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

BLUETOOTH LOW ENERGY CERTIFICATION TEST REPORT

FOR

GLASS

MODEL NUMBER: XEB

FCC ID: A4R-X1

REPORT NUMBER: 12U14656- 4, REVISION A

ISSUE DATE: NOVEMBER 29, 2012

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

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

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	11/29/12	Initial Issue	T. LEE
A	12/18/12	Add Duty Cycle Information	T.LEE

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: GLASS

MODEL: XEB

SERIAL NUMBER: 015498FC0A011010

DATE TESTED: NOVEMBER 28 and 29, 2012

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass

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

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

Approved & Released For UL CCS By:

TIM LEE
WiSE PROJECT ENGINEER
UL CCS

Tested By:

THANH NGUYEN
EMC ENGINEER
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

3. FACILITIES AND ACCREDITATION

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

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

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

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

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.52 dB
Radiated Disturbance, 30 to 1000 MHz	4.94 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a glass providing a heads-up video display. The device incorporates an 802.11 b/g 2.4 GHz WLAN and BT, BT-LE radio. This report covers the BT-LE radio mode.

The radio module is manufactured by Broadcom.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	BT-LE	5.81	3.81

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a coaxial monopole antenna, with a maximum gain is 3.32 dBi.

5.4. SOFTWARE AND FIRMWARE

The firmware/software installed in the EUT during testing was 20121114095638.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emission and power line conducted emission were performed video playing with audio sound and 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 Z orientation(The right side up) was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Z orientation operated by AC adapter.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
AC Charger	Google	10AG212020	N/A	DoC

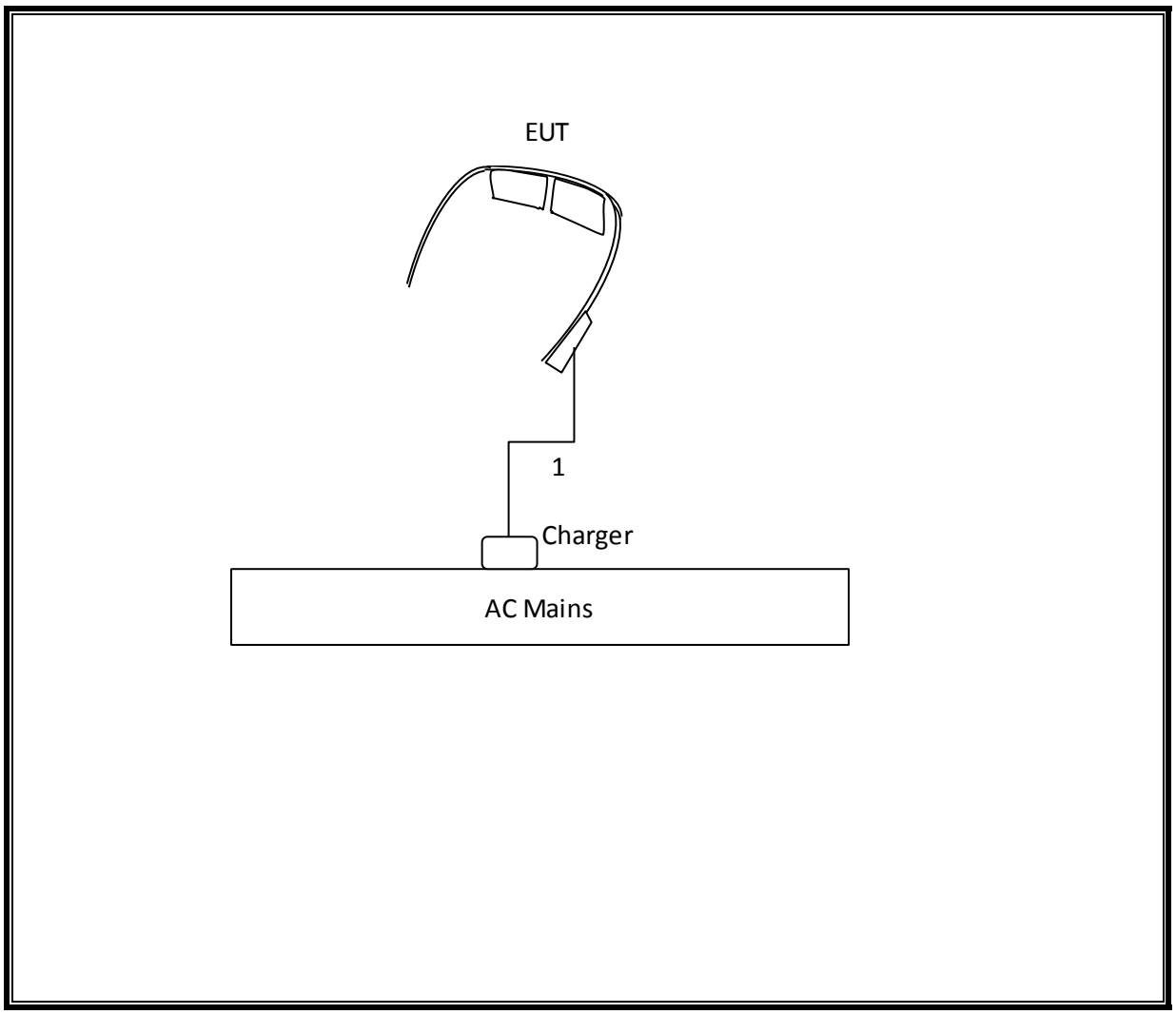
I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	DC	1	Barrel	Unshielded	1.8 m	To LT

TEST SETUP

The EUT was set up as shown in the following diagrams. A video stored within the EUT was played on the heads-up display with audio running to the vibrating element and transmit the Bluetooth Low Energy mode.

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**
Antenna, Horn, 18 GHz	EMCO	3115	C00872	09/20/12	09/20/13
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01012	10/21/12	21/10/13
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C00749	10/21/12	10/21/13
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00558	02/21/12	02/21/13
Bilog 30-2000MHz	Sunol	JB1	C01071	01/26/12	01/26/13
Power meter	HP	437B	T226	06/25/12	06/25/13
Power Sensor	HP	8481A	T233	06/26/12	06/26/13
LISN, 30 MHz	FCC	LISN-50/250-25-	N02625	12/13/11	12/13/12
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BN	N02481	03/07/12	03/07/13
EMI Test Receiver	R&S	ESC20	N02396	08/18/12	08/18/13

7. ANTENNA PORT TEST RESULTS

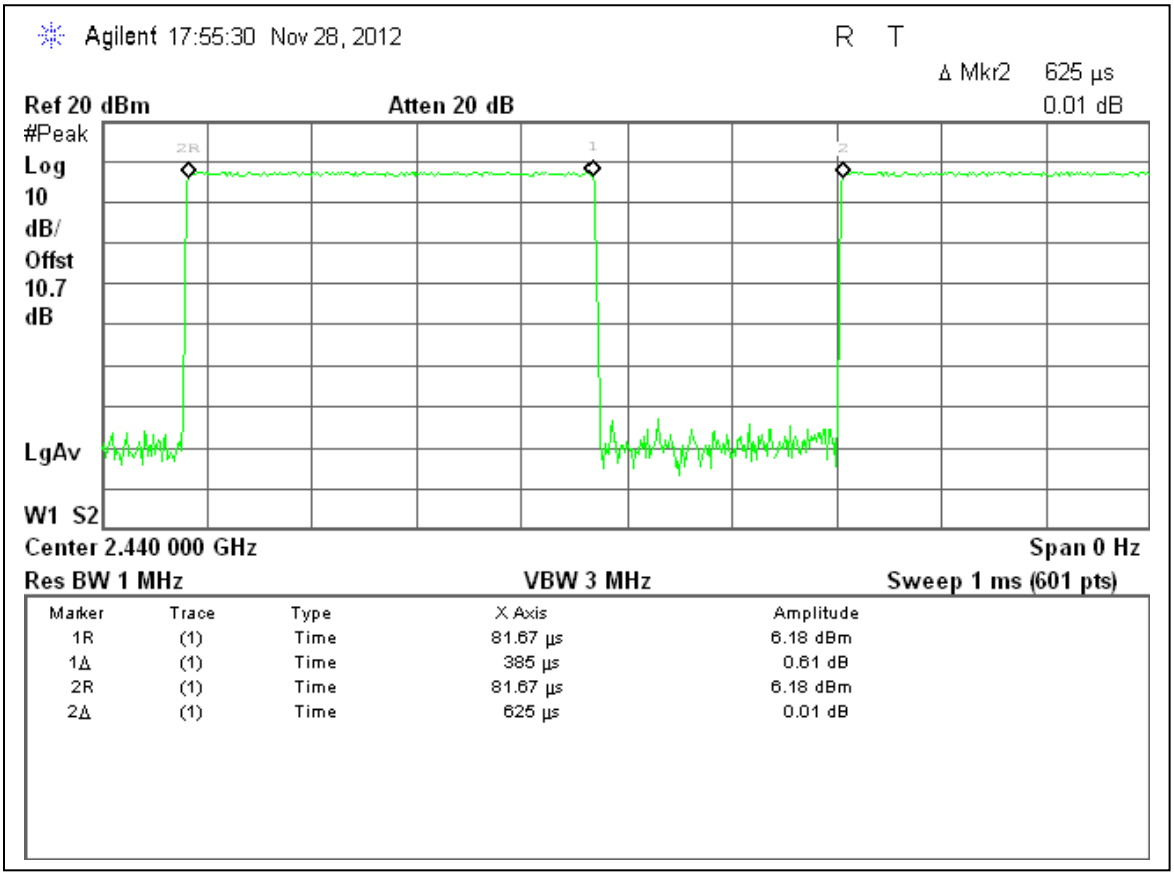
7.1. DUTY CYCLE

LIMITS

None; for reporting purposes only.

