NCC LP0002

CERTIFICATION TEST REPORT

FOR

Multimedia Device with BLE, 2.4GHz and 5GHz WLAN Radios

MODEL NUMBER: NC2-6A5

FCC ID: A4RNC2-6A5

REPORT NUMBER: 15U20917-E22

ISSUE DATE: AUGUST 3, 2015

Prepared for
GOOGLE
1600 AMPHITEATRE PARKWAY
MOUNTAIN VIEW, CA 94043, U.S.A.

Prepared by
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	8/3/15	Initial Issue	F. de Anda

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TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS 5

2. TEST METHODOLOGY 6

3. FACILITIES AND ACCREDITATION 6

4. CALIBRATION AND UNCERTAINTY 6

4.1. MEASURING INSTRUMENT CALIBRATION 6

4.2. SAMPLE CALCULATION 6

4.3. MEASUREMENT UNCERTAINTY 7

5. EQUIPMENT UNDER TEST 8

5.1. DESCRIPTION OF EUT 8

5.2. MAXIMUM OUTPUT POWER 8

5.3. DESCRIPTION OF AVAILABLE ANTENNAS 8

5.4. SOFTWARE AND FIRMWARE 8

5.5. WORST-CASE CONFIGURATION AND MODE 9

5.6. DESCRIPTION OF TEST SETUP 10

6. TEST AND MEASUREMENT EQUIPMENT 13

7. ANTENNA PORT TEST RESULTS 14

7.1. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS 14

7.2. 6 dB BANDWIDTH ANTENNA 1 16

7.3. 6 dB BANDWIDTH ANTENNA 2 19

7.4. 99% BANDWIDTH ANTENNA 1 22

7.5. 99% BANDWIDTH ANTENNA 2 25

7.6. OUTPUT POWER ANTENNA 1 28

7.7. OUTPUT POWER ANTENNA 2 31

7.8. AVERAGE POWER ANTENNA 1 34

7.9. AVERAGE POWER ANTENNA 2 35

7.10. POWER SPECTRAL DENSITY ANTENNA 1 36

7.11. POWER SPECTRAL DENSITY ANTENNA 2 39

7.12. CONDUCTED SPURIOUS EMISSIONS ANTENNA 1 42

7.13. CONDUCTED SPURIOUS EMISSIONS ANTENNA 2 46

8. RADIATED TEST RESULTS 50

8.1. LIMITS AND PROCEDURE 50

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8.2. TX ABOVE 1 GHz FOR BLUETOOTH LOW ENERGY MODE IN THE 2.4 GHz BAND ANTENNA 1 51

8.3. TX ABOVE 1 GHz FOR BLUETOOTH LOW ENERGY MODE IN THE 2.4 GHz BAND ANTENNA 2 61

8.4. WORST-CASE ABOVE 18 GHz 71

8.5. WORST-CASE BELOW 1 GHz 72

9. AC POWER LINE CONDUCTED EMISSIONS 74

10. SETUP PHOTOS 77

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: GOOGLE
1600 AMPHITEATRE PARKWAY
MOUNTAIN VIEW, CA 94043, U.S.A.

MODEL: NC2-6A5

SERIAL NUMBER: 5323103ZZAJR (RADIATED) &
PROTO 1 (CONDUCTED)

DATE TESTED: May 6, 2015 – June 19, 2015

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
NCC LP0002	Pass

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

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

Approved & Released For
UL Verification Services Inc. By:

FRANCISCO DE ANDA
PROJECT LEAD
UL Verification Services Inc.

Tested By:

CHRIS XIONG
EMC ENGINEER
UL Verification Services Inc.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with NCC LP0002, ANSI C63.10-2009 for FCC and ANSI C63.10-2013 for IC, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 4, and RSS-247 Issue 1.

Testing for radiated emissions above 1GHz was performed with the EUT elevated at 1.5m instead of 0.8m. 1.5m is the required height in ANSI C63.10:2013 as referenced by RSS GEN issue 4. This test height has been permitted by FCC as discussed in FCC/TCB conference call in December 2014.

3. FACILITIES AND ACCREDITATION

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

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

47173 Benicia Street	47266 Benicia Street
☐ Chamber A	☐ Chamber D
☐ Chamber B	☐ Chamber E
☐ Chamber C	☒ Chamber F
	☐ Chamber G
	☐ Chamber H

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through H are covered under Industry Canada company address code 2324B with site numbers 2324B -1 through 2324B-8, respectively.

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

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

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

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

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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
Radiated Disturbance, 1 to 6 GHz	± 3.86 dB
Radiated Disturbance, 6 to 18 GHz	± 4.23 dB
Radiated Disturbance, 18 to 26 GHz	± 5.30 dB
Radiated Disturbance, 26 to 40 GHz	± 5.23 dB

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

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a Multimedia Device with BLE, 2.4Ghz and 5GHz WLAN Radios.

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	BLE	6.35	4.32

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PCB antenna, with a maximum gain of 3.1dBi for antenna 1 and 2.3dBi for antenna 2.

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 15.2.7.09.

The test utility software used during testing was Labtool ver 2.0.0.71

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5.5. WORST-CASE CONFIGURATION AND MODE

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

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

Worst-case data rates as provided by the client were:

BLE: 1 Mbps.

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5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adapter	Lenovo	ADLX65NCC2A	11545N0263Z1Z5994AH GRO	N/A
AC Adapter	Google	N/A	Proto 1	N/A
Laptop	Lenovo	E440	PF-074E9W 15/01	N/A
USB Hub	Belkin	N10117	P11438	N/A
USB LAN Adapter	HP	538507	001	N/A

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	DC	1	Barrel	unshielded	0.8	
2	USB	1	USB	unshielded	1.5	Power cable
3	USB	1	USB	unshielded	2.5	
4	LAN	1	RJ45	unshielded	2.5	
5	USB	1	USB	unshielded	0.1	
6	USB	1	USB	unshielded	0.2	Data
7	USB	1	Micro USB	unshielded	0.2	Y-cable

TEST SETUP

The EUT is connected to a host laptop via USB HUB and USB-to-LAN Adapter, test software exercises the radio.

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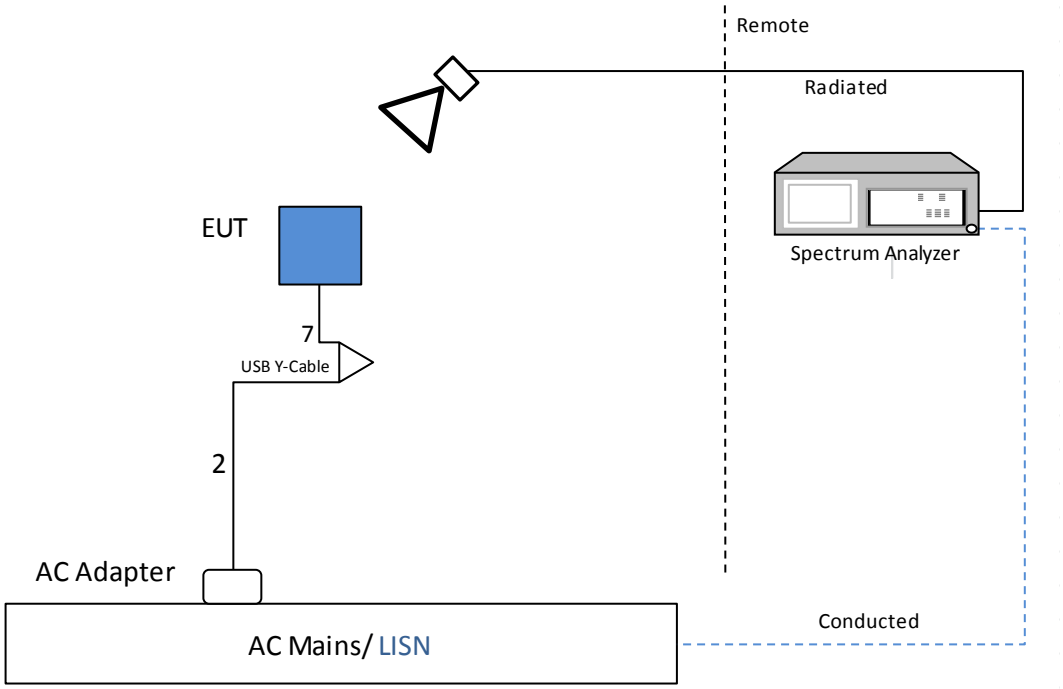
SETUP DIAGRAM FOR RADIATED and AC LC TESTS



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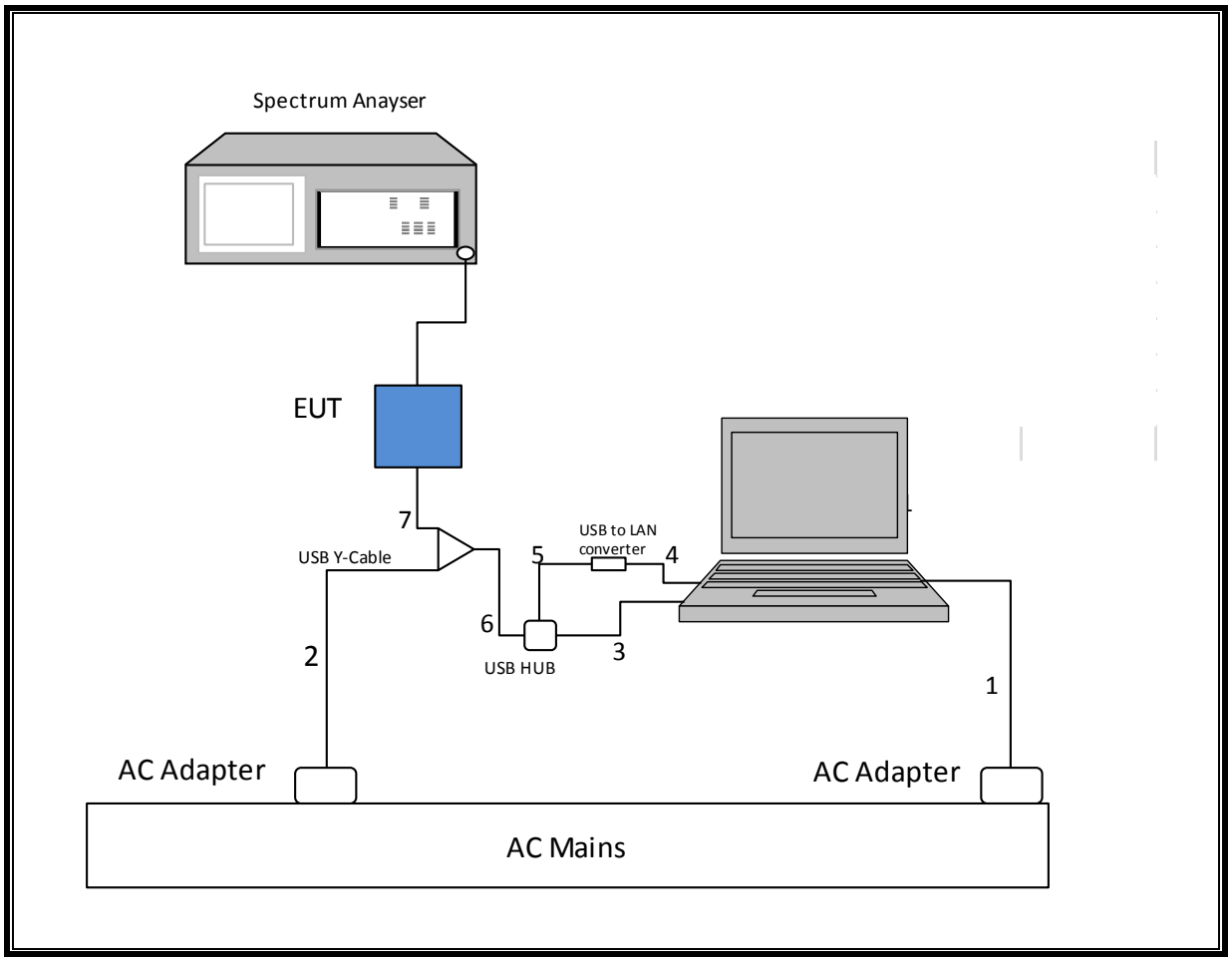
SETUP DIAGRAM FOR CONDUCTED TESTS



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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**
Radiated Software	UL	UL EMC	Ver 9.5, July 22, 2014	
Conducted Software	UL	UL EMC	Ver 2.2, March 31, 2015	
Spectrum Analyzer, PXA, 3Hz to	Agilent	N9030A	341	02/20/16
Antenna, Horn 1-18GHz	ETS Lindgren	3117	120	03/26/16
Antenna, Broadband Hybrid, 30MHz	Sunol Sciences	JB1	122	02/13/16
Amplifier, 10KHz to 1GHz,	Sonoma	310N	173	06/09/16
Amplifier, 1 - 18GHz	Miteq	AFS42-	742	01/31/16
Amplifier, 26 - 40GHz	Miteq	NSP4000-SP2	88	4/7/2016
Filter, HPF 3.0GHz	Micro-Tronics	HPM17543	427	01/31/16
Filter, LPF 5.0GHz	Micro-Tronics	LPS17541	421	1/31/2016
Filter, HPF 6GHz HPF	Micro-Tronics	HPS17542	425	1/31/2016
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826	89	12/17/15
Amplifier, 1 to 26.5GHz, 23.5dB Gain	Agilent	8449B	404	04/13/16
Spectrum Analyzer, 40 GHz	Agilent	8564E	106	08/06/15
LISN, 30MHz	FCC	50/250-25-2	24	01/16/16
Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	341	02/20/16
UL EMC Software	UL	UL EMC	Rev 9.5.03	
Antenna Port Software	UL	UL RF	Ver 2.2	

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7. ANTENNA PORT TEST RESULTS

7.1. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (usec)	Period (usec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
BLE	378.000	626.000	0.604	60.38%	2.19	0.003

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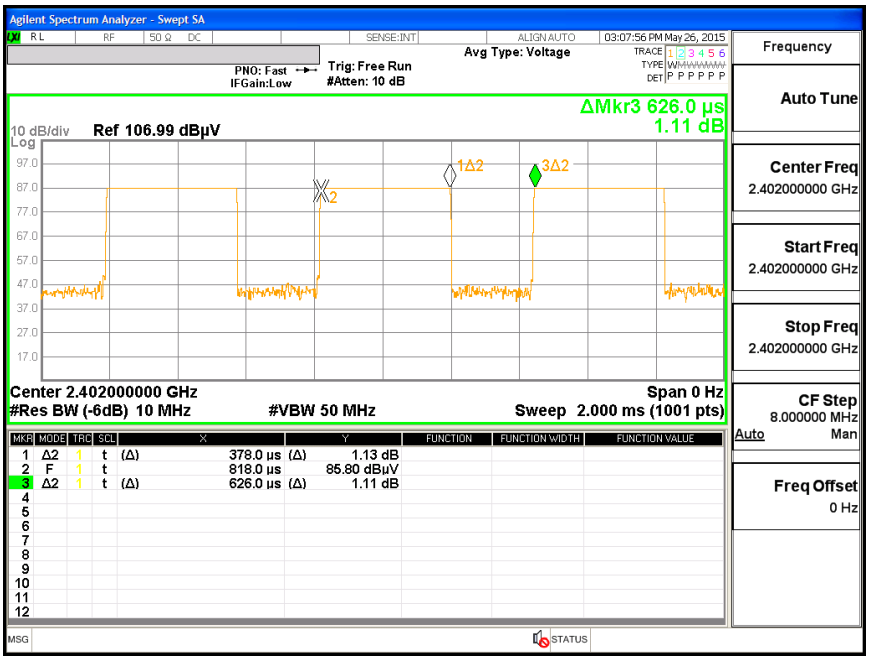
DUTY CYCLE PLOTS

DUTY CYCLE BLE MODE



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7.2. 6 dB BANDWIDTH ANTENNA 1

LIMITS

FCC §15.247 (a) (2)

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6840	0.5
Middle	2440	0.6864	0.5
High	2480	0.6828	0.5

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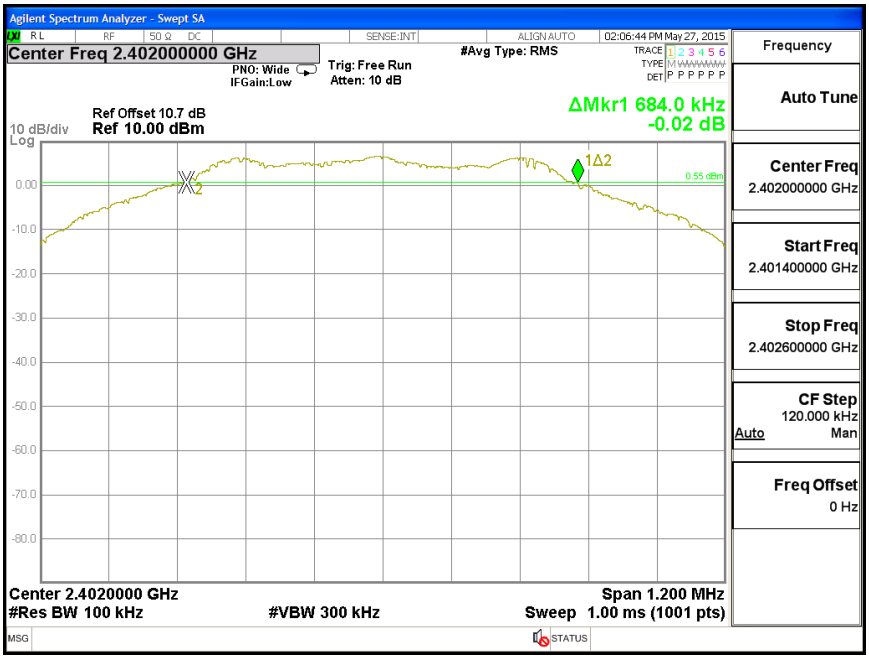
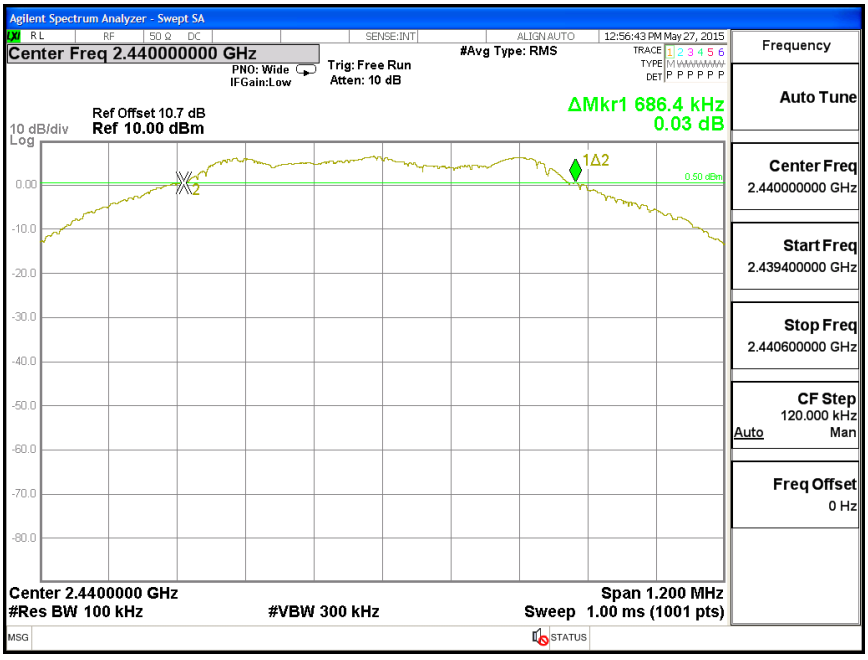
6 dB BANDWIDTH

6 dB BANDWIDTH LOW CH



6 dB BANDWIDTH MID CH



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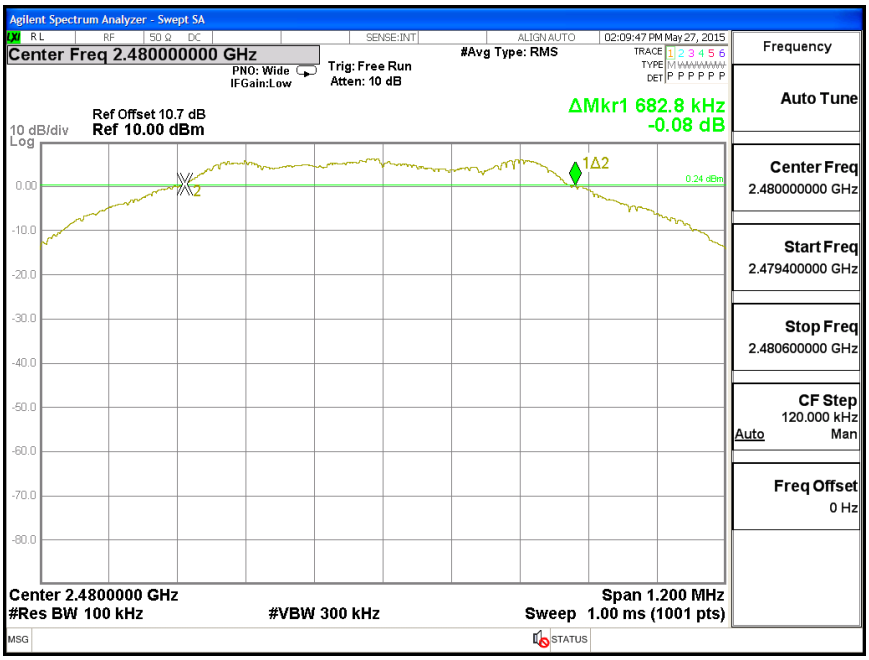
6 dB BANDWIDTH HIGH CH



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7.3. 6 dB BANDWIDTH ANTENNA 2

LIMITS

FCC §15.247 (a) (2)

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6852	0.5
Middle	2440	0.6851	0.5
High	2480	0.6780	0.5

