CERTIFICATION TEST REPORT

Report Number. : 12458150-E5V4

Applicant	:	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
Model	:	A2032
FCC ID	:	BCG-A2032
IC	:	579C-A2032
EUT Description	:	BLUETOOTH EARBUD
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5

Date Of Issue:
March 21, 2019

Prepared by:
UL Verification Services Inc.
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NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	12/11/18	Initial Issue	Francisco Guarnero
V2	02/07/2019	Updated ETU name and phone #	Tony Li
V3	02/11/2019	Updated Client's Request Section 8.4 & 8.5	Tony Li
V4	03/21/2019	Corrected model number for Support Equipment Charger case	Chin Pang

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: BLUETOOTH EARBUD

MODEL: A2032

SERIAL NUMBER: GFHX403EJJNW

DATE TESTED: AUGUST 15, 2018 – DECEMBER 10, 2018

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

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 the U.S. government.

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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 v05, ANSI C63.10-2013, RSS-GEN Issue 5, 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, and 47658 Kato Road, 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	47658 Kato Rd
☐ Chamber A (ISED:2324B-1)	☒ Chamber D (ISED:22541-1)	☐ Chamber K (ISED:2324A-1)
☐ Chamber B (ISED:2324B-2)	☒ Chamber E (ISED:22541-2)	☐ Chamber L (ISED:2324A-3)
☐ Chamber C (ISED:2324B-3)	☐ Chamber F (ISED:22541-3)	
	☐ Chamber G (ISED:22541-4)	
	☐ Chamber H (ISED:22541-5)	

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through C are covered under ISED company address code 2324B with site numbers 2324B -1 through 2324B-3, respectively. Chambers D through H are covered under ISED company address code 22541 with site numbers 22541 -1 through 22541-5, respectively. Chambers K and L are covered under ISED company address code 2324A with site numbers 2324A-1 and 2324A-3, respectively.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

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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

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

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5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The EUT is a Bluetooth earbud for the right ear. It has an integral battery, microphone and antenna. It can charge via bottom contacts with charging case. It is designed to work in conjunction with left earbud.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	BLE	9.84	9.64

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	Ant 1 (dBi)
2.4	-7.2

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 1A610.

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

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

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5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	Macbook Pro	C02P41RZG086	FCC DoC
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
EUT AC Adapter	Apple	A1385	D292365CDYADHLHC3	NA
Charger Case	Apple	A1602	DLCWV47HJMMT	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	2	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
NA						

I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Un-shielded	1	N/A

TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

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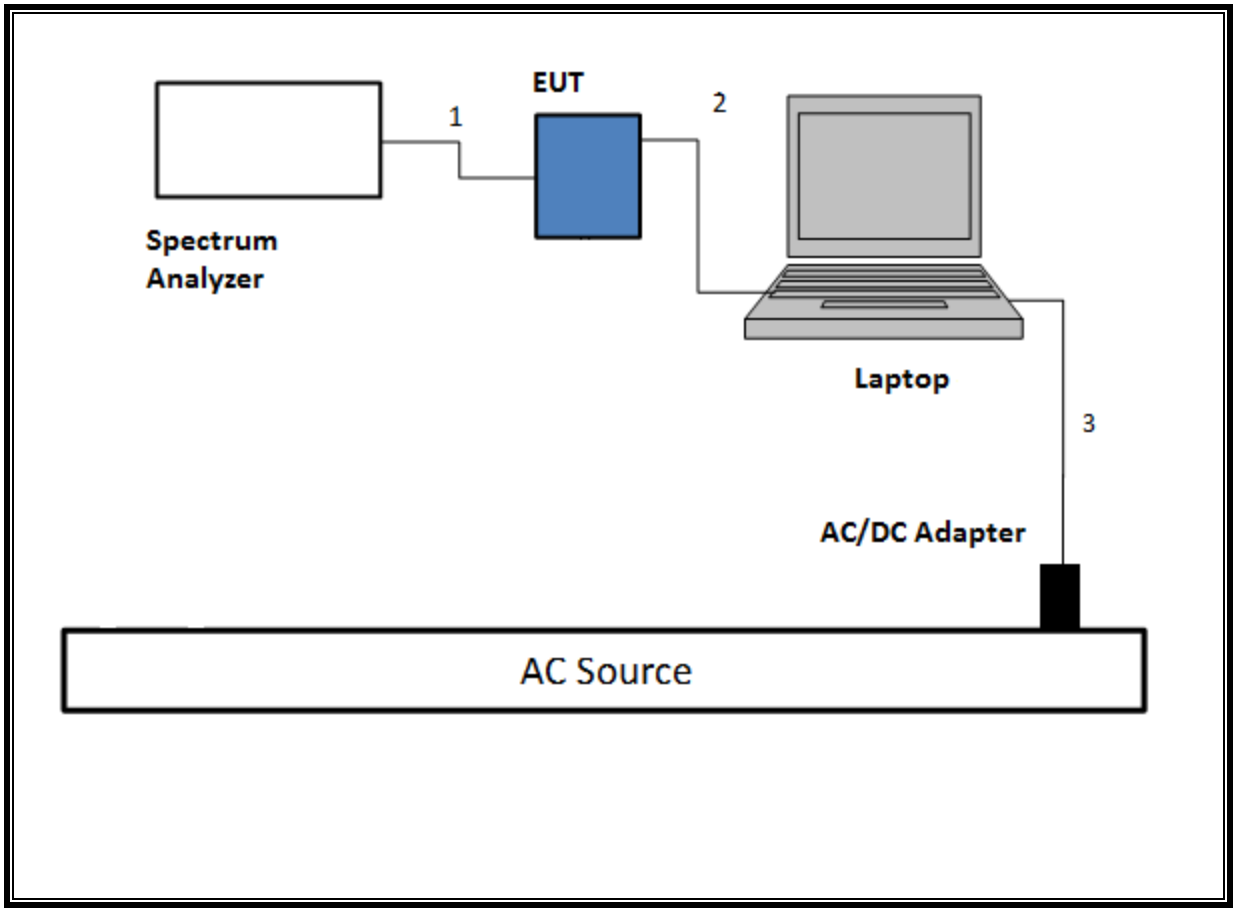
SETUP DIAGRAM FOR CONDUCTED TESTS



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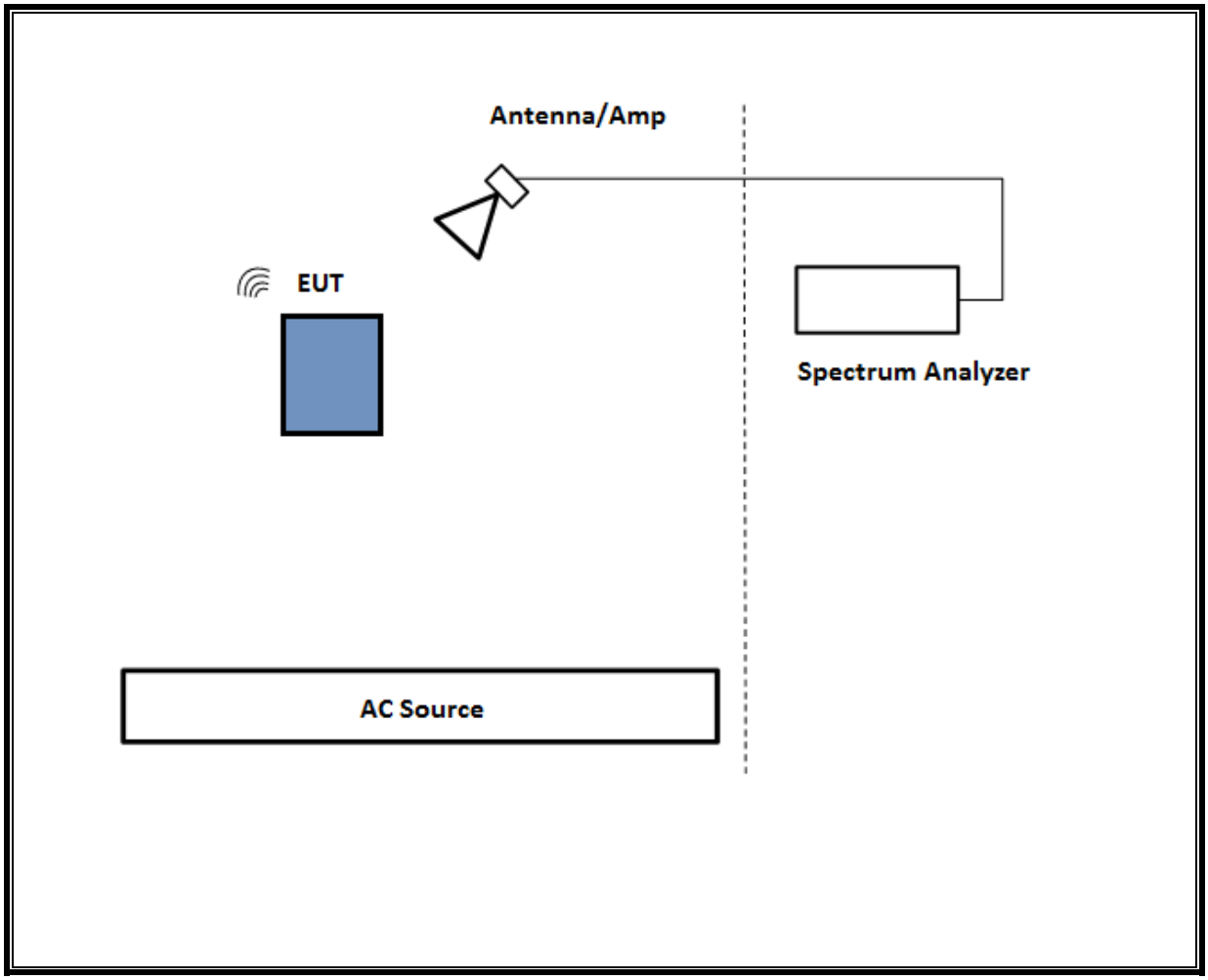
SETUP DIAGRAM FOR RADIATED TESTS ABOVE 1GHz



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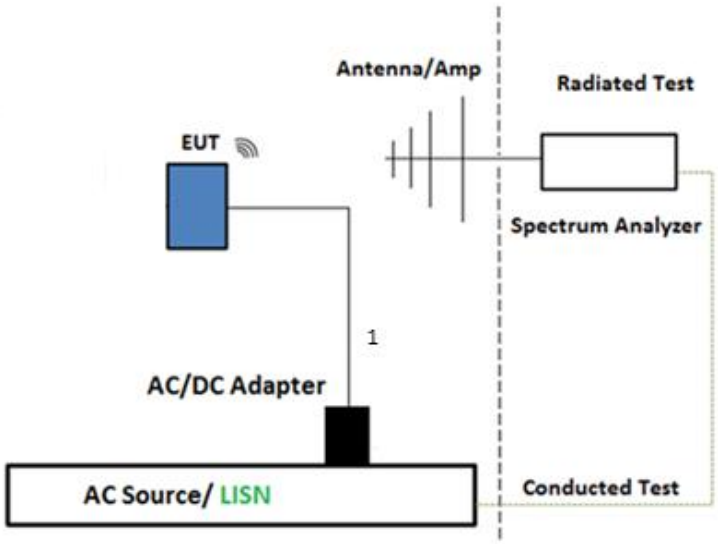
SETUP DIAGRAM FOR BELOW 1GHz and AC LINE CONDUCTED TEST



