



**FCC 47 CFR PART 15 SUBPART C  
INDUSTRY CANADA RSS-210 ISSUE 8**

**CERTIFICATION TEST REPORT**

**FOR**

**Cellular Phone with Bluetooth and WLAN Radios**

**MODEL NUMBER: A1586**

**FCC ID: BCG-E2816A  
IC: 579C-E2816A**

**REPORT NUMBER: 14U17673-E1 Revision C**

**ISSUE DATE: AUGUST 02, 2014**

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**NVLAP LAB CODE 200065-0**

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--	7/21/14	Initial Issue	F. de Anda
A	7/23/14	EUT Description Updated	H.Lau
B	7/29/14	Update to referenced reports	F. de Anda
C	08/02/14	Address TCB Questions	T. Lee

## TABLE OF CONTENTS

<b>1. ATTESTATION OF TEST RESULTS .....</b>	<b>5</b>
<b>2. TEST METHODOLOGY .....</b>	<b>6</b>
<b>3. FACILITIES AND ACCREDITATION .....</b>	<b>6</b>
<b>4. CALIBRATION AND UNCERTAINTY .....</b>	<b>6</b>
4.1. <i>MEASURING INSTRUMENT CALIBRATION .....</i>	<i>6</i>
4.2. <i>SAMPLE CALCULATION .....</i>	<i>6</i>
4.3. <i>MEASUREMENT UNCERTAINTY.....</i>	<i>7</i>
<b>5. EQUIPMENT UNDER TEST .....</b>	<b>8</b>
5.1. <i>DESCRIPTION OF EUT .....</i>	<i>8</i>
5.2. <i>MAXIMUM OUTPUT POWER.....</i>	<i>8</i>
5.3. <i>DESCRIPTION OF AVAILABLE ANTENNAS .....</i>	<i>8</i>
5.4. <i>SOFTWARE AND FIRMWARE.....</i>	<i>8</i>
5.5. <i>WORST-CASE CONFIGURATION AND MODE.....</i>	<i>9</i>
5.6. <i>DESCRIPTION OF TEST SETUP.....</i>	<i>10</i>
<b>6. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>14</b>
<b>7. MEASUREMENT METHODS .....</b>	<b>15</b>
<b>8. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS .....</b>	<b>16</b>
8.1. <i>ON TIME AND DUTY CYCLE RESULTS.....</i>	<i>16</i>
8.1.1. <i>DUTY CYCLE PLOTS .....</i>	<i>17</i>
8.1.2. <i>DUTY CYCLE PLOTS .....</i>	<i>17</i>
<b>9. ANTENNA PORT TEST RESULTS .....</b>	<b>18</b>
9.1. <i>BASIC DATA RATE GFSK MODULATION.....</i>	<i>18</i>
9.1.1. <i>20 dB AND 99% BANDWIDTH .....</i>	<i>18</i>
9.1.2. <i>HOPPING FREQUENCY SEPARATION .....</i>	<i>21</i>
9.1.3. <i>NUMBER OF HOPPING CHANNELS.....</i>	<i>23</i>
9.1.4. <i>AVERAGE TIME OF OCCUPANCY .....</i>	<i>26</i>
9.1.5. <i>OUTPUT POWER .....</i>	<i>30</i>
9.1.6. <i>AVERAGE POWER.....</i>	<i>33</i>
9.1.7. <i>CONDUCTED SPURIOUS EMISSIONS.....</i>	<i>34</i>
9.2. <i>ENHANCED DATA RATE 8PSK MODULATION .....</i>	<i>39</i>
9.2.1. <i>20 dB AND 99% BANDWIDTH .....</i>	<i>39</i>
9.2.2. <i>HOPPING FREQUENCY SEPARATION .....</i>	<i>42</i>
9.2.3. <i>NUMBER OF HOPPING CHANNELS.....</i>	<i>44</i>
9.2.4. <i>AVERAGE TIME OF OCCUPANCY .....</i>	<i>47</i>
9.2.5. <i>OUTPUT POWER .....</i>	<i>51</i>
9.2.6. <i>AVERAGE POWER.....</i>	<i>54</i>
9.2.7. <i>CONDUCTED SPURIOUS EMISSIONS.....</i>	<i>55</i>

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<b>10.</b>	<b>RADIATED TEST RESULTS .....</b>	<b>60</b>
10.1.	LIMITS AND PROCEDURE.....	60
10.2.	TRANSMITTER ABOVE 1GHz.....	61
10.2.1.	BASIC DATA RATE GFSK MODULATION .....	61
10.2.2.	ENHANCED DATA RATE 8PSK MODULATION.....	71
10.3.	WORST-CASE ABOVE 18 GHz.....	81
10.4.	WORST-CASE BELOW 1 GHz.....	82
<b>11.</b>	<b>AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>84</b>
<b>12.</b>	<b>SETUP PHOTOS .....</b>	<b>88</b>

# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE, INC.  
1 INFINITE LOOP  
CUPERTINO, CA 95014, U.S.A.

**EUT DESCRIPTION:** Cellular Phone with Bluetooth and WLAN Radios

**MODEL:** A1586

**SERIAL NUMBER:** C39MF01KFY6W - Conducted, C39MD06FFY70 - Radiated

**DATE TESTED:** APRIL 10-JULY 21, 2014

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-210 Issue 8 Annex 8	Pass
INDUSTRY CANADA RSS-GEN Issue 3	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For  
UL Verification Services Inc. By:



FRANCISCO DE ANDA  
Project Lead  
UL Verification Services Inc.

Tested By:



Oliver Su  
Senior Engineer  
UL Verification Services Inc.

## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

## 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street
<input type="checkbox"/> Chamber A	<input checked="" type="checkbox"/> Chamber D
<input type="checkbox"/> Chamber B	<input checked="" type="checkbox"/> Chamber E
<input type="checkbox"/> Chamber C	<input type="checkbox"/> Chamber F
	<input type="checkbox"/> Chamber G
	<input type="checkbox"/> Chamber H

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://ts.nist.gov/standards/scopes/2000650.htm>.

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

### 4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

### 4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	$\pm 3.52$ dB
Radiated Disturbance, 30 to 1000 MHz	$\pm 4.94$ dB

Uncertainty figures are valid to a confidence level of 95%.

## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

Model A1586 is a mobile phone with multimedia functions (music, application support, and video), Cellular GSM/GPRS/EGPRS/CDMA2000/EVDO Rev.A/ EVDO Rev.B/WCDMA/HSPA+/DC-HSDPA/LTE FDD & Carrier Aggregation/TDD/TD-SCDMA radio, IEEE 802.11a/b/g/n/ac radio, Bluetooth radio and NFC. The rechargeable battery is not user accessible.

### 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	Basic GFSK	11.86	15.35
2402 - 2480	Enhanced 8PSK	11.33	13.58

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PiFA antenna, with a maximum gain of -.38dBi.

### 5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Bluetool 1.8.5



## 5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case mode and channel used for 30-1000 MHz radiated and power line conducted emissions was including headset, AC charger and the mode and channel with the highest output power.

The EUT is a portable device that has three orientations; therefore X, Y and Z orientations have been investigated with AC adapter and Headset. The worst case was found to be at X (Flatbed) position without AC adapter and headset (for above 1GHz).

Based on the manufacturer's attestation that the nominal output power is reduced as the data rate increases, the data rates tested represent the highest power and worst-case with respect to EMC performance.

Worst-case data rates were:

GFSK mode: DH1  
8PSK mode: 3-DH5

There are three vendors of the WiFi/Bluetooth radio modules: variant 1, variant 2 and variant 3 and they have the same mechanical outline, same on board antenna, matching circuit, antenna structure and same specification. Baseline testing was performed on all three variants to determine the worst case on all conducted power and radiated emissions.

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
AC/DC adapter	Apple	A1401	60812	NA
Earphone	Apple	NA	NA	NA
Laptop	Apple	A1278	C02HJ0A7DTY4	NA

### I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-Shielded	0.1	to spectrum Analyzer
2	USB	1	USB	Shielded	1m	To EUT

### I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
None used						

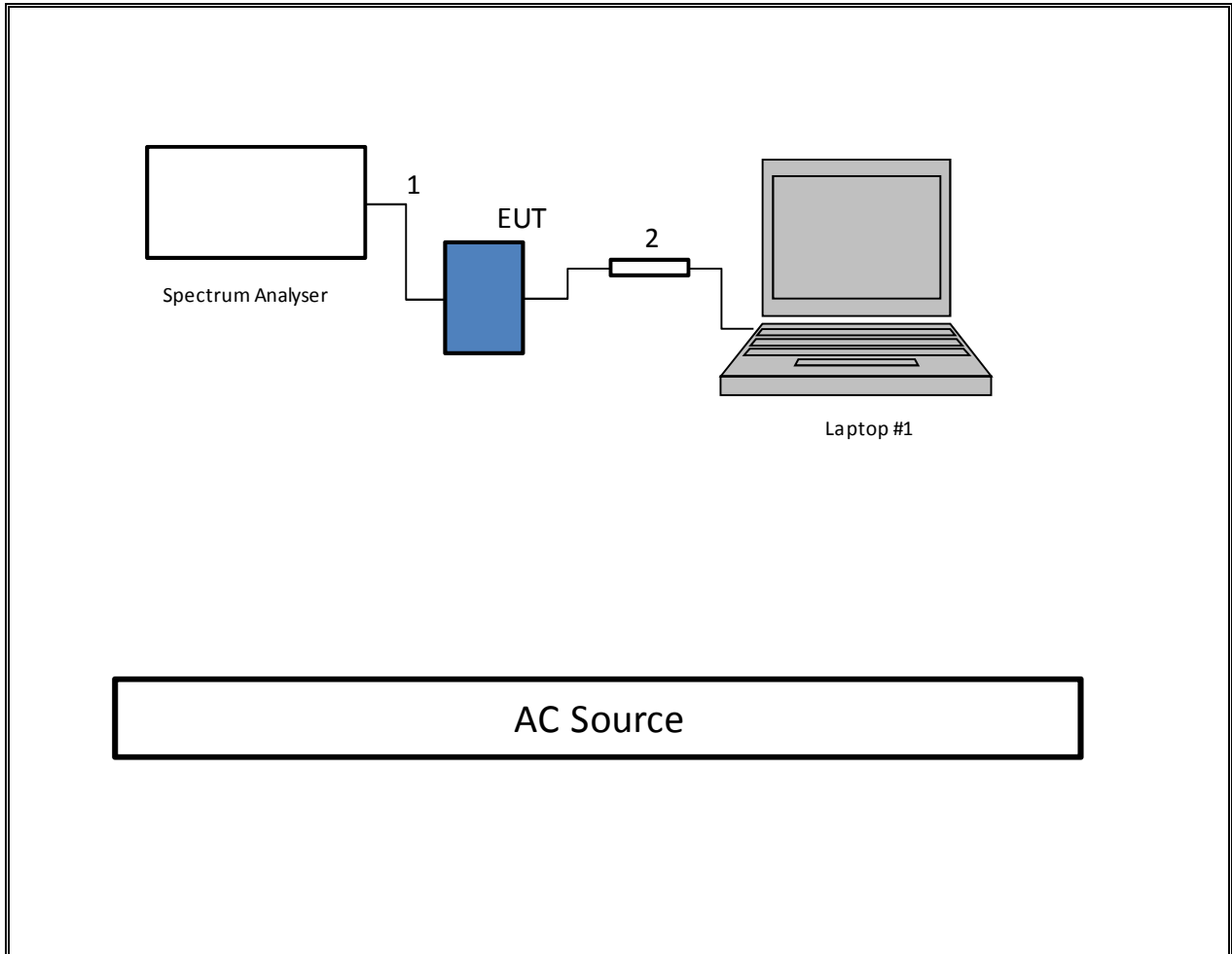
### I/O CABLES (BELOW 1GHZ & AC LINE CONDUCTED TESTS)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	US115	Un-Shielded	80cm	NA
2	DC	1	USB	Un-Shielded	1m	NA
3	Audio	1	Jack	Un-Shielded	0.5m	NA

**TEST SETUP- CONDUCTED PORT**

The EUT was tested connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

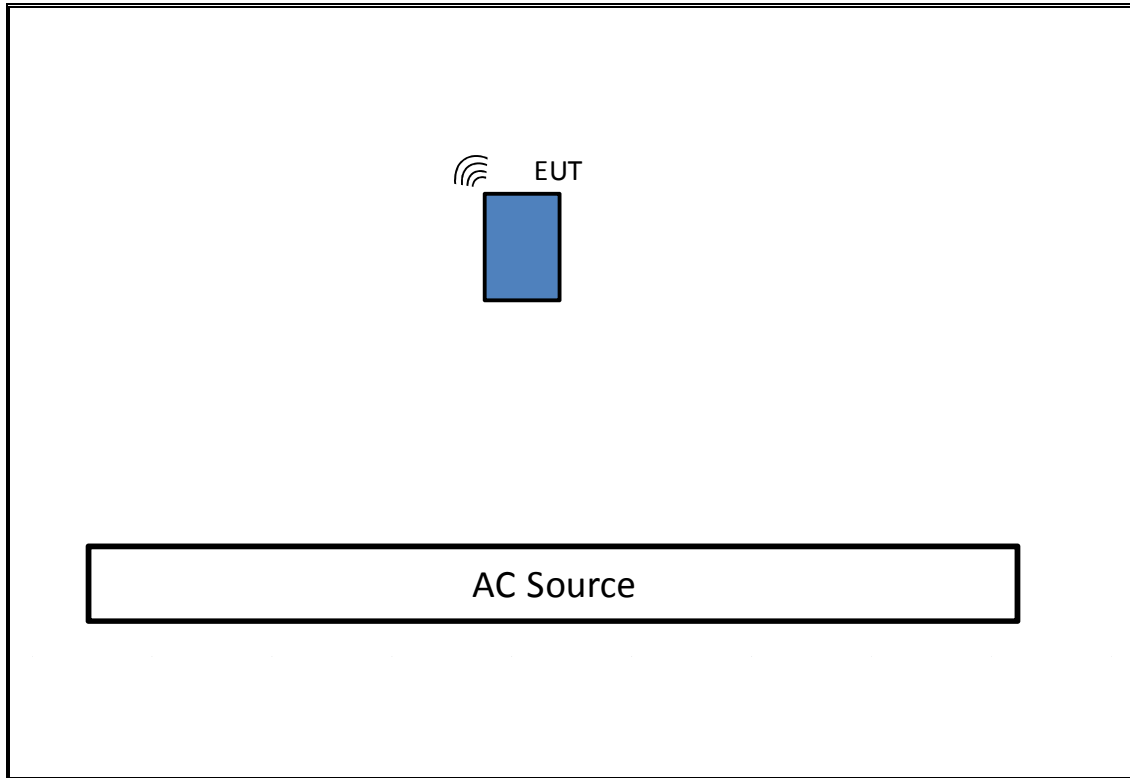
**SETUP DIAGRAM**



**TEST SETUP- RADIATED-ABOVE 1 GHZ**

The EUT was tested battery powered. Test software exercised the EUT.

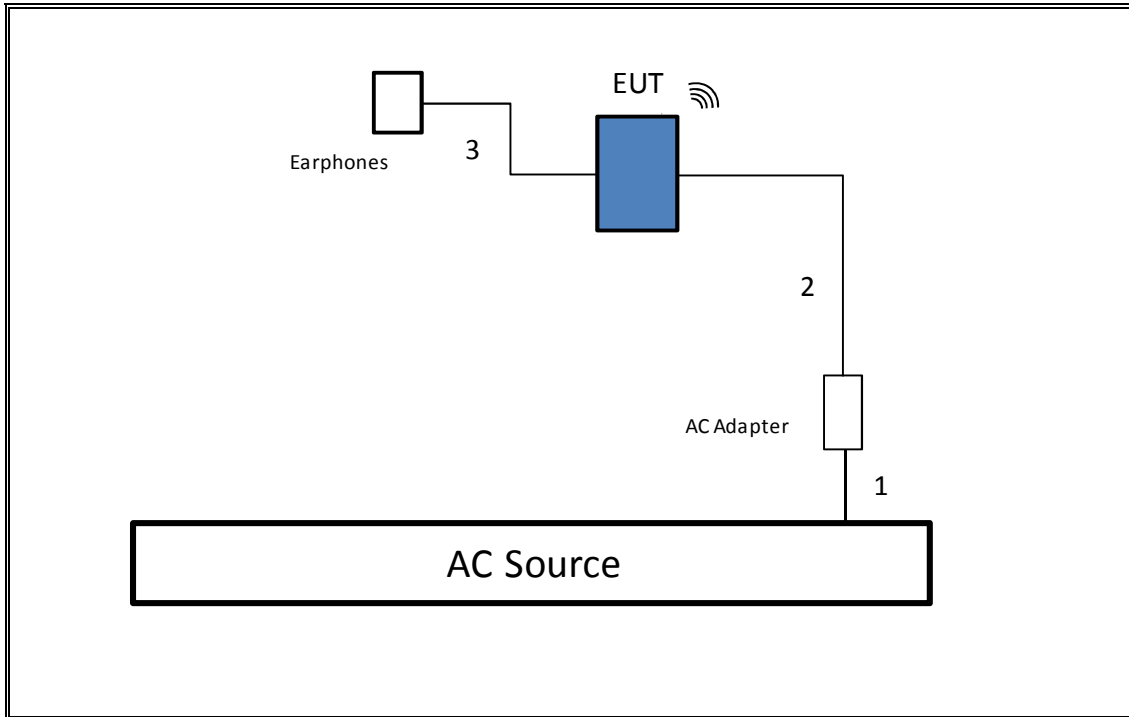
**SETUP DIAGRAM**



**TEST SETUP- BELOW 1GHZ & AC LINE CONDUCTED TESTS**

The EUT was tested with earphones connected and powered by AC adapter. Test software exercised the EUT.

**SETUP DIAGRAM**



## 6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	Asset	Cal Due
Antenna, Horn, 18 GHz	ETS Lindgren	3117	F00131	02/18/15
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	11/26/14
Antenna, Horn, 40 GHz	ARA	MWH-2640	C00981	07/15/15
Peak / Average Power Sensor	Agilent / HP	N1911A	F00153	03/06/15
Wideband Power Sensor	Agilent	N1921A	F00361	10/02/14
Peak Power Meter	Agilent / HP	E9323A	F00025	04/03/15
Spectrum Analyzer, 44 GHz	Agilent / HP	N9030A	F00129	02/22/15
Spectrum Analyzer, 40 GHz	Agilent	8564E	C00951	07/29/14
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	F00168	03/28/15
Preamplifier, 1300 MHz	Sonoma	310	F00008	05/27/15
Preamplifier, 26.5 GHz	Agilent / HP	8449B	F00165	03/25/15

## 7. MEASUREMENT METHODS

6 dB BW: KDB 558074 D01.

Output Power: KDB 558074 D01.

Power Spectral Density: KDB 558074 D01.

Out-of-band emissions in non-restricted bands: KDB 558074 D01.

Out-of-band emissions in restricted bands: KDB 558074 D01.

## 8. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

### LIMITS

None; for reporting purposes only.

### PROCEDURE

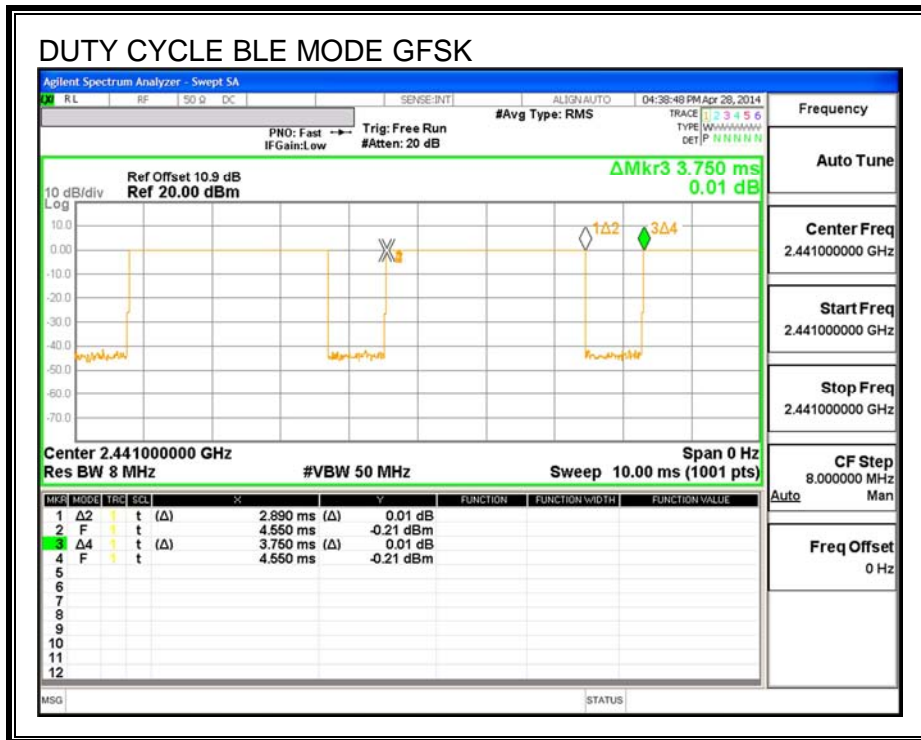
KDB 789033 Zero-Span Spectrum Analyzer Method.

### 8.1. ON TIME AND DUTY CYCLE RESULTS

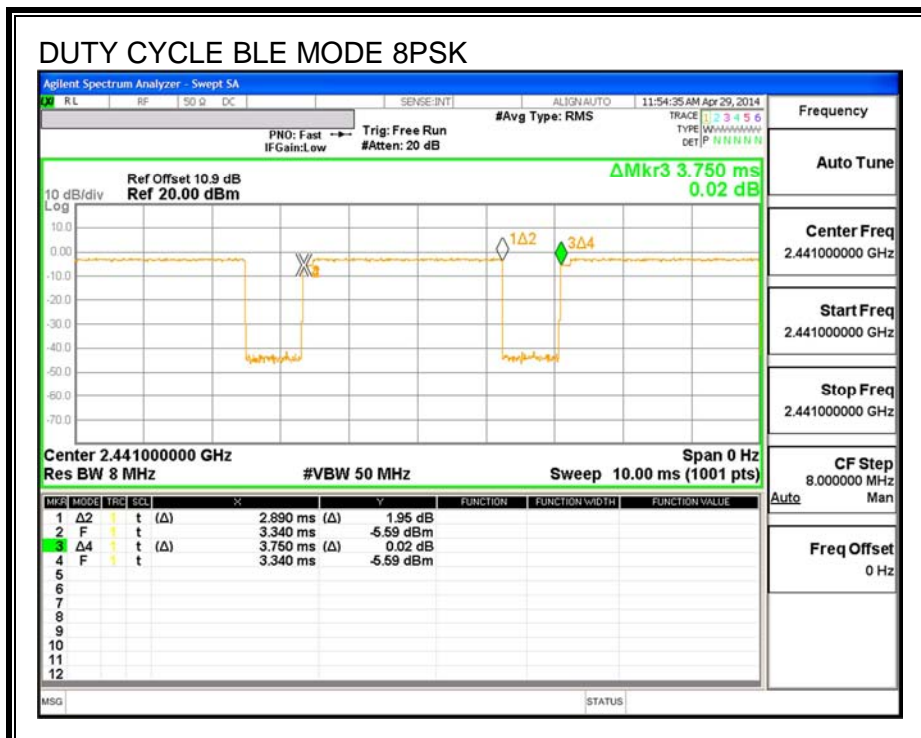
Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
GFSK	2.890	3.750	0.771	77.1%	1.131	0.346
8PSK	2.890	3.750	0.771	77.1%	1.131	0.346



### 8.1.1. DUTY CYCLE PLOTS



### 8.1.2. DUTY CYCLE PLOTS



## 9. ANTENNA PORT TEST RESULTS

### 9.1. BASIC DATA RATE GFSK MODULATION

#### 9.1.1. 20 dB AND 99% BANDWIDTH

##### LIMIT

None; for reporting purposes only.

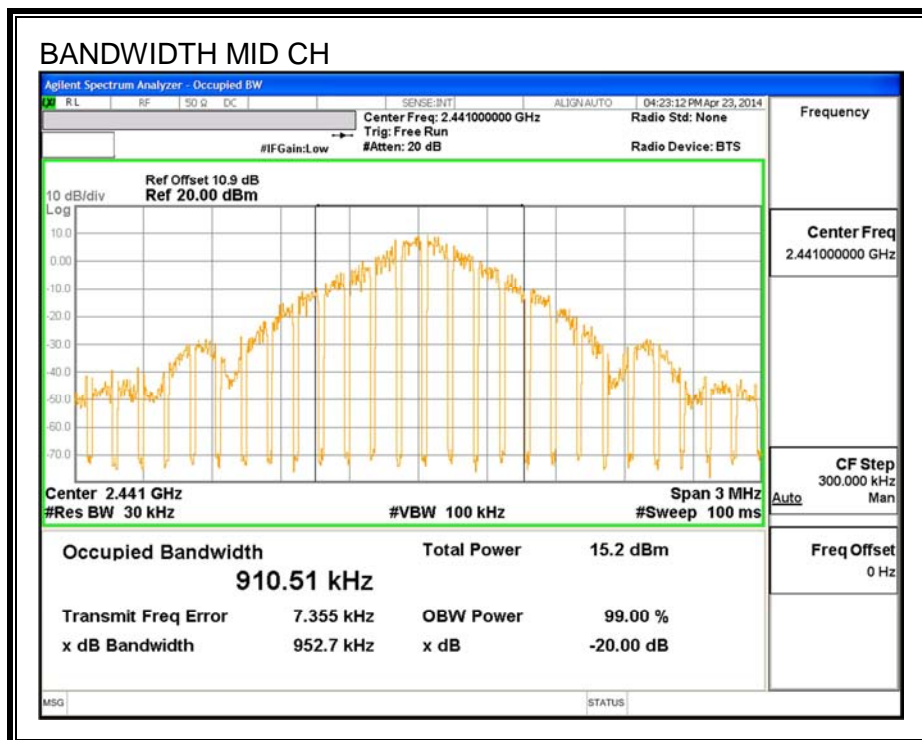
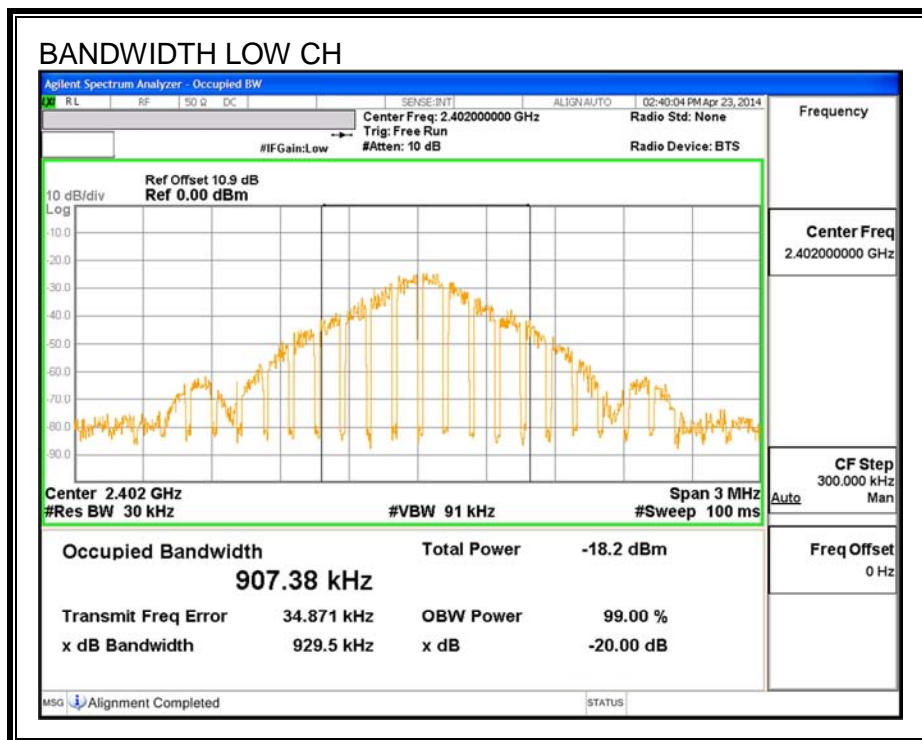
##### TEST PROCEDURE

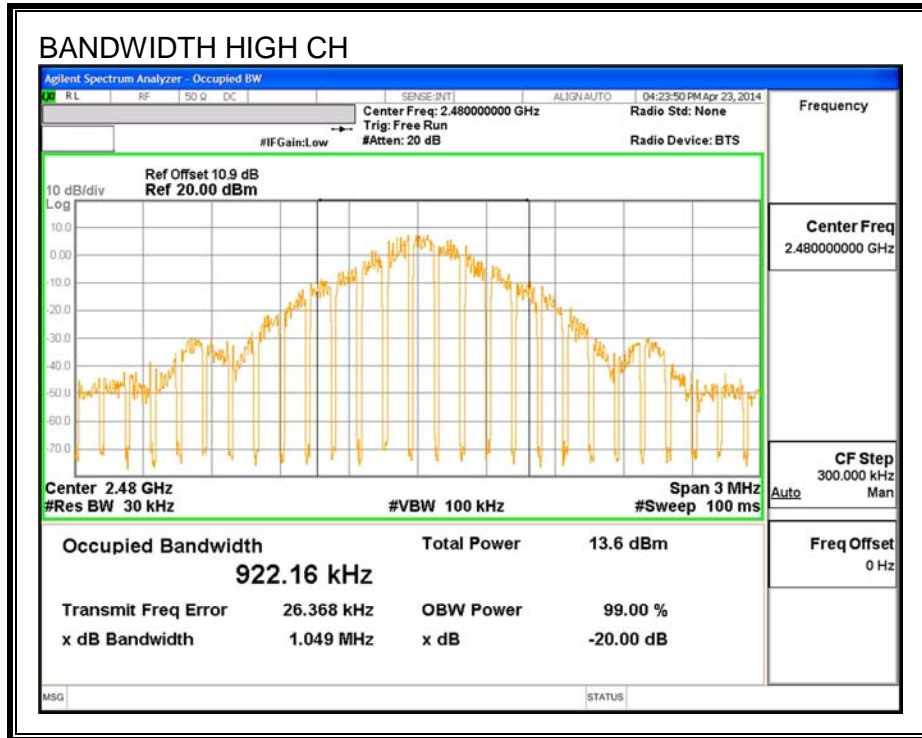
The transmitter output is connected to a spectrum analyzer. The RBW is set to  $\geq 1\%$  of the 20 dB bandwidth. The VBW is set to  $\geq$  RBW. The sweep time is coupled.

##### RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	929.5	907.38
Middle	2441	952.7	910.51
High	2480	1049.0	922.16

**20 dB AND 99% BANDWIDTH**





## 9.1.2. HOPPING FREQUENCY SEPARATION

### LIMIT

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

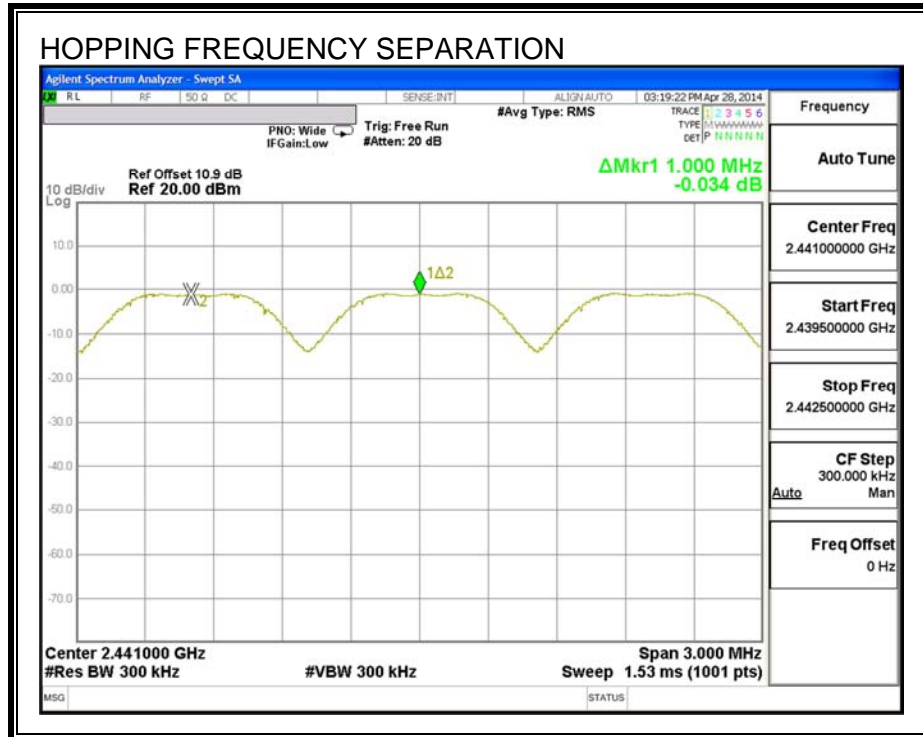
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

### RESULTS

**HOPPING FREQUENCY SEPARATION**



### **9.1.3. NUMBER OF HOPPING CHANNELS**

#### **LIMIT**

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

#### **TEST PROCEDURE**

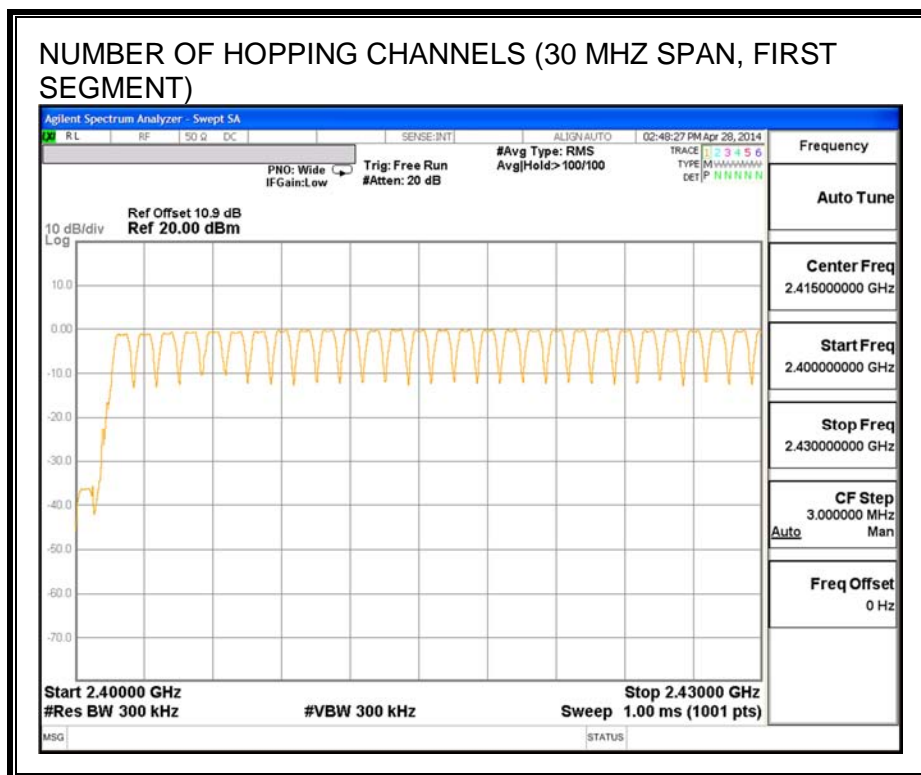
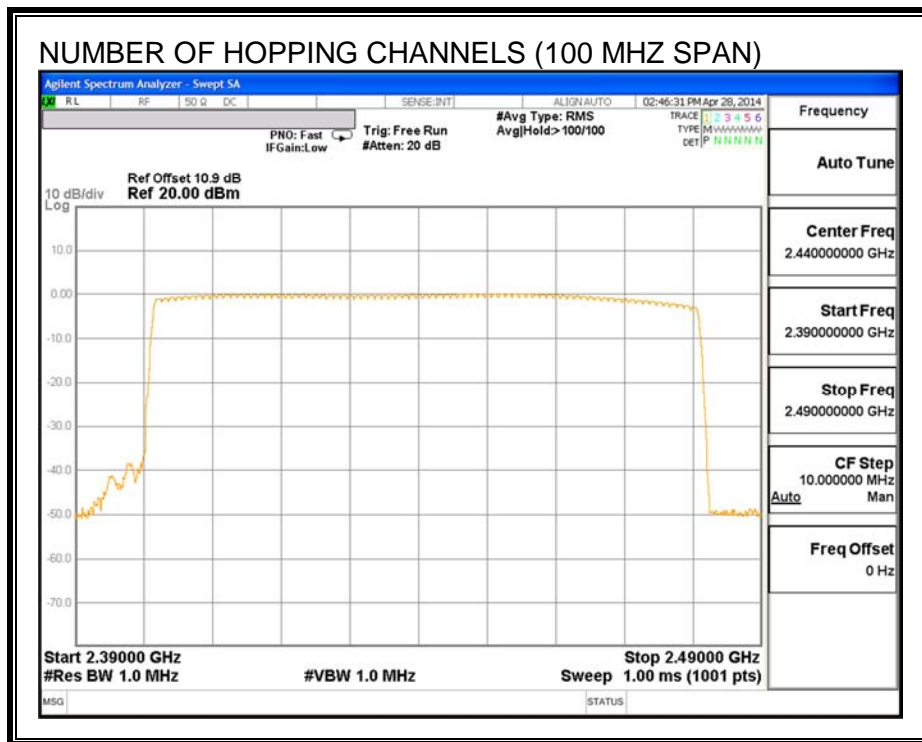
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

#### **RESULTS**

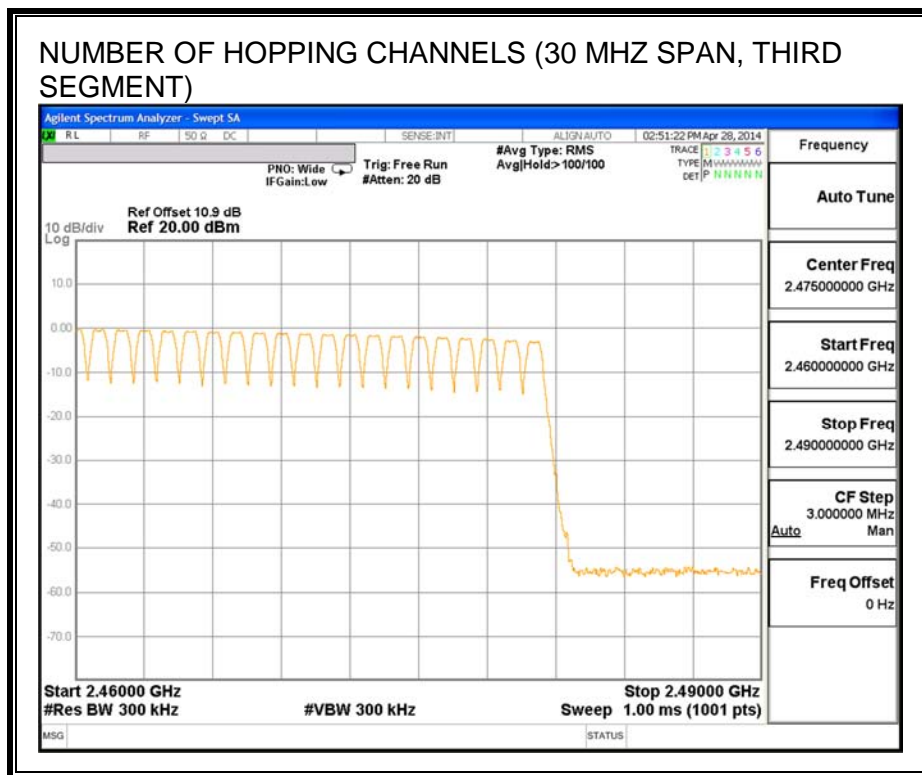
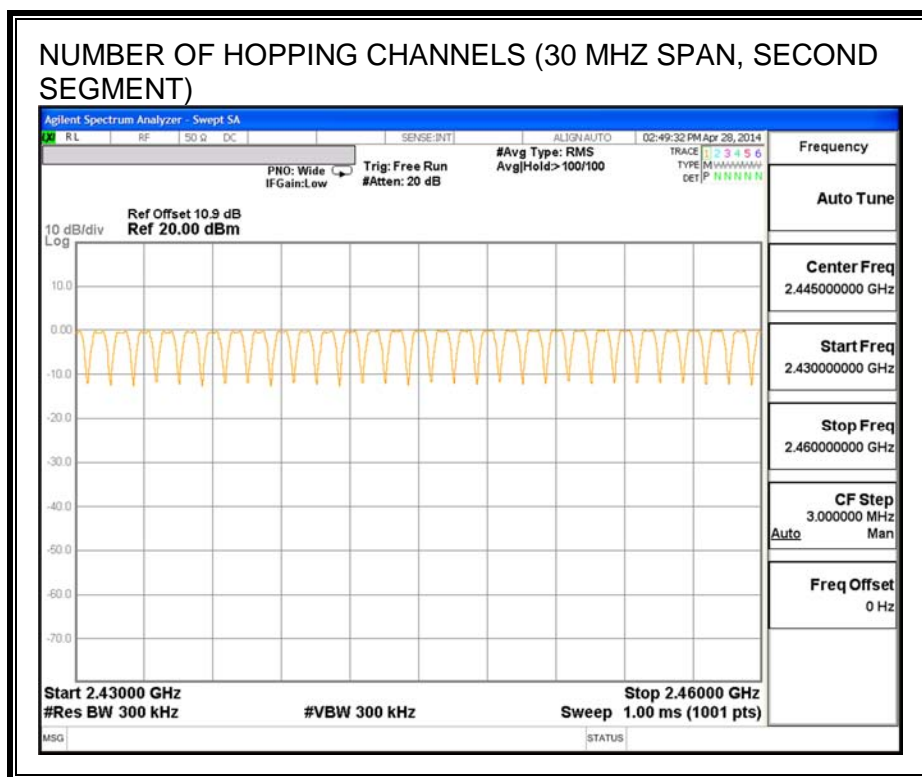
Normal Mode: 79 Channels observed.

.

**NUMBER OF HOPPING CHANNELS**







### 9.1.4. AVERAGE TIME OF OCCUPANCY

#### LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

#### TEST PROCEDURE

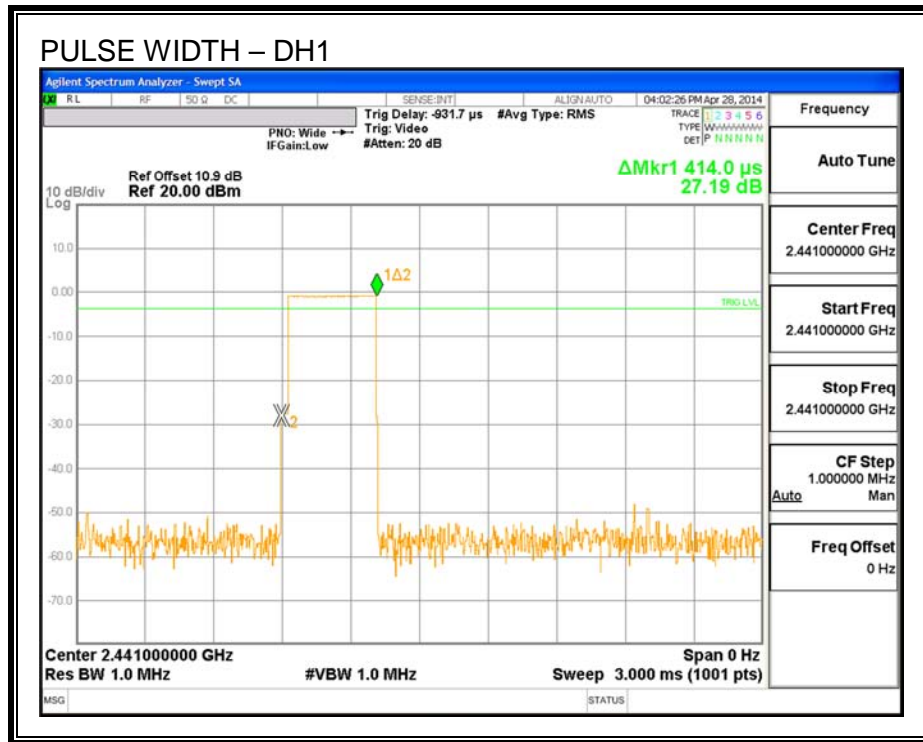
The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 31.6 second period (79 channels \* 0.4 s) is equal to  $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$ .

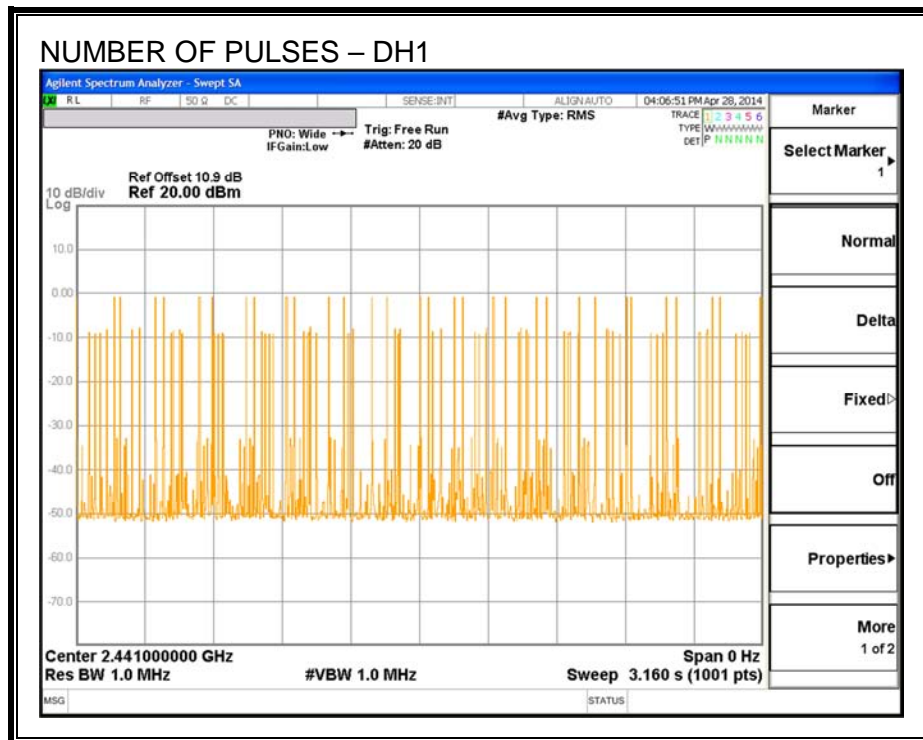
#### RESULTS

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.414	32	0.132	0.4	-0.268
DH3	1.674	19	0.318	0.4	-0.082
DH5	2.91	11	0.320	0.4	-0.080

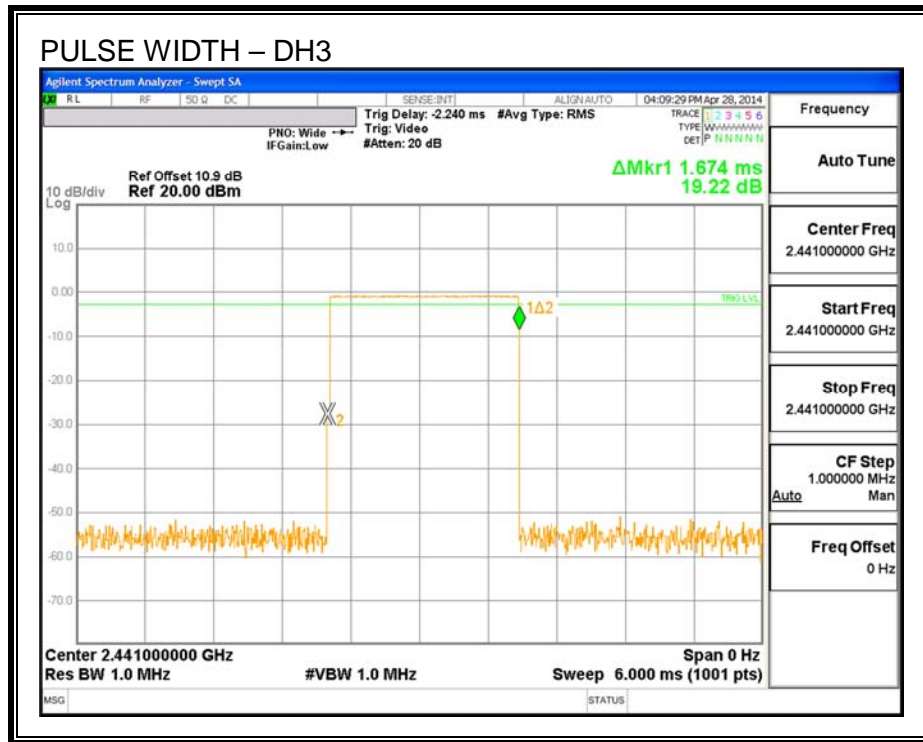
**PULSE WIDTH - DH1**



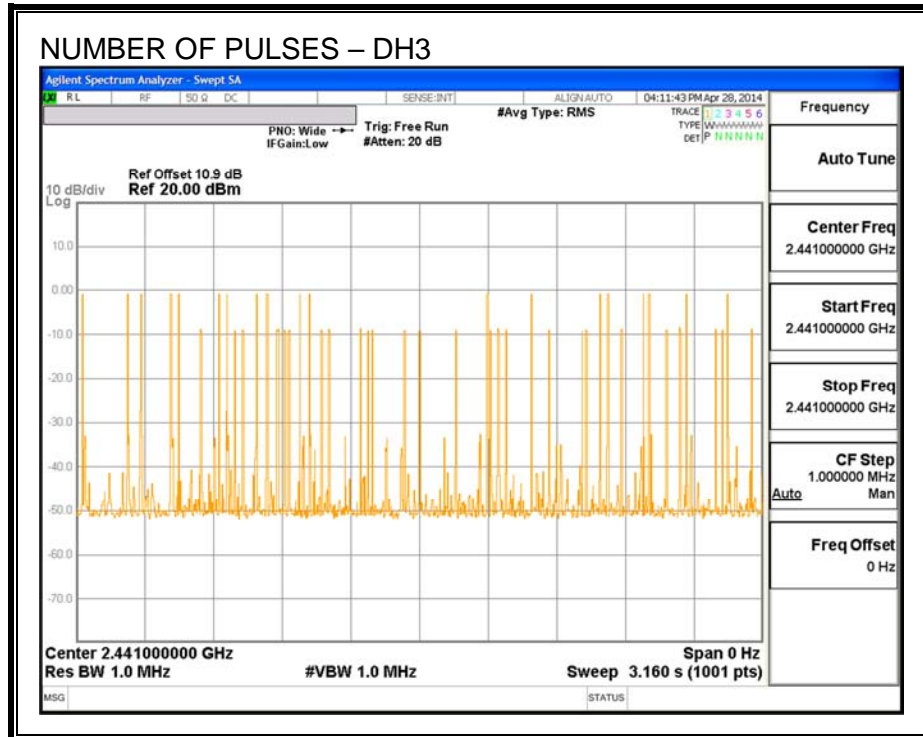
**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1**



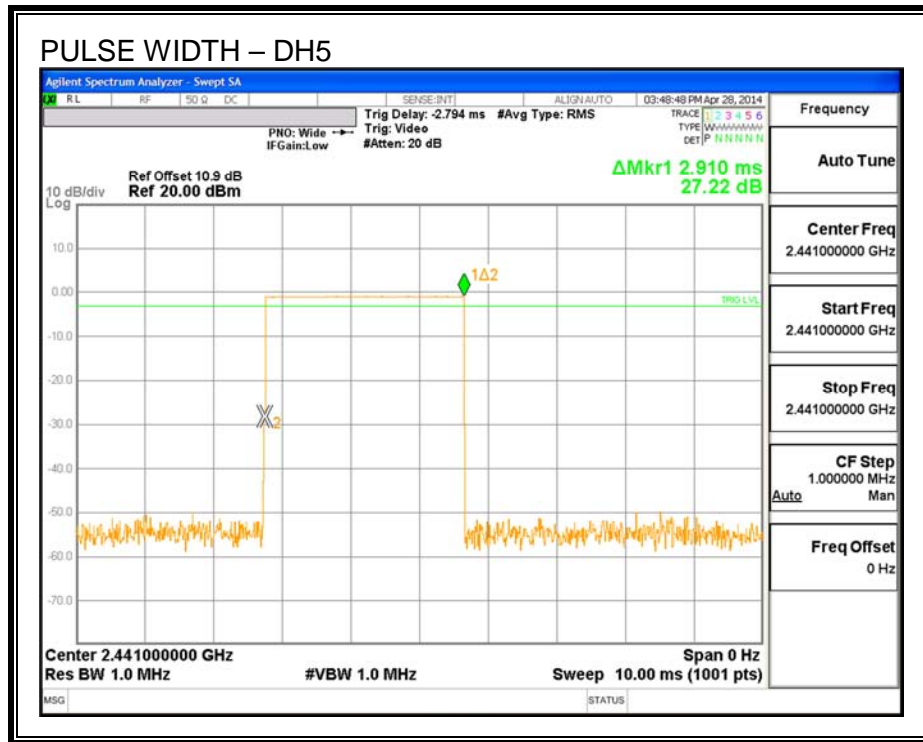
**PULSE WIDTH – DH3**



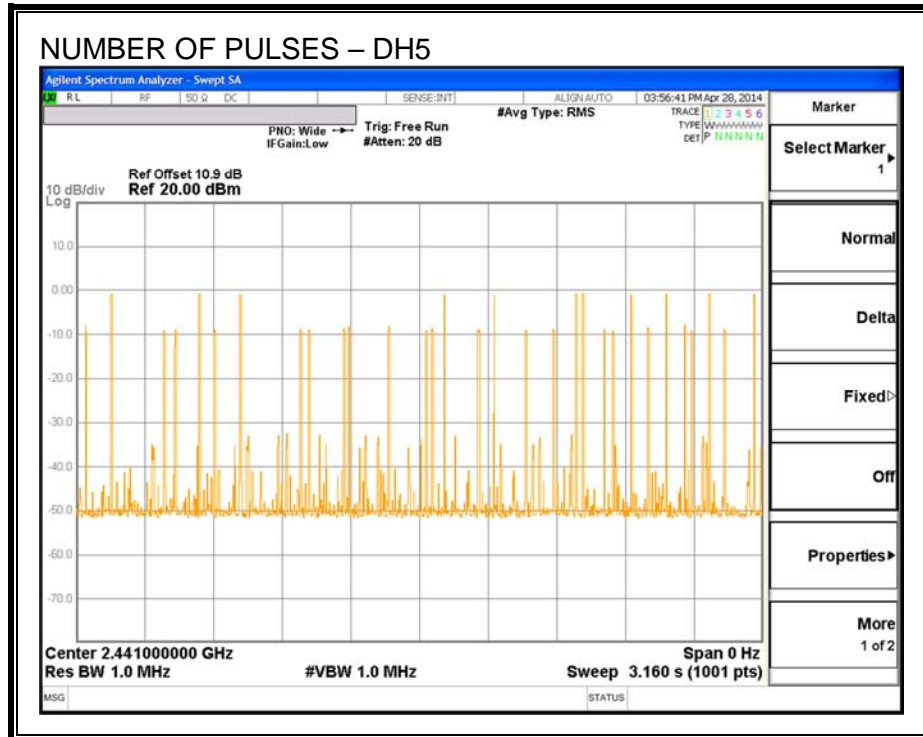
**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3**



**PULSE WIDTH – DH5**



**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5**



### 9.1.5. OUTPUT POWER

#### LIMIT

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm.

