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

CERTIFICATION TEST REPORT

FOR

GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE radio, IEEE 802.11a/b/g/n and Bluetooth radio

MODEL NUMBER: A1428 and A1429

FCC ID: BCG-E2599A
IC: 579C-E2599A
IC: 579C-E2610A

REPORT NUMBER: 11U14136-5, Revision A

ISSUE DATE: AUGUST 7, 2012

Prepared for
APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

Prepared by
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
-	07/27/2012	Original	T. LEE
A	08/07/2012	Added Model A1429	T. LEE

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE radio, IEEE 802.11a/b/g/n and Bluetooth radio.

MODEL: A1428 and A1429

SERIAL NUMBER: C39HV0HPF5P5

DATE TESTED: MAY 22 and JULY 9, 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

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:

TIM LEE
STAFF ENGINEER
UL CCS

Tested By:

CHIN PANG
EMC ENGINEER
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, and 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

Model A1428, is a mobile phone with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/CDMA1xRTT/ EV-DO Rev 0, A, B /1xAdvanced/ LTE radio, IEEE 802.11a/b/g/n radio and Bluetooth radio. The rechargeable battery is not user accessible.

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	Basic GFSK	13.73	23.60
2402 - 2480	Enhanced 8PSK	12.94	19.68

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PiFA antenna, with a maximum gain as below table.

Frequency (GHz)	Gain (dBi) Type: Pifa
2.400-2.480	-1.4
5.150-5.250	0.14
5.250-5.350	-1.66
5.47-5.725	-0.83
5725-5850	-2.85

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was WL Tool FW 6.10.56.166.

The EUT is also linked in Bluetooth Enable Test mode with Rohde & Schwarz CBT Test box.

5.5. MODEL DIFFERNECE

Model A1428 is identical to Model A1429 except in the license bands. Model A1429 encompasses CDMA technology. Testing conducted on Model A1428 is considered representative for Model A1429

5.6. WORST-CASE CONFIGURATION AND MODE

For Radiated Emissions below 1 GHz and Power line Conducted Emissions, the channel with the highest conducted output power was selected as worst-case scenario.

EUT is a portable device that has three orientations; therefore, X Y and Z orientations have been investigated, and the worst case was found to be at Z position.

5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	Asset	Cal Due
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01159	04/09/13
Antenna, Horn, 18 GHz	EMCO	3115	C00872	05/29/13
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	04/28/13
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	04/16/13
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	01/27/13
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01063	04/12/13
EMI Test Receiver, 9 kHz-7 GHz	R & S	ESCI 7	1000741	07/06/13
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	11/10/12
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	12/04/12
Peak Power Meter	Agilent / HP	E4416A	C00963	12/04/12
Bluetooth Tester	R&S	CBT	NA	05/15/13

I/O CABLES (CONDUCTED)

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	In/Out	1	SMA	Shielded	0.2m	NA
2	In/Out	1	SMA	Shielded	0.6m	NA
3	Antenna Port	1	SMA	Shielded	0.1m	To BT tester

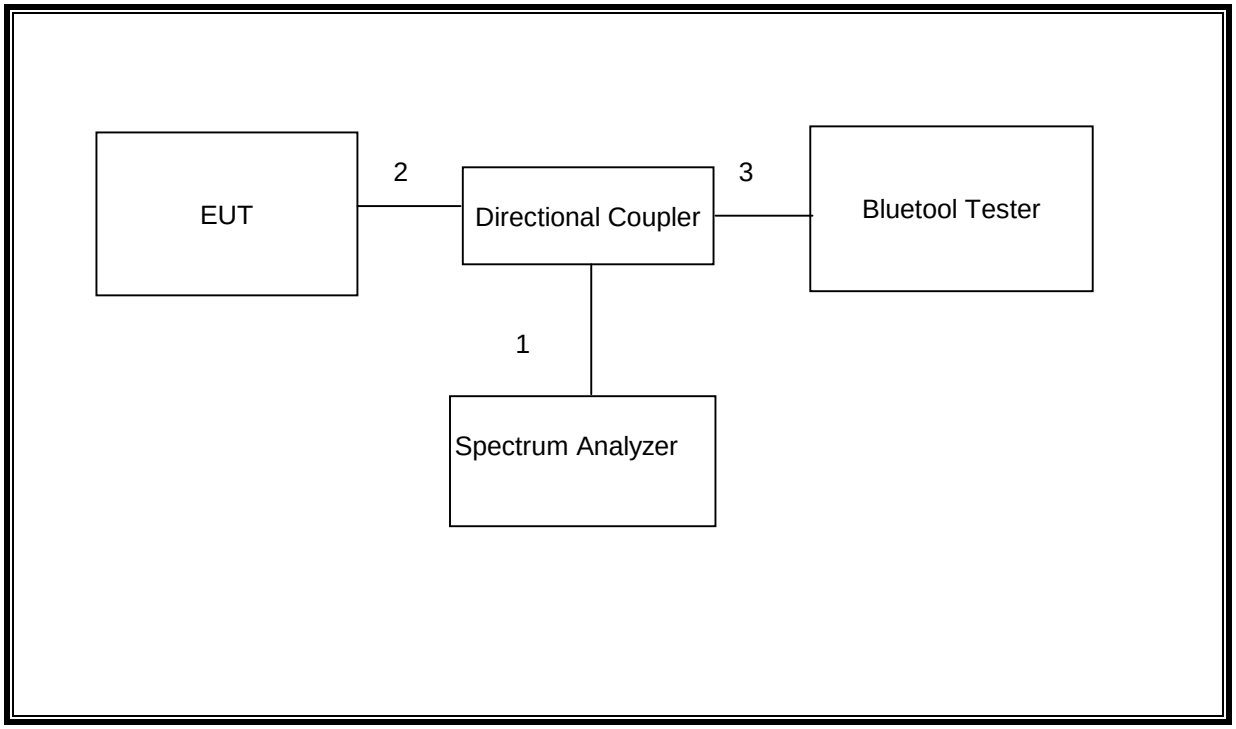
I/O CABLES (RADIATED)

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	2	US115VAC	Shielded	2m	NA
2	DC	1	DC	Shielded	1m	NA
3	Audio	1	Earphone	Shielded	0.5m	NA
4	Antenna Port	1	Monopole Antenna	Un-shielded	2m	NA

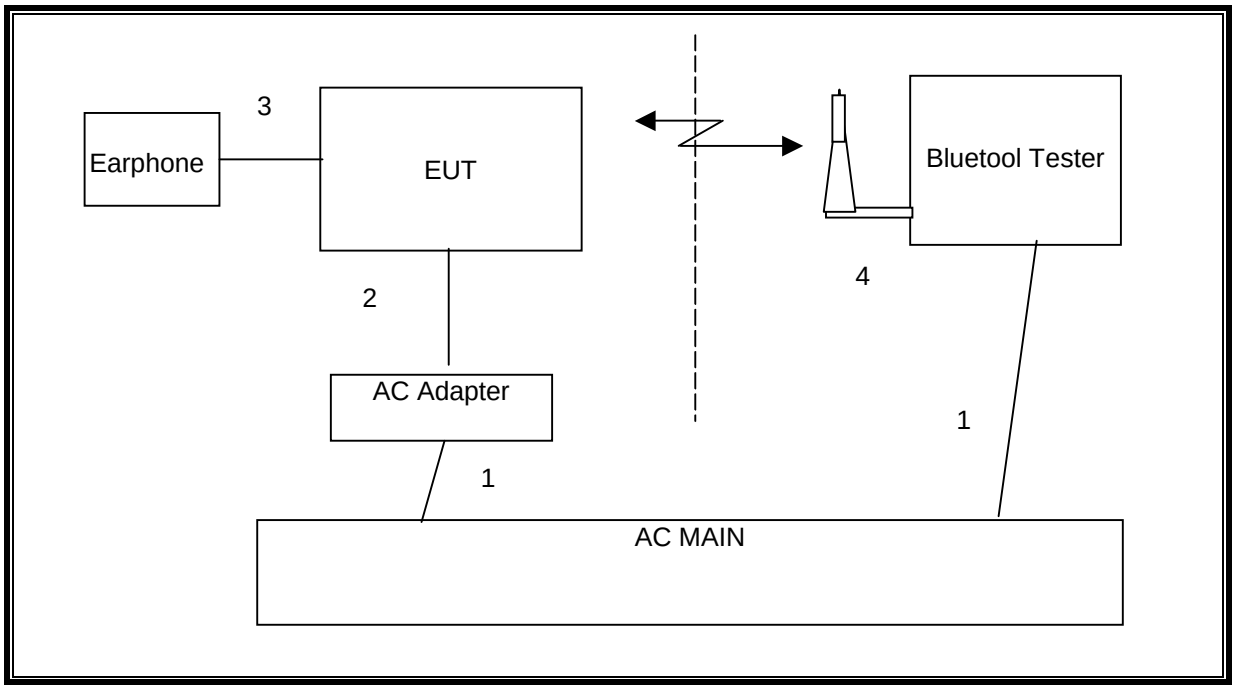
TEST SETUP

The EUT is a stand-alone device.

SETUP DIAGRAM FOR TESTS (CONDUCTED)



SETUP DIAGRAM FOR TESTS (RADIATED)



6. TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset**	**Cal Due**
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01159	04/09/13
Antenna, Horn, 18 GHz	EMCO	3115	C00872	05/29/13
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00589	04/28/13
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	04/16/13
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EMI Test Receiver, 9 kHz-7 GHz	R & S	ESCI 7	1000741	07/06/13
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Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	12/04/12
Peak Power Meter	Agilent / HP	E4416A	C00963	12/04/12
Bluetooth Tester	R&S	CBT	NA	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.

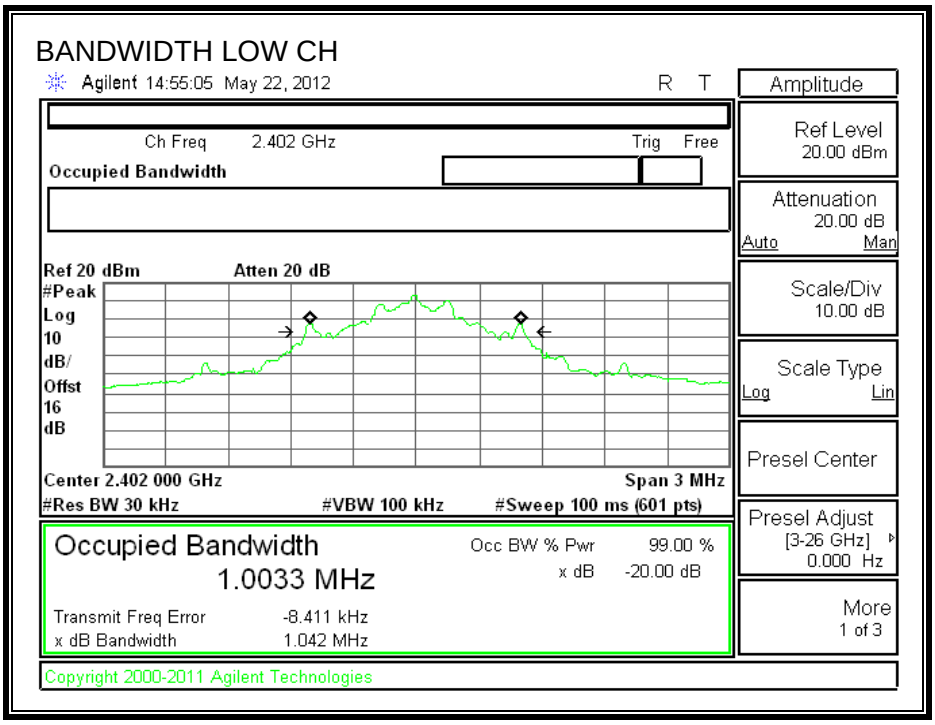
TEST PROCEDURE

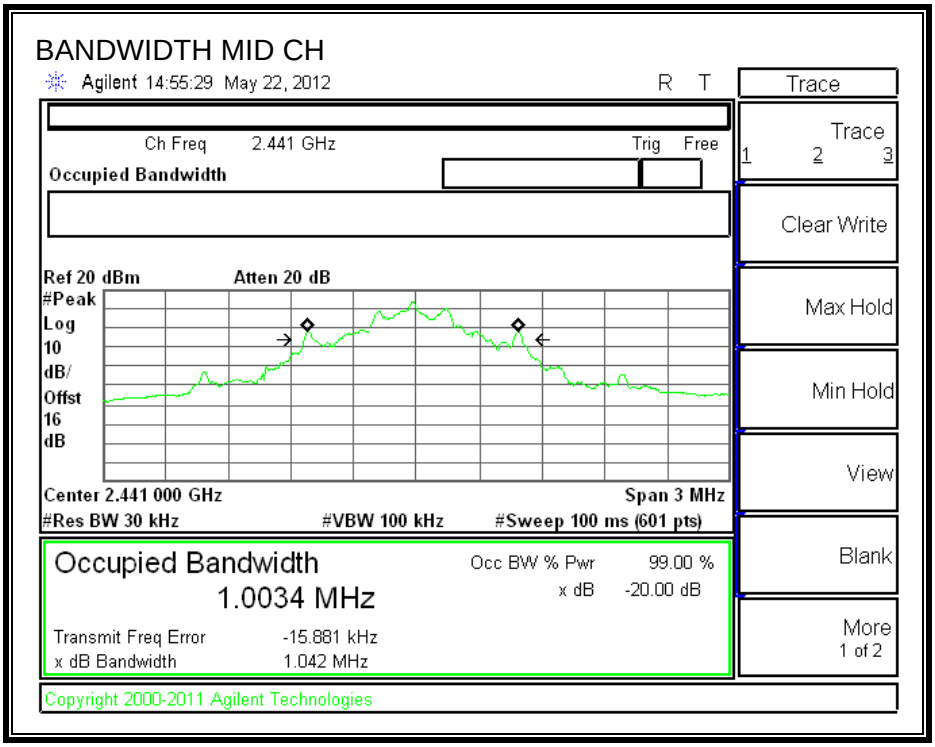
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

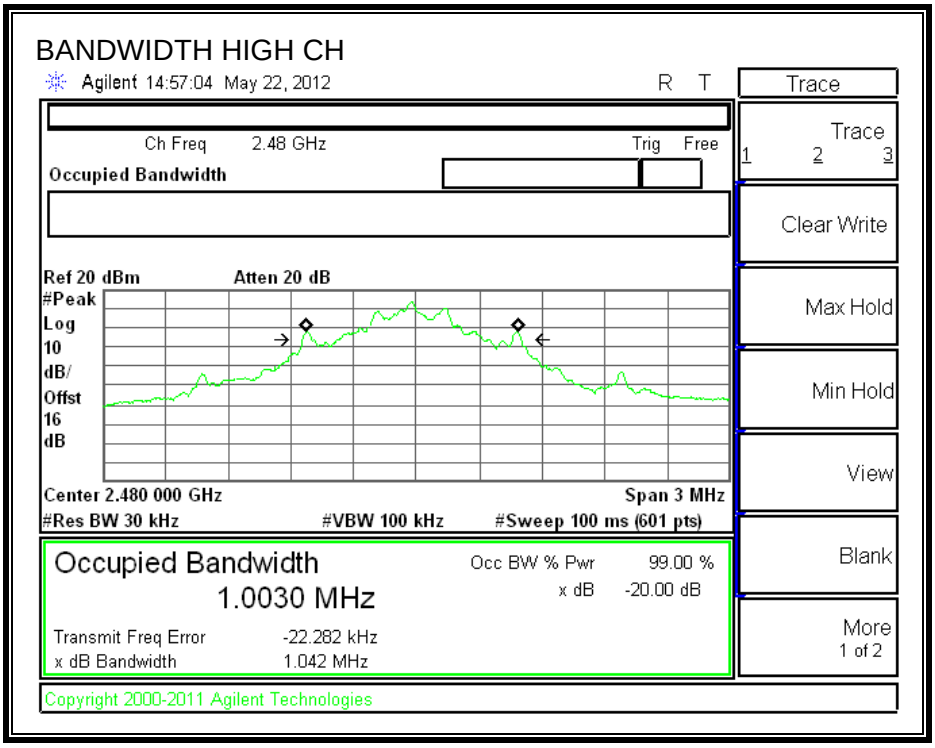
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.003	1.0294
Middle	2441	1.003	1.0235
High	2480	1.003	1.0165

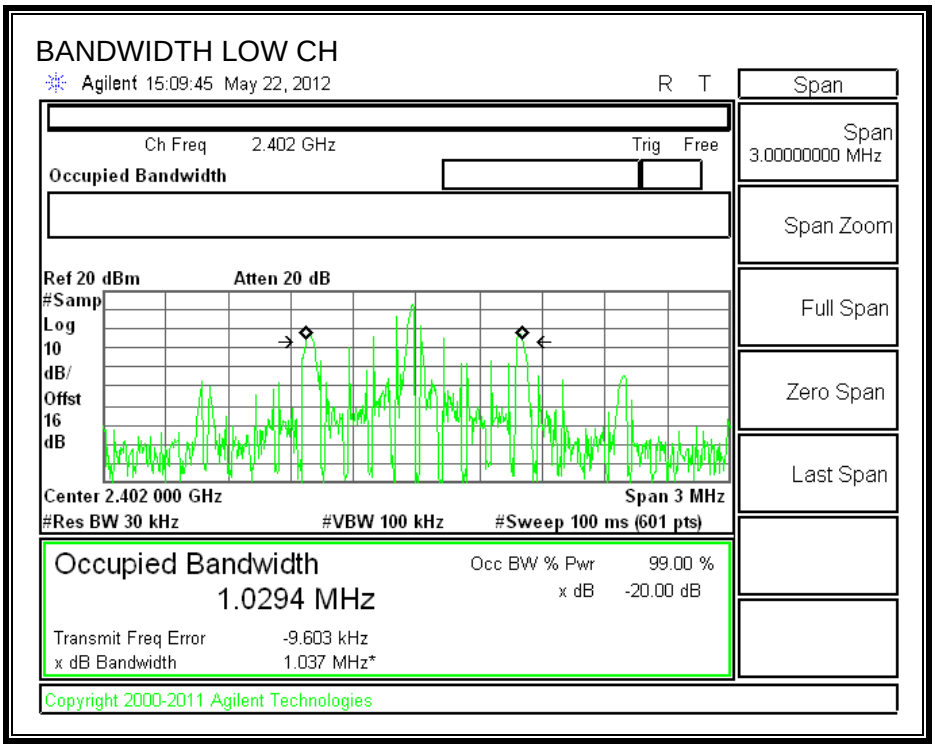
20 dB BANDWIDTH

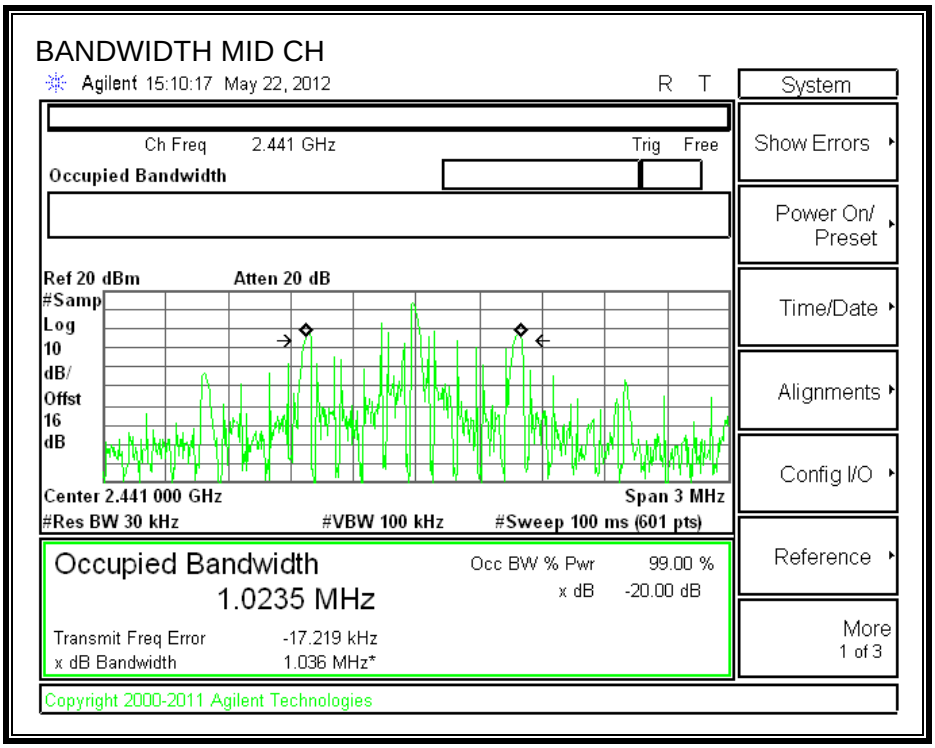


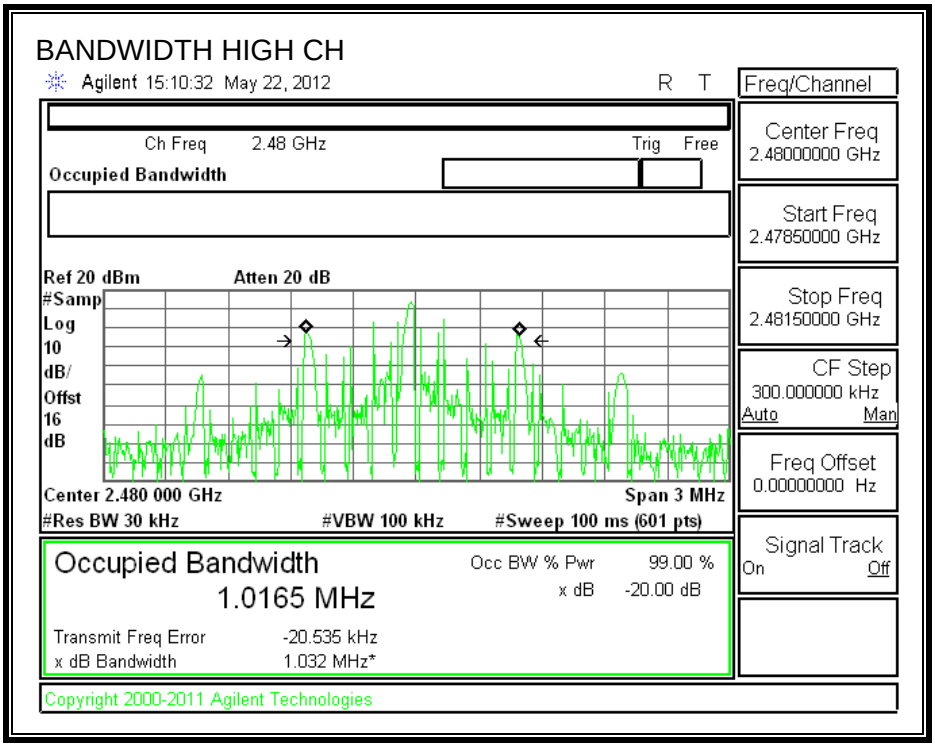




99% BANDWIDTH







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.

