



**FCC CFR47 PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 7**

CERTIFICATION TEST REPORT

FOR

**Handheld Touch Screen IPOD Music Device with 802.11 b/g
and Bluetooth radio functions**

MODEL NUMBER: A1288

REPORT NUMBER: 08U11969-5

ISSUE DATE: AUGUST 27, 2008

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 INFINITY LOOP
CUPERTINO, CALIFORNIA 95014, U.S.A.

EUT DESCRIPTION: Handheld Touch Screen IPOD Music Device with 802.11 b/g and Bluetooth radio functions

MODEL: A1288

SERIAL NUMBER: 9C8310HP2013

DATE TESTED: AUGUST 18 – 26, 2008

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-210 Issue 7 Annex 8	Pass
INDUSTRY CANADA RSS-GEN Issue 2	Pass

Compliance Certification Services, Inc. (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 CCS based on interpretations and/or observations of test results. 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 CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by CCS will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

Approved & Released For CCS By:

Tested By:



FRANK IBRAHIM
EMC SUPERVISOR
COMPLIANCE CERTIFICATION SERVICES

VIEN TRAN
EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

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 2, and RSS-210 Issue 7.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

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. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Power Line Conducted Emission	+/- 2.3 dB
Radiated Emission	+/- 3.4 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

Handheld Touch Screen IPOD Music Device with 802.11 b/g and Bluetooth radio functions. The radio module is manufactured by Komatsu Murata Manufacturing.

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	8.66	7.35
2402 - 2480	Enhanced 8PSK	10.34	10.81

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Ant. Gain: 1.5dBi
Ant. Type: IFA
Polarization: Linear

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 4.172 rc47.0, rev 4.172.47.0.

The EUT driver software installed in the host support equipment during testing was None UI 5.F83 Diagnostic

The test utility software used during testing was WL Tool.exe

5.5. WORST-CASE CONFIGURATIONS

The worst-case data rate for each mode is determined to be as follows, based on input from the manufacturer of the radio:

All final tests in the GFSK mode were made at 1 Mb/s.
All final tests in the 8PSK mode were made at 3 Mb/s.

For radiated emissions below 1 GHz, the channel with highest power was used; this was determined to be Low Channel for EDR mode, at a data rate of 3 Mbps.

Three orthogonal orientations were investigated, it was determined that X orientation was worst-case; therefore, all final tests were performed with EUT in the X orientation.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST			
Description	Manufacturer	Model	Serial Number
Bluetooth Tester	Rohde & Schwarz	1153.9000K35	12/17/2174
Laptop	Apple	A1181	AOU253727
AC Adapter	Dongguan Samsung	A1184	611-0565
AC Adapter	Flextronics	A1265	1X8100000185

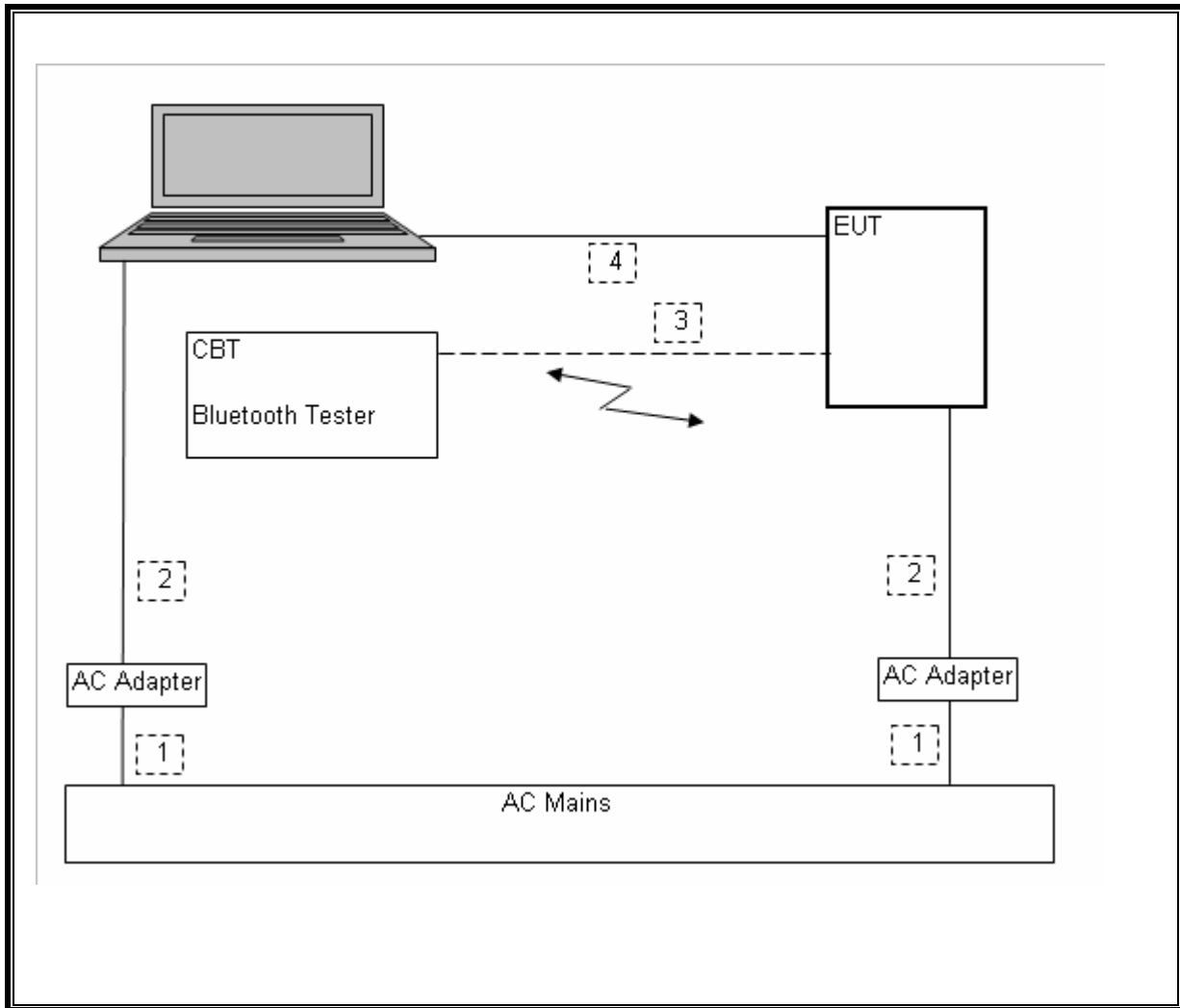
I/O CABLES

I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	2	US115	Shielded	2m	N/A
2	DC	2	DC	Un-shielded	2m	N/A
3	USB	1	USB	Shielded	.40m	N/A
4	SMA	1	SMA	Shielded	.80m	N/A

TEST SETUP

The EUT is linked to Bluetooth tester to set up channel, test mode, & modulation. It also is connected to a host laptop computer via USB cable to turn on EUT during the tests. Test software exercised the radio card.

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
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C00996	09/11/07	09/11/08
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	08/03/07	09/27/08
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4407B	C01098	08/06/07	11/09/08
Peak Power Meter	Agilent / HP	E4416A	C00963	02/14/08	12/02/09
Peak / Average Power Sensor	Agilent	E9327A	C00964	02/14/08	12/02/09
Antenna, Horn, 18 GHz	ETS	3117	C01005	04/15/08	04/15/09
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	08/03/07	09/27/08
Preamplifier, .1 - 1300MHz GHz	Agilent / HP	8447D	C00750	05/09/07	05/09/09
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	09/29/08	09/29/08
Antenna Horn, 26.5 GHz	ARA	SWH-28	C01011	01/03/07	10/03/08

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.

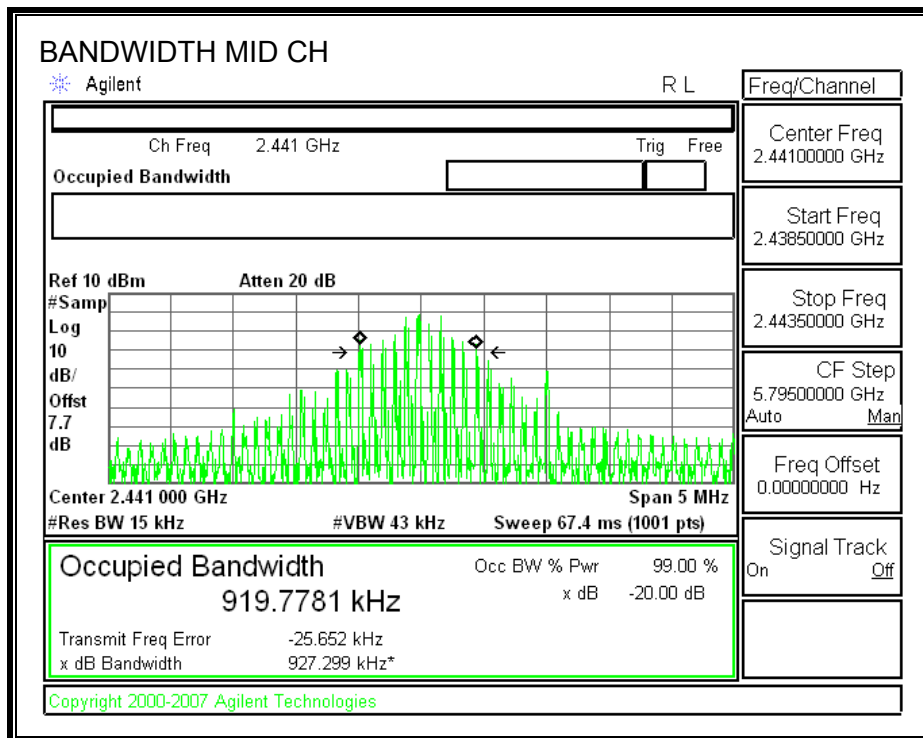
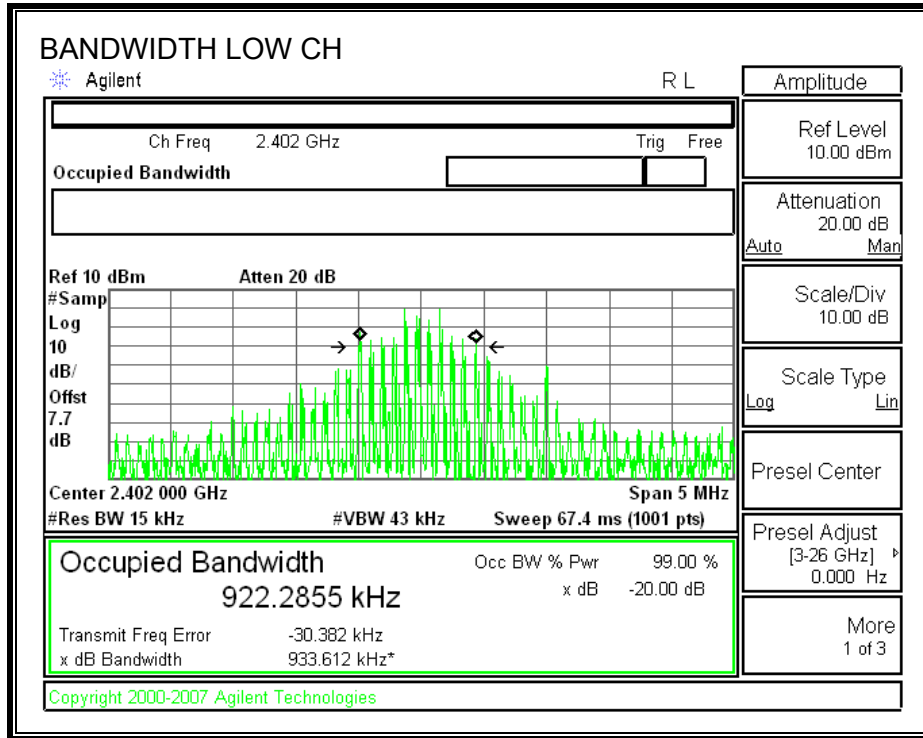
TEST PROCEDURE

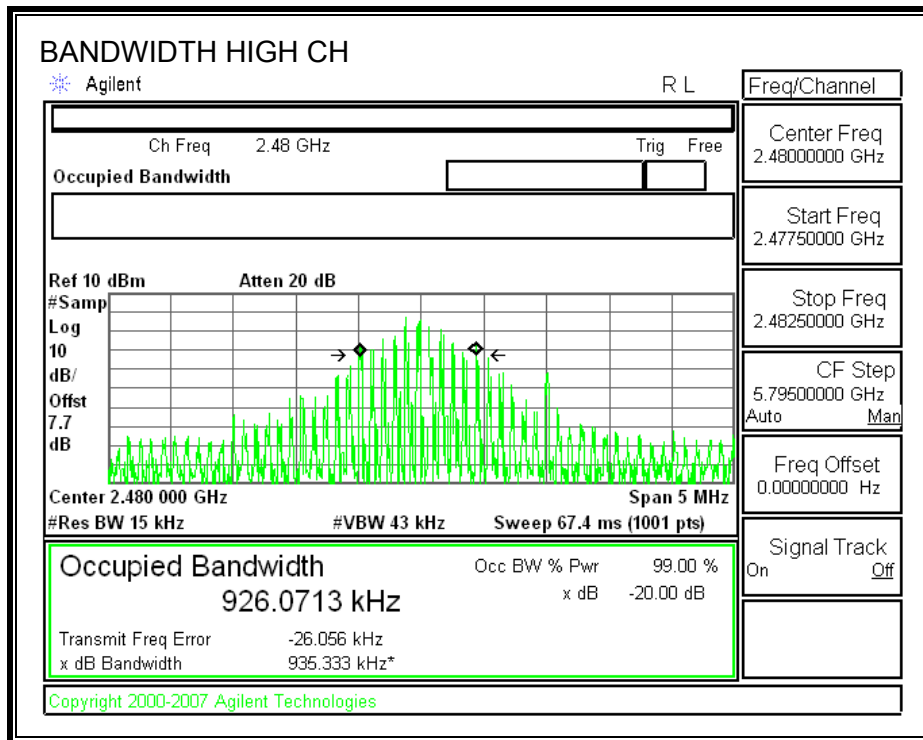
The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to \geq RBW. The sweep time is coupled.

RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	933.612	922.2855
Middle	2441	927.299	919.7781
High	2480	935.333	926.0713

20 dB AND 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 hopping channel, whichever is greater.

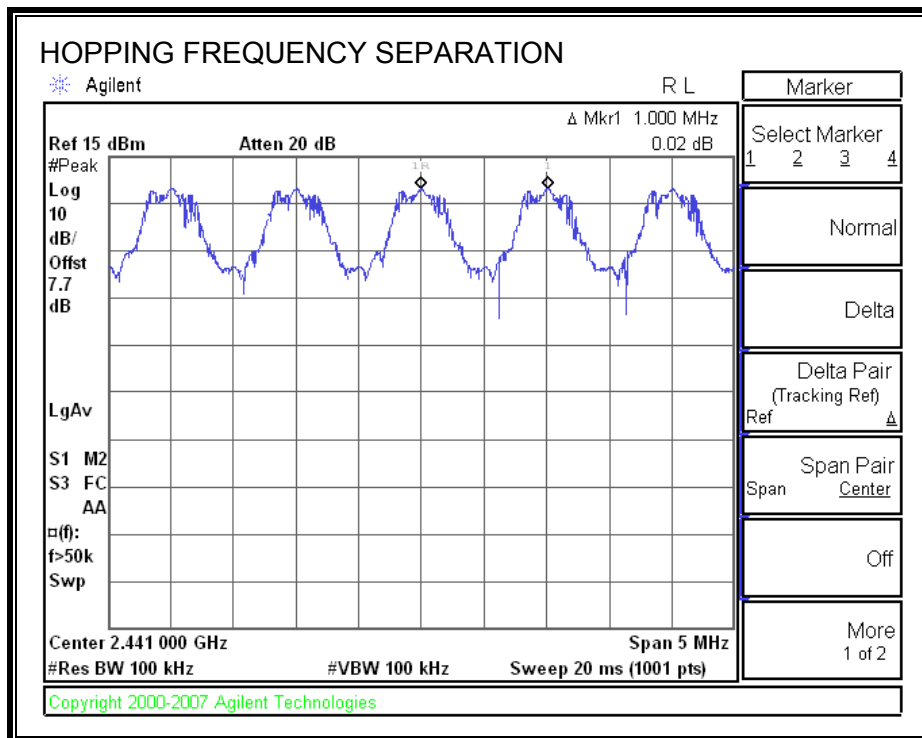
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

TEST PROCEDURE

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

RESULTS

HOPPING FREQUENCY SEPARATION



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.

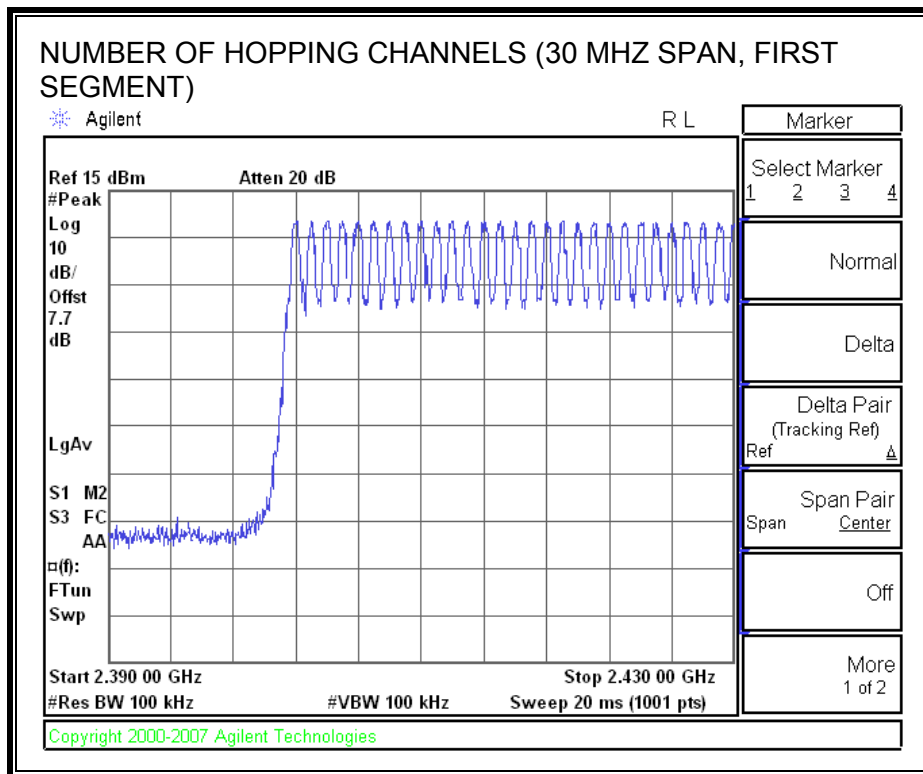
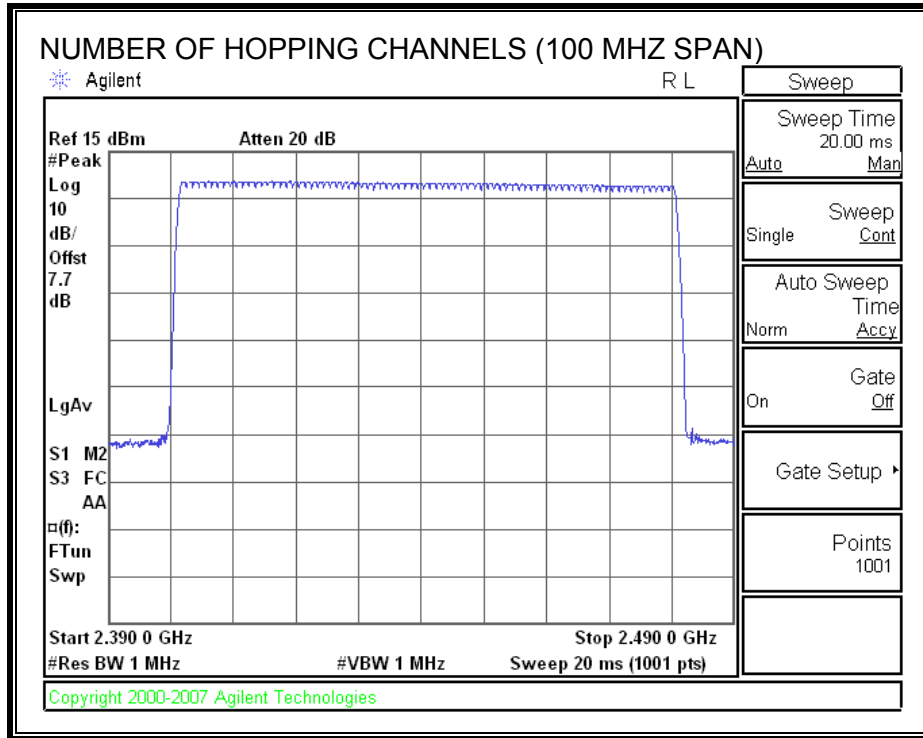
TEST PROCEDURE

