



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

CERTIFICATION TEST REPORT

FOR

PORTABLE COMPUTER

MODEL NUMBER: A1534

FCC ID: BCGA1534

IC: 579C-A1534

REPORT NUMBER: 14U18574-E1, VERSION B

ISSUE DATE: FEBRUARY 11, 2015

Prepared for

APPLE, INC.

1 INFINITE LOOP

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Prepared by

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	01/23/15	Initial Issue	F. DeAnda
B	02/11/15	Revised report to address TCB's questions	T. Chu

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: PORTABLE COMPUTER

MODEL: A1534

SERIAL NUMBER: C02N900CFYFG (Conducted), C02N900LG17D (RADIATED)

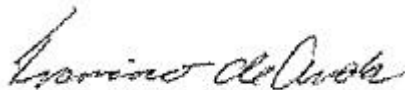
DATE TESTED: 09/25/2014 - 10/01/2014

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 4	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:



NANCY GARCIA
EMC ENGINEER
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 4, 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
☐ Chamber A	☒ Chamber D
☐ Chamber B	☐ Chamber E
☐ Chamber C	☒ Chamber F
	☐ Chamber G
	☐ 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	± 3.52 dB
Radiated Disturbance, 30 to 1000 MHz	± 4.94 dB
Radiated Disturbance, 1 to 6 GHz	± 3.86 dB
Radiated Disturbance, 6 to 18 GHz	± 4.23 dB
Radiated Disturbance, 18 to 26 GHz	± 5.30 dB
Radiated Disturbance, 26 to 40 GHz	± 5.23 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a Laptop Device with Bluetooth and WLAN Radios (AC 80 MHZ Beam-Forming)

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	11.74	14.93
2402 - 2480	Enhanced 8PSK	11.89	15.47

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an inverted-F Antenna (IFA), with a maximum gain of 2.24 dBi.

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 4.30f9.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emission, 30-1000MHz and 18-26GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

All testing was performed with the EUT in normal use orientation as described by the manufacturer.

Worst-case data rates were:

GFSK mode: DH5
8PSK mode: 3-DH5

DQPSK mode has been verified to have the lowest power.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
AC/ DC Adapter	Apple Inc.	A1540	C4H433700AZFPWW1E	N/A
Earphone	Apple Inc.	N/A	N/A	N/A

I/O CABLES (CONDUCTED TEST)

Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	2	SMA	Un-Shielded	0.2	To Spectrum Analyzer
2	DC	1	Lightning	Un-Shielded	2	

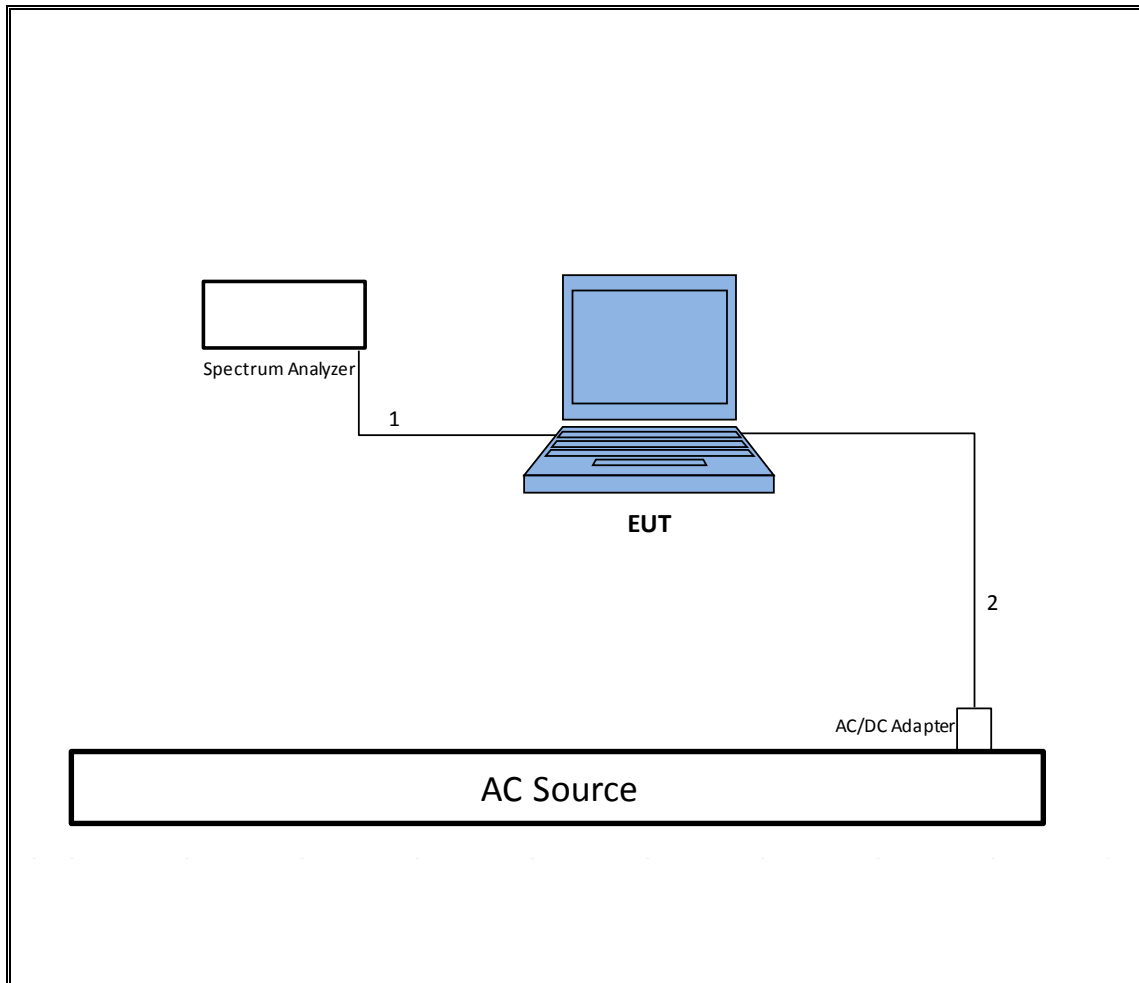
I/O CABLES (RADIATED AND AC POWER CONDUCTED TEST)

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

TEST SETUP- CONDUCTED PORT

The EUT was tested connected to spectrum analyzer via antenna port. Test software exercised the EUT.

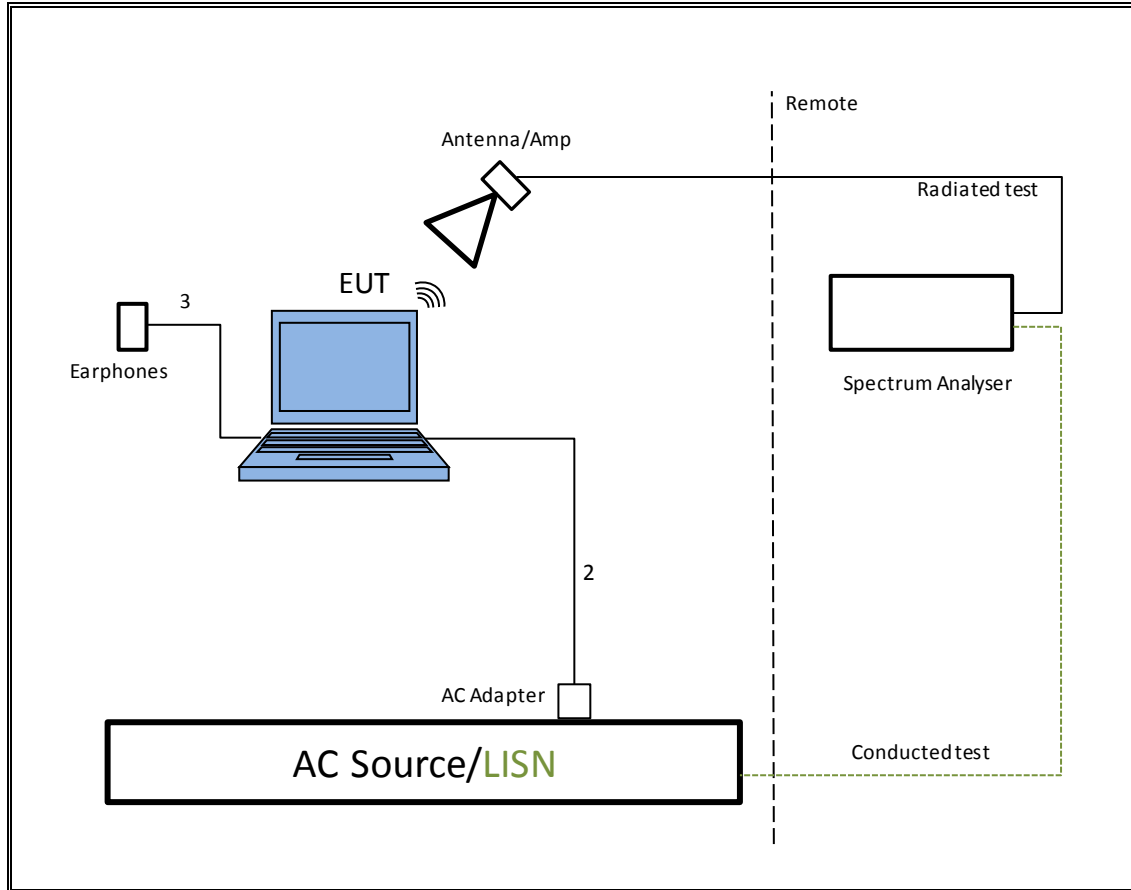
SETUP DIAGRAM



TEST SETUP- RADIATED BELOW 1 GHz & AC LINE CONDUCTED TESTS

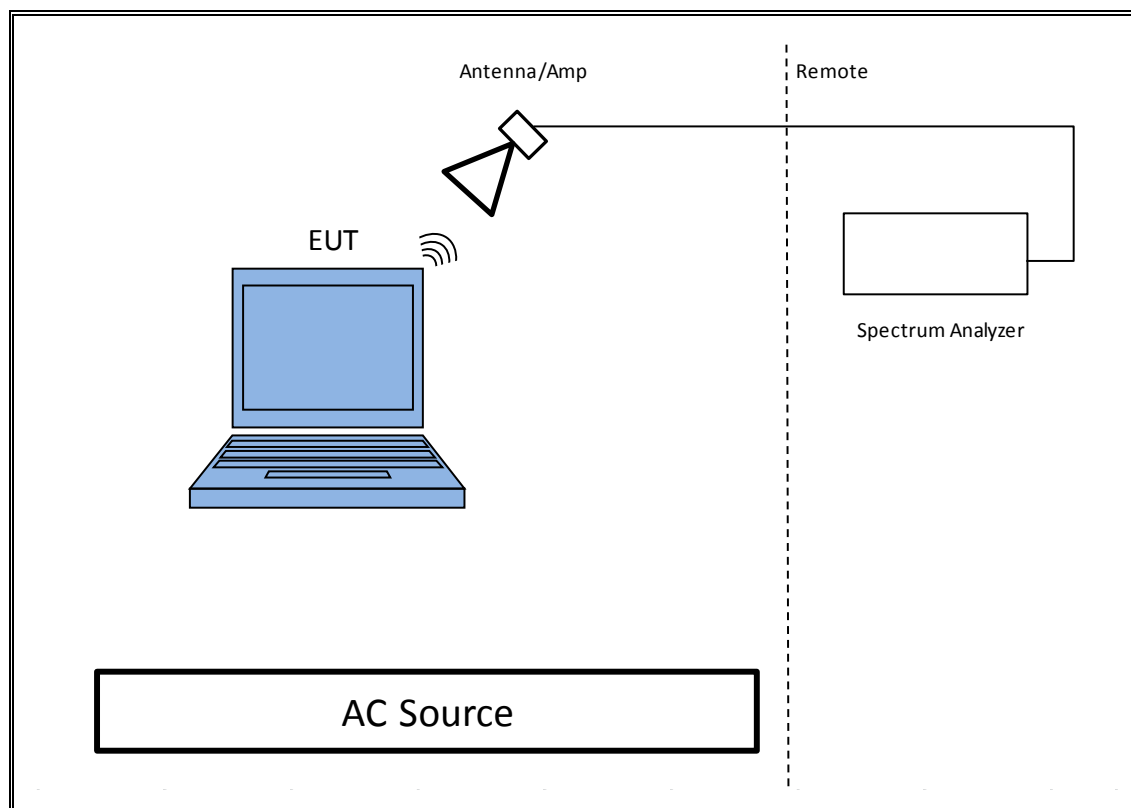
The EUT's test software exercised the radio card.

SETUP DIAGRAM



TEST SETUP- RADIATED ABOVE 1 GHz

The EUT's test software exercised the radio card.



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	T Number	Cal Due
PXA Signal Analyzer	Agilent	N9030A	T342	06/25/15
Power Meter	Agilent	N1911A	T382	04/09/15
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T344	02/18/15
Antenna, Hybrid 30MHz to 2GHz	Sunol Sciences	JB3	T407	05/05/15
PXA Signal Analyzer 3Hz to 44GHz	Agilent	N9030A	T340	03/11/15
Amplifier, 10KHz to 1GHz	Sonoma	310N	T286	04/23/15
Amplifier, 1 to 18GHz	Miteq	AFS42-00101	T740	01/11/15
PXA Signal Analyzer 3Hz to 44GHz	Agilent	N9030A	T341	02/12/15
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T120	03/20/15
Antenna, Hybrid 30MHz to 2GHz	Sunol Sciences	JB1	T122	04/22/15
Amplifier, 1 to 18GHz	Miteq	AFS42-00101	T742	01/20/15
Amplifier, 10KHz to 1GHz	Sonoma	310N	T173	12/30/14
EMI Test Receiver, 9 kHz-7 GHz	R & S	ESCI 7	T284	09/16/15
LISN, 30 MHz	FCC	LISN-50/250-25	T24	01/17/15
Amplifier, 1 to 26.5 Ghz	Agilent	8449B	T404	03/25/15
Antenna Horn 18 to 26.5 Ghz	ARA	MWH-1826/B	T89	11/26/14
Spectrum Analyzer	Agilent	8564E	T106	08/06/15

7. ON TIME AND DUTY CYCLE

LIMITS

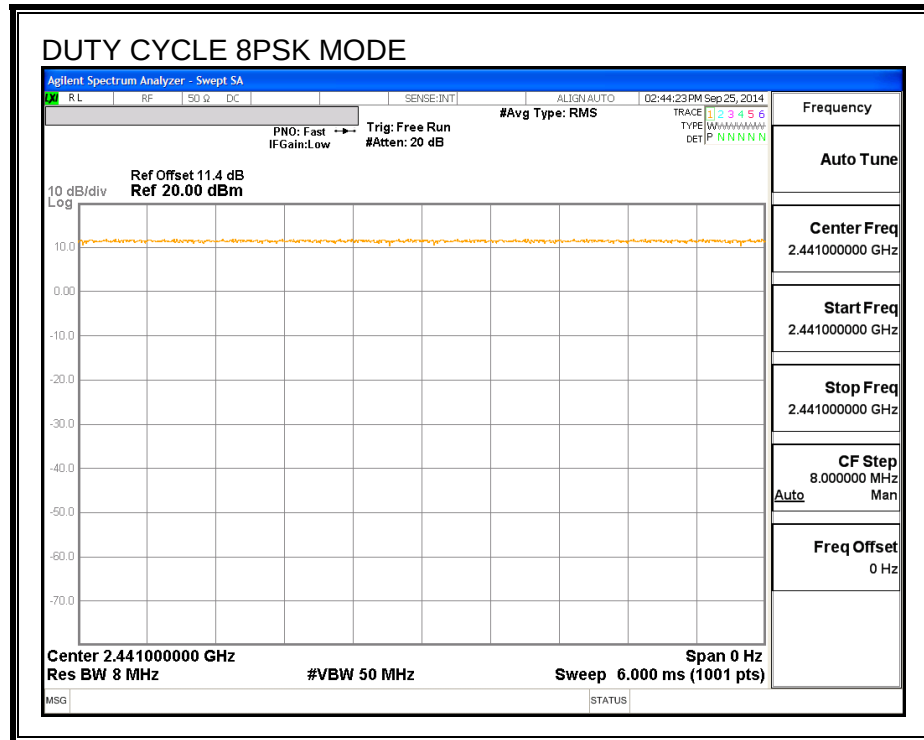
None; for reporting purposes only.

PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

7.1. 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)
2.4 GHz band (Hopping OFF)						
Bluetooth GFSK	1.000	1.000	1.000	100.00%	0.00	0.010
Bluetooth 8PSK	1.000	1.000	1.000	100.00%	0.00	0.010



8. ANTENNA PORT TEST RESULTS

8.1. BASIC DATA RATE GFSK MODULATION

8.1.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

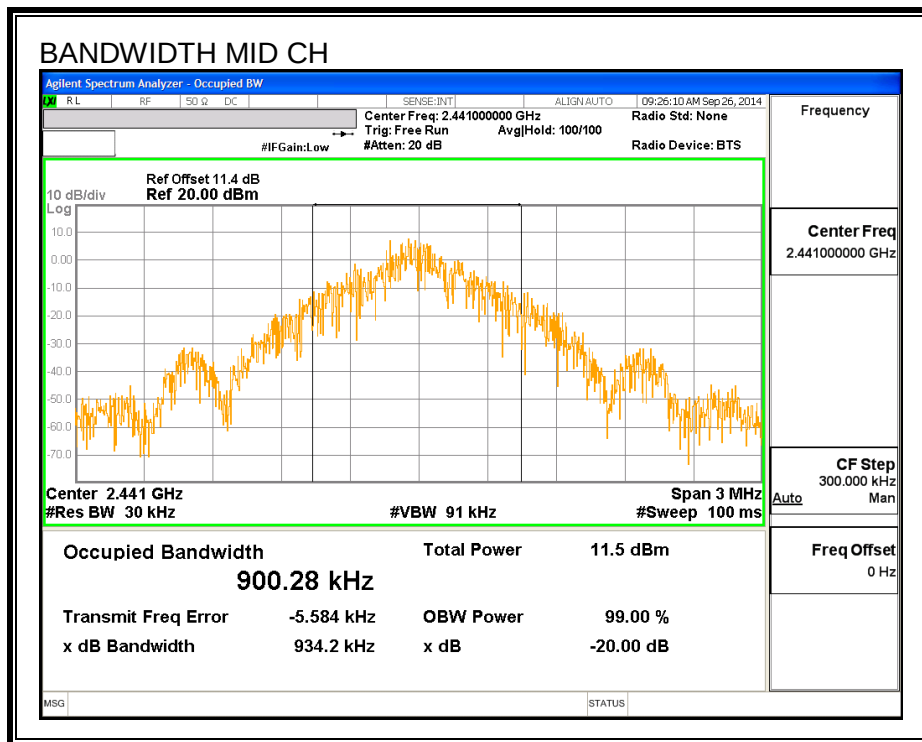
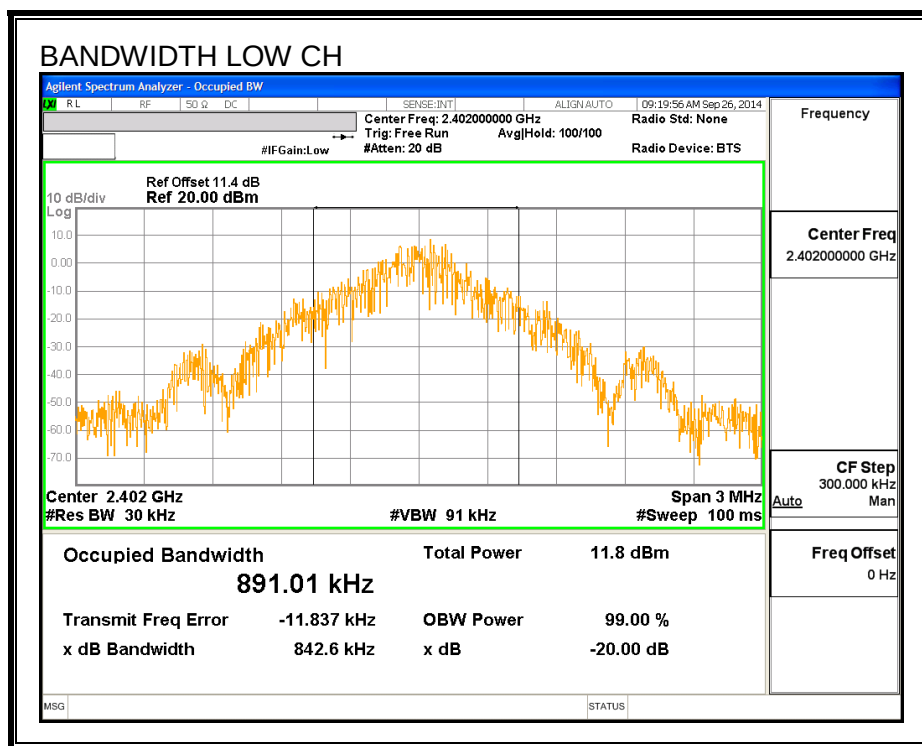
TEST PROCEDURE

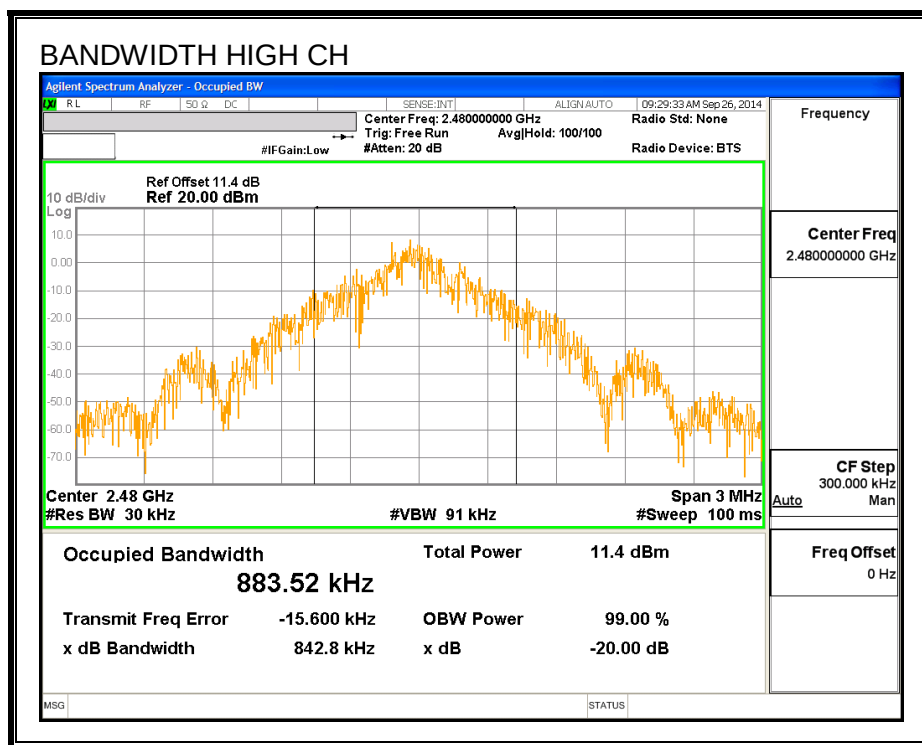
The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to $\geq$ RBW. The sweep time is coupled.

RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	842.6	891.01
Middle	2441	934.2	900.28
High	2480	842.8	883.52

20 dB AND 99% BANDWIDTH





8.1.2. 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.

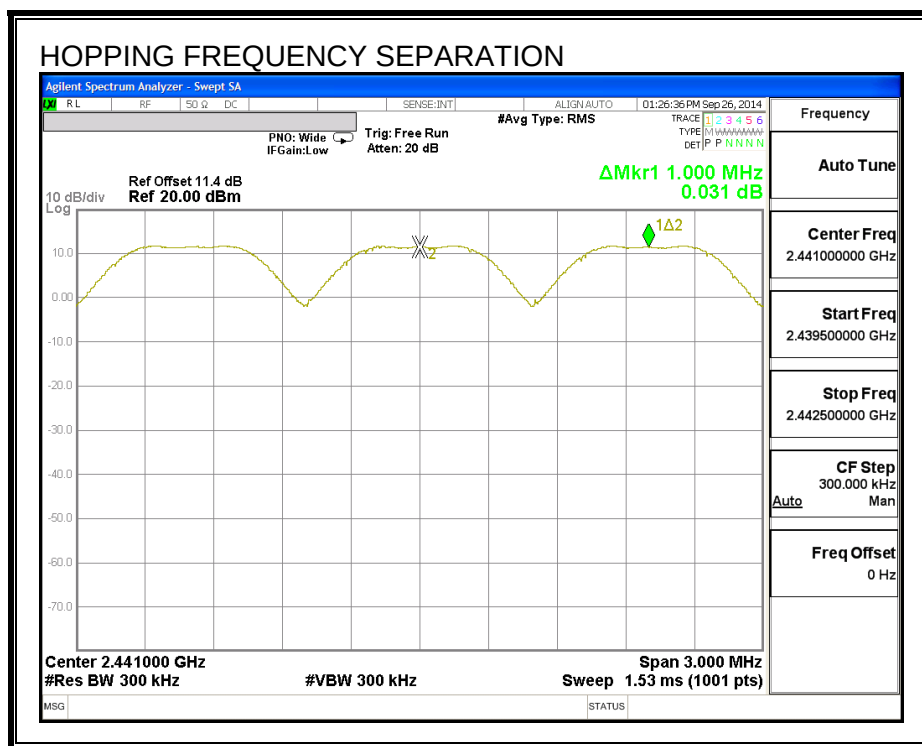
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to => RBW. The sweep time is coupled.

RESULTS

HOPPING FREQUENCY SEPARATION



8.1.3. 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.

