FCC CFR47 PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8

CERTIFICATION TEST REPORT

FOR

802.11n + BT MODULE

MODEL NUMBER: WCN3660

FCC ID: PPD-WCN3660
IC: 4104A-WCN3660

REPORT NUMBER: 12U14222-9

ISSUE DATE: JUNE 11, 2012

Prepared for
QUALCOMM ATHEROS, INC
1700 TECHNOLOGY DRIVE
SAN JOSE, CA 95110 U.S.A.

Prepared by
COMPLIANCE CERTIFICATION SERVICES (UL CCS)
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	06/11/12	Initial Issue	F. Ibrahim

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS 5

2. TEST METHODOLOGY 6

3. FACILITIES AND ACCREDITATION 6

4. CALIBRATION AND UNCERTAINTY 6

4.1. MEASURING INSTRUMENT CALIBRATION 6

4.2. SAMPLE CALCULATION 6

4.3. MEASUREMENT UNCERTAINTY 6

5. EQUIPMENT UNDER TEST 7

5.1. DESCRIPTION OF EUT 7

5.2. MODIFICATIONS 7

5.3. MAXIMUM OUTPUT POWER 7

5.4. DESCRIPTION OF AVAILABLE ANTENNAS 7

5.5. SOFTWARE AND FIRMWARE 7

5.6. WORST-CASE CONFIGURATION AND MODE 8

5.7. DESCRIPTION OF TEST SETUP 9

6. TEST AND MEASUREMENT EQUIPMENT 11

7. ANTENNA PORT TEST RESULTS 12

7.1. BASIC DATA RATE GFSK MODULATION 12

7.1.1. 20 dB AND 99% BANDWIDTH 12

7.1.2. HOPPING FREQUENCY SEPARATION 19

7.1.3. NUMBER OF HOPPING CHANNELS 21

7.1.4. AVERAGE TIME OF OCCUPANCY 26

7.1.5. OUTPUT POWER 33

7.1.6. AVERAGE POWER 37

7.1.7. CONDUCTED SPURIOUS EMISSIONS 38

7.2. ENHANCED DATA RATE 8PSK MODULATION 47

7.2.1. 20 dB AND 99% BANDWIDTH 47

7.2.2. HOPPING FREQUENCY SEPARATION 54

7.2.3. NUMBER OF HOPPING CHANNELS 56

7.2.4. AVERAGE TIME OF OCCUPANCY 61

7.2.5. OUTPUT POWER 68

7.2.6. AVERAGE POWER 72

7.2.7. CONDUCTED SPURIOUS EMISSIONS 73

8. RADIATED TEST RESULTS 82

8.1. LIMITS AND PROCEDURE 82

8.2. TRANSMITTER ABOVE 1 GHz 83

8.2.1. BASIC DATA RATE GFSK MODULATION 83

8.2.2. ENHANCED DATA RATE 8PSK MODULATION 92

9. AC POWER LINE CONDUCTED EMISSIONS 101

10. MAXIMUM PERMISSIBLE EXPOSURE 106

11. SETUP PHOTOS 110

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: QUALCOMM ATHEROS, INC
1700 TECHNOLOGY DRIVE
SAN JOSE, CA, 95110, U.S.A.

EUT DESCRIPTION: 802.11n + BT MODULE

MODEL: WCN3660

SERIAL NUMBER: N10FXYDC9 and N10G84TRF

DATE TESTED: March 23 - June 6, 2012

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

Compliance Certification Services (UL CCS) 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 CCS 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 CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS 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 CCS By:

FRANK IBRAHIM
EMC SUPERVISOR
UL CCS

Tested By:

DENNIS HUANG
EMC ENGINEER
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, 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 Benicia Street, Fremont, California, USA.

UL CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

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:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

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

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is Qualcomm Atheros 802.11n + Bluetooth Adapter supports 802.11a/b/g/n and Bluetooth v2.1 + EDR/ Bluetooth 3.0/ Bluetooth 4.0 LE operation.

The test platform contains the WCN3660 module and the Qualcomm APQ8060A host processor which serves as the WLAN and BT baseband.

The radio module is manufactured by Qualcomm Atheros.

5.2. MODIFICATIONS

The manufacturer declares the following modification in order to pass 2nd harmonic:

"We have identified a source of leakage for the 2nd harmonic as the 1.8V bias line from the WCN3660 chip. We implemented a notch filter on this line inside the module to filter the harmonic and achieve compliance. This filter will be used in the production version of the module. It was added at the output of chip inside the Y0253 module on Vdd 1p8 LDO net

5.3. 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	8.59	7.23
2402 - 2480	Enhanced 8PSK	9.62	9.16

5.4. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes **WCN3660 WLAN/BT** antenna with the following specification:

Band of operation (MHz)	2400-2483.5	5.15-5.35	5.47-5.725	5.725-5.850
Antenna Type	PIFA	PIFA	PIFA	PIFA
Antenna model	EBJ Aux	ED4 Main	ED4 Aux	ED4 Main
Antenna Gain (dBi)	3.62	5.6	5.3	4.8

5.5. SOFTWARE AND FIRMWARE

The test utility software used during testing was QRCT, Version 2.4.74.0.

5.6. WORST-CASE CONFIGURATION AND MODE

Radiated emission below 1 GHz and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

The fundamental frequency of the EUT was investigated in three orthogonal orientations, X,Y and Z; it was found that Y orientation is worst-case; therefore, all final radiated emissions testing was performed with the EUT in Y orientation.

All Radiated Emissions tests were tested with a new modified module (see Section 5.2 for Client's Description of changes).

All Antenna port tests were tested with the original RF module and verified with the new modified module to ensure its compliance performance.

5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop PC	Lenovo	2007-64U	L3-5C76D	DoC
Laptop 1	HP	EliteBook 8460P	CNU20326PD	Doc
Laptop 1 AC/DC Adapter	HP	PPP012D-S	608428-003	Doc
AC/DC Combo Adapter	Lenovo	40Y7649	670044390K	DoC
Host (MTP Test Platform)	Qualcomm	N10G1DJYG	7415BA7C	None
JTAG & Power Supply Adapter Board	Qualcomm	1DN14ASSY20-N6859	N10G1C4WW	None
Module Test Board	Qualcomm	1DN14ASSY20-Y0122	N10G3JMG8	None
DC power supply	Lambda	LA-300	783974	None
DC power supply	Xantrex	XHR 60-18	27519	None

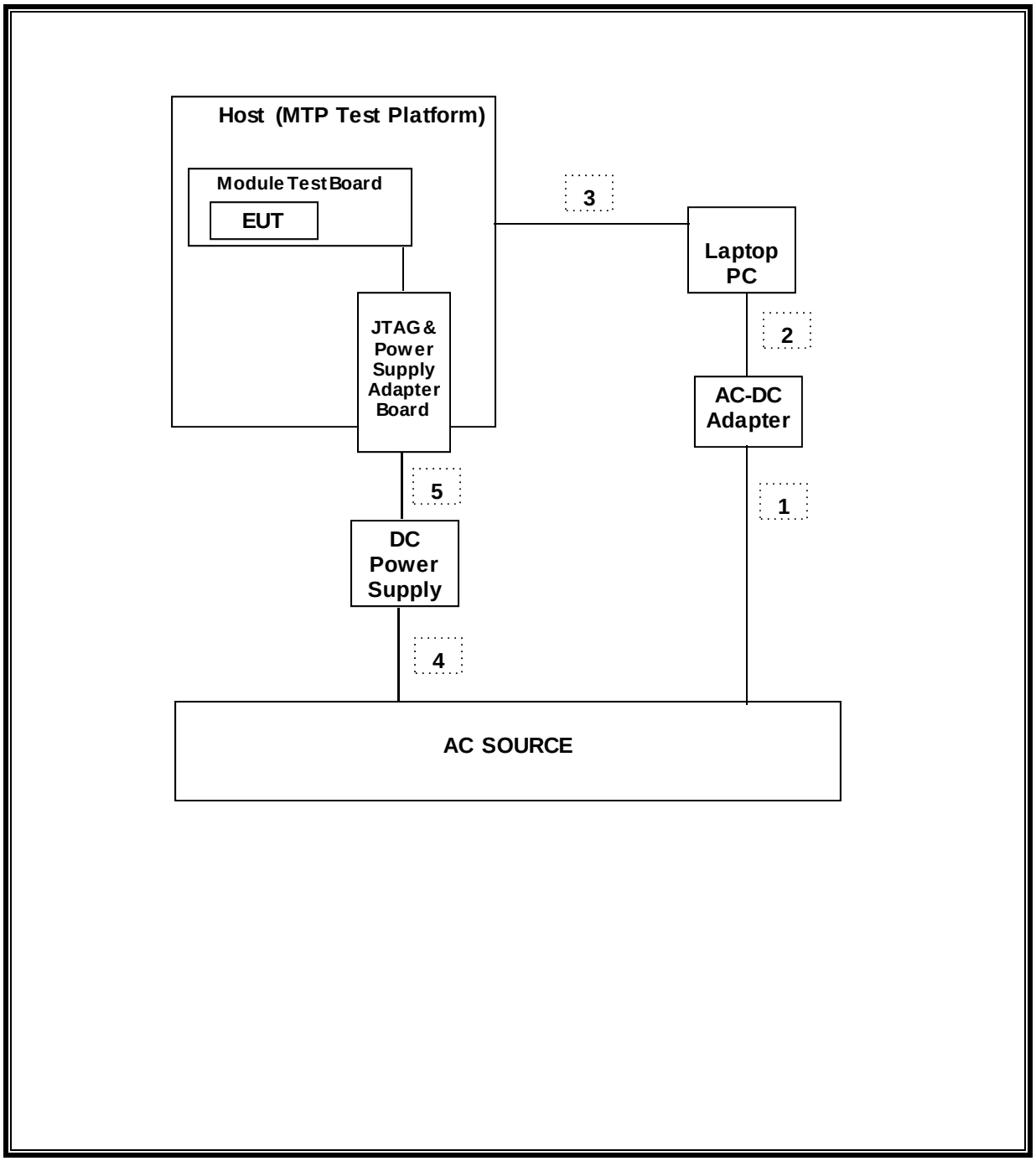
I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	US 115V	Shielded	1	N/A
2	DC	1	DC	Un-shielded	1.85	Ferrite at laptop's end
3	USB	1	USB	Un-shielded	1.8	N/A
4	AC	1	US 115V	Shielded	1.85	N/A
5	DC	1	DC	Un-shielded	1	N/A

TEST SETUP

The EUT is soldered on a test board that is mounted on the MTP Test Platform. The back cover of the MTP is removed so that the EUT is totally exposed, outside of the host platform. Test software exercised the EUT.

SETUP DIAGRAM FOR TESTS



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 Date**	**Cal Due**
Power Meter	Agilent / HP	437B	N02778	08/11/10	08/11/12
Power Sensor, 18 GHz	Agilent / HP	8481A	N02782	08/04/11	08/04/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01016	07/16/11	07/16/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00580	01/27/11	11/11/12
Antenna, Horn, 18 GHz	EMCO	3115	C00783	06/30/11	06/30/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01063	07/12/11	07/12/12
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01178	08/15/11	08/15/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	07/16/11	07/16/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	01/27/11	11/11/12
Antenna, Horn, 18 GHz	EMCO	3115	C00945	06/30/11	06/30/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	07/12/11	07/12/12
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01179	02/16/12	02/16/13
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01176	08/04/11	08/04/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01016	07/16/11	07/16/12
True RMS Multimeter	Fluke	26III	CCS-130	04/25/12	04/25/13
DC Power Supply	HP	E3610A	N02844	CNR	CNR
EMI Test Receiver	R & S	ESHS 20	N02396	08/19/11	08/19/13
LISN	FCC	FCC-LISN-50/250	C00626	12/13/11	12/13/12
Bluetooth Tester (CBT)	Rohde & Schwarz	1153.9000K35	10090	05/15/12	05/15/13

7. ANTENNA PORT TEST RESULTS

7.1. BASIC DATA RATE GFSK MODULATION

7.1.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

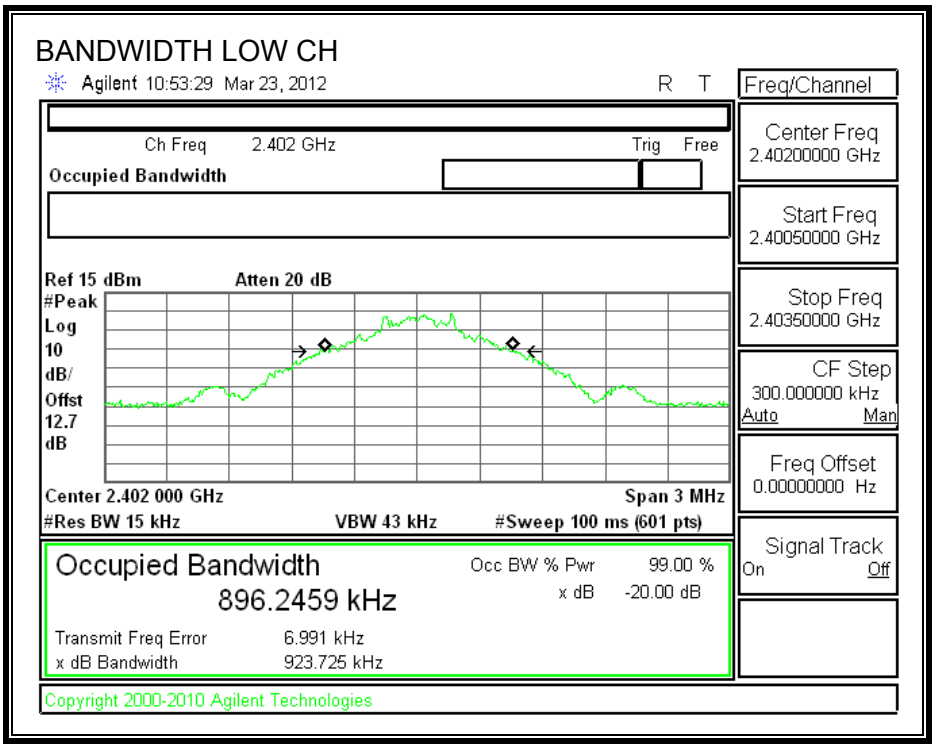
TEST PROCEDURE

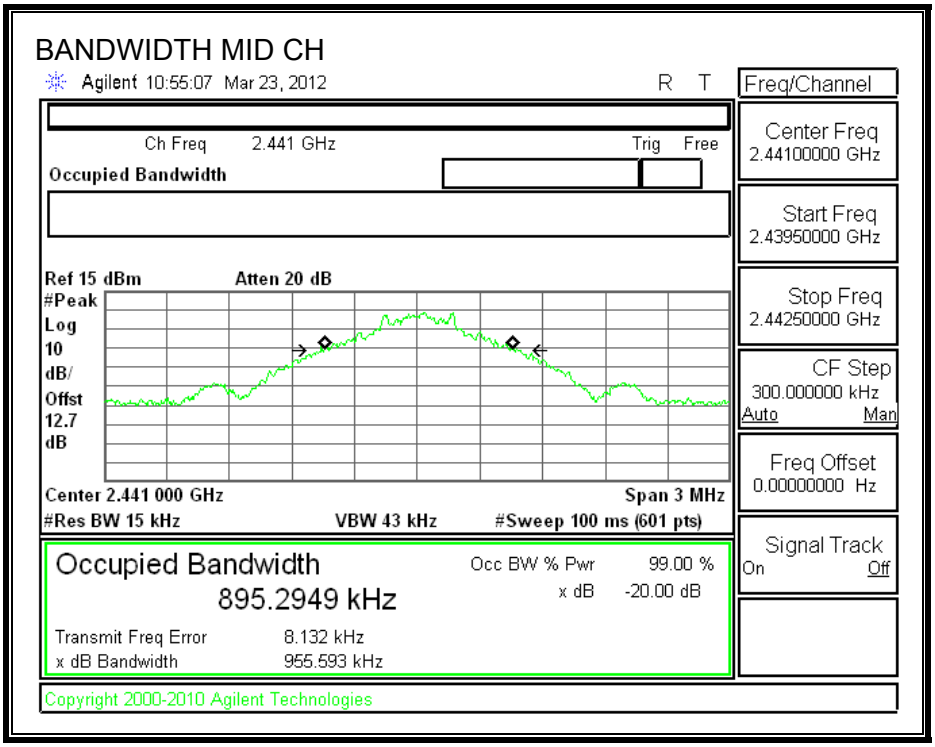
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

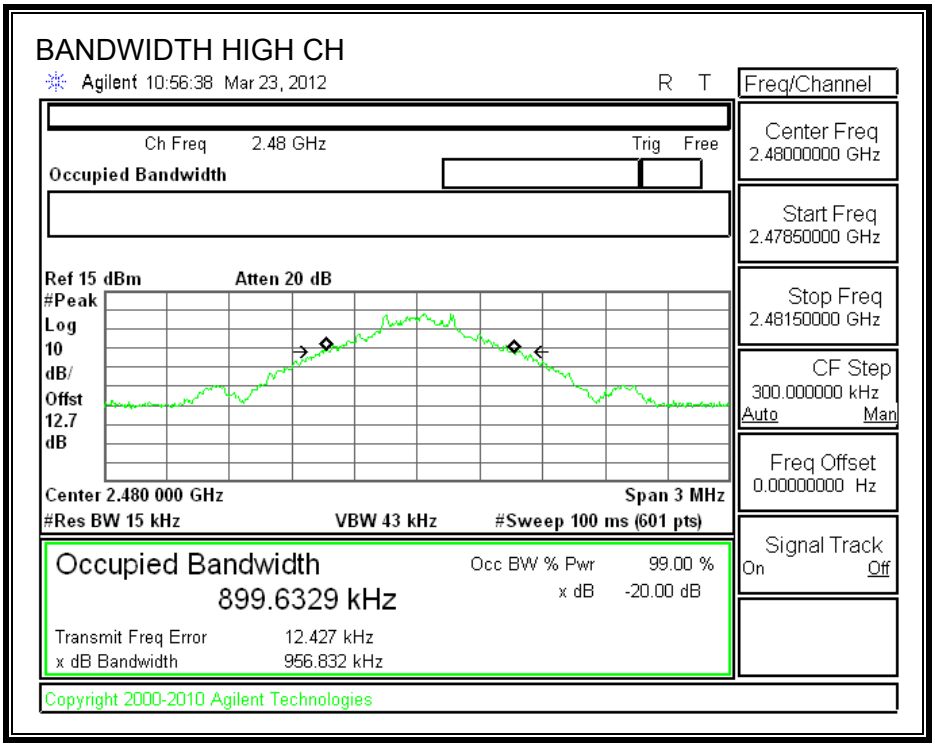
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	923.725	898.5850
Middle	2441	955.593	910.5084
High	2480	956.832	906.1054

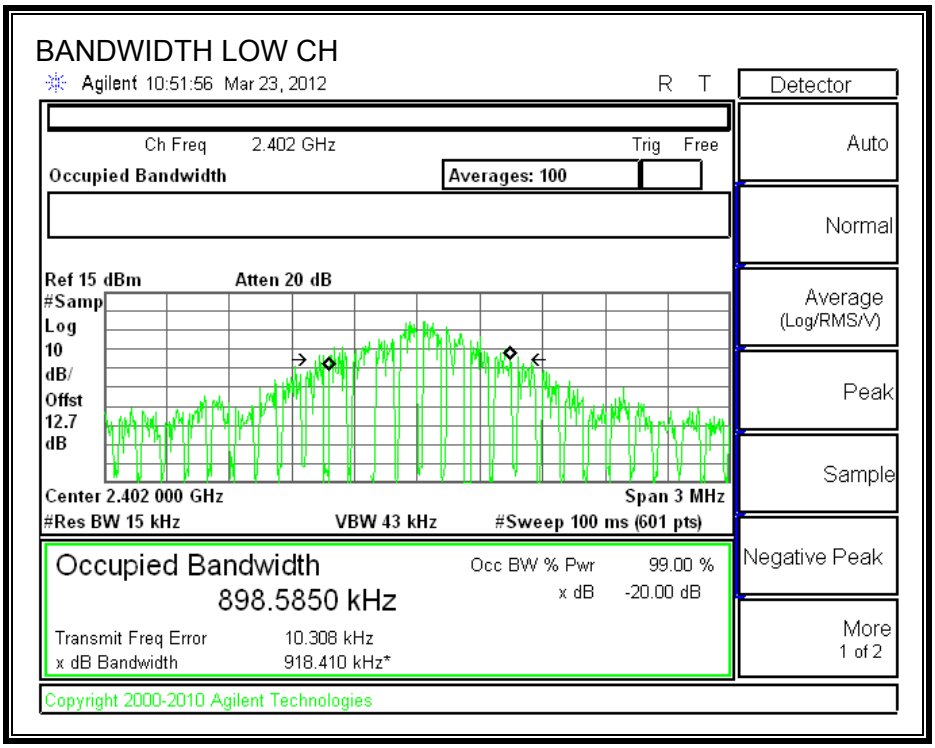
20 dB BANDWIDTH

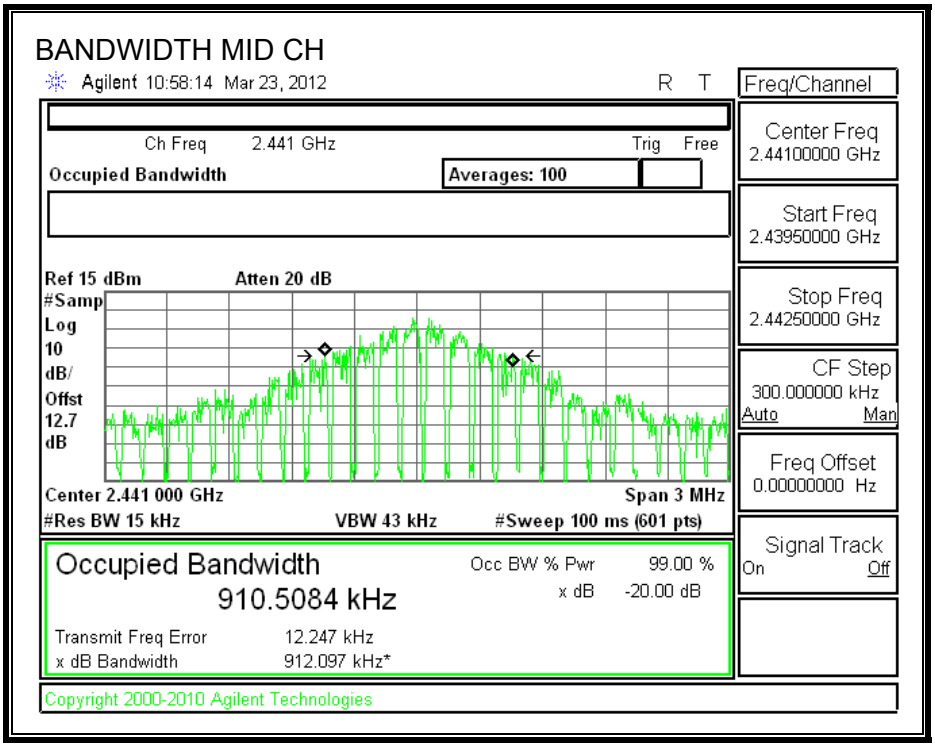


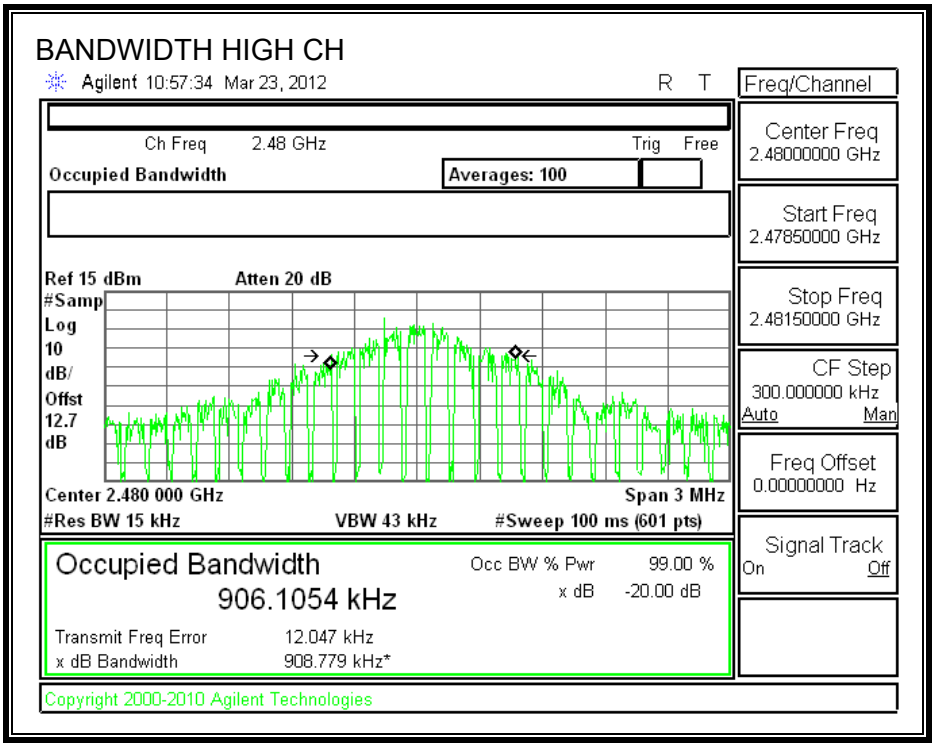




99% BANDWIDTH







7.1.2. 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 hoping channel, whichever is greater.

