CERTIFICATION TEST REPORT

Report Number. : 11949808-E2V2

Applicant	:	APPLE, INC. 1 INFINITE LOOP CUPERTINO, CA 95014, U.S.A.
Model	:	A1639
FCC ID	:	BCG-A1639
IC	:	579C-A1639
EUT Description	:	WIRELESS SPEAKER
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C INDUSTRY CANADA RSS - 247 ISSUE 2

Date Of Issue:
October 16, 2017

Prepared by:
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	10/9/2017	Initial Issue	Tri Pham
V2	10/16/2017	Address TCB's Questions	Chin Pang

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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 7

4.1. MEASURING INSTRUMENT CALIBRATION 7

4.2. SAMPLE CALCULATION 7

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 14

7. ANTENNA PORT TEST RESULTS 15

7.1. MEASUREMENT METHODS 15

7.2. ON TIME, DUTY CYCLE 16

7.4. Antenna A Pmax 18

7.4.1. 6 dB BANDWIDTH 18
7.4.2. 99% BANDWIDTH 21
7.4.3. AVERAGE POWER 24
7.4.4. OUTPUT POWER 25
7.4.5. POWER SPECTRAL DENSITY 26
7.4.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS 29

7.5. Antenna A ePA 2M Pmax 33

7.5.1. AVERAGE POWER 33
7.5.2. OUTPUTPOWER 34

7.6. Antenna A Plow 35

7.6.1. 6 dB BANDWIDTH 35
7.6.2. 99% BANDWIDTH 38
7.6.3. AVERAGE POWER 41
7.6.4. OUTPUT POWER 42
7.6.5. POWER SPECTRAL DENSITY 43
7.6.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS 46

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7.7. Antenna A iPA 2M Pmax....50
7.7.1. AVERAGE POWER....50
7.7.2. OUTPUTPOWER....51

8. RADIATED TEST RESULTS....52

8.1. LIMITS AND PROCEDURE....52

8.3. Antenna A Pmax....53
8.3.1. RESTRICTED BANDEDGE (LOW CHANNEL)....53
8.3.2. AUTHORIZED BANDEDGE (HIGH CHANNEL)....55
8.3.3. HARMONICS AND SPURIOUS EMISSIONS....57

8.4. Antenna A Plow....63
8.4.1. RESTRICTED BANDEDGE (LOW CHANNEL)....63
8.4.2. AUTHORIZED BANDEDGE (HIGH CHANNEL)....65
8.4.3. HARMONICS AND SPURIOUS EMISSIONS....67

8.5. WORST-CASE BELOW 1 GHz....73

8.6. WORST-CASE ABOVE 18 GHz....75

8.7. AC POWER LINE CONDUCTED EMISSIONS....77

8.8. EUT POWERED BY AC/DC ADAPTER....78

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: WIRELESS SPEAKER

MODEL: A1639

SERIAL NUMBER: CC4V2283J5Y3

DATE TESTED: SEPTEMBER 06 – 27, 2017

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-247 Issue 2	Pass
INDUSTRY CANADA RSS-GEN Issue 4	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:

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Senior Engineer
UL VERIFICATION SERVICES INC.

Prepared By:

Jingang Li
Test Engineer
UL VERIFICATION SERVICES INC.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, KDB 558074 D01 v04, ANSI C63.10-2013, RSS-GEN Issue 4, and RSS-247 Issue 2.

3. FACILITIES AND ACCREDITATION

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 (IC:2324B-1)	☐ Chamber D (IC:22541-1)
☐ Chamber B (IC:2324B-2)	☐ Chamber E (IC:22541-2)
☐ Chamber C (IC:2324B-3)	☒ Chamber F (IC:22541-3)
	☐ Chamber G (IC:22541-4)
	☐ Chamber H (IC:22541-5)

The above test sites and facilities are covered under FCC Test Firm Registration # 208313.

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.

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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
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 dB
Occupied Channel Bandwidth	±0.39 %

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 Wireless speaker with multimedia function, IEEE 802.11a/b/g/n/ac and Bluetooth radio. It has no rechargeable battery. It is powered by 100-240V ~ 50-60Hz, 1A AC Supply Line.

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, Pmax	20.27	106.41
2402 - 2480	BLE, Plow	12.31	17.02

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Band (GHz)	Antenna A Gain (dBi)
2.4	3.80

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 15A420

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5.5. WORST-CASE CONFIGURATION AND MODE

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT was set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 30MHz, below 1GHz, above 18GHz and power line conducted emissions were performed with the EUT transmits at the channel with the highest output power as worst-case scenario.

The EUT was tested in Normal operation Y axis orientation. (Standup)

Worst-case data rate as provided by the client and baseline scan was:

BLE: 1Mbps

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

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5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
Laptop	Apple	MackBook Air 4	NA	NA
Dongle	N/A	N/A	HDG1409226823	NA

I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	3	N/A

I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	3	N/A

I/O CABLES (AC POWER CONDUCTED TEST AND BELOW 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	3	N/A

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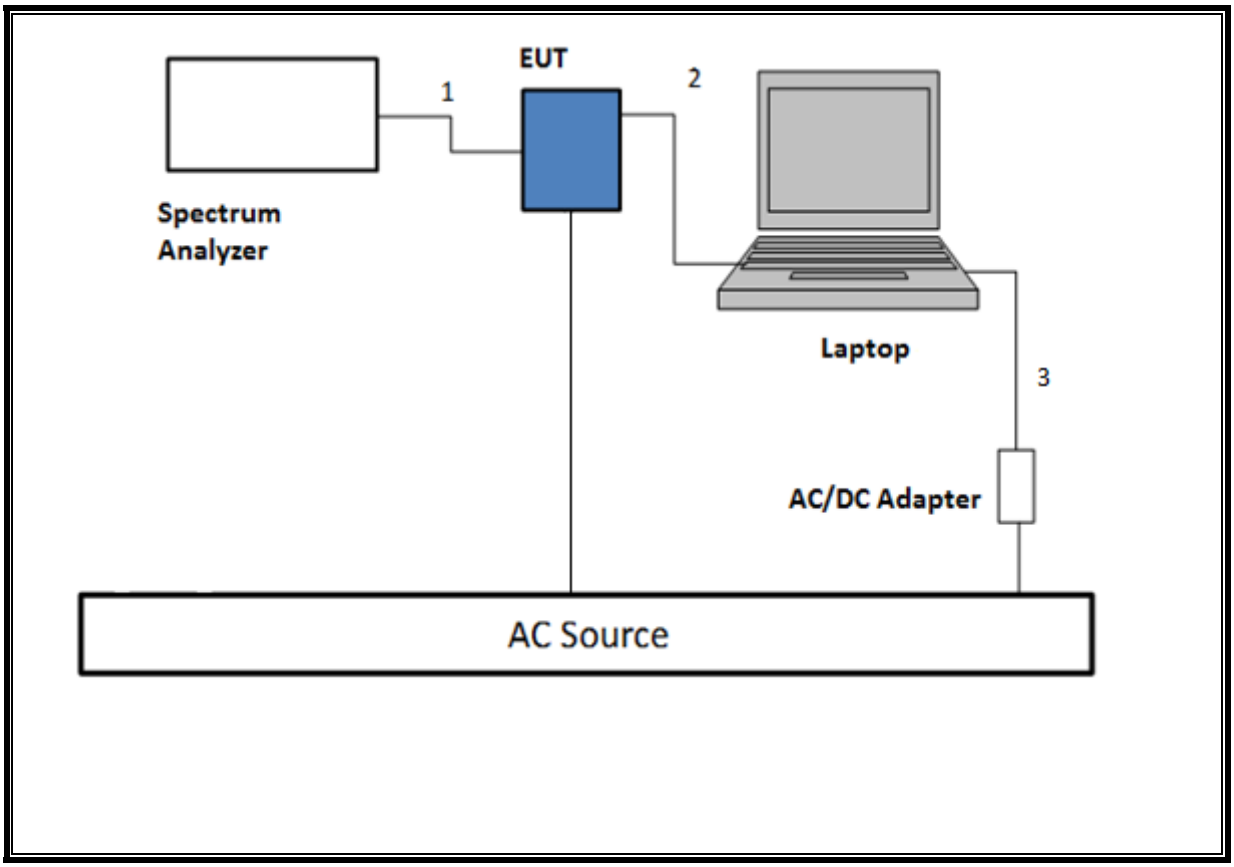
TEST SETUP

The EUT was powered by AC cord. Test software exercised the EUT.

SETUP DIAGRAM



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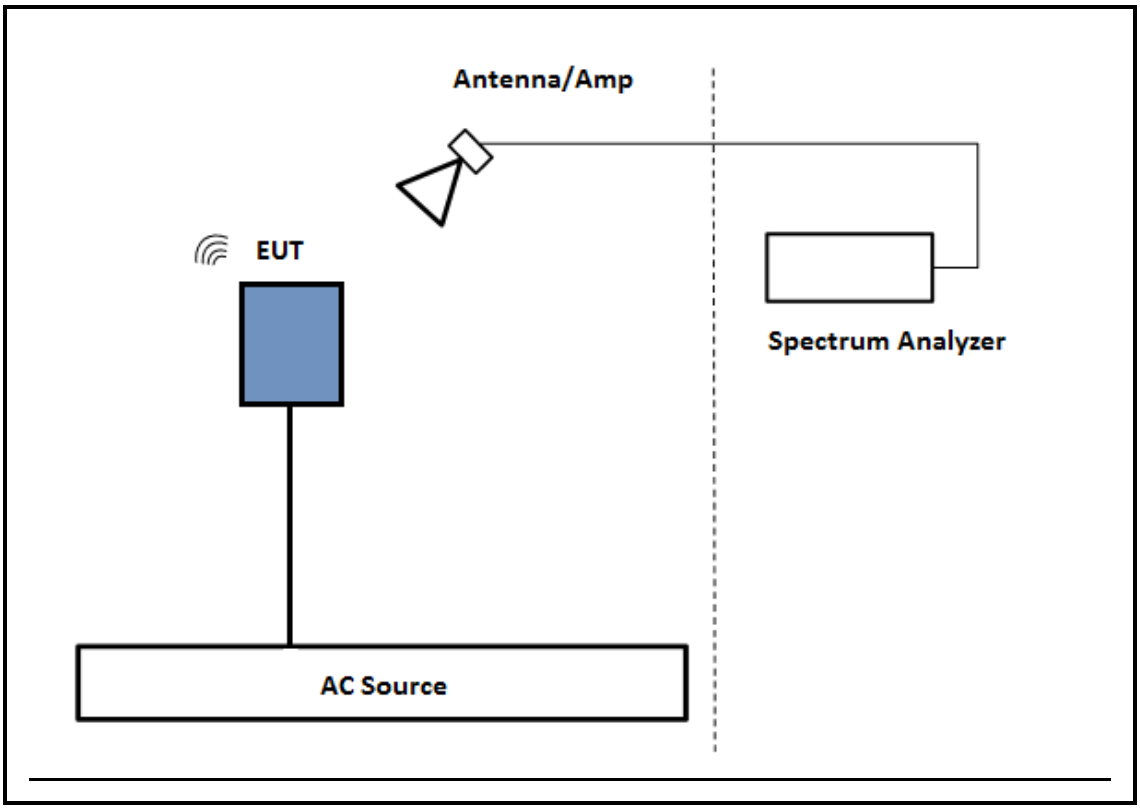
TEST SETUP- RADIATED-ABOVE 1 GHZ

The EUT was powered by AC cord. Test software exercised the EUT.

SETUP DIAGRAM



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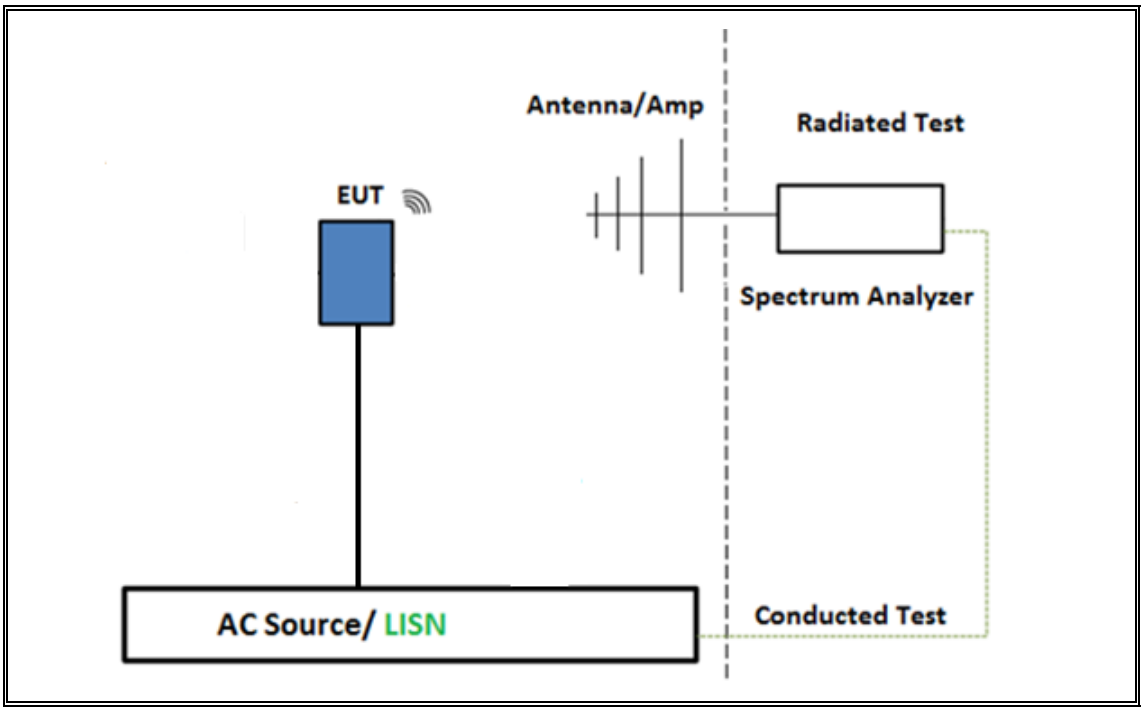
TEST SETUP- BELOW 1GHZ & AC LINE CONDUCTED TESTS

The EUT was powered by AC cord. Test software exercised the EUT.

SETUP DIAGRAM



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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**
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T119	3/28/2018
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB1	T122	1/31/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T742	11/29/2017
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T173	6/24/2018
Spectrum Analyzer, PSA, 3Hz to 44GHz	Agilent (Keysight) Technologies	E4446A	T177	03/20/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T342	2/23/2018
Antenna Horn, 18 to 26GHz	ARA	MWH-1826	T89	1/04/2018
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	7/23/2018
Power Meter, P-series single channel	Keysight	N1912A	T1244	6/15/2018
Power Sensor	Keysight	N1921A	T1225	3/29/2018
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	01/06/2018
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/15/2018
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016	
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

NOTE: *testing is completed before equipment calibration expiration date.

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7. ANTENNA PORT TEST RESULTS

7.1. MEASUREMENT METHODS

6 dB BW: KDB 558074 D01 v04, Section 8.1.

Output Power: KDB 558074 D01 v04, Section 9.1.3.

Power Spectral Density: KDB 558074 D01 v04, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v04, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v04, Section 12.1.

Band-edge: KDB 558074 D01 v04, Section 12.1.

Conducted line emissions: C63.10, Clause 6.2

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7.2. ON TIME, DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (khz)
BLE Pmax	128	128	1.00	100	0.00	0.010
BLE Plow	128	128	1.00	100	0.00	0.010

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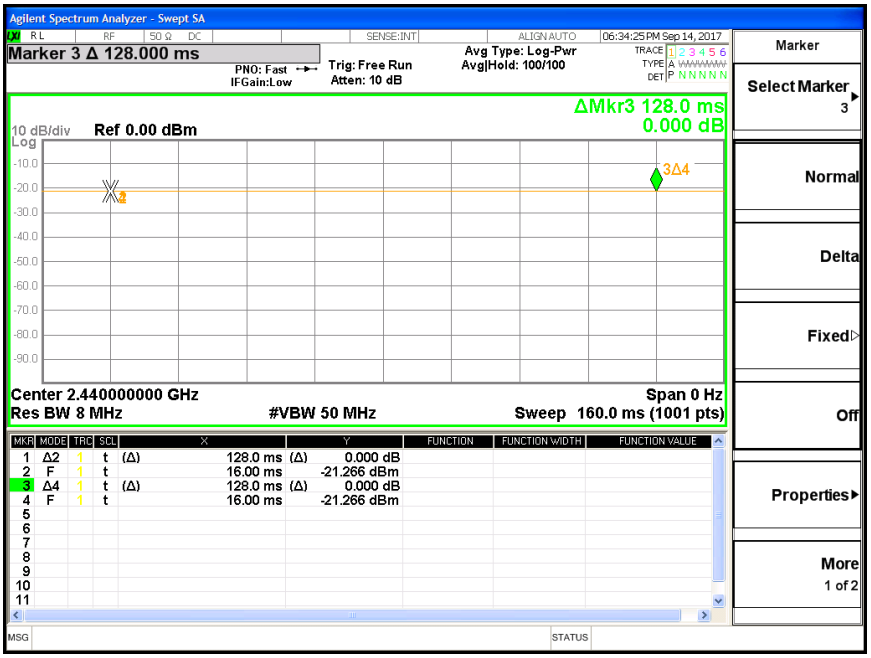
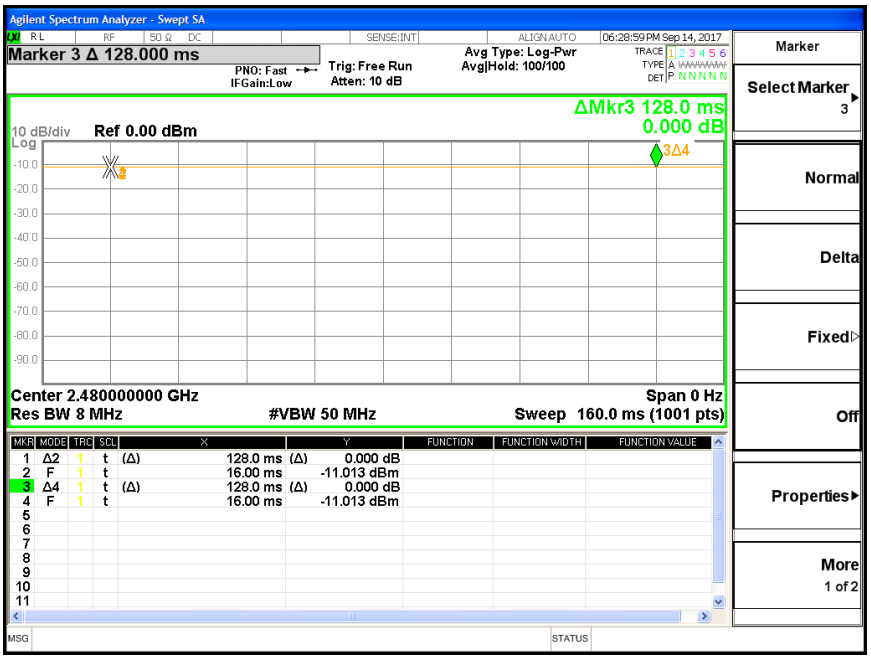
DUTY CYCLE PLOTS

DUTY CYCLE BLE PLOW MODE



DUTY CYCLE BLE PMAX MODE



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7.4. Antenna A Pmax

7.4.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-247 (5.2) (a)

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

RESULTS

Channel	Frequency	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.710	0.5
Middle	2440	0.656	0.5
High	2480	0.702	0.5