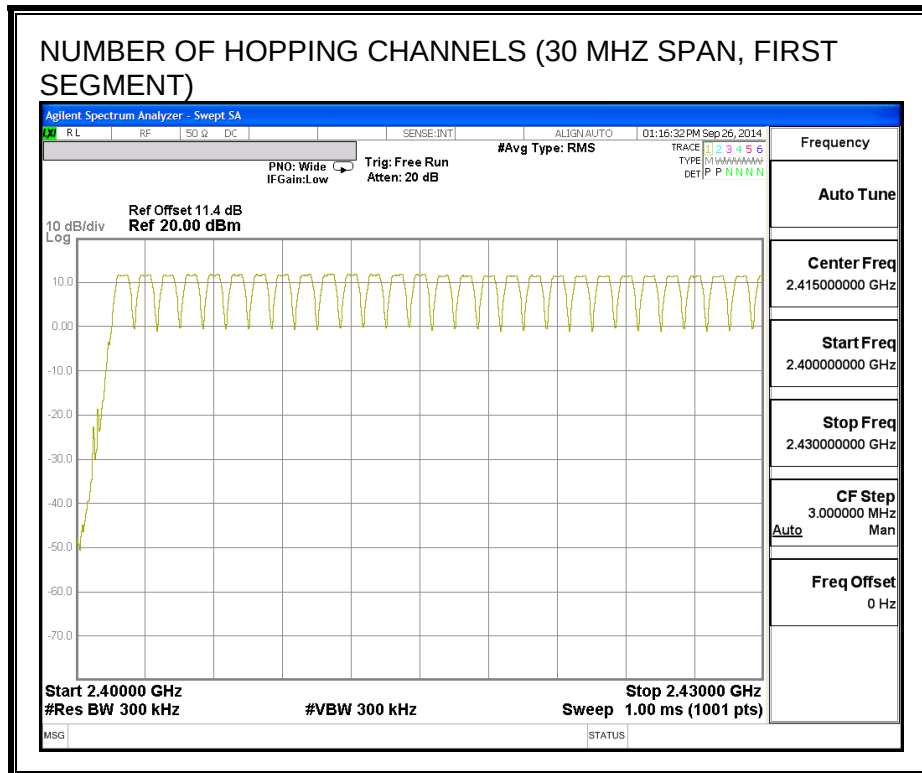
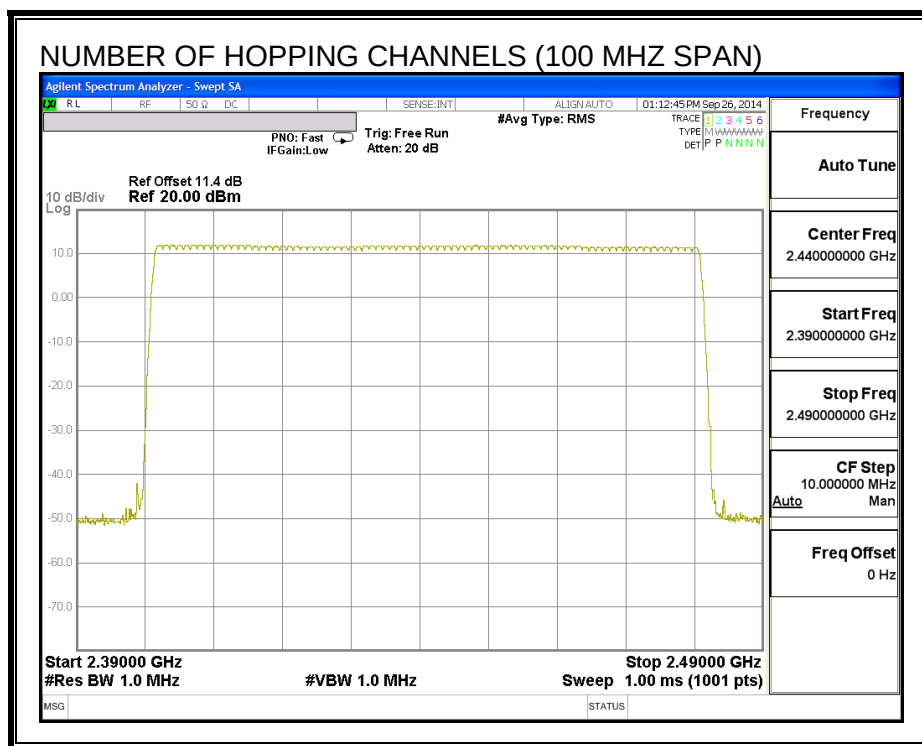
TEST PROCEDURE

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.

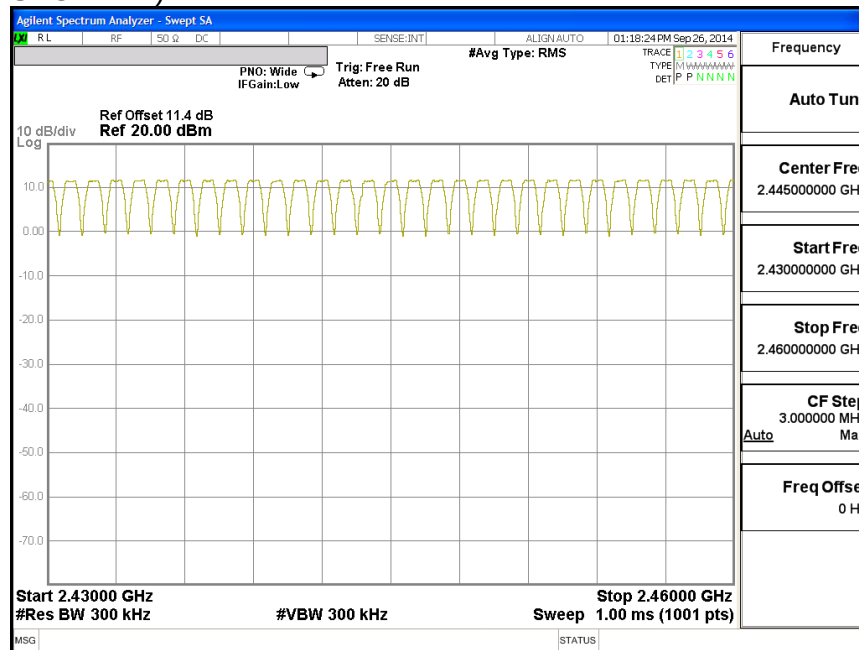
RESULTS

Normal Mode: 79 Channels observed.

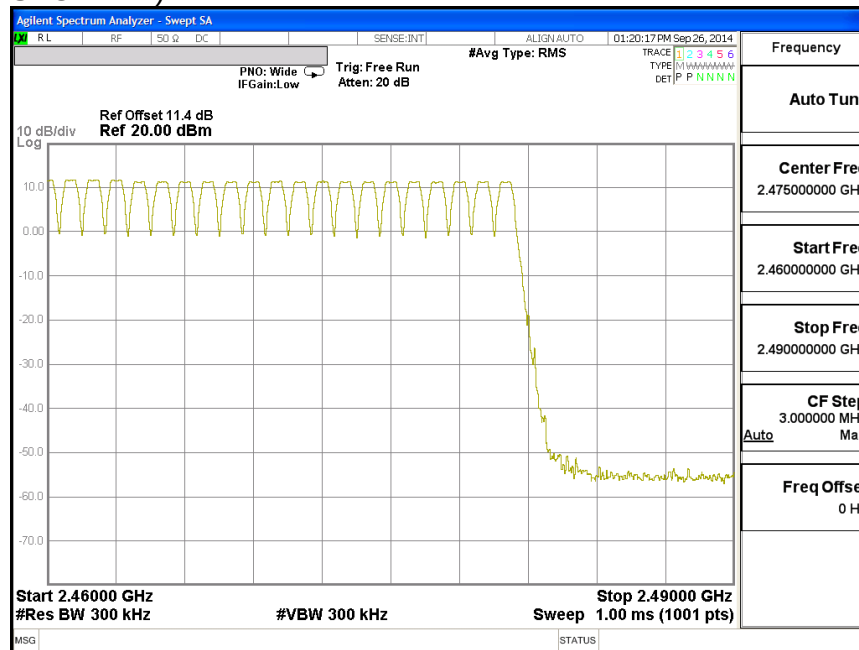
NUMBER OF HOPPING CHANNELS



NUMBER OF HOPPING CHANNELS (30 MHz SPAN, SECOND SEGMENT)



NUMBER OF HOPPING CHANNELS (30 MHz SPAN, THIRD SEGMENT)



8.1.4. 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

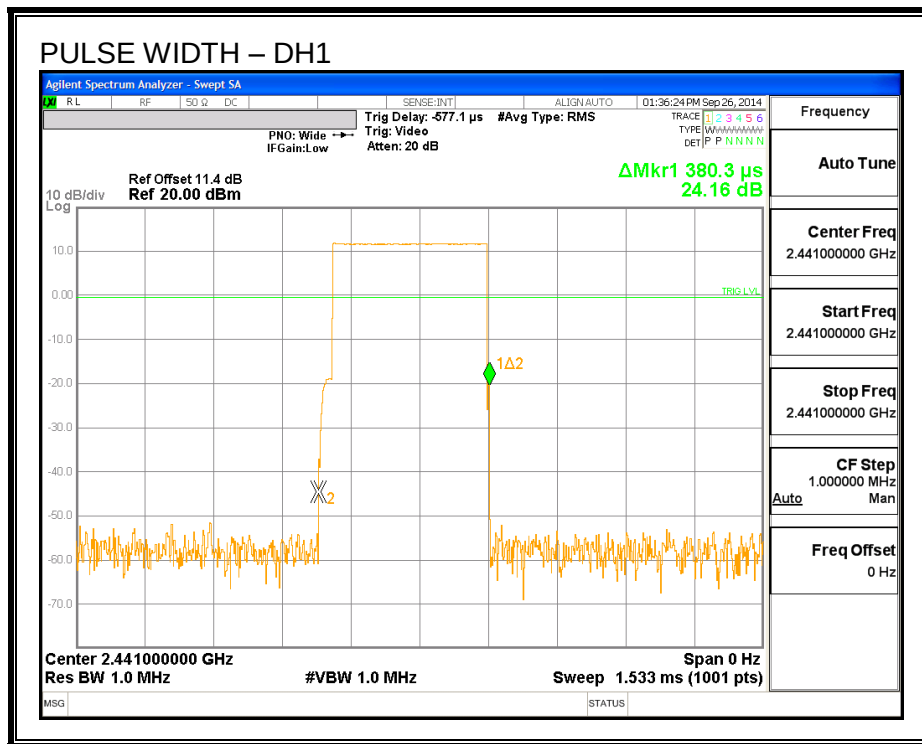
The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

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

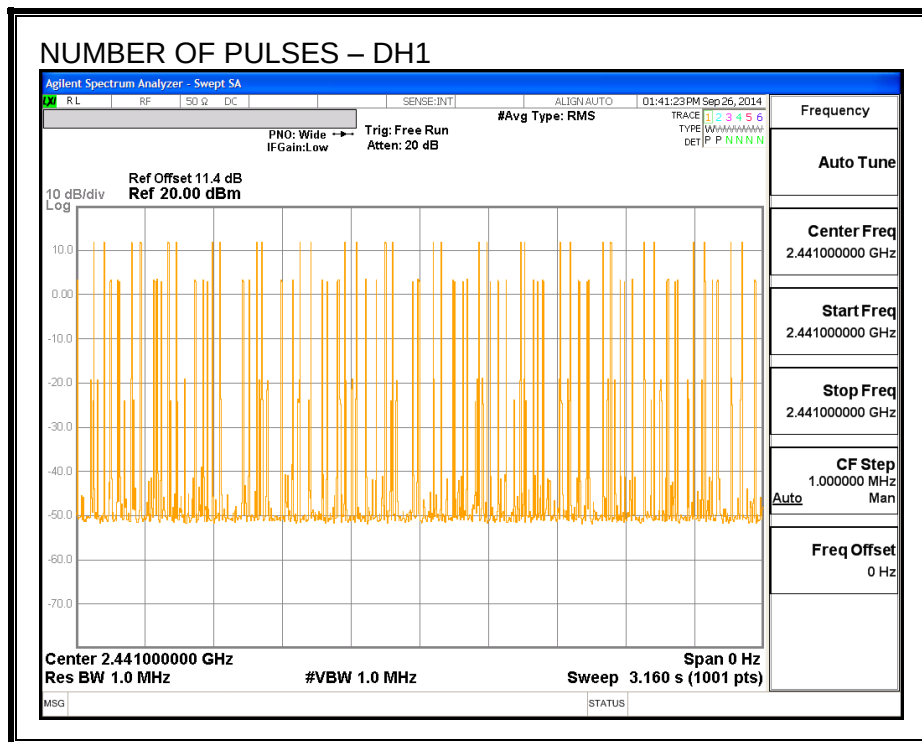
RESULTS

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	0.380	32	0.122	0.4	-0.278
DH3	1.825	16	0.292	0.4	-0.108
DH5	2.25	14	0.315	0.4	-0.085

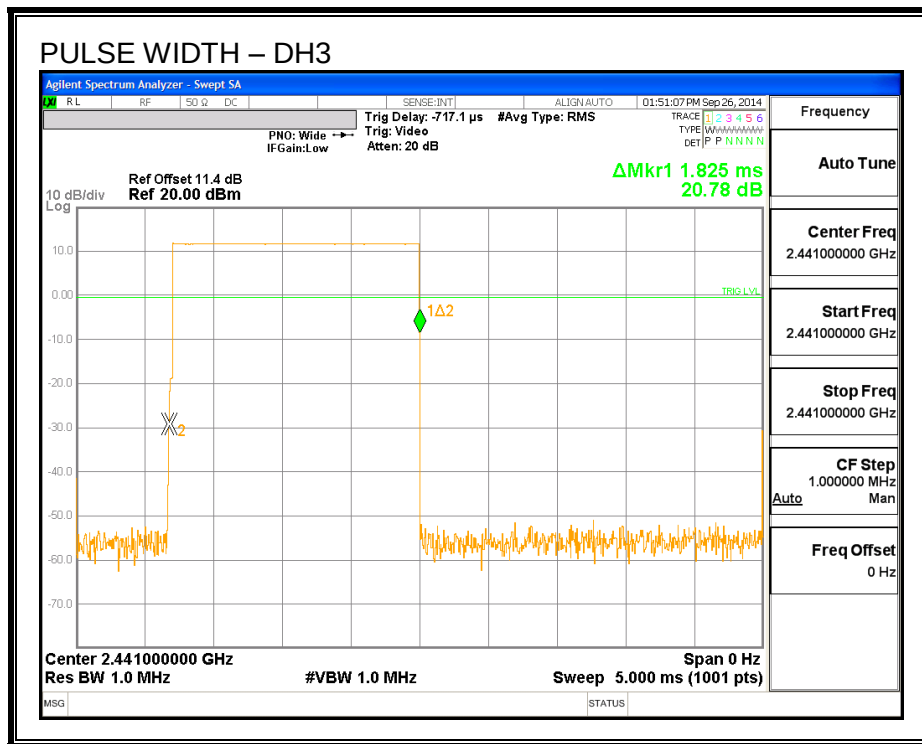
PULSE WIDTH - DH1



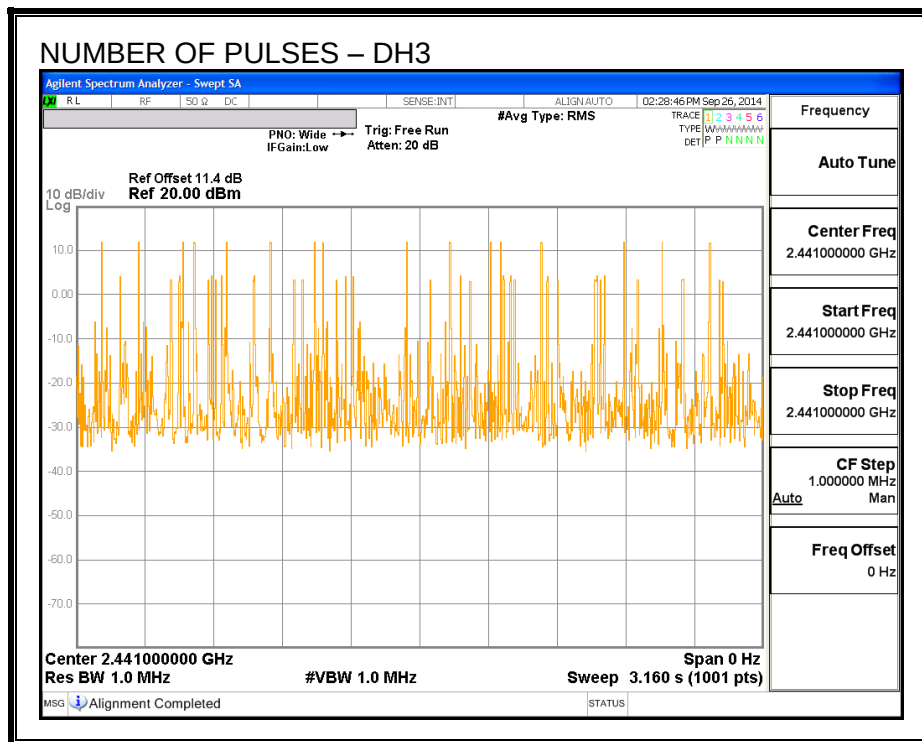
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



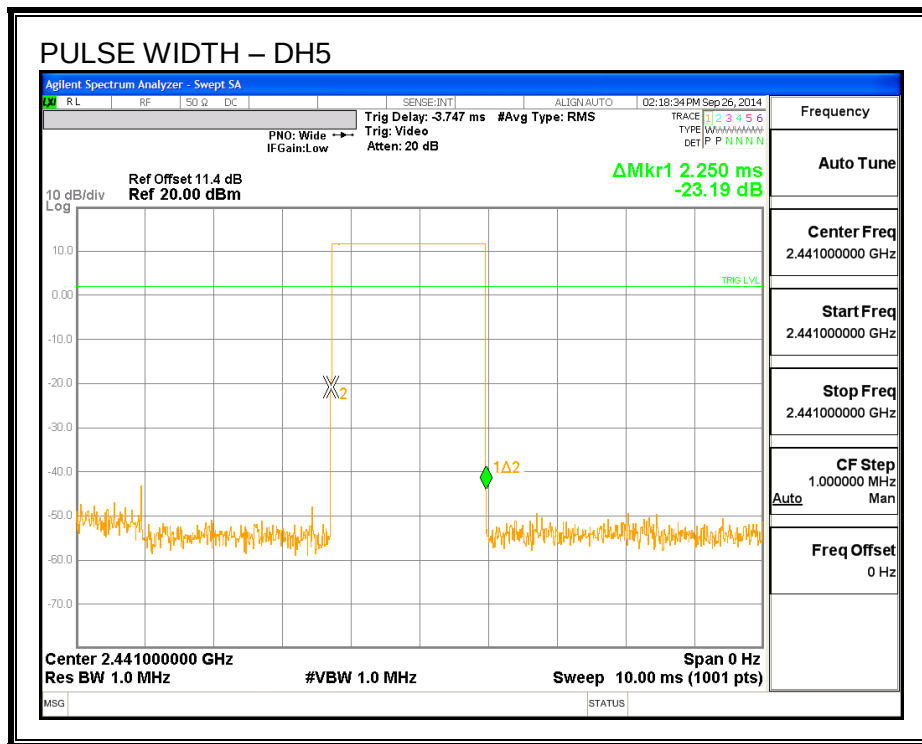
PULSE WIDTH – DH3



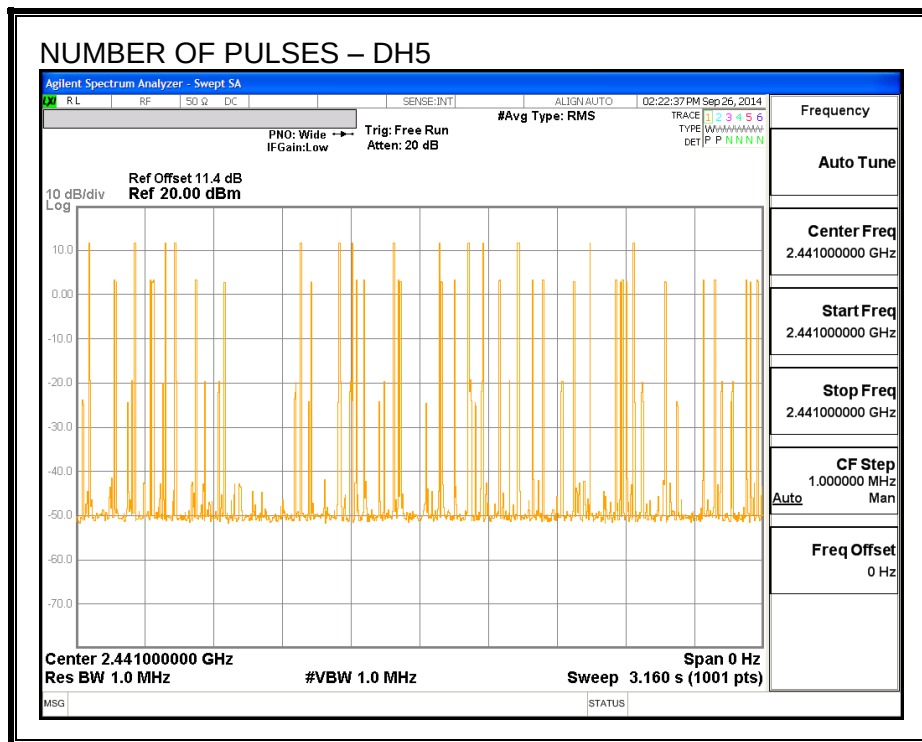
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



8.1.5. OUTPUT POWER

LIMIT

§15.247 (b) (1)

RSS-210 Issue 8 Clause A8.4

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

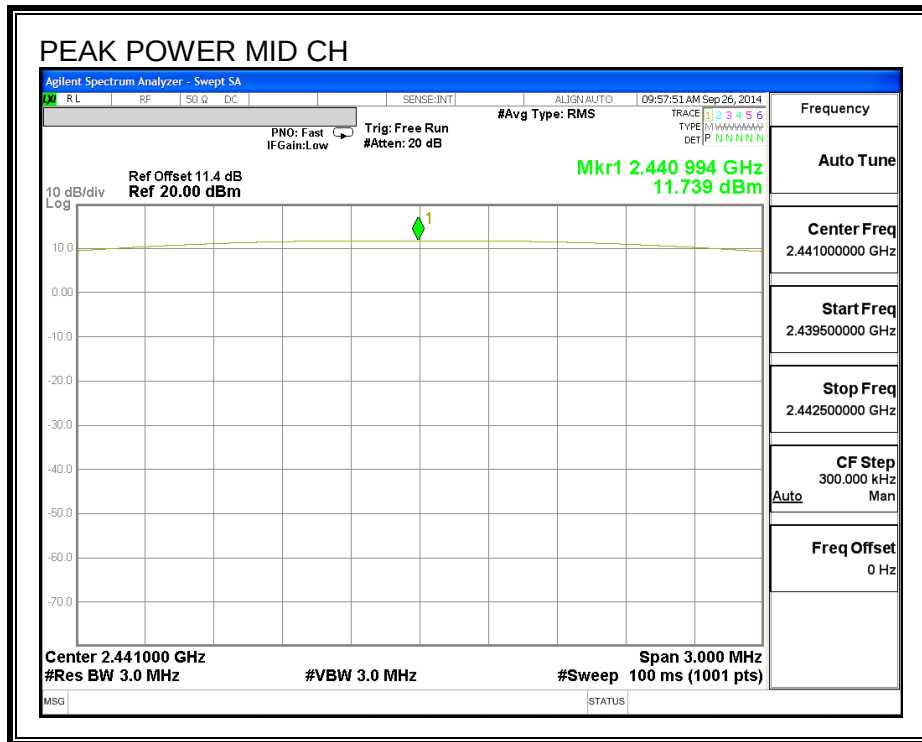
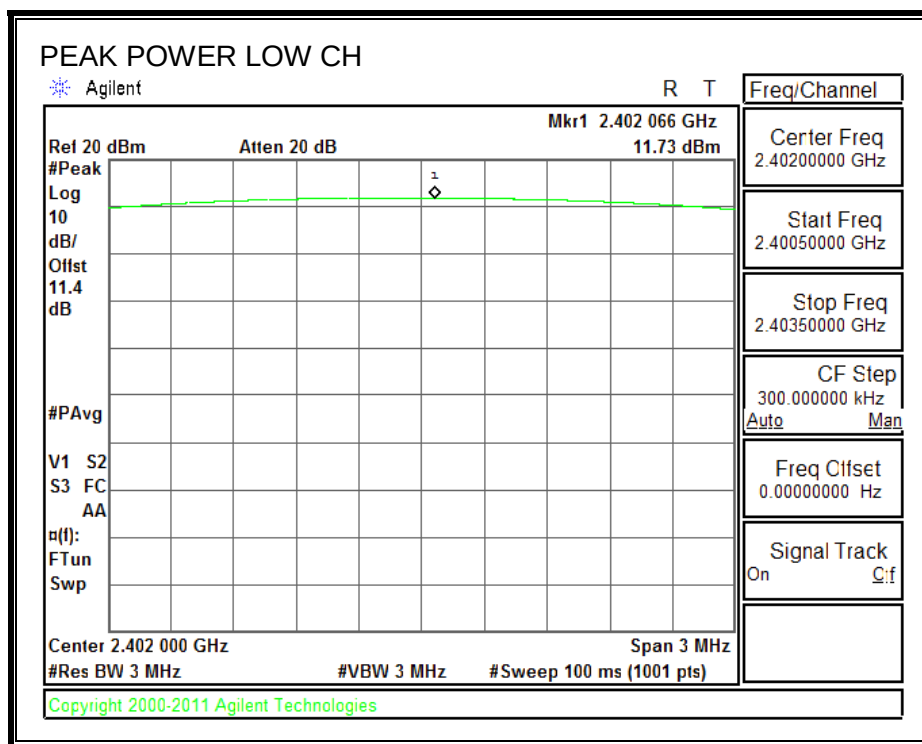
TEST PROCEDURE

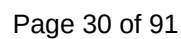
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.73	30	-18.27
Middle	2441	11.74	30	-18.26
High	2480	11.49	30	-18.51

OUTPUT POWER





8.1.6. 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 11.4 dB (including 10 dB pad and 1.4 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	11.61
Middle	2441	11.54
High	2480	11.22

8.1.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

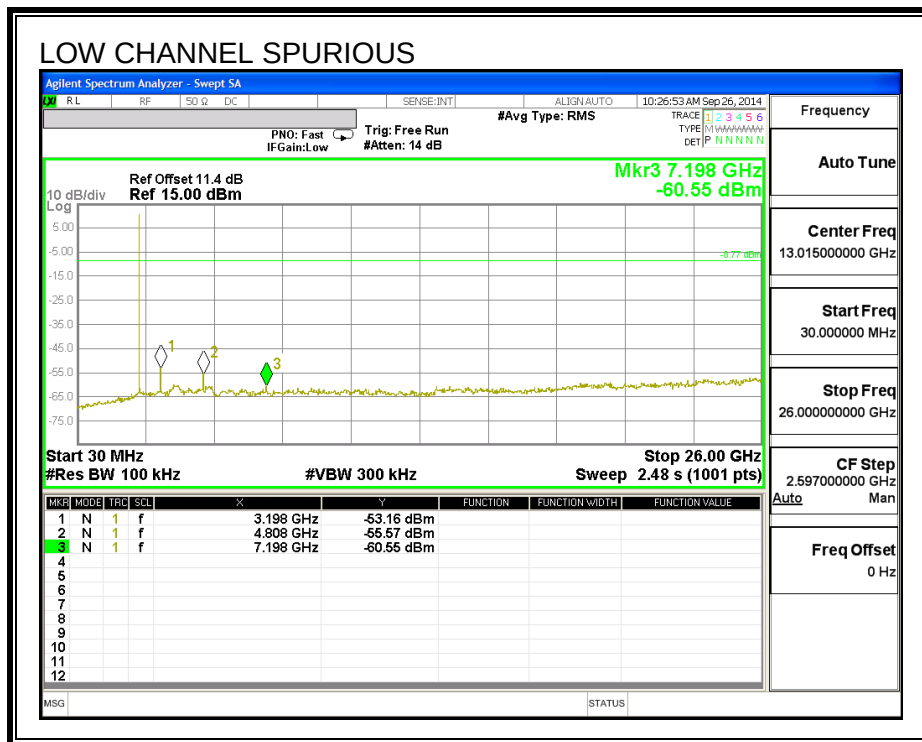
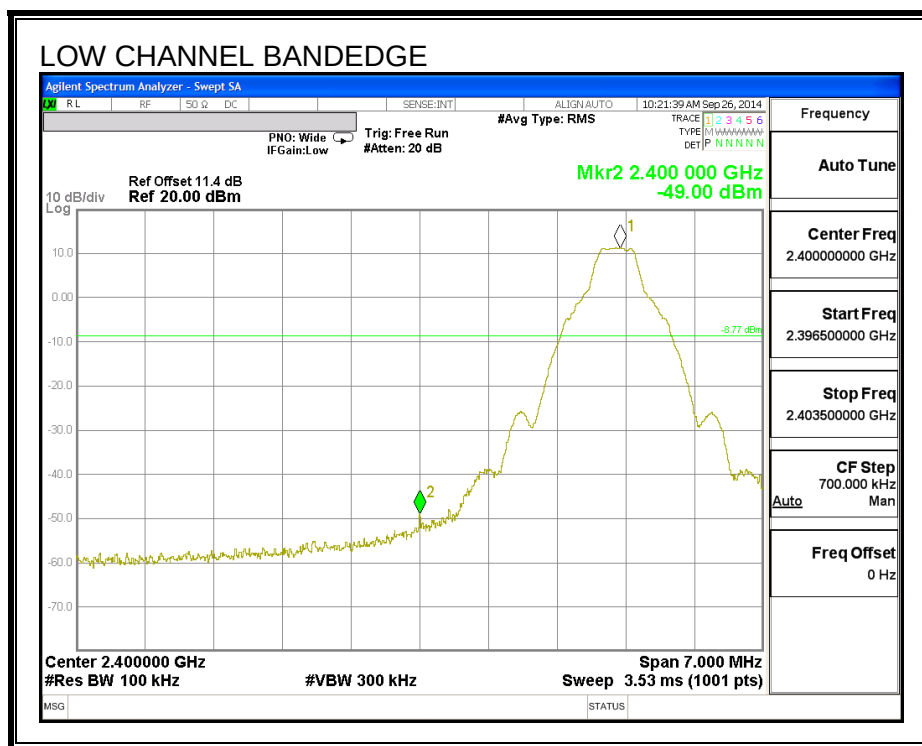
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