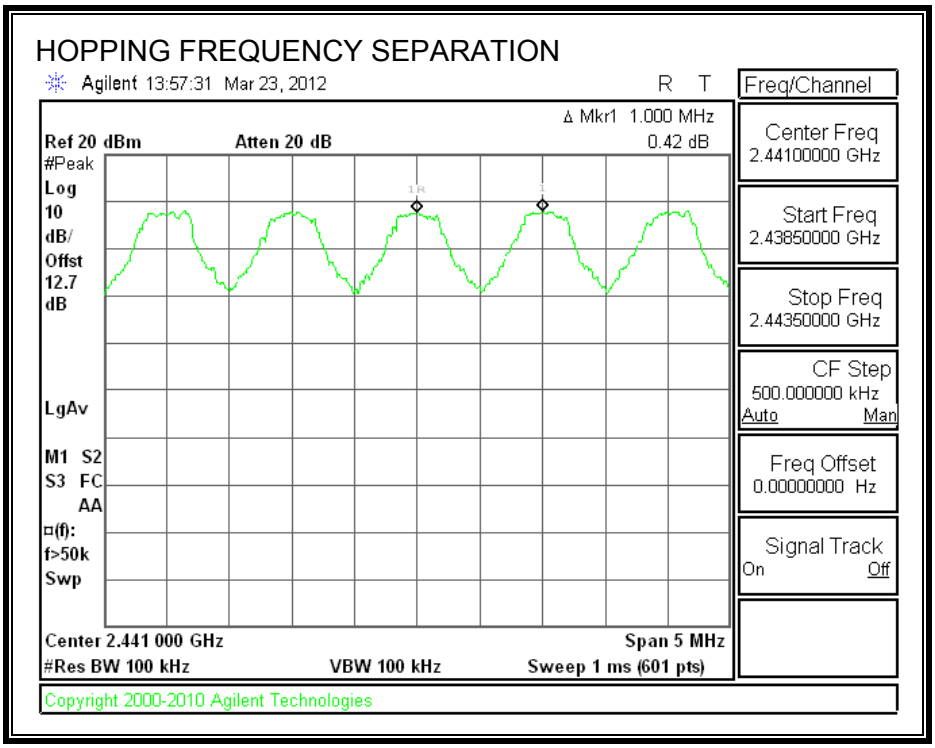
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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



7.1.3. 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.

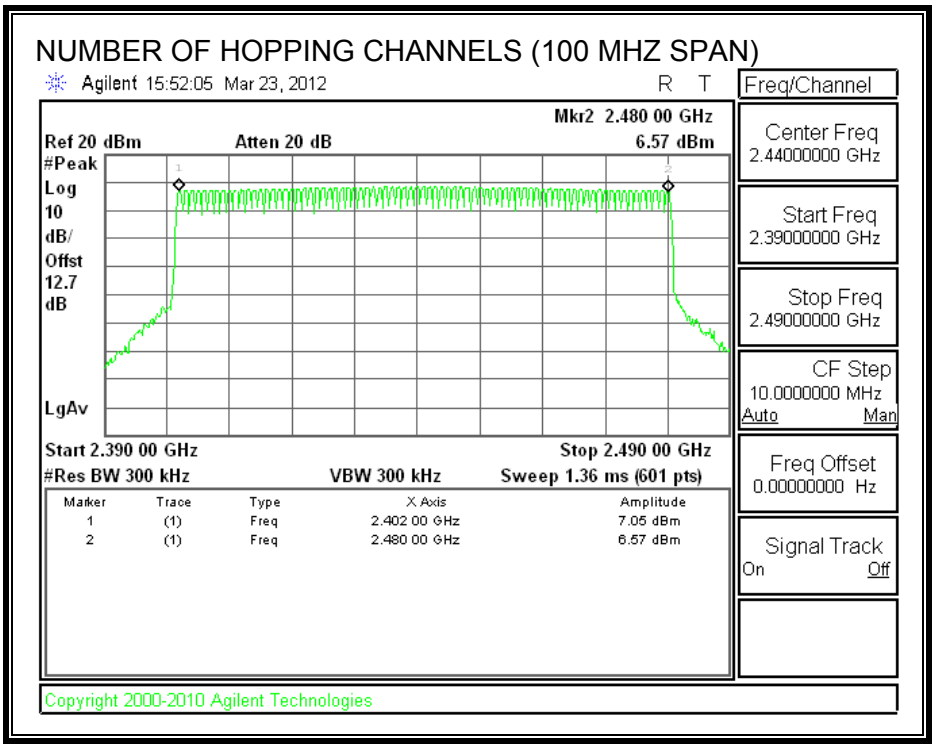
TEST PROCEDURE

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.

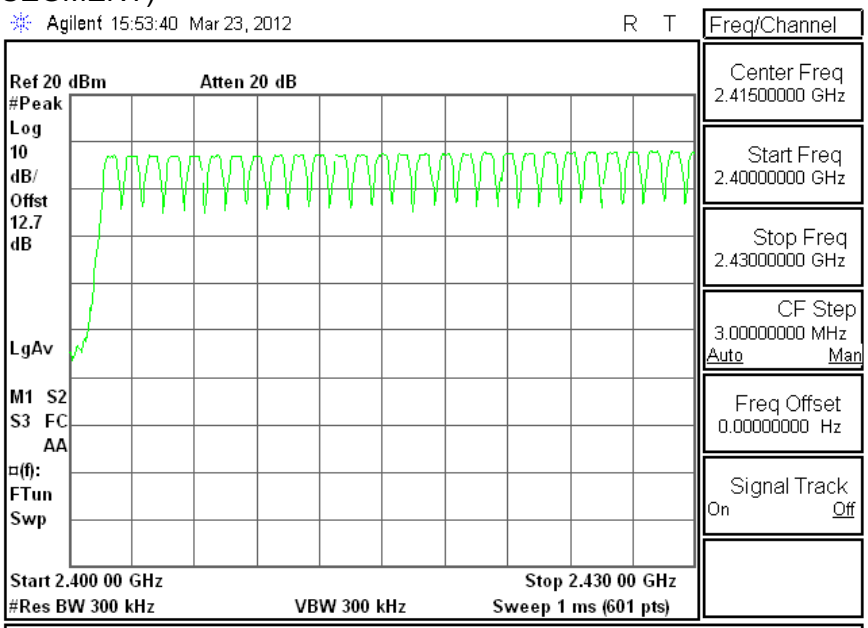
RESULTS

Normal Mode: 79 Channels observed.
AFH Mode: 79 Channels declared.

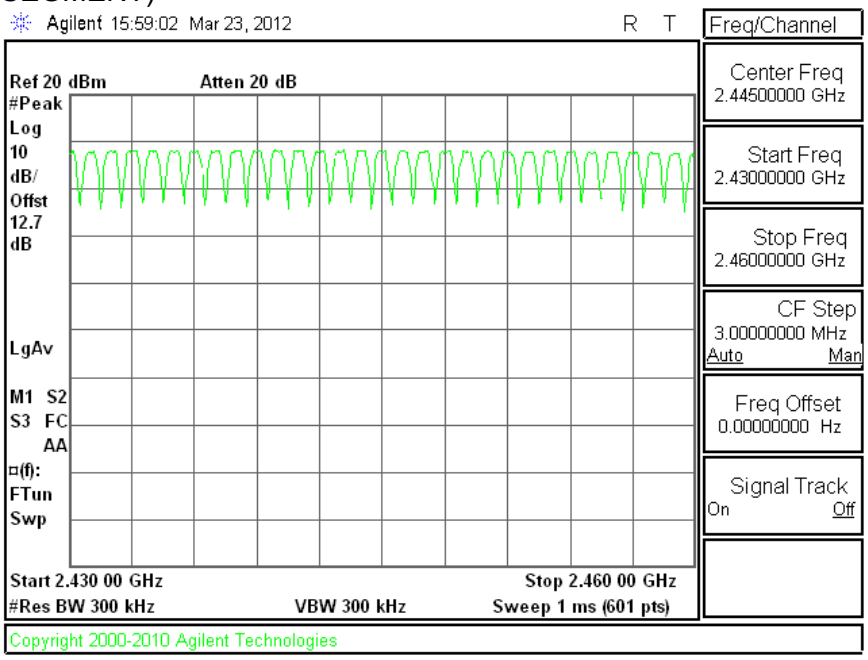
NUMBER OF HOPPING CHANNELS



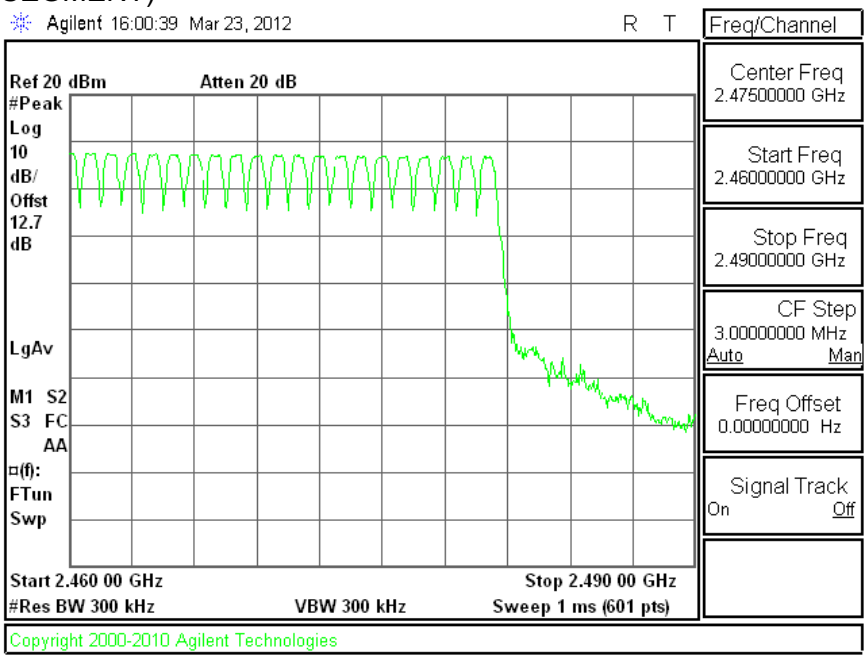
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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



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



7.1.4. 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.

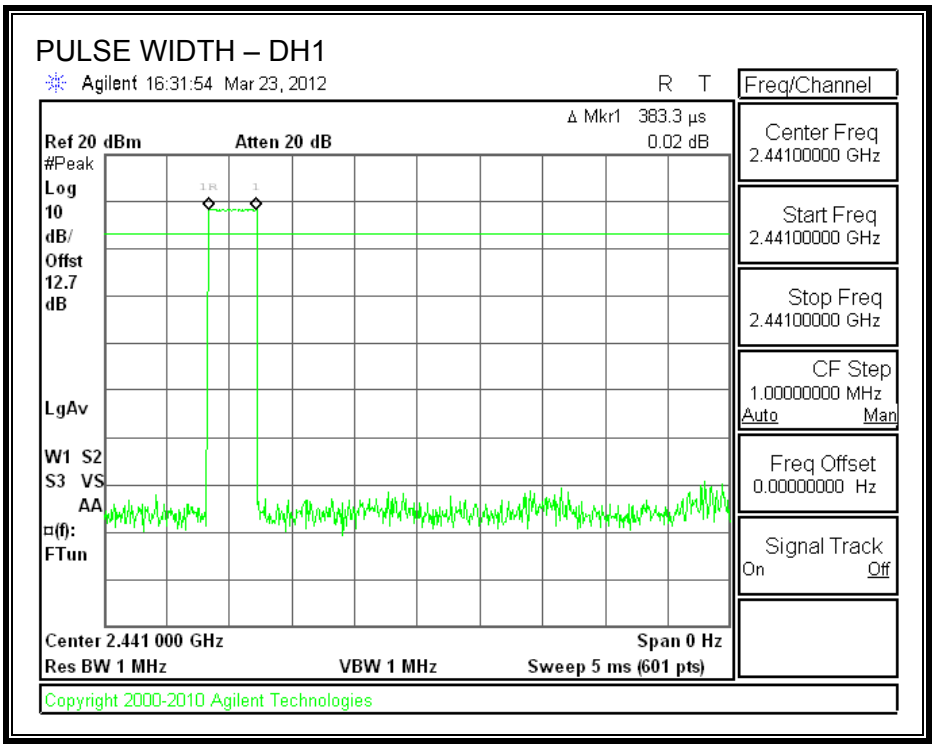
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to 10 * (# of pulses in 0.8 s) * pulse width.

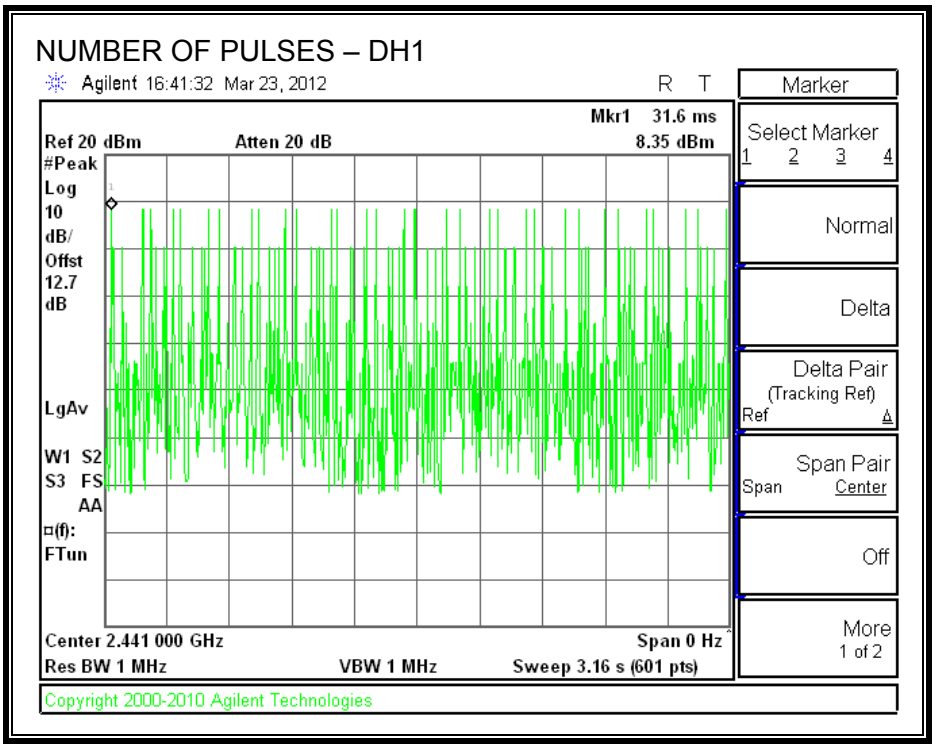
RESULTS

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	0.3833	32	0.1227	0.4	-0.2773
DH3	1.6420	19	0.3120	0.4	-0.0880
DH5	2.8820	6	0.1729	0.4	-0.2271
DH Packet	Pulse Width (msec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.3833	64	0.2453	0.4	-0.1547
DH3	1.6420	21	0.3448	0.4	-0.0552
DH5	2.8820	13	0.3747	0.4	-0.0253

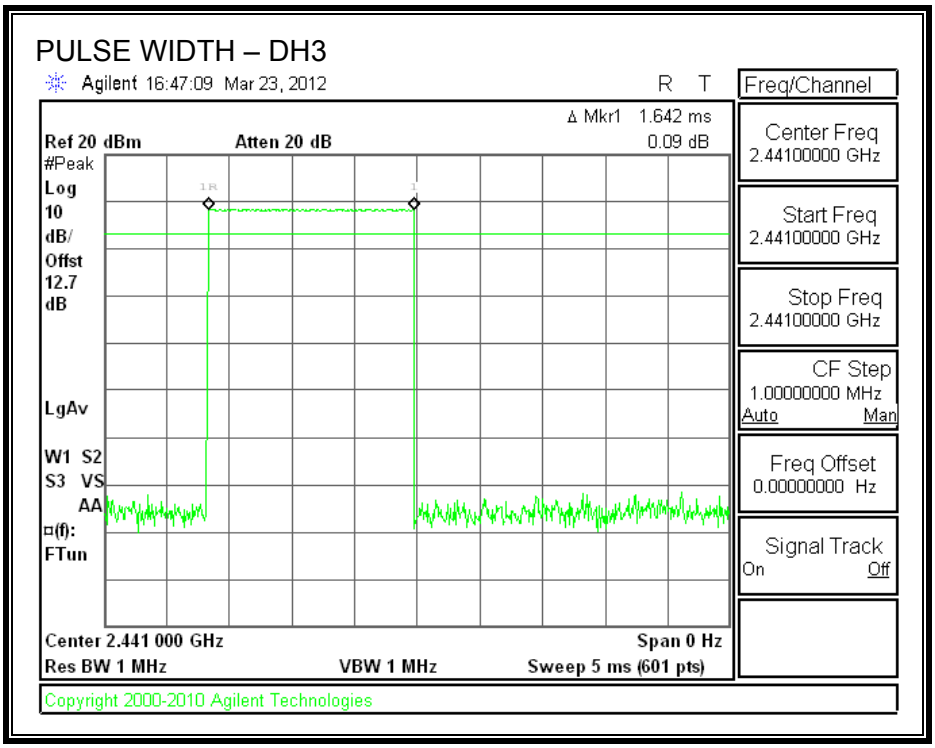
PULSE WIDTH - DH1



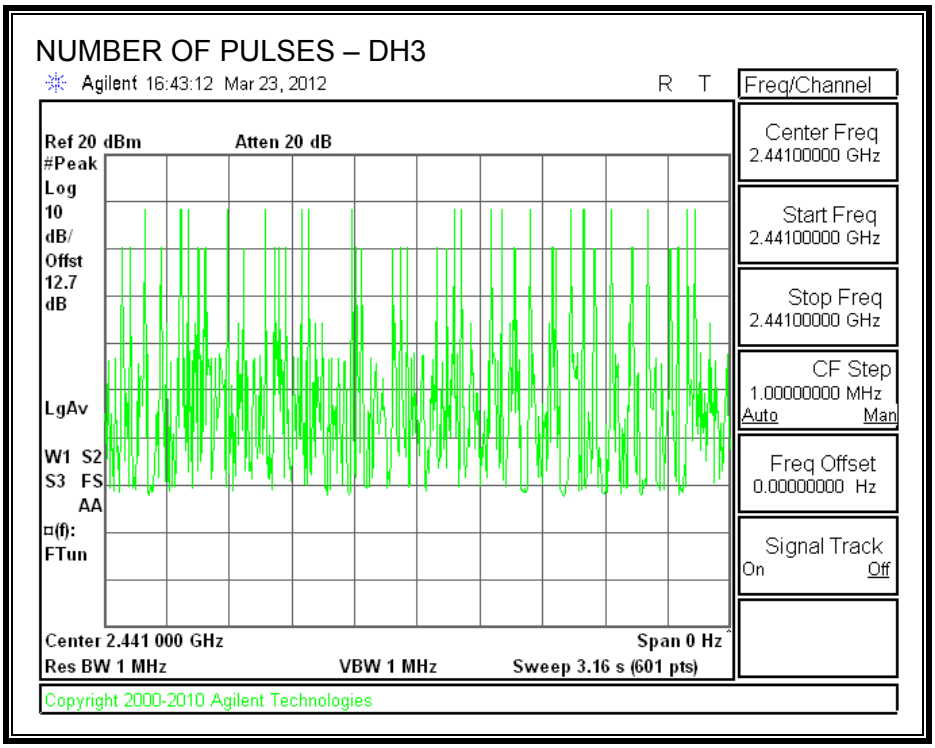
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



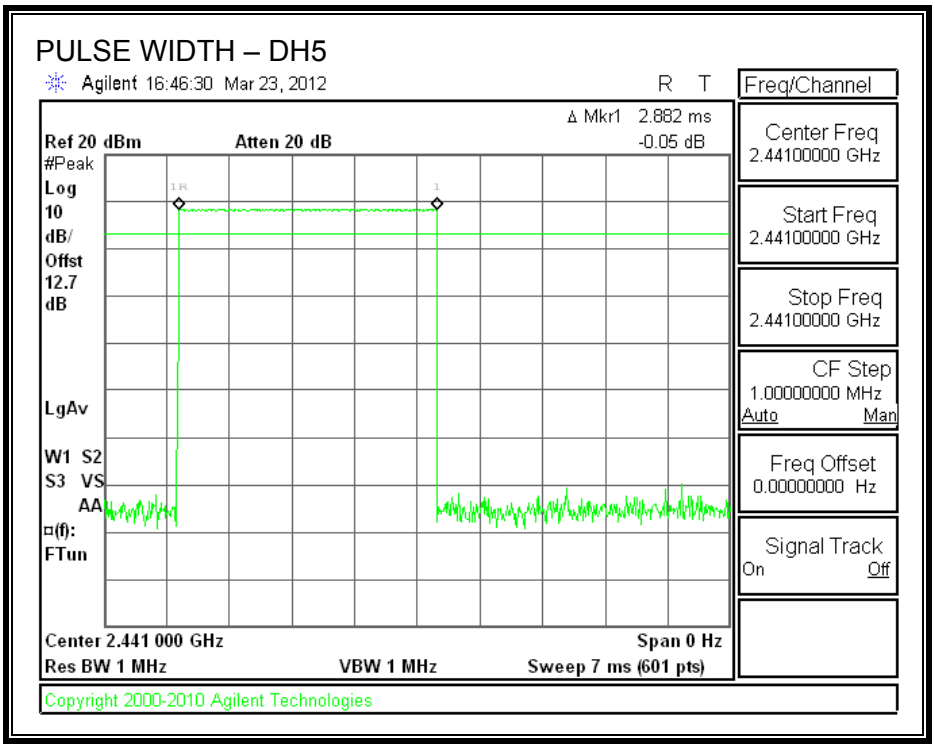
PULSE WIDTH – DH3



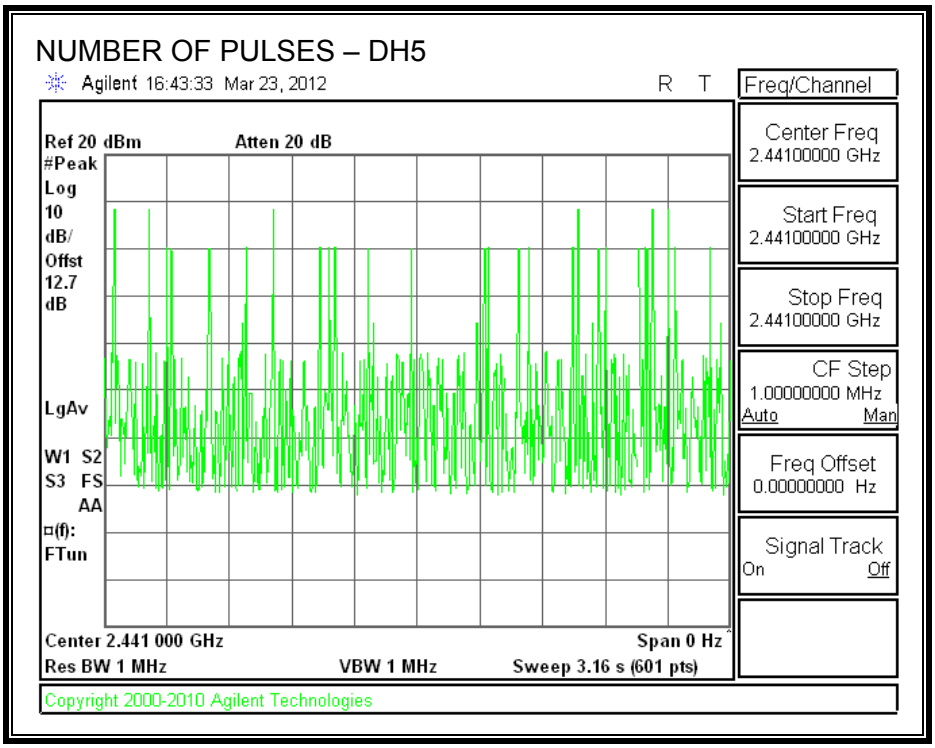
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



7.1.5. 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.