RESULTS

Mode	Tx on (usec)	Tx on + Tx off (usec)	Duty Cycle (%)	Correction Factor (dB)
BLE	385	625	61.60	2.10



7.2. BLUETOOTH LOW ENERGY

7.2.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

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

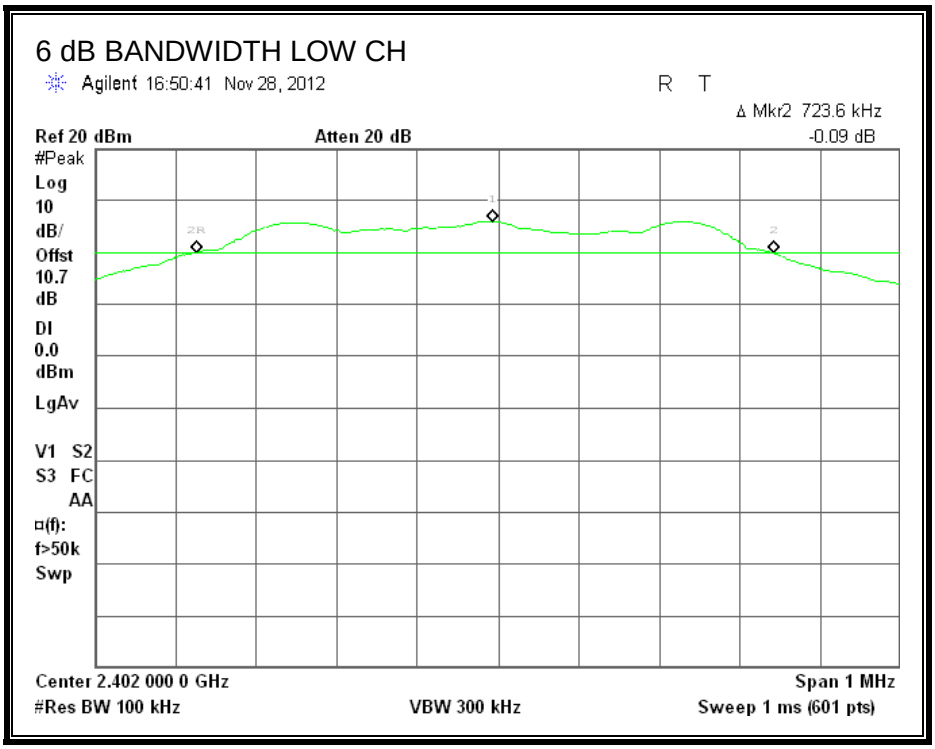
TEST PROCEDURE

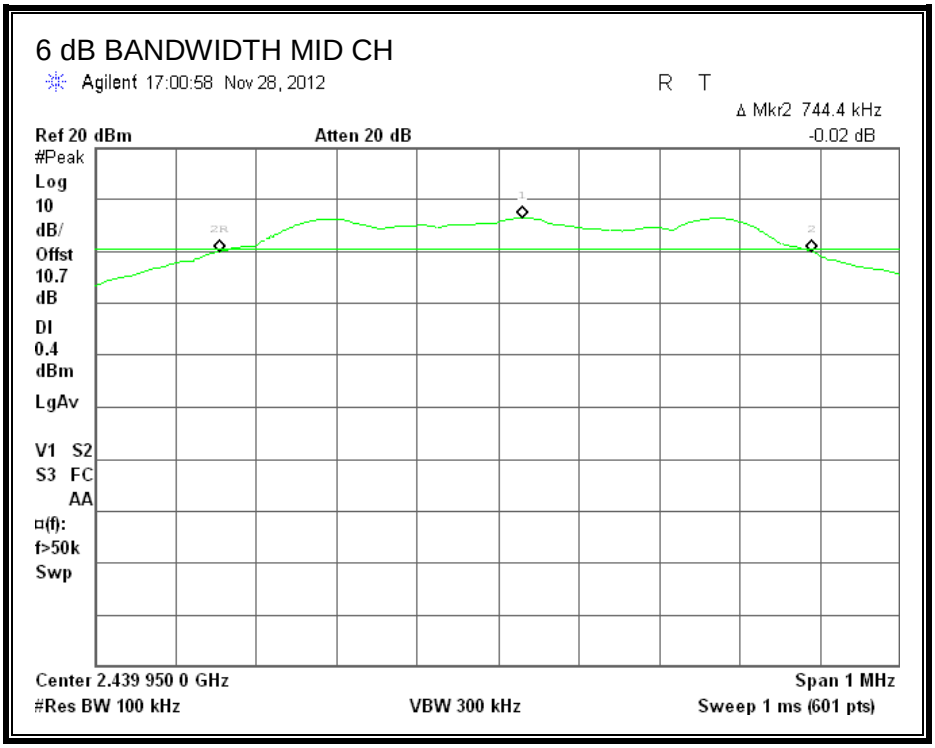
The transmitter output is connected to a spectrum analyzer with the RBW set between 1% and 5% of the EBW, the VBW >= 3 x RBW, peak detector and max hold.

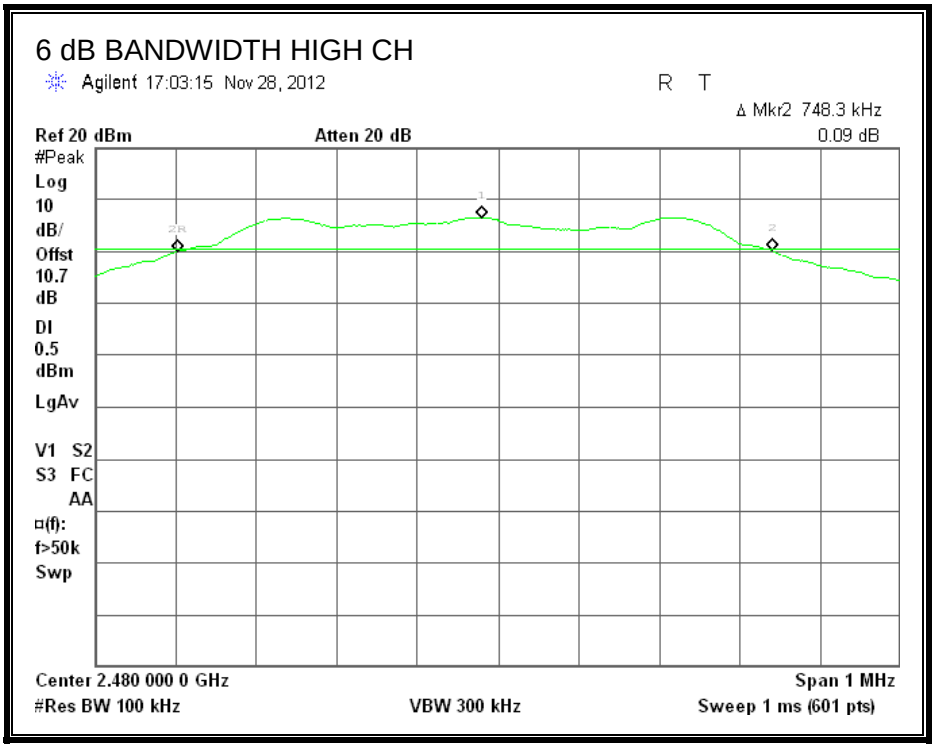
RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.7236	0.5
Middle	2440	0.7444	0.5
High	2480	0.7483	0.5

6 dB BANDWIDTH







7.2.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

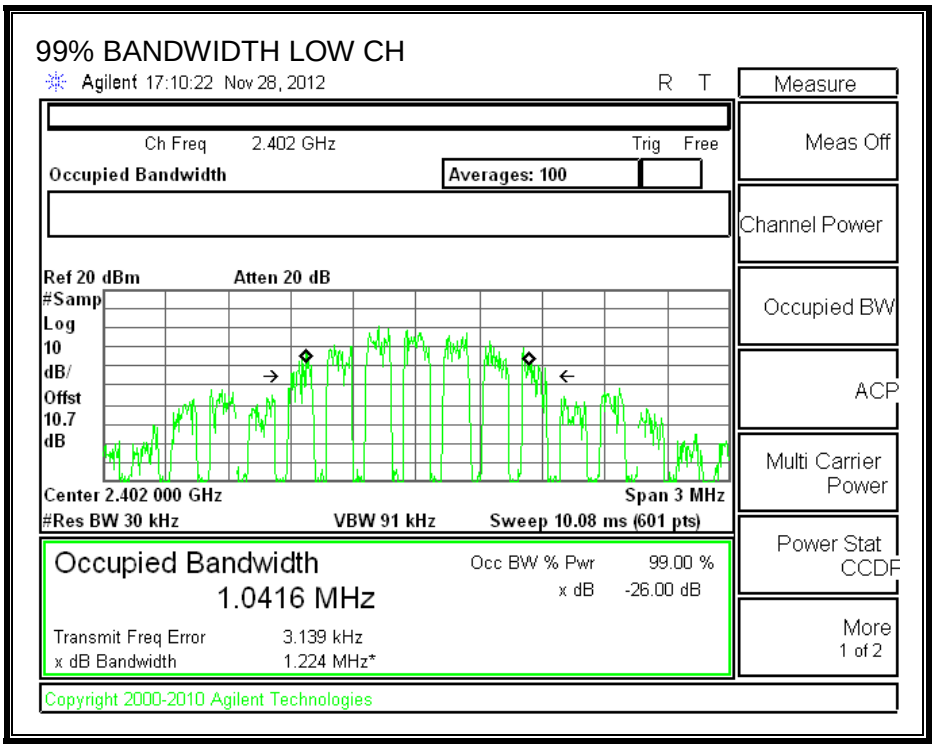
TEST PROCEDURE

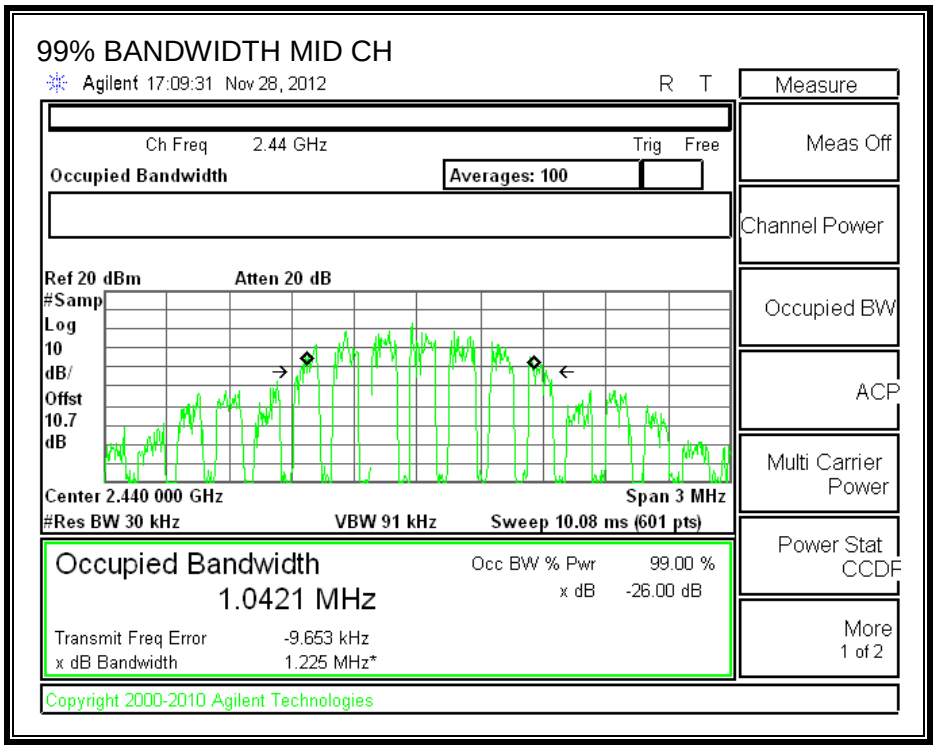
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth and to 1% of the span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