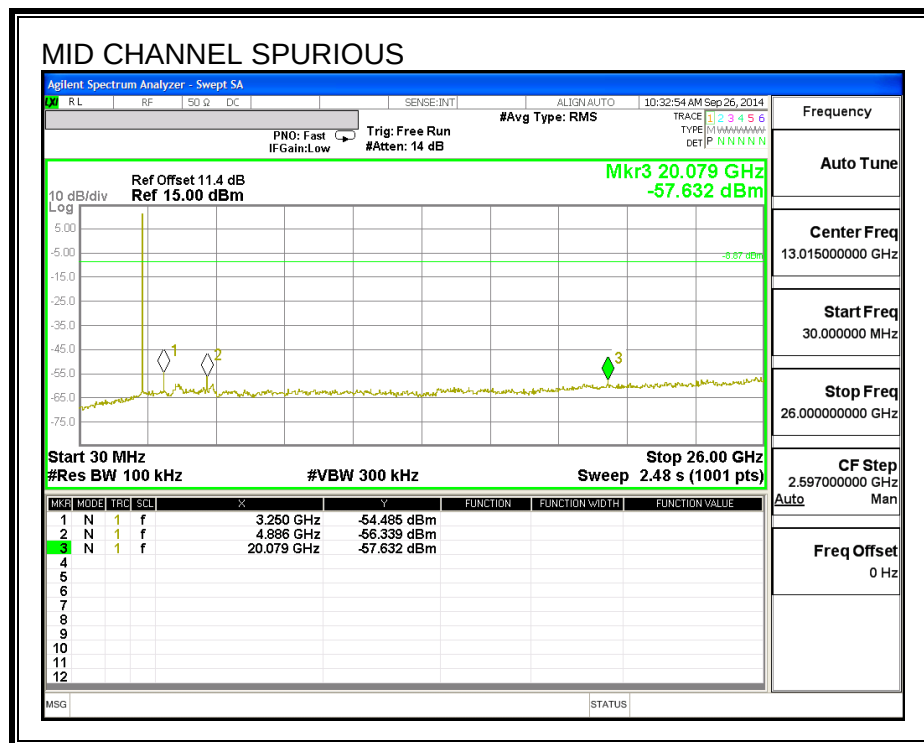
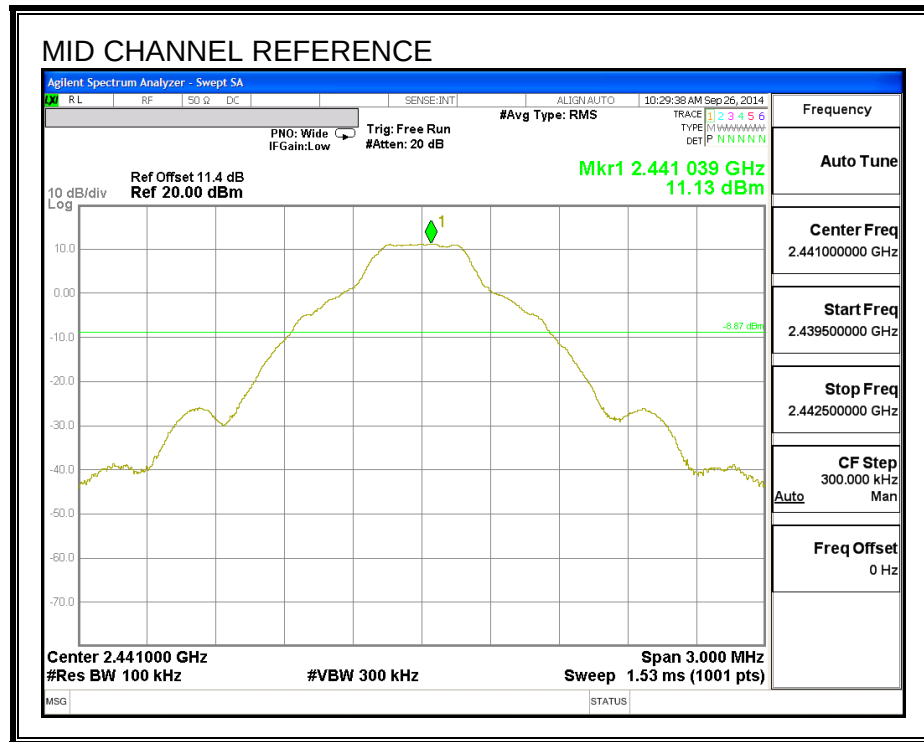
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

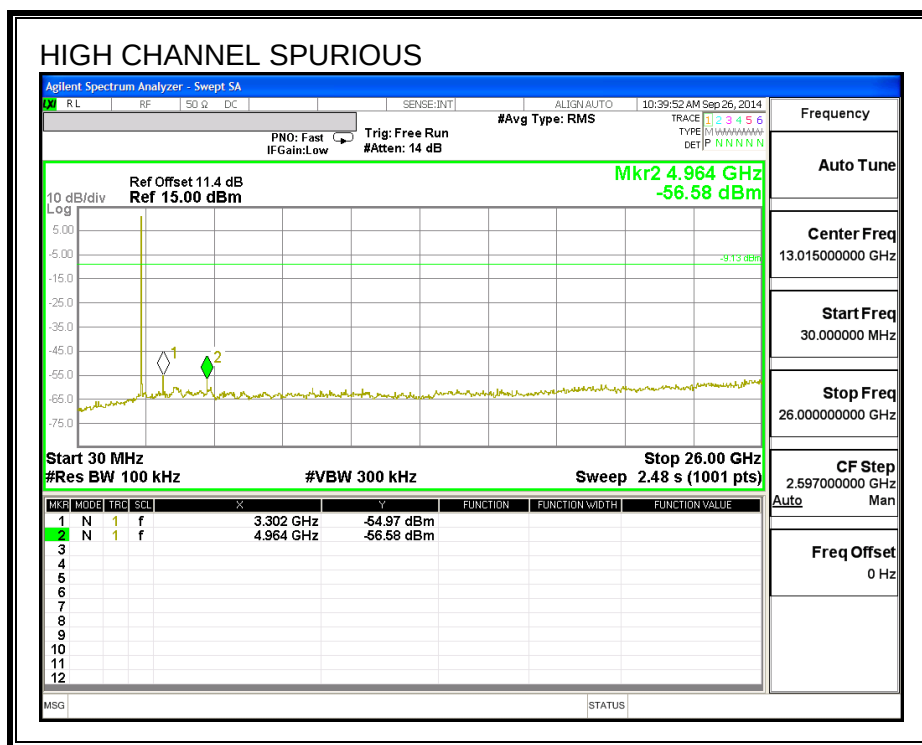
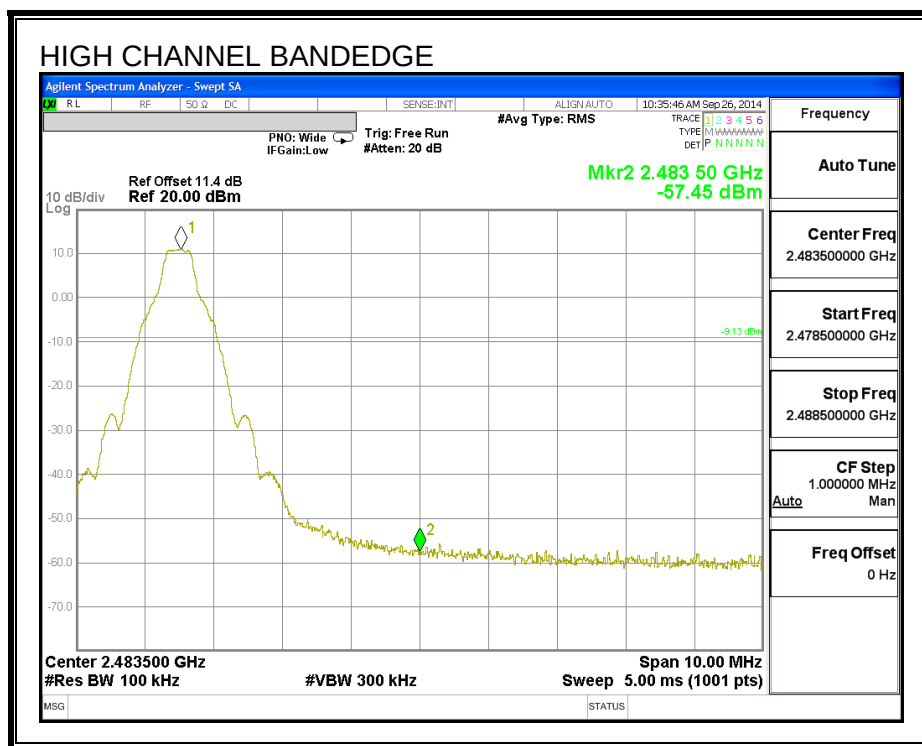
SPURIOUS EMISSIONS, LOW CHANNEL



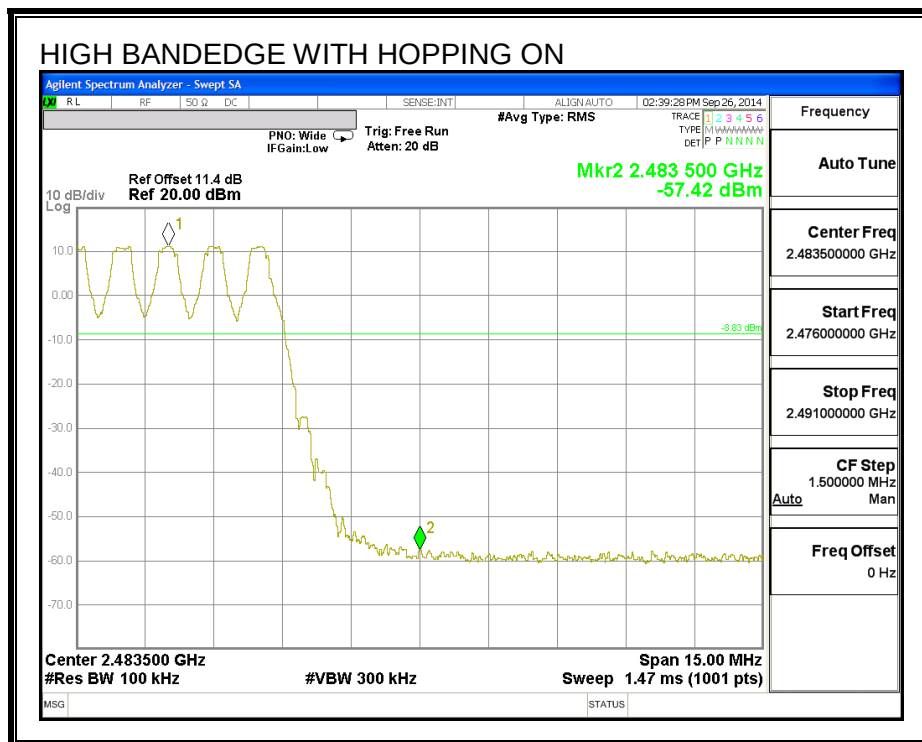
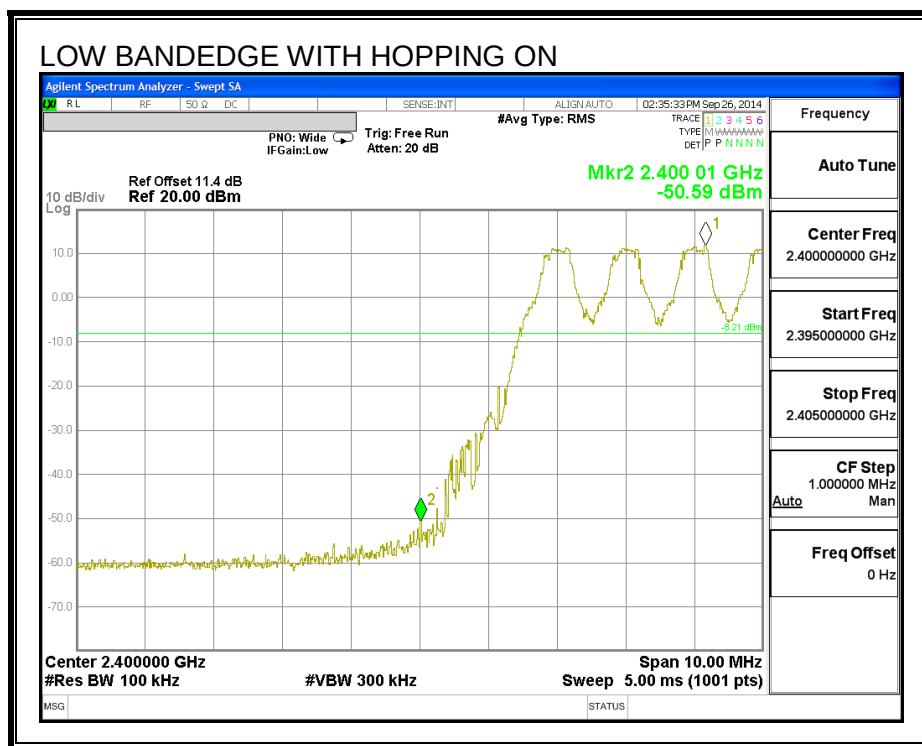
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



8.2. ENHANCED DATA RATE QPSK MODULATION

8.2.1. 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 11.4 dB (including 10 dB pad and 1.4 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	9.70
Middle	2441	9.51
High	2480	9.29

8.3. ENHANCED DATA RATE 8PSK MODULATION

8.3.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

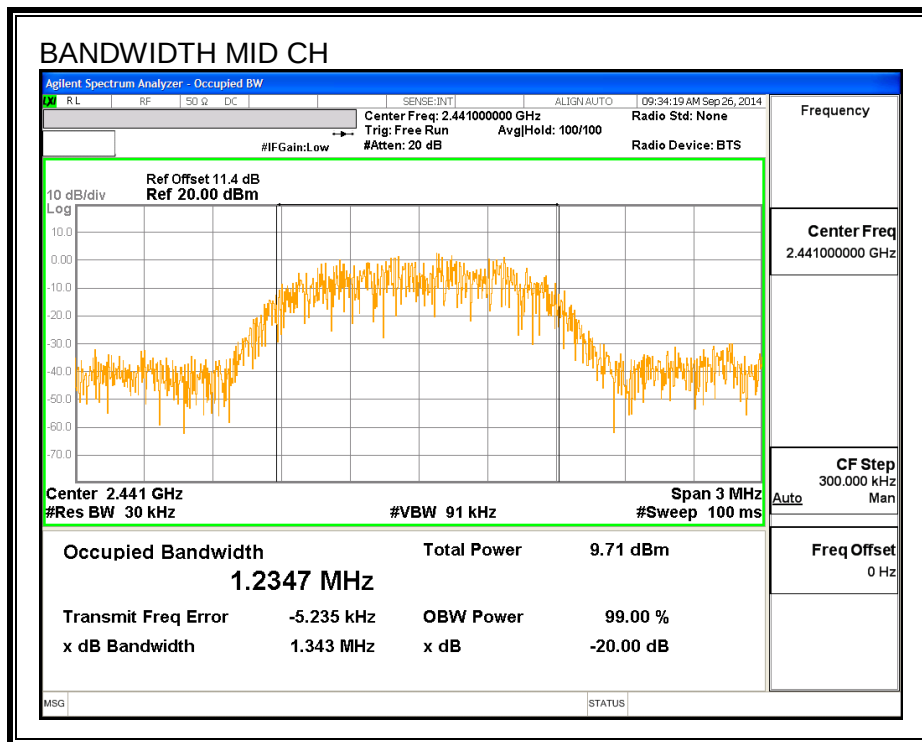
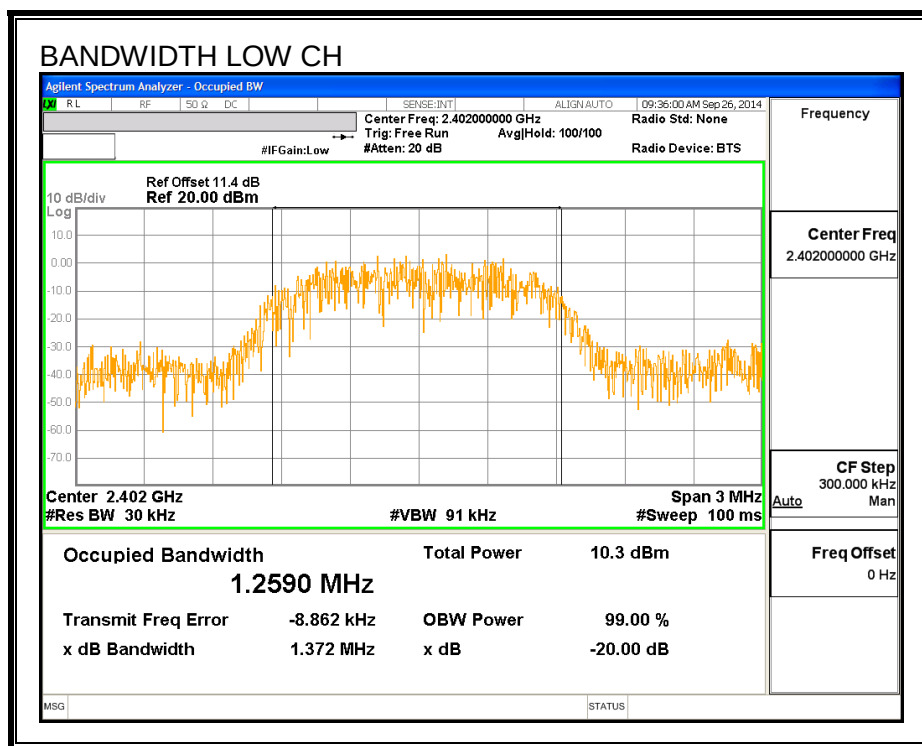
TEST PROCEDURE

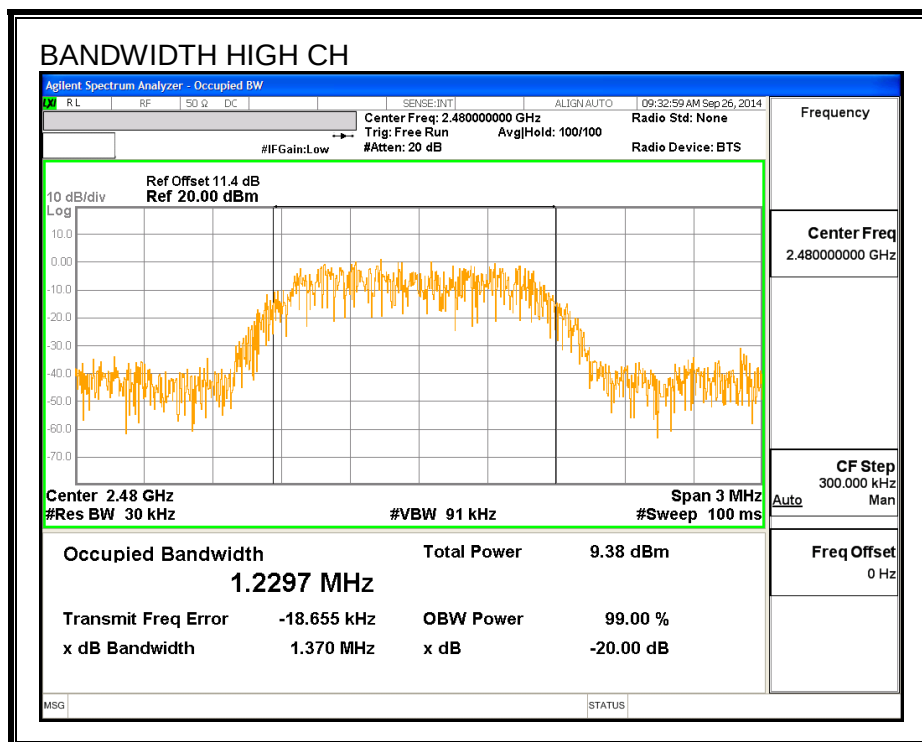
The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to $\geq$ RBW. The sweep time is coupled.

RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.372	1.2590
Middle	2441	1.343	1.2347
High	2480	1.370	1.2297

20 dB AND 99% BANDWIDTH





8.3.2. 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.

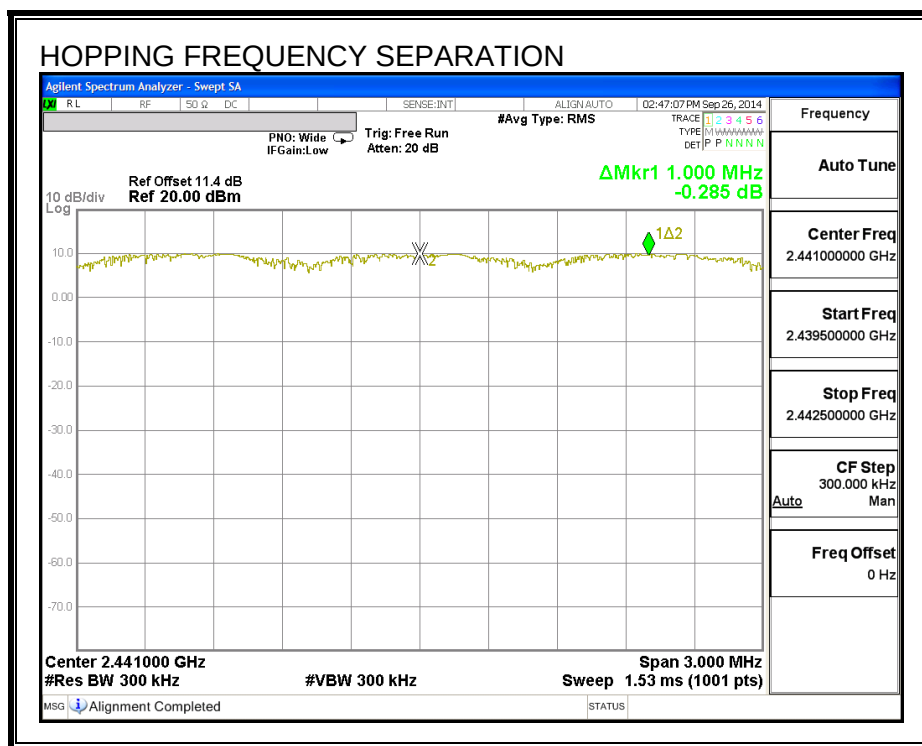
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to => RBW. The sweep time is coupled.

RESULTS

HOPPING FREQUENCY SEPARATION



8.3.3. 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.