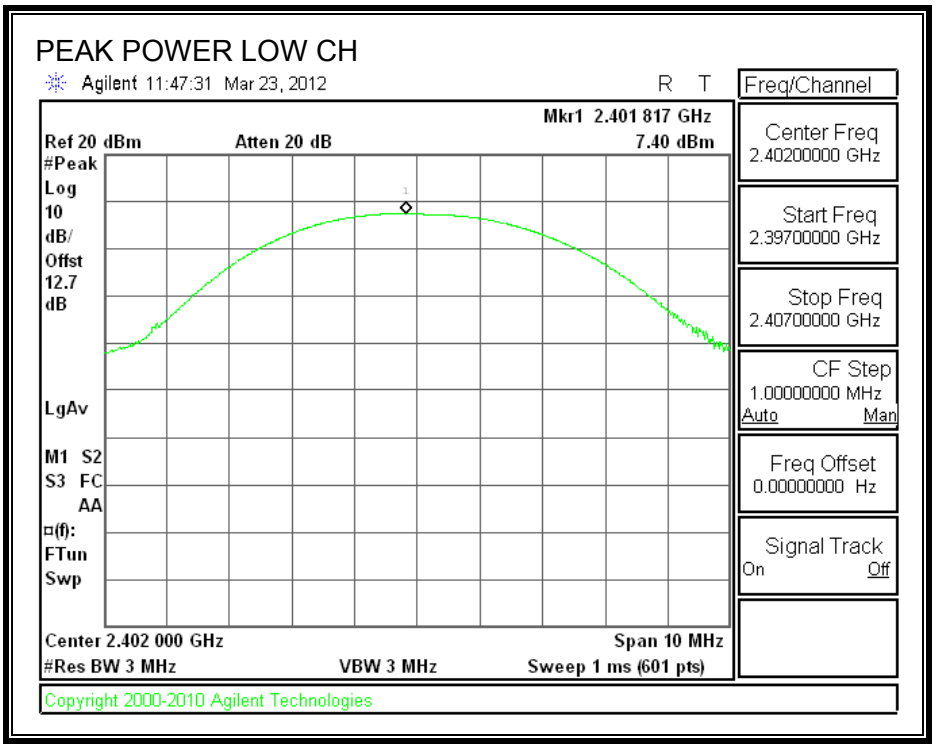
TEST PROCEDURE

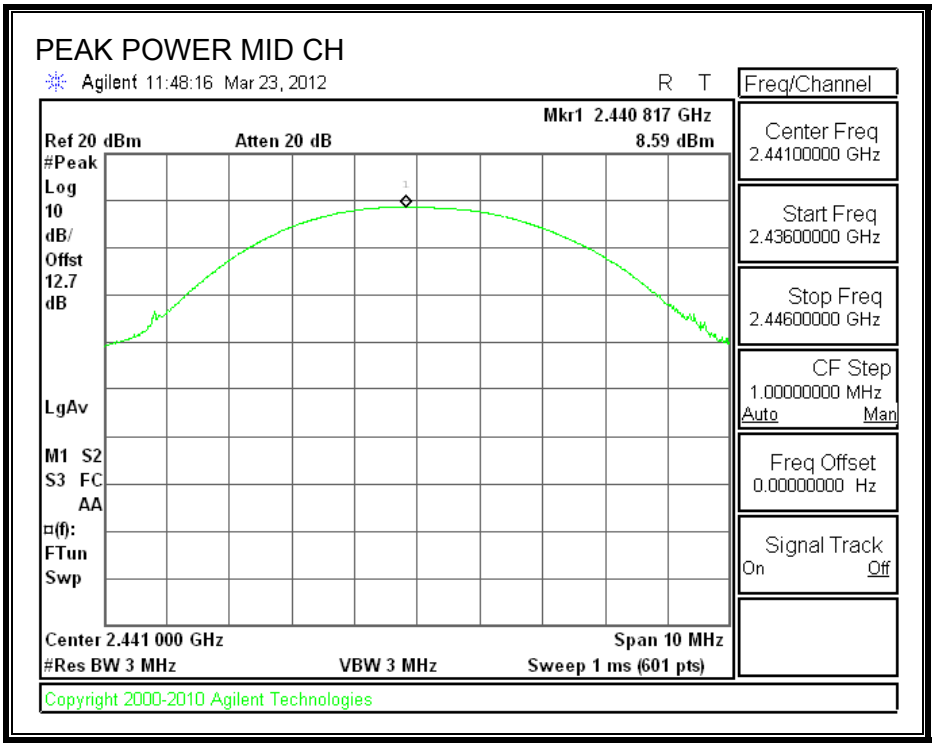
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

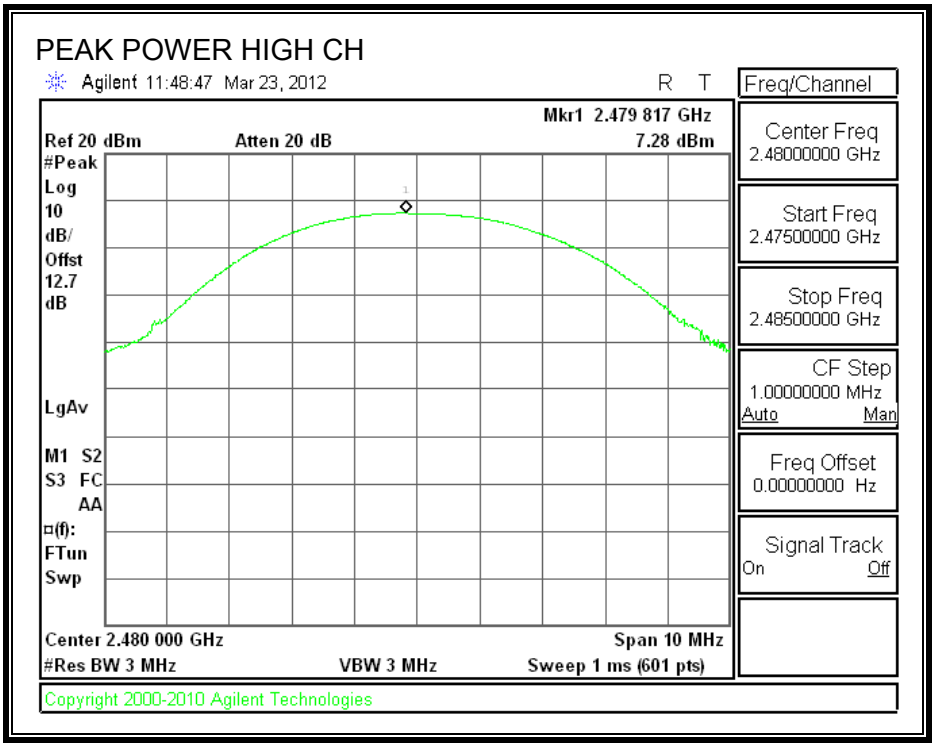
RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	7.40	30	-22.60
Middle	2441	8.59	30	-21.41
High	2480	7.28	30	-22.72

OUTPUT POWER







7.1.6. 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 12.7 dB (including 12 dB pad and 0.7 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	5.60
Middle	2441	6.77
High	2480	5.49

7.1.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

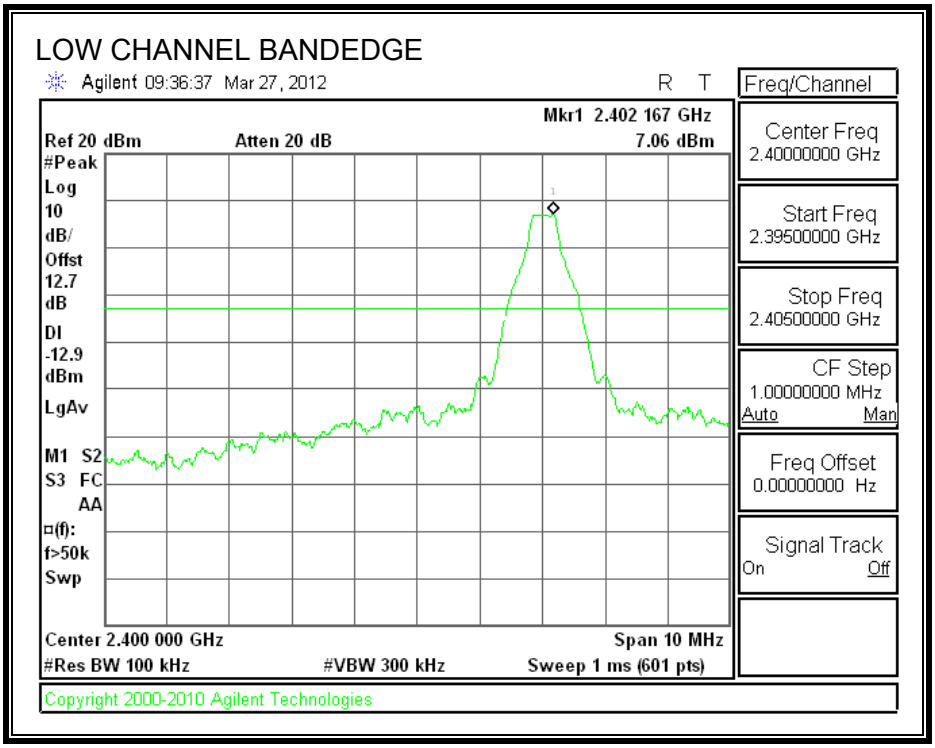
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

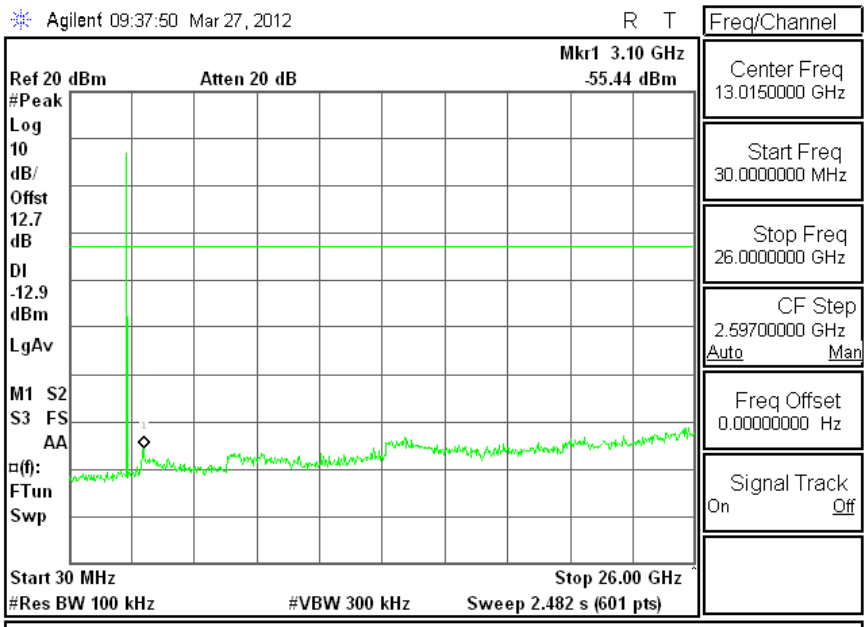
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