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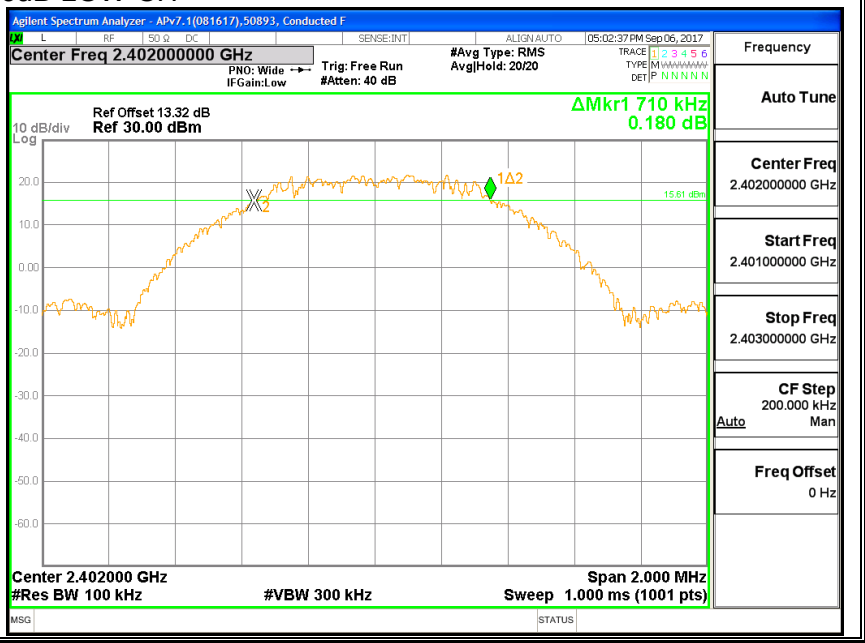
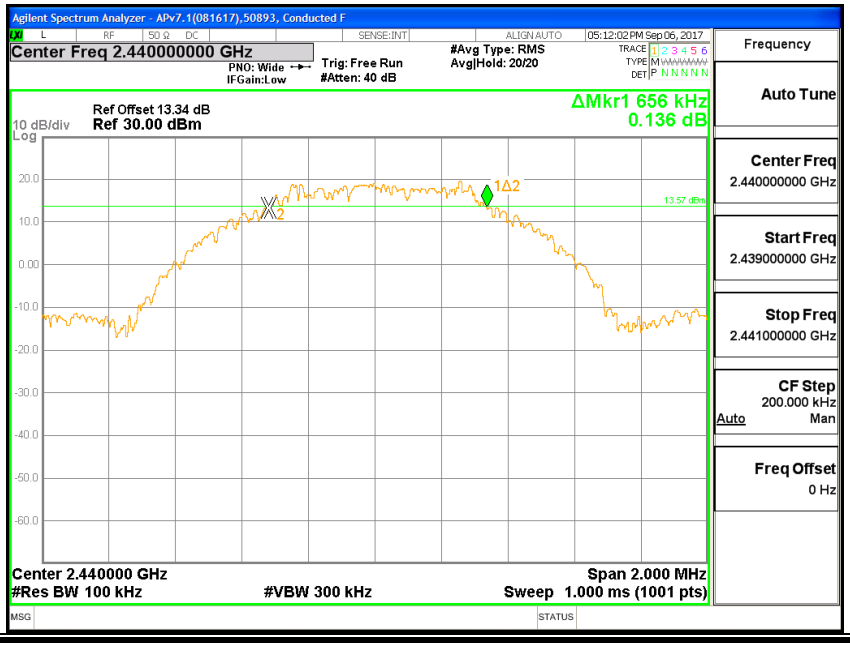
6dB LOW CH



6dB MID CH



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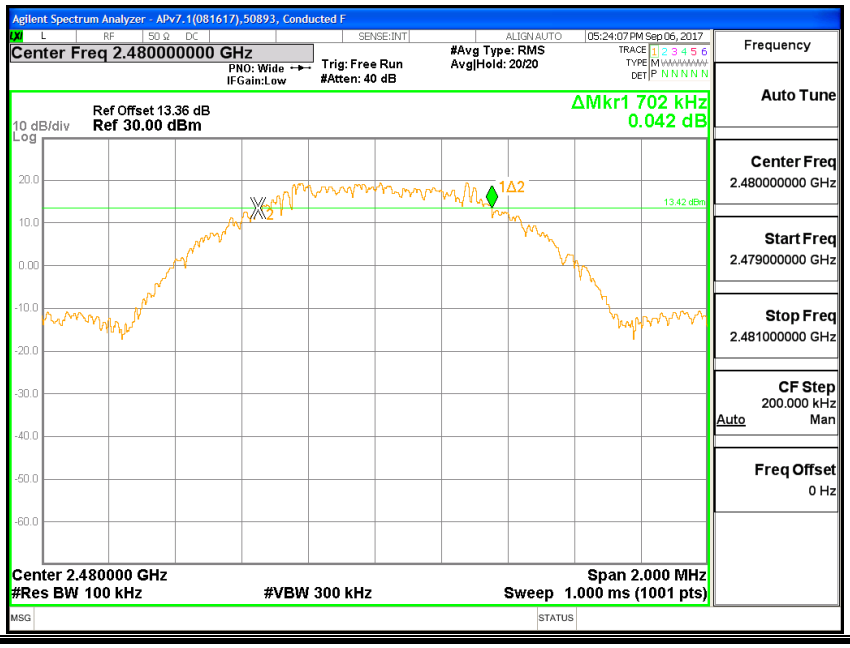
6dB HIGH CH



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7.4.2. 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	1.0507
Middle	2440	1.0512
High	2480	1.0505

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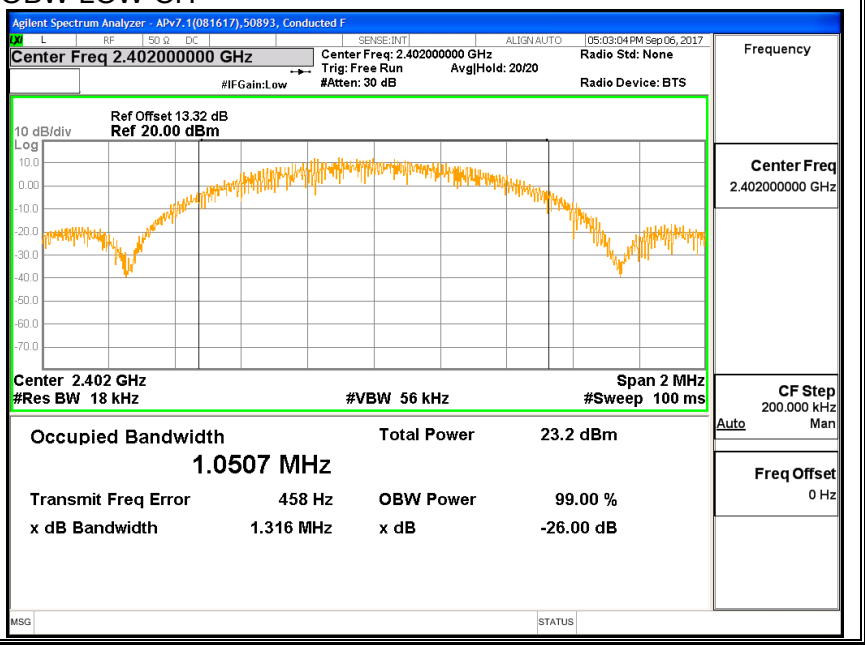
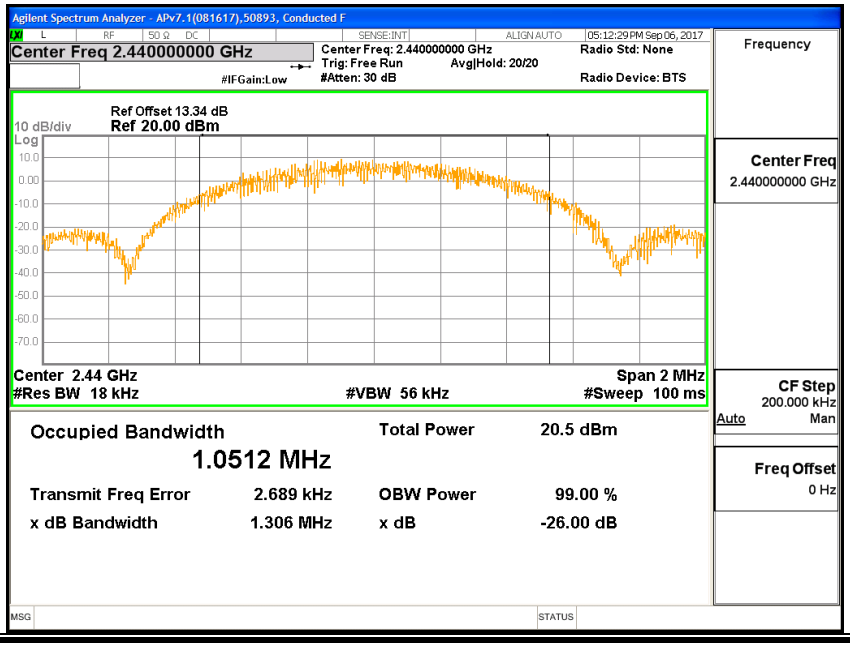
OBW LOW CH



OBW MID CH



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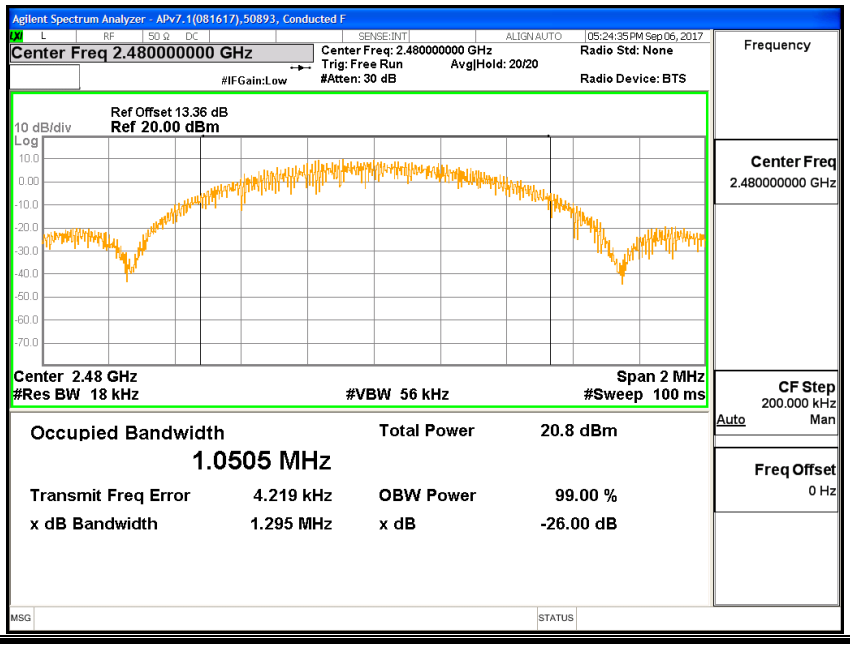
OBW HIGH CH



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7.4.3. AVERAGE POWER

ID:	50893	Date:	9/6/2017

LIMITS

None; for reporting purposes only.

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

RESULTS

Channel	Frequency (MHz)	Average Power (MHz)
Low	2402	19.78
Middle	2440	19.92
High	2480	19.83

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7.4.4. OUTPUT POWER

ID:	50893	Date:	9/6/2017

LIMITS

FCC §15.247 (b)

IC RSS-247 (5.4) (d)

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	20.11	30	-9.89
Middle	2440	20.27	30	-9.73
High	2480	20.19	30	-9.81

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7.4.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

IC RSS-247 (5.2) (b)

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	6.615	8	-1.385
Middle	2440	5.140	8	-2.860
High	2480	4.318	8	-3.682

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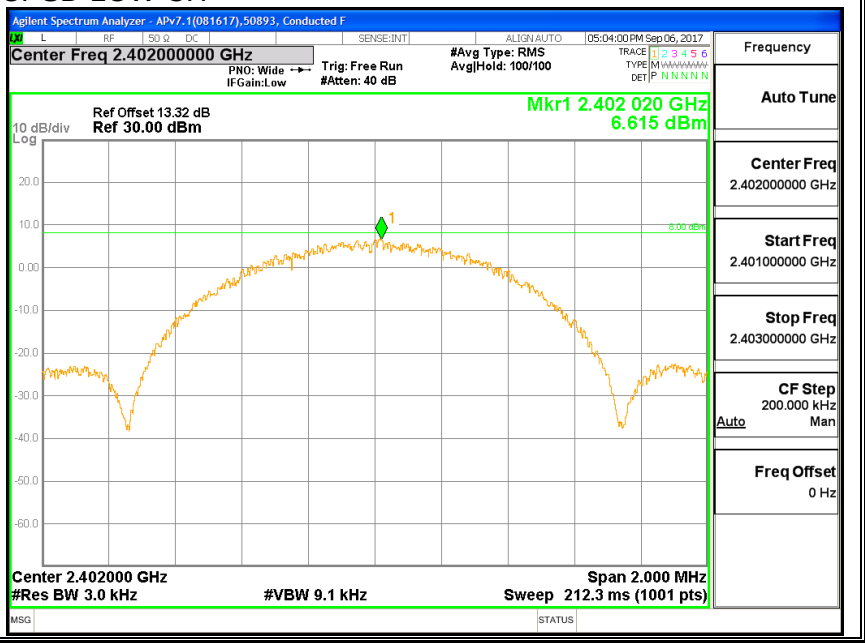
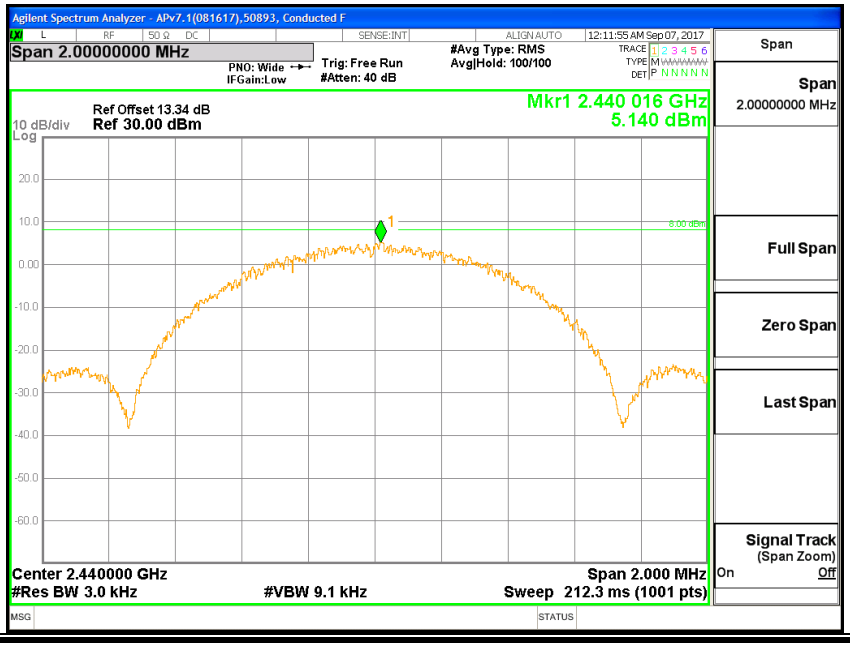
CPSD LOW CH



CPSD MID CH



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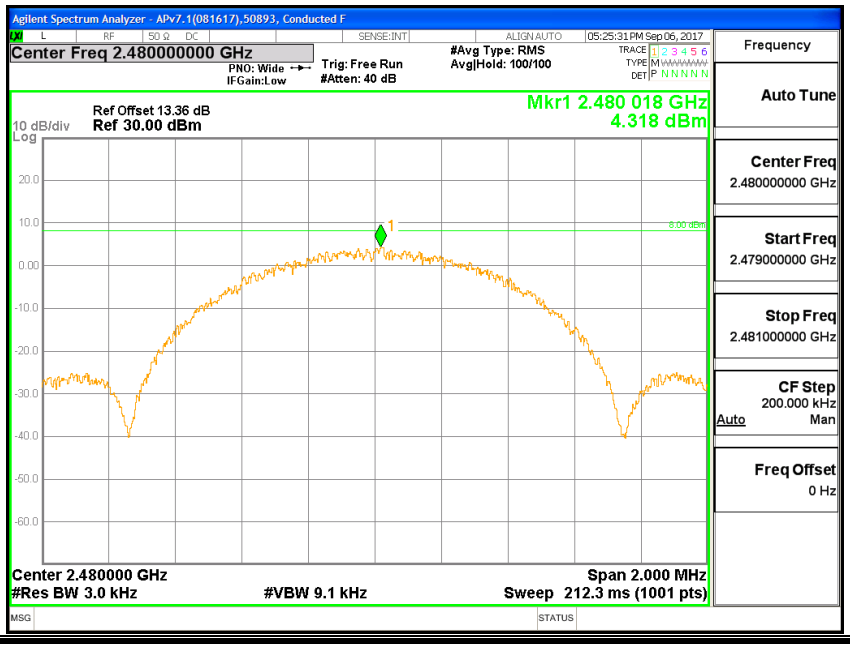
CPSD HIGH CH



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7.4.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

LIMITS

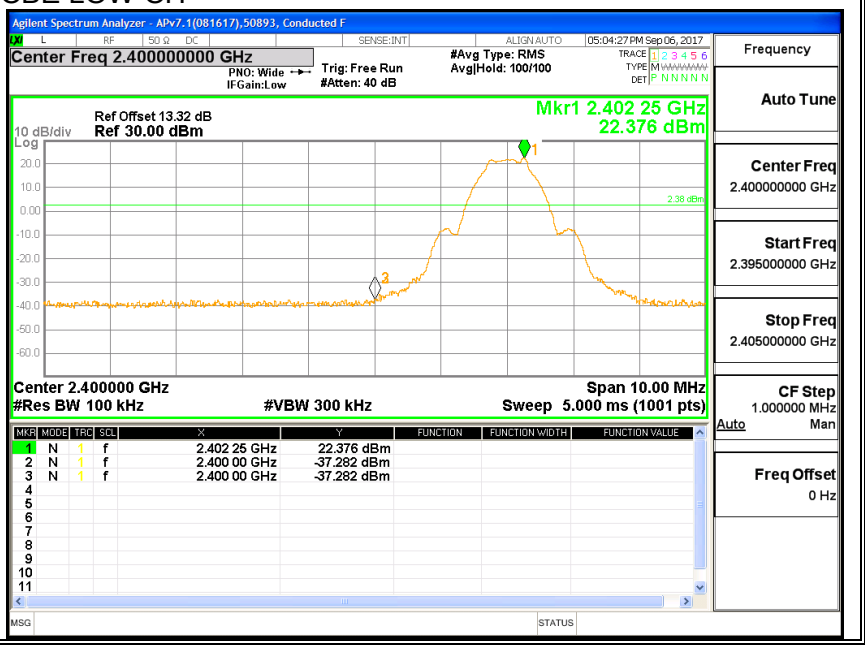
FCC §15.247 (d)

IC RSS-247 (5.5)

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

RESULTS

CBE LOW CH



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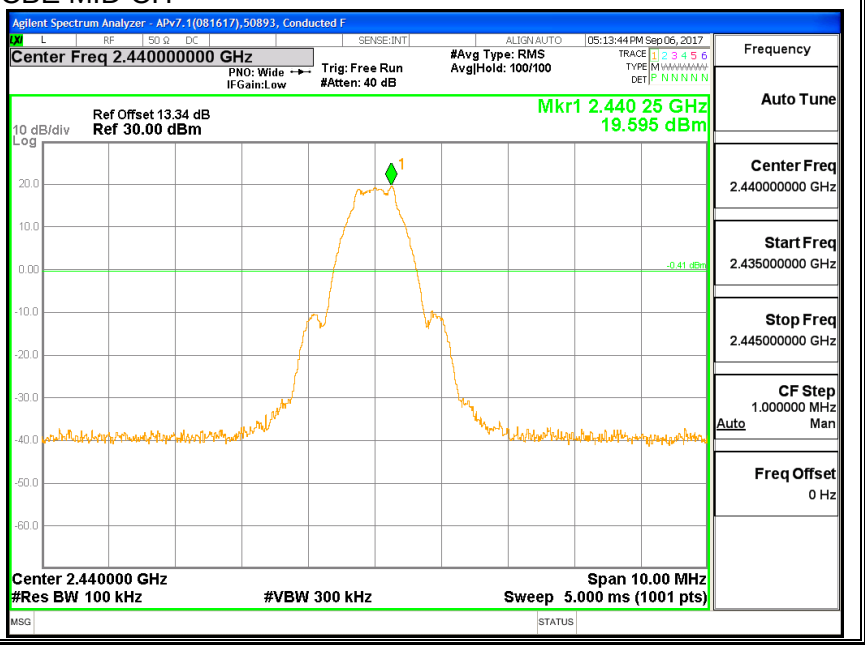
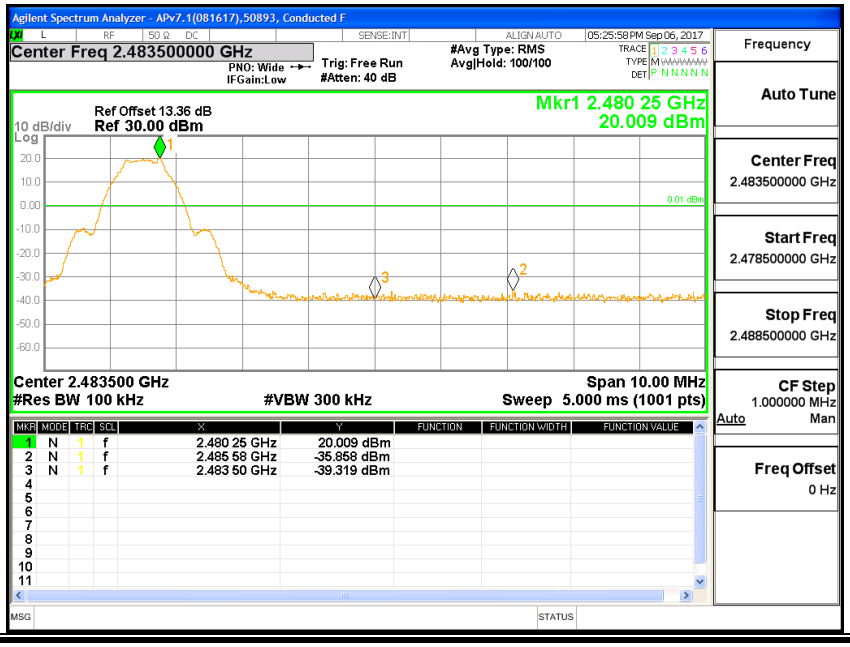
CBE MID CH