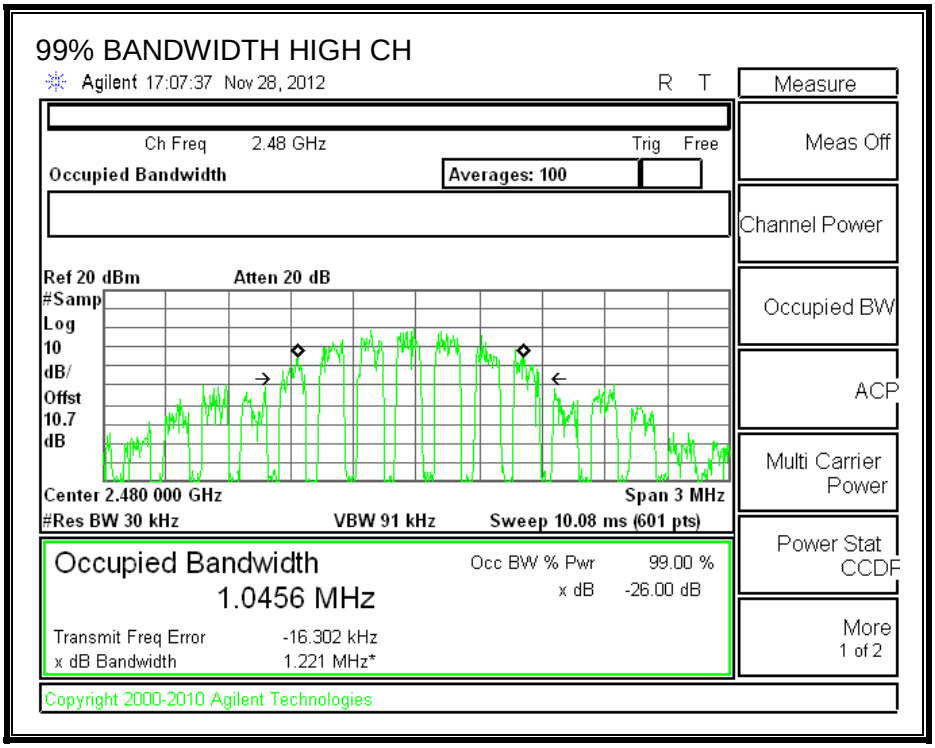
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0416
Middle	2440	1.0421
High	2480	1.0456

99% BANDWIDTH







7.2.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 10.7 dB (including 10 dB pad and .7 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	2402	3.91
Mid	2440	4.24
High	2480	4.16

7.2.4. OUTPUT POWER

LIMITS

FCC §15.247

IC RSS-210 A8.4

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

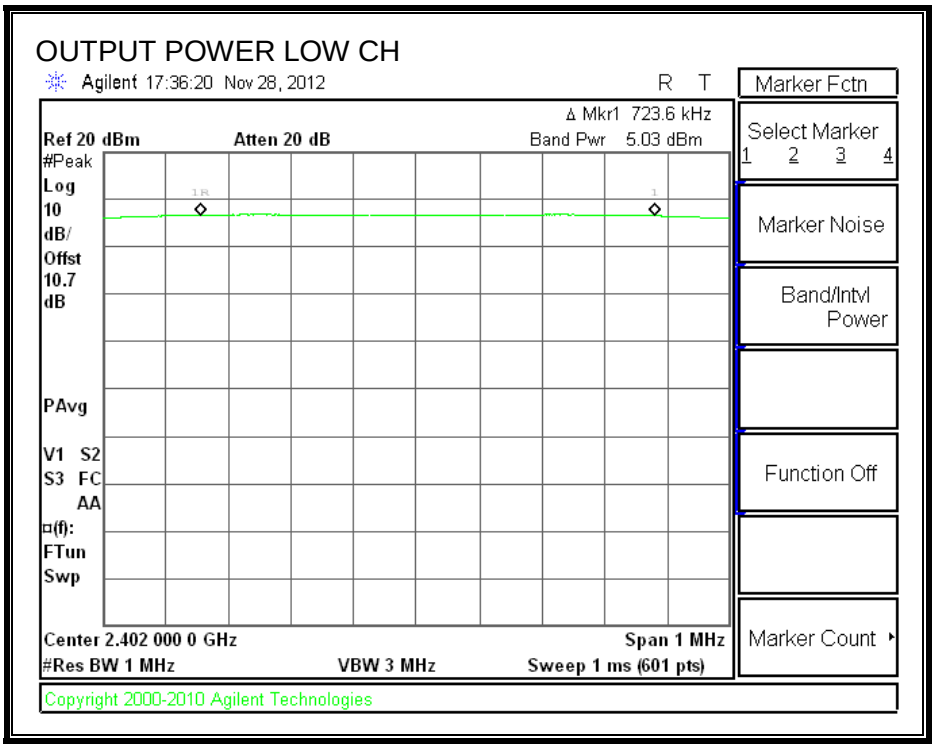
DIRECTIONAL ANTENNA GAIN

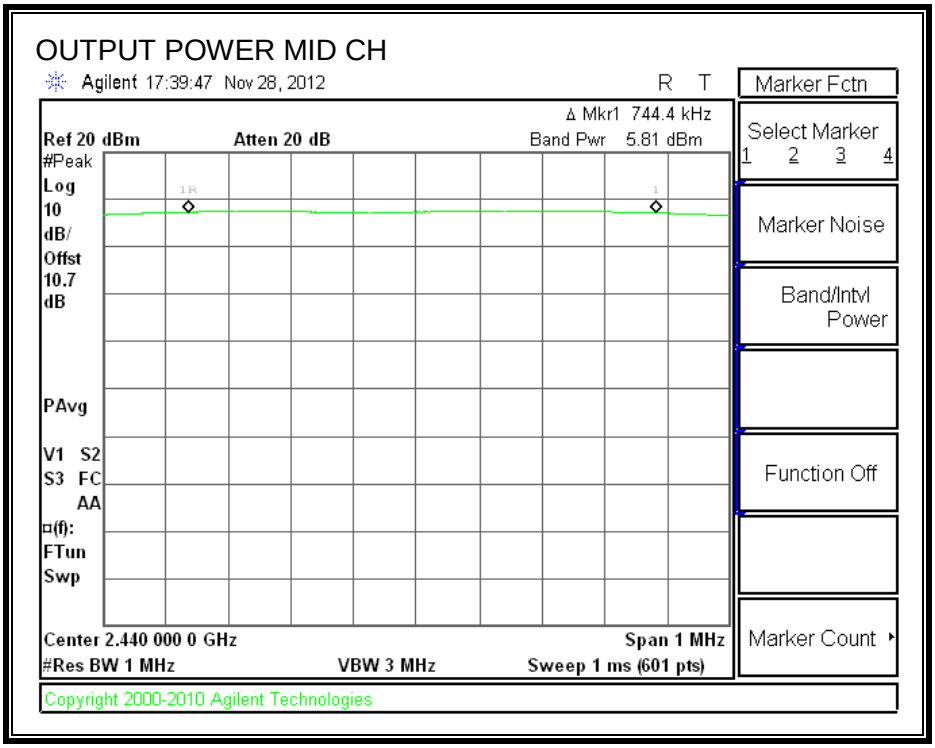
There is only one transmitter output therefore the directional gain is equal to the antenna gain.

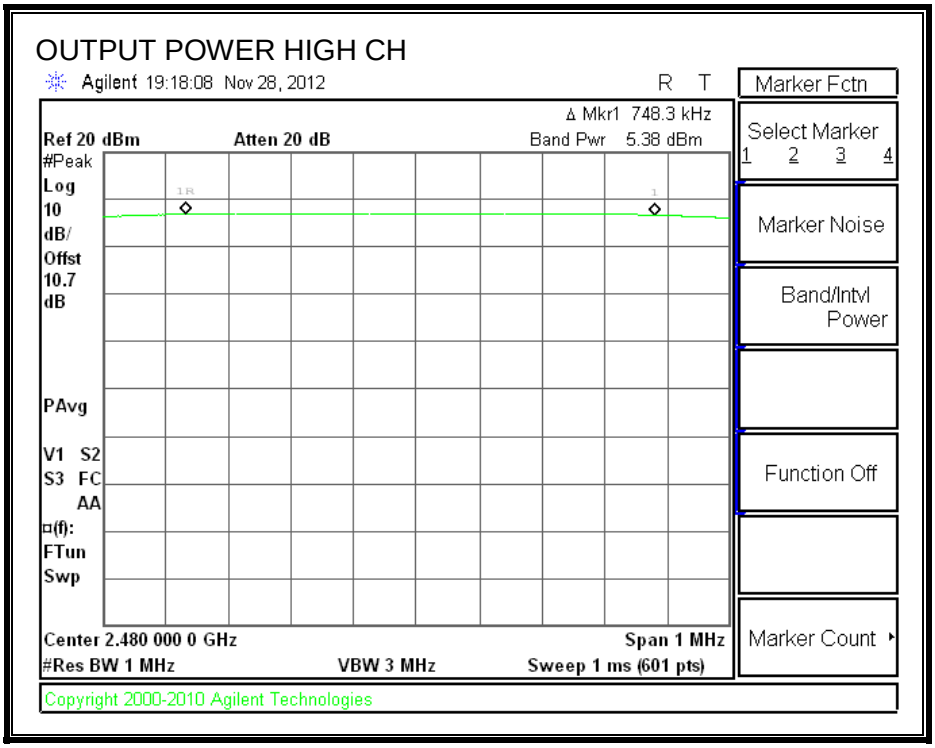
RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	5.030	30	-24.970
Middle	2440	5.810	30	-24.190
High	2480	5.380	30	-24.620