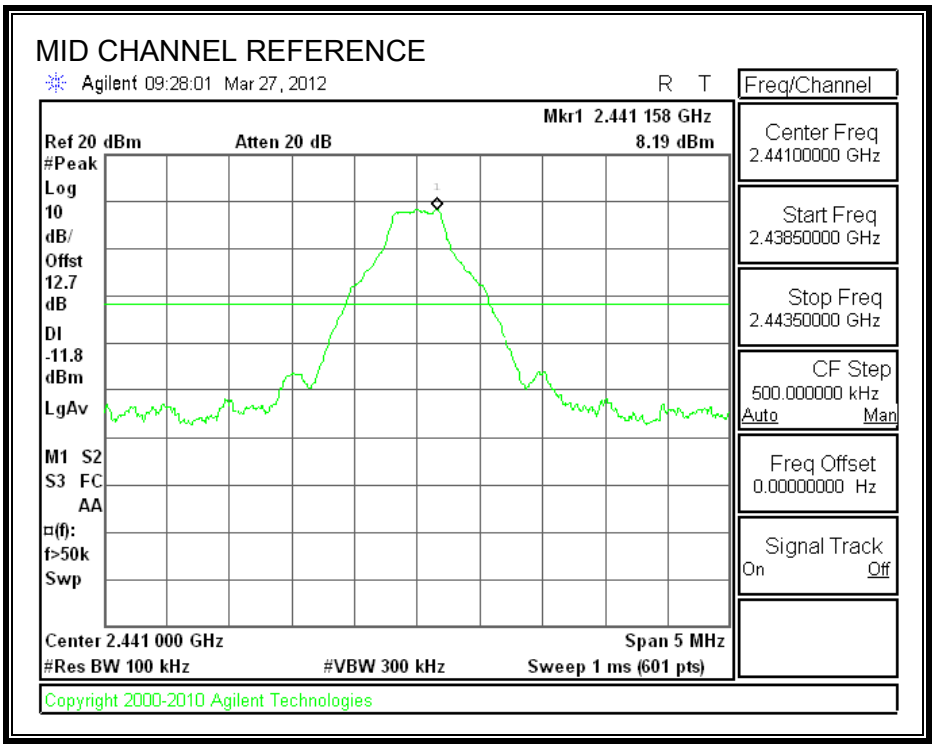
SPURIOUS EMISSIONS, LOW CHANNEL

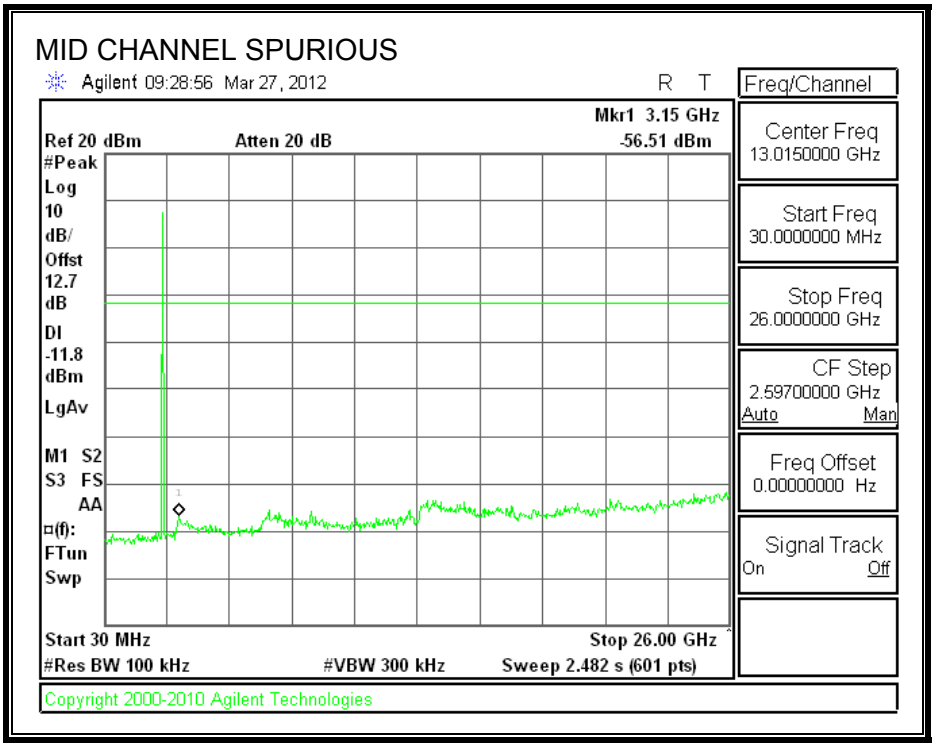


LOW CHANNEL SPURIOUS

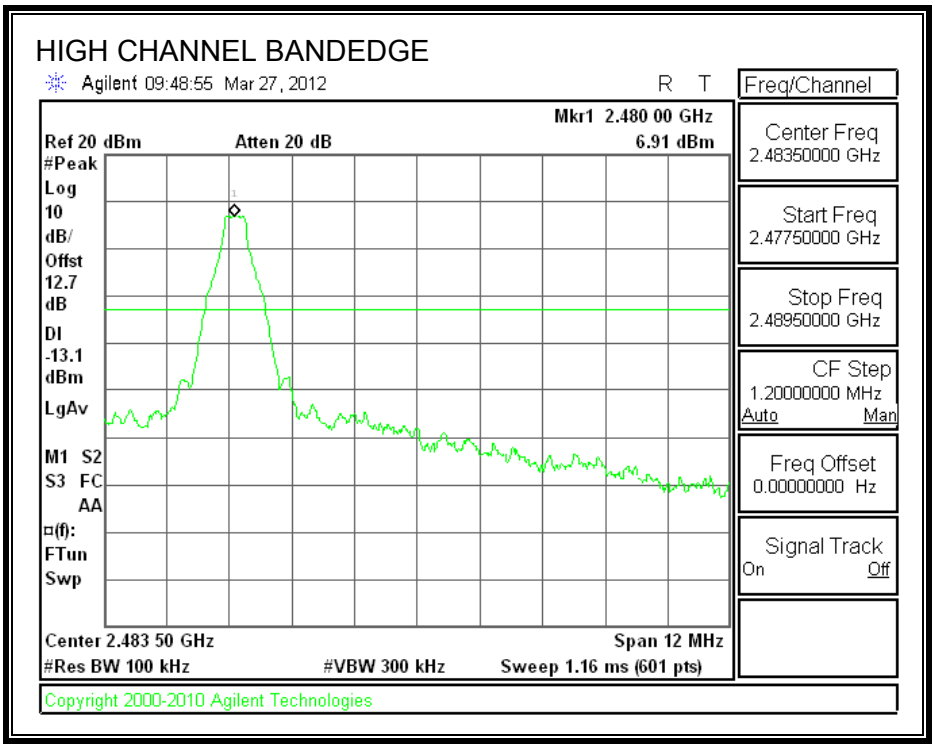


SPURIOUS EMISSIONS, MID CHANNEL

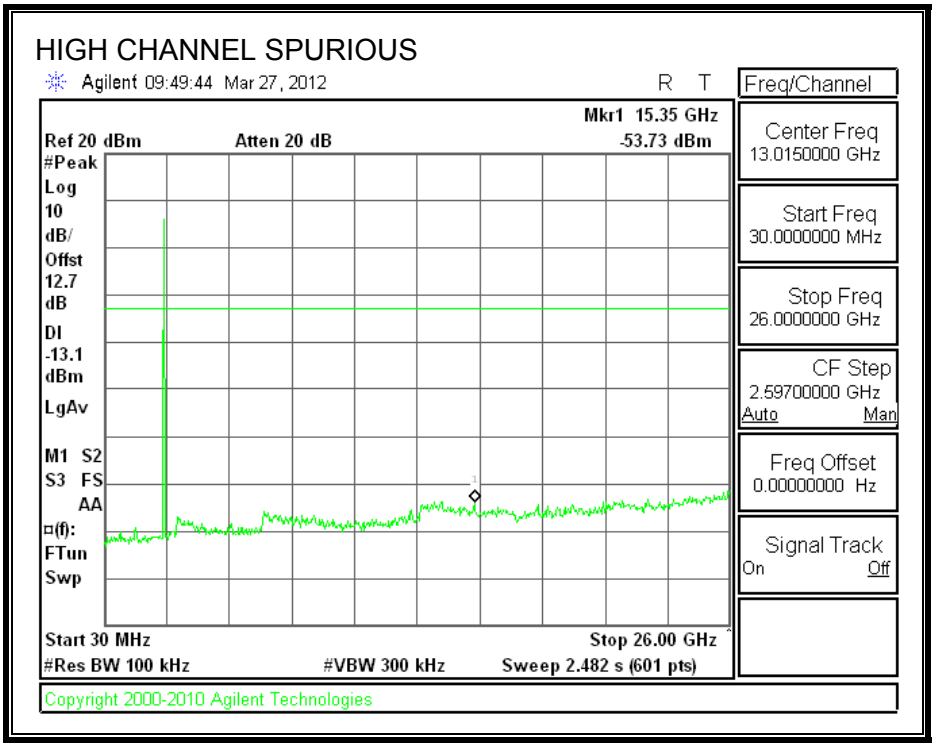




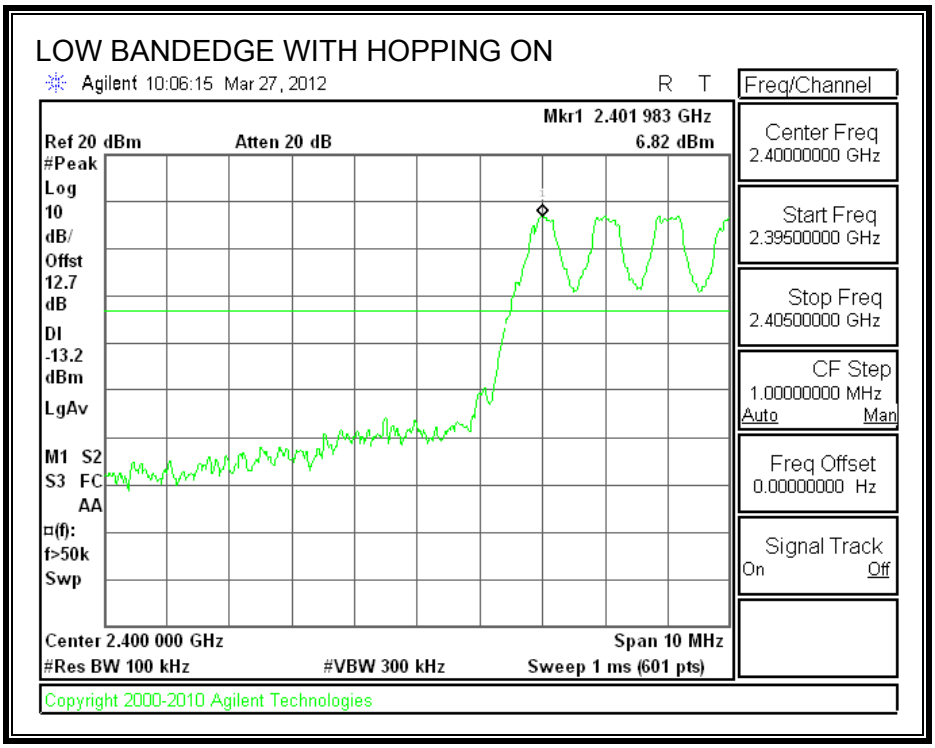
SPURIOUS EMISSIONS, HIGH CHANNEL

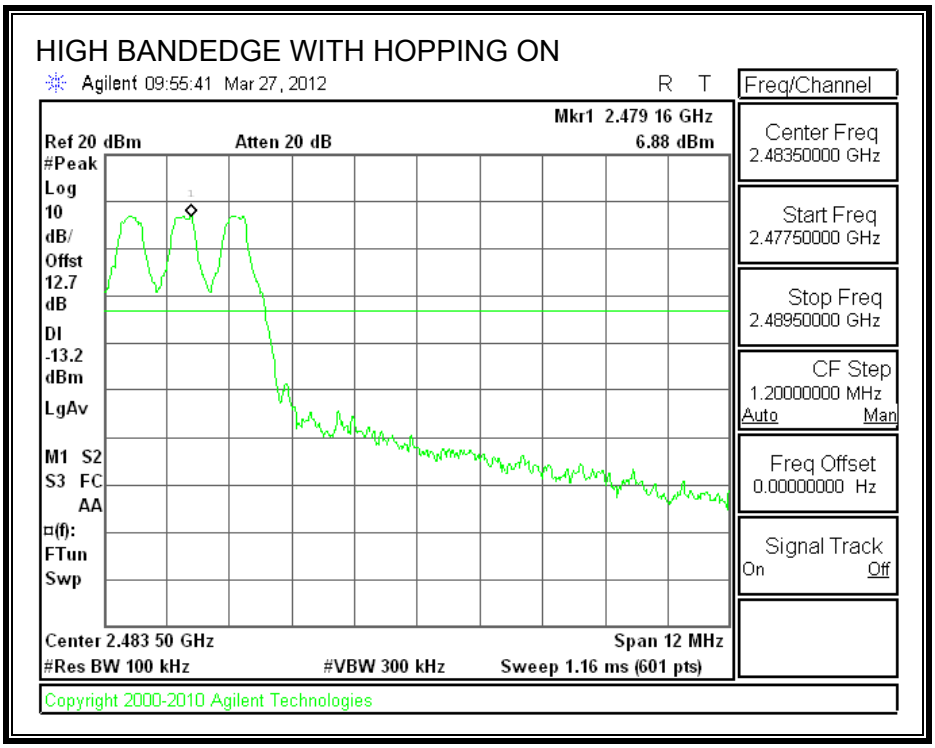


HIGH CHANNEL SPURIOUS



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON





7.2. ENHANCED DATA RATE 8PSK MODULATION

7.2.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

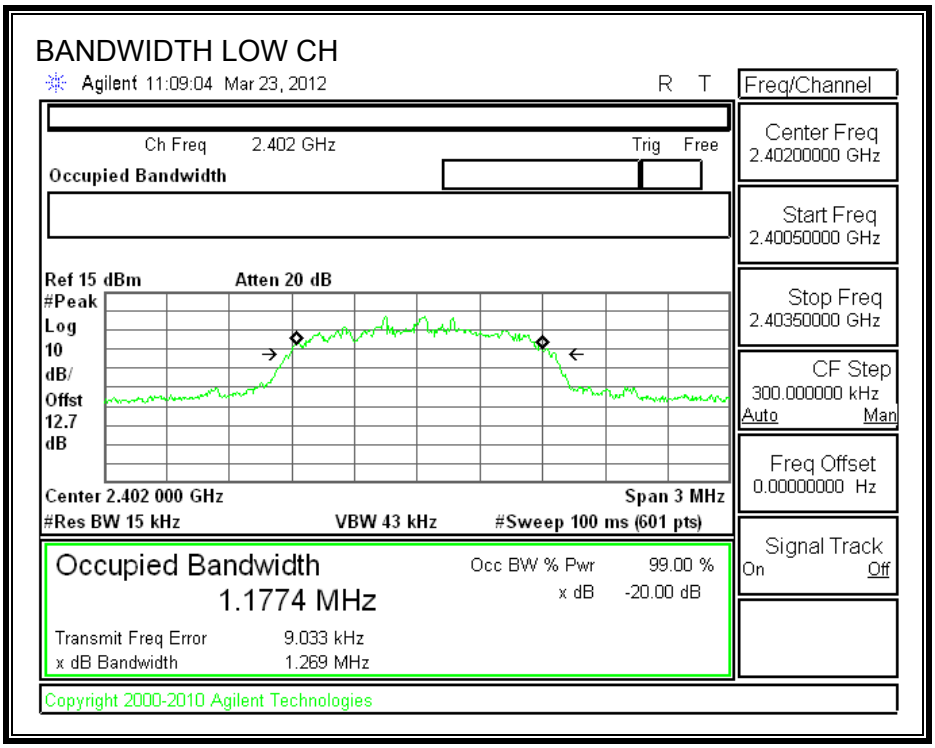
TEST PROCEDURE

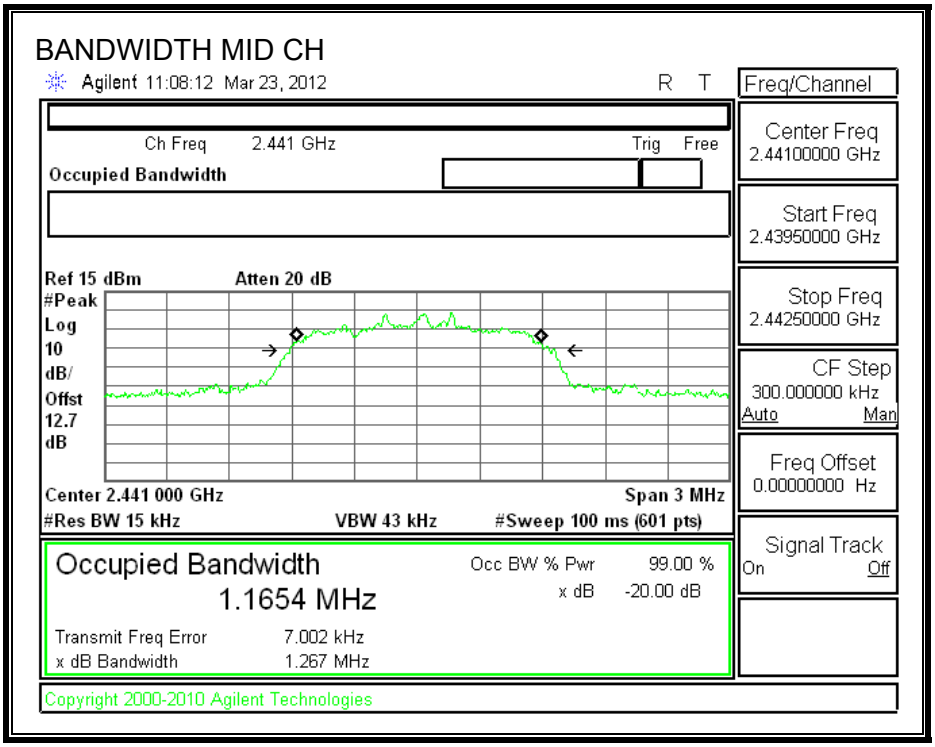
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

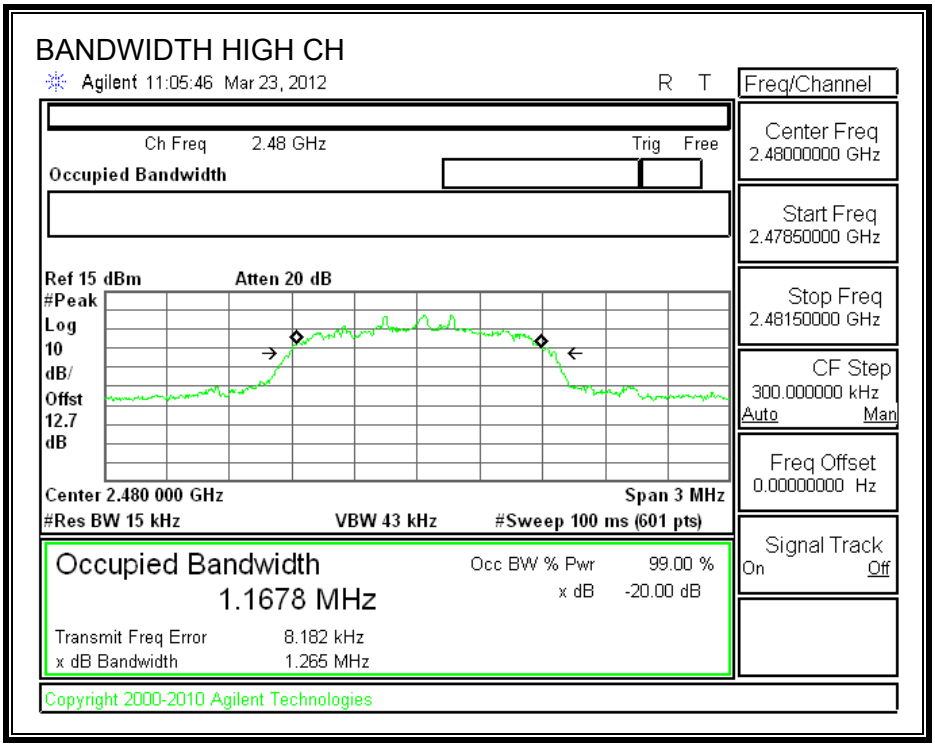
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1269	1199.9
Middle	2441	1267	1197.3
High	2480	1265	1194.8

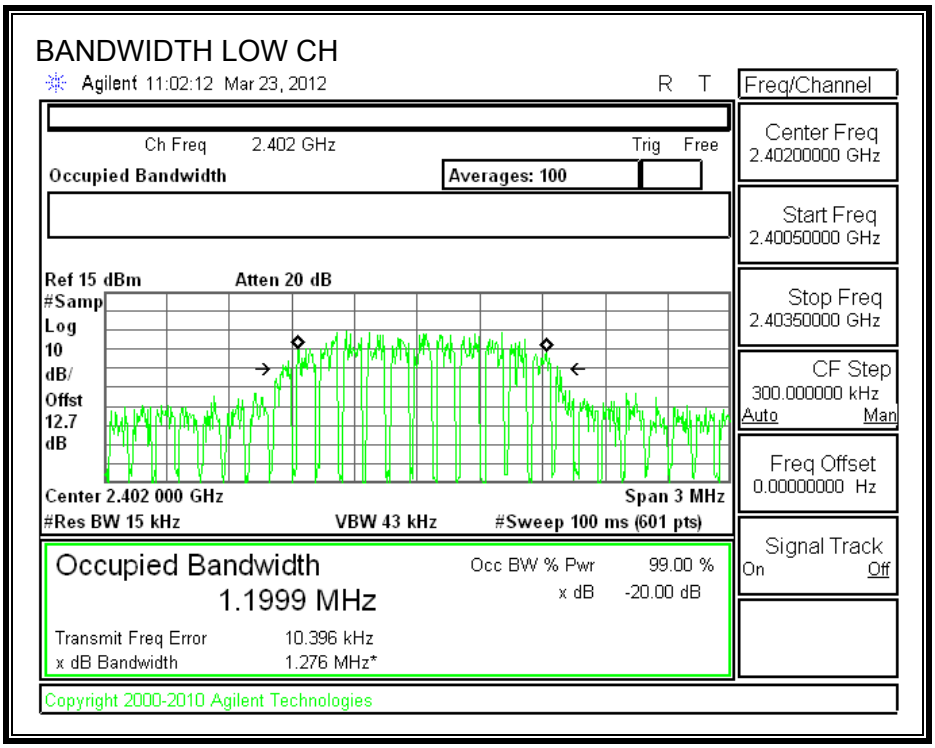
20 dB BANDWIDTH

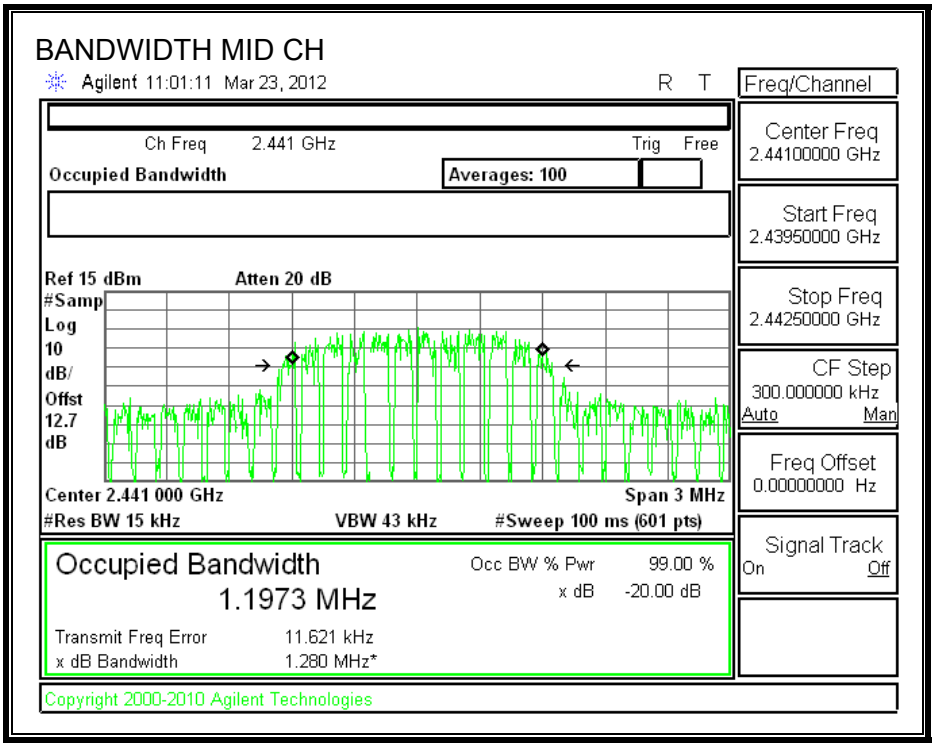


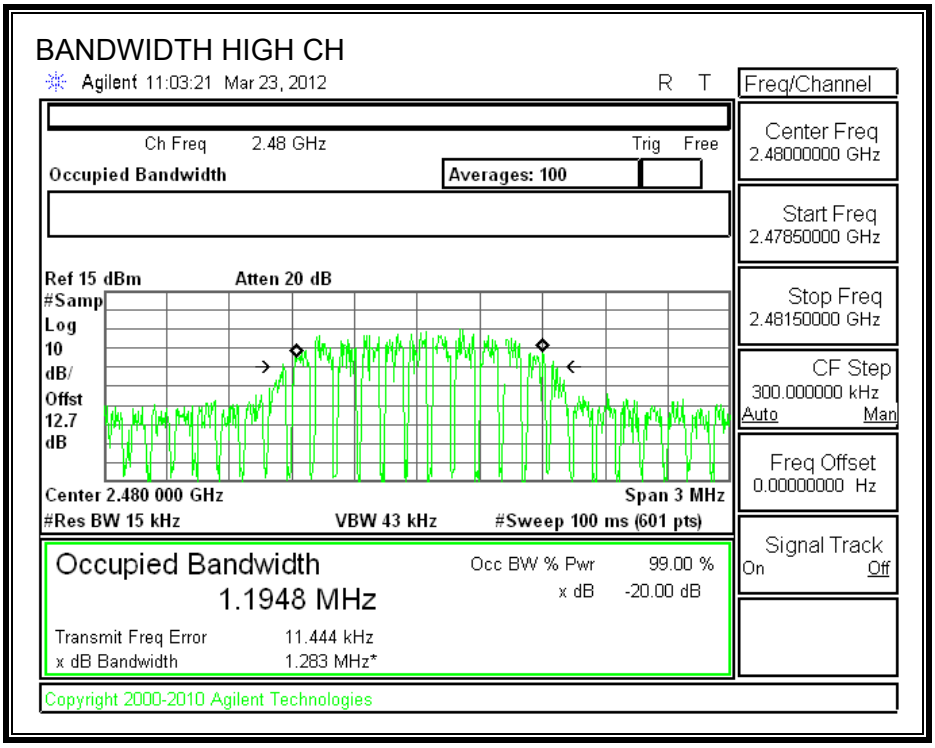




99% BANDWIDTH







7.2.2. 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 hoping channel, whichever is greater.

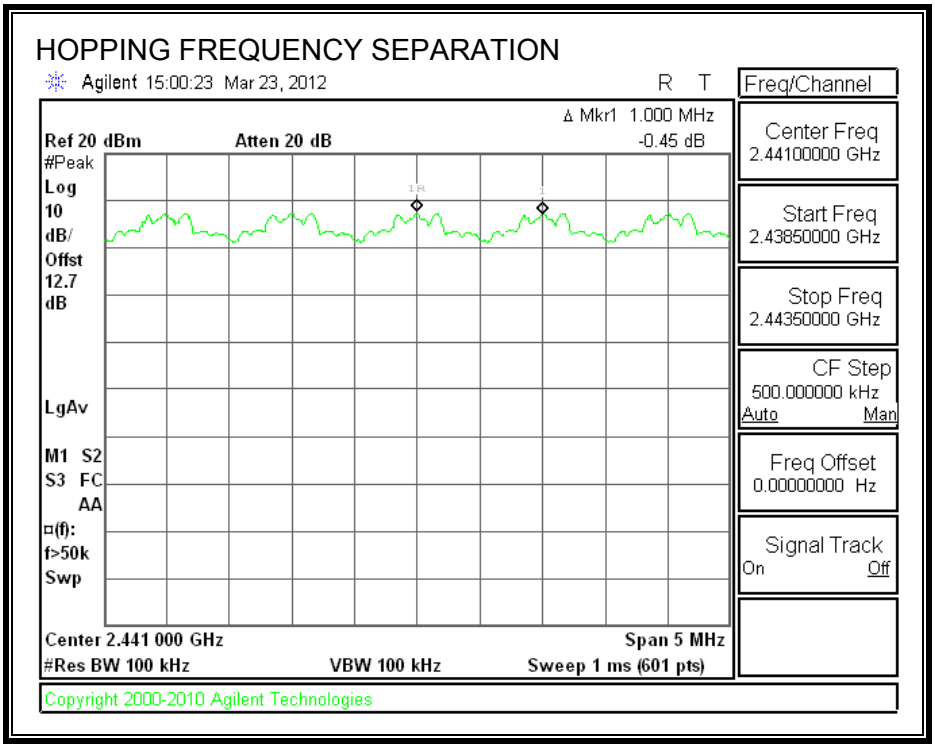
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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



7.2.3. 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.

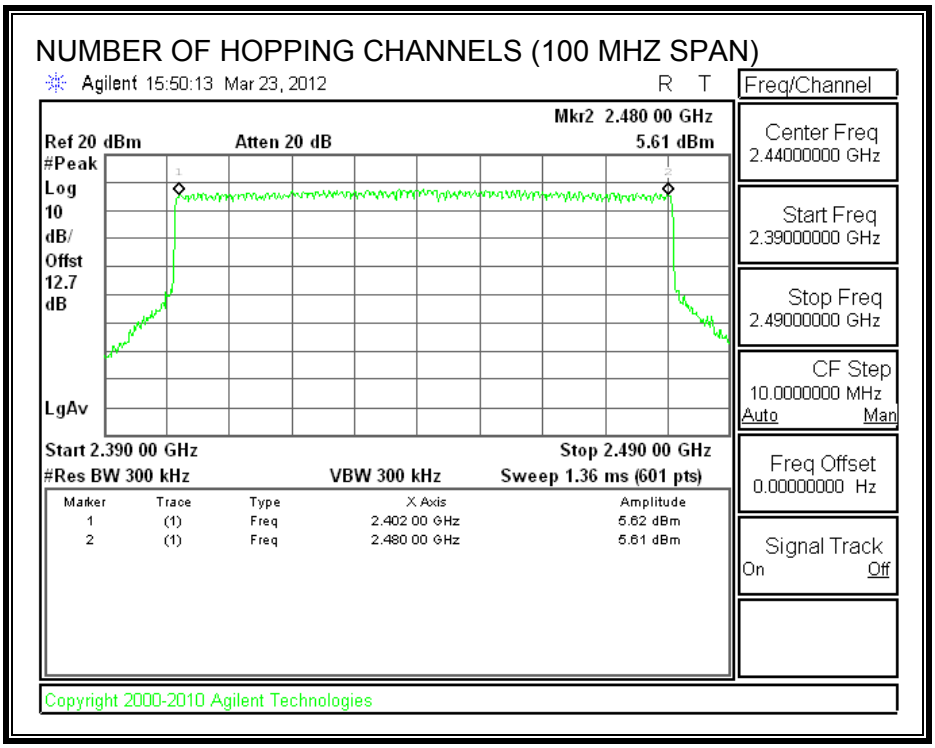
TEST PROCEDURE

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.

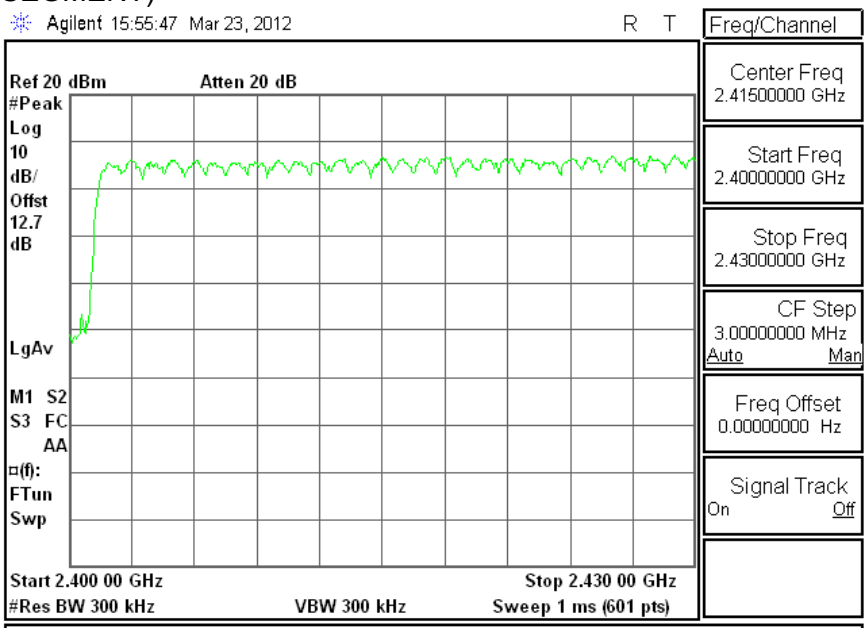
RESULTS

Normal Mode: 79 Channels observed.
AFH Mode: 79 Channels declared.