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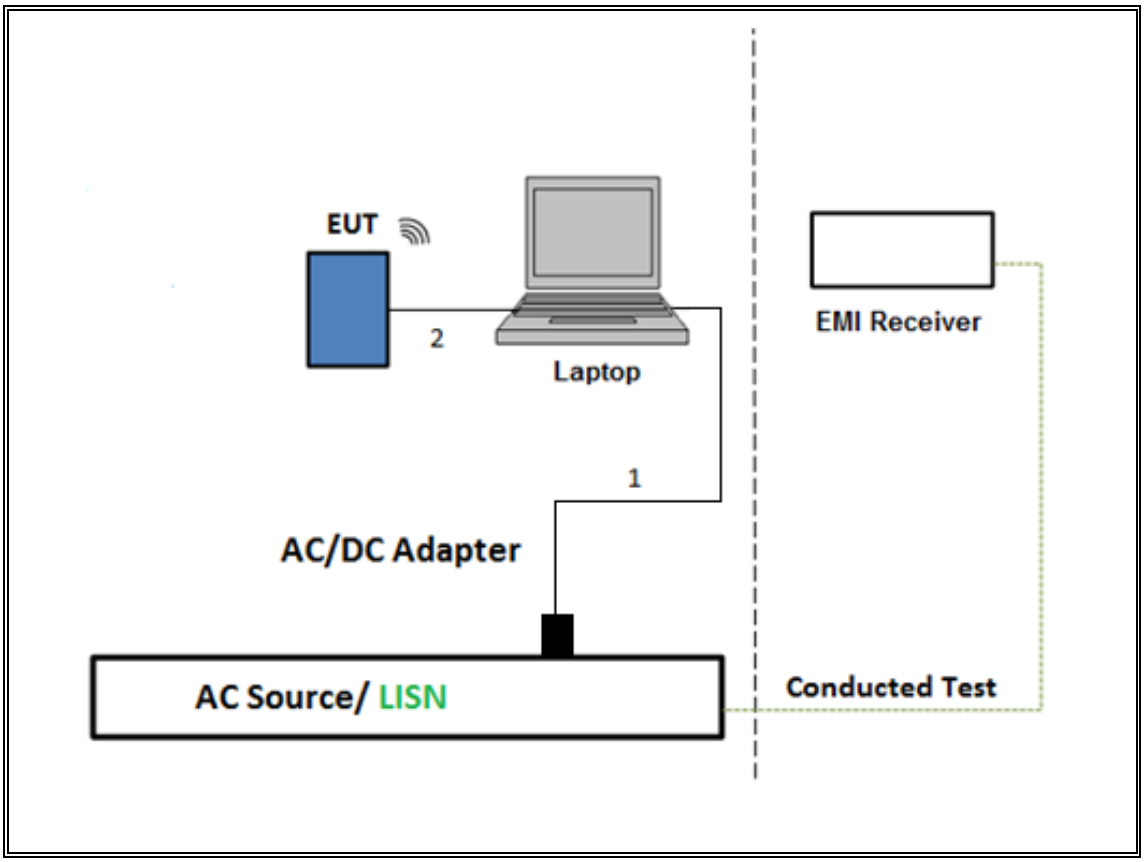
TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



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6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 558074 D01 v05, Section 6.

6 dB BW: KDB 558074 D01 v05, Section 8.1.

Output Power: KDB 558074 D01 v05, Section 9.1.3.

Power Spectral Density: KDB 558074 D01 v05, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v05, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v05, Section 12.1.

Band-edge: KDB 558074 D01 v05, Section 12.1.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

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7. 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**	**ID Num**	**Cal Due**
Amplifier, 10KHz to 1GHz, 32dB	Sonoma Instrument Co.	310	T286	06/04/2019
Amplifier, 10KHz to 1GHz, 32dB	Sonoma Instrument Co.	310	T285	07/06/2019
Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T740	10/06/2019
Amplifier, 1 to 18GHz, 35dB	AMPLICAL	AMP1G18-35	138301	09/15/2019
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB3	T899	07/24/2019
Antenna, Broadband Hybrid, 30MHz to 2000MHz w/4dB Pad	Sunol Sciences Corp.	JB3	T477	07/24/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T712	02/08/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T119	04/03/2019
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T227	10/29/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T341	09/26/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T907	02/07/2019
Thermo-Hygrometer	EXTECH	445703	T1007	09/18/2019
Thermometer	Control Company	14-650-118, 15557603	T1816	01/11/2019
True RMS Multi Meter	Fluke Corporation	87V	T360	04/30/2019
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	01/25/2019
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2019
**LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/19/2019
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016	
Conducted Software	UL	UL EMC	Ver 8.7, August 9, 2018	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

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8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

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)
2.4GHz Band						
BLE	100.000	100.000	1.000	100.00%	0.00	0.010

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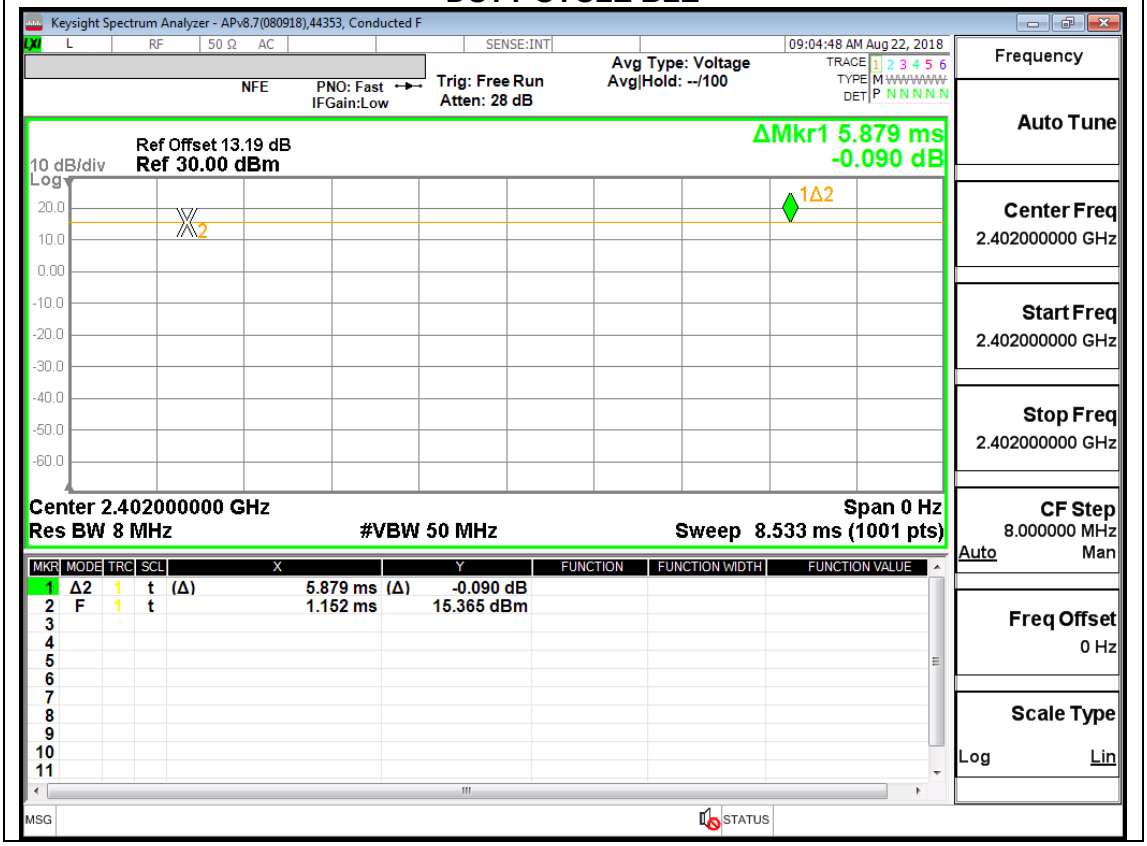
DUTY CYCLE PLOTS

DUTY CYCLE BLE



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8.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

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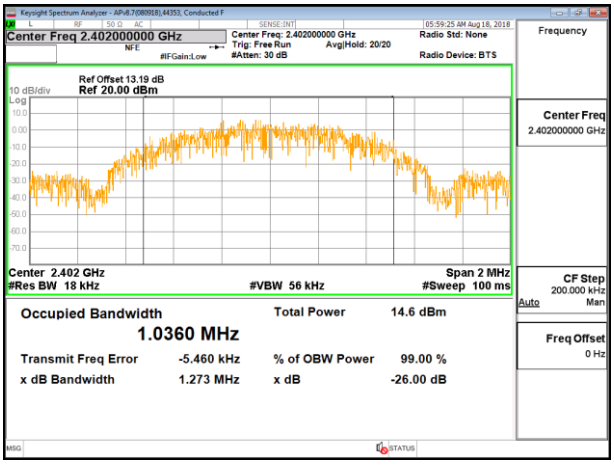
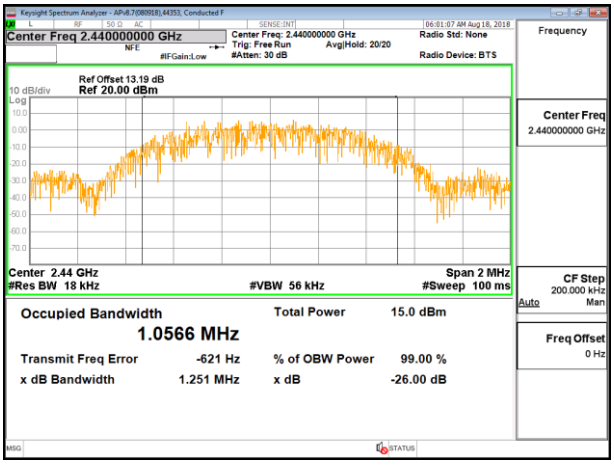
8.2.1. BLE (1Mbps)

