



**FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8
(ADDITIONAL CHANNELS 12 AND 13)**

CERTIFICATION TEST REPORT

FOR

QUAD-BAND RADIO WITH WLAN AND BT RADIO

MODEL NUMBER: A1457

**FCC ID: BCG-E2643B
IC: 579C-E2643B**

REPORT NUMBER: 13U15637-17

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

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	09/06/13	Initial Issue	T. Chan

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: QUAD-BAND RADIO WITH WLAN AND BT RADIO

MODEL: A1457

SERIAL NUMBER: C39KD00CFJ0Y

DATE TESTED: APRIL 24 – JUNE 10, 2013

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-210 Issue 8 Annex 8	Pass
INDUSTRY CANADA RSS-GEN Issue 3	Pass

UL 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:

Tested By:



Thu Chan
WiSE Operations Manager
UL Verification Services Inc.



Francisco Guarnero
WiSE Lab Technician
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2009, 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.

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

UL Verification Services Inc. 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:

$$\begin{aligned}\text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m}\end{aligned}$$

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, Model A1457 is a mobile phone with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE radio, IEEE 802.11a/b/g/n, Bluetooth and GPS radio. The rechargeable battery is not user accessible.

Testing of Model A1457 (FCC ID: BCG-E2643B) and (IC #: 579C-E2643B) is considered representative of Model A1530 (FCC ID: BCG-E2643A) and (IC #: 579C-E2643A). Model A1457 is identical to Model A1530 except for the WWAN functions. Both the WLAN and WWAN antenna locations for both models are identical.

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)
2467 - 2472	802.11b	17.355	54.39
2467 - 2472	802.11g	19.790	95.28
2467 - 2472	802.11n HT20	19.460	88.31

5.3. WORST-CASE CONFIGURATION AND MODE

Channels 12 and 13 don't have the highest output power, therefore, only 6dB bandwidth, output power, conducted and radiated spurious harmonic test items were performed. Due to the lower power (than Channels 1-11) and the uniform distribution of power according to the occupied bandwidth plots, PSD measurements are not required.

The fundamental of the EUT was investigated in three orthogonal orientations X, Y, Z, it was determined that X orientation was worst-case orientation for 2.4GHz; therefore, all final radiated testing was performed with the EUT in worst case orientation.

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

Based on the baseline scan, the worst-case data rates were:

802.11b mode: 1 Mbps

802.11g mode: 6 Mbps

802.11n HT20mode: MCS0

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
Horn Antenna 1-18GHz	ETS Lindgren	3117	F00133	02/19/14
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00580	01/28/14
Antenna, Horn, 26.5 GHz	ARA	SWH-28	C01015	05/06/14
Antenna, Biconolog, 30MHz-1 GHz	Sunol Sciences	JB3	F00215	03/07/14
Peak / Average Power Sensor	Agilent / HP	E9323A	F00026	07/27/14
P-Series single channel Power Meter	Agilent / HP	N1911A	F00153	07/26/14
Spectrum Analyzer, 3Hz-44GHz	Agilent	N9030A	F00127	02/22/14
PreApmplifier, 1-26.5GHz	Agilent	8449B	C01052	10/22/13
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	04/17/14
Antenna, Horn, 40 GHz	ARA	MWH-2640/B	C00981	06/14/14
EMI Test Receiver, 30 MHz	R & S	ESHS 20	N02396	08/15/14

7. ANTENNA PORT TEST RESULTS

7.1. 2.4 GHz BAND

7.1.1. 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

KDB 558074 D01 v01 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247".

RESULTS

b mode

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
12	2467	8.078	0.5
13	2472	8.040	0.5

g mode

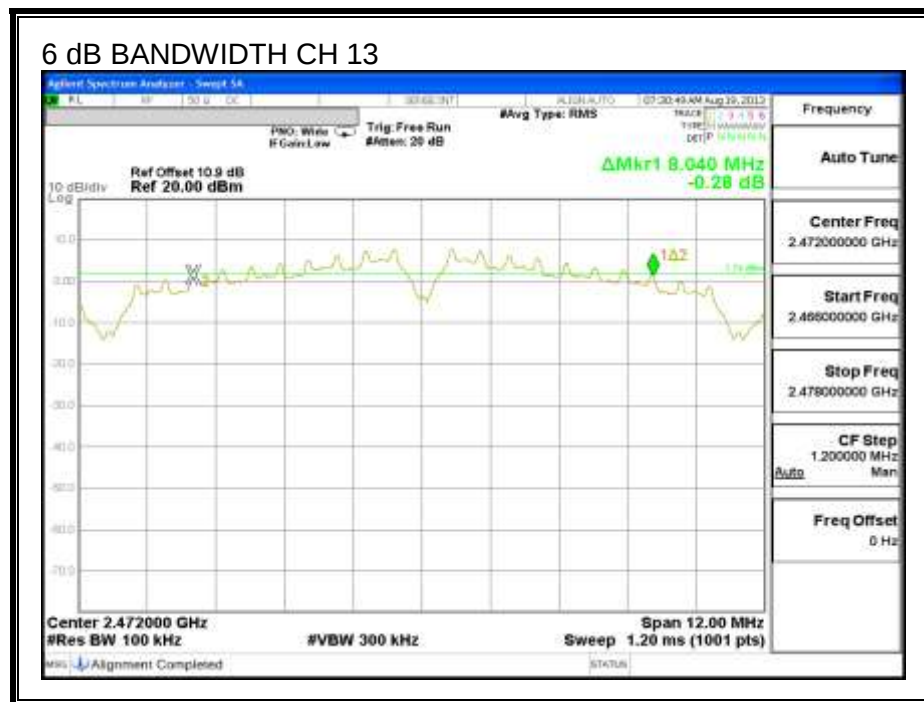
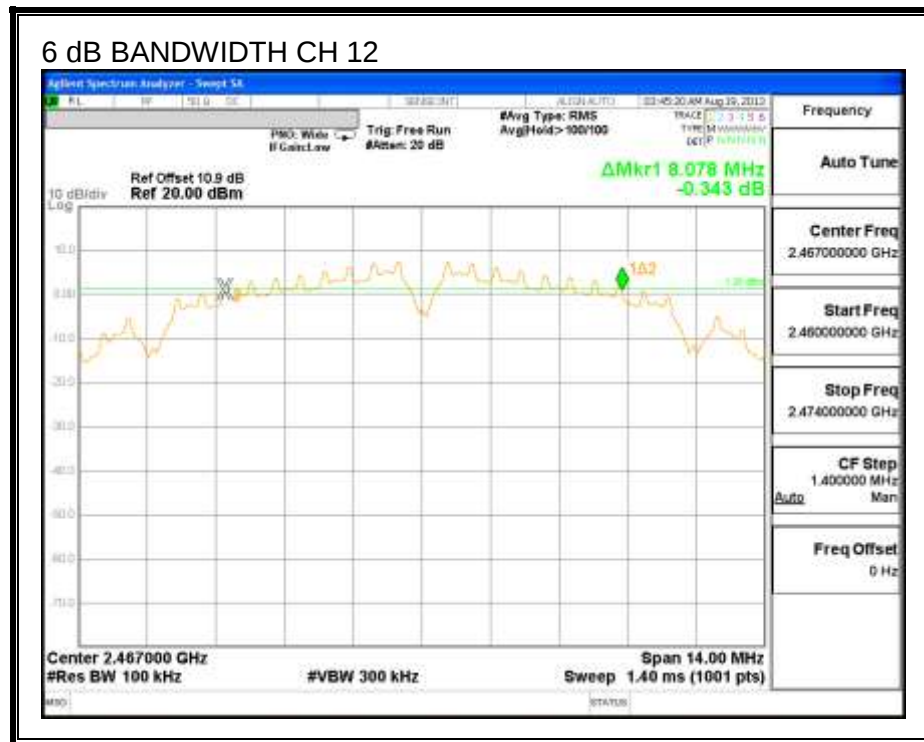
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
12	2467	16.399	0.5
13	2472	16.422	0.5

HT20 mode

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
12	2467	17.641	0.5
13	2472	17.618	0.5

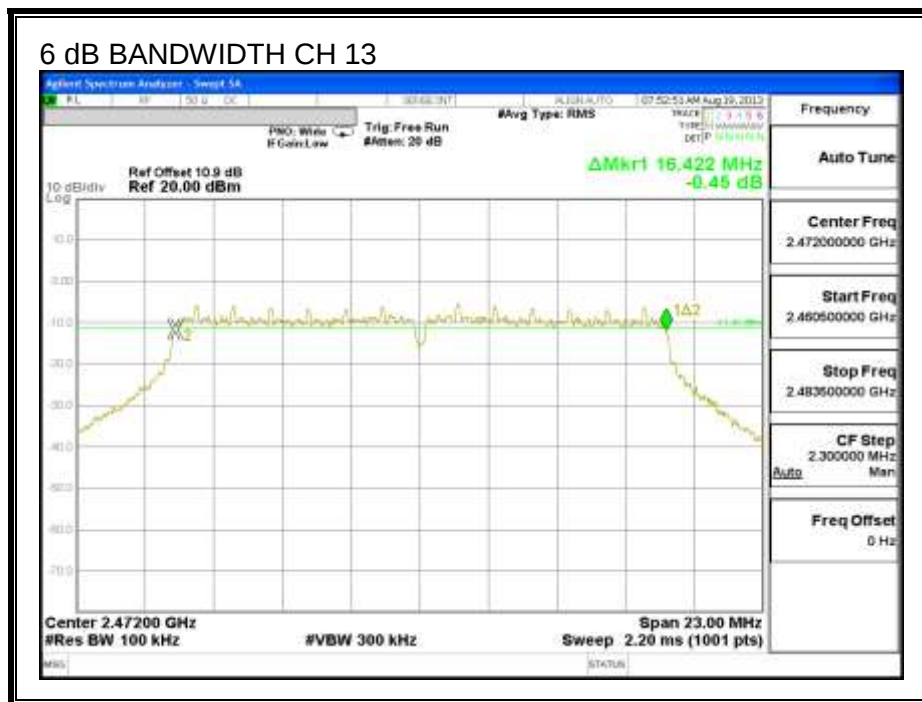
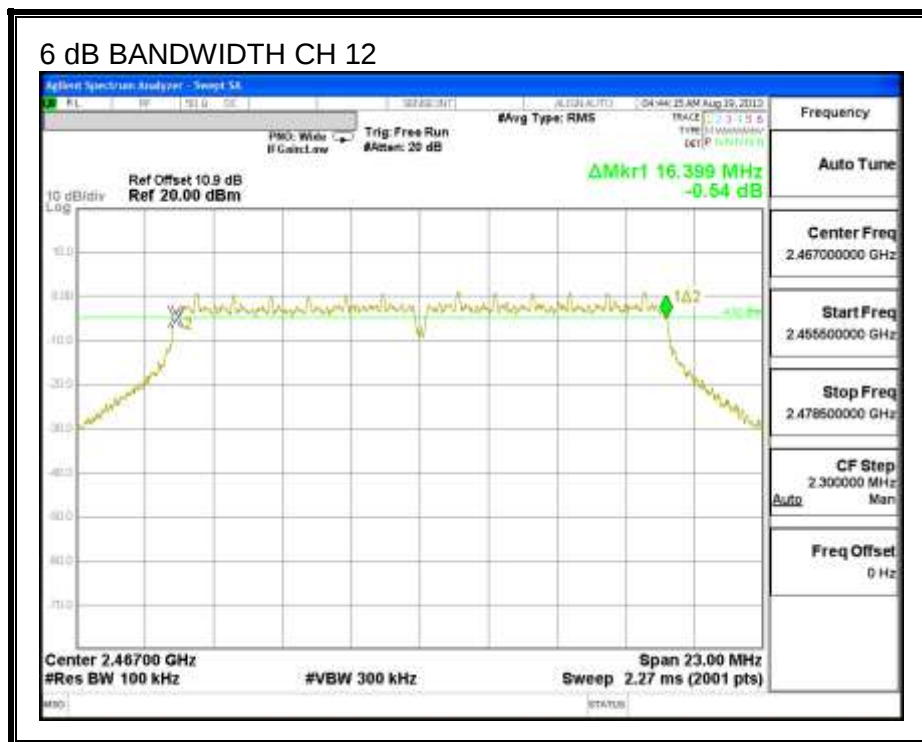
B MODE

6 dB BANDWIDTH



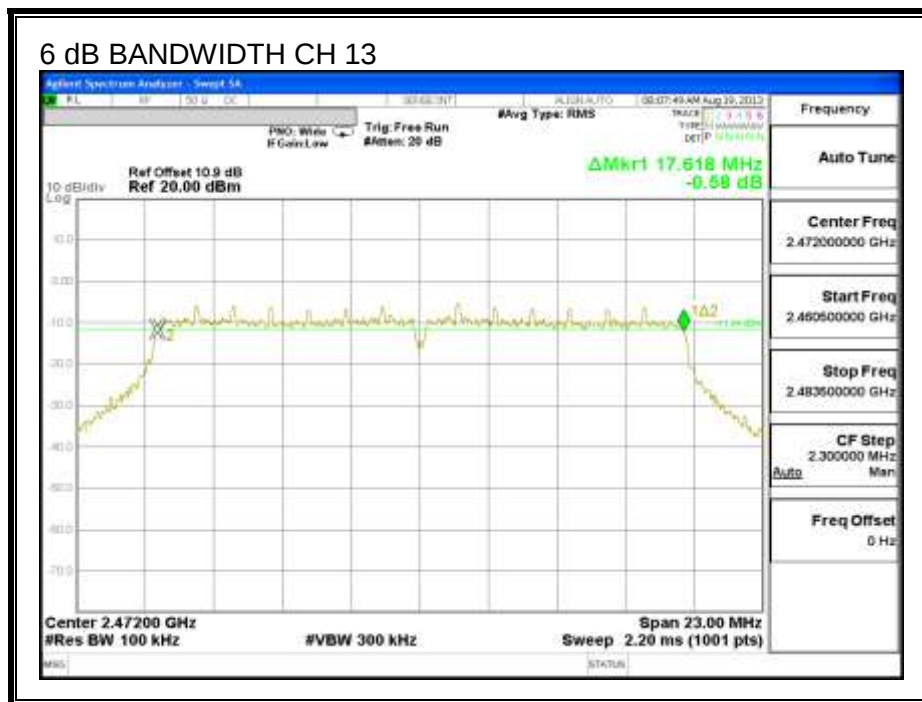
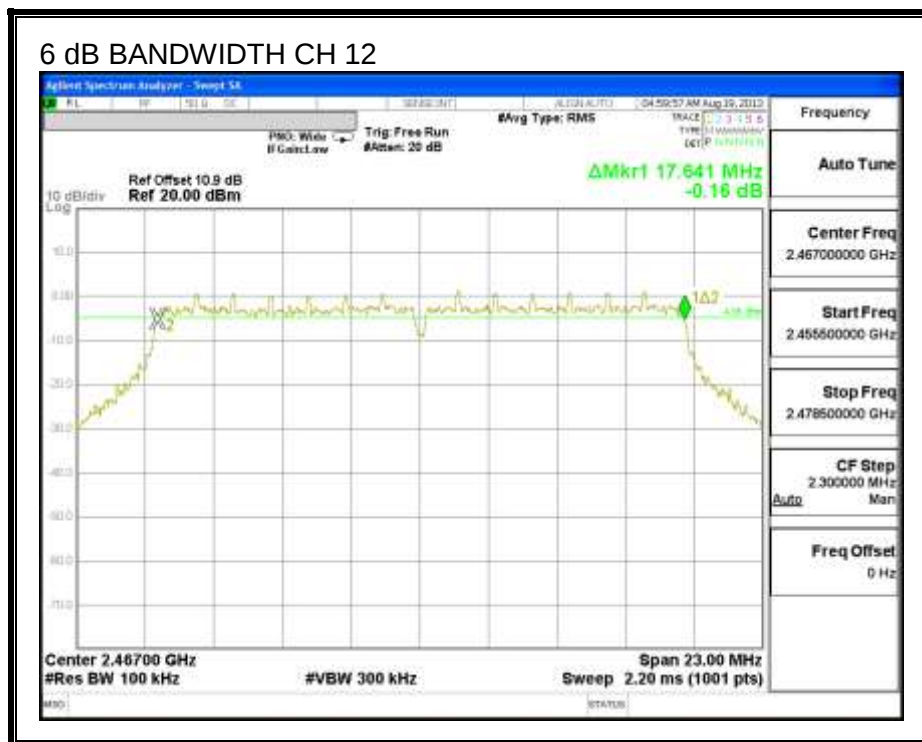
G MODE

6 dB BANDWIDTH



HT20 MODE

6 dB BANDWIDTH



7.1.2. 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 11 dB (including 10 dB pad and 1dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

b mode

Channel	Frequency (MHz)	Power (dBm)
12	2467	14.50
13	2472	14.50

g mode

Channel	Frequency (MHz)	Power (dBm)
12	2467	12.00
13	2472	5.00

HT20 mode

Channel	Frequency (MHz)	Power (dBm)
12	2467	12.00
13	2472	5.00

7.1.3. 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

B MODE

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
12	2467	1.09	30.00	30	36	30.00
13	2472	1.09	30.00	30	36	30.00

Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
12	2467	16.950	16.95	30.00	-13.05
13	2472	17.355	17.36	30.00	-12.65

G MODE

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
12	2467	1.09	30.00	30	36	30.00
13	2472	1.09	30.00	30	36	30.00

Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
12	2467	19.79	19.79	30.00	-10.21
13	2472	12.46	12.46	30.00	-17.54