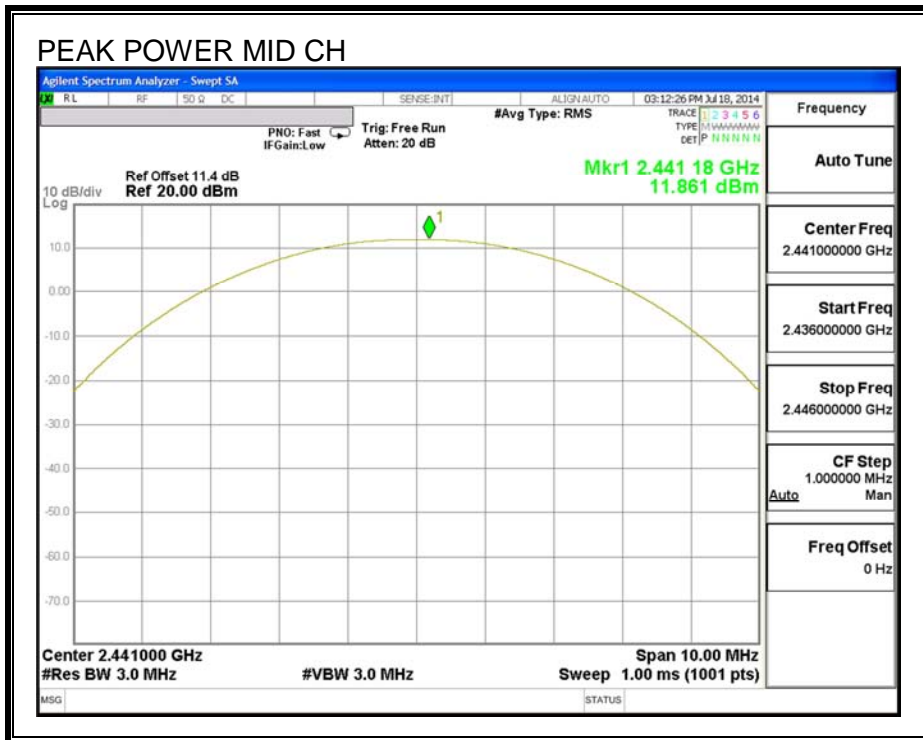
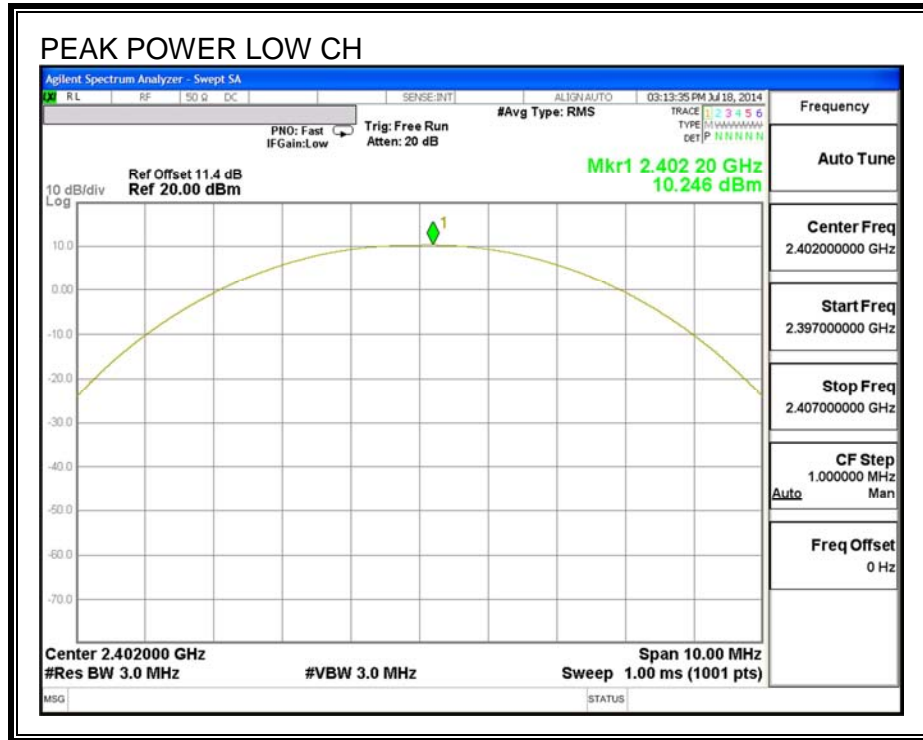
#### TEST PROCEDURE

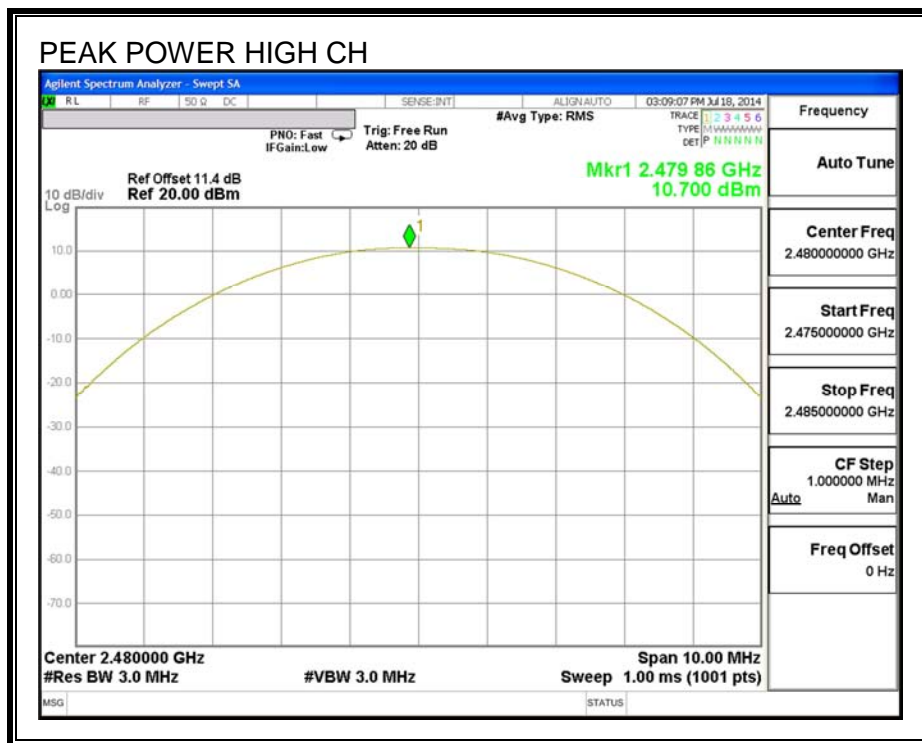
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

#### RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	10.25	30	-19.75
Middle	2441	11.86	30	-18.14
High	2480	10.70	30	-19.30

**OUTPUT POWER**







### 9.1.6. AVERAGE POWER

#### LIMIT

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 10.9 dB (including 10 dB pad and .9 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	10.12
Middle	2441	11.75
High	2480	10.55

## 9.1.7. CONDUCTED SPURIOUS EMISSIONS

### LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

### TEST PROCEDURE

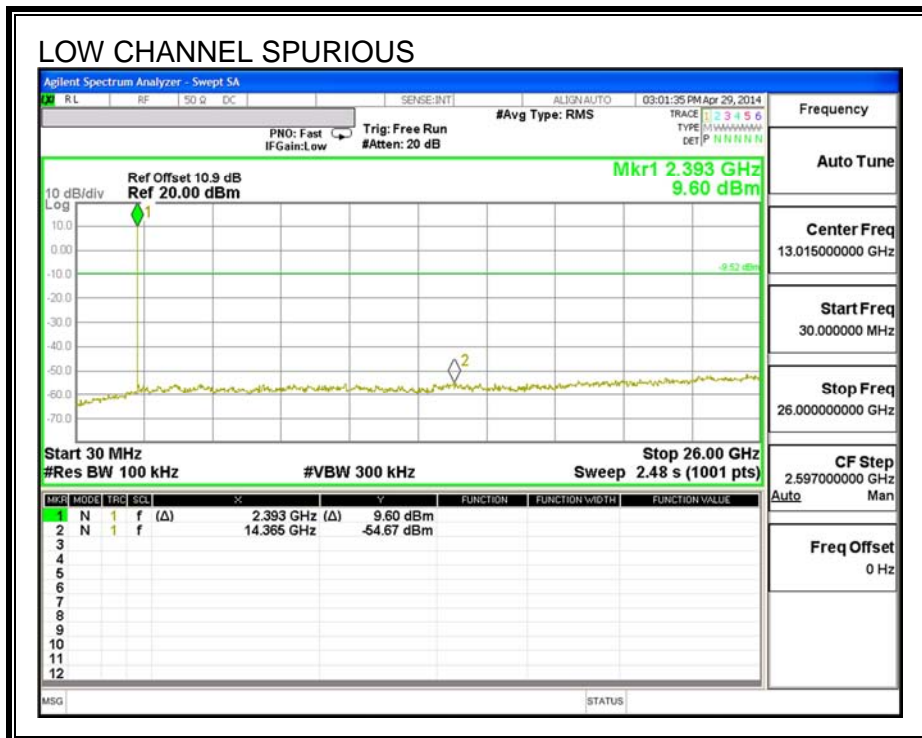
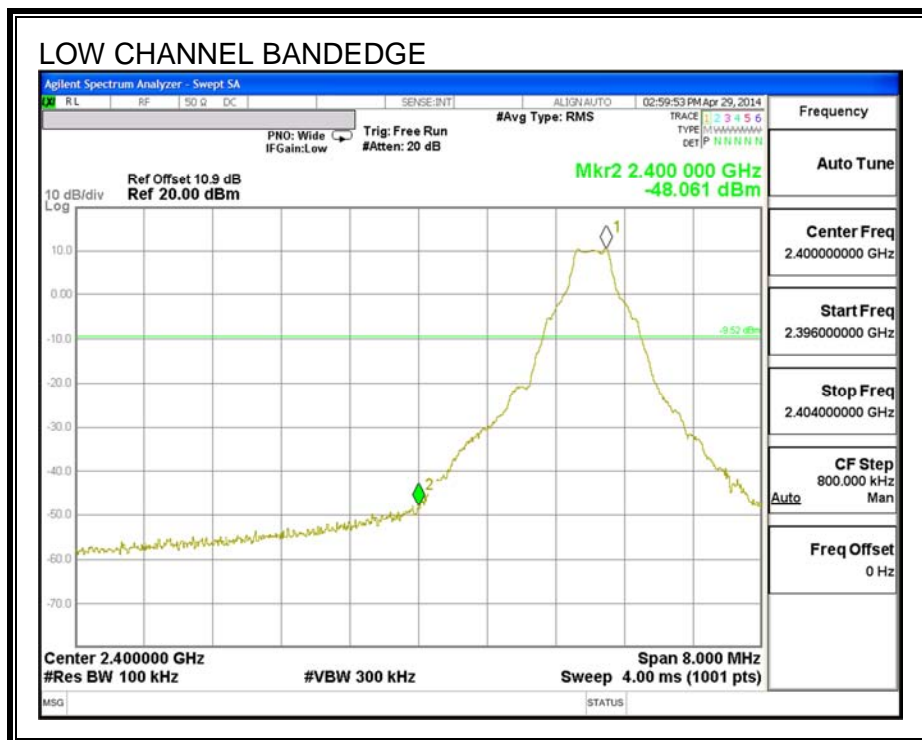
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

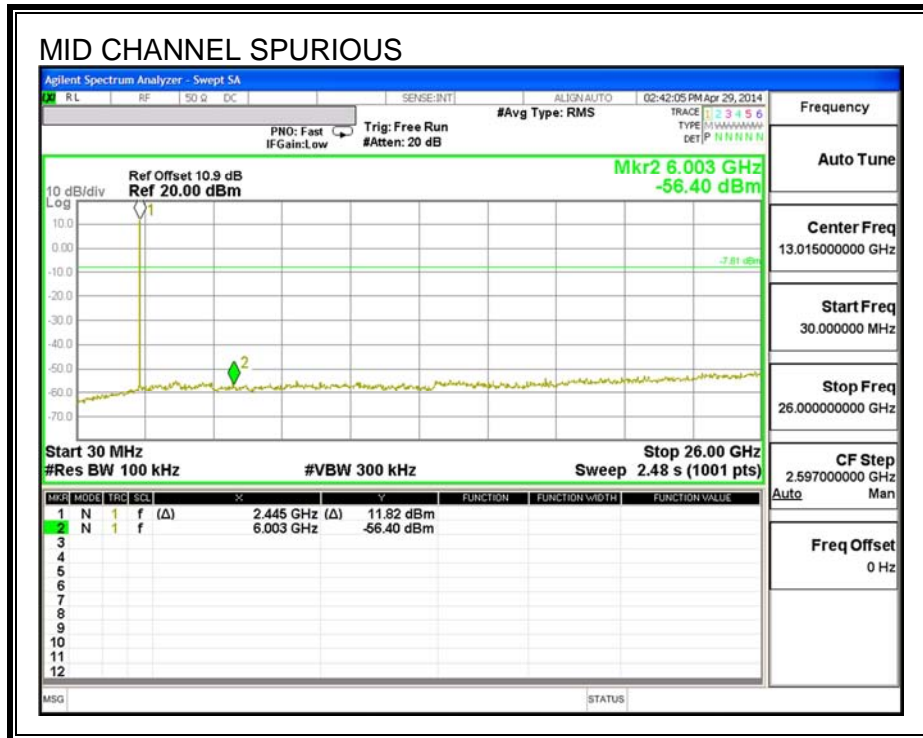
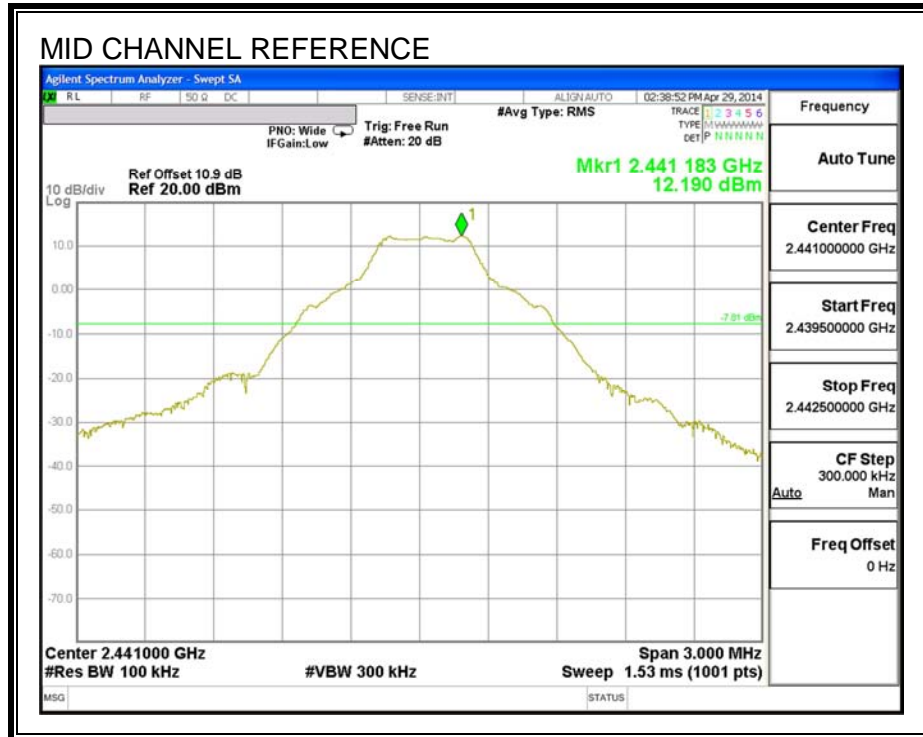
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

### RESULTS

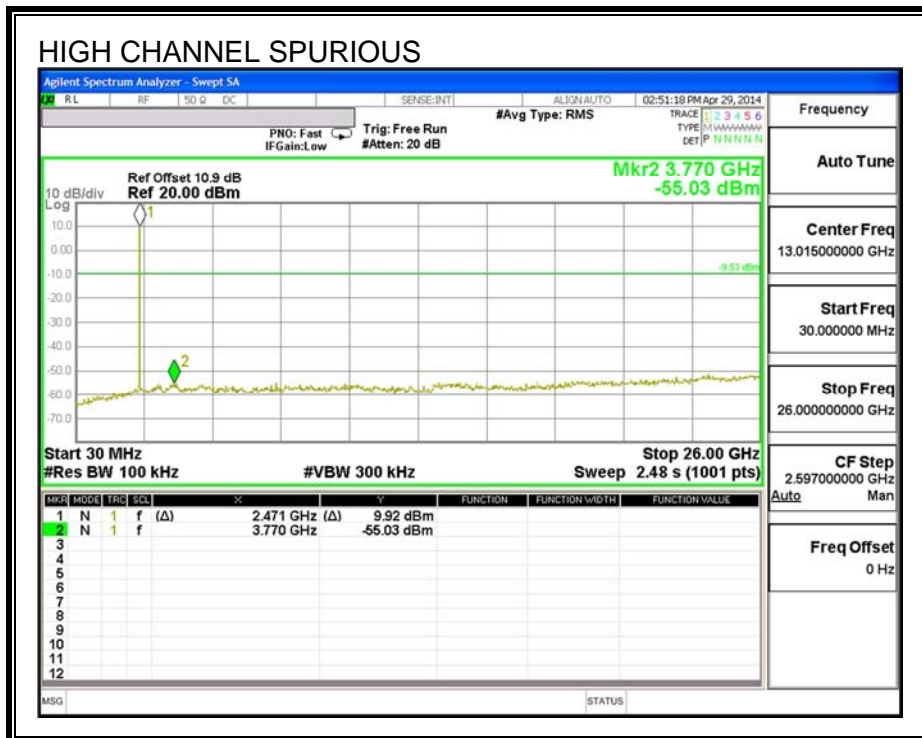
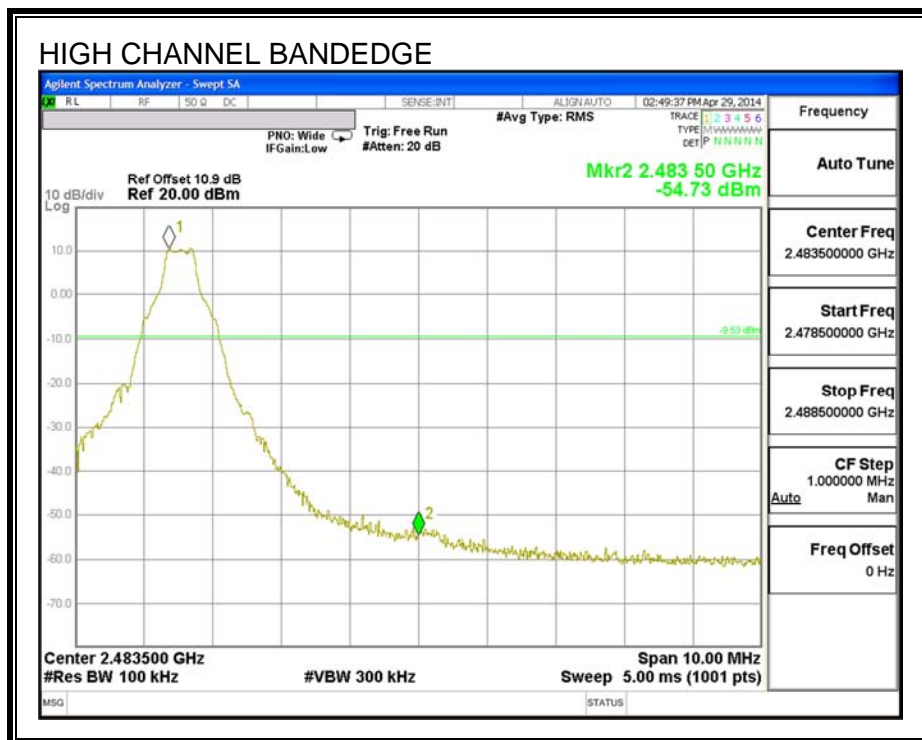
**SPURIOUS EMISSIONS, LOW CHANNEL**



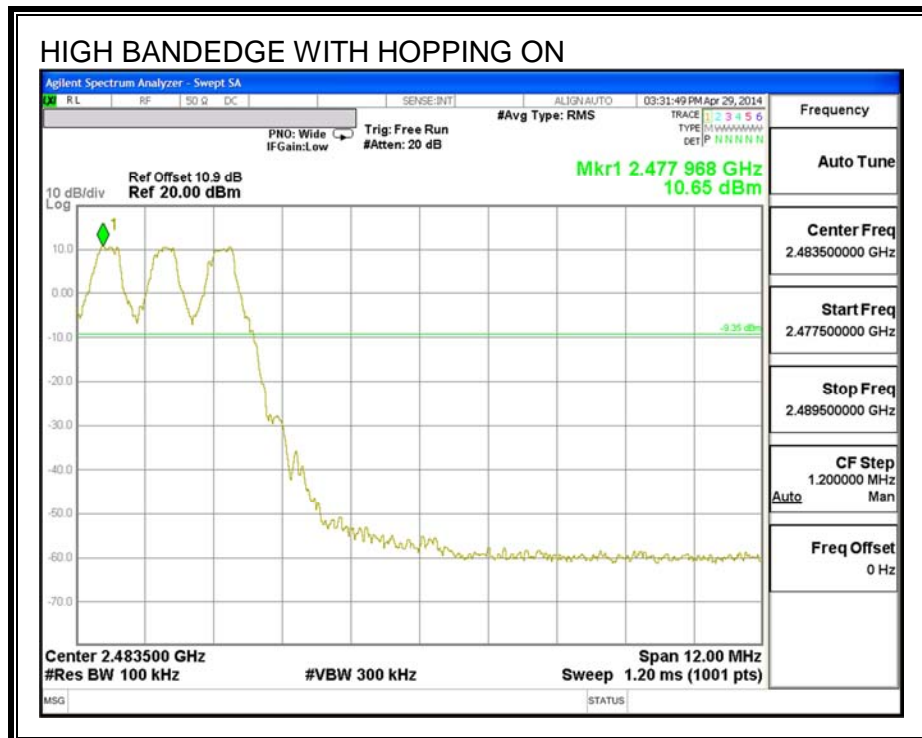
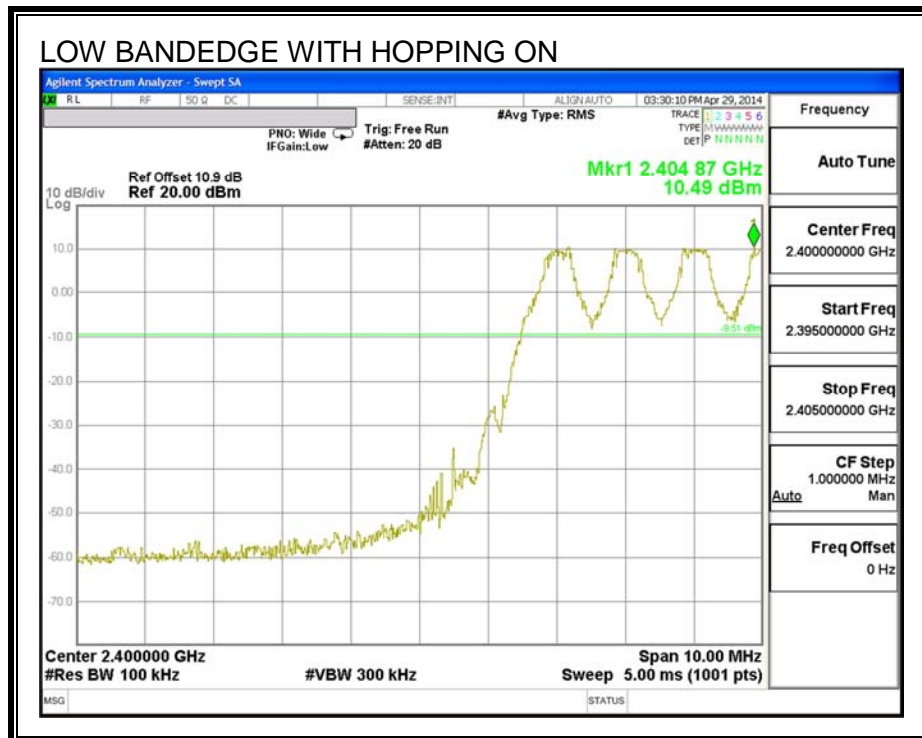
**SPURIOUS EMISSIONS, MID CHANNEL**



**SPURIOUS EMISSIONS, HIGH CHANNEL**



**SPURIOUS BANDEGE EMISSIONS WITH HOPPING ON**



## 9.2. ENHANCED DATA RATE 8PSK MODULATION

### 9.2.1. 20 dB AND 99% BANDWIDTH

#### LIMIT

None; for reporting purposes only.

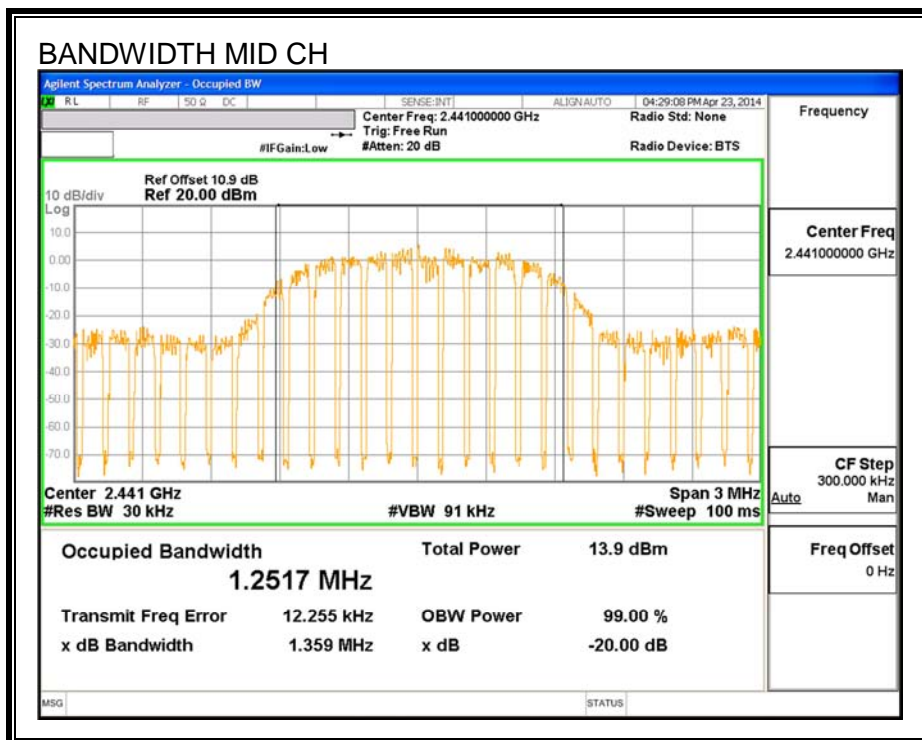
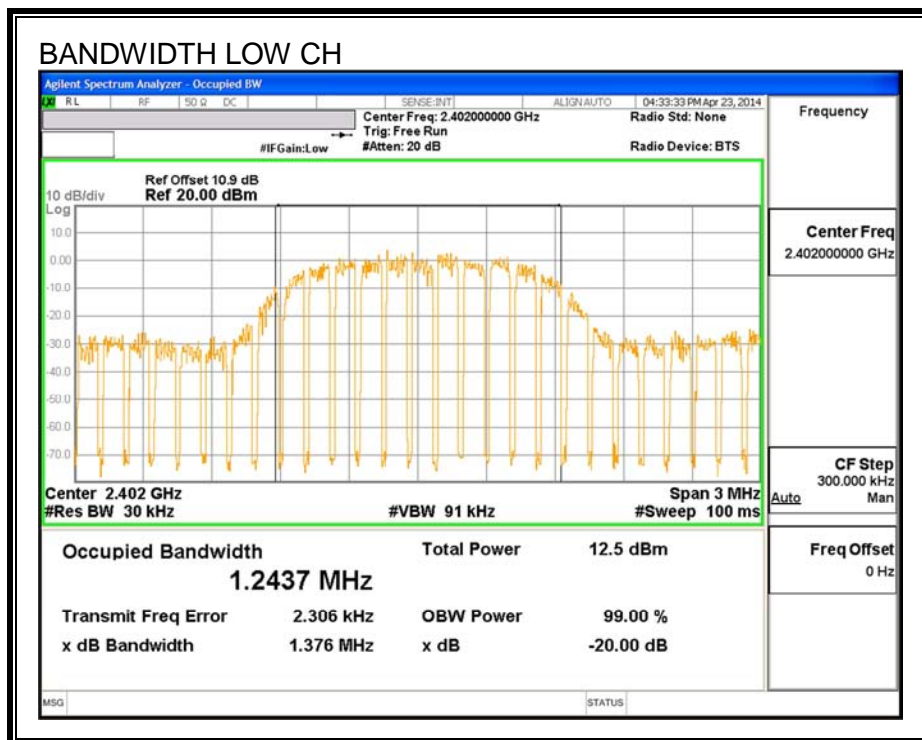
#### TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to  $\geq 1\%$  of the 20 dB bandwidth. The VBW is set to  $\geq$  RBW. The sweep time is coupled.