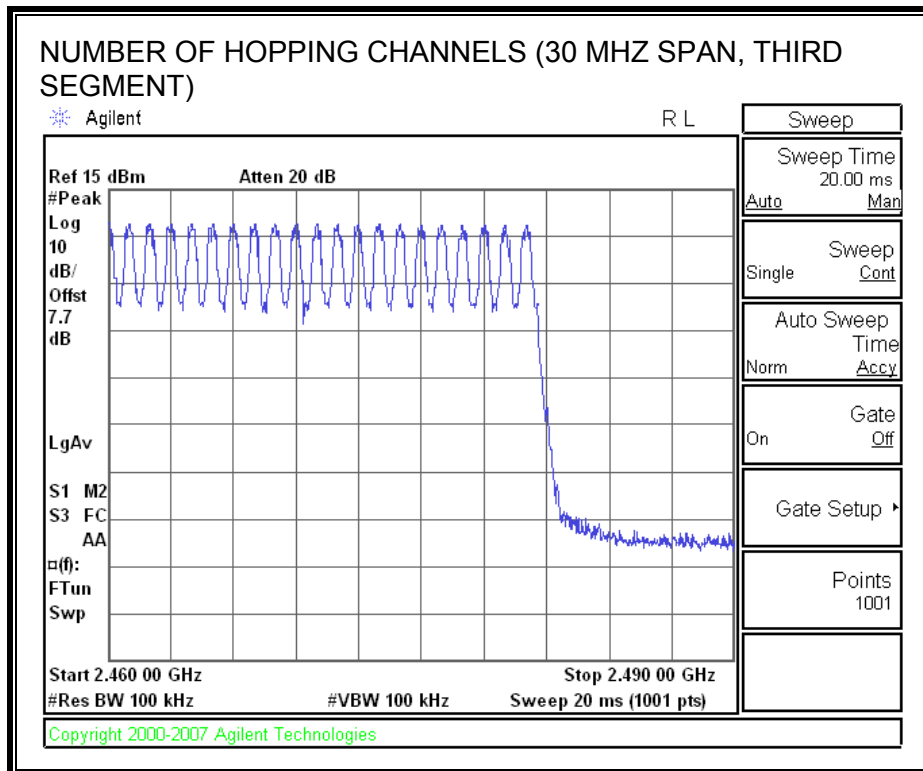
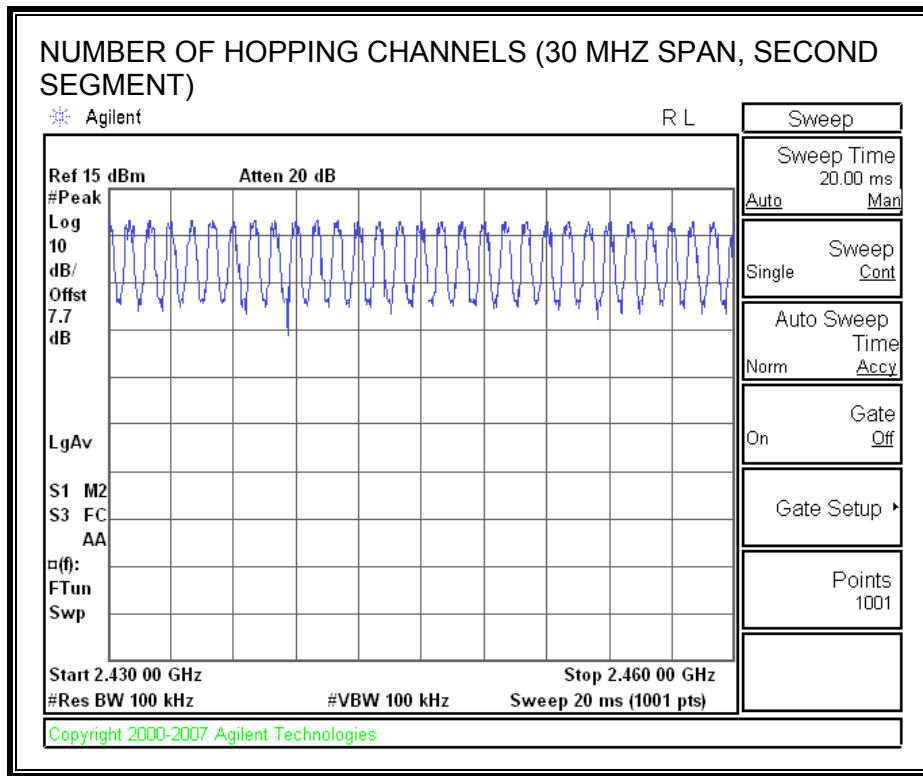
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

79 Channels observed.

NUMBER OF HOPPING CHANNELS





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.

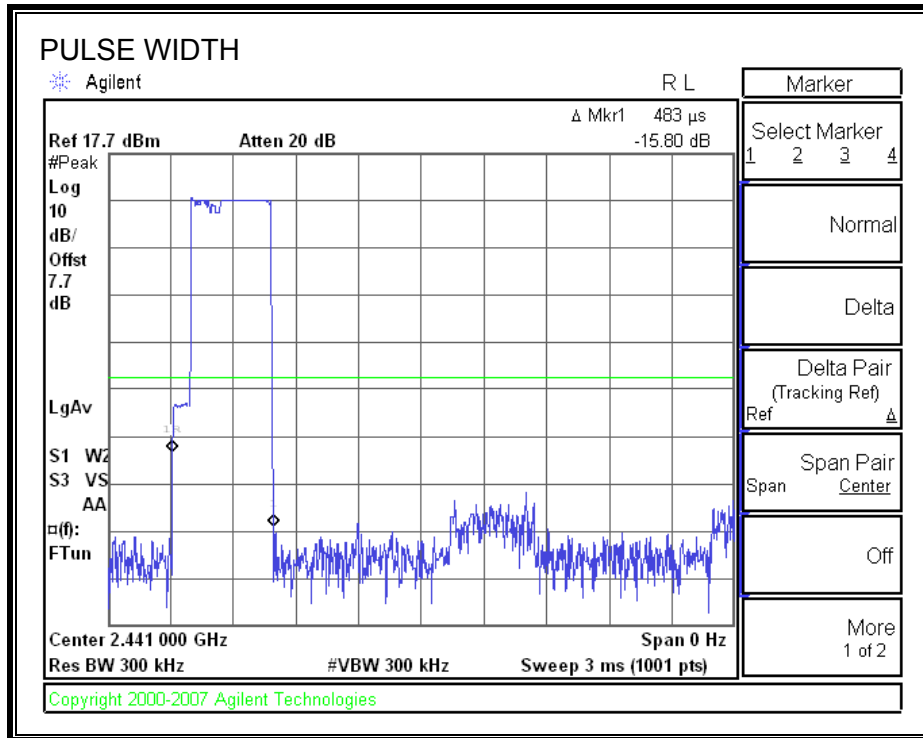
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$.

RESULTS

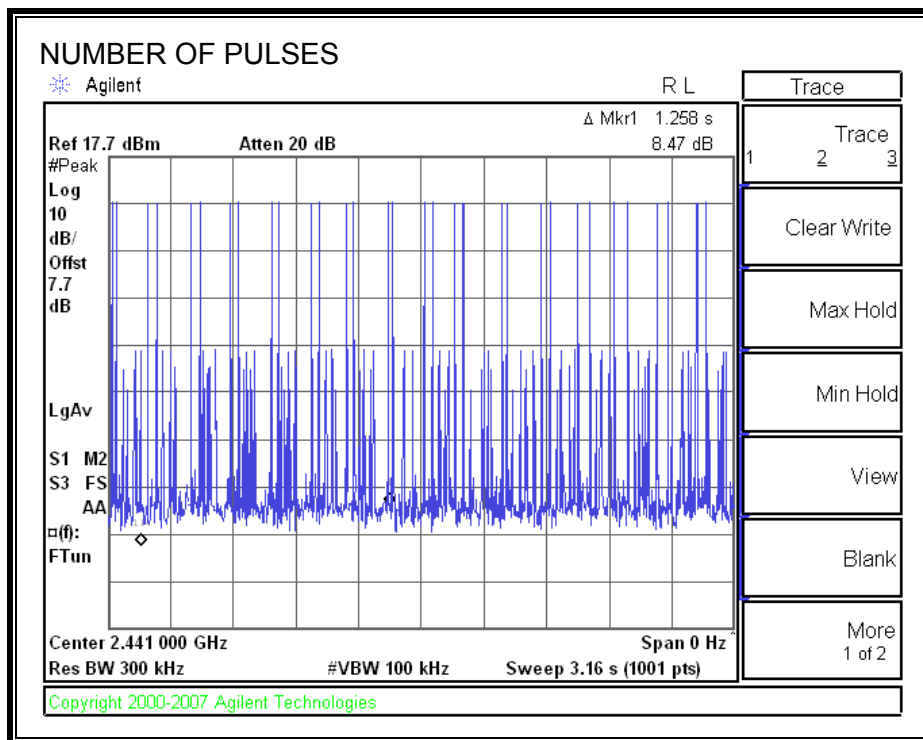
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
DH1	0.483	35	0.169	0.4	-0.231
DH3	1.737	15	0.261	0.4	-0.139
DH5	2.98	10	0.298	0.4	-0.102

DH1

PULSE WIDTH

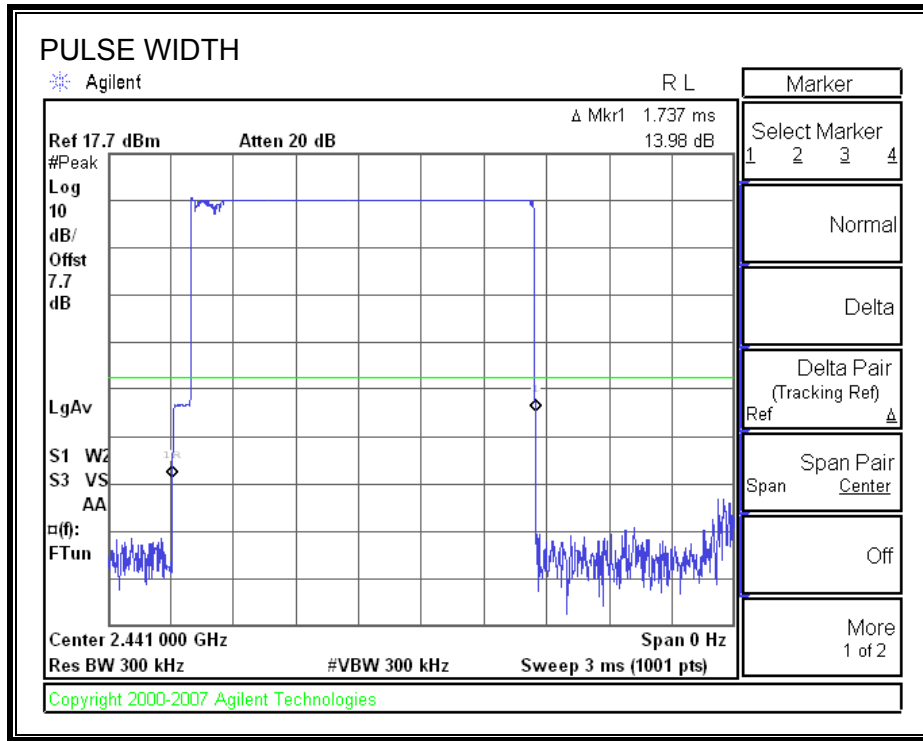


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

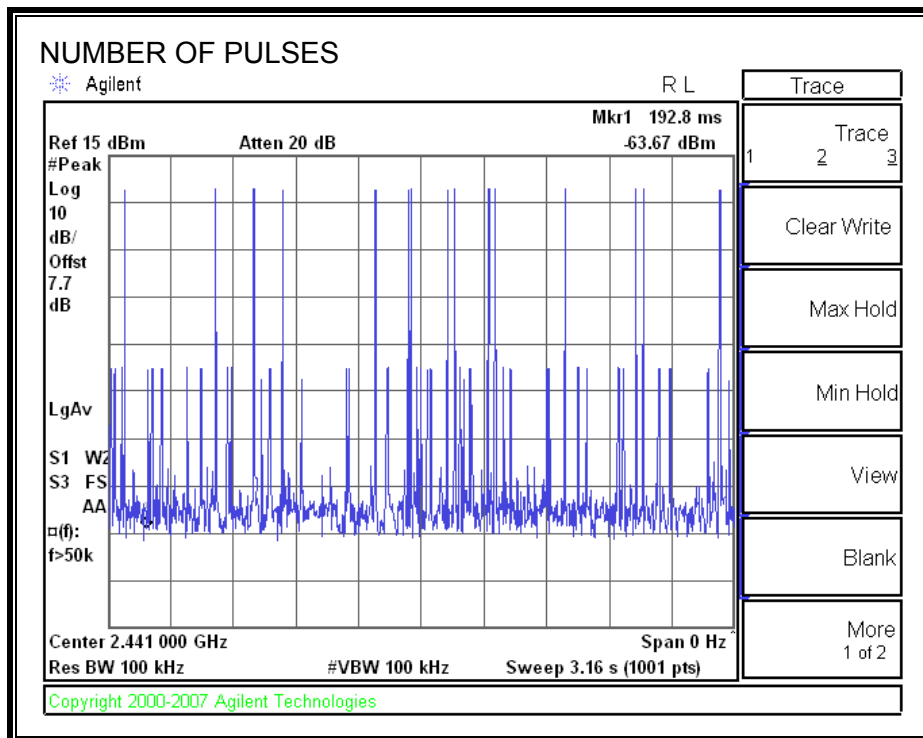


DH3

PULSE WIDTH

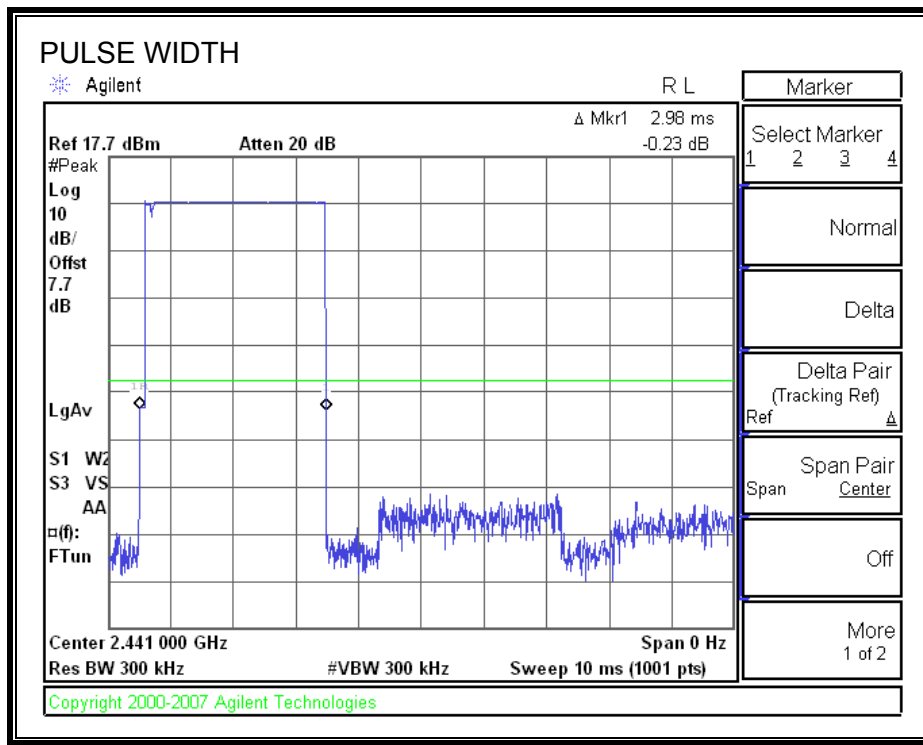


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

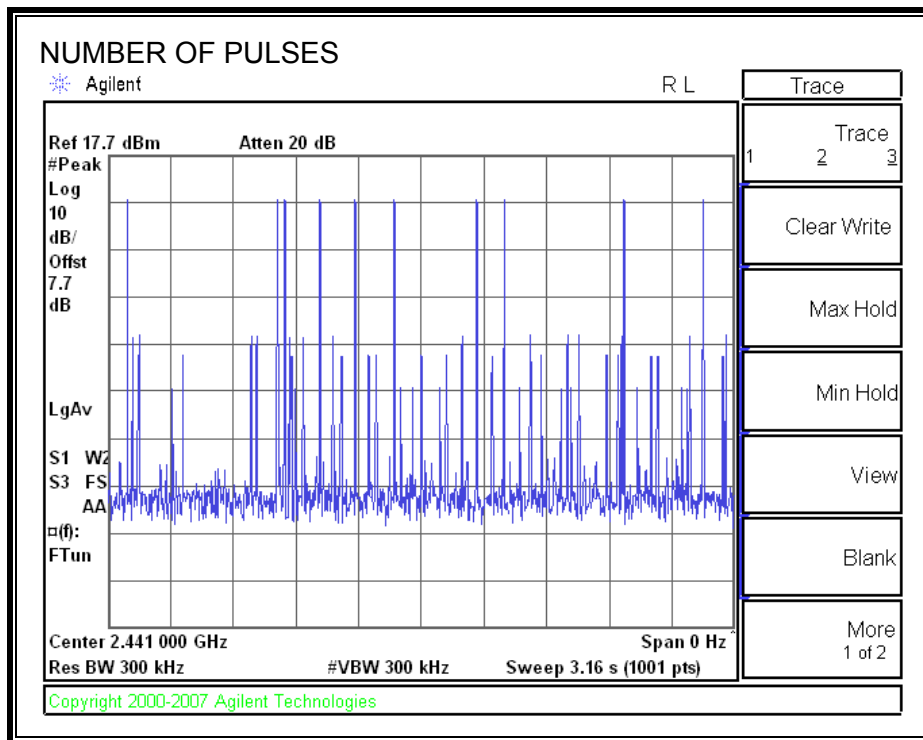


DH5

PULSE WIDTH



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.