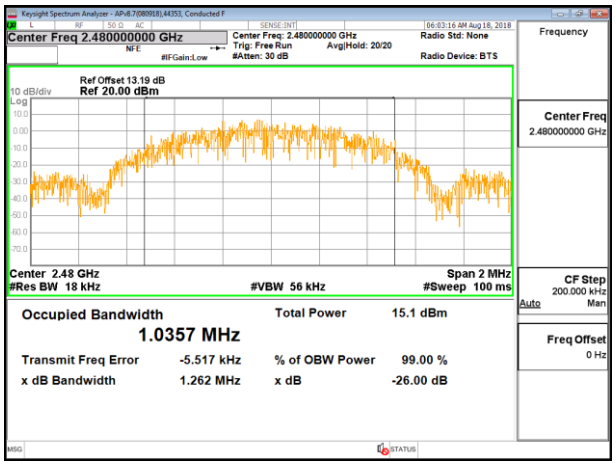
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0360
Middle	2440	1.0566
High	2480	1.0357



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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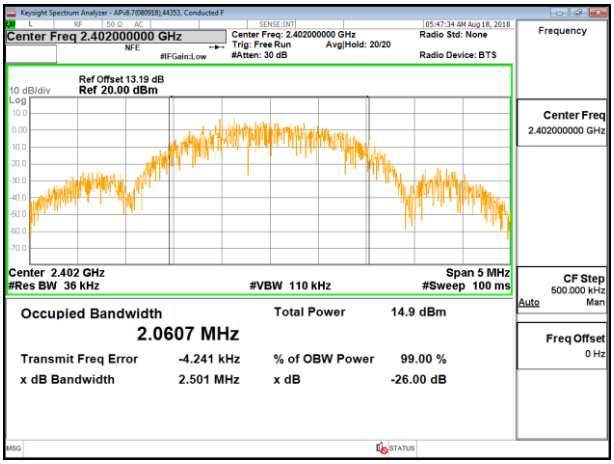
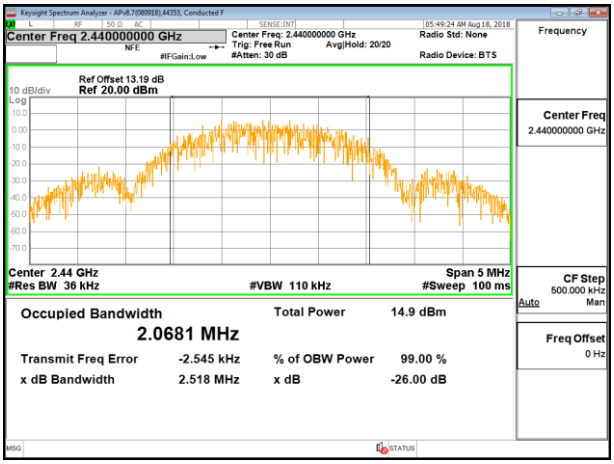
8.2.2. BLE (2Mbps)

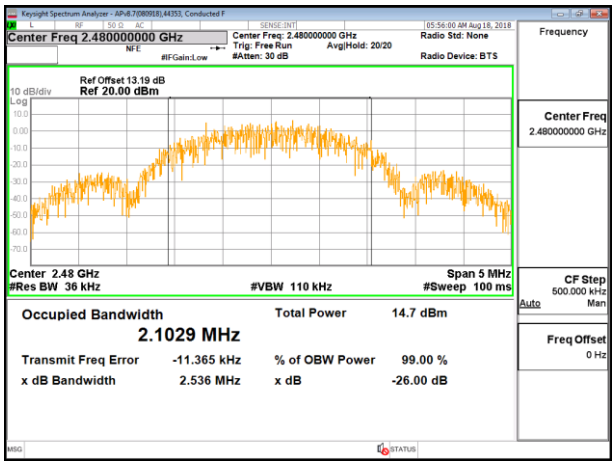
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.0607
Middle	2440	2.0681
High	2478	2.1029



LOW CHANNEL



MID CHANNEL



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8.3. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

RSS-247 5.2 (a)

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

RESULTS

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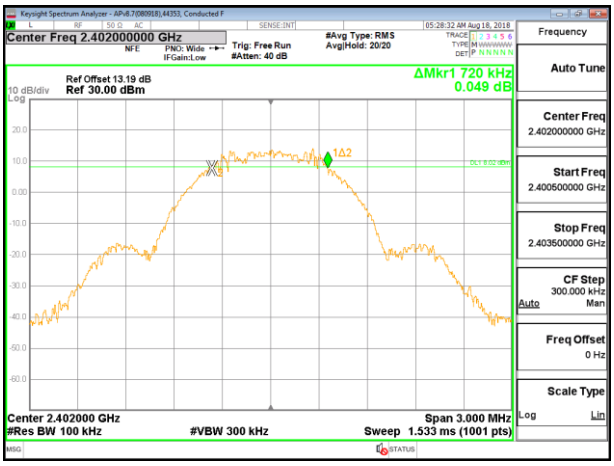
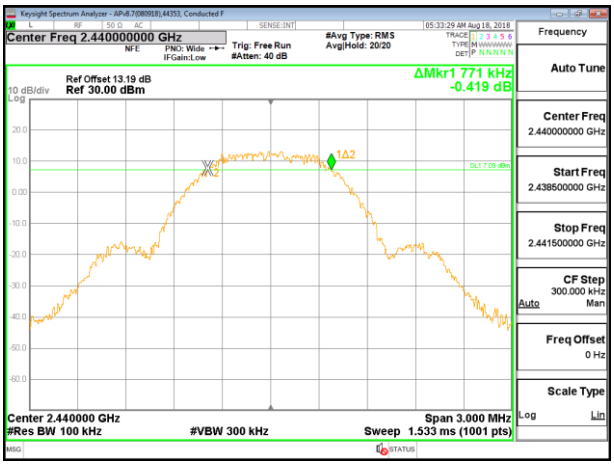
8.3.1. BLE (1Mbps)

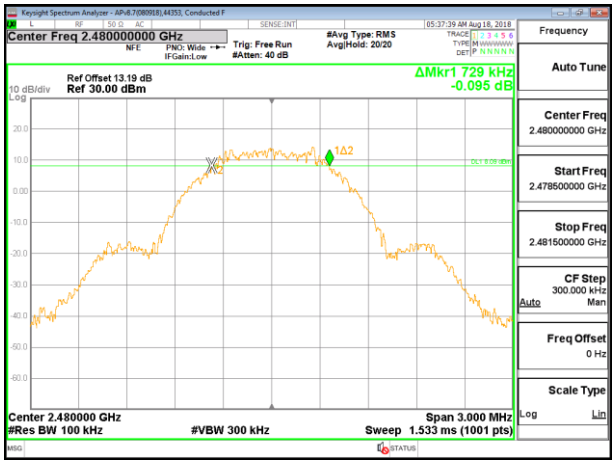
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.7200	0.5
Middle	2440	0.7710	0.5
High	2480	0.7290	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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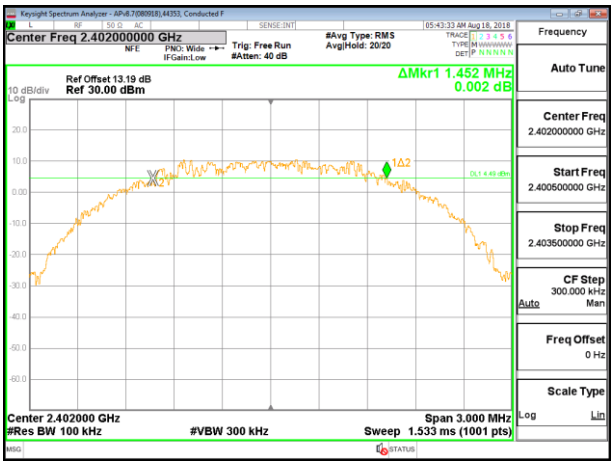
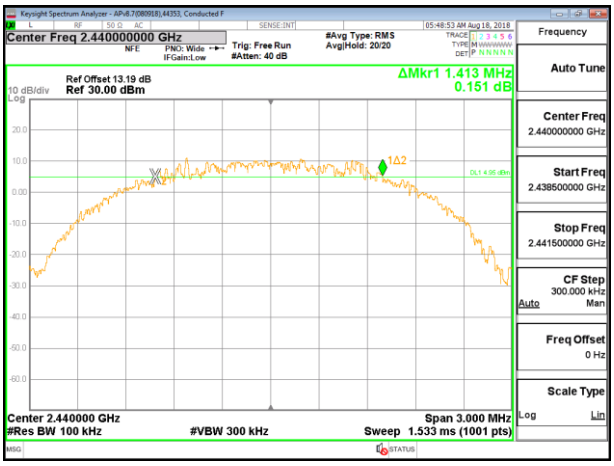
8.3.2. BLE (2Mbps)

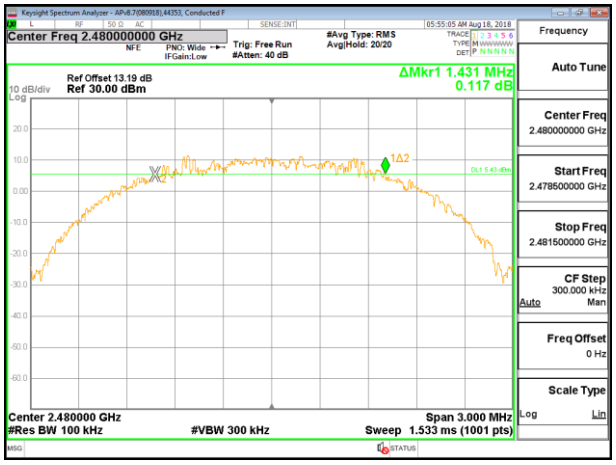
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	1.4520	0.5
Middle	2440	1.4130	0.5
High	2478	1.4310	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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8.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

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 power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated peak reading of power.