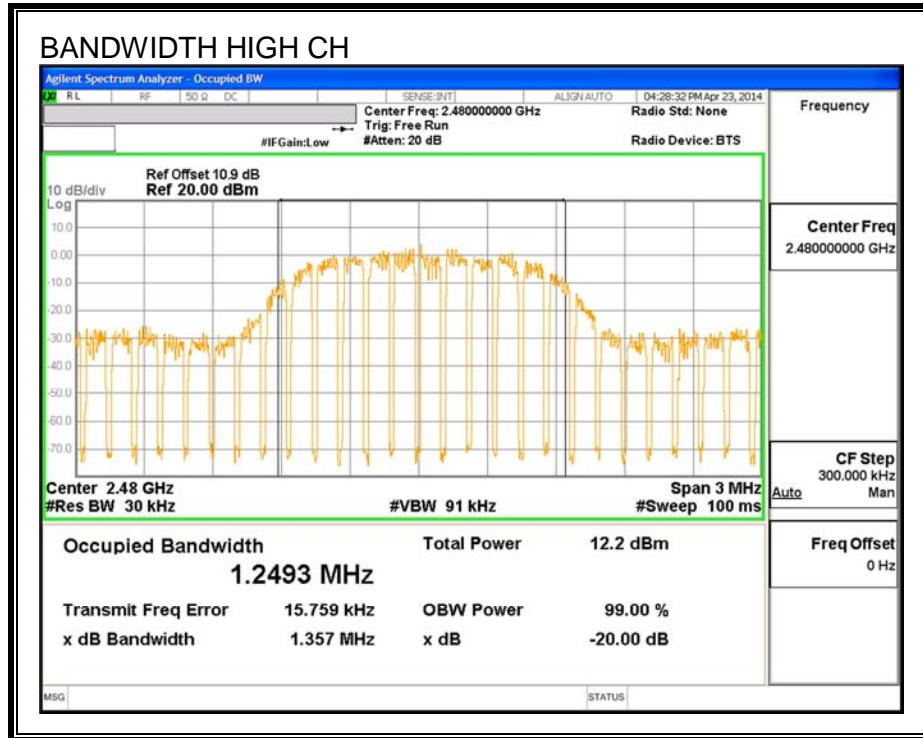
#### RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.376	1.2437
Middle	2441	1.359	1.2517
High	2480	1.357	1.2493

**20 dB AND 99% BANDWIDTH**







## 9.2.2. HOPPING FREQUENCY SEPARATION

### LIMIT

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

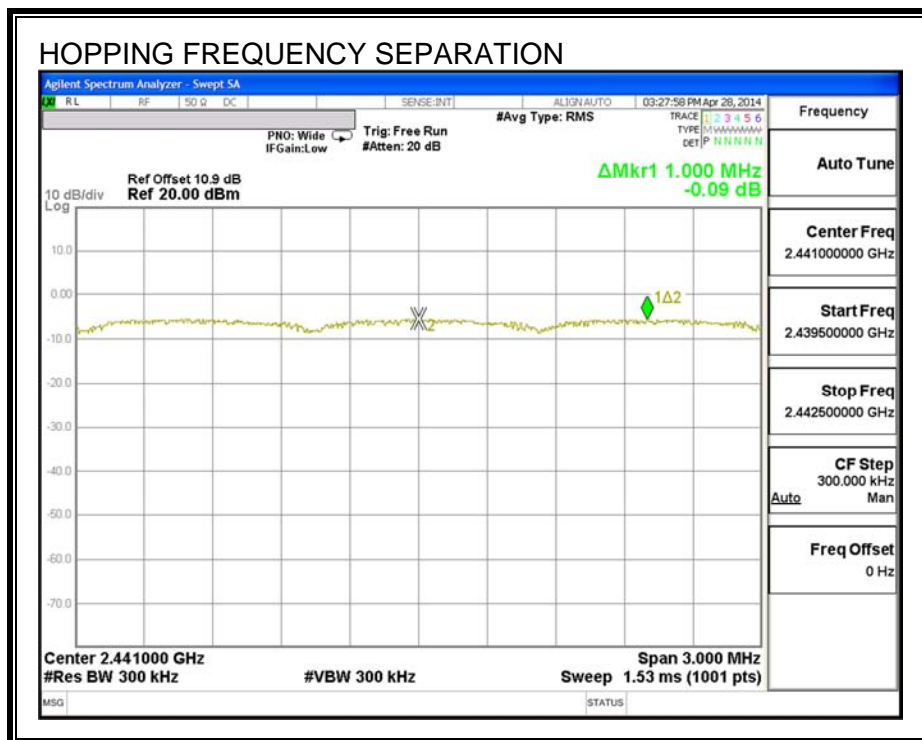
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 100 kHz. The sweep time is coupled.

### RESULTS

**HOPPING FREQUENCY SEPARATION**



### **9.2.3. NUMBER OF HOPPING CHANNELS**

#### **LIMIT**

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

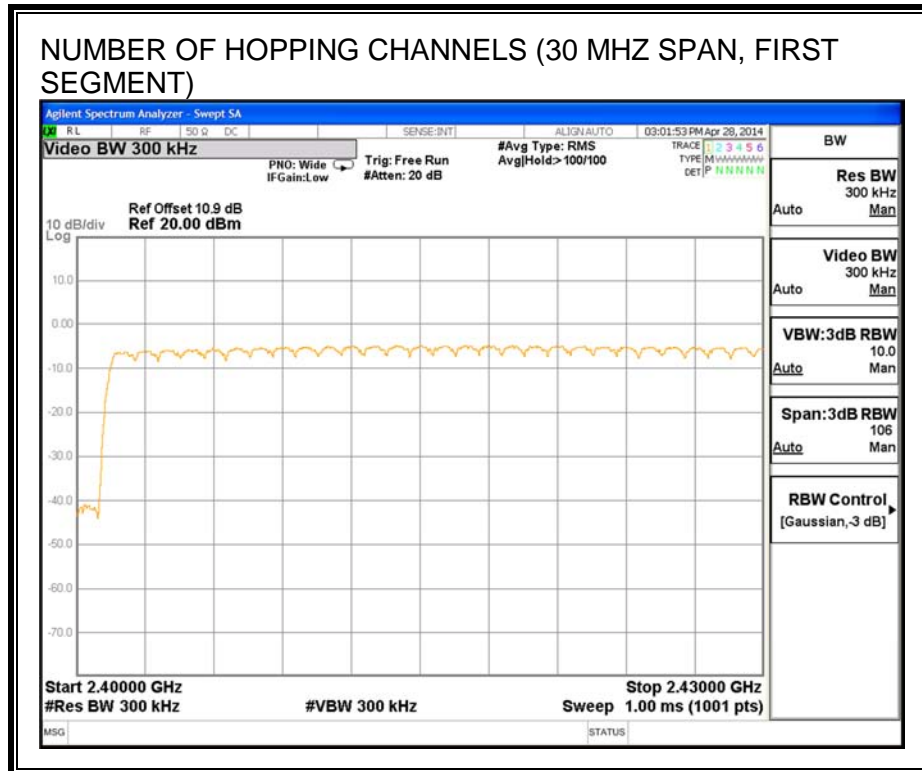
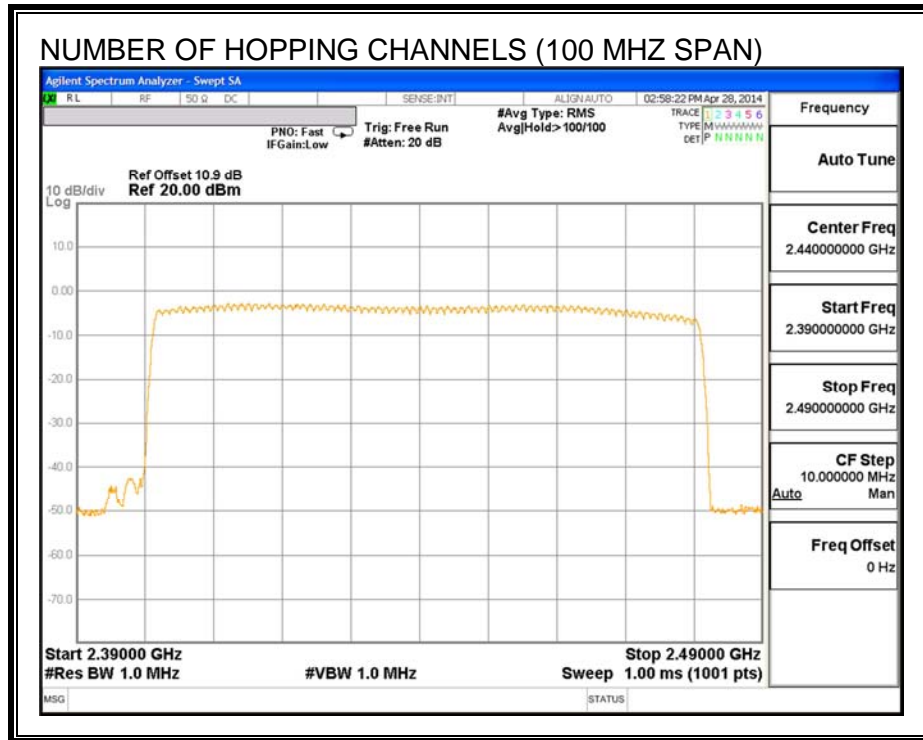
#### **TEST PROCEDURE**

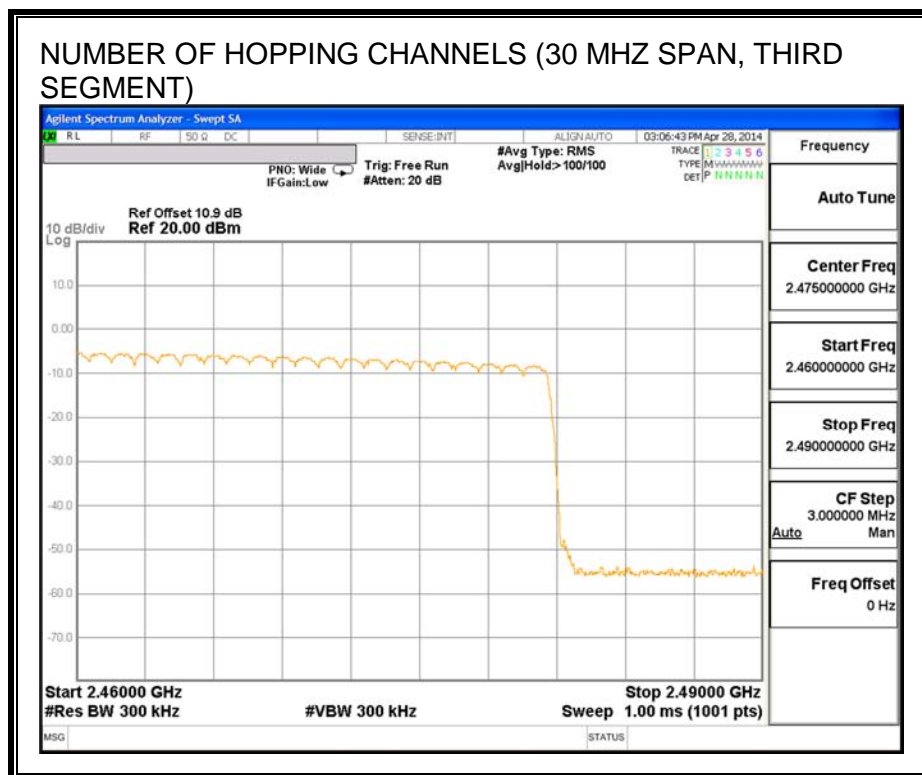
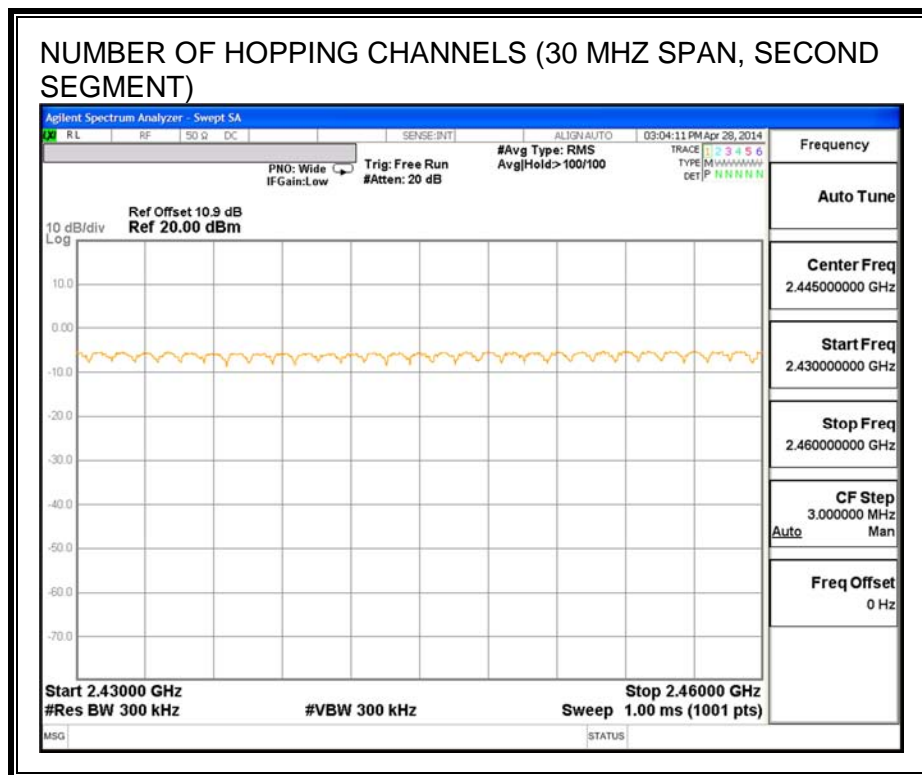
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

#### **RESULTS**

Normal Mode: 79 Channels observed.

**NUMBER OF HOPPING CHANNELS**





### 9.2.4. AVERAGE TIME OF OCCUPANCY

#### LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

#### TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 31.6 second period (79 channels \* 0.4 s) is equal to  $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$ .

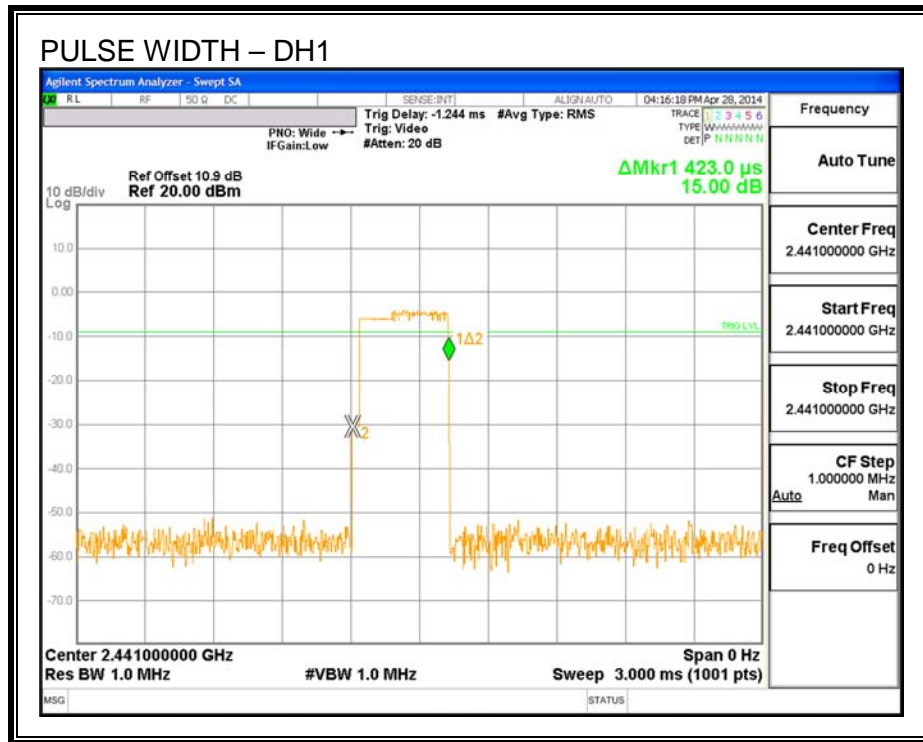
#### RESULTS

Time Of Occupancy =  $10 * xx \text{ pulses} * yy \text{ msec} = zz \text{ msec}$

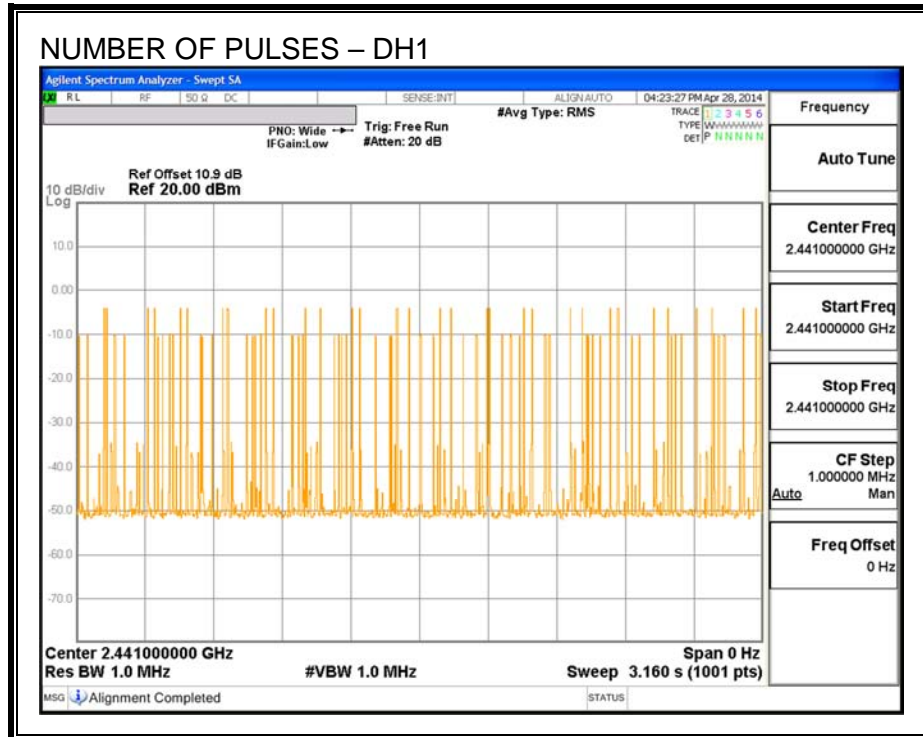
#### 8PSK (EDR) Mode

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
3DH1	0.423	32	0.135	0.4	-0.265
3DH3	1.68	12	0.202	0.4	-0.198
3DH5	2.93	12	0.352	0.4	-0.048

**PULSE WIDTH - DH1**

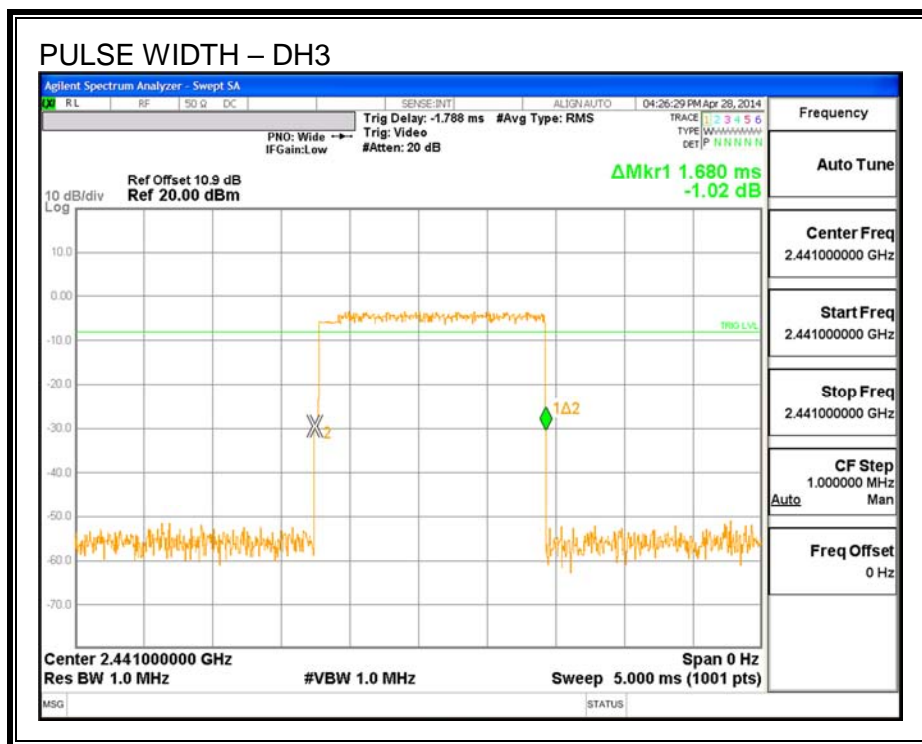


**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1**

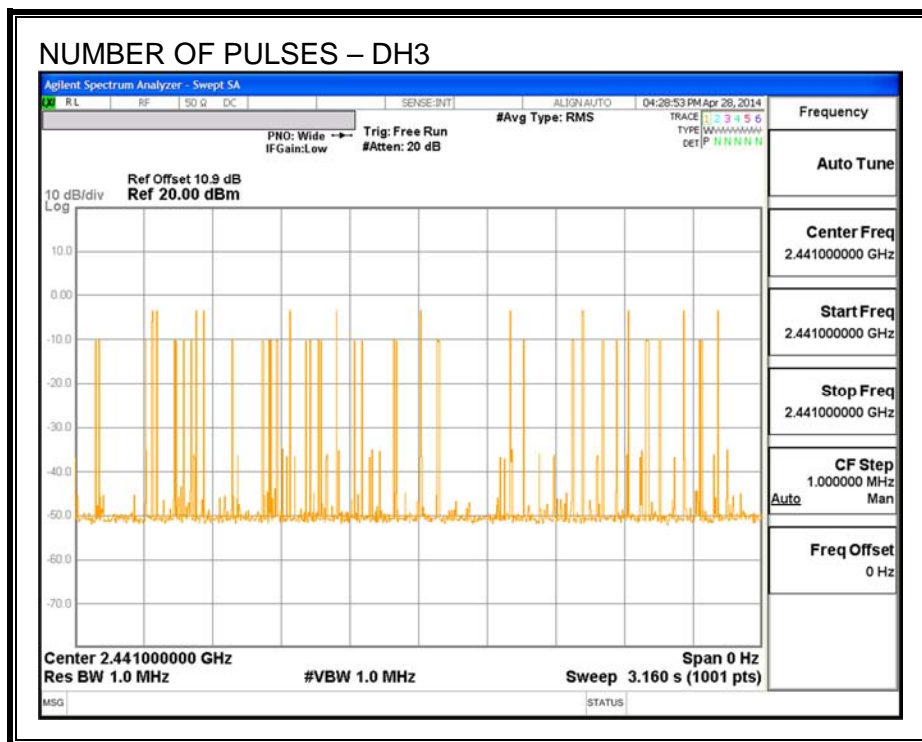




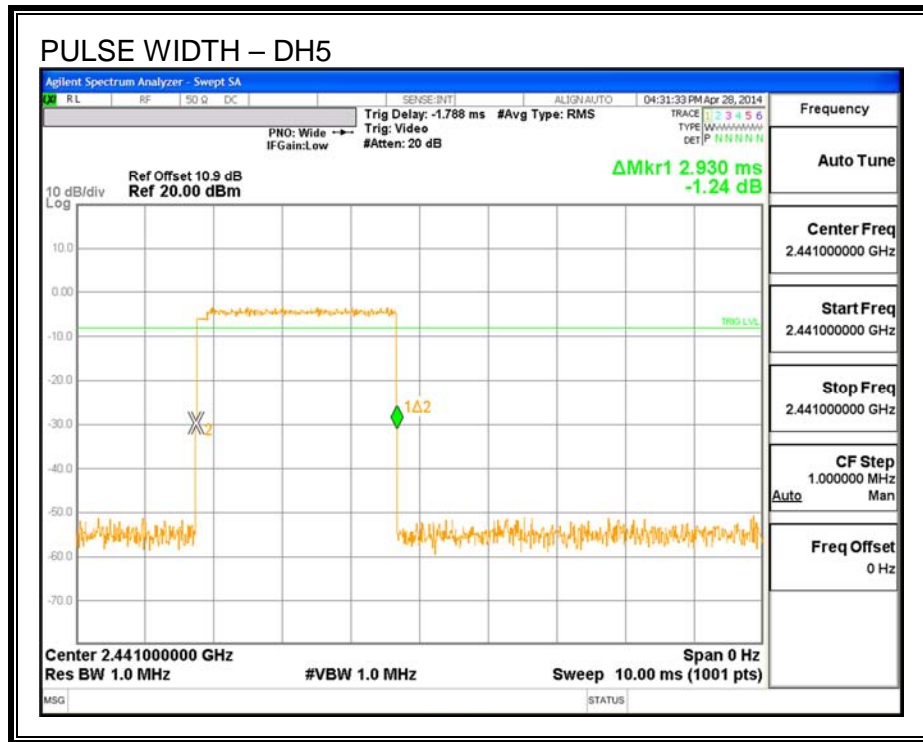
**PULSE WIDTH – DH3**



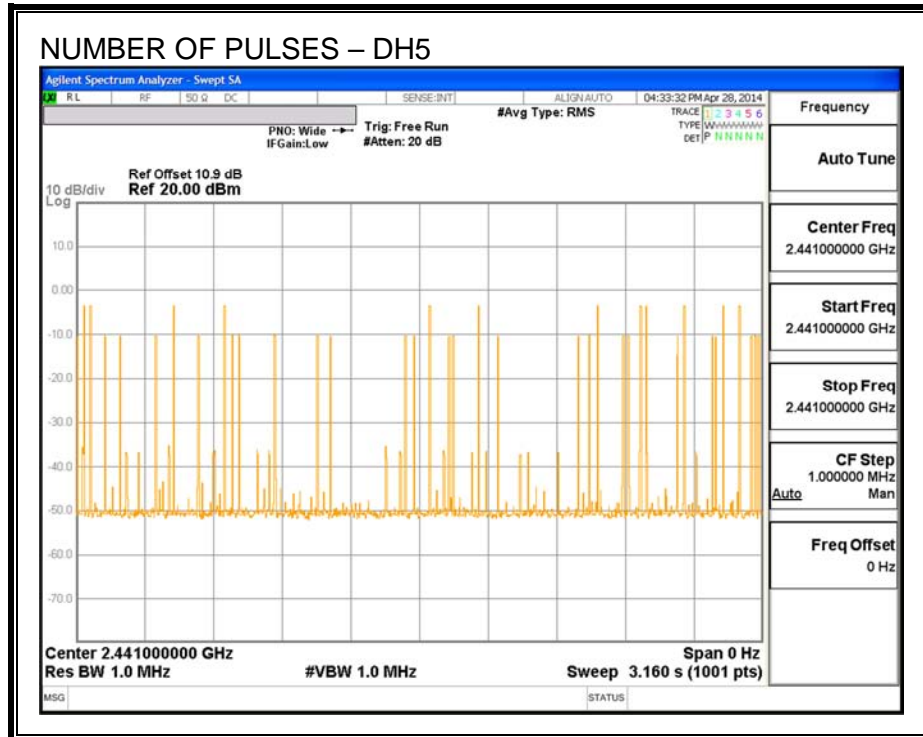
**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3**



**PULSE WIDTH – DH5**



**NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5**



## 9.2.5. OUTPUT POWER

### LIMIT

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm.