HT20 MODE

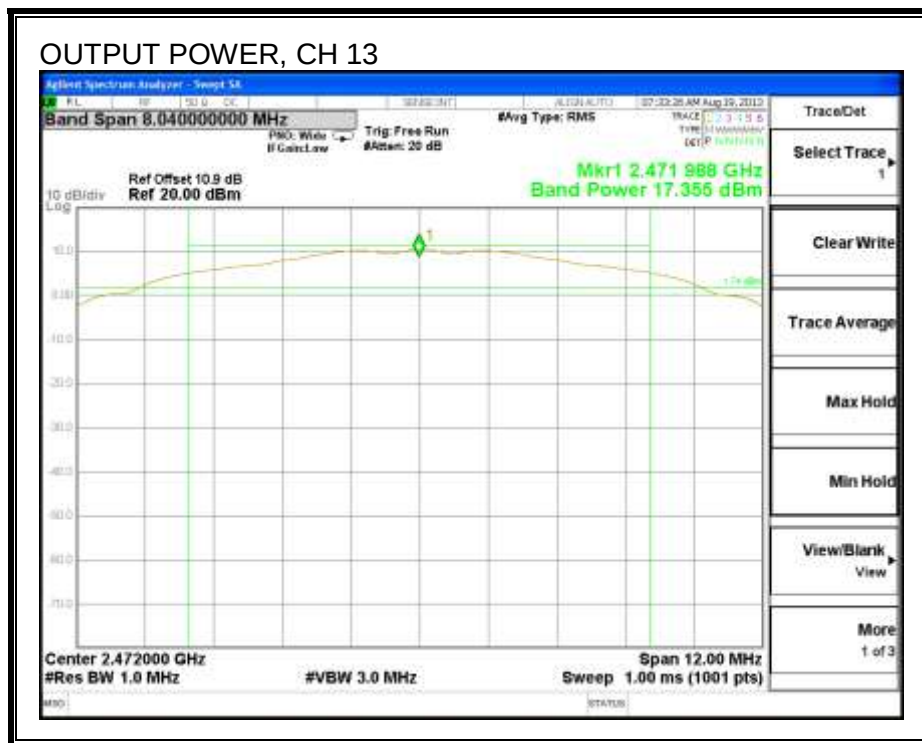
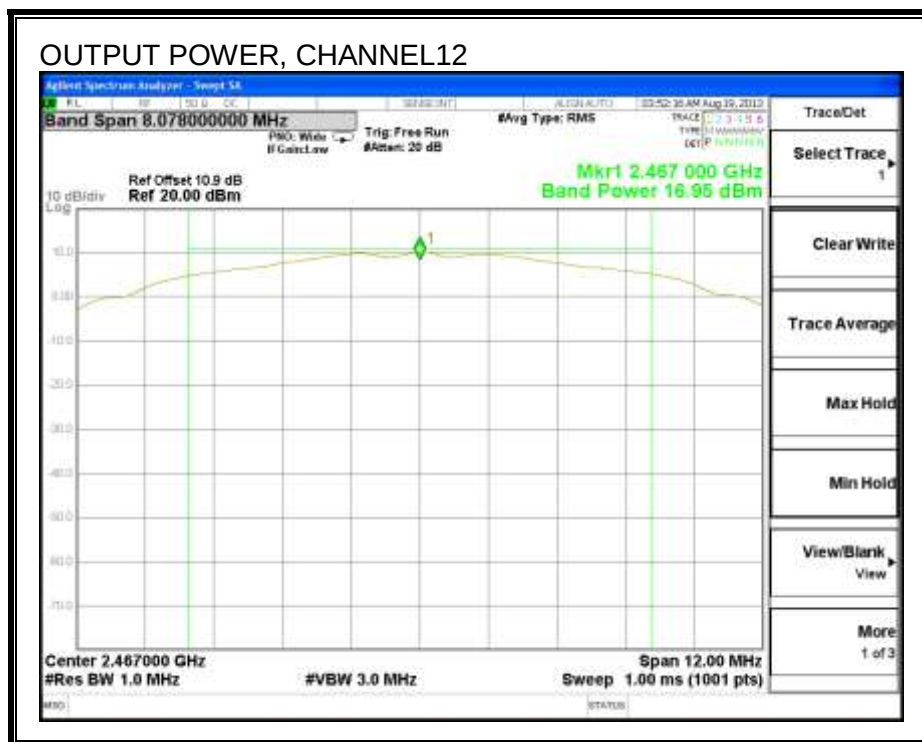
Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
12	2467	1.09	30.00	30	36	30.00
13	2472	1.09	30.00	30	36	30.00

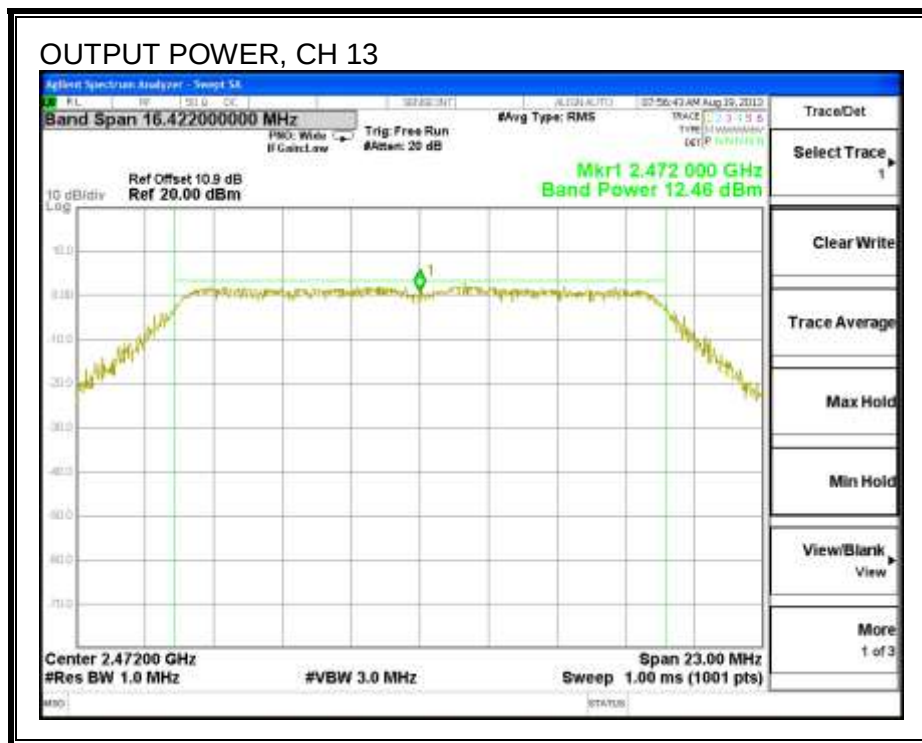
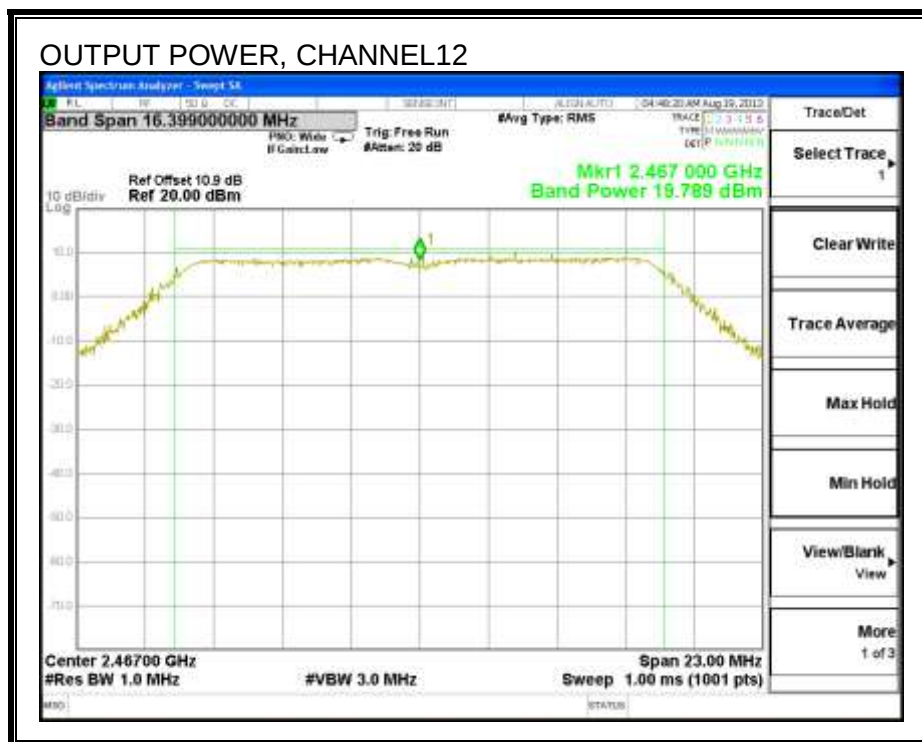
Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
12	2467	19.46	19.46	30.00	-10.54
13	2472	12.84	12.84	30.00	-17.16

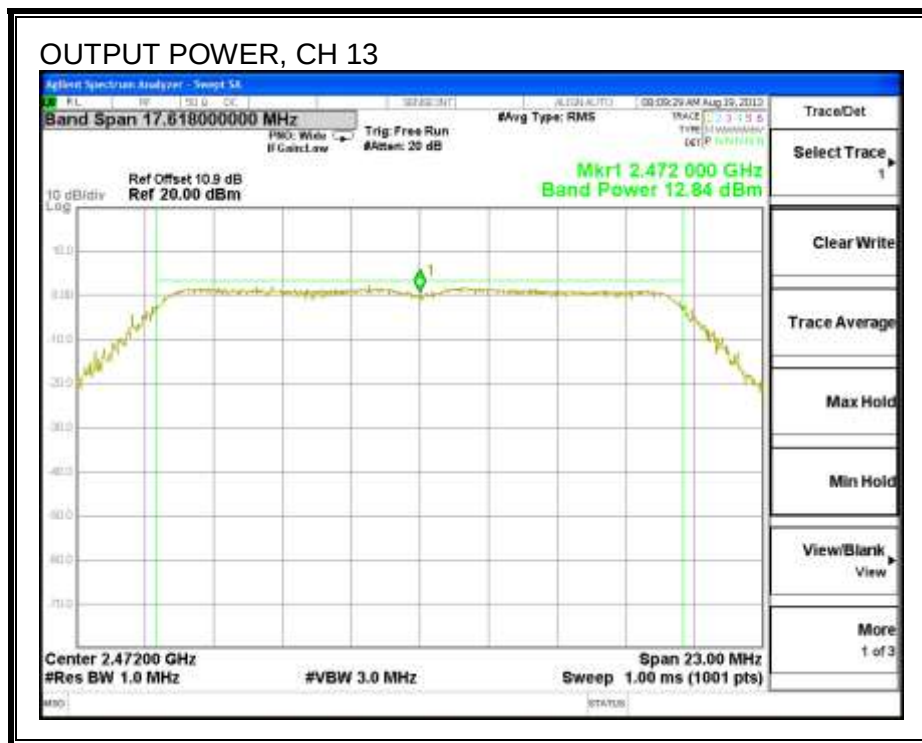
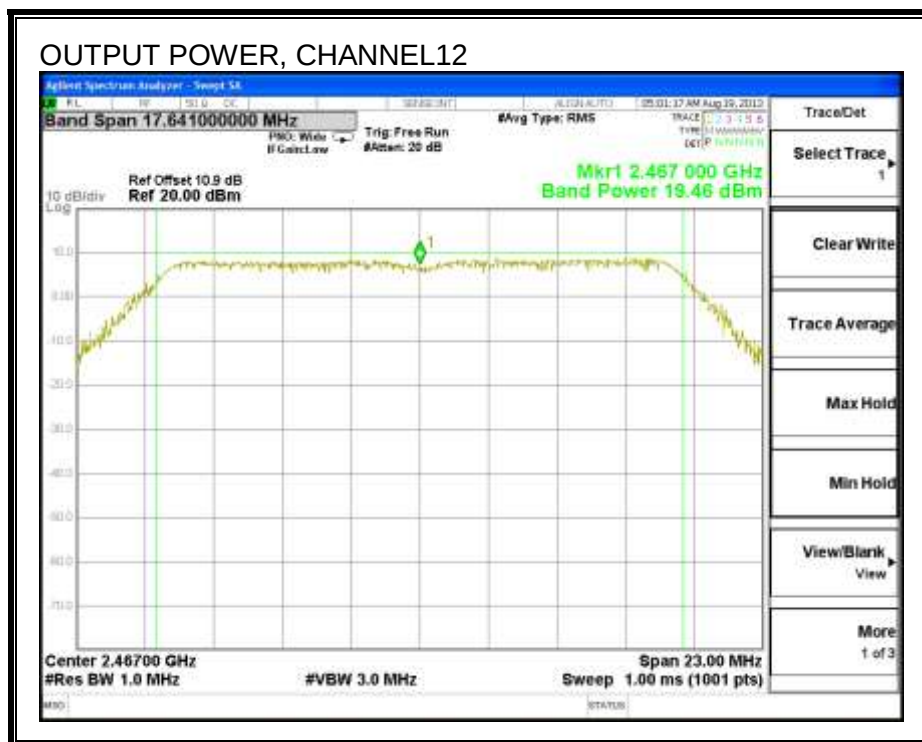
B MODE OUTPUT POWER



G MODE OUTPUT POWER



HT20 Mode OUTPUT POWER



7.1.4. OUT-OF-BAND EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

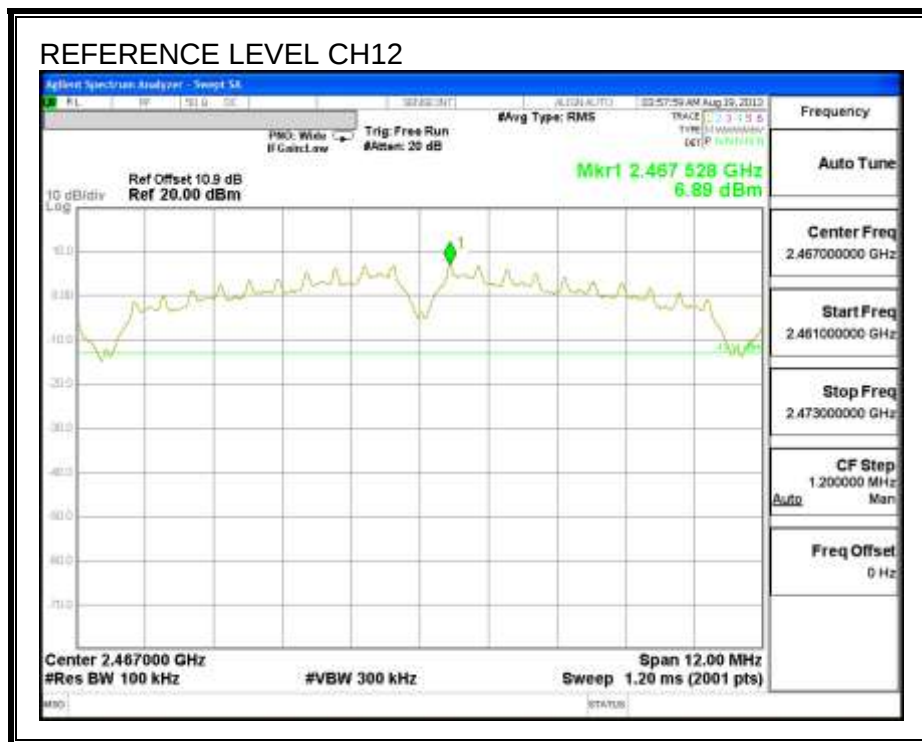
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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

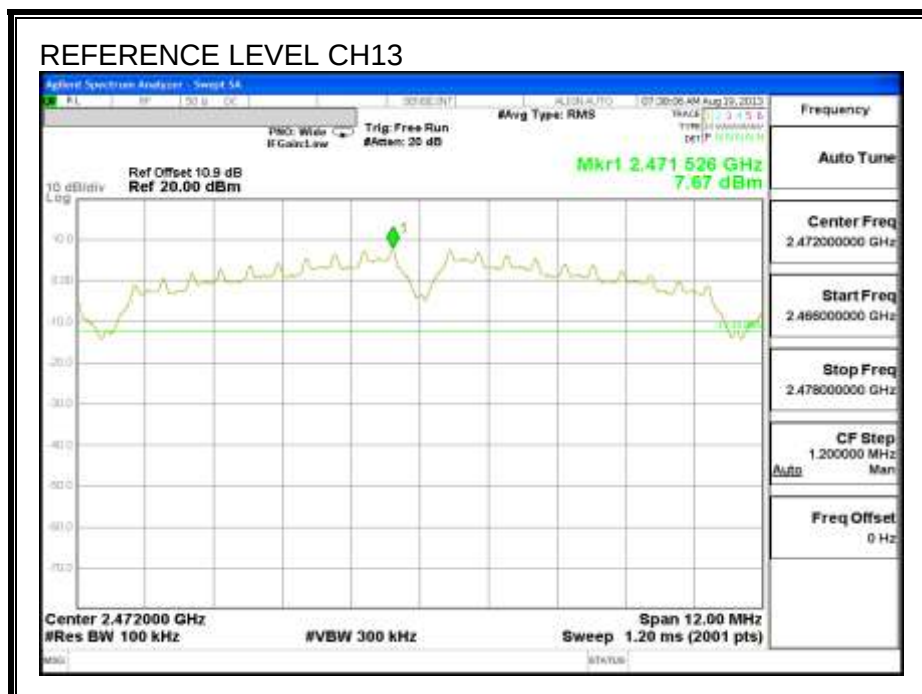
The transmitter output is connected to a spectrum analyzer with RBW = 100 kHz, VBW = 300 kHz, peak detector, and max hold. Measurements utilizing these settings are made of the in-band reference level, band edge (where measurements to the general radiated limits will not be made) and out-of-band emissions.