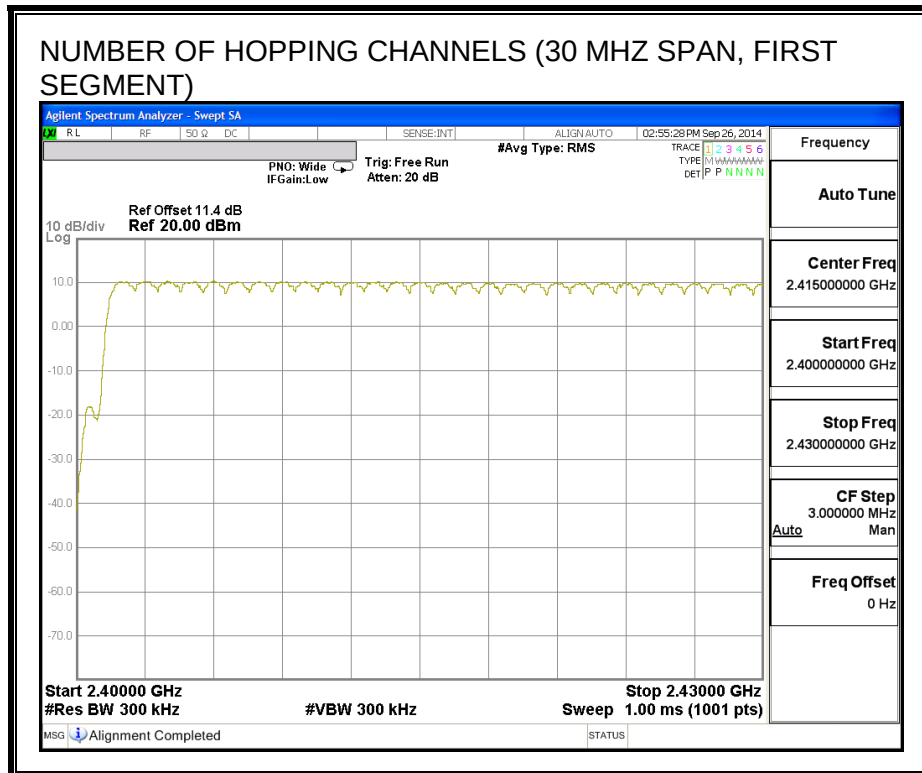
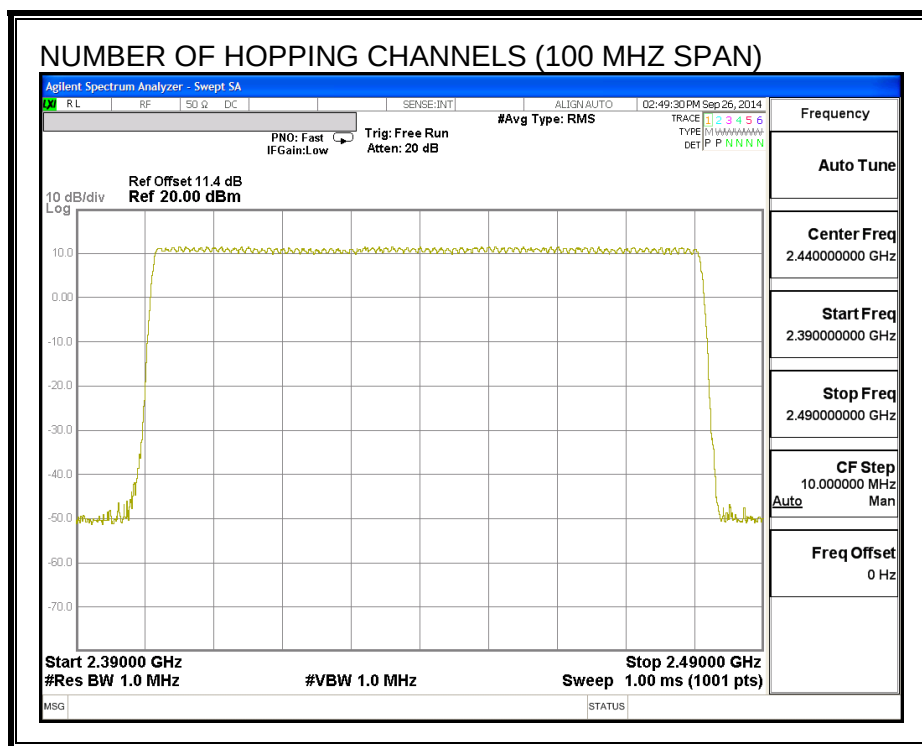
TEST PROCEDURE

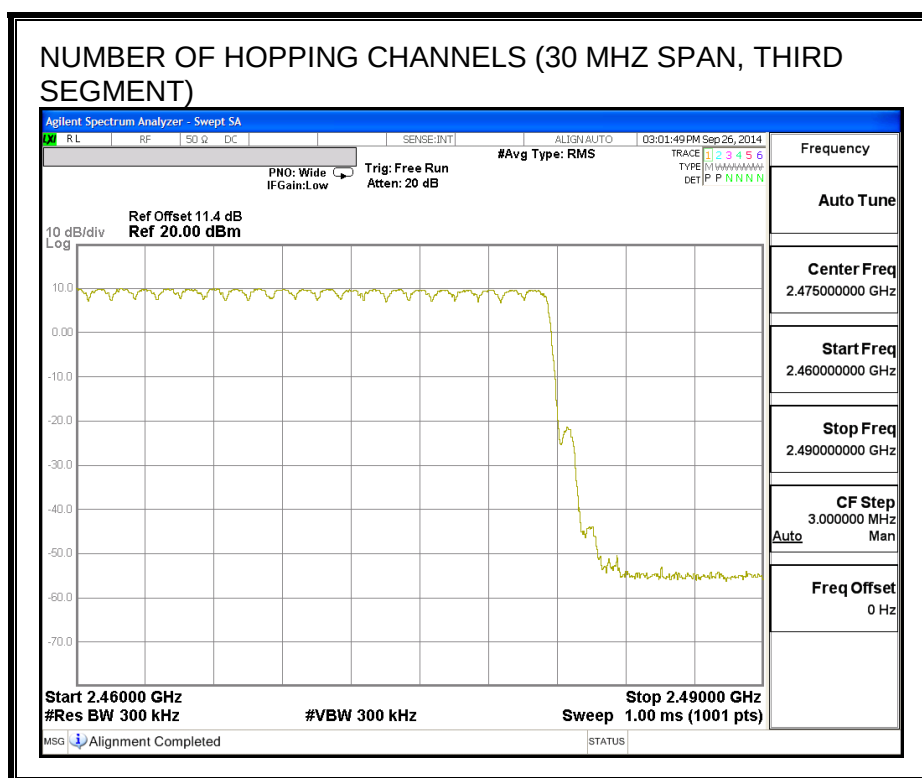
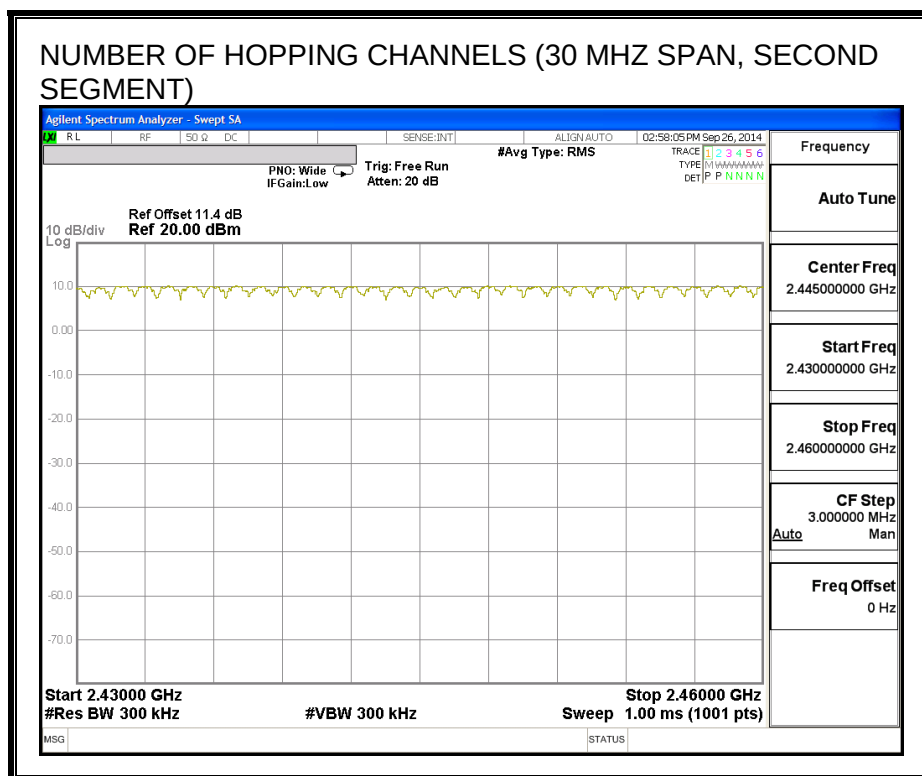
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

Normal Mode: 79 Channels observed.

NUMBER OF HOPPING CHANNELS





8.3.4. 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 $10 * (\# \text{ of pulses in 3.16 s}) * \text{pulse width}$.

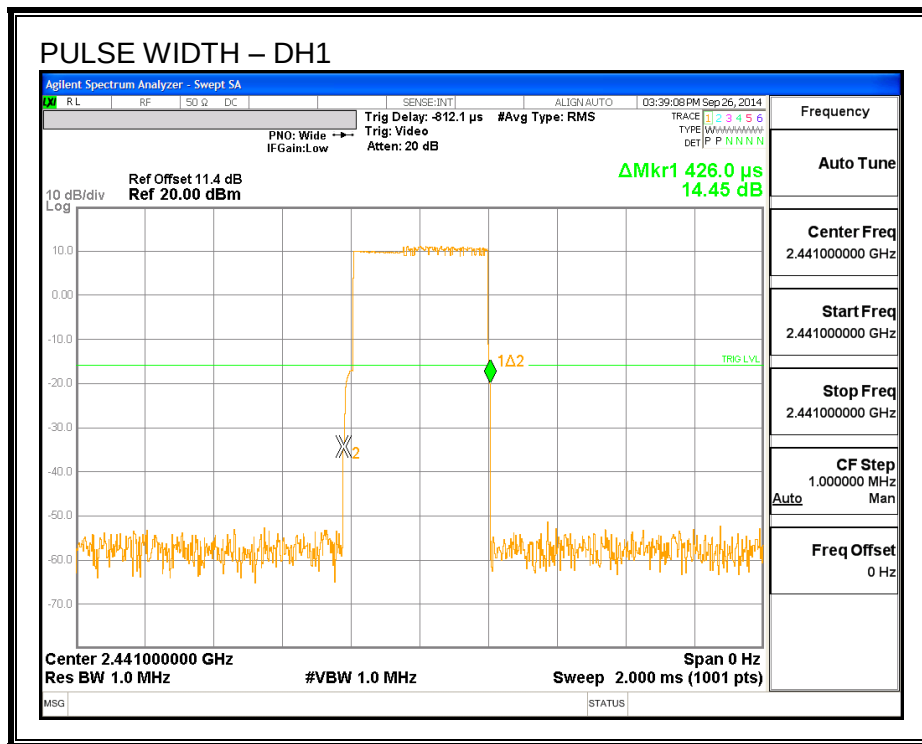
RESULTS

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

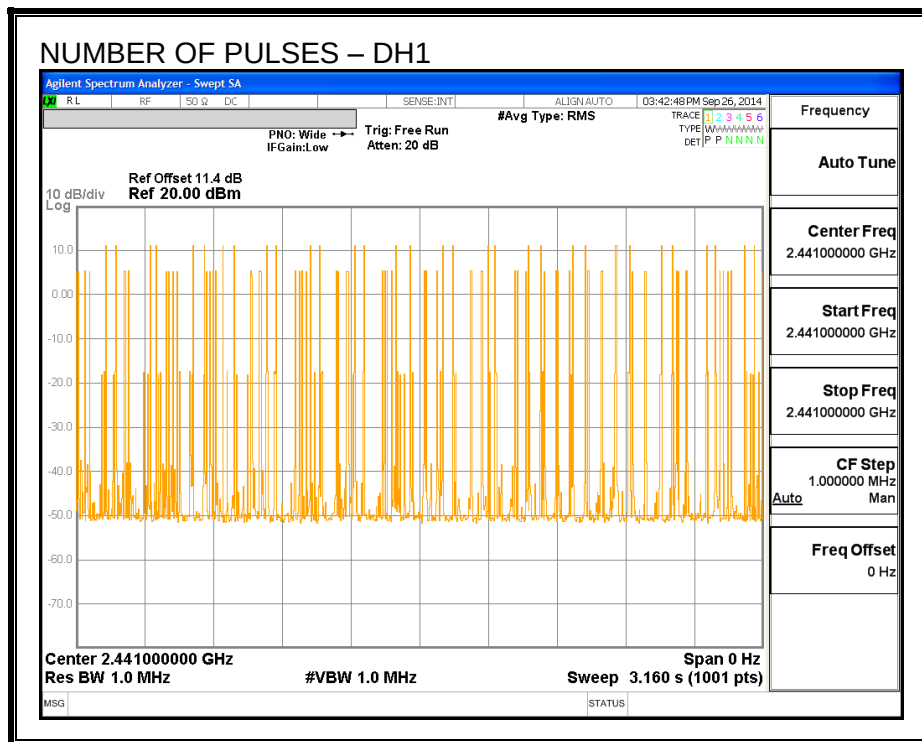
8PSK (EDR) Mode

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
3DH1	0.426	32	0.136	0.4	-0.264
3DH3	1.805	17	0.307	0.4	-0.093
3DH5	2.23	13	0.290	0.4	-0.110

PULSE WIDTH - DH1



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



PULSE WIDTH – DH3

Agilent Spectrum Analyzer – Sweep SA

M	RL	RF	SQ	Q	DC	SENSE:INT1	ALIGN:AUTO	05:38:51 PM Sep 26, 2014
---	----	----	----	---	----	------------	------------	--------------------------

PN0: Wide
IF Gain: Low

Trig Delay: -727.1 μ s
Trig: Video
Atten: 20 dB

#Avg Type: RMS

TRACE 1 2 3 4 5 6
TYPE W W W W W W
DET P P N N N N

Frequency

Auto Tune

Ref Offset 11.4 dB
Ref 20.00 dBm

Δ Mkr1 1.805 ms
30.09 dB

10 dB/div
Log

1 Δ 2

X2

TRIG LVL

Center 2.441000000 GHz
Res BW 1.0 MHz

#VBW 1.0 MHz

Span 0 Hz
Sweep 5.000 ms (1001 pts)

MSG

STATUS

Center Freq 2.441000000 GHz
Start Freq 2.441000000 GHz
Stop Freq 2.441000000 GHz
CF Step 1.000000 MHz <u>Auto</u> Man
Freq Offset 0 Hz

NUMBER OF PULSES – DH3

Agilent Spectrum Analyzer - Swept SA

VL RL RF SQ Z DC SENSE:INT ALIGN:AUTO 05:37:07 PM Sep 26, 2014

#Avg Type: RMS

Trace 1 2 3 4 5 6
Type W W W W W W W W
Det P P N N N N N

Ref Offset 11.4 dB
Ref 20.00 dBm

10 dB/div
Log

PNO: Wide → Trig: Free Run
IF Gain: Low Atten: 20 dB

Center 2.441000000 GHz
Res BW 1.0 MHz
Span 0 Hz
Sweep 3.160 s (1001 pts)

Auto Tune

Center Freq
2.441000000 GHz

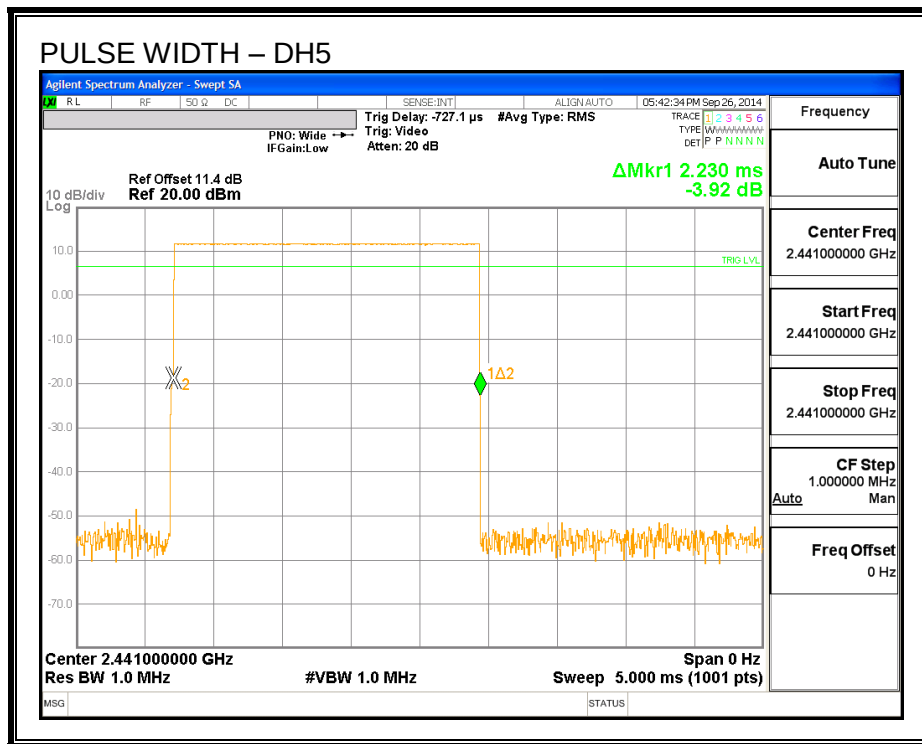
Start Freq
2.441000000 GHz

Stop Freq
2.441000000 GHz

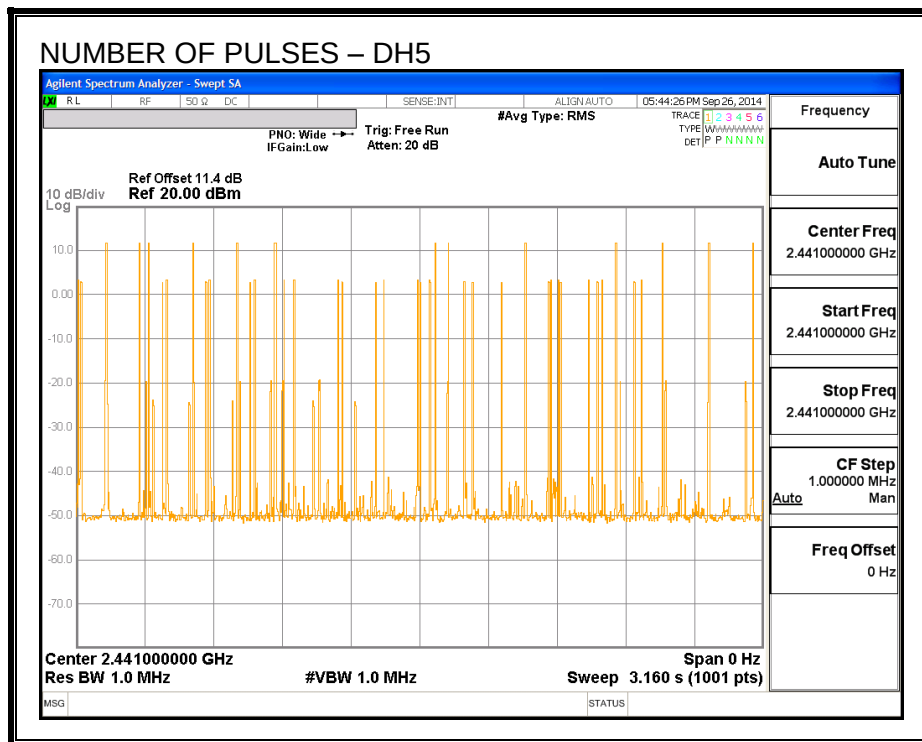
CF Step
1.000000 MHz
Auto Man

Freq Offset
0 Hz

PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



8.3.5. OUTPUT POWER

LIMIT

§15.247 (b) (1)

RSS-210 Issue 8 Clause A8.4

The maximum antenna gain is less than 6 dBi, therefore the limit is 21 dBm.

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.

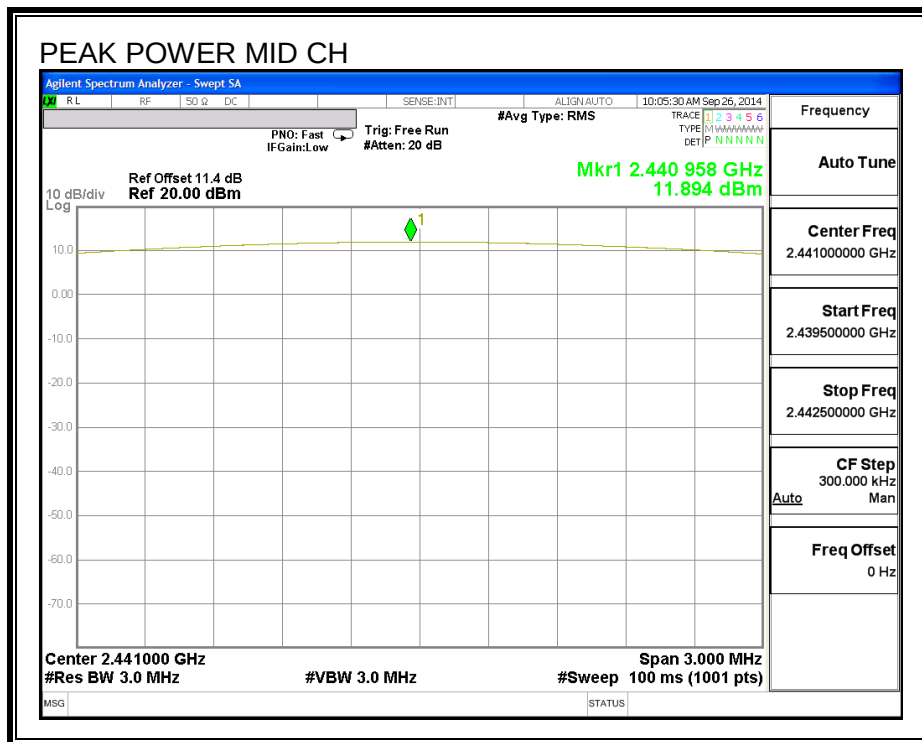
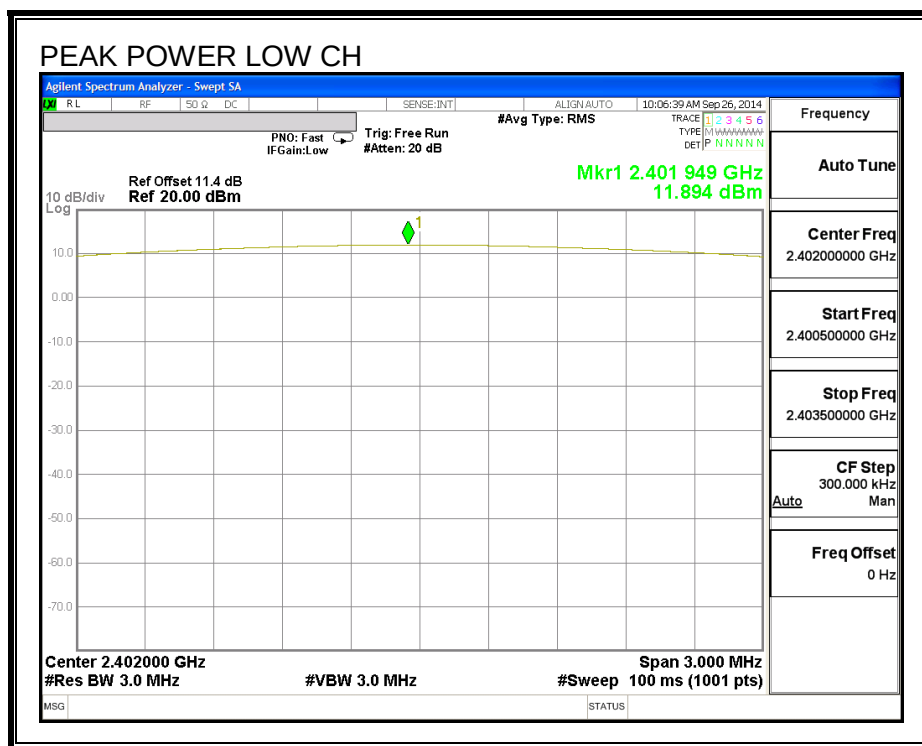
TEST PROCEDURE

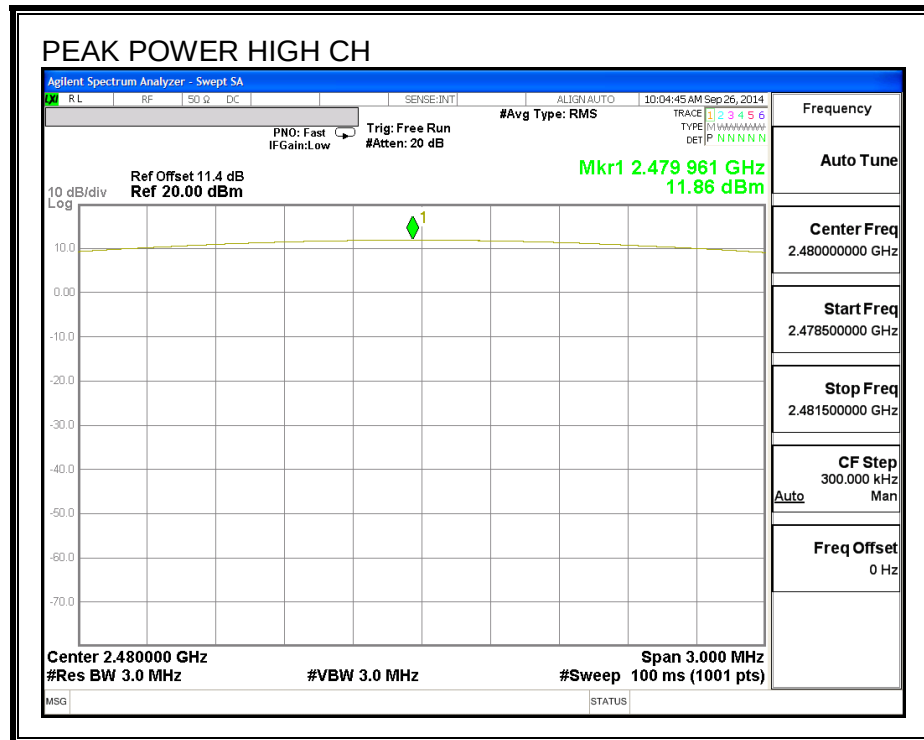
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.894	21	-9.11
Middle	2441	11.894	21	-9.11
High	2480	11.860	21	-9.14

OUTPUT POWER





8.3.6. 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 11.4 dB (including 10 dB pad and 1.4 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	9.76
Middle	2441	9.60
High	2480	9.40

8.3.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

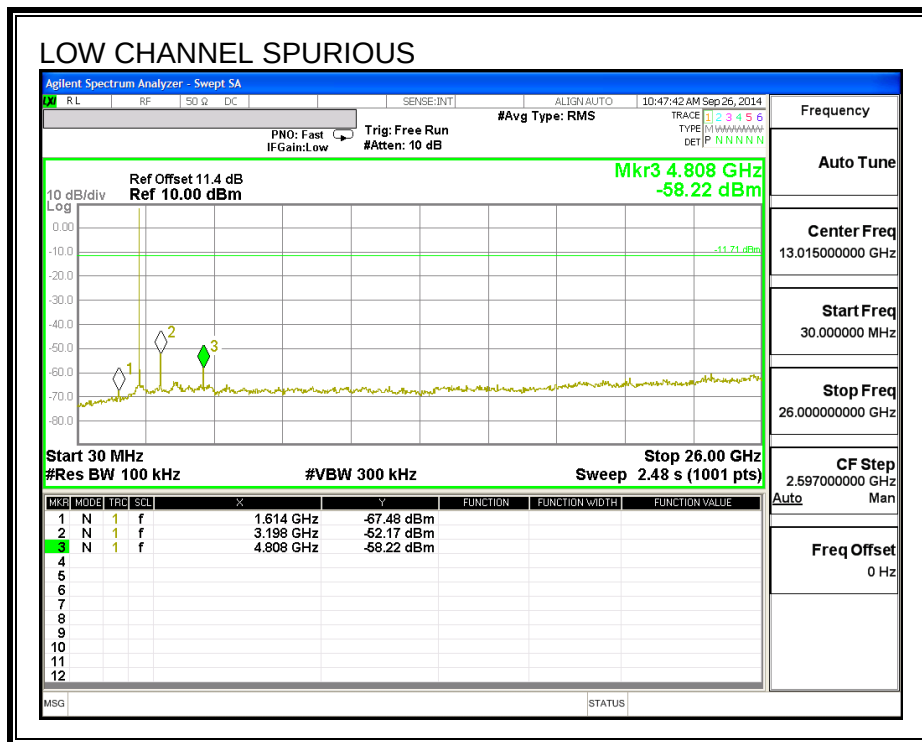
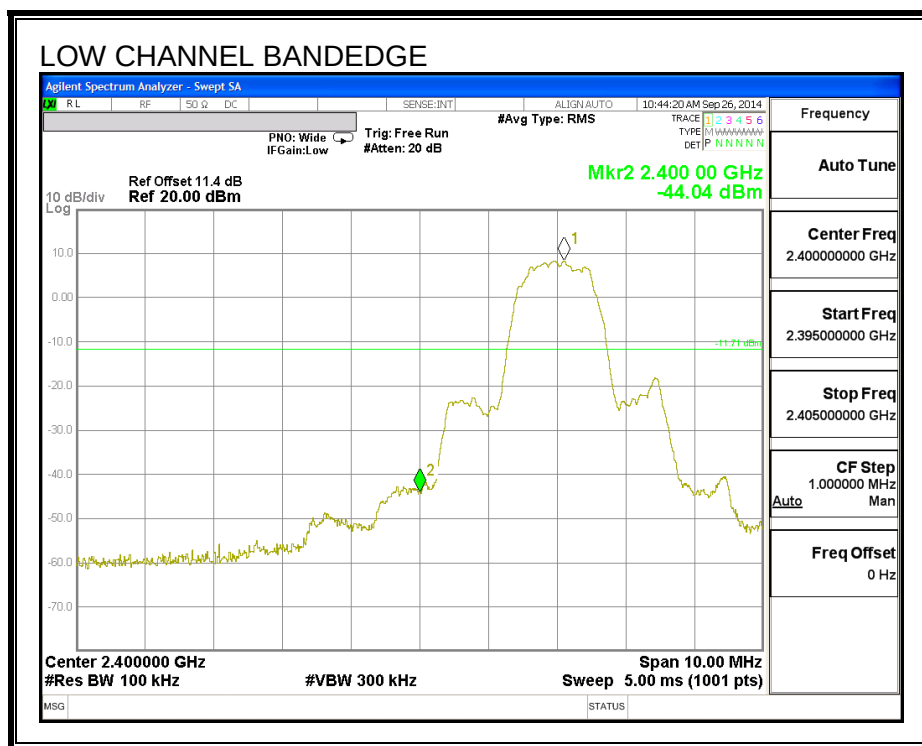
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