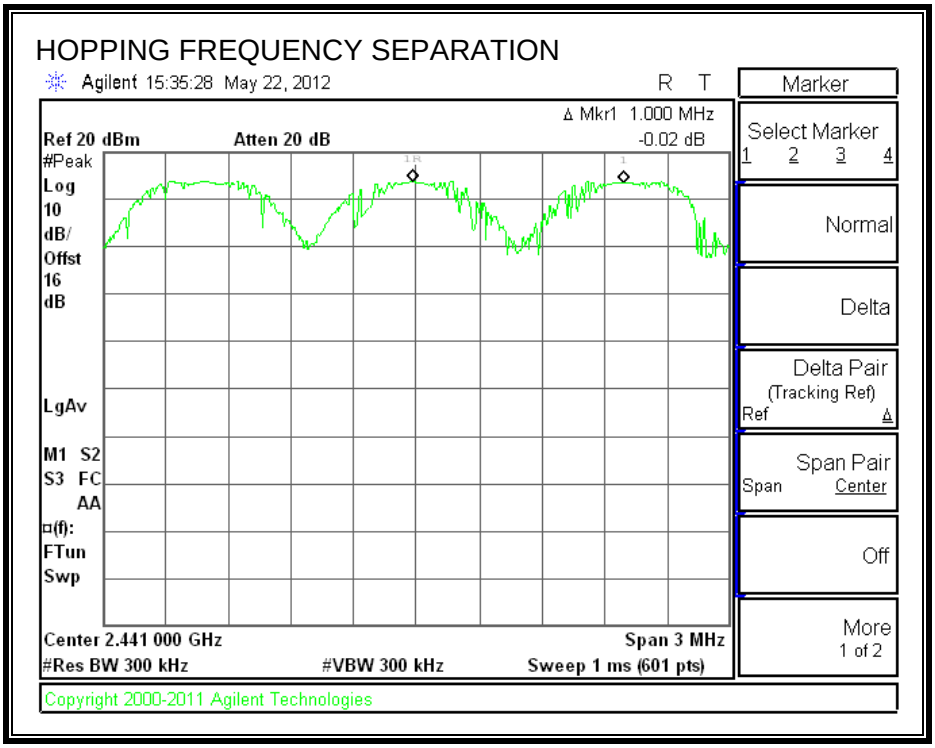
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

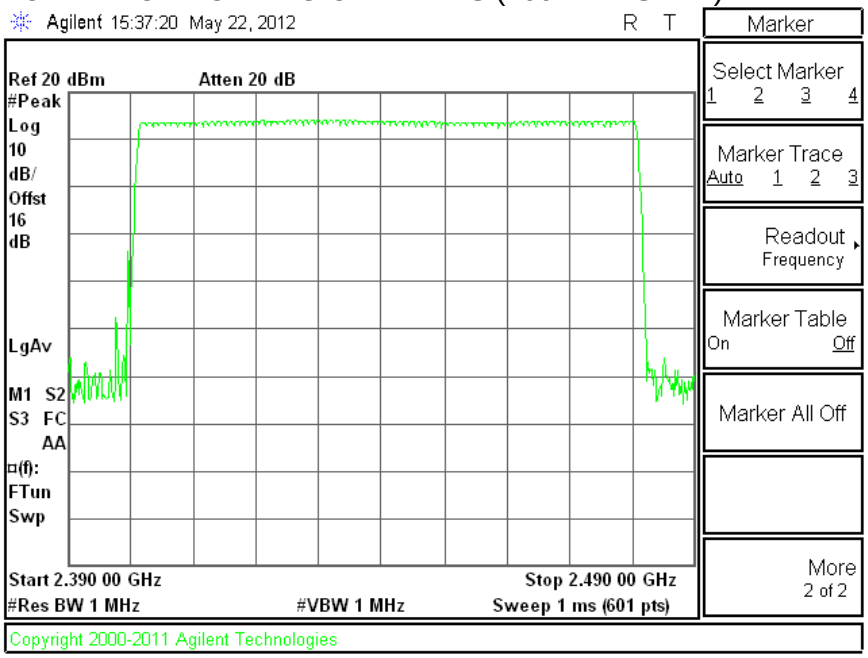
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

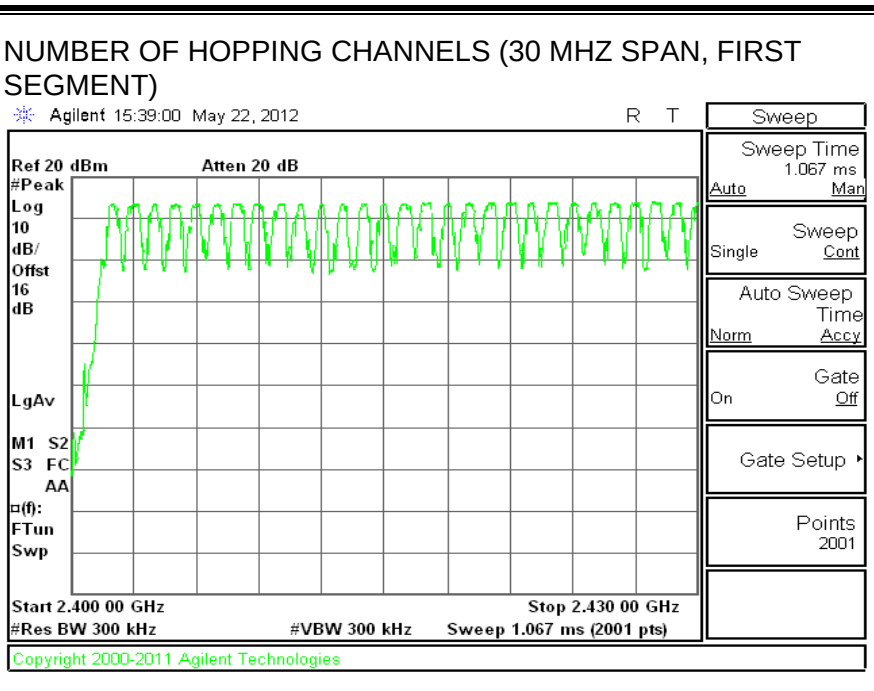
79 Channels observed.

NUMBER OF HOPPING CHANNELS

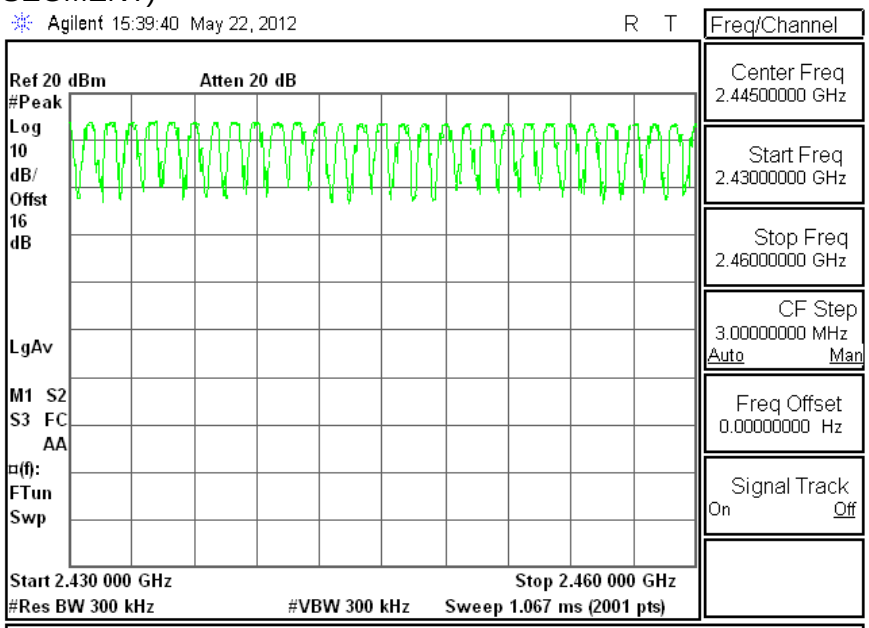
NUMBER OF HOPPING CHANNELS (100 MHZ SPAN)



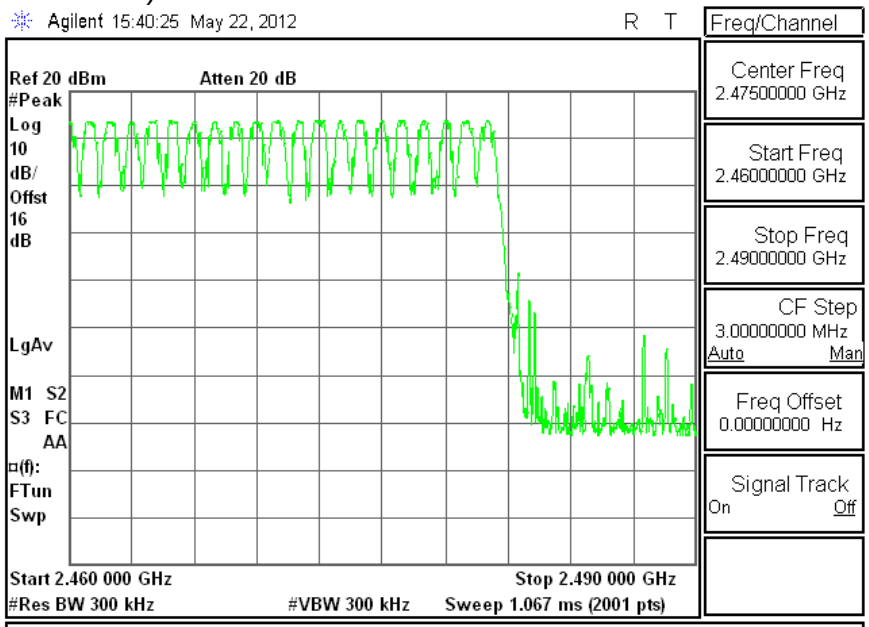
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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.

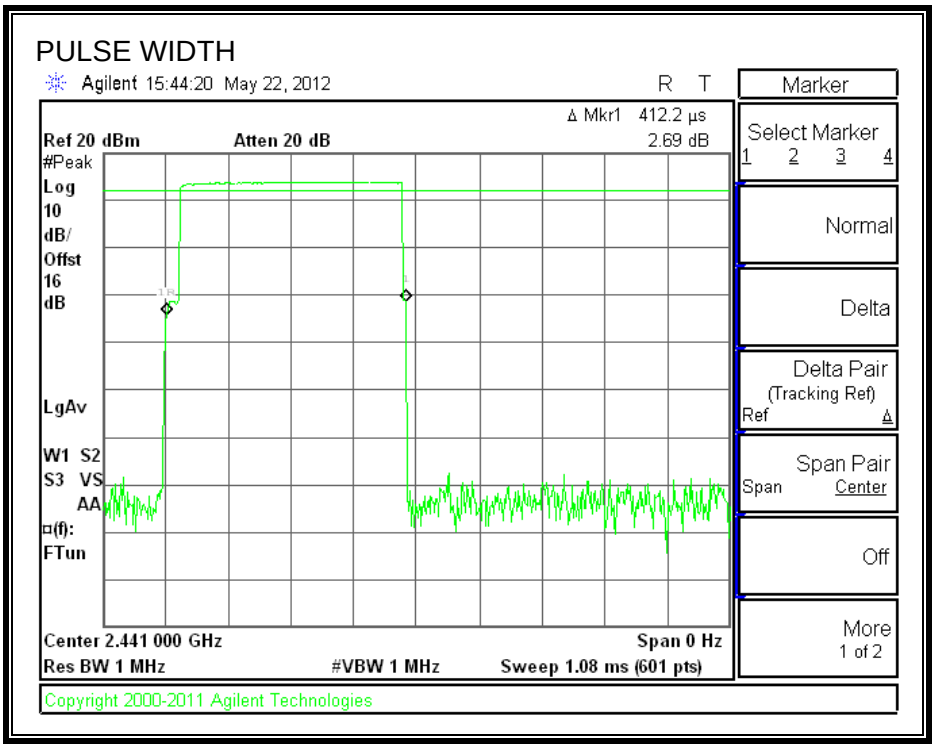
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

RESULTS

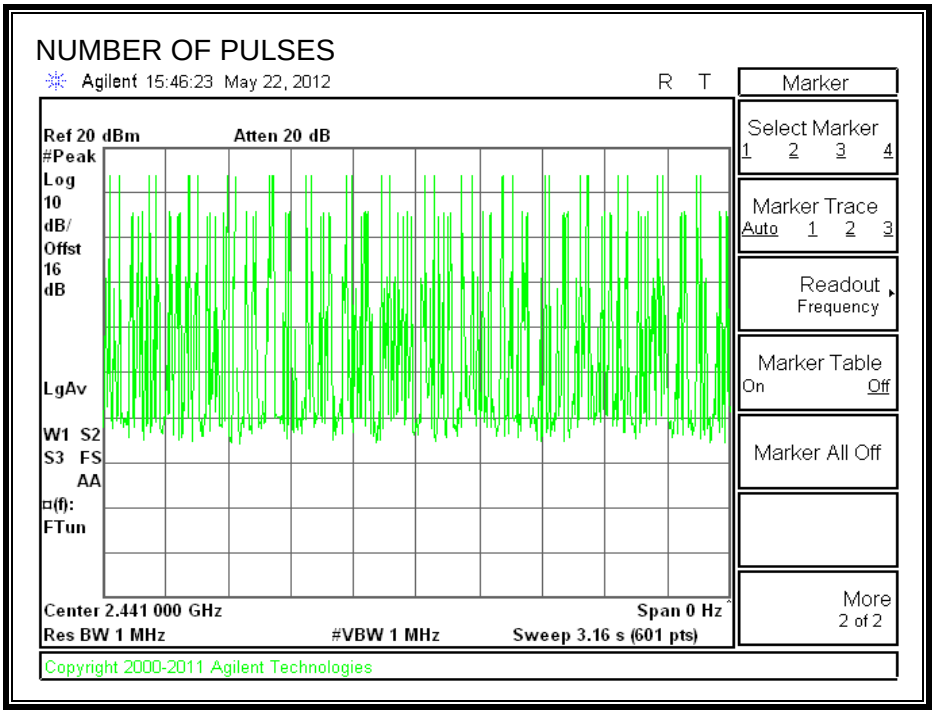
GFSK Mode

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
DH1	0.412	35	0.144	0.4	-0.256
DH3	1.675	19	0.318	0.4	-0.082
DH5	2.917	11	0.321	0.4	-0.079

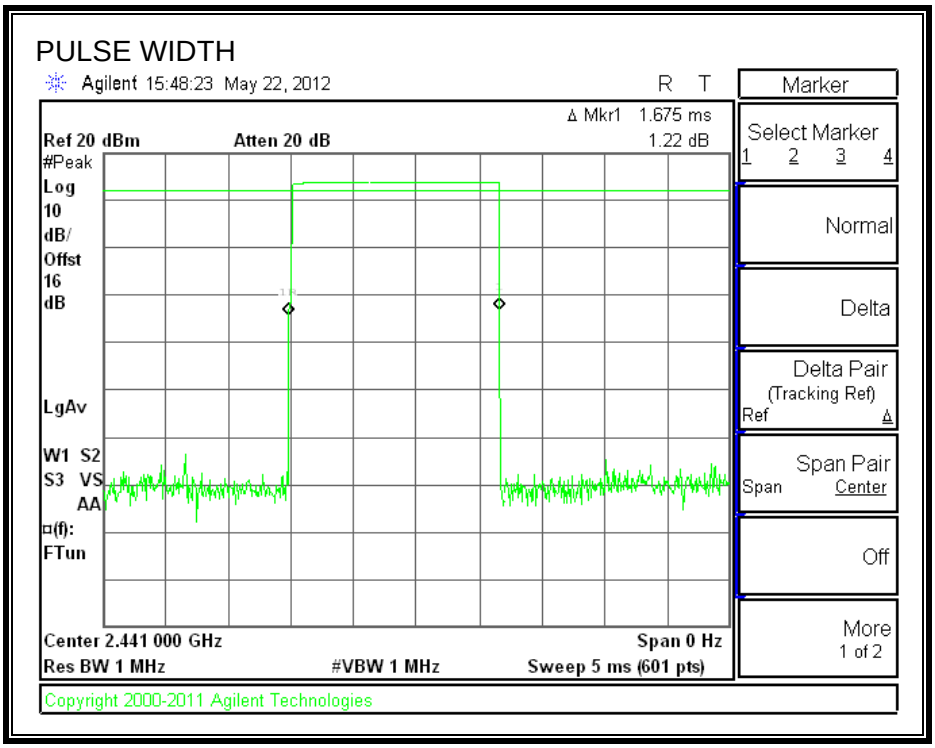
PULSE WIDTH GFSK DH1



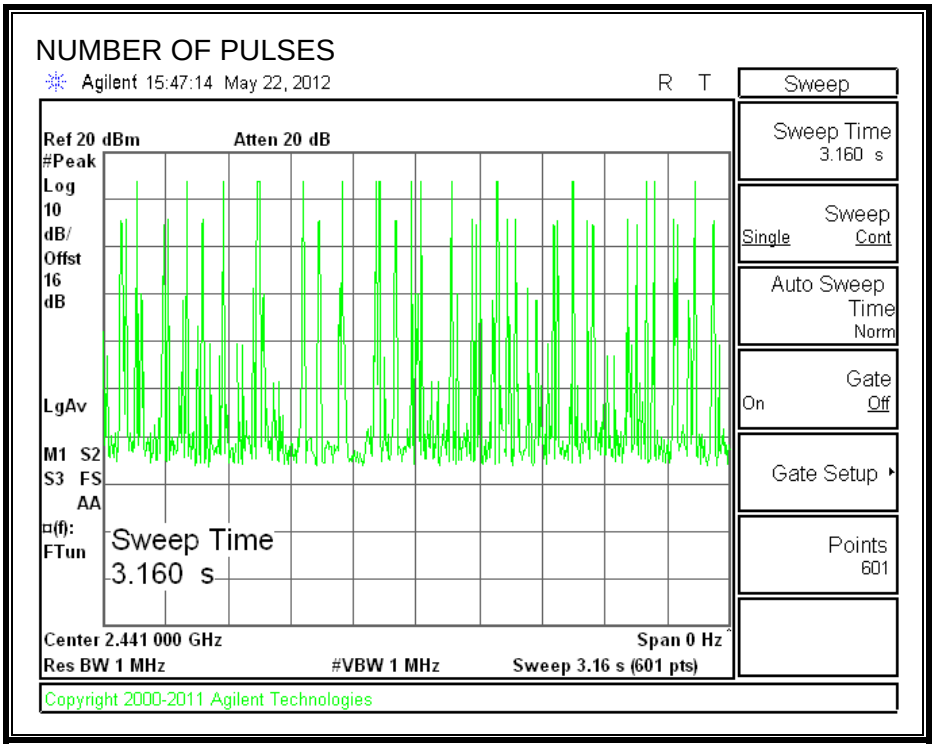
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



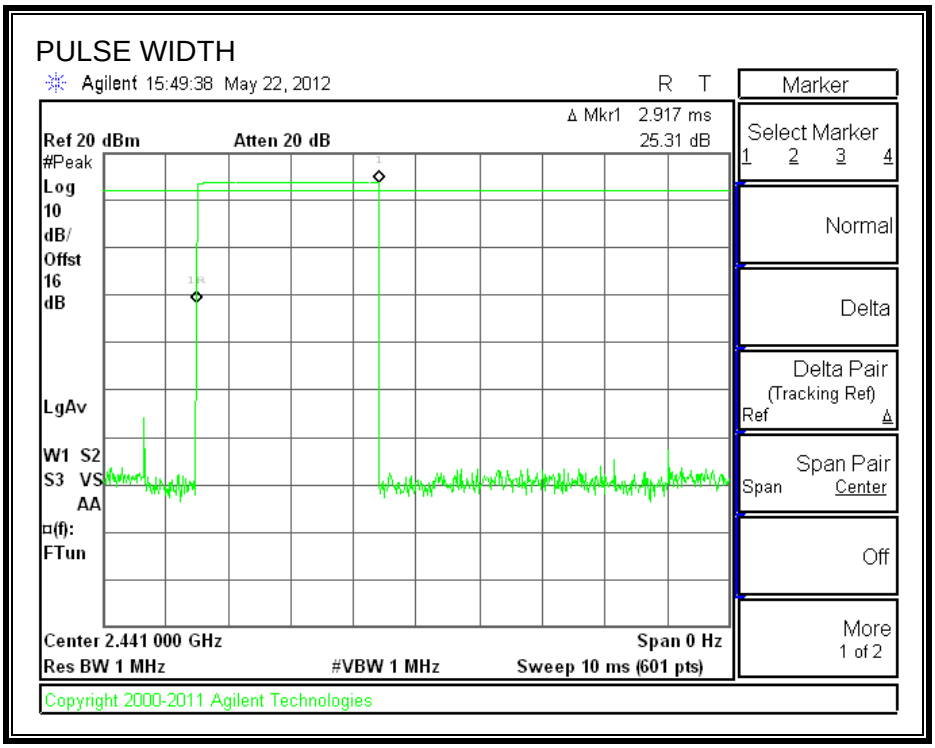
PULSE WIDTH GFSK DH3



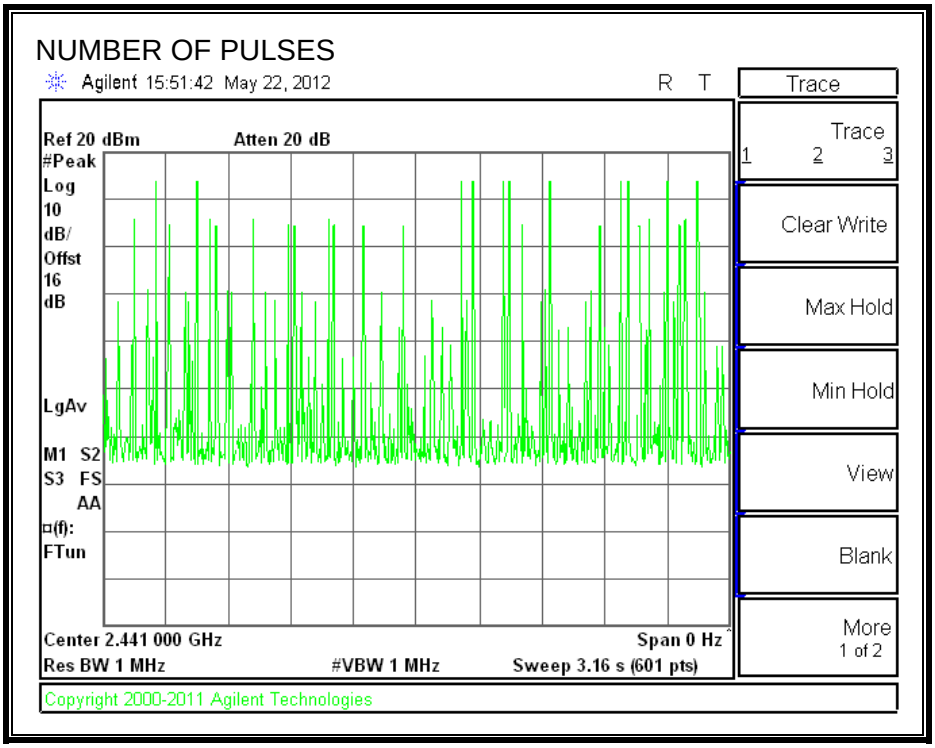
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



PULSE WIDTH GFSK DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



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.