RESULTS

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8.4.1. BLE (1Mbps)

Tested By:	31300
Date:	12/10/2018

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.84	30	-20.160
Middle	2440	9.66	30	-20.340
High	2480	9.41	30	-20.590

8.4.2. BLE (2Mbps)

Tested By:	31300
Date:	12/10/2018

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	9.58	30	-20.420
Middle	2440	9.59	30	-20.410
High	2478	9.43	30	-20.570

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8.5. 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 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

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8.5.1. BLE (1Mbps)

Tested By:	31300
Date:	12/10/2018

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	9.54
Middle	2440	9.40
High	2480	9.10

8.5.2. BLE (2Mbps)

Tested By:	31300
Date:	12/10/2018

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	9.27
Middle	2440	9.30
High	2478	9.12

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8.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

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

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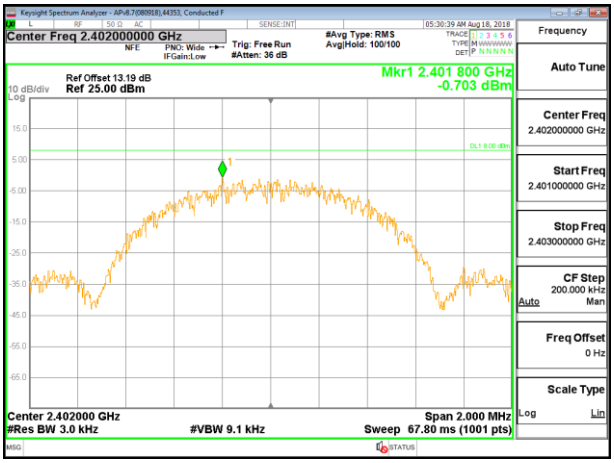
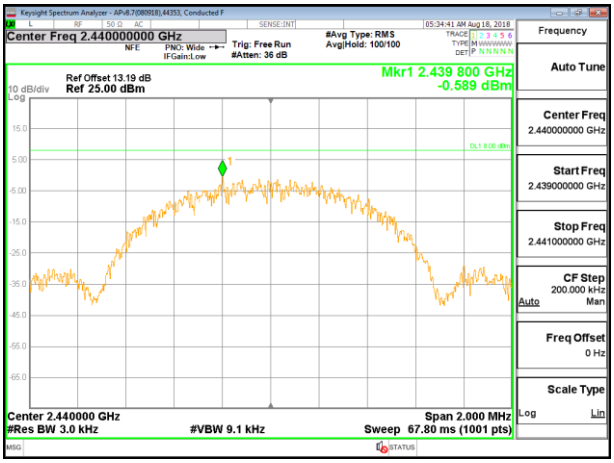
8.6.1. BLE (1Mbps)

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-0.70	8	-8.70
Middle	2440	-0.59	8	-8.59
High	2480	-1.49	8	-9.49



LOW CHANNEL



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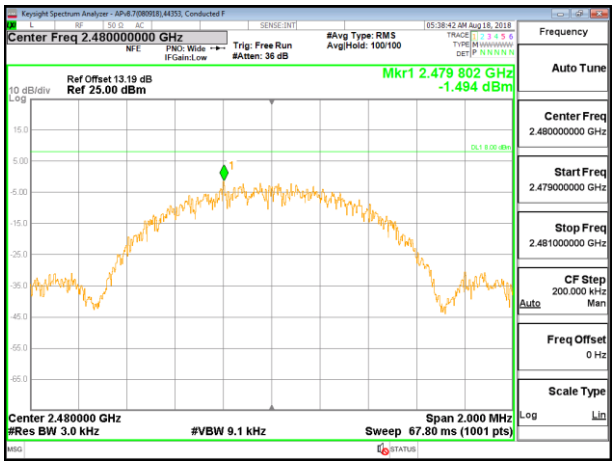

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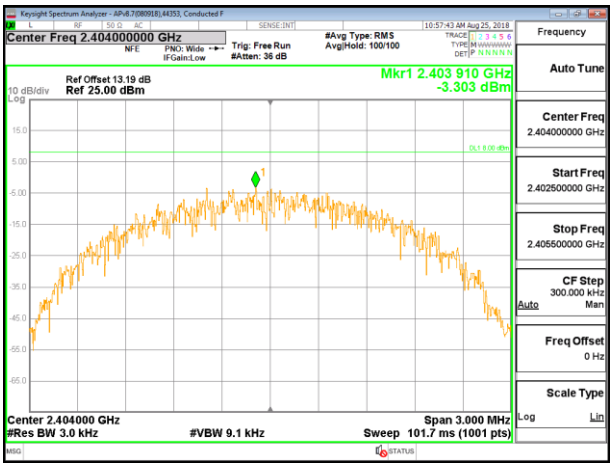
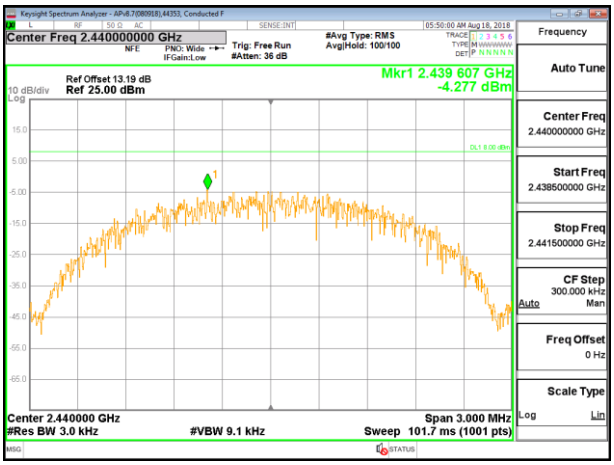
8.6.2. BLE (2Mbps)

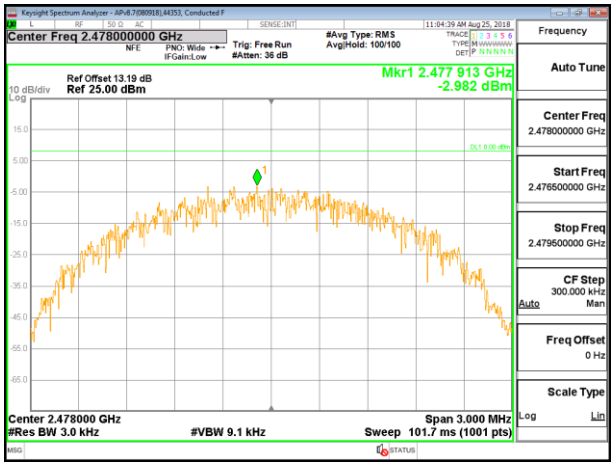
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-3.30	8	-11.30
Middle	2440	-4.28	8	-12.28
High	2478	-2.98	8	-10.98



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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8.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

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

RESULTS

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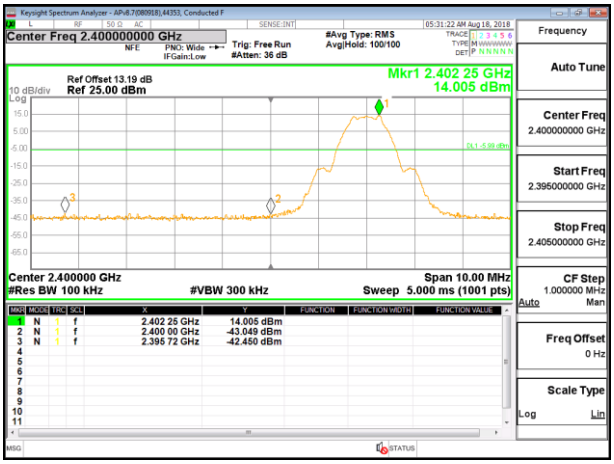
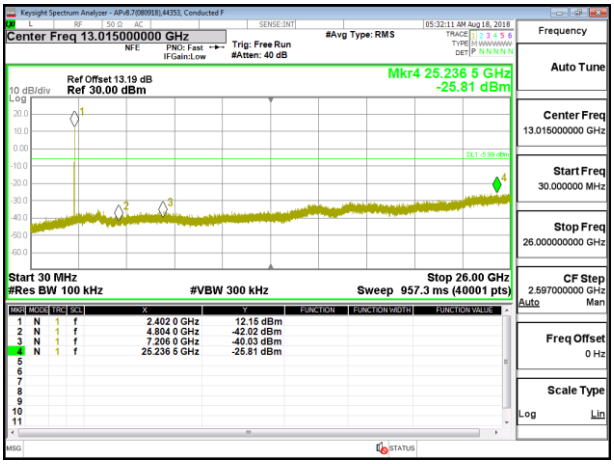
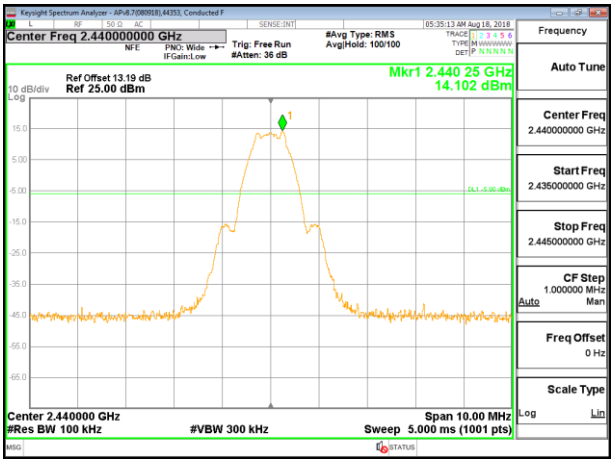
8.7.1. BLE (1Mbps)