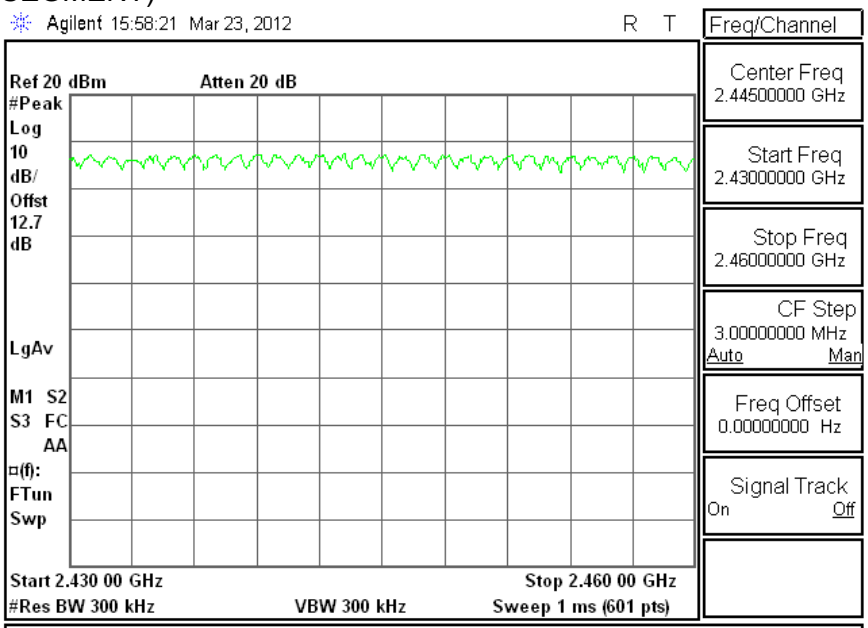
NUMBER OF HOPPING CHANNELS



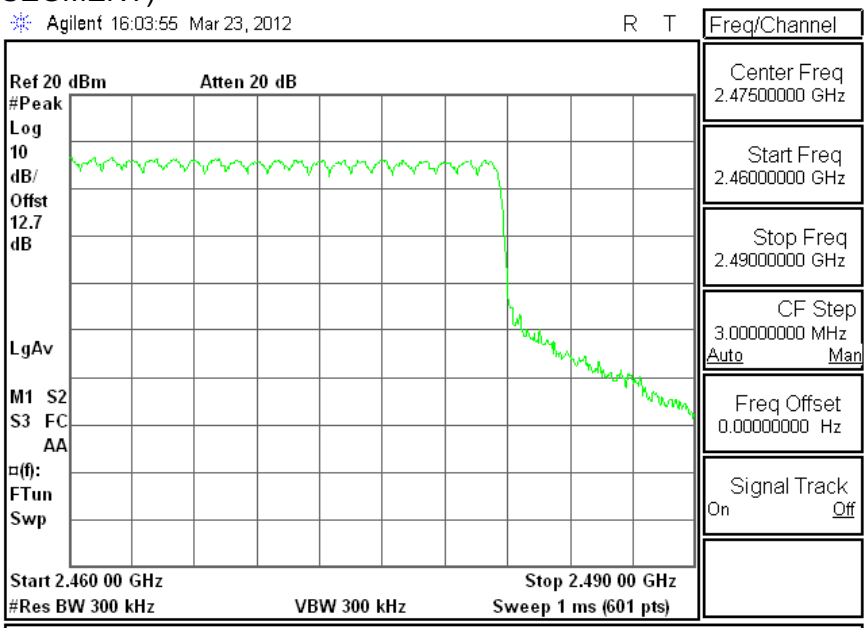
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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



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



7.2.4. 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.

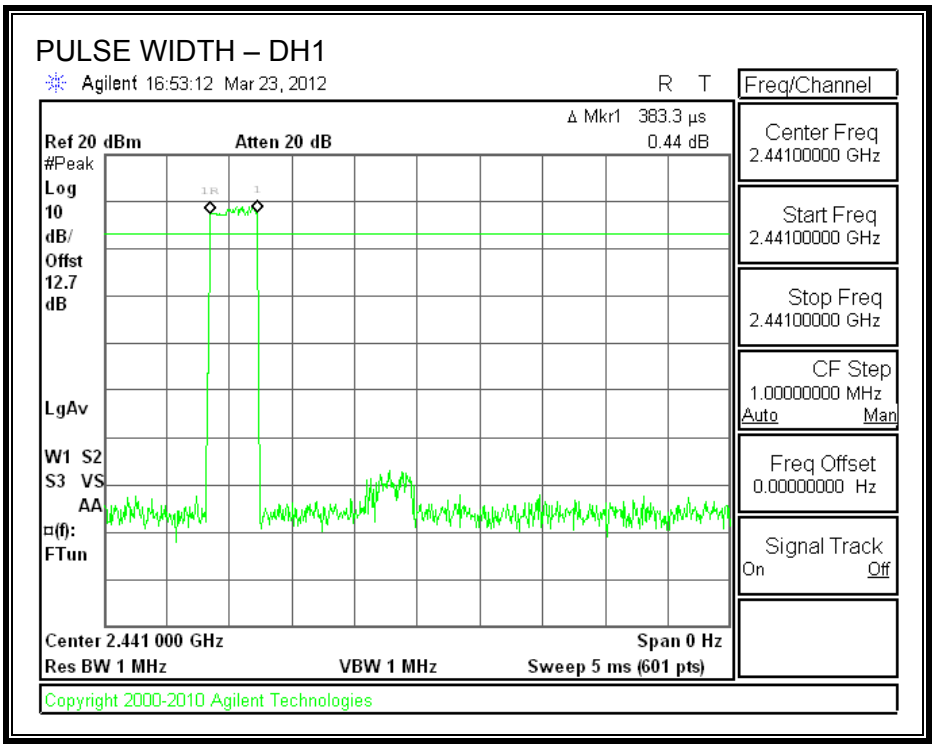
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

RESULTS

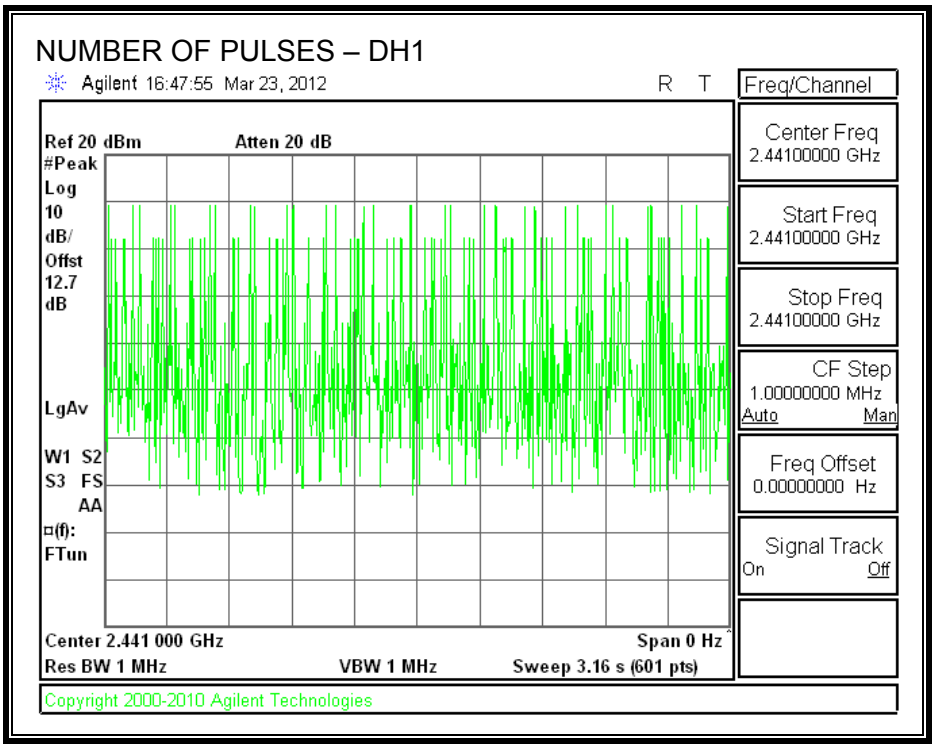
8PSK (EDR) Mode

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
DH1	0.3833	29	0.1112	0.4	-0.2888
DH3	1.6420	17	0.2791	0.4	-0.1209
DH5	2.8930	8	0.2314	0.4	-0.1686

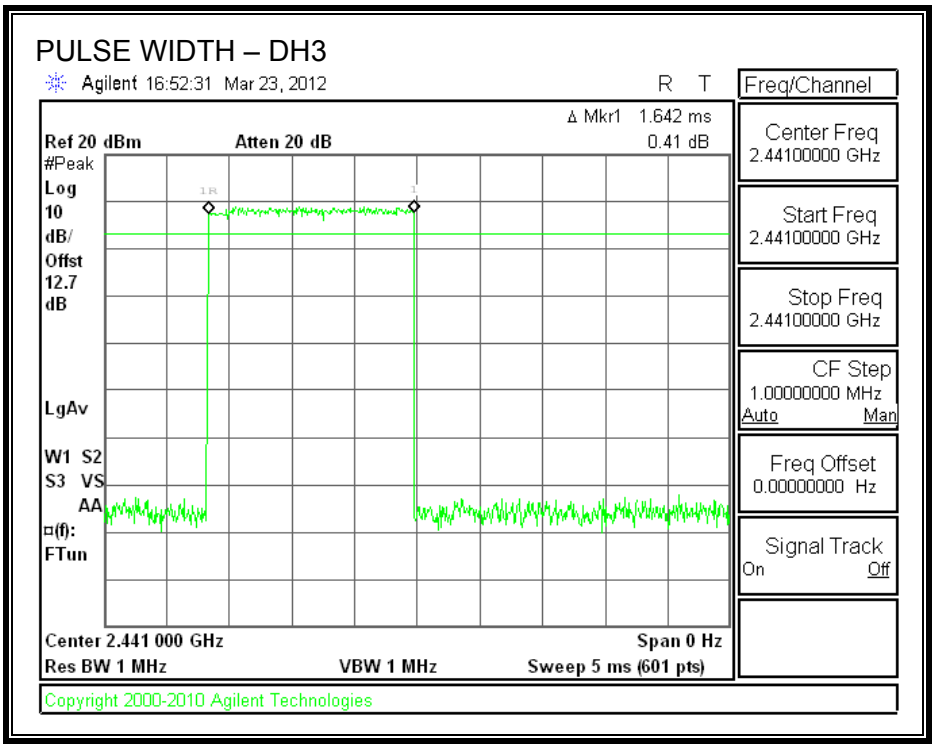
PULSE WIDTH - DH1



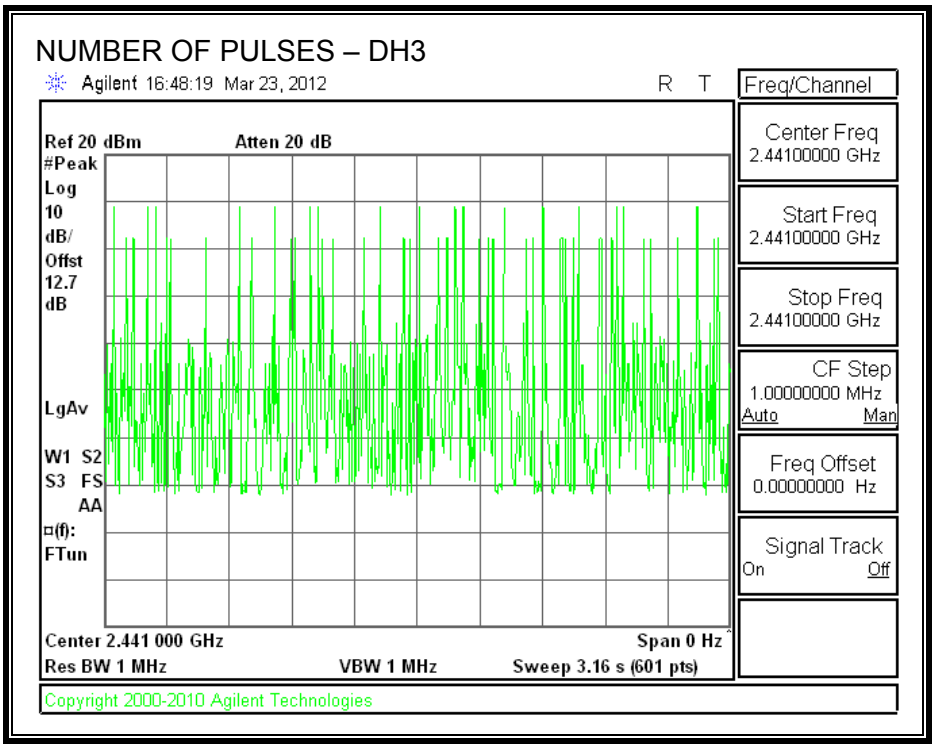
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



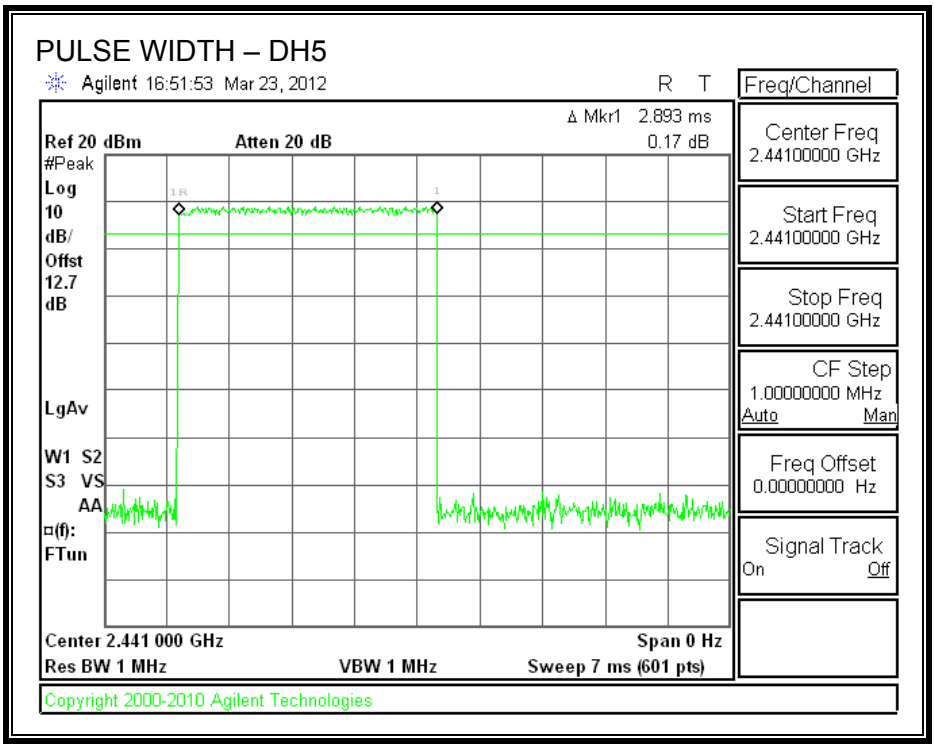
PULSE WIDTH – DH3



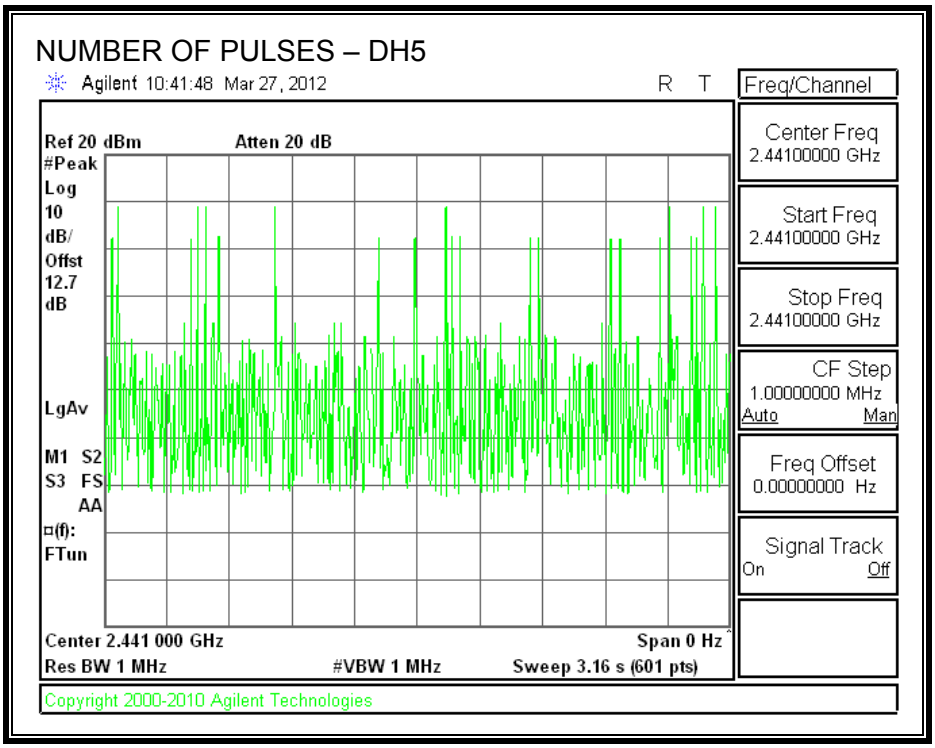
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5



7.2.5. 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 20.97 dBm.

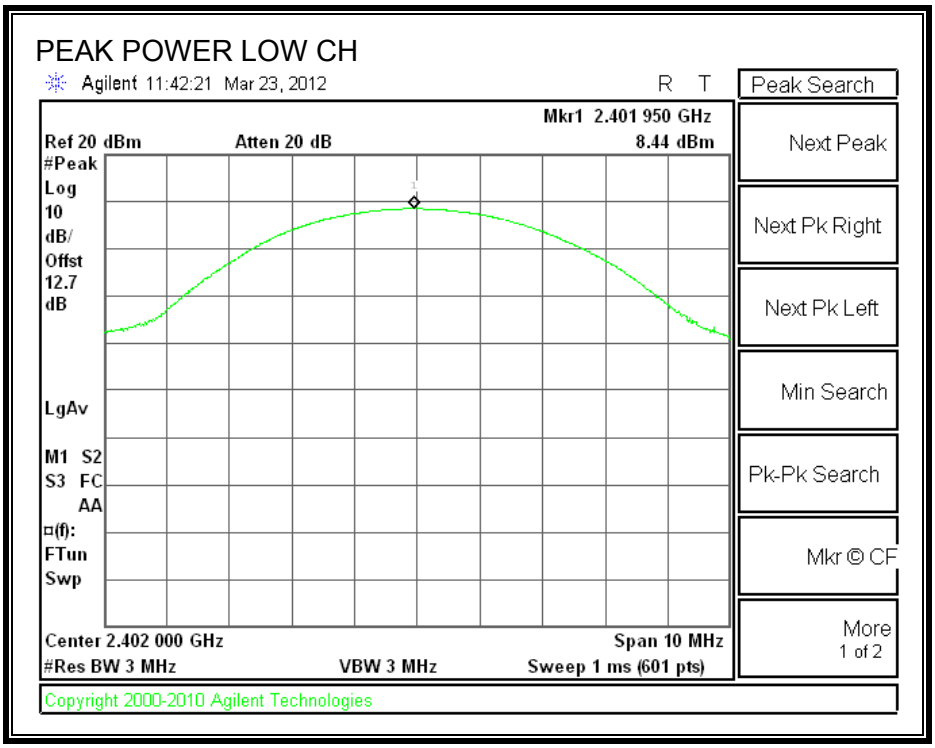
TEST PROCEDURE

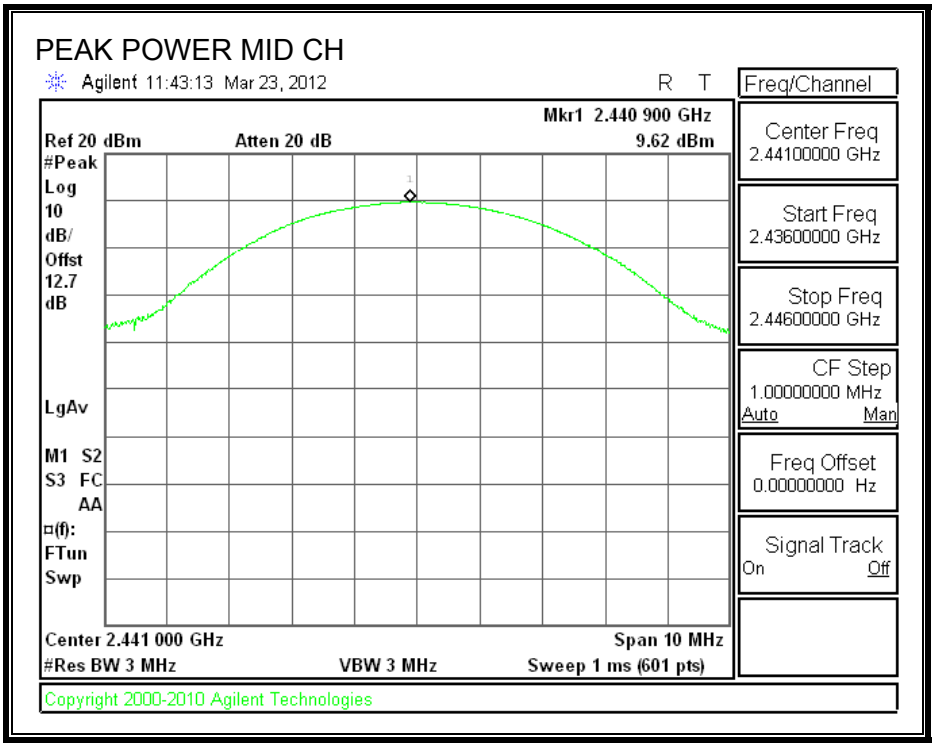
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

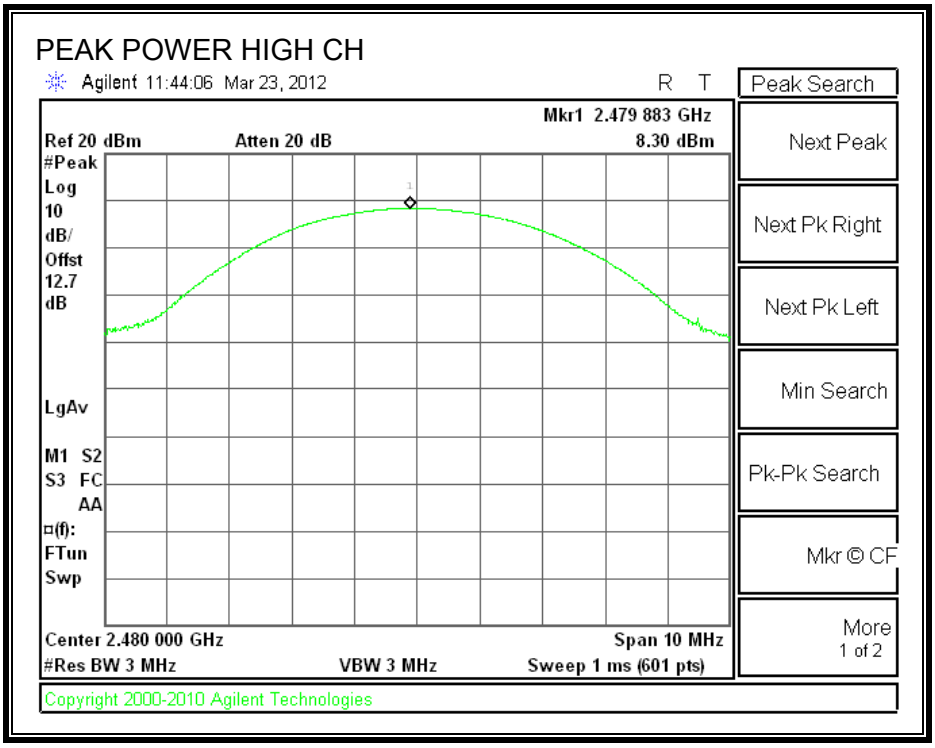
RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	8.44	20.97	-12.53
Middle	2441	9.62	20.97	-11.35
High	2480	8.30	20.97	-12.67

OUTPUT POWER







7.2.6. 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 12.7 dB (including 12 dB pad and 0.7 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	4.24
Middle	2441	5.36
High	2480	4.08

7.2.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

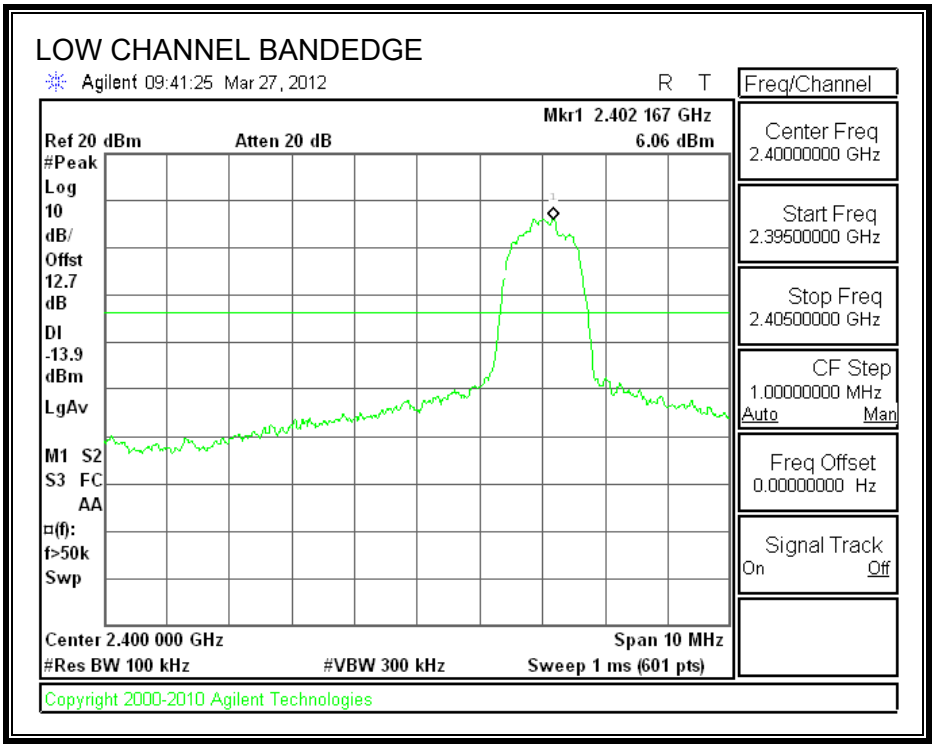
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

