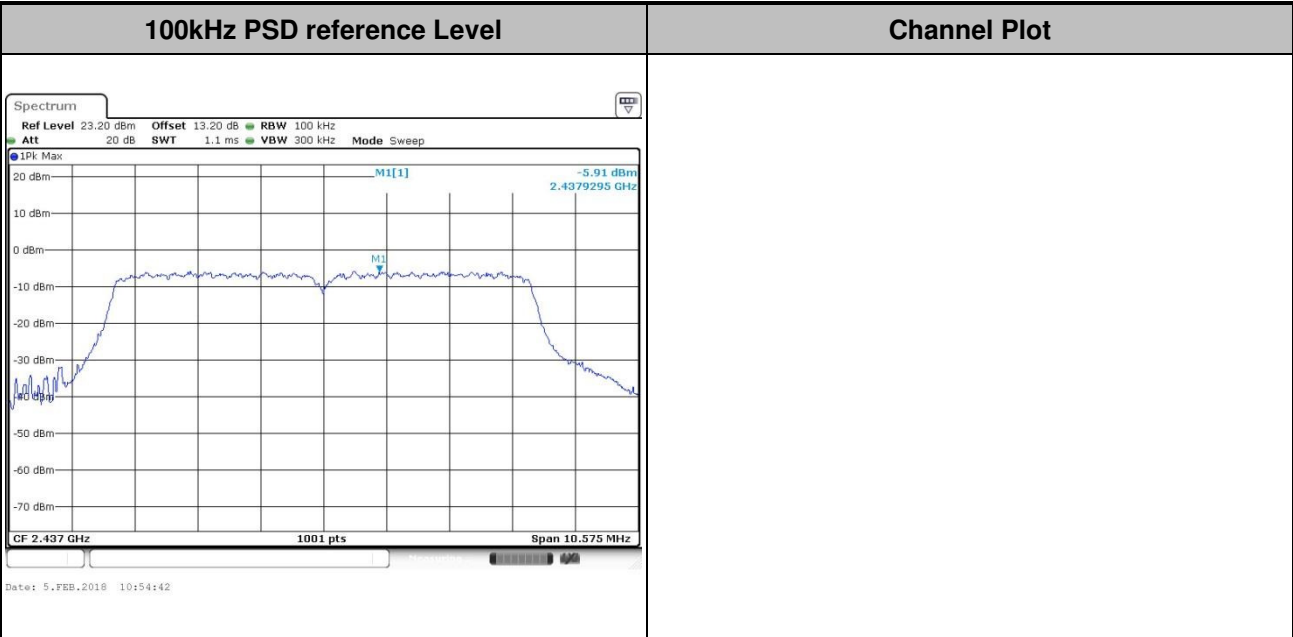


Test Mode :	802.11n HT (8MHz)	Test Channel :	01
-------------	-------------------	----------------	----