OUTPUT POWER







7.2.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

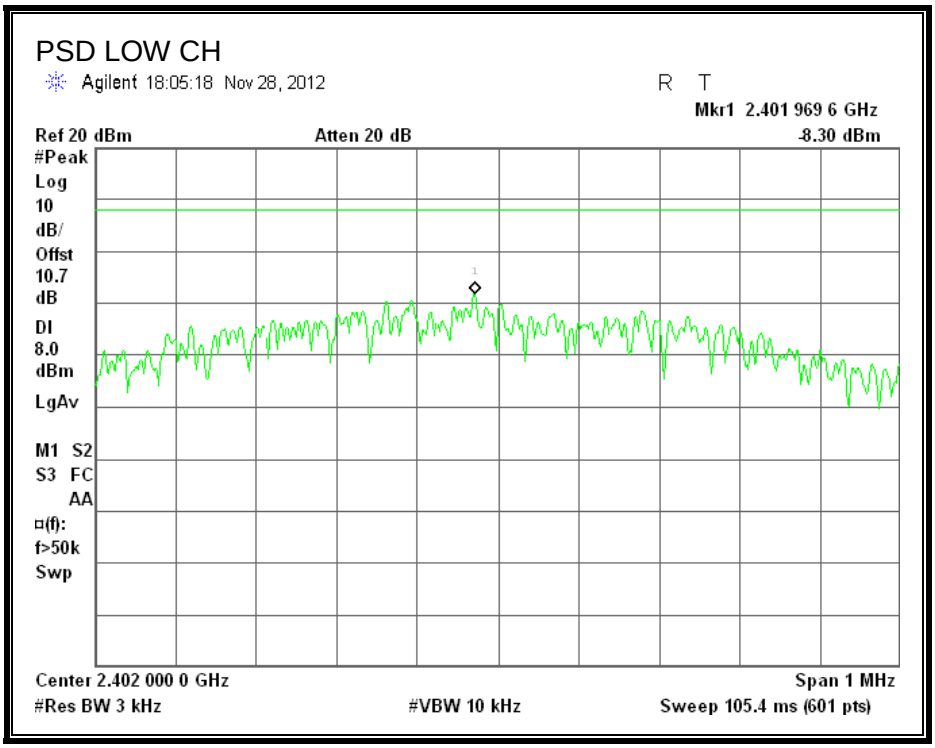
IC RSS-210 A8.2

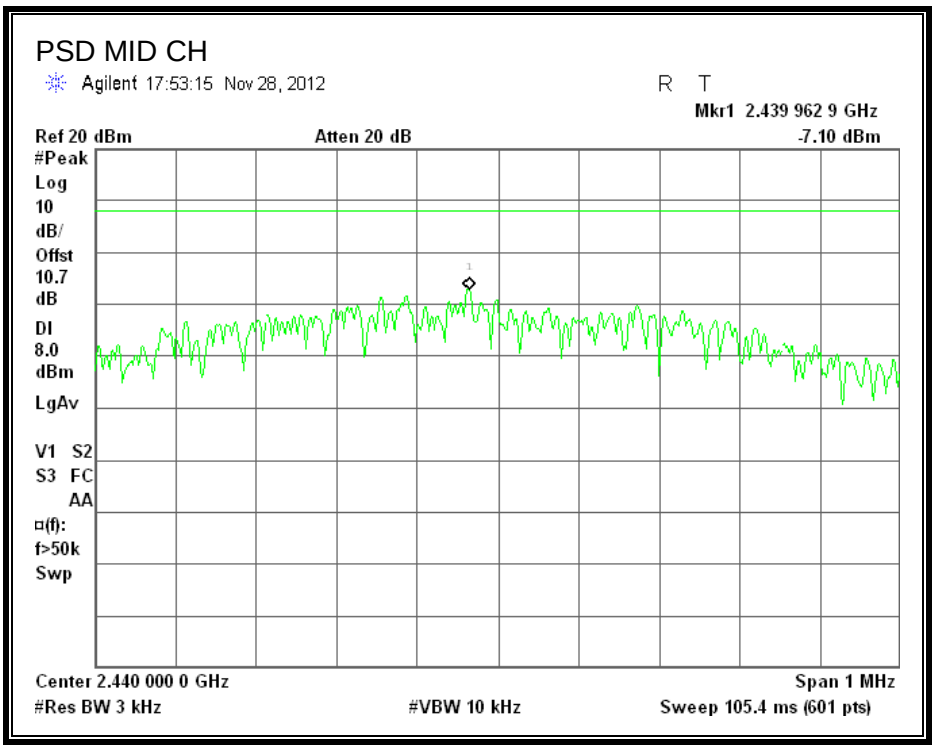
The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

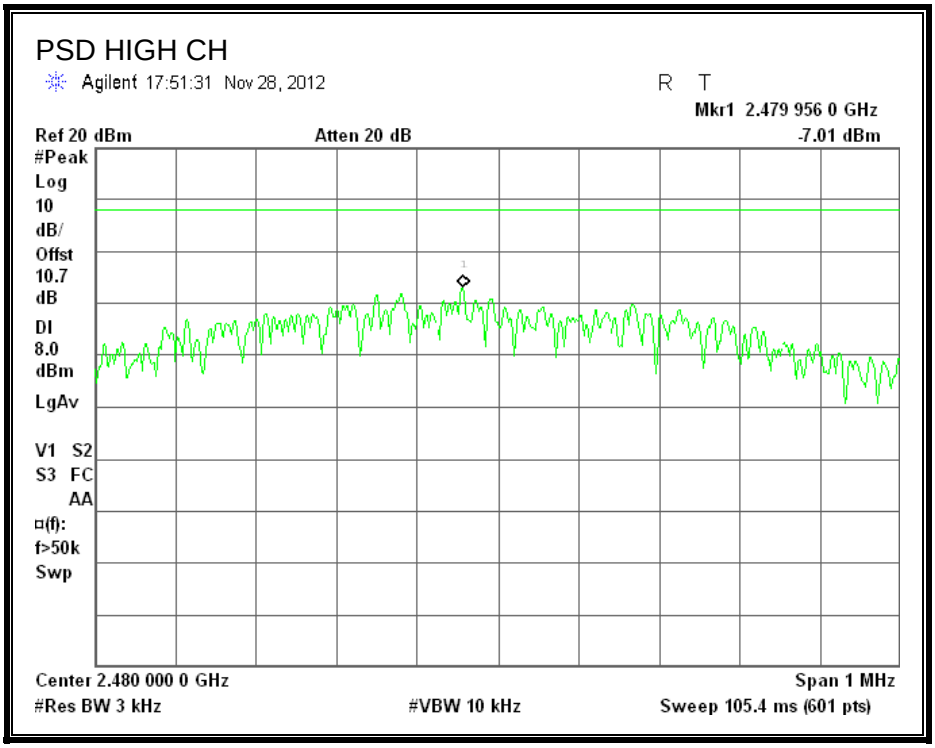
RESULTS

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-8.30	8	-16.30
Middle	2440	-7.10	8	-15.10
High	2480	-7.01	8	-15.01

POWER SPECTRAL DENSITY







7.2.6. OUT-OF-BAND EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

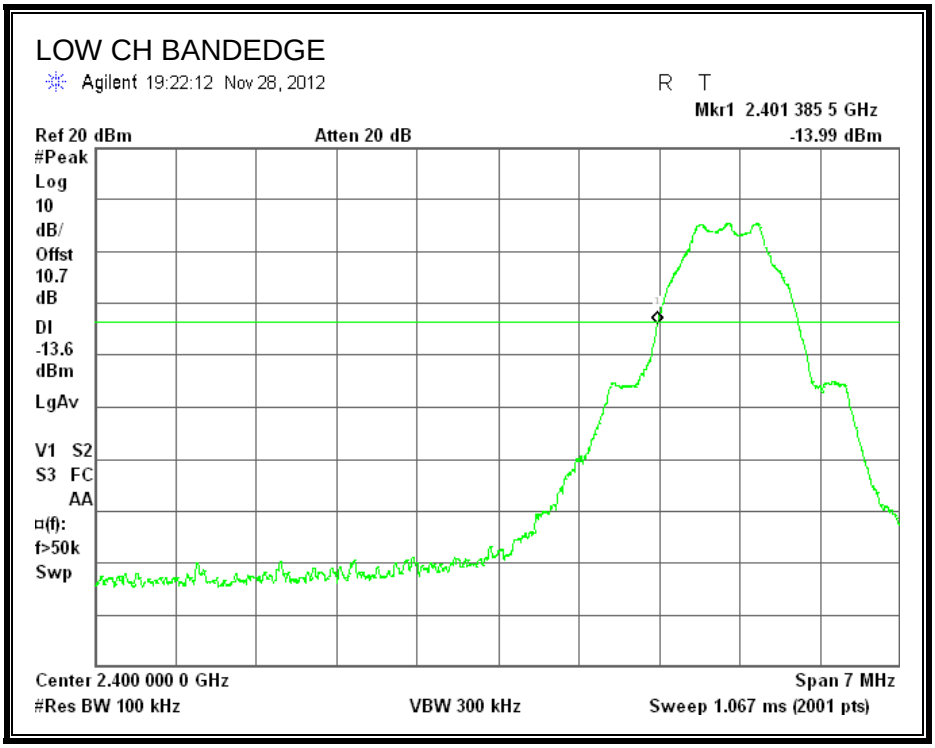
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

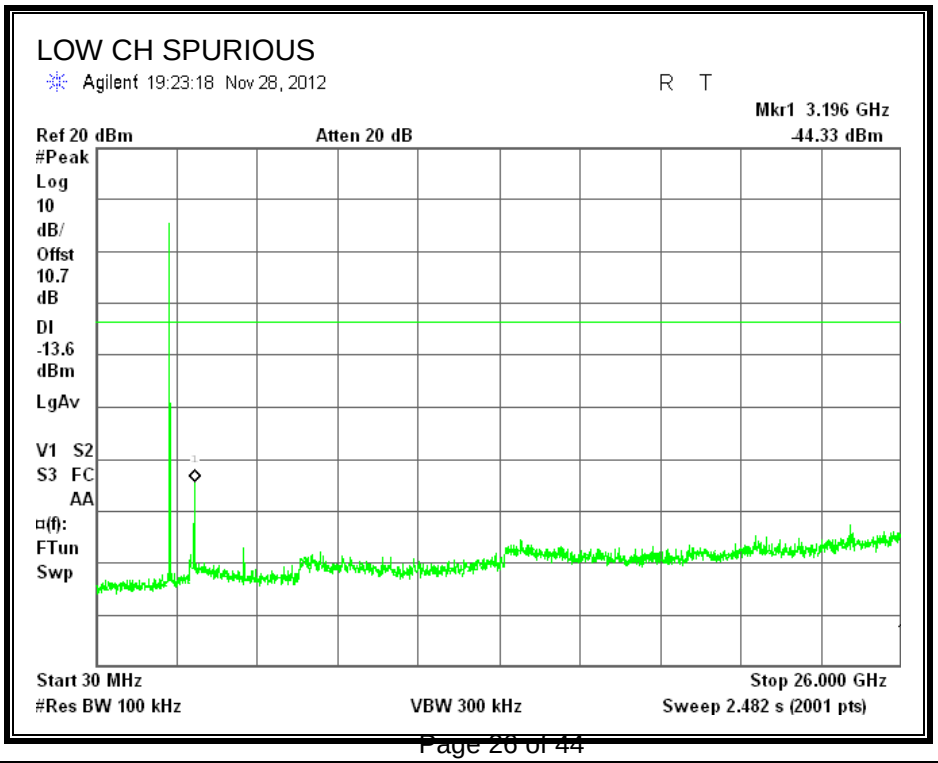
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer with RBW = 100 kHz, VBW = 300 kHz, peak detector, and max hold. Measurements utilizing these settings are made of the in-band reference level, bandedge (where measurements to the general radiated limits will not be made) and out-of-band emissions.