RESULTS

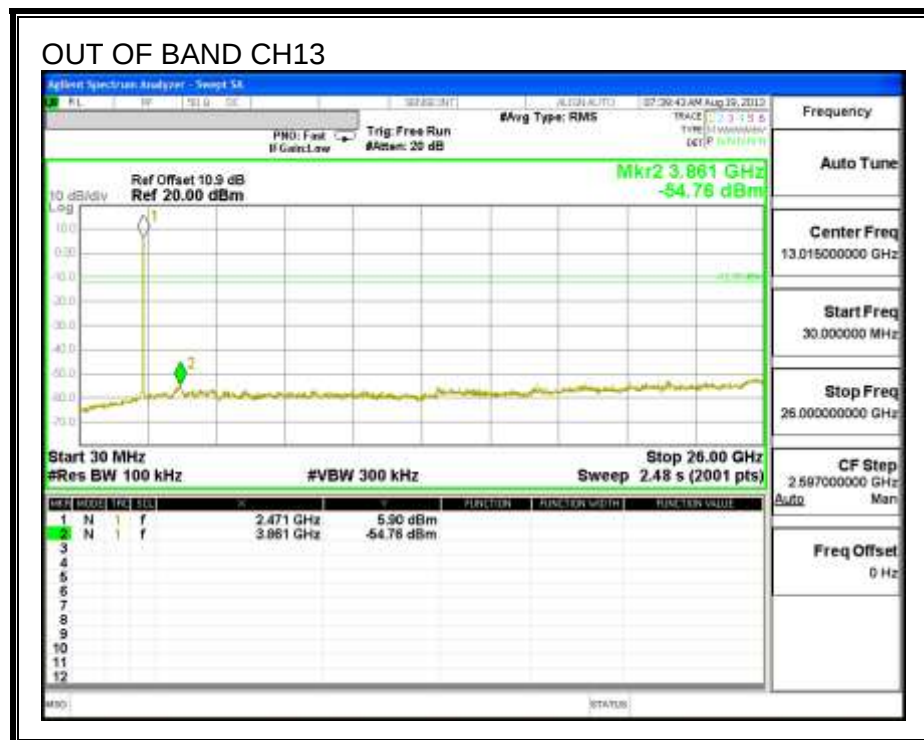
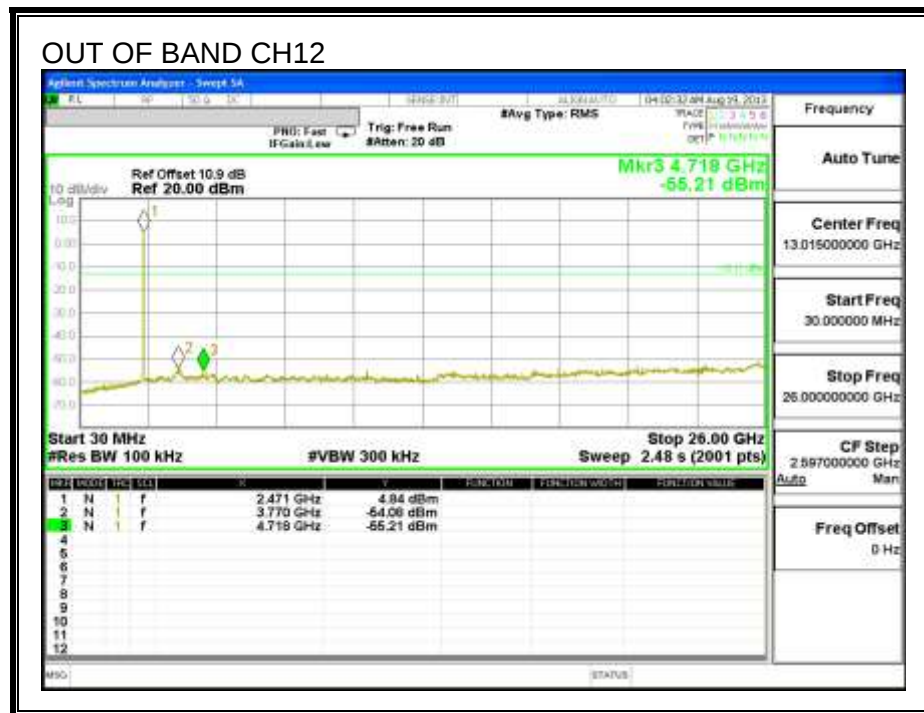
B MODE IN-BAND REFERENCE LEVEL



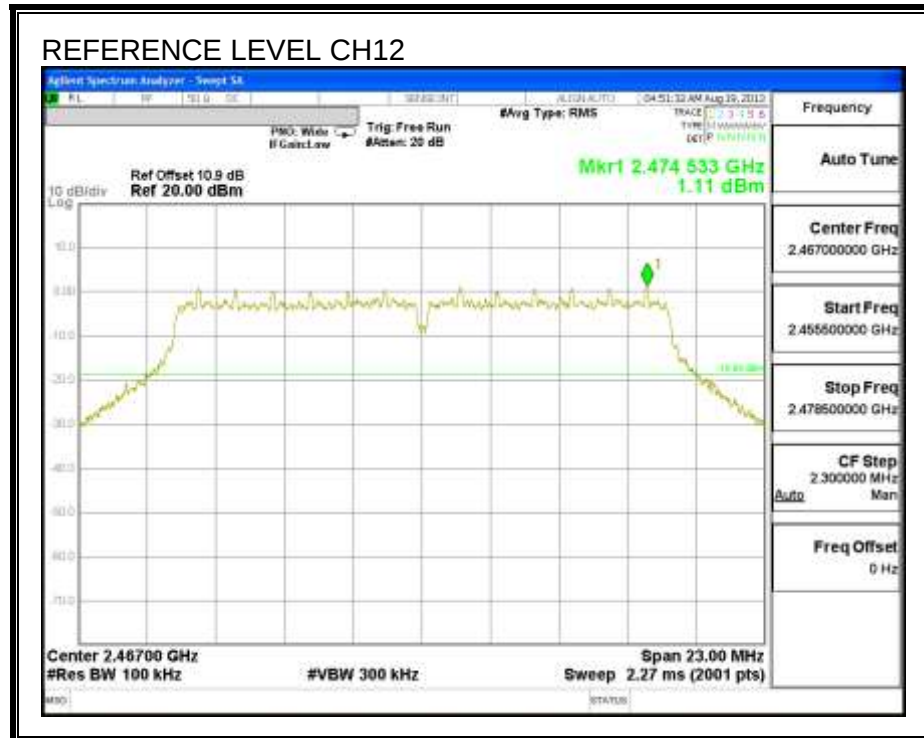
B MODE IN-BAND REFERENCE LEVEL



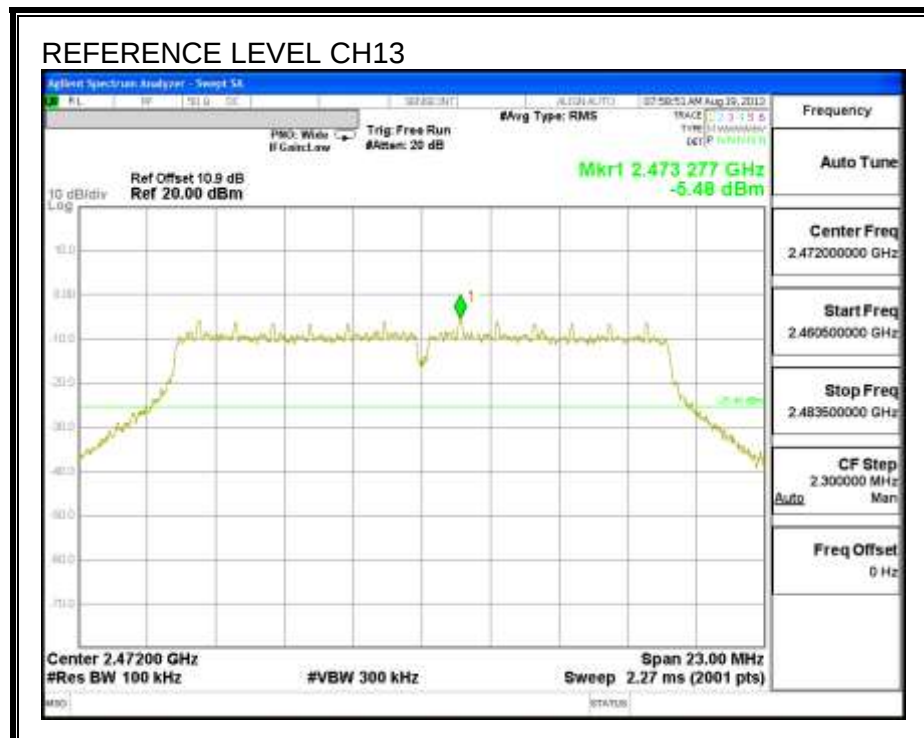
B MODE OUT-OF-BAND EMISSIONS



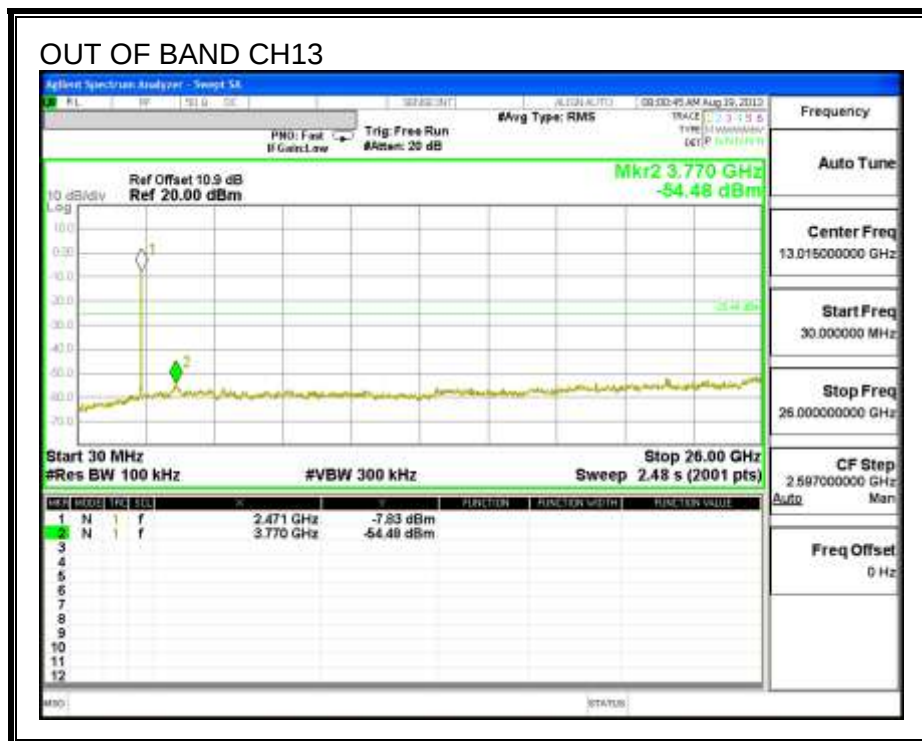
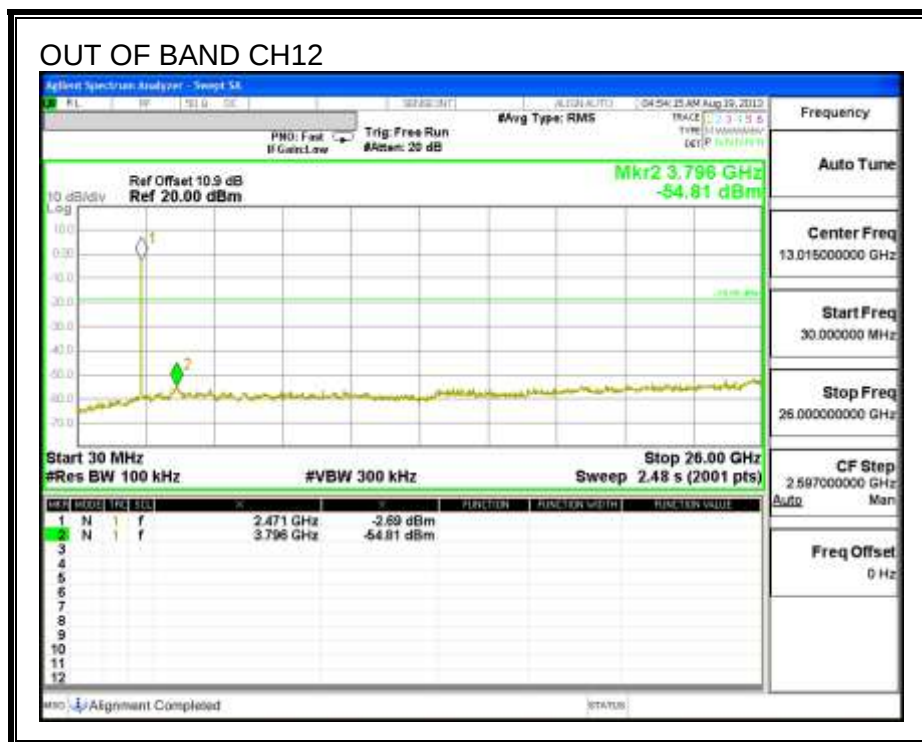
G MODE IN-BAND REFERENCE LEVEL



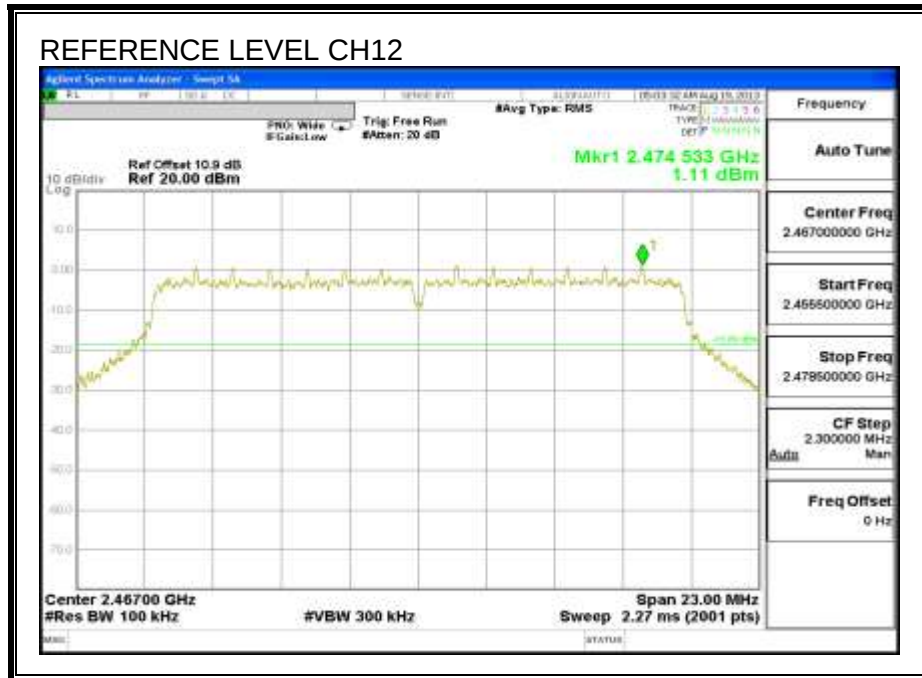
G MODE IN-BAND REFERENCE LEVEL



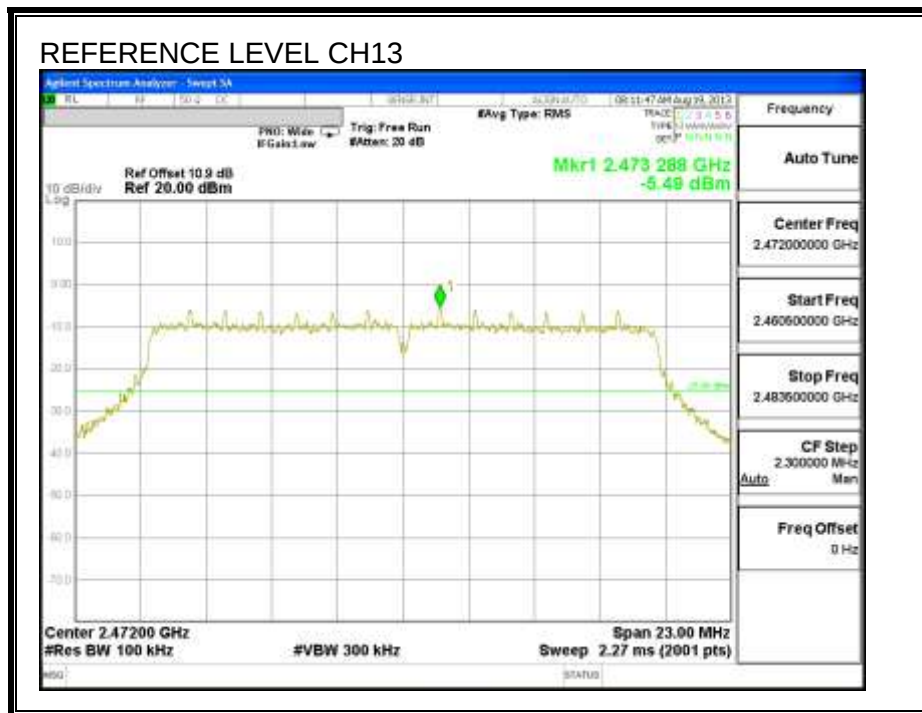
G MODE OUT-OF-BAND EMISSIONS



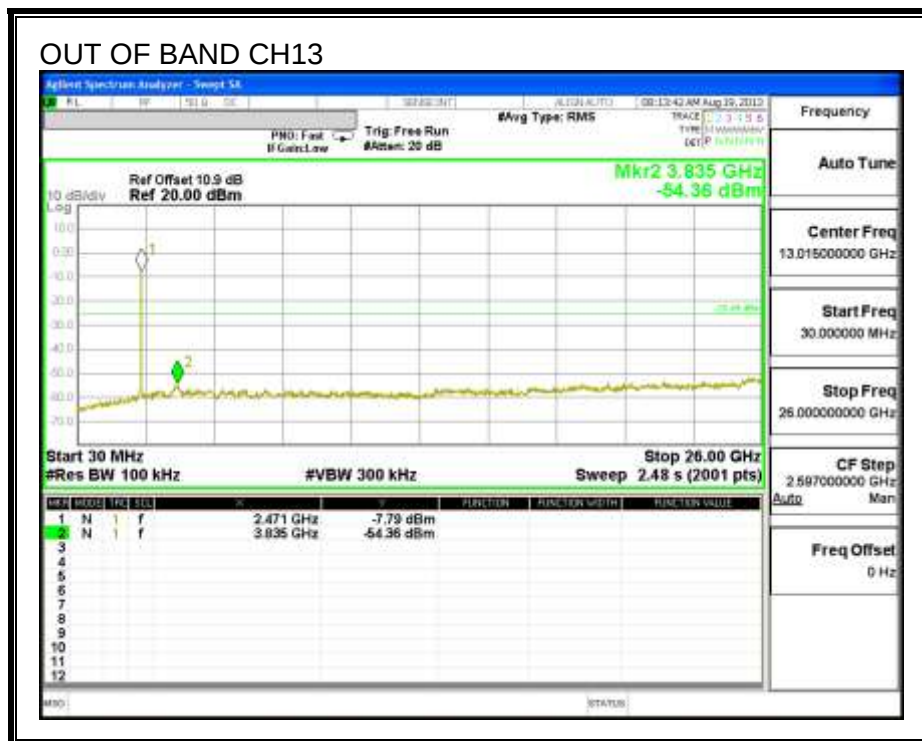
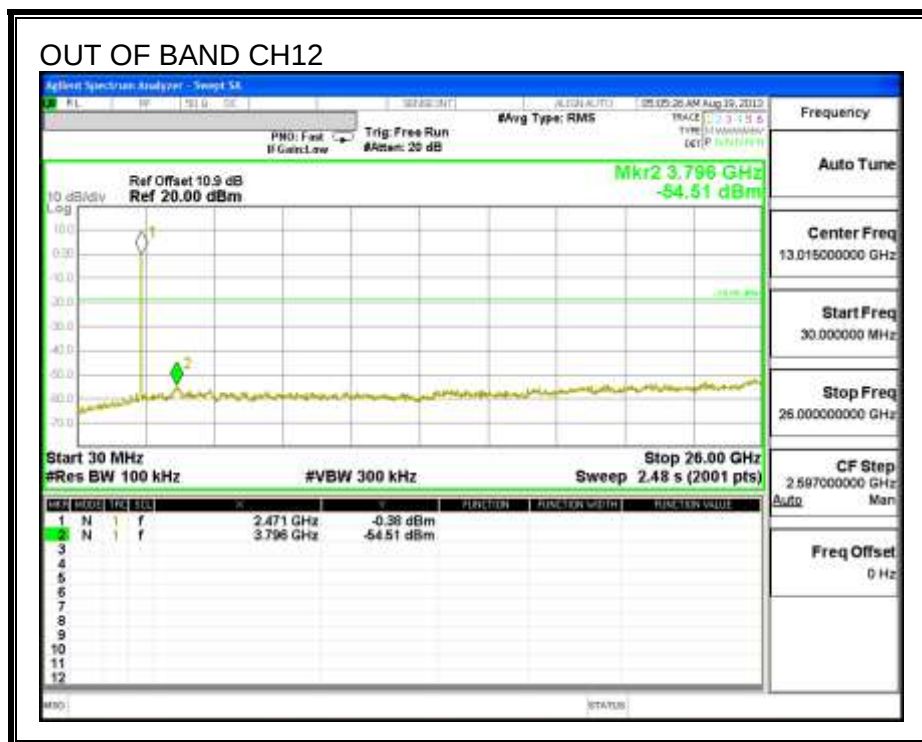
HT20 MODE IN-BAND REFERENCE LEVEL



HT20 MODE IN-BAND REFERENCE LEVEL



OUT-OF-BAND EMISSIONS



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.