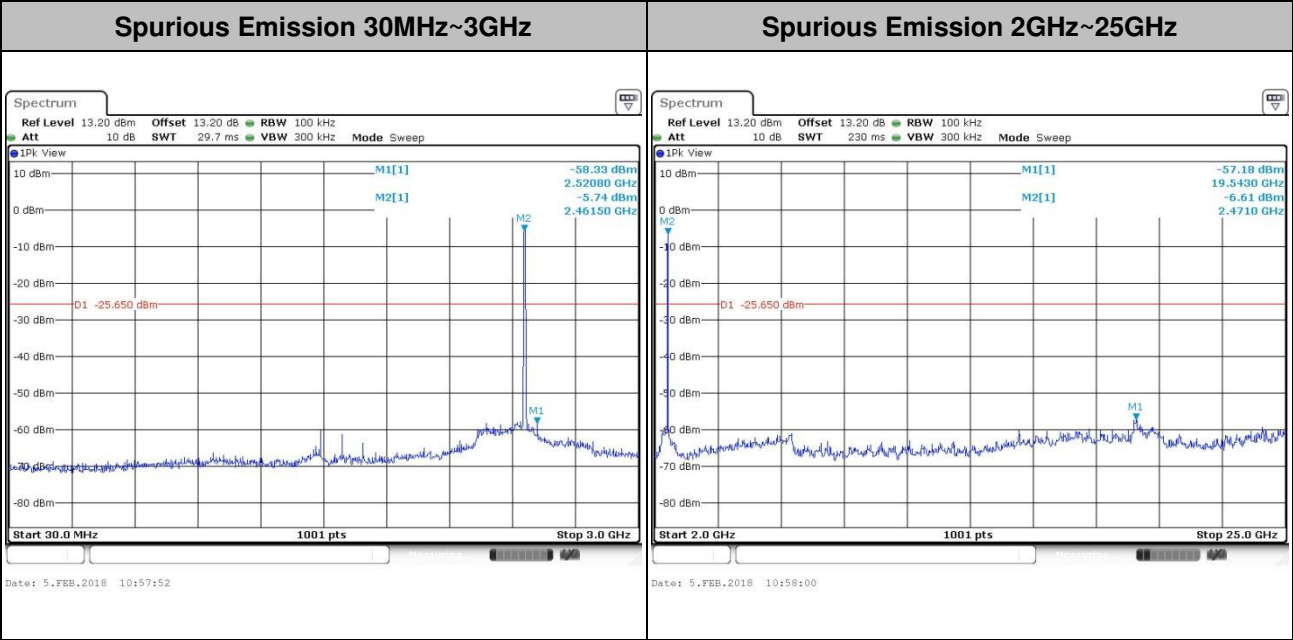
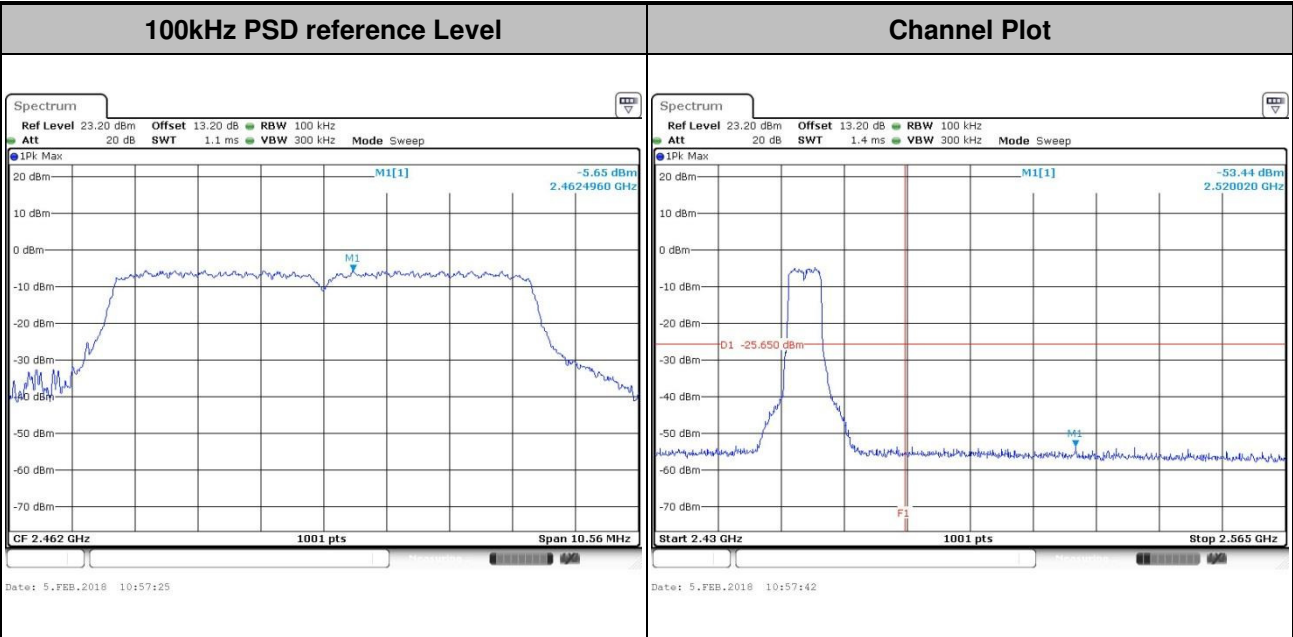


Test Mode :	802.11n HT (8MHz)	Test Channel :	06
-------------	-------------------	----------------	----