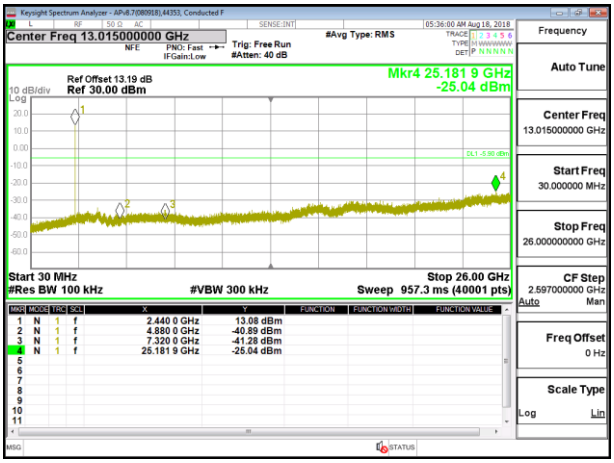
LOW CHANNEL BANDEDGE



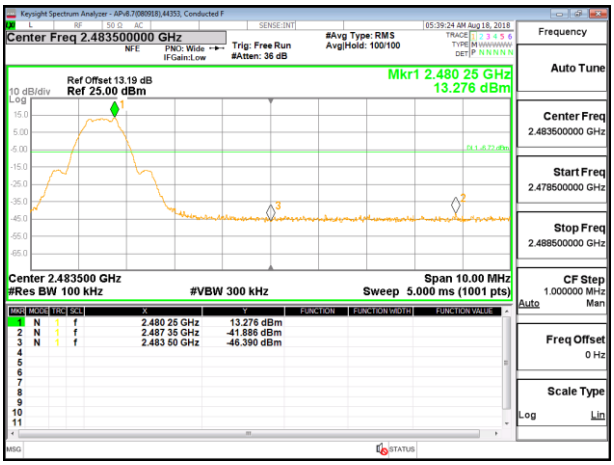
OUT-OF-BAND LOW CHANNEL



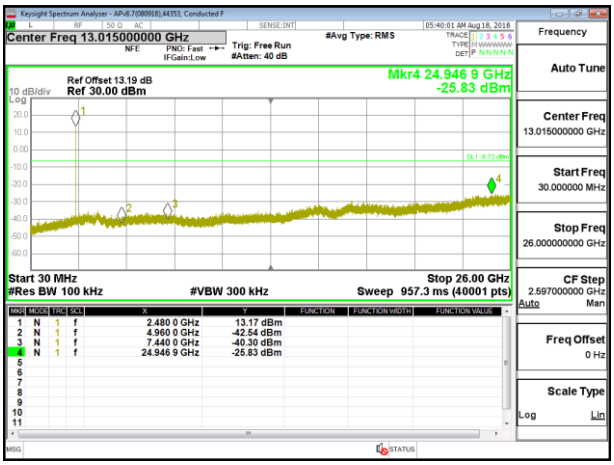
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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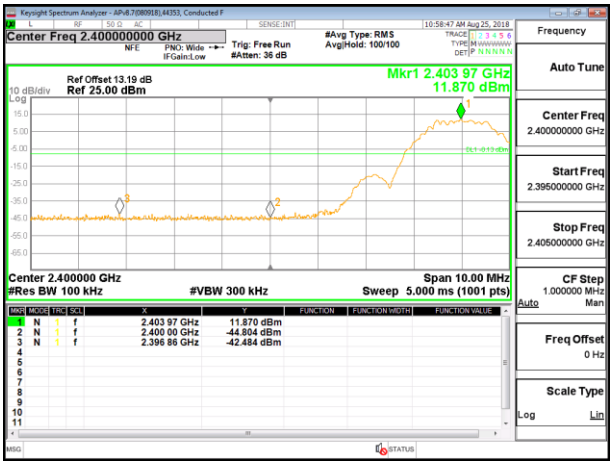
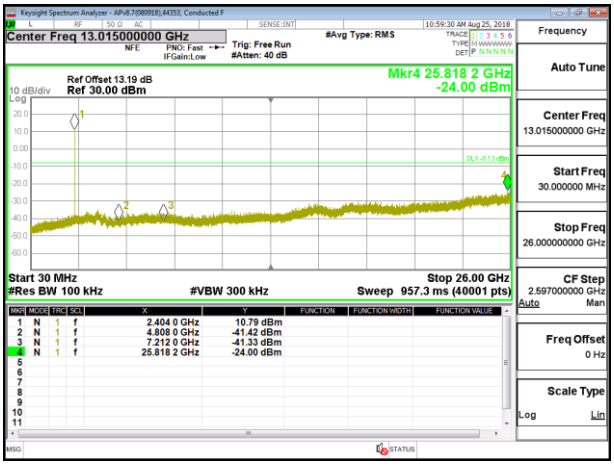
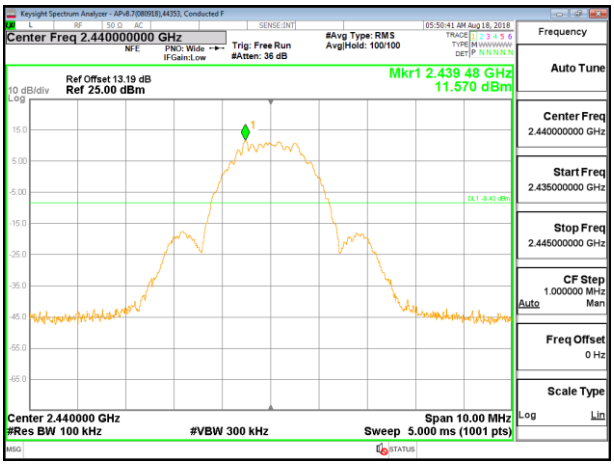
8.7.2. BLE (2Mbps)



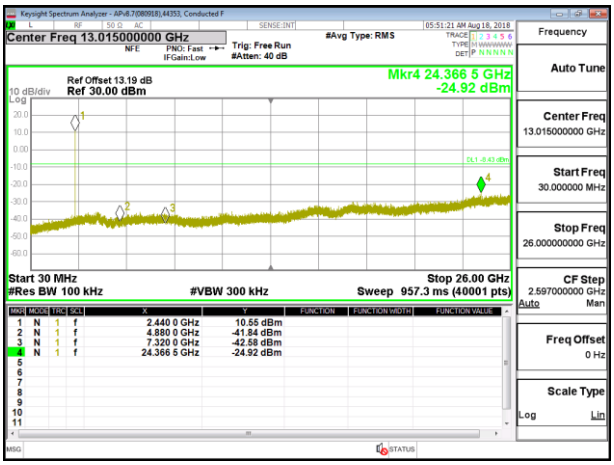
LOW CHANNEL BANDEDGE



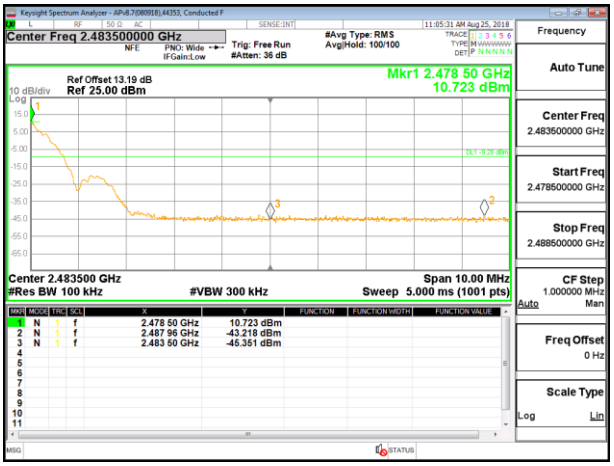
OUT-OF-BAND LOW CHANNEL



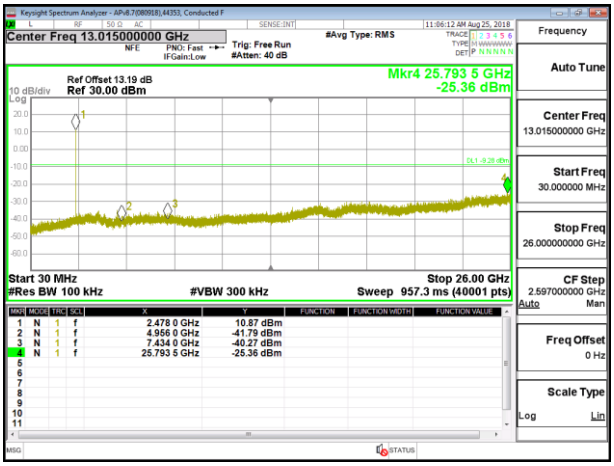
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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9. RADIATED TEST RESULTS

9.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

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
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
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 spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

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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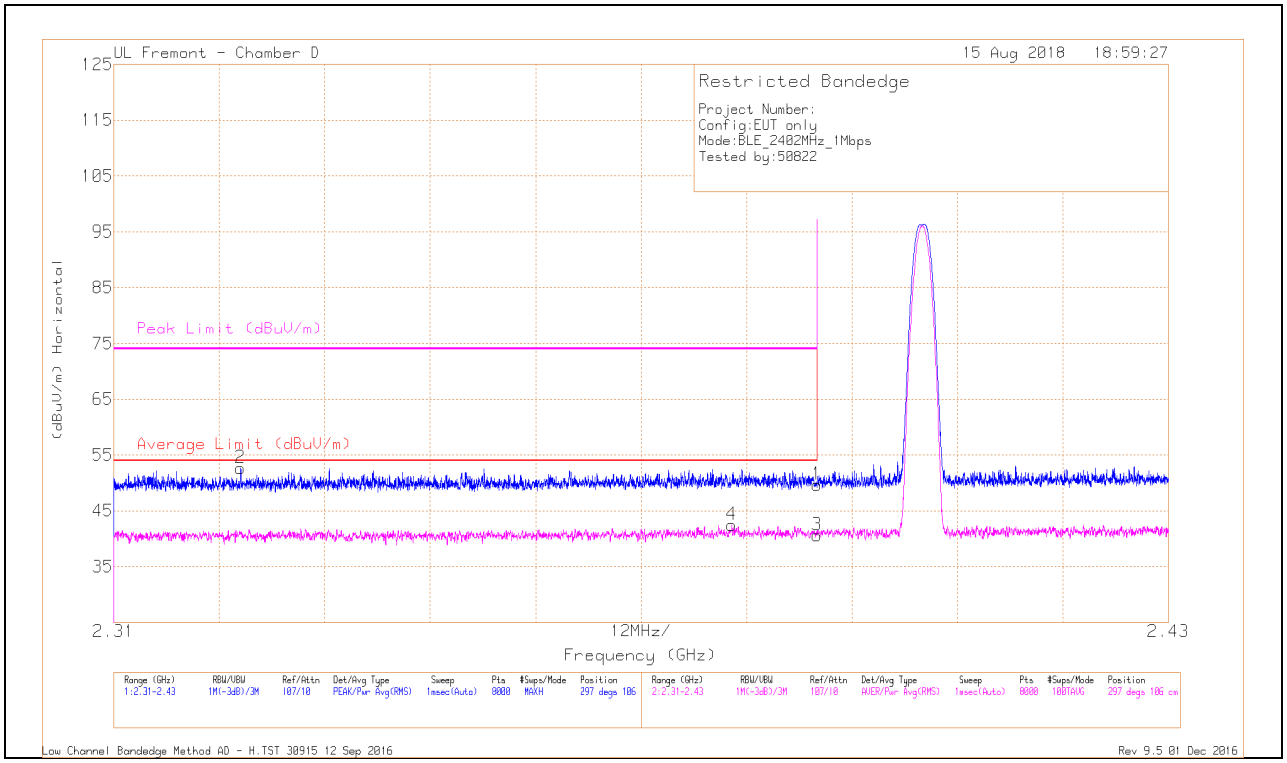
9.2. TRANSMITTER ABOVE 1 GHz

9.2.1. BLE (1Mbps)

Antenna 1

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



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	38.1	Pk	32.1	-20.5	49.7	-	-	74	-24.3	297	106	H
2	* 2.324	41.42	Pk	31.8	-20.6	52.62	-	-	74	-21.38	297	106	H
3	* 2.39	29.03	RMS	32.1	-20.5	40.63	54	-13.37	-	-	297	106	H
4	* 2.38	30.79	RMS	32.1	-20.4	42.49	54	-11.51	-	-	297	106	H