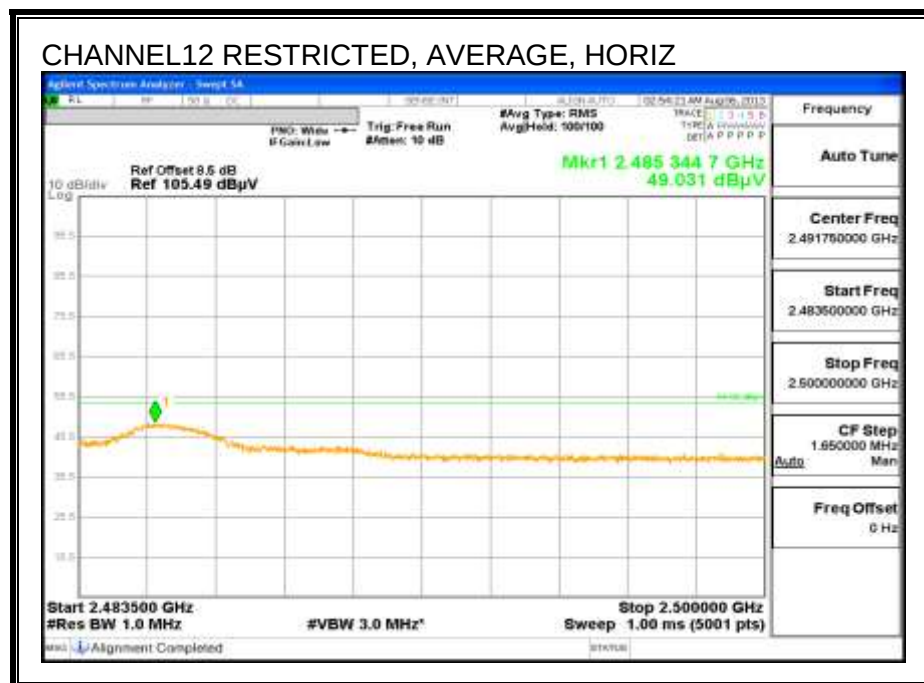
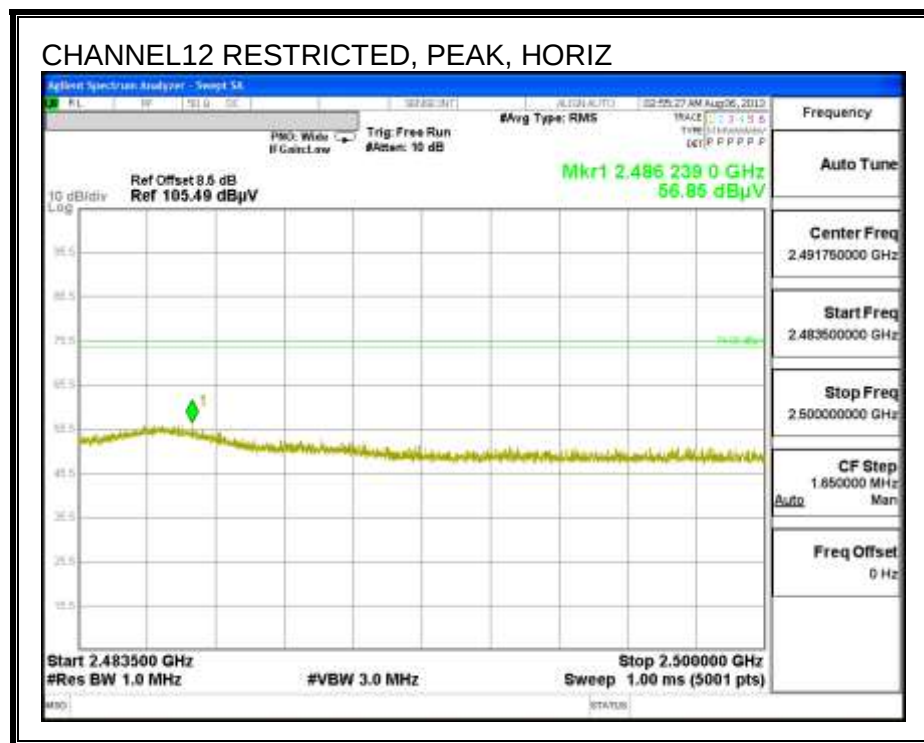
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

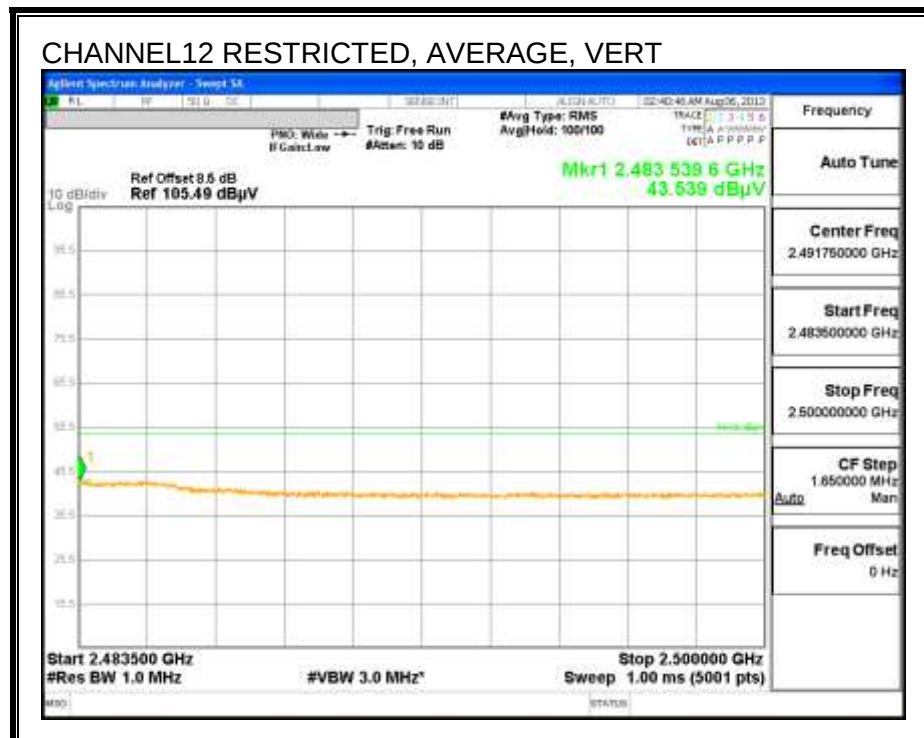
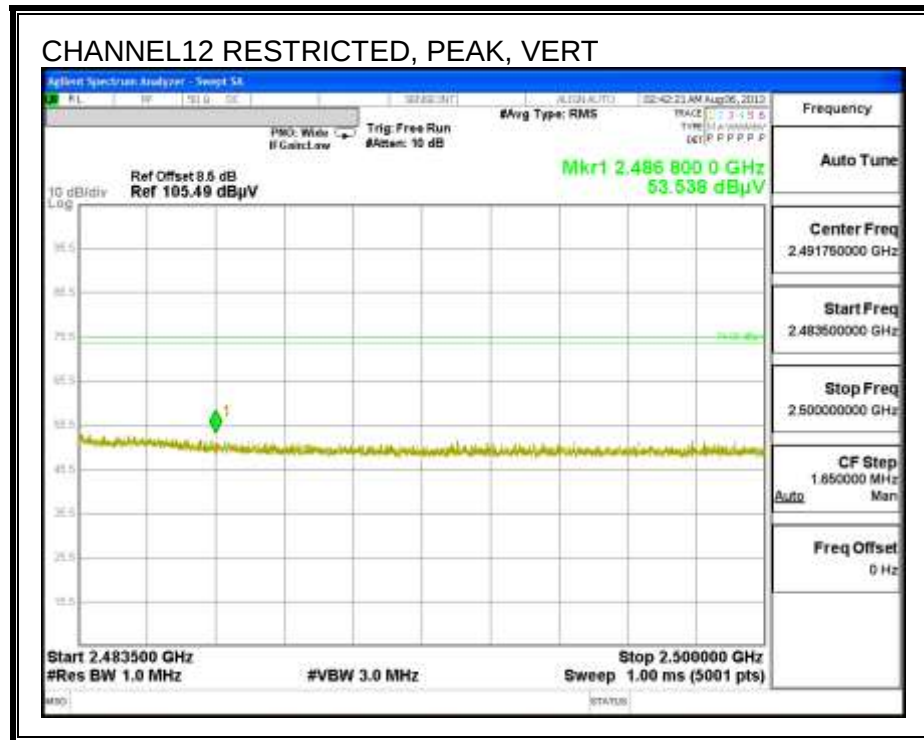
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized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

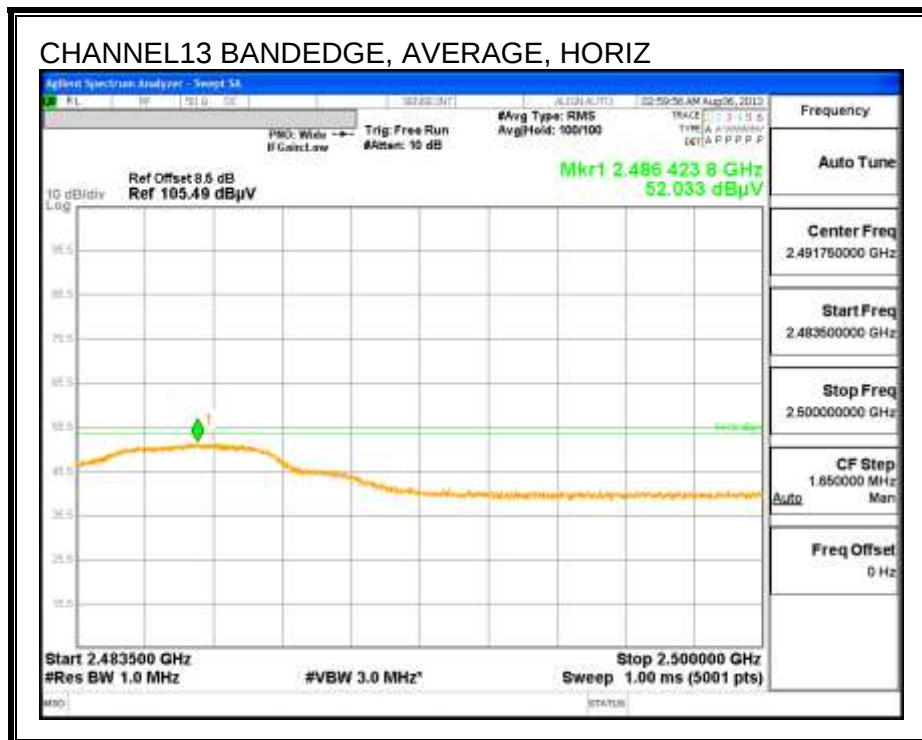
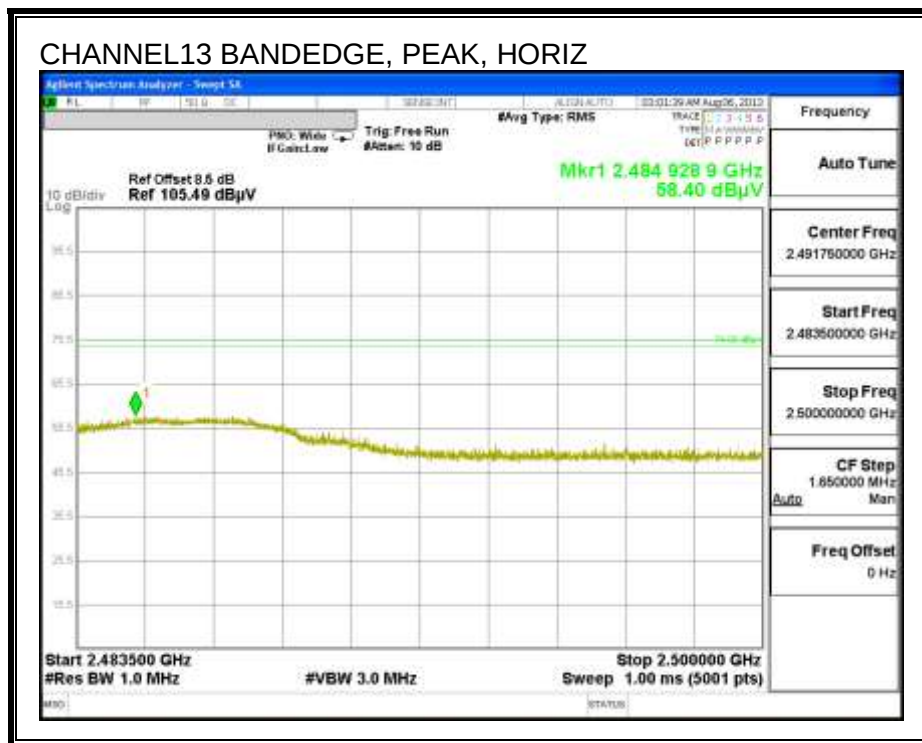
8.2. TRANSMITTER ABOVE 1 GHz

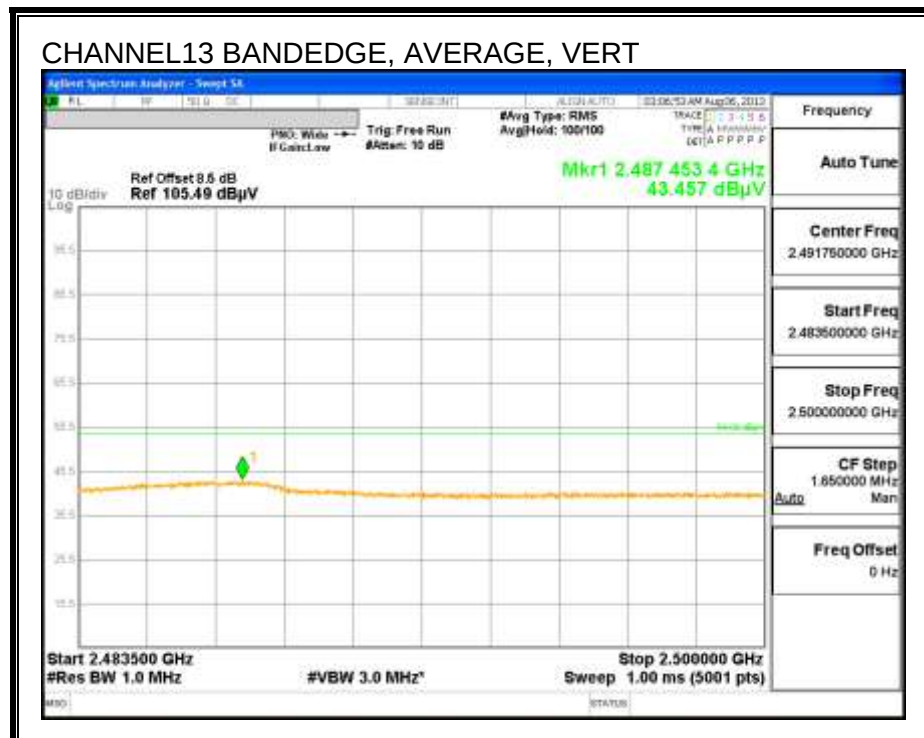
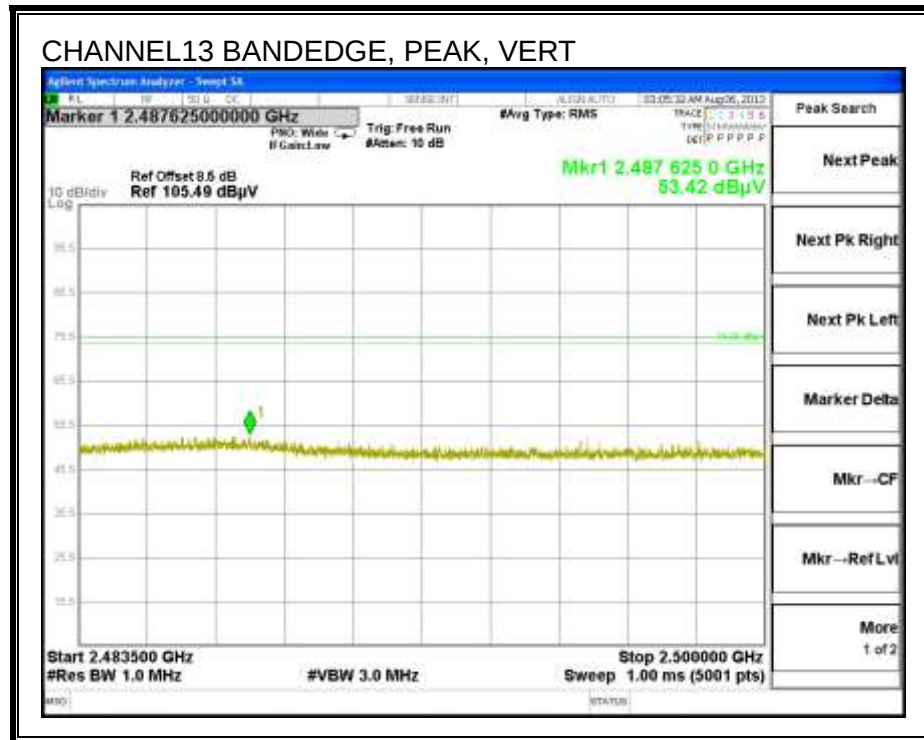
8.2.1. TX ABOVE 1 GHz 802.11B MODE IN THE 2.4 GHz BAND

RESTRICTED BANDEDGE (CHANNEL12)