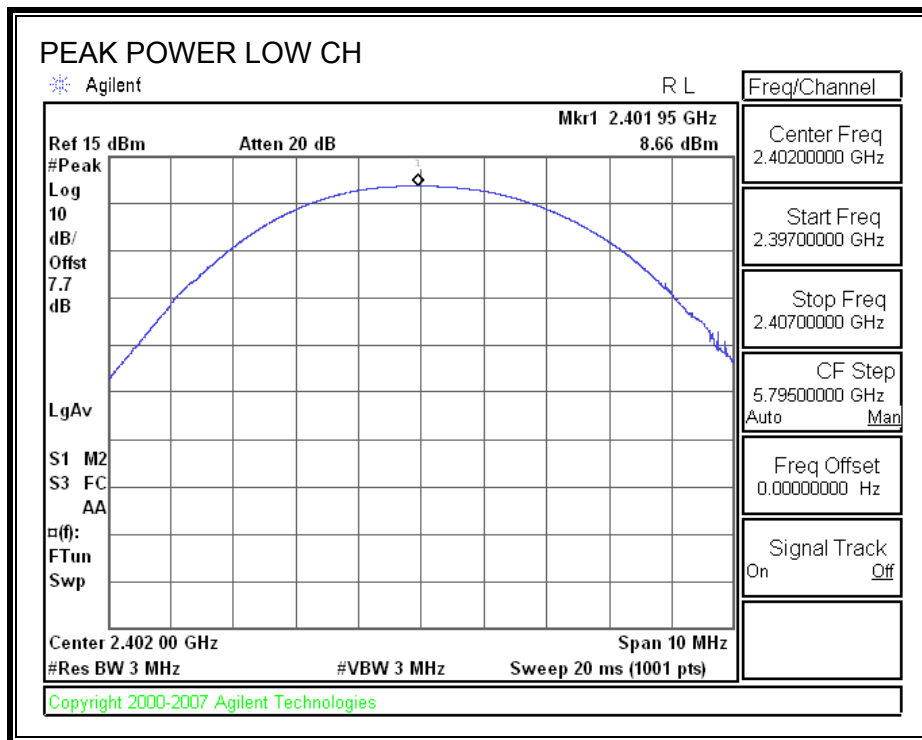
TEST PROCEDURE

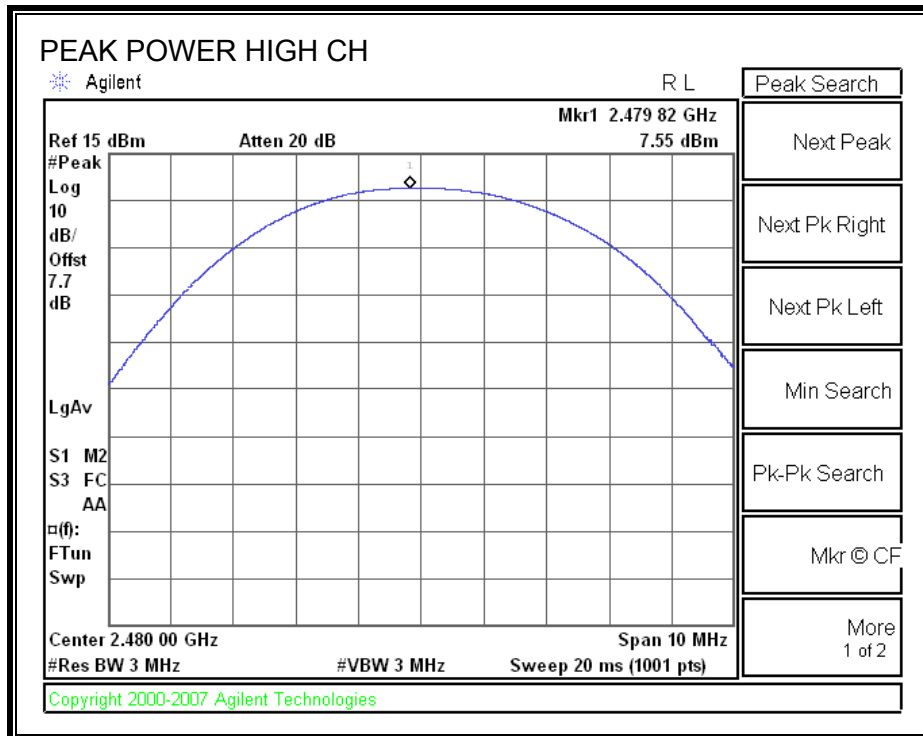
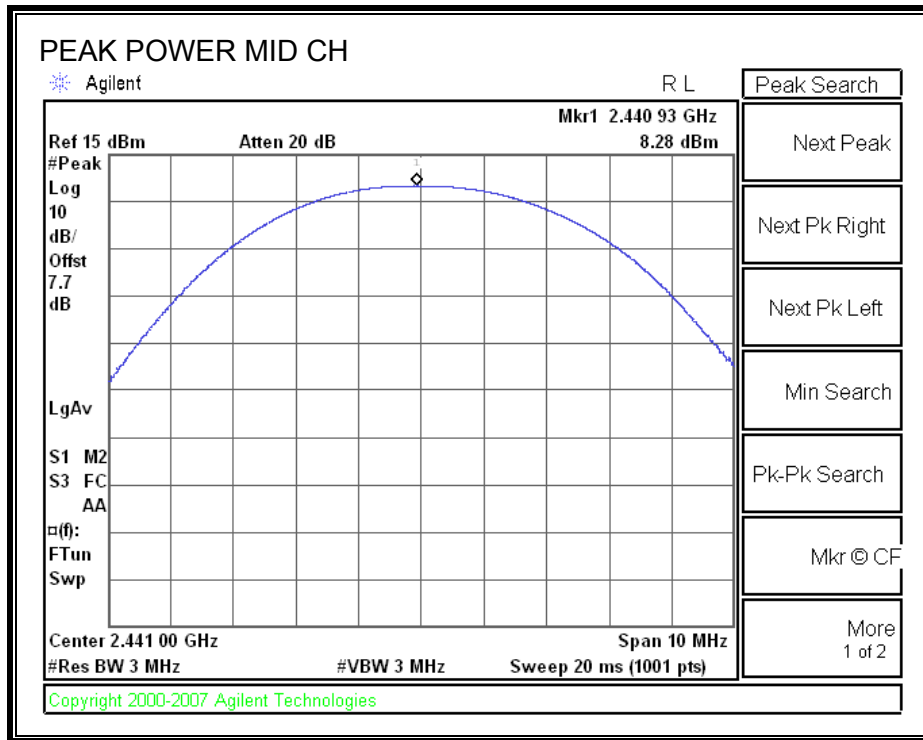
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	8.66	30	-21.34
Middle	2441	8.28	30	-21.72
High	2480	7.55	30	-22.45

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 7.7dB (including 6 dB pad and 1.7dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.03
Middle	2441	7.70
High	2480	6.94

7.1.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

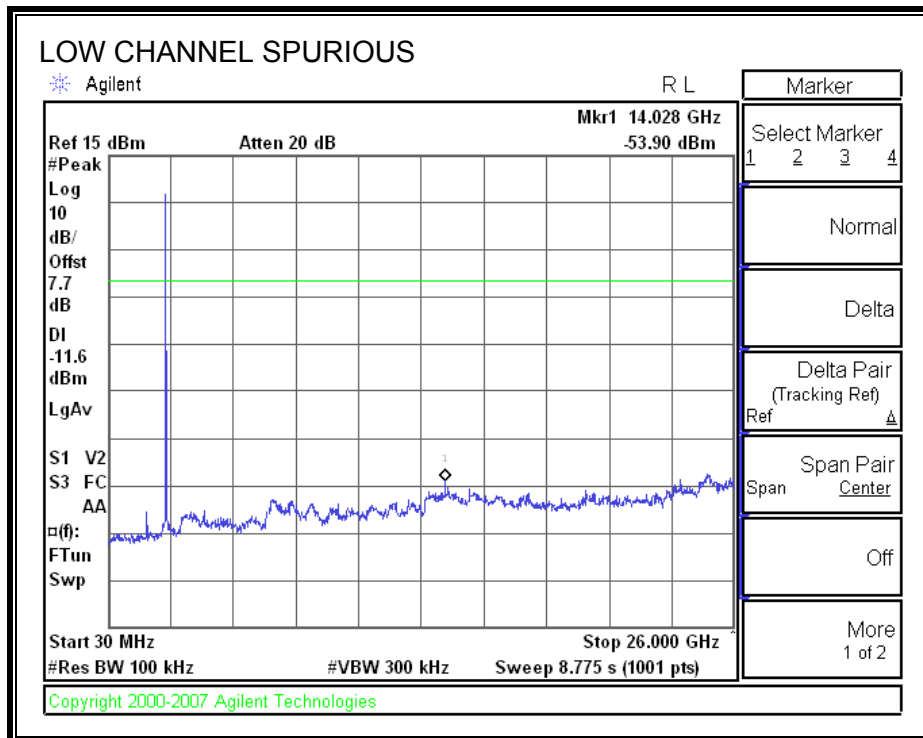
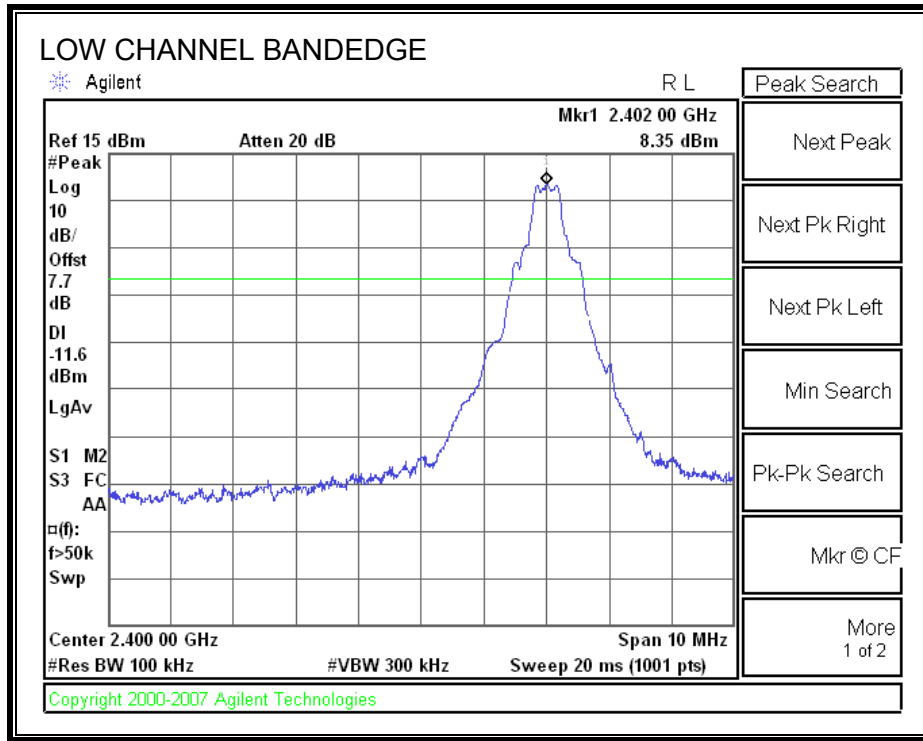
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

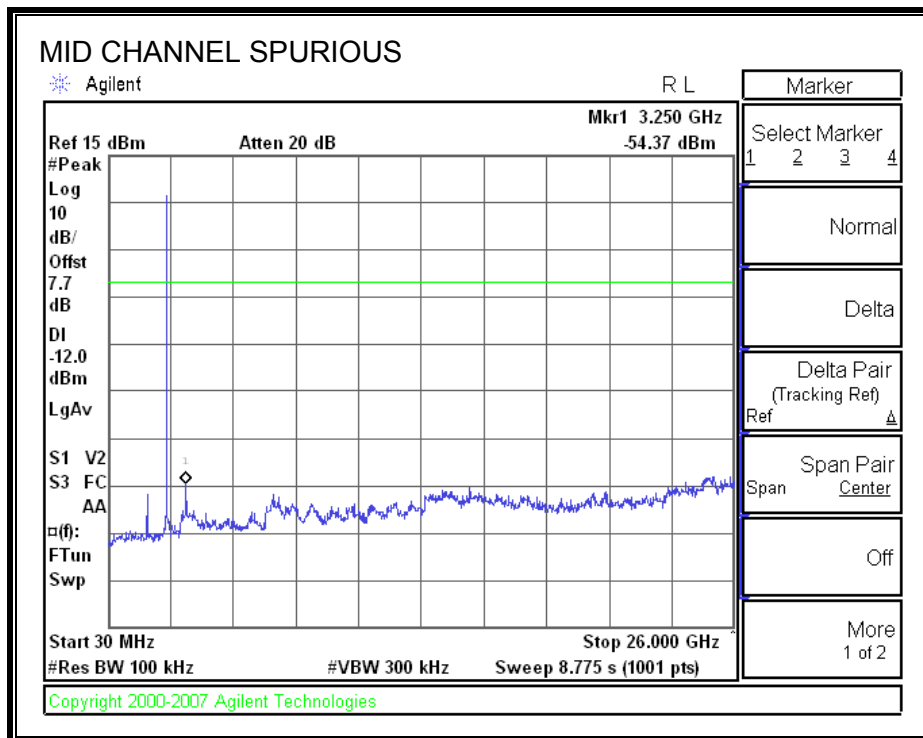
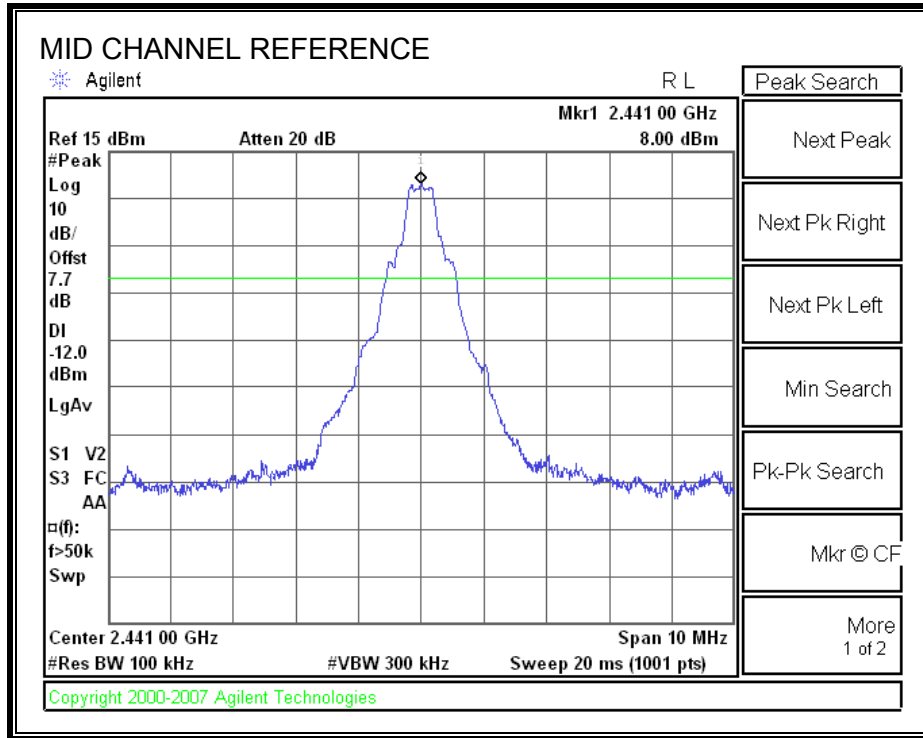
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

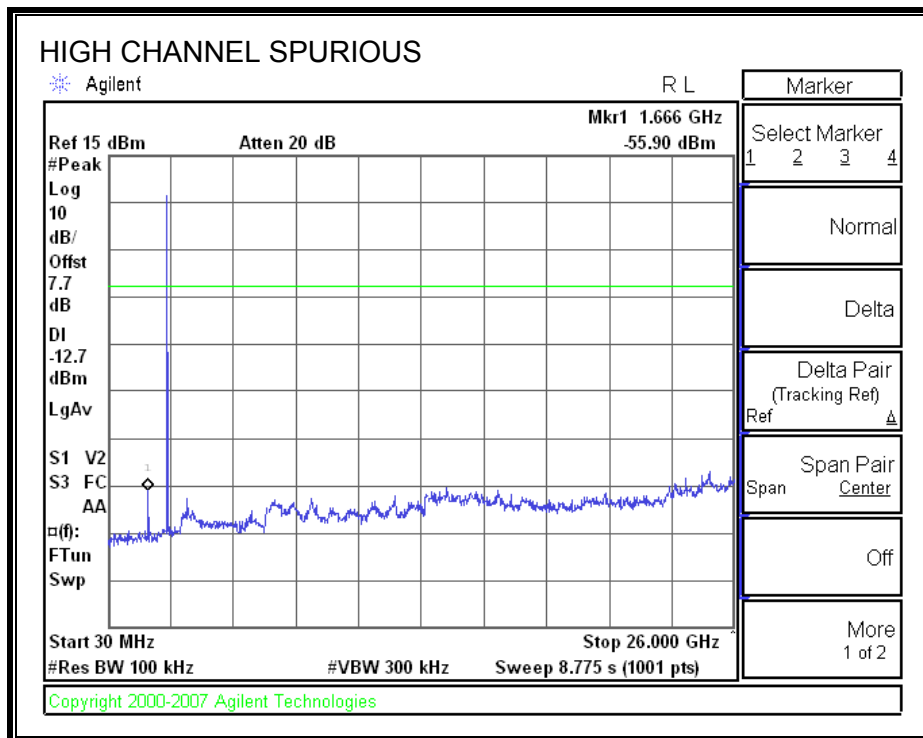
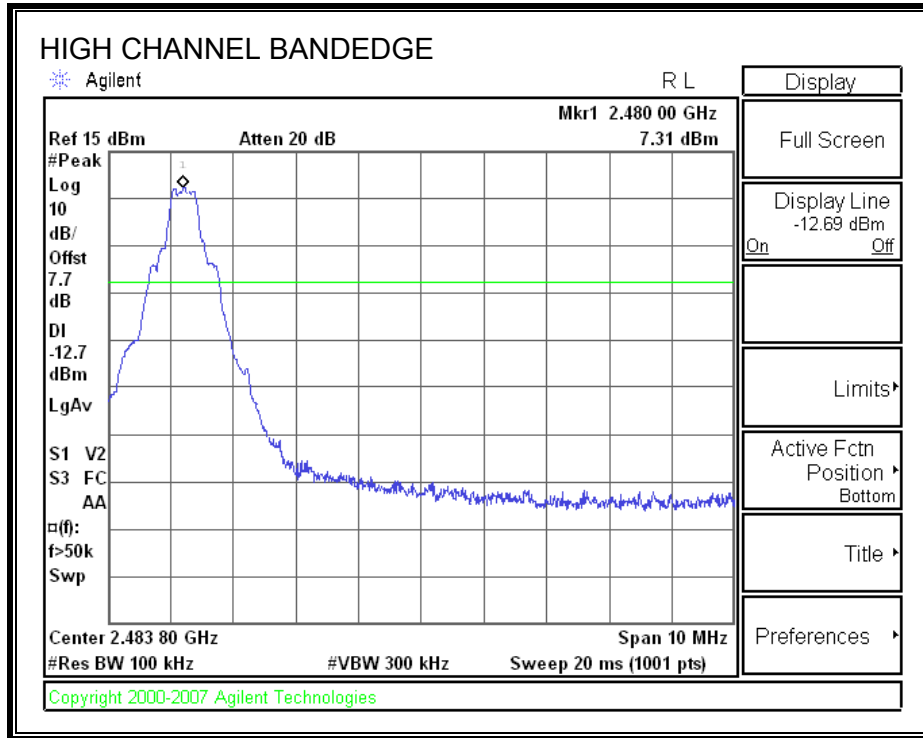
SPURIOUS EMISSIONS, LOW CHANNEL



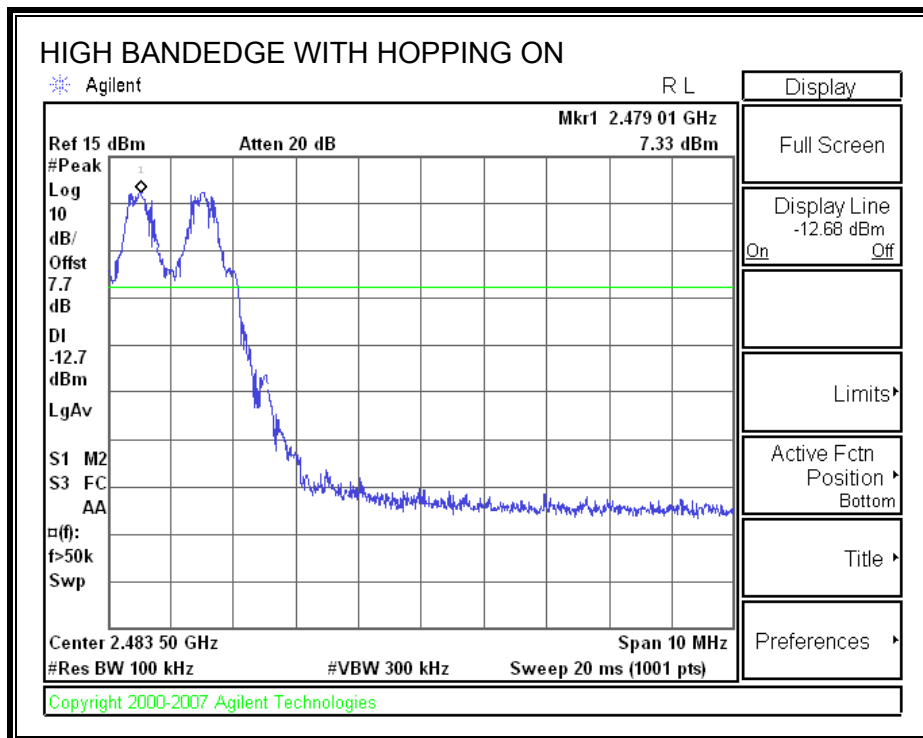
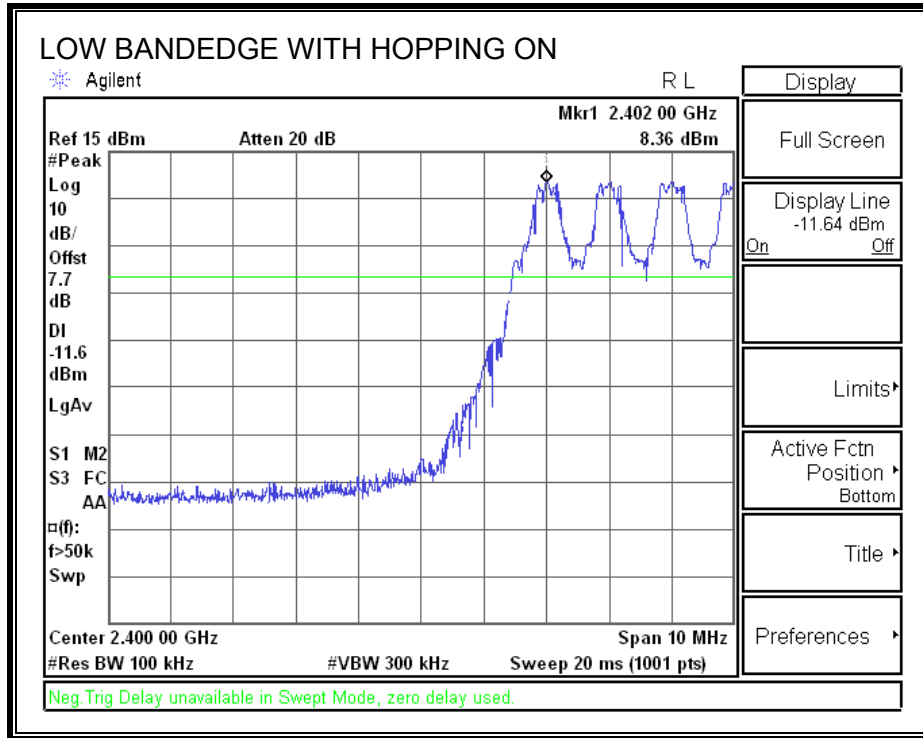
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