CBE HIGH CH



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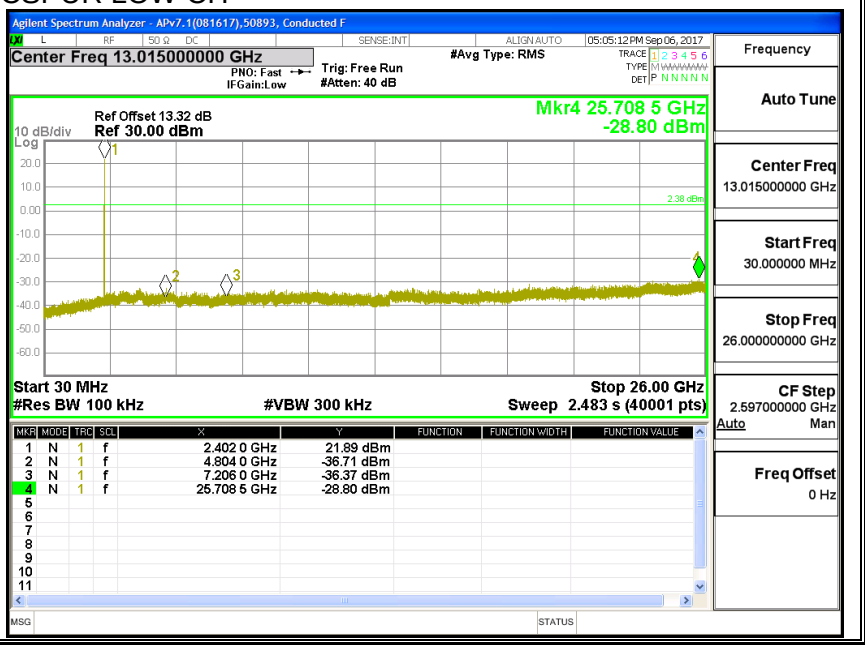
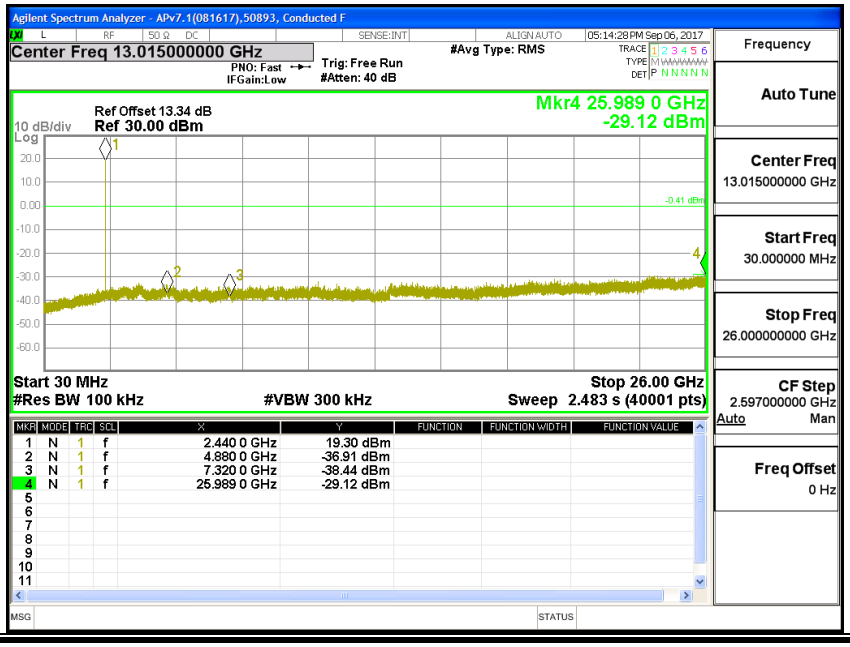
CSPUR LOW CH



CSPUR MID CH



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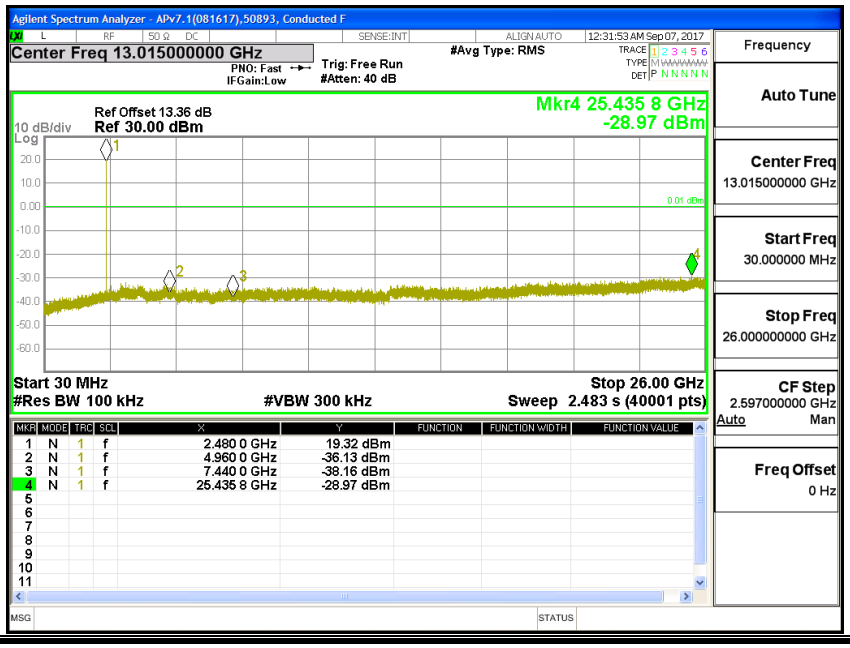
CSPUR HIGH CH



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7.5. Antenna A 2M Pmax

7.5.1. AVERAGE POWER

ID:	50893	Date:	9/27/2017

LIMITS

None; for reporting purposes only.

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

RESULTS

Channel	Frequency (MHz)	Average Power (MHz)
Low	2402	19.45
Middle	2440	19.60
High	2480	19.34

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7.5.2. OUTPUT POWER

ID:	50893	Date:	9/27/2017

LIMITS

FCC §15.247 (b)

IC RSS-247 (5.4) (d)

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

TEST PROCEDURE

The transmitter output is connected to a broadband Peak/average RF power meter

RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	23.29	30	-6.71
Middle	2440	20.37	30	-9.63
High	2480	20.99	30	-9.01

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7.6. Antenna A Plow

7.6.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-247 (5.2) (a)

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

RESULTS

Channel	Frequency	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.726	0.5
Middle	2440	0.710	0.5
High	2480	0.690	0.5

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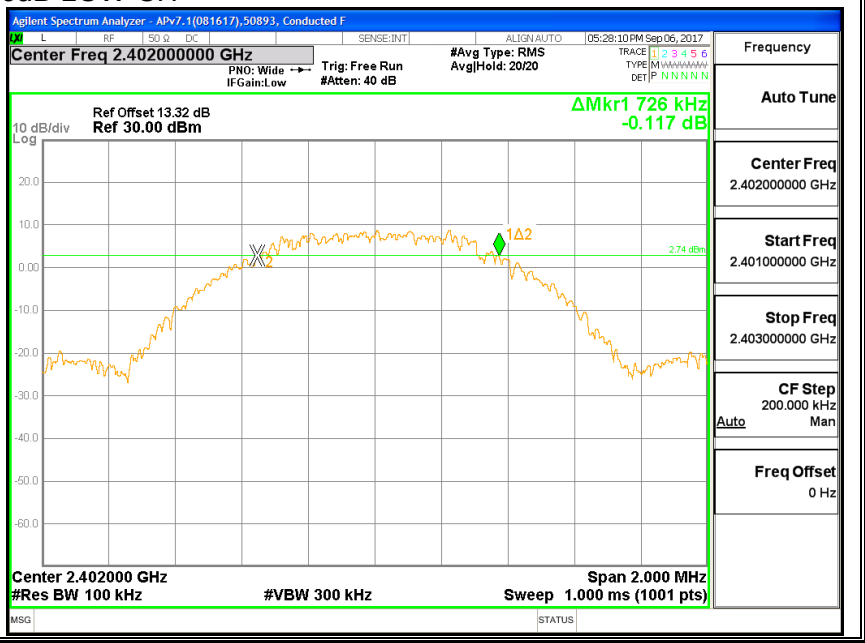
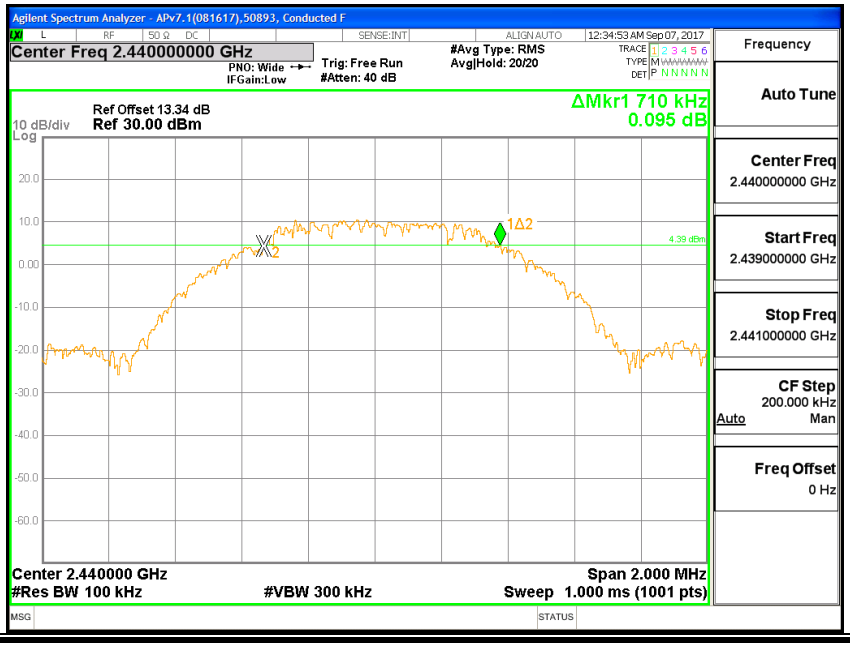
6dB LOW CH



6dB MID CH



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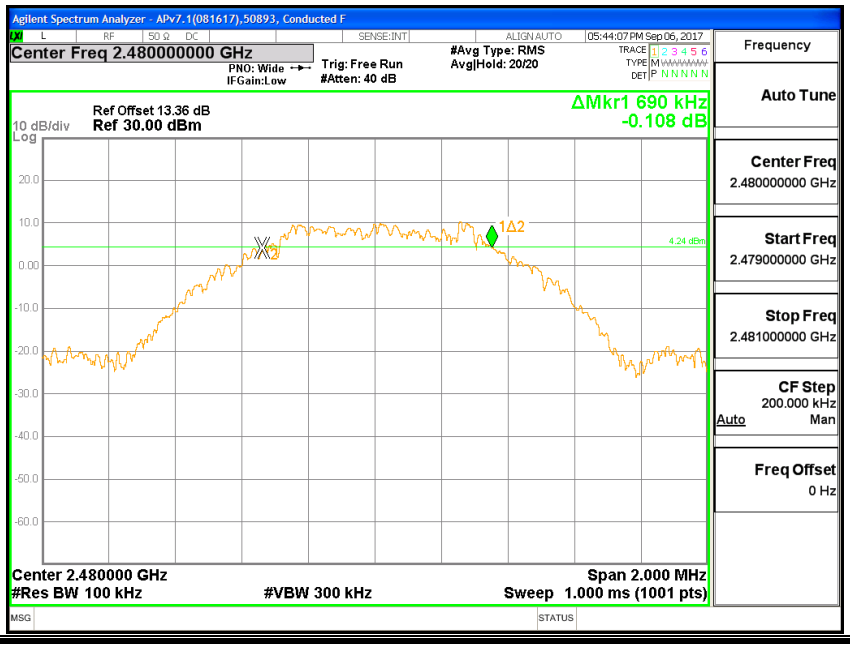
6dB HIGH CH



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7.6.2. 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	1.0621
Middle	2440	1.0529
High	2480	1.0576

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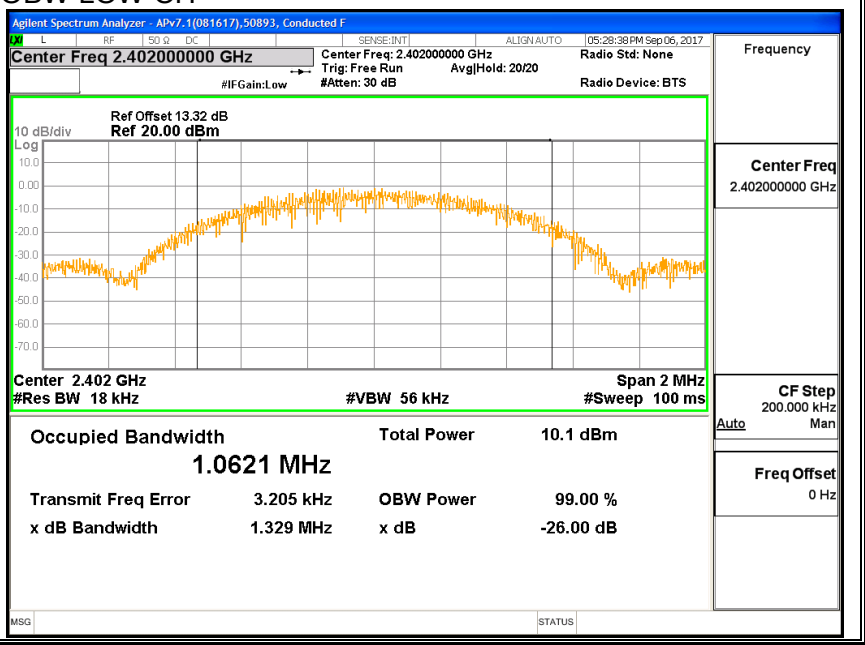
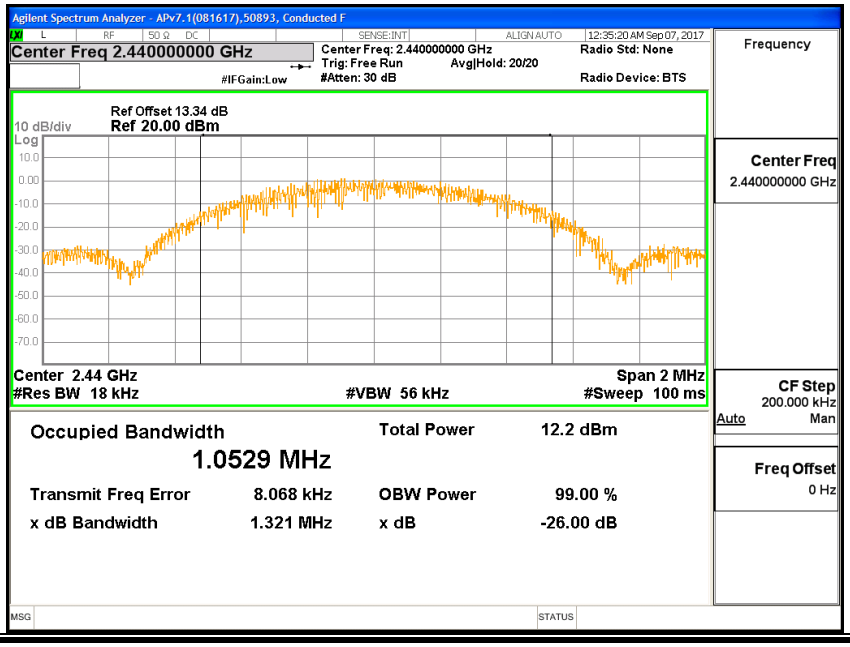
OBW LOW CH



OBW MID CH



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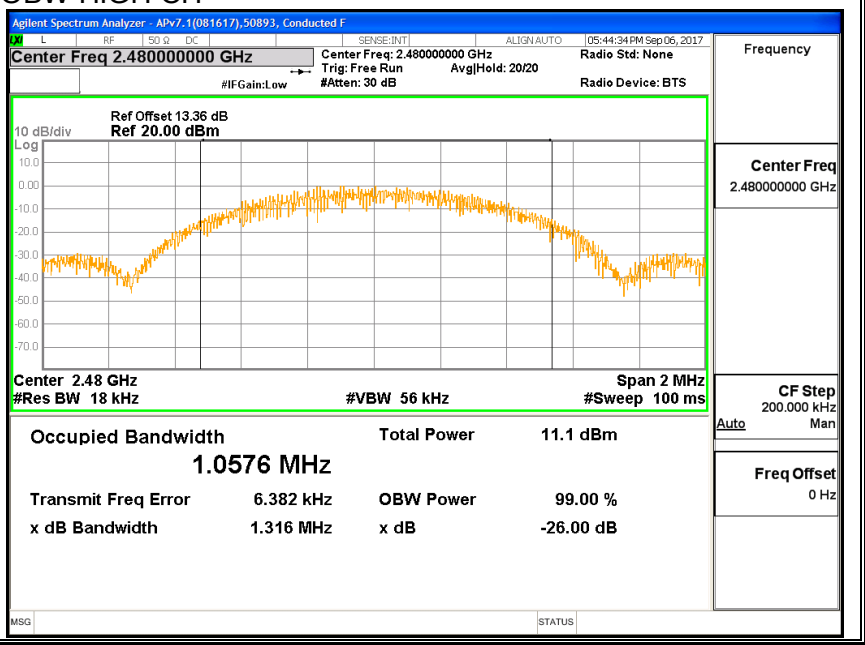
OBW HIGH CH



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7.6.3. AVERAGE POWER

ID:	50893	Date:	9/6/2017

LIMITS

None; for reporting purposes only.