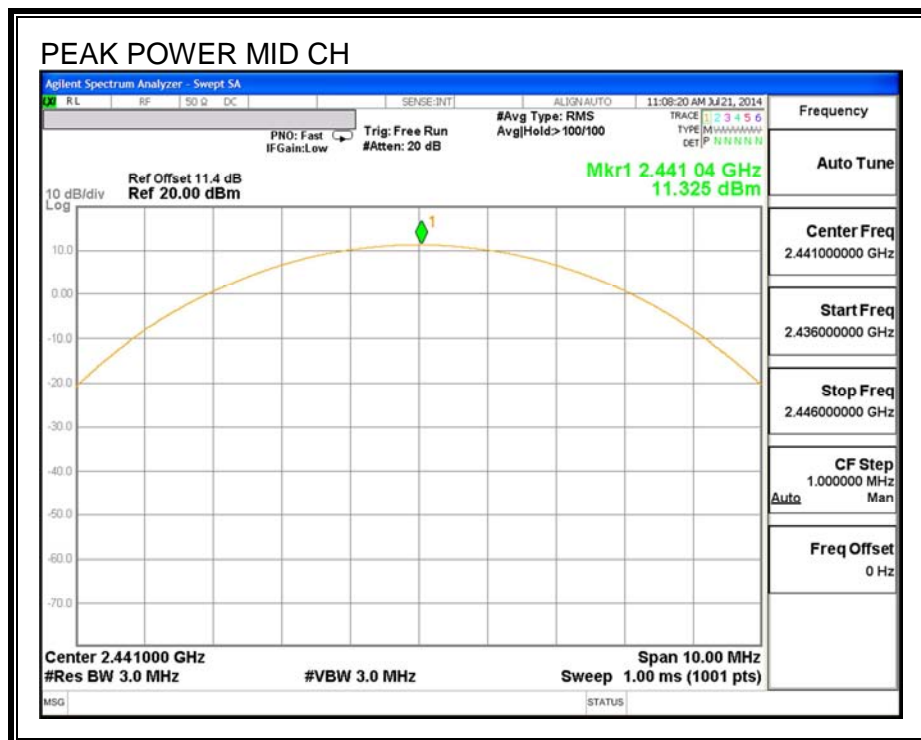
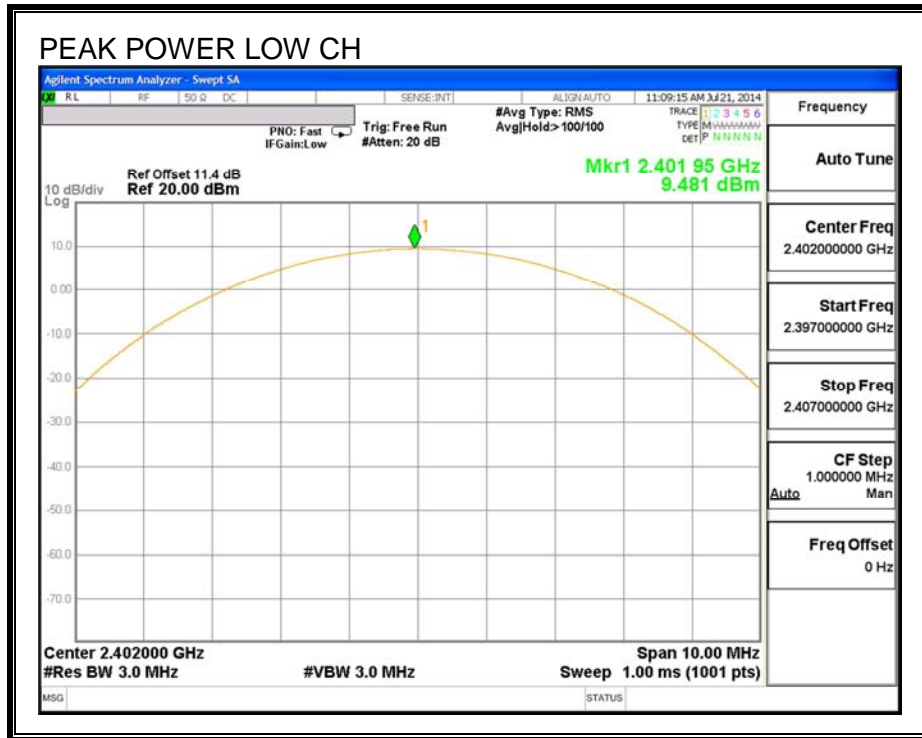
### TEST PROCEDURE

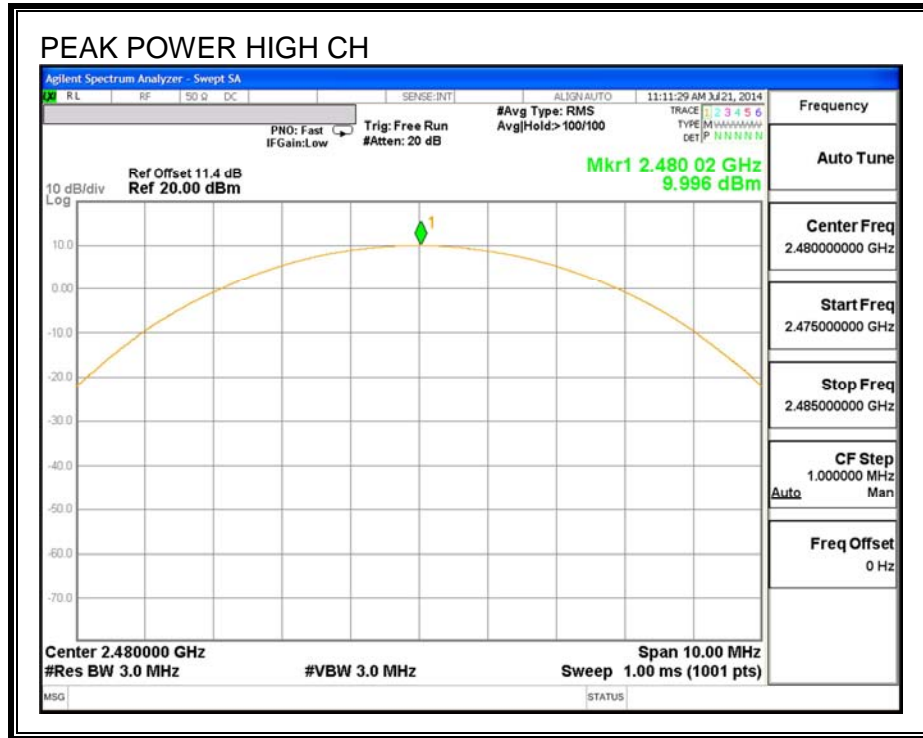
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

### RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.48	30	-20.52
Middle	2441	11.33	30	-18.68
High	2480	10.00	30	-20.00

**OUTPUT POWER**





### 9.2.6. AVERAGE POWER

#### LIMIT

None; for reporting purposes only.

#### TEST PROCEDURE

The transmitter output is connected to a power meter.

#### RESULTS

The cable assembly insertion loss of 10.9 dB (including 10 dB pad and .9 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.00
Middle	2441	9.80
High	2480	8.50

## 9.2.7. CONDUCTED SPURIOUS EMISSIONS

### LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

### TEST PROCEDURE

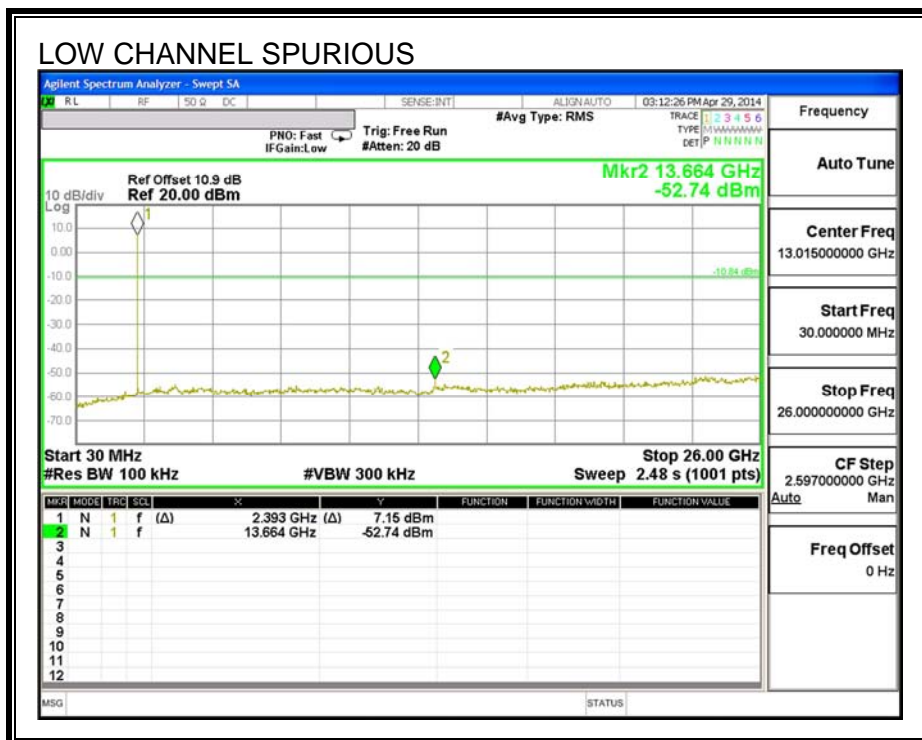
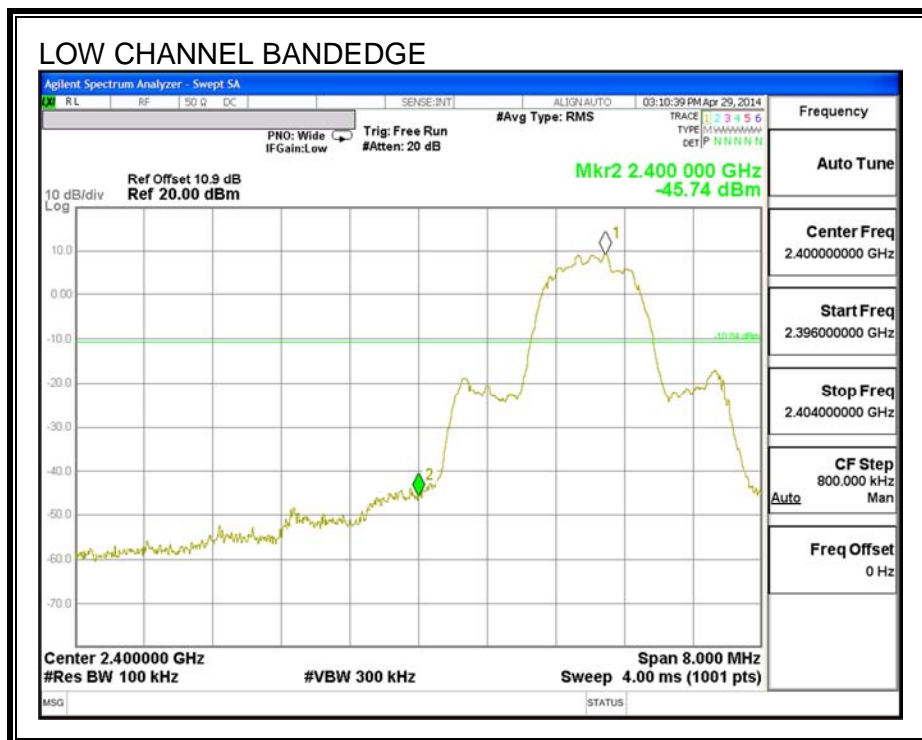
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

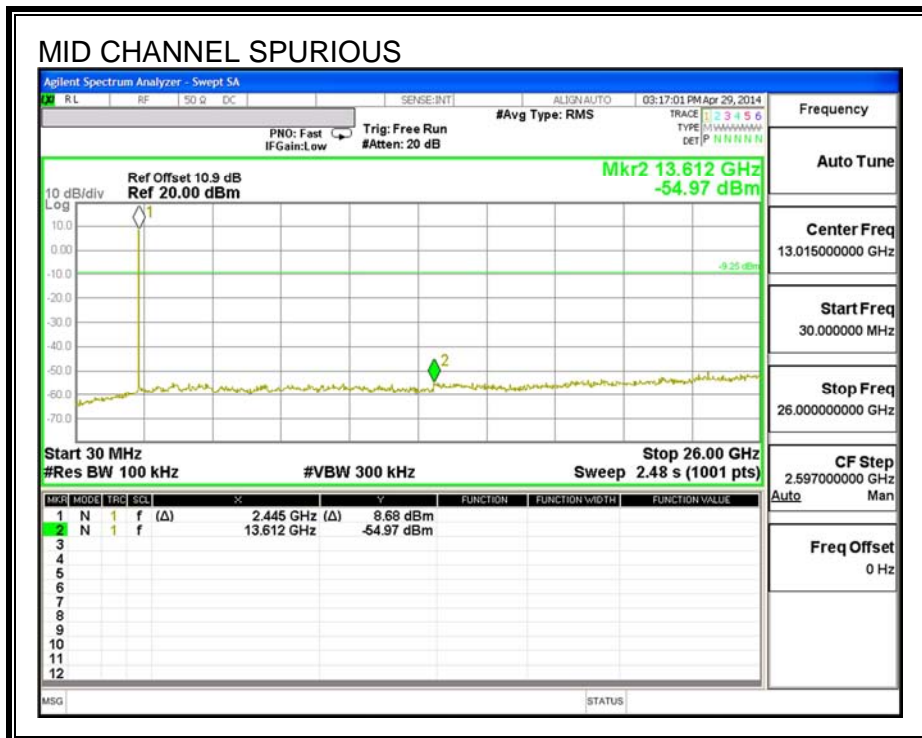
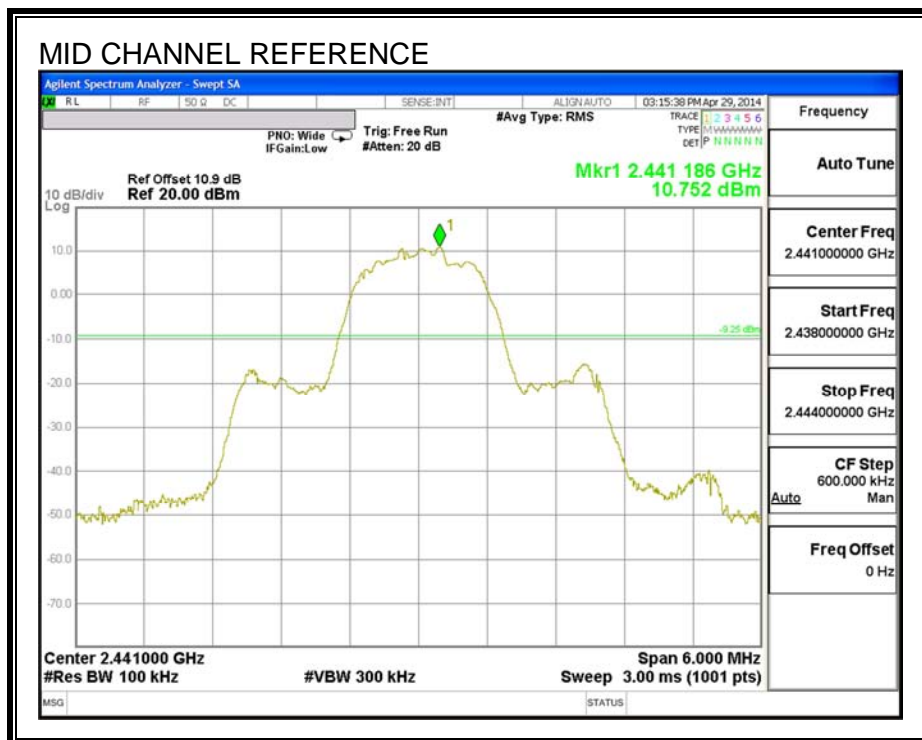
### RESULTS

**SPURIOUS EMISSIONS, LOW CHANNEL**

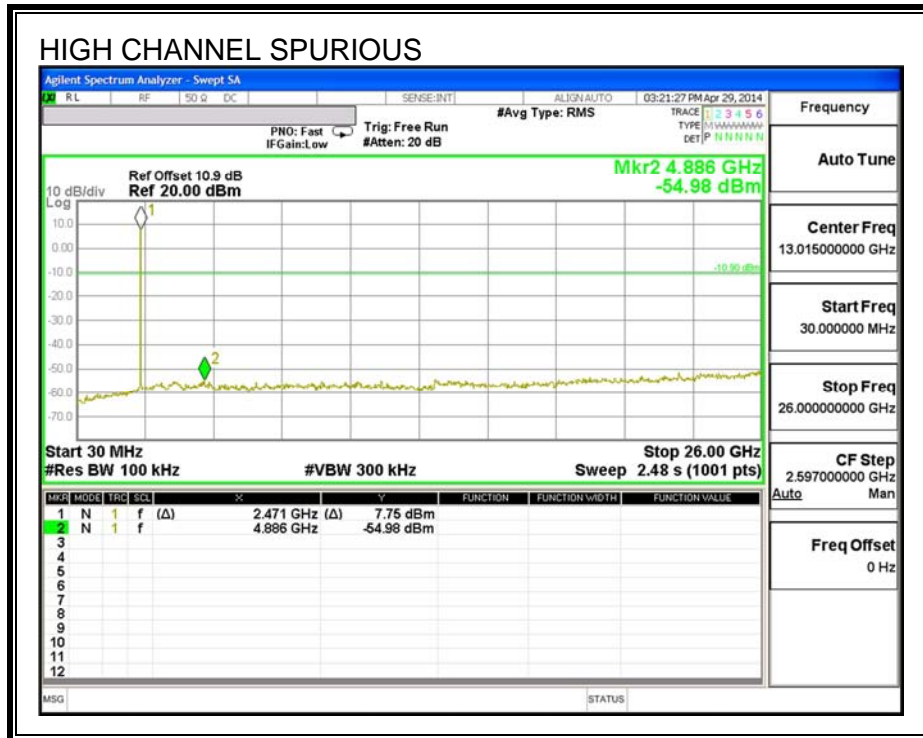
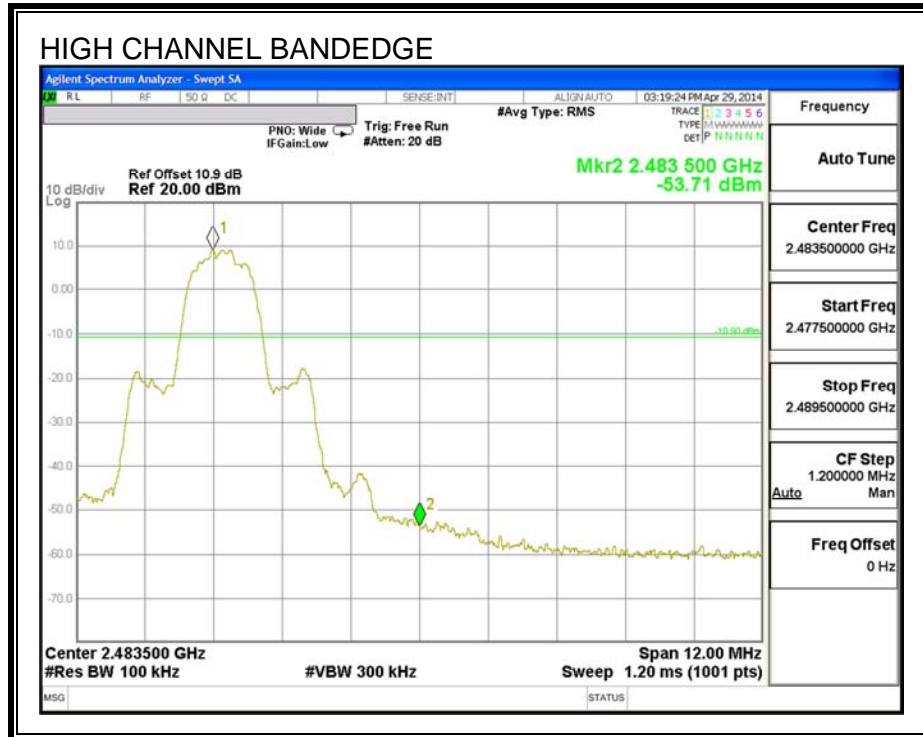




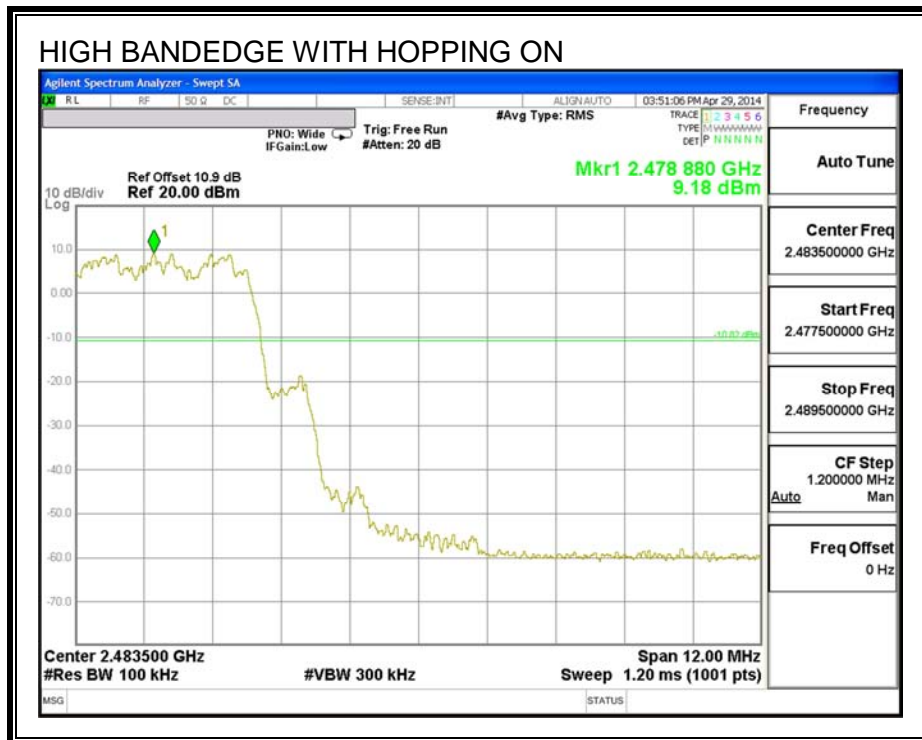
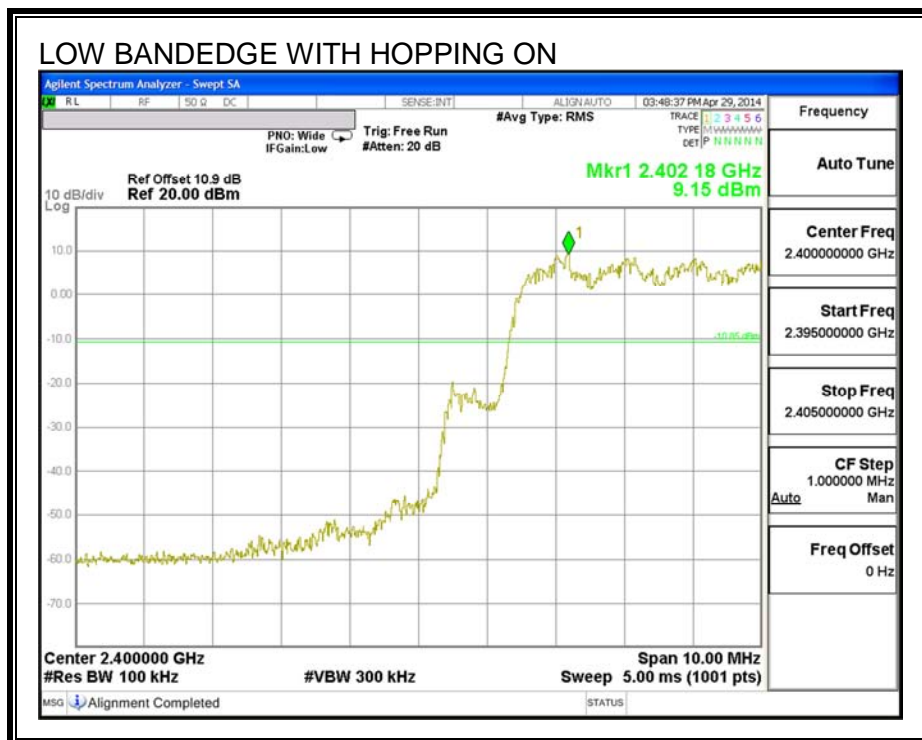
**SPURIOUS EMISSIONS, MID CHANNEL**