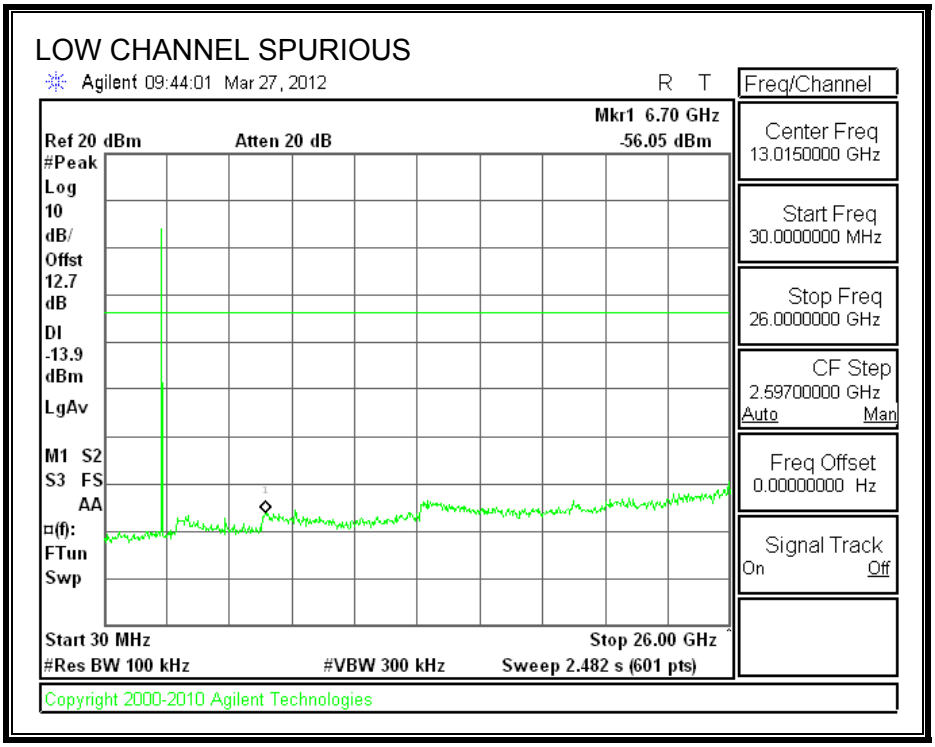
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

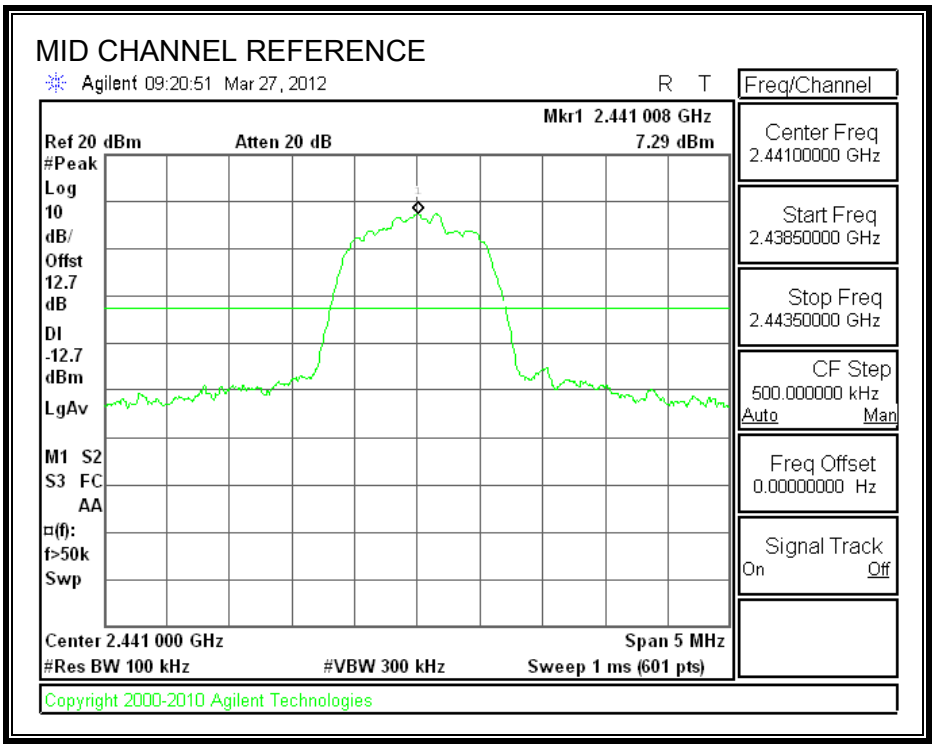
SPURIOUS EMISSIONS, LOW CHANNEL

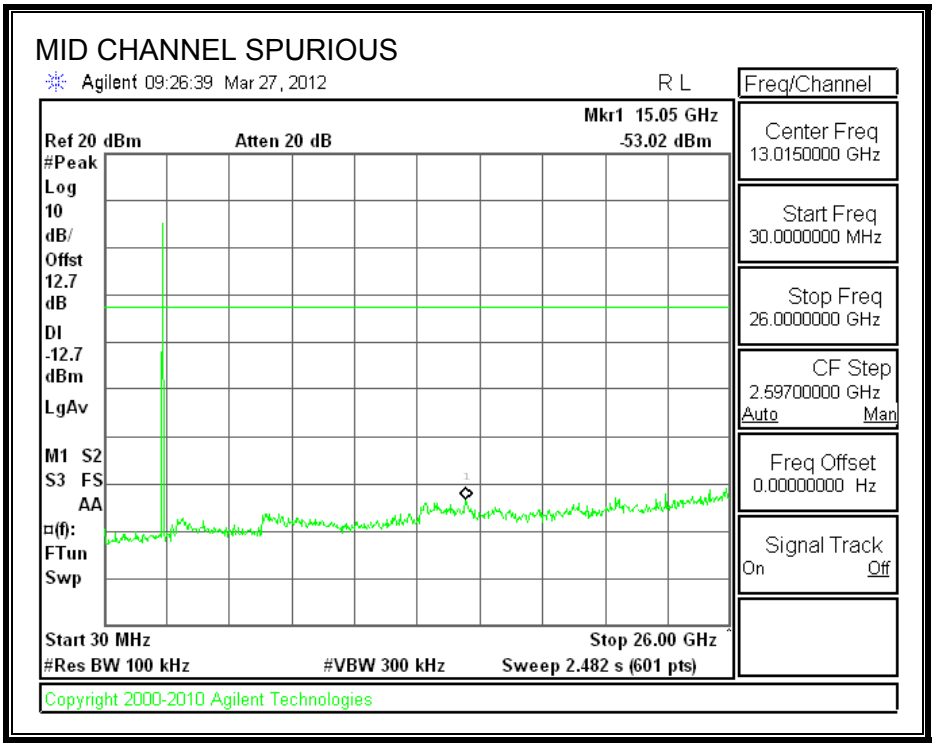


LOW CHANNEL SPURIOUS

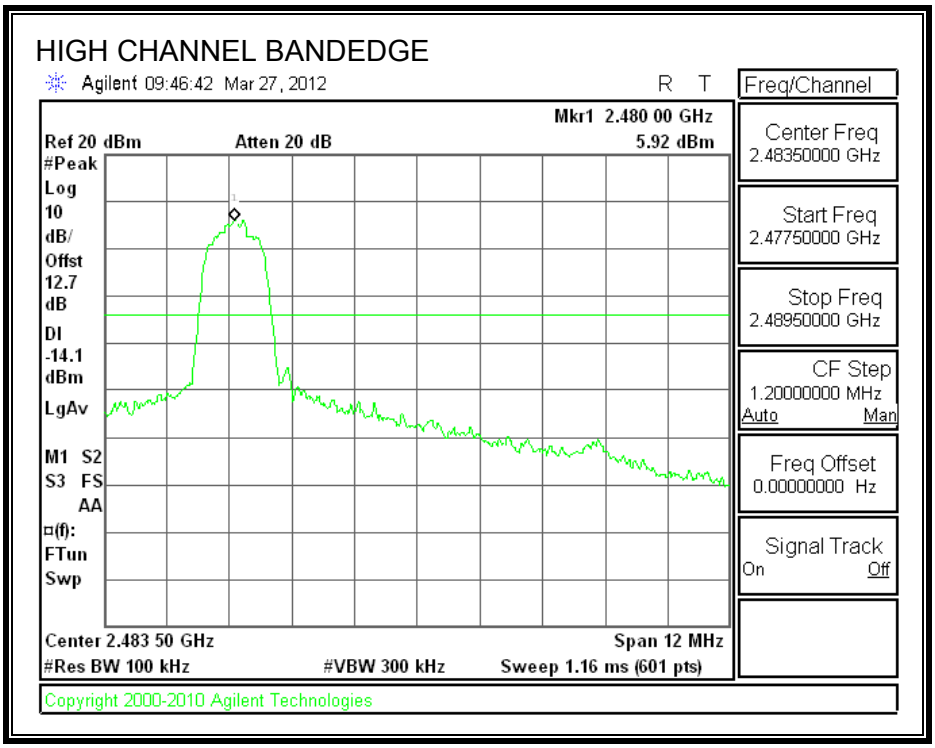


SPURIOUS EMISSIONS, MID CHANNEL

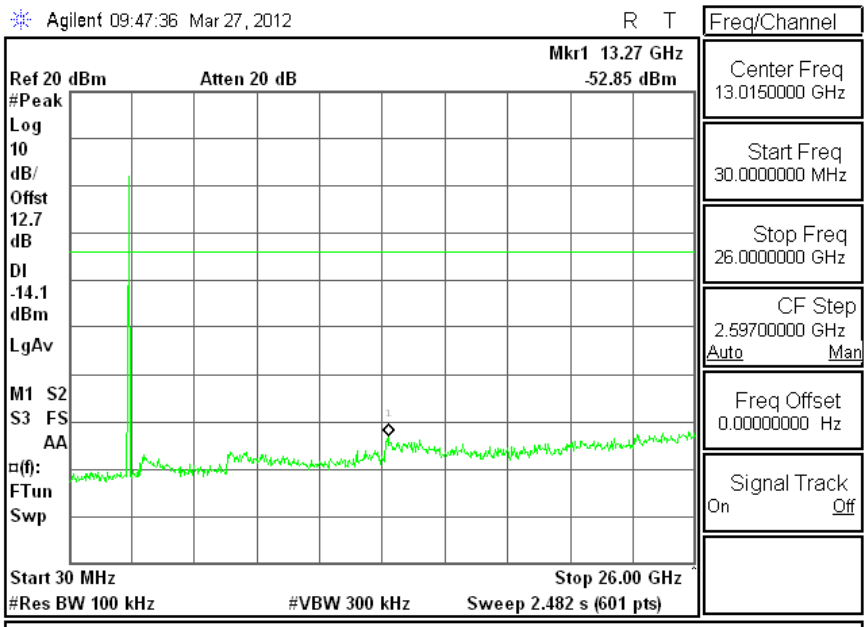




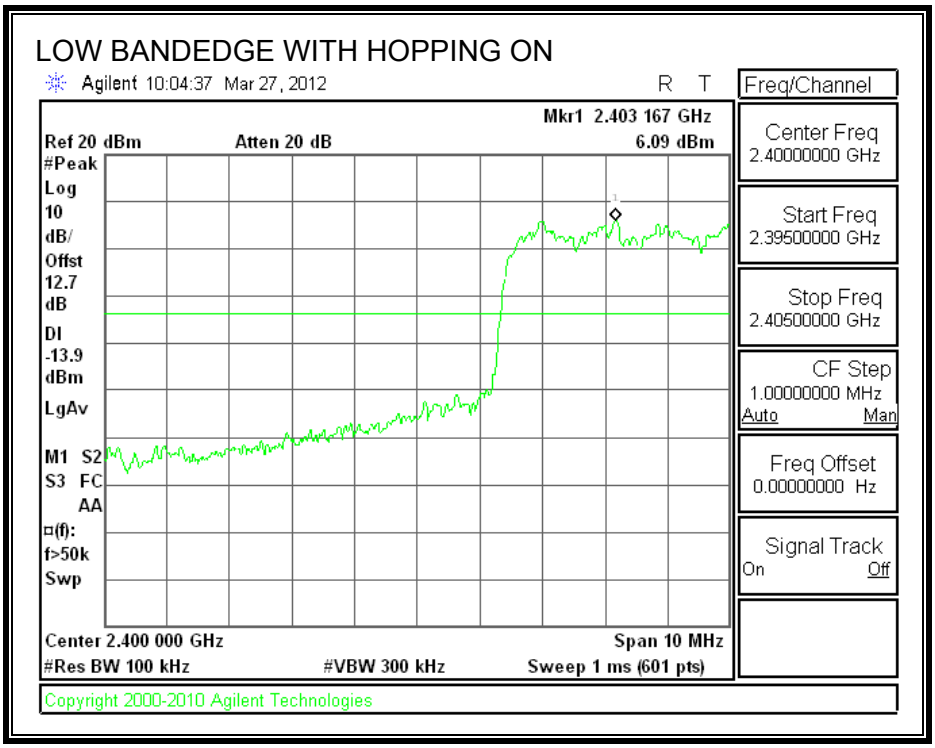
SPURIOUS EMISSIONS, HIGH CHANNEL



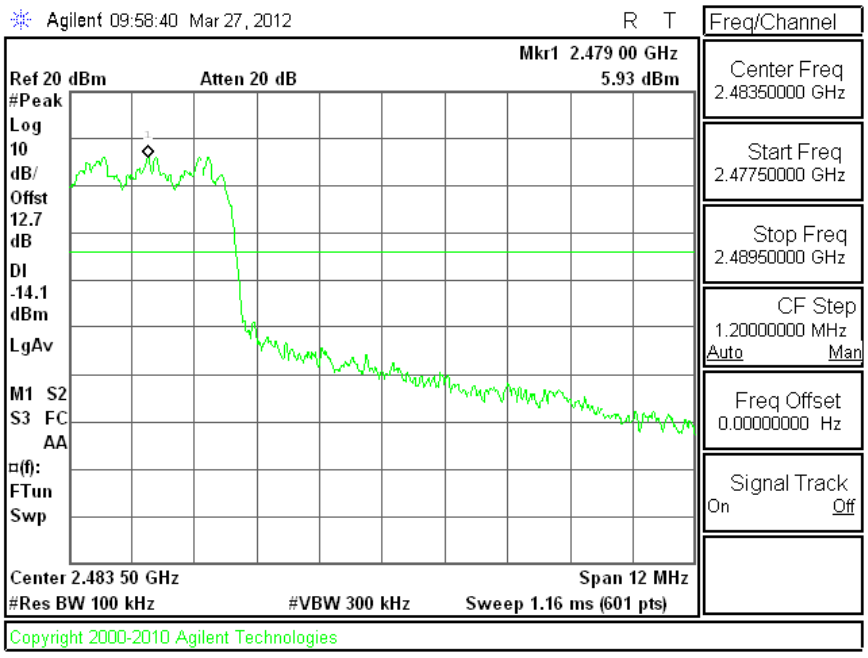
HIGH CHANNEL SPURIOUS



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



8. RADIATED TEST RESULTS

8.1. 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.

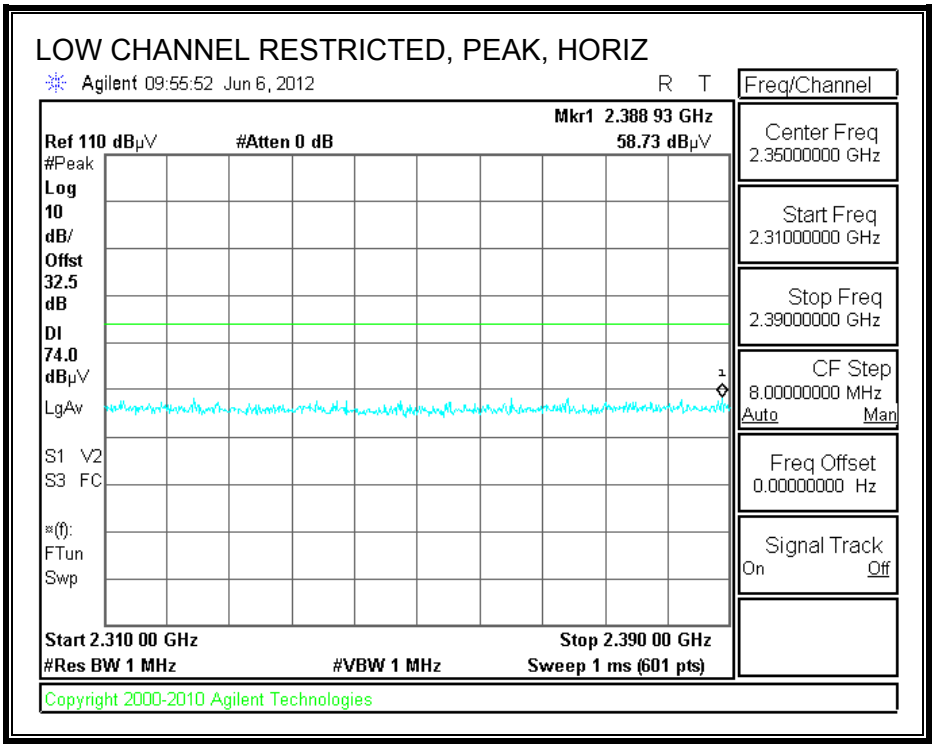
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

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.

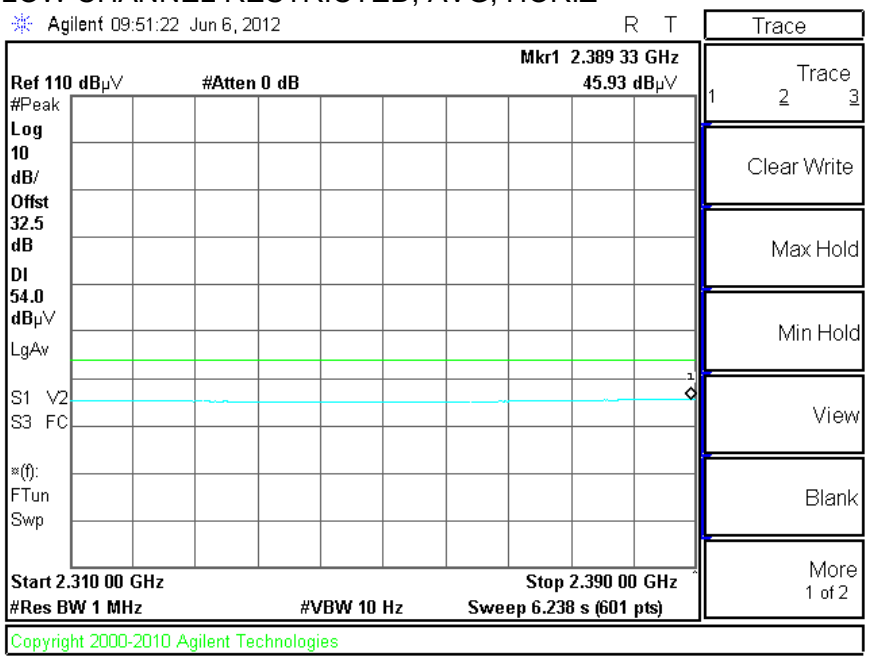
8.2. TRANSMITTER ABOVE 1 GHz

8.2.1. BASIC DATA RATE GFSK MODULATION

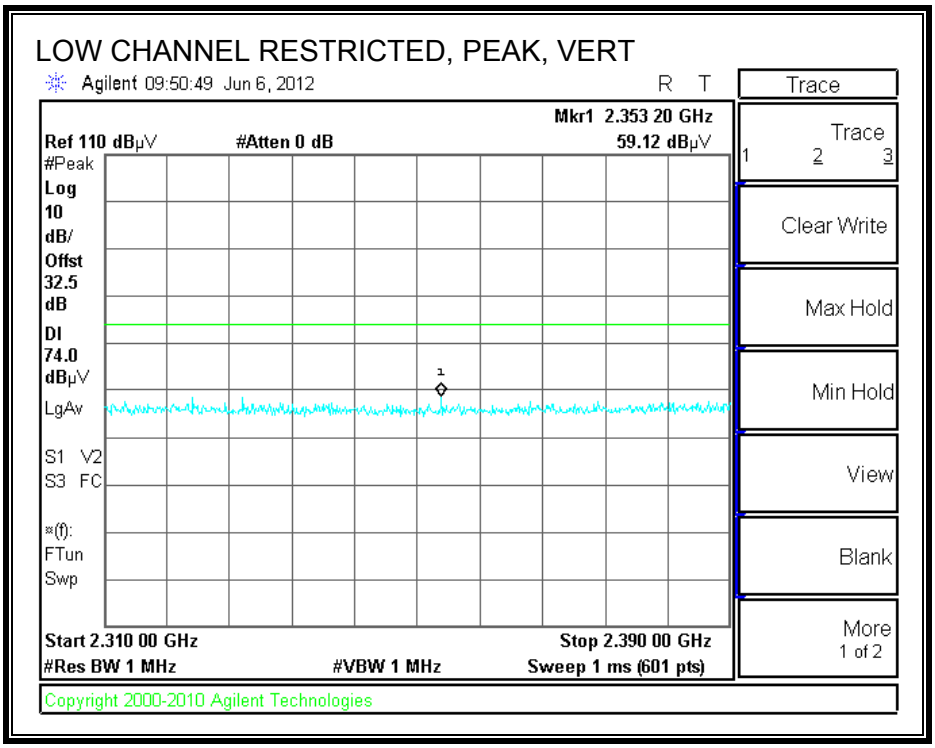
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