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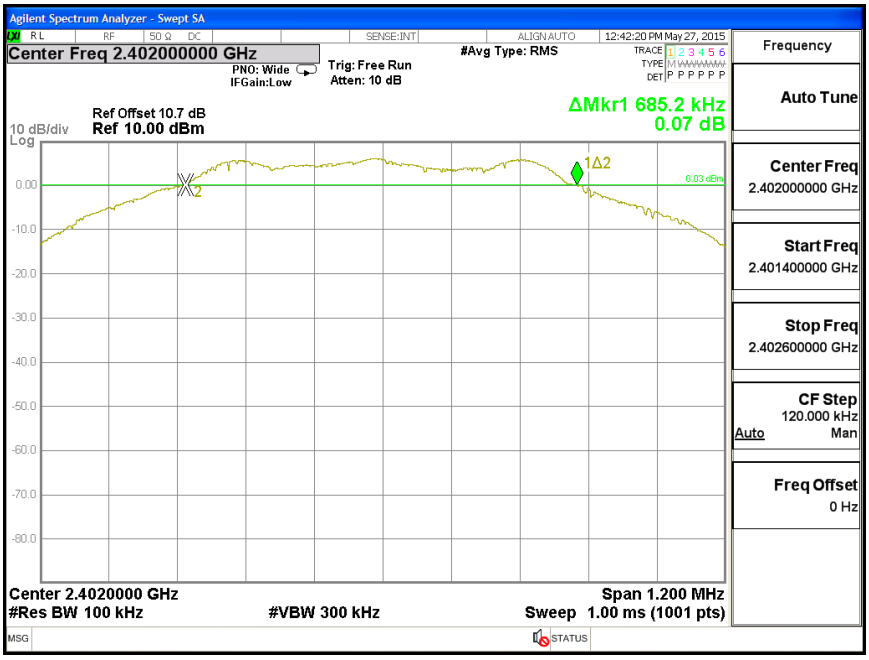
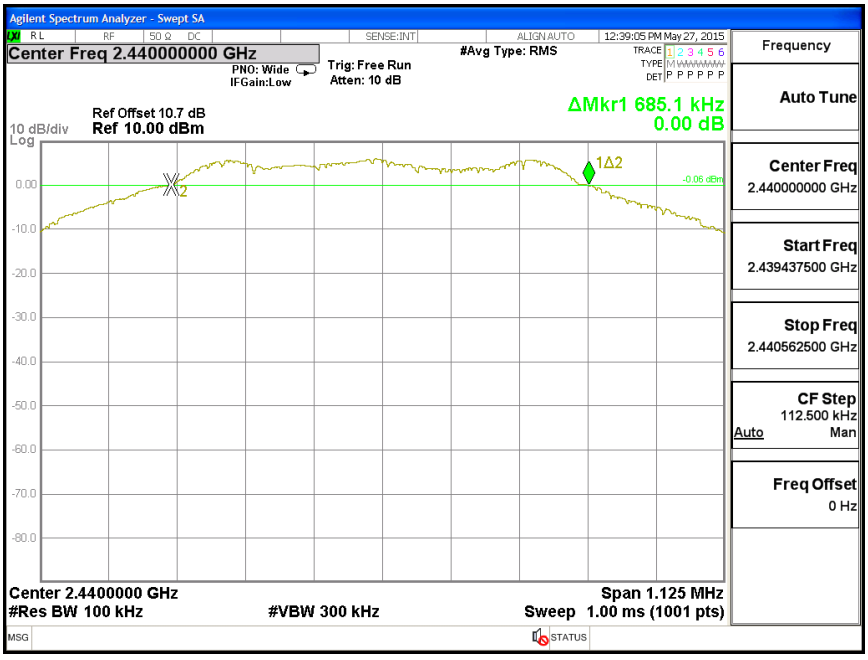
6 dB BANDWIDTH

6 dB BANDWIDTH LOW CH



6 dB BANDWIDTH MID CH



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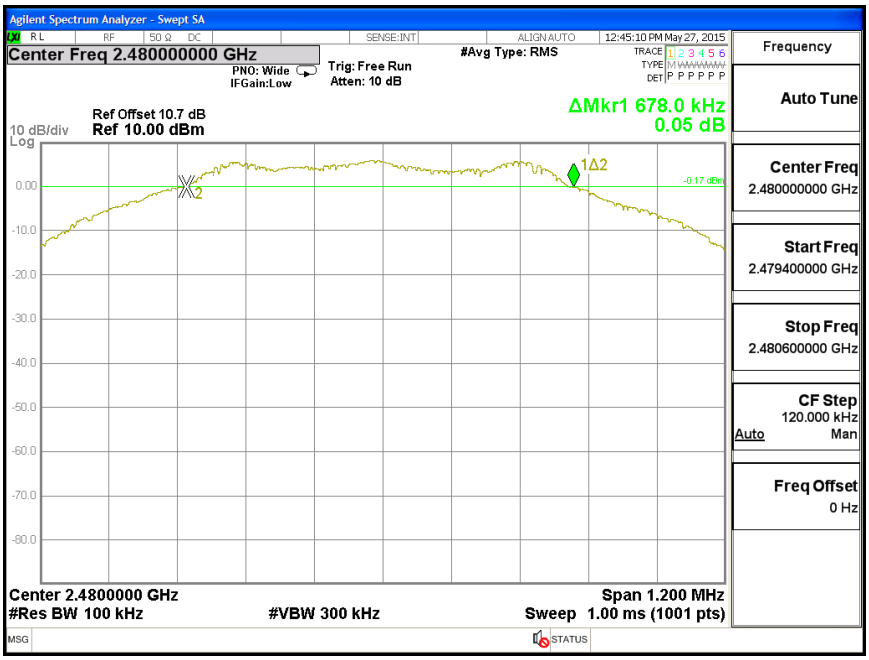
6 dB BANDWIDTH HIGH CH



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7.4. 99% BANDWIDTH ANTENNA 1

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth and to 1% of the span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0273
Middle	2440	1.0309
High	2480	1.0296

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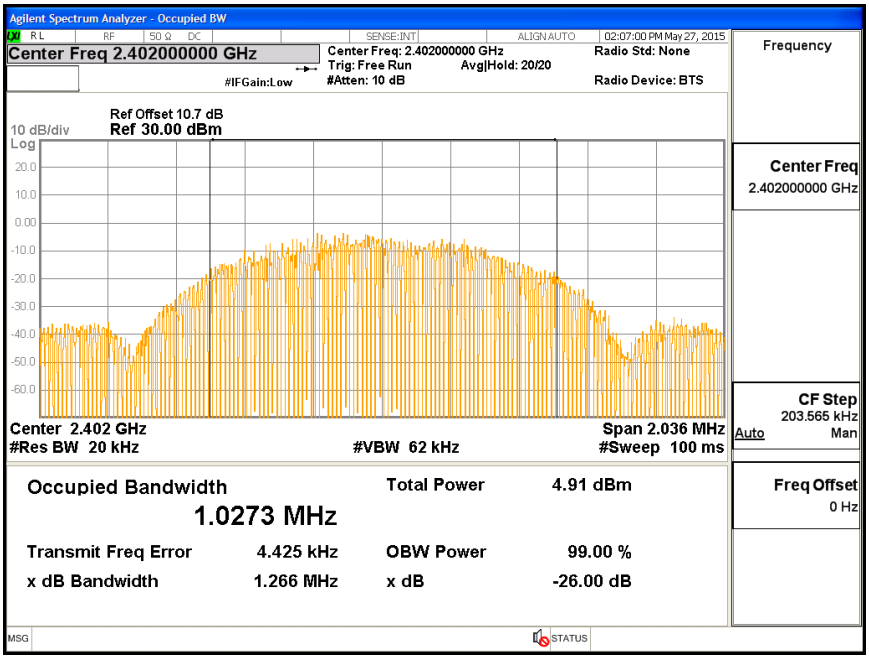
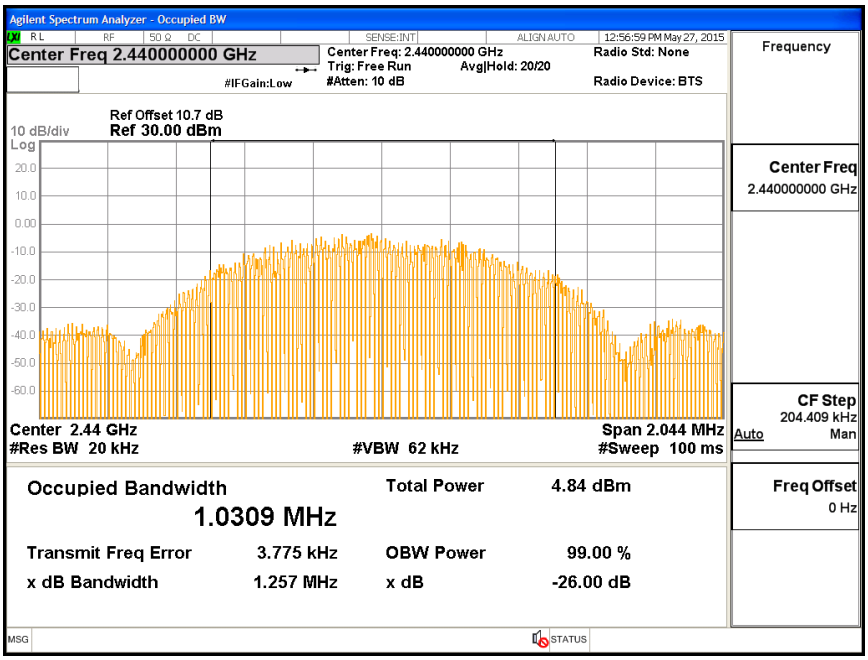
99% BANDWIDTH

99% BANDWIDTH LOW CH



99% BANDWIDTH MID CH



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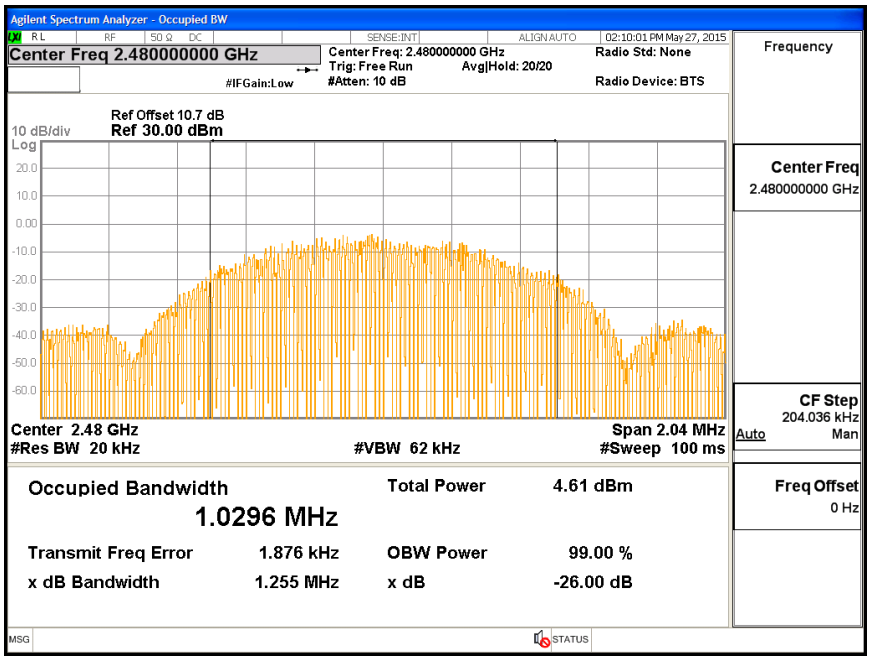
99% BANDWIDTH HIGH CH



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7.5. 99% BANDWIDTH ANTENNA 2

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth and to 1% of the span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0273
Middle	2440	1.0281
High	2480	1.0281

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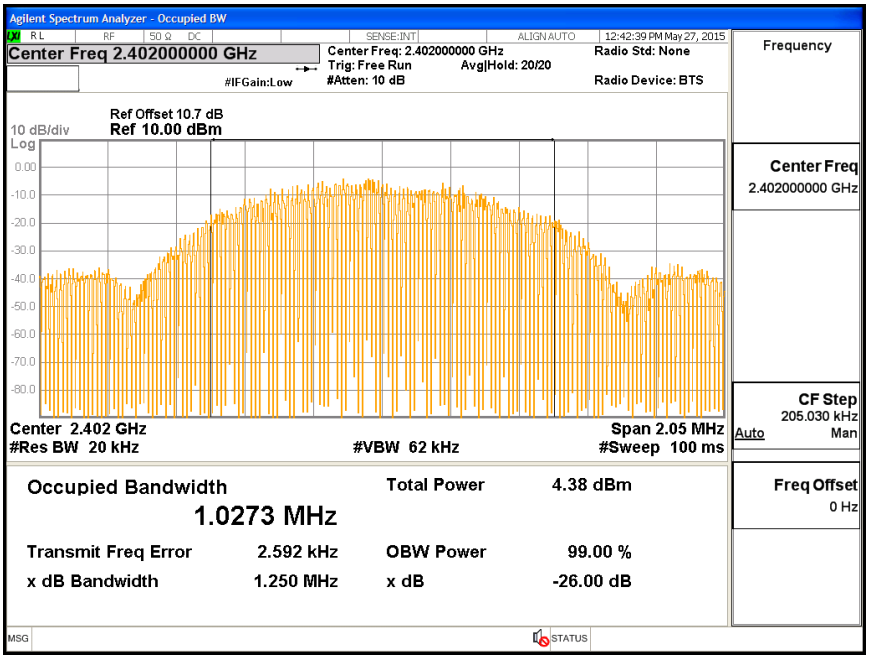
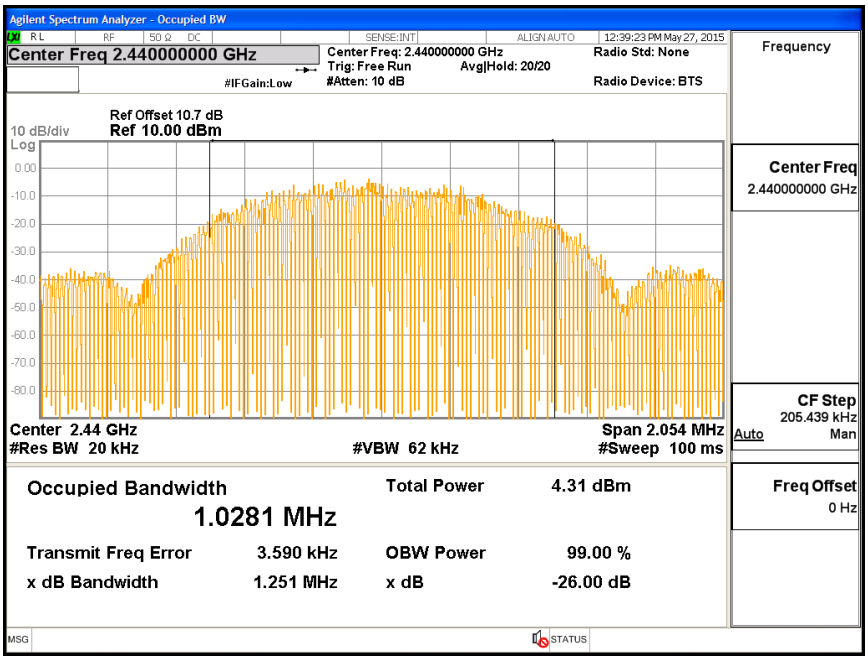
99% BANDWIDTH

99% BANDWIDTH LOW CH



99% BANDWIDTH MID CH



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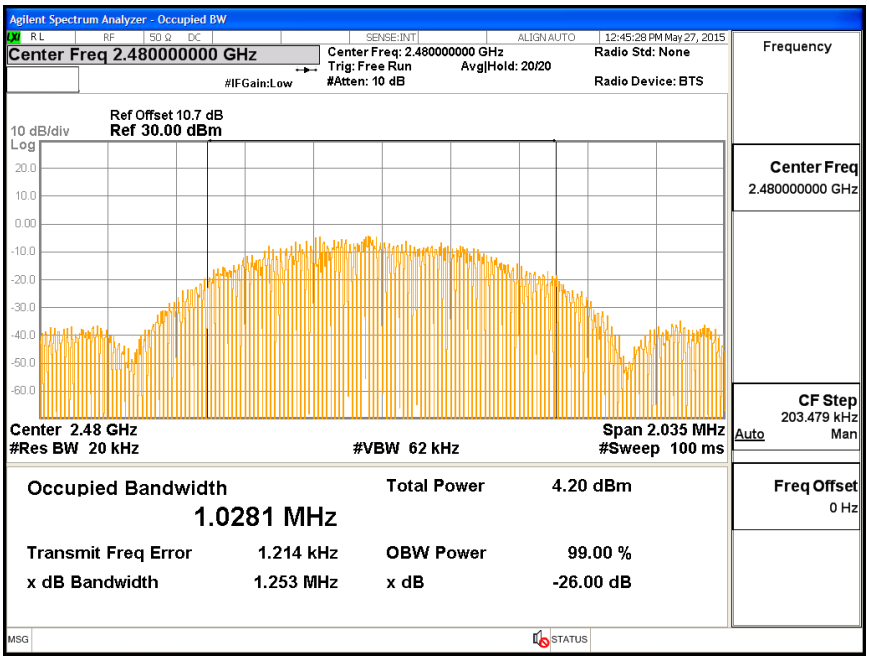
99% BANDWIDTH HIGH CH



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7.6. OUTPUT POWER ANTENNA 1

LIMITS

FCC §15.247 (b)

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

RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	6.352	30	-23.648
Middle	2440	6.172	30	-23.828
High	2480	5.892	30	-24.108

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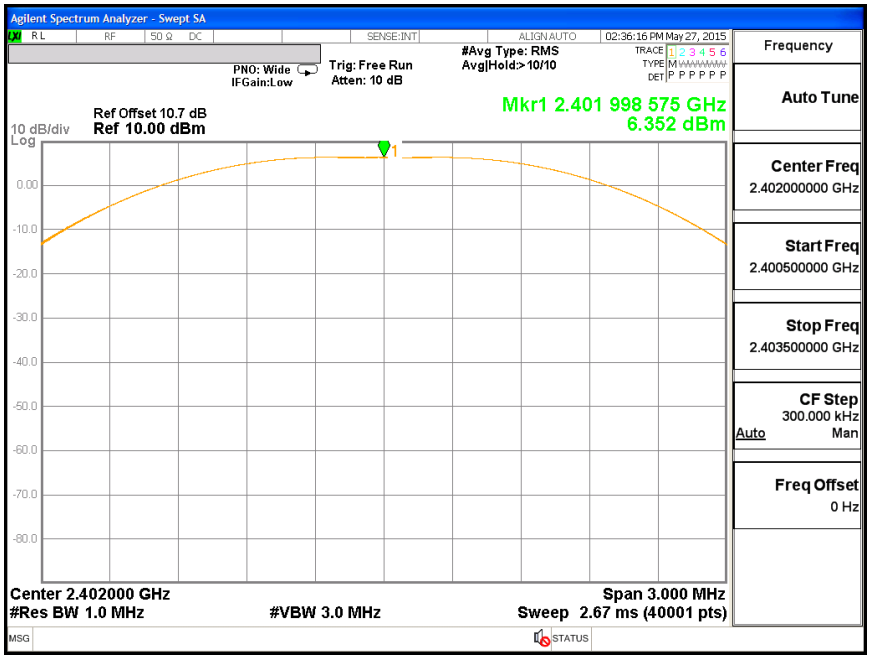
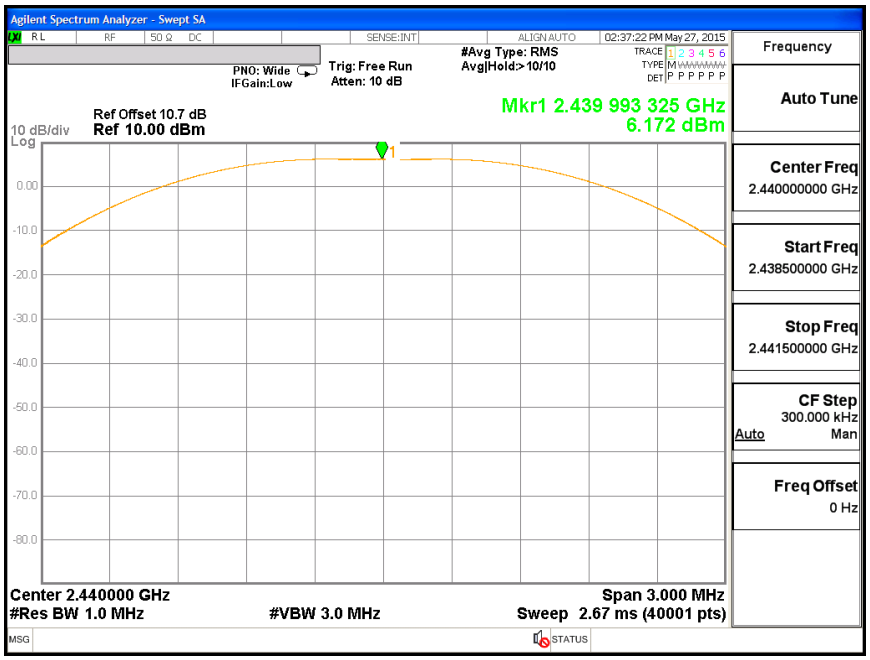
OUTPUT POWER

OUTPUT POWER LOW CH



OUTPUT POWER MID CH



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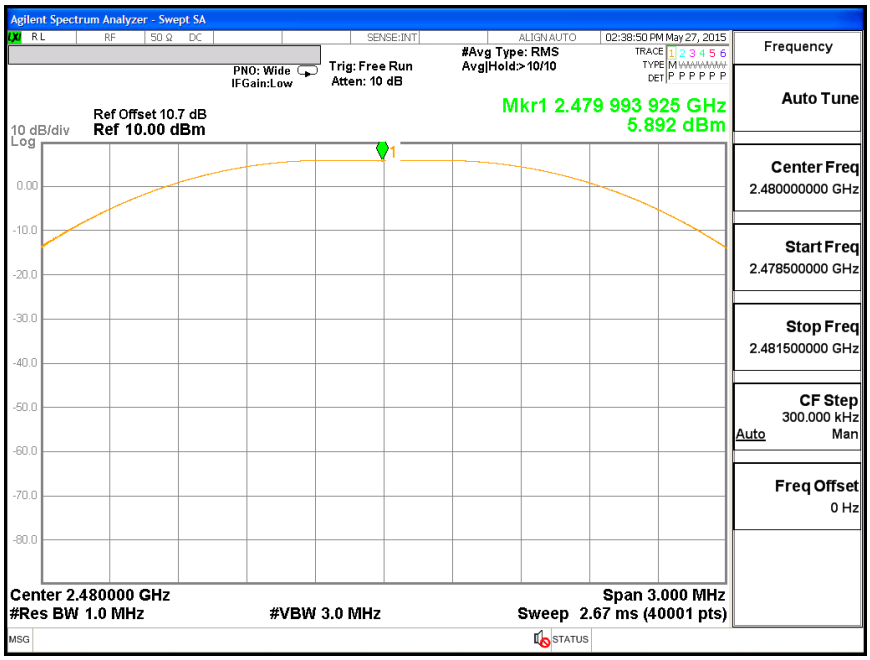
OUTPUT POWER HIGH CH