**SPURIOUS EMISSIONS, HIGH CHANNEL**



**SPURIOUS BANDEGE EMISSIONS WITH HOPPING ON**



## 10. RADIATED TEST RESULTS

### 10.1. LIMITS AND PROCEDURE

#### LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

#### TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

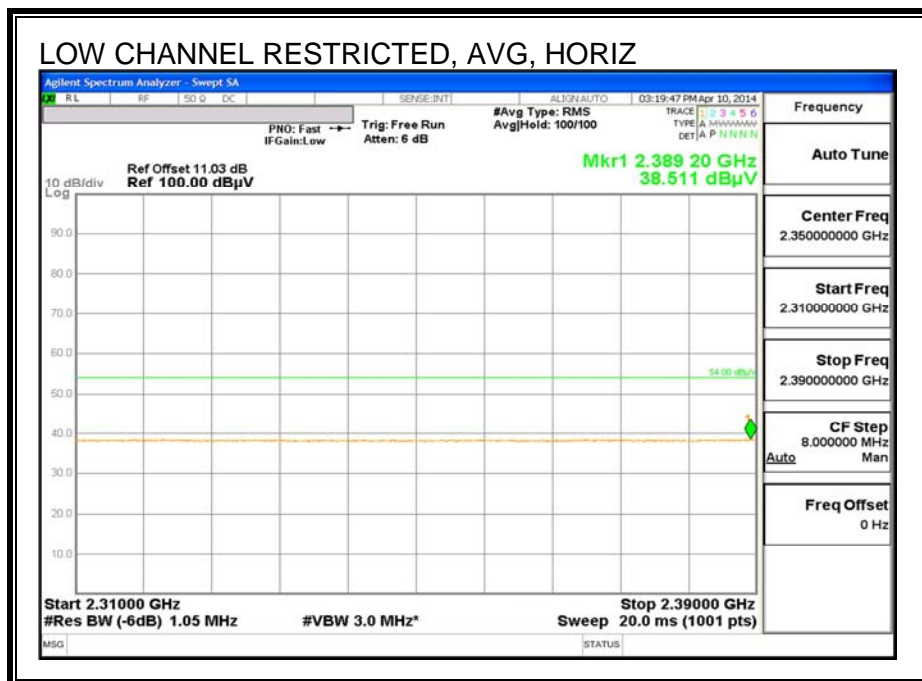
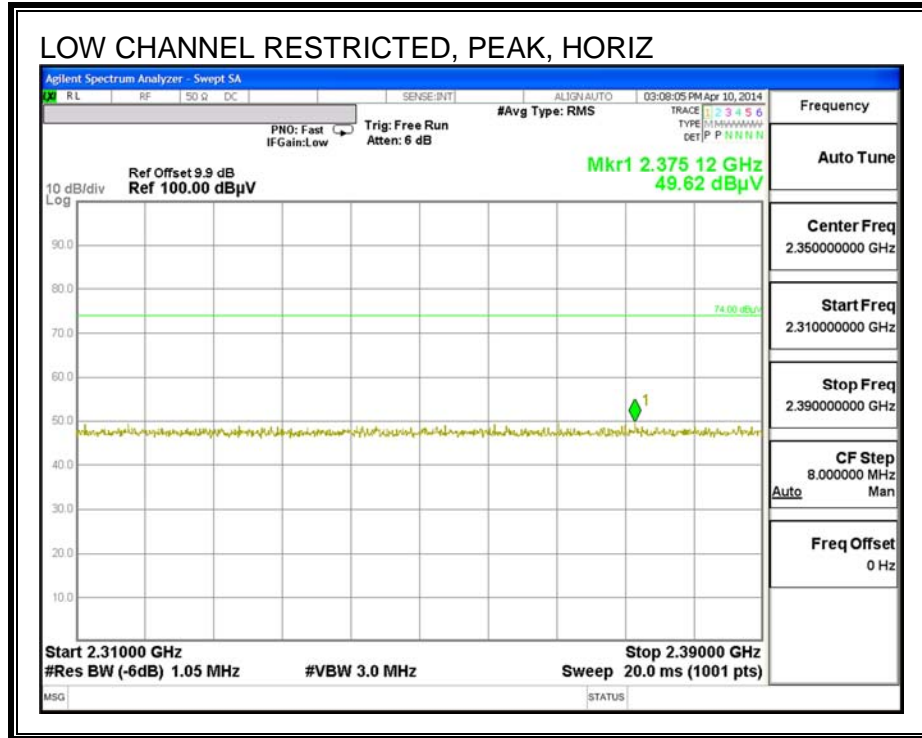
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

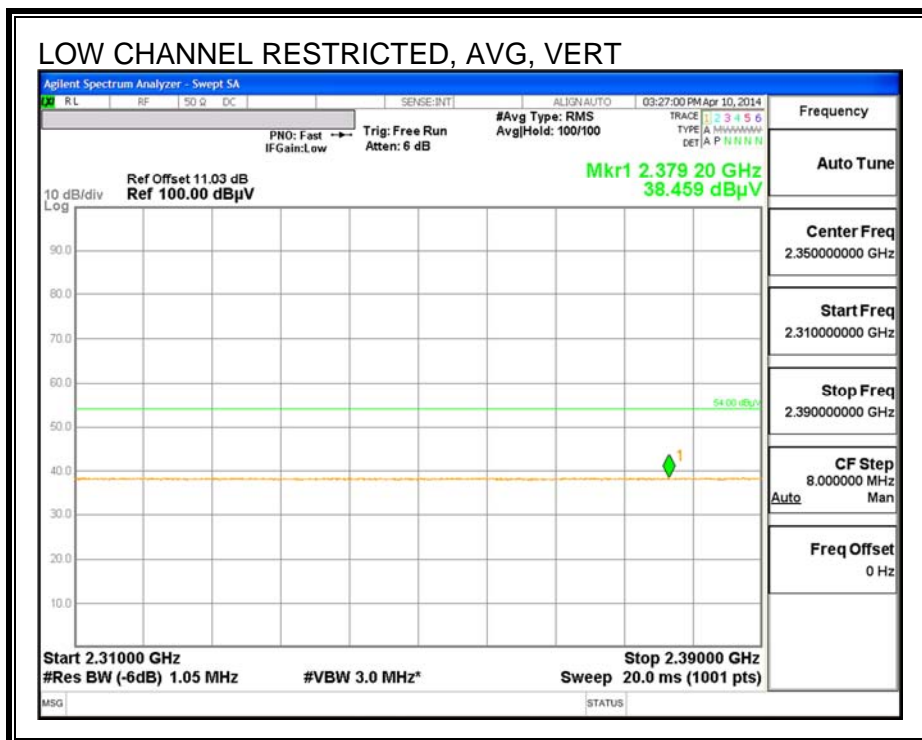
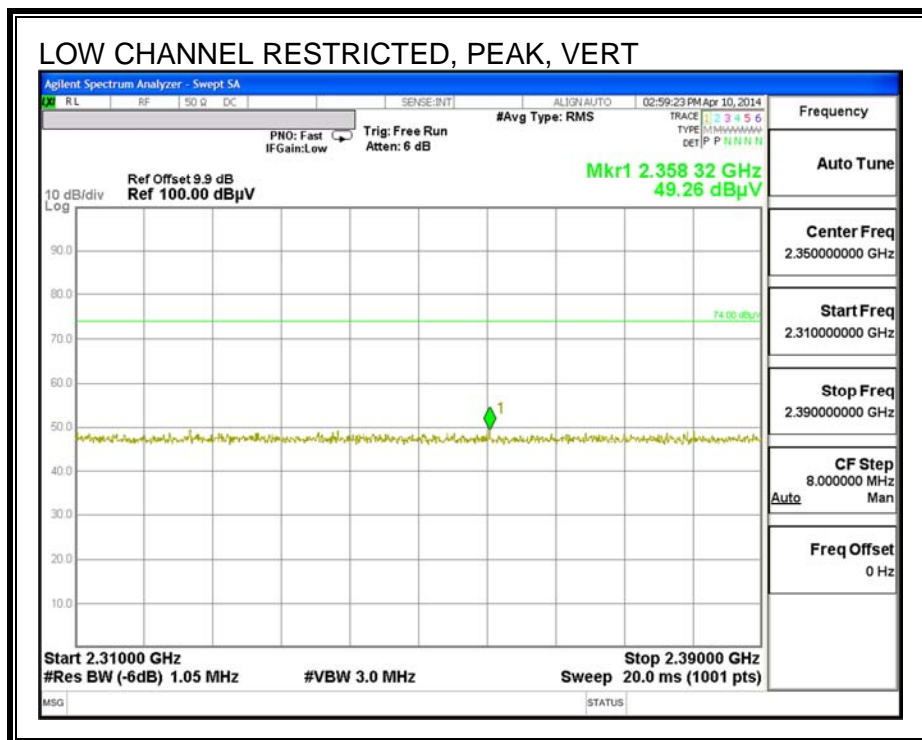
## 10.2. TRANSMITTER ABOVE 1GHz

### 10.2.1. BASIC DATA RATE GFSK MODULATION

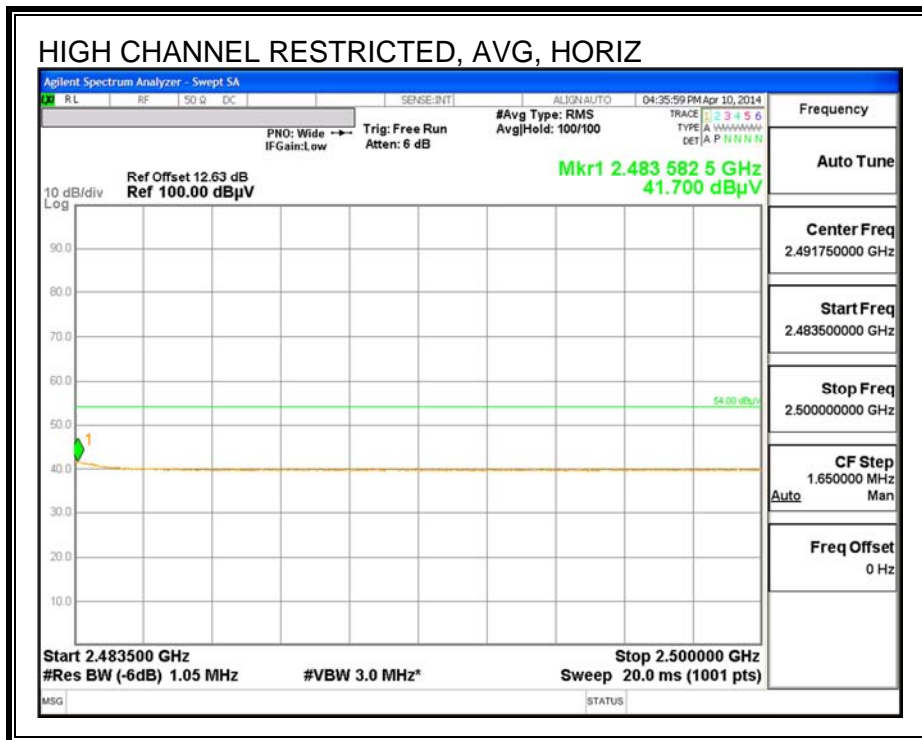
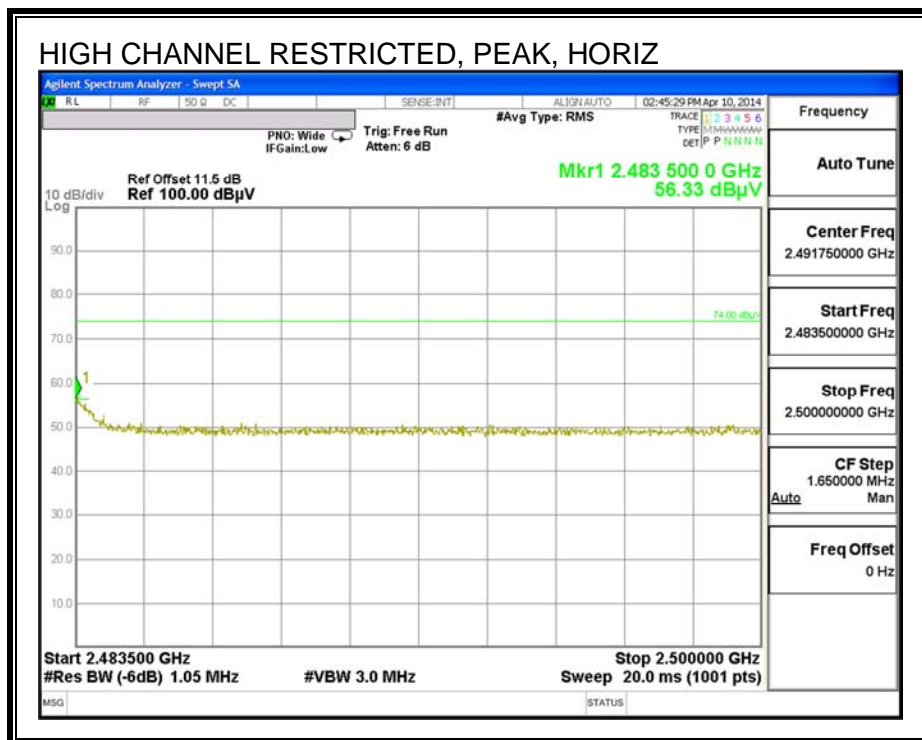
#### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



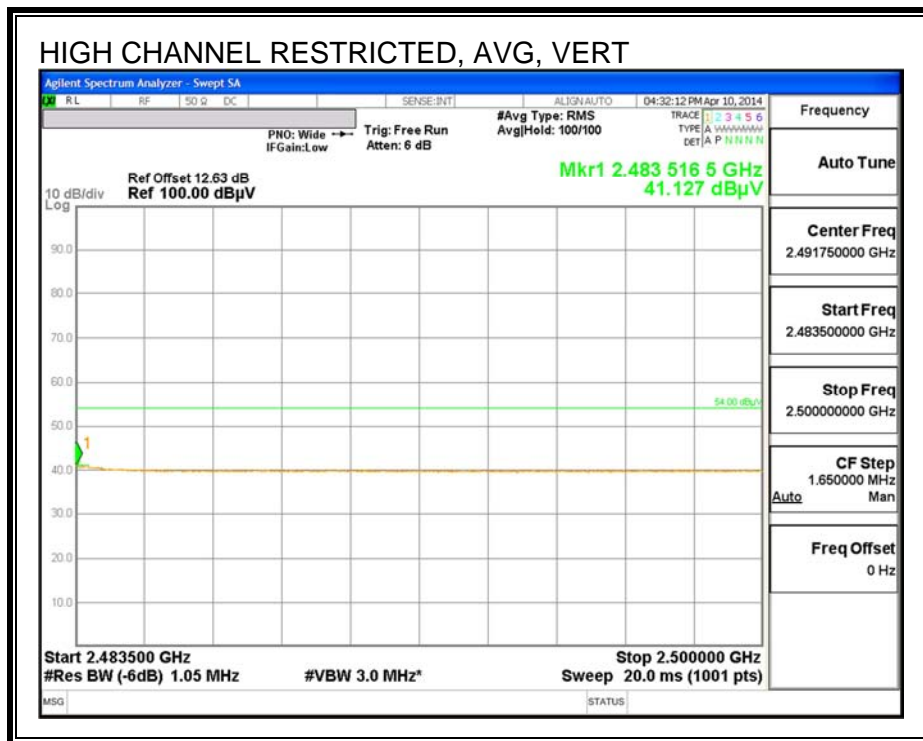
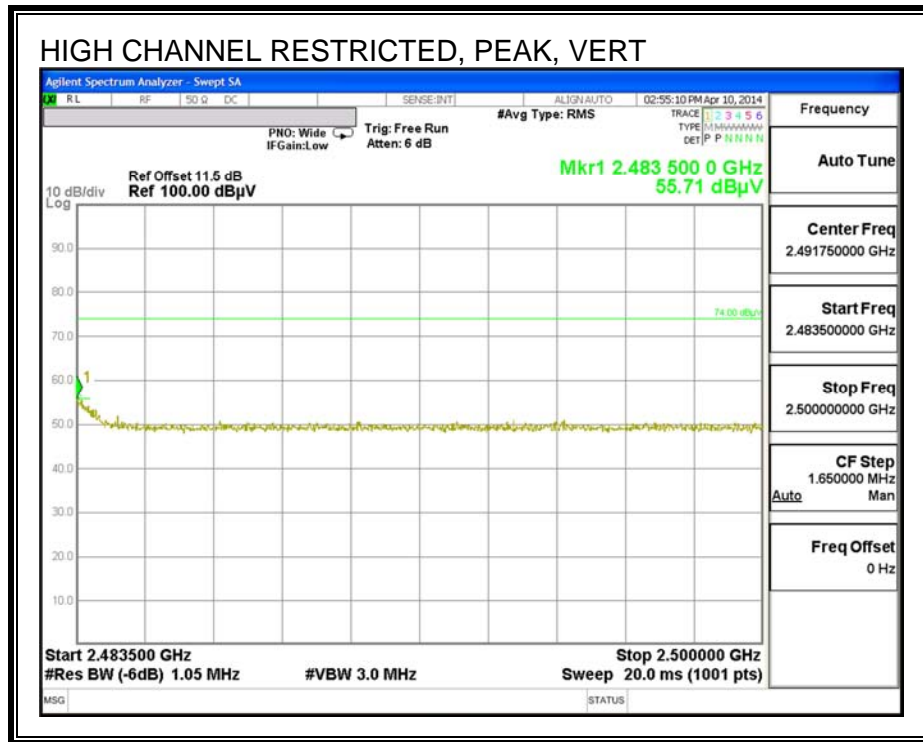
**RESTRICTED BANEDGE (LOW CHANNEL, VERTICAL)**



**RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)**

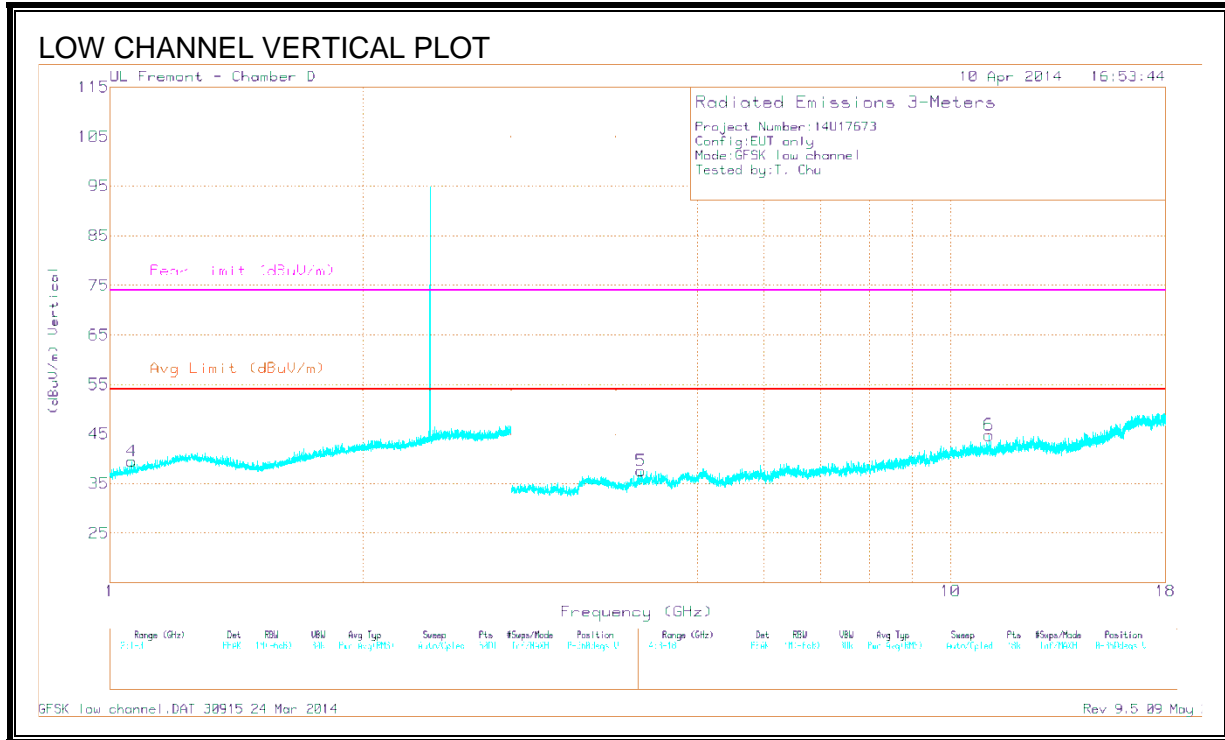
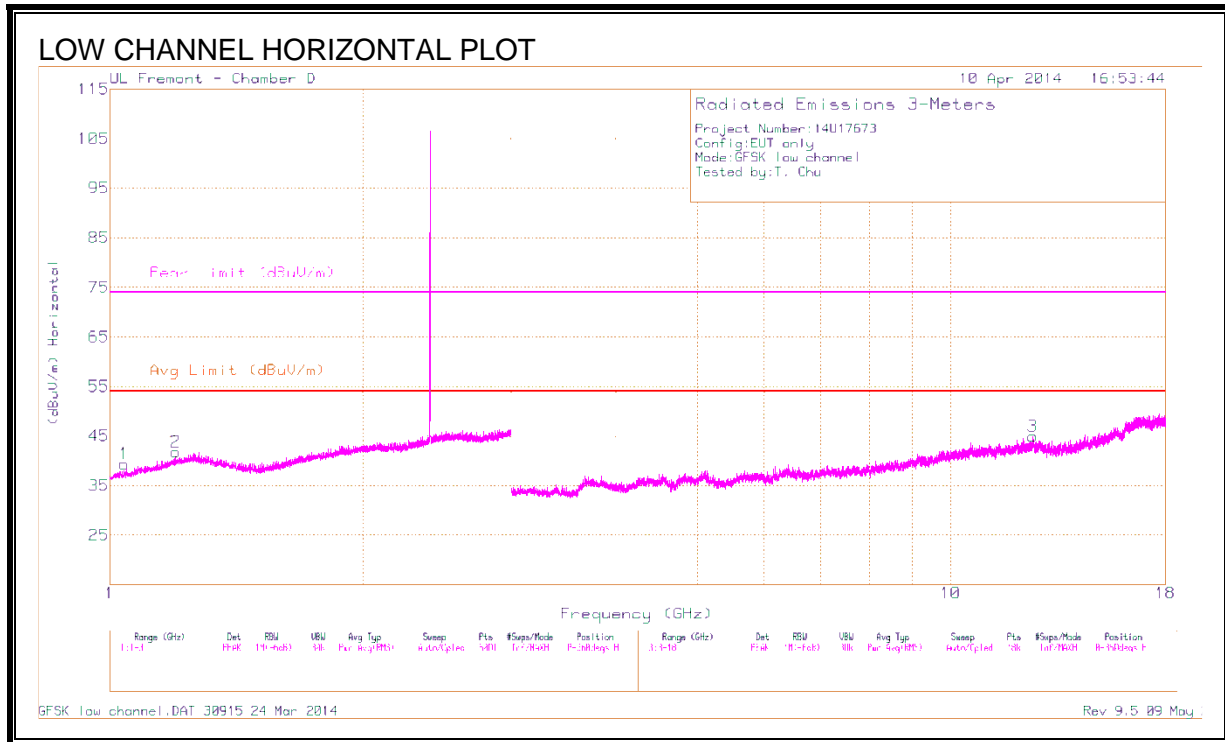


**RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)**





**LOW CHANNEL HARMONICS AND SPURIOUS EMISSIONS**



**DATA**

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fitr/ Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.041	41.86	PK3	26.7	-22.4	0	46.16	-	-	74	-27.84	182	179	H
	* 1.041	28.98	VB1T	26.6	-22.4	1.2	34.38	54	-19.62	-	-	182	179	H
2	* 1.197	41.93	PK3	28.9	-22	0	48.83	-	-	74	-25.17	182	179	H
	* 1.197	28.89	VB1T	28.9	-22	1.2	36.99	54	-17.01	-	-	182	179	H
4	* 1.06	42.17	PK3	26.9	-22.4	0	46.67	-	-	74	-27.33	229	202	V
	* 1.06	29.04	VB1T	27	-22.4	1.2	34.84	54	-19.16	-	-	229	202	V
3	* 12.52	35.08	PK3	38.5	-20.8	0	52.78	-	-	74	-21.22	262	100	H
	* 12.52	22.14	VB1T	38.5	-20.8	1.2	41.04	54	-12.96	-	-	262	100	H
5	* 4.281	38.03	PK3	33	-27.4	0	43.63	-	-	74	-30.37	262	100	V
	* 4.281	25.37	VB1T	33	-27.4	1.2	32.17	54	-21.83	-	-	262	100	V
6	* 11.096	34.45	PK3	37.5	-21	0	50.95	-	-	74	-23.05	262	100	V
	* 11.096	22.17	VB1T	37.5	-21	1.2	39.87	54	-14.13	-	-	262	100	V

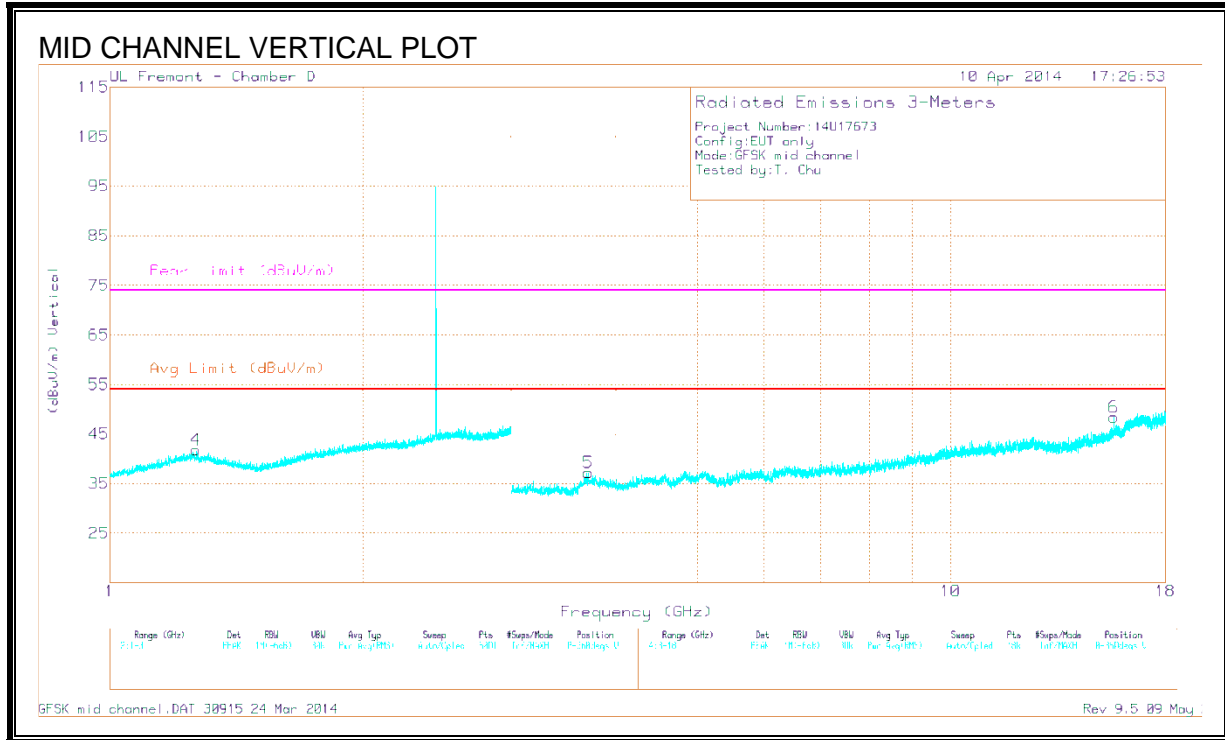
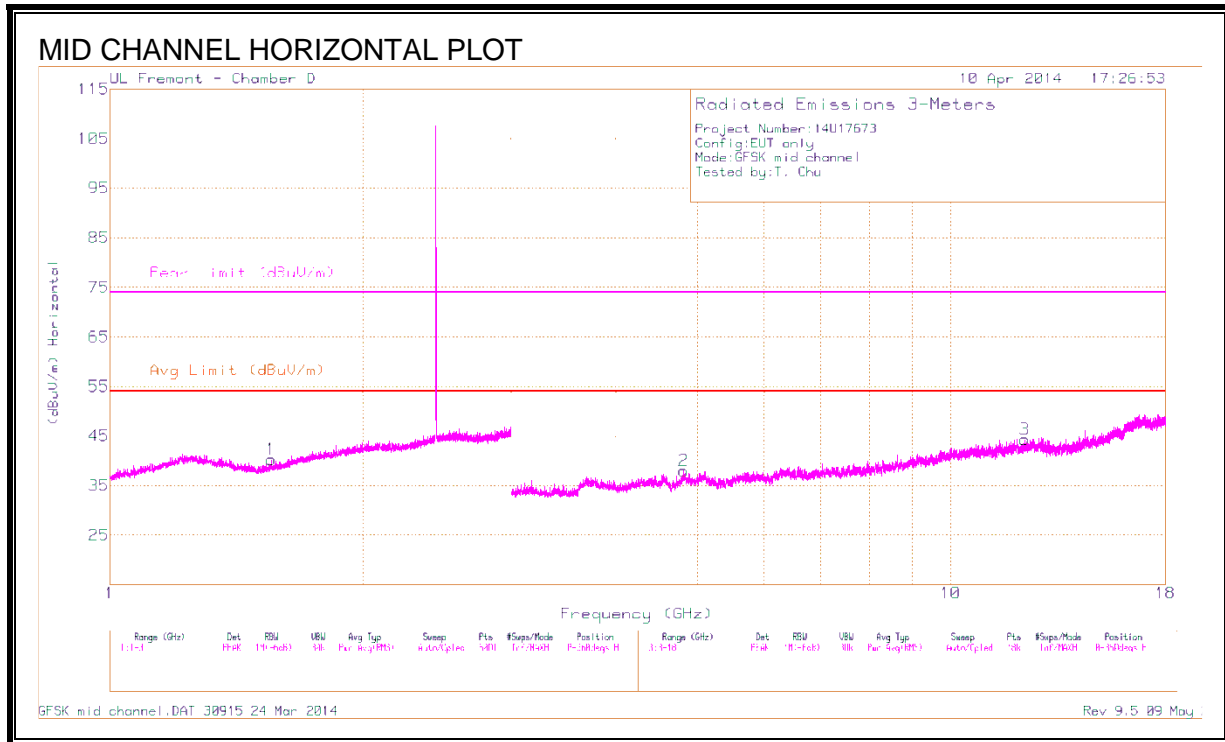
\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