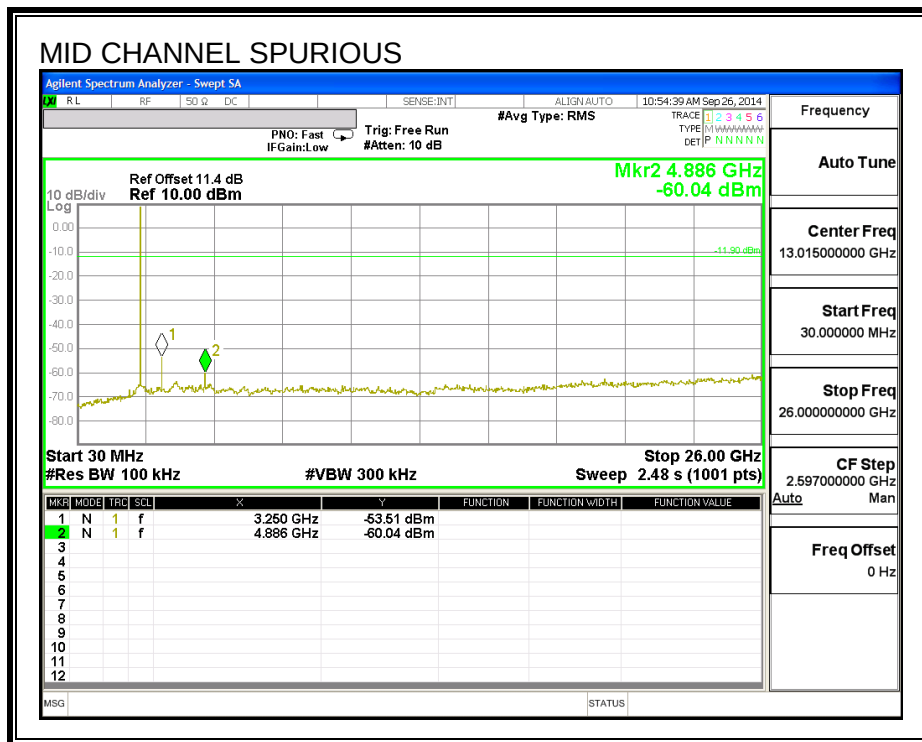
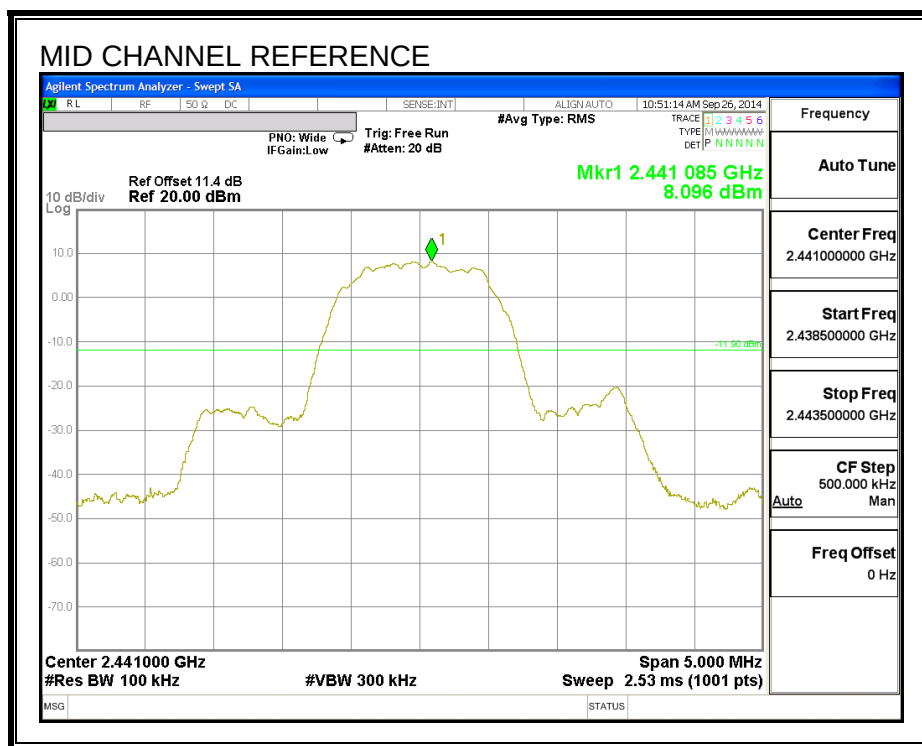
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

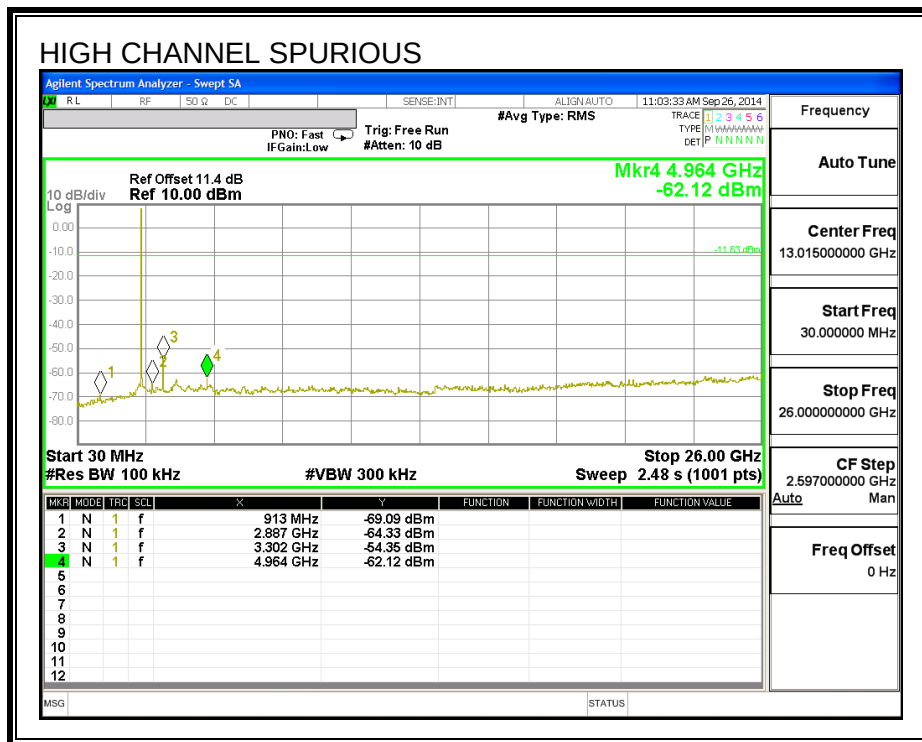
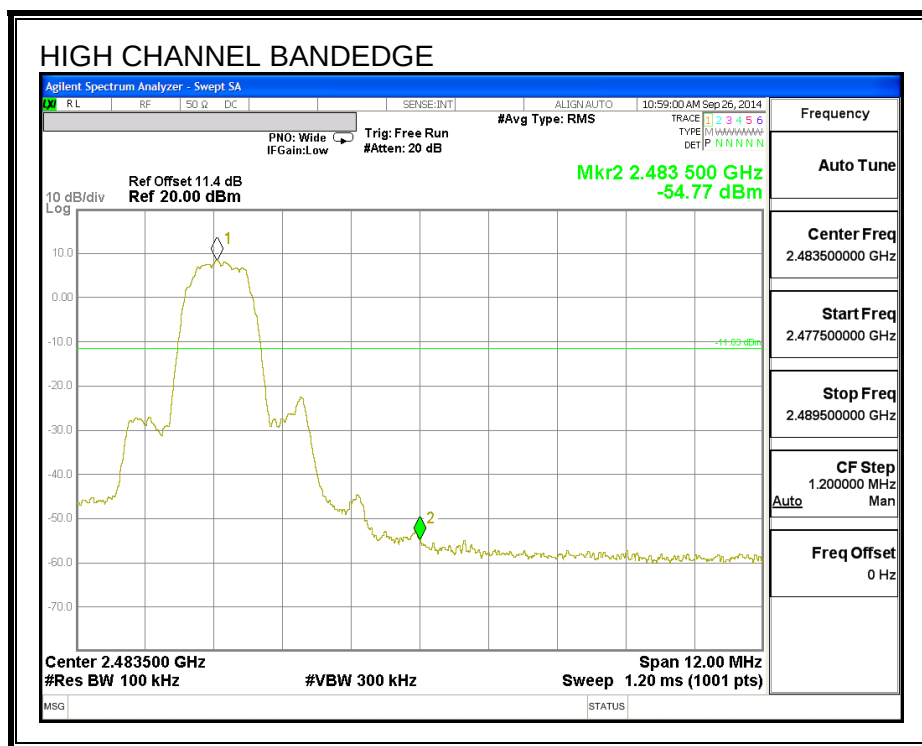
SPURIOUS EMISSIONS, LOW CHANNEL



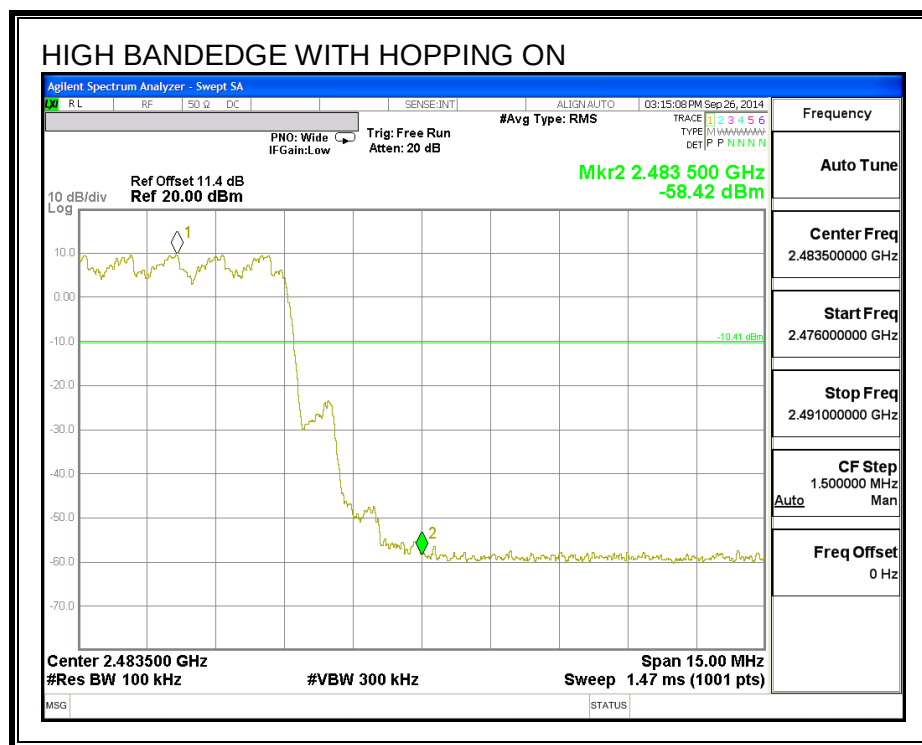
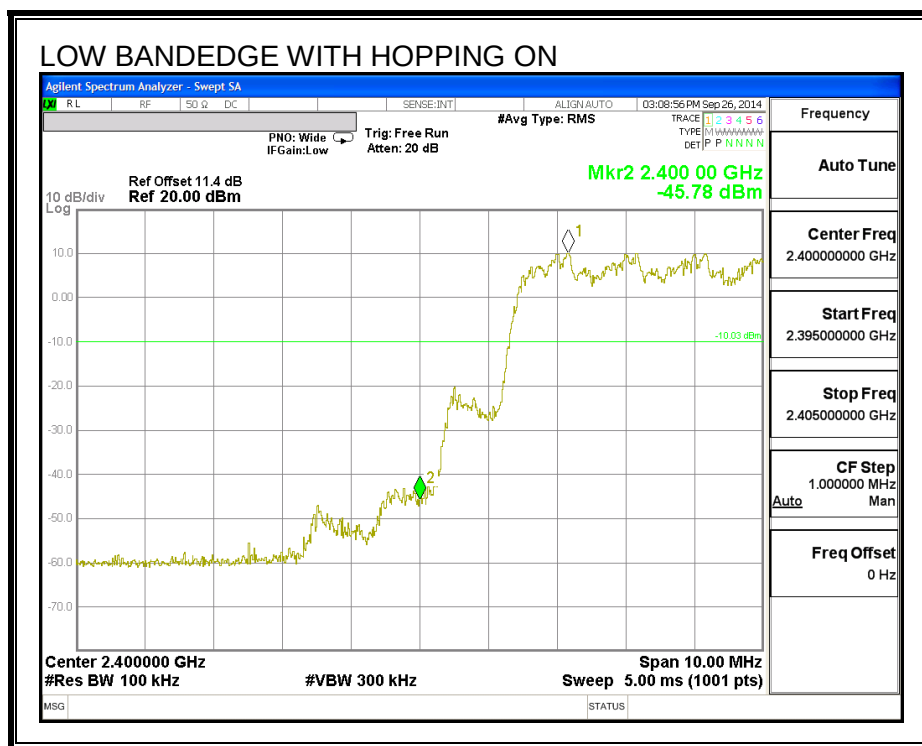
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



9. RADIATED TEST RESULTS

9.1. LIMITS

LIMITS

FCC §15.205 and §15.209

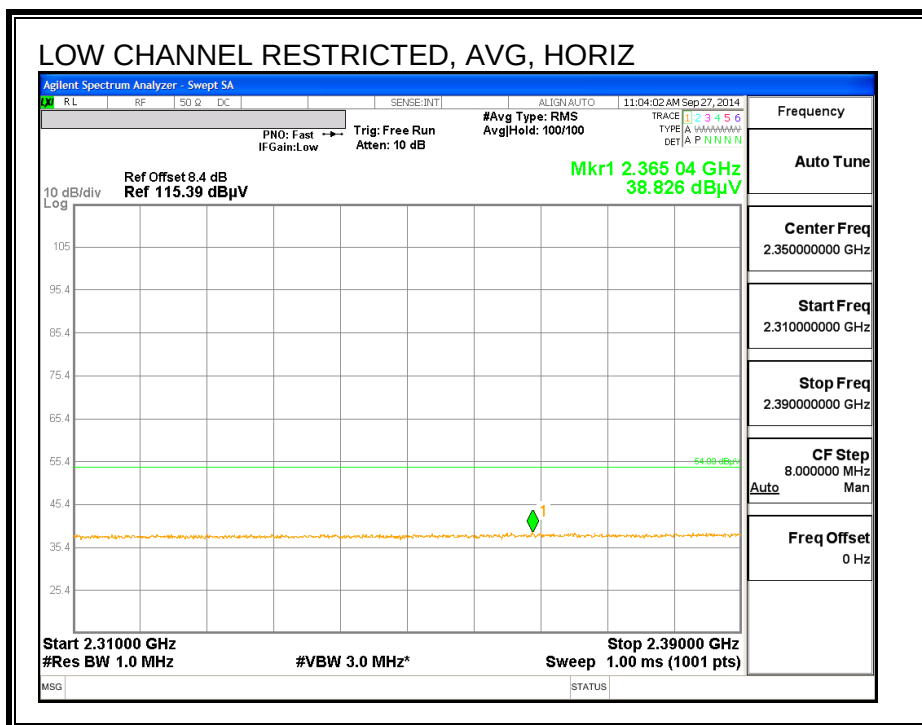
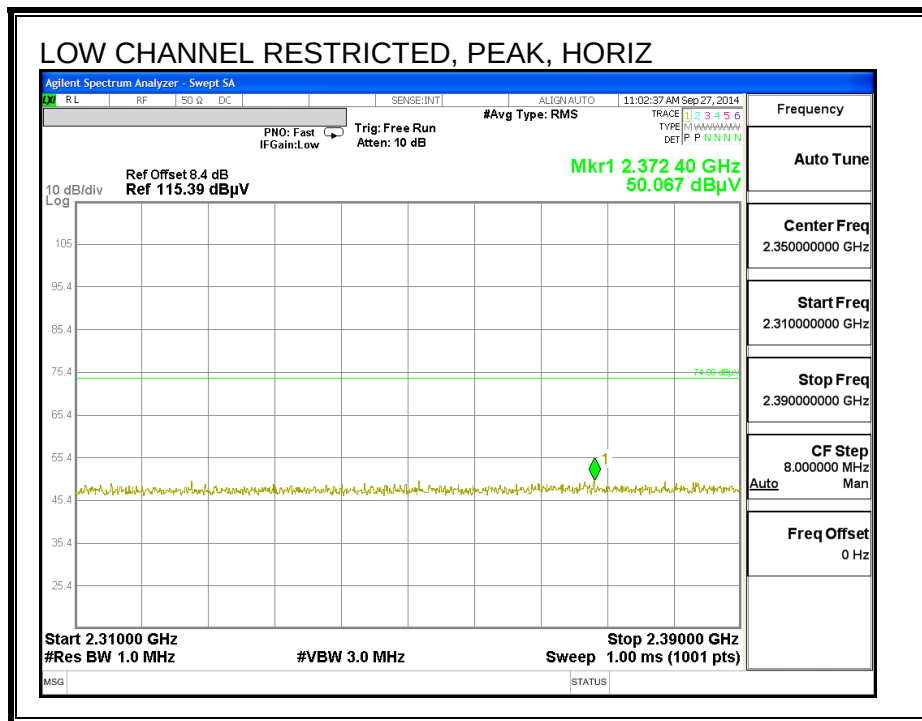
IC RSS-210 Clause 2.6 (Transmitter)

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

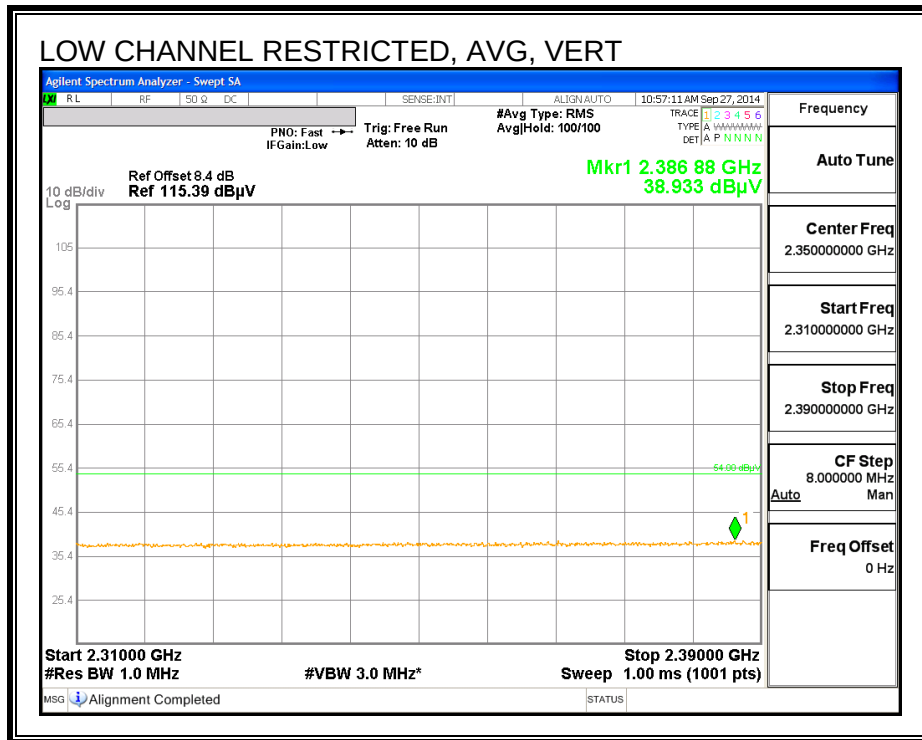
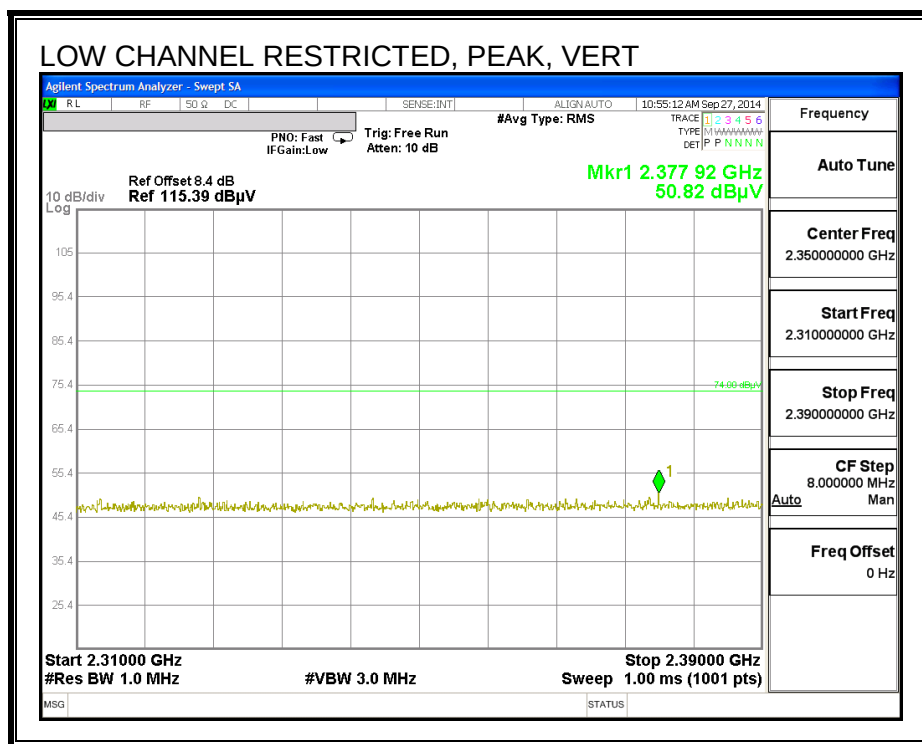
9.2. TRANSMITTER ABOVE 1 GHz

9.2.1. BASIC DATA RATE GFSK MODULATION

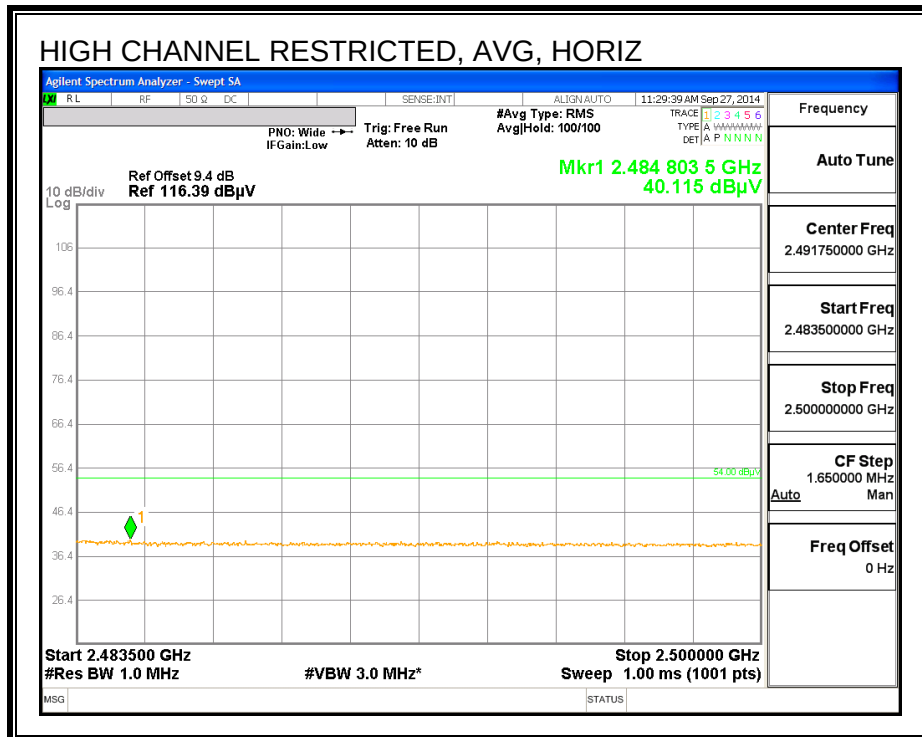
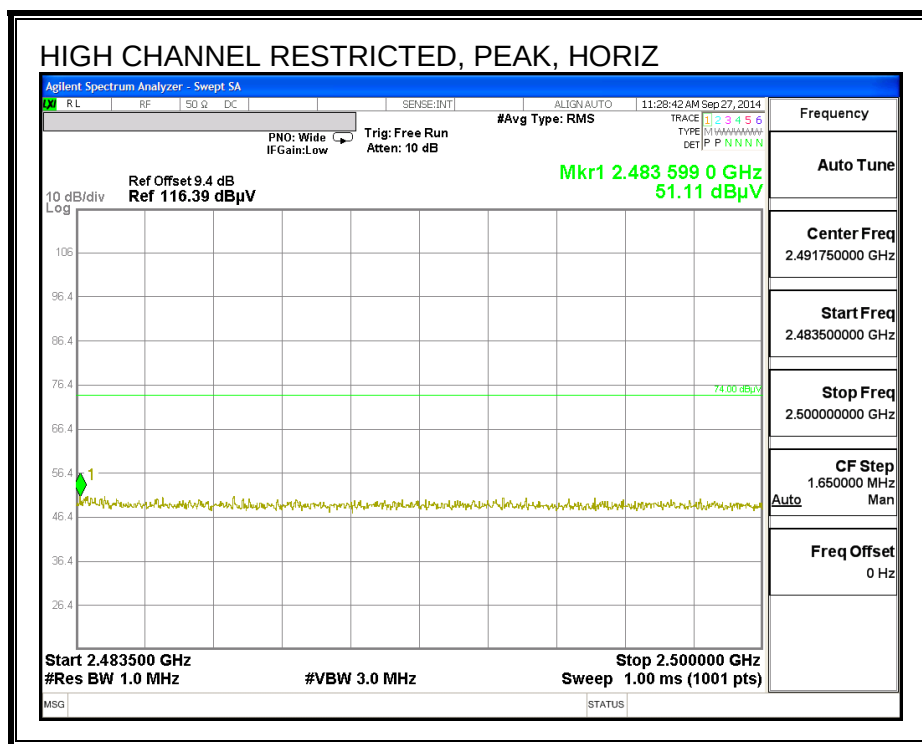
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