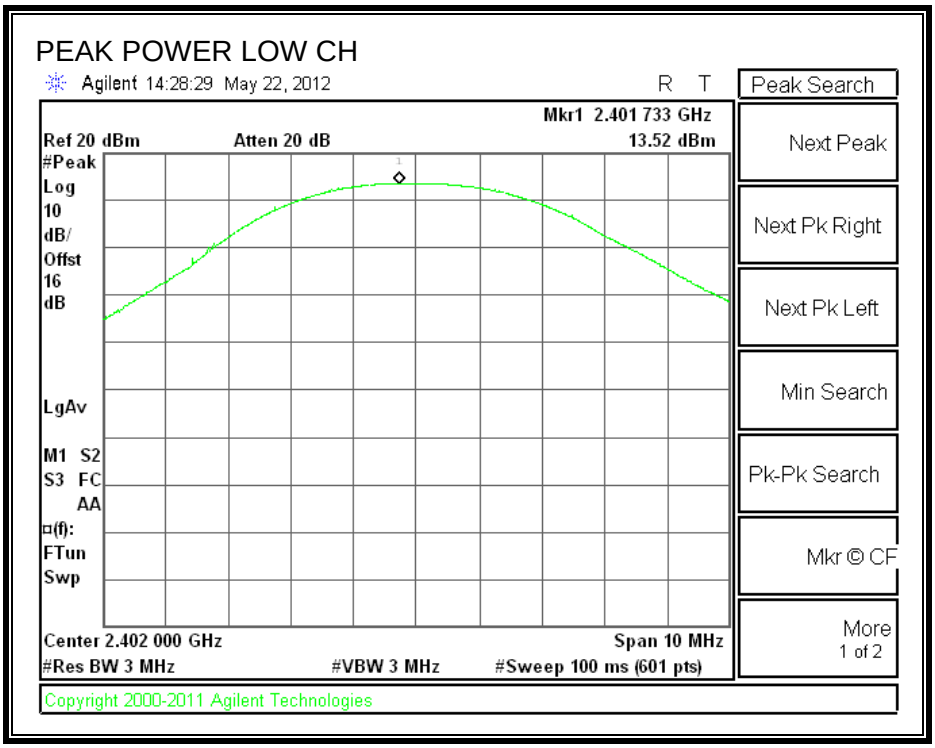
TEST PROCEDURE

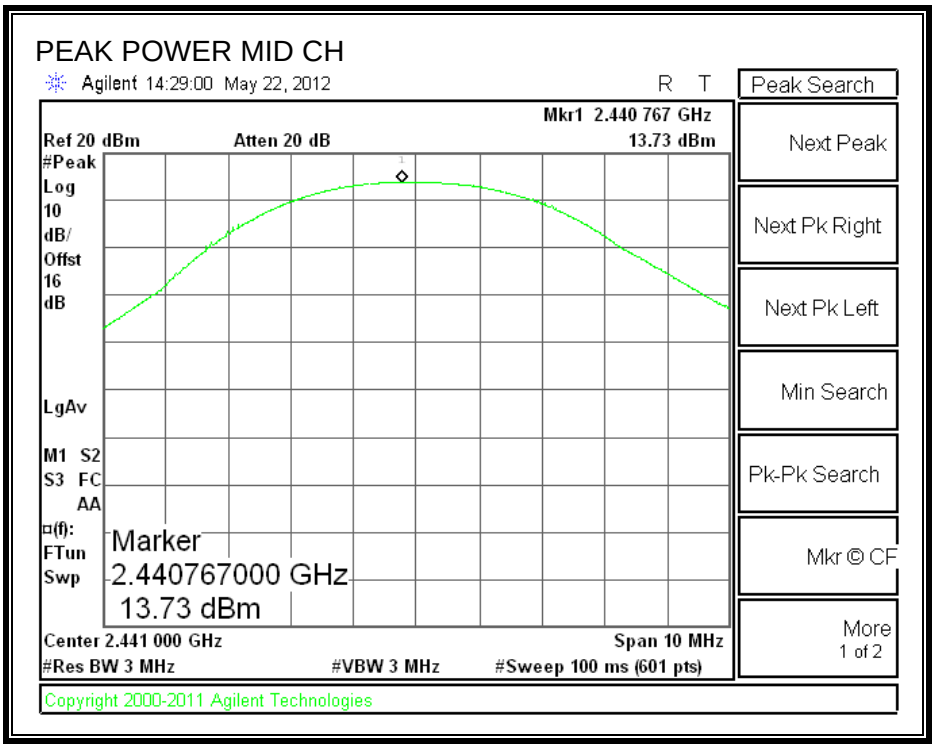
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

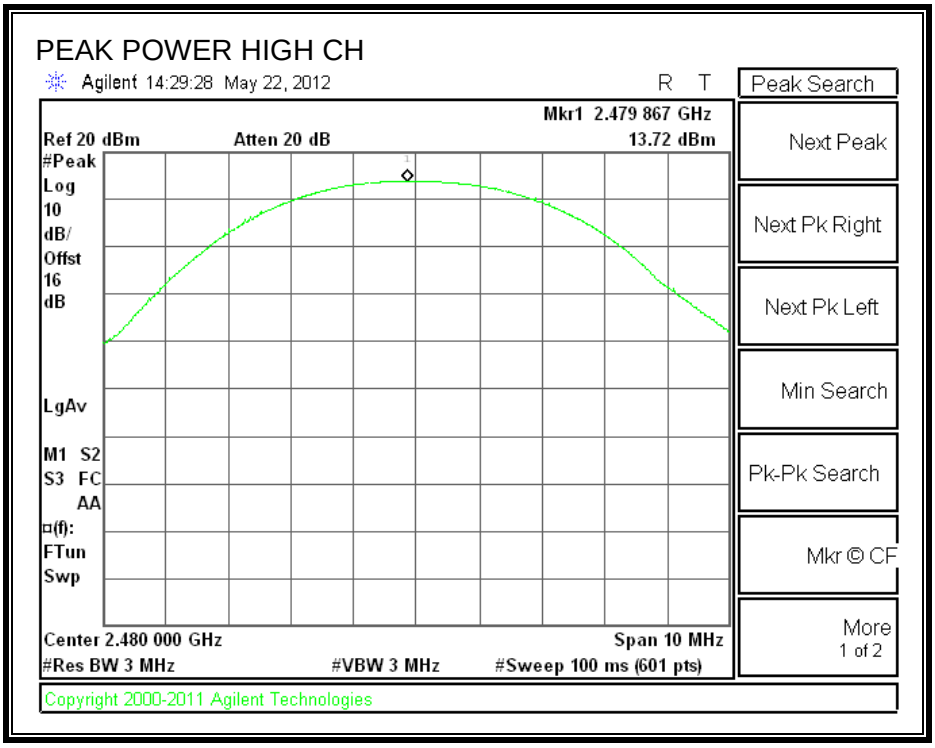
RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	13.52	30	-16.48
Middle	2441	13.73	30	-16.27
High	2480	13.72	30	-16.28

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 10.8 dB (including 10 dB pad and 0.8 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	13.20
Middle	2441	13.40
High	2480	13.40

7.1.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

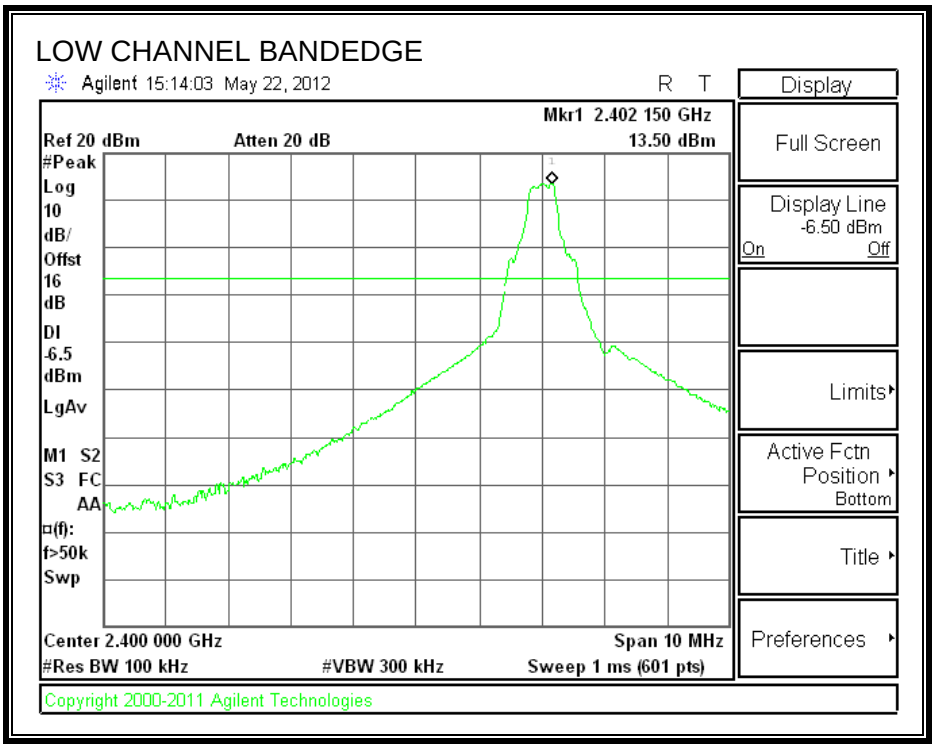
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

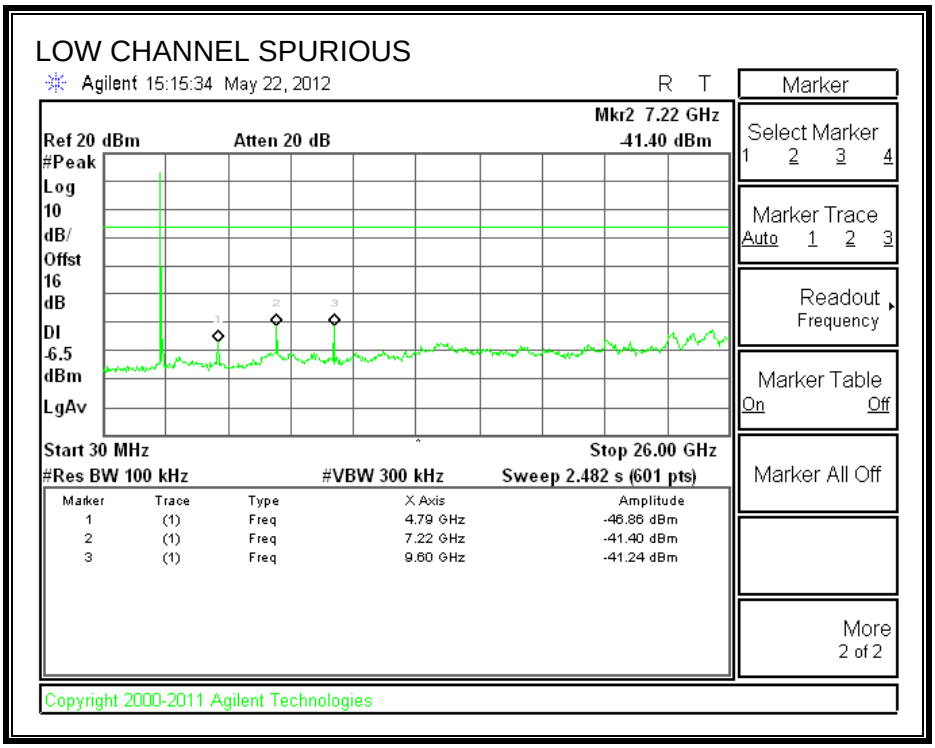
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

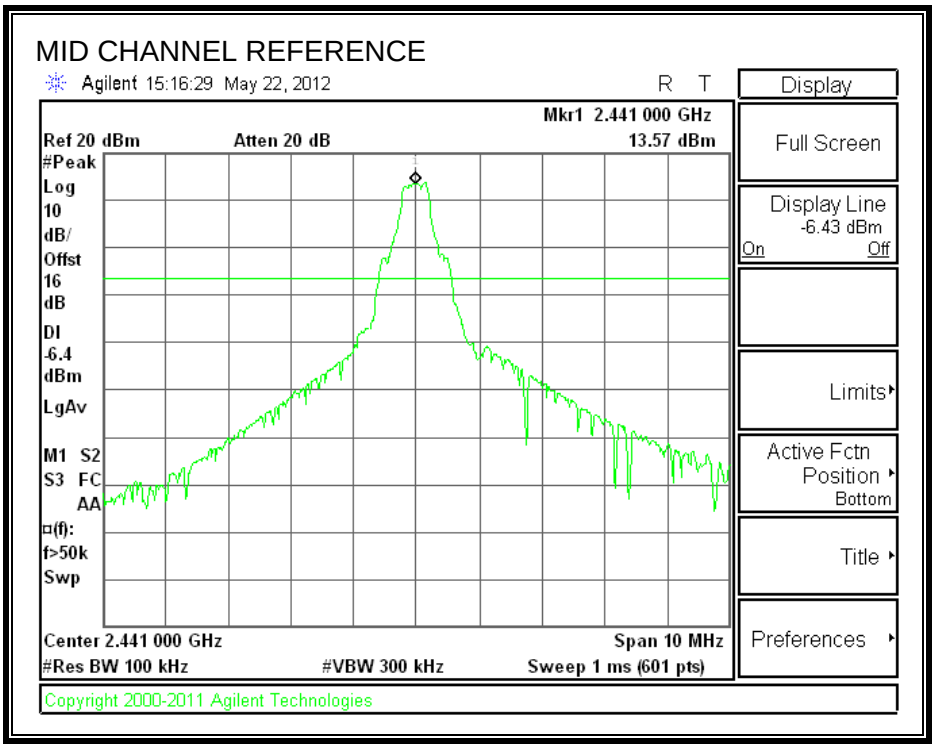
RESULTS

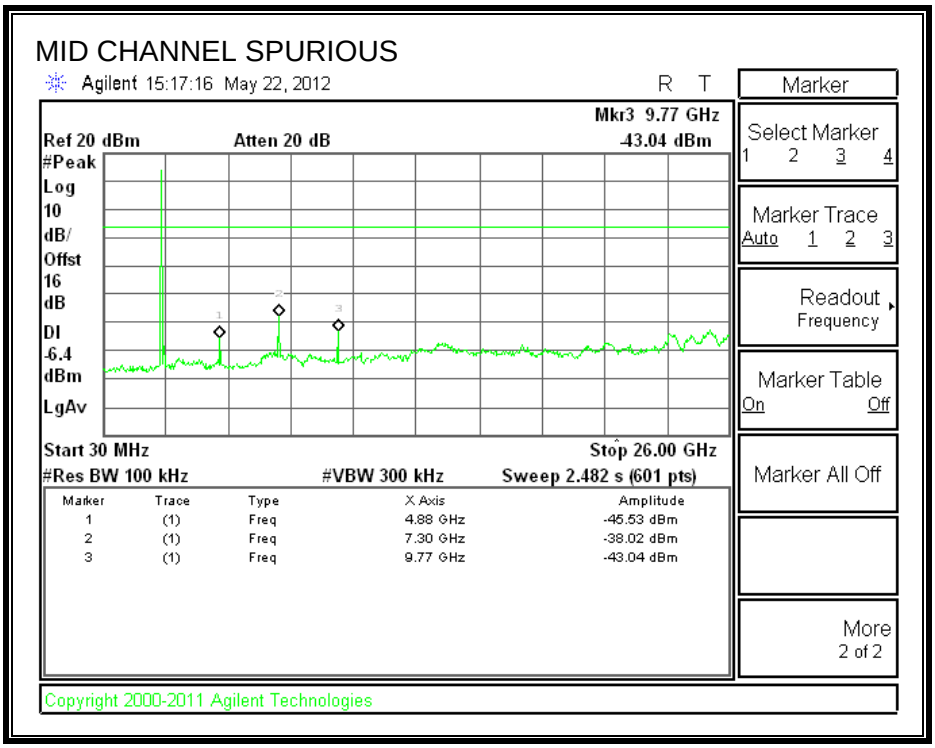
SPURIOUS EMISSIONS, LOW CHANNEL



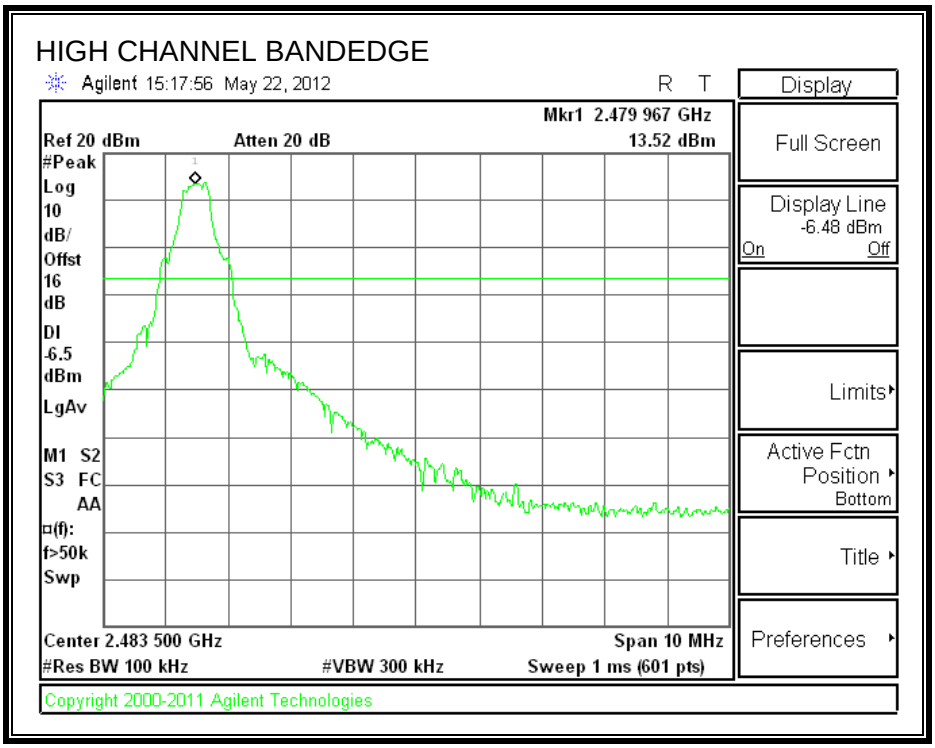


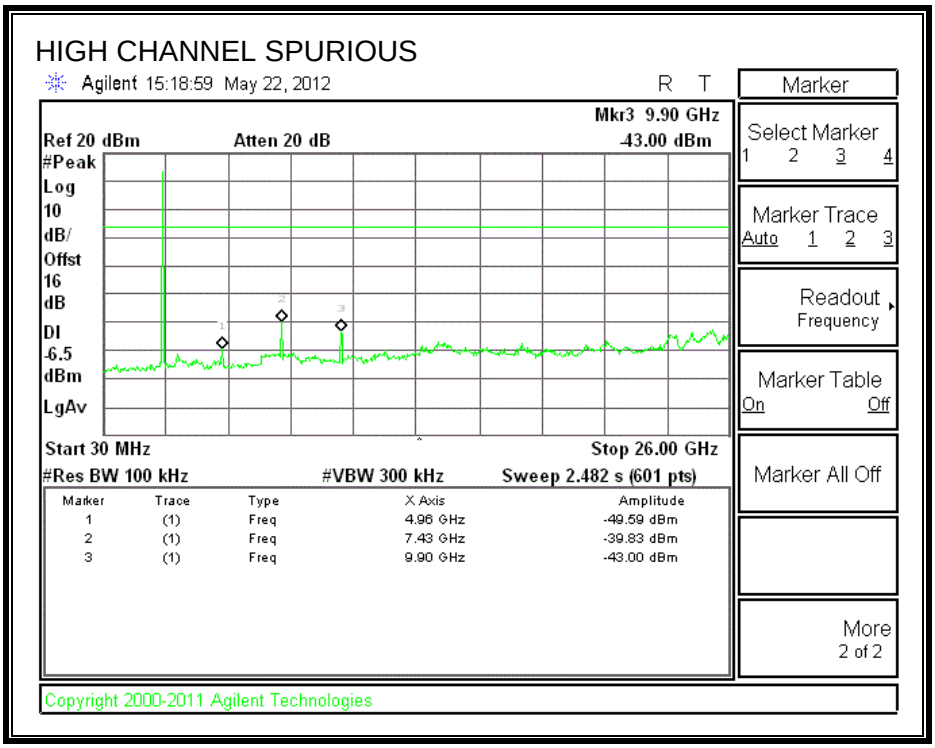
SPURIOUS EMISSIONS, MID CHANNEL





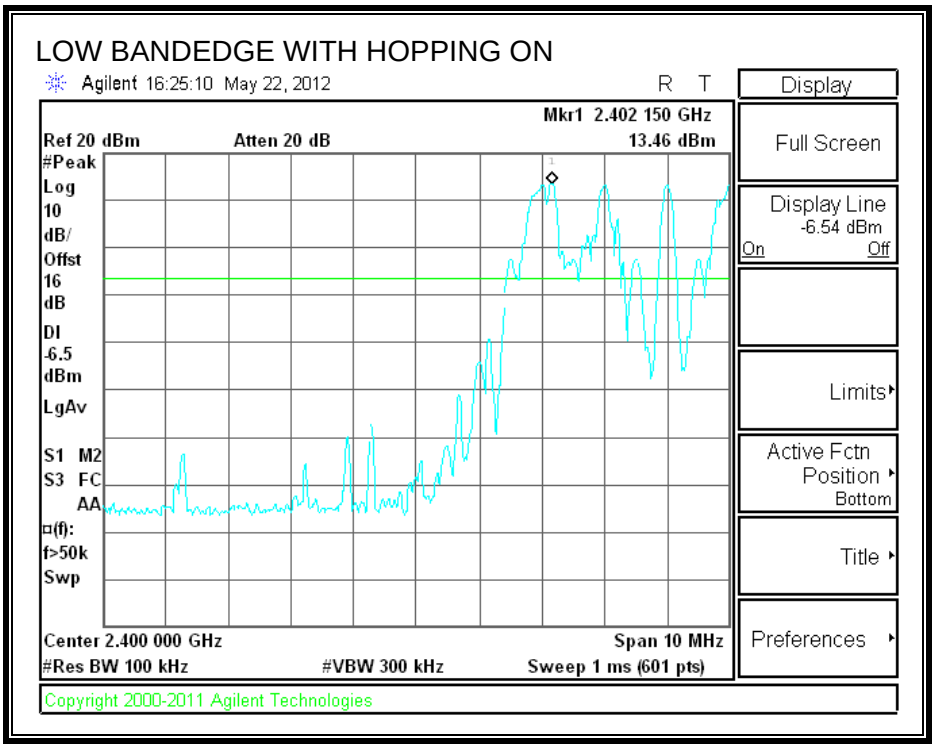
SPURIOUS EMISSIONS, HIGH CHANNEL



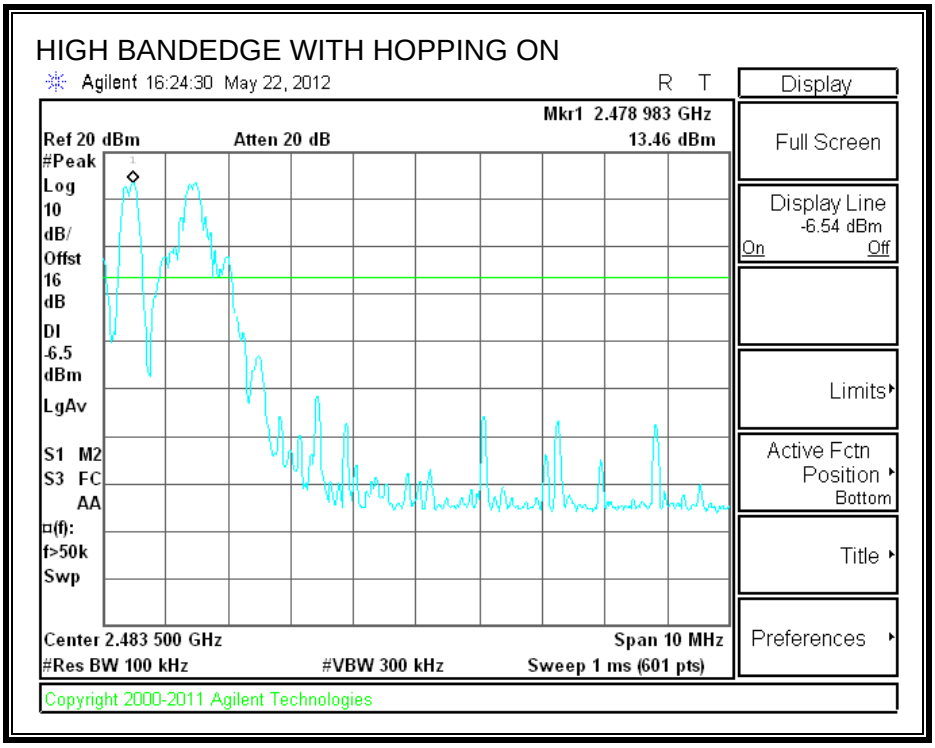


SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



8. ENHANCED DATA RATE QPSK MODULATION

8.1.1. 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.