FCC Part15 Subpart C 2400MHz Spurious Emissions with Average Scan.TST 30915 24 Mar 2014

Rev 9.5 31 Mar 2014

**MID CHANNEL HARMONICS AND SPURIOUS EMISSIONS**



**DATA**

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.555	41.26	PK3	27.5	-21.6	0	47.16	-	-	74	-26.84	262	100	H
	* 1.554	28.59	VB1T	27.4	-21.6	1.2	35.59	54	-18.41	-	-	262	100	H
4	* 1.267	41.74	PK3	29.4	-22	0	49.14	-	-	74	-24.86	262	146	V
	* 1.268	28.88	VB1T	29.4	-22.1	1.2	37.38	54	-16.62	-	-	262	146	V
2	* 4.816	38.07	PK3	33.5	-26.8	0	44.77	-	-	74	-29.23	299	100	H
	* 4.814	24.95	VB1T	33.5	-26.8	1.2	32.85	54	-21.15	-	-	299	100	H
3	* 12.238	34.67	PK3	38.4	-21.6	0	51.47	-	-	74	-22.53	299	100	H
	* 12.238	21.94	VB1T	38.4	-21.6	1.2	39.94	54	-14.06	-	-	299	100	H
5	* 3.709	38.78	PK3	32.6	-27.9	0	43.48	-	-	74	-30.52	272	202	V
	* 3.711	25.71	VB1T	32.6	-28	1.2	31.51	54	-22.49	-	-	272	202	V
6	* 15.623	35.05	PK3	39.9	-20.5	0	54.45	-	-	74	-19.55	215	202	V
	* 15.624	22.44	VB1T	39.9	-20.5	1.2	43.04	54	-10.96	-	-	215	202	V

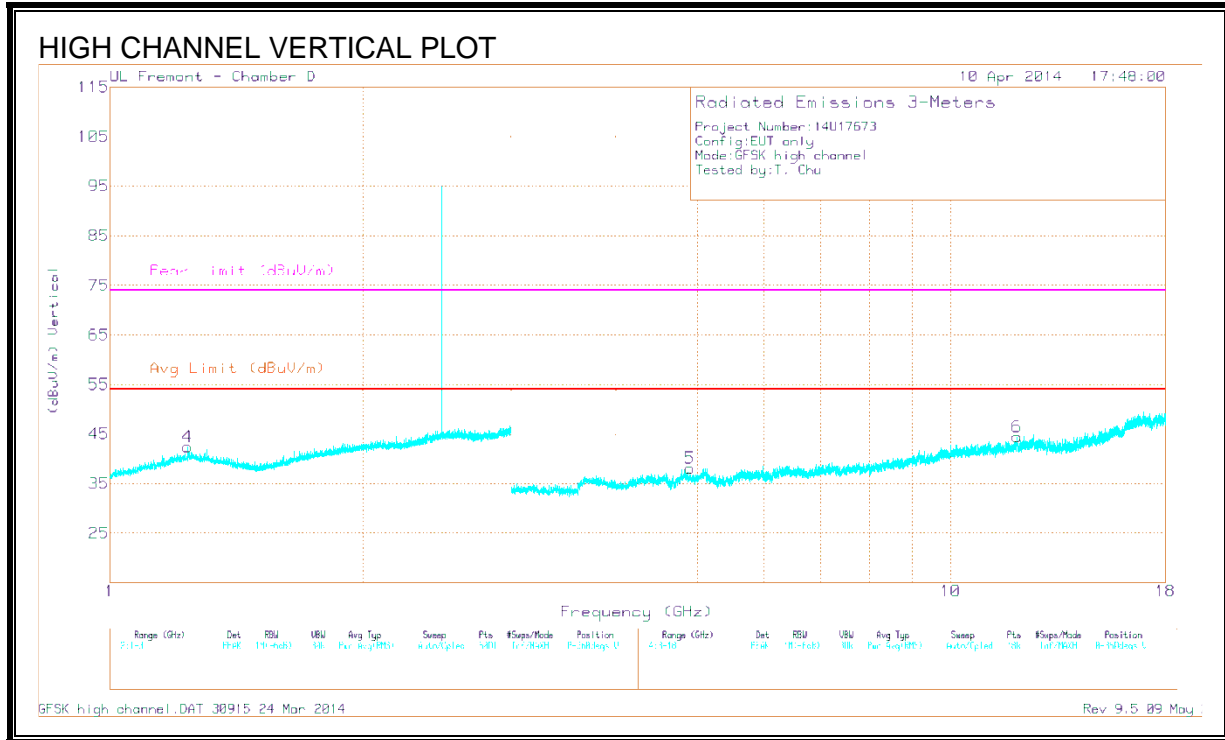
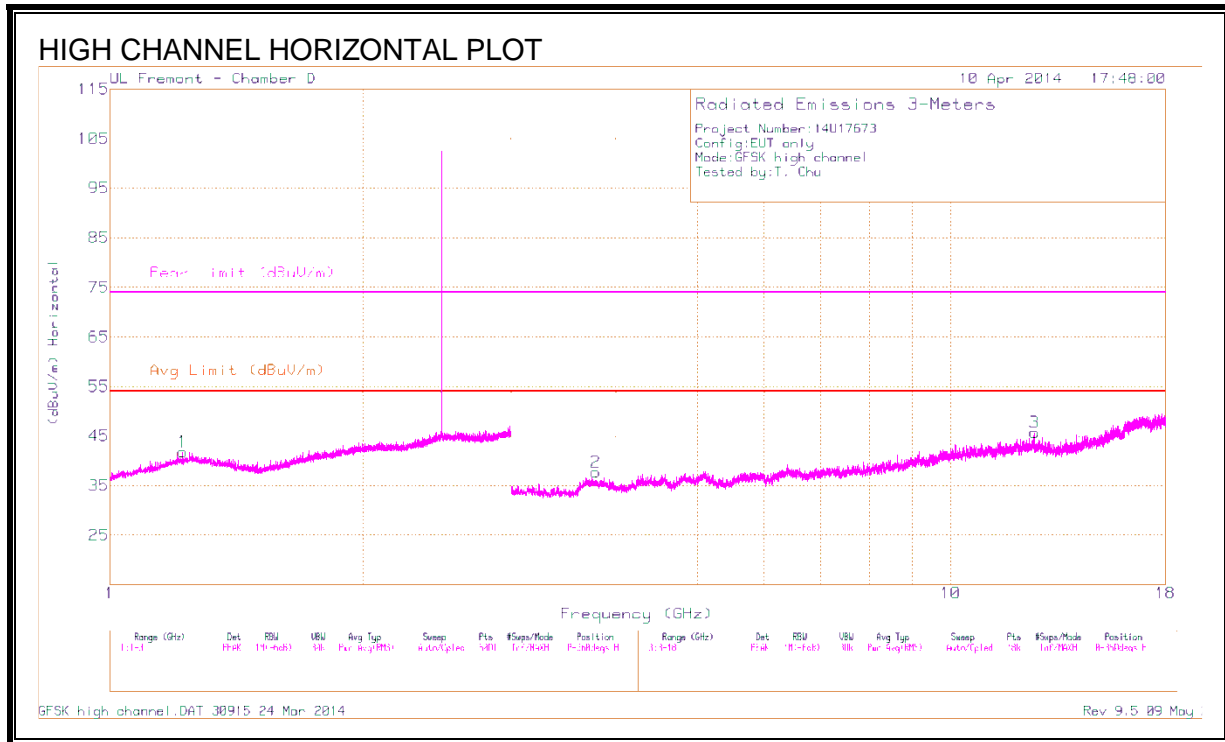
\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

FCC Part15 Subpart C 2400MHz Spurious Emissions with Average Scan.TST 30915 24 Mar 2014

Rev 9.5 31 Mar 2014

**HIGH CHANNEL HARMONICS AND SPURIOUS EMISSIONS**



**DATA**

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cb/Fitr /Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.219	42.11	PK3	29.2	-22	0	49.31	-	-	74	-24.69	215	202	H
	* 1.221	28.88	VB1T	29.2	-22	1.2	37.28	54	-16.72	-	-	215	202	H
4	* 1.235	42.35	PK3	29.4	-22	0	49.75	-	-	74	-24.25	215	172	V
	* 1.236	28.86	VB1T	29.4	-22	1.2	37.46	54	-16.54	-	-	215	172	V
2	* 3.782	39.23	PK3	32.7	-28.6	0	43.33	-	-	74	-30.67	215	172	H
	* 3.783	26.56	VB1T	32.7	-28.6	1.2	31.86	54	-22.14	-	-	215	172	H
3	* 12.579	34.71	PK3	38.6	-21.7	0	51.61	-	-	74	-22.39	215	156	H
	* 12.578	21.97	VB1T	38.6	-21.7	1.2	40.07	54	-13.93	-	-	215	156	H
5	* 4.895	37.19	PK3	33.5	-27.3	0	43.39	-	-	74	-30.61	23	115	V
	* 4.897	25.12	VB1T	33.5	-27.4	1.2	32.42	54	-21.58	-	-	23	115	V
6	* 11.998	34.41	PK3	38.2	-20.7	0	51.91	-	-	74	-22.09	133	122	V
	* 11.995	22.06	VB1T	38.2	-20.7	1.2	40.76	54	-13.24	-	-	133	122	V

\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

FCC Part15 Subpart C 2400MHz Spurious Emissions with Average Scan. TST 30915 24 Mar 2014

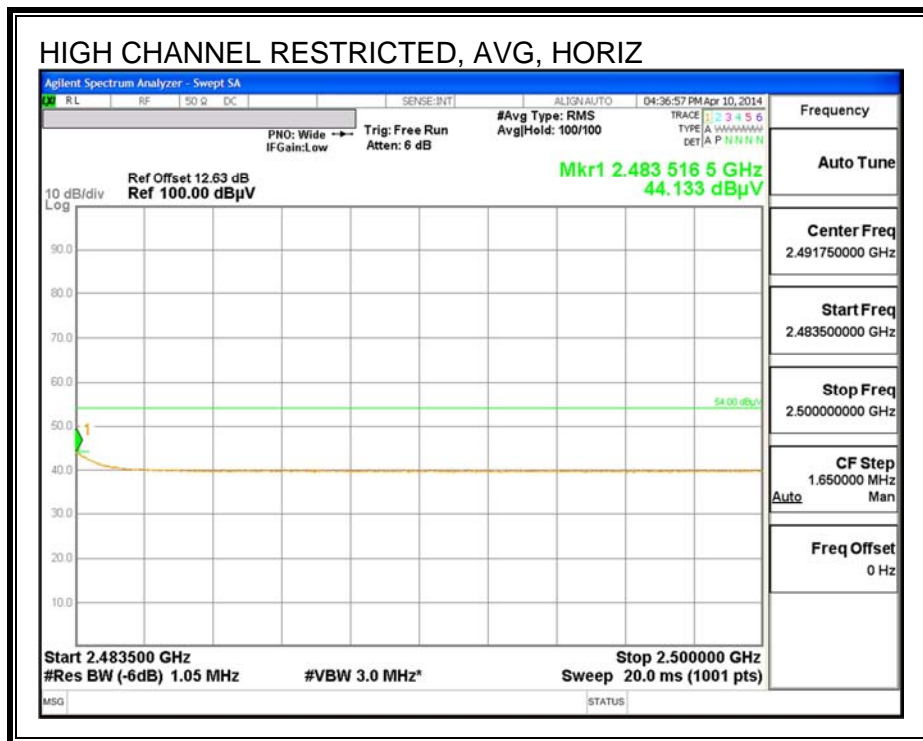
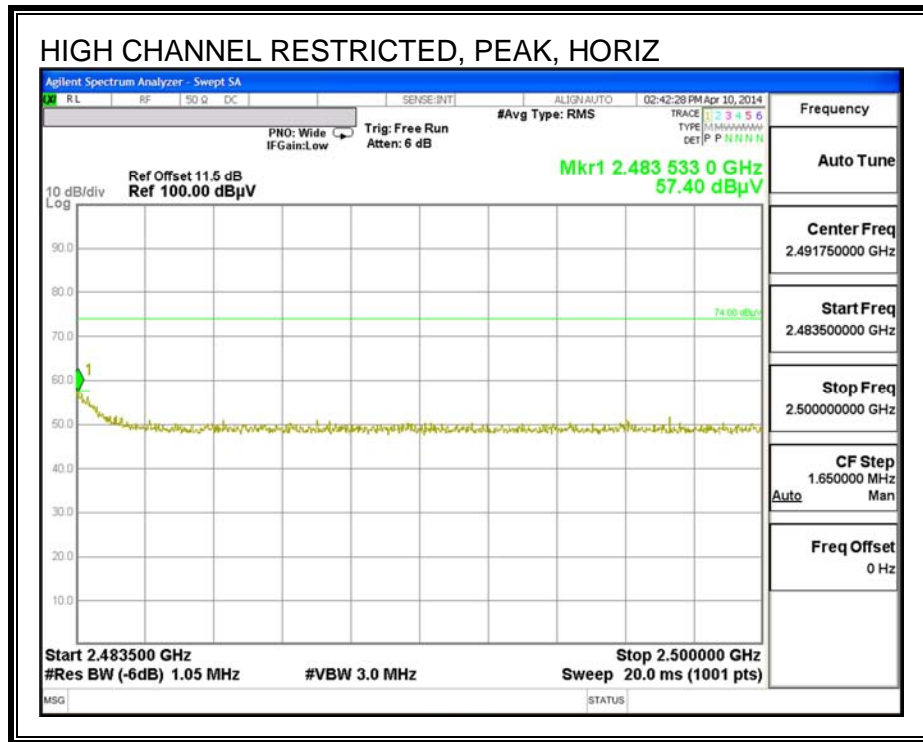
Rev 9.5 31 Mar 2014



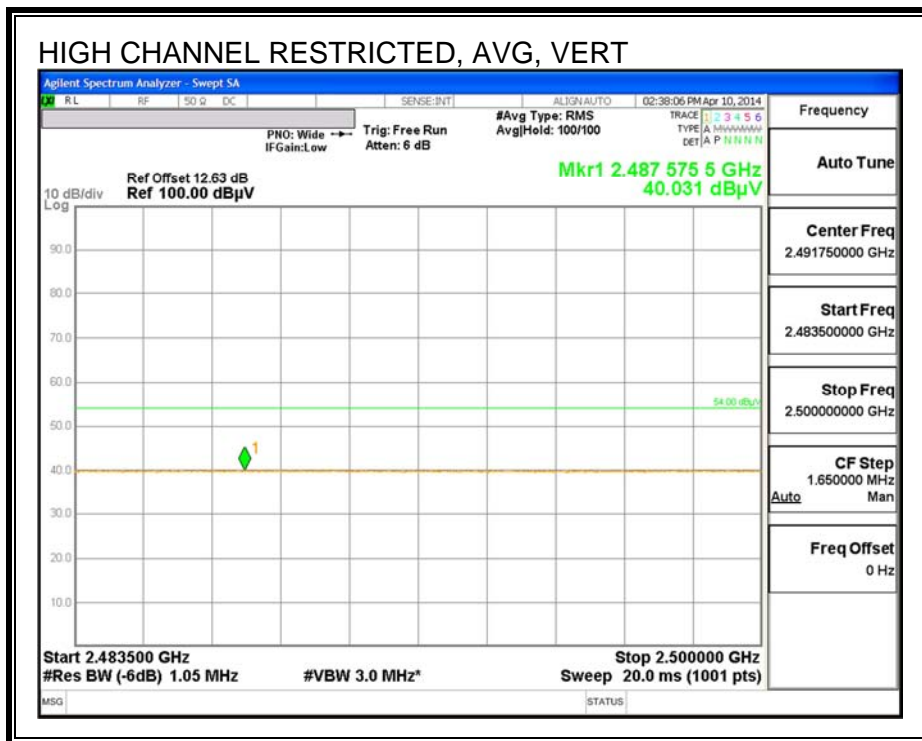
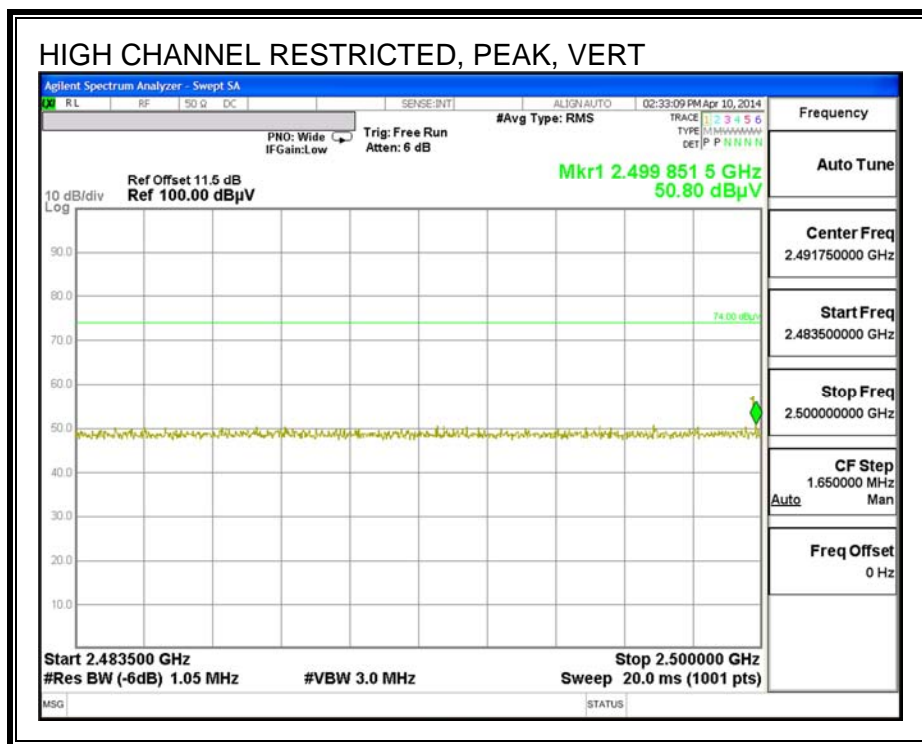




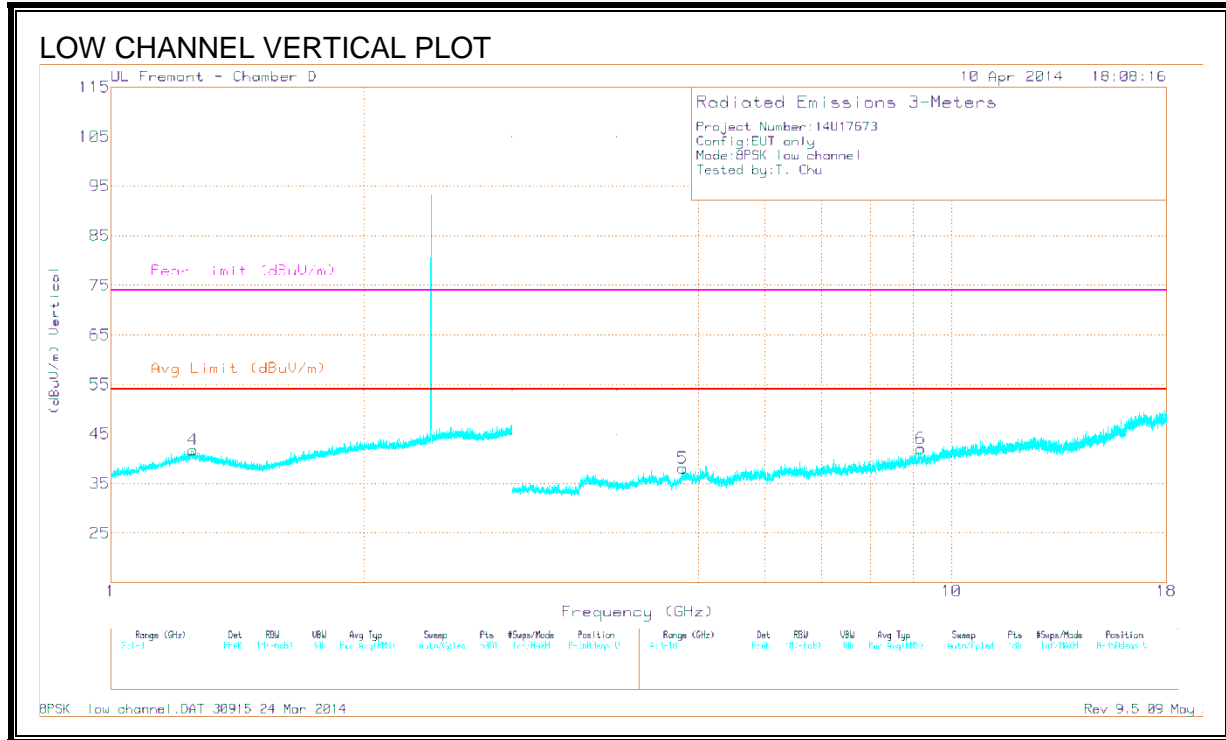
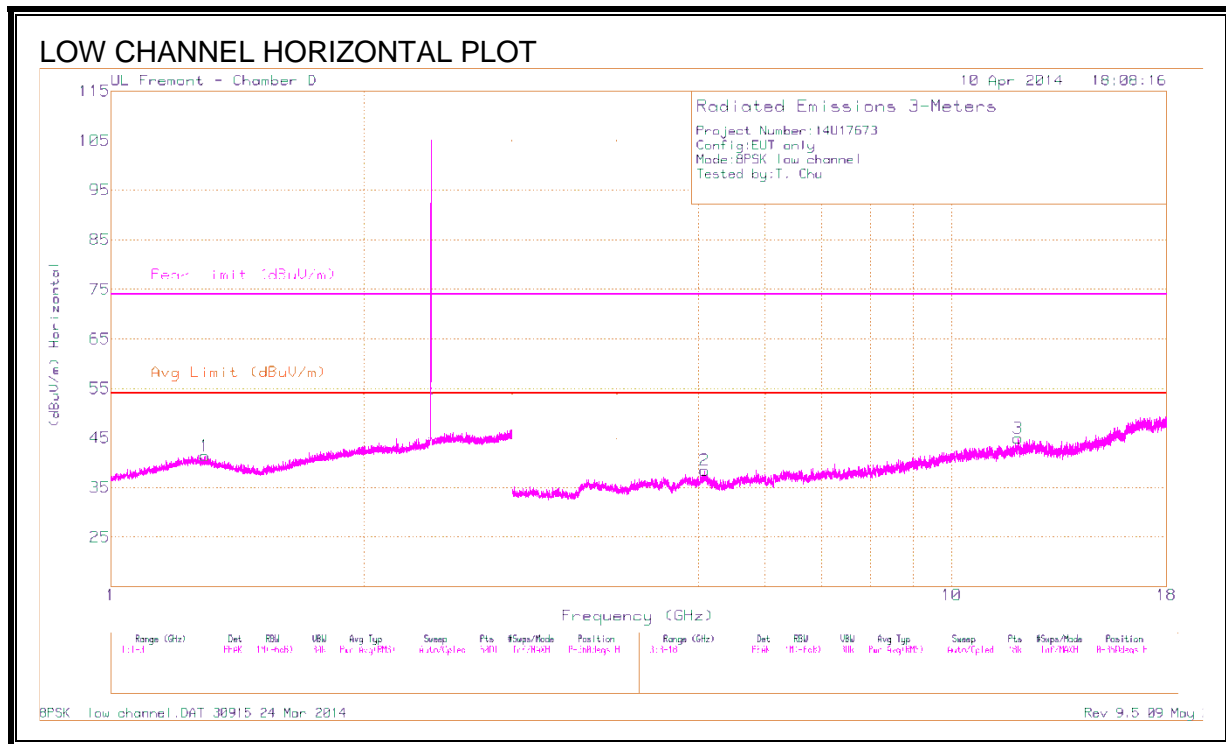
**RESTRICTED BANDEGE (HIGH CHANNEL, HORIZONTAL)**



**RESTRICTED BANDEGE (HIGH CHANNEL, VERTICAL)**



**LOW CHANNEL HARMONICS AND SPURIOUS EMISSIONS**



**DATA**

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Filtr/ Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.297	41.45	PK3	29.1	-22	0	48.55	-	-	74	-25.45	133	122	H
	* 1.297	28.9	VB1T	29.1	-22	1.1	37.1	54	-16.9	-	-	133	122	H
4	* 1.252	42.07	PK3	29.6	-22.1	0	49.57	-	-	74	-24.43	154	139	V
	* 1.25	28.92	VB1T	29.6	-22.1	1.1	37.52	54	-16.48	-	-	154	139	V
2	* 5.089	37.58	PK3	33.6	-25.9	0	45.28	-	-	74	-28.72	206	231	H
	* 5.087	25.15	VB1T	33.6	-26	1.1	33.85	54	-20.15	-	-	206	231	H
3	* 11.994	34.67	PK3	38.2	-20.7	0	52.17	-	-	74	-21.83	206	111	H
	* 11.994	22.12	VB1T	38.2	-20.7	1.1	40.72	54	-13.28	-	-	206	111	H
5	* 4.786	38.84	PK3	33.5	-27.5	0	44.84	-	-	74	-29.16	191	111	V
	* 4.787	25.86	VB1T	33.5	-27.4	1.1	33.06	54	-20.94	-	-	191	111	V
6	* 9.184	34.13	PK3	35.9	-21.2	0	48.83	-	-	74	-25.17	191	111	V
	* 9.18	22.03	VB1T	35.9	-21.3	1.1	37.73	54	-16.27	-	-	191	111	V