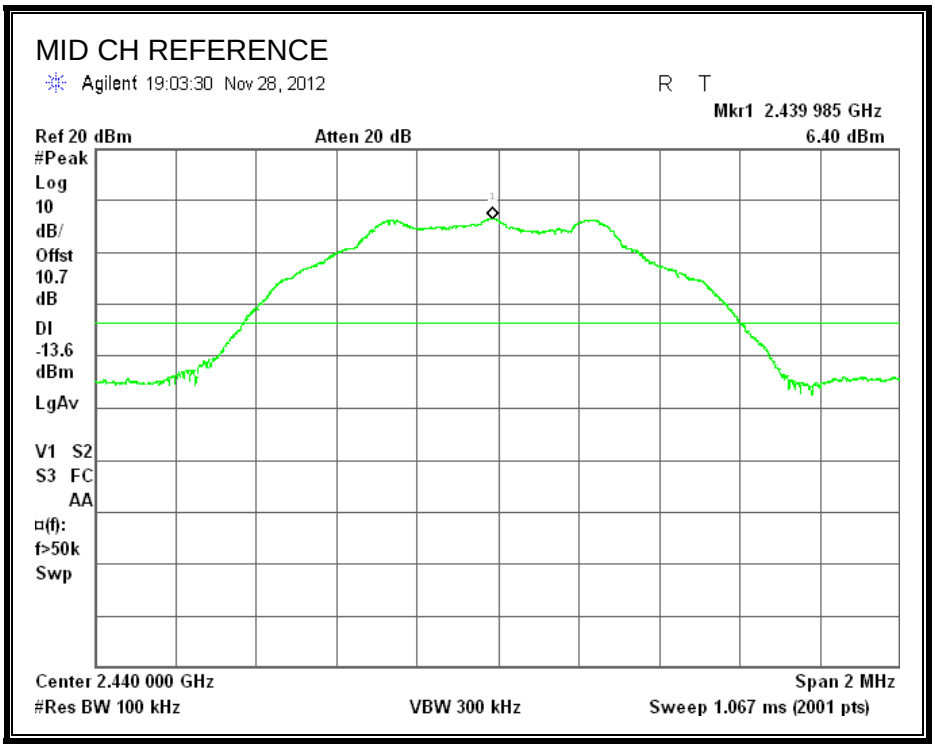
RESULTS

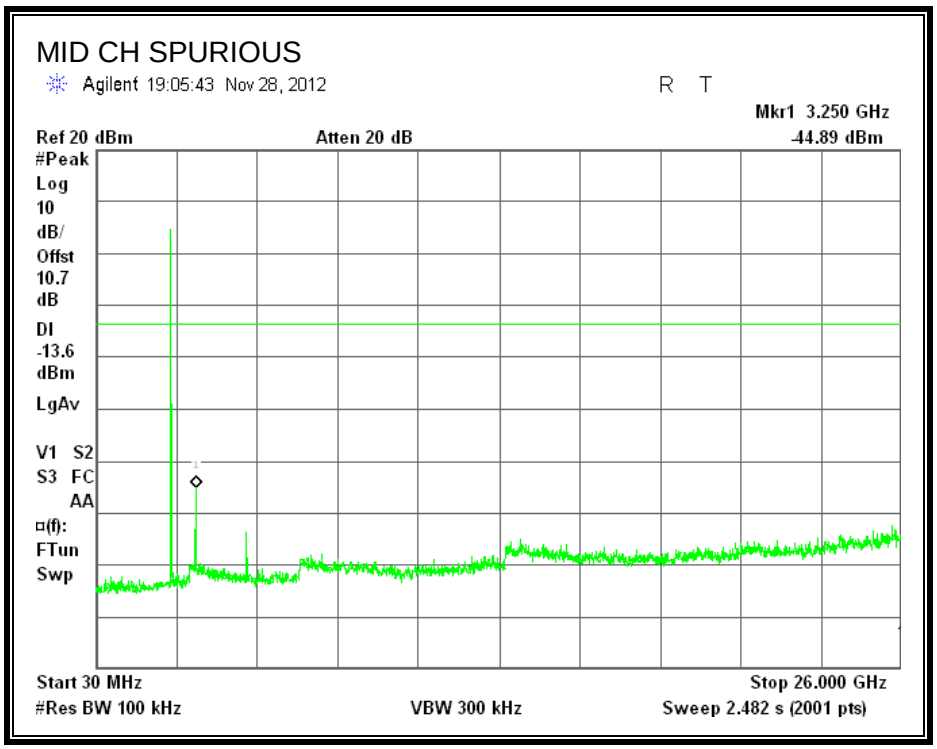
SPURIOUS EMISSIONS, LOW CHANNEL



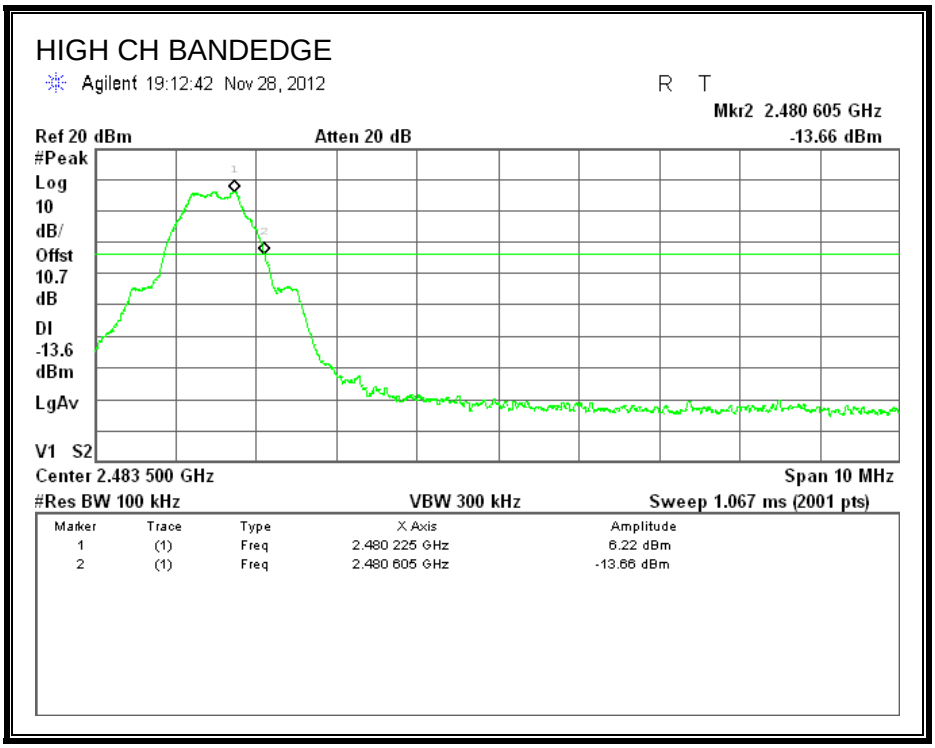


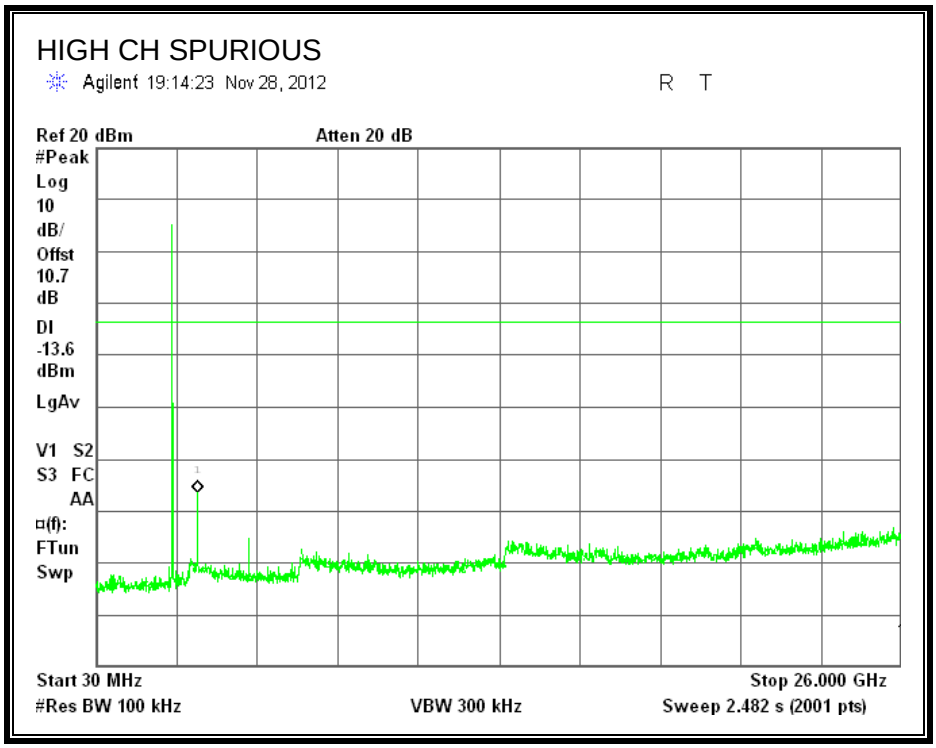
SPURIOUS EMISSIONS, MID CHANNEL





SPURIOUS EMISSIONS, HIGH CHANNEL





8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

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

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.

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; the video bandwidth is set to 1 MHz for peak measurements and as applicable for average measurements.

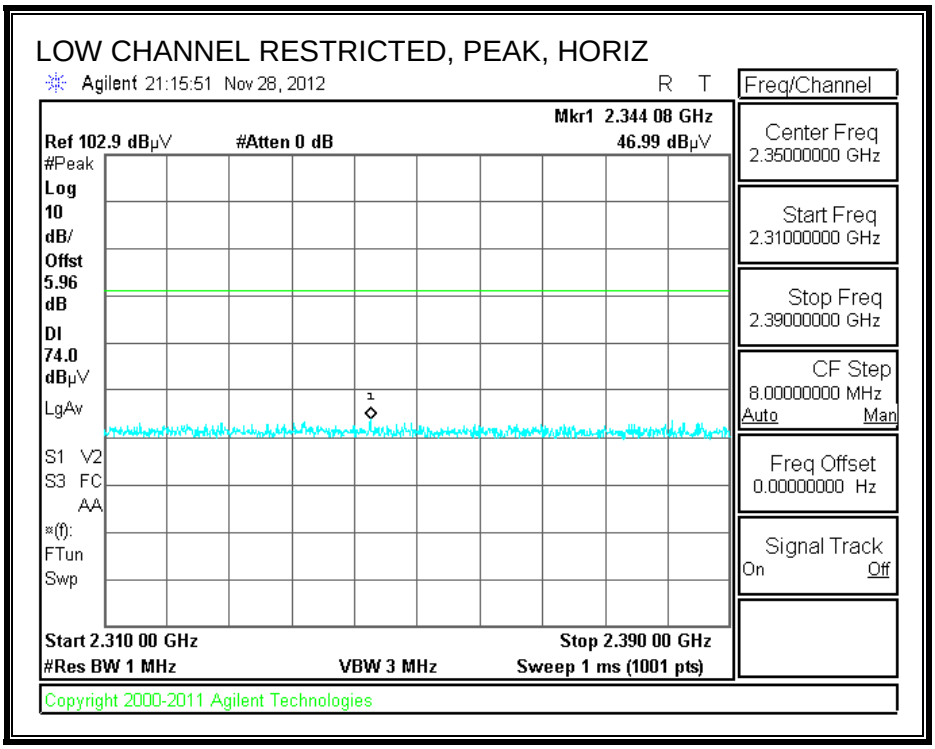
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