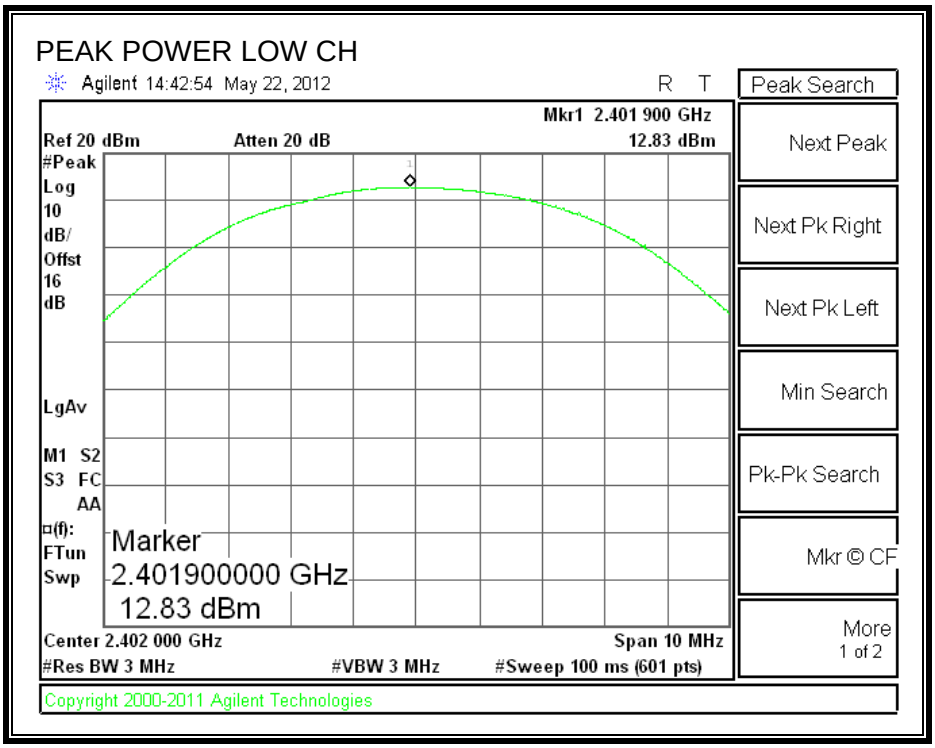
TEST PROCEDURE

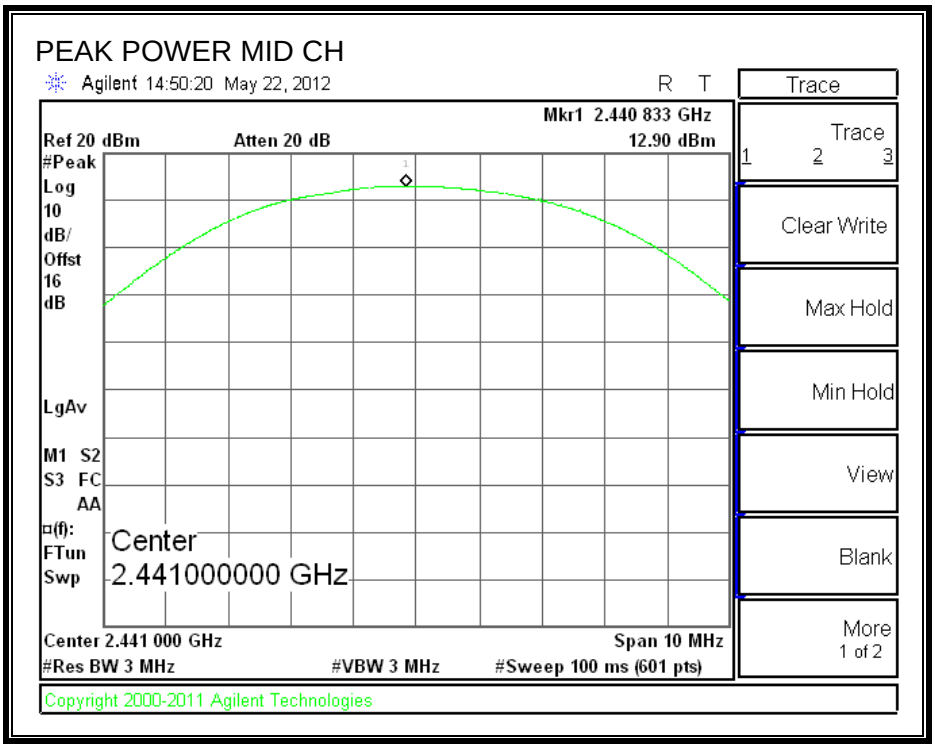
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

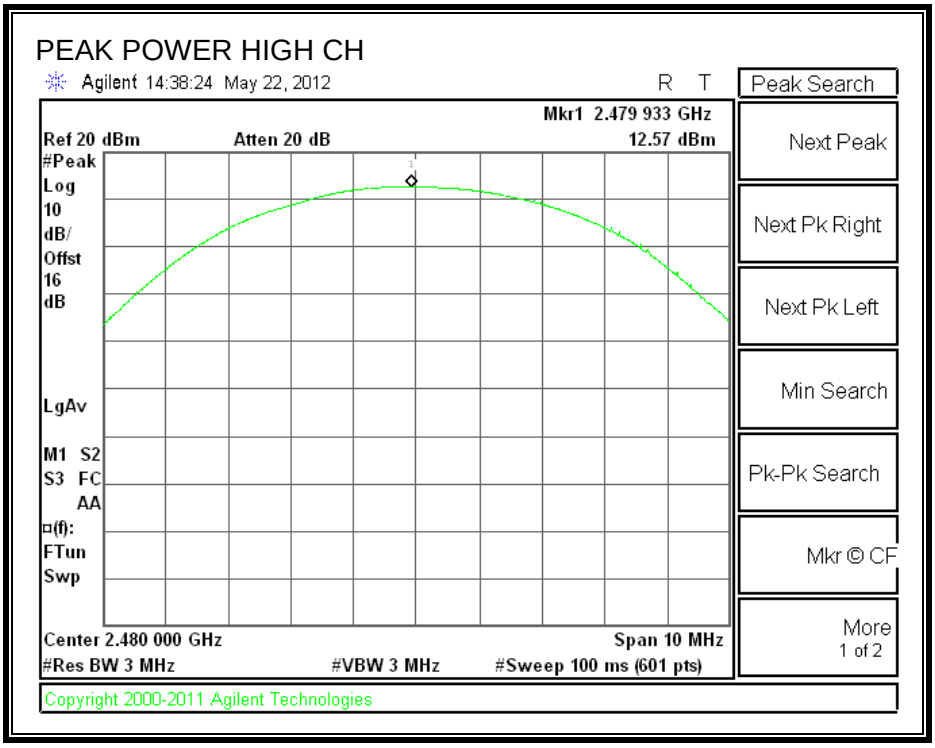
RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.83	30	-17.17
Middle	2441	12.90	30	-17.10
High	2480	12.57	30	-17.43

OUTPUT POWER







8.1.2. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 10.8dB (including 10 dB pad and 0.8dB 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	11.50
Middle	2441	11.40
High	2480	11.30

9. ENHANCED DATA RATE 8PSK MODULATION

9.1.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

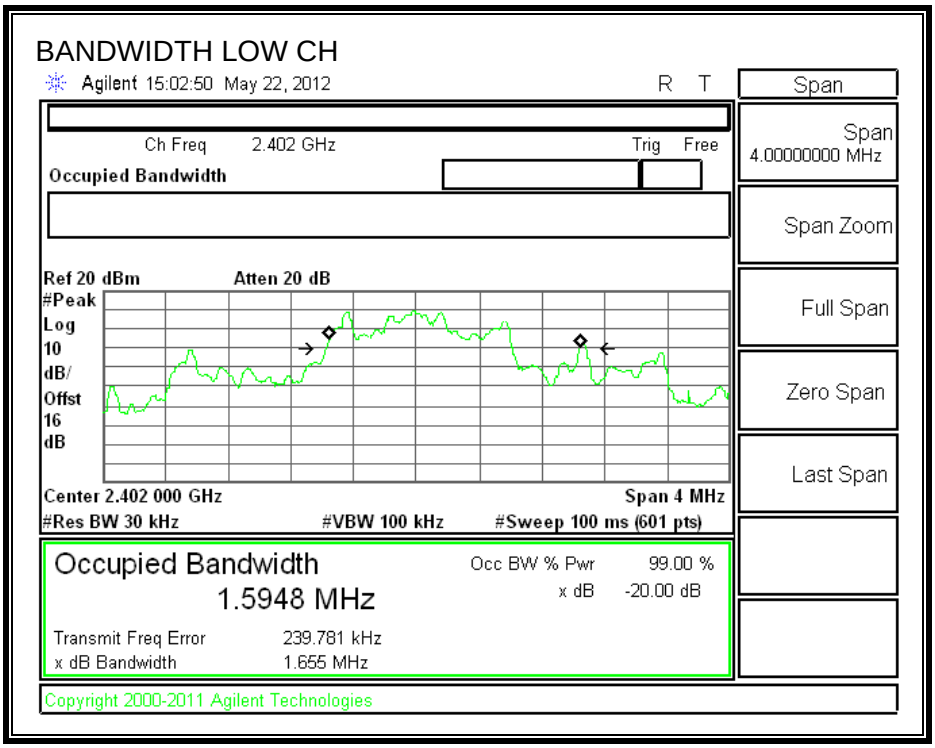
TEST PROCEDURE

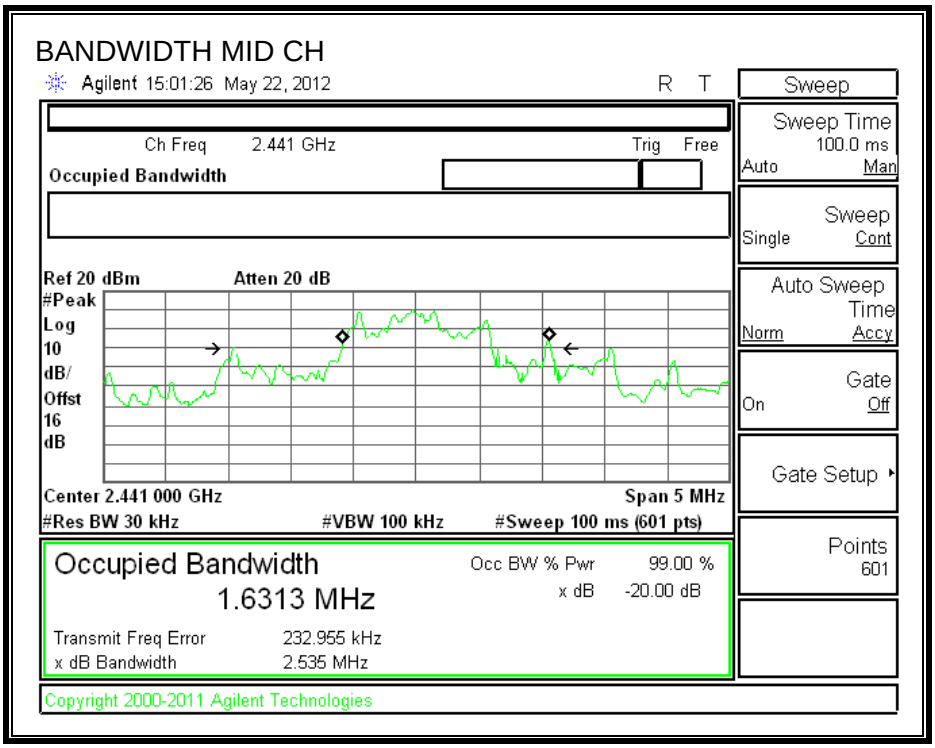
The transmitter output is connected to a spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

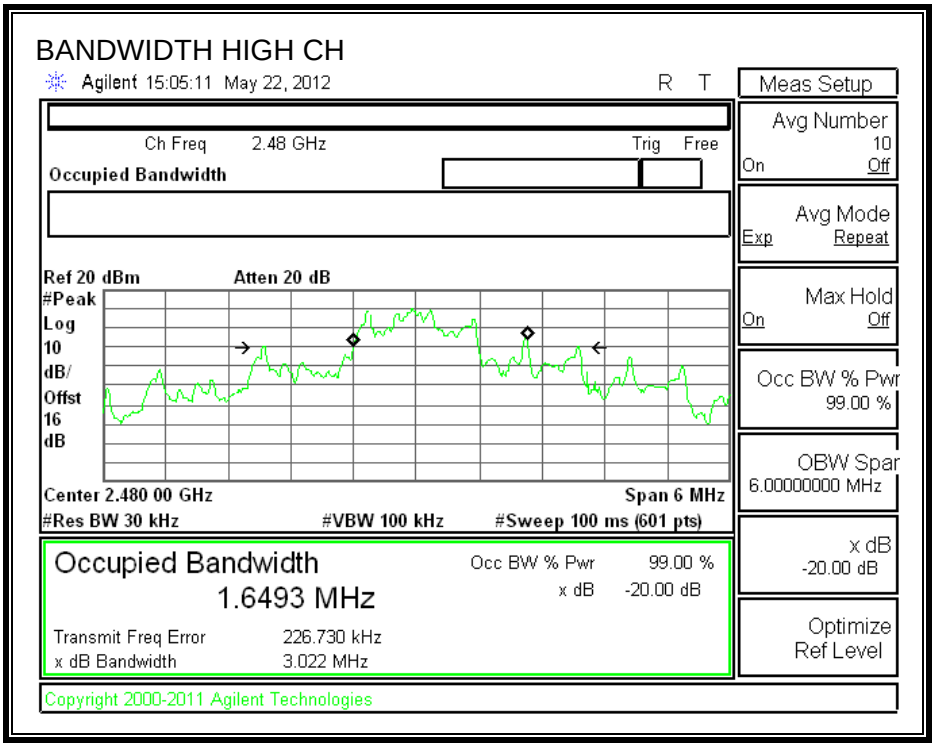
RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.595	2.9788
Middle	2441	1.631	2.9679
High	2480	1.649	2.9822

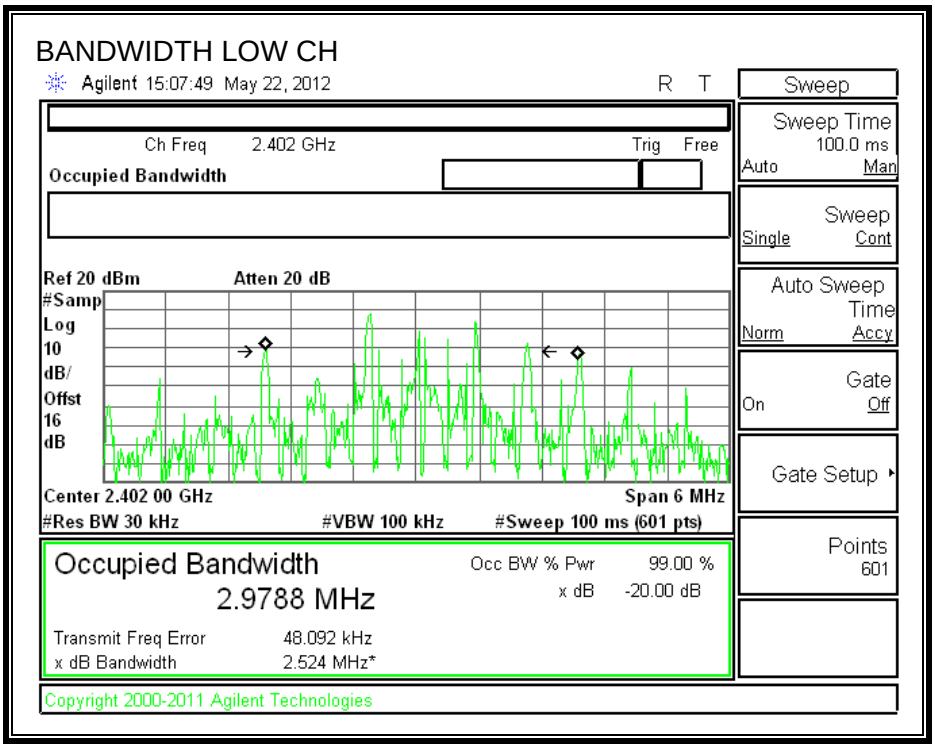
20 dB BANDWIDTH

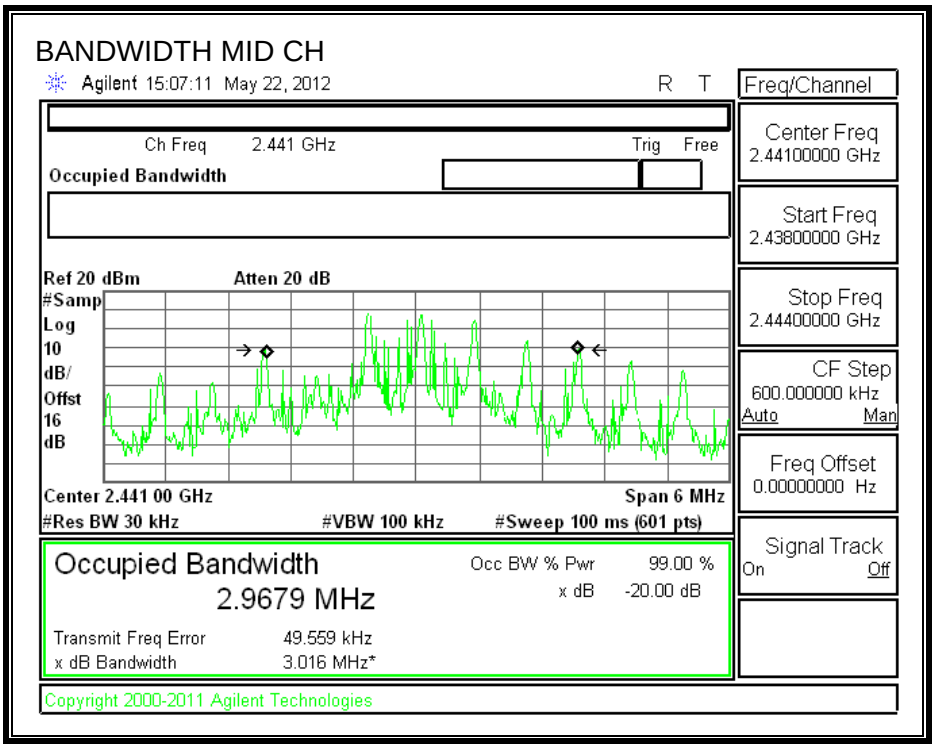


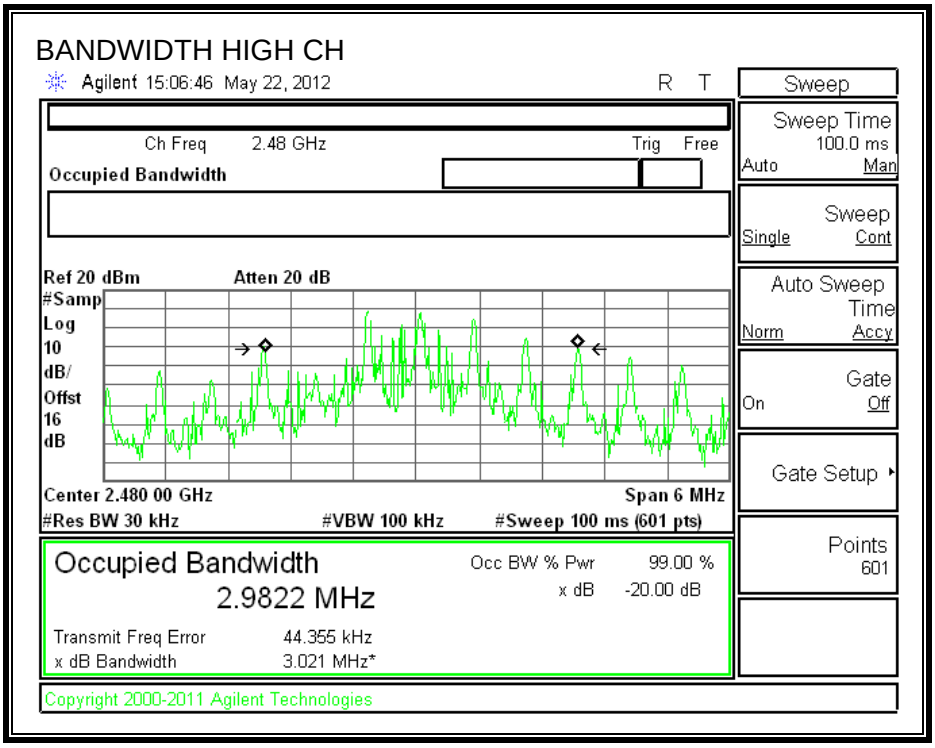




99% BANDWIDTH







9.1.2. HOPPING FREQUENCY SEPARATION

LIMIT

FCC §15.247 (a) (1)

IC RSS-210 A8.1 (b)

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

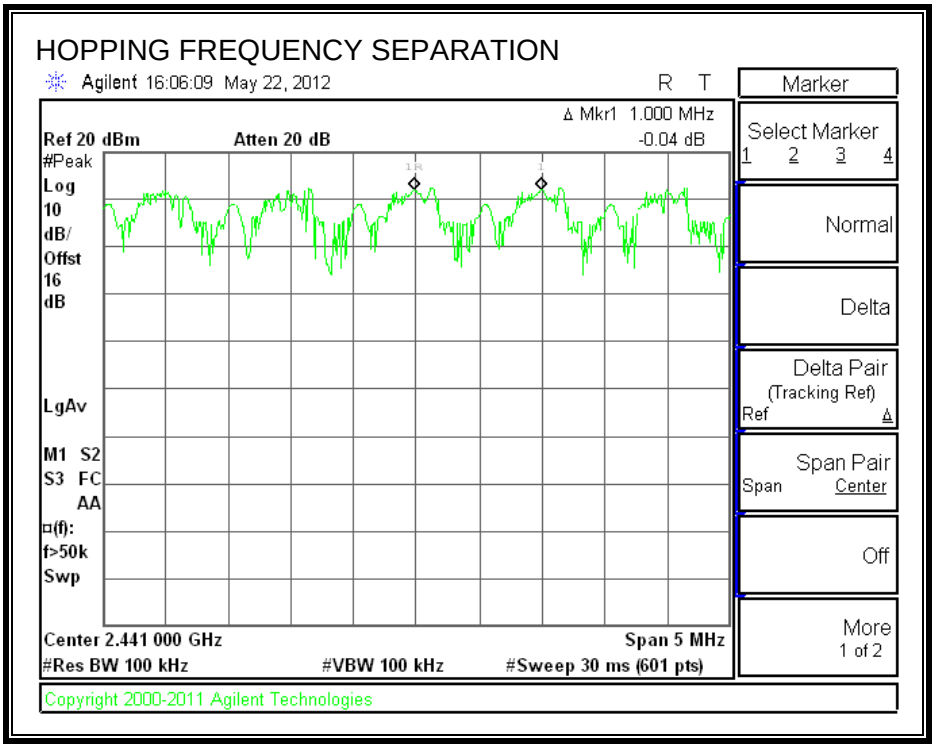
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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



9.1.3. NUMBER OF HOPPING CHANNELS

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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

TEST PROCEDURE

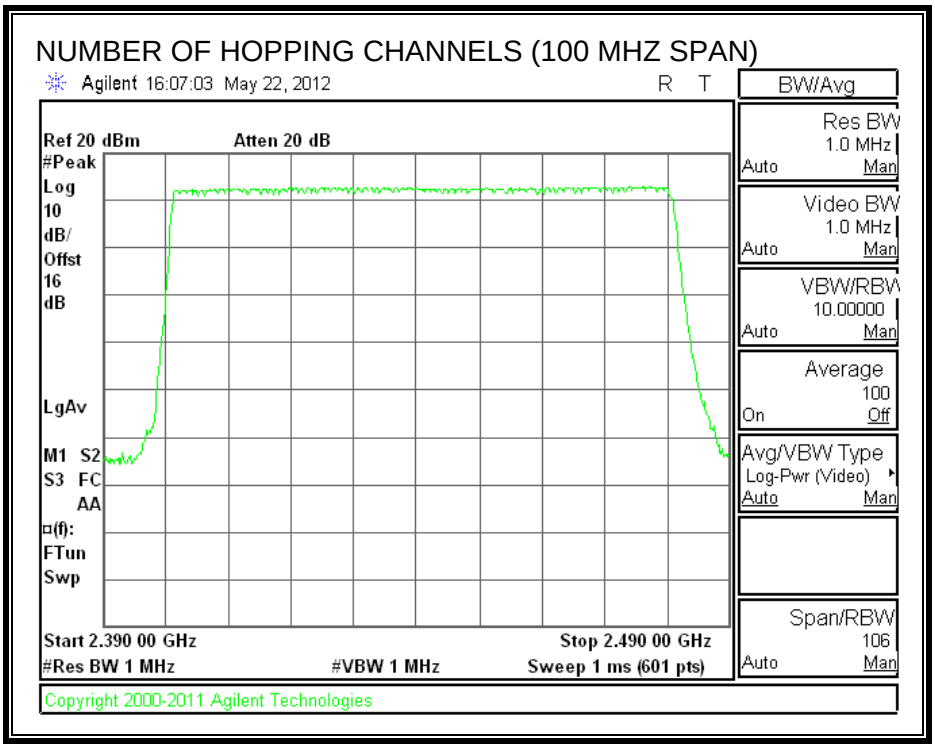
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

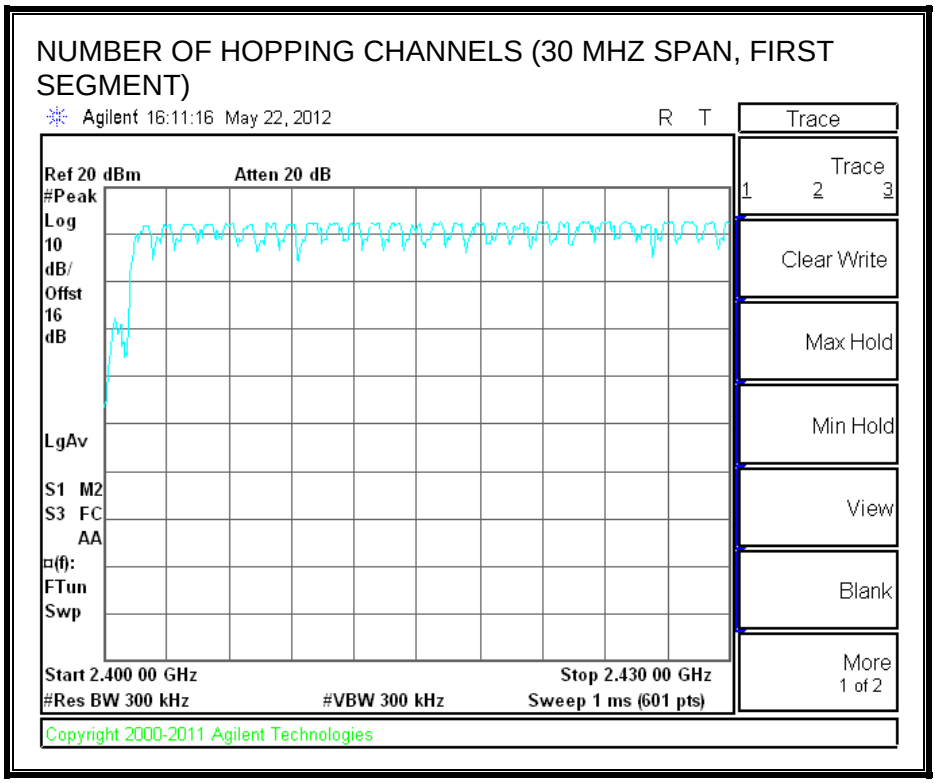
79 Channels observed.