7.2. ENHANCED DATA RATE 8PSK MODULATION

7.2.1. 20 dB AND 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

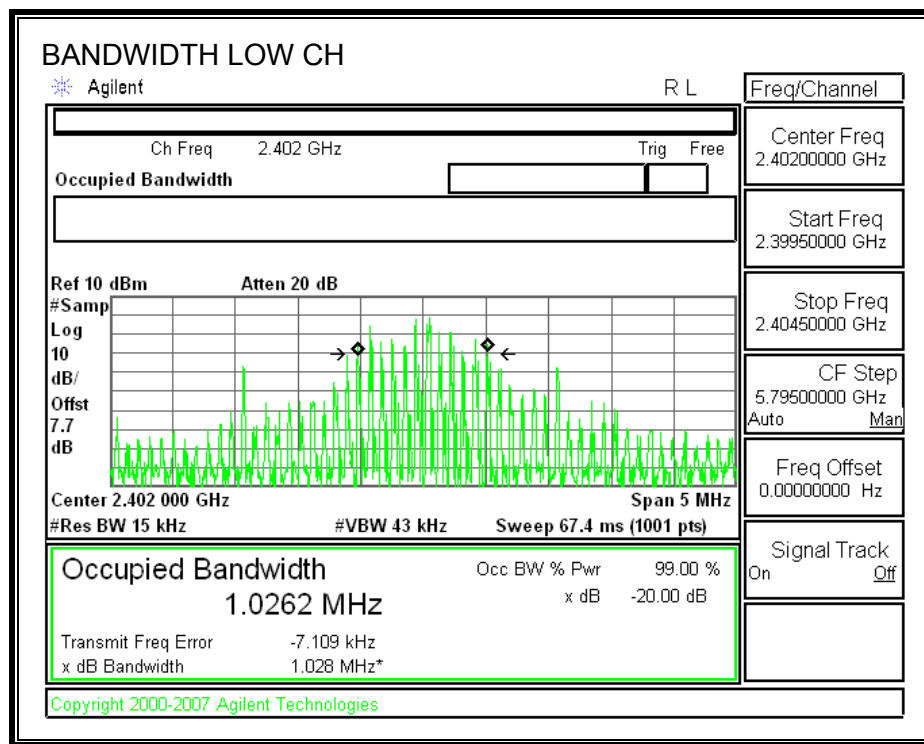
TEST PROCEDURE

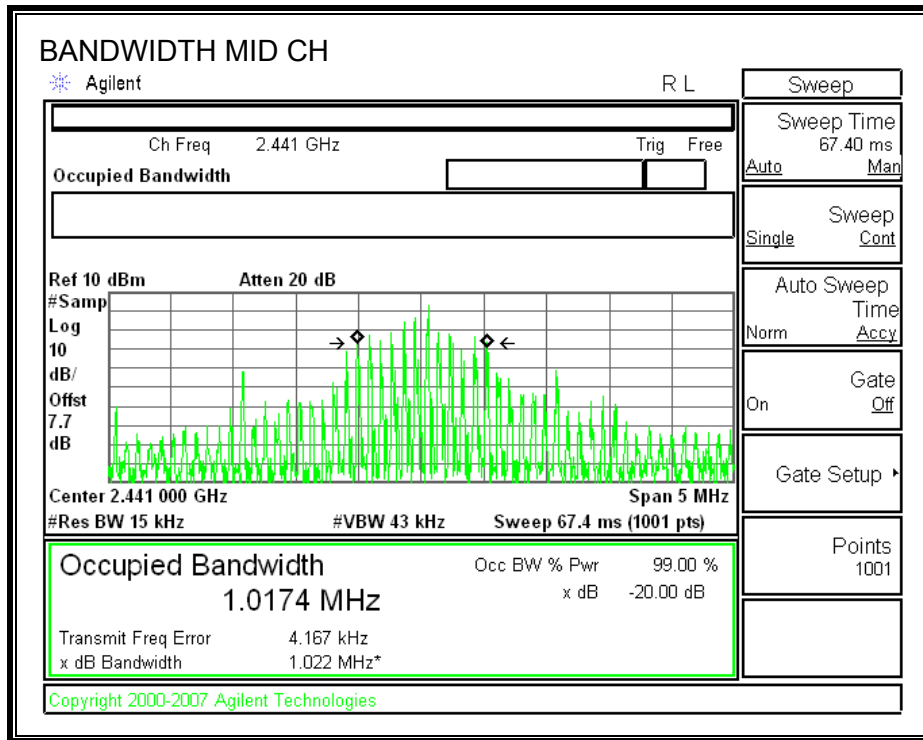
The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to \geq RBW. The sweep time is coupled.

RESULTS

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Low	2402	1.028	1.0262
Middle	2441	1.022	1.0174
High	2480	1.026	1.0199

20 dB AND 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 hopping channel, whichever is greater.

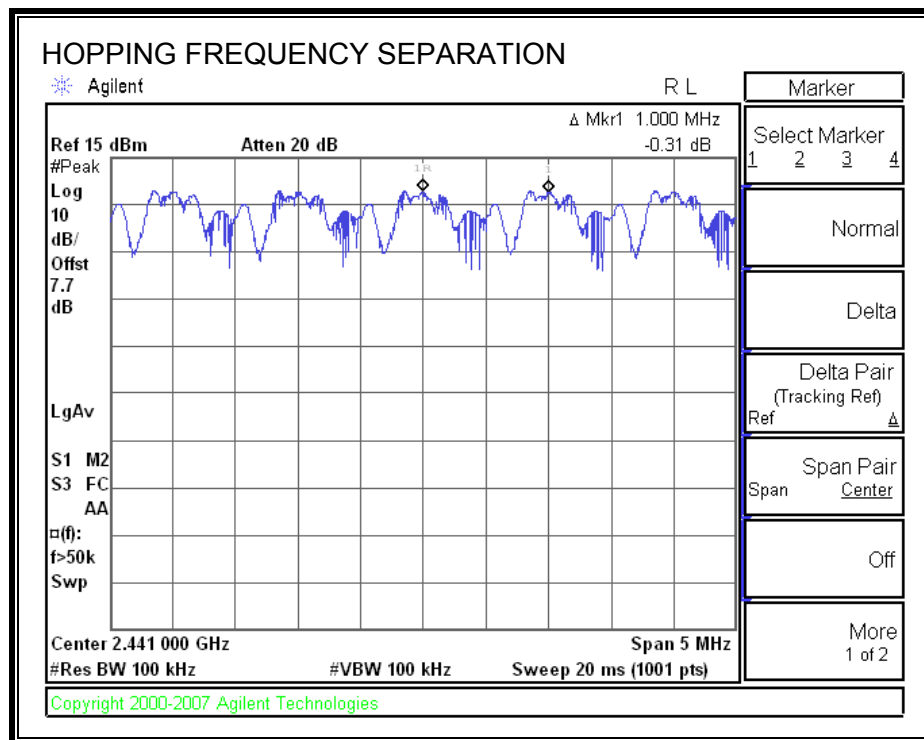
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

TEST PROCEDURE

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

RESULTS

HOPPING FREQUENCY SEPARATION



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.

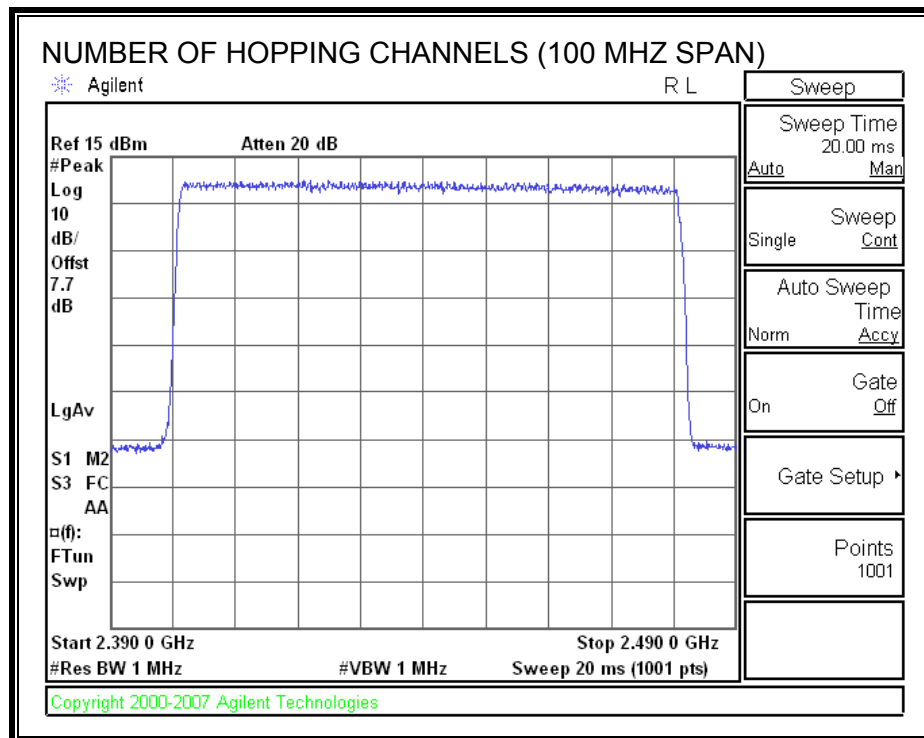
TEST PROCEDURE

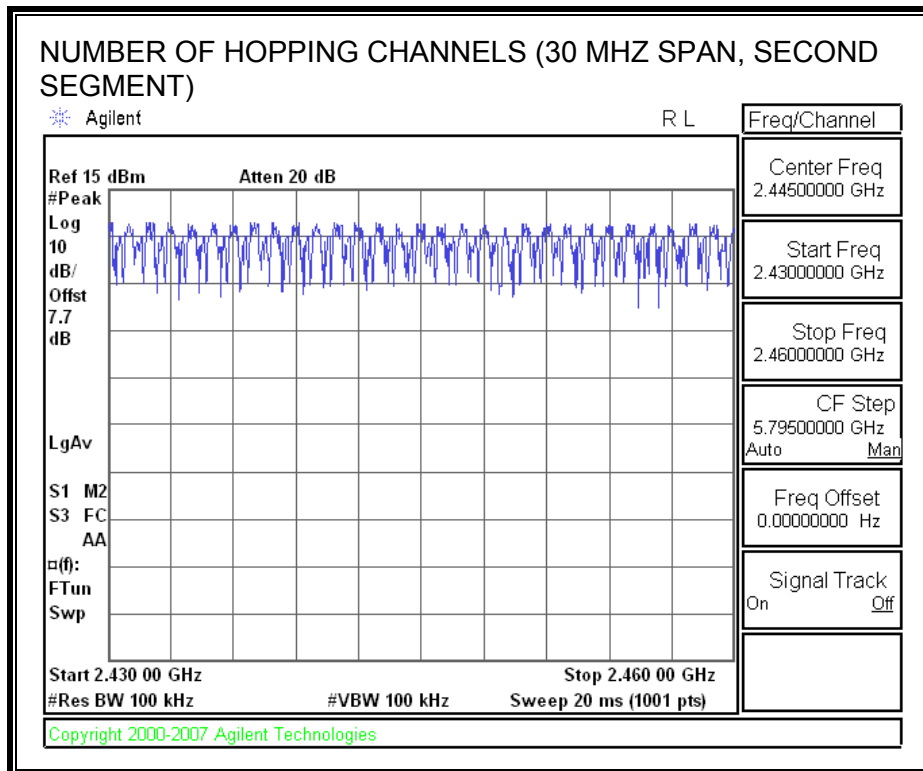
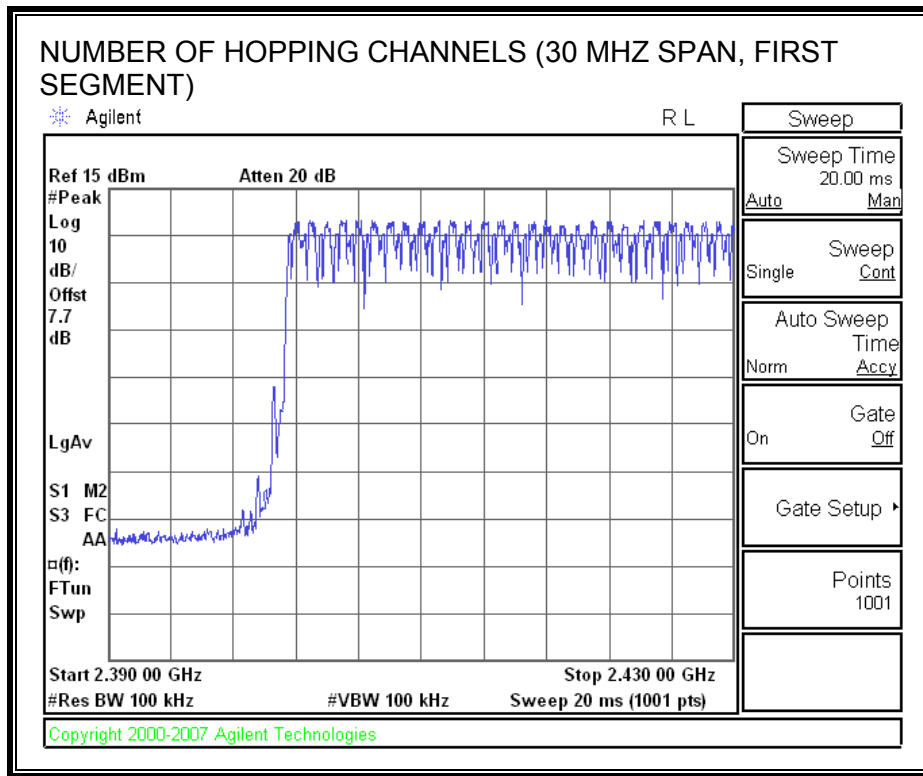
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

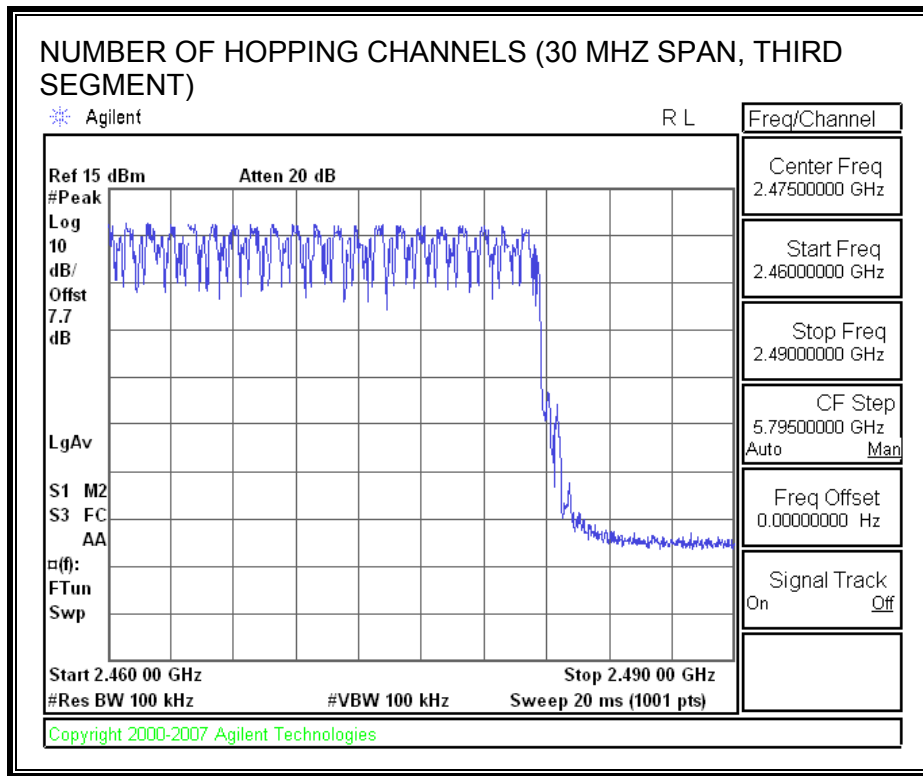
RESULTS

79 Channels observed.

NUMBER OF HOPPING CHANNELS







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.

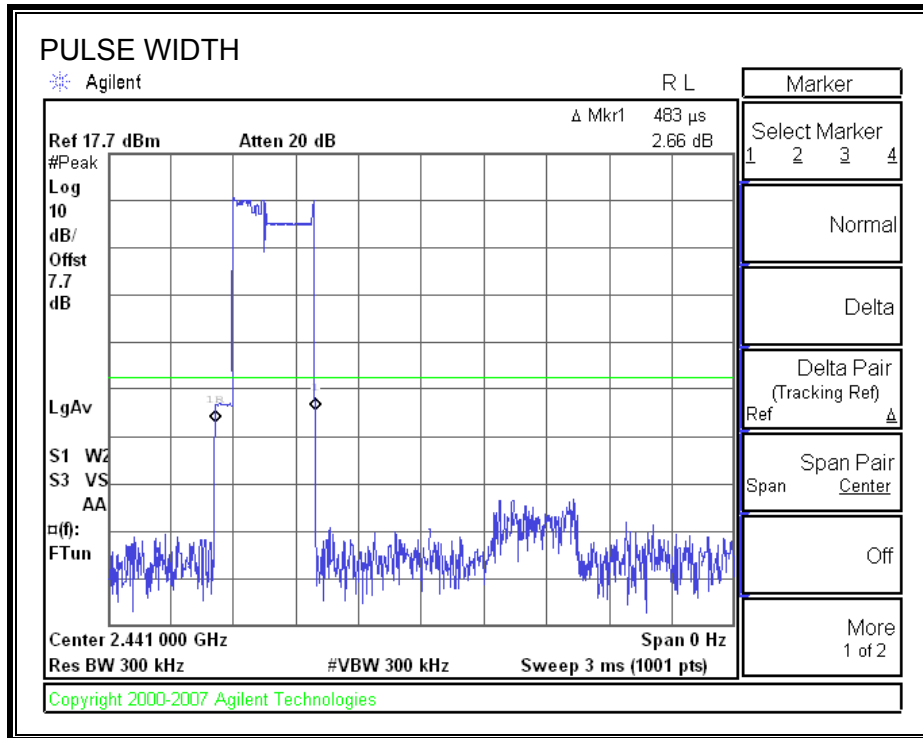
The average time of occupancy in the specified 31.6 second period (79 channels * 0.4 s) is equal to $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$.