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7.7. OUTPUT POWER ANTENNA 2

LIMITS

FCC §15.247 (b)

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

RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	5.697	30	-24.303
Middle	2440	5.688	30	-24.312
High	2480	5.539	30	-24.461

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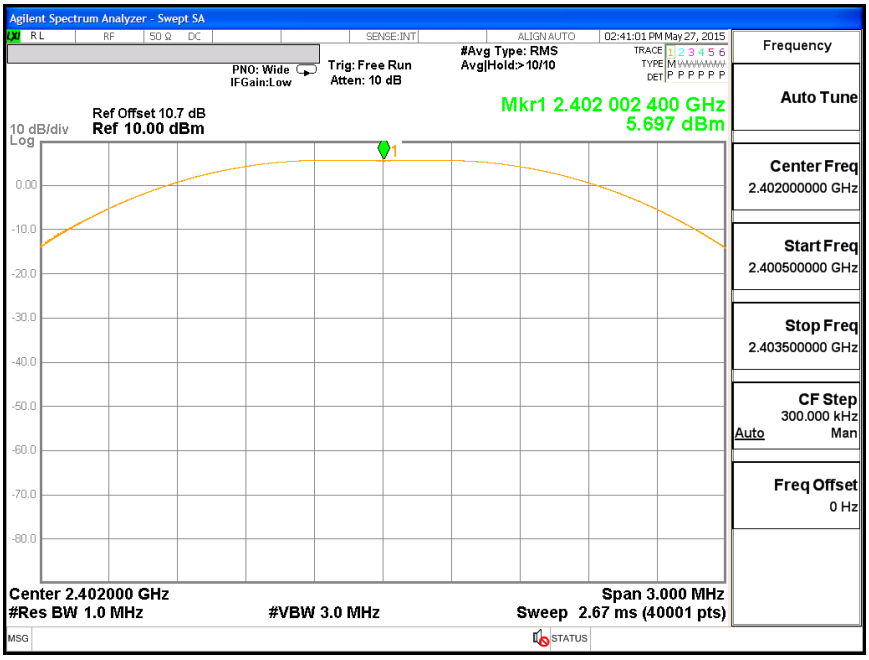
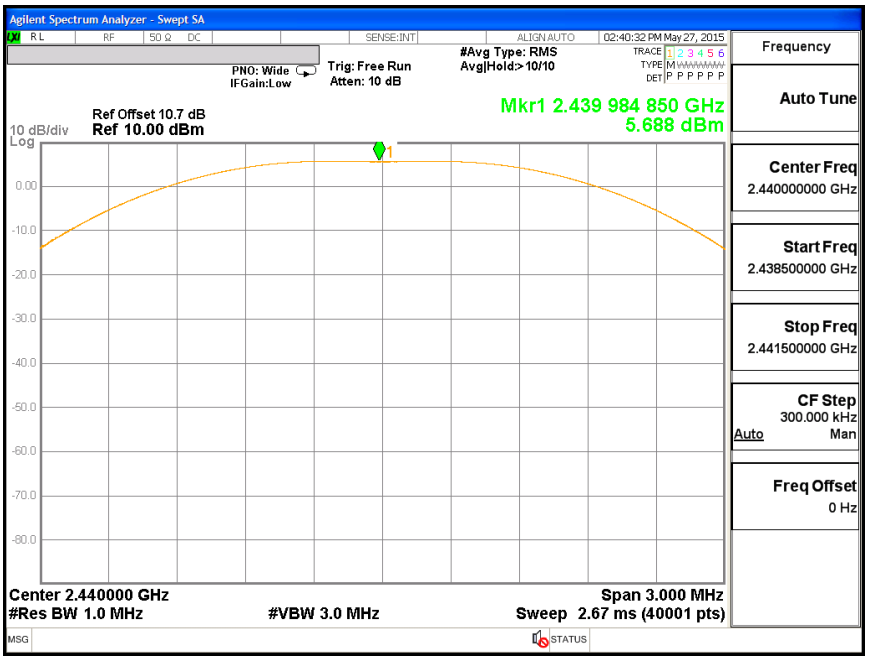
OUTPUT POWER

OUTPUT POWER LOW CH



OUTPUT POWER MID CH



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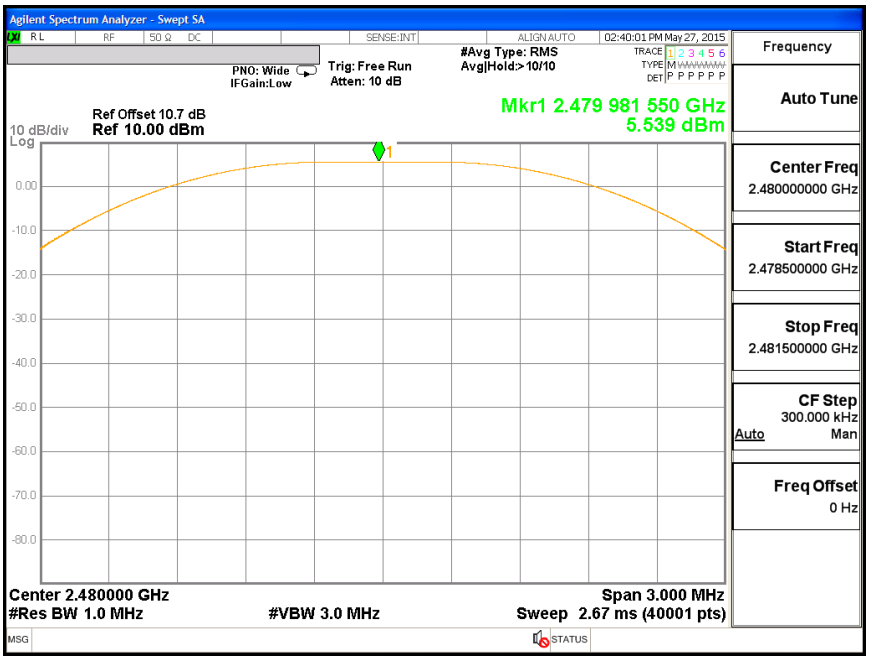
OUTPUT POWER HIGH CH



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7.8. AVERAGE POWER ANTENNA 1

LIMITS

None; for reporting purposes only.

RESULTS

The cable assembly insertion loss of 10.7dB (including 10 dB pad and 0.7dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	6.07
Middle	2440	5.93
High	2480	5.75

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7.9. AVERAGE POWER ANTENNA 2

LIMITS

None; for reporting purposes only.

RESULTS

The cable assembly insertion loss of 10.7 dB (including 10 dB pad and 0.7 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	5.57
Middle	2440	5.48
High	2480	5.42

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7.10. POWER SPECTRAL DENSITY ANTENNA 1

LIMITS

FCC §15.247 (e)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-9.039	8	-17.04
Middle	2440	-9.042	8	-17.04
High	2480	-9.309	8	-17.31

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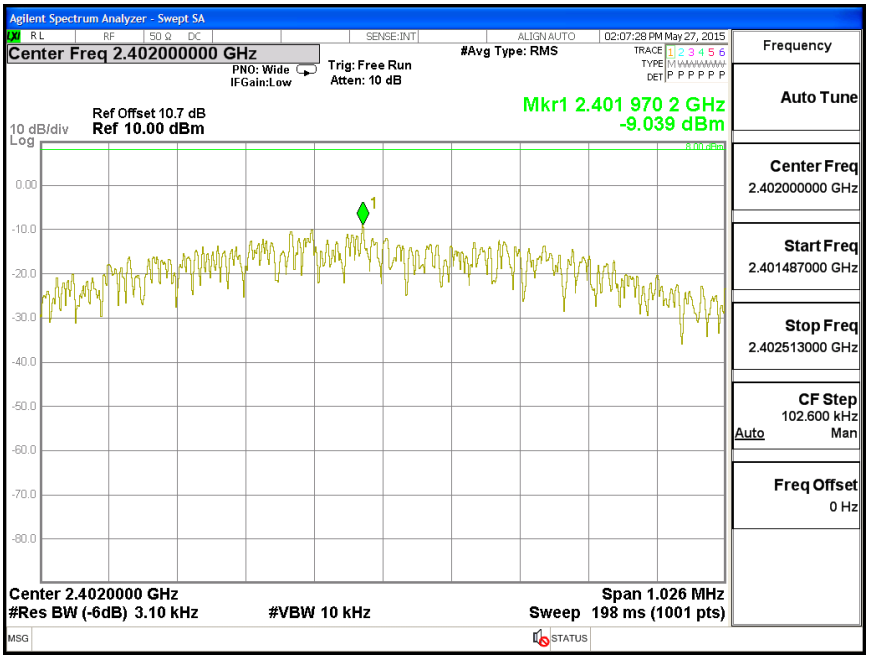
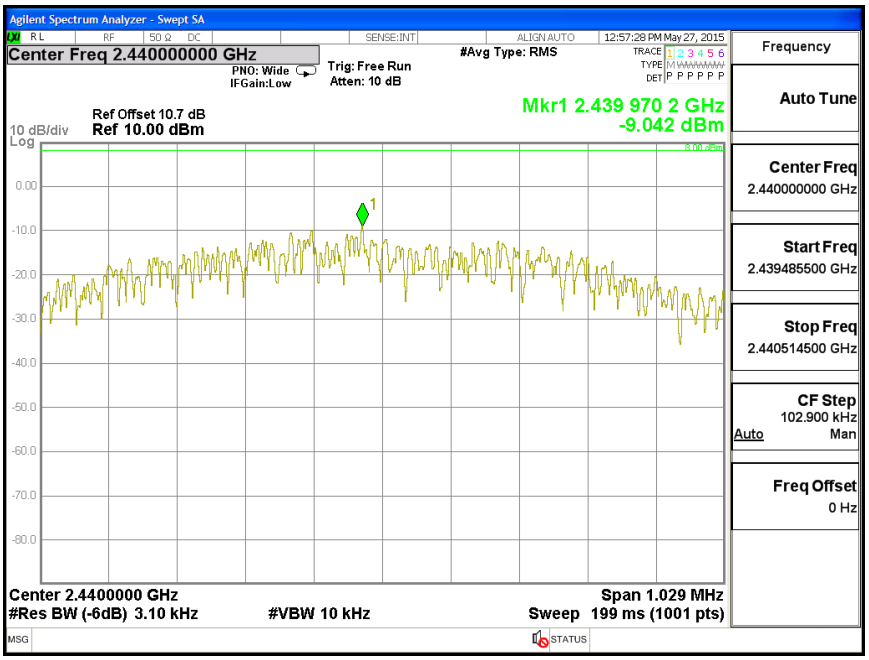
POWER SPECTRAL DENSITY

PSD LOW CH



PSD MID CH



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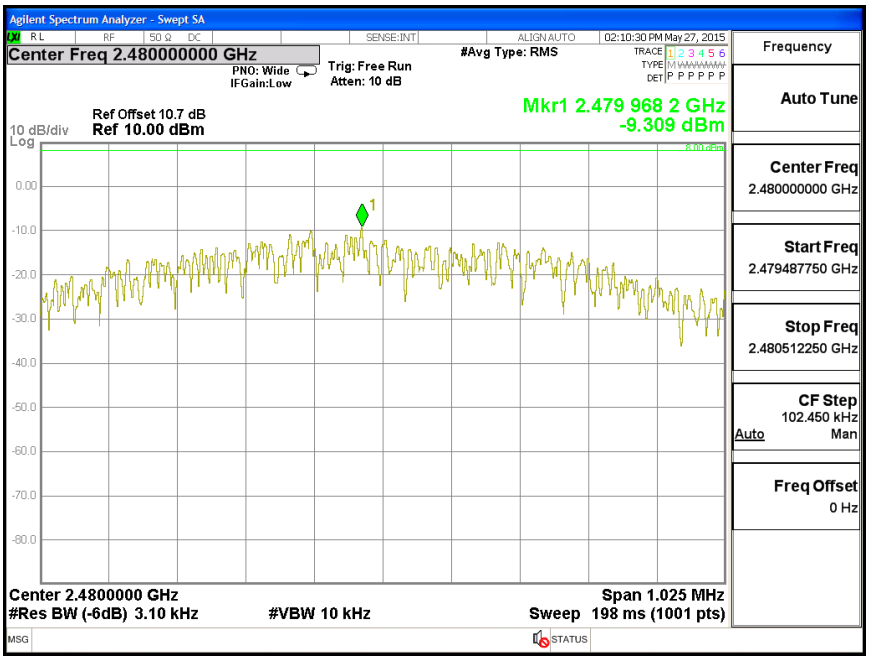
PSD HIGH CH



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7.11. POWER SPECTRAL DENSITY ANTENNA 2

LIMITS

FCC §15.247 (e)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-9.694	8	-17.69
Middle	2440	-9.680	8	-17.68
High	2480	-9.712	8	-17.71

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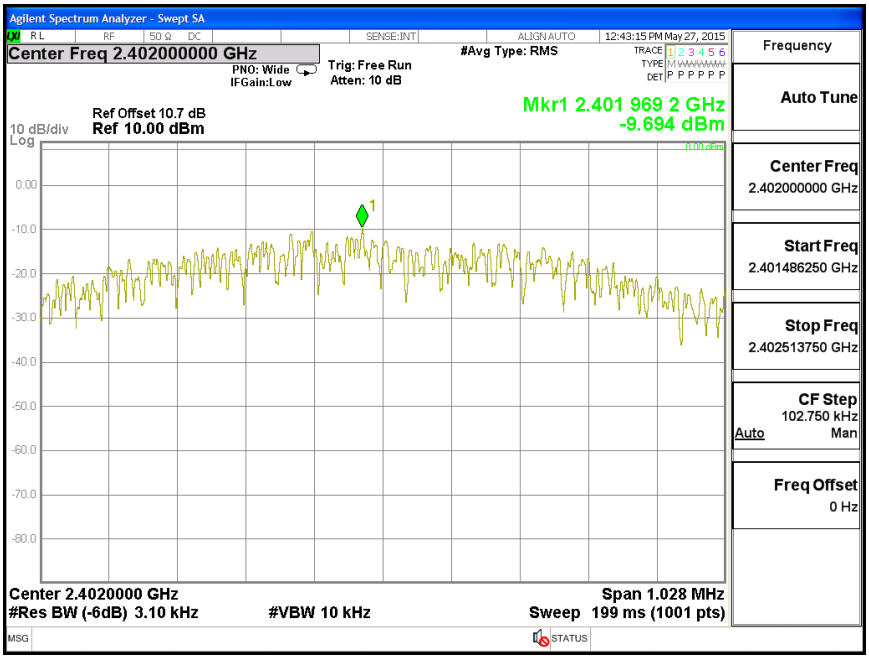
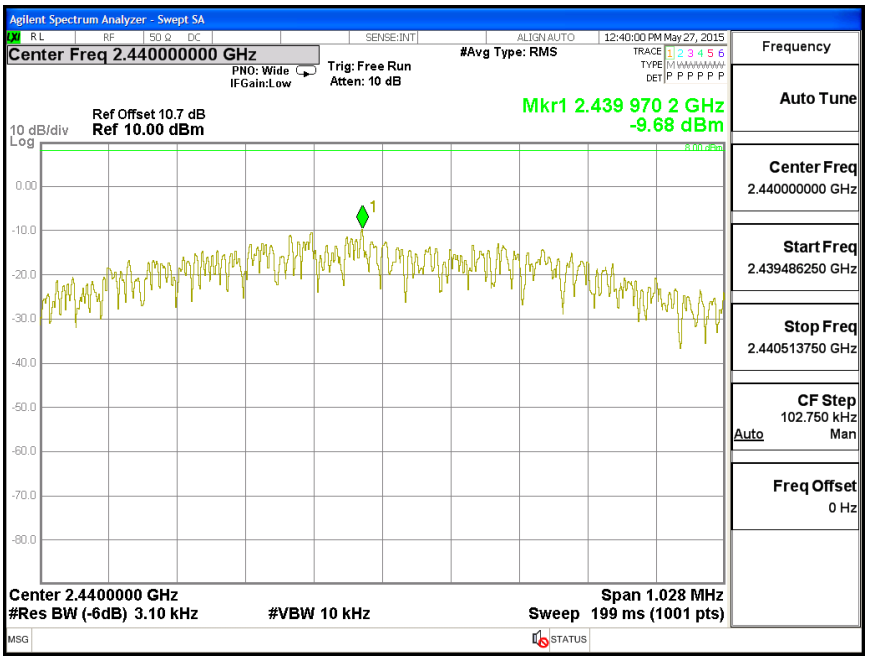
POWER SPECTRAL DENSITY

PSD LOW CH



PSD MID CH



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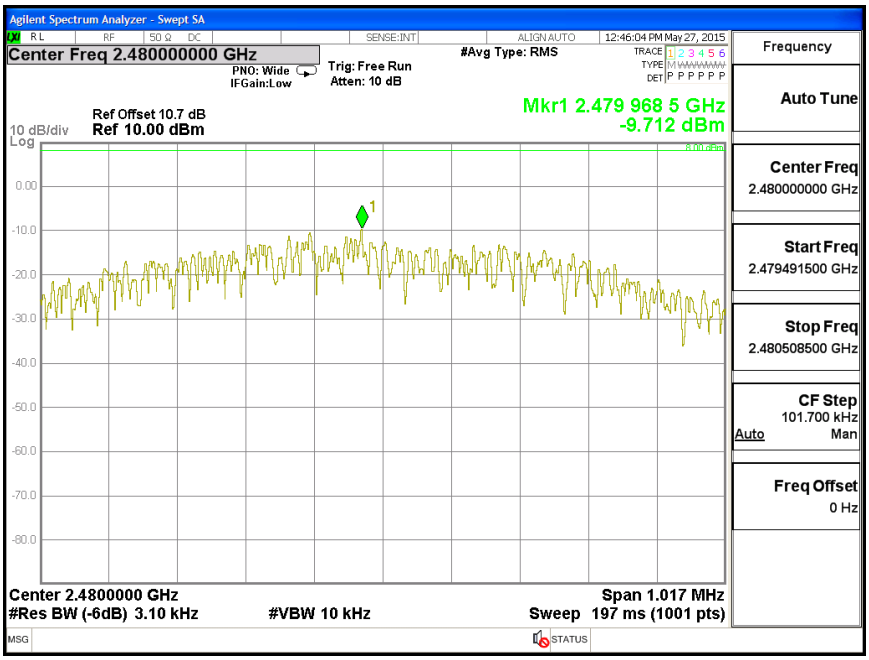
PSD HIGH CH



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7.12. CONDUCTED SPURIOUS EMISSIONS ANTENNA 1

LIMITS

FCC §15.247 (d)

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

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.

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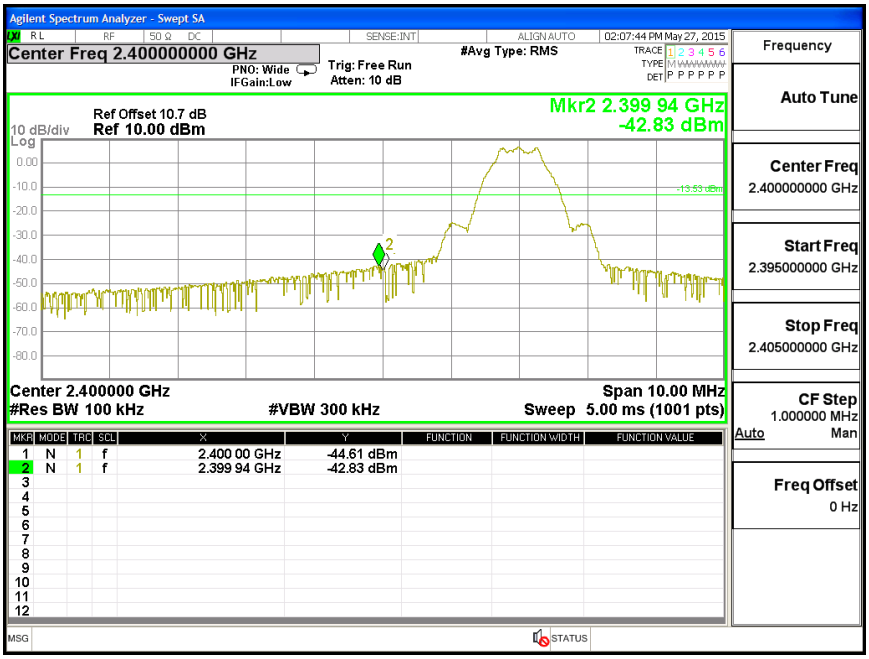
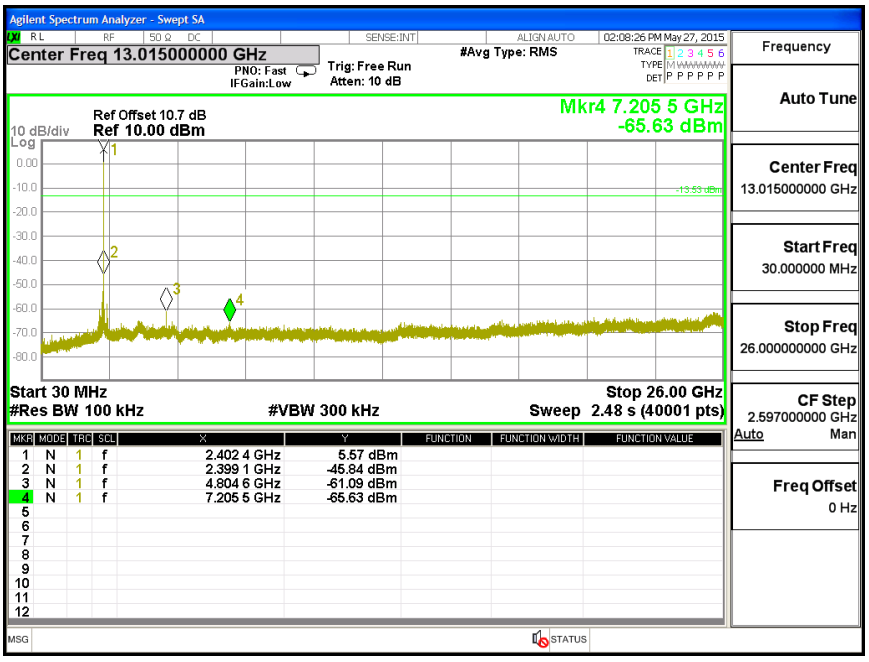
RESULTS