NUMBER OF HOPPING CHANNELS

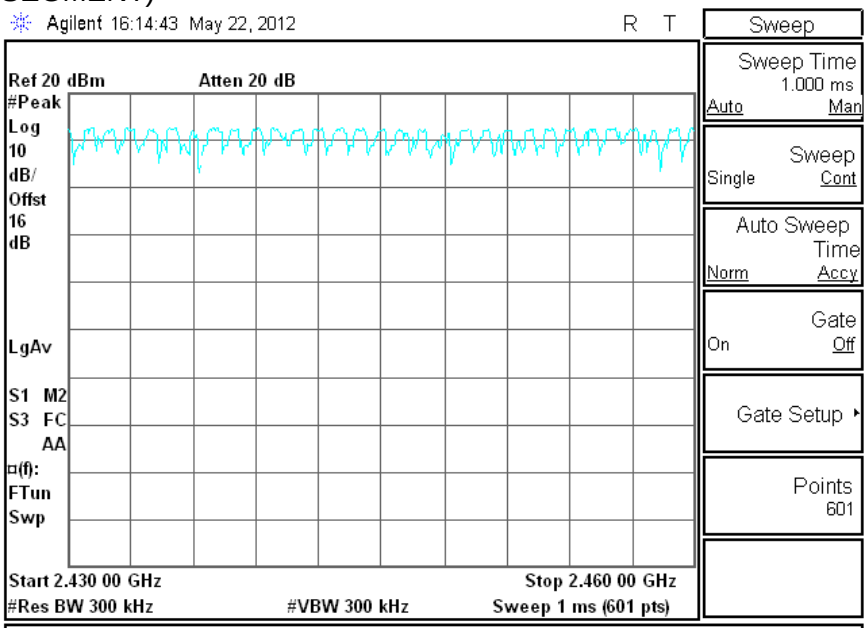
NUMBER OF HOPPING CHANNELS (100 MHZ SPAN)



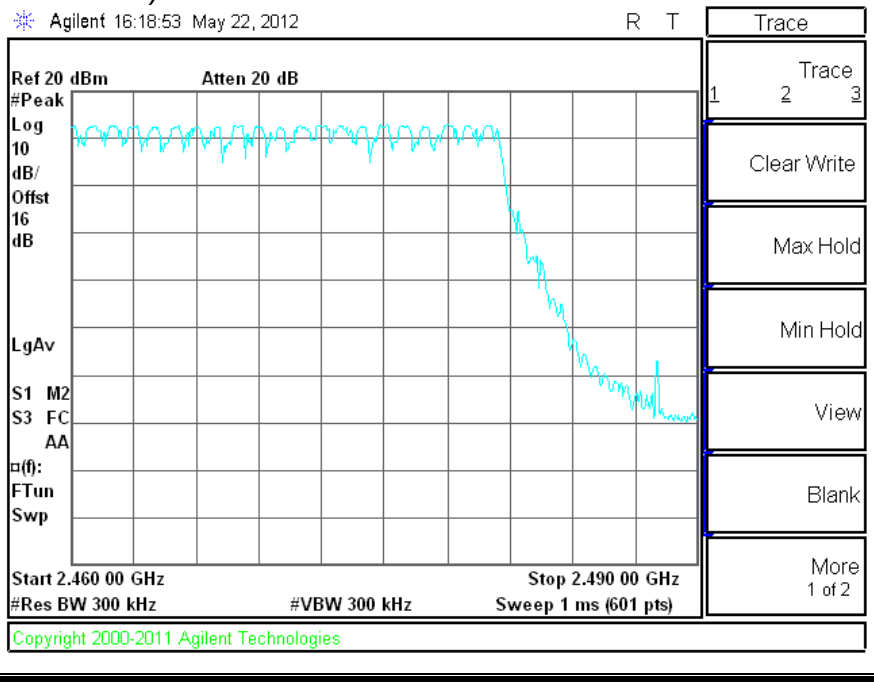
NUMBER OF HOPPING CHANNELS (30 MHZ SPAN, FIRST SEGMENT)



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



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



9.1.4. AVERAGE TIME OF OCCUPANCY

LIMIT

FCC §15.247 (a) (1) (iii)

IC RSS-210 A8.1 (d)

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

TEST PROCEDURE

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

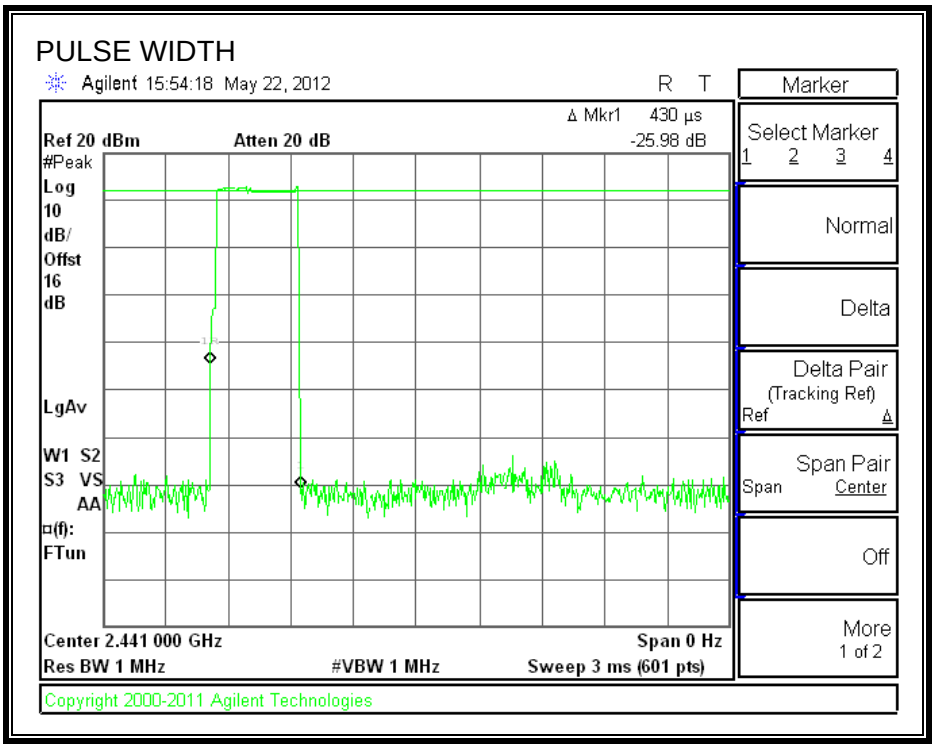
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to 10 * (# of pulses in 3.16 s) * pulse width.

RESULTS

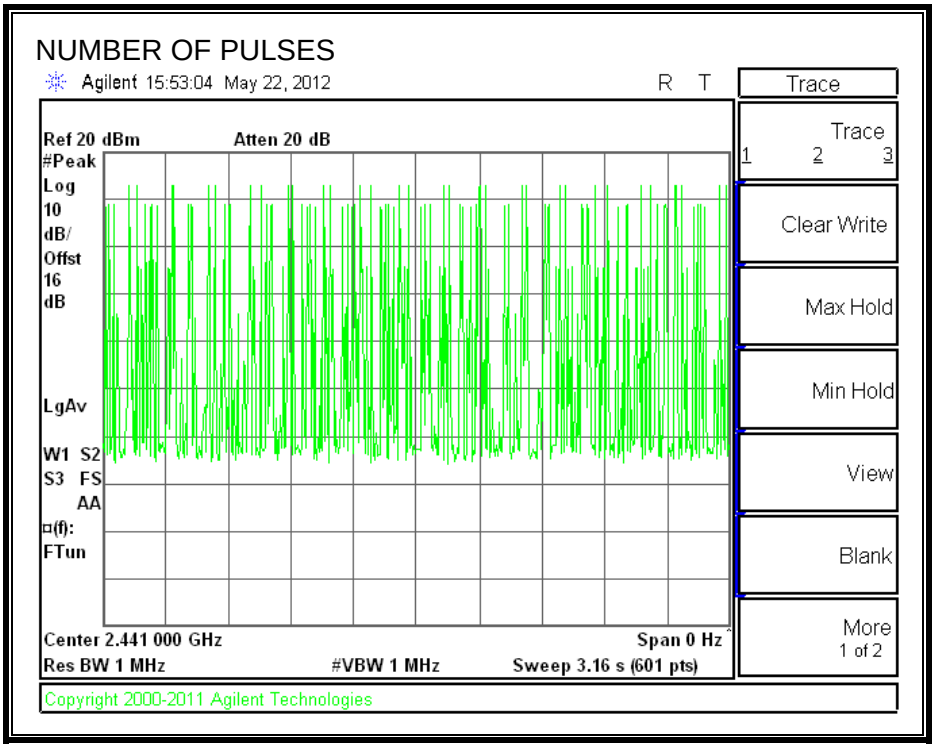
8PSK Mode

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
DH1	0.4300	34	0.146	0.4	-0.254
DH3	1.6770	17	0.285	0.4	-0.115
DH5	2.9330	10	0.293	0.4	-0.107

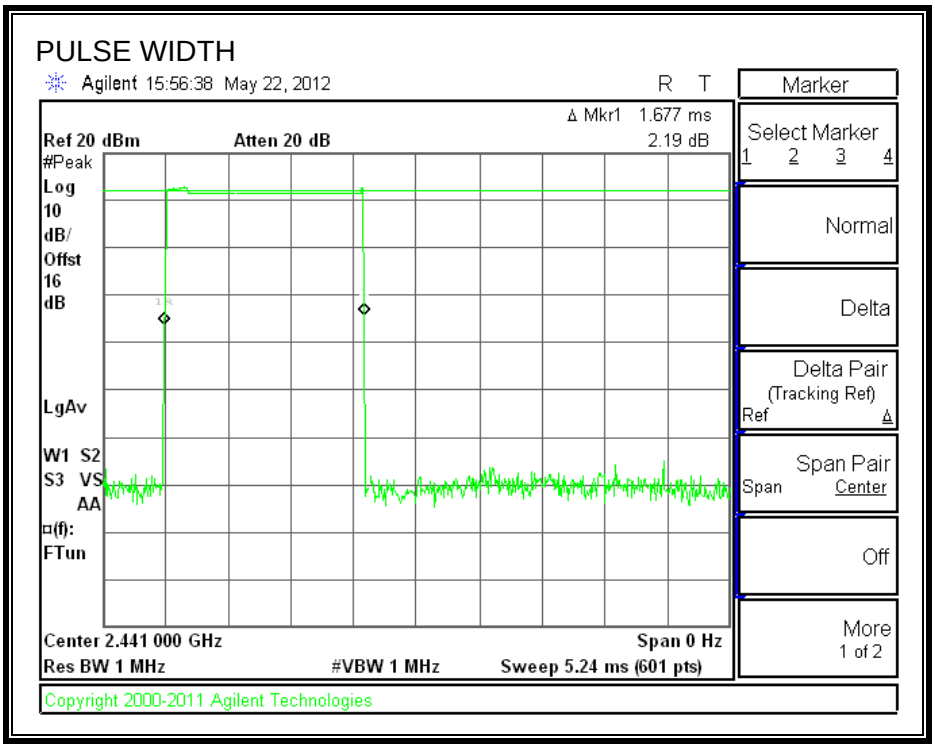
PULSE WIDTH 8PSK DH1



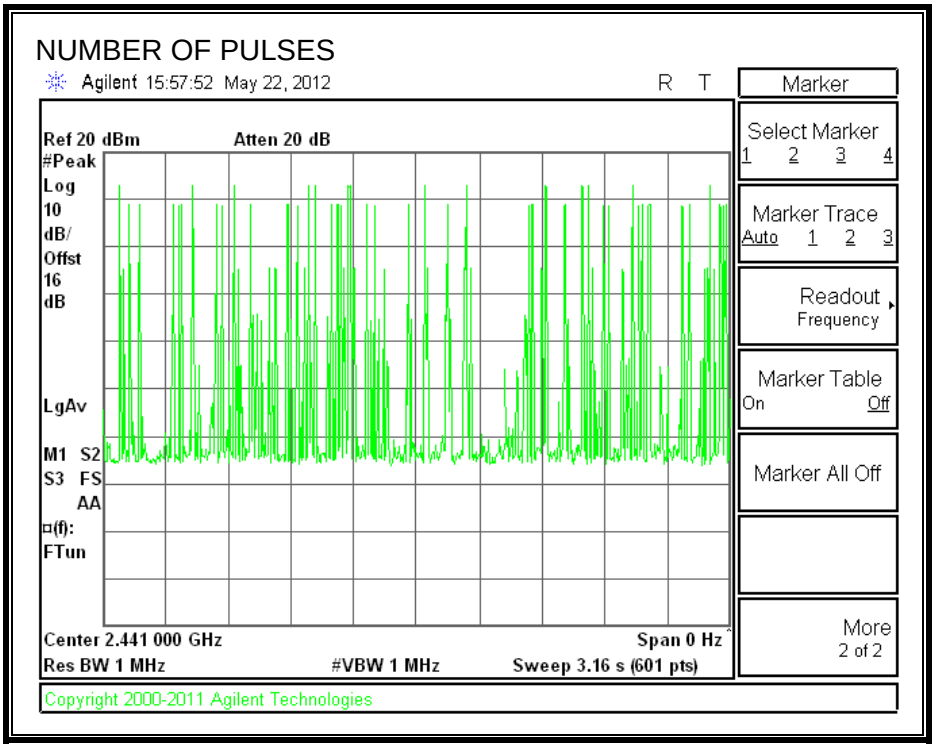
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



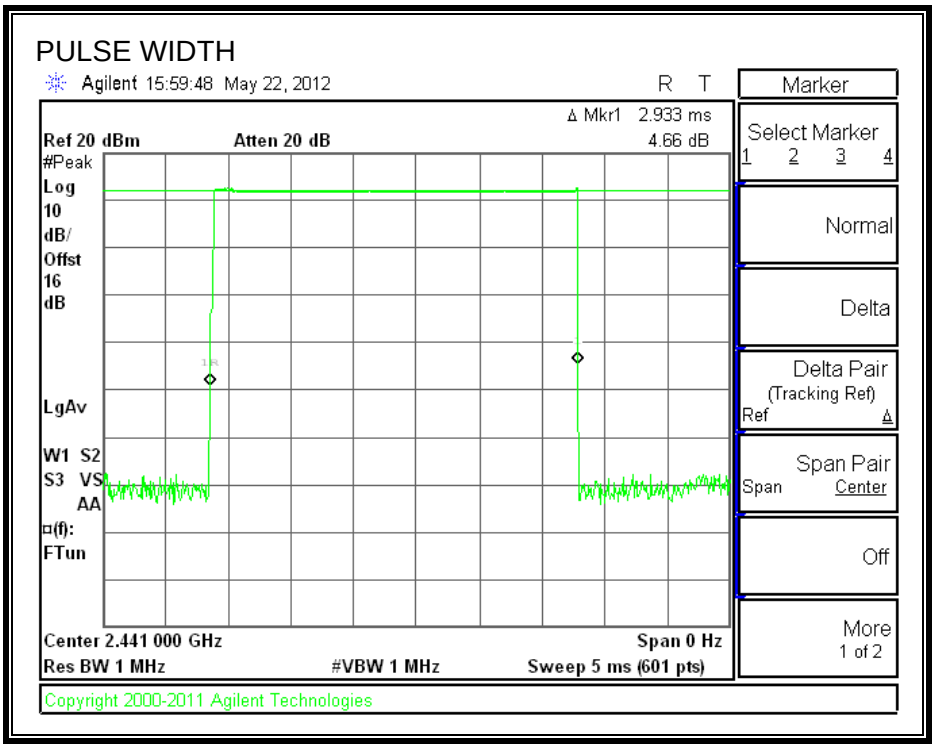
PULSE WIDTH 8PSK DH3



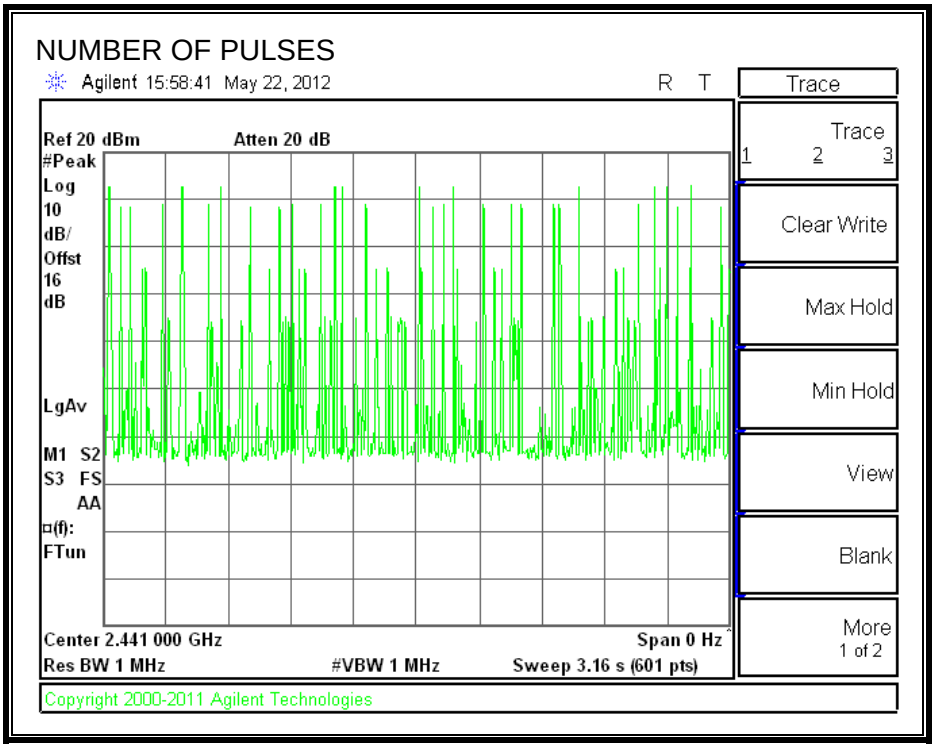
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



PULSE WIDTH 8PSK DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



9.1.5. OUTPUT POWER

LIMIT

§15.247 (b) (1)

RSS-210 Issue 7 Clause A8.4

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

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.

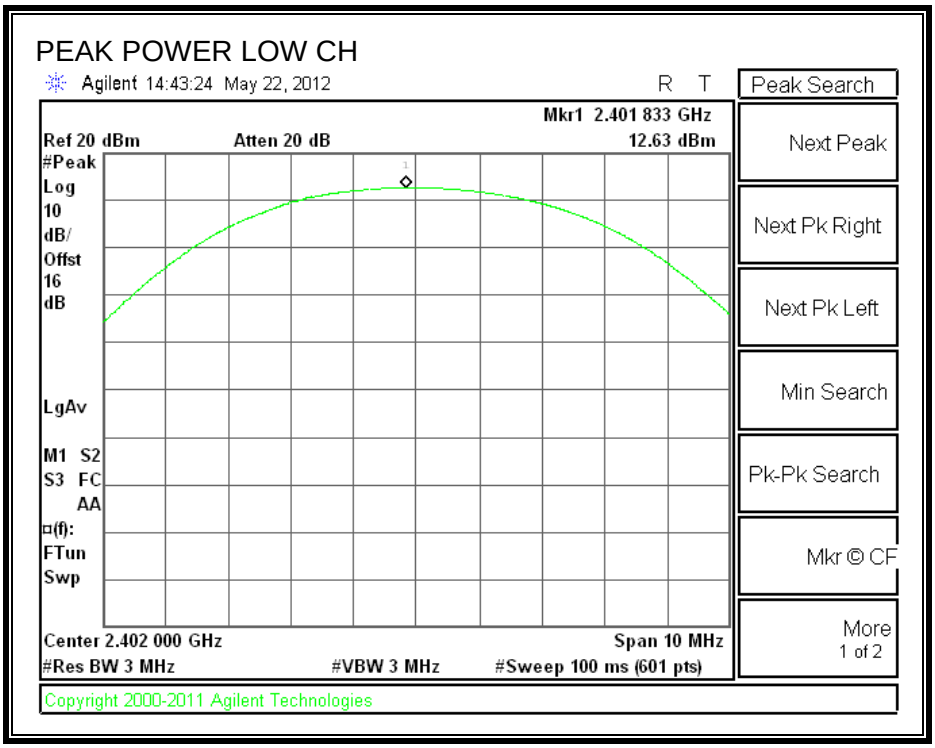
TEST PROCEDURE

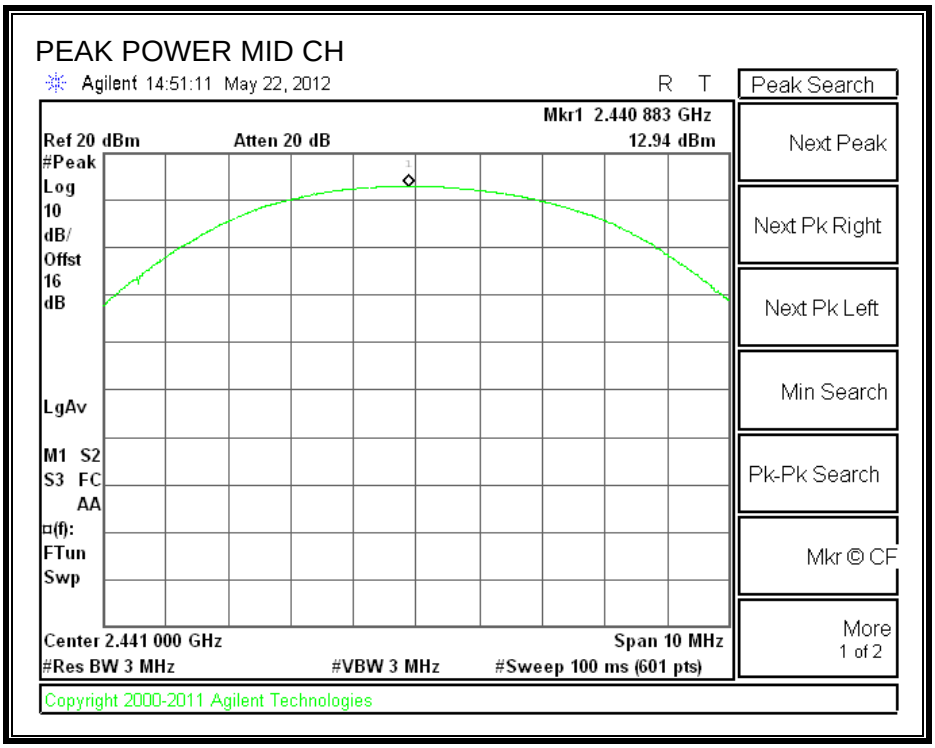
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

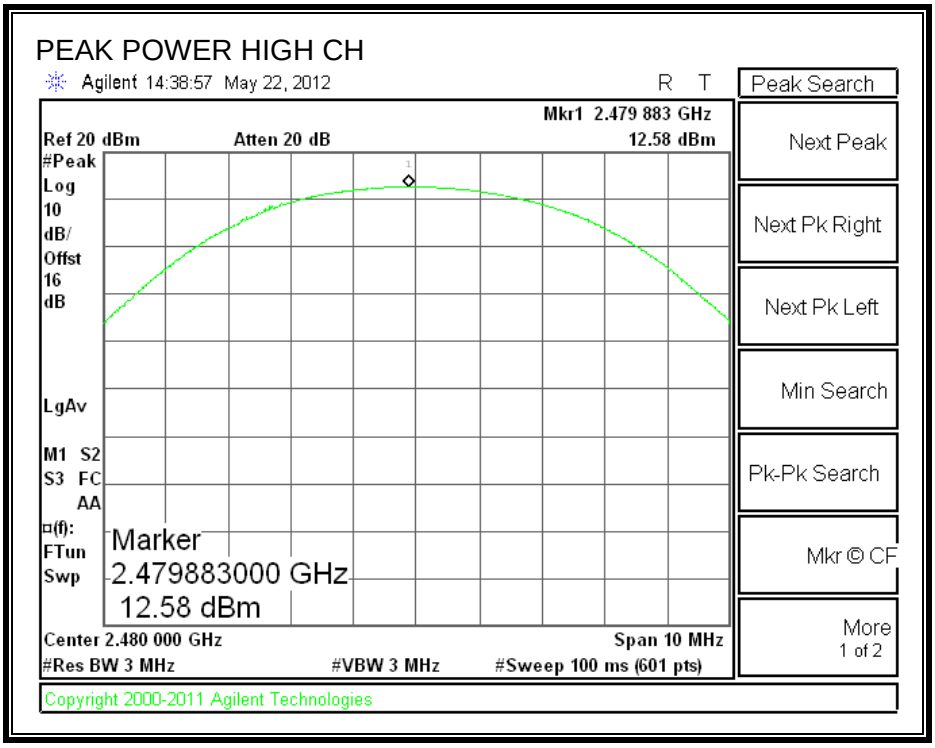
RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.63	21	-8.37
Middle	2441	12.94	21	-8.06
High	2480	12.58	21	-8.42

OUTPUT POWER







9.1.6. AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 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	11.40
Middle	2441	11.30
High	2480	11.30