RESULTS

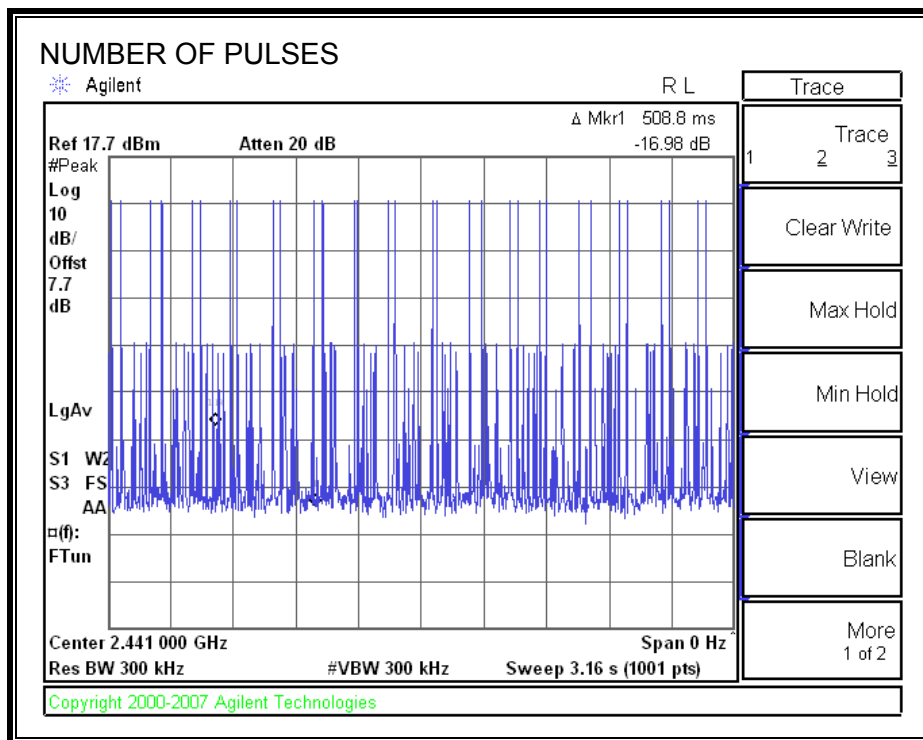
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of (sec)	Limit (sec)	Margin (sec)
DH1	0.483	31	0.150	0.4	-0.250
DH3	1.75	13	0.228	0.4	-0.173
DH5	2.998	11	0.330	0.4	-0.070

3DH1

PULSE WIDTH

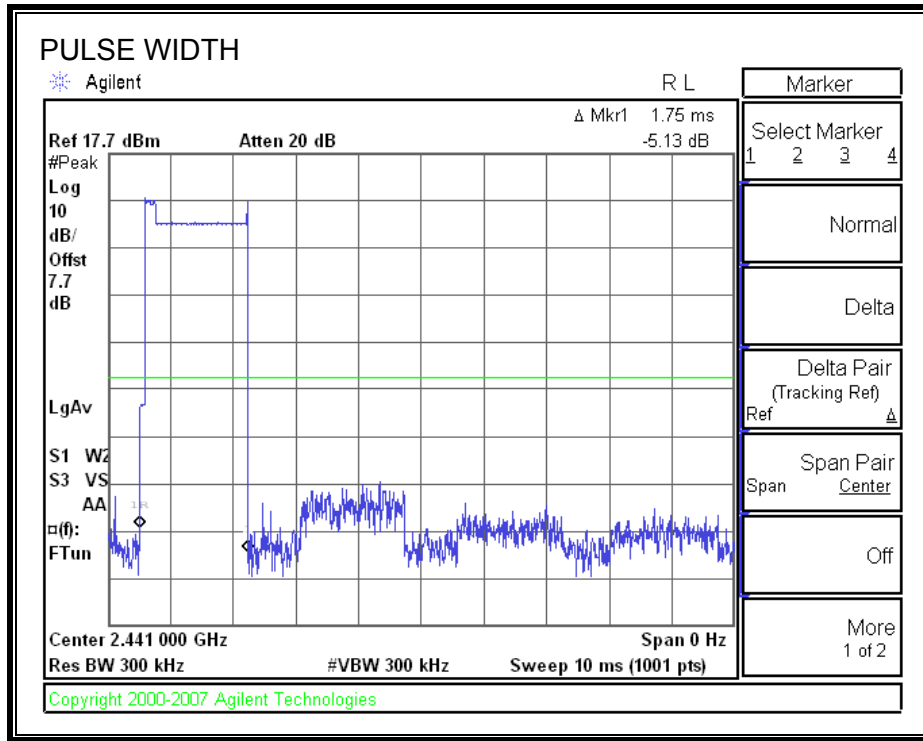


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

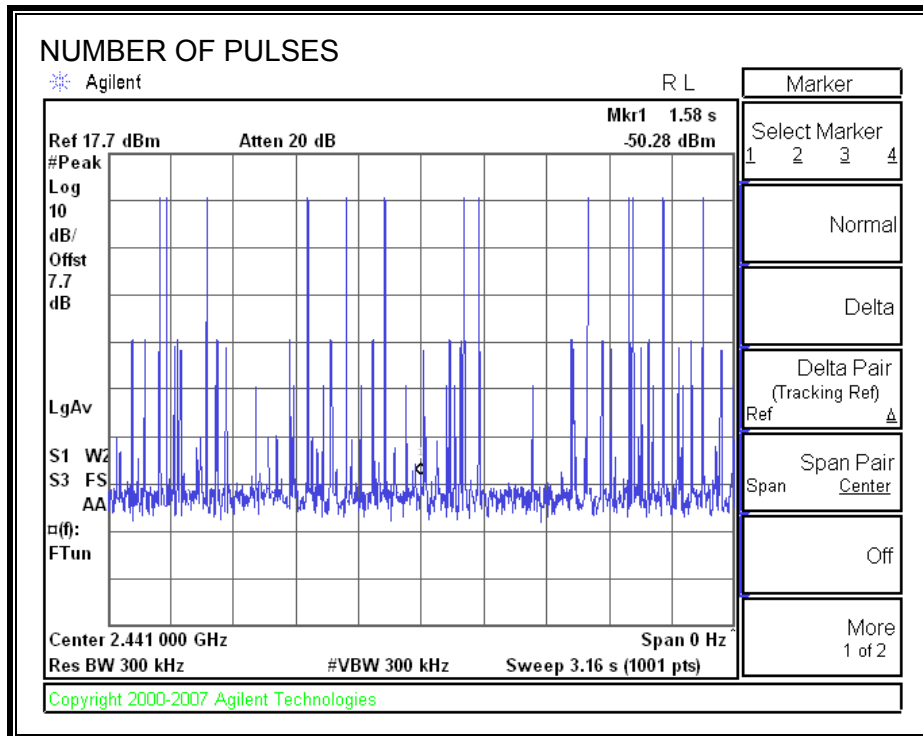


3DH3

PULSE WIDTH

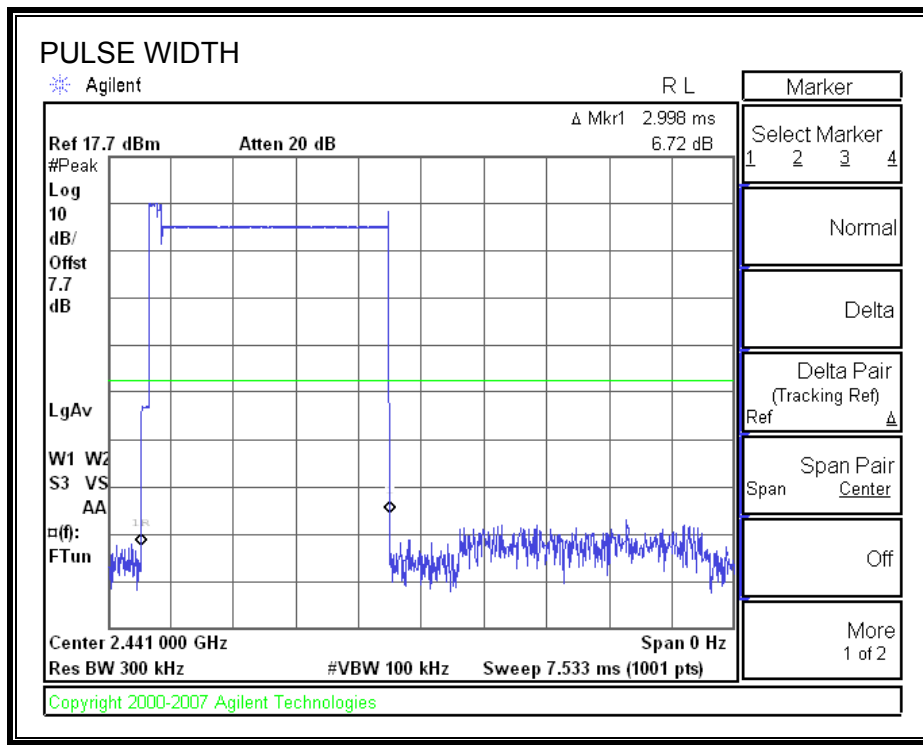


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD

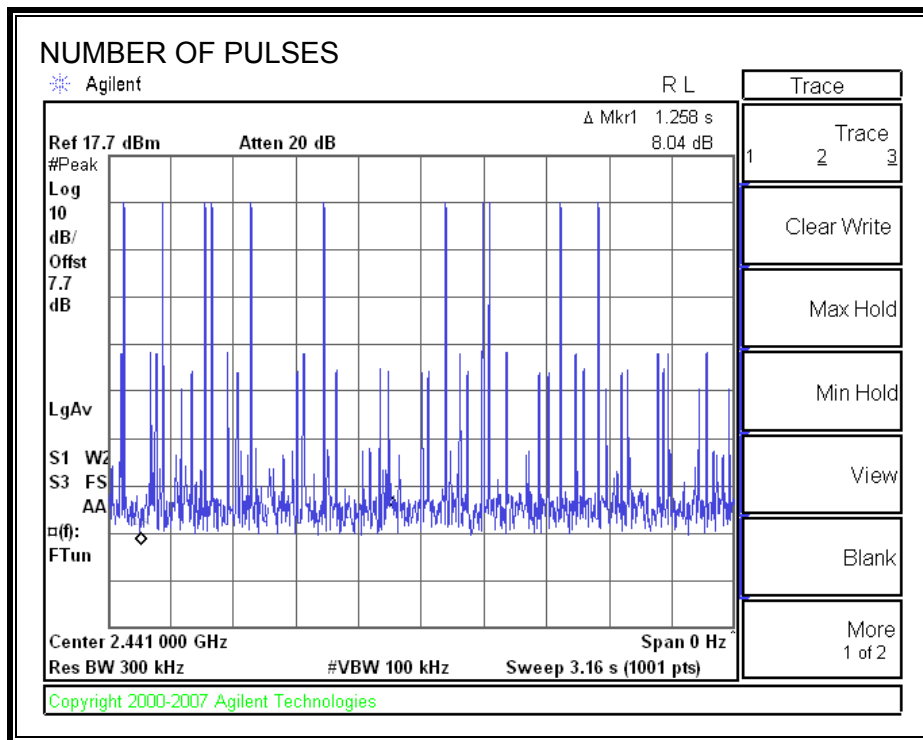


3DH5

PULSE WIDTH



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD



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 30 dBm.

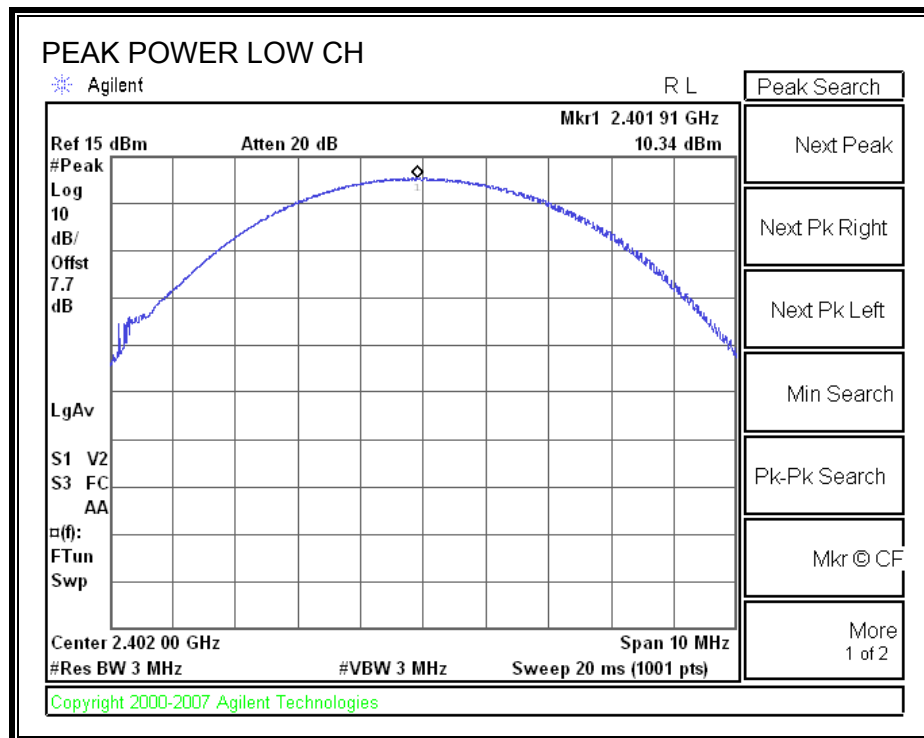
TEST PROCEDURE

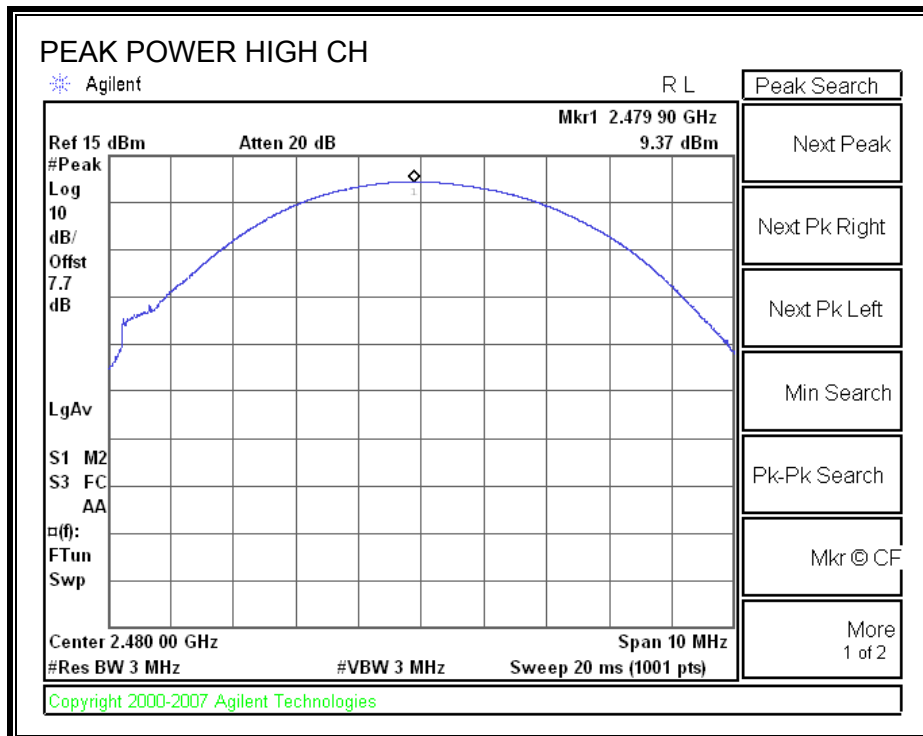
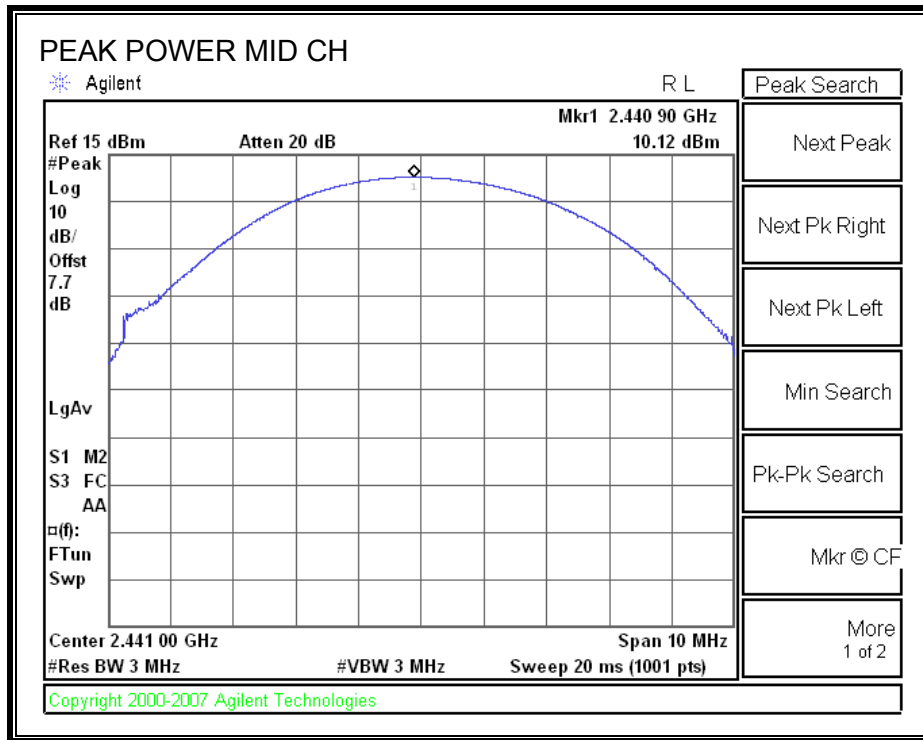
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

RESULTS

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	10.34	30	-19.66
Middle	2441	10.12	30	-19.88
High	2480	9.37	30	-20.63

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 7.7dB (including 6dB pad and 1.7 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	8.00
Middle	2441	7.68
High	2480	6.83

7.2.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Limit = -20 dBc

TEST PROCEDURE

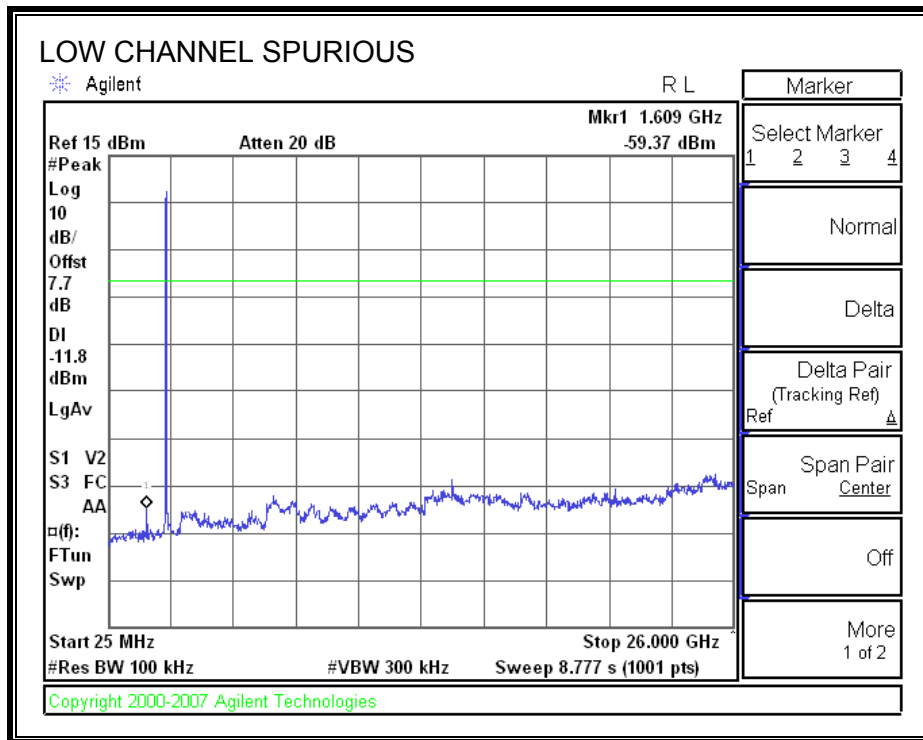
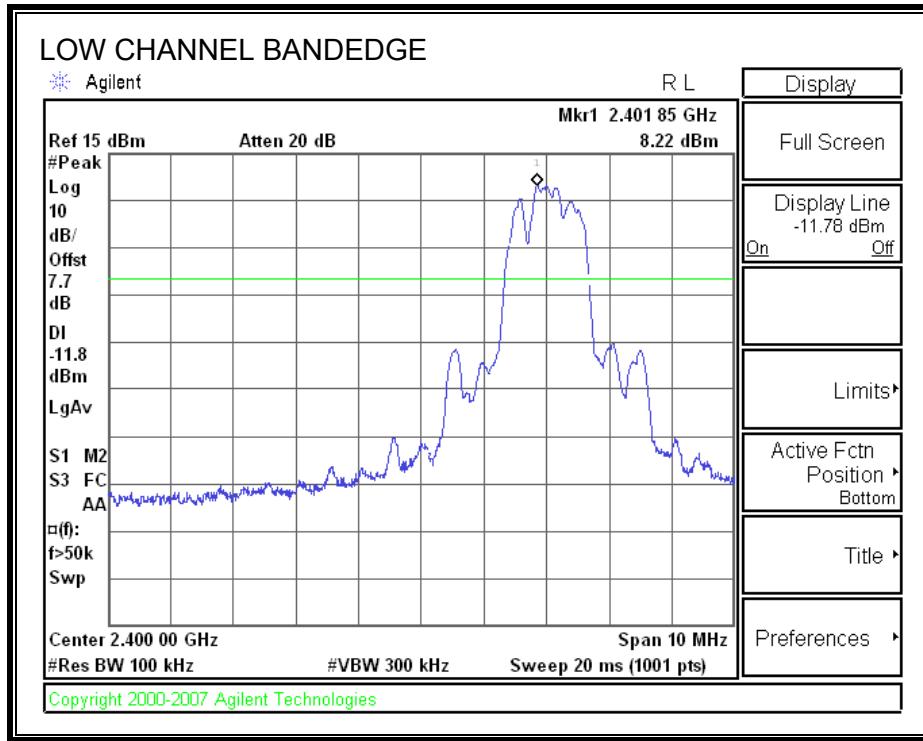
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