SPURIOUS EMISSIONS, LOW CHANNEL

LOW CH BANDEDGE



LOW CH SPURIOUS



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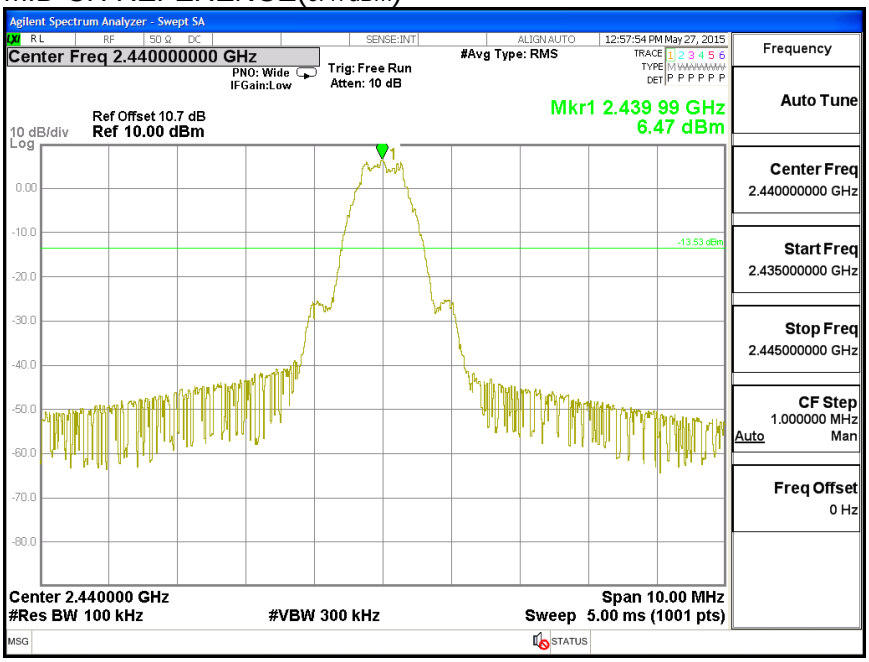
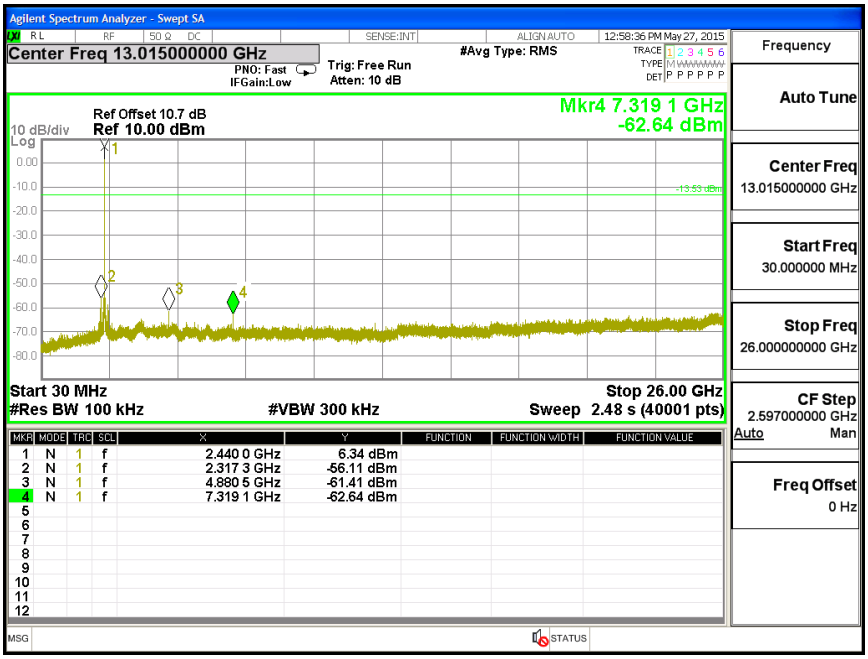
SPURIOUS EMISSIONS, MID CHANNEL

MID CH REFERENCE(6.47dBm)



MID CH SPURIOUS



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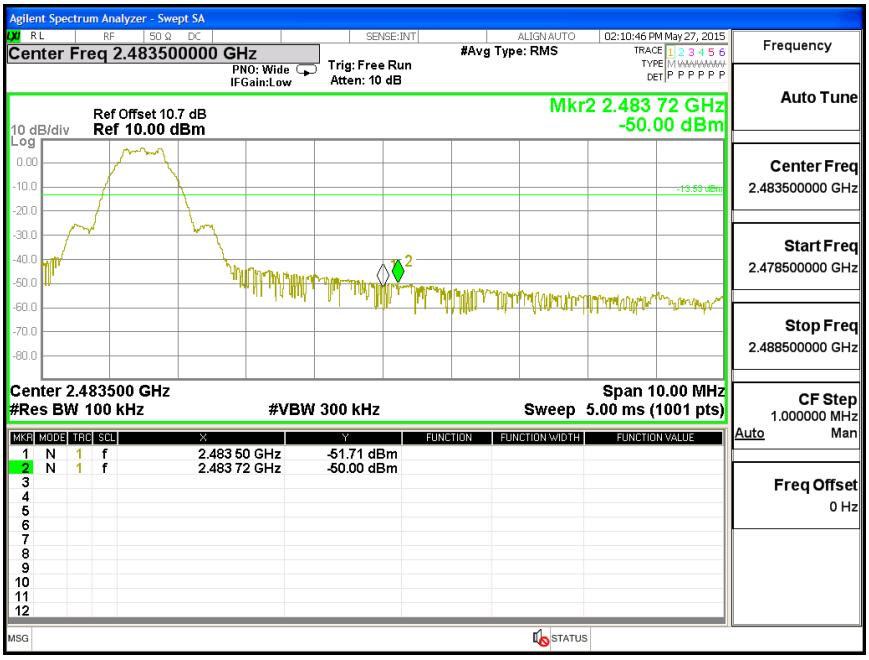
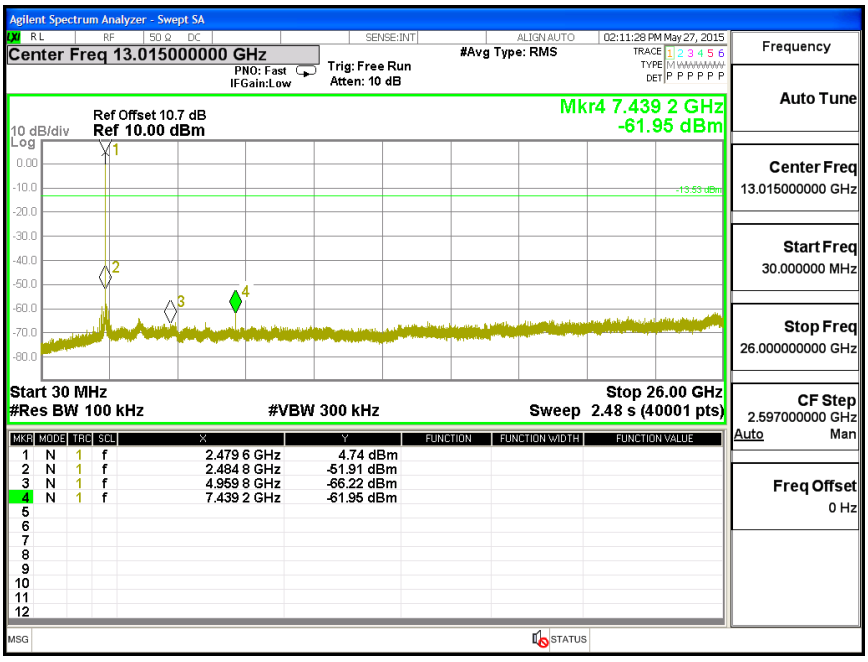
SPURIOUS EMISSIONS, HIGH CHANNEL

HIGH CH BANDEDGE



HIGH CH SPURIOUS



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7.13. CONDUCTED SPURIOUS EMISSIONS ANTENNA 2

LIMITS

FCC §15.247 (d)

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

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.

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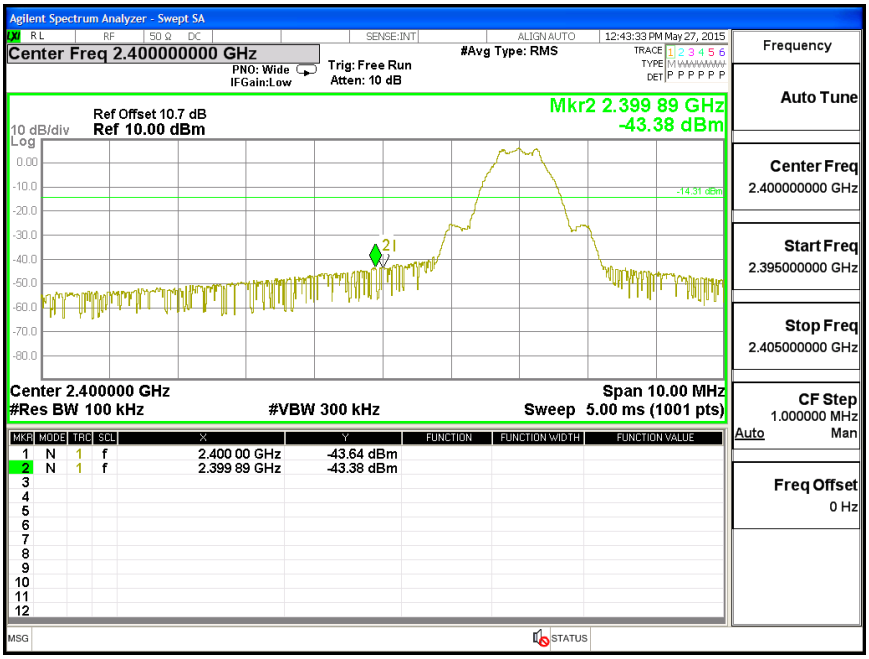
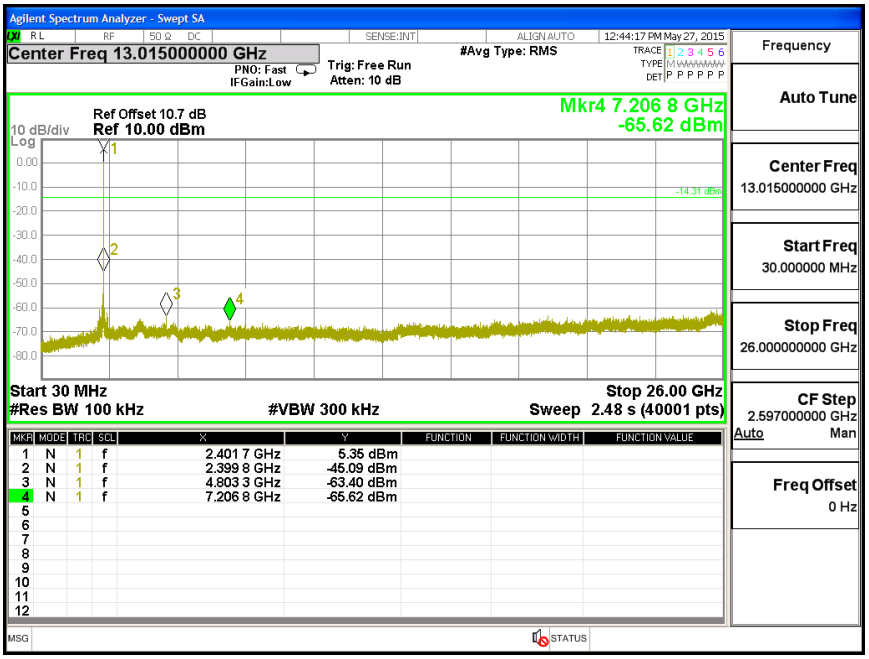
RESULTS

SPURIOUS EMISSIONS, LOW CHANNEL

LOW CH BANDEDGE



LOW CH SPURIOUS



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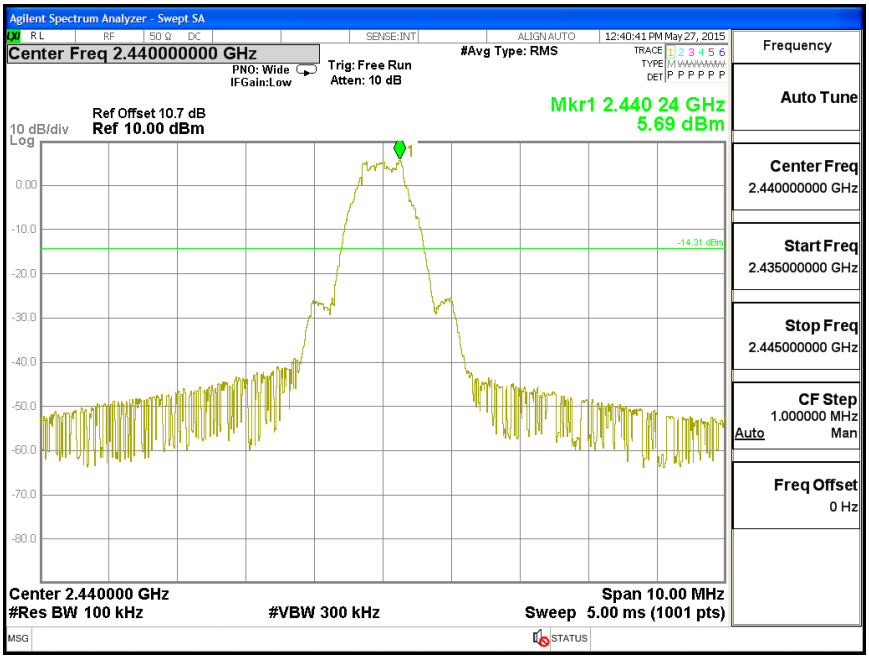
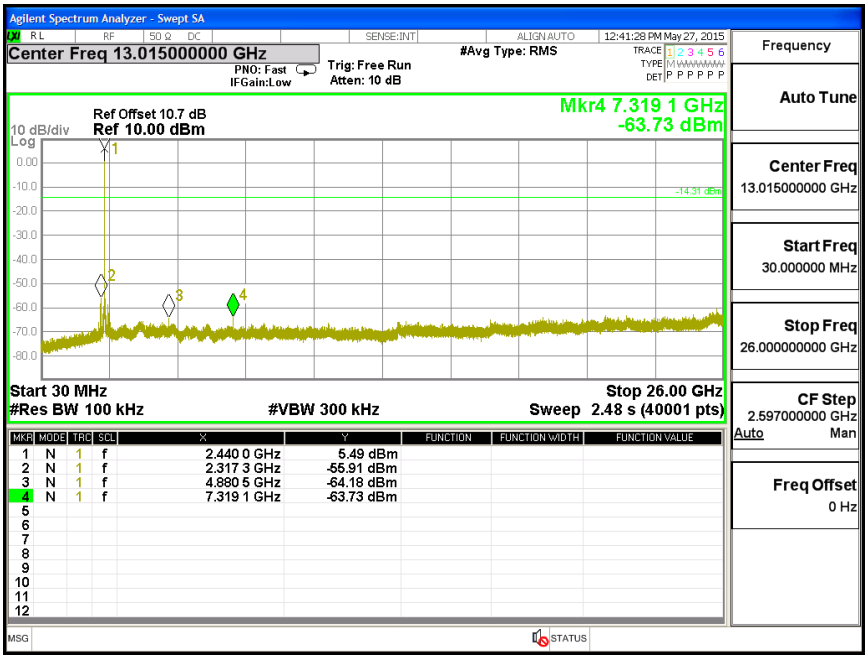
SPURIOUS EMISSIONS, MID CHANNEL

MID CH REFERENCE



MID CH SPURIOUS



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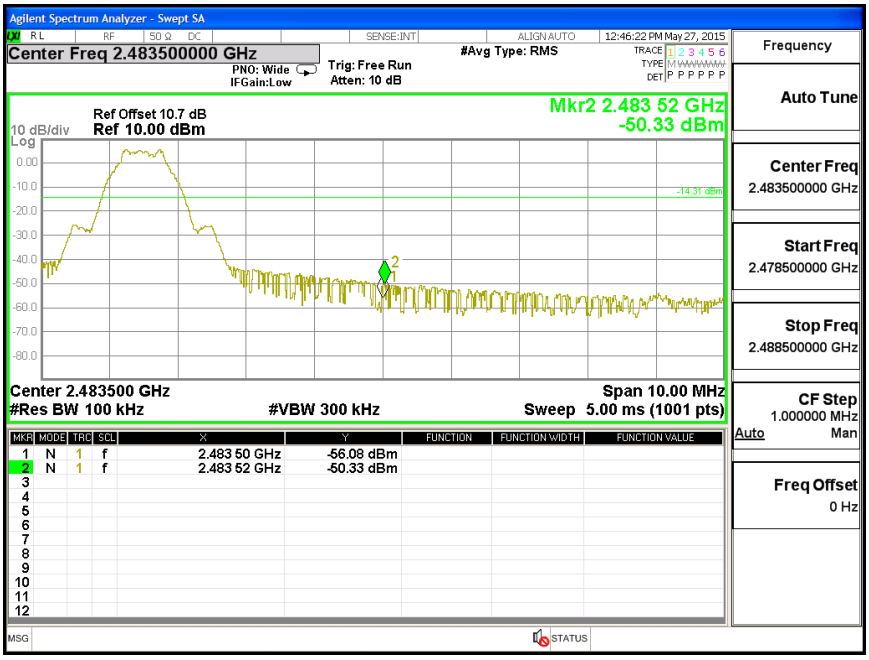
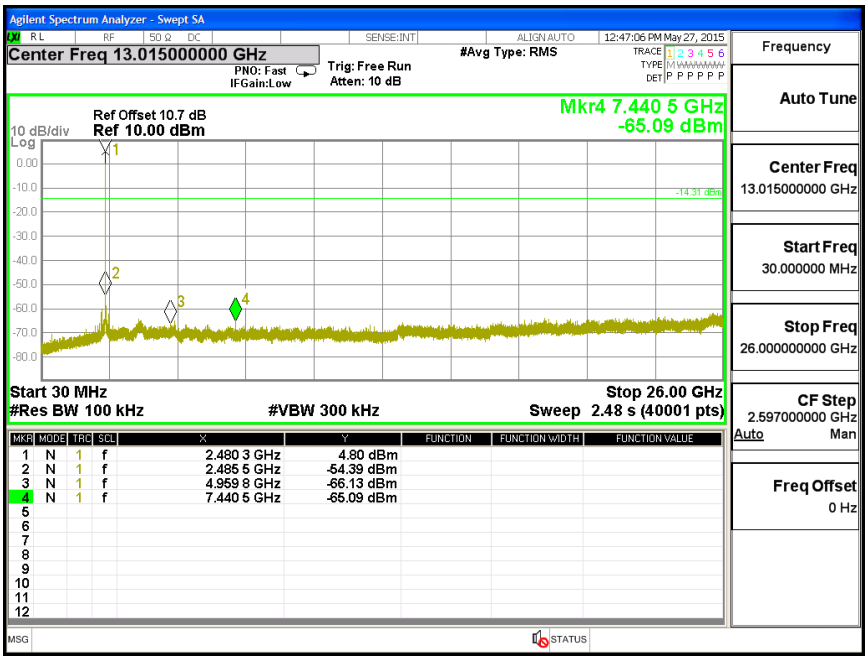
SPURIOUS EMISSIONS, HIGH CHANNEL

HIGH CH BANDEDGE



HIGH CH SPURIOUS



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8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

NCC § 2.7 and §2.8

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 for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. 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 3 MHz for peak measurements and 1 MHz resolution bandwidth with 3MHz video bandwidth with average detector 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.