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

RESULTS

Channel	Frequency (MHz)	Average Power (MHz)
Low	2402	11.80
Middle	2440	11.92
High	2480	11.76

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7.6.4. OUTPUT POWER

ID:	50893	Date:	9/6/2017

LIMITS

FCC §15.247 (b)

IC RSS-247 (5.4) (d)

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	12.09	30	-17.81
Middle	2440	12.31	30	-17.69
High	2480	12.06	30	-17.94

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7.6.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

IC RSS-247 (5.2) (b)

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	-6.338	8	-14.338
Middle	2440	-4.174	8	-12.174
High	2480	-5.359	8	-13.359

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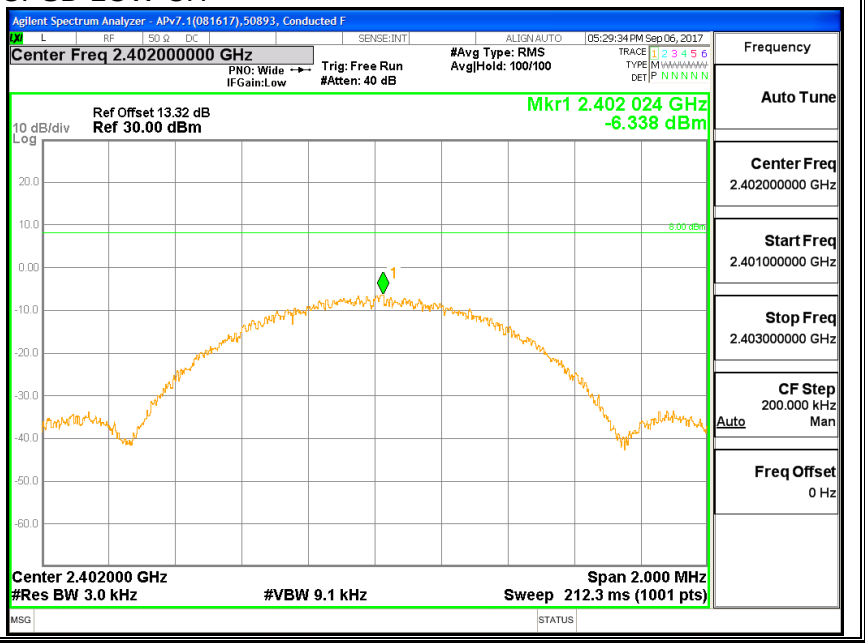
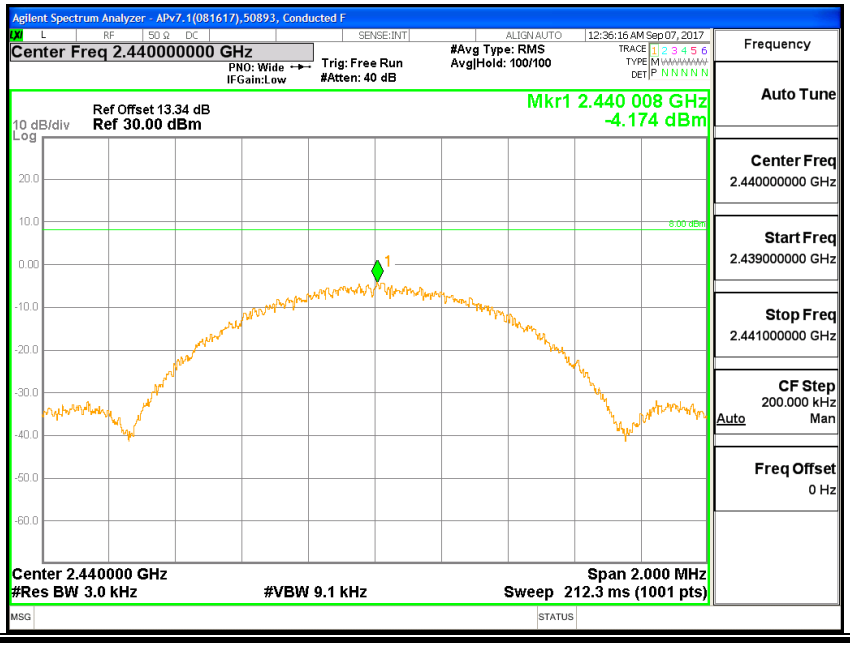
CPSD LOW CH



CPSD MID CH



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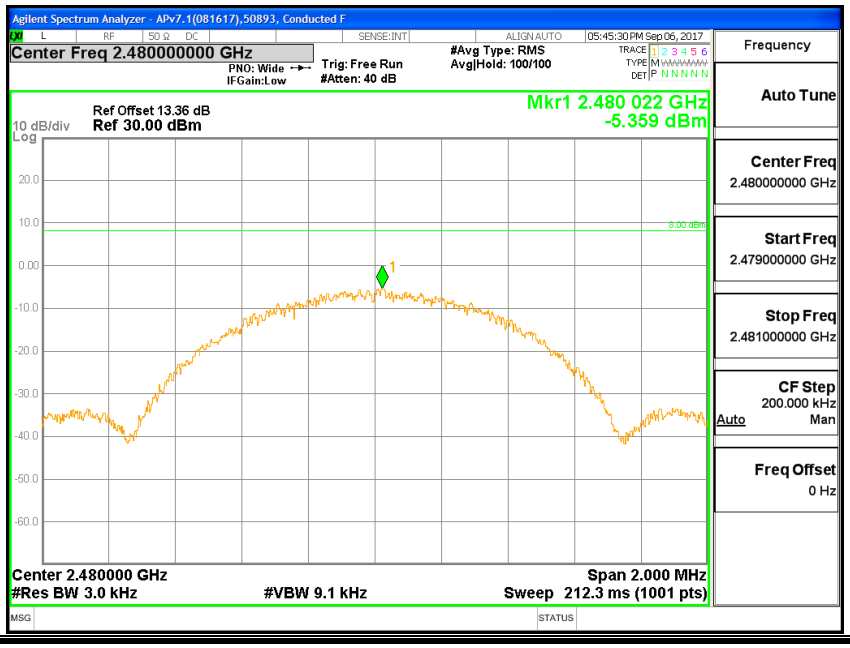
CPSD HIGH CH



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7.6.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

LIMITS

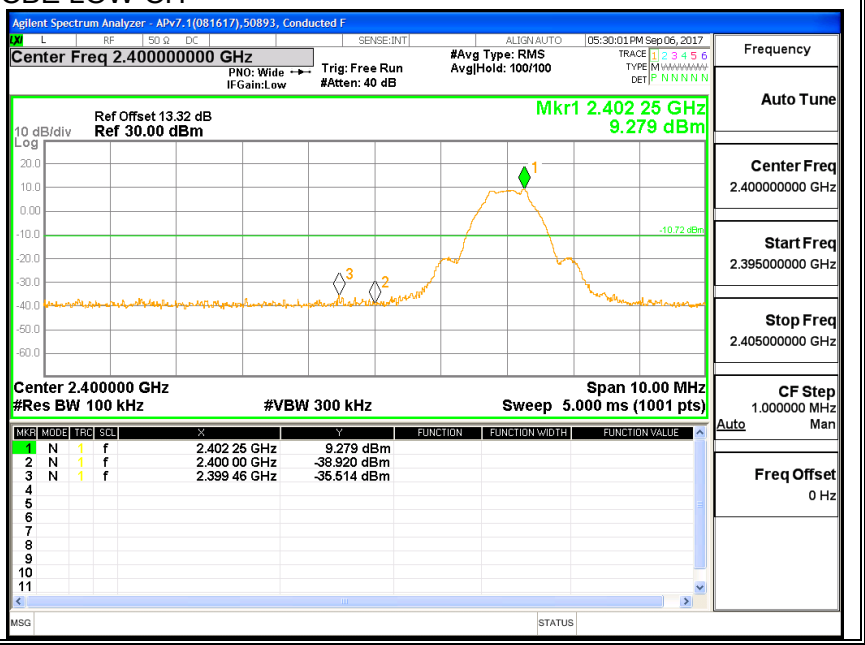
FCC §15.247 (d)

IC RSS-247 (5.5)

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

RESULTS

CBE LOW CH



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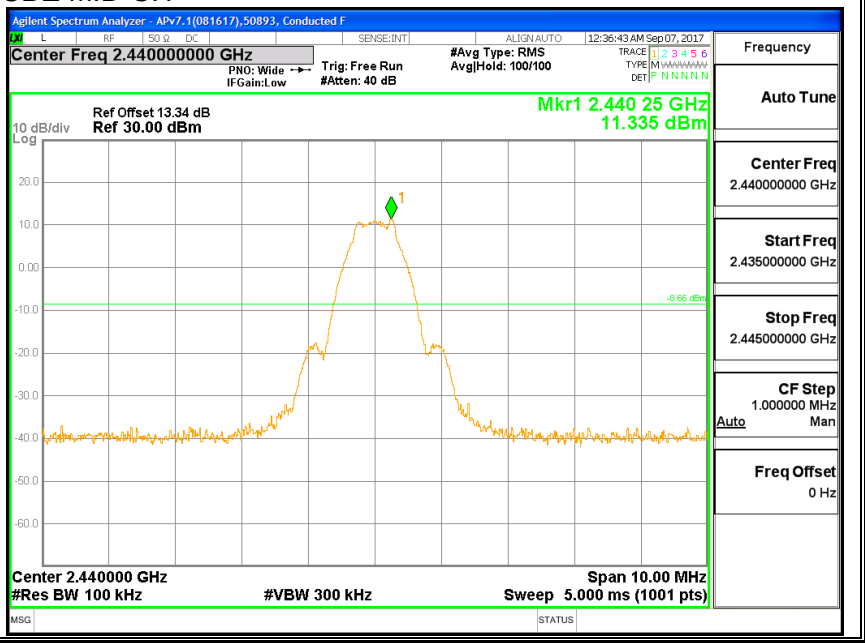
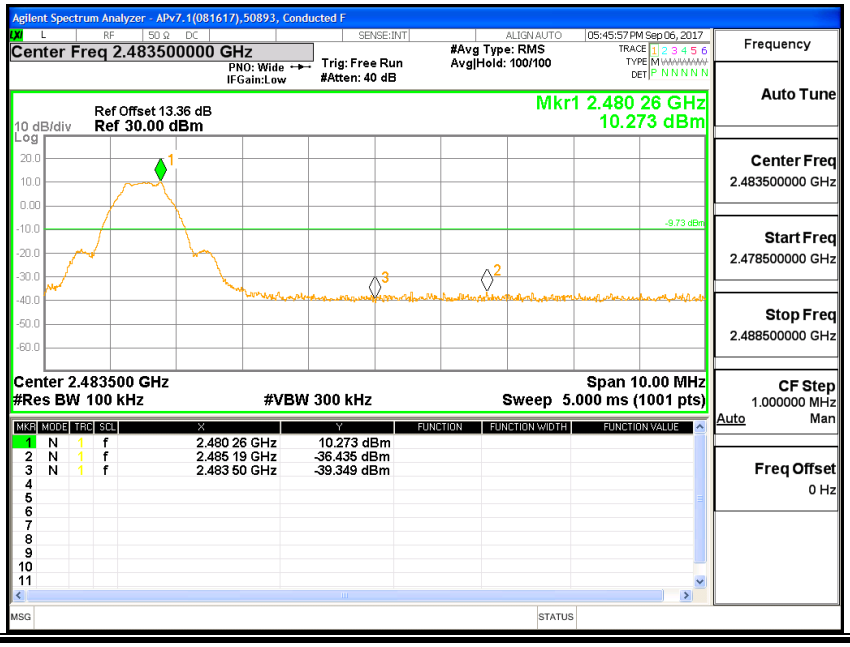
CBE MID CH



CBE HIGH CH



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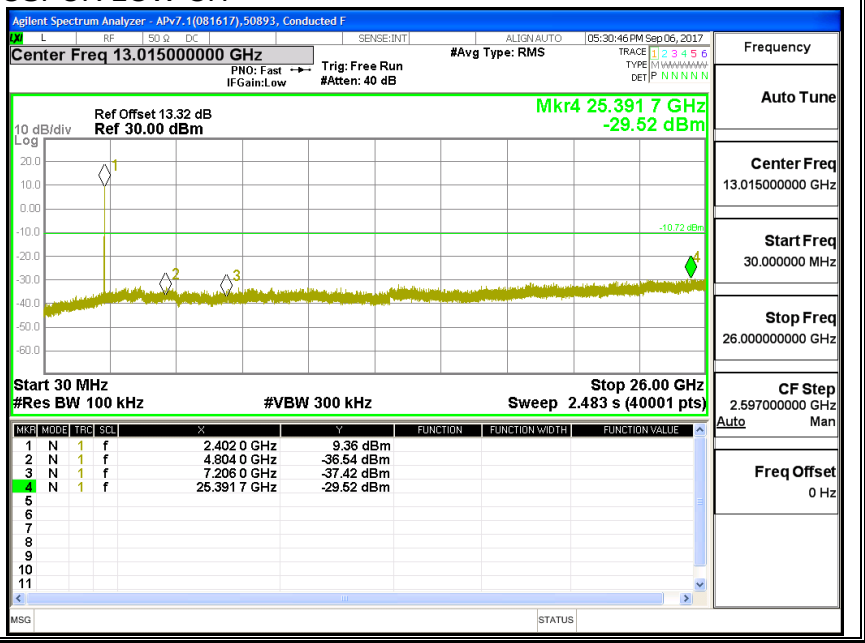
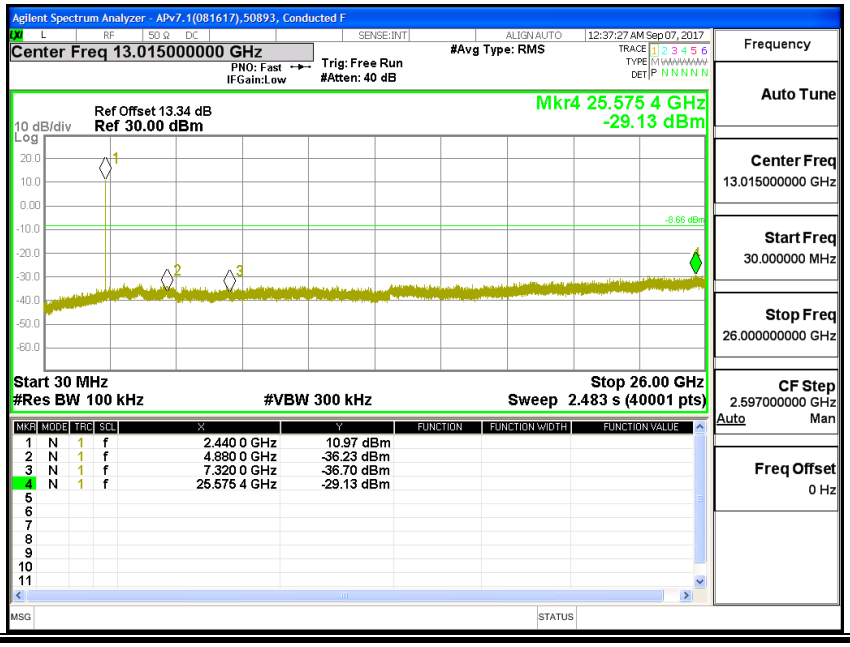
CSPUR LOW CH



CSPUR MID CH



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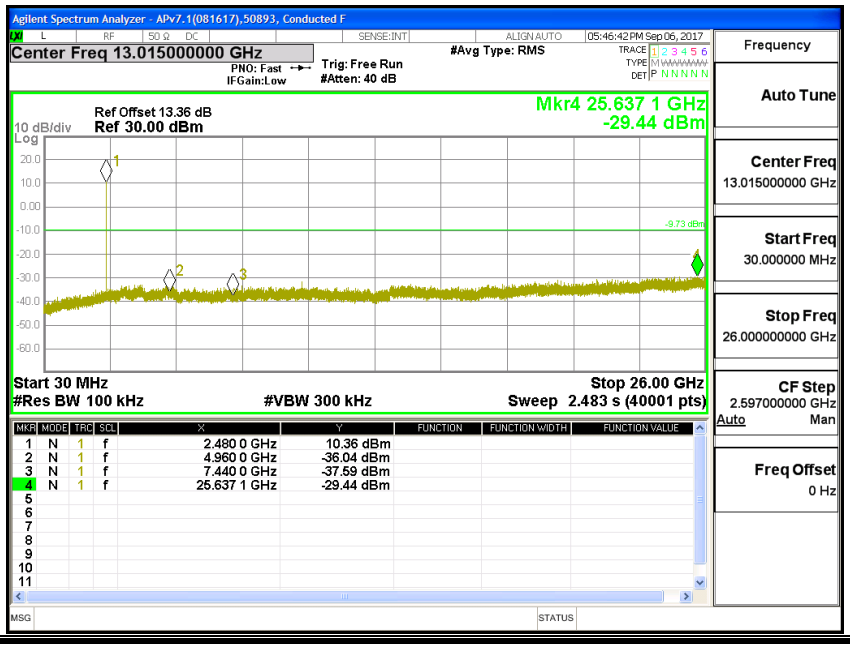
CSPUR HIGH CH



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7.7. Antenna A 2M Plow

7.7.1. AVERAGE POWER

ID:	50893	Date:	9/27/2017

LIMITS

None; for reporting purposes only.

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

RESULTS

Channel	Frequency (MHz)	AV Power (MHz)
Low	2402	11.15
Middle	2440	11.70
High	2480	11.13

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7.7.2. OUTPUT POWER

ID:	50893	Date:	9/27/2017

LIMITS

FCC §15.247 (b)

IC RSS-247 (5.4) (d)

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

TEST PROCEDURE

The transmitter output is connected to a broadband Peak/average RF power meter

RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.56	30	-19.47
Middle	2440	12.10	30	-17.90
High	2480	11.49	30	-18.51

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8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-GEN, Section 8.9 and 8.10.

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 pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

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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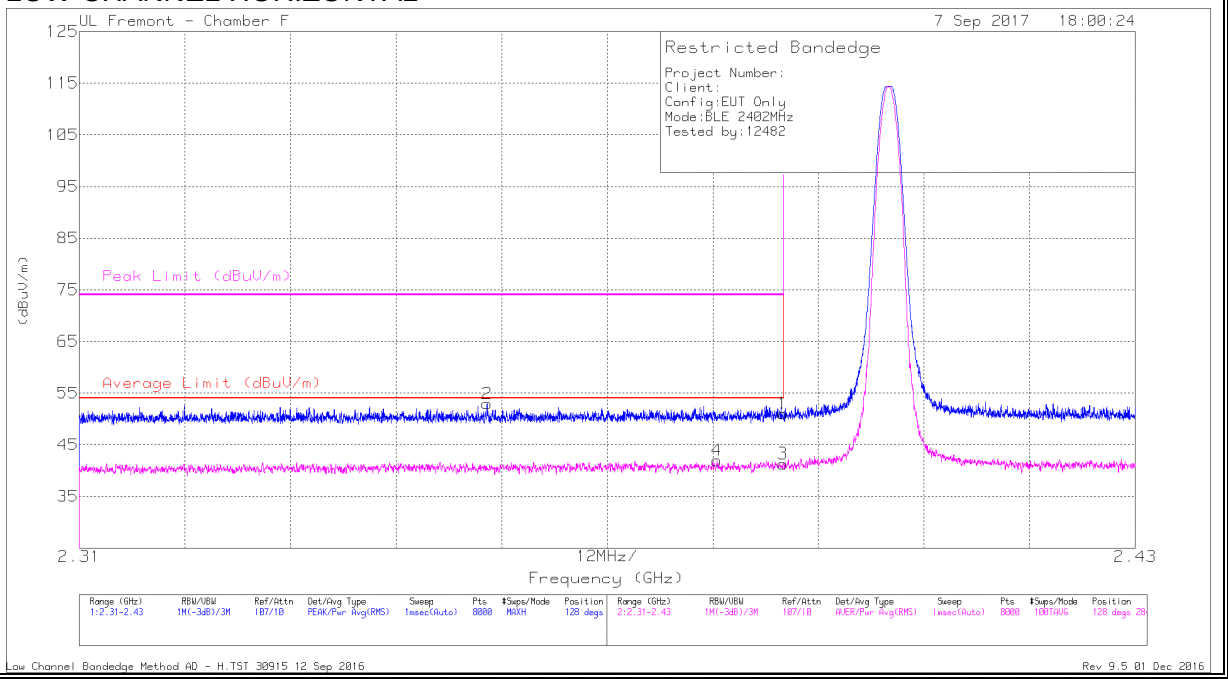
8.3. Antenna A Pmax

8.3.1. RESTRICTED BANDEDGE (LOW CHANNEL)

LOW CHANNEL HORIZONTAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	40.15	Pk	31.9	-21	51.05	-	-	74	-22.95	128	284	H
2	* 2.356	42.14	Pk	31.8	-21	52.94	-	-	74	-21.06	128	284	H
3	* 2.39	30.4	RMS	31.9	-21	41.3	54	-12.7	-	-	128	284	H
4	* 2.382	31.05	RMS	31.8	-20.9	41.95	54	-12.05	-	-	128	284	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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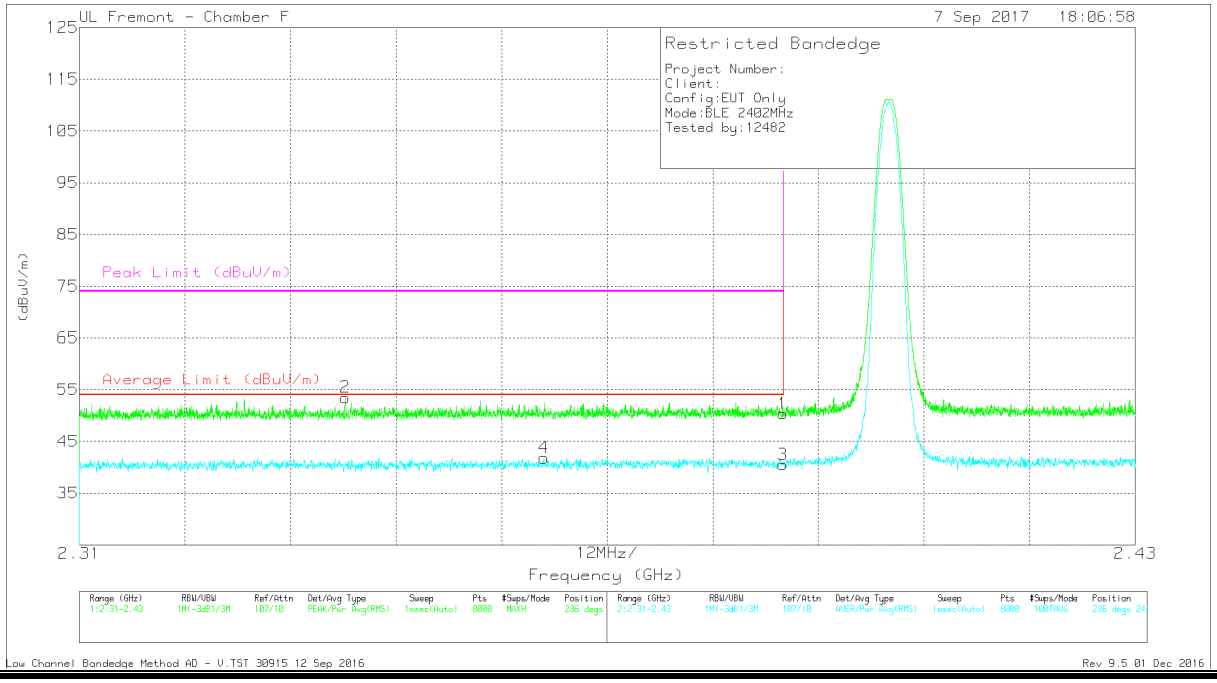
LOW CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	39.47	Pk	31.9	-21	50.37	-	-	74	-23.63	236	244	V
2	* 2.34	42.79	Pk	31.7	-21	53.49	-	-	74	-20.51	236	244	V
3	* 2.39	29.62	RMS	31.9	-21	40.52	54	-13.48	-	-	236	244	V
4	* 2.363	31.04	RMS	31.8	-21	41.84	54	-12.16	-	-	236	244	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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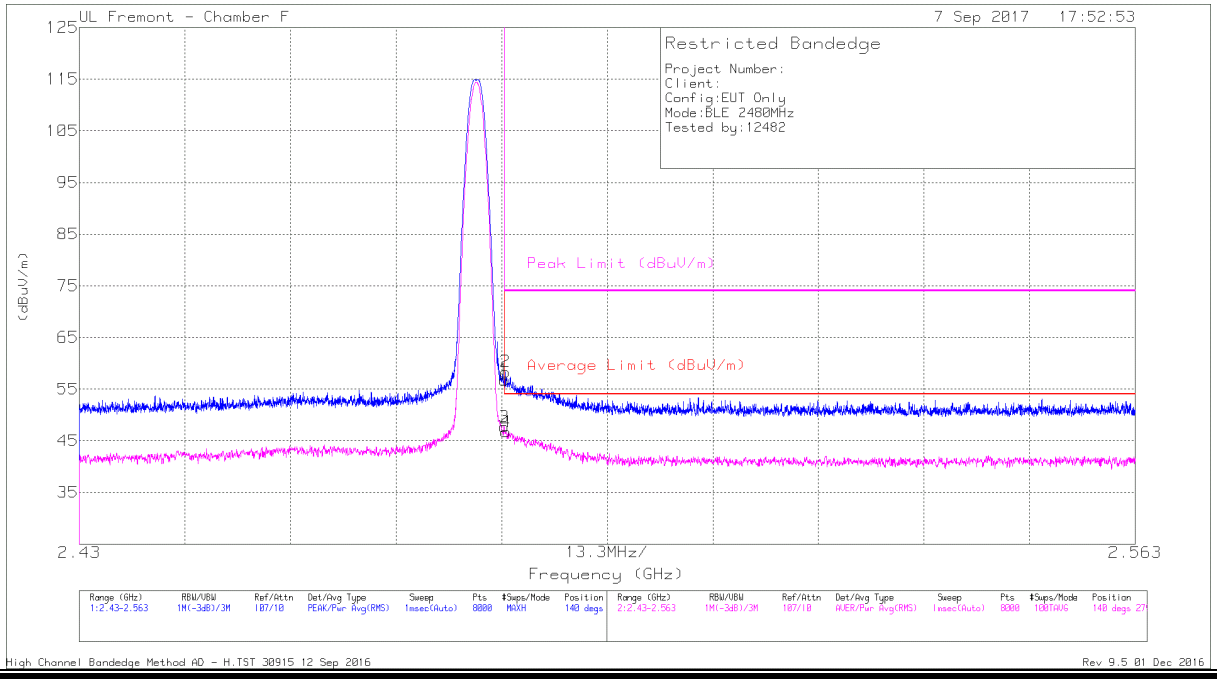
8.3.2. AUTHORIZED BANDEDGE (HIGH CHANNEL)