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

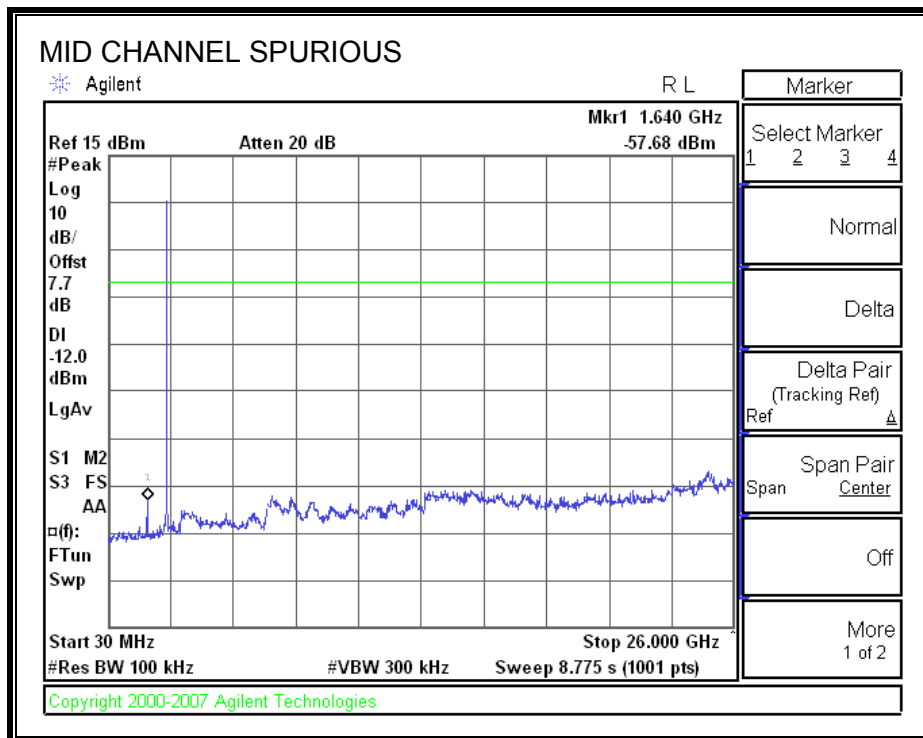
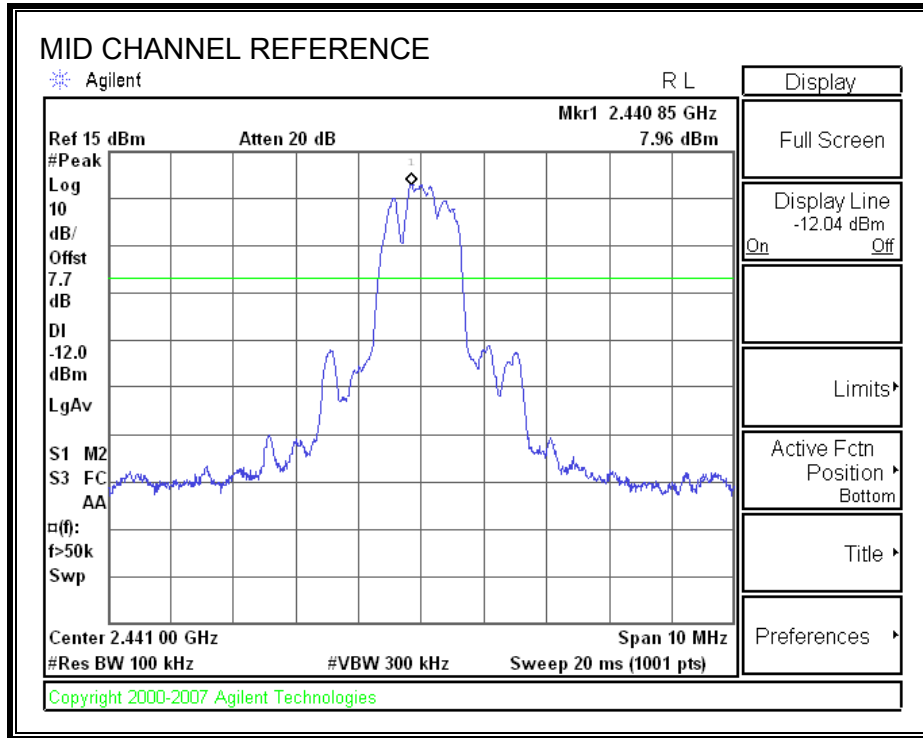
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

RESULTS

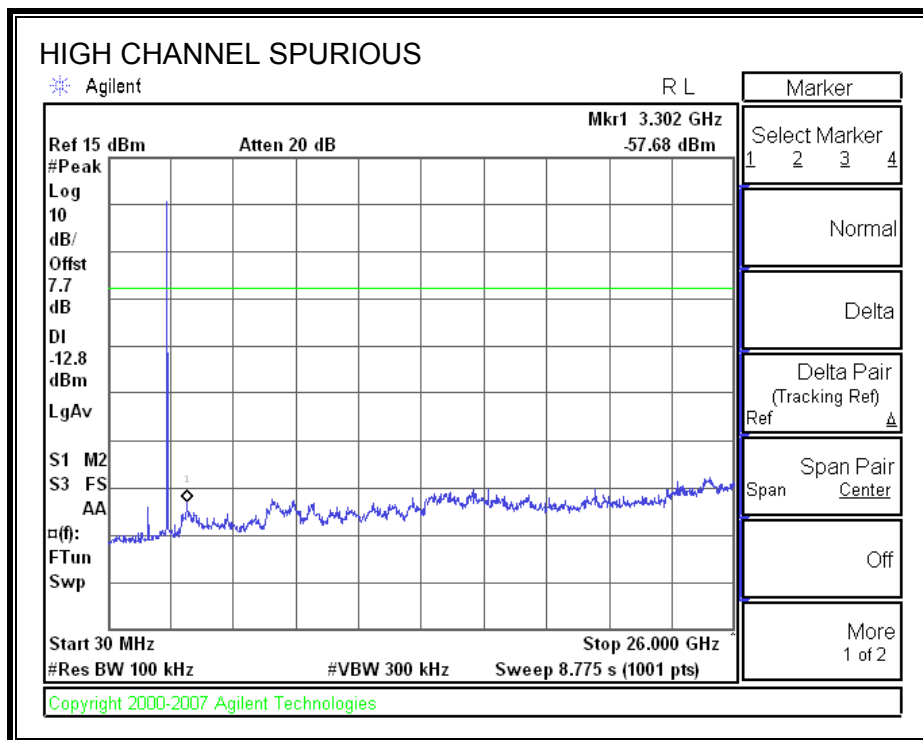
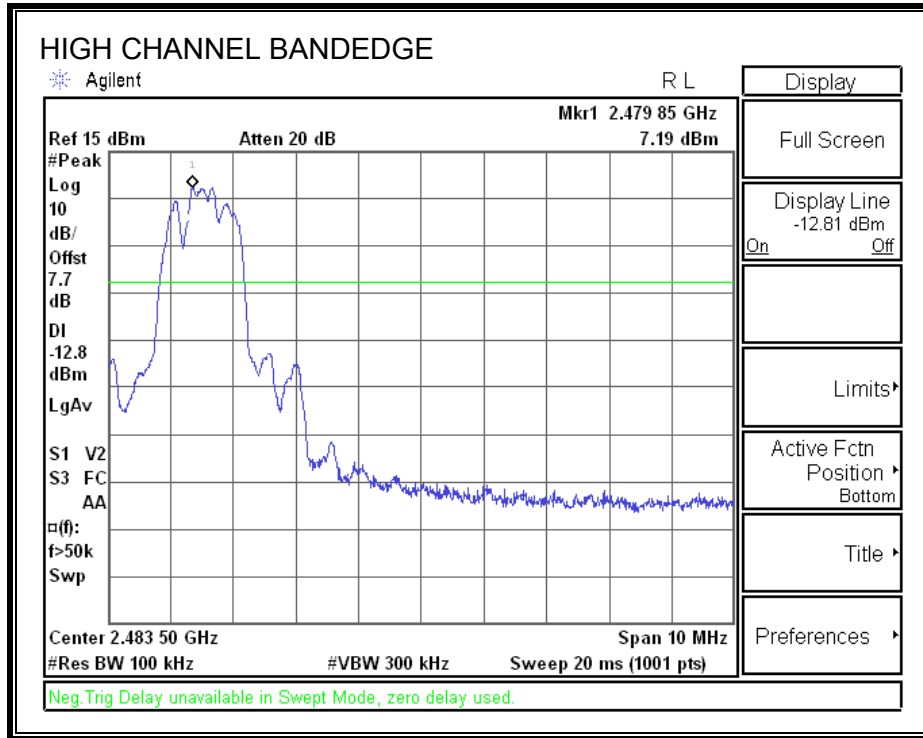
SPURIOUS EMISSIONS, LOW CHANNEL



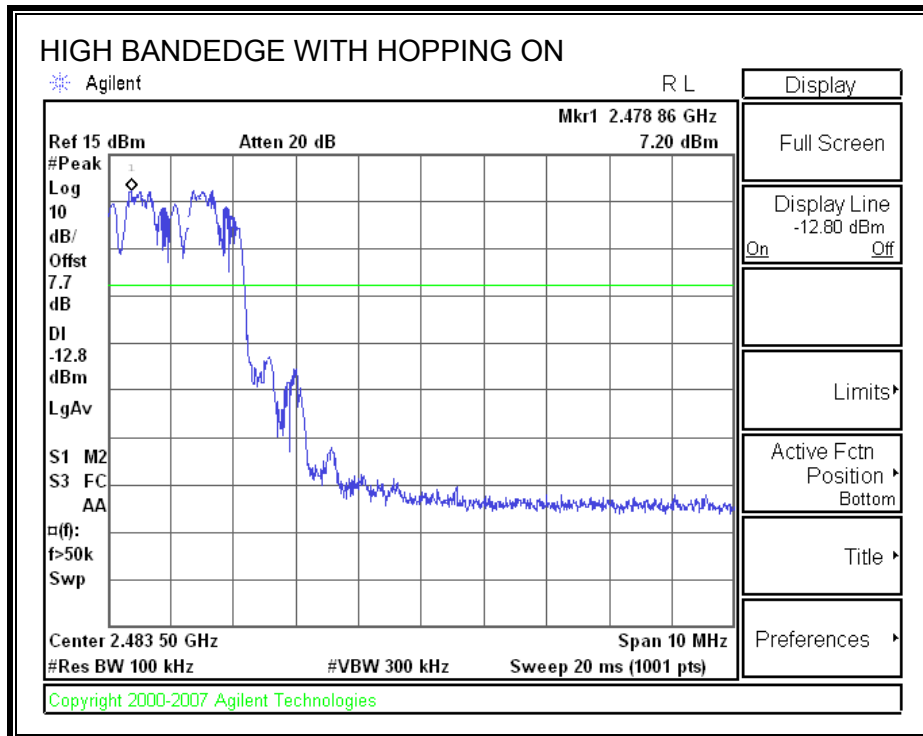
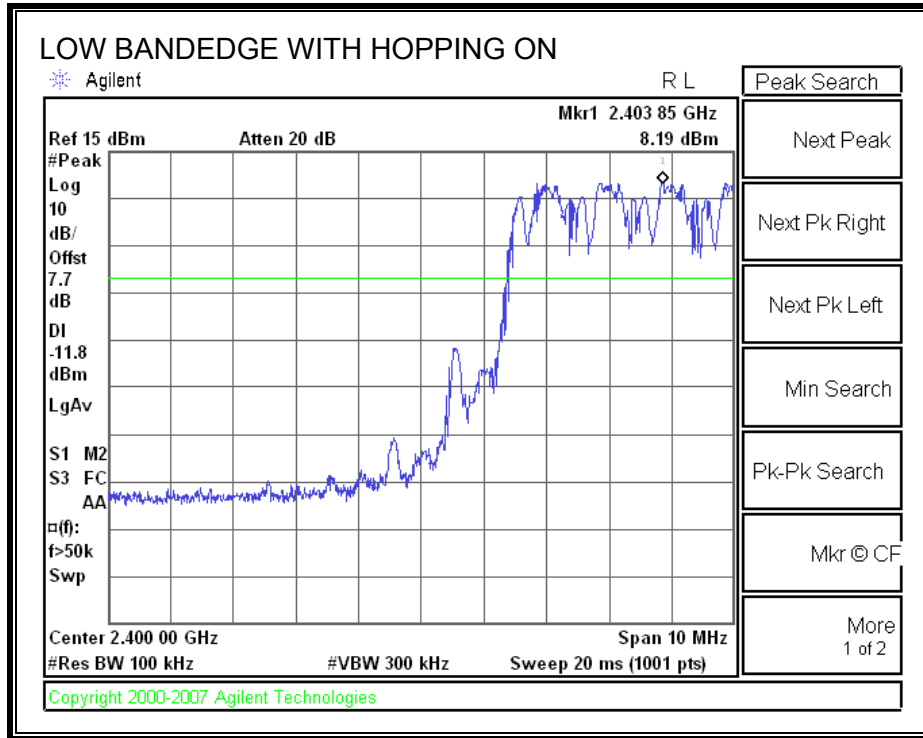
SPURIOUS EMISSIONS, MID CHANNEL



SPURIOUS EMISSIONS, HIGH CHANNEL



SPURIOUS BANDEDGE EMISSIONS 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.

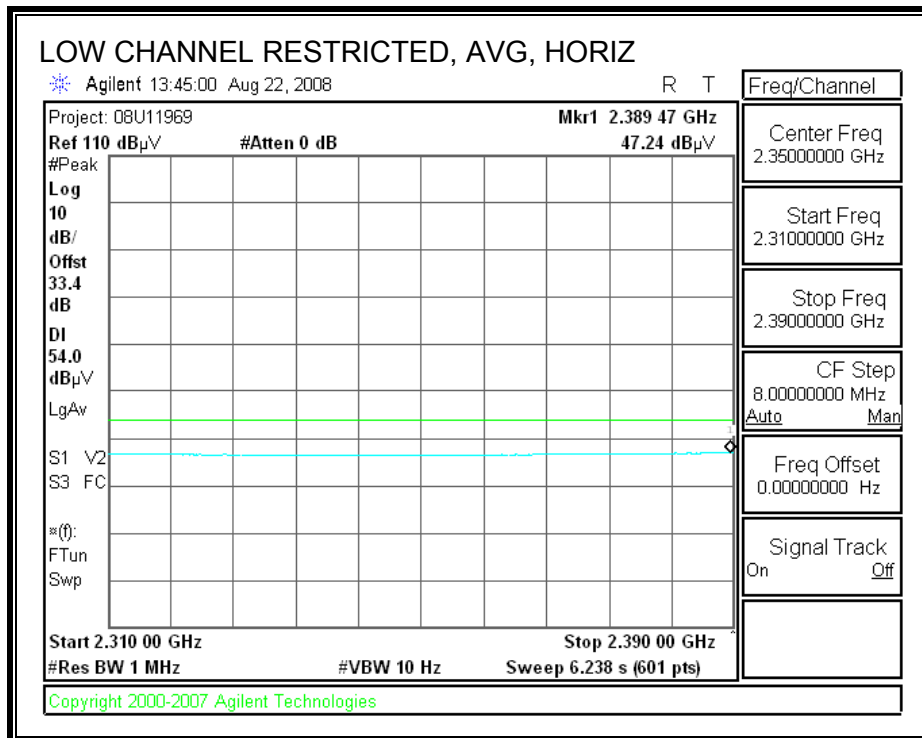
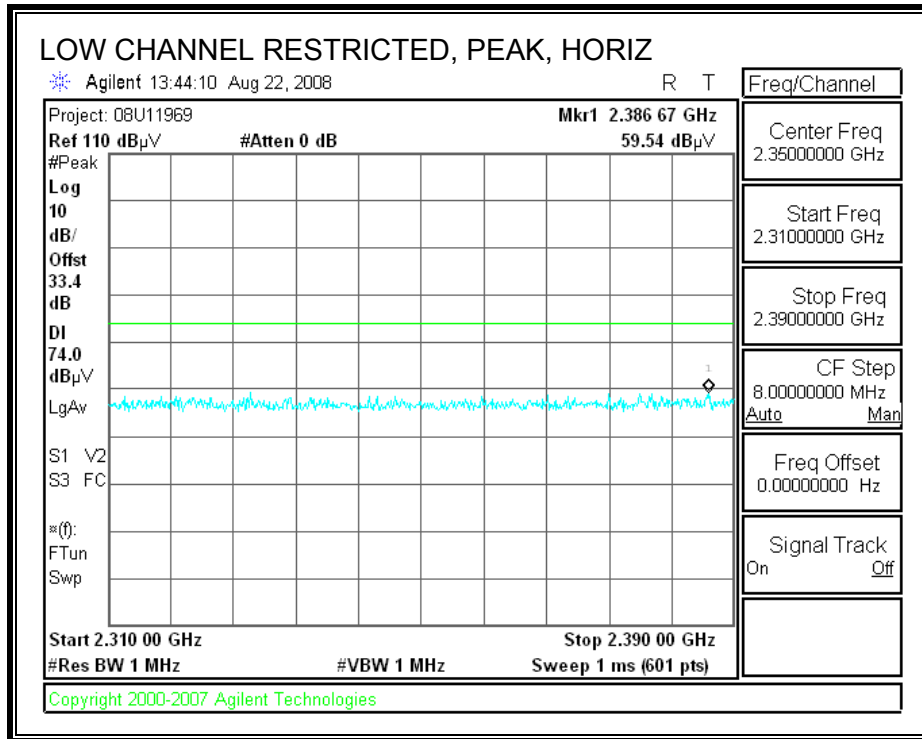
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

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.

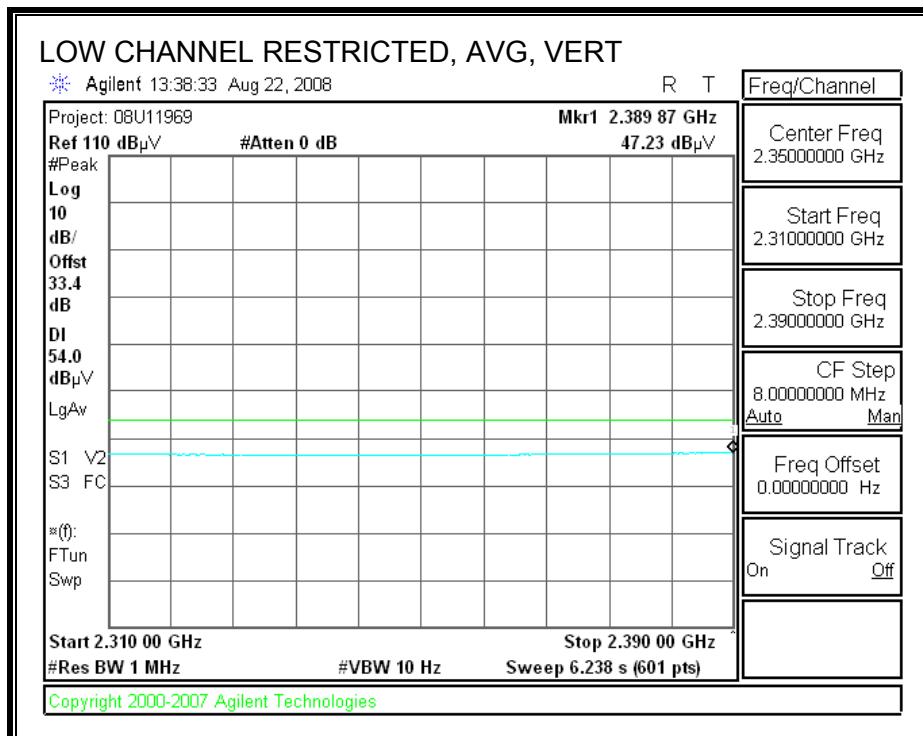
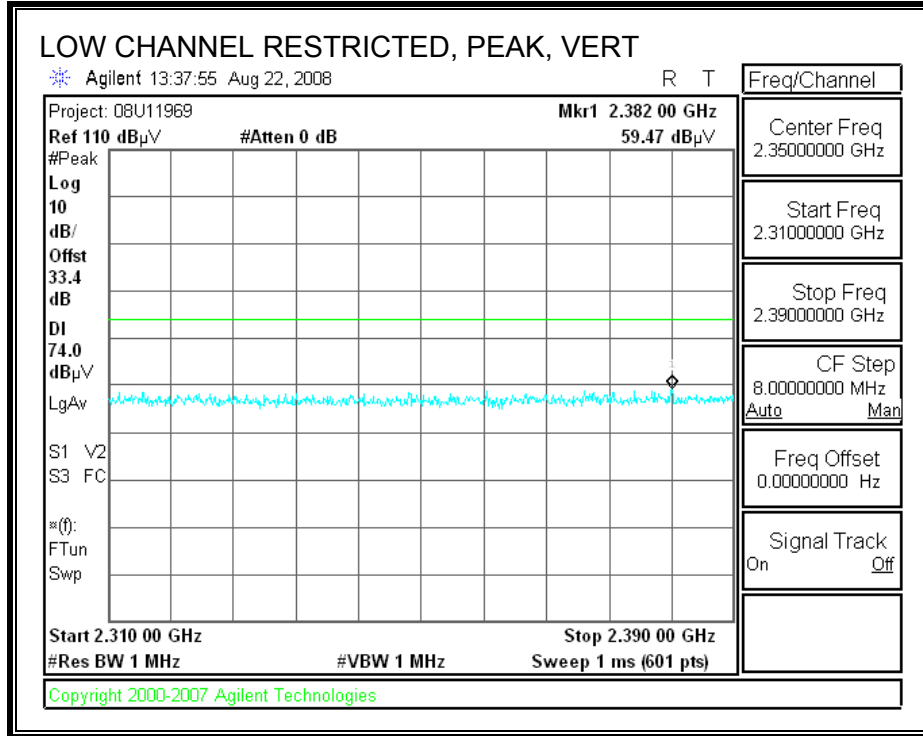
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.1.1. BASIC DATA RATE GFSK MODULATION