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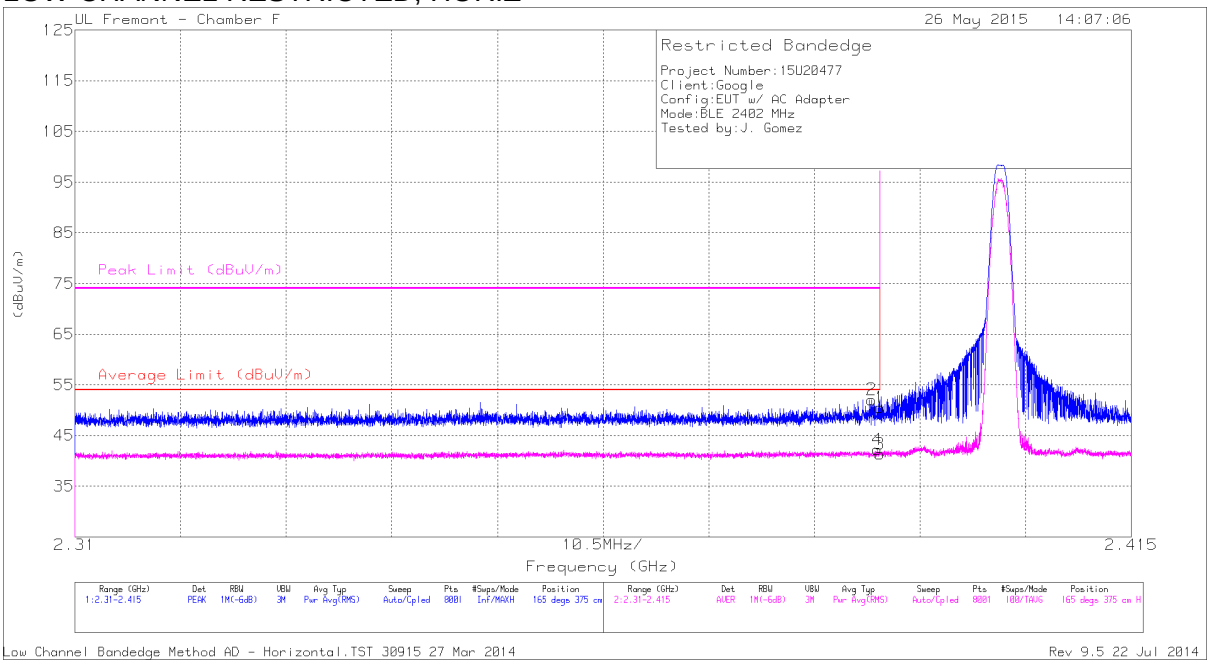
8.2. TX ABOVE 1 GHz FOR BLUETOOTH LOW ENERGY MODE IN THE 2.4 GHz BAND ANTENNA 1

RESTRICTED BANDEDGE (LOW CHANNEL)

LOW CHANNEL RESTRICTED, HORIZ



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Flt r/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	39.51	PK	31.9	-20.9	0	50.51	-	-	74	-23.49	165	375	H
2	* 2.389	41.09	PK	31.9	-20.9	0	52.09	-	-	74	-21.91	165	375	H
3	* 2.39	28.18	RMS	31.9	-20.9	2.19	41.37	54	-12.63	-	-	165	375	H
4	* 2.39	29	RMS	31.9	-20.9	2.19	42.19	54	-11.81	-	-	165	375	H

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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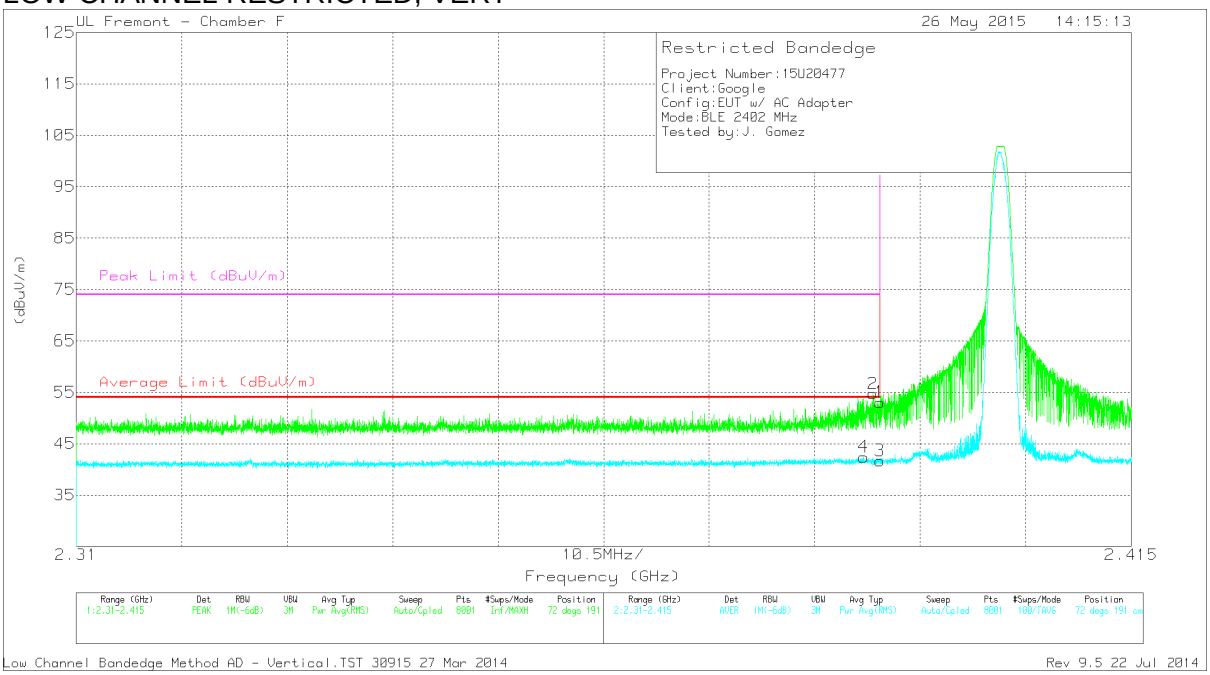
LOW CHANNEL RESTRICTED, VERT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	42.07	PK	31.9	-20.9	0	53.07	-	-	74	-20.93	72	191	V
2	* 2.389	43.73	PK	31.9	-20.9	0	54.73	-	-	74	-19.27	72	191	V
3	* 2.39	28.49	RMS	31.9	-20.9	2.19	41.68	54	-12.32	-	-	72	191	V
4	* 2.388	29.24	RMS	31.9	-20.9	2.19	42.43	54	-11.57	-	-	72	191	V

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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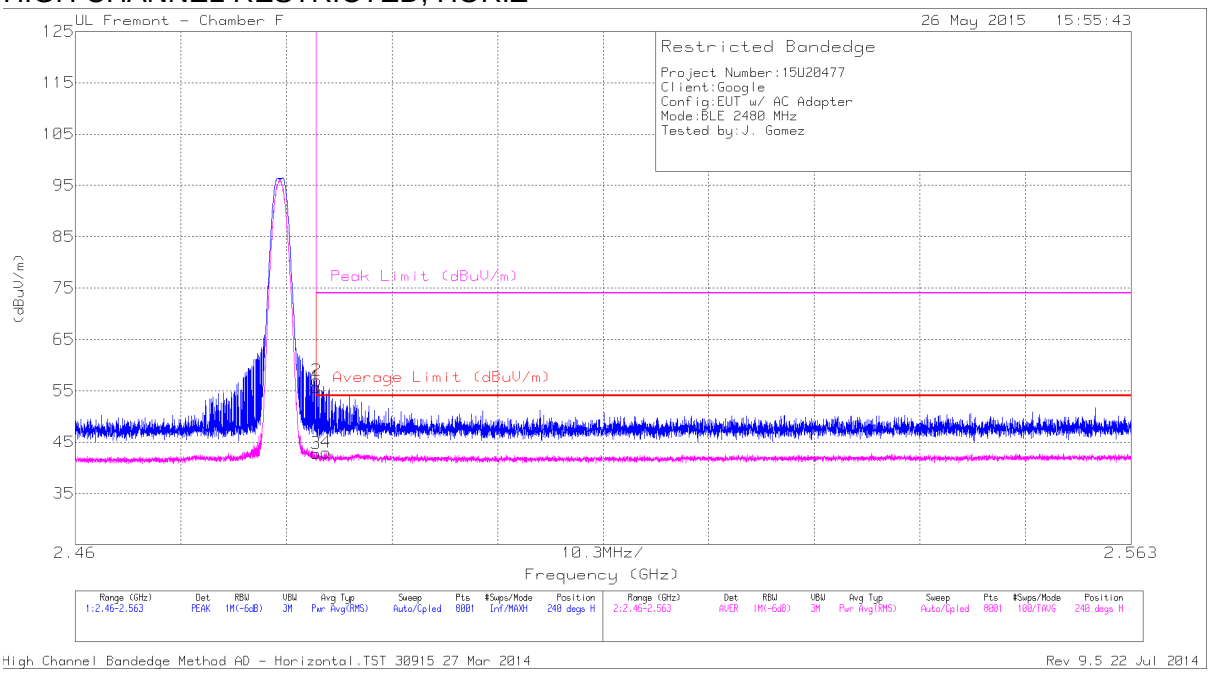
RESTRICTED BANDEDGE (HIGH CHANNEL)

HIGH CHANNEL RESTRICTED, HORIZ



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Flt r/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	44.35	PK	32.2	-20.9	0	55.65	-	-	74	-18.35	240	226	H
2	* 2.484	45.7	PK	32.2	-20.9	0	57	-	-	74	-17	240	226	H
3	* 2.484	29.3	RMS	32.2	-20.9	2.19	42.79	54	-11.21	-	-	240	226	H
4	* 2.485	29.47	RMS	32.2	-20.9	2.19	42.96	54	-11.04	-	-	240	226	H

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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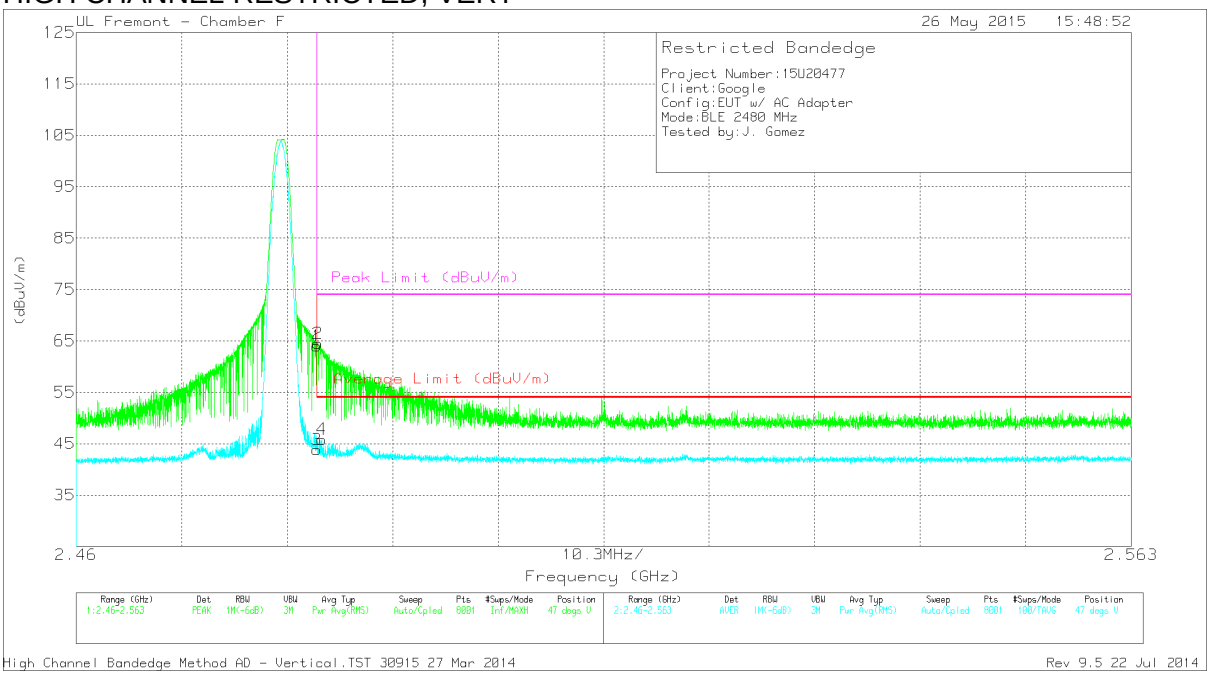
HIGH CHANNEL RESTRICTED, VERT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	52.7	PK	32.2	-20.9	0	64	-	-	74	-10	47	183	V
2	* 2.484	53.18	PK	32.2	-20.9	0	64.48	-	-	74	-9.52	47	183	V
3	* 2.484	30.35	RMS	32.2	-20.9	2.19	43.84	54	-10.16	-	-	47	183	V
4	* 2.484	32.34	RMS	32.2	-20.9	2.19	45.83	54	-8.17	-	-	47	183	V

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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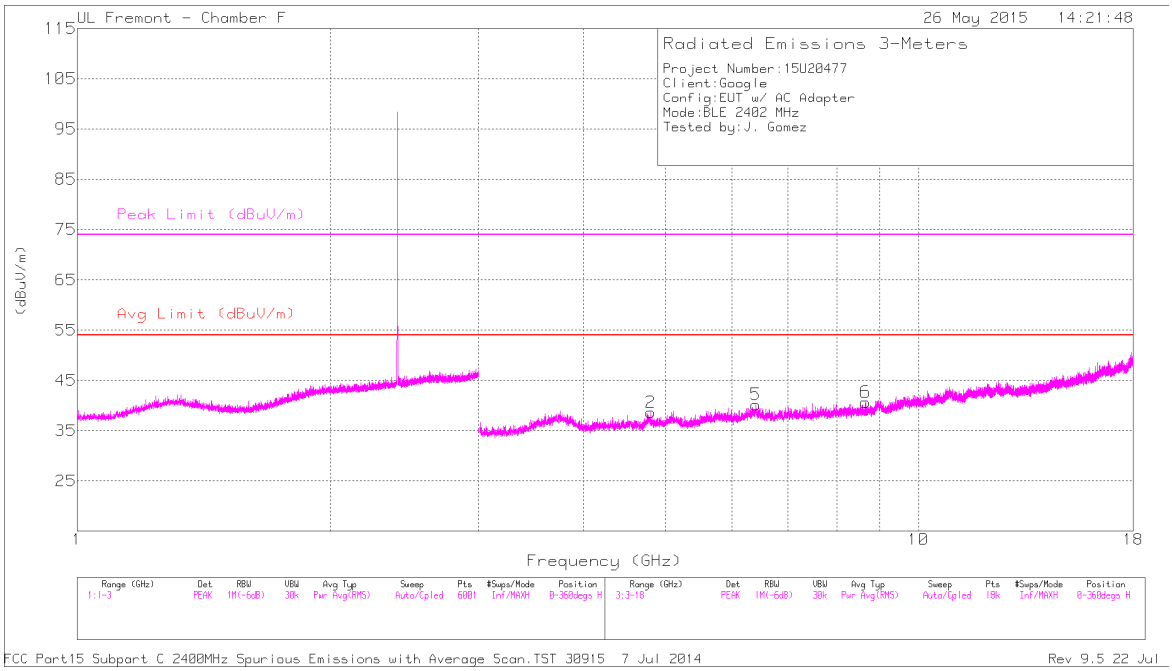
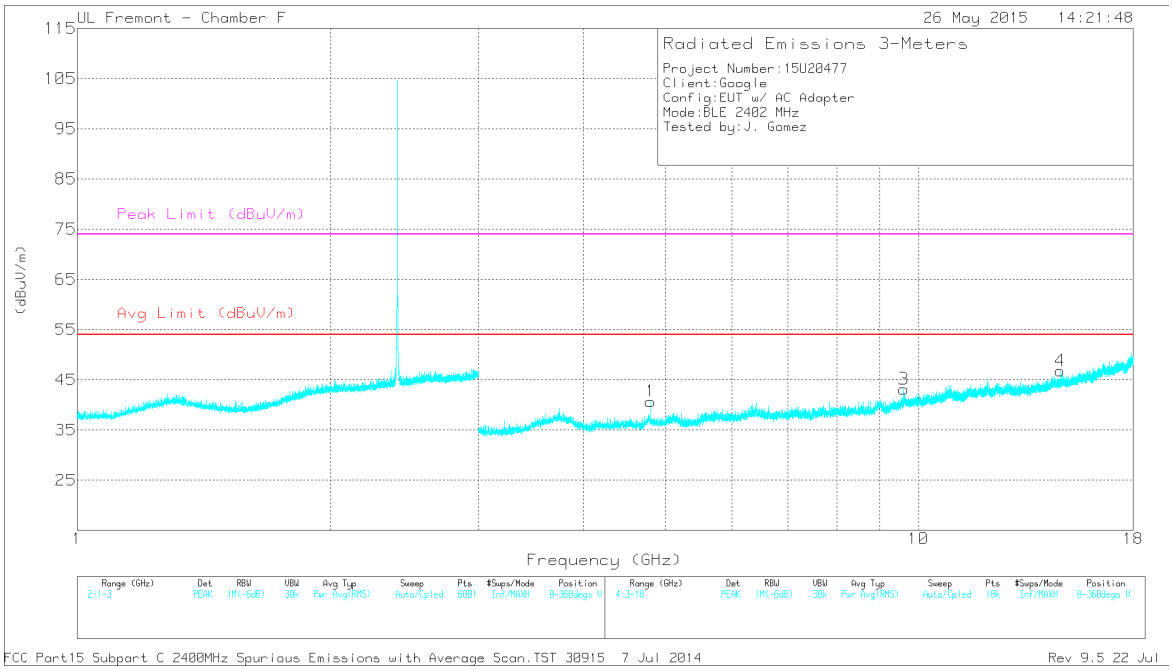
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr /Pad (db)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 4.804	40.11	PK2	34.1	-27.5	0	46.71	-	-	74	-27.29	354	182	H
	* 4.804	28.46	MAv1	34.1	-27.5	2.19	37.25	54	-16.75	-	-	354	182	H
5	6.406	30.79	PK	35.9	-26.5	0	40.19	-	-	-	-	0-360	201	H
6	8.653	28.6	PK	35.9	-23.8	0	40.7	-	-	-	-	0-360	100	H
1	* 4.804	39.06	PK2	34.1	-27.5	0	45.66	-	-	74	-28.34	68	105	V
	* 4.804	28.17	MAv1	34.1	-27.5	2.19	36.96	54	-17.04	-	-	68	105	V
3	9.609	27.47	PK	36.9	-21.2	0	43.17	-	-	-	-	0-360	201	V
4	14.743	30.4	PK	40.1	-23.7	0	46.8	-	-	-	-	0-360	201	V

* - indicates frequency in CFR 47, Part 15 and Industry Canada RSS-Restricted Band.

PK - Peak detector

PK2 - KDB558074 Method: Maximum Peak

MAv1 - KDB558074 Option 1 Maximum RMS Average

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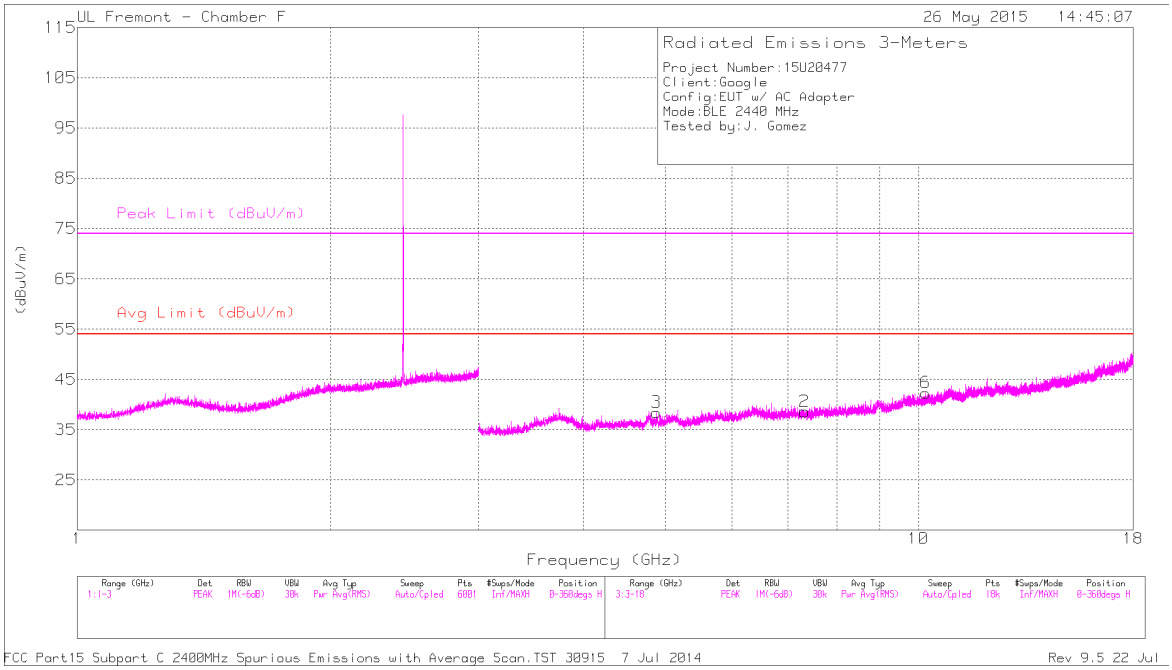
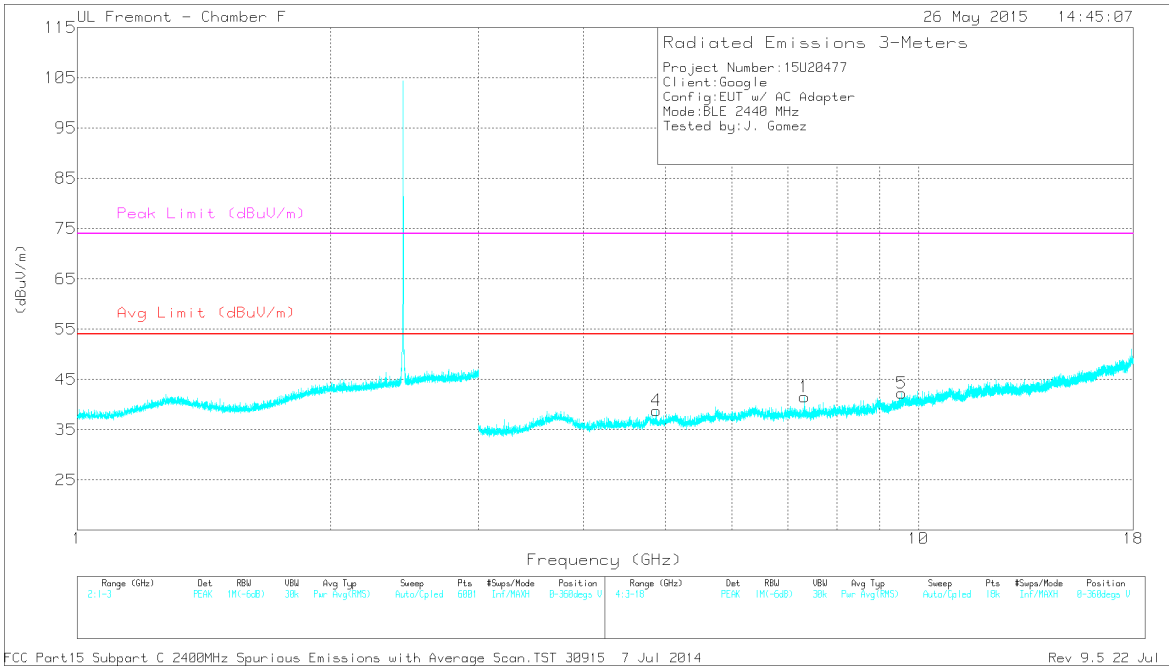
MID CHANNEL

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr /Pad (db)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 7.321	38.7	PK2	35.7	-26.3	0	48.1	-	-	74	-25.9	192	307	H
	* 7.319	27.43	MAv1	35.7	-26.3	2.19	39.02	54	-14.98	-	-	192	307	H
3	* 4.88	39.57	PK2	34.1	-27.9	0	45.77	-	-	74	-28.23	75	111	H
	* 4.88	28.1	MAv1	34.1	-27.9	2.19	36.49	54	-17.51	-	-	75	111	H
6	10.203	27.04	PK	37.2	-21.9	0	42.34	-	-	-	-	0-360	100	H
1	* 7.32	39.62	PK2	35.7	-26.3	0	49.02	-	-	74	-24.98	76	249	V
	* 7.319	29.63	MAv1	35.7	-26.3	2.19	41.22	54	-12.78	-	-	76	249	V
4	* 4.879	38.51	PK2	34.1	-27.9	0	44.71	-	-	74	-29.29	112	157	V
	* 4.88	28.36	MAv1	34.1	-27.9	2.19	36.75	54	-17.25	-	-	112	157	V
5	9.55	27.39	PK	36.8	-21.9	0	42.29	-	-	-	-	0-360	101	V

* - indicates frequency in CFR 47, Part 15 and Industry Canada RSS-Restricted Band.