HIGH CHANNEL HORIZONTAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	45.66	Pk	32.1	-21	56.76	-	-	74	-17.24	140	279	H
2	* 2.484	47.26	Pk	32.1	-21	58.36	-	-	74	-15.64	140	279	H
3	* 2.484	36.62	RMS	32.1	-21	47.72	54	-6.28	-	-	140	279	H
4	* 2.484	35.64	RMS	32.1	-21	46.74	54	-7.26	-	-	140	279	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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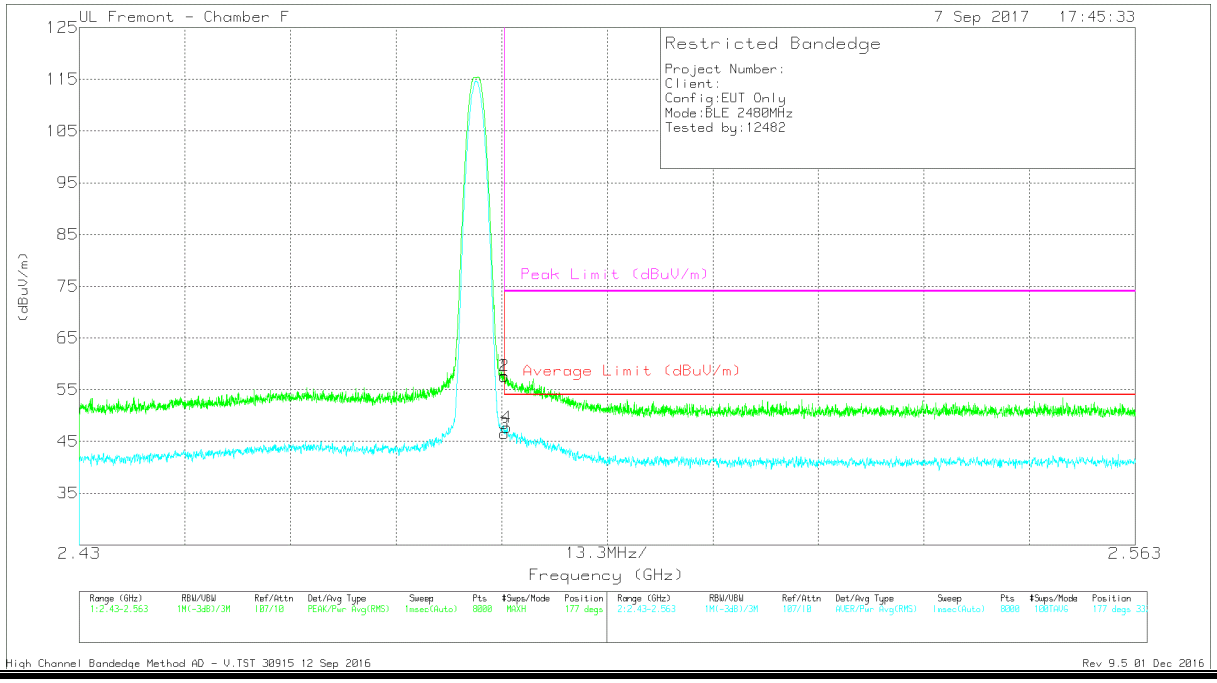
HIGH CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	46.47	Pk	32.1	-21	57.57	-	-	74	-16.43	177	332	V
2	* 2.484	46.56	Pk	32.1	-21	57.66	-	-	74	-16.34	177	332	V
3	* 2.484	35.4	RMS	32.1	-21	46.5	54	-7.5	-	-	177	332	V
4	* 2.484	36.51	RMS	32.2	-21	47.71	54	-6.29	-	-	177	332	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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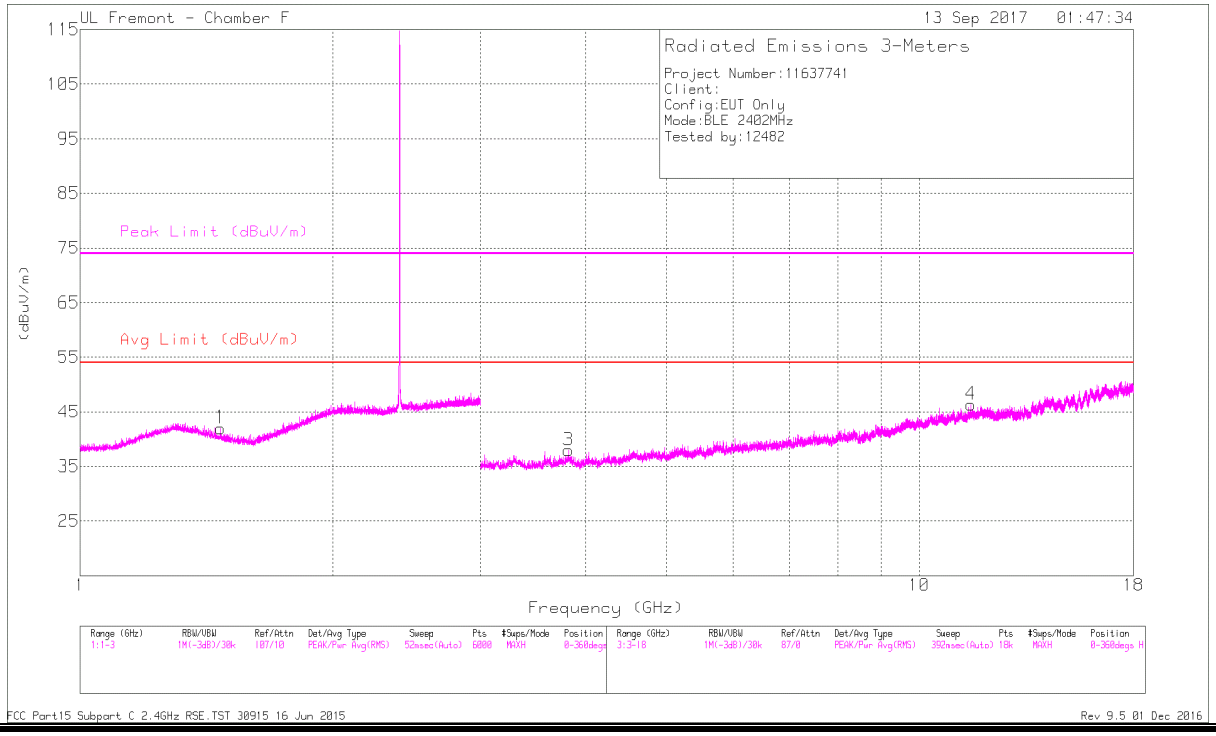
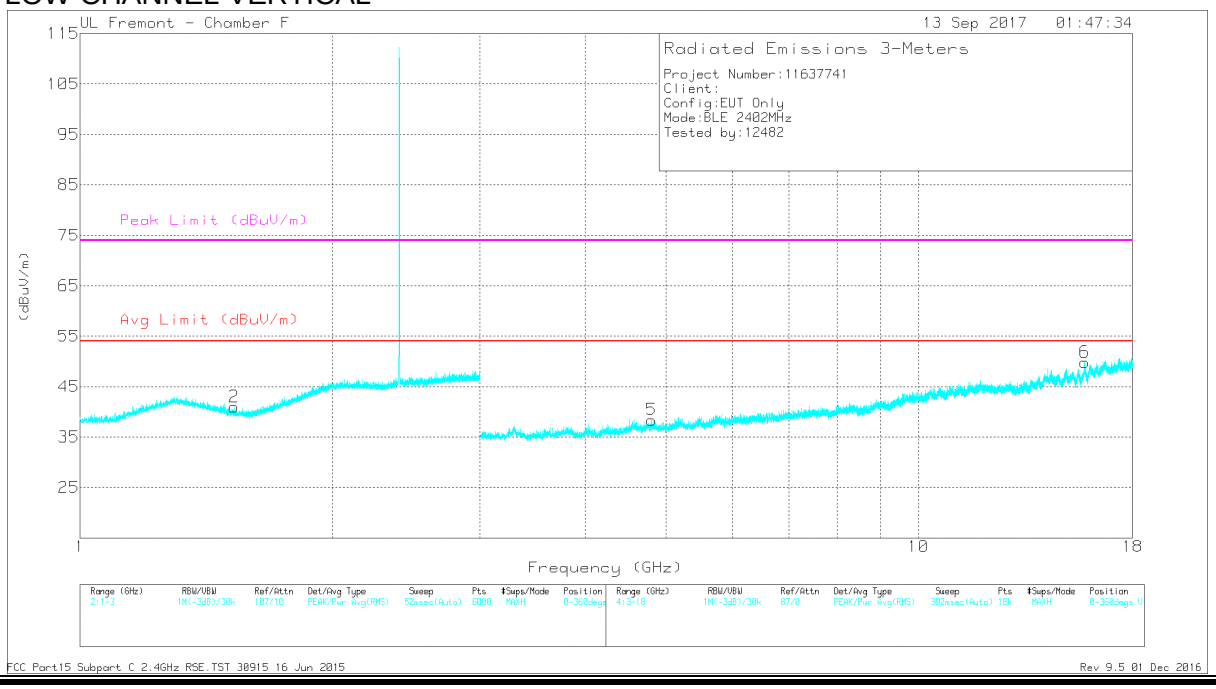
8.3.3. HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL HORIZONTAL



LOW CHANNEL VERTICAL



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Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.468	42.18	PK2	28.2	-22	48.38			74	-25.62	260	202	H
	* 1.47	30.5	MAv1	28.1	-22	36.6	54	-17.4	-	-	260	202	H
2	* 1.528	41.88	PK2	27.6	-22	47.48			74	-26.52	159	132	V
	* 1.528	30.45	MAv1	27.6	-22	36.05	54	-17.95	-	-	159	132	V
3	* 3.817	39.06	PK2	33.3	-28.3	44.06			74	-29.94	114	272	H
	* 3.82	28.13	MAv1	33.3	-28.3	33.13	54	-20.87	-	-	114	272	H
4	* 11.521	35.16	PK2	38.5	-21.1	52.56			74	-21.44	305	225	H
	* 11.522	24.08	MAv1	38.5	-21.2	41.38	54	-12.62	-	-	305	225	H
5	* 4.804	37.88	PK2	34.1	-27.4	44.58			74	-29.42	134	198	V
	* 4.804	26.83	MAv1	34.1	-27.5	33.43	54	-20.57	-	-	134	198	V
6	* 15.8	35.57	PK2	42.3	-22.4	55.47			74	-18.53	269	314	V
6	* 15.796	25.25	MAv1	42.2	-22.4	45.05	54	-8.95	-	-	269	314	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average
FCC Part15 Subpart C 2.4GHz RSE.TST 30915 16 Jun 2015
Rev 9.5 01 Dec 2016

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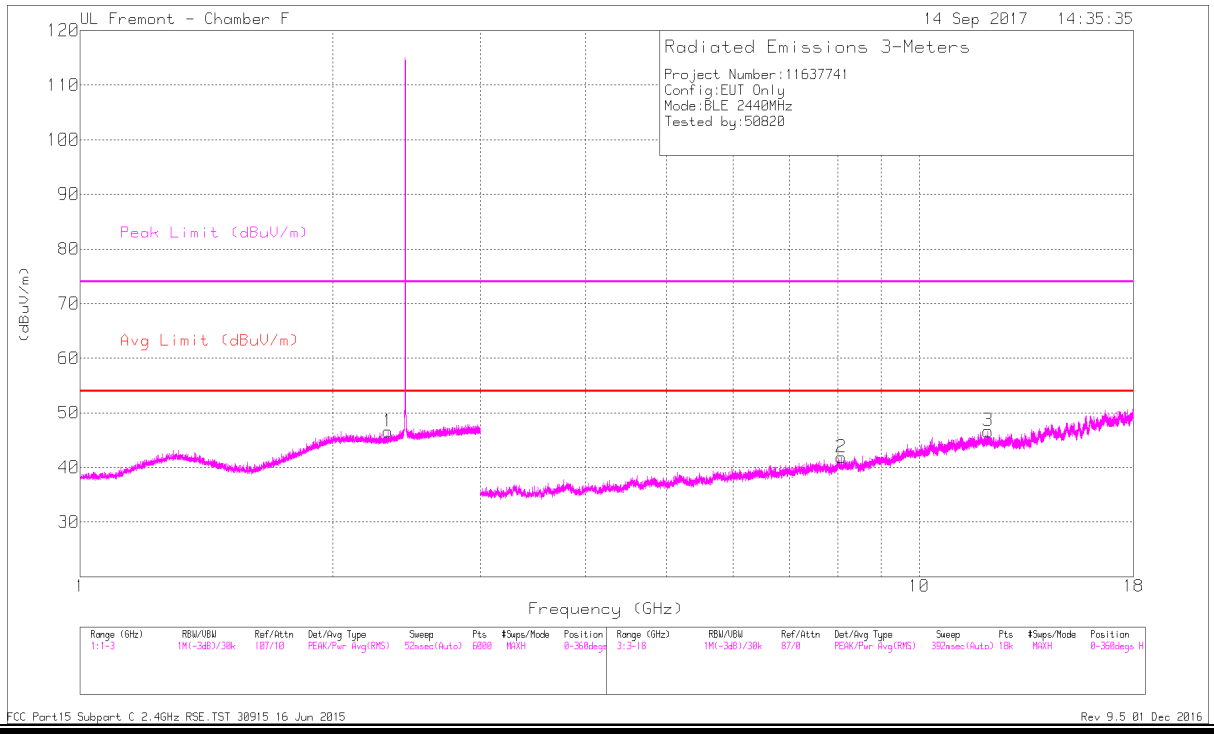
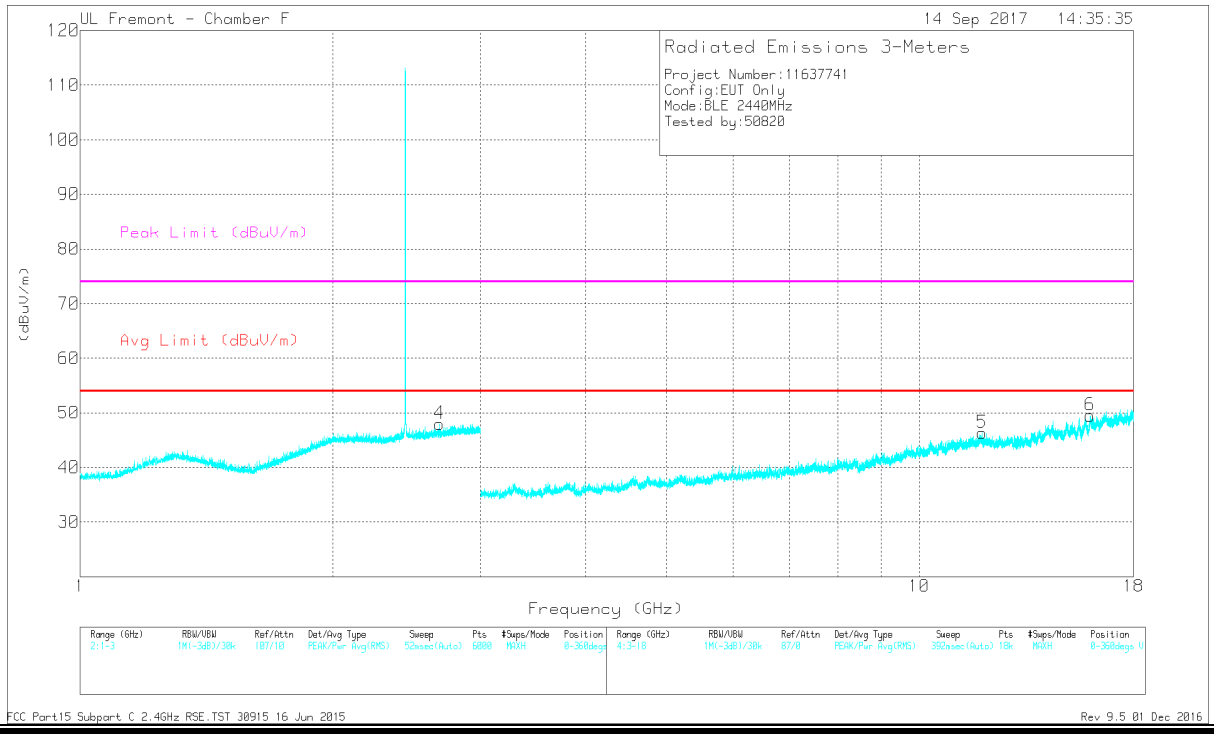
MID CHANNEL HORIZONTAL



MID CHANNEL VERTICAL



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Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.329	42.06	PK2	31.7	-21	52.76			74	-21.24	322	201	H
	* 2.33	30.31	MAv1	31.7	-21	41.01	54	-12.99	-	-	322	201	H
4	* 2.68	42.2	PK2	32.5	-20.7	54			74	-20	260	214	V
	* 2.68	30.39	MAv1	32.5	-20.7	42.19	54	-11.81	-	-	260	214	V
2	* 8.075	36.32	PK2	36	-24.2	48.12			74	-25.88	163	187	H
	* 8.075	25.26	MAv1	36	-24.2	37.06	54	-16.94	-	-	163	187	H
3	* 12.078	35.58	PK2	38.8	-22.1	52.28			74	-21.72	135	252	H
	* 12.08	24.71	MAv1	38.8	-22.1	41.41	54	-12.59	-	-	135	252	H
5	* 11.889	35.39	PK2	38.9	-21.8	52.49			74	-21.51	241	155	V
	* 11.888	24.31	MAv1	38.9	-21.8	41.41	54	-12.59	-	-	241	155	V
6	* 15.986	35.99	PK2	41.7	-21.6	56.09			74	-17.91	302	291	V
	* 15.987	25.17	MAv1	41.7	-21.5	45.37	54	-8.63	-	-	302	291	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average
FCC Part15 Subpart C 2.4GHz RSE.TST 30915 16 Jun 2015
Rev 9.5 01 Dec 2016