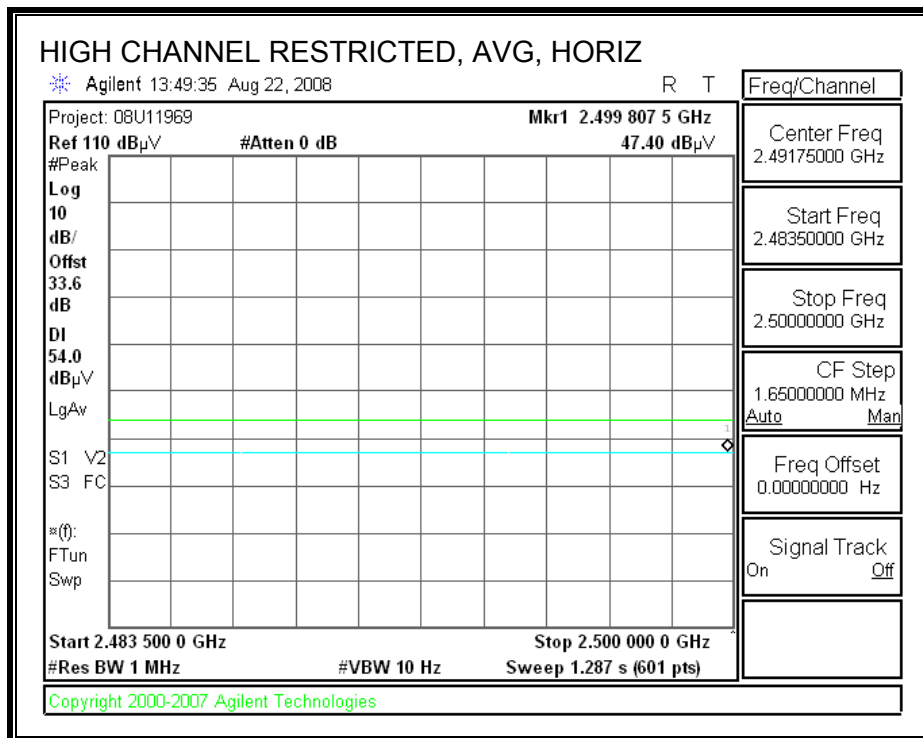
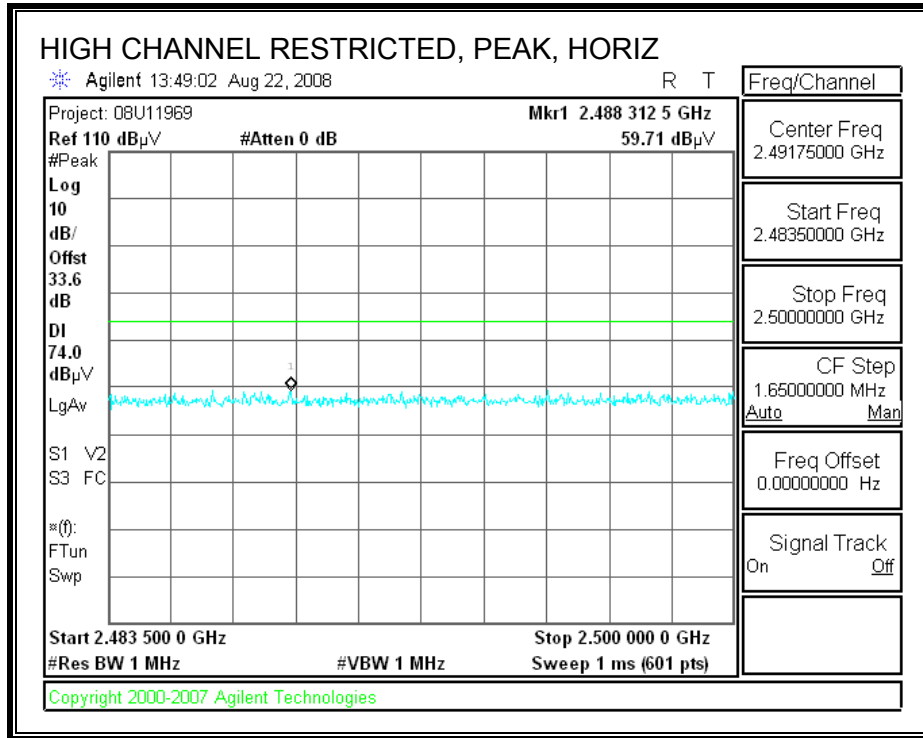
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



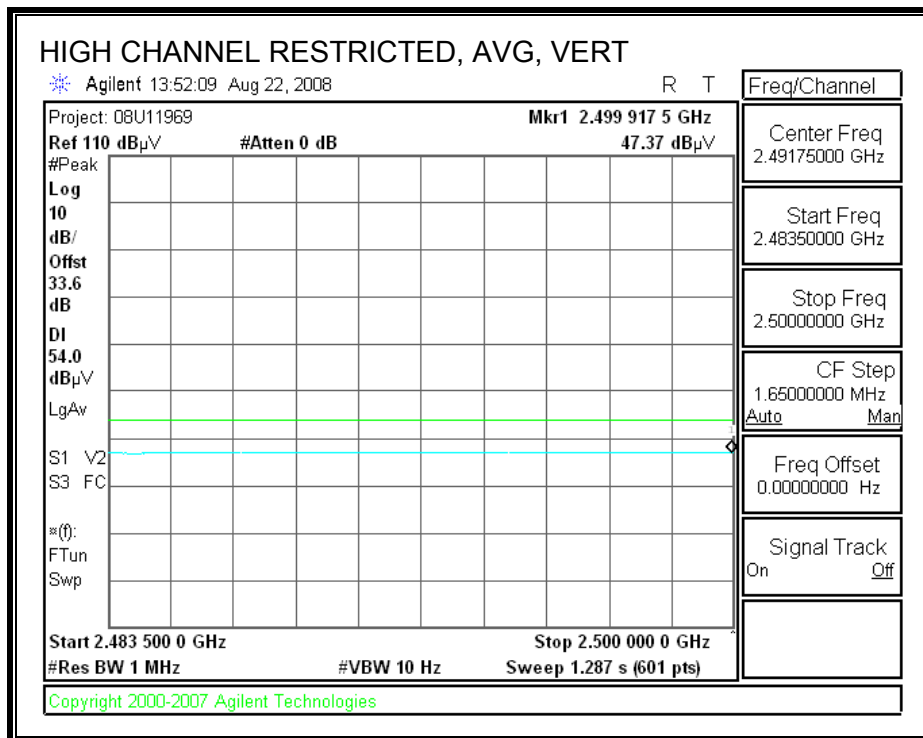
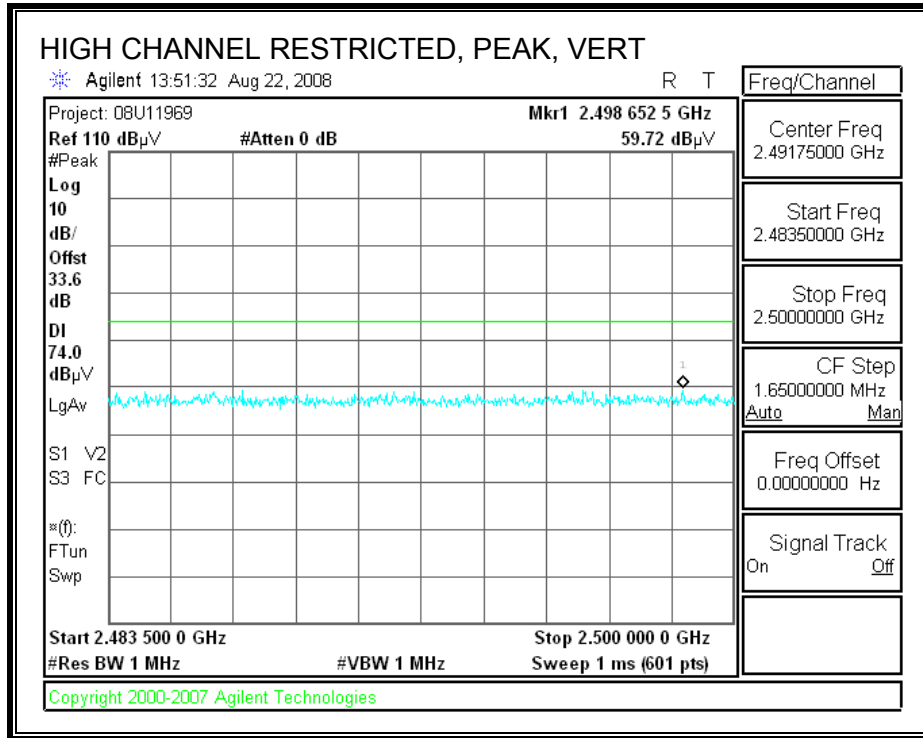
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
 Compliance Certification Services, Fremont 5m Chamber

Company: Apple Computer
 Project #: 08U11969-3
 Date: 8/22/2008
 Test Engineer: Thanh Nguyen
 Configuration: EUT and support Laptop
 Mode: BT Transmit GFSK

Test Equipment:

Horn 1-18GHz	Pre-amplifier 1-26GHz	Pre-amplifier 26-40GHz	Horn > 18GHz	Limit
T120; S/N: 29310 @3m	T34 HP 8449B		T125; ARA 18-26GHz; S/N:1007	FCC 15.205

Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable	HPF	Reject Filter	Peak Measurements RBW=VBW=1MHz Average Measurements RBW=1MHz ; VBW=10Hz
		C-5m Chamber		R_001	

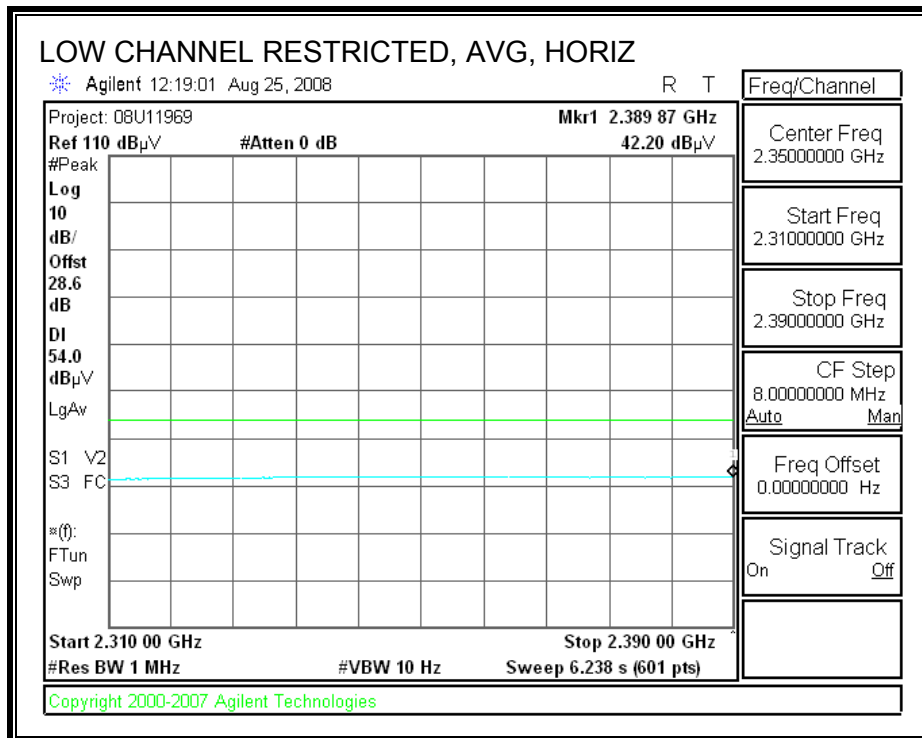
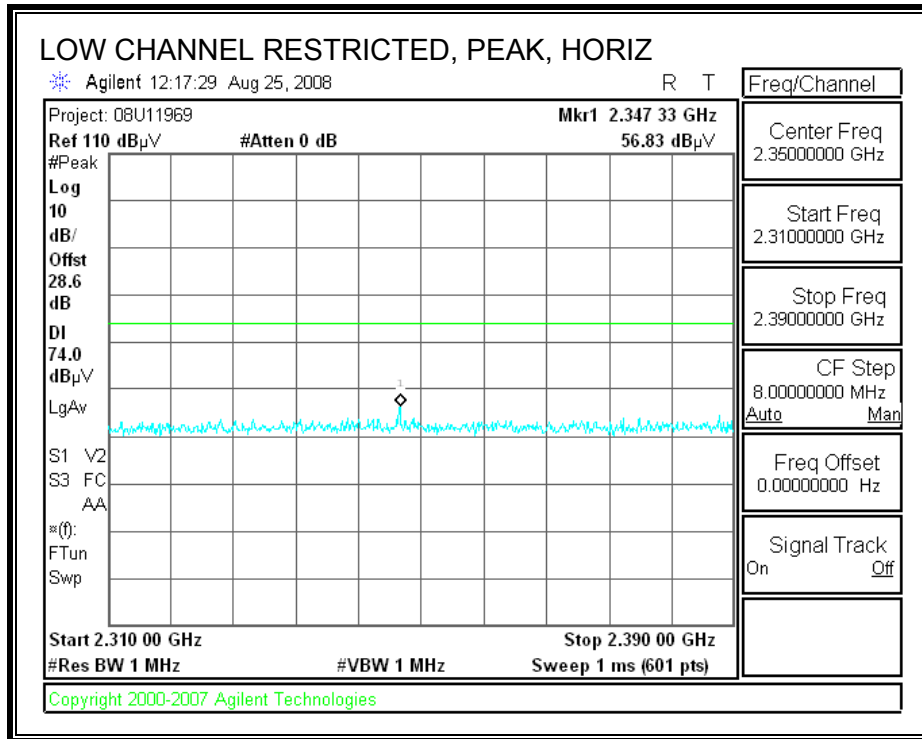
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Filt dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
Low Ch. 2402MHz															
4.804	3.0	48.11	40.94	33.7	0.0	-34.8	0.0	0.0	47.0	39.8	74	54	-27.0	-14.2	Y
12.010	3.0	45.88	34.24	37.7	0.0	-32.5	0.0	0.0	51.1	39.5	74	54	-22.9	-14.5	Y
4.804	3.0	44.64	35.35	33.7	0.0	-34.8	0.0	0.0	43.5	34.2	74	54	-30.5	-19.8	H
12.010	3.0	44.15	31.74	37.7	0.0	-32.5	0.0	0.0	49.4	37.0	74	54	-24.6	-17.0	Noise floor
Mid Ch. 2441MHz															
4.882	3.0	47.76	41.92	33.8	0.0	-34.8	0.0	0.0	46.7	40.9	74	54	-27.3	-13.1	Y
7.323	3.0	47.09	38.51	35.2	0.0	-34.1	0.0	0.0	48.2	39.6	74	54	-25.8	-14.4	V
12.205	3.0	42.99	30.71	37.7	0.0	-32.5	0.0	0.0	48.2	35.9	74	54	-25.8	-18.1	Noise floor
4.882	3.0	44.74	33.76	33.8	0.0	-34.8	0.0	0.0	43.7	32.7	74	54	-30.3	-21.3	H
7.323	3.0	43.94	32.99	35.2	0.0	-34.1	0.0	0.0	45.0	34.1	74	54	-29.0	-19.9	H
High Ch. 2480MHz															
4.960	3.0	49.48	44.25	33.8	0.0	-34.8	0.0	0.0	48.5	43.3	74	54	-25.5	-10.7	Y
7.440	3.0	46.66	39.36	35.2	0.0	-34.1	0.0	0.0	47.8	40.5	74	54	-26.2	-13.5	V
12.400	3.0	43.80	28.68	37.6	0.0	-32.5	0.0	0.0	48.9	33.8	74	54	-25.1	-20.2	Noise floor
4.960	3.0	48.03	42.62	33.8	0.0	-34.8	0.0	0.0	47.0	41.6	74	54	-27.0	-12.4	H
7.440	3.0	45.23	37.19	35.2	0.0	-34.1	0.0	0.0	46.4	38.3	74	54	-27.6	-15.7	H
12.400	3.0	40.59	30.95	37.6	0.0	-32.5	0.0	0.0	45.7	36.0	74	54	-28.3	-18.0	Noise floor

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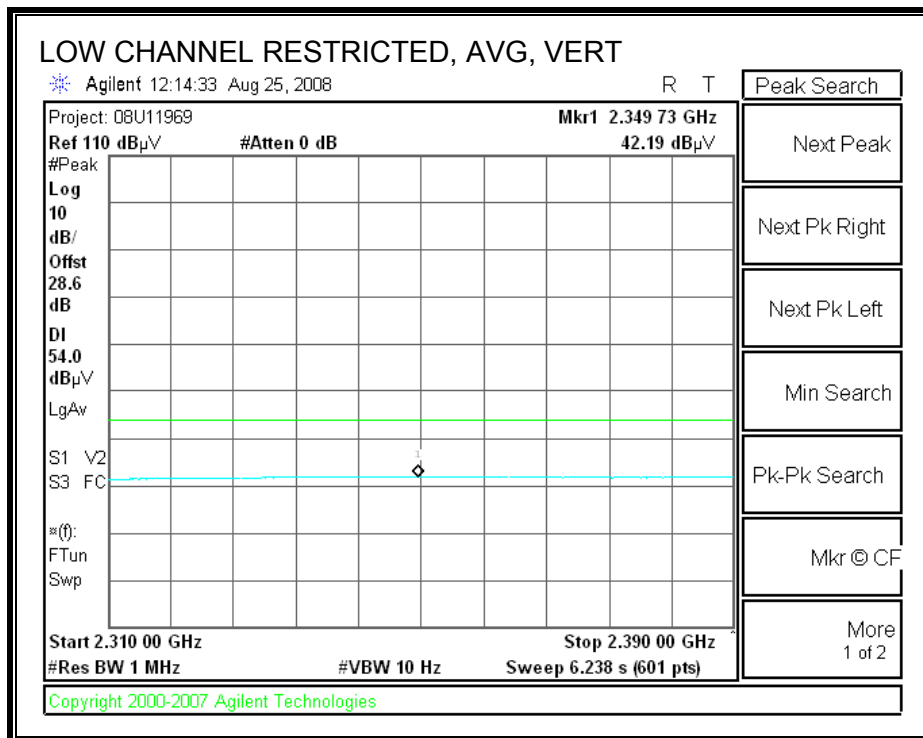
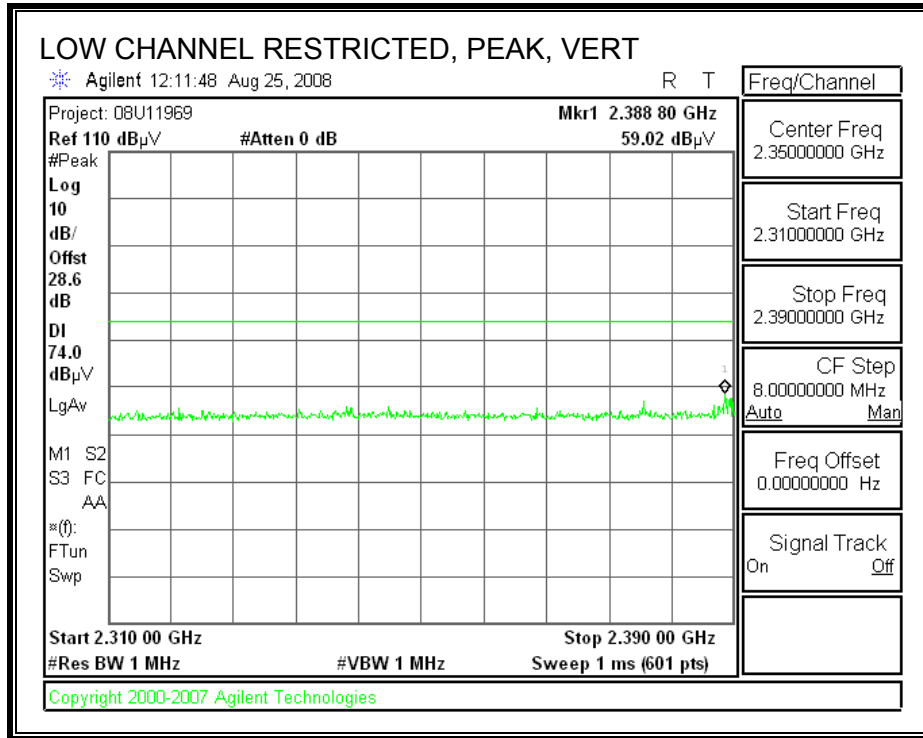
f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field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