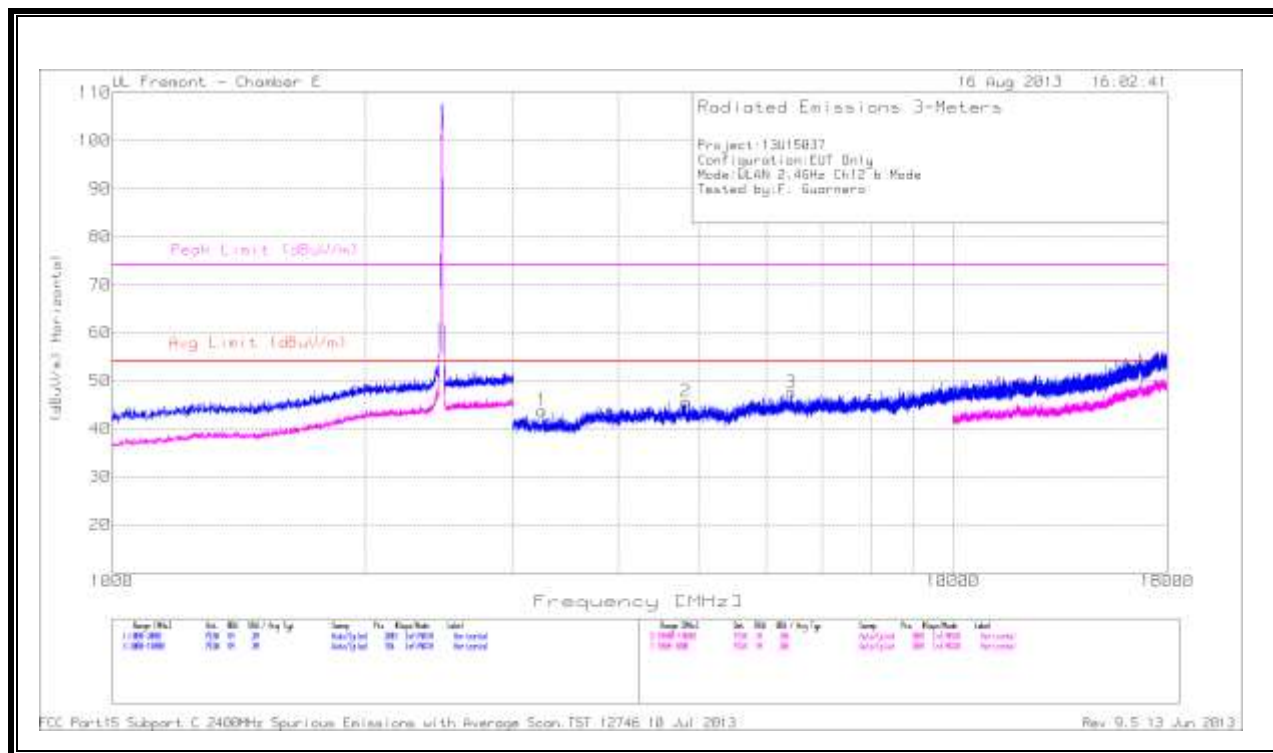




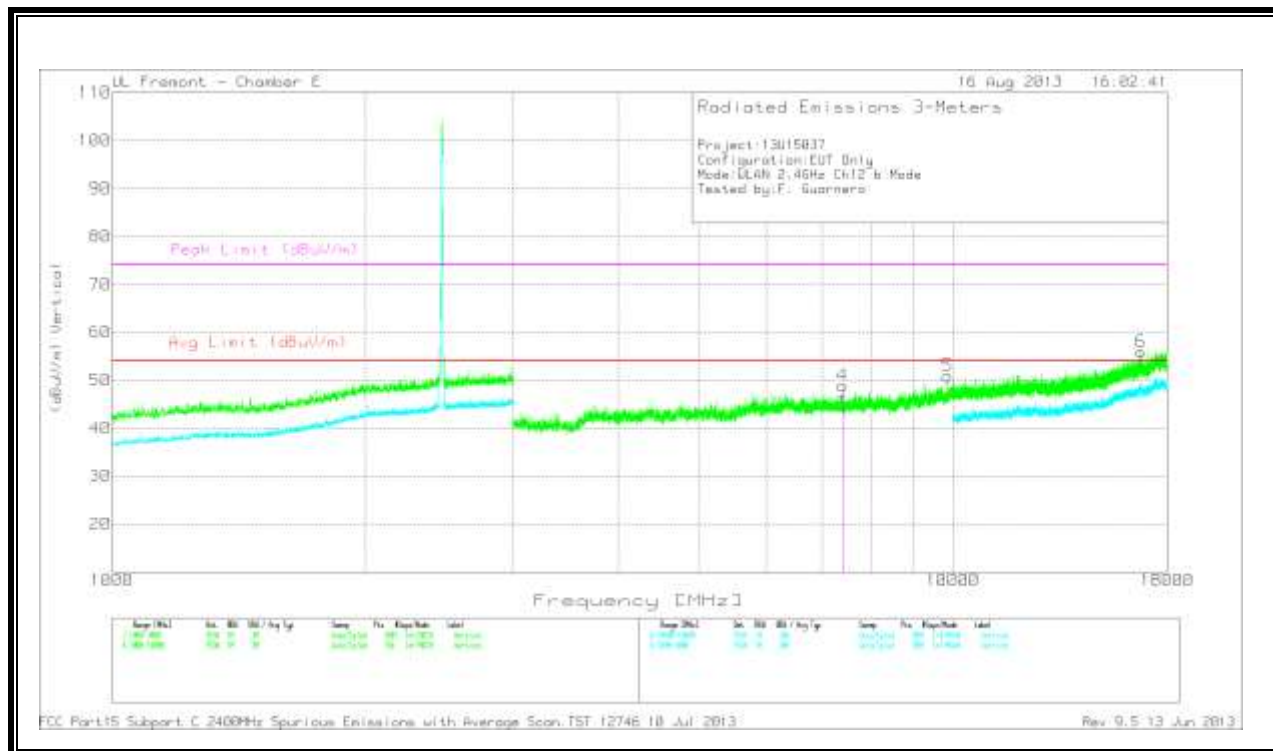


B MODE, CH 12

HARMONICS AND SPURIOUS EMISSIONS



HARMONICS AND SPURIOUS EMISSIONS



DATA

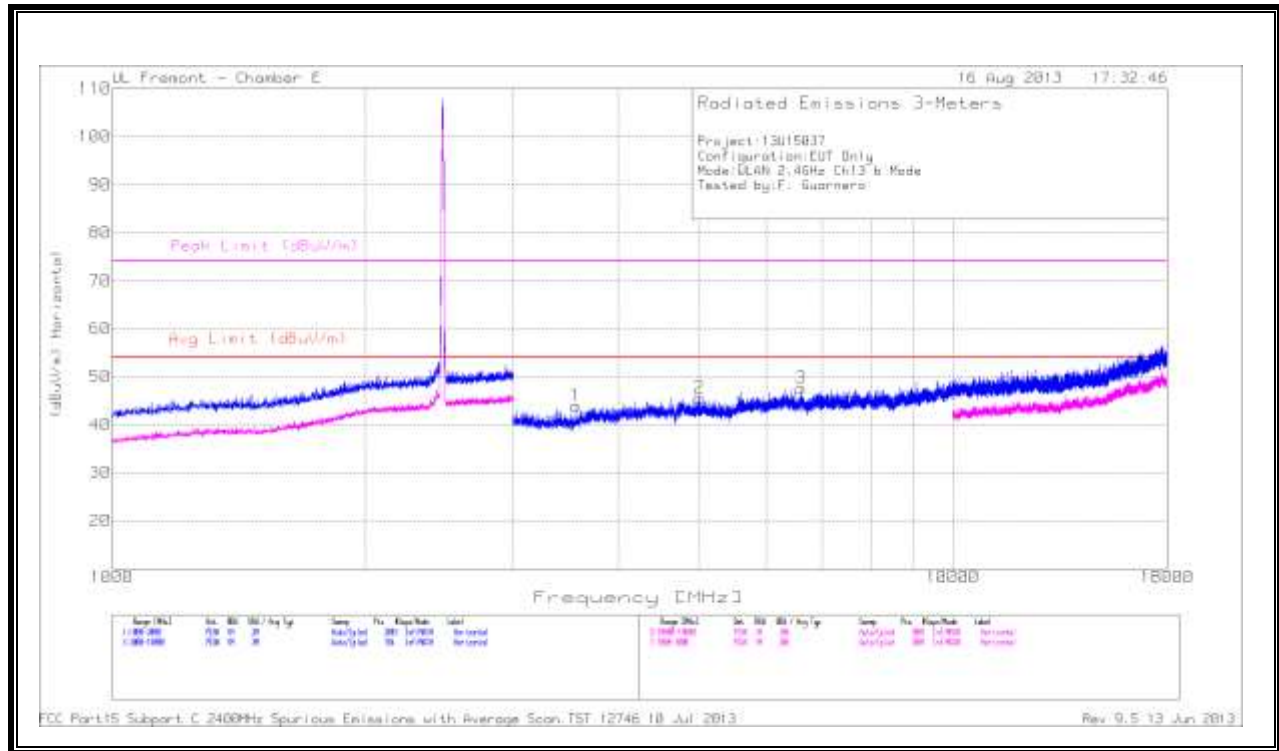
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/ 3GHz HPF	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarity
1	*3.246	42.74	PK	33.4	-32.4	43.74					199	H
2	4.817	42.47	PK	34.4	-31.2	45.67	53.97	-8.3	74	-28.33	100	H
3	*6.429	40.96	PK	35.8	-29.2	47.56	53.97				199	H
4	7.4	40.85	PK	36.1	-28.1	48.85	53.97	-5.12	74	-25.15	199	V
	7.4	38.55	RMS	36.1	-28.1	46.55	53.97	-7.42	74	-27.45	113	V
*5	9.868	38.73	PK	37.8	-25.7	50.83					199	V
*6	16.745	35.28	PK	41.4	-20.8	55.88					199	V

*Not in Restricted Band

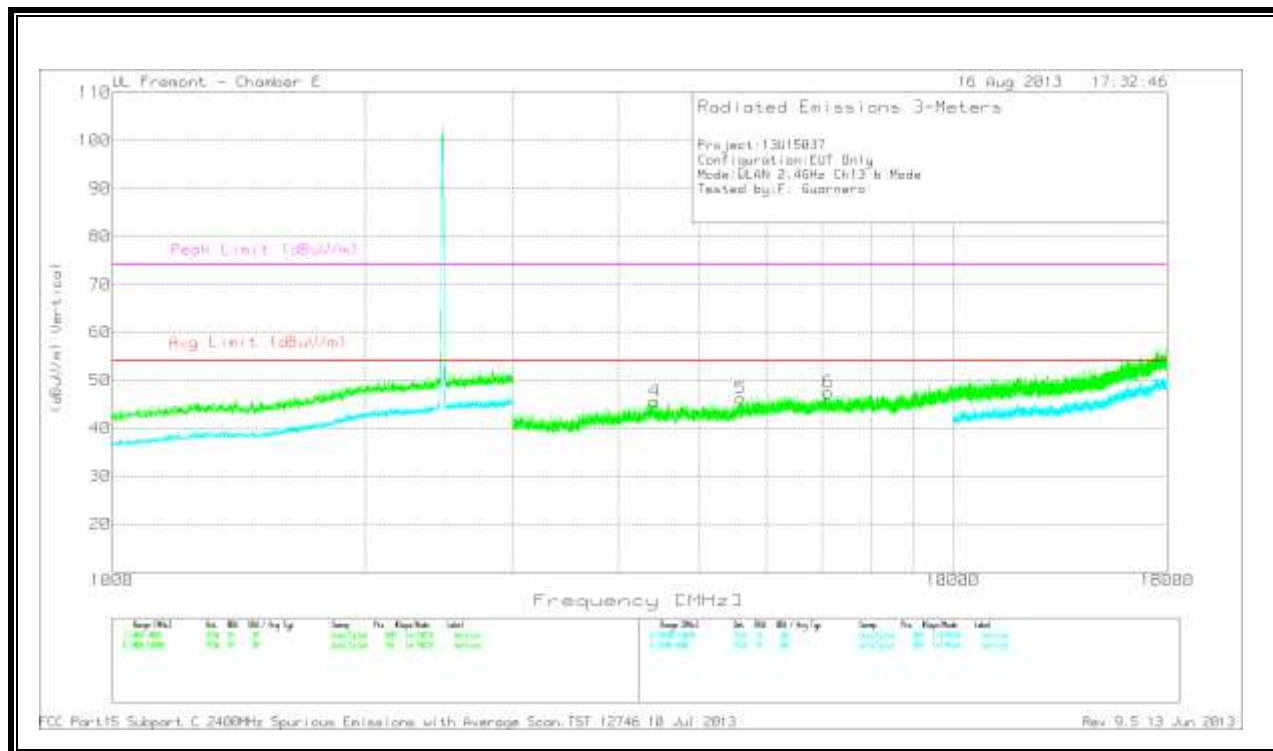
RMS - RMS detection

CH 13

HARMONICS AND SPURIOUS EMISSIONS



HARMONICS AND SPURIOUS EMISSIONS



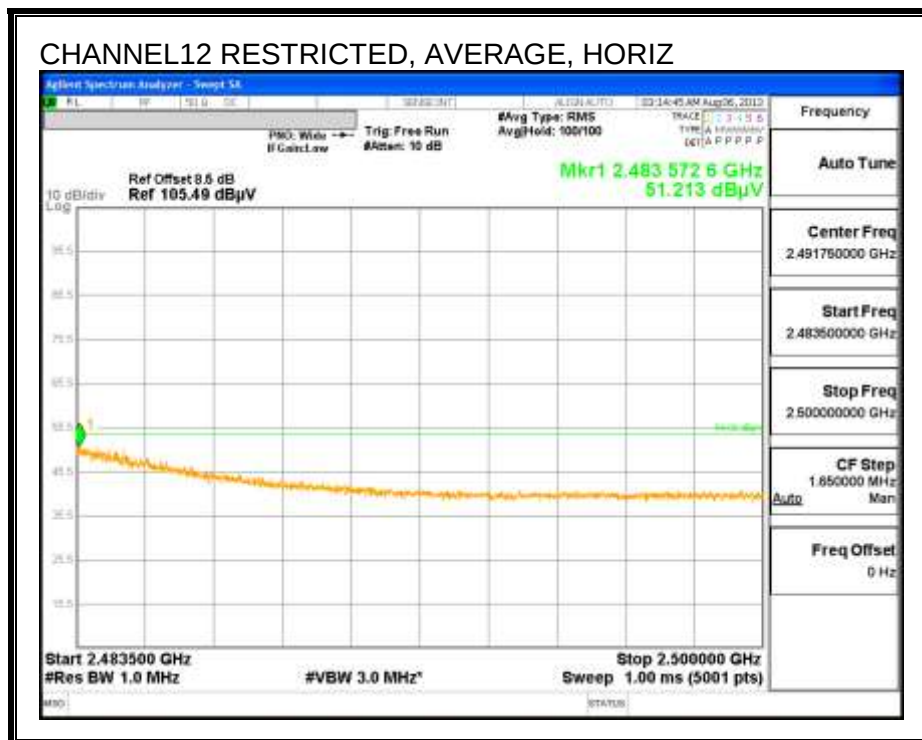
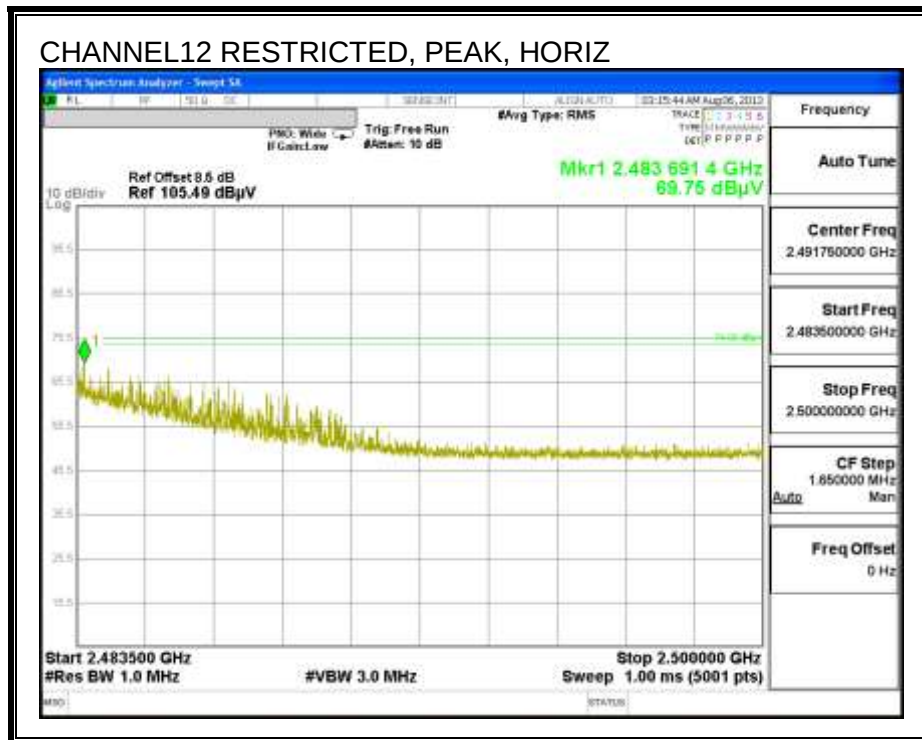
DATA

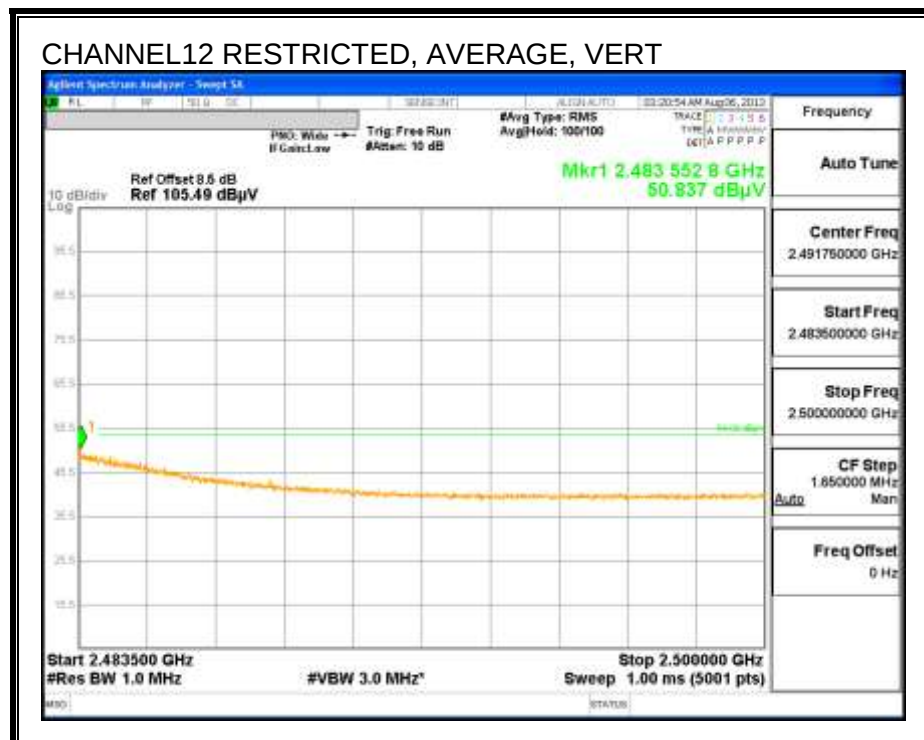
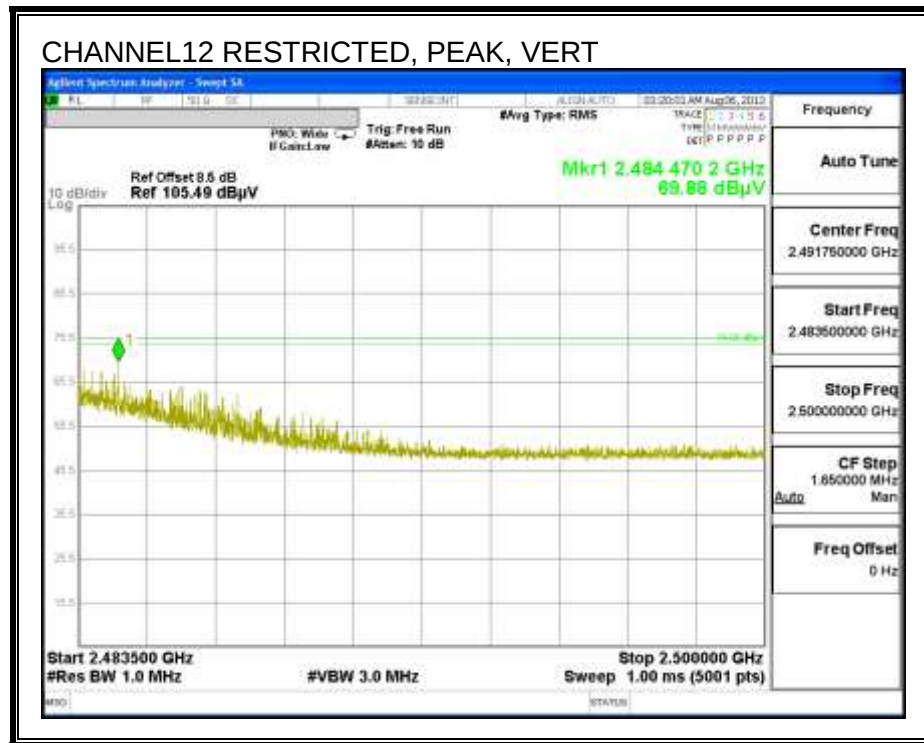
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/ 3GHz HPF	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarity
1	*3.564	42.61	PK	33.3	-32	43.91					100	H
2	4.997	42.19	PK	34.4	-31	45.59	53.97	-8.38	74	-28.41	100	H
3	*6.601	40.35	PK	35.8	-28.5	47.65					199	H
4	*4.422	42.44	PK	34.2	-31	45.64					199	V
5	*5.597	41.69	PK	35	-30.5	46.19					199	V
6	*7.115	40.23	PK	36	-28.8	47.43					100	V