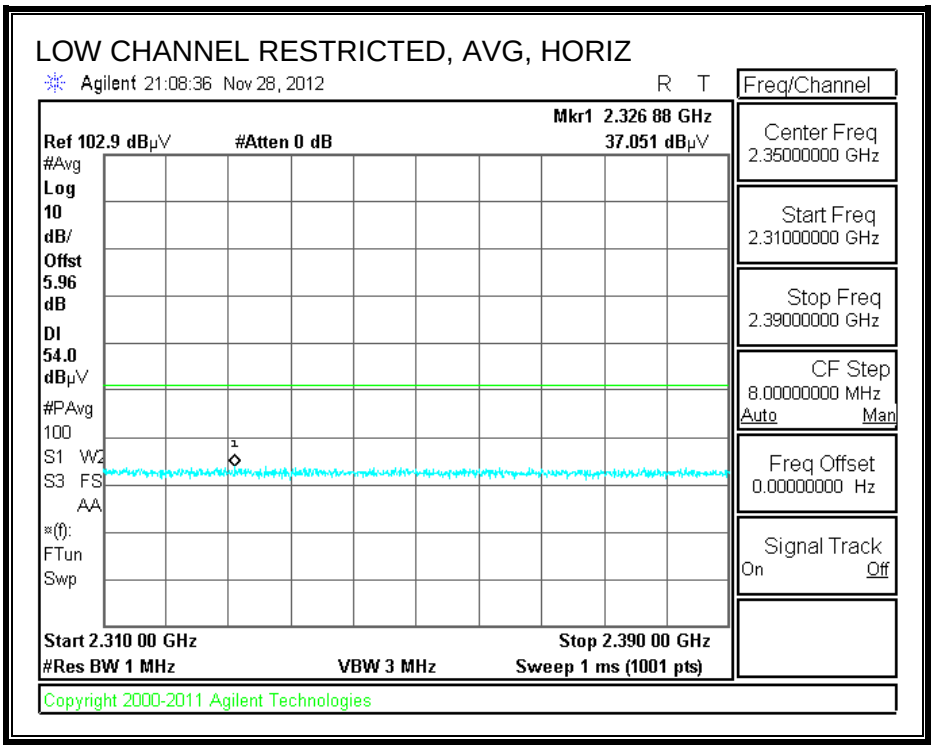
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

8.2. TRANSMITTER ABOVE 1 GHz

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

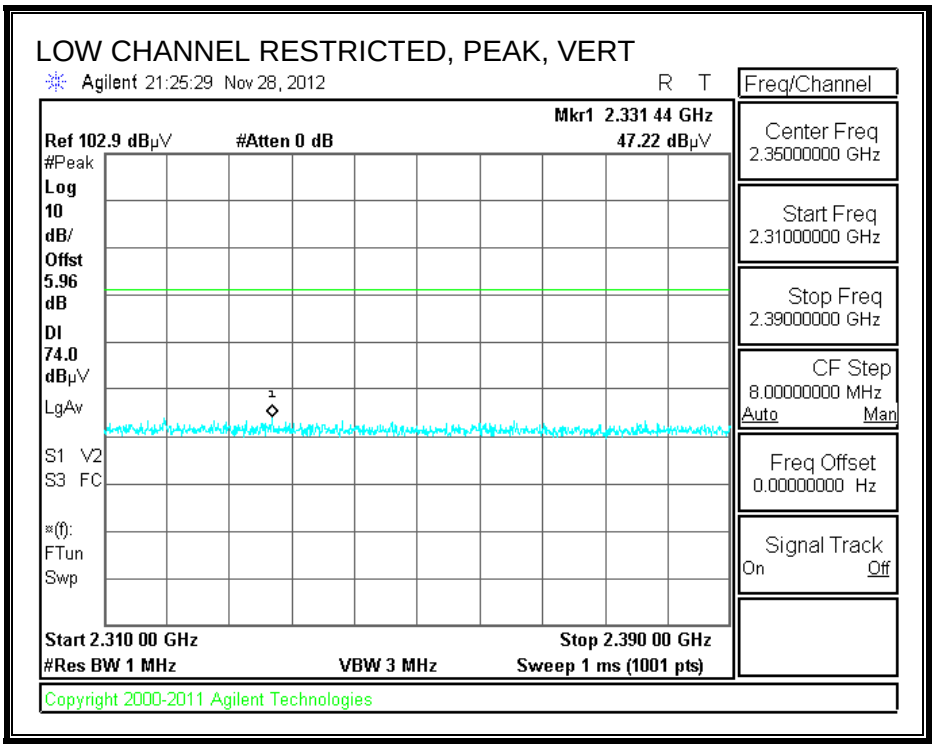
RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

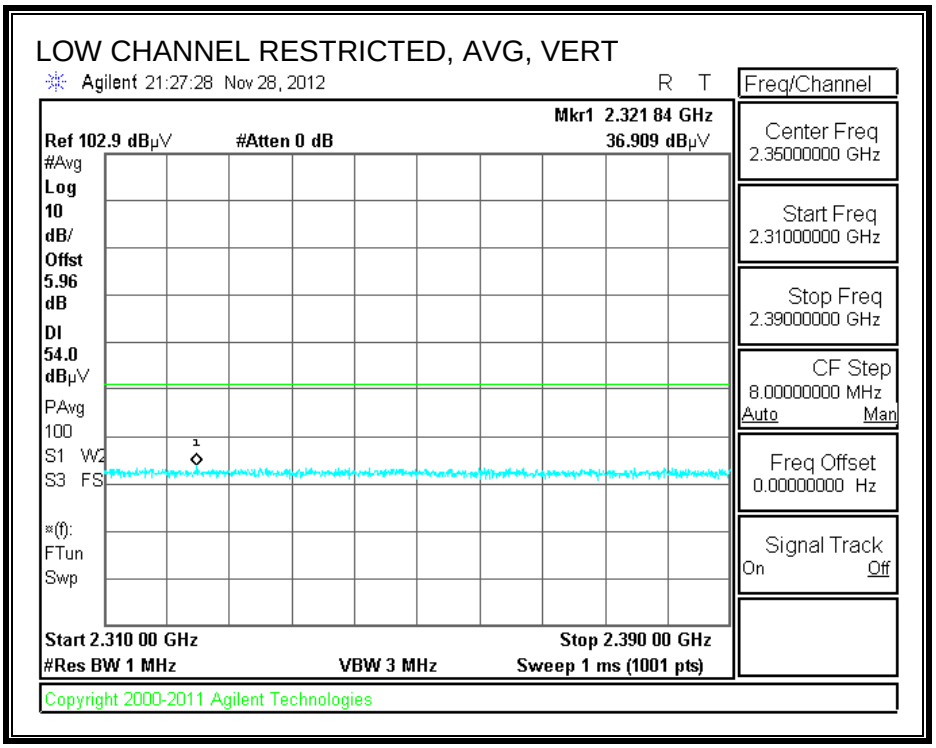




Actual Average = Measured Average + Correction Factor
= 37.051 dBuV + 2.10
= 39.15 dBuV

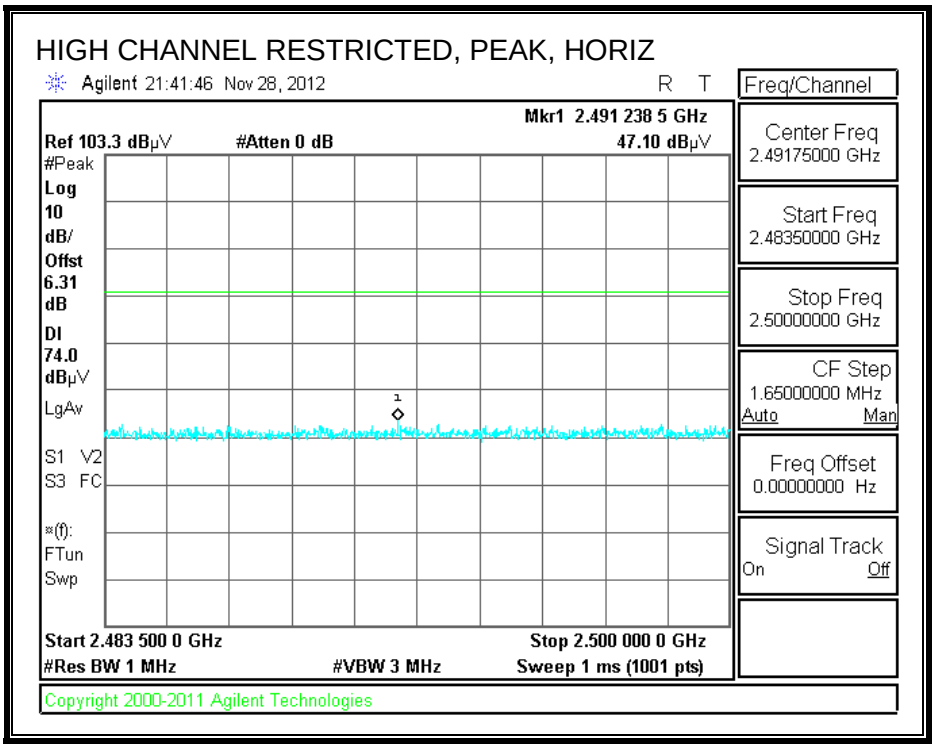
RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

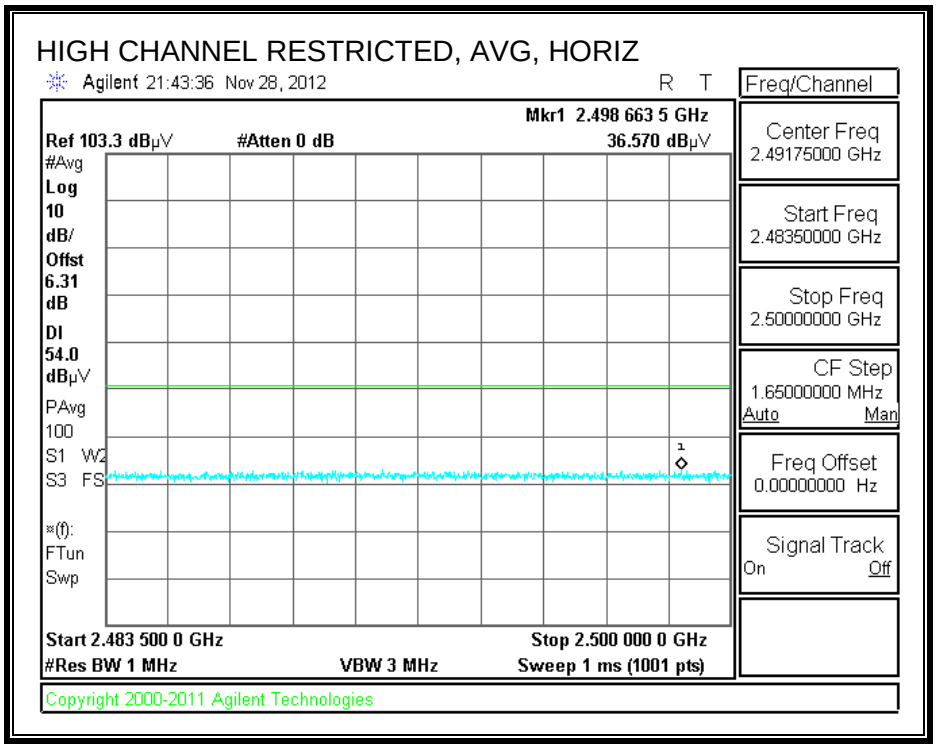




Actual Average = Measured Average + Correction Factor
= 36.909 dBuV + 2.10
= 39.01 dBuV