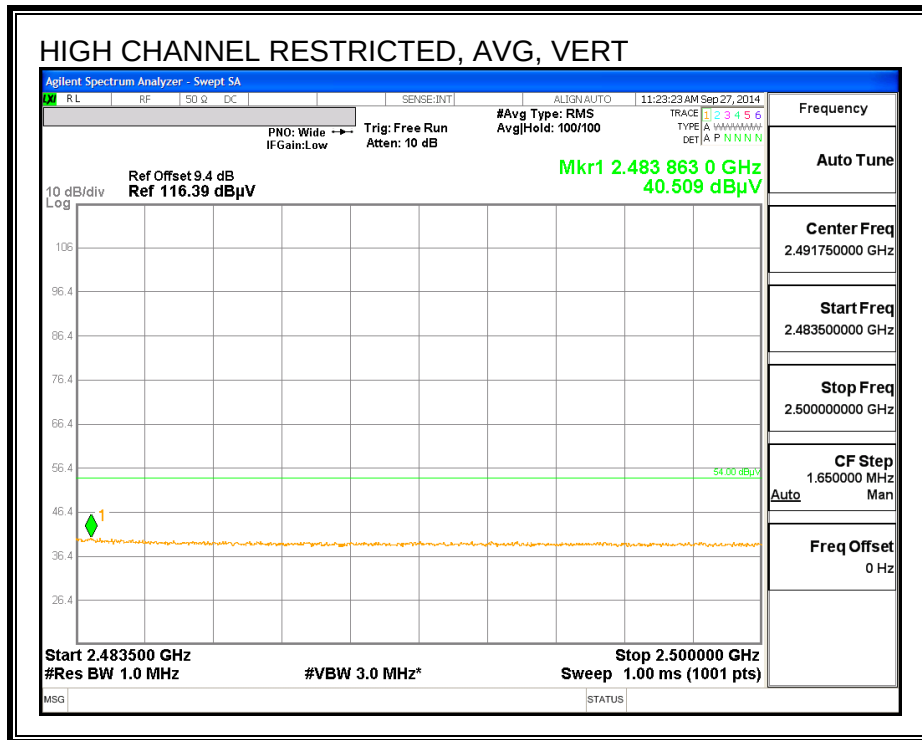
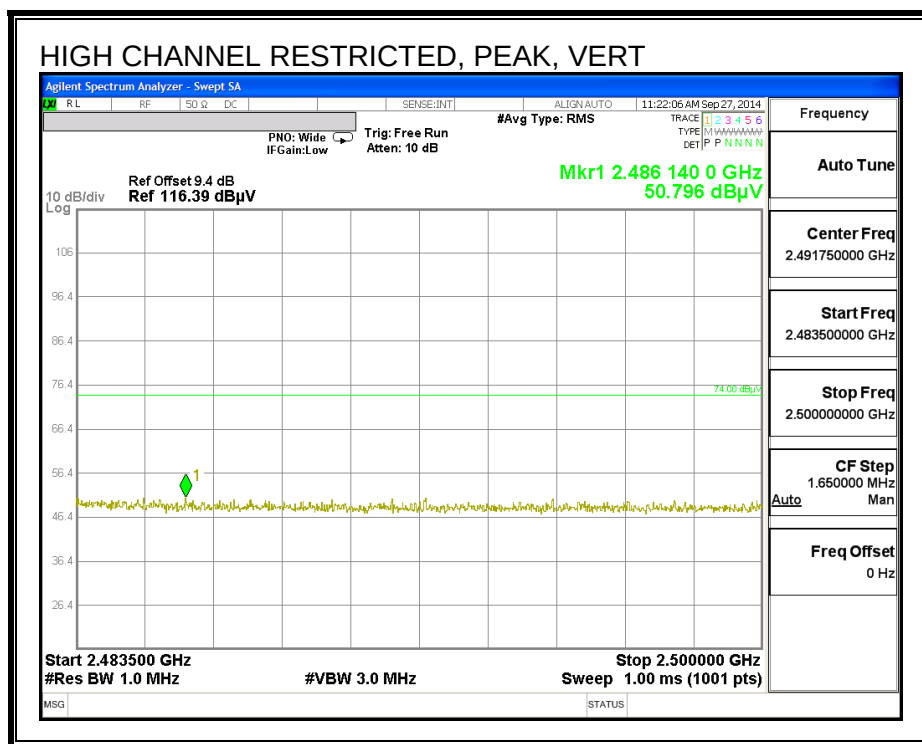
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



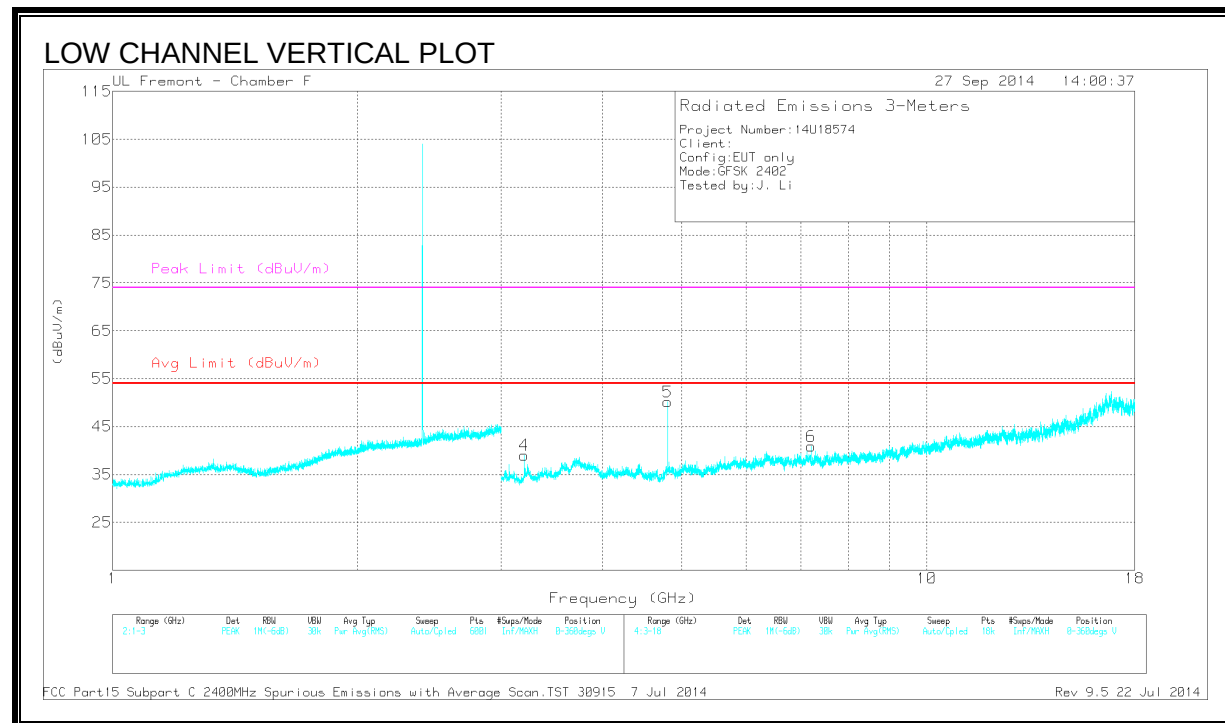
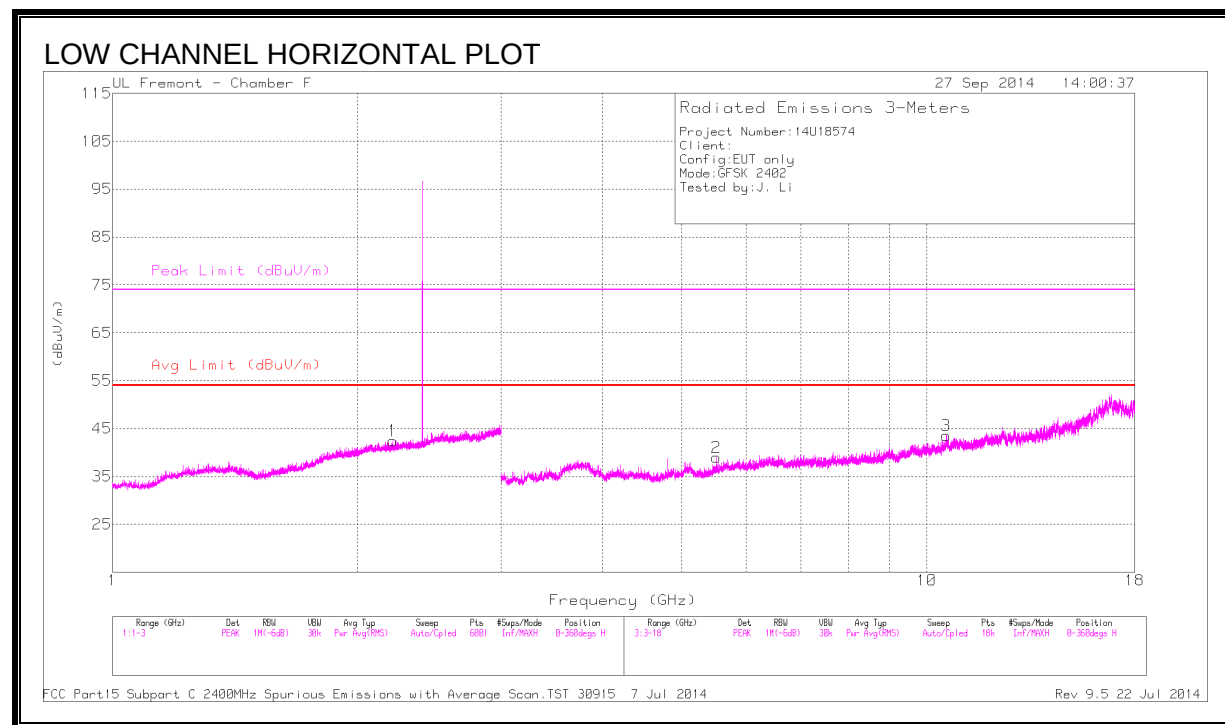
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS(LOW)



DATA

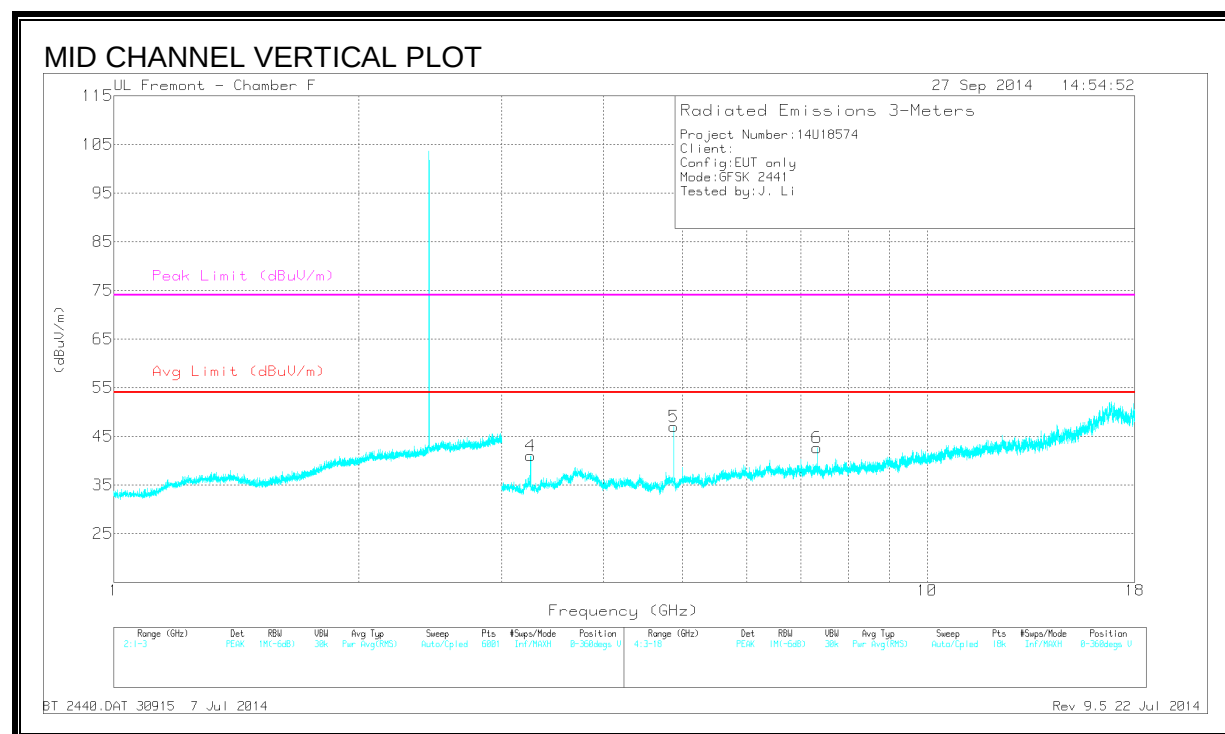
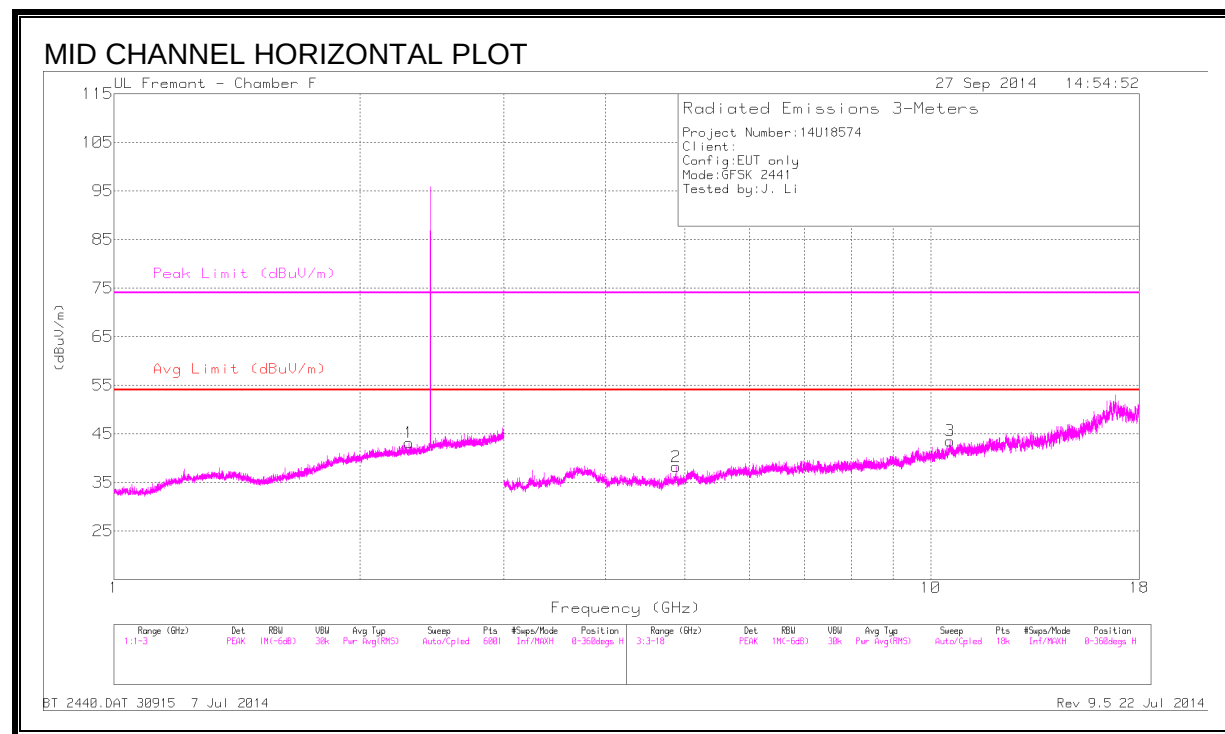
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl /Ftr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 2.207	41.68	PK3	31.8	-24	49.48	-	-	74	-24.52	220	202	H
* 2.205	28.7	VB10	31.8	-24	36.5	54	-17.5	-	-	220	202	H
5.513	37.84	PK3	34.6	-28.4	44.04	-	-	-	-	256	287	H
5.513	25.39	VB10	34.6	-28.4	31.59	-	-	-	-	256	287	H
10.556	33.83	PK3	37.8	-21.2	50.43	-	-	-	-	195	214	H
10.554	21.16	VB10	37.8	-21.3	37.66	-	-	-	-	195	214	H
3.203	42.78	PK3	33.3	-29.4	46.68	-	-	-	-	166	230	V
3.203	35.06	VB10	33.3	-29.4	38.96	-	-	-	-	166	230	V
* 4.804	45.46	PK3	34.1	-27.4	52.16	-	-	74	-21.84	219	186	V
* 4.804	41.82	VB10	34.1	-27.4	48.52	54	-5.48	-	-	219	186	V
7.206	39.09	PK3	35.5	-26.8	47.79	-	-	-	-	263	178	V
7.206	29.72	VB10	35.5	-26.8	38.42	-	-	-	-	263	178	V

* - indicates frequency in CFR15.205/IC8.10 Restricted Band

PK3 - FHSS Method: Maximum Peak

VB10Hz - FHSS Method: 10Hz Video Bandwidth

HARMONICS AND SPURIOUS EMISSIONS(MID)



DATA

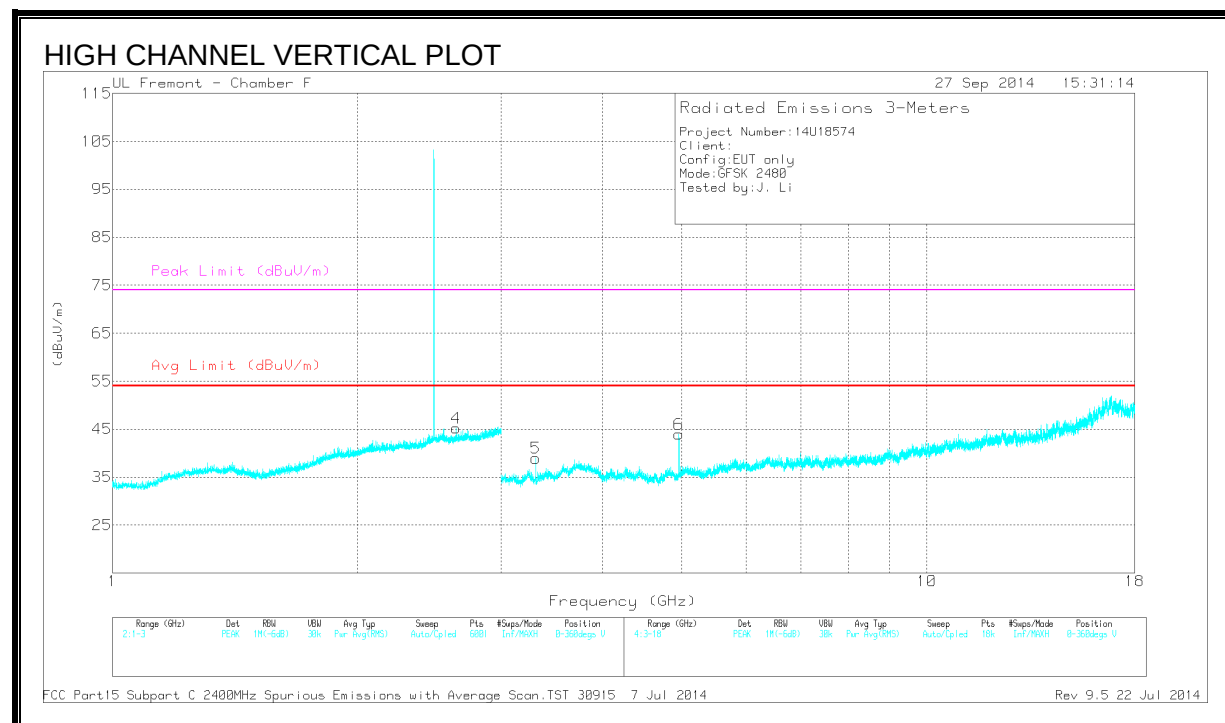
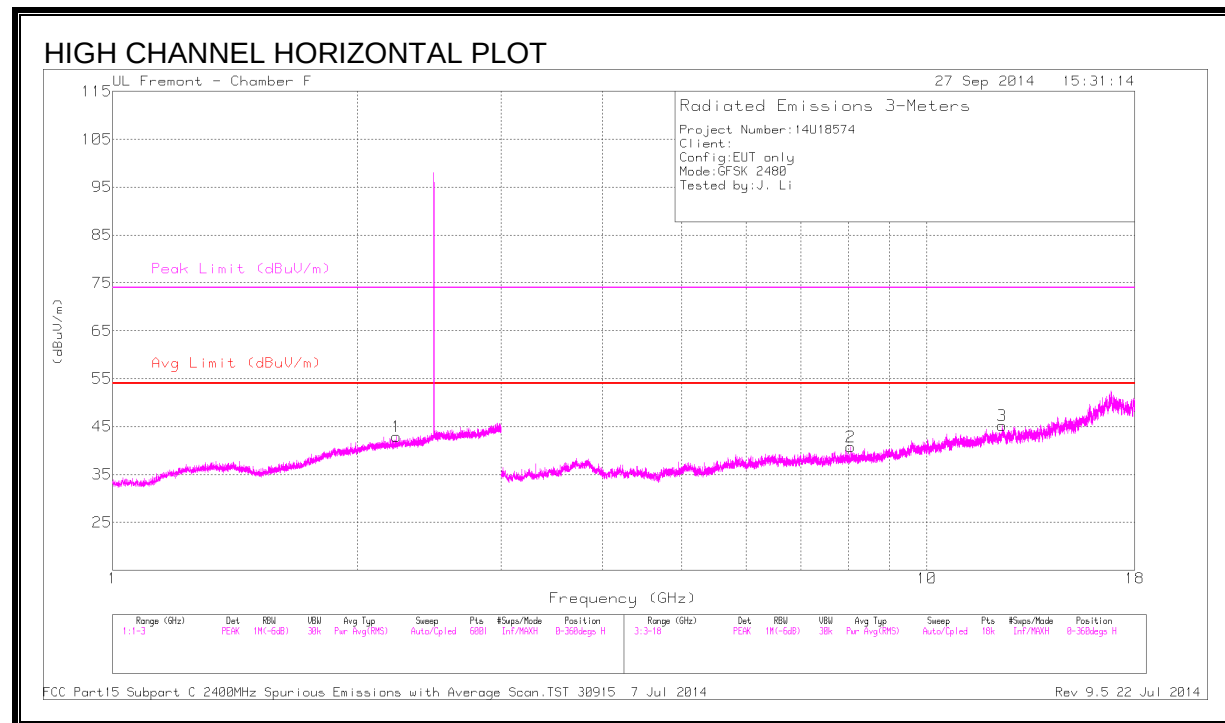
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl /Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 2.298	41.52	PK3	31.8	-23.4	49.92	-	-	74	-24.08	96	234	H
* 2.298	28.52	VB10	31.8	-23.4	36.92	54	-17.08	-	-	96	234	H
* 4.881	36.81	PK3	34.2	-27.8	43.21	-	-	74	-30.79	177	219	H
* 4.882	24.23	VB10	34.2	-27.9	30.53	54	-23.47	-	-	177	219	H
10.567	33.88	PK3	37.8	-20.9	50.78	-	-	-	-	162	195	H
10.566	20.96	VB10	37.8	-20.9	37.86	-	-	-	-	162	195	H
3.255	42.75	PK3	33.5	-29.2	47.05	-	-	-	-	175	236	V
3.255	35.45	VB10	33.5	-29.2	39.75	-	-	-	-	175	236	V
* 4.882	42.76	PK3	34.2	-27.9	49.06	-	-	74	-24.94	222	229	V
* 4.882	38.31	VB10	34.2	-27.9	44.61	54	-9.39	-	-	222	229	V
* 7.323	40.25	PK3	35.6	-26.7	49.15	-	-	74	-24.85	232	208	V
* 7.323	31.94	VB10	35.6	-26.7	40.84	54	-13.16	-	-	232	208	V

* - indicates frequency in CFR15.205/IC8.10 Restricted Band

PK3 - FHSS Method: Maximum Peak

VB10Hz - FHSS Method: 10Hz Video Bandwidth

HARMONICS AND SPURIOUS EMISSIONS(HIGH)



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl /Ftr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 2.231	41.92	PK3	31.8	-23.7	50.02	-	-	74	-23.98	254	216	H
* 2.231	28.65	VB10	31.8	-23.7	36.75	54	-17.25	-	-	254	216	H
2.642	41.75	PK3	32.7	-23.2	51.25	-	-	-	-	211	179	V
2.644	28.82	VB10	32.7	-23.2	38.32	-	-	-	-	211	179	V
* 8.063	35.92	PK3	35.7	-25.1	46.52	-	-	74	-27.48	158	260	H
* 8.064	23.56	VB10	35.7	-25.1	34.16	54	-19.84	-	-	158	260	H
* 12.37	34.68	PK3	38.9	-21.1	52.48	-	-	74	-21.52	122	186	H
* 12.371	22.21	VB10	38.9	-21.2	39.91	54	-14.09	-	-	122	186	H
3.307	42.07	PK3	33.7	-29.4	46.37	-	-	-	-	181	255	V
3.307	34.26	VB10	33.7	-29.4	38.56	-	-	-	-	181	255	V
* 4.96	42.29	PK3	34.2	-29.2	47.29	-	-	74	-26.71	225	225	V
* 4.96	36.2	VB10	34.2	-29.2	41.2	54	-12.8	-	-	225	225	V

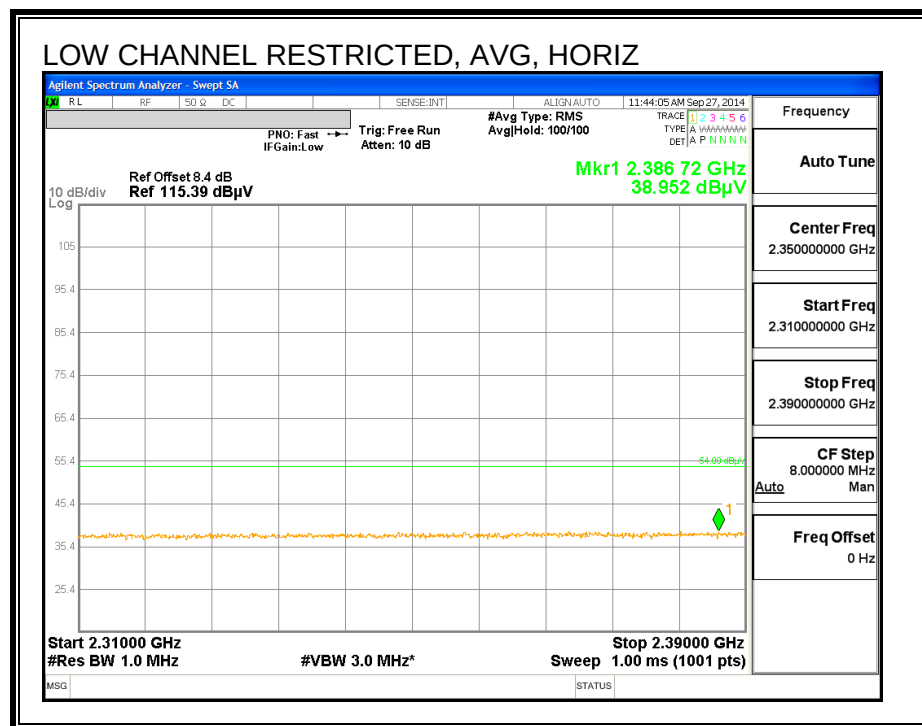
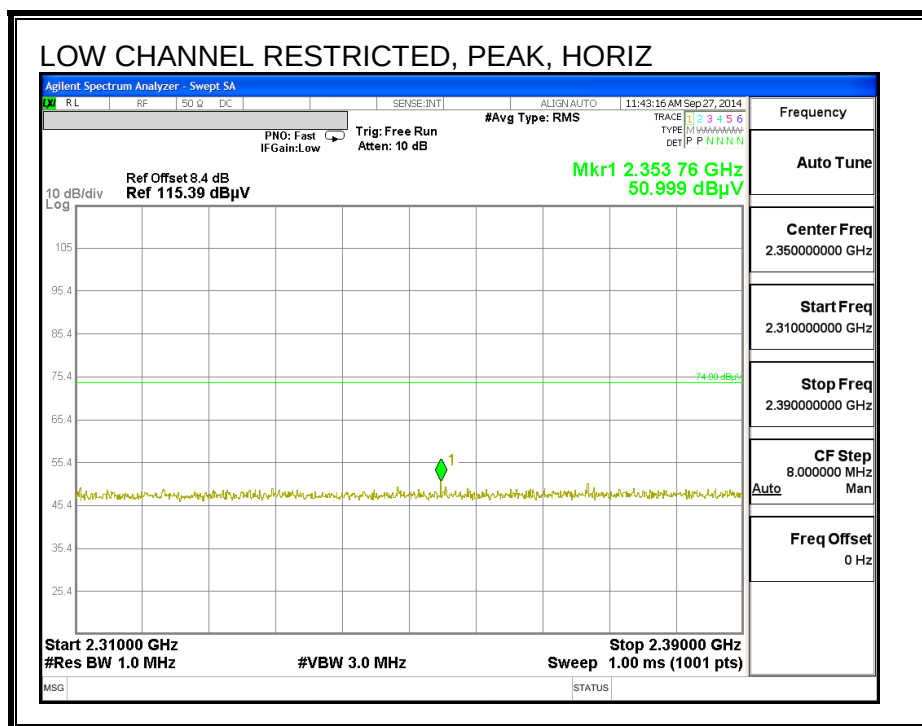
* - indicates frequency in CFR15.205/IC8.10 Restricted Band