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

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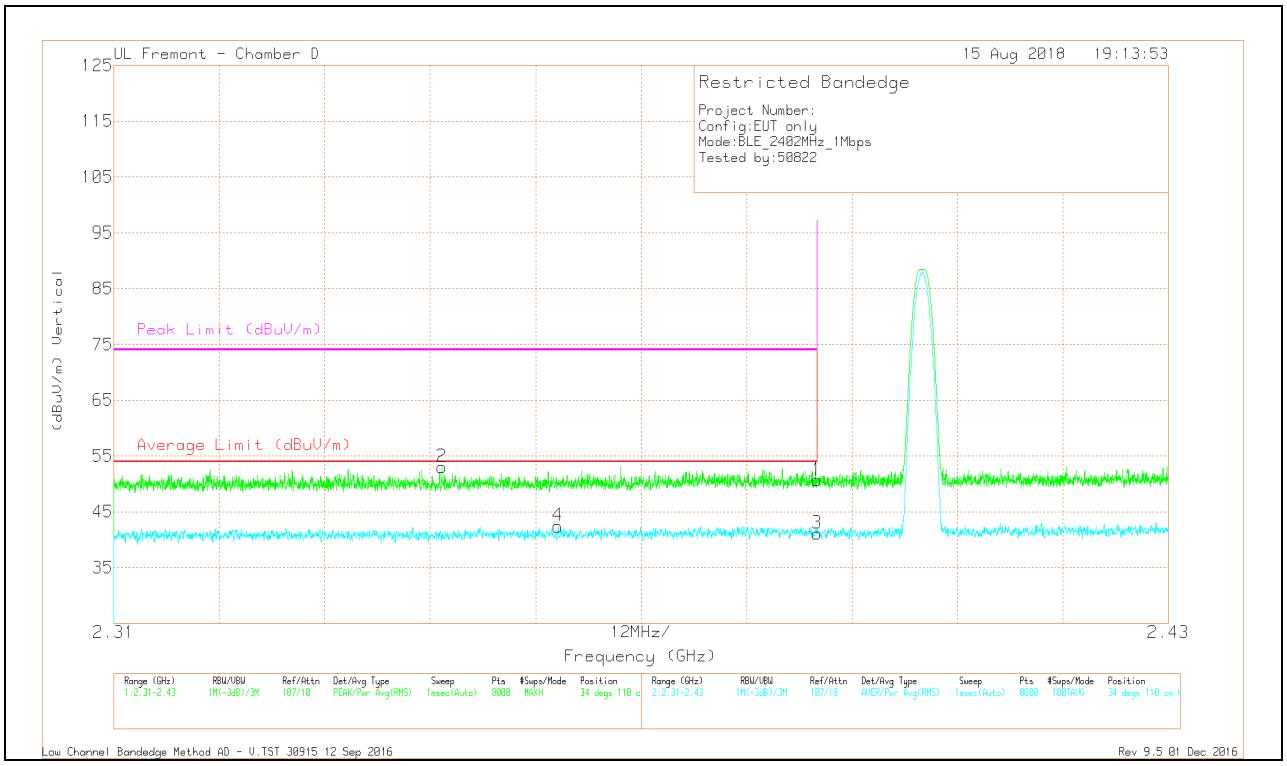
VERTICAL RESULT



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	39.08	Pk	32.1	-20.5	50.68	-	-	74	-23.32	34	110	V
2	* 2.347	41.84	Pk	31.8	-20.6	53.04	-	-	74	-20.96	34	110	V
3	* 2.39	29.55	RMS	32.1	-20.5	41.15	54	-12.85	-	-	34	110	V
4	* 2.361	31.11	RMS	31.9	-20.6	42.41	54	-11.59	-	-	34	110	V

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

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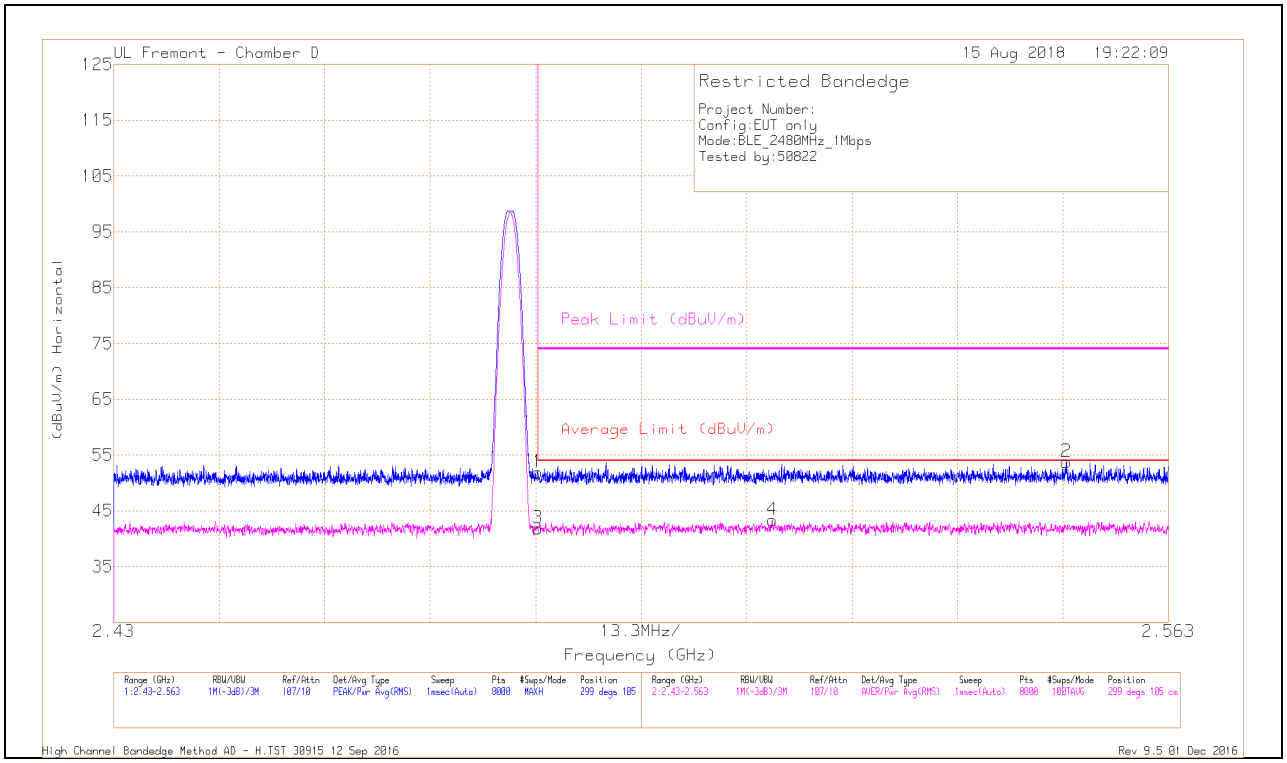
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



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	39.79	Pk	32.5	-20.4	51.89	-	-	74	-22.11	299	105	H
3	* 2.484	29.77	RMS	32.5	-20.4	41.87	54	-12.13	-	-	299	105	H
4	2.513	30.98	RMS	32.7	-20.3	43.38	54	-10.62	-	-	299	105	H
2	2.55	41.68	Pk	32.5	-20.4	53.78	-	-	74	-20.22	299	105	H

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

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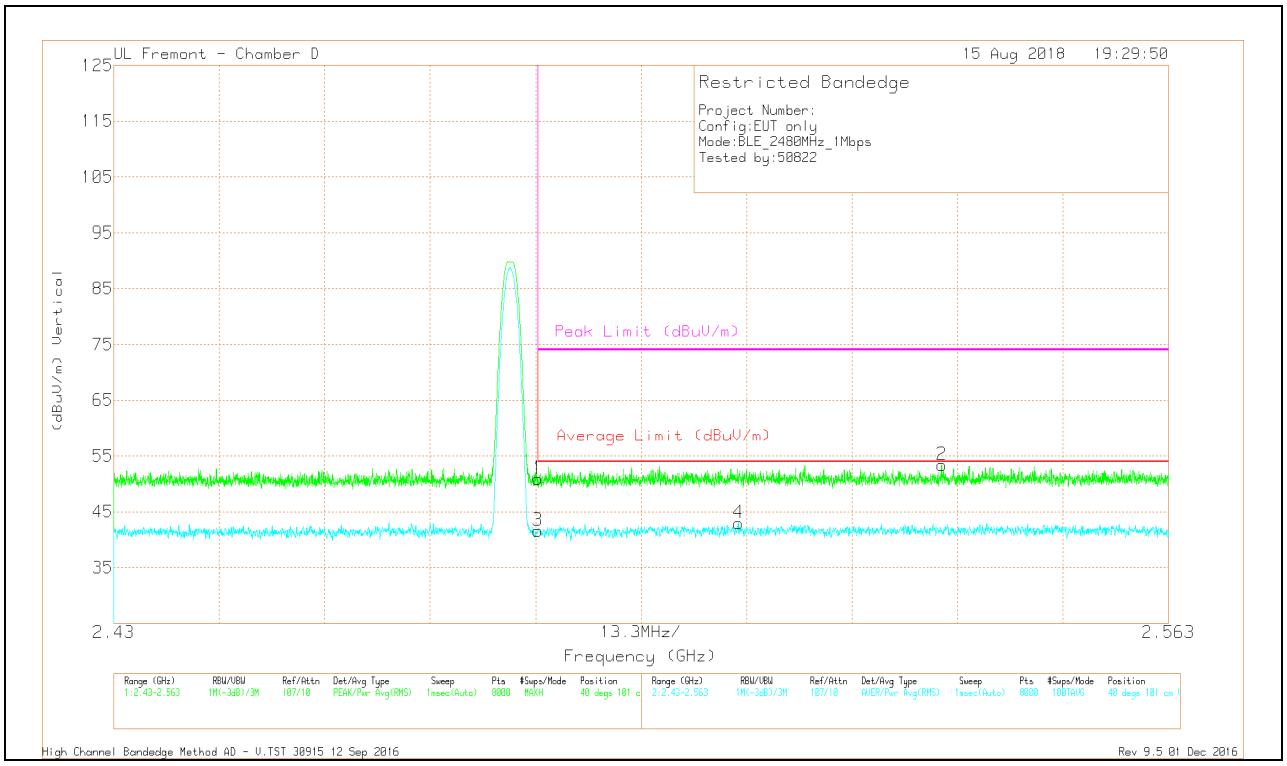
VERTICAL RESULT



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	38.81	Pk	32.5	-20.4	50.91	-	-	74	-23.09	40	101	V
3	* 2.484	29.54	RMS	32.5	-20.4	41.64	54	-12.36	-	-	40	101	V
4	2.509	30.61	RMS	32.6	-20.3	42.91	54	-11.09	-	-	40	101	V
2	2.534	41.07	Pk	32.7	-20.4	53.37	-	-	74	-20.63	40	101	V