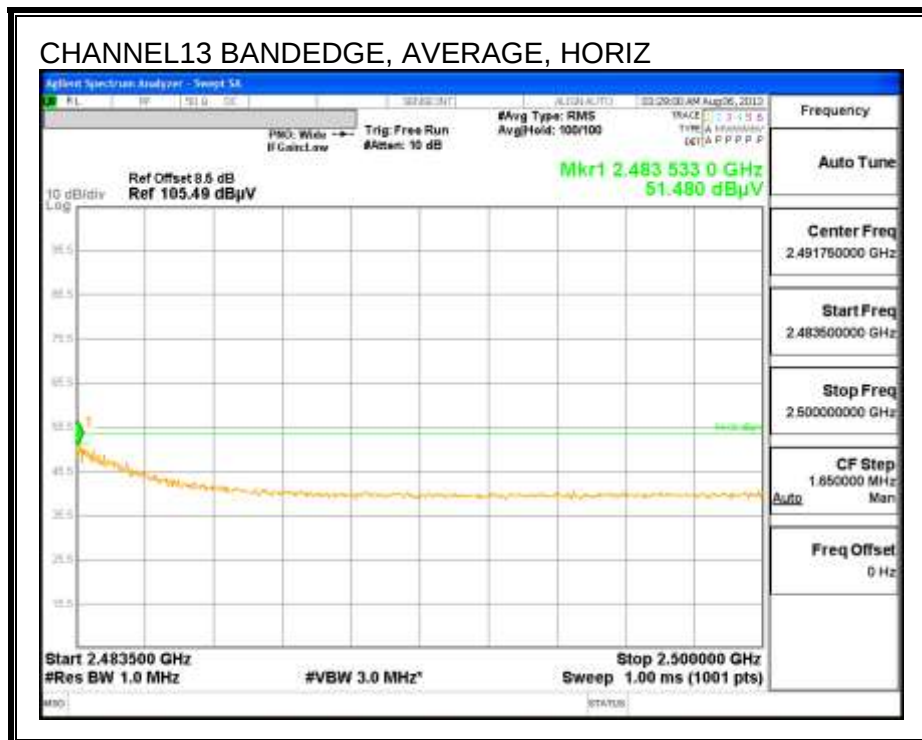
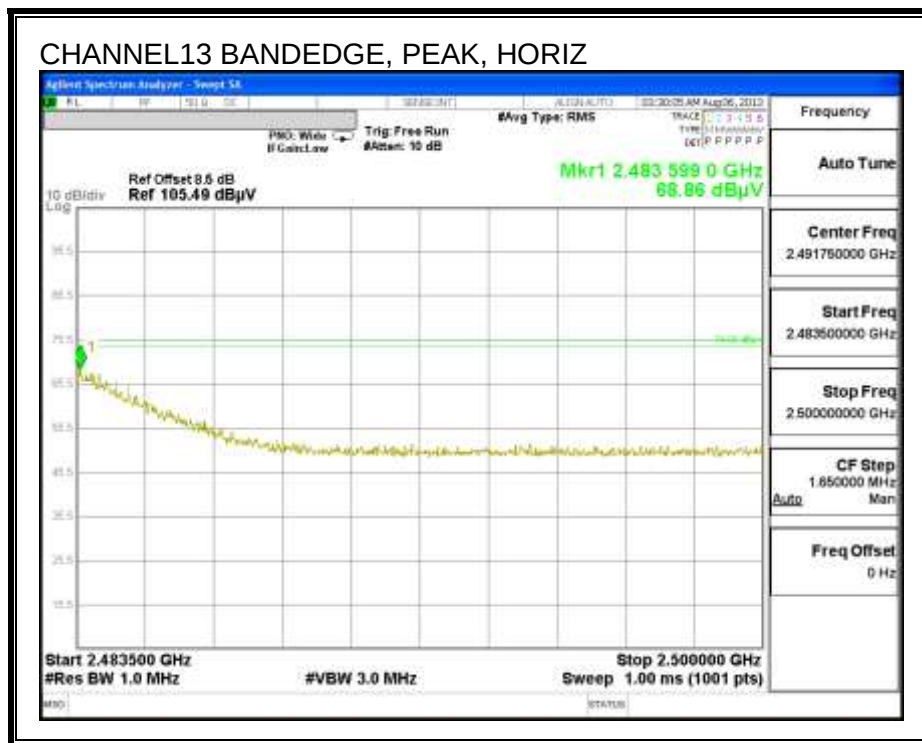
*Not in Restricted Band

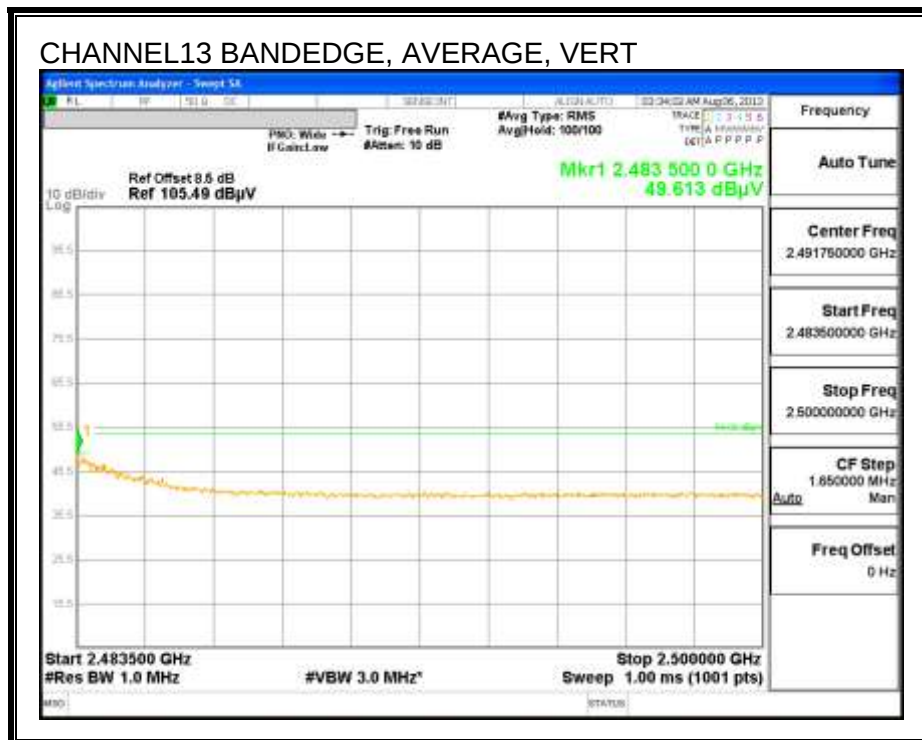
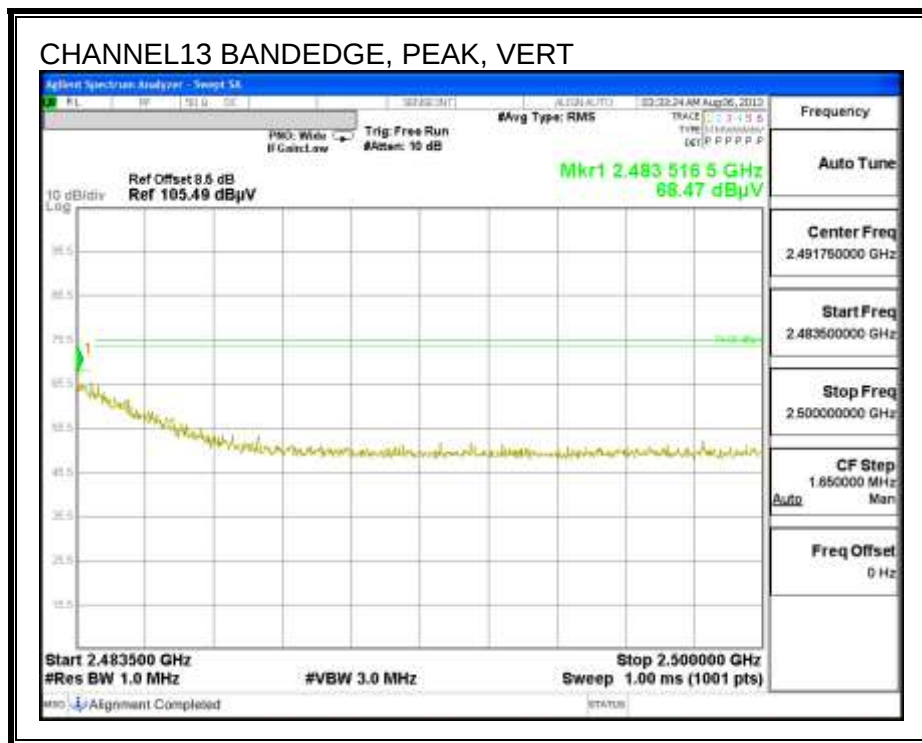
8.2.2. TX ABOVE 1 GHz 802.11G MODE IN THE 2.4 GHz BAND

RESTRICTED BANDEDGE (LOW CHANNEL)



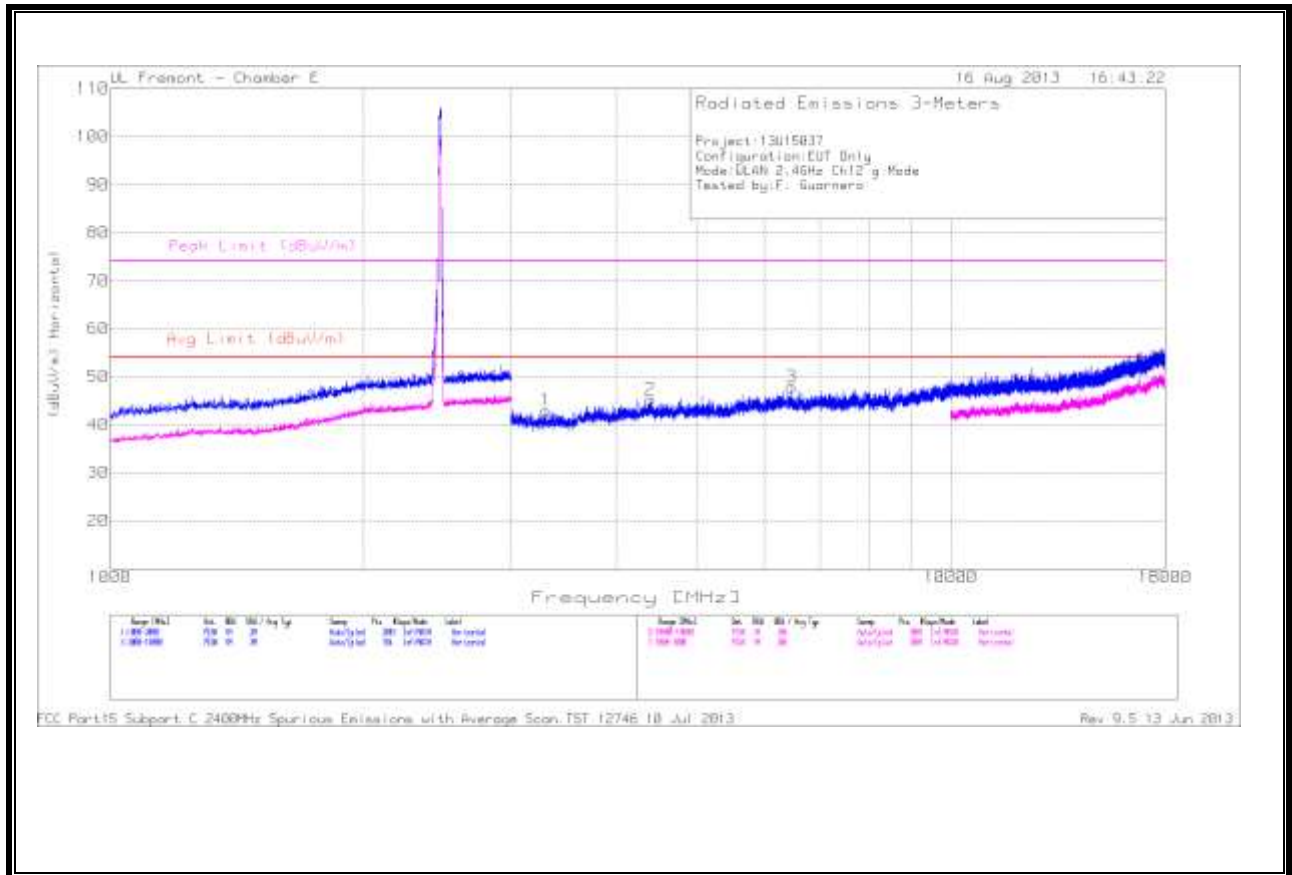






G MODE

CH 12 HARMONICS AND SPURIOUS EMISSIONS



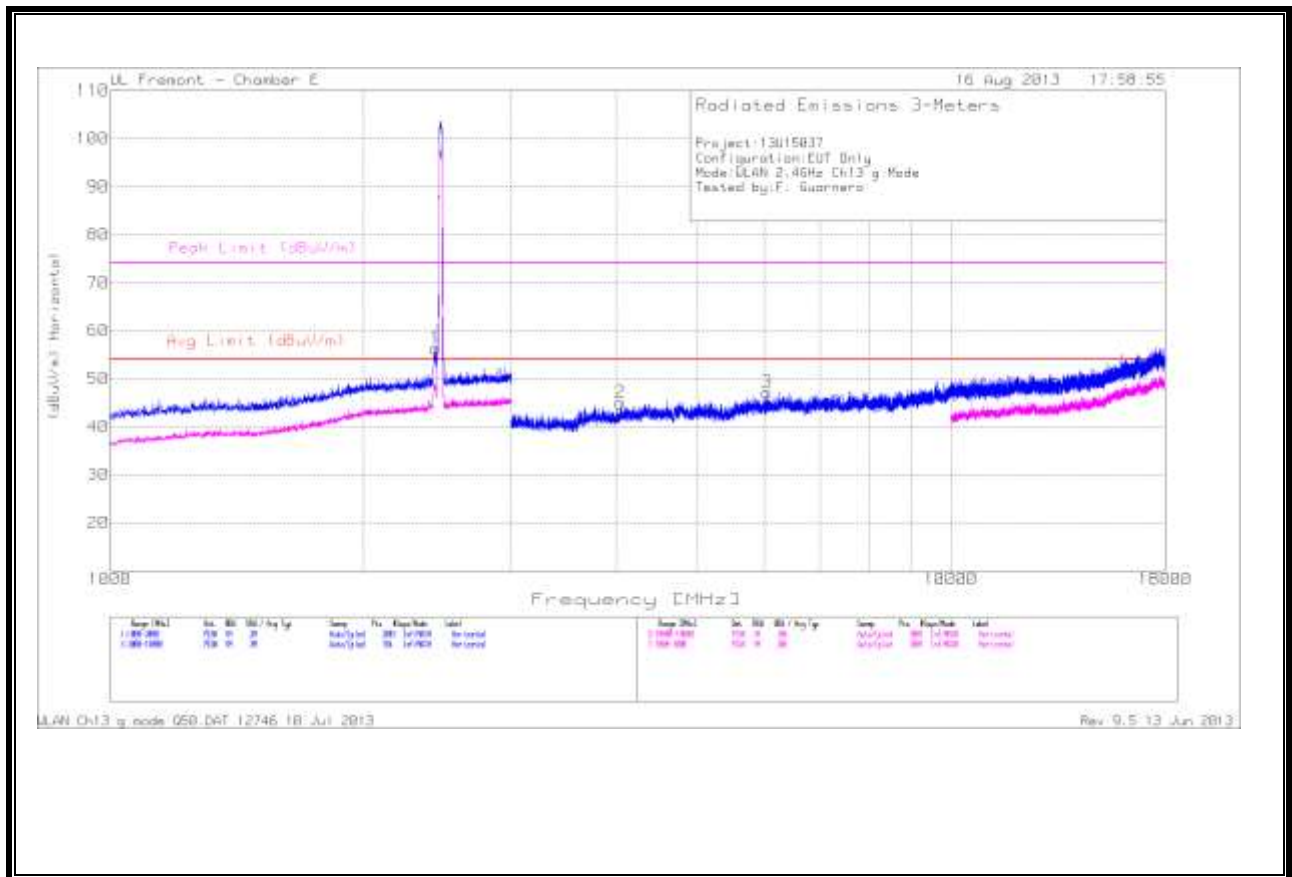
DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/ 3GHz HPF	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarity
1	*3.297	41.86	PK	33.3	-32.2	42.96					199	H
2	4.394	41.7	PK	34.2	-30.7	45.2	53.97	-8.77	74	-28.8	100	H
3	*6.469	41.65	PK	35.8	-29.6	47.85					100	H
4	*3.119	42.12	PK	33.3	-31.7	43.72					199	V
5	*5.782	41.44	PK	35.5	-29.8	47.14					199	V
6	7.38	39.19	PK	36.1	-27.8	47.49	53.97	-6.48	74	-26.51	199	V