9.1.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

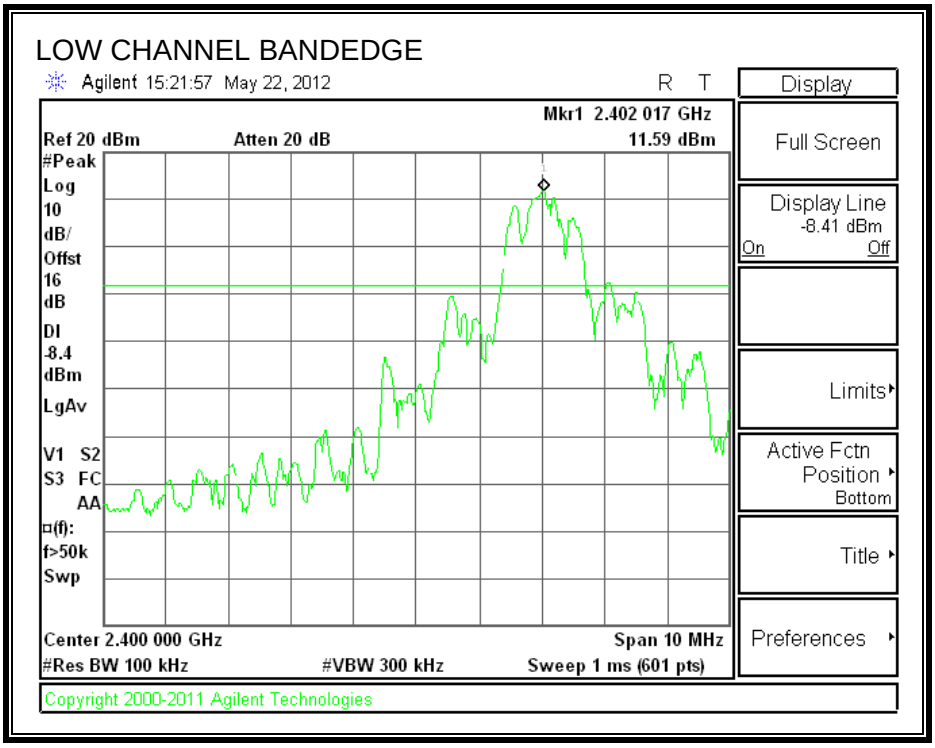
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

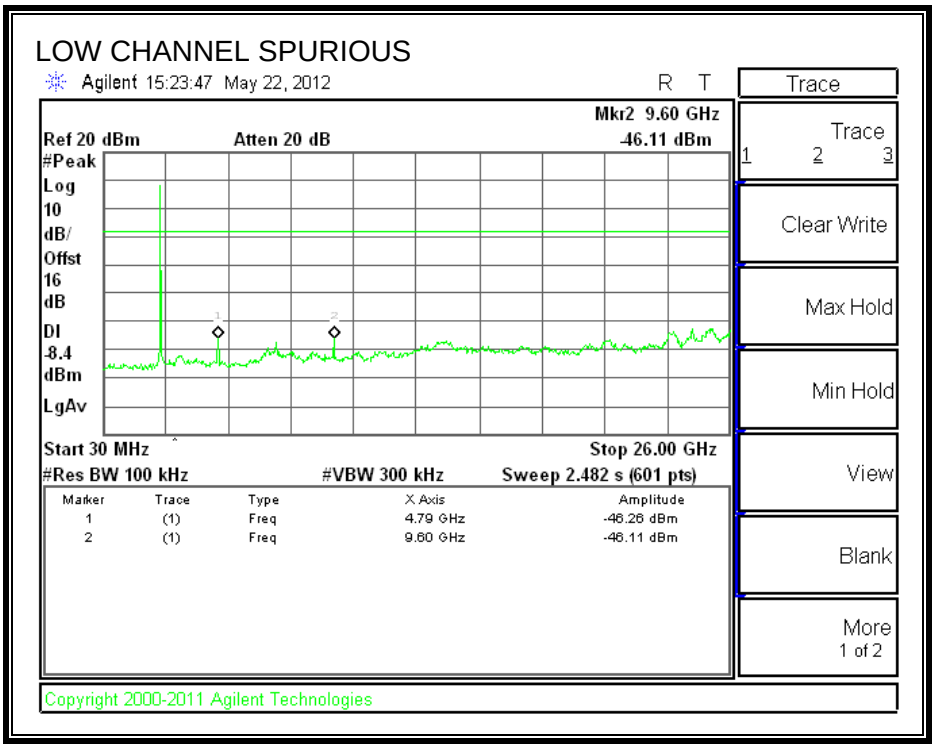
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

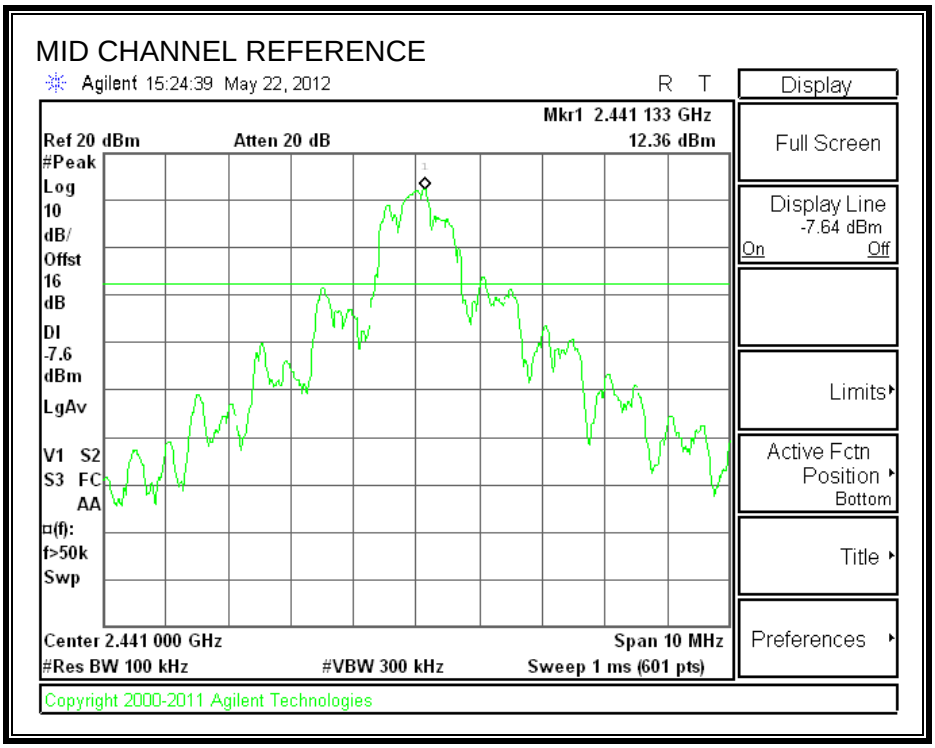
RESULTS

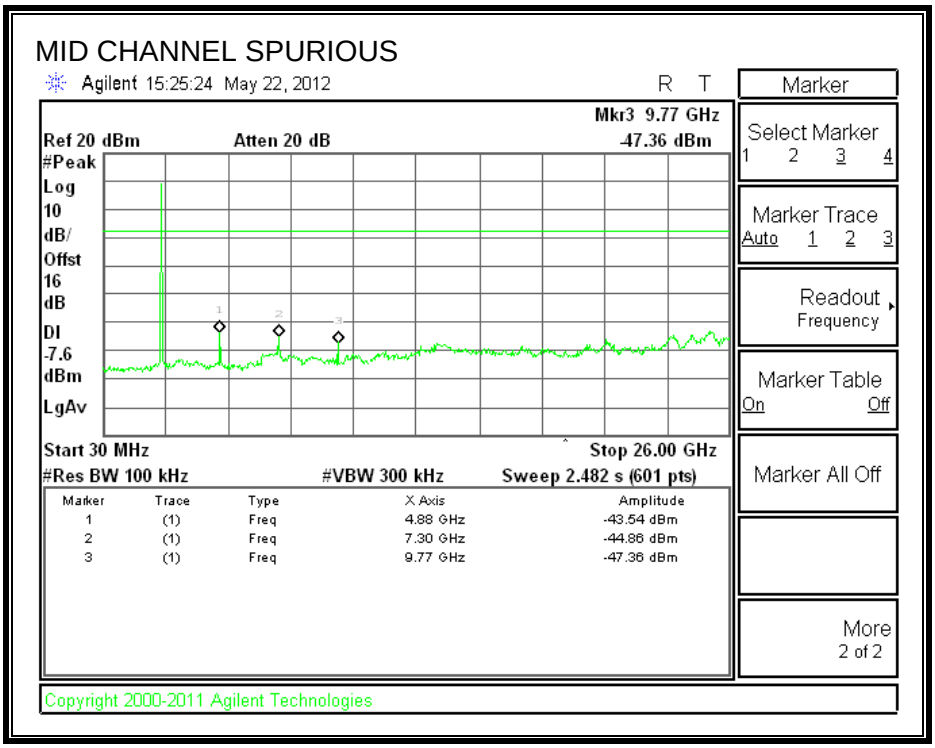
SPURIOUS EMISSIONS, LOW CHANNEL



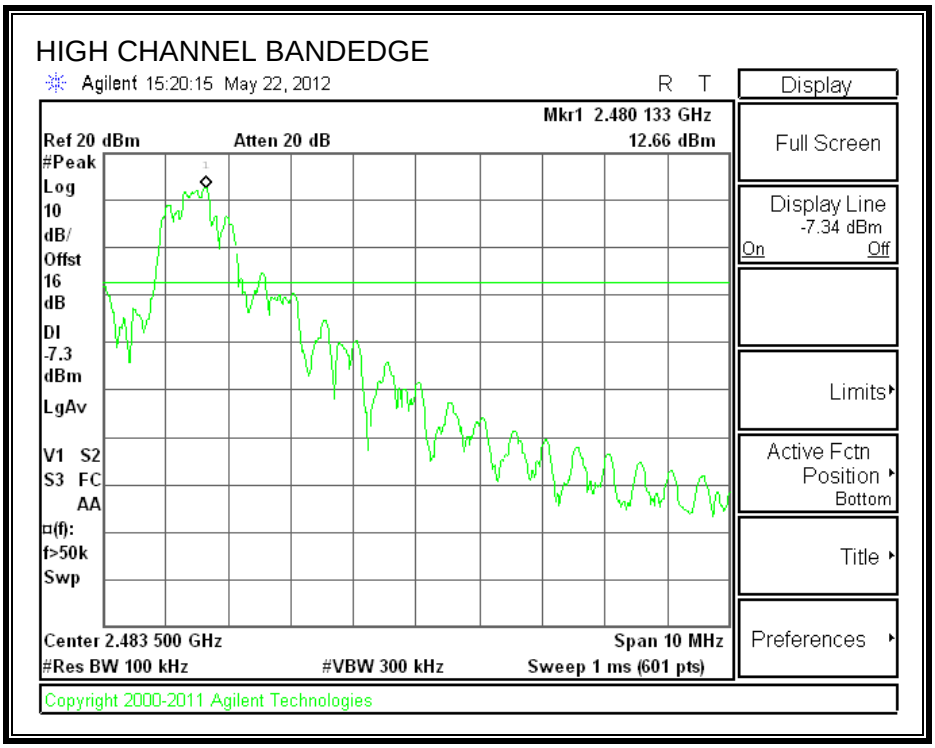


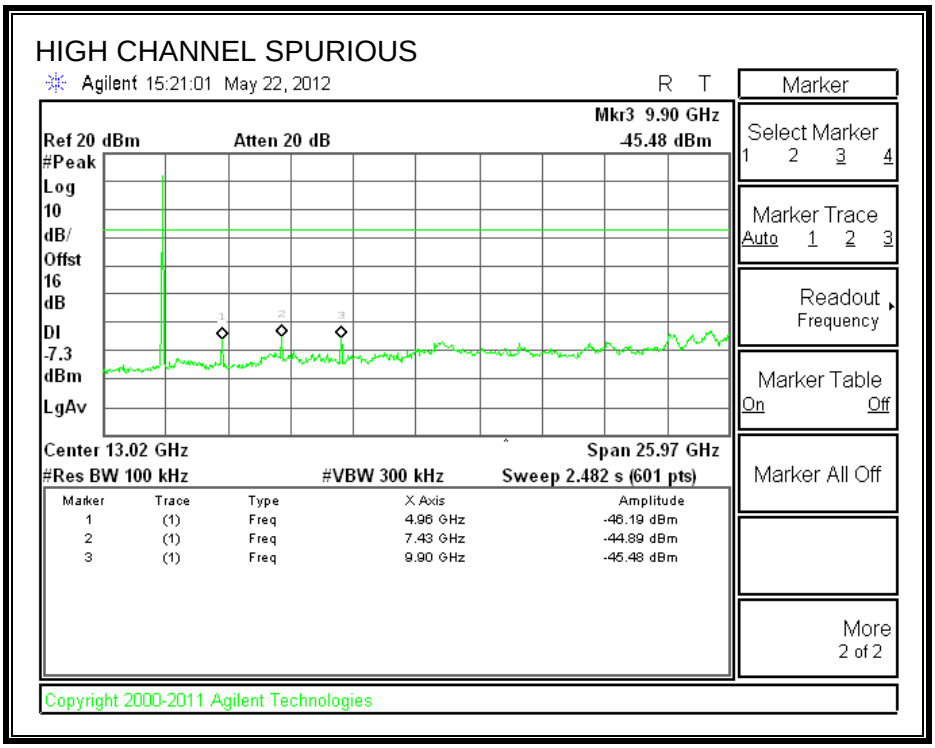
SPURIOUS EMISSIONS, MID CHANNEL





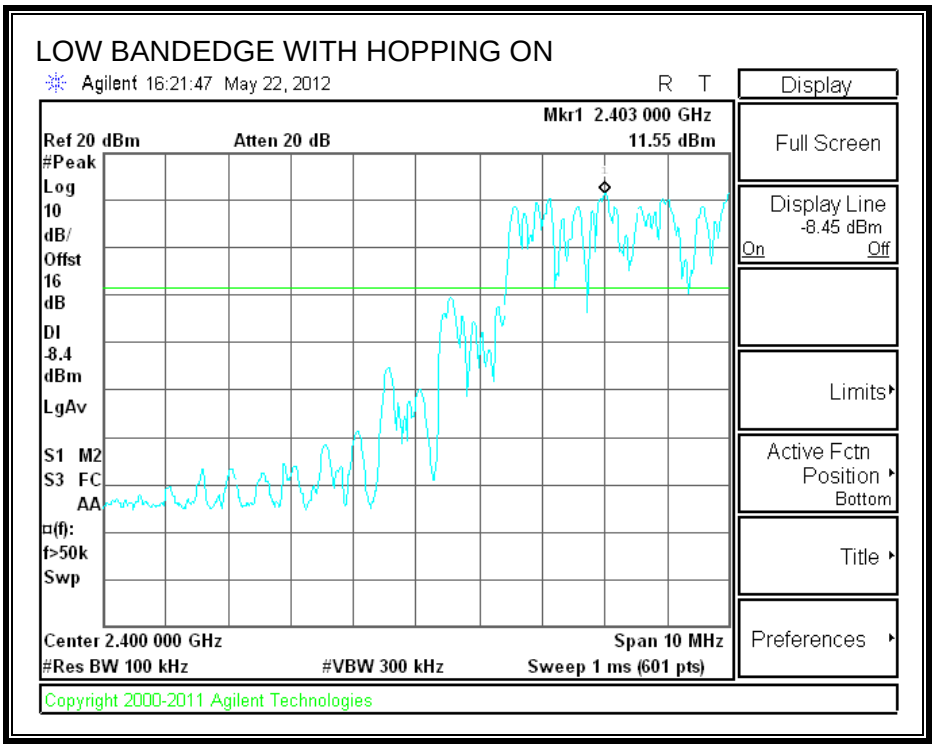
SPURIOUS EMISSIONS, HIGH CHANNEL



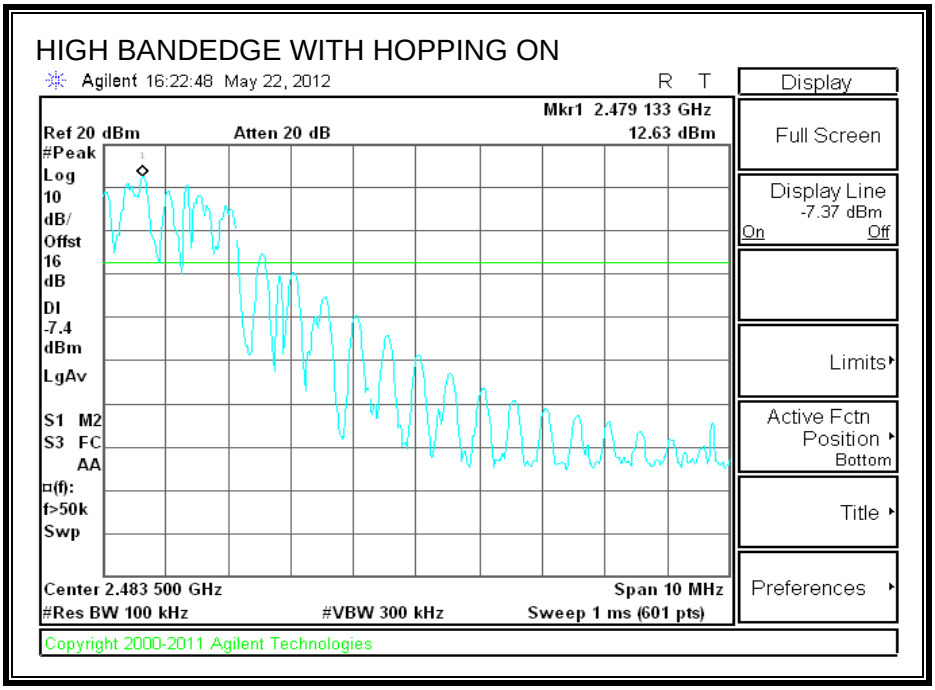


SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE WITH HOPPING ON



HIGH BANDEDGE WITH HOPPING ON



10. RADIATED TEST RESULTS

10.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

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

TEST PROCEDURE

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

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

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

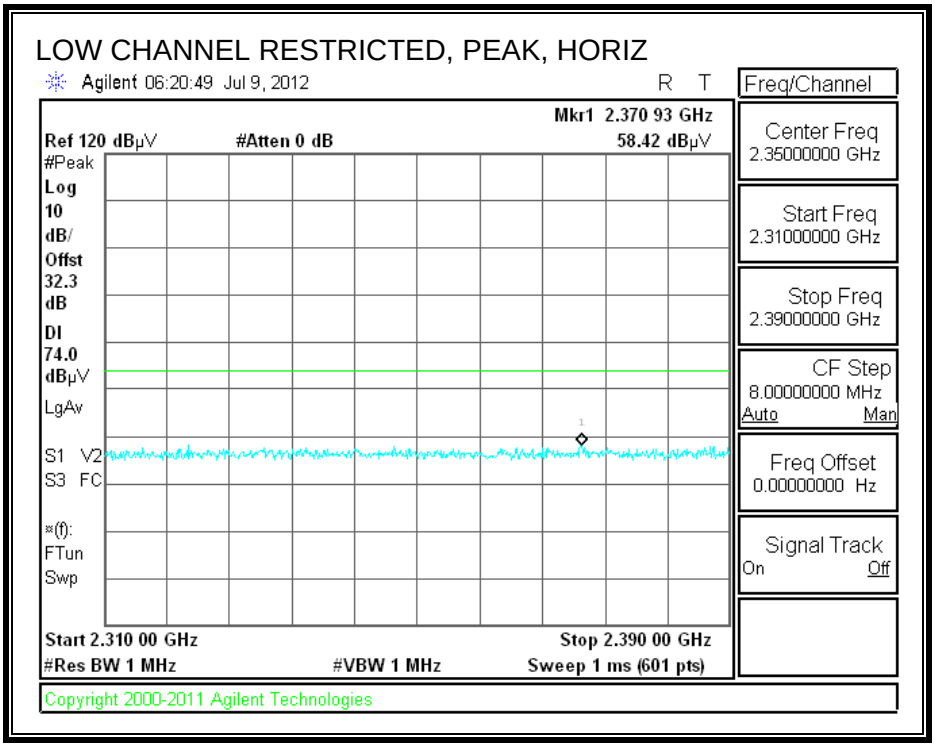
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

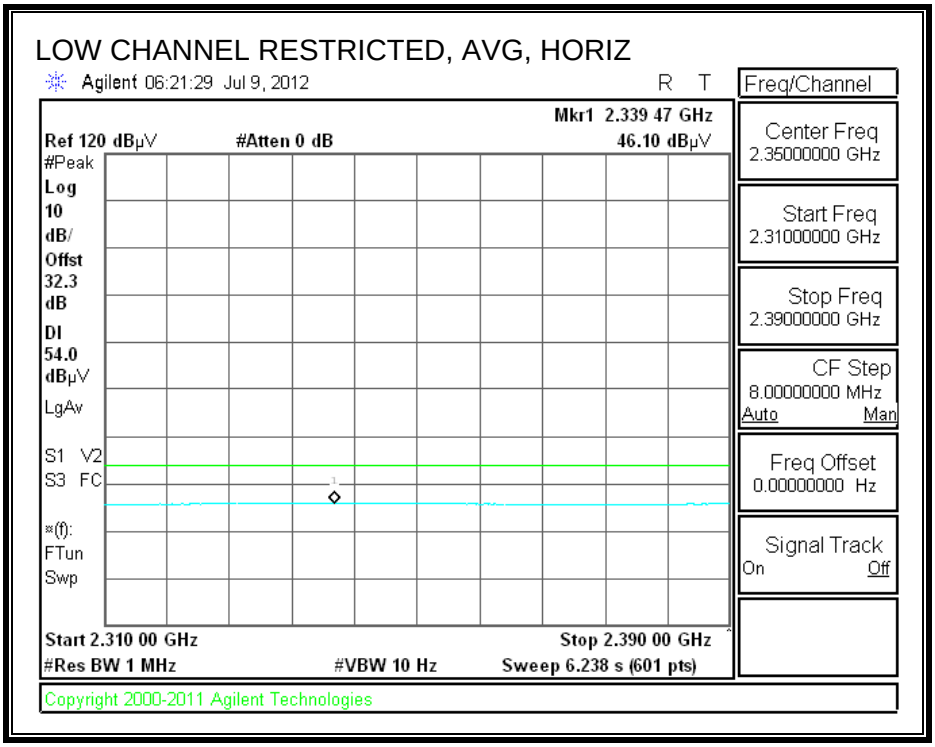
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

10.2. TRANSMITTER ABOVE 1 GHz

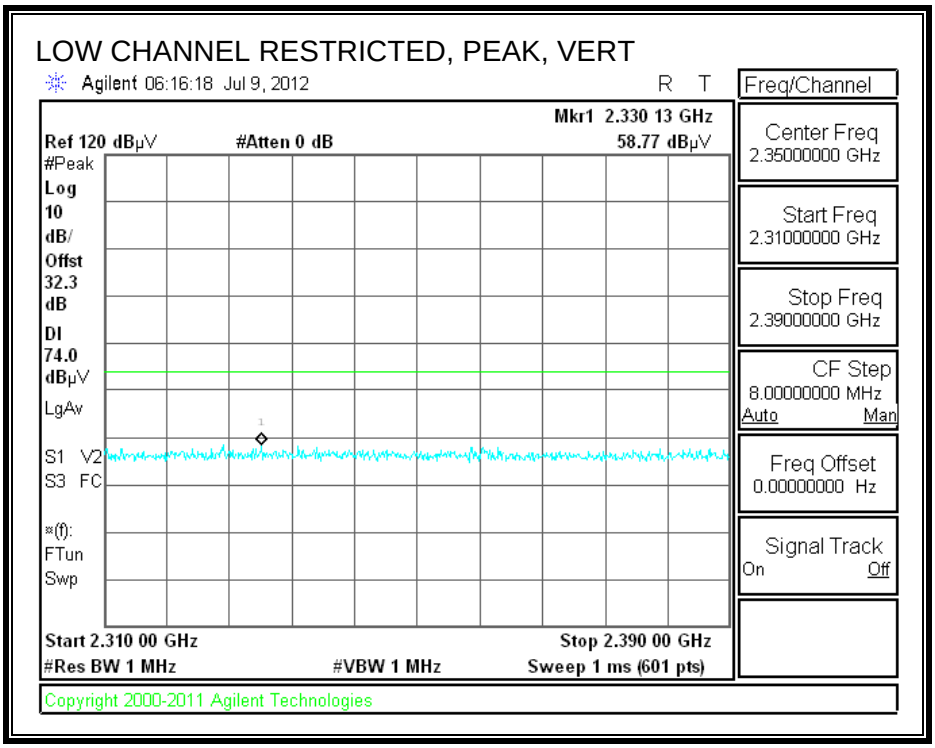
10.2.1. BASIC DATA RATE GFSK MODULATION

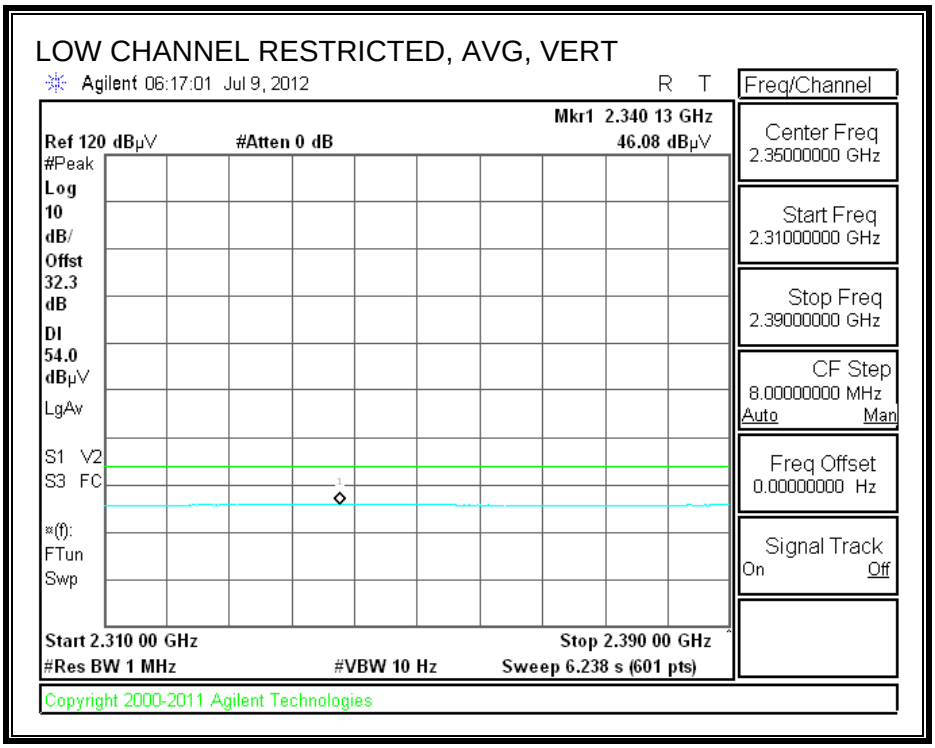
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