8.1.2. ENHANCED DATA RATE 8PSK MODULATION

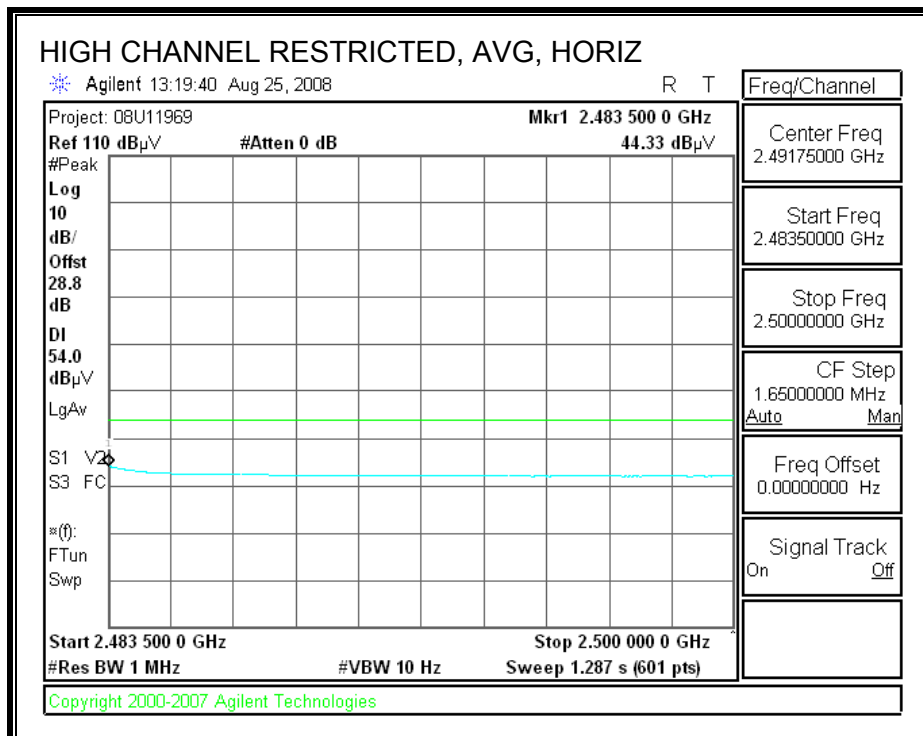
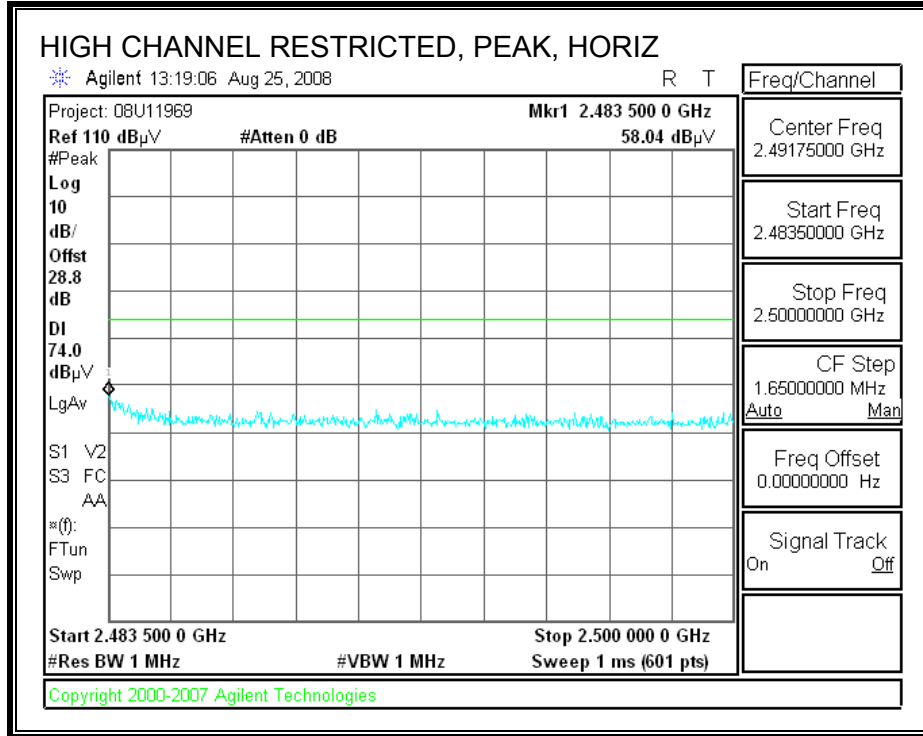
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



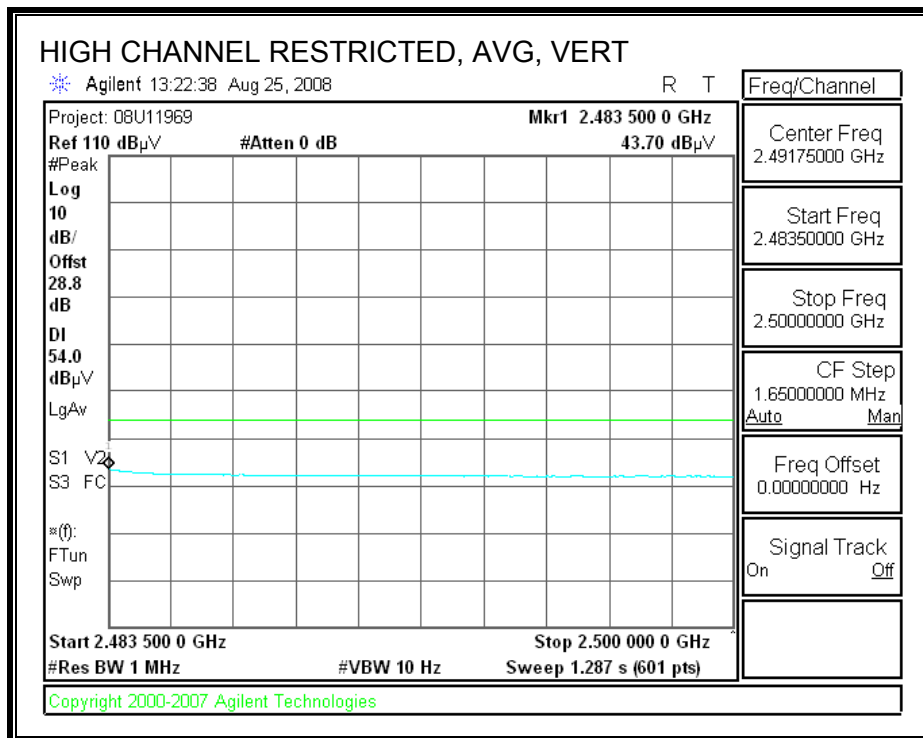
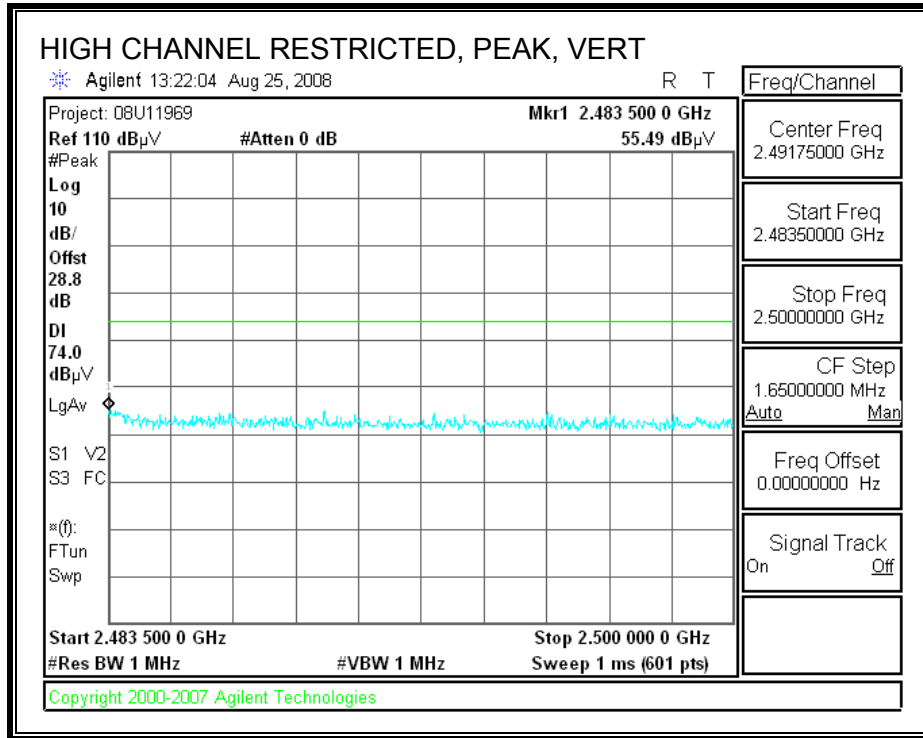
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement																	
Compliance Certification Services, Fremont 5m Chamber																	
Company: Apple Computer																	
Project #: 08U11969-3																	
Date: 8/25/2008																	
Test Engineer: Thanh Nguyen																	
Configuration: EUT, support Laptop																	
Mode: BT Transmit 8PSK																	
Test Equipment:																	
Horn 1-18GHz			Pre-amplifier 1-26GHz			Pre-amplifier 26-40GHz			Horn > 18GHz			Limit					
T120; S/N: 29310 @3m			T34 HP 8449B						T125; ARA 18-26GHz; S/N:1007			FCC 15.205					
Hi Frequency Cables																	
2 foot cable			3 foot cable			12 foot cable			HPF		Reject Filter		Peak Measurements RBW=VBW=1MHz				
						C-5m Chamber					R_001		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	Filt dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)		
Low Ch. 2402MHz																	
4.804	3.0	52.44	46.69	33.7	0.0	-34.8	0.0	0.0	51.3	45.5	74	54	-22.7	-8.5	V		
12.010	3.0	43.06	28.95	37.7	0.0	-32.5	0.0	0.0	48.3	34.2	74	54	-25.7	-19.8	Noise floor		
4.804	3.0	44.64	35.35	33.7	0.0	-34.8	0.0	0.0	43.5	34.2	74	54	-30.5	-19.8	H		
12.010	3.0	44.15	31.74	37.7	0.0	-32.5	0.0	0.0	49.4	37.0	74	54	-24.6	-17.0	Noise floor		
Mid Ch. 2441MHz																	
4.882	3.0	51.58	45.39	33.8	0.0	-34.8	0.0	0.0	50.5	44.3	74	54	-23.5	-9.7	V		
7.323	3.0	45.70	35.93	35.2	0.0	-34.1	0.0	0.0	46.8	37.0	74	54	-27.2	-17.0	V		
12.205	3.0	45.01	32.95	37.7	0.0	-32.5	0.0	0.0	50.2	38.1	74	54	-23.8	-15.9	V		
7.323	3.0	43.67	33.47	35.2	0.0	-34.1	0.0	0.0	44.7	34.5	74	54	-29.3	-19.5	H		
12.205	3.0	41.38	29.98	37.7	0.0	-32.5	0.0	0.0	46.5	35.1	74	54	-27.5	-18.9	Noise floor		
High Ch. 2480MHz																	
4.960	3.0	51.81	45.53	33.8	0.0	-34.8	0.0	0.0	50.8	44.5	74	54	-23.2	-9.5	V		
7.440	3.0	48.59	40.48	35.2	0.0	-34.1	0.0	0.0	49.7	41.6	74	54	-24.3	-12.4	V		
12.400	3.0	41.67	29.44	37.6	0.0	-32.5	0.0	0.0	46.8	34.5	74	54	-27.2	-19.5	Noise floor		
4.960	3.0	46.85	37.95	33.8	0.0	-34.8	0.0	0.0	45.9	37.0	74	54	-28.1	-17.0	H		
7.440	3.0	48.85	36.45	35.2	0.0	-34.1	0.0	0.0	50.0	37.6	74	54	-24.0	-16.4	H		
12.400	3.0	40.59	30.95	37.6	0.0	-32.5	0.0	0.0	45.7	36.0	74	54	-28.3	-18.0	Noise floor		
Rev. 412.7																	
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										

8.2. RECEIVER ABOVE 1 GHz

High Frequency Measurement
 Compliance Certification Services, Fremont 5m Chamber

Company: Apple Computer
 Project #: 08U11969-3
 Date: 8/25/2008
 Test Engineer: Thanh Nguyen
 Configuration: EUT and test JIG
 Mode: Receive Mode

Test Equipment:

Horn 1-18GHz T120: S/N: 29310 @3m	Pre-amplifer 1-26GHz T34 HP 8449B	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit FCC 15.209
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Hi Frequency Cables

2 foot cable	3 foot cable	12 foot cable C-5m Chamber	HPF	Reject Filter R_001	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	Fln dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
1.333	3.0	51.33	45.69	29.1	0.0	-37.8	0.0	0.0	42.6	37.0	74	54	-31.4	-17.0	V
1.500	3.0	50.35	36.24	29.7	0.0	-37.6	0.0	0.0	42.5	28.4	74	54	-31.5	-25.6	V
1.100	3.0	50.47	42.16	28.2	0.0	-38.1	0.0	0.0	40.6	32.3	74	54	-33.4	-21.7	H
1.333	3.0	51.67	33.46	29.1	0.0	-37.8	0.0	0.0	43.0	24.8	74	54	-31.0	-29.2	H
1.500	3.0	49.44	29.46	29.7	0.0	-37.6	0.0	0.0	41.6	21.6	74	54	-32.4	-32.4	H
No other emissions were detected above noise floor															

Rev. 4127

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		

8.3. WORST-CASE BELOW 1 GHz

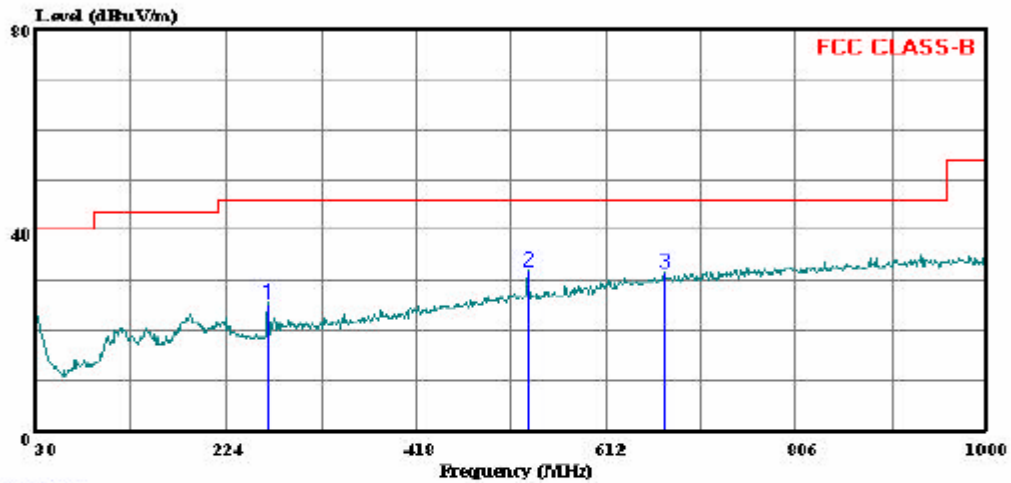
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

HORIZONTAL PLOT & DATA



Compliance Certification Services
 47173 Benicia Street
 Fremont, CA 94538
 Tel: (510) 771-1000
 Fax: (510) 661-0888

Data#: 4 File#: BT Below 1GHz.BMIDate: 08-22-2008 Time: 14:28:49



(Fremont)

Trace: 3

Ref Trace:

Condition: FCC CLASS-B 3m ANTENNA B_5M 021109 HORIZONTAL
 Test Operator:: Thanh Nguyen
 Project #: : 08U11969
 Company: : Apple Inc.
 Configuration:: BUT & Support Equipments
 Mode : : Tx worst case
 Target: : FCC Class B

Page: 1

	Read		Limit	Over		
Freq	Level	Factor	Level	Line	Limit	Remark
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	266.680	37.33	-12.04	25.28	46.00	-20.72 Peak
2	532.460	35.83	-3.91	31.93	46.00	-14.07 Peak
3	670.200	31.83	-0.29	31.55	46.00	-14.45 Peak

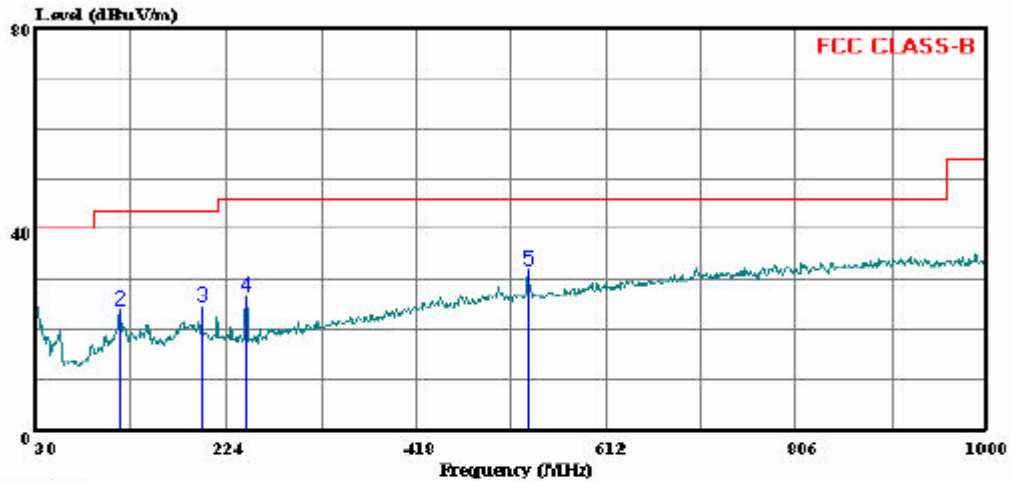
SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)

VERTICAL PLOT& DATA



Compliance Certification Services
 47173 Benicia Street
 Fremont, CA 94538
 Tel: (510) 771-1000
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Data#: 2 File#: BT Below 1GHZ.EMIDate: 08-22-2008 Time: 14:22:14



(Excerpt)
 Trace: 1

Ref Trace:

Condition: FCC CLASS-B 3m ANTENNA B_5M 021109 VERTICAL
 Test Operator:: Thanh Nguyen
 Project #: : 08U11969
 Company: : Apple Inc.
 Configuration: : BUT & Support Equipments
 Mode : : TX worst case
 Target: : FCC Class B

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	Read		Limit	Over		
Freq	Level	Factor	Level	Line	Limit	Remark
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	30.000	33.33	-6.96	26.37	40.00	-13.63 Peak
2	115.360	37.00	-13.01	23.99	43.50	-19.51 Peak
3	199.750	36.83	-12.30	24.53	43.50	-18.97 Peak
4	244.370	39.50	-12.71	26.79	46.00	-19.21 Peak
5	532.460	35.67	-3.91	31.76	46.00	-14.24 Peak

9. AC POWER LINE CONDUCTED EMISSIONS

The EUT is operated by battery; therefore this test is not applicable.

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/ <i>f</i>	2.19/ <i>f</i>		6
10–30	28	2.19/ <i>f</i>		6
30–300	28	0.073	2*	6
300–1 500	1.585 <i>f</i> ^{0.5}	0.0042 <i>f</i> ^{0.5}	<i>f</i> /150	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	616 000 / <i>f</i> ^{1.2}
150 000–300 000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616 000 / <i>f</i> ^{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/m² is equivalent to 1 mW/cm².
 3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG).

CALCULATIONS

Given

$$E = \sqrt{(30 * P * G) / d}$$

and

$$S = E^2 / 3770$$

where

E = Field Strength in Volts/meter

P = Power in Watts

G = Numeric antenna gain

d = Distance in meters

S = Power Density in milliwatts/square centimeter

Combining equations, rearranging the terms to express the distance as a function of the remaining variables, changing to units of Power to mW and Distance to cm, and substituting the logarithmic form of power and gain yields:

$$d = 0.282 * 10^{((P + G) / 20)} / \sqrt{S}$$

where

d = MPE distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm²

Rearranging terms to calculate the power density at a specific distance yields

$$S = 0.0795 * 10^{((P + G) / 10)} / (d^2)$$

The power density in units of mW/cm² is converted to units of W/m² by multiplying by a factor of 10.

LIMITS

From FCC §1.1310 Table 1 (B), the maximum value of S = 1.0 mW/cm²

From IC Safety Code 6, Section 2.2 Table 5 Column 4, S = 10 W/m²

RESULTS

(MPE distance equals 20 cm)

Mode	Band	MPE Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	FCC Power Density (mW/cm ²)	IC Power Density (W/m ²)
Bluetooth	2.4 GHz	20.0	10.34	1.50	0.00	0.03