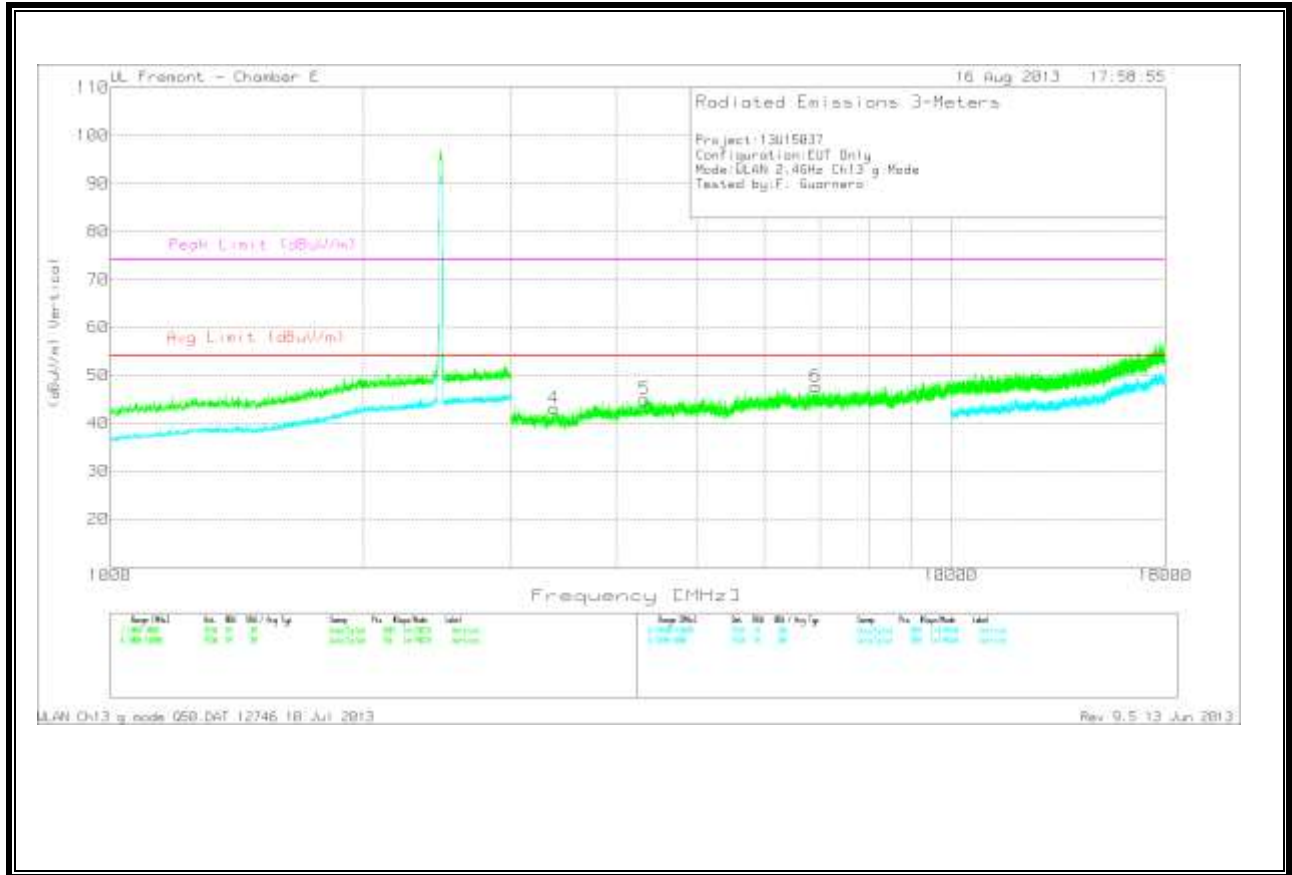
*Not in Restricted Band

CH13

HARMONICS AND SPURIOUS EMISSIONS



HARMONICS AND SPURIOUS EMISSIONS



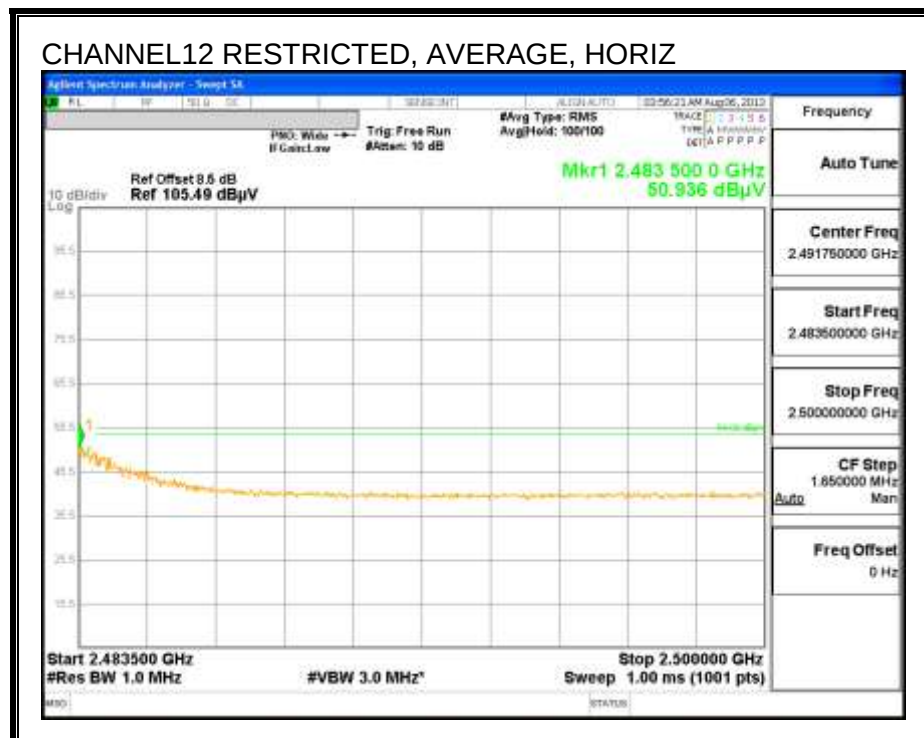
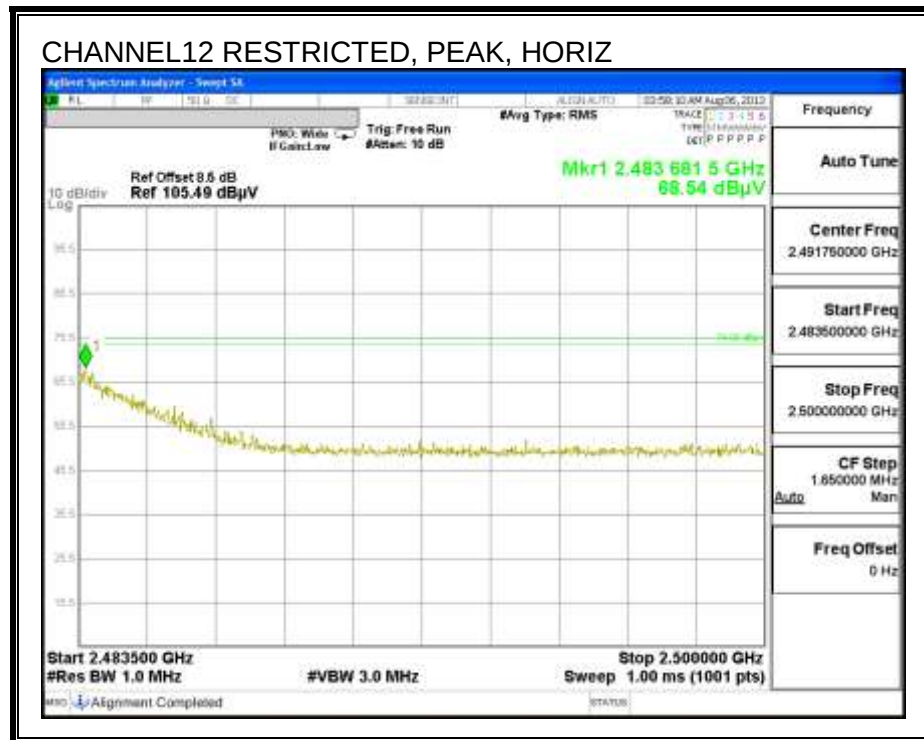
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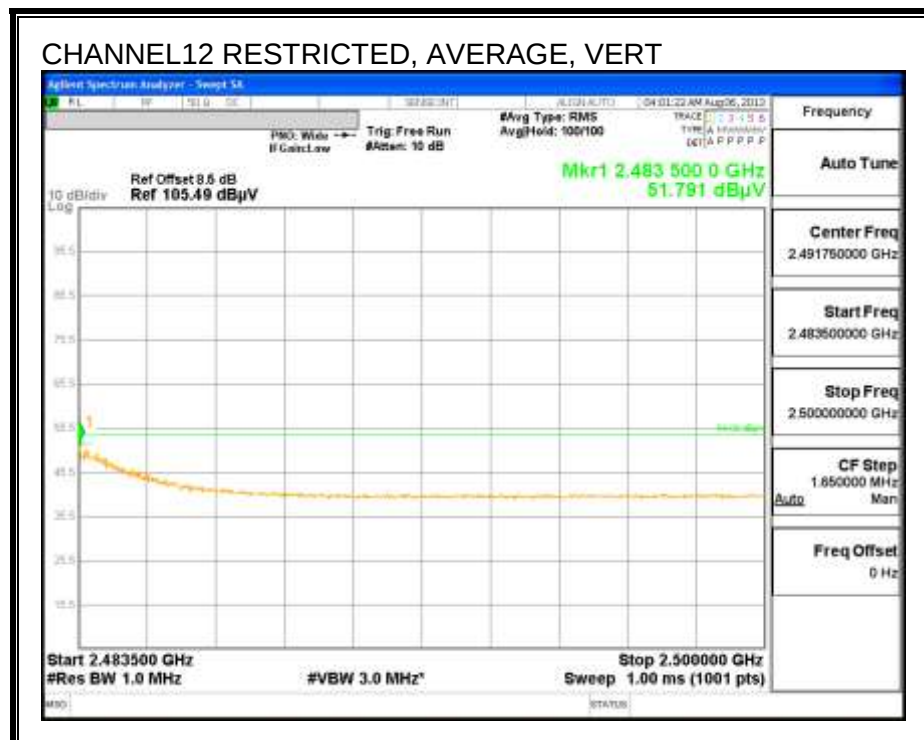
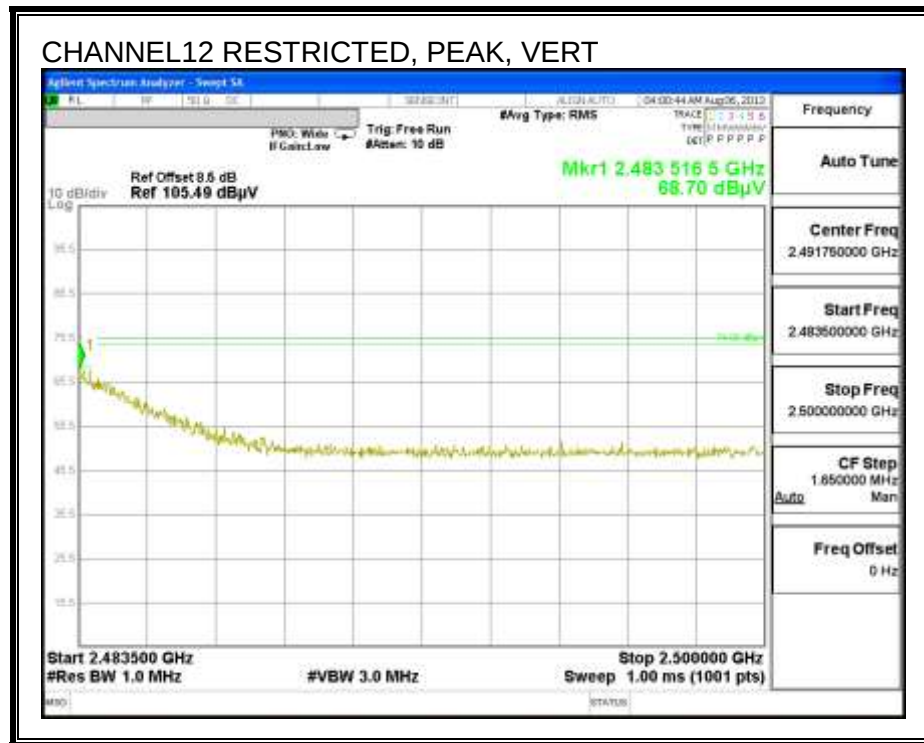
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/ 3GHz HPF	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarity
*1	2.437	48.41	PK	32.6	-24.7	56.31					99	H
2	4.049	41.34	PK	33.8	-30.2	44.94	53.97	-9.03	74	-29.06	100	H
3	*6.05	40.46	PK	35.8	-29.1	47.16					199	H
4	*3.373	41.62	PK	33.3	-31.8	43.12					199	V
5	4.325	41.67	PK	34.1	-30.8	44.97	53.97	-9	74	-29.03	100	V
6	*6.909	40.7	PK	35.9	-28.9	47.7					100	V

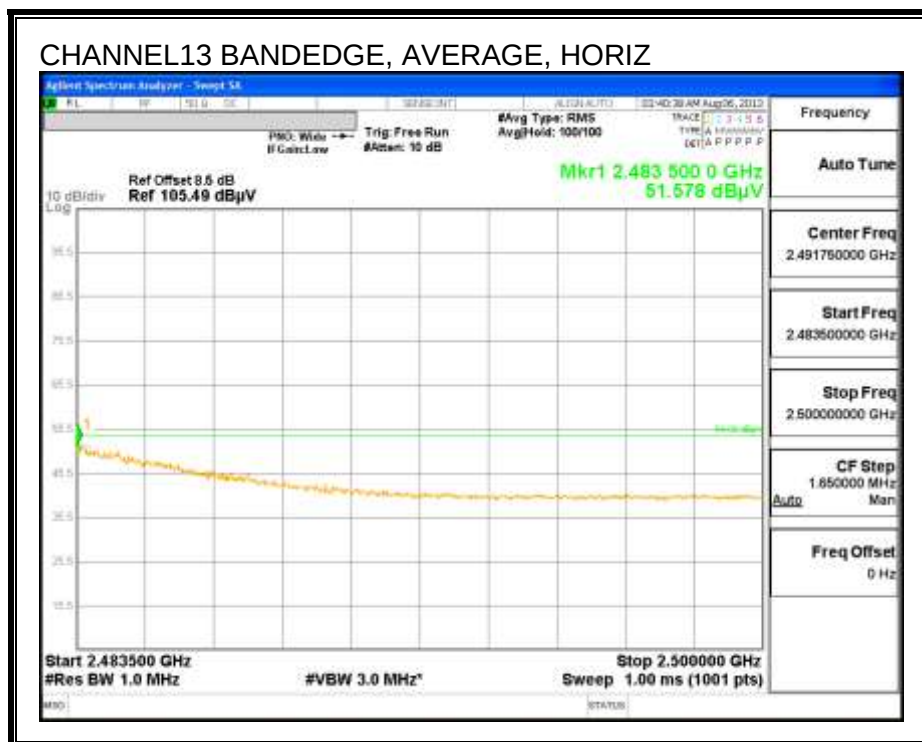
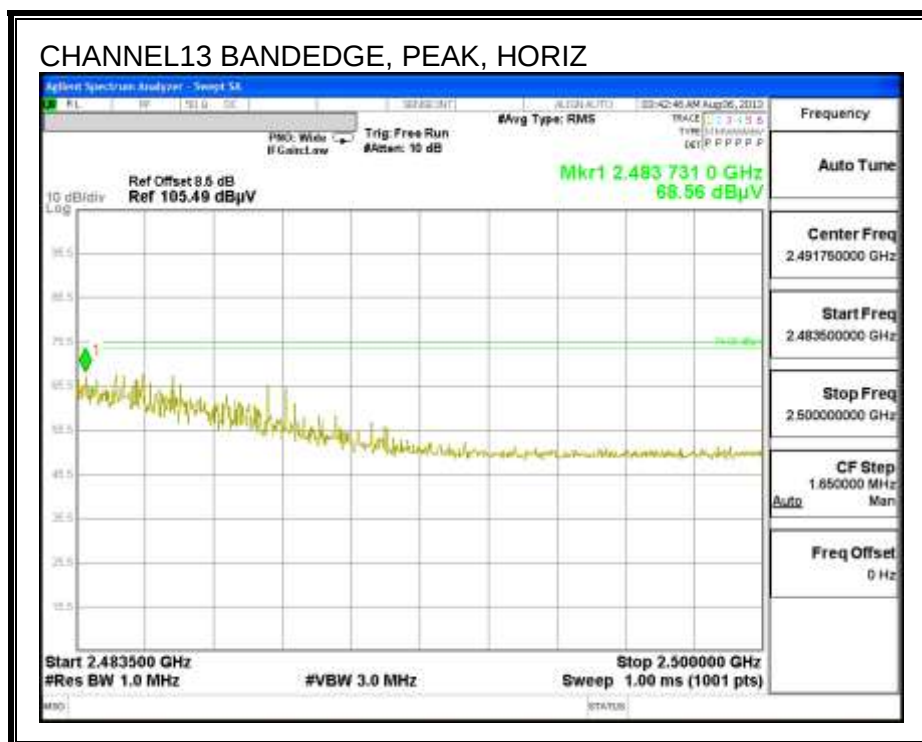
*Not in Restricted Band