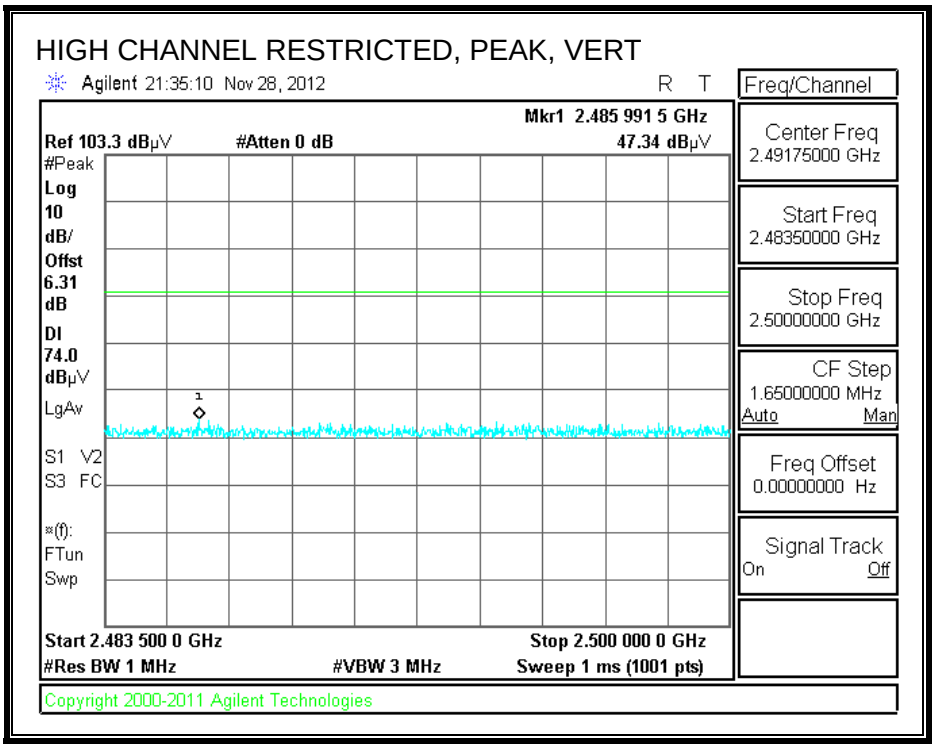
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)

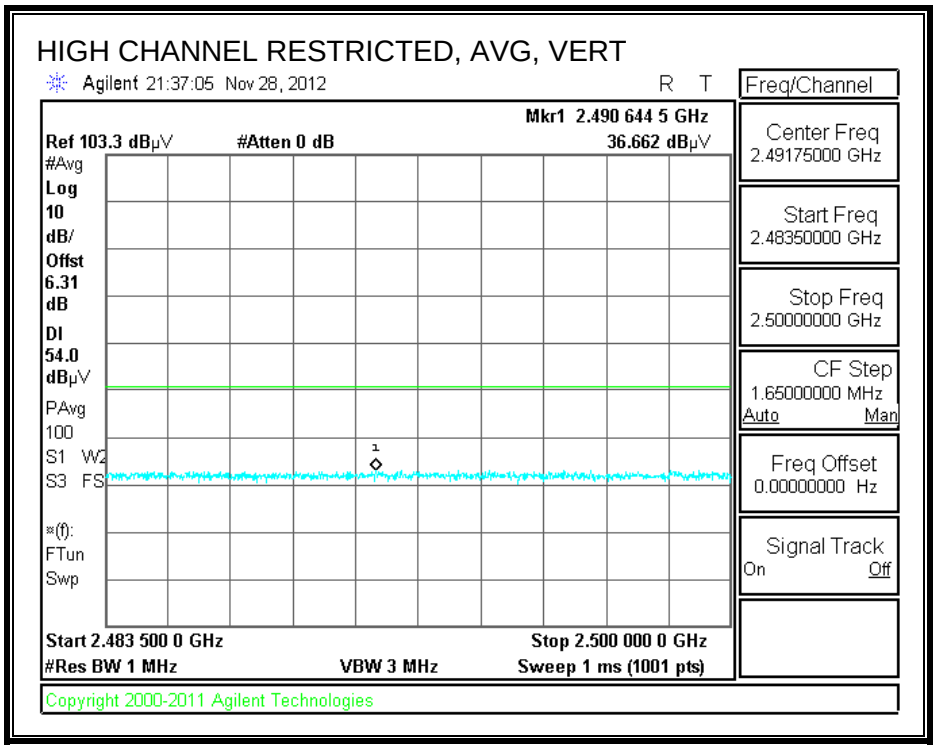




Actual Average = Measured Average + Correction Factor
= 36.570 dBuV + 2.10
= 38.67 dBuV

RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)





Actual Average = Measured Average + Correction Factor
= 36.662 dBuV + 2.10
= 38.76 dBuV

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 3m Chamber

Company:	GOOGLE
Project #:	12U14656
Date:	11/29/2012
Test Engineer:	Thanh Nguyen
Configuration:	EUT at worst position
Mode:	Tx BT LE

Test Equipment:

Horn 1-18GHz	Pre-amplifer 1-26GHz	Pre-amplifer 26-40GHz	Horn > 18GHz	Limit
T60; S/N: 2238 @3m	T34 HP 8449B			FCC 15.209

Hi Frequency Cables

3' cable 22807700	12' cable 22807600	20' cable 22807500	HPF	Reject Filter
3' cable 22807700	12' cable 22807600	20' cable 22807500		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	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
Low Ch															
4.804	3.0	38.28	24.34	33.1	6.8	-34.1	0.0	0.0	44.1	30.1	74	54	-29.9	-23.9	Noise floor/V
4.804	3.0	37.32	25.82	33.1	6.8	-34.1	0.0	0.0	43.1	31.6	74	54	-30.9	-22.4	Noise floor/H
Mid ch															
4.880	3.0	38.43	26.22	33.2	6.8	-34.0	0.0	0.0	44.4	32.2	74	54	-29.6	-21.8	Noise floor/V
4.880	3.0	38.23	25.38	33.2	6.8	-34.0	0.0	0.0	44.2	31.3	74	54	-29.8	-22.7	Noise floor/H
High Ch 2480MHz															
4.960	3.0	38.43	25.15	33.2	6.9	-34.0	0.0	0.0	44.5	31.2	74	54	-29.5	-22.8	Noise floor/V
4.960	3.0	38.53	25.36	33.2	6.9	-34.0	0.0	0.0	44.6	31.4	74	54	-29.4	-22.6	Noise floor/H

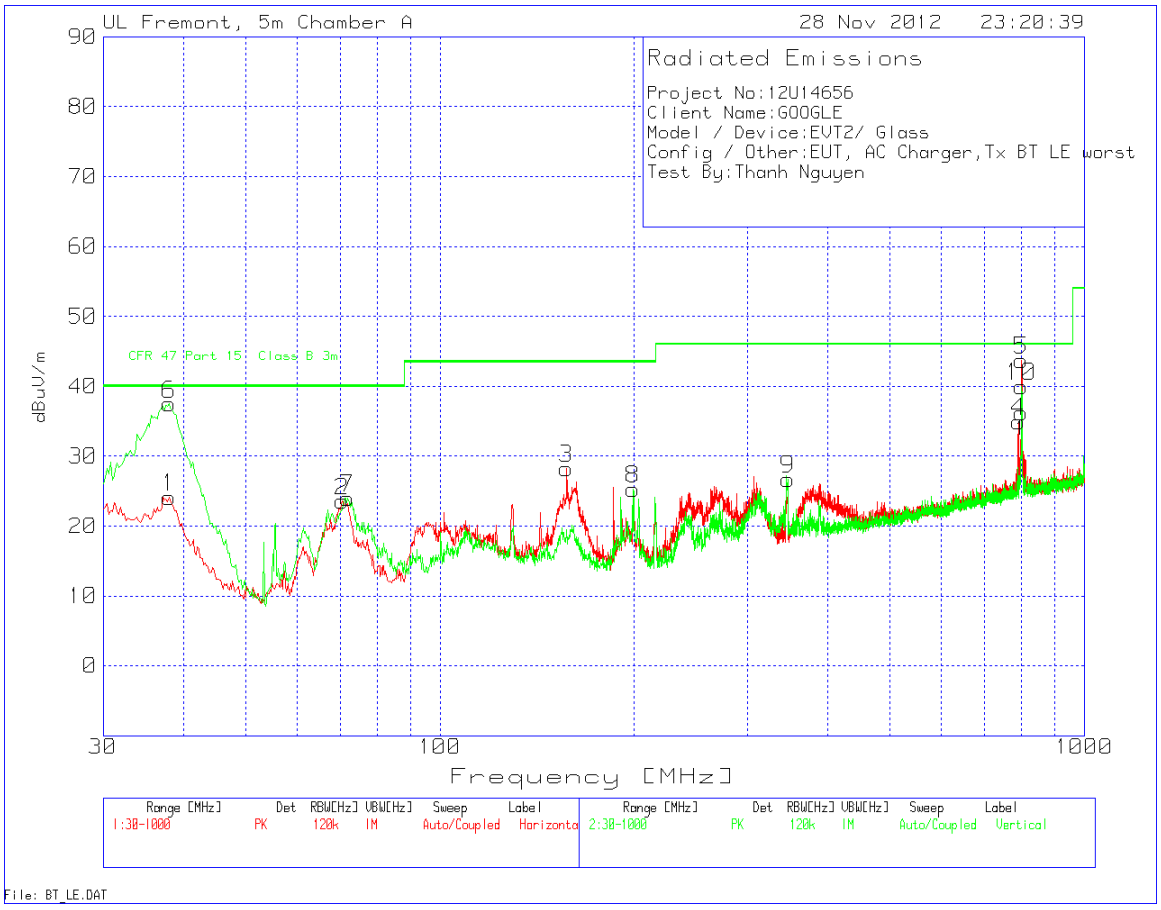
Rev. 11.10.11

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

8.3. WORST-CASE BELOW 1 GHz

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

EMI PLOT



EMI DATA

Project No:12U14656									
Client Name:GOOGLE									
Model / Device:EVT2/ Glass									
Config / Other:EUT, AC Charger,Tx BT LE worst case									
Test By:Thanh Nguyen									
Horizontal 30 - 1000MHz									
Test Frequency	**Meter Reading**	**Detector**	**25MHz-1GHz ChmbrA Amplified.TX (dB)**	**T243 Sunol Bilog.TXT (dB)**	**dBuV/m**	**CFR 47 Part 15 Class B 3m**	**Margin**	**Height [cm]**	**Polarity**
37.9476	36.23	PK	-27.4	15.3	24.13	40	-15.87	400	Horz
70.5136	42.54	PK	-27.1	8.1	23.54	40	-16.46	200	Horz
157.3561	42.72	PK	-26.5	12	28.22	43.5	-15.28	200	Horz
790.6475	37.7	PK	-23.3	20.6	35	46	-11	100	Horz
799.3705	46.02	PK	-23.3	21	43.72	46	-2.28	100	Horz
799.5745	37.08	QP	-23.3	21	34.78	46	-11.22	268	Horz
Vertical 30 - 1000MHz									
Test Frequency	**Meter Reading**	**Detector**	**25MHz-1GHz ChmbrA Amplified.TX (dB)**	**T243 Sunol Bilog.TXT (dB)**	**dBuV/m**	**CFR 47 Part 15 Class B 3m**	**Margin**	**Height [cm]**	**Polarity**
37.9476	49.56	PK	-27.4	15.3	37.46	40	-2.54	100	Vert
38.0508	44.89	QP	-27.4	15.3	32.79	40	-7.21	65	Vert
71.8705	43.02	PK	-27.1	8.1	24.02	40	-15.98	300	Vert
199.6143	39.23	PK	-26.2	12.3	25.33	43.5	-18.17	100	Vert
346.5488	38.14	PK	-25.6	14.2	26.74	46	-19.26	100	Vert
798.4013	42.43	PK	-23.3	20.9	40.03	46	-5.97	100	Vert
798.9114	28.31	QP	-23.3	21	26.01	46	-19.99	136	Vert