PK3 - FHSS Method: Maximum Peak

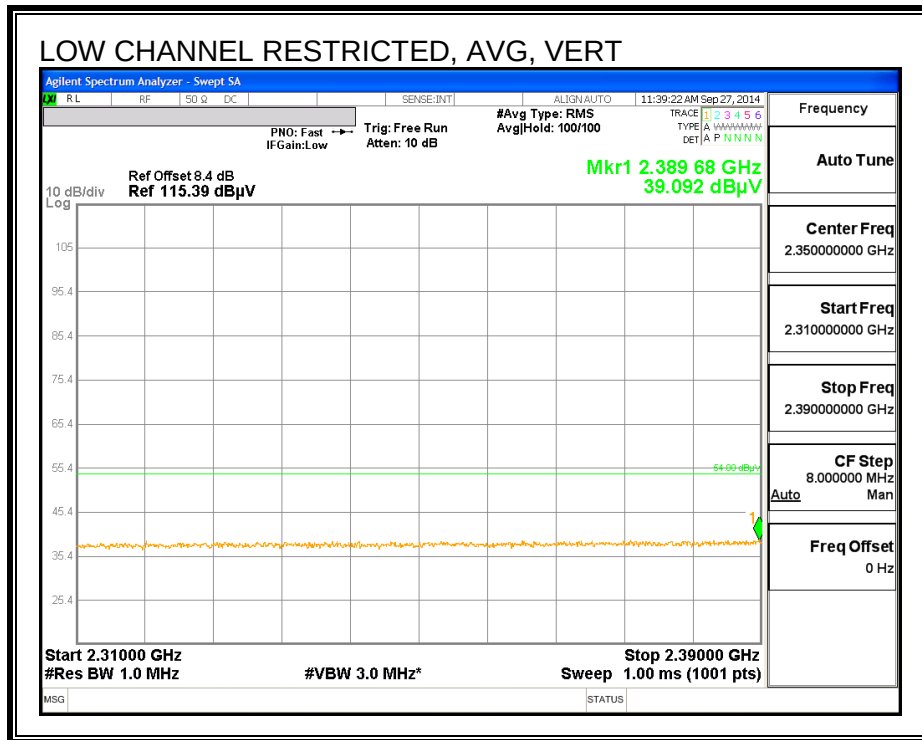
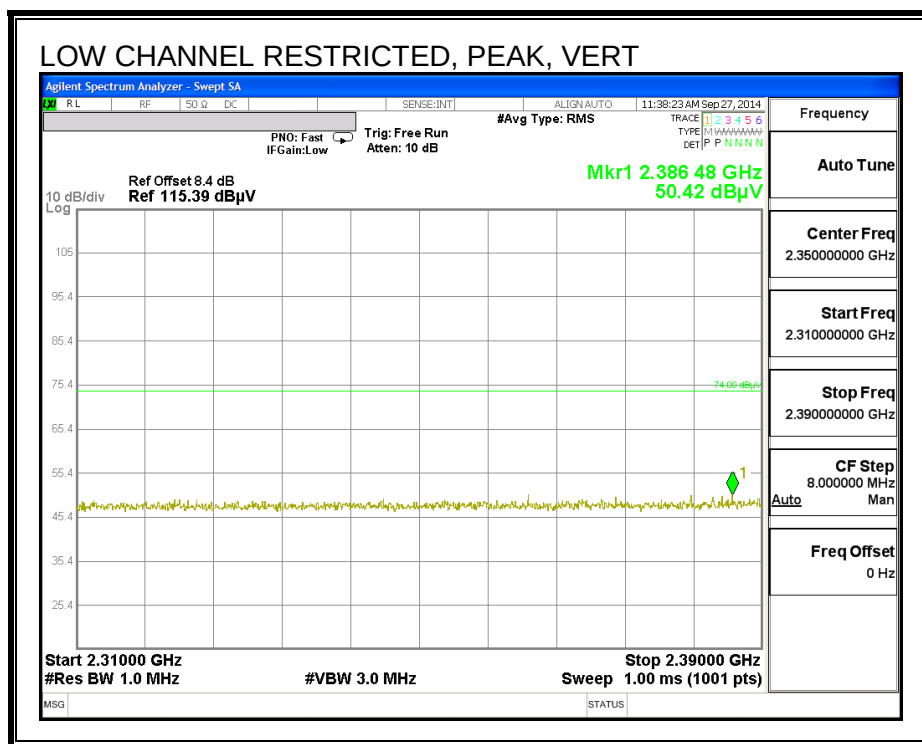
VB10Hz - FHSS Method: 10Hz Video Bandwidth

9.2.2. ENHANCED DATA RATE 8PSK MODULATION

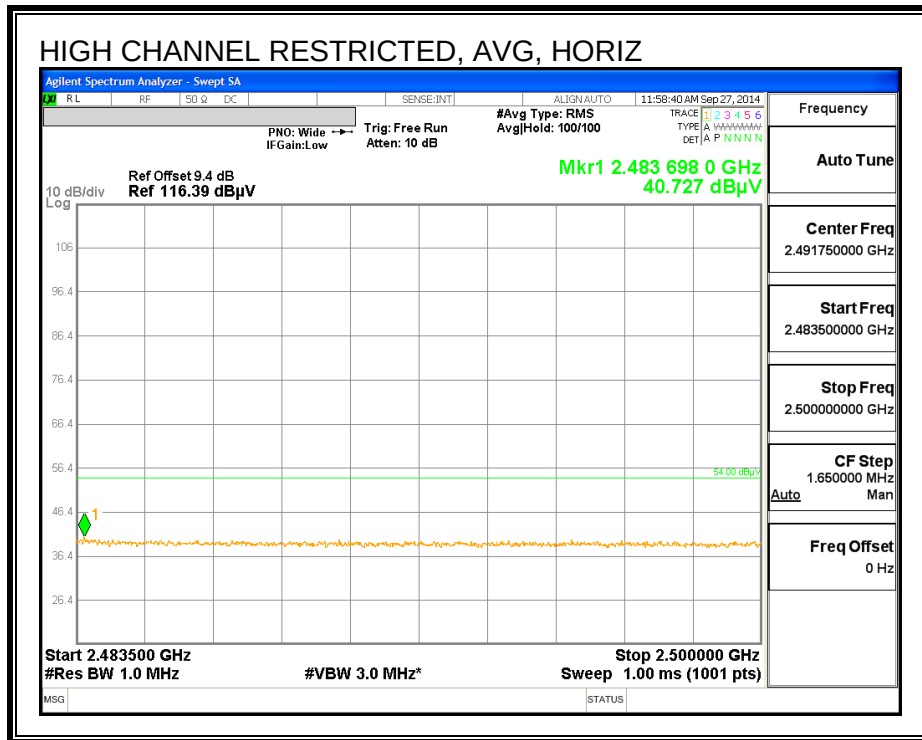
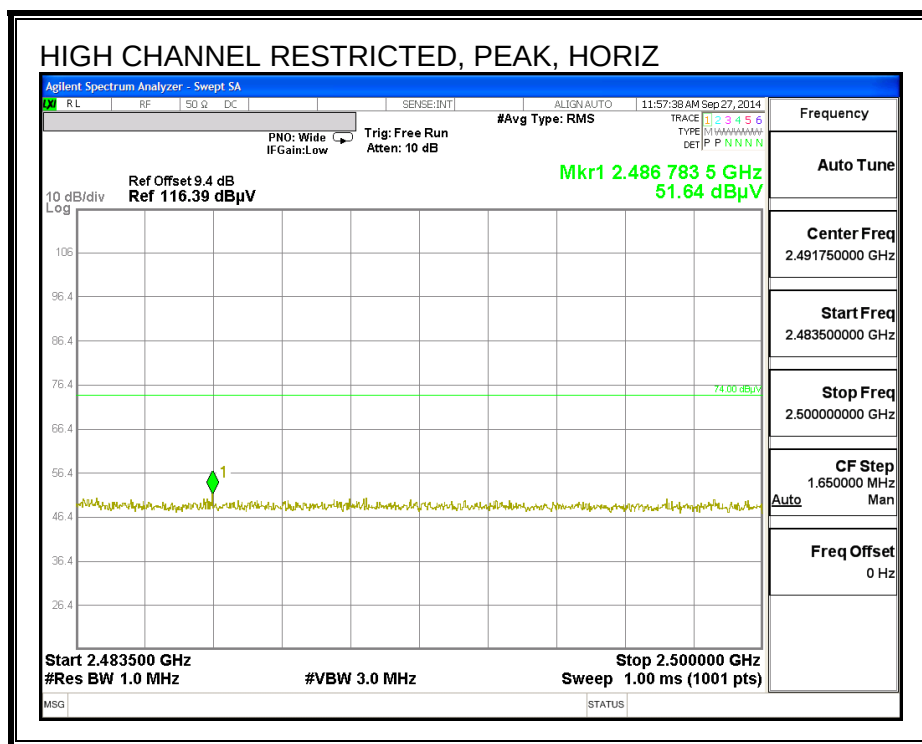
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



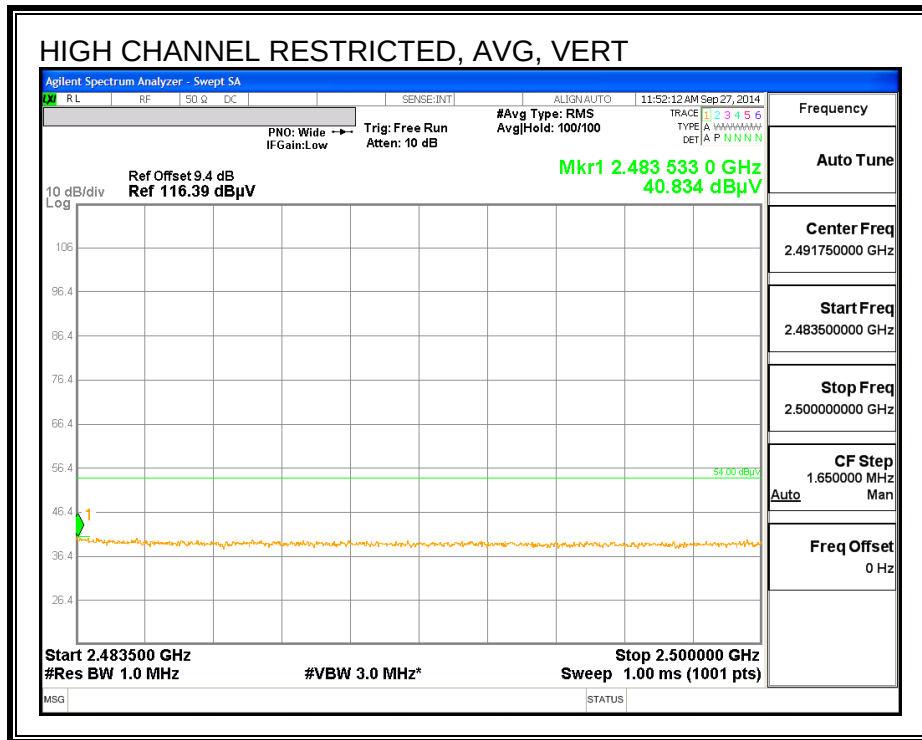
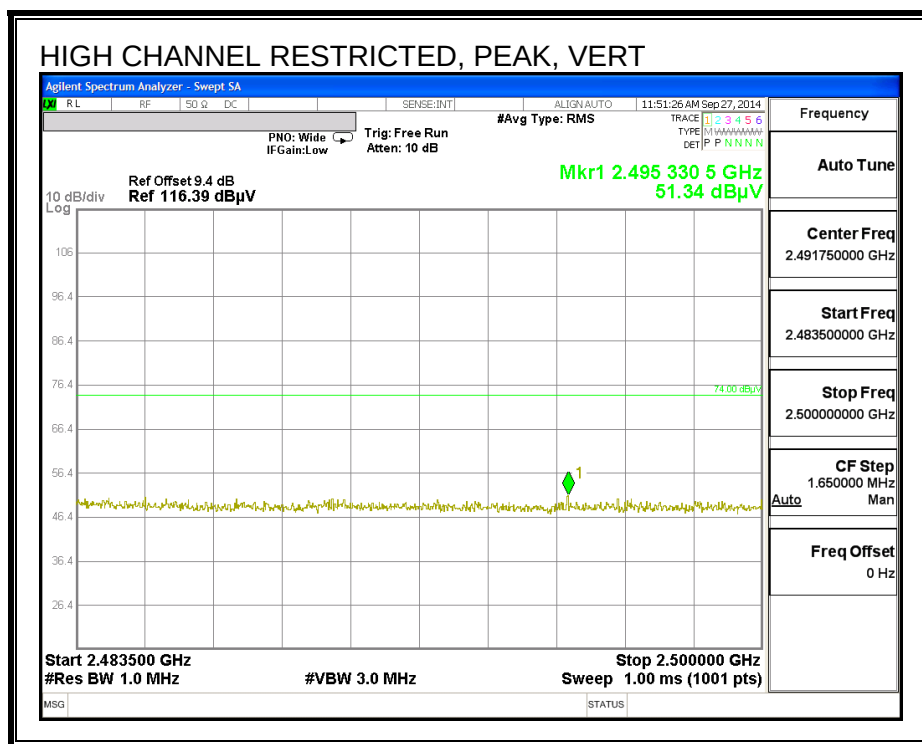
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



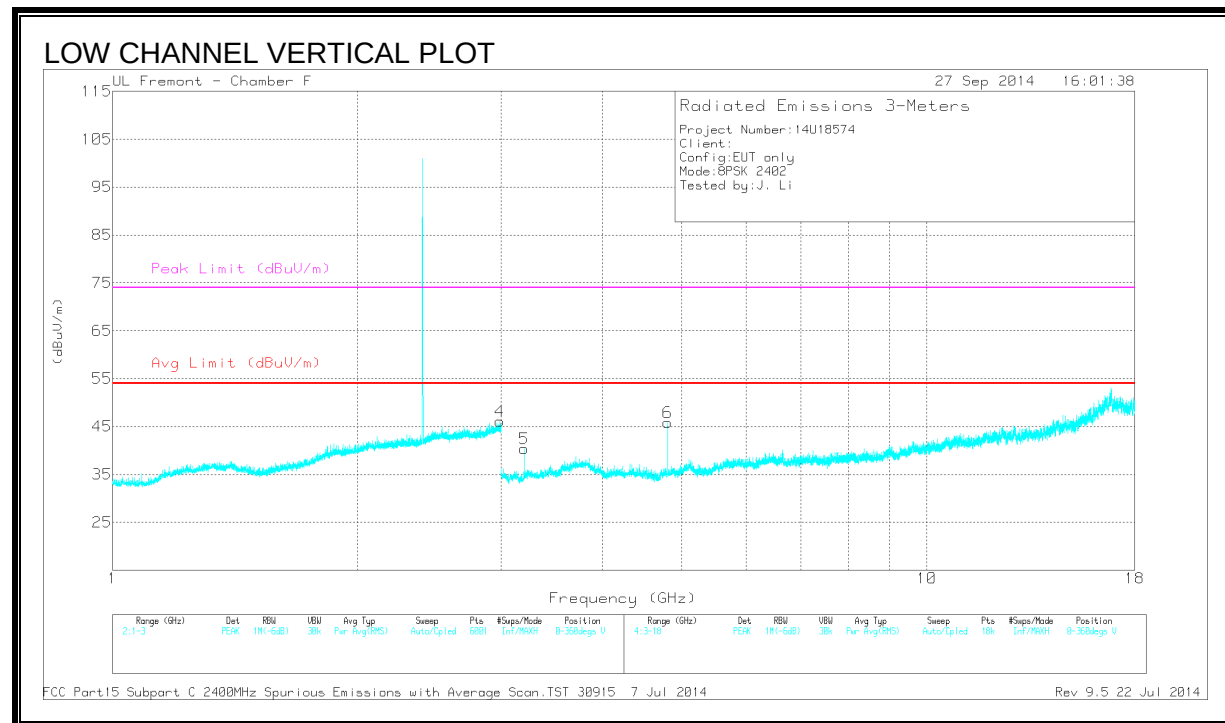
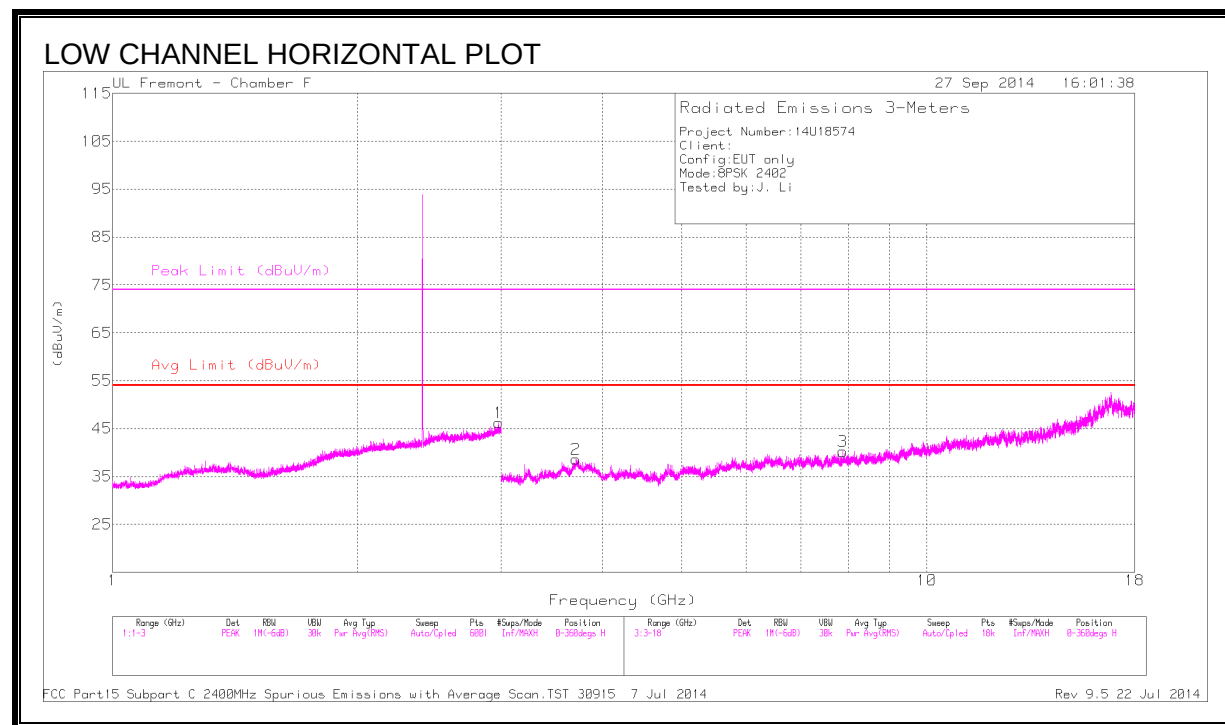
RESTRICTED BANEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS(LOW)



DATA

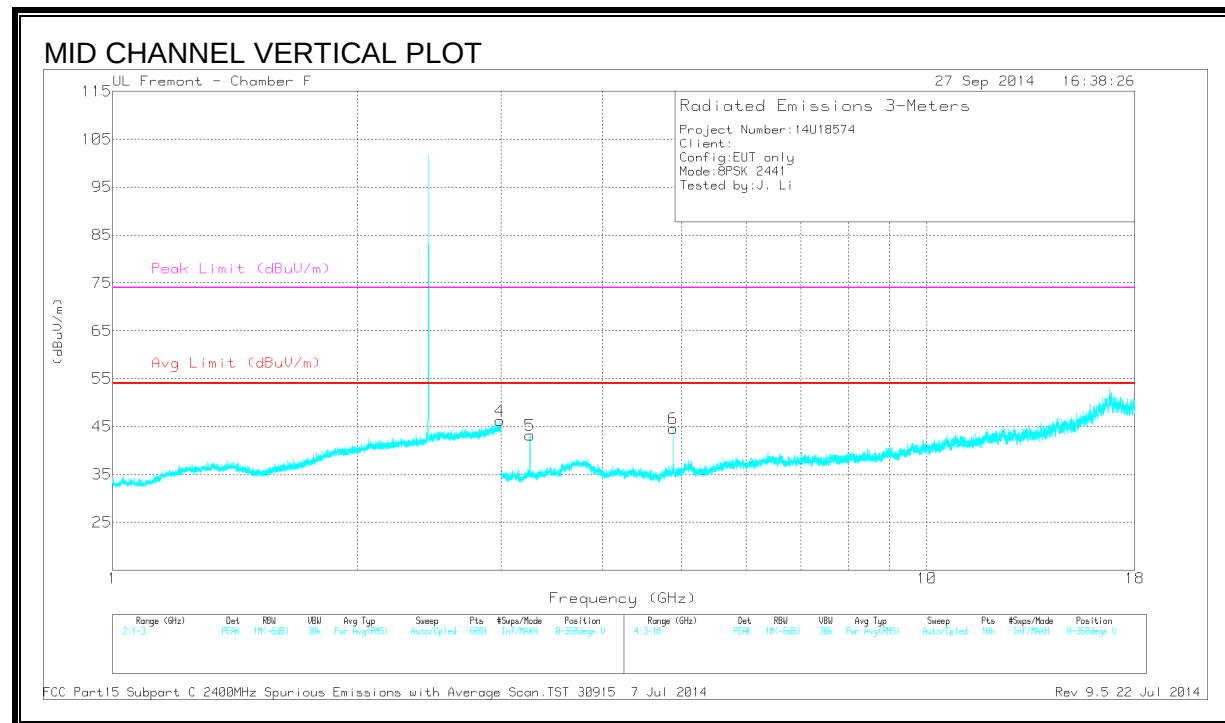
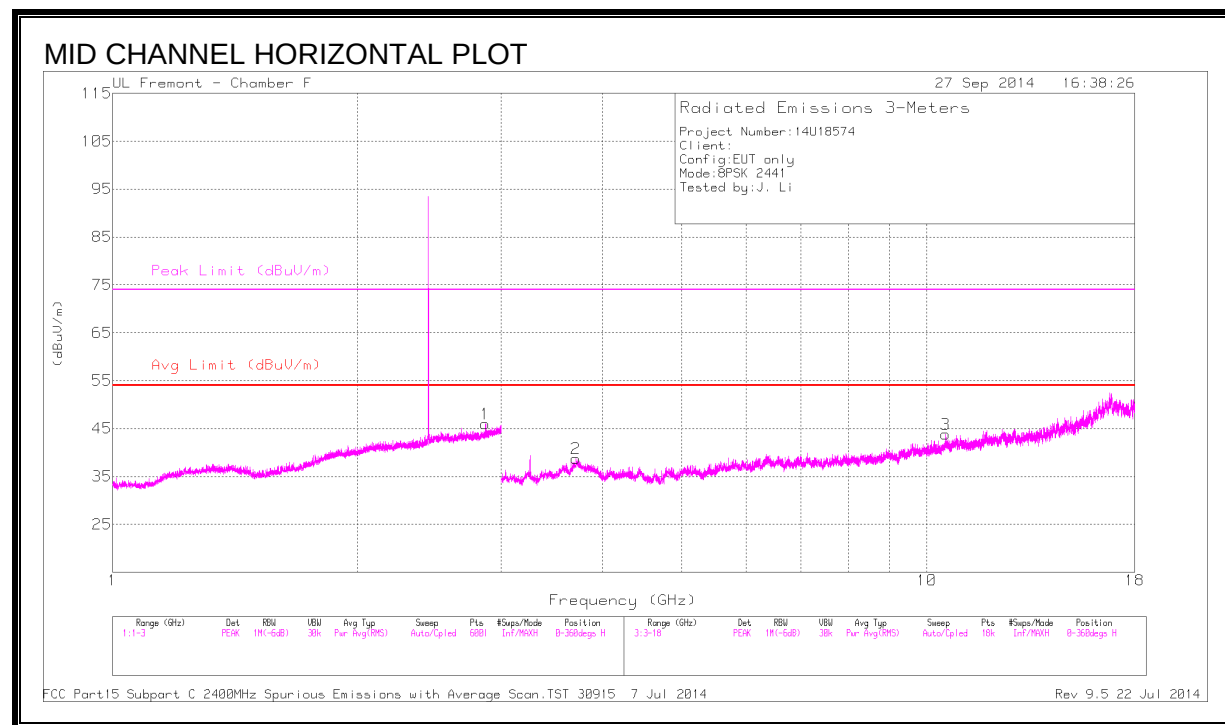
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl /Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2.981	41.65	PK3	33.3	-22	52.95	-	-	-	-	256	168	H
2.980	28.61	VB10	33.3	-22	39.91	-	-	-	-	256	168	H
2.002	42.07	PK3	31.7	-24.8	48.97	-	-	-	-	102	196	V
1.999	28.77	VB10	31.7	-24.8	35.67	-	-	-	-	102	196	V
* 3.707	38.74	PK3	34.8	-29.4	44.14	-	-	74	-29.86	215	213	H
* 3.706	26.15	VB10	34.8	-29.4	31.55	54	-22.45	-	-	215	213	H
7.885	37.2	PK3	35.7	-26.1	46.8	-	-	-	-	147	224	H
7.885	24.37	VB10	35.7	-26.1	33.97	-	-	-	-	147	224	H
3.203	43.25	PK3	33.3	-29.4	47.15	-	-	-	-	179	235	V
3.203	35.06	VB10	33.3	-29.4	38.96	-	-	-	-	179	235	V
* 4.803	42.98	PK3	34.1	-27.4	49.68	-	-	74	-24.32	234	190	V
* 4.804	36.02	VB10	34.1	-27.4	42.72	54	-11.28	-	-	234	190	V

* - indicates frequency in CFR15.205/IC8.10 Restricted Band

PK3 - FHSS Method: Maximum Peak

VB10Hz - FHSS Method: 10Hz Video Bandwidth

HARMONICS AND SPURIOUS EMISSIONS(MID)