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

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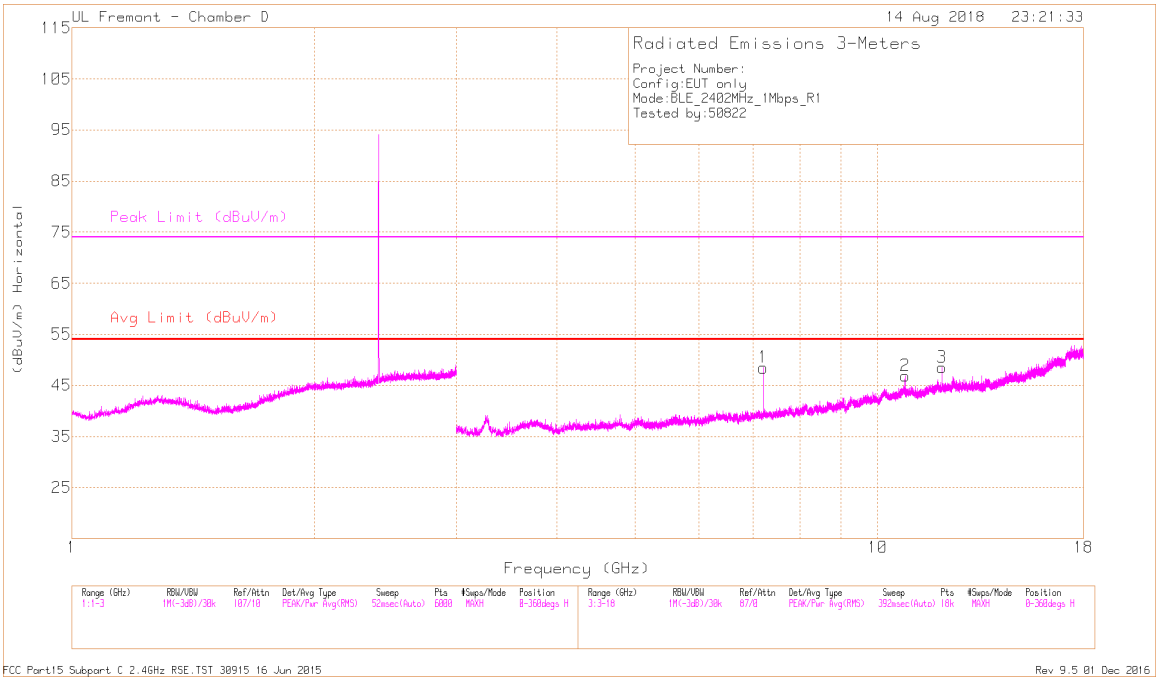
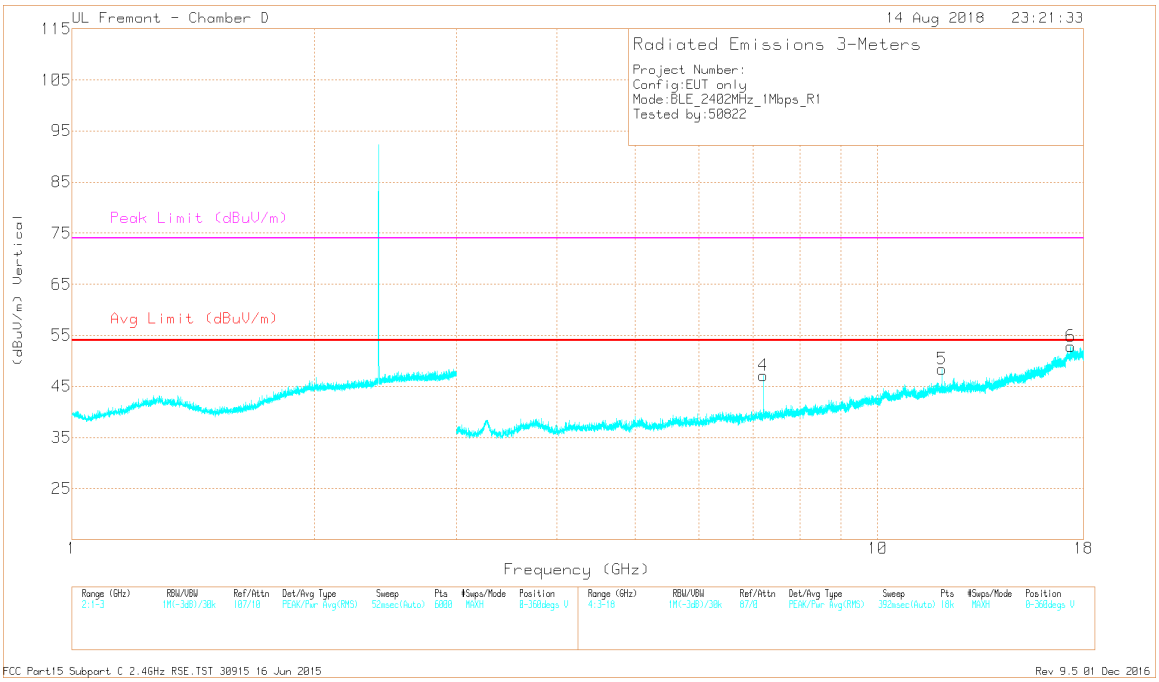
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

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
2	* 10.81	35.55	PK2	38.1	-19.9	53.75			74	-20.25	181	104	H
	* 10.81	25.67	MAv1	38.1	-19.9	43.87	54	-10.13	-	-	181	104	H
3	* 12.008	35.71	PK2	39.1	-20.4	54.41			74	-19.59	86	113	H
	* 12.009	25	MAv1	39.1	-20.5	43.6	54	-10.4	-	-	86	113	H
5	* 12.012	35	PK2	39.1	-20.5	53.6			74	-20.4	213	121	V
	* 12.011	24.34	MAv1	39.1	-20.5	42.94	54	-11.06	-	-	213	121	V
1	7.205	40.78	PK2	35.6	-24.6	51.78	-	-	-	-	77	117	V
4	7.206	38.46	PK2	35.6	-24.6	49.46	-	-	-	-	86	106	H
6	17.356	33.67	PK2	41.2	-16.7	58.17	-	-	-	-	86	209	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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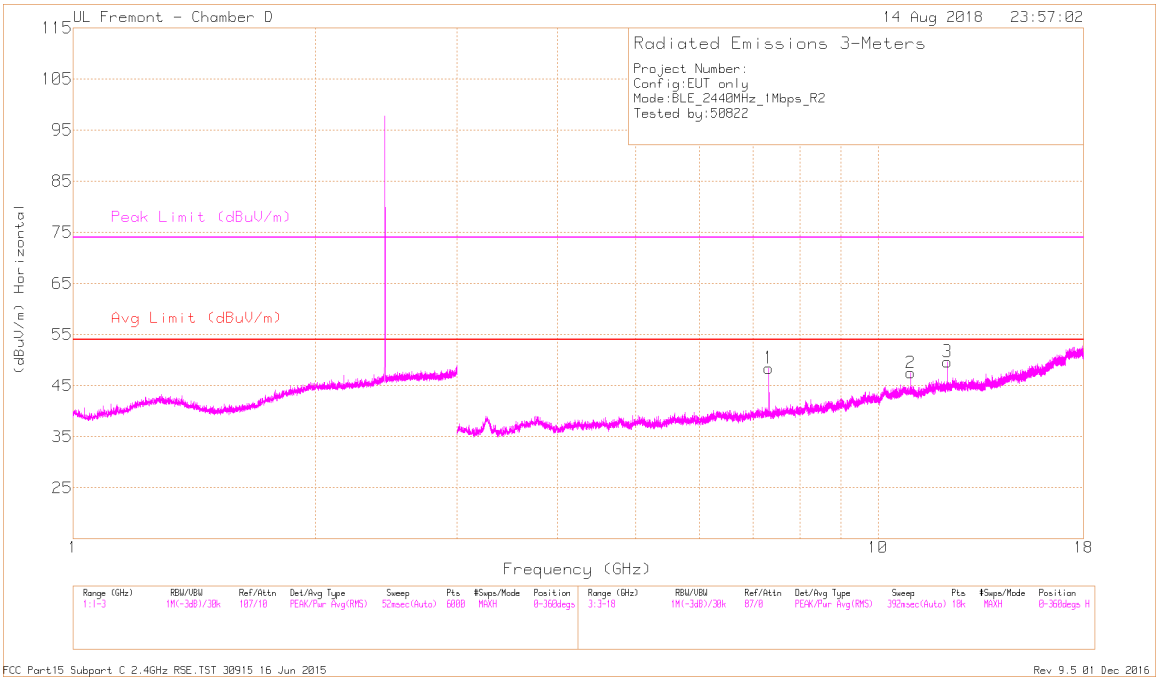
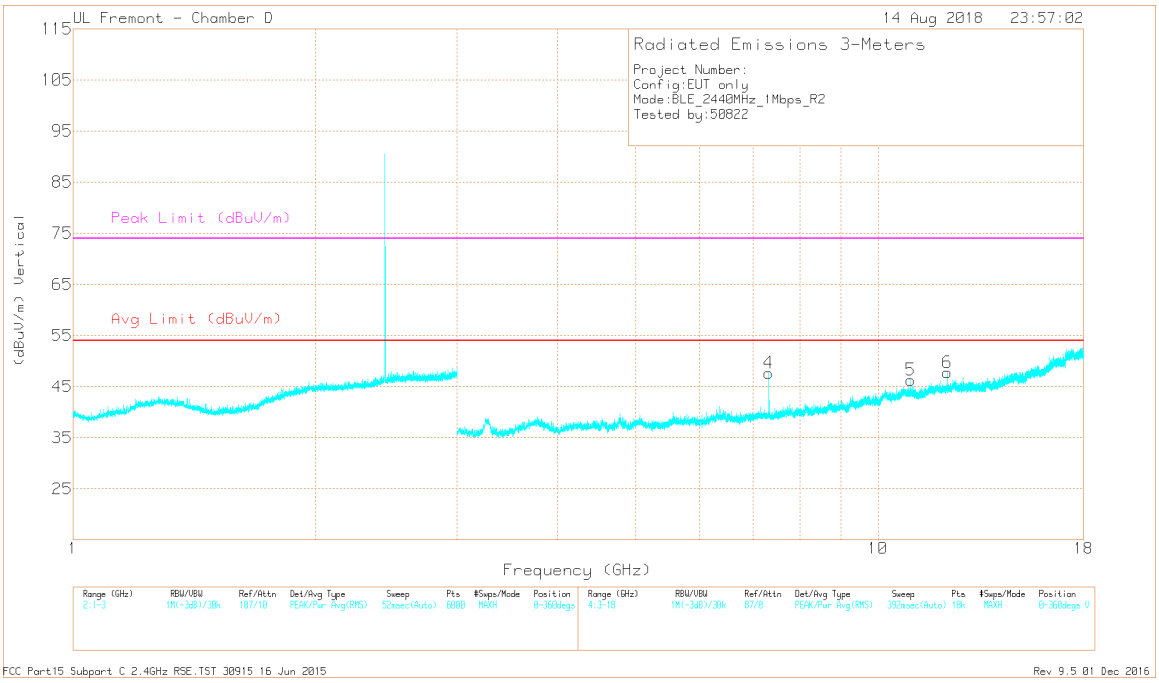
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