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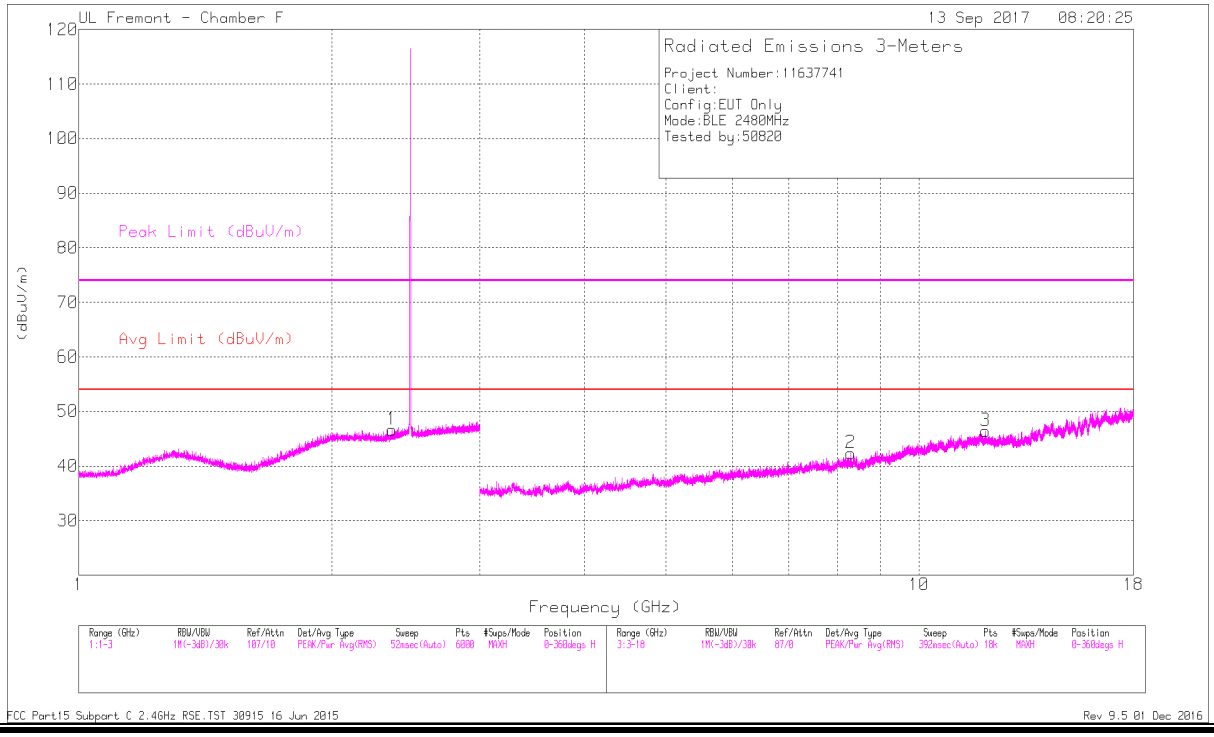
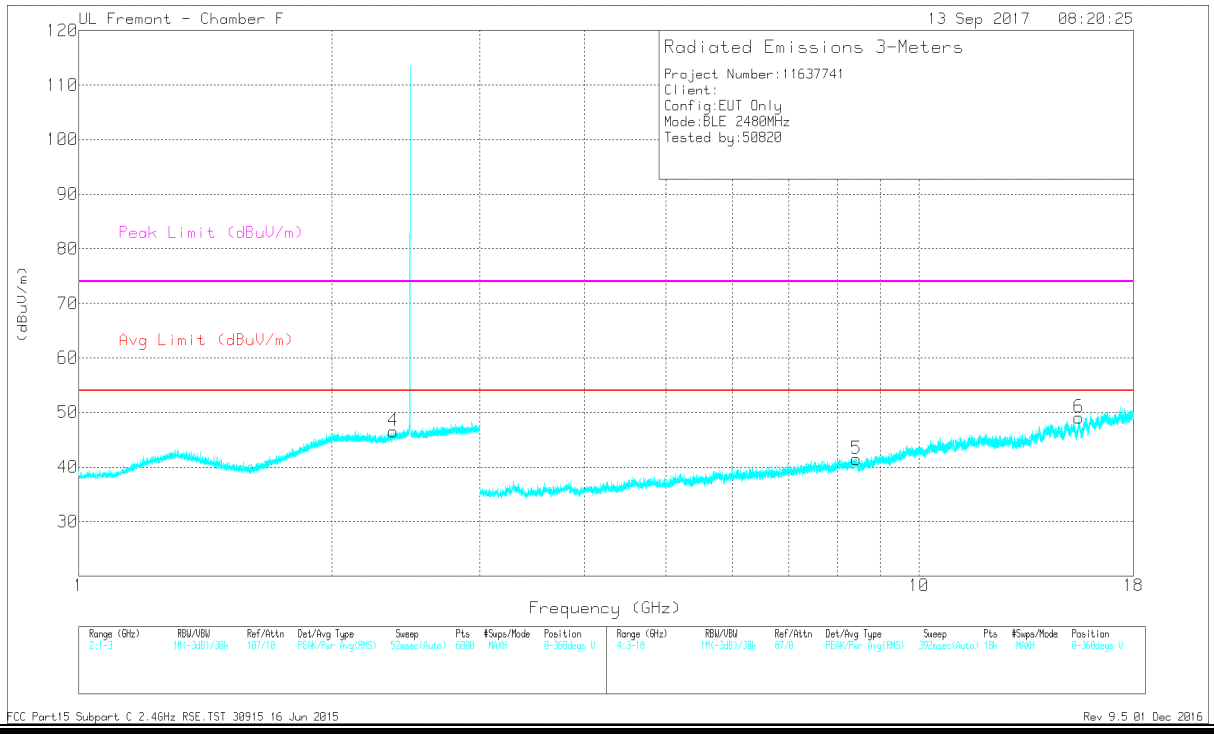
HIGH CHANNEL HORIZONTAL



HIGH CHANNEL VERTICAL



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Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.357	41.63	PK2	31.8	-21	52.43			74	-21.57	211	132	H
	* 2.357	30.45	MAv1	31.8	-21	41.25	54	-12.75	-	-	211	132	H
4	* 2.368	41.83	PK2	31.8	-20.9	52.73			74	-21.27	160	110	V
	* 2.365	30.45	MAv1	31.8	-20.9	41.35	54	-12.65	-	-	160	110	V
2	* 8.294	37.02	PK2	36.1	-24.5	48.62			74	-25.38	301	278	H
	* 8.293	25.51	MAv1	36.1	-24.5	37.11	54	-16.89	-	-	301	278	H
3	* 11.997	36.51	PK2	39.3	-22.5	53.31			74	-20.69	254	122	H
	* 11.997	24.74	MAv1	39.3	-22.5	41.54	54	-12.46	-	-	254	122	H
5	* 8.417	35.57	PK2	35.9	-23.5	47.97			74	-26.03	179	231	V
	* 8.42	24.86	MAv1	35.9	-23.6	37.16	54	-16.84	-	-	179	231	V
6	* 15.492	36.41	PK2	41.4	-22.3	55.51			74	-18.49	114	200	V
	* 15.493	25.62	MAv1	41.5	-22.3	44.82	54	-9.18	-	-	114	200	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average
FCC Part15 Subpart C 2.4GHz RSE.TST 30915 16 Jun 2015
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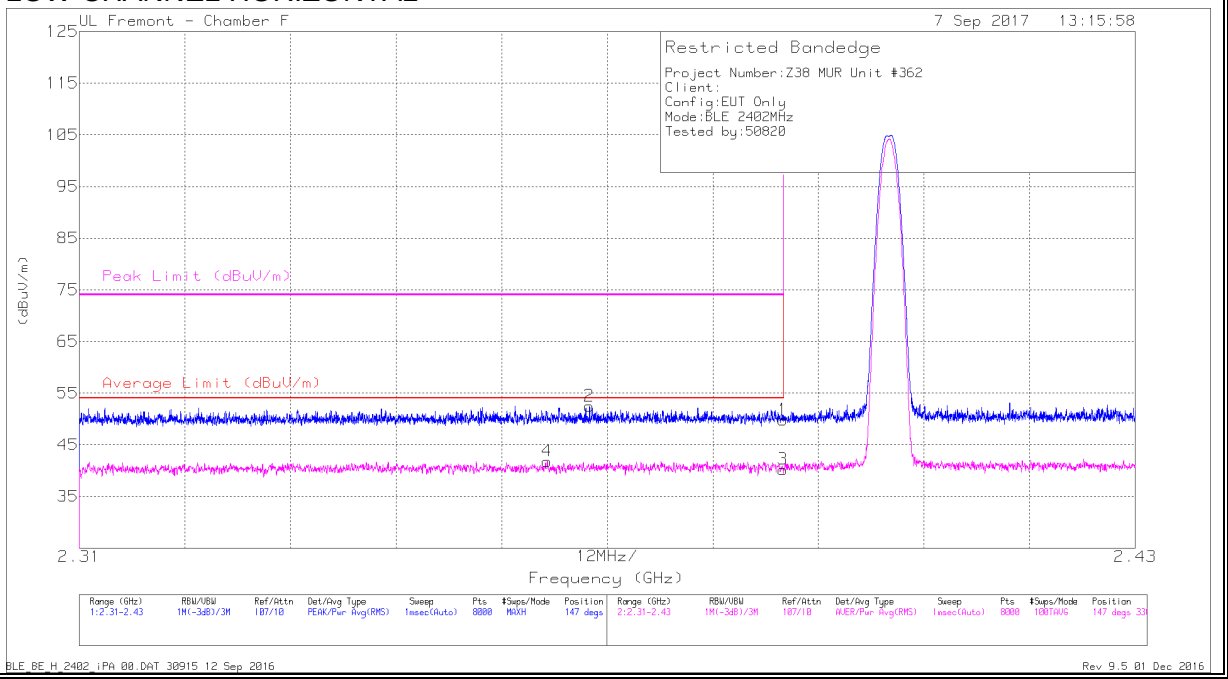
8.4. Antenna A Plow

8.4.1. RESTRICTED BANDEDGE (LOW CHANNEL)

LOW CHANNEL HORIZONTAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	38.93	Pk	31.9	-21	49.83	-	-	74	-24.17	147	336	H
2	* 2.368	41.61	Pk	31.8	-20.9	52.51	-	-	74	-21.49	147	336	H
3	* 2.39	29.33	RMS	31.9	-21	40.23	54	-13.77	-	-	147	336	H
4	* 2.363	31.01	RMS	31.8	-21	41.81	54	-12.19	-	-	147	336	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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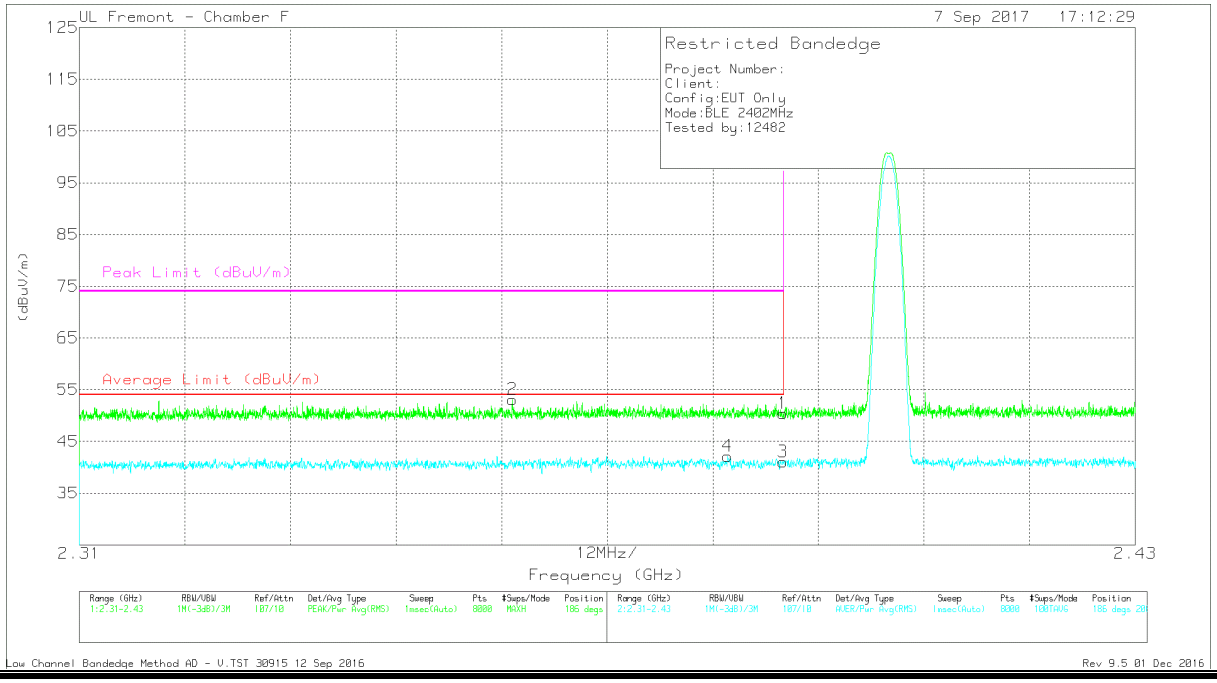
LOW CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	39.53	Pk	31.9	-21	50.43	-	-	74	-23.57	186	206	V
2	* 2.359	42.31	Pk	31.8	-21	53.11	-	-	74	-20.89	186	206	V
3	* 2.39	30.17	RMS	31.9	-21	41.07	54	-12.93	-	-	186	206	V
4	* 2.384	31.26	RMS	31.8	-20.9	42.16	54	-11.84	-	-	186	206	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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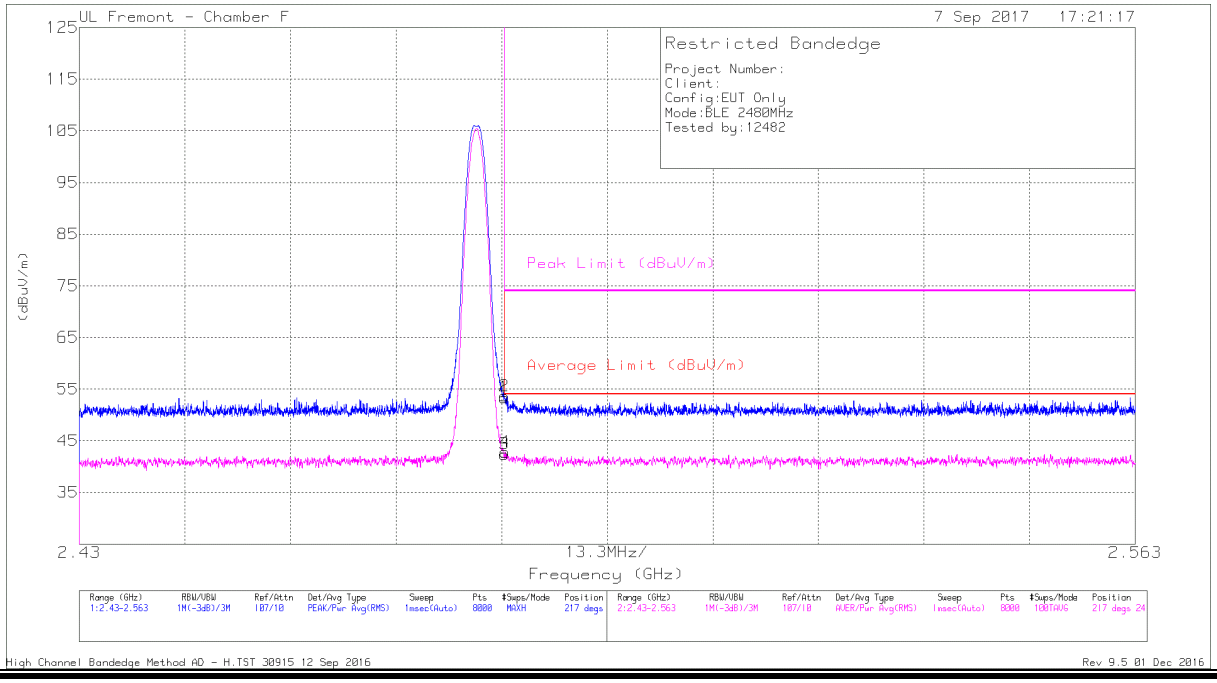
8.4.2. AUTHORIZED BANDEDGE (HIGH CHANNEL)

HIGH CHANNEL HORIZONTAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	42.26	Pk	32.1	-21	53.36	-	-	74	-20.64	217	241	H
2	* 2.484	42.57	Pk	32.1	-21	53.67	-	-	74	-20.33	217	241	H
3	* 2.484	31.32	RMS	32.1	-21	42.42	54	-11.58	-	-	217	241	H
4	* 2.484	31.72	RMS	32.1	-21	42.82	54	-11.18	-	-	217	241	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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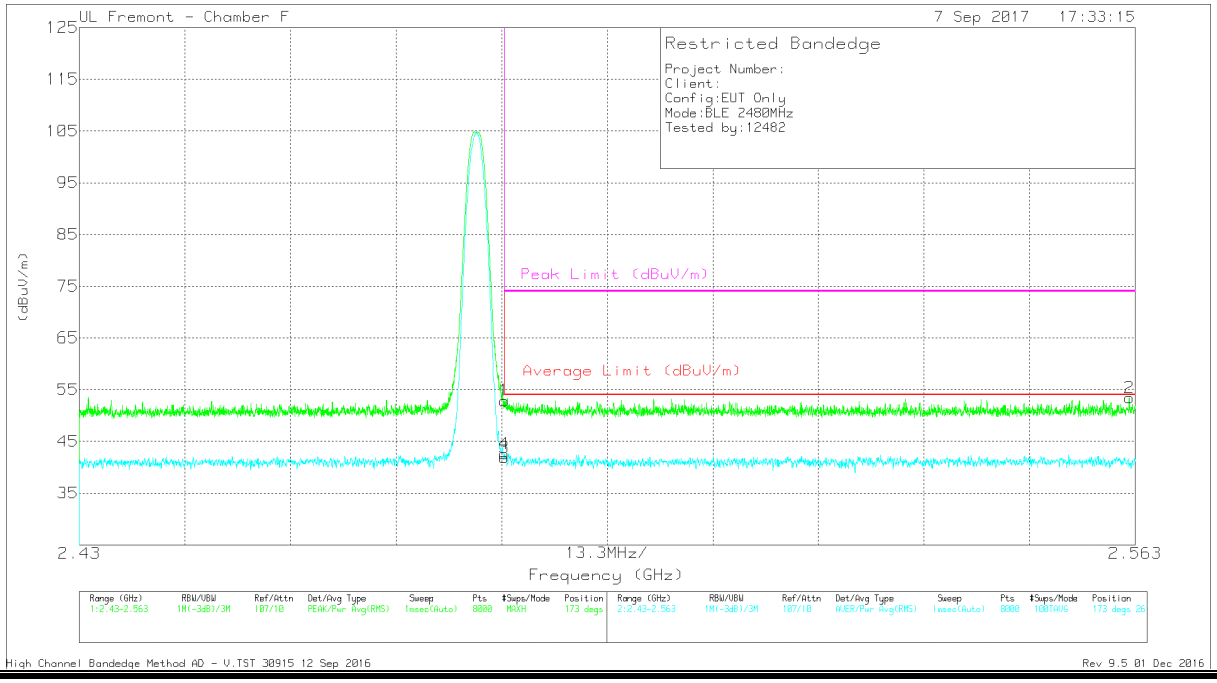
HIGH CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (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	41.79	Pk	32.1	-21	52.89	-	-	74	-21.11	173	267	V
2	2.562	42.12	Pk	32.2	-20.9	53.42	-	-	74	-20.58	173	267	V
3	* 2.484	30.76	RMS	32.1	-21	41.86	54	-12.14	-	-	173	267	V
4	* 2.484	31.5	RMS	32.1	-21	42.6	54	-11.4	-	-	173	267	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