PK - Peak detector

PK2 - KDB558074 Method: Maximum Peak

MAv1 - KDB558074 Option 1 Maximum RMS Average

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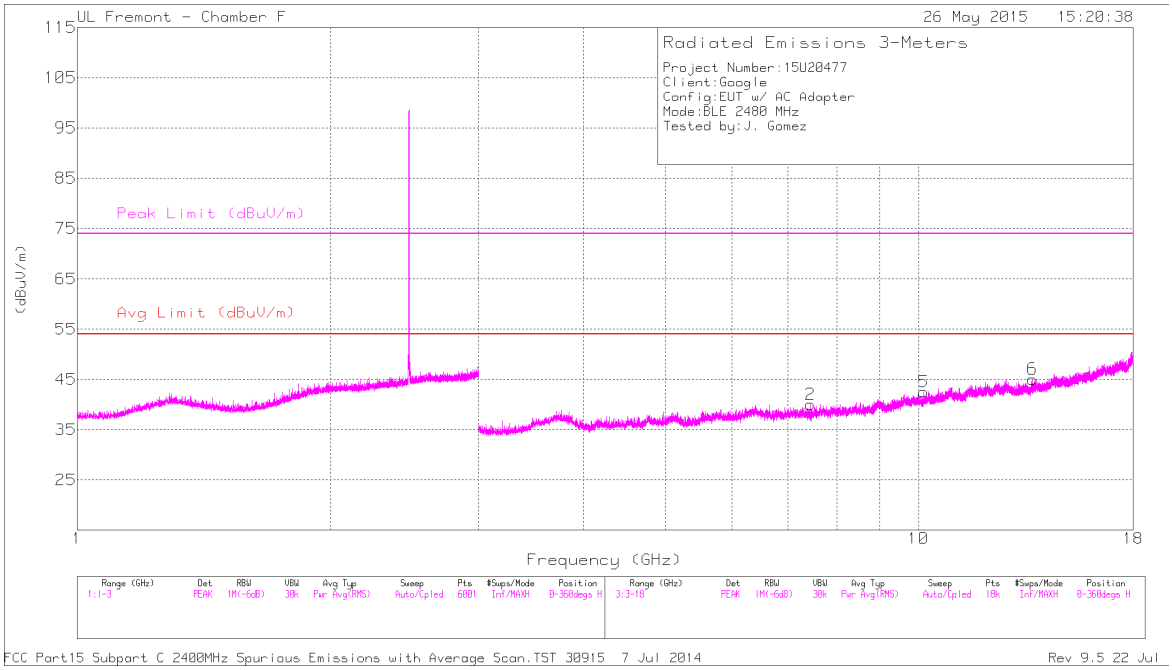
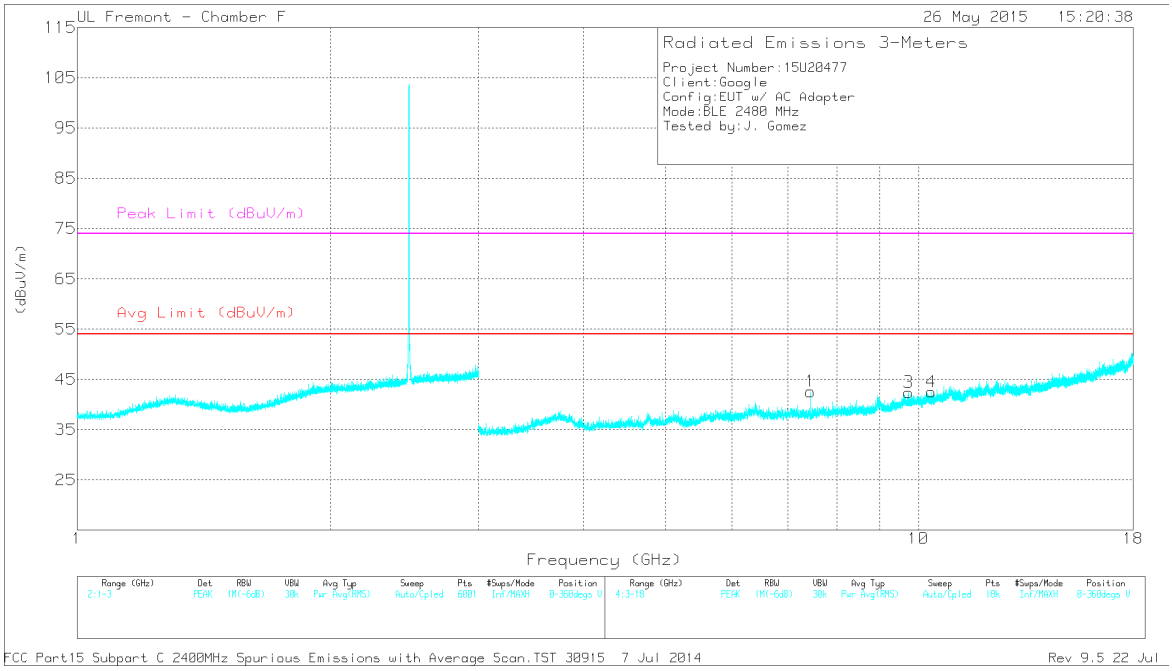
HIGH CHANNEL

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr /Pad (db)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 7.439	37.61	PK2	35.7	-26	0	47.31	-	-	74	-26.69	0	284	H
	* 7.439	26.94	MAv1	35.7	-26	2.19	38.83	54	-15.17	-	-	0	284	H
5	10.152	27.22	PK	37.2	-21.9	0	42.52	-	-	-	-	0-360	201	H
6	13.656	29.78	PK	38.9	-23.6	0	45.08	-	-	-	-	0-360	201	H
1	* 7.439	39.89	PK2	35.7	-26	0	49.59	-	-	74	-24.41	110	136	V
	* 7.439	30.25	MAv1	35.7	-26	2.19	42.14	54	-11.86	-	-	110	136	V
3	9.732	27.83	PK	37.1	-22.5	0	42.43	-	-	-	-	0-360	202	V
4	10.364	27.54	PK	37.3	-22.3	0	42.54	-	-	-	-	0-360	202	V

* - indicates frequency in CFR 47, Part 15 and Industry Canada RSS-Restricted Band.

PK - Peak detector

PK2 - KDB558074 Method: Maximum Peak

MAv1 - KDB558074 Option 1 Maximum RMS Average

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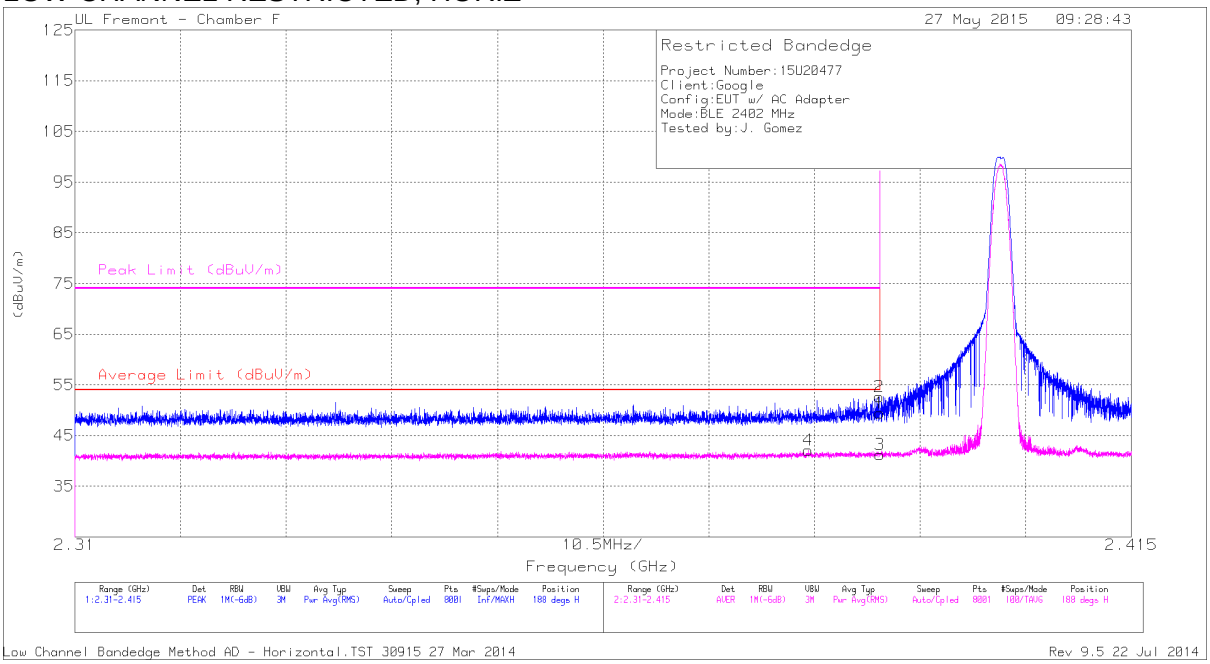
8.3. TX ABOVE 1 GHz FOR BLUETOOTH LOW ENERGY MODE IN THE 2.4 GHz BAND ANTENNA 2

RESTRICTED BANDEDGE (LOW CHANNEL)

LOW CHANNEL RESTRICTED, HORIZ



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Flt r/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	38.47	PK	31.9	-20.9	0	49.47	-	-	74	-24.53	188	272	H
2	* 2.39	41.65	PK	31.9	-20.9	0	52.65	-	-	74	-21.35	188	272	H
3	* 2.39	28.05	RMS	31.9	-20.9	2.19	41.24	54	-12.76	-	-	188	272	H
4	* 2.383	28.87	RMS	31.9	-20.9	2.19	42.06	54	-11.94	-	-	188	272	H

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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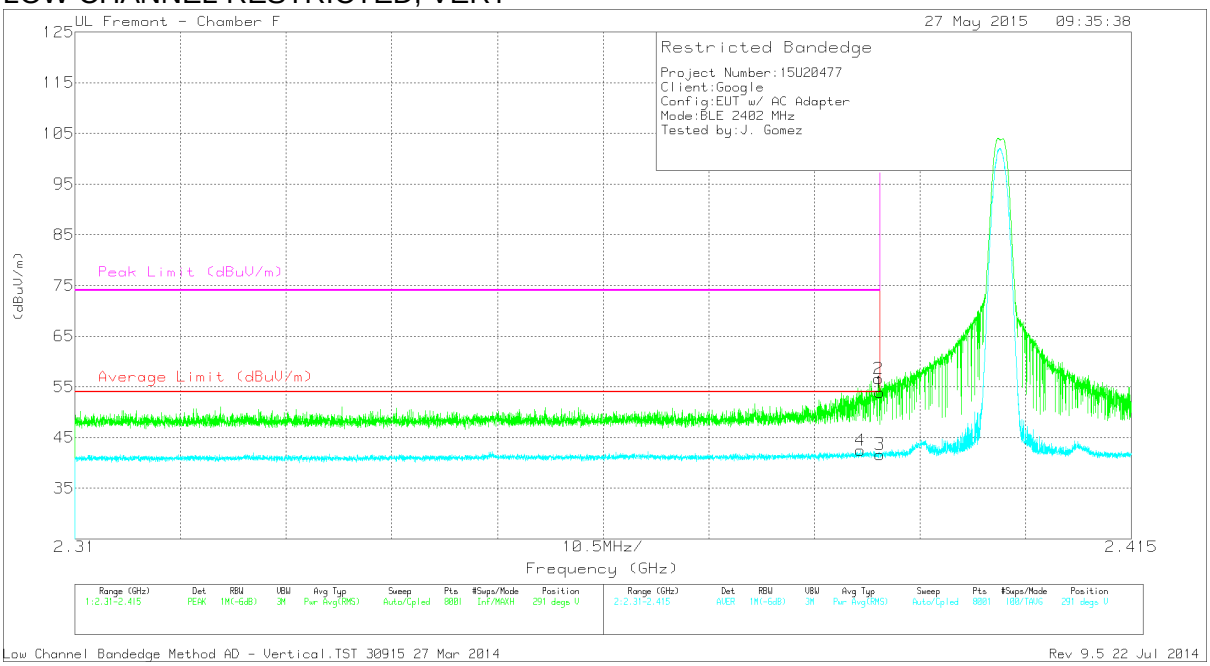
LOW CHANNEL RESTRICTED, VERT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	42.9	PK	31.9	-20.9	0	53.9	-	-	74	-20.1	291	107	V
2	* 2.39	45.66	PK	31.9	-20.9	0	56.66	-	-	74	-17.34	291	107	V
3	* 2.39	28.47	RMS	31.9	-20.9	2.19	41.66	54	-12.34	-	-	291	107	V
4	* 2.388	29.28	RMS	31.9	-20.9	2.19	42.47	54	-11.53	-	-	291	107	V

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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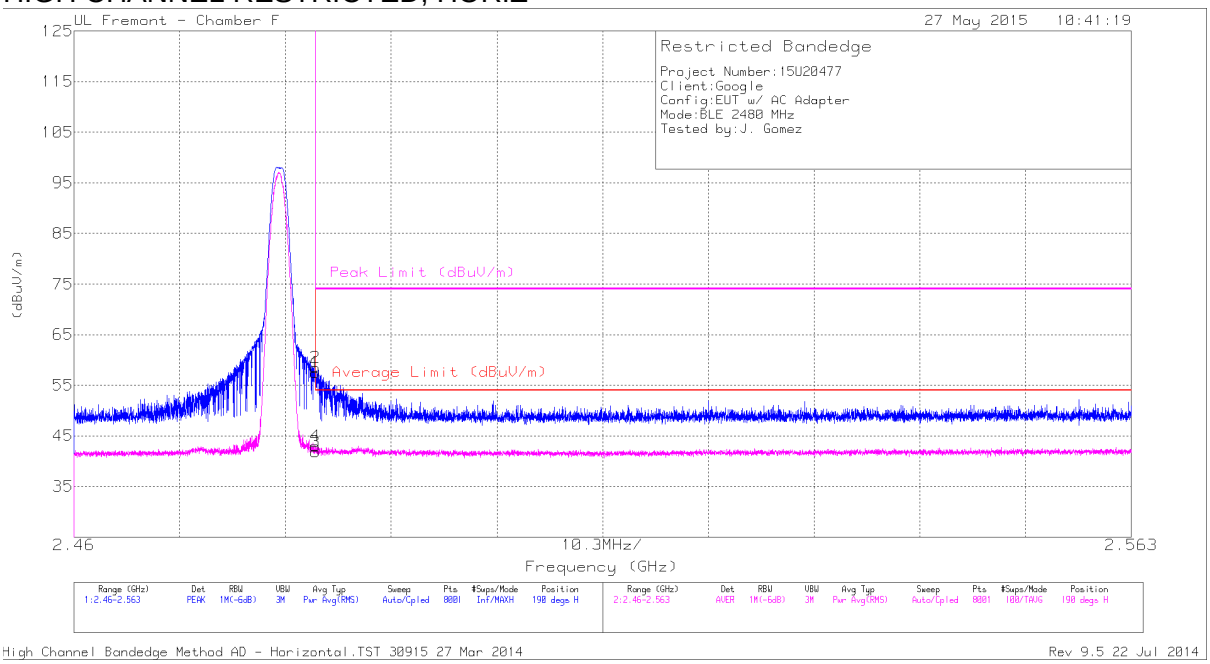
RESTRICTED BANDEDGE (HIGH CHANNEL)

HIGH CHANNEL RESTRICTED, HORIZ



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Flt r/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	46.21	PK	32.2	-20.9	0	57.51	-	-	74	-16.49	190	115	H
2	* 2.484	47.14	PK	32.2	-20.9	0	58.44	-	-	74	-15.56	190	115	H
3	* 2.484	28.38	RMS	32.2	-20.9	2.19	41.87	54	-12.13	-	-	190	115	H
4	* 2.484	29.52	RMS	32.2	-20.9	2.19	43.01	54	-10.99	-	-	190	115	H

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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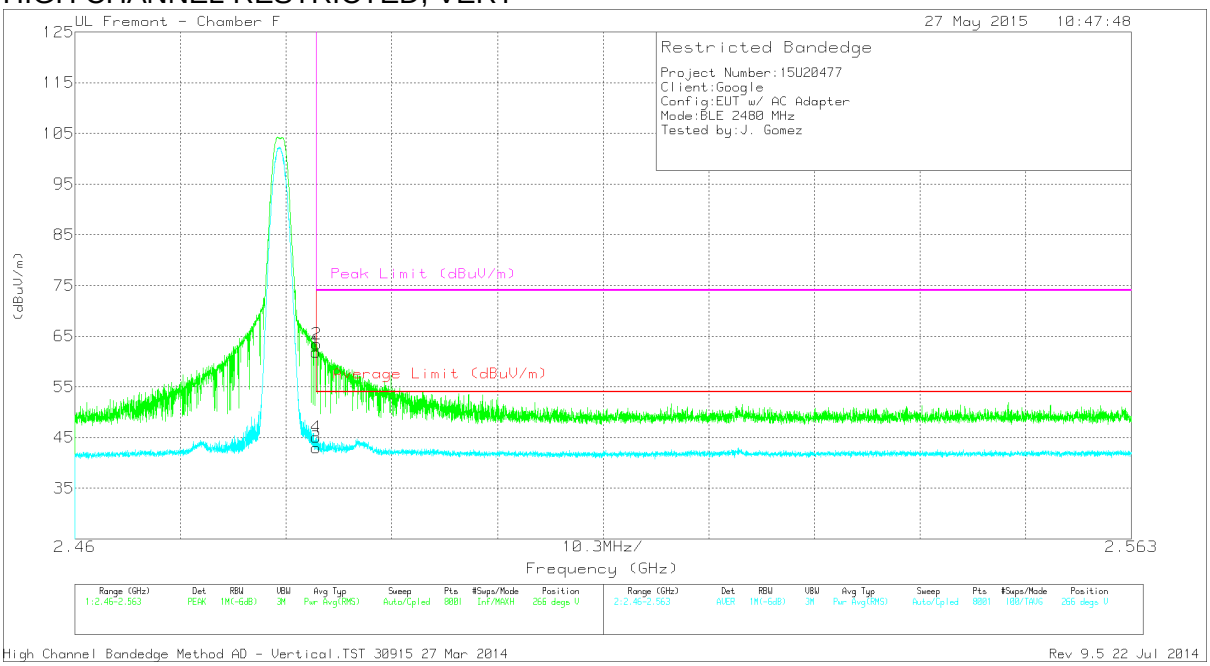
HIGH CHANNEL RESTRICTED, VERT



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	50.49	PK	32.2	-20.9	0	61.79	-	-	74	-12.21	266	140	V
2	* 2.484	52.15	PK	32.2	-20.9	0	63.45	-	-	74	-10.55	266	140	V
3	* 2.484	29.54	RMS	32.2	-20.9	2.19	43.03	54	-10.97	-	-	266	140	V
4	* 2.484	31.57	RMS	32.2	-20.9	2.19	45.06	54	-8.94	-	-	266	140	V

* - indicates frequency in CFR 47, Part 15 Restricted Band" and "Industry Canada RSS-Restricted Band

PK - Peak detector
RMS - RMS detection

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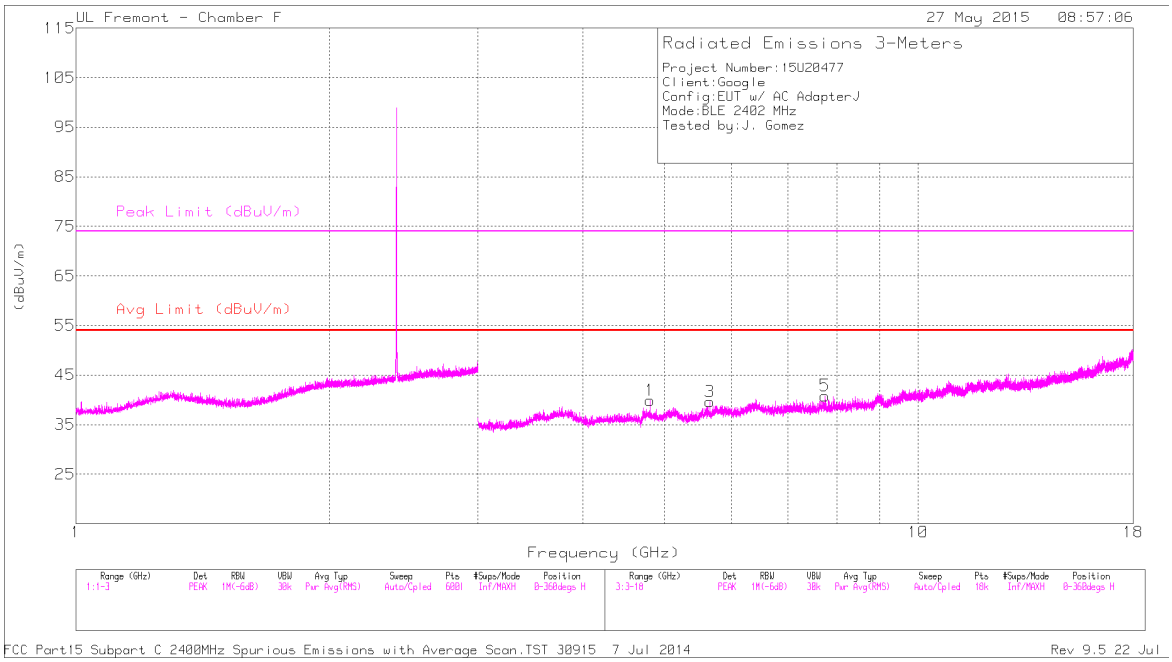
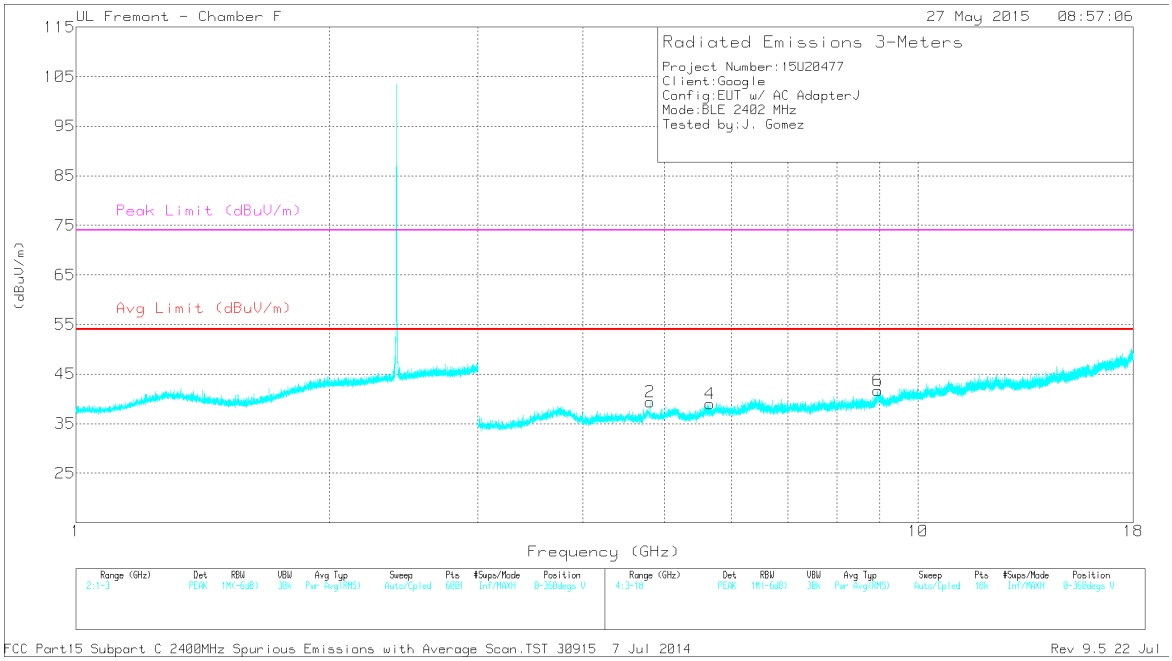
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr /Pad (db)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.804	40.19	PK2	34.1	-27.5	0	46.79	-	-	74	-27.21	21	273	H
	* 4.804	30.76	MAv1	34.1	-27.5	2.19	39.55	54	-14.45	-	-	21	273	H
3	5.654	32.55	PK	34.8	-27.7	0	39.65	-	-	-	-	0-360	101	H
5	7.756	30.44	PK	35.7	-25.3	0	40.84	-	-	-	-	0-360	101	H
2	* 4.804	39.79	PK2	34.1	-27.5	0	46.39	-	-	74	-27.61	152	222	V
	* 4.804	29.05	MAv1	34.1	-27.5	2.19	37.84	54	-16.16	-	-	152	222	V
4	5.657	31.92	PK	34.8	-27.7	0	39.02	-	-	-	-	0-360	101	V
6	8.958	27.72	PK	36.1	-22.2	0	41.62	-	-	-	-	0-360	201	V

* - indicates frequency in CFR 47, Part 15 and Industry Canada RSS-Restricted Band.