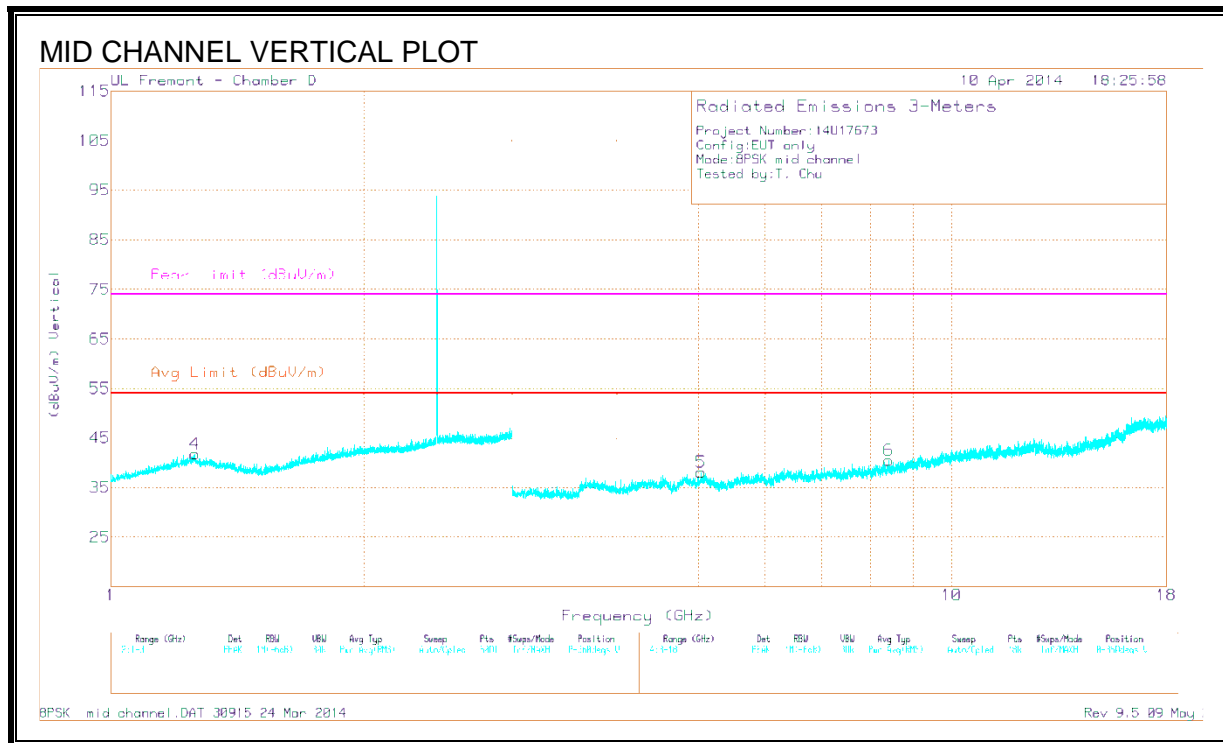
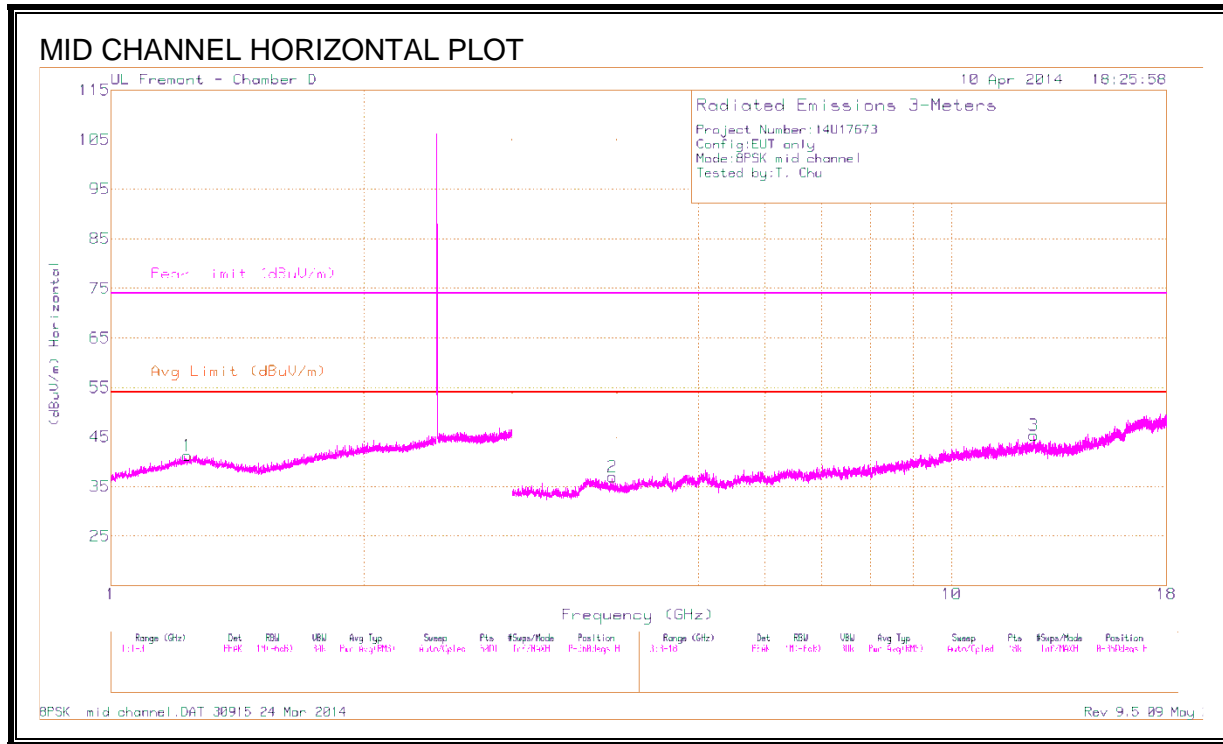
\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

8PSK low channel.DAT 30915 24 Mar 2014

Rev 9.5 31 Mar 2014

**MID CHANNEL HARMONICS AND SPURIOUS EMISSIONS**



**DATA**

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.23	41.51	PK3	29.3	-22	0	48.81	-	-	74	-25.19	191	111	H
	* 1.23	28.9	VB1T	29.3	-22	1.1	37.3	54	-16.7	-	-	191	111	H
4	* 1.261	41.77	PK3	29.5	-22	0	49.27	-	-	74	-24.73	191	122	V
	* 1.261	28.94	VB1T	29.5	-22	1.1	37.54	54	-16.46	-	-	191	122	V
2	* 3.953	39.17	PK3	32.9	-28.2	0	43.87	-	-	74	-30.13	211	143	H
	* 3.951	26.16	VB1T	32.9	-28.2	1.1	31.96	54	-22.04	-	-	211	143	H
3	* 12.525	34.53	PK3	38.5	-20.8	0	52.23	-	-	74	-21.77	155	114	H
	* 12.525	22.18	VB1T	38.5	-20.8	1.1	40.98	54	-13.02	-	-	155	114	H
5	* 5.029	38.35	PK3	33.5	-27.3	0	44.55	-	-	74	-29.45	209	183	V
	* 5.029	25.71	VB1T	33.5	-27.2	1.1	33.11	54	-20.89	-	-	209	183	V
6	* 8.415	35.6	PK3	35.4	-23.6	0	47.4	-	-	74	-26.6	209	183	V
	* 8.415	23.28	VB1T	35.4	-23.6	1.1	36.18	54	-17.82	-	-	209	183	V

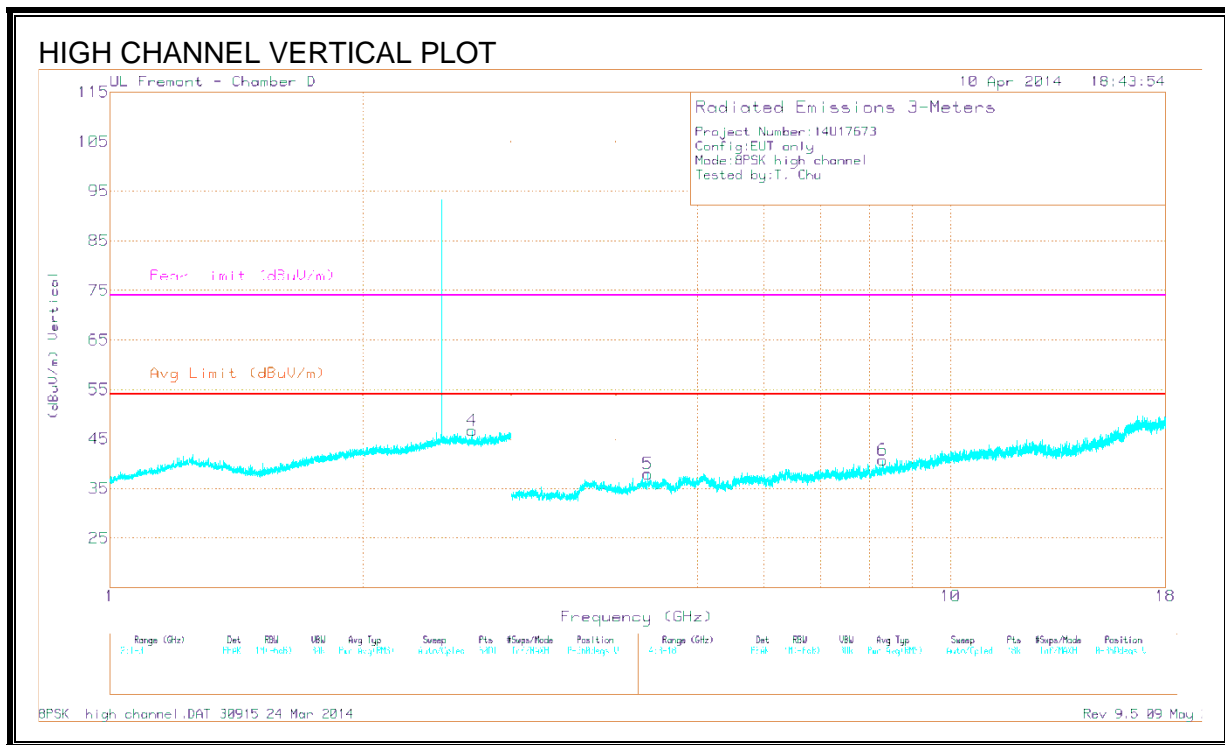
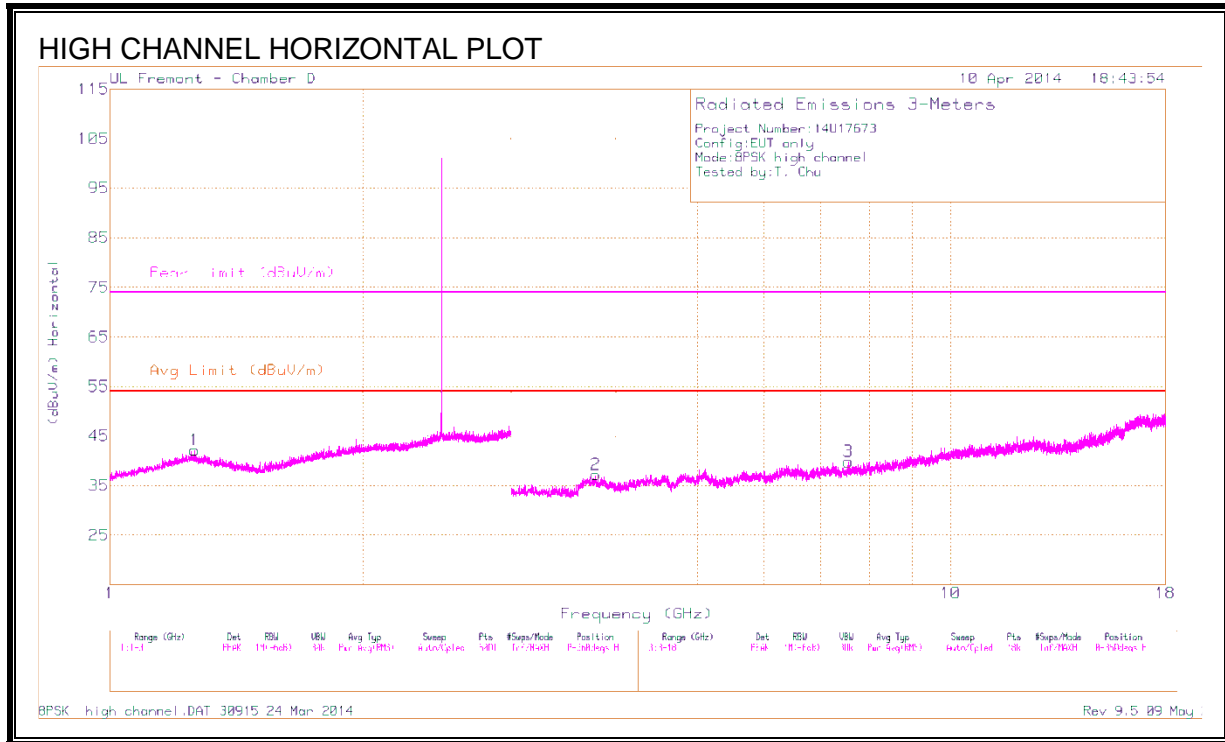
\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

FCC Part15 Subpart C 2400MHz Spurious Emissions with Average Scan.TST 30915 24 Mar 2014

Rev 9.5 31 Mar 2014

**HIGH CHANNEL HARMONICS AND SPURIOUS EMISSIONS**



**DATA**

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cb/Ftr /Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.262	41.78	PK3	29.5	-22	0	49.28	-	-	74	-24.72	219	141	H
	* 1.262	28.91	VB1T	29.5	-22	1.1	37.51	54	-16.49	-	-	219	141	H
4	* 2.695	41.47	PK3	31.7	-20.1	0	53.07	-	-	74	-20.93	225	151	V
	* 2.695	28.76	VB1T	31.7	-20.1	1.1	41.46	54	-12.54	-	-	225	151	V
2	* 3.784	40.11	PK3	32.7	-28.6	0	44.21	-	-	74	-29.79	225	174	H
	* 3.784	26.52	VB1T	32.7	-28.6	1.1	31.72	54	-22.28	-	-	225	174	H
3	* 7.55	37.05	PK3	35.2	-25	0	47.25	-	-	74	-26.75	205	150	H
	* 7.55	24.24	VB1T	35.2	-25.1	1.1	35.44	54	-18.56	-	-	205	150	H
5	* 4.362	37.87	PK3	33.2	-27.8	0	43.27	-	-	74	-30.73	166	166	V
	* 4.362	25.69	VB1T	33.2	-27.9	1.1	32.09	54	-21.91	-	-	166	166	V
6	* 8.303	35.04	PK3	35.3	-23.6	0	46.74	-	-	74	-27.26	166	155	V
	* 8.303	23.23	VB1T	35.3	-23.7	1.1	35.93	54	-18.07	-	-	166	155	V

\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

FCC Part15 Subpart C 2400MHz Spurious Emissions with Average Scan.TST 30915 24 Mar 2014

Rev 9.5 31 Mar 2014



### 10.3. WORST-CASE ABOVE 18 GHz

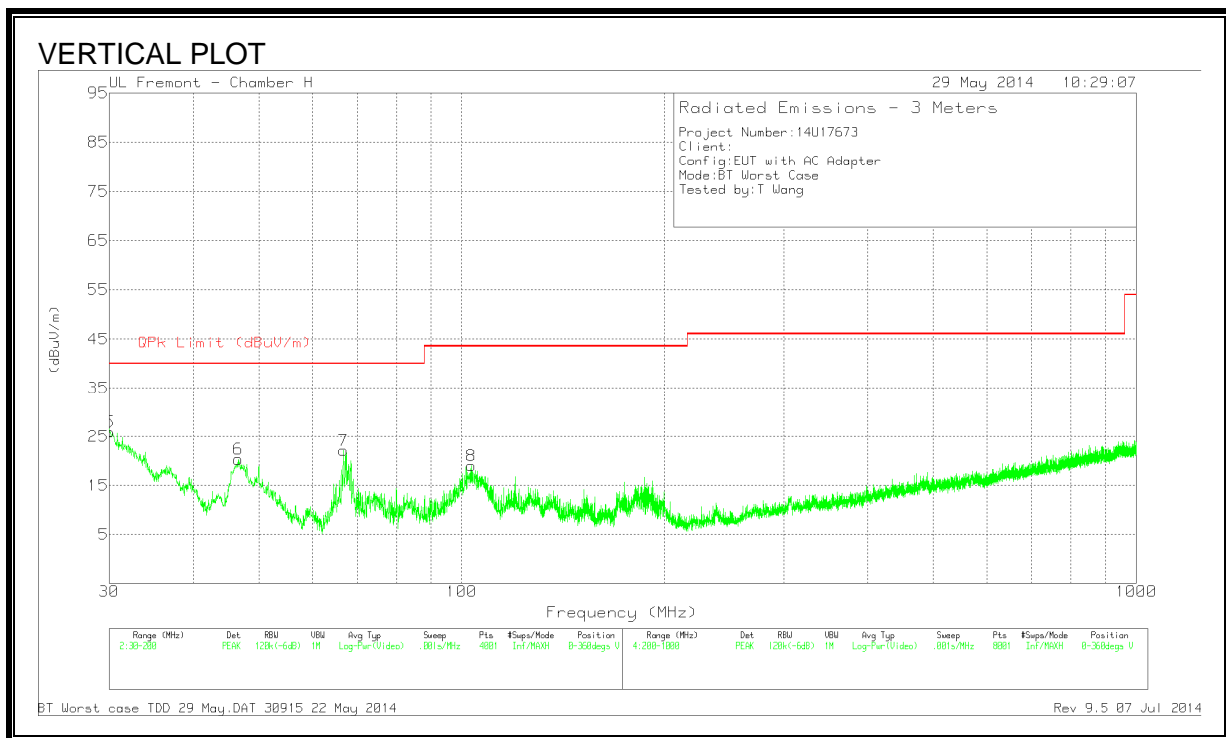
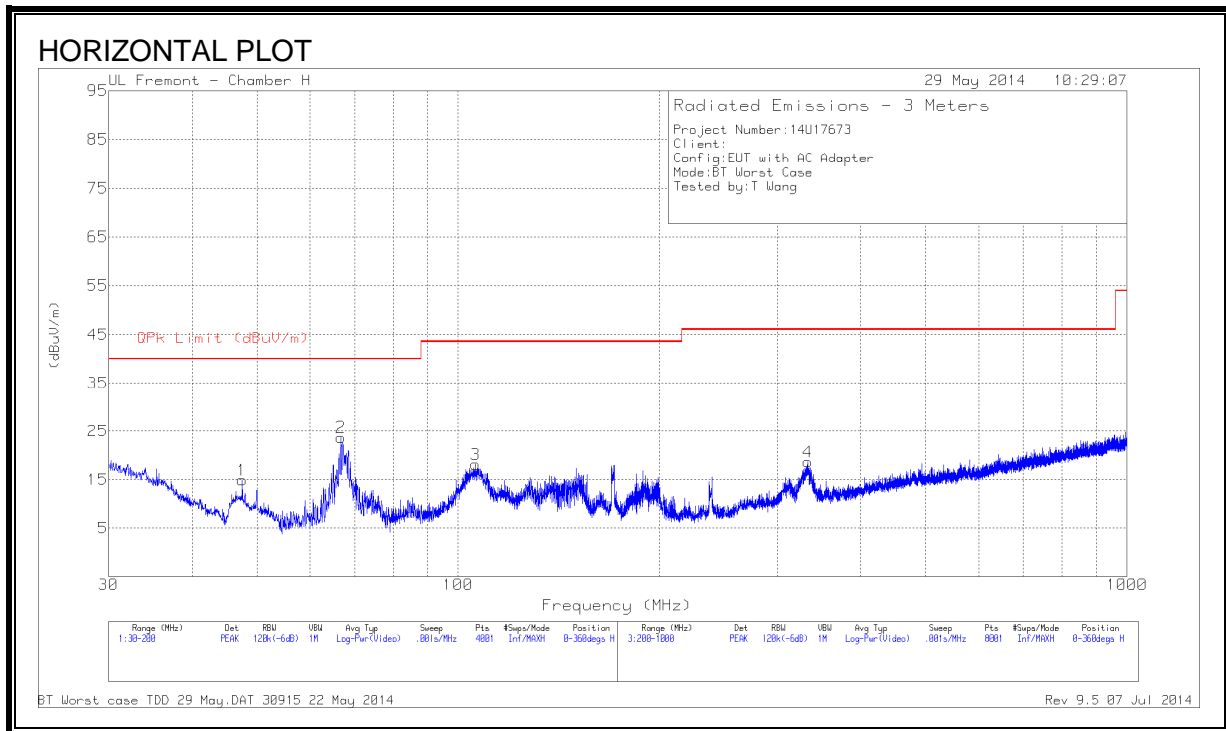
#### SPURIOUS EMISSIONS 18 TO 26 GHz (WORST-CASE CONFIGURATION, HORIZONTAL & VERTICAL)



Note: GFSK, highest power mode used for test.

### 10.4. WORST-CASE BELOW 1 GHz

#### SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



**DATA**

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Hybrid	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	* 333.4	34.77	PK	14	-30.1	18.67	46.02	-27.35	0-360	100	H
5	30.085	36.33	PK	21.4	-31.8	25.93	40	-14.07	0-360	100	V
6	46.66	42.55	PK	9.5	-31.7	20.35	40	-19.65	0-360	100	V
1	47.5525	37.49	PK	9	-31.6	14.89	40	-25.11	0-360	201	H
2	66.7625	47.18	PK	8.1	-31.6	23.68	40	-16.32	0-360	201	H
7	66.7625	45.62	PK	8.1	-31.6	22.12	40	-17.88	0-360	100	V
8	103.2275	39.22	PK	11.1	-31.3	19.02	43.52	-24.5	0-360	100	V
3	106.16	37.62	PK	11.8	-31.3	18.12	43.52	-25.4	0-360	301	H

\* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band

PK - Peak detector

FCC Part 15 Subpart C 30-1000MHz.TST 30915 18 Jan 2014

Rev 9.5 18 Apr 2014

Note: GFSK, highest power mode used for test.

## 11. AC POWER LINE CONDUCTED EMISSIONS

### LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

\*Decreases with the logarithm of the frequency.

### TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

### RESULTS

**6 WORST EMISSIONS**

Line-L1 .15 - 30MHz

**Trace Markers**

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L1 (dB)	LC Cables 1&3 (dB)	Corrected Reading dBuV	CISPR 22 Class B QP	Margin to Limit (dB)	CISPR 22 Class B Avg	Margin to Limit (dB)
1	.1725	49.47	PK	1.2	0	50.67	64.8	-14.13	-	-
2	.1725	29.62	Av	1.2	0	30.82	-	-	54.8	-23.98
3	.7845	44.42	PK	.3	0	44.72	56	-11.28	-	-
4	.7845	31.84	Av	.3	0	32.14	-	-	46	-13.86
5	17.439	41.59	PK	.3	.2	42.09	60	-17.91	-	-
6	17.439	27.51	Av	.3	.2	28.01	-	-	50	-21.99

Line-L2 .15 - 30MHz

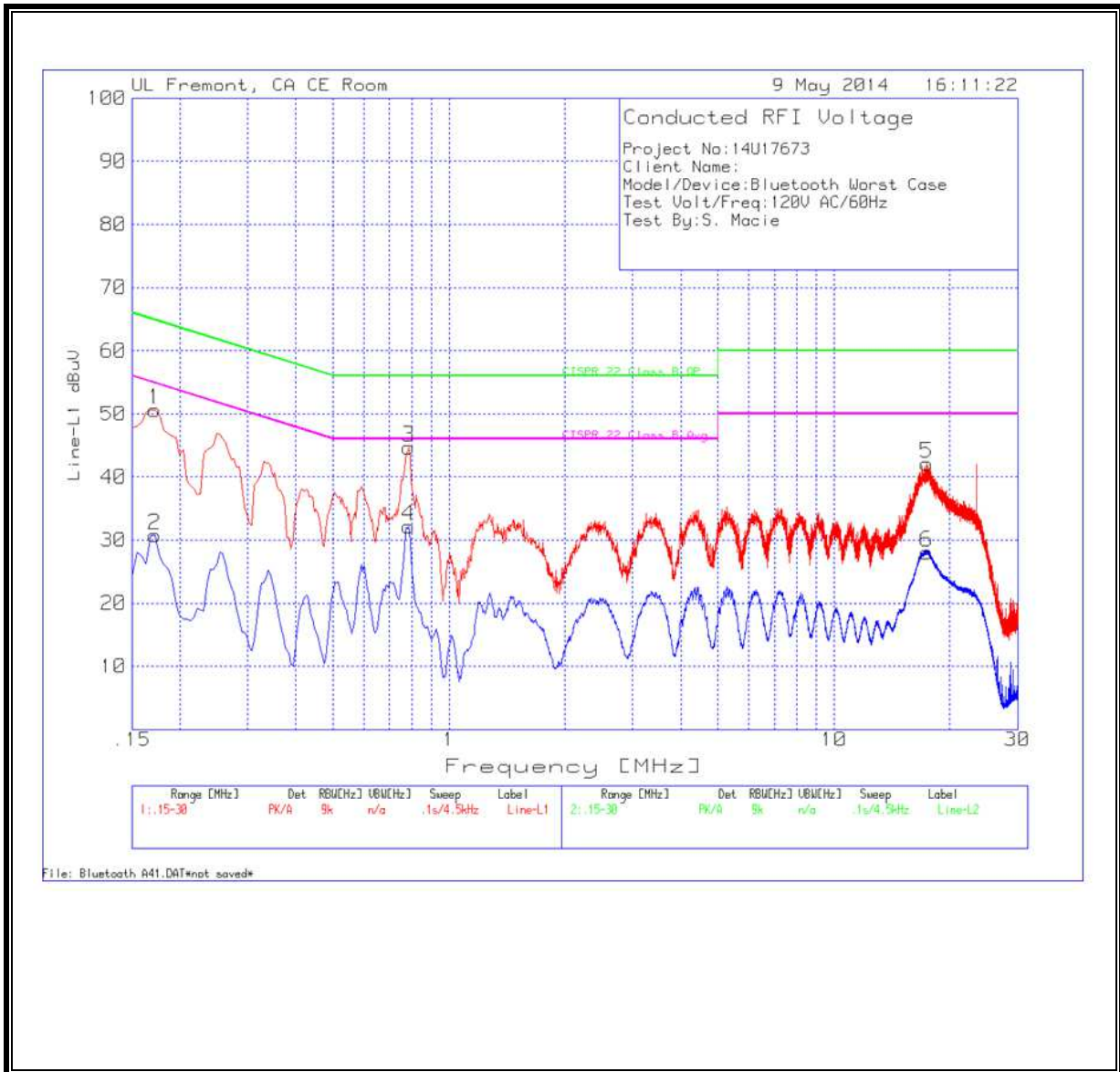
**Trace Markers**

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L2 (dB)	LC Cables 2&3 (dB)	Corrected Reading dBuV	CISPR 22 Class B QP	Margin to Limit (dB)	CISPR 22 Class B Avg	Margin to Limit (dB)
7	.1635	47.92	PK	1.3	0	49.22	65.3	-16.08	-	-
8	.1635	23.96	Av	1.3	0	25.26	-	-	55.3	-30.04
9	.78	44.18	PK	.3	0	44.48	56	-11.52	-	-
10	.78	27.19	Av	.3	0	27.49	-	-	46	-18.51
11	17.664	40.17	PK	.3	.2	40.67	60	-19.33	-	-
12	17.664	22.32	Av	.3	.2	22.82	-	-	50	-27.18

PK - Peak detector

Av - average detection

**LINE 1 RESULTS**



**LINE 2 RESULTS**