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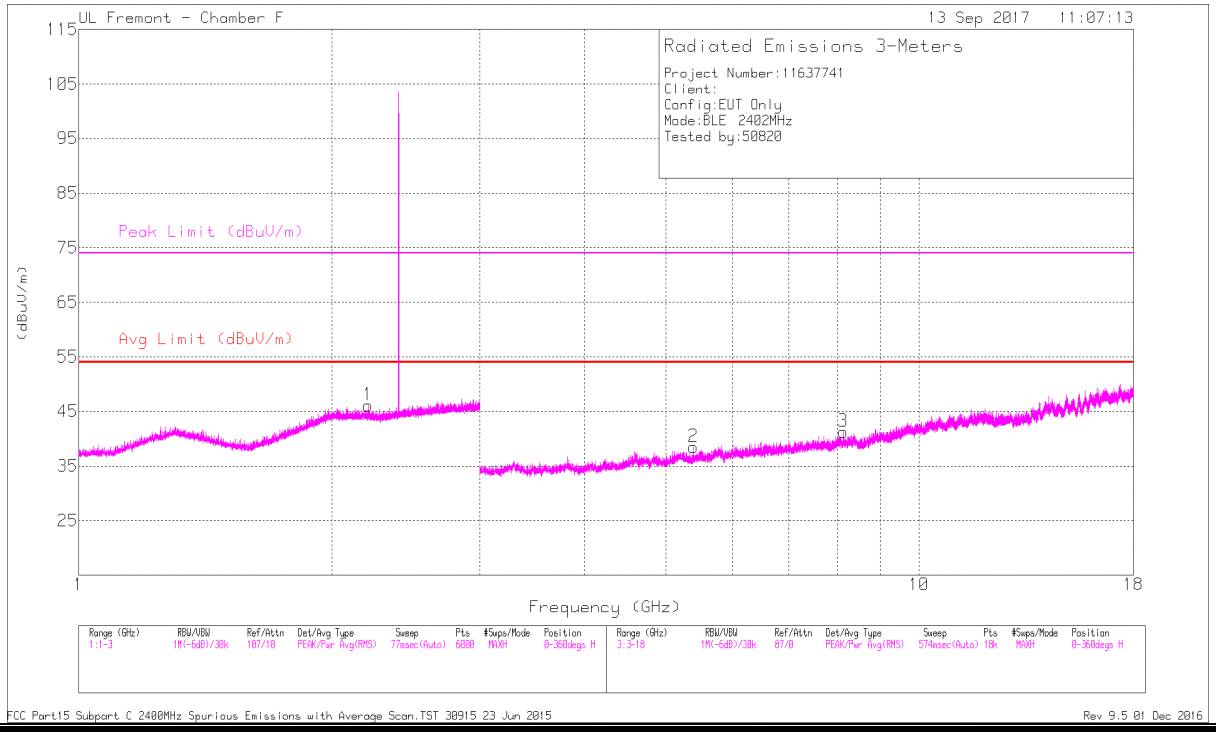
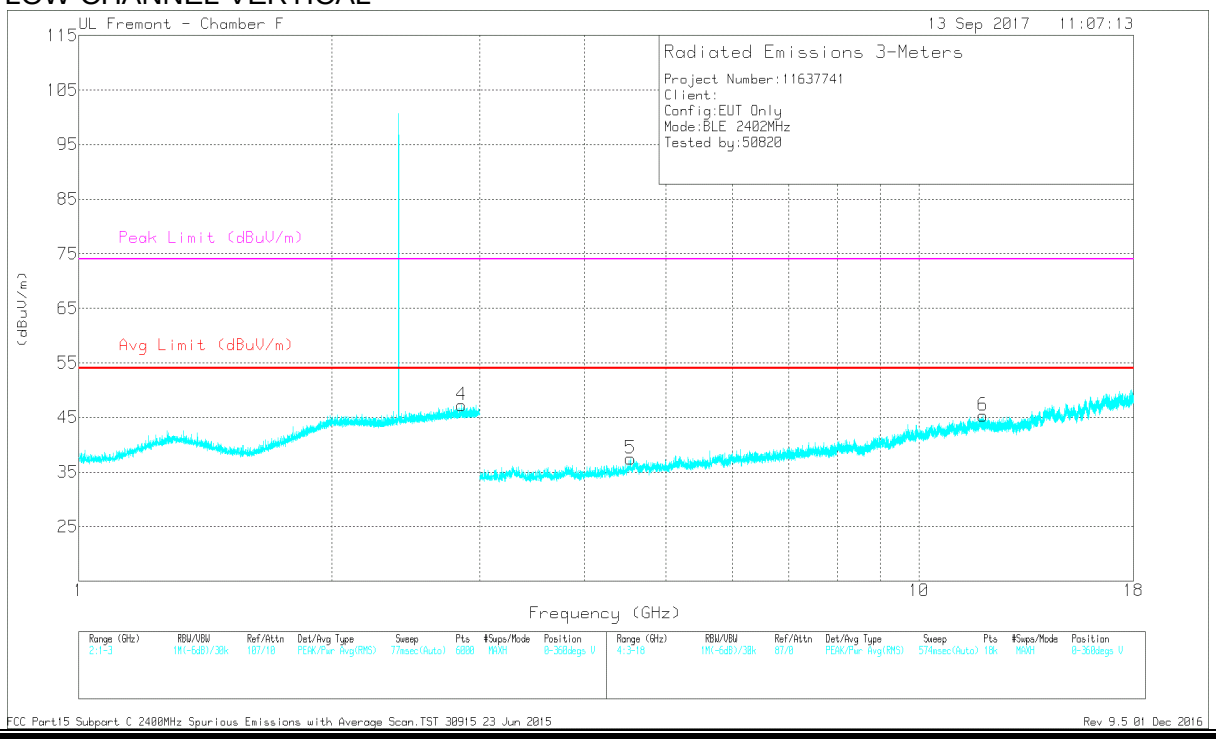
8.4.3. HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL HORIZONTAL



LOW CHANNEL VERTICAL



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Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.212	40.2	PK2	32	-21	51.2			74	-22.8	156	199	H
	* 2.209	28.76	MAv1	32	-21.1	39.66	54	-14.34	-	-	156	199	H
4	* 2.858	40.52	PK2	32.8	-20.4	52.92			74	-21.08	213	144	V
	* 2.859	28.65	MAv1	32.8	-20.4	41.05	54	-12.95	-	-	213	144	V
2	* 5.391	36.49	PK2	34.7	-27.7	43.49			74	-30.51	336	252	H
	* 5.392	25.65	MAv1	34.7	-27.7	32.65	54	-21.35	-	-	336	252	H
3	* 8.126	34.74	PK2	36.1	-24	46.84			74	-27.16	110	200	H
	* 8.124	23.57	MAv1	36.1	-24	35.67	54	-18.33	-	-	110	200	H
5	* 4.538	36.93	PK2	34.1	-27.8	43.23			74	-30.77	204	303	V
	* 4.535	25.94	MAv1	34.1	-27.8	32.24	54	-21.76	-	-	204	303	V
6	* 11.924	33.62	PK2	39	-22.1	50.52			74	-23.48	189	244	V
	* 11.922	22.65	MAv1	39	-22.1	39.55	54	-14.45	-	-	189	244	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

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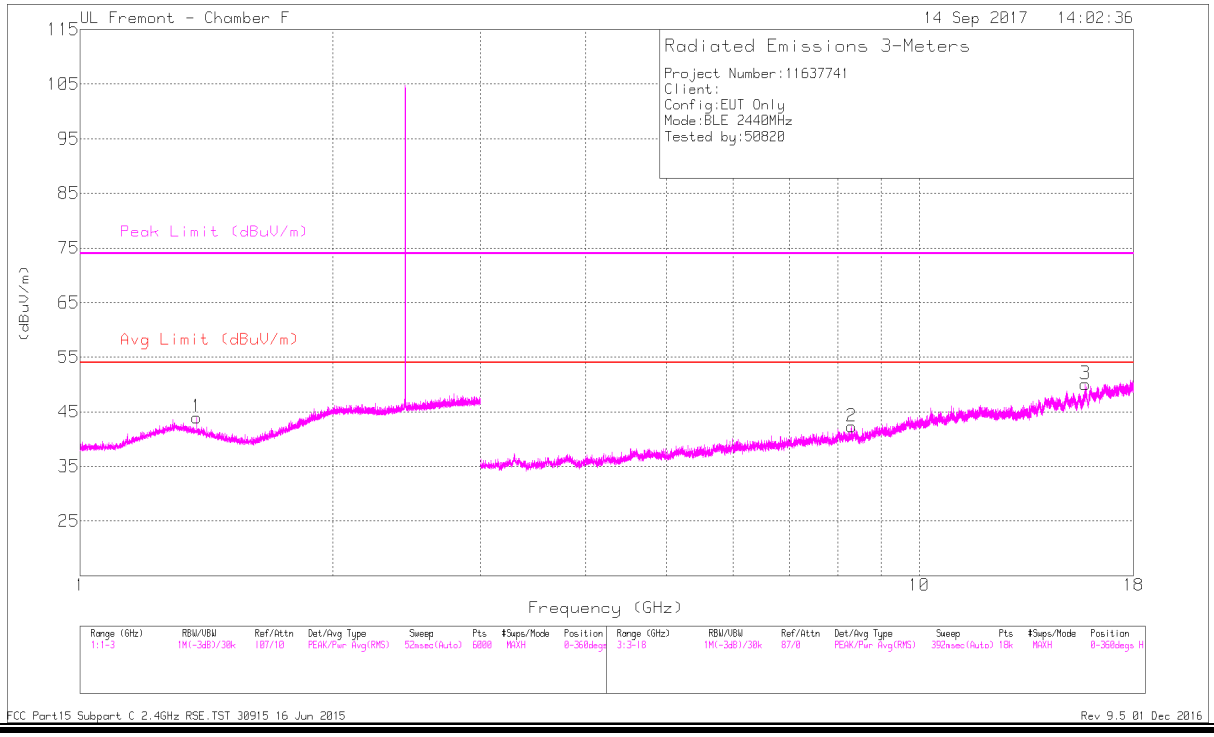
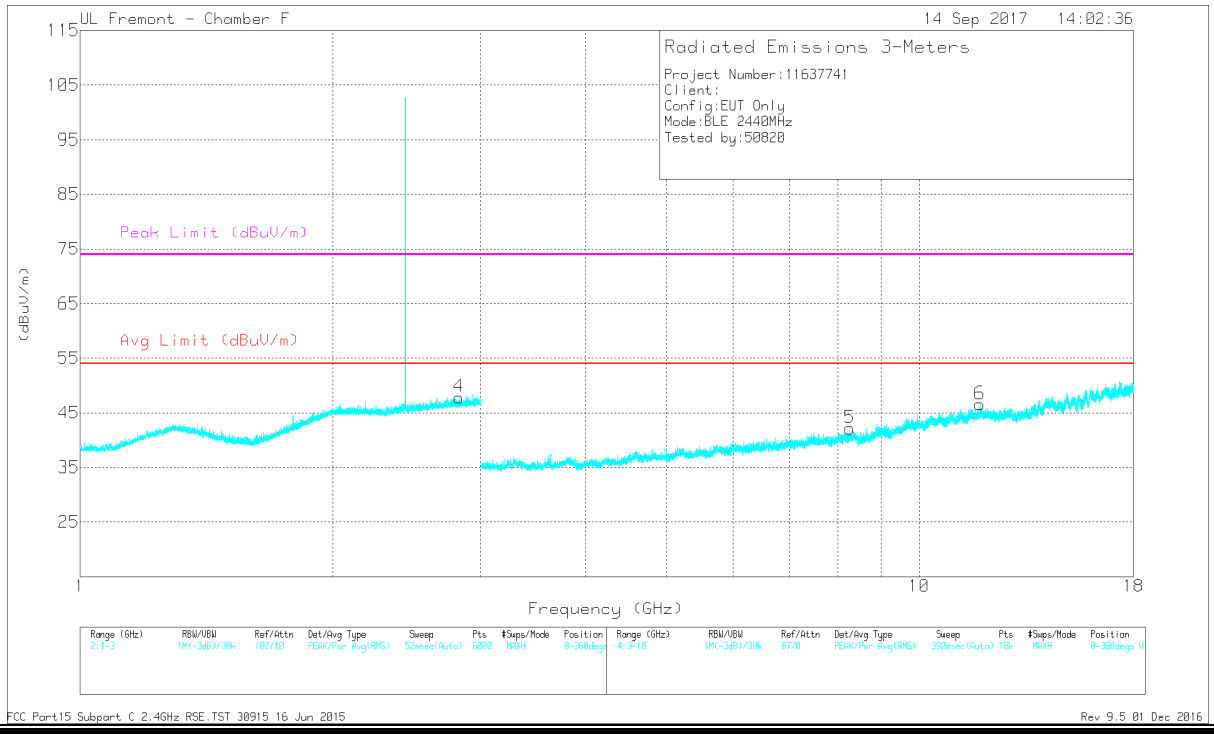
MID CHANNEL HORIZONTAL



MID CHANNEL VERTICAL



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Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.375	41.99	PK2	29.3	-22.1	49.19			74	-24.81	312	196	H
	* 1.378	30.54	MAv1	29.3	-22.1	37.74	-16.26	54	-	-	312	196	H
4	* 2.828	41.52	PK2	32.8	-20.4	53.92			74	-20.08	160	178	V
	* 2.828	30.11	MAv1	32.8	-20.4	42.51	-11.49	54	-	-	160	178	V
2	* 8.309	37.38	PK2	36	-24.4	48.98			74	-25.02	112	200	H
	* 8.311	25.62	MAv1	36	-24.5	37.12	-16.88	54	-	-	112	200	H
3	* 15.774	36.45	PK2	41.9	-22.3	56.05			74	-17.95	263	315	H
	* 15.777	25.36	MAv1	41.9	-22.3	44.96	-9.04	54	-	-	263	315	H
5	* 8.269	36.87	PK2	36.1	-24.4	48.57			74	-25.43	249	163	V
	* 8.27	25.53	MAv1	36.1	-24.4	37.23	-16.77	54	-	-	249	163	V
6	* 11.815	35.66	PK2	39	-21.6	53.06			74	-20.94	260	345	V
	* 11.817	24.42	MAv1	39	-21.6	41.82	-12.18	54	-	-	260	345	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average
FCC Part15 Subpart C 2.4GHz RSE.TST 30915 16 Jun 2015
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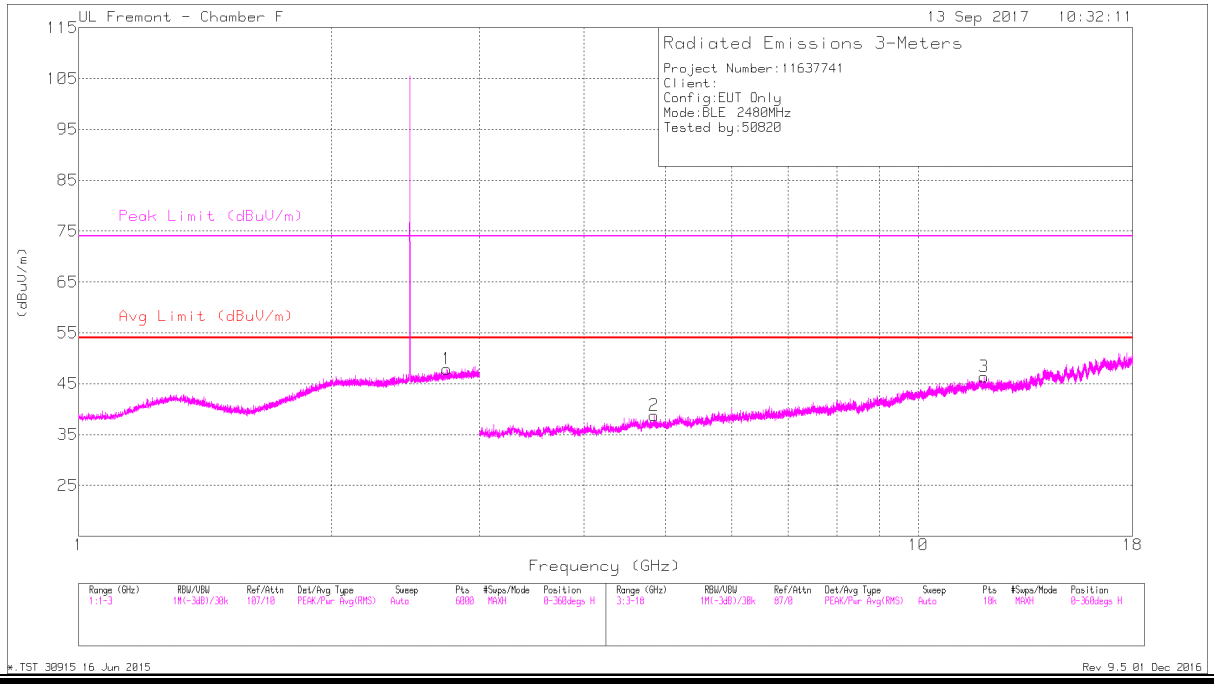
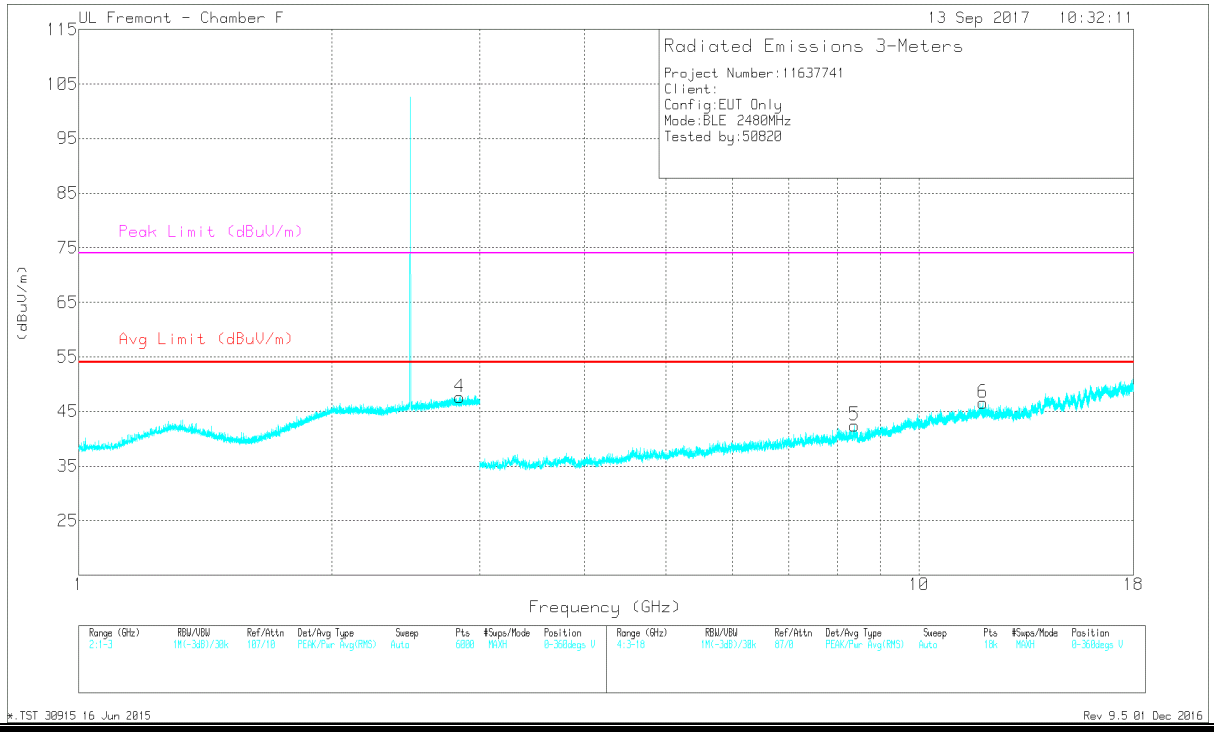
HIGH CHANNEL HORIZONTAL