PK - Peak detector

PK2 - KDB558074 Method: Maximum Peak

MAv1 - KDB558074 Option 1 Maximum RMS Average

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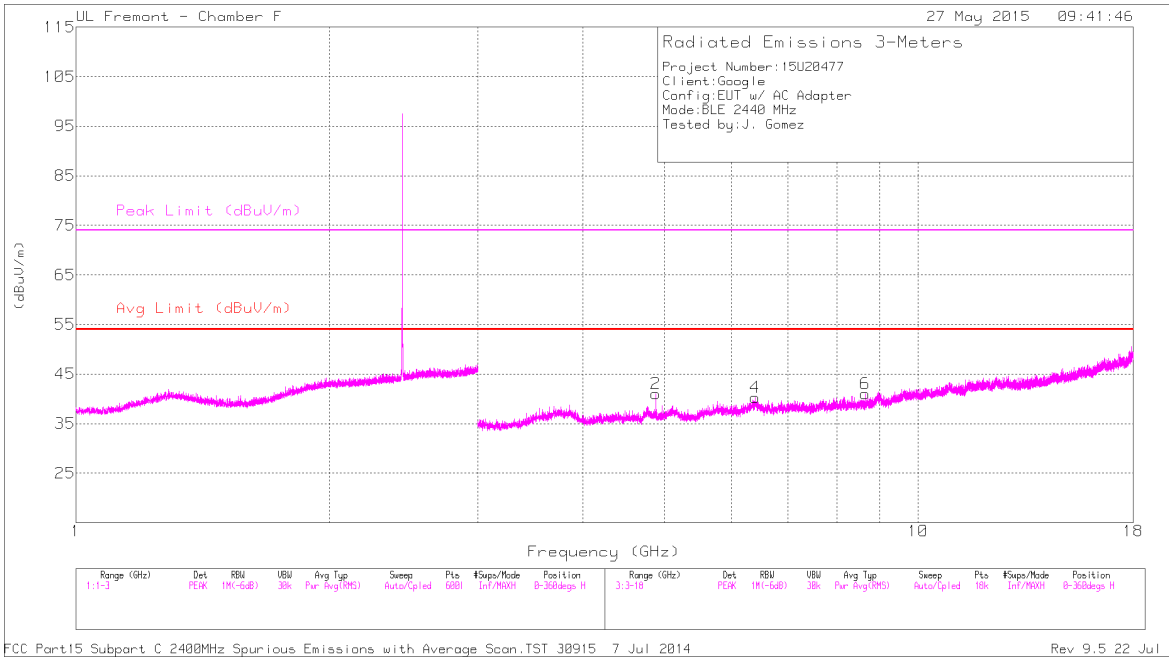
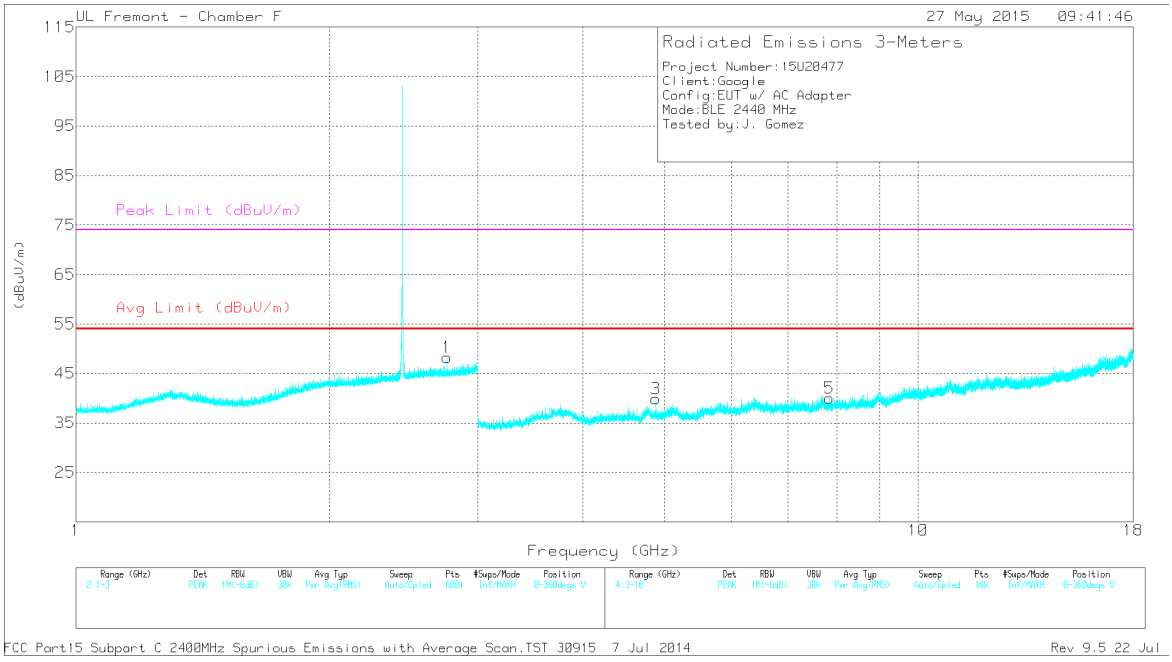
MID CHANNEL

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr /Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.757	41.42	PK2	32.7	-20.7	0	53.42	-	-	74	-20.58	20	208	V
	* 2.76	29.66	MAv1	32.7	-20.6	2.19	43.95	54	-10.05	-	-	20	208	V
2	* 4.88	41.85	PK2	34.1	-27.9	0	48.05	-	-	74	-25.95	150	178	H
	* 4.88	32.5	MAv1	34.1	-27.9	2.19	40.89	54	-13.11	-	-	150	178	H
4	6.402	30.99	PK	35.9	-26.6	0	40.29	-	-	-	-	0-360	201	H
6	8.65	28.92	PK	35.9	-23.8	0	41.02	-	-	-	-	0-360	201	H
3	* 4.88	39.99	PK2	34.1	-27.9	0	46.19	-	-	74	-27.81	246	161	V
	* 4.88	29.64	MAv1	34.1	-27.9	2.19	38.03	54	-15.97	-	-	246	161	V
5	7.848	30.06	PK	35.7	-25.7	0	40.06	-	-	-	-	0-360	201	V

* - indicates frequency in CFR 47, Part 15 and Industry Canada RSS-Restricted Band.

PK - Peak detector

PK2 - KDB558074 Method: Maximum Peak

MAv1 - KDB558074 Option 1 Maximum RMS Average

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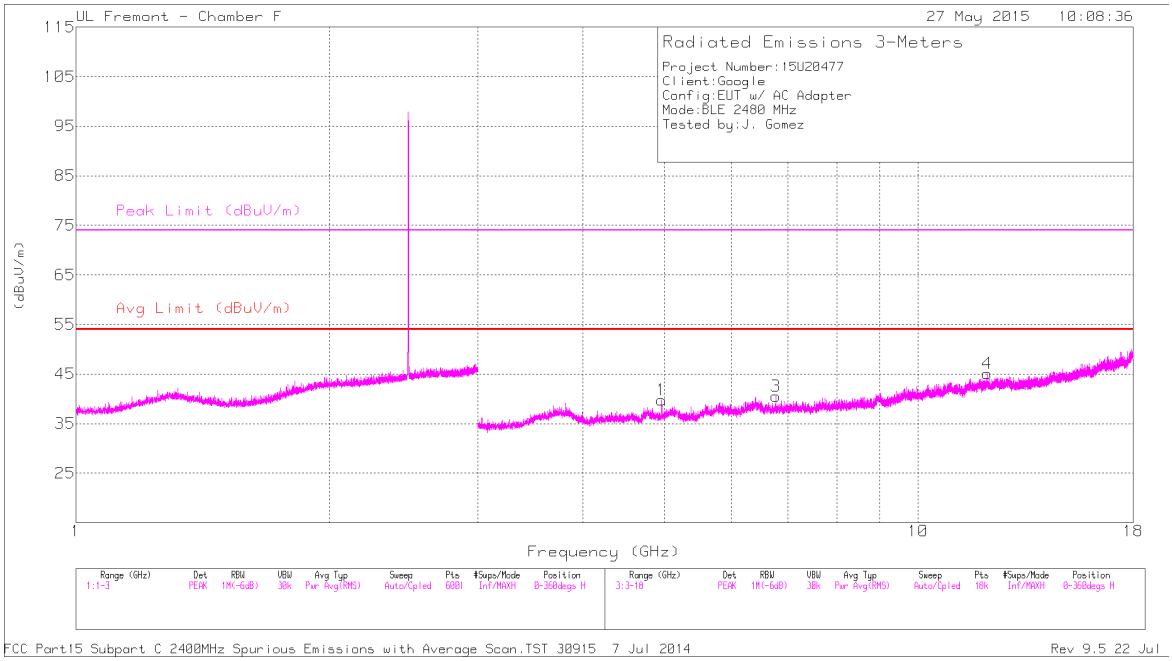
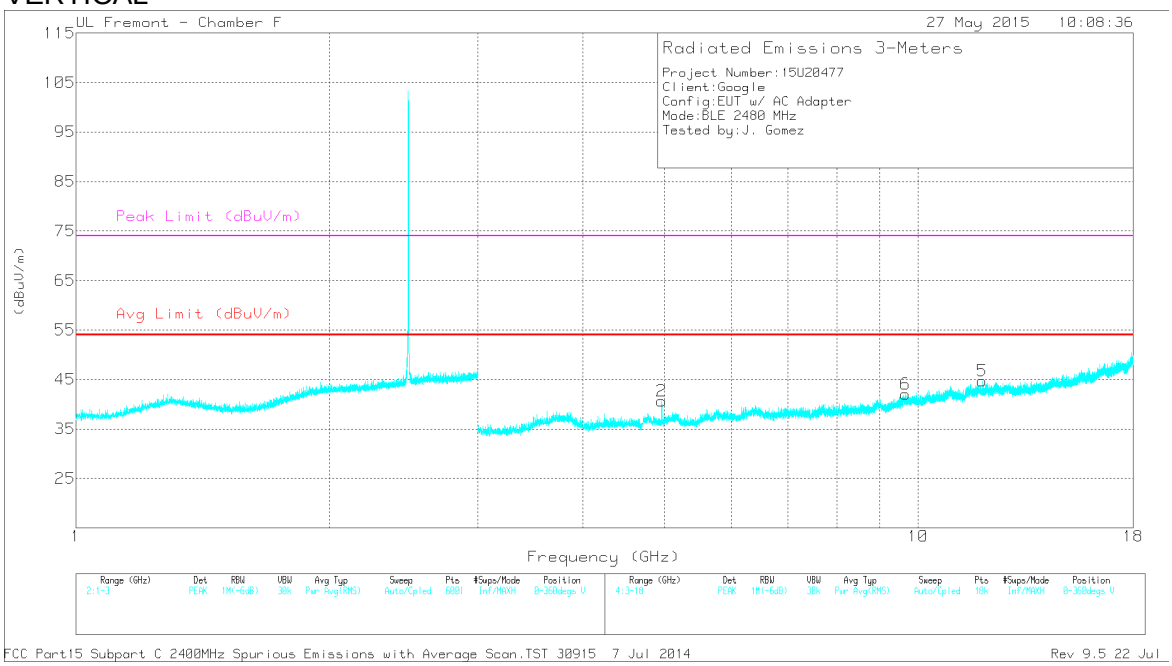
HIGH CHANNEL

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr /Pad (db)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 4.959	41.15	PK2	34.1	-28.9	0	46.35	-	-	74	-27.65	174	192	H
	* 4.96	31.45	MAv1	34.1	-28.9	2.19	38.84	54	-15.16	-	-	174	192	H
3	6.781	31.47	PK	35.7	-26.7	0	40.47	-	-	-	-	0-360	201	H
4	* 12.077	34.96	PK2	39.1	-21.8	0	52.26	-	-	74	-21.74	215	100	H
	* 12.077	23.07	MAv1	39.1	-21.8	2.19	42.56	54	-11.44	-	-	215	100	H
2	* 4.959	41.22	PK2	34.1	-28.9	0	46.42	-	-	74	-27.58	238	117	V
	* 4.96	31.11	MAv1	34.1	-28.9	2.19	38.5	54	-15.5	-	-	238	117	V
5	* 11.911	34.94	PK2	39.1	-22.6	0	51.44	-	-	74	-22.56	43	114	V
	* 11.91	23.05	MAv1	39.1	-22.6	2.19	41.74	54	-12.26	-	-	43	114	V
6	9.652	27.23	PK	37	-22.2	0	42.03	-	-	-	-	0-360	101	V

* - indicates frequency in CFR 47, Part 15 and Industry Canada RSS-Restricted Band.

PK - Peak detector

PK2 - KDB558074 Method: Maximum Peak

MAv1 - KDB558074 Option 1 Maximum RMS Average

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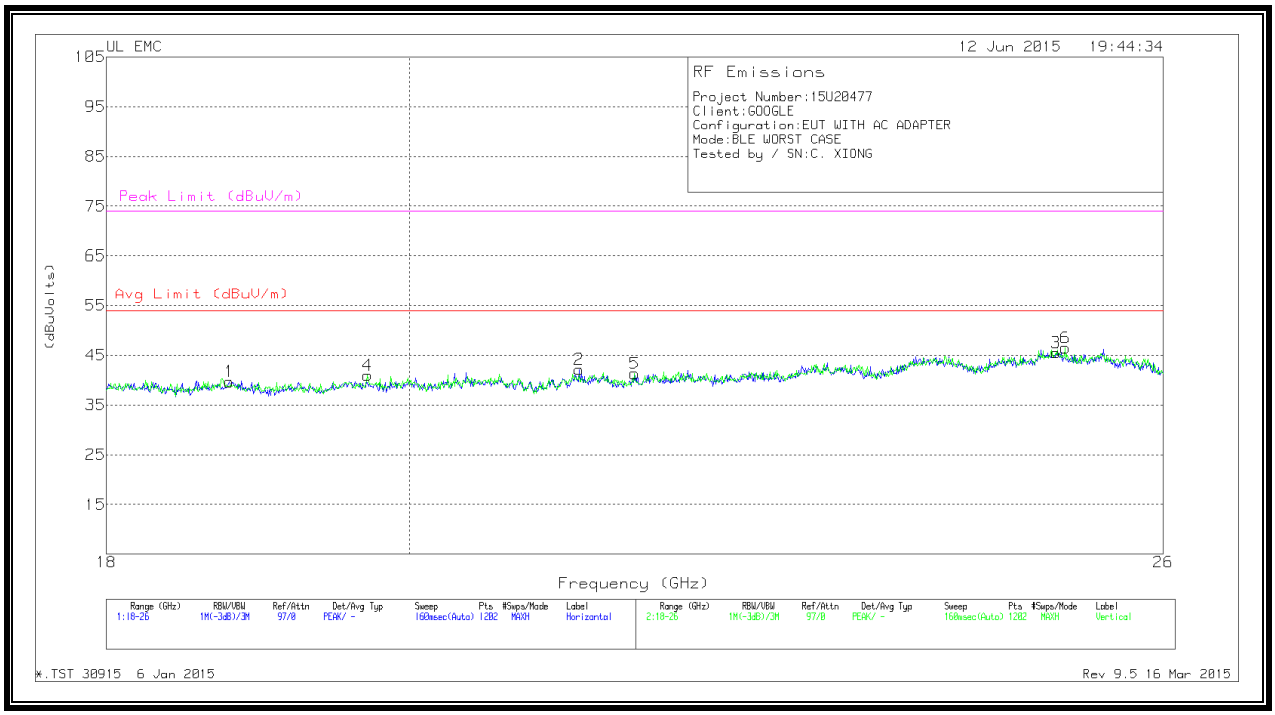
8.4. WORST-CASE ABOVE 18 GHz

SPURIOUS EMISSIONS 18 TO 26 GHz (WORST-CASE CONFIGURATION)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	T89 AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	18.786	40.77	Pk	32.5	-24.1	-9.5	39.67	54	-14.33	74	-34.33
2	21.217	42.37	Pk	33.1	-23.8	-9.5	42.17	54	-11.83	74	-31.83
3	25.047	43.5	Pk	34.1	-22.6	-9.5	45.5	54	-8.5	74	-28.5
4	19.712	42	Pk	32.5	-24	-9.5	41	54	-13	74	-33
5	21.63	41.03	Pk	33.2	-23.4	-9.5	41.33	54	-12.67	74	-32.67
6	25.127	45.2	Pk	33.8	-23	-9.5	46.5	54	-7.5	74	-27.5

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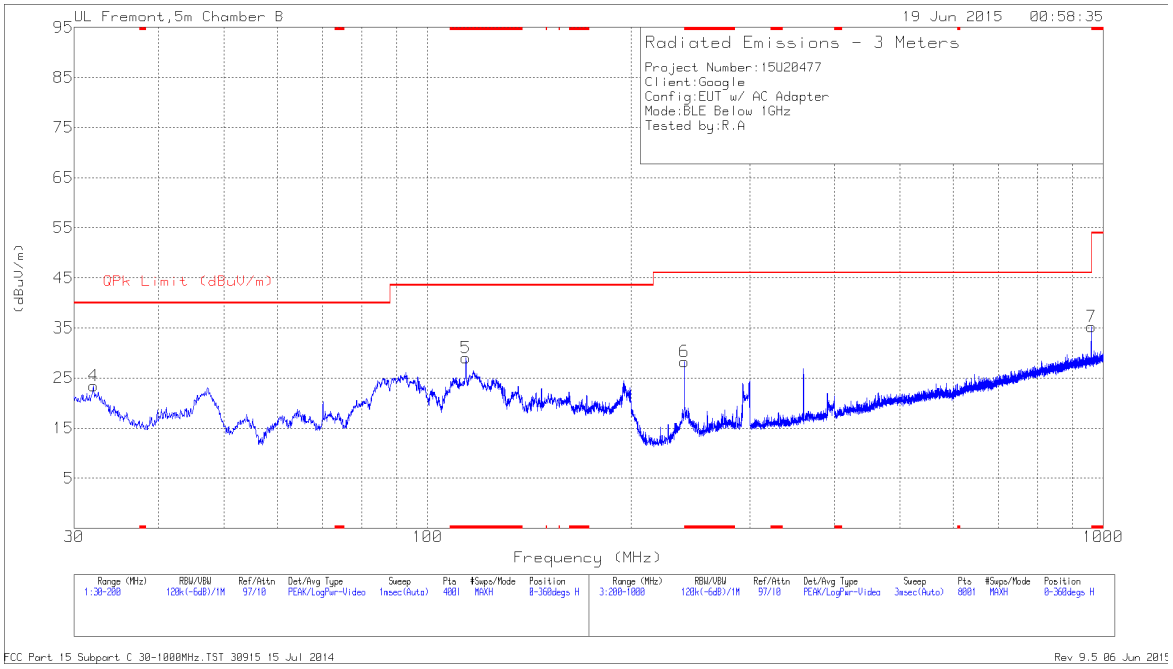
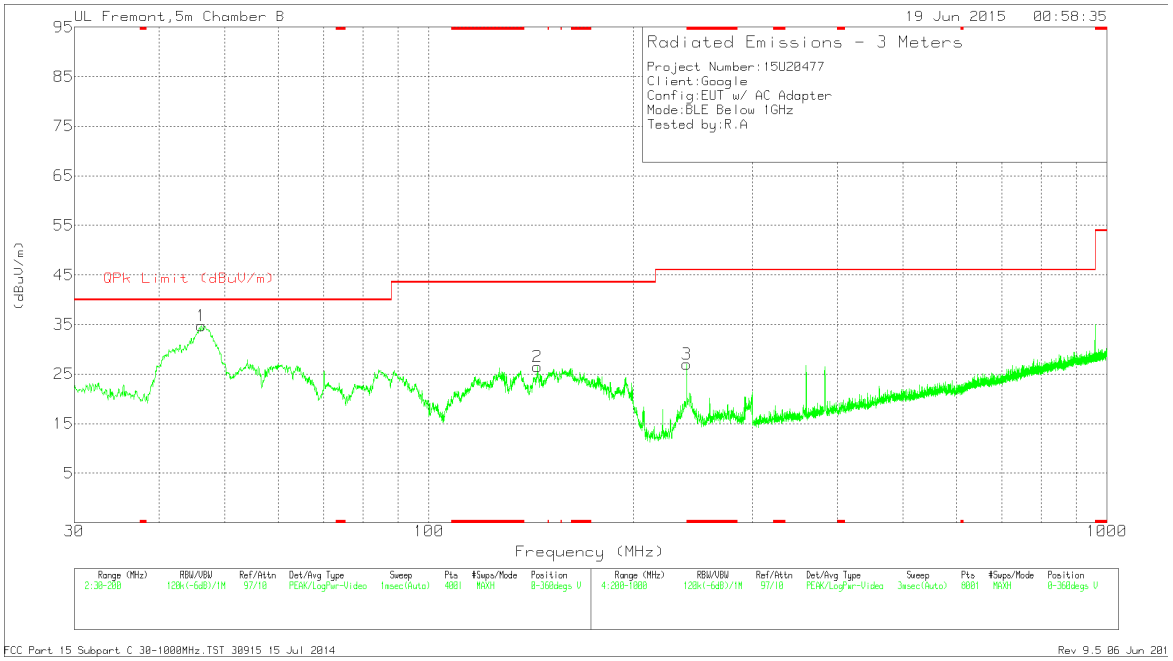
8.5. WORST-CASE BELOW 1 GHz