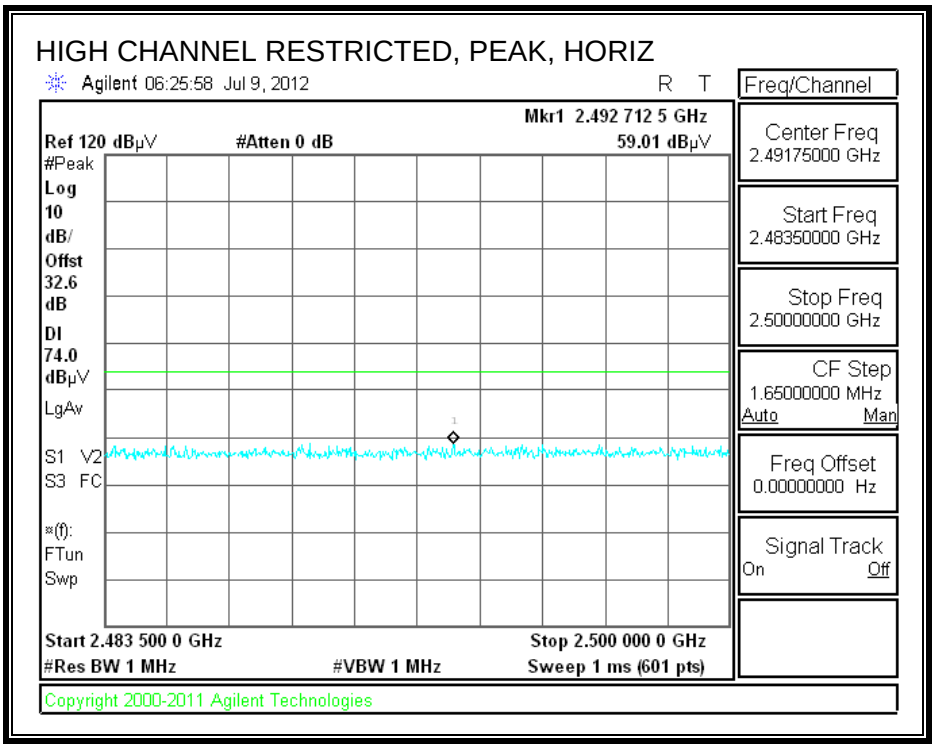


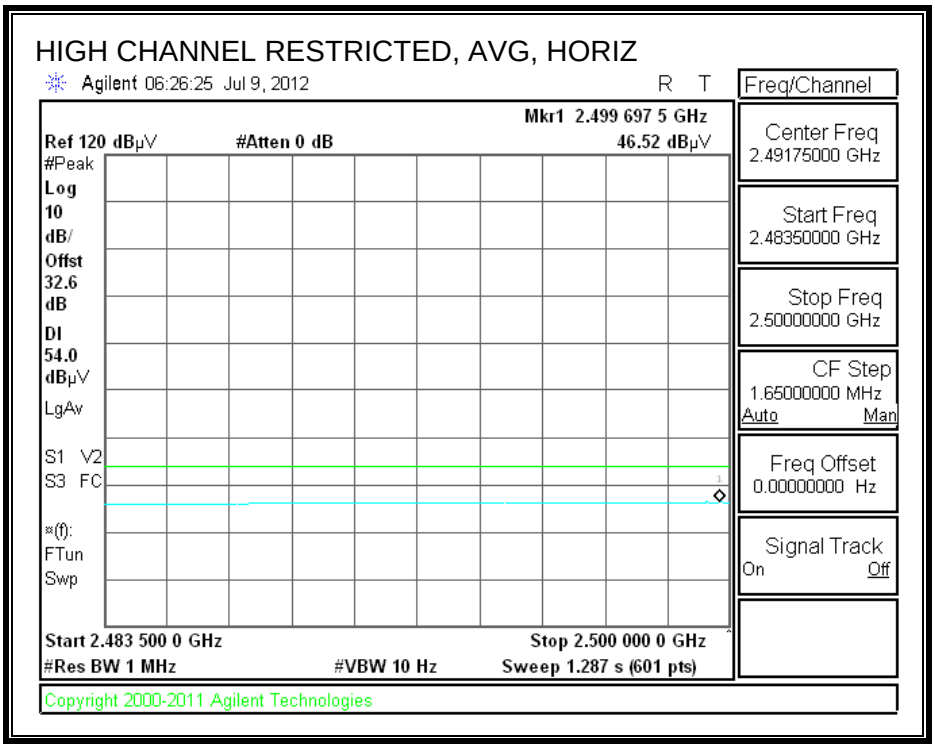
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



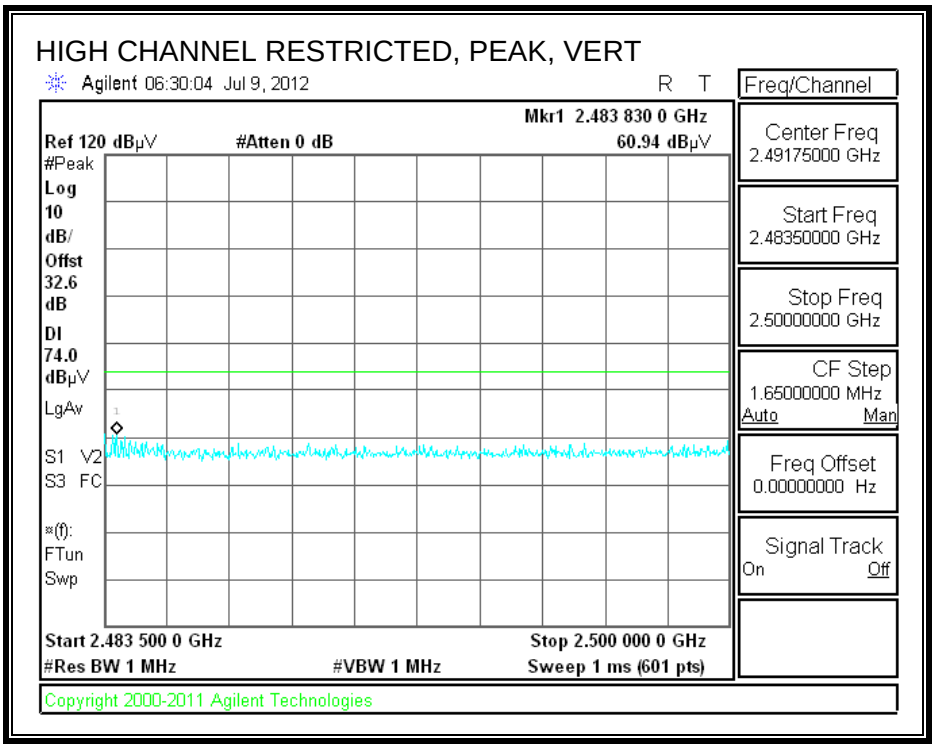


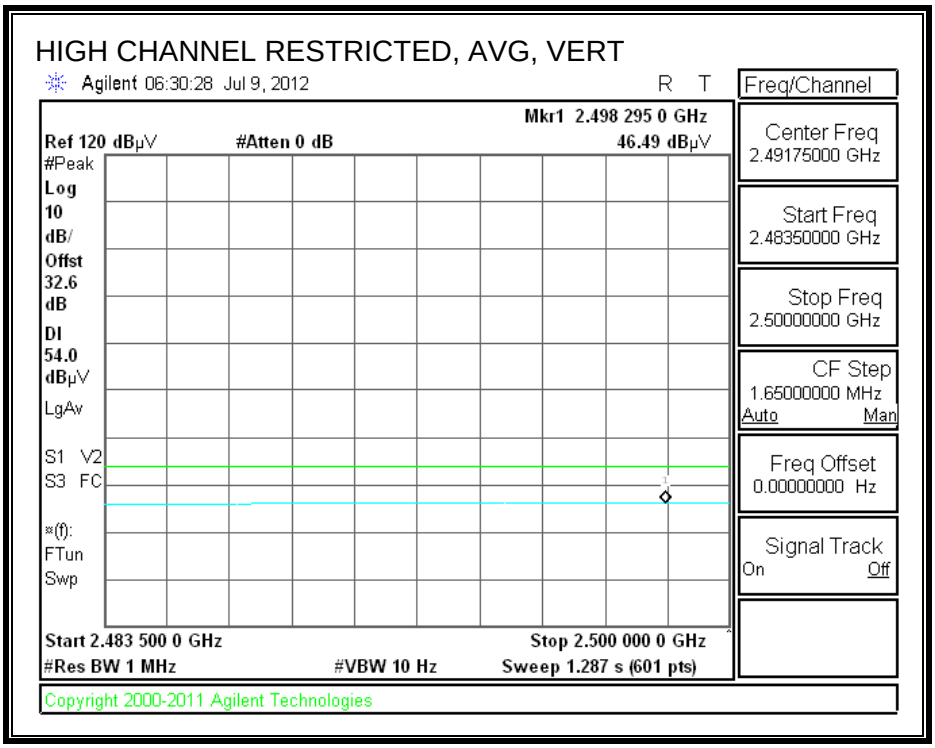
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)





RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)





HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: William Zhuang
Date: 07/09/12
Project #: 11U14136
Company: Apple
Test Target:
Mode Oper: Bluetooth, GFSK, X position

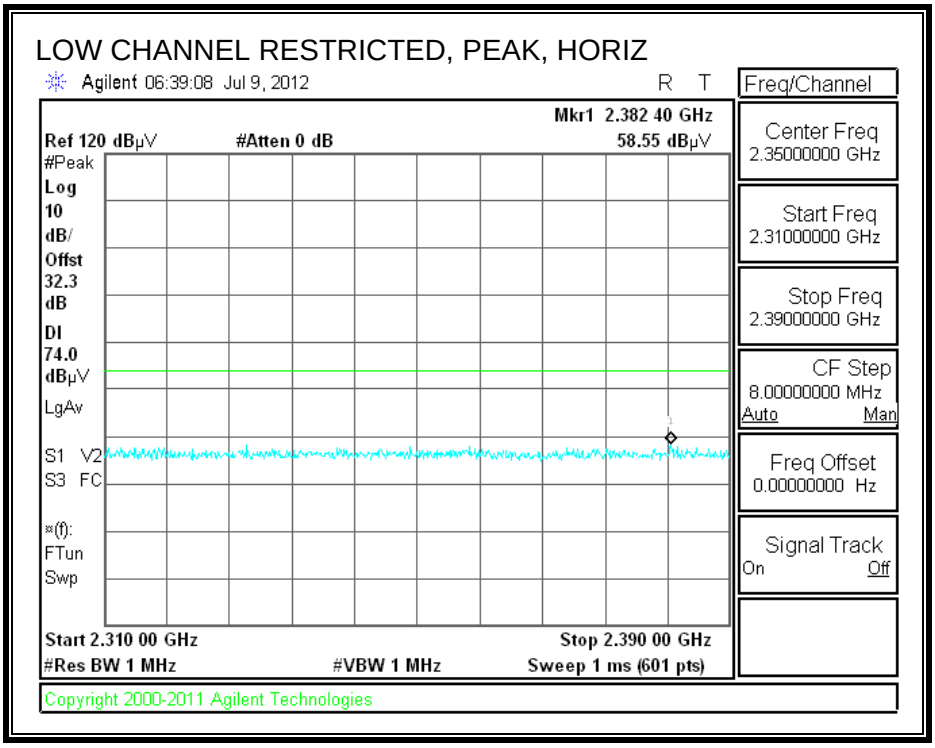
f	Measurement Frequency	Amp	Preamp Gain		Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters		Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m		Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength		Margin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

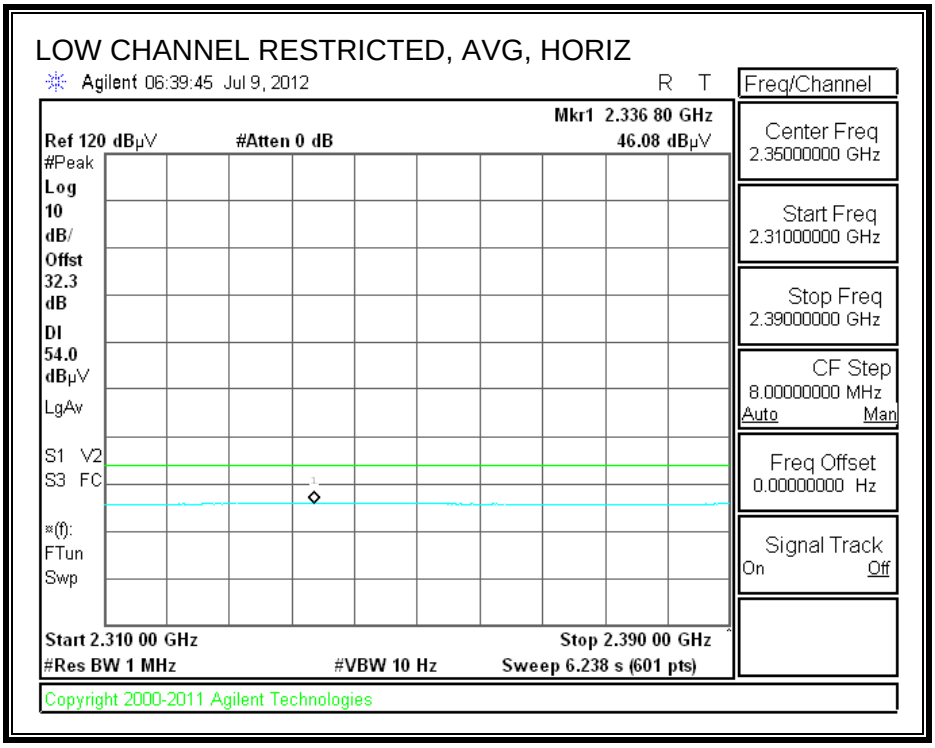
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
GFSK, Low Ch. 2402 MHz, 13.5 dBm													
4.804	3.0	43.3	33.1	6.2	-34.8	0.0	0.0	47.7	74.0	-26.3	V	P	
4.804	3.0	32.4	33.1	6.2	-34.8	0.0	0.0	36.9	54.0	-17.1	V	A	
4.804	3.0	42.7	33.1	6.2	-34.8	0.0	0.0	47.1	74.0	-26.9	H	P	
4.804	3.0	32.0	33.1	6.2	-34.8	0.0	0.0	36.5	54.0	-17.5	H	A	
GFSK, Mid Ch. 2441 MHz, 13.5 dBm													
4.882	3.0	44.9	33.1	6.2	-34.8	0.0	0.0	49.5	74.0	-24.5	V	P	
4.882	3.0	33.6	33.1	6.2	-34.8	0.0	0.0	38.1	54.0	-15.9	V	A	
4.882	3.0	45.3	33.1	6.2	-34.8	0.0	0.0	49.9	74.0	-24.1	H	P	
4.882	3.0	33.7	33.1	6.2	-34.8	0.0	0.0	38.2	54.0	-15.8	H	A	
7.323	3.0	49.9	35.8	8.4	-34.9	0.0	0.0	59.2	74.0	-14.8	H	P	
7.323	3.0	35.8	35.8	8.4	-34.9	0.0	0.0	45.1	54.0	-8.9	H	A	
7.323	3.0	48.6	35.8	8.4	-34.9	0.0	0.0	57.9	74.0	-16.1	V	P	
7.323	3.0	35.3	35.8	8.4	-34.9	0.0	0.0	44.6	54.0	-9.4	V	A	
GFSK, High Ch. 2480 MHz, 13.5 dBm													
4.960	3.0	45.3	33.2	6.3	-34.8	0.0	0.0	50.0	74.0	-24.0	V	P	
4.960	3.0	33.8	33.2	6.3	-34.8	0.0	0.0	38.5	54.0	-15.5	V	A	
4.960	3.0	45.3	33.2	6.3	-34.8	0.0	0.0	50.0	74.0	-24.0	H	P	
4.960	3.0	33.9	33.2	6.3	-34.8	0.0	0.0	38.6	54.0	-15.4	H	A	
7.440	3.0	49.0	36.0	8.4	-34.9	0.0	0.0	58.5	74.0	-15.5	H	P	
7.440	3.0	36.0	36.0	8.4	-34.9	0.0	0.0	45.5	54.0	-8.5	H	A	
7.440	3.0	48.2	36.0	8.4	-34.9	0.0	0.0	57.7	74.0	-16.3	V	P	
7.440	3.0	35.2	36.0	8.4	-34.9	0.0	0.0	44.7	54.0	-9.3	V	A	

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

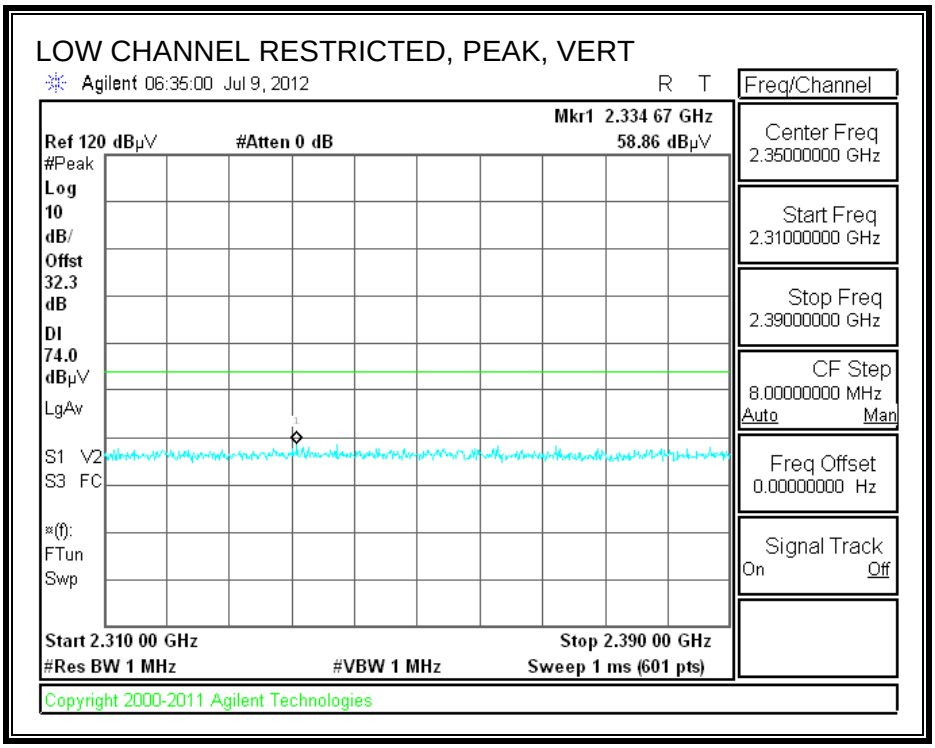
10.2.2. ENHANCED DATA RATE 8PSK MODULATION

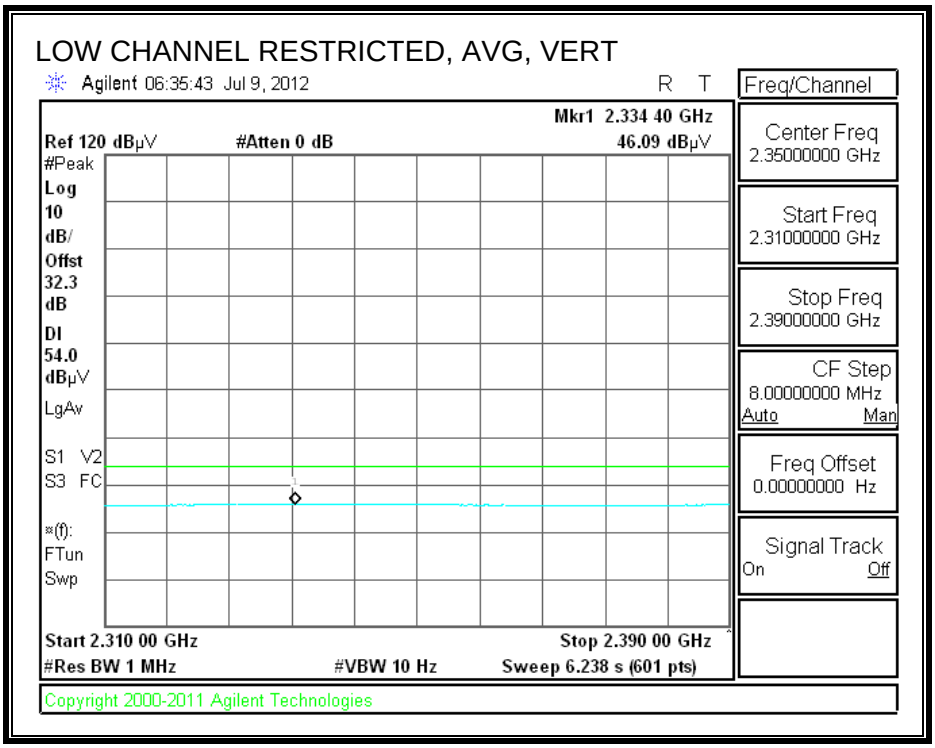
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