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

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

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

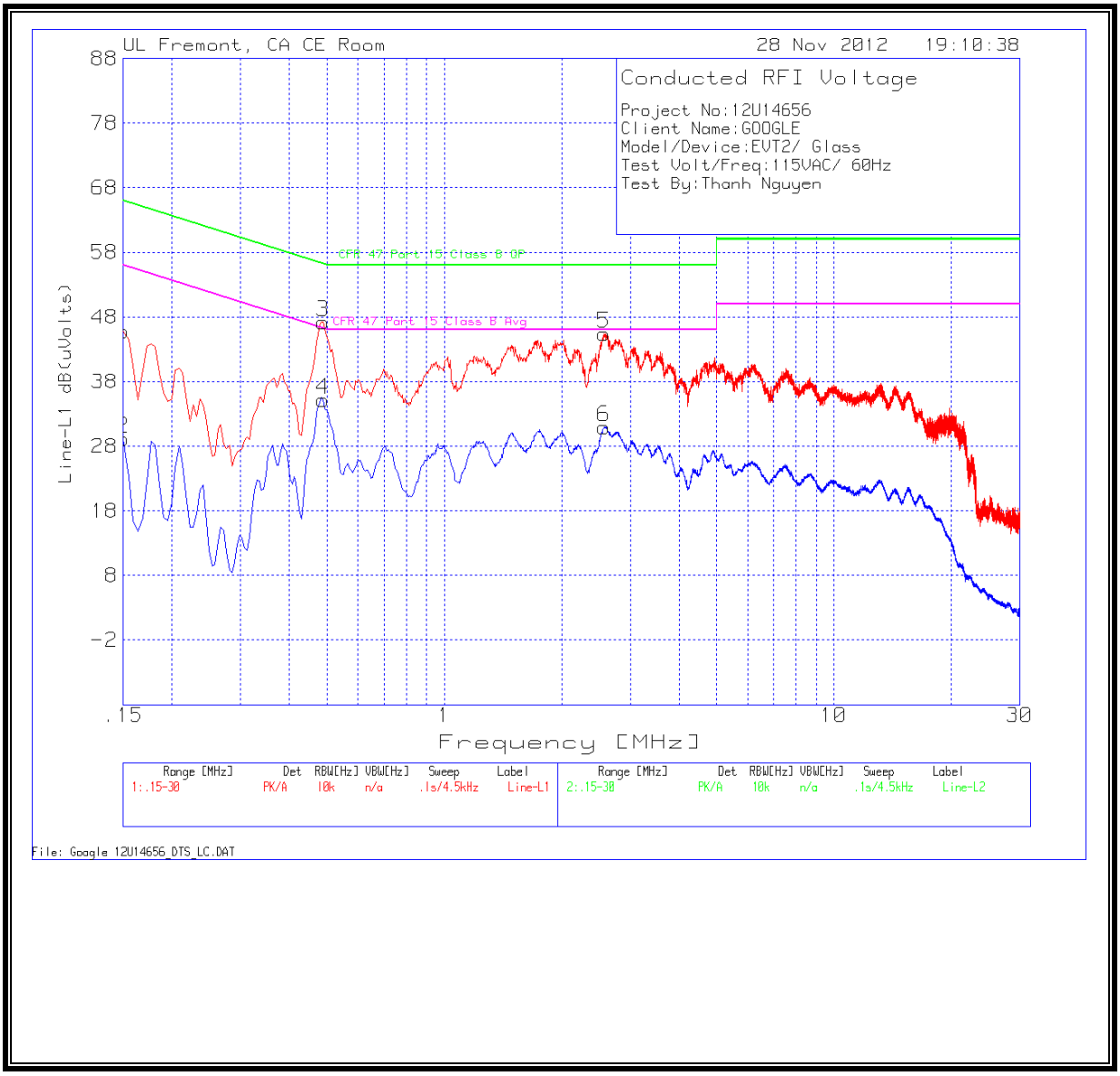
ANSI C63.4

RESULTS

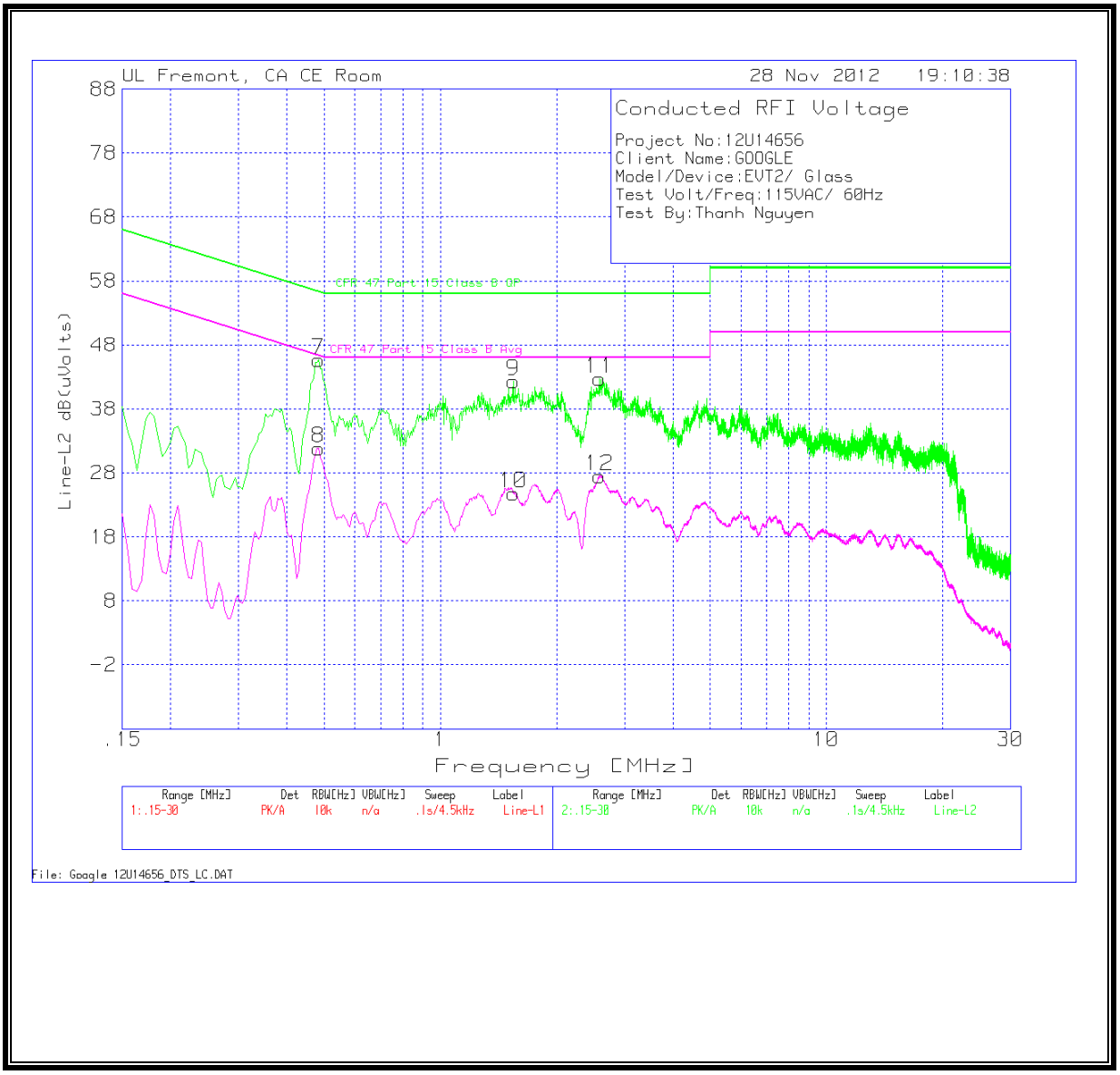
6 WORST EMISSIONS

Project No:12U14656									
Client Name:GOOGLE									
Model/Device:EVT2/ Glass									
Test Volt/Freq:115VAC/ 60Hz									
Test By:Thanh Nguyen									
Line-L1 .15 - 30MHz									
Test Frequency	**Meter Reading**	**Detector**	**T24 IL L1.TXT (dB)**	**LC Cables 1&3.TXT (dB)**	**dB(uVolts)**	**CFR 47 Part 15 Class B QP**	**Margin**	**CFR 47 Part 15 Class B Avg**	**Margin**
0.15	45.72	PK	0.1	0	45.82	66	-20.18	-	-
0.15	29.01	Av	0.1	0	29.11	-	-	56	-26.89
0.4875	47.11	PK	0.1	0	47.21	56.2	-8.99	-	-
0.4875	35.1	Av	0.1	0	35.2	-	-	46.2	-11
2.571	45.25	PK	0.1	0.1	45.45	56	-10.55	-	-
2.571	30.7	Av	0.1	0.1	30.9	-	-	46	-15.1
Line-L2 .15 - 30MHz									
Test Frequency	**Meter Reading**	**Detector**	**T24 IL L1.TXT (dB)**	**LC Cables 1&3.TXT (dB)**	**dB(uVolts)**	**CFR 47 Part 15 Class B QP**	**Margin**	**CFR 47 Part 15 Class B Avg**	**Margin**
0.483	45.52	PK	0.1	0	45.62	56.3	-10.68	-	-
0.483	31.78	Av	0.1	0	31.88	-	-	46.3	-14.42
1.545	42.09	PK	0.1	0.1	42.29	56	-13.71	-	-
1.545	24.64	Av	0.1	0.1	24.84	-	-	46	-21.16
2.589	42.54	PK	0.1	0.1	42.74	56	-13.26	-	-
2.589	27.28	Av	0.1	0.1	27.48	-	-	46	-18.52

LINE 1 RESULTS



LINE 2 RESULTS



END OF REPORT