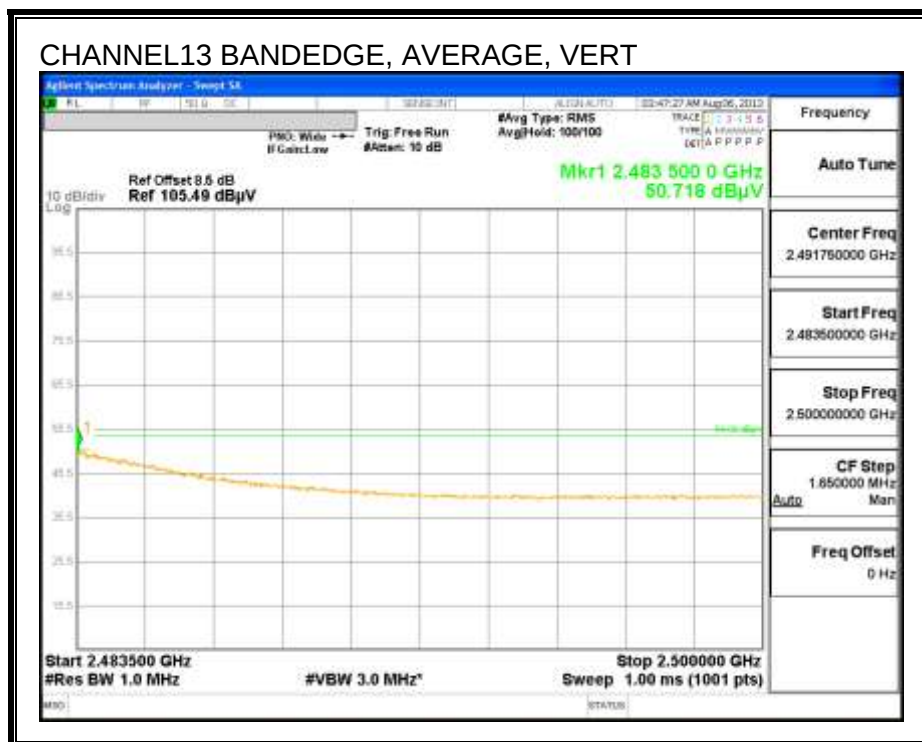
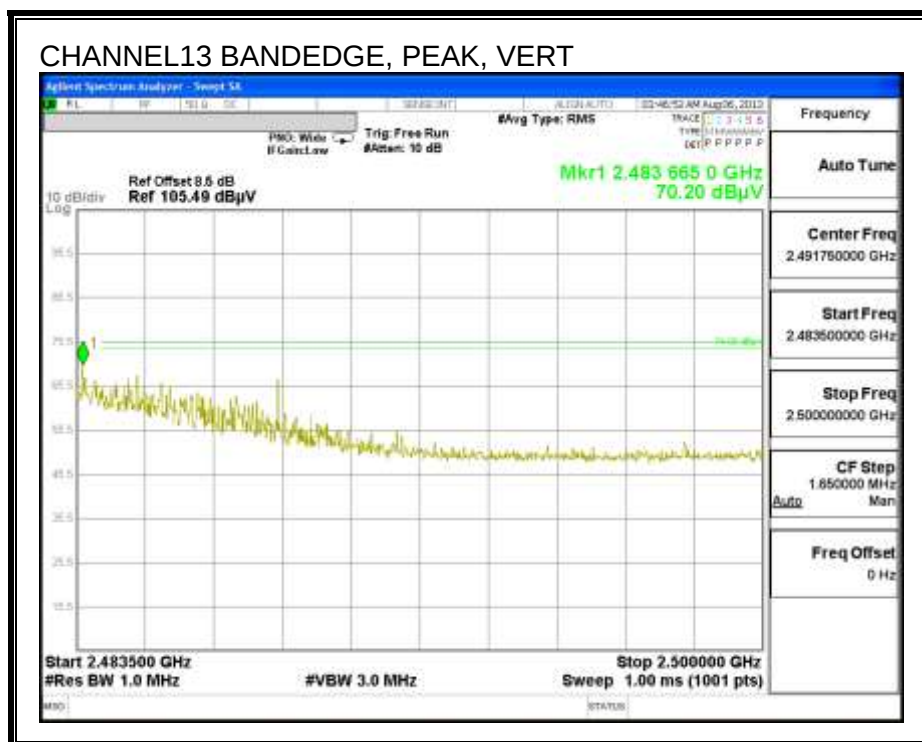
8.2.3. TX ABOVE 1 GHz 802.11N HT20 MODE IN THE 2.4 GHz BAND

RESTRICTED BANDEDGE (LOW CHANNEL)



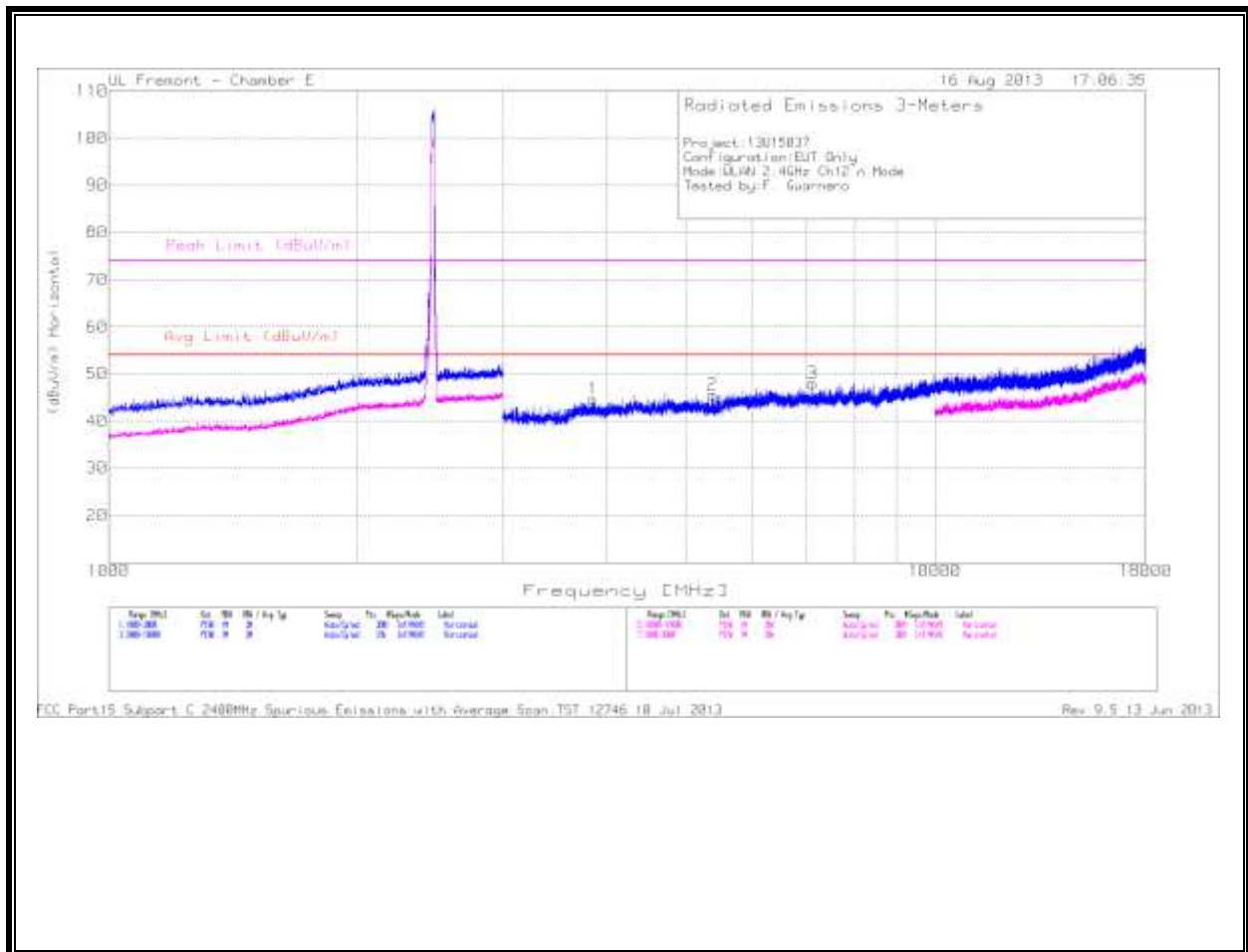




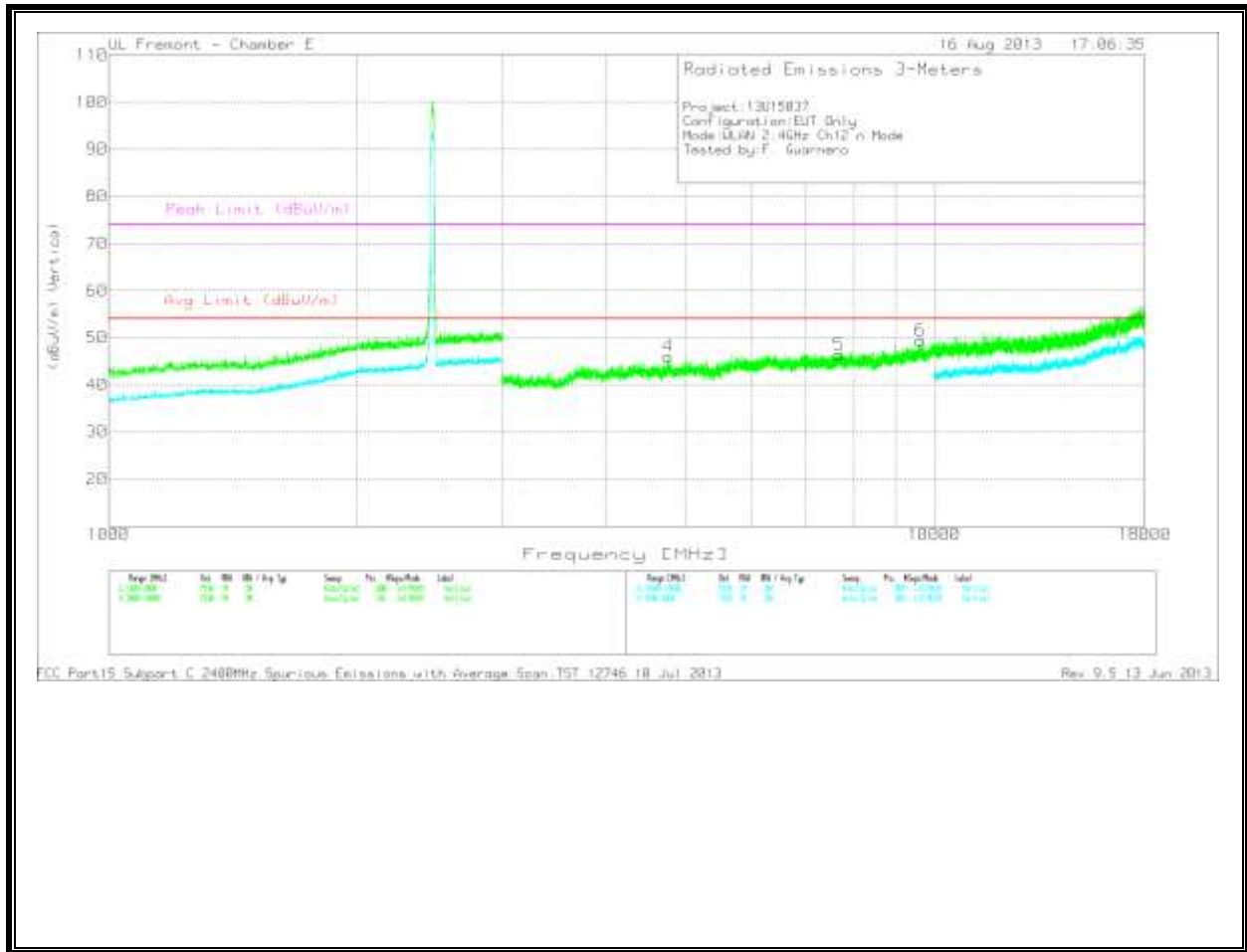


HT20, CH 12

HARMONICS AND SPURIOUS EMISSIONS



HARMONICS AND SPURIOUS EMISSIONS



DATA

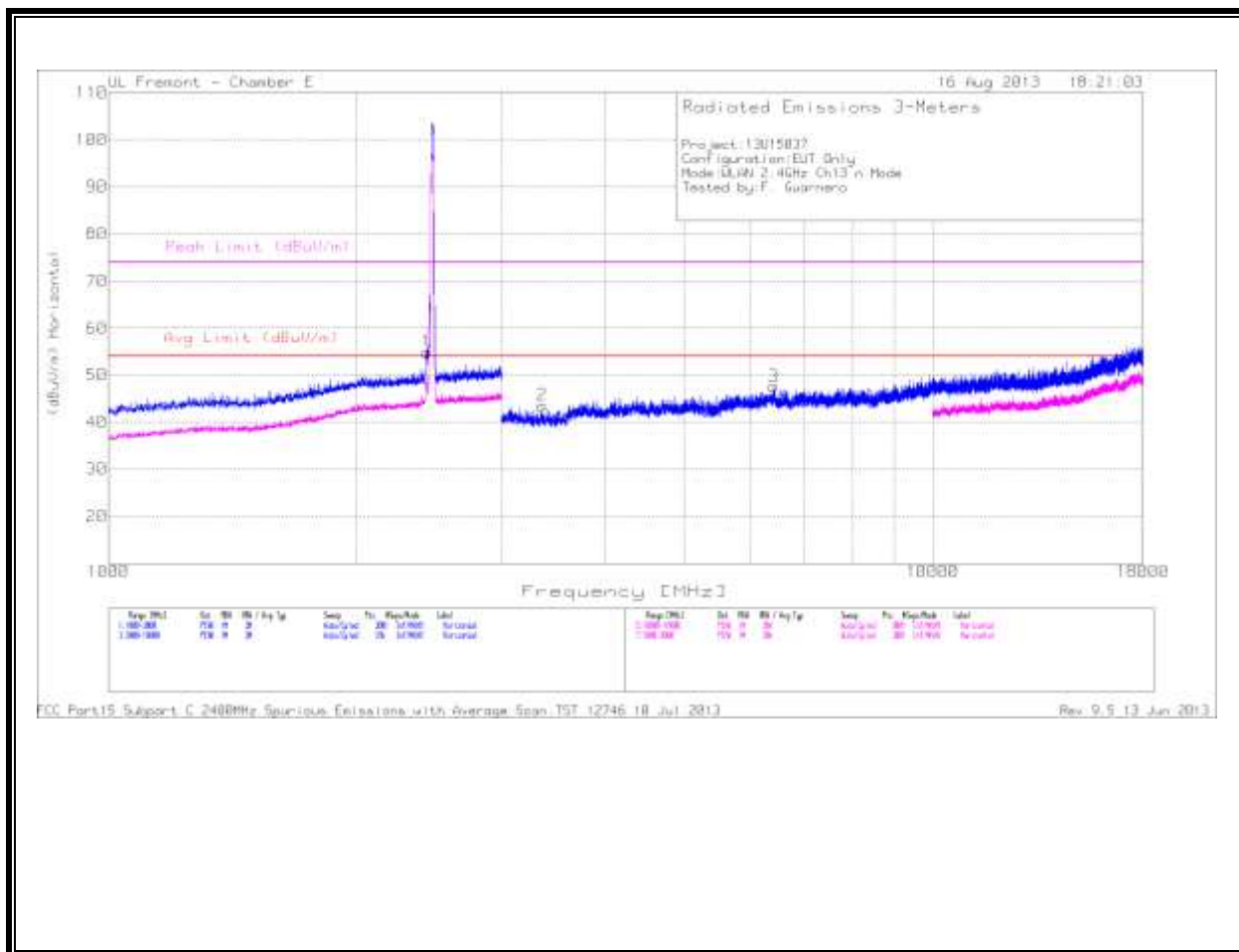
HT20, CH 12

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/ 3GHz HPF	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarity
1	3.857	43.24	PK	33.7	-32.3	44.64	53.97	-9.33	74	-29.36	100	H
2	5.387	41.55	PK	34.8	-30.7	45.65	53.97	-8.32	74	-28.35	199	H
* ₃	7.108	40.49	PK	36	-28.5	47.99					100	H
4	4.761	42.53	PK	34.4	-30.9	46.03	53.97	-7.94	74	-27.97	199	V
5	7.671	37.92	PK	36.2	-27.7	46.42	53.97	-7.55	74	27.58	199	V
*6	9.629	36.39	PK	37.6	-24.6	49.39					100	V

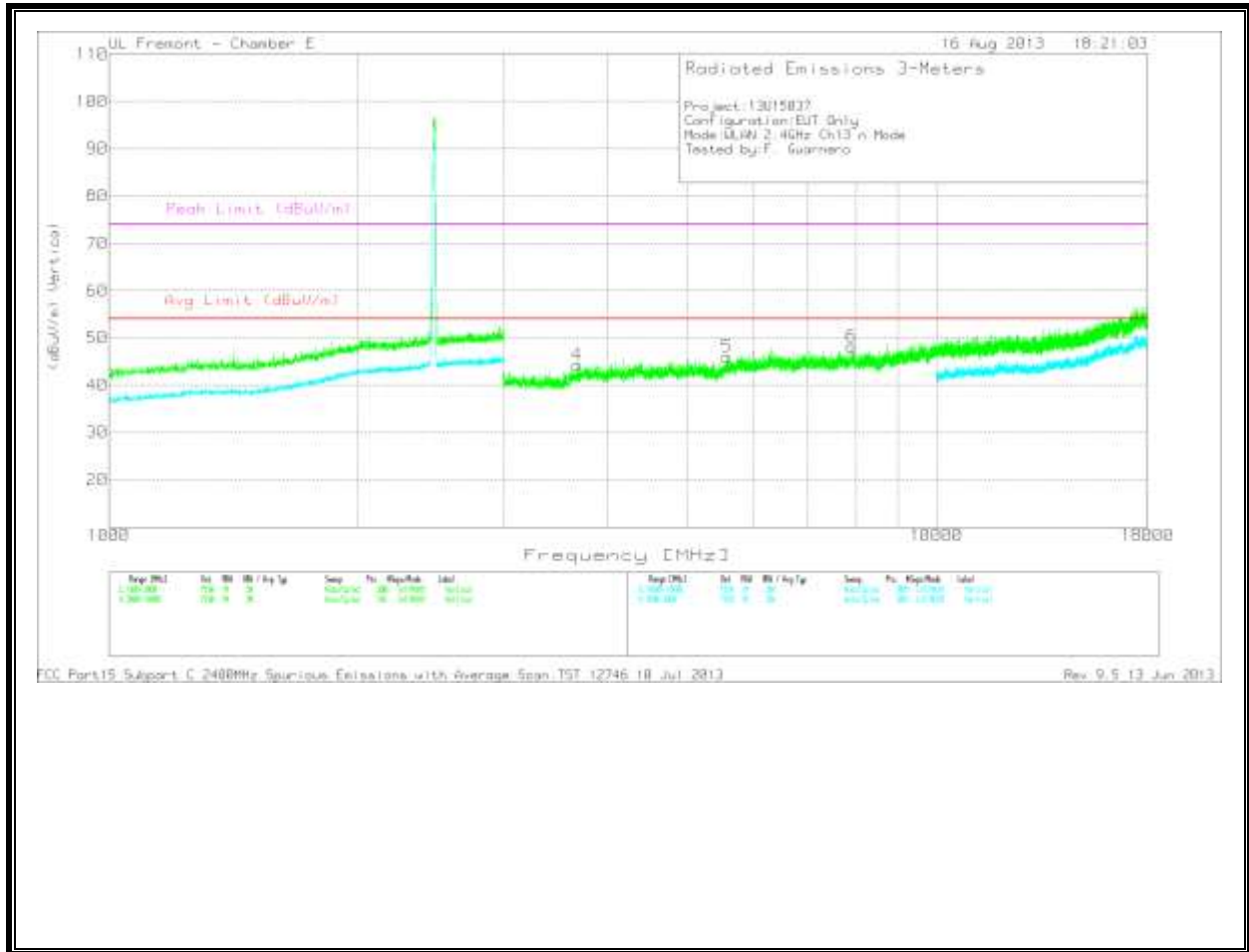
*Not in Restricted Band

CH13

HARMONICS AND SPURIOUS EMISSIONS



HARMONICS AND SPURIOUS EMISSIONS



DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/ 3GHz HPF	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin dB	Height (cm)	Polarity
*1	2.433	47.07	PK	32.6	-24.7	54.97					99	H
*2	3.362	42.21	PK	33.3	-31.9	43.61					199	H
*3	6.416	40.69	PK	35.8	-28.9	47.59					199	H
4	3.682	42.31	PK	33.5	-31.5	44.31	53.97	-9.66	74	-29.69	100	V
*5	5.586	41.41	PK	35	-30.4	46.01					199	V
*6	7.902	39.44	PK	36.2	-27.4	48.24					100	V

*Not in Restricted Band

END OF REPORT