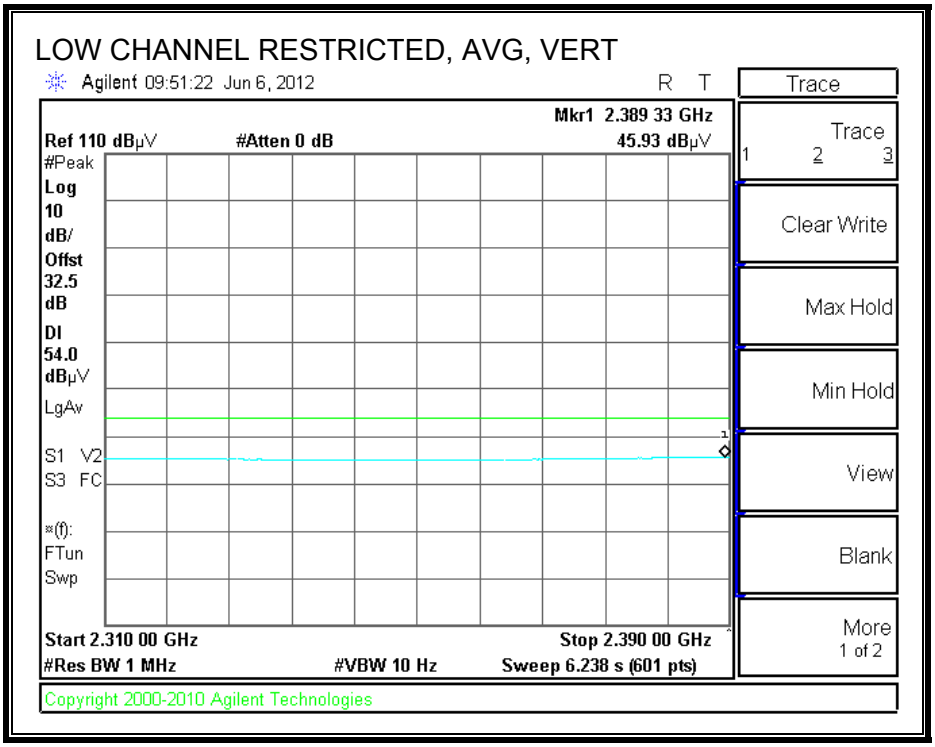
LOW CHANNEL RESTRICTED, AVG, HORIZ



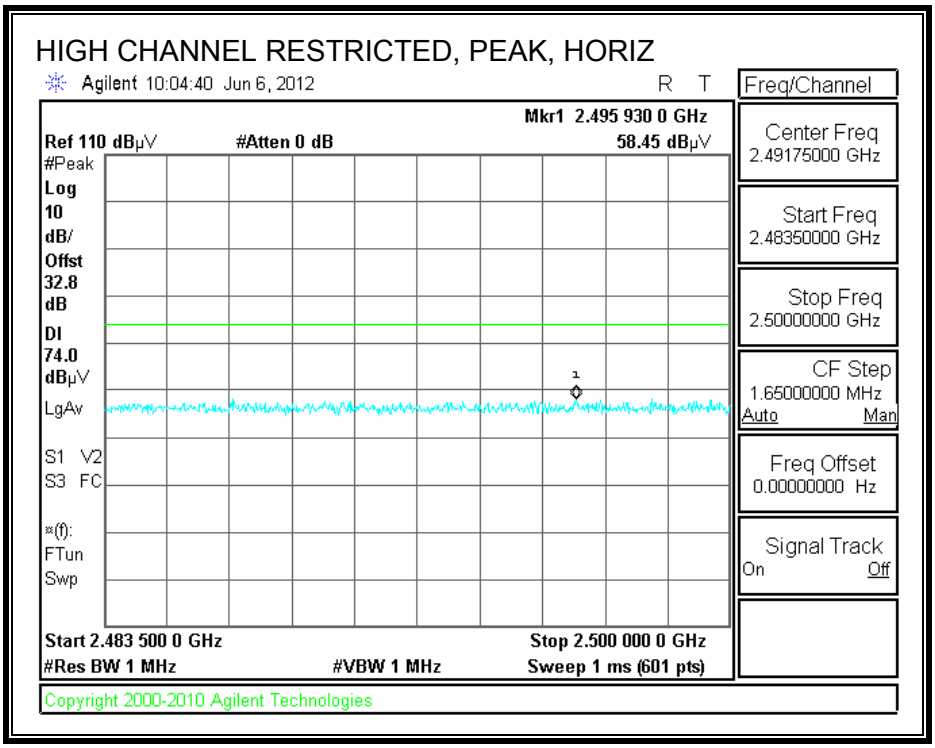
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



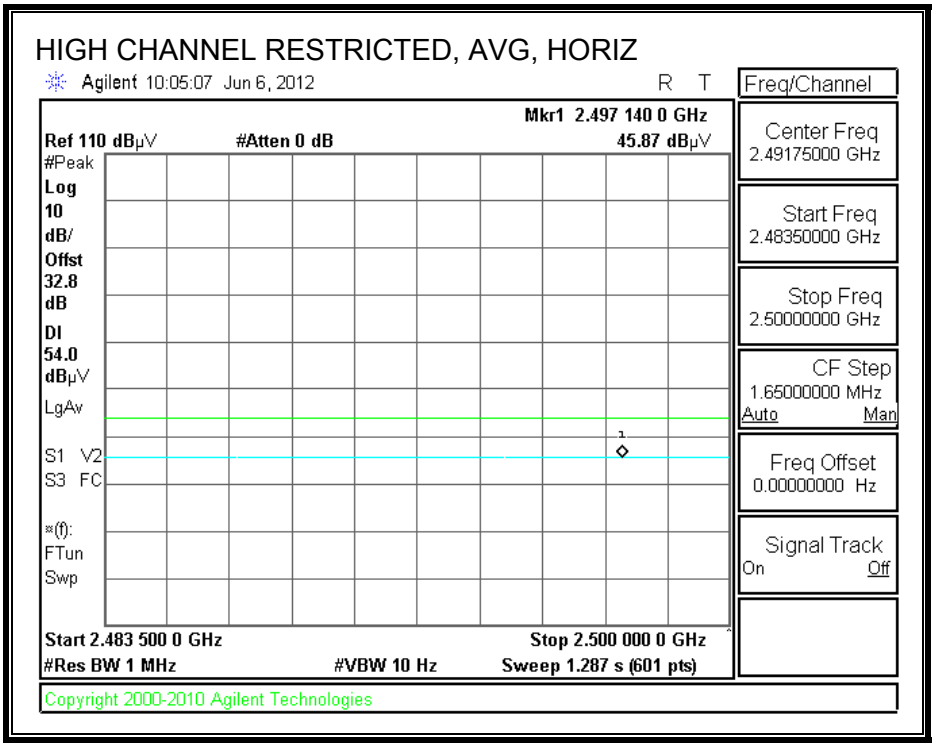
LOW CHANNEL RESTRICTED, AVG, VERT



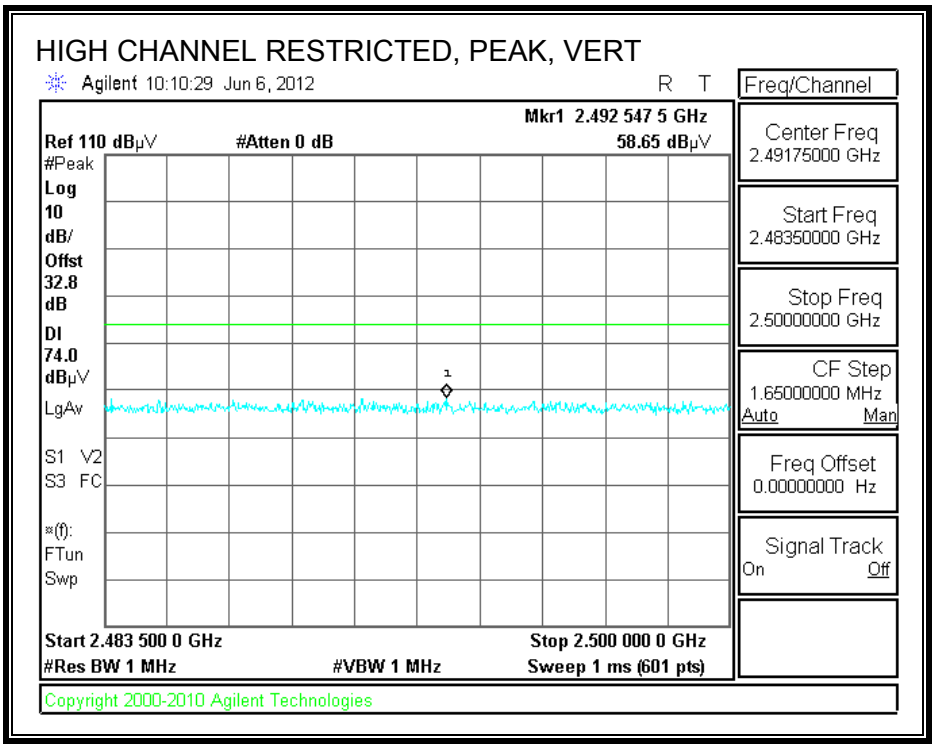
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



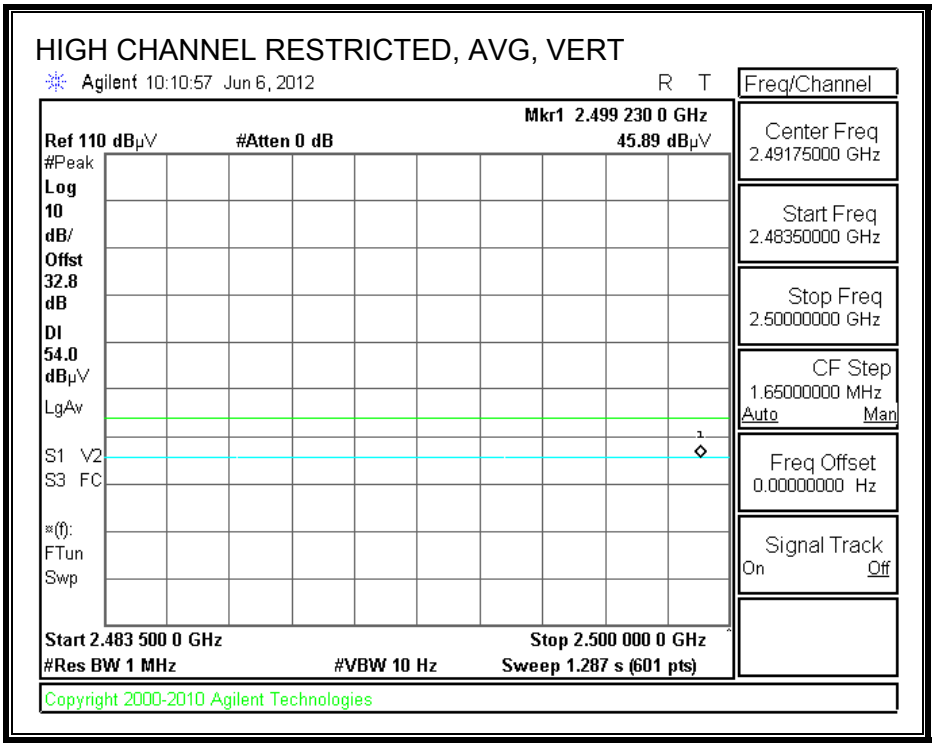
HIGH CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HIGH CHANNEL RESTRICTED, AVG, VERT



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Oliver Su
Date: 06/04/12
Project #: 12U14222
Company: Qualcomm Atheros
Test Target: FCC 15 205
Mode Oper: EUT was attached to a host phone with open cover, Bluetooth GFSK, Tx

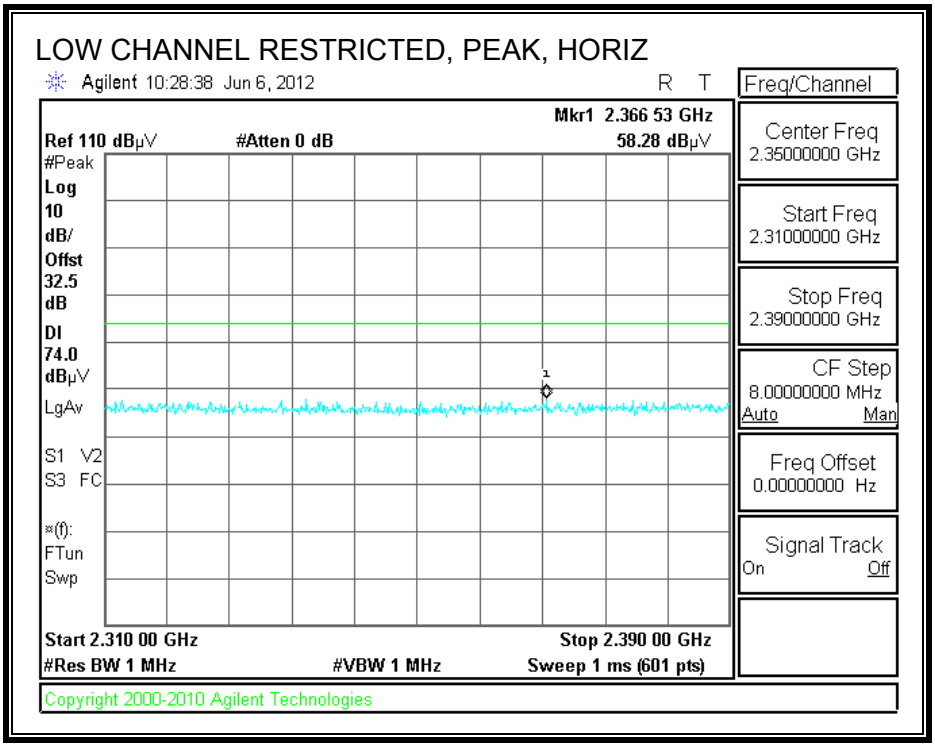
f	Measurement Frequency	Amp	Preamp Gain		Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters		Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m		Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength		Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

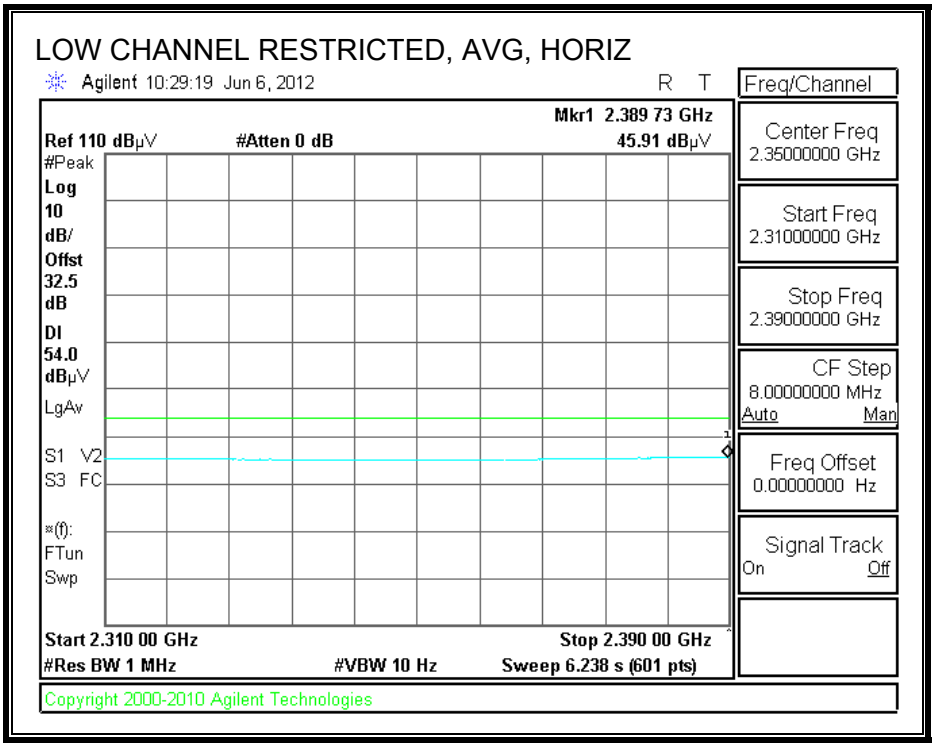
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Ant.High cm	Table Angle Degree	Notes
Low Ch (2402MHz)															
4.804	3.0	38.8	33.4	6.2	-35.5	0.0	0.0	42.9	74.0	-31.1	V	P	191.8	118.1	
4.804	3.0	29.4	33.4	6.2	-35.5	0.0	0.0	33.5	54.0	-20.5	V	A	191.8	118.1	
4.804	3.0	38.6	33.4	6.2	-35.5	0.0	0.0	42.7	74.0	-31.3	H	P	101.6	108.8	
4.804	3.0	27.5	33.4	6.2	-35.5	0.0	0.0	31.6	54.0	-22.4	H	A	101.6	108.8	
12.010	3.0	34.4	39.3	11.3	-35.4	0.0	0.0	49.6	74.0	-24.4	V	P	200.0	18.0	
12.010	3.0	22.5	39.3	11.3	-35.4	0.0	0.0	37.7	54.0	-16.3	V	A	200.0	18.0	
12.010	3.0	34.1	39.3	11.3	-35.4	0.0	0.0	49.3	74.0	-24.7	H	P	100.0	270.2	
12.010	3.0	22.5	39.3	11.3	-35.4	0.0	0.0	37.7	54.0	-16.3	H	A	100.0	270.2	
19.216	3.0	34.8	44.3	14.0	-33.9	0.0	0.0	59.2	74.0	-14.8	V	P	122.9	198.1	
19.216	3.0	21.4	44.3	14.0	-33.9	0.0	0.0	45.8	54.0	-8.2	V	A	122.9	198.1	
19.216	3.0	33.3	44.3	14.0	-33.9	0.0	0.0	57.7	74.0	-16.3	H	P	111.8	113.0	
19.216	3.0	21.4	44.3	14.0	-33.9	0.0	0.0	45.8	54.0	-8.2	H	A	111.8	113.0	
Mid Ch (2441MHz)															
4.882	3.0	36.3	33.5	6.2	-35.5	0.0	0.0	40.5	74.0	-33.5	V	P	196.6	116.2	
4.882	3.0	26.4	33.5	6.2	-35.5	0.0	0.0	30.7	54.0	-23.3	V	A	196.6	116.2	
4.882	3.0	35.6	33.5	6.2	-35.5	0.0	0.0	39.9	74.0	-34.1	H	P	199.4	0.0	
4.882	3.0	23.7	33.5	6.2	-35.5	0.0	0.0	27.9	54.0	-26.1	H	A	199.4	0.0	
7.323	3.0	35.7	35.7	8.4	-35.4	0.0	0.0	44.3	74.0	-29.7	V	P	160.0	317.1	
7.323	3.0	23.3	35.7	8.4	-35.4	0.0	0.0	31.9	54.0	-22.1	V	A	160.0	317.1	
7.323	3.0	34.9	35.7	8.4	-35.4	0.0	0.0	43.6	74.0	-30.4	H	P	131.8	290.6	
7.323	3.0	23.2	35.7	8.4	-35.4	0.0	0.0	31.9	54.0	-22.1	H	A	131.8	290.6	
High Ch (2480MHz)															
4.960	3.0	36.3	33.2	6.9	-34.0	0.0	0.0	42.4	74.0	-31.6	H	P	177.0	106.0	
4.960	3.0	23.8	33.2	6.9	-34.0	0.0	0.0	29.9	54.0	-24.1	H	A	177.0	106.0	
4.960	3.0	36.2	33.2	6.9	-34.0	0.0	0.0	42.3	74.0	-31.7	V	P	98.0	310.0	
4.960	3.0	24.5	33.2	6.9	-34.0	0.0	0.0	30.5	54.0	-23.5	V	A	98.0	310.0	
7.440	3.0	35.2	36.5	9.1	-33.0	0.0	0.0	47.7	74.0	-26.3	V	P	170.0	135.0	
7.440	3.0	22.8	36.5	9.1	-33.0	0.0	0.0	35.4	54.0	-18.6	V	A	170.0	135.0	
7.440	3.0	35.1	36.5	9.1	-33.0	0.0	0.0	47.6	74.0	-26.4	H	P	164.0	64.0	
7.440	3.0	22.6	36.5	9.1	-33.0	0.0	0.0	35.1	54.0	-18.9	H	A	164.0	64.0	

Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

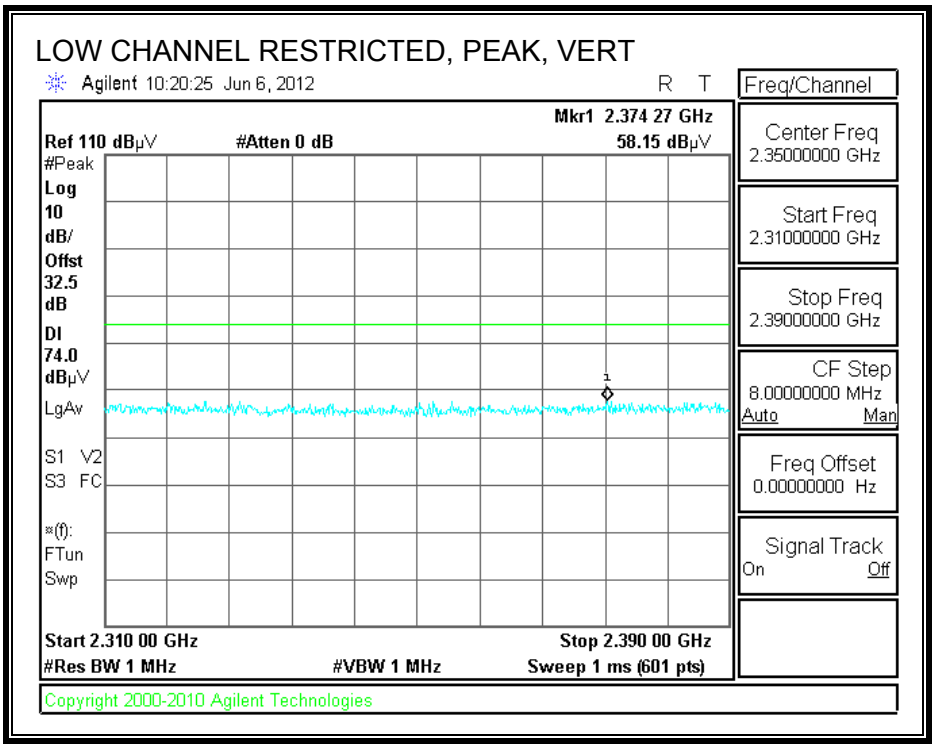
8.2.2. ENHANCED DATA RATE 8PSK MODULATION

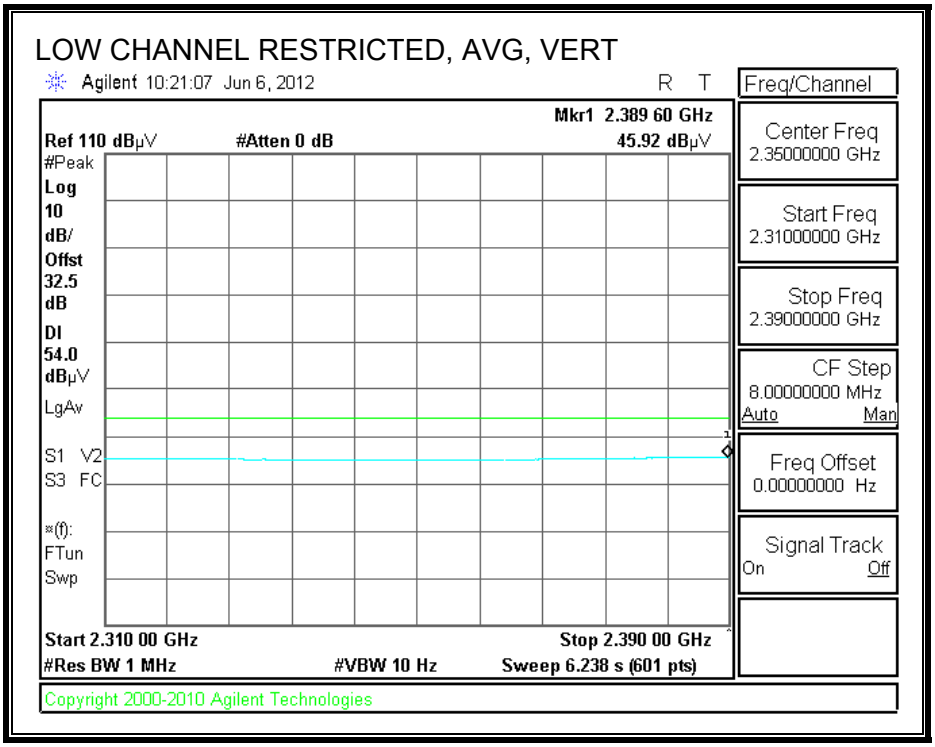
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