HIGH CHANNEL VERTICAL



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Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.746	42.15	PK2	32.6	-20.6	54.15			74	-19.85	155	200	H
	* 2.747	30.38	MAv1	32.6	-20.6	42.38	-11.62	54	-	-	155	200	H
4	* 2.842	41.74	PK2	32.8	-20.5	54.04			74	-19.96	219	167	V
	* 2.844	30.16	MAv1	32.8	-20.4	42.56	-11.44	54	-	-	219	167	V
2	* 4.846	37.94	PK2	34.2	-27.4	44.74			74	-29.26	284	301	H
	* 4.845	26.99	MAv1	34.2	-27.4	33.79	-20.21	54	-	-	284	301	H
3	* 11.986	35.9	PK2	39.2	-22.5	52.6			74	-21.4	143	218	H
	* 11.987	24.7	MAv1	39.3	-22.5	41.5	-12.50	54	-	-	143	218	H
5	* 8.377	36.19	PK2	36	-23.5	48.69			74	-25.31	89	188	V
	* 8.378	25.1	MAv1	36	-23.5	37.6	-16.40	54	-	-	89	188	V
6	* 11.919	35.76	PK2	39	-22	52.76			74	-21.24	305	222	V
	* 11.918	24.11	MAv1	39	-22	41.11	-12.89	54	-	-	305	222	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average
*.TST 30915 16 Jun 2015
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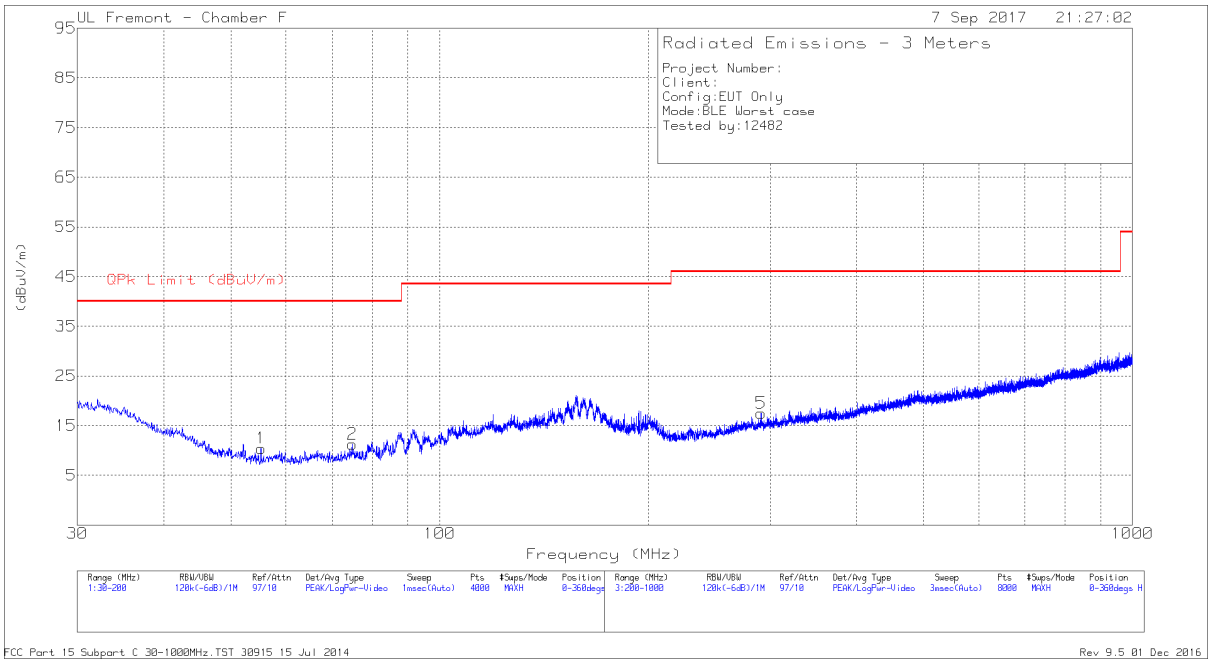
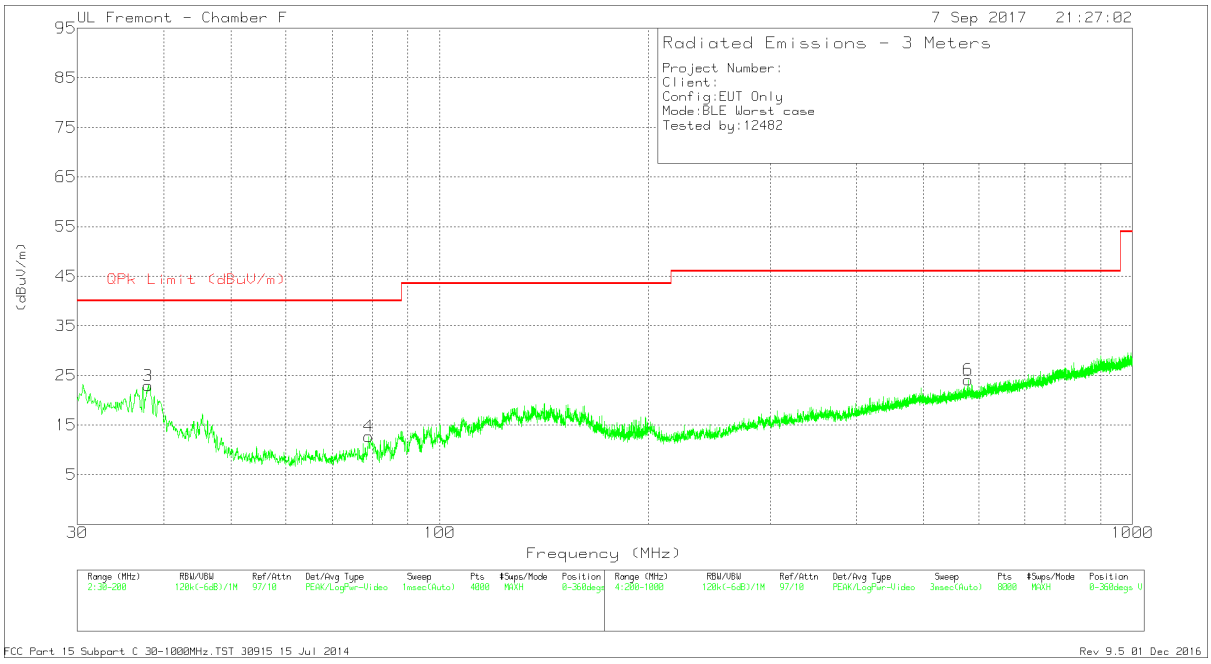
8.5. WORST-CASE BELOW 1 GHz

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

HORIZONTAL PLOT



VERTICAL PLOT



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DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T122 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	55.2515	30.15	Pk	11.9	-31.6	10.45	40	-29.55	0-360	99	H
2	* 74.8066	30.79	Pk	11.9	-31.4	11.29	40	-28.71	0-360	399	H
3	* 37.9921	35.55	Pk	19.1	-31.7	22.95	40	-17.05	0-360	100	V
4	79.0364	32.3	Pk	11.7	-31.3	12.7	40	-27.3	0-360	100	V
5	291.2119	30.02	Pk	17.4	-29.9	17.52	46.02	-28.5	0-360	199	H
6	579.9494	30.12	Pk	22.7	-28.7	24.12	46.02	-21.9	0-360	100	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

FCC Part15C 30-1000MHz.TST 30915 15 Jul 2014
Rev 9.5 01 Dec 2016

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888

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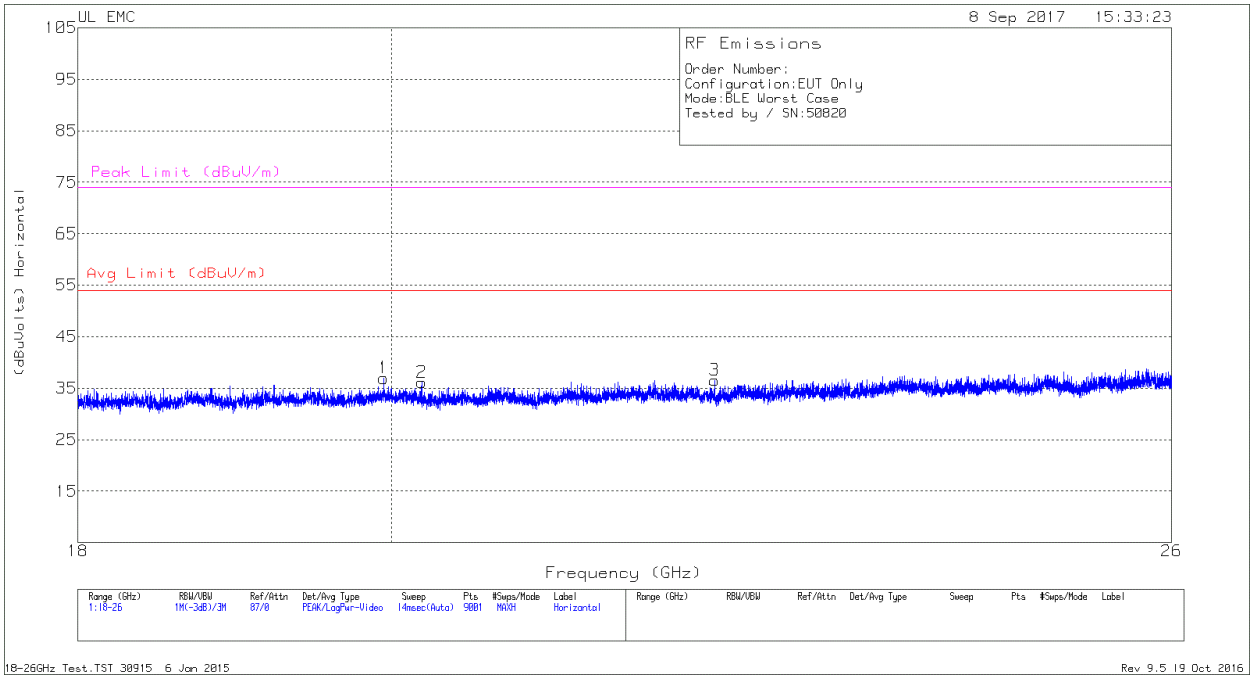
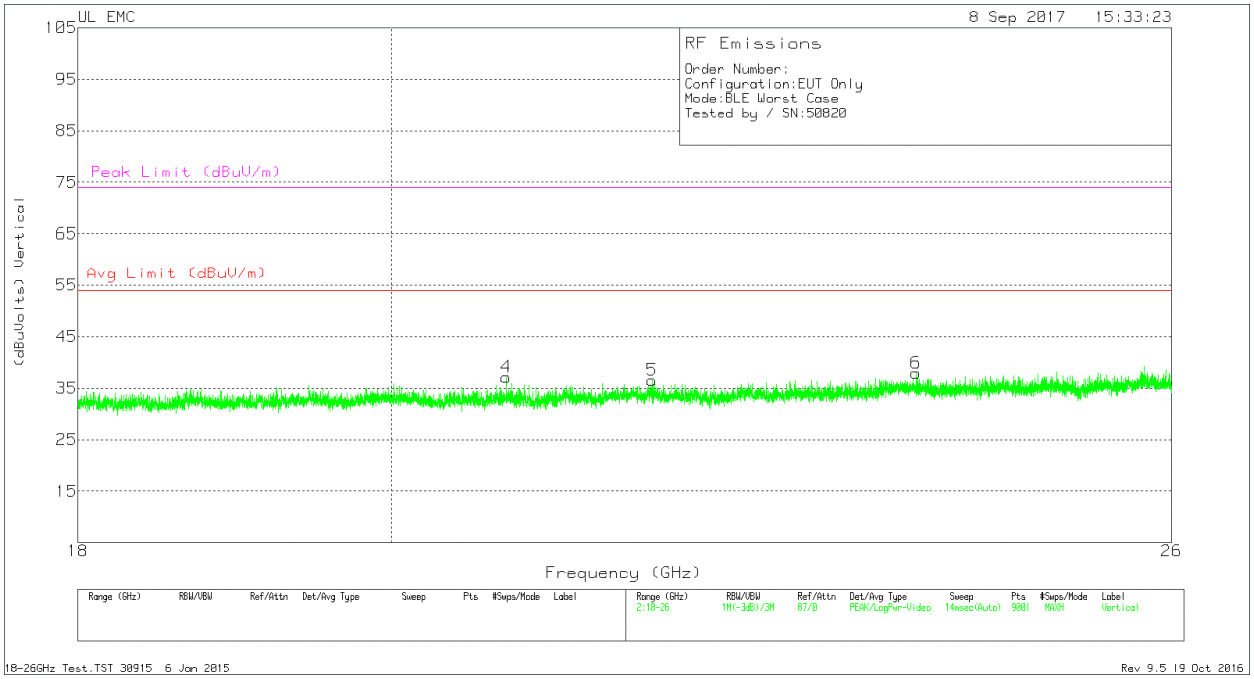
8.6. WORST-CASE ABOVE 18 GHz

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

HORIZONTAL PLOT



VERTICAL PLOT



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Data

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	19.948	38.65	Pk	32.9	-25.1	-9.5	36.95	54	-17.05	74	-37.05
2	20.207	38.35	Pk	32.6	-25.3	-9.5	36.15	54	-17.85	74	-37.85
3	22.297	38.13	Pk	32.8	-24.9	-9.5	36.53	54	-17.47	74	-37.47
4	20.788	38.72	Pk	32.7	-24.8	-9.5	37.12	54	-16.88	74	-36.88
5	21.832	37.62	Pk	33.3	-24.9	-9.5	36.52	54	-17.48	74	-37.48
6	23.86	38.07	Pk	33.5	-24.1	-9.5	37.97	54	-16.03	74	-36.03

Pk - Peak detector

18-26GHz Test.TST 30915 6 Jan 2015

Rev 9.5 19 Oct 2016

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8.7. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

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

*Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

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

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

RESULTS

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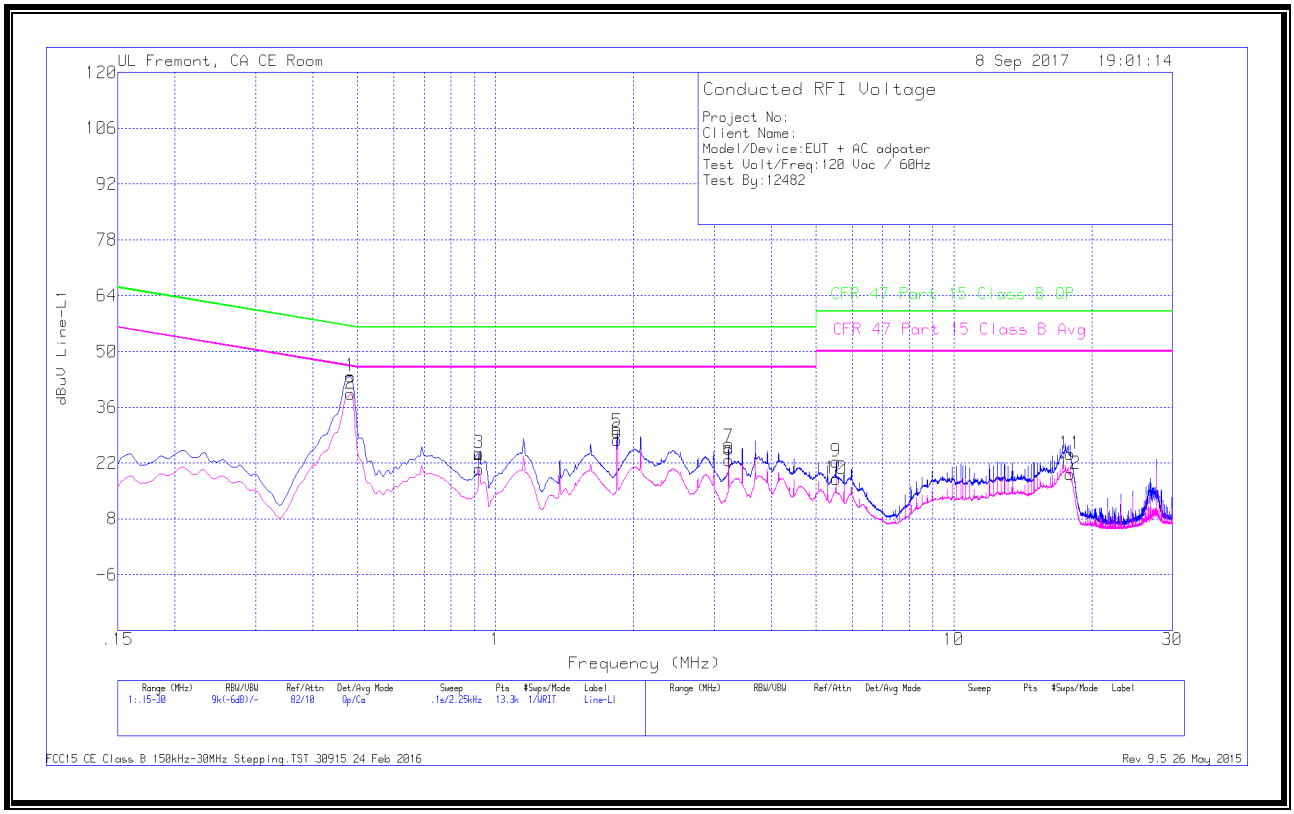
8.8. EUT POWERED BY AC/DC ADAPTER

LINE 1 RESULTS



WORST EMISSIONS

Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
1	.483	33.54	Qp	0	.1	10.1	43.74	56.29	-12.55	-	-
2	.483	29.16	Ca	0	.1	10.1	39.36	-	-	46.29	-6.93
3	.92175	14.27	Qp	0	.1	10.1	24.47	56	-31.53	-	-
4	.92175	10.22	Ca	0	.1	10.1	20.42	-	-	46	-25.58
5	1.84425	19.56	Qp	0	.1	10.1	29.76	56	-26.24	-	-
6	1.84425	17.57	Ca	0	.1	10.1	27.77	-	-	46	-18.23
7	3.22575	15.89	Qp	0	.1	10.1	26.09	56	-29.91	-	-
8	3.22575	12.52	Ca	0	.1	10.1	22.72	-	-	46	-23.28
9	5.532	12.1	Qp	0	.1	10.1	22.3	60	-37.7	-	-
10	5.532	7.86	Ca	0	.1	10.1	18.06	-	-	50	-31.94
11	17.9273	13.71	Qp	0	.3	10.3	24.31	60	-35.69	-	-
12	17.9273	8.69	Ca	0	.3	10.3	19.29	-	-	50	-30.71

Qp - Quasi-Peak detector

Ca - CISPR average detection

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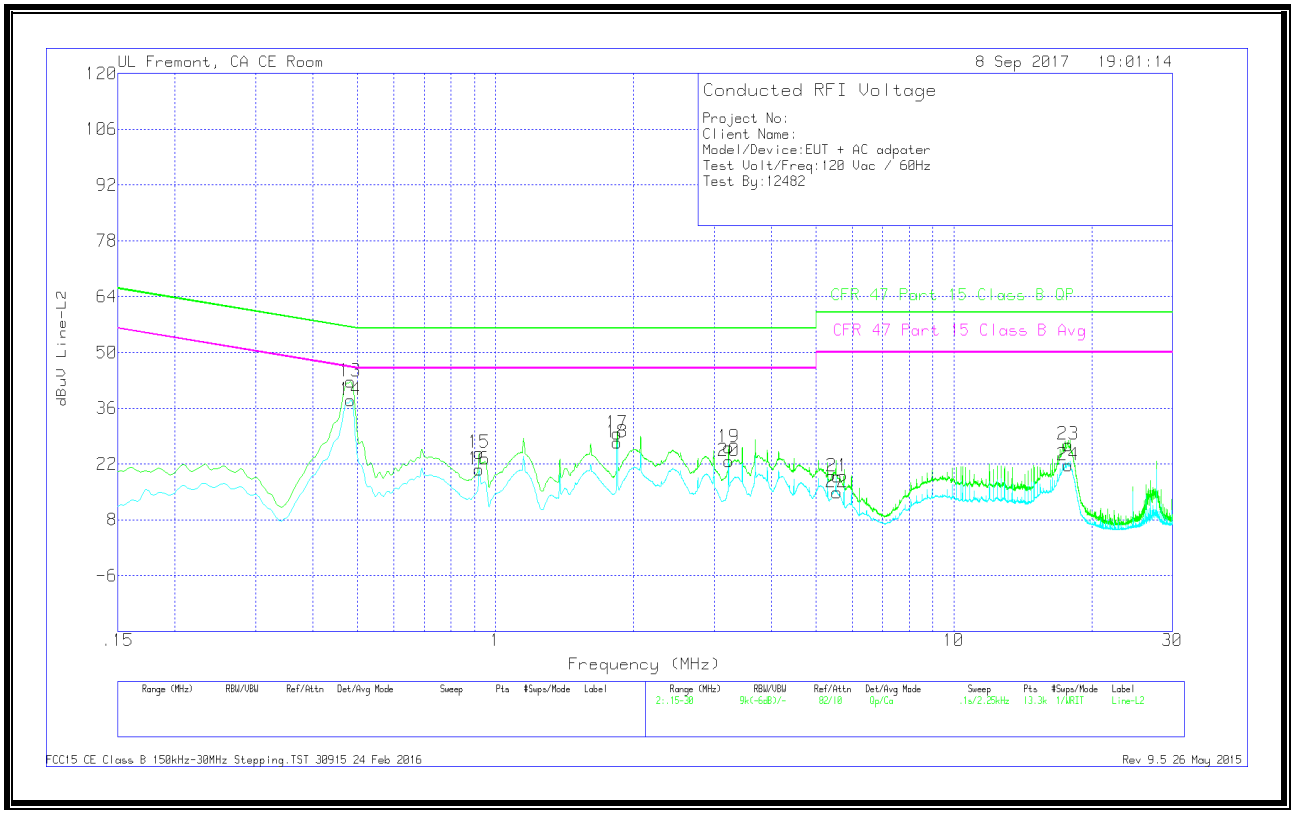
LINE 2 RESULTS



WORST EMISSIONS

Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L2	LC Cables C2&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
13	.483	32.47	Qp	0	.1	10.1	42.67	56.29	-13.62	-	-
14	.483	27.86	Ca	0	.1	10.1	38.06	-	-	46.29	-8.23
15	.92175	14.55	Qp	0	.1	10.1	24.75	56	-31.25	-	-
16	.92175	10.38	Ca	0	.1	10.1	20.58	-	-	46	-25.42
17	1.842	19.41	Qp	0	.1	10.1	29.61	56	-26.39	-	-
18	1.842	17.27	Ca	0	.1	10.1	27.47	-	-	46	-18.53
19	3.228	15.92	Qp	0	.1	10.1	26.12	56	-29.88	-	-
20	3.228	12.53	Ca	0	.1	10.1	22.73	-	-	46	-23.27
21	5.5635	8.74	Qp	0	.1	10.1	18.94	60	-41.06	-	-
22	5.56238	4.61	Ca	0	.1	10.1	14.81	-	-	50	-35.19
23	17.7743	16.2	Qp	0	.3	10.3	26.8	60	-33.2	-	-
24	17.7585	11.06	Ca	0	.3	10.3	21.66	-	-	50	-28.34

Qp - Quasi-Peak detector

Ca - CISPR average detection

END OF REPORT

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