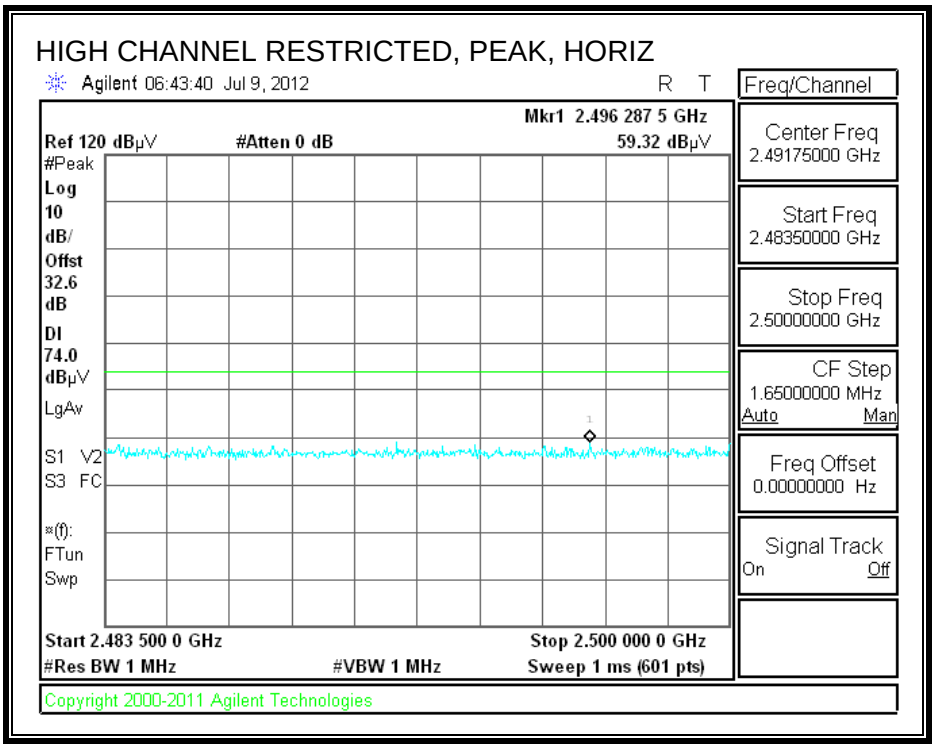


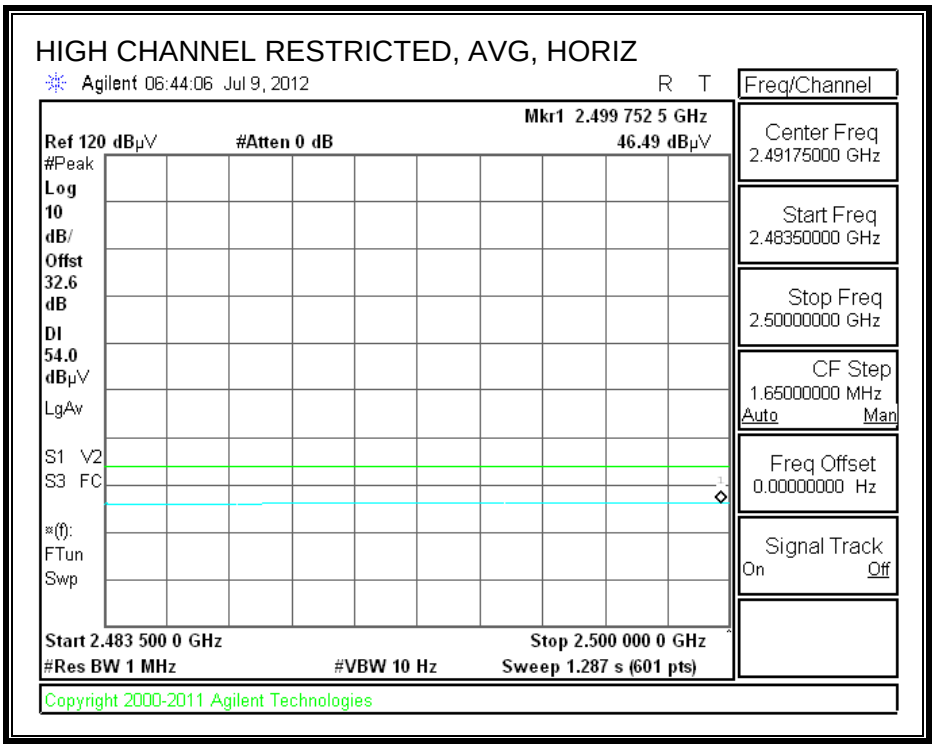
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



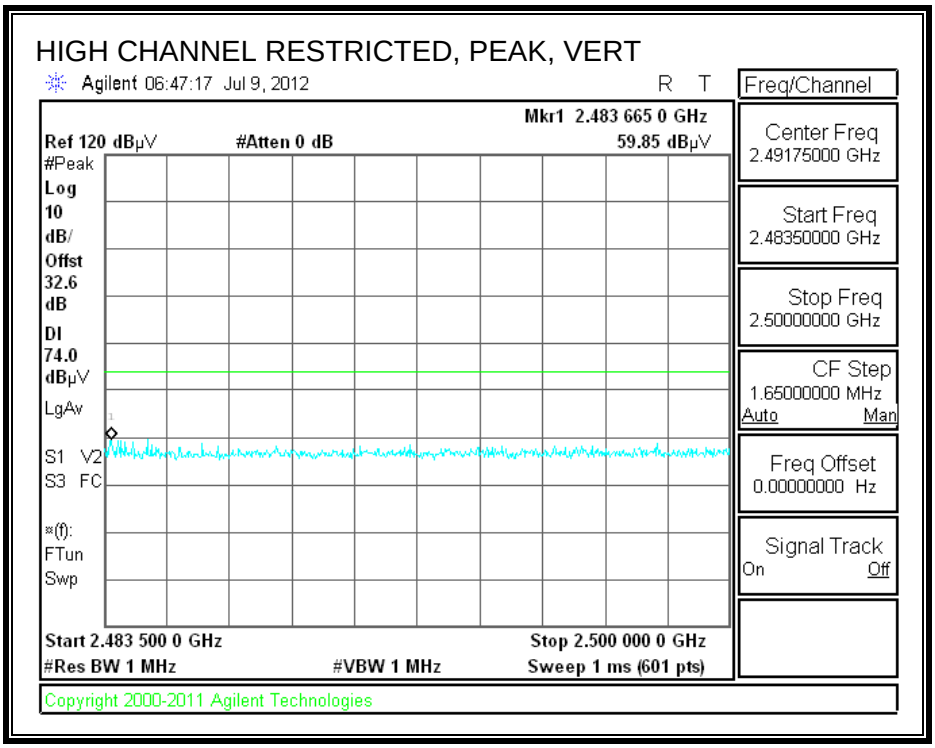


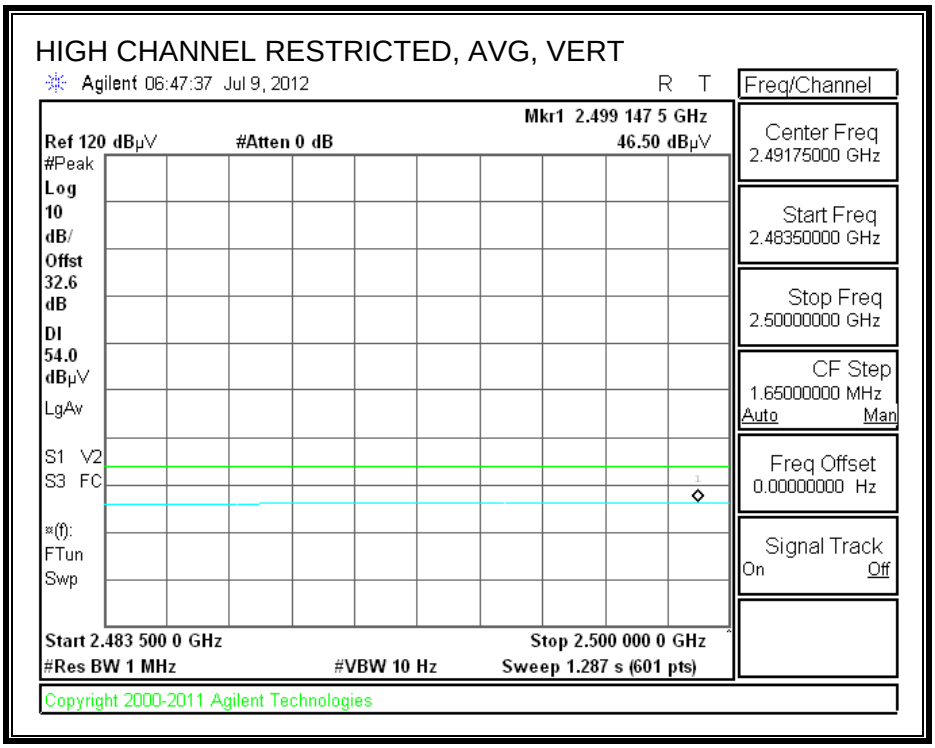
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)





RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)





HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: William Zhuang
Date: 07/09/12
Project #: 11U14136
Company: Apple
Test Target:
Mode Oper: Bluetooth, 8PSK, Power Setting: 11.5 dBm, X position

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	Notes
Low Ch. 2402 MHz													
4.804	3.0	45.4	33.1	6.2	-34.8	0.0	0.0	49.9	74.0	-24.1	V	P	
4.804	3.0	33.0	33.1	6.2	-34.8	0.0	0.0	37.5	54.0	-16.5	V	A	
4.804	3.0	44.1	33.1	6.2	-34.8	0.0	0.0	48.5	74.0	-25.5	H	P	
4.804	3.0	32.3	33.1	6.2	-34.8	0.0	0.0	36.8	54.0	-17.2	H	A	
Mid Ch. 2441 MHz													
4.882	3.0	42.4	33.1	6.2	-34.8	0.0	0.0	46.9	74.0	-27.1	V	P	
4.882	3.0	31.1	33.1	6.2	-34.8	0.0	0.0	35.7	54.0	-18.3	V	A	
4.882	3.0	41.7	33.1	6.2	-34.8	0.0	0.0	46.3	74.0	-27.7	H	P	
4.882	3.0	29.4	33.1	6.2	-34.8	0.0	0.0	34.0	54.0	-20.0	H	A	
7.323	3.0	47.2	35.8	8.4	-34.9	0.0	0.0	56.4	74.0	-17.6	H	P	
7.323	3.0	33.3	35.8	8.4	-34.9	0.0	0.0	42.6	54.0	-11.4	H	A	
7.323	3.0	45.0	35.8	8.4	-34.9	0.0	0.0	54.3	74.0	-19.7	V	P	
7.323	3.0	31.9	35.8	8.4	-34.9	0.0	0.0	41.2	54.0	-12.8	V	A	
High Ch. 2480 MHz													
4.960	3.0	45.4	33.2	6.3	-34.8	0.0	0.0	50.1	74.0	-23.9	V	P	
4.960	3.0	33.5	33.2	6.3	-34.8	0.0	0.0	38.2	54.0	-15.8	V	A	
4.960	3.0	45.5	33.2	6.3	-34.8	0.0	0.0	50.2	74.0	-23.8	H	P	
4.960	3.0	33.4	33.2	6.3	-34.8	0.0	0.0	38.1	54.0	-15.9	H	A	
7.440	3.0	41.8	36.0	8.4	-34.9	0.0	0.0	51.3	74.0	-22.7	H	P	
7.440	3.0	29.7	36.0	8.4	-34.9	0.0	0.0	39.2	54.0	-14.8	H	A	
7.440	3.0	40.9	36.0	8.4	-34.9	0.0	0.0	50.4	74.0	-23.6	V	P	
7.440	3.0	29.6	36.0	8.4	-34.9	0.0	0.0	39.1	54.0	-14.9	V	A	

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

10.3. RECEIVER ABOVE 1 GHz

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber-B

Company: Apple
Project #: 11U14136
Date: 7/09/2012
Test Engineer: William Zhuang
Configuration: EUT alone
Mode: Rx On

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T59; S/N: 3245 @3m	T145 Agilent 3008A0056			RX RSS 210

Hi Frequency Cables

3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter
3' cable 22807700	12' cable 22807600	20' cable 22807500		

Peak Measurements
RBW=VBW=1MHz
Average Measurements
RBW=1MHz ; VBW=10Hz

f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
1.098	3.0	43.5	30.9	24.3	2.7	-35.9	0.0	0.0	34.6	22.0	74	54	-39.4	-32.0	V
1.098	3.0	43.3	30.8	24.3	2.7	-35.9	0.0	0.0	34.4	21.9	74	54	-39.6	-32.1	H
1.857	3.0	41.5	29.5	27.7	3.6	-35.5	0.0	0.0	37.3	25.4	74	54	-36.7	-28.6	H
1.857	3.0	41.7	29.4	27.7	3.6	-35.5	0.0	0.0	37.5	25.3	74	54	-36.5	-28.7	V
3.267	3.0	40.0	28.0	31.0	5.1	-35.1	0.0	0.0	40.9	28.9	74	54	-33.1	-25.1	V
3.267	3.0	41.1	28.0	31.0	5.1	-35.1	0.0	0.0	42.1	28.9	74	54	-31.9	-25.1	H

Rev. 07.08.11

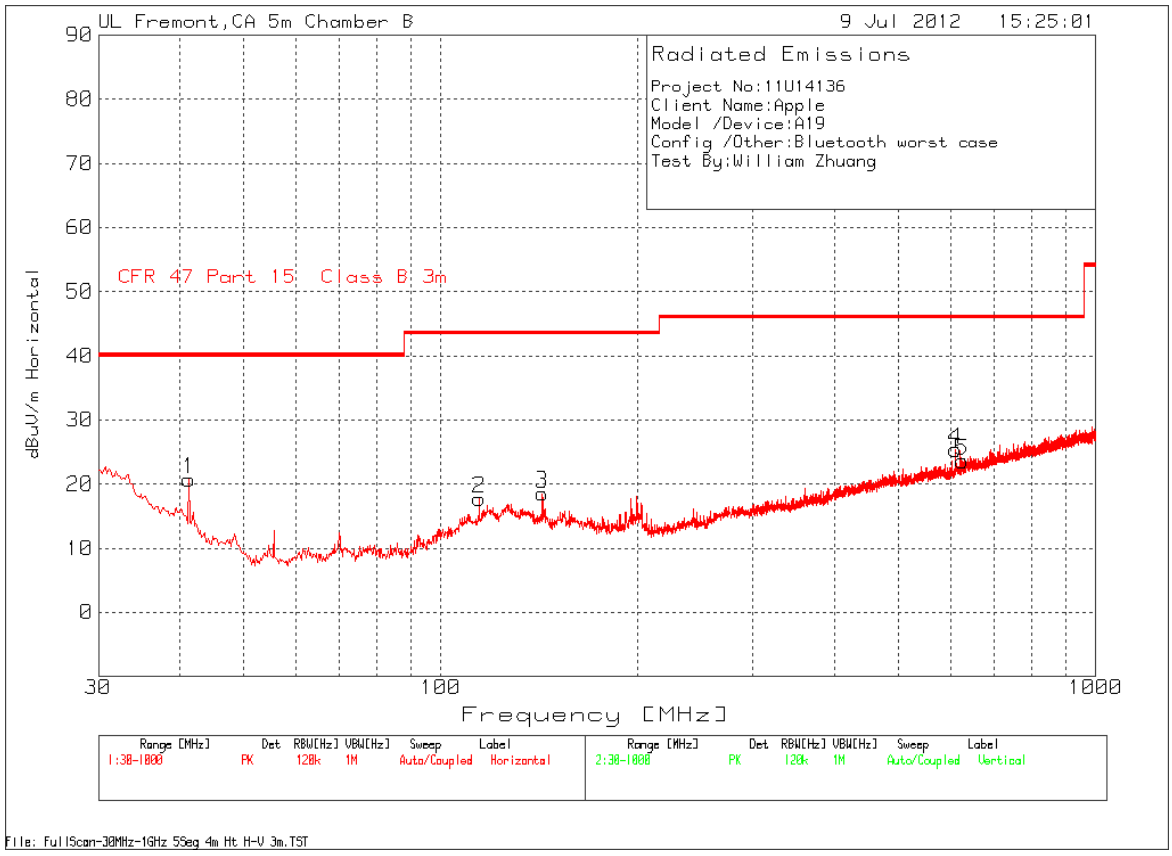
f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field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

10.4. WORST-CASE BELOW 1 GHz

BLUETOOTH

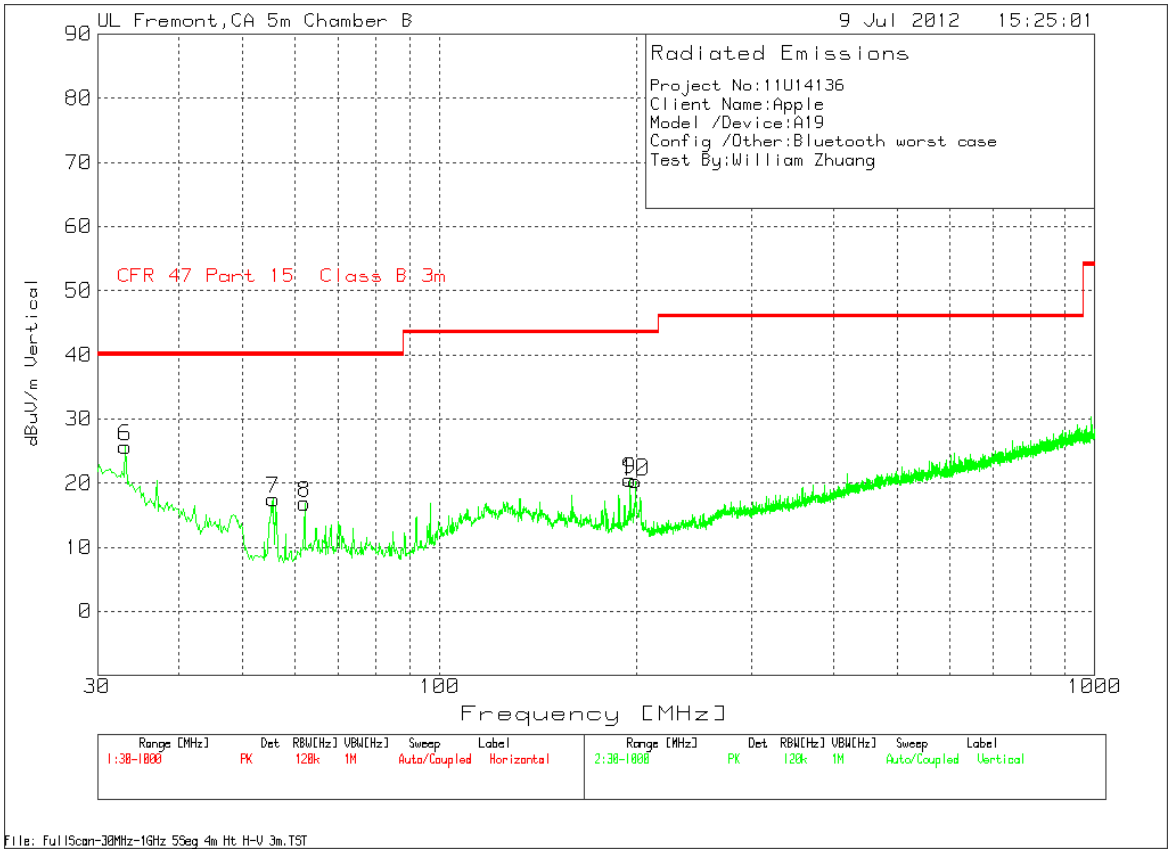
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

HORIZONTAL PLOT



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

VERTICAL PLOT



HORIZONTAL AND VERTICAL DATA

Project No:11U14136								
Client Name:Apple								
Model /Device:A19								
Config /Other:Bluetooth worst case								
Test By:William Zhuang								
Horizontal 30 - 1000MHz								
Test Frequ	Meter Rea	Detector	T122 Suno	5mB Amp	dBuV/m	CFR 47 Par	Margin	Polarity
41.243	37.1	PK	12.8	-29.2	20.7	40	-19.3	Horz
114.5164	32.64	PK	13.5	-28.4	17.74	43.5	-25.76	Horz
143.0116	33.73	PK	12.9	-28.1	18.53	43.5	-24.97	Horz
611.9225	32.78	PK	19	-26.4	25.38	46	-20.62	Horz
626.6547	30.91	PK	19.2	-26.5	23.61	46	-22.39	Horz
Vertical 30 - 1000MHz								
Test Frequ	Meter Rea	Detector	T122 Suno	5mB Amp	dBuV/m	CFR 47 Par	Margin	Polarity
33.1015	35.91	PK	19	-29.2	25.71	40	-14.29	Vert
55.7814	39.3	PK	7.2	-29	17.5	40	-22.5	Vert
62.1783	38.19	PK	7.6	-28.9	16.89	40	-23.11	Vert
195.1559	36.22	PK	11.9	-27.6	20.52	43.5	-22.98	Vert
199.0328	35.21	PK	12.7	-27.6	20.31	43.5	-23.19	Vert

11. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

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

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

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

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

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

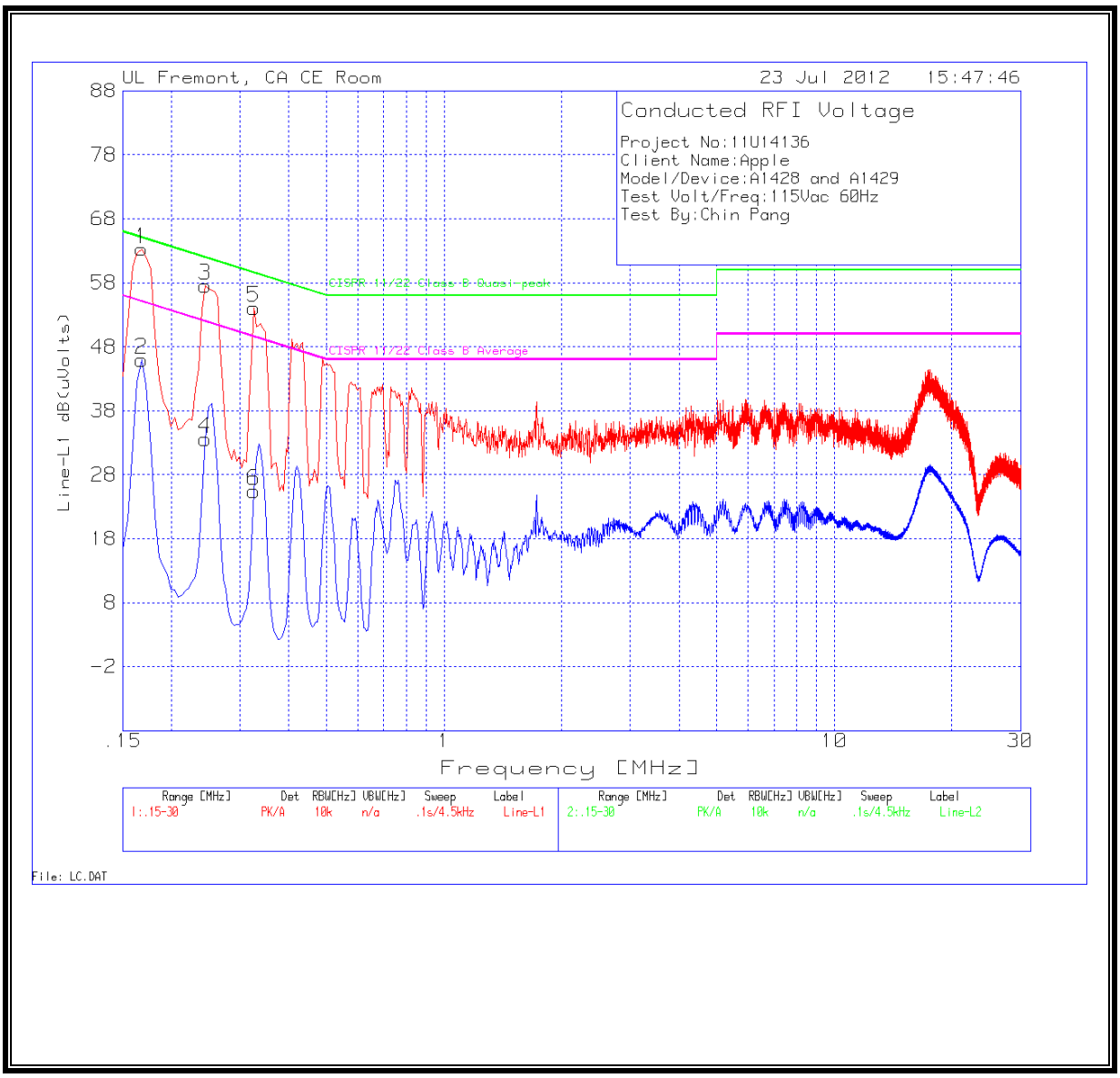
RESULTS

6 WORST EMISSIONS

BLUETOOTH

Project No:11U14136									
Client Name:Apple									
Model/Device:A1428 and A1429									
Test Volt/Freq:115Vac 60Hz									
Test By:Chin Pang									
Line-L1 .15 - 30MHz									
Test Frequ	Meter Rea	Detector	T24 IL L1.T	LC Cables	dB(uVolts	CISPR 11/:	Margin	CISPR 11/:	Margin
0.168	63.2	PK	0.1	0	63.3	65.1	-1.8	-	-
0.168	45.89	Av	0.1	0	45.99	-	-	55.1	-9.11
0.2445	57.43	PK	0.1	0	57.53	61.9	-4.37	-	-
0.2445	33.52	Av	0.1	0	33.62	-	-	51.9	-18.28
0.3255	54.03	PK	0.1	0	54.13	59.6	-5.47	-	-
0.3255	25.37	Av	0.1	0	25.47	-	-	49.6	-24.13
Line-L2 .15 - 30MHz									
Test Frequ	Meter Rea	Detector	T24 IL L2.T	LC Cables	dB(uVolts	CISPR 11/:	Margin	CISPR 11/:	Margin
0.1635	53.72	PK	0.1	0	53.82	65.3	-11.48	-	-
0.1635	32.37	Av	0.1	0	32.47	-	-	55.3	-22.83
0.2445	50.33	PK	0.1	0	50.43	61.9	-11.47	-	-
0.2445	29.13	Av	0.1	0	29.23	-	-	51.9	-22.67
0.321	46.08	PK	0.1	0	46.18	59.7	-13.52	-	-
0.321	21.42	Av	0.1	0	21.52	-	-	49.7	-28.18

LINE 1 RESULTS



LINE 2 RESULTS