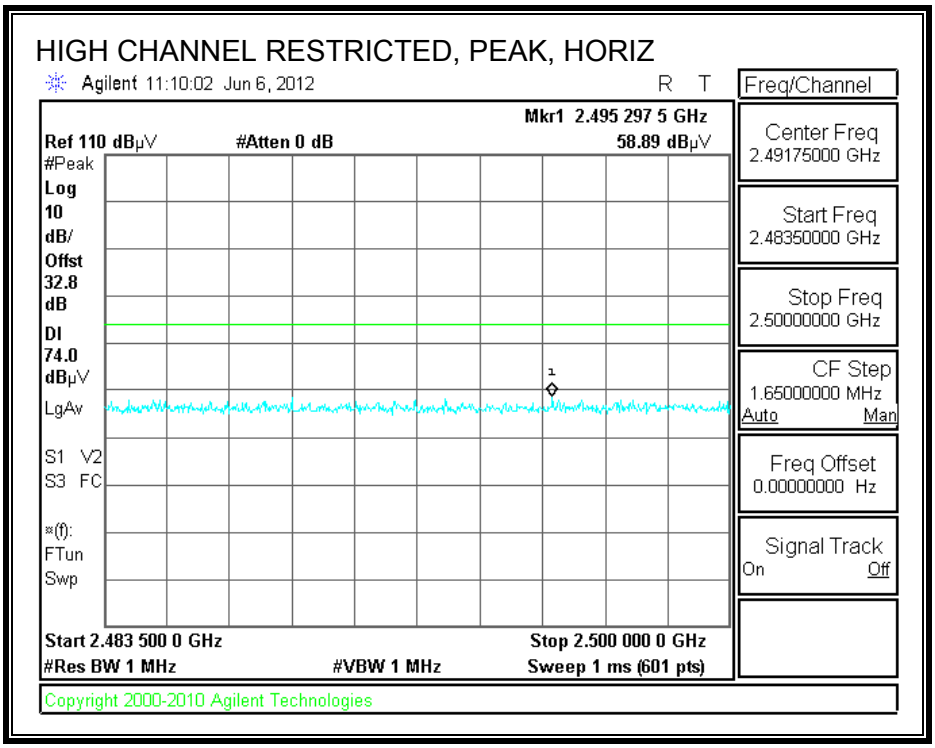


RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

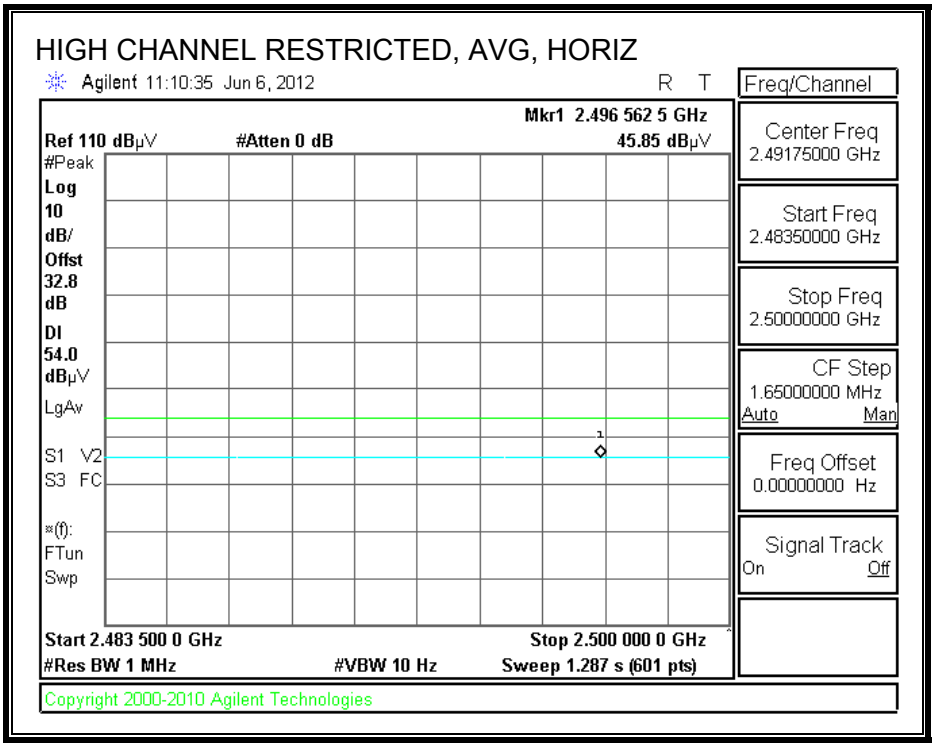




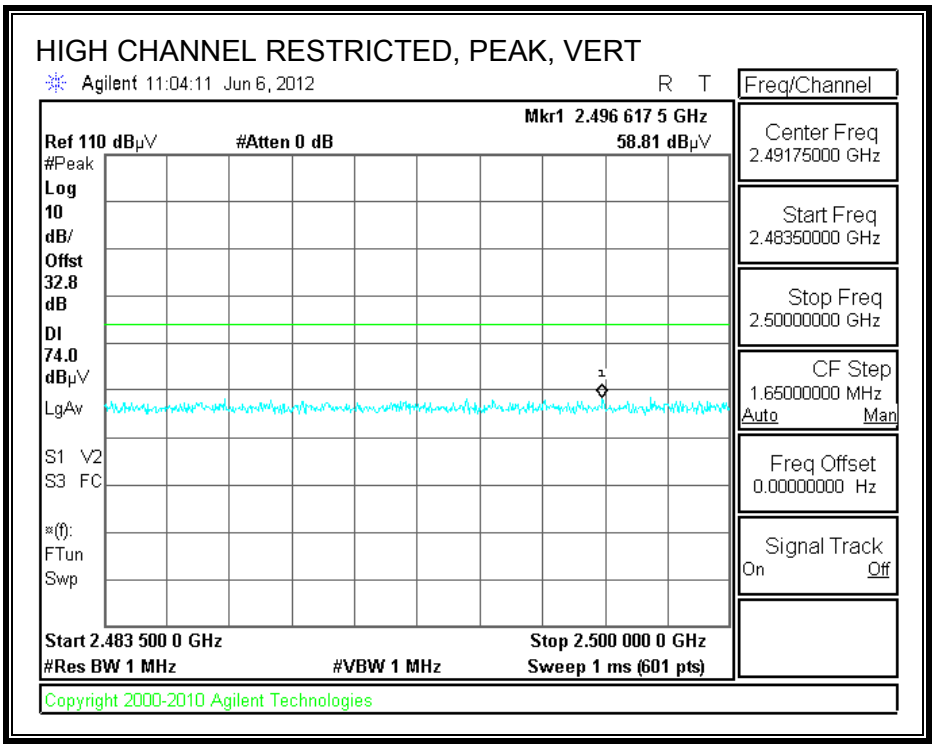
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



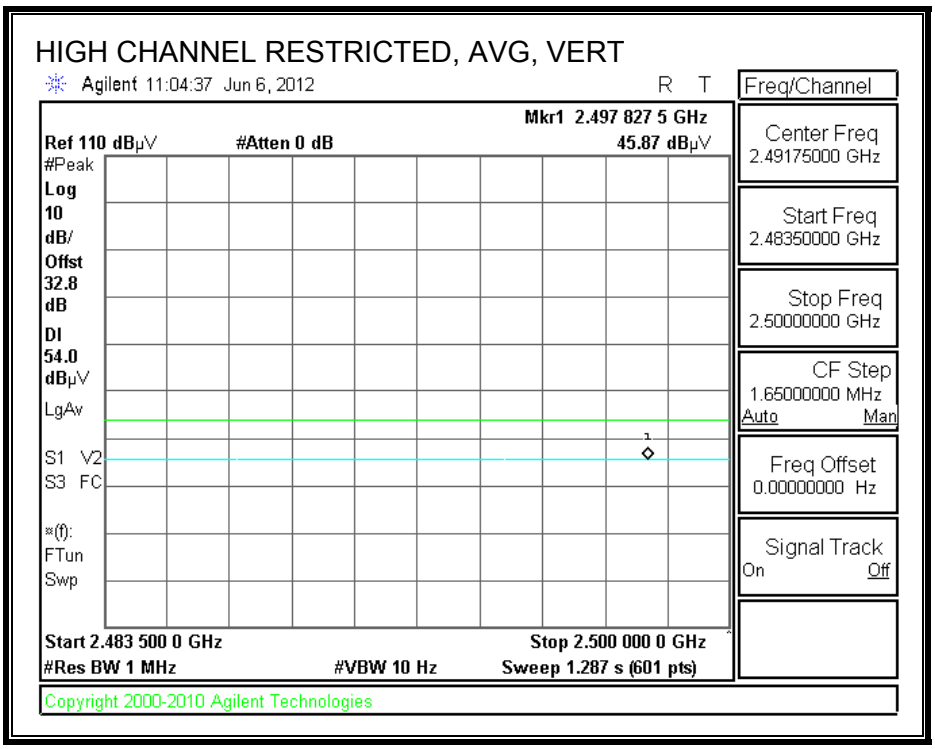
HIGH CHANNEL RESTRICTED, AVG, HORIZ



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HIGH CHANNEL RESTRICTED, AVG, VERT



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Oliver Su
Date: 06/04/12
Project #: 12U14222
Company: Qualcomm Atheros
Test Target: FCC 15 205
Mode Oper: EUT was attached to a host phone with open cover, Bluetooth 8PSK, Tx

f	Measurement Frequency	Amp	Preamp Gain		Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters		Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m		Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength		Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Ant.High cm	Table Angle Degree	Notes
Low ch (2402 MHz)															
4.804	3.0	36.2	33.1	6.8	-34.1	0.0	0.0	42.0	74.0	-32.0	H	P	183.0	241.0	
4.804	3.0	23.9	33.1	6.8	-34.1	0.0	0.0	29.7	54.0	-24.3	H	A	183.0	241.0	
4.804	3.0	38.5	33.1	6.8	-34.1	0.0	0.0	44.3	74.0	-29.7	V	P	118.0	49.0	
4.804	3.0	26.5	33.1	6.8	-34.1	0.0	0.0	32.3	54.0	-21.7	V	A	118.0	49.0	
12.010	3.0	33.8	39.4	11.9	-32.5	0.0	0.0	52.6	74.0	-21.4	H	P	105.0	27.0	
12.010	3.0	21.8	39.4	11.9	-32.5	0.0	0.0	40.6	54.0	-13.4	H	A	105.0	27.0	
12.010	3.0	33.6	39.4	11.9	-32.5	0.0	0.0	52.4	74.0	-21.6	V	P	192.0	356.0	
12.010	3.0	21.8	39.4	11.9	-32.5	0.0	0.0	40.6	54.0	-13.4	V	A	192.0	356.0	
Mid Ch (2441 MHz)															
4.882	3.0	36.2	33.1	6.8	-34.1	0.0	0.0	42.0	74.0	-32.0	V	P	137.0	225.0	
4.882	3.0	24.3	33.1	6.8	-34.1	0.0	0.0	30.1	54.0	-23.9	V	A	137.0	225.0	
4.882	3.0	36.8	33.1	6.8	-34.1	0.0	0.0	42.6	74.0	-31.4	H	P	130.0	293.0	
4.882	3.0	24.2	33.1	6.8	-34.1	0.0	0.0	30.0	54.0	-24.0	H	A	130.0	293.0	
7.323	3.0	35.5	36.3	9.1	-33.1	0.0	0.0	47.8	74.0	-26.2	V	P	173.0	7.0	
7.323	3.0	22.6	36.3	9.1	-33.1	0.0	0.0	34.9	54.0	-19.1	V	A	173.0	7.0	
7.323	3.0	35.2	36.3	9.1	-33.1	0.0	0.0	47.5	74.0	-26.5	H	P	196.0	293.0	
7.323	3.0	22.7	36.3	9.1	-33.1	0.0	0.0	35.0	54.0	-19.0	H	A	196.0	293.0	
High Ch (2480 MHz)															
4.960	3.0	35.6	33.2	6.9	-34.0	0.0	0.0	41.7	74.0	-32.3	V	P	163.0	53.0	
4.960	3.0	24.5	33.2	6.9	-34.0	0.0	0.0	30.5	54.0	-23.5	V	A	163.0	53.0	
4.960	3.0	35.8	33.2	6.9	-34.0	0.0	0.0	41.9	74.0	-32.1	H	P	139.0	313.0	
4.960	3.0	23.5	33.2	6.9	-34.0	0.0	0.0	29.6	54.0	-24.4	H	A	139.0	313.0	
7.440	3.0	35.3	36.5	9.1	-33.0	0.0	0.0	47.8	74.0	-26.2	V	P	154.0	134.0	
7.440	3.0	22.7	36.5	9.1	-33.0	0.0	0.0	35.2	54.0	-18.8	V	A	154.0	134.0	
7.440	3.0	35.4	36.5	9.1	-33.0	0.0	0.0	47.9	74.0	-26.1	H	P	141.0	127.0	
7.440	3.0	22.6	36.5	9.1	-33.0	0.0	0.0	35.2	54.0	-18.9	H	A	141.0	127.0	

Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

9. 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

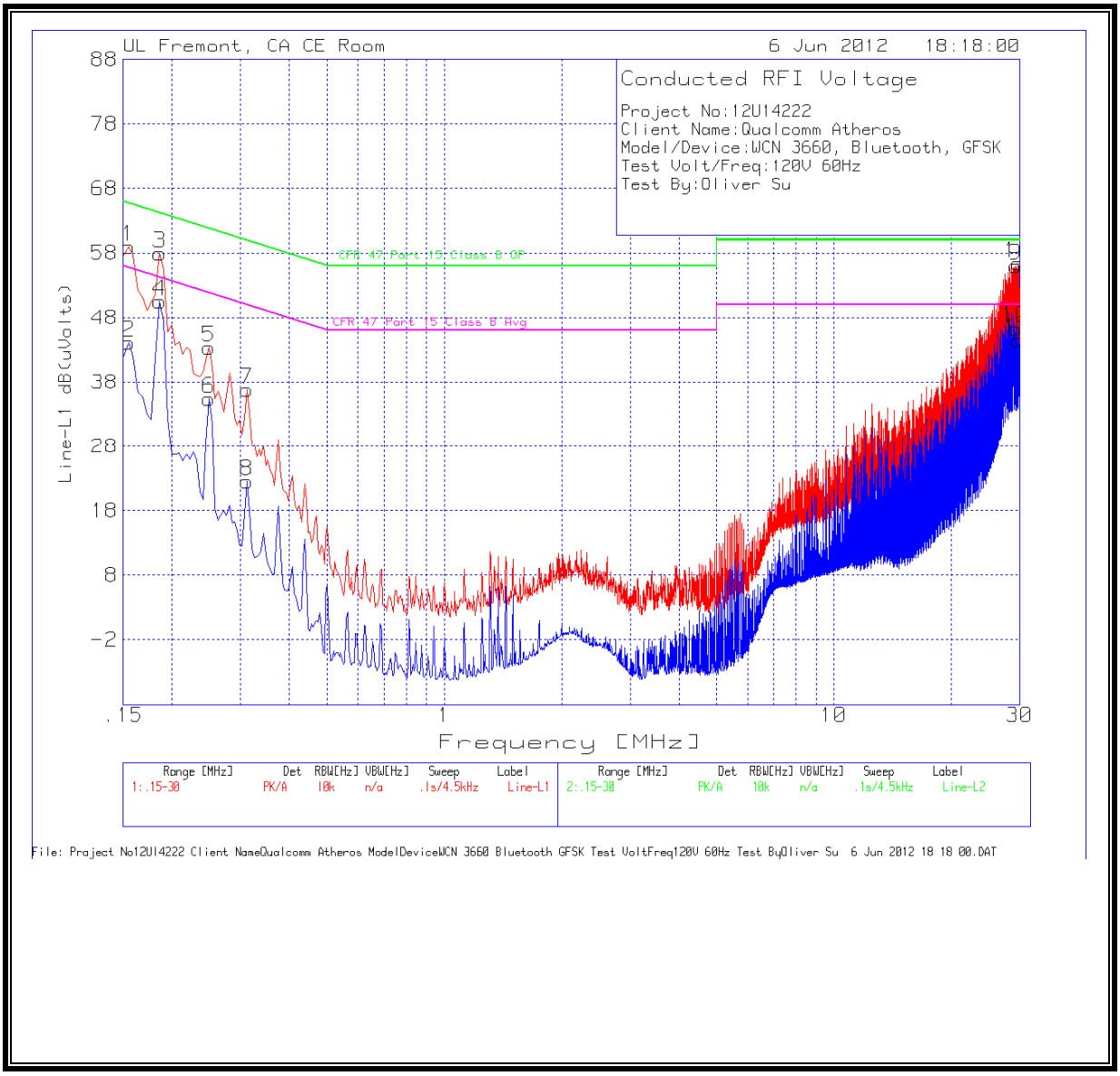
6 WORST EMISSIONS

Line-L1 .15 - 30MHz

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L1 (dB)	LC Cables 1&3 (dB)	Corrected Reading dB(uVolts)	CFR 47 Part 15 Class B QP	Margin to Limit (dB)	CFR 47 Part 15 Class B Avg	Margin to Limit (dB)
1	.1545	58.86	PK	.1	0	58.96	65.8	-6.84	-	-
2	.1545	44.03	Av	.1	0	44.13	-	-	55.8	-11.67
3	.186	57.82	PK	.1	0	57.92	64.2	-6.28	-	-
4	.186	50.43	Av	.1	0	50.53	-	-	54.2	-3.67
5	.249	43.23	PK	.1	0	43.33	61.8	-18.47	-	-
6	.249	35.37	Av	.1	0	35.47	-	-	51.8	-16.33
7	.312	36.74	PK	.1	0	36.84	59.9	-23.06	-	-
8	.312	22.35	Av	.1	0	22.45	-	-	49.9	-27.45
9	29.3325	55.2	PK	.5	.3	56	60	-4	-	-
10	29.3325	45.56	Av	.5	.3	46.36	-	-	50	-3.64
11	29.769	55.56	PK	.5	.3	56.36	60	-3.64	-	-
12	29.769	43.75	Av	.5	.3	44.55	-	-	50	-5.45

LINE 1 RESULTS

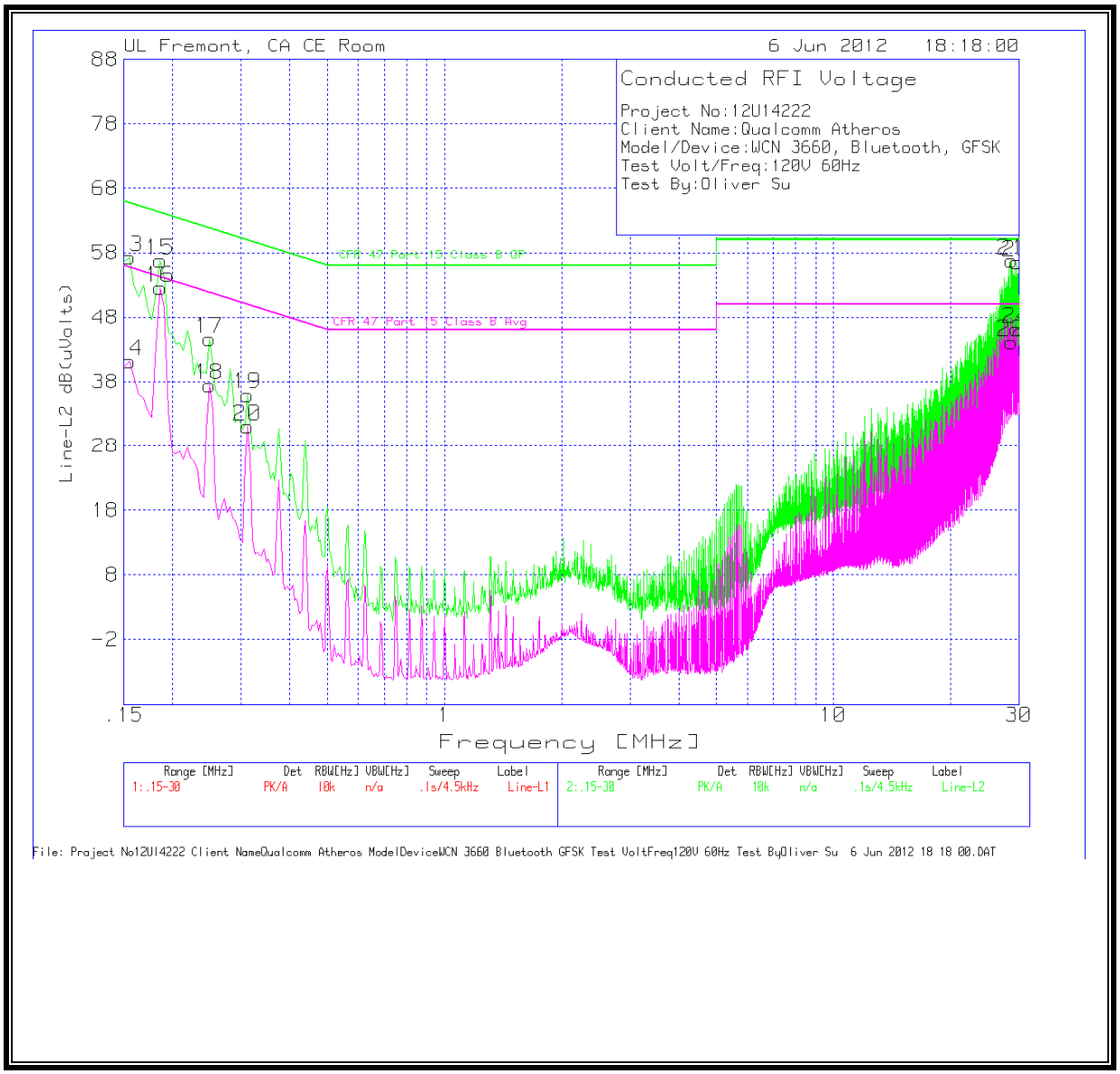


LINE 2 RESULTS

Line-L2 .15 - 30MHz

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L2 (dB)	LC Cables 2&3 (dB)	Corrected Reading dB(uVolts)	CFR 47 Part 15 Class B QP	Margin to Limit (dB)	CFR 47 Part 15 Class B Avg	Margin to Limit (dB)
13	.1545	57.21	PK	.1	0	57.31	65.8	-8.49	-	-
14	.1545	41.11	Av	.1	0	41.21	-	-	55.8	-14.59
15	.186	56.71	PK	.1	0	56.81	64.2	-7.39	-	-
16	.186	52.5	Av	.1	0	52.6	-	-	54.2	-1.6
17	.249	44.52	PK	.1	0	44.62	61.8	-17.18	-	-
18	.249	37.35	Av	.1	0	37.45	-	-	51.8	-14.35
19	.312	35.9	PK	.1	0	36	59.9	-23.9	-	-
20	.312	31.01	Av	.1	0	31.11	-	-	49.9	-18.79
21	28.77	56	PK	.5	.3	56.8	60	-3.2	-	-
22	28.77	43.38	Av	.5	.3	44.18	-	-	50	-5.82
23	29.5215	55.78	PK	.5	.3	56.58	60	-3.42	-	-
24	29.5215	45.38	Av	.5	.3	46.18	-	-	50	-3.82



10. MAXIMUM PERMISSIBLE EXPOSURE

FCC RULES

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

IC RULES

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m^2)	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	$280/f$	$2.19/f$		6
10–30	28	$2.19/f$		6
30–300	28	0.073	2*	6
300–1 500	$1.585f^{0.5}$	$0.0042f^{0.5}$	$f/150$	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000–300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616\,000/f^{1.2}$

* Power density limit is applicable at frequencies greater than 100 MHz.

Notes: 1. Frequency, f, is in MHz.
2. A power density of 10 W/m^2 is equivalent to 1 mW/cm^2.
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

EQUATIONS

Power density is given by:

S = EIRP / (4 * Pi * D^2)

where

S = Power density in W/m^2
EIRP = Equivalent Isotropic Radiated Power in W
D = Separation distance in m

Power density in units of W/m^2 is converted to units of mWc/m^2 by dividing by 10.

Distance is given by:

D = SQRT (EIRP / (4 * Pi * S))

where

D = Separation distance in m
EIRP = Equivalent Isotropic Radiated Power in W
S = Power density in W/m^2

For multiple colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the Power * Gain product (in linear units) of each transmitter.

Total EIRP = (P1 * G1) + (P2 * G2) + ... + (Pn * Pn)

where

Px = Power of transmitter x
Gx = Numeric gain of antenna x

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

LIMITS

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm^2

From IC Safety Code 6, Section 2.2 Table 5 Column 4, S = 10 W/m^2

RESULTS

Band	Mode	Separation Distance (m)	Output AV Power (dBm)	Antenna Gain (dBi)	IC Power Density (W/m^2)	FCC Power Density (mW/cm^2)
2.4 GHz	Bluetooth	0.20	6.77	3.62	0.02	0.002