DATA

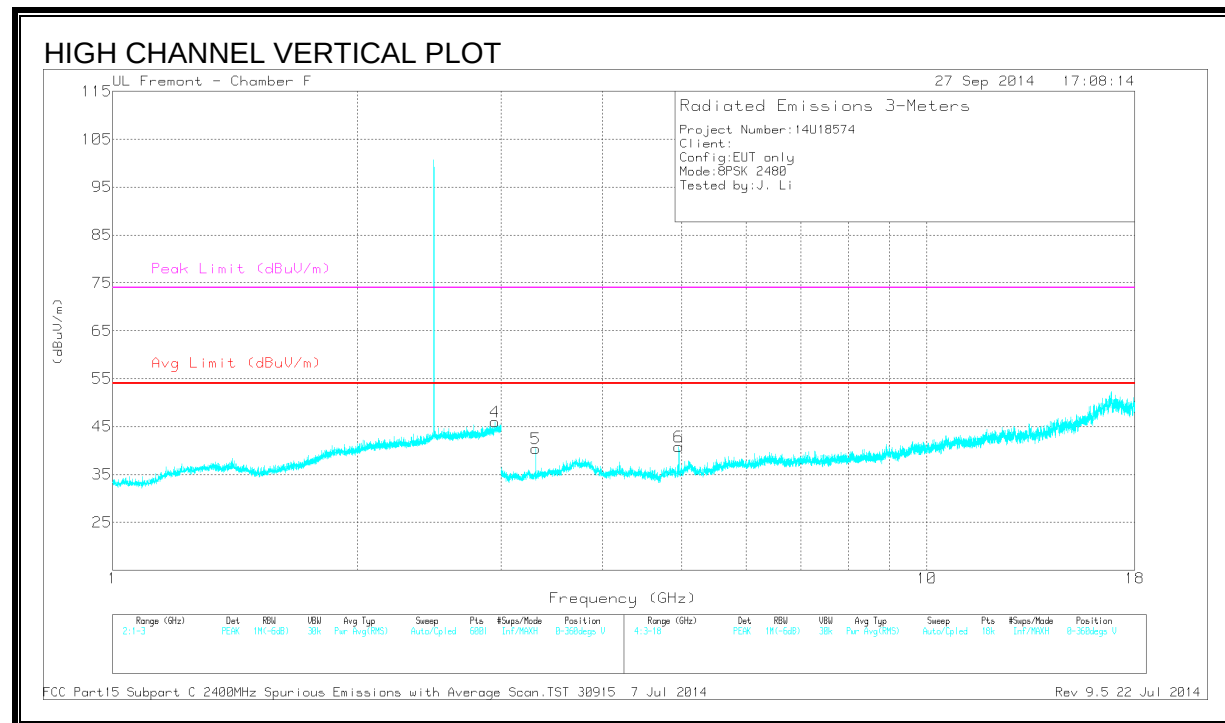
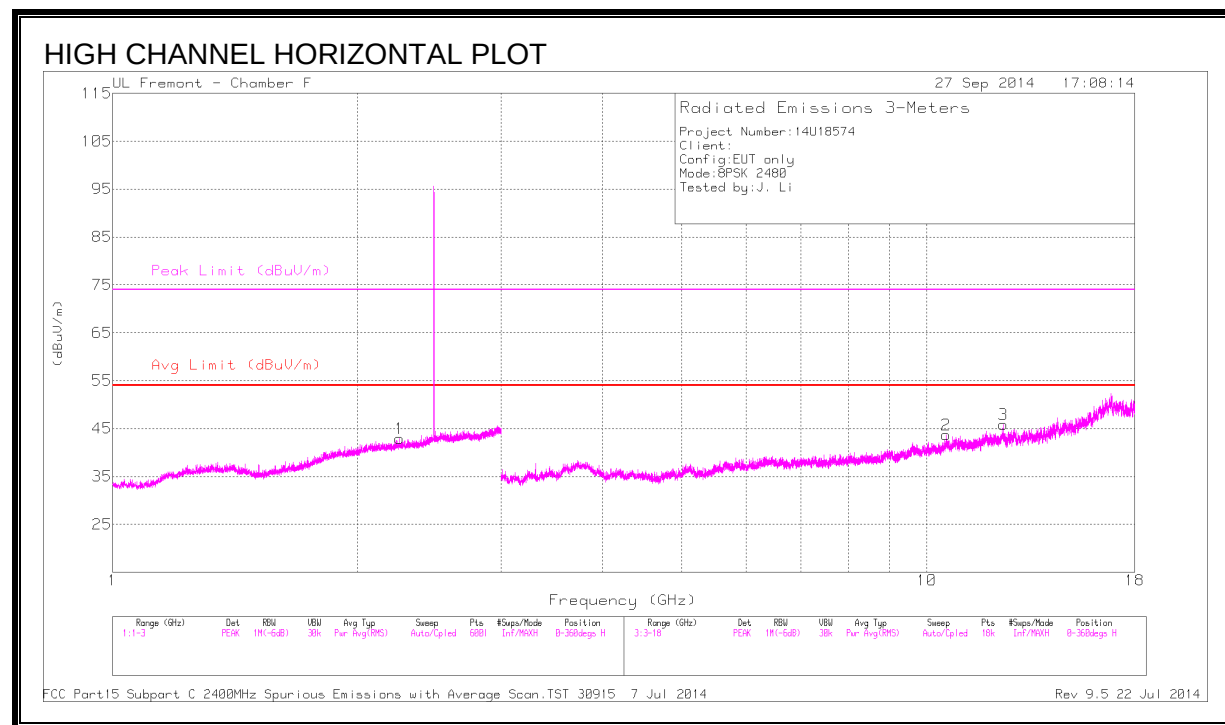
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl /Fitr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 2.871	41.4	PK3	33.1	-22.5	52	-	-	74	-22	122	189	H
* 2.872	28.44	VB10	33.1	-22.5	39.04	54	-14.96	-	-	122	189	H
2.99	41.44	PK3	33.3	-22.1	52.64	-	-	-	-	141	223	V
2.988	28.57	VB10	33.3	-22.1	39.77	-	-	-	-	141	223	V
* 3.708	38.37	PK3	34.8	-29.4	43.77	-	-	74	-30.23	219	237	H
* 3.708	26.01	VB10	34.8	-29.4	31.41	54	-22.59	-	-	219	237	H
10.542	33.46	PK3	37.8	-21.6	49.66	-	-	-	-	176	209	H
10.541	21.35	VB10	37.8	-21.7	37.45	-	-	-	-	176	209	H
3.255	44.35	PK3	33.5	-29.2	48.65	-	-	-	-	163	269	V
3.255	38.39	VB10	33.5	-29.2	42.69	-	-	-	-	163	269	V
* 4.882	42.13	PK3	34.2	-27.9	48.43	-	-	74	-25.57	227	233	V
* 4.882	35	VB10	34.2	-27.9	41.3	54	-12.7	-	-	227	233	V

* - indicates frequency in CFR15.205/IC8.10 Restricted Band

PK3 - FHSS Method: Maximum Peak

VB10Hz - FHSS Method: 10Hz Video Bandwidth

HARMONICS AND SPURIOUS EMISSIONS(HIGH)



DATA

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl /Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 2.250	41.73	PK3	31.8	-23.4	50.13	-	-	74	-23.87	226	155	H
* 2.247	28.56	VB10	31.8	-23.5	36.86	54	-17.14	-	-	226	155	H
2.001	41.73	PK3	31.7	-24.8	48.63	-	-	-	-	165	187	V
1.999	28.76	VB10	31.7	-24.8	35.66	-	-	-	-	165	187	V
10.561	33.95	PK3	37.8	-21	50.75	-	-	-	-	204	175	H
10.560	21.08	VB10	37.8	-21	37.88	-	-	-	-	204	175	H
* 12.408	34.38	PK3	38.9	-21.9	51.38	-	-	74	-22.62	173	239	H
* 12.408	22.07	VB10	38.9	-21.9	39.07	54	-14.93	-	-	173	239	H
3.307	42.04	PK3	33.7	-29.4	46.34	-	-	-	-	181	261	V
3.307	33.91	VB10	33.7	-29.4	38.21	-	-	-	-	181	261	V
* 4.960	41.51	PK3	34.2	-29.2	46.51	-	-	74	-27.49	224	151	V
* 4.960	32.6	VB10	34.2	-29.2	37.6	54	-16.4	-	-	224	151	V

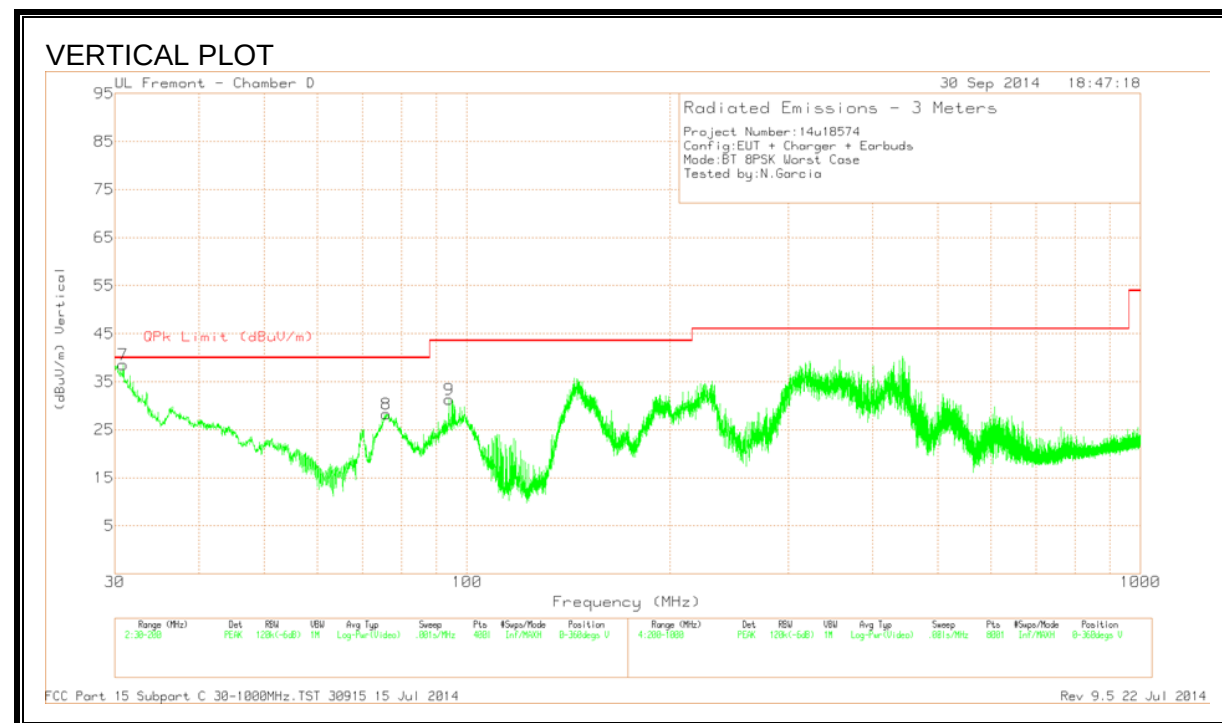
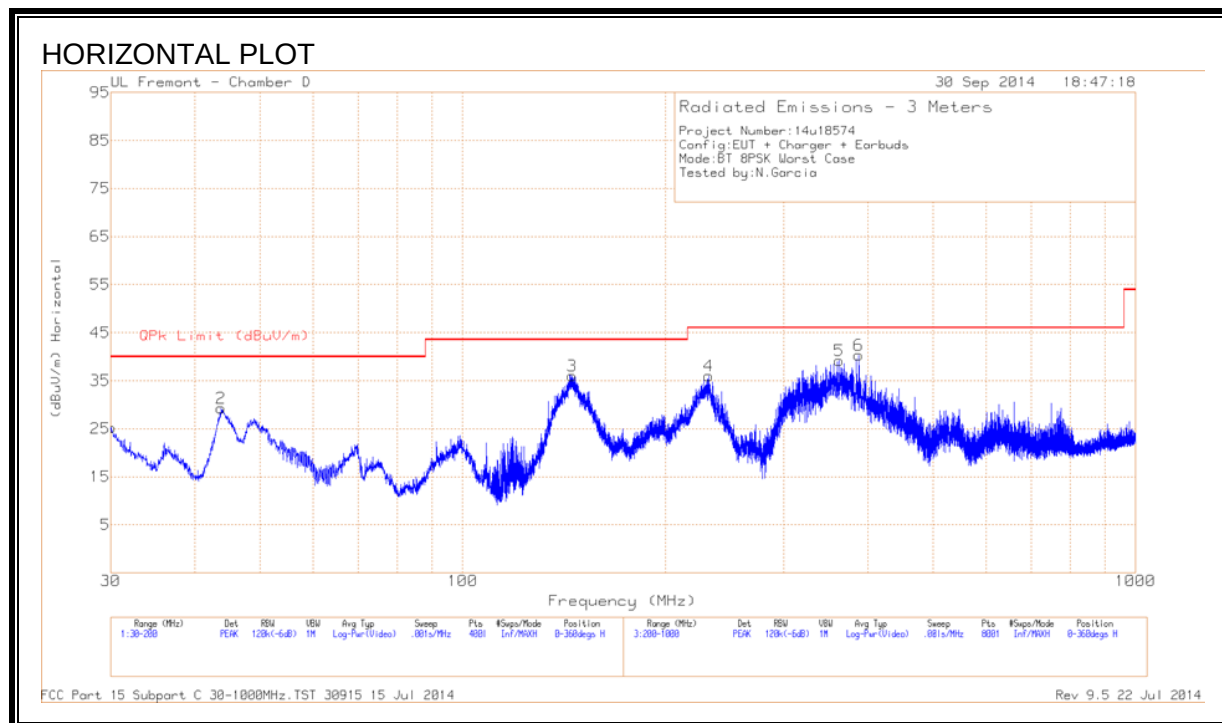
* - indicates frequency in CFR15.205/IC8.10 Restricted Band

PK3 - FHSS Method: Maximum Peak

VB10Hz - FHSS Method: 10Hz Video Bandwidth

9.3. WORST-CASE BELOW 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL & VERTICAL)



HORIZONTAL AND VERTICAL DATA

Trace Markers

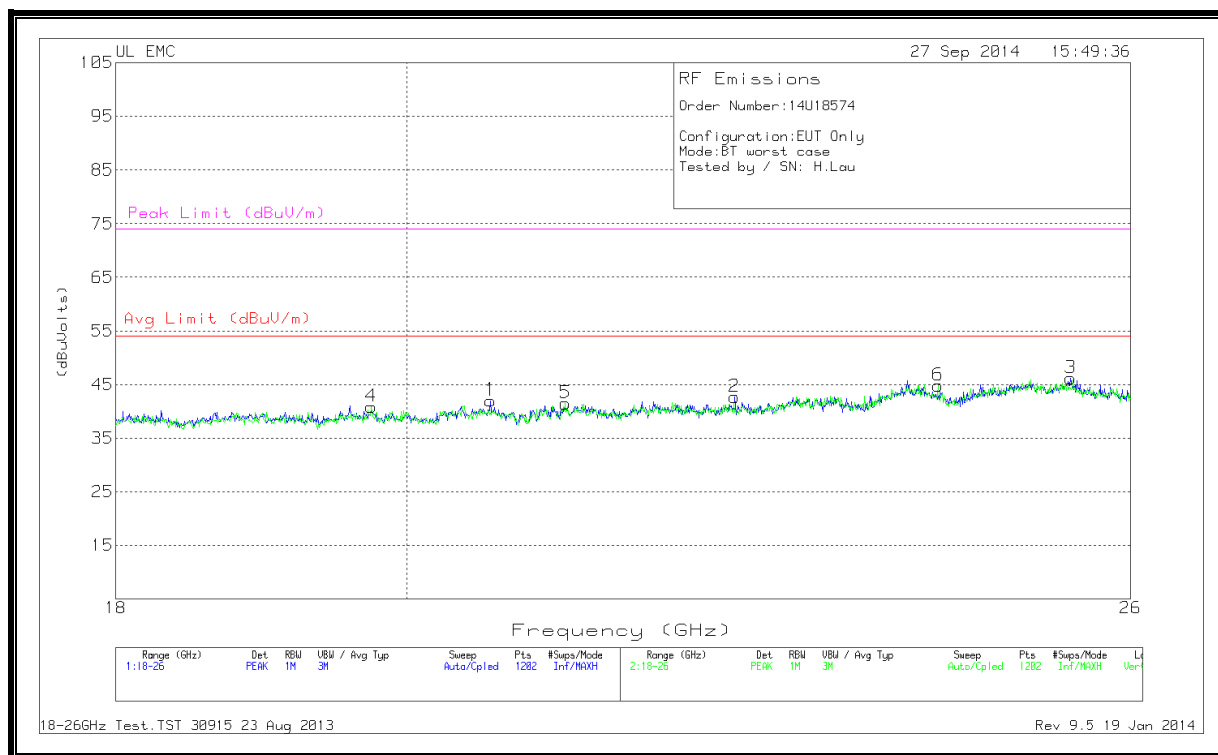
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Hybrid	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	30.085	35.5	PK	21.4	-31.7	25.2	40	-14.8	0-360	301	H
7	30.7008	44.14	QP	20.9	-31.7	33.34	40	-6.66	307	111	V
2	43.7275	49.56	PK	11.3	-31.6	29.26	40	-10.74	0-360	401	H
8	75.815	51.63	PK	8	-31.4	28.23	40	-11.77	0-360	100	V
9	94.09	54.08	PK	8.7	-31.5	31.28	43.52	-12.24	0-360	100	V
3	145.5575	54.75	PK	12.6	-31.3	36.05	43.52	-7.47	0-360	201	H
4	232	55.38	PK	11.2	-30.6	35.98	46.02	-10.04	0-360	100	H
5	362.6	54.45	PK	14.8	-30.1	39.15	46.02	-6.87	0-360	100	H
6	387.6587	40.6	QP	15.2	-30.1	25.7	46.02	-20.32	147	113	H

PK - Peak detector

QP - Quasi-Peak detector

9.4. WORST-CASE ABOVE 18 GHz

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



DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T89 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	20.618	42.2	PK	32.9	-23.6	-9.5	42	54	-12	74	-32
2	22.523	42.17	PK	33.4	-23.4	-9.5	42.67	54	-11.33	74	-31.33
3	25.44	44.57	PK	34.1	-23	-9.5	46.17	54	-7.83	74	-27.83
4	19.745	41.73	PK	32.7	-24.1	-9.5	40.83	54	-13.17	74	-33.17
5	21.184	41.5	PK	33	-23.5	-9.5	41.5	54	-12.5	74	-32.5
6	24.248	43.43	PK	33.8	-22.9	-9.5	44.83	54	-9.17	74	-29.17

PK - Peak detector

10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

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

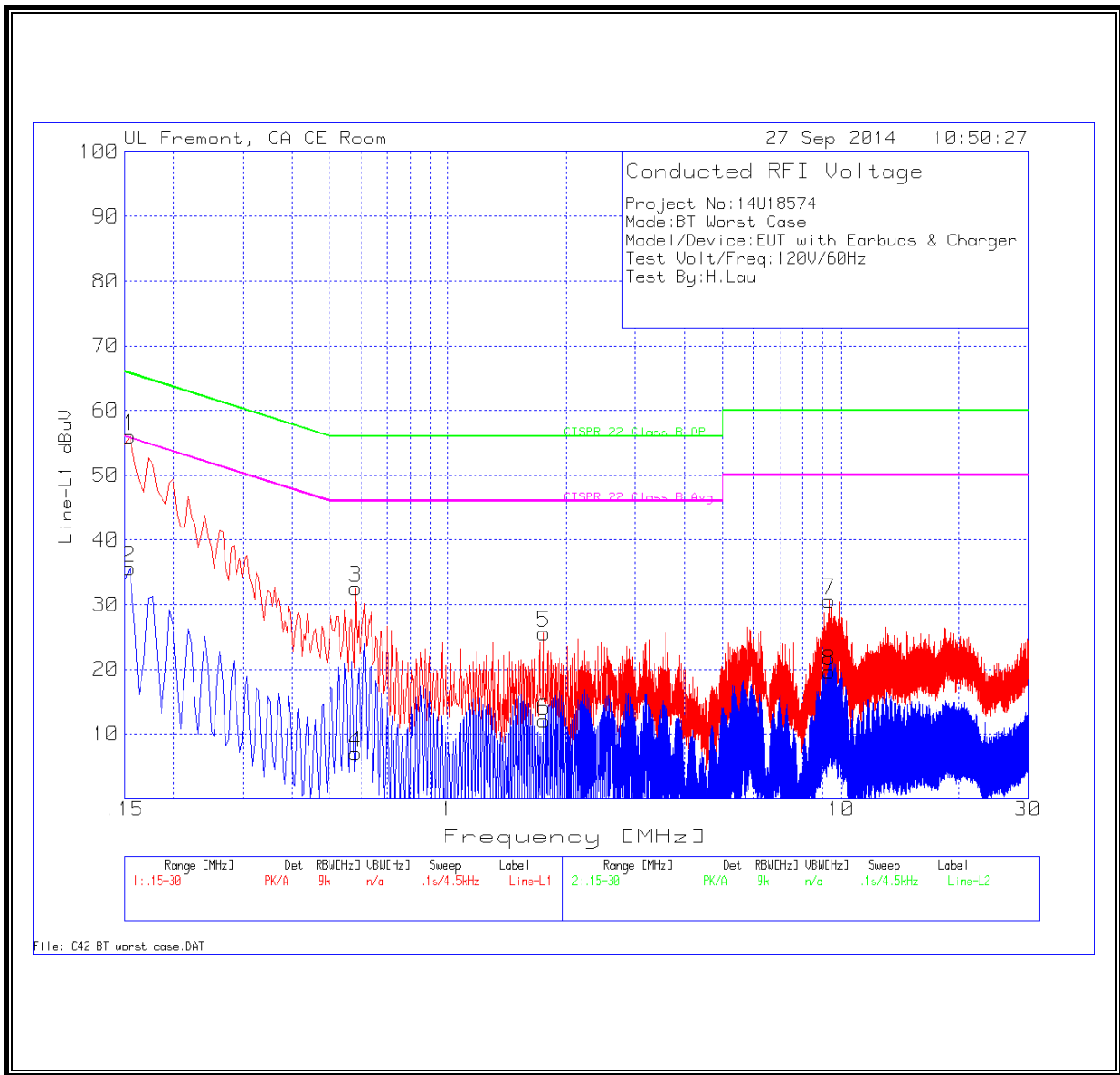
The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

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

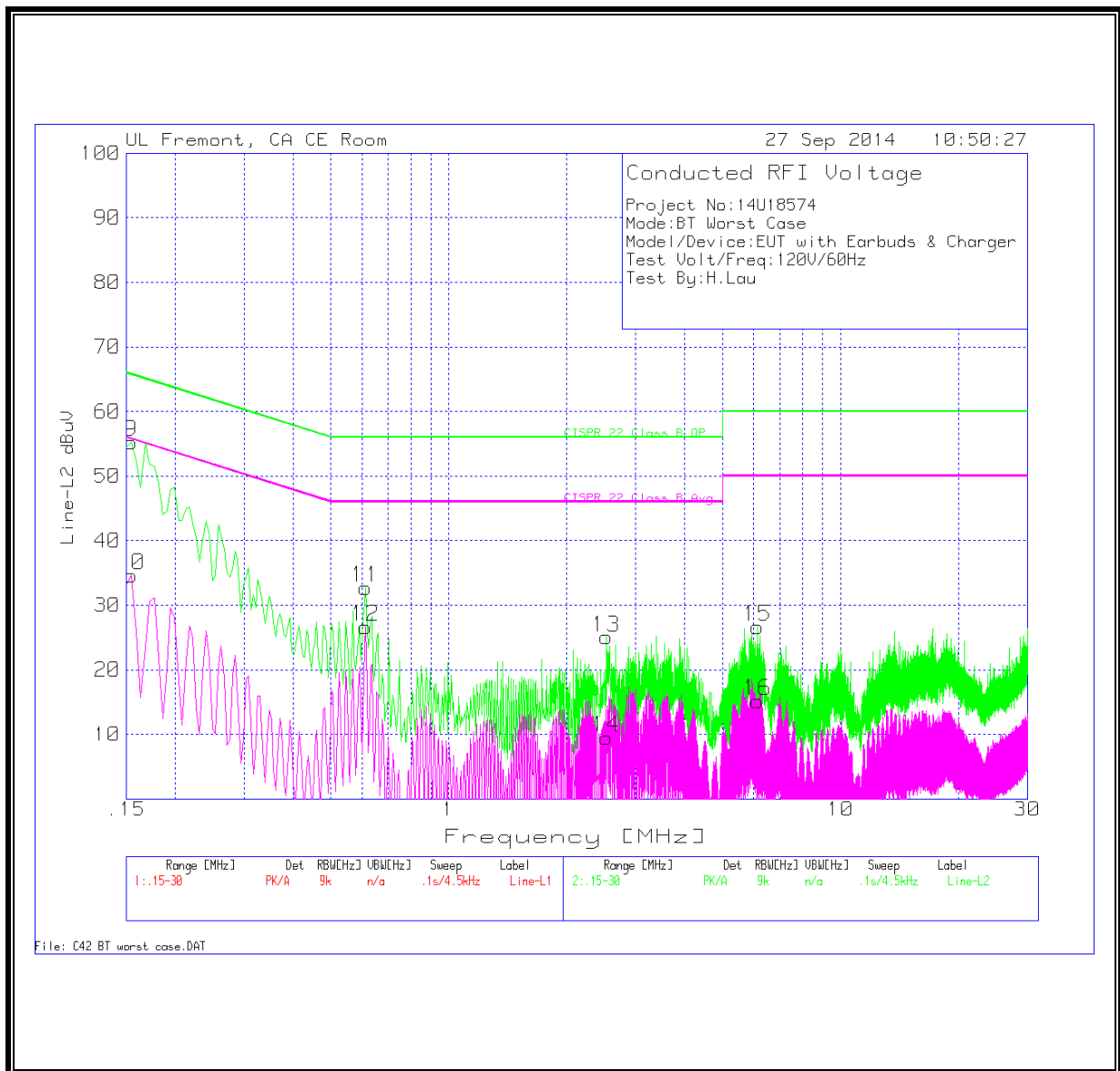
Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

LINE 1 PLOT



LINE 2 PLOT



WORST EMISSIONS DATA

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	.1545	54.71	PK	1.3	0	56.01	65.8	-9.79	-	-
2	.1545	34.41	Av	1.3	0	35.71	-	-	55.8	-20.09
3	.582	32.27	PK	.3	0	32.57	56	-23.43	-	-
4	.582	6.76	Av	.3	0	7.06	-	-	46	-38.94
5	1.7475	25.33	PK	.2	.1	25.63	56	-30.37	-	-
6	1.7475	11.76	Av	.2	.1	12.06	-	-	46	-33.94
7	9.33	30.32	PK	.2	.1	30.62	60	-29.38	-	-
8	9.33	19.41	Av	.2	.1	19.71	-	-	50	-30.29

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)
9	.1545	53.89	PK	1.4	0	55.29	65.8	-10.51	-	-
10	.1545	33.19	Av	1.4	0	34.59	-	-	55.8	-21.21
11	.6135	32.41	PK	.3	0	32.71	56	-23.29	-	-
12	.6135	26.38	Av	.3	0	26.68	-	-	46	-19.32
13	2.5305	24.73	PK	.2	.1	25.03	56	-30.97	-	-
14	2.5305	9.2	Av	.2	.1	9.5	-	-	46	-36.5
15	6.144	26.4	PK	.2	.1	26.7	60	-33.3	-	-
16	6.144	14.9	Av	.2	.1	15.2	-	-	50	-34.8

PK - Peak detector

Av - average detection