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

HORIZONTAL



VERTICAL



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DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T243 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
5	* 113.98	43.48	Pk	13.4	-27.8	29.08	43.52	-14.44	0-360	199	H
6	* 240	43.08	Pk	11.6	-26.4	28.28	46.02	-17.74	0-360	101	H
7	* 960	34.6	Pk	22.9	-22.2	35.3	46.02	-10.72	0-360	101	H
3	* 240	41.79	Pk	11.6	-26.4	26.99	46.02	-19.03	0-360	101	V
4	32.04	32.89	Pk	19.4	-28.8	23.49	40	-16.51	0-360	199	H
1	46.1925	53.47	Pk	9.9	-28.6	34.77	40	-5.23	0-360	101	V
2	144.58	41.24	Pk	12.8	-27.5	26.54	43.52	-16.98	0-360	101	V

* - indicates frequency in CFR15.205/IC7.2.2 Restricted Band
Pk - Peak detector

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9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

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

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

ANSI C63.4

RESULTS

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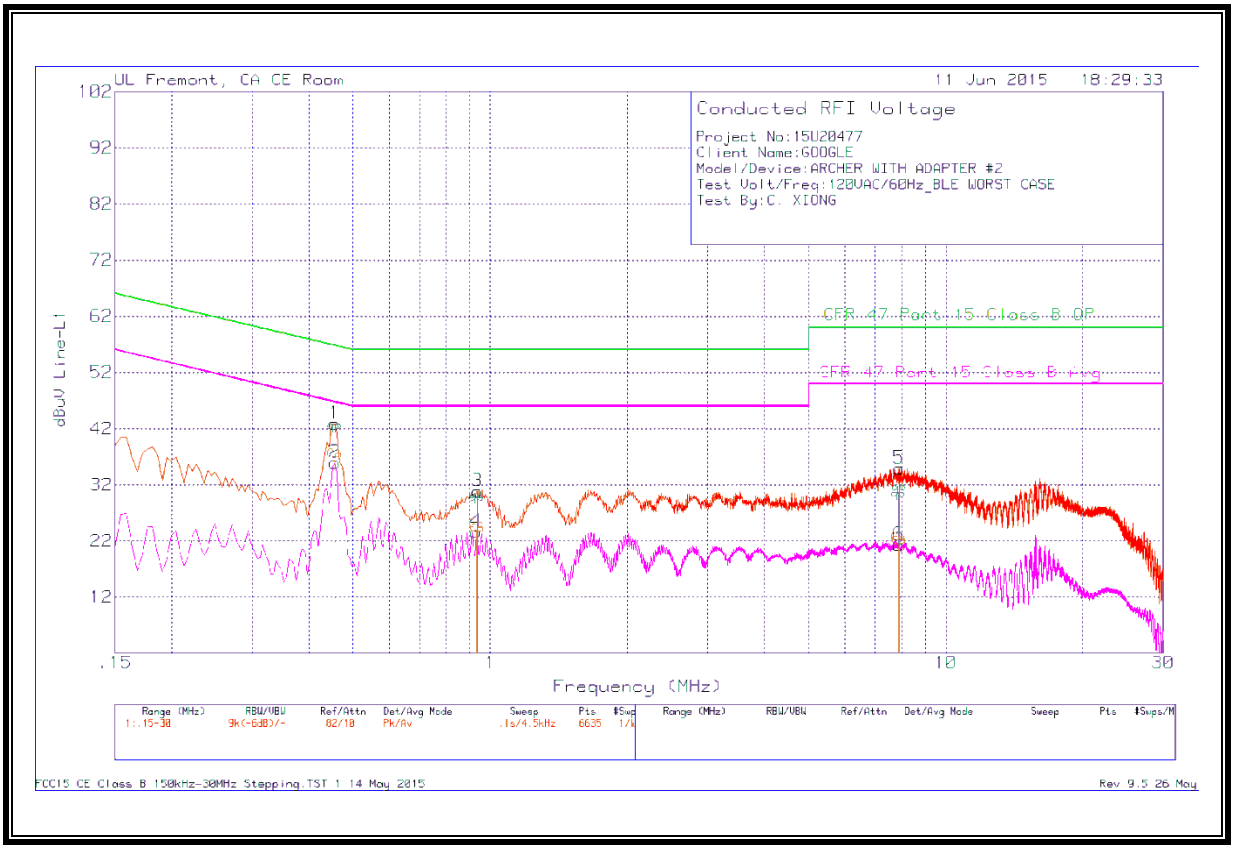
LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz

Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L1	LC Cables 1&3	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	Margin (dB)	CFR 47 Part 15 Class B Avg	Margin (dB)
.45578	35.97	Ca	.4	0	36.37	-	-	46.77	-10.4
.93638	22.83	Ca	.3	0	23.13	-	-	46	-22.87
.93413	23.66	Ca	.3	0	23.96	-	-	46	-22.04
7.89878	20.67	Ca	.2	.1	20.97	-	-	50	-29.03
7.87268	21.22	Ca	.2	.1	21.52	-	-	50	-28.48

Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L1	LC Cables 1&3	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	Margin (dB)	CFR 47 Part 15 Class B Avg	Margin (dB)
.45578	41.08	Qp	.4	0	41.48	56.77	-15.29	-	-
.93638	28.41	Qp	.3	0	28.71	56	-27.29	-	-
.93413	28.82	Qp	.3	0	29.12	56	-26.88	-	-
7.89878	30.17	Qp	.2	.1	30.47	60	-29.53	-	-
7.87268	29.06	Qp	.2	.1	29.36	60	-30.64	-	-

Ca - CISPR average detection
Qp - Quasi-Peak detector

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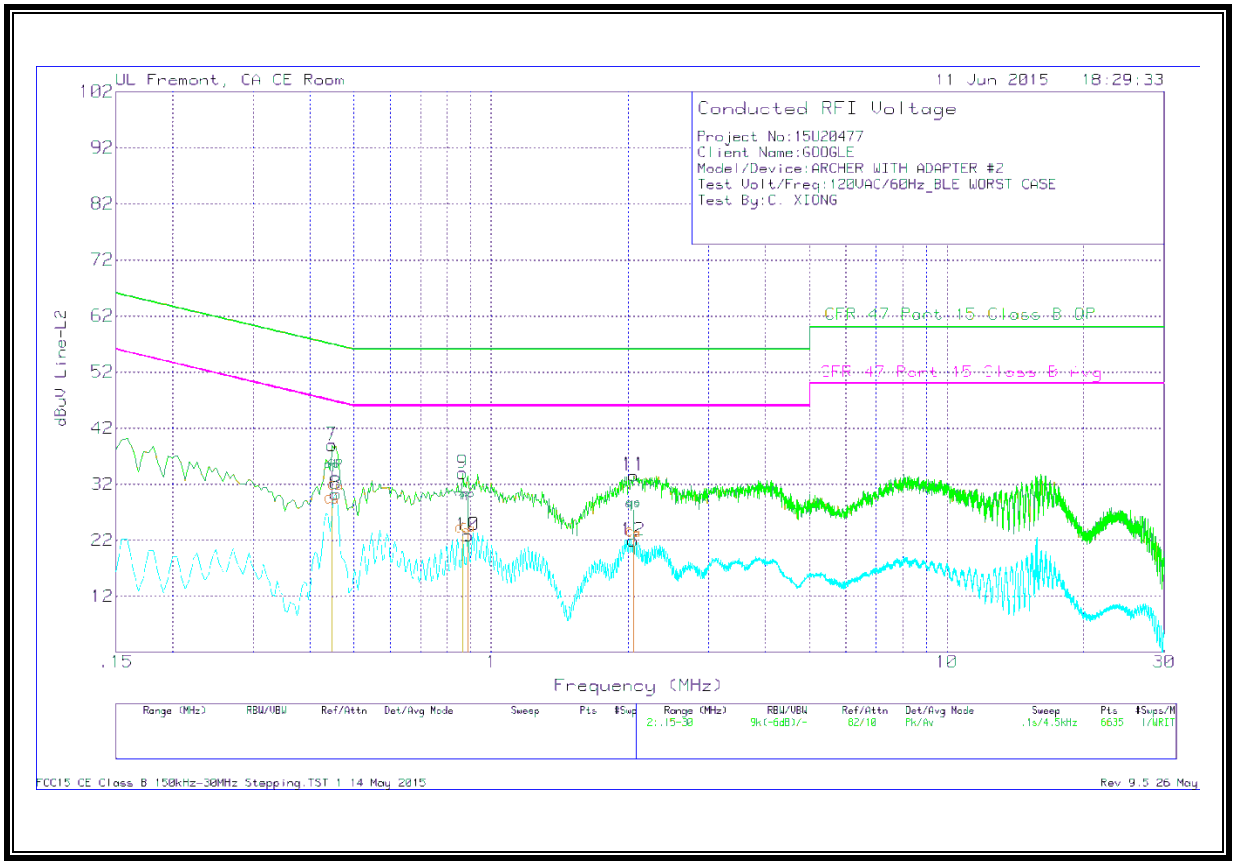
LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz

Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L2	LC Cables 2&3	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	Margin (dB)	CFR 47 Part 15 Class B Avg	Margin (dB)
.44813	27.68	Ca	.4	0	28.08	-	-	46.91	-18.83
.45668	30.1	Ca	.4	0	30.5	-	-	46.75	-16.25
.86528	22.44	Ca	.3	0	22.74	-	-	46	-23.26
.88778	22.79	Ca	.3	0	23.09	-	-	46	-22.91
2.05418	21.71	Ca	.2	.1	22.01	-	-	46	-23.99
2.05013	22.01	Ca	.2	.1	22.31	-	-	46	-23.69

Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L2	LC Cables 2&3	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	Margin (dB)	CFR 47 Part 15 Class B Avg	Margin (dB)
.44813	34.04	Qp	.4	0	34.44	56.91	-22.47	-	-
.45668	34.69	Qp	.4	0	35.09	56.75	-21.66	-	-
.86528	29.08	Qp	.3	0	29.38	56	-26.62	-	-
.88778	28.88	Qp	.3	0	29.18	56	-26.82	-	-
2.05418	27.39	Qp	.2	.1	27.69	56	-28.31	-	-
2.05013	27.12	Qp	.2	.1	27.42	56	-28.58	-	-

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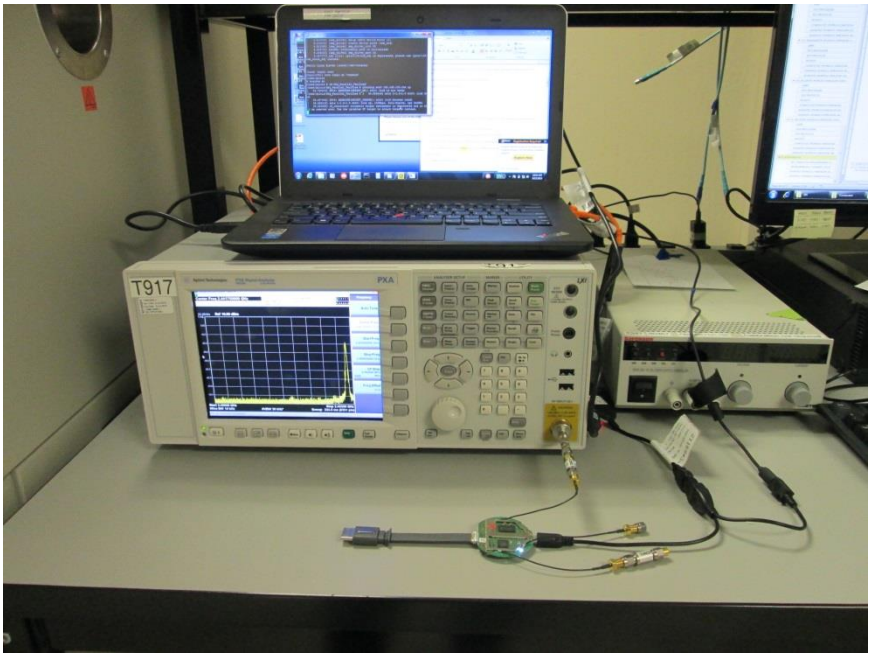
10. SETUP PHOTOS

ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP

ANTENNA PORT CONDUCTED PHOTO



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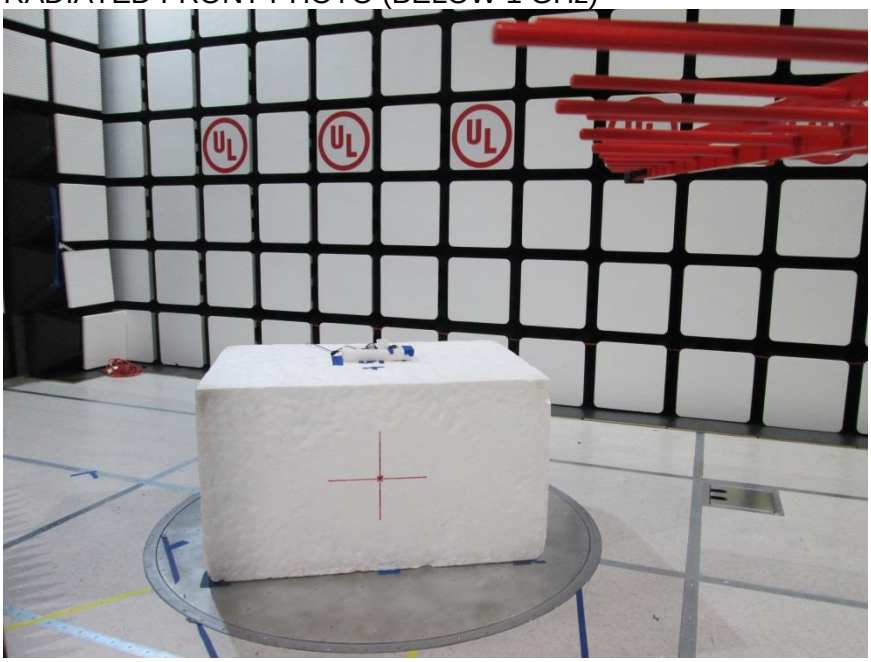
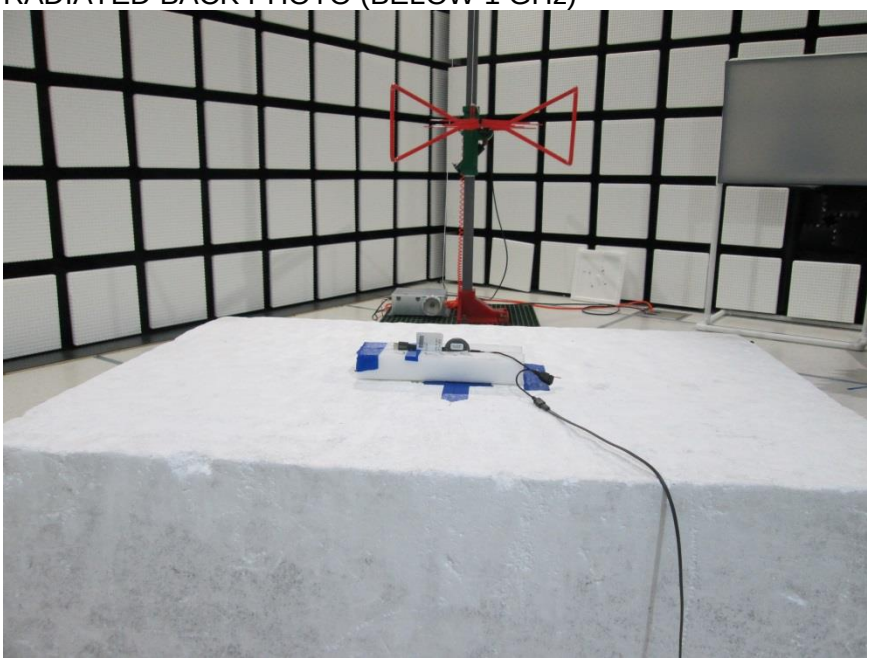
RADIATED RF MEASUREMENT SETUP (BELOW 1 GHz)

RADIATED FRONT PHOTO (BELOW 1 GHz)



RADIATED BACK PHOTO (BELOW 1 GHz)



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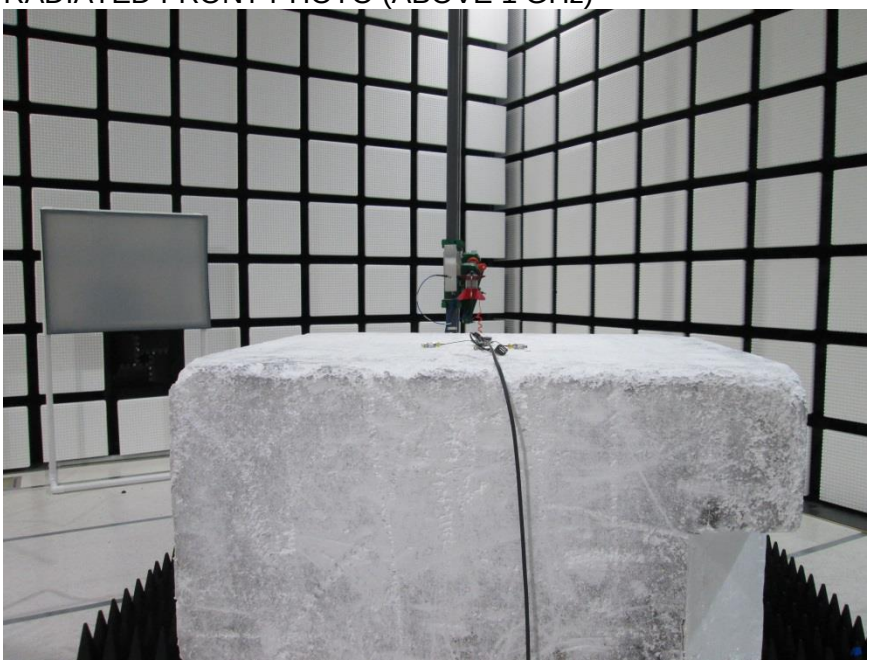
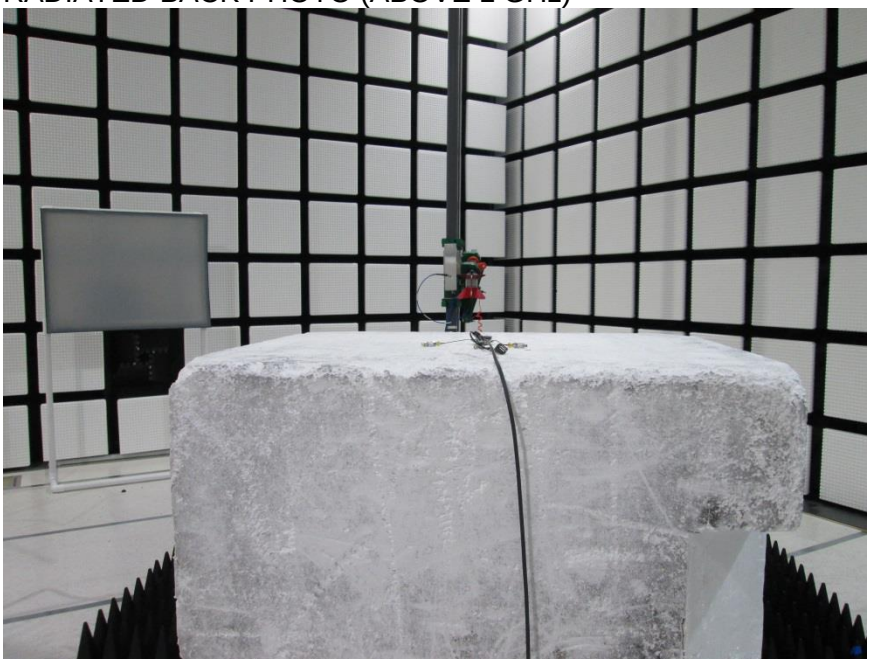
RADIATED RF MEASUREMENT SETUP (ABOVE 1 GHz)

RADIATED FRONT PHOTO (ABOVE 1 GHz)



RADIATED BACK PHOTO (ABOVE 1 GHz)



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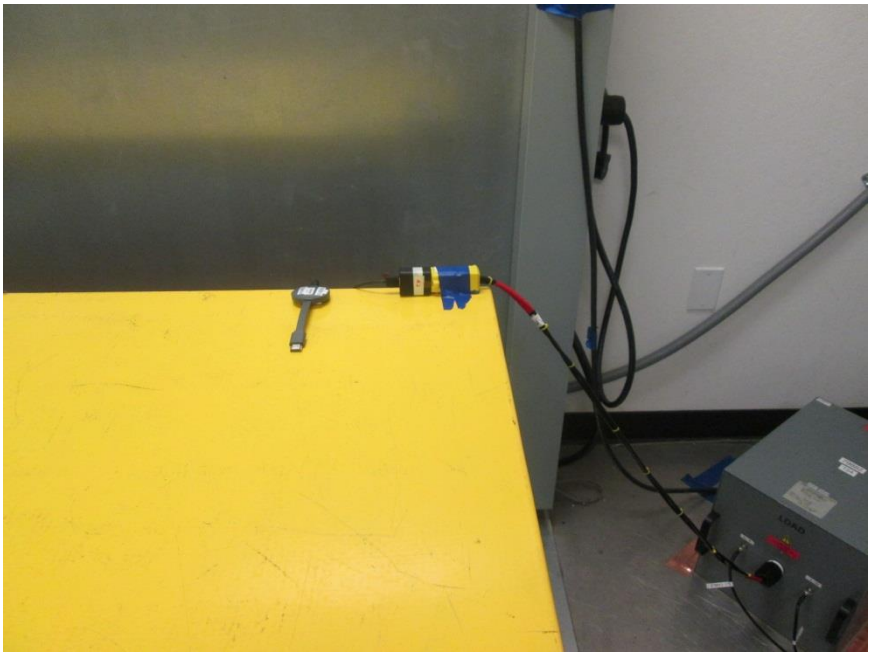
POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP

LINE CONDUCTED FRONT PHOTO



LINE CONDUCTED BACK PHOTO

END OF REPORT

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