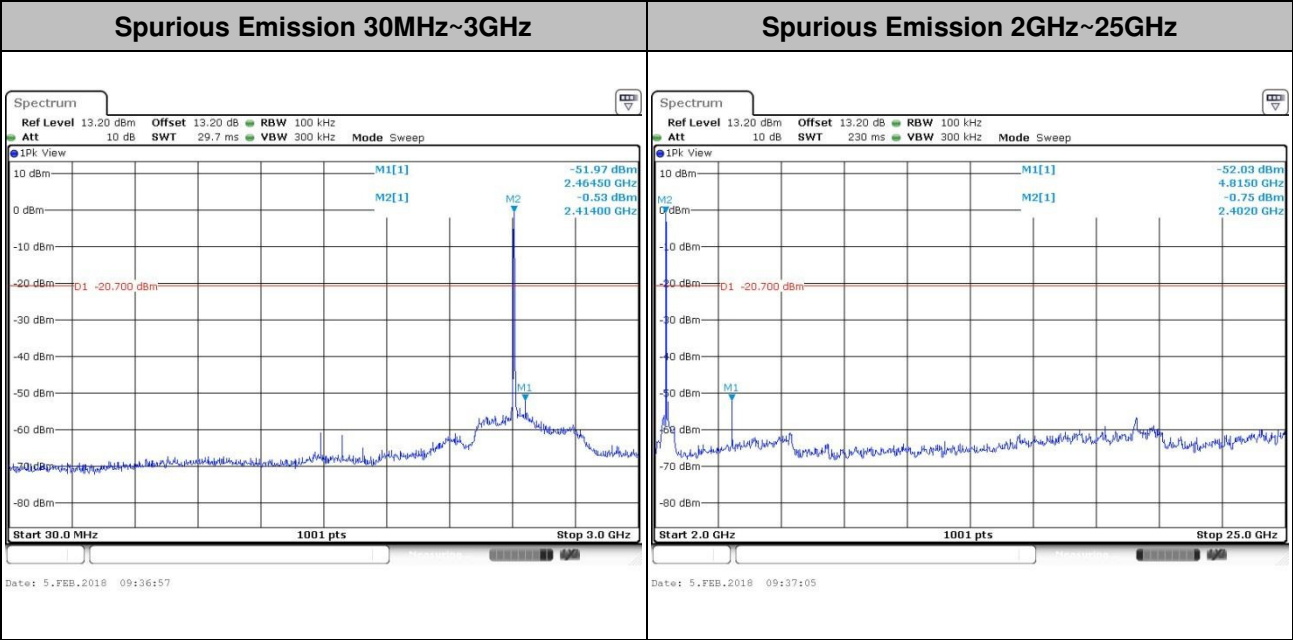
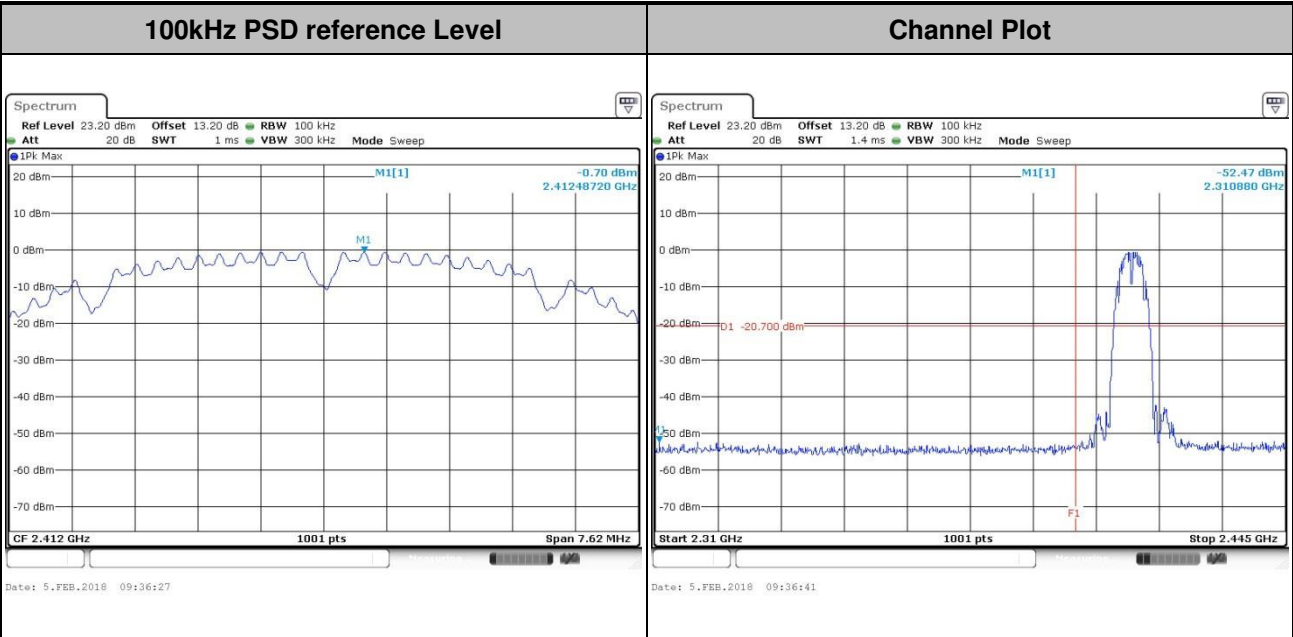


Test Mode :	802.11n HT (8MHz)	Test Channel :	11
-------------	-------------------	----------------	----





Test Mode :	802.11b (10MHz)	Test Channel :	01
-------------	-----------------	----------------	----





Test Mode :	802.11b (10MHz)	Test Channel :	06
-------------	-----------------	----------------	----