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	* 7.32	41.78	PK2	35.8	-24.7	52.88			74	-21.12	113	111	H
	* 7.321	33.95	MAv1	35.8	-24.6	45.15	54	-8.85	-	-	113	111	H
2	* 10.981	36.33	PK2	38	-20.1	54.23			74	-19.77	108	104	H
	* 10.981	26.94	MAv1	38	-20.1	44.84	54	-9.16	-	-	108	104	H
3	* 12.199	36.03	PK2	39	-20.1	54.93			74	-19.07	86	112	H
	* 12.199	26.55	MAv1	39	-20.1	45.45	54	-8.55	-	-	86	112	H
4	* 7.32	40.76	PK2	35.8	-24.6	51.96			74	-22.04	16	104	V
	* 7.321	32.51	MAv1	35.8	-24.6	43.71	54	-10.29	-	-	16	104	V
5	* 10.981	34.58	PK2	38	-20.1	52.48			74	-21.52	200	103	V
	* 10.981	23.76	MAv1	38	-20.1	41.66	54	-12.34	-	-	200	103	V
6	* 12.202	34.92	PK2	39	-20.1	53.82			74	-20.18	37	189	V
	* 12.201	23.89	MAv1	39	-20.1	42.79	54	-11.21	-	-	37	189	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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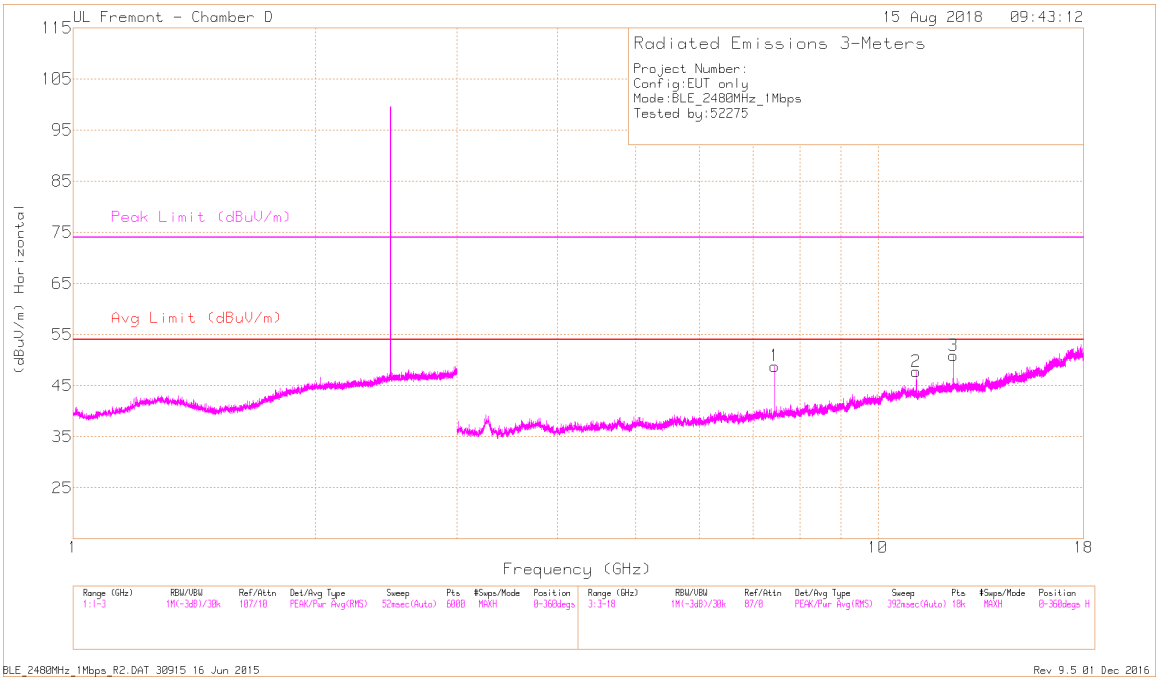
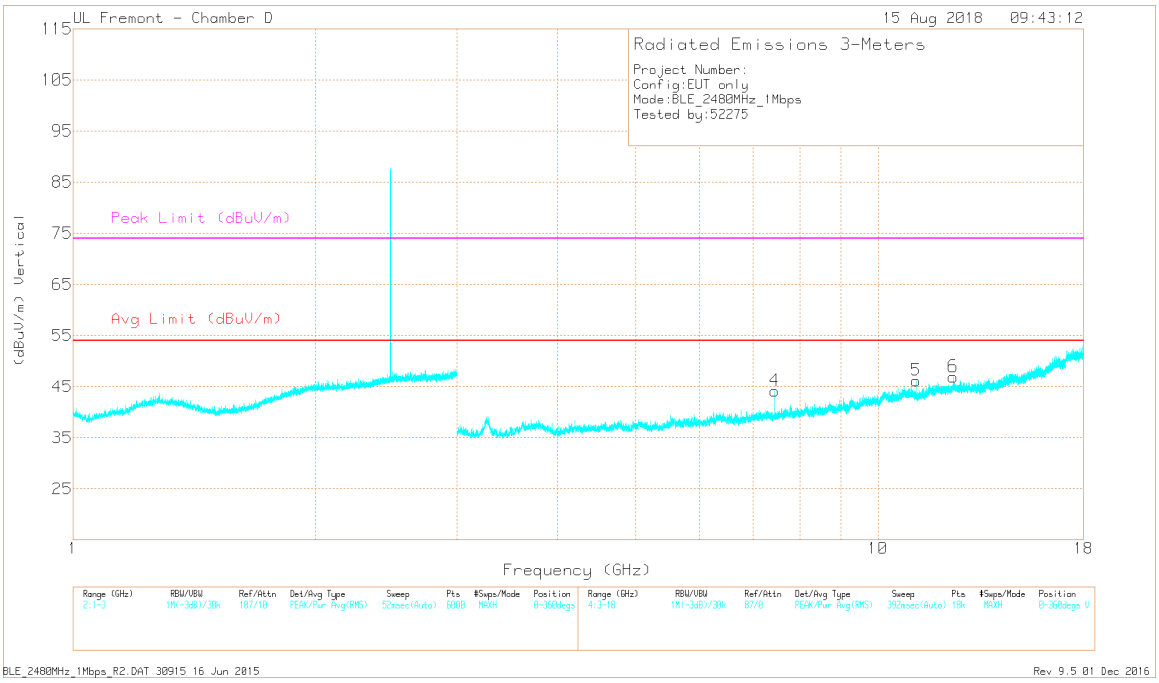
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

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
* 7.44	41.26	PK2	35.9	-24	53.16	-	-	74	-20.84	269	103	H
* 7.439	34.11	MAv1	35.9	-24	46.01	54	-7.99	-	-	269	103	H
* 11.159	36.76	PK2	38.1	-20.4	54.46	-	-	74	-19.54	254	104	H
* 11.159	27.04	MAv1	38.1	-20.4	44.74	54	-9.26	-	-	254	104	H
* 12.401	37.58	PK2	39.1	-19.7	56.98	-	-	74	-17.02	283	106	H
* 12.401	28.09	MAv1	39.1	-19.7	47.49	54	-6.51	-	-	283	106	H
* 7.441	30.71	PK2	35.9	-23.9	42.71	-	-	74	-31.29	94	188	V
* 7.441	7.7	MAv1	35.9	-23.9	19.7	54	-34.3	-	-	94	188	V
* 11.16	29.66	PK2	38.1	-20.4	47.36	-	-	74	-26.64	326	285	V
* 11.161	11.03	MAv1	38.1	-20.4	28.73	54	-25.27	-	-	326	285	V
* 12.399	29.92	PK2	39	-19.7	49.22	-	-	74	-24.78	117	209	V
* 12.4	11.78	MAv1	39.1	-19.7	31.18	54	-22.82	-	-	117	209	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

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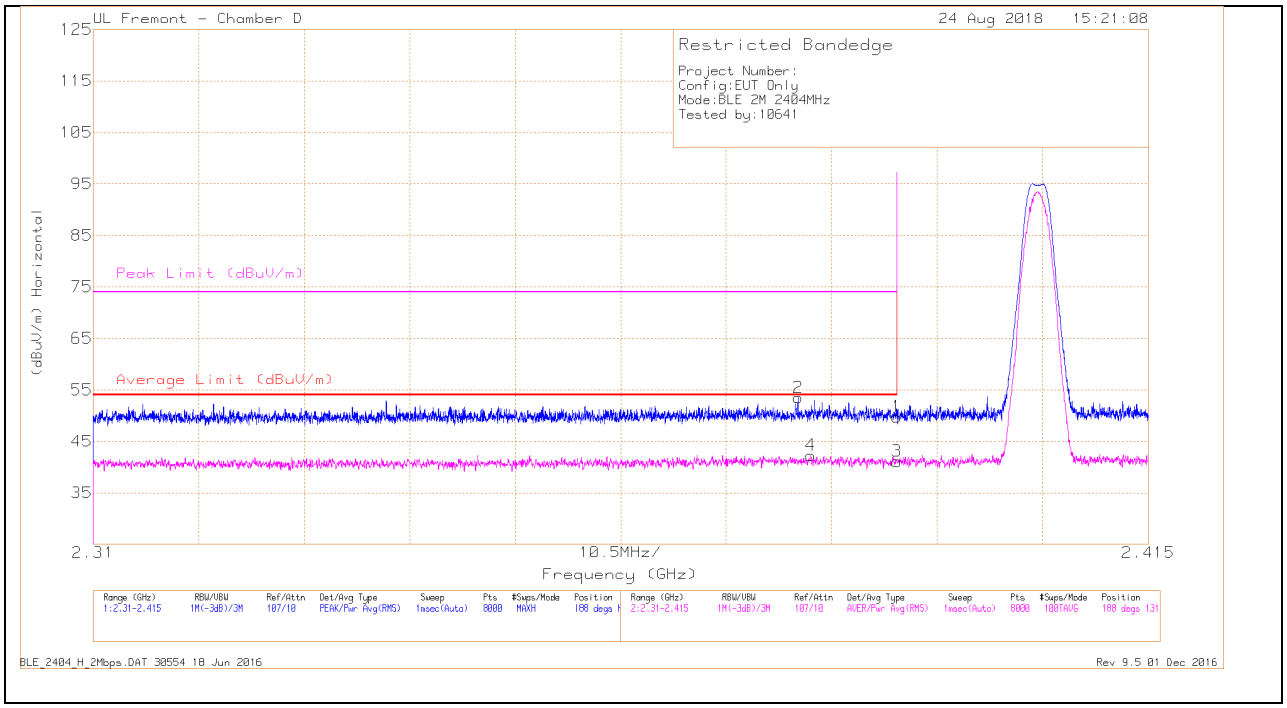
9.2.2. BLE (2Mbps)

Antenna 1

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



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	38.18	Pk	32.1	-20.5	49.78	-	-	74	-24.22	188	131	H
2	* 2.38	41.77	Pk	32.1	-20.4	53.47	-	-	74	-20.53	188	131	H
3	* 2.39	29.52	RMS	32.1	-20.5	41.12	54	-12.88	-	-	188	131	H
4	* 2.381	30.59	RMS	32.1	-20.4	42.29	54	-11.71	-	-	188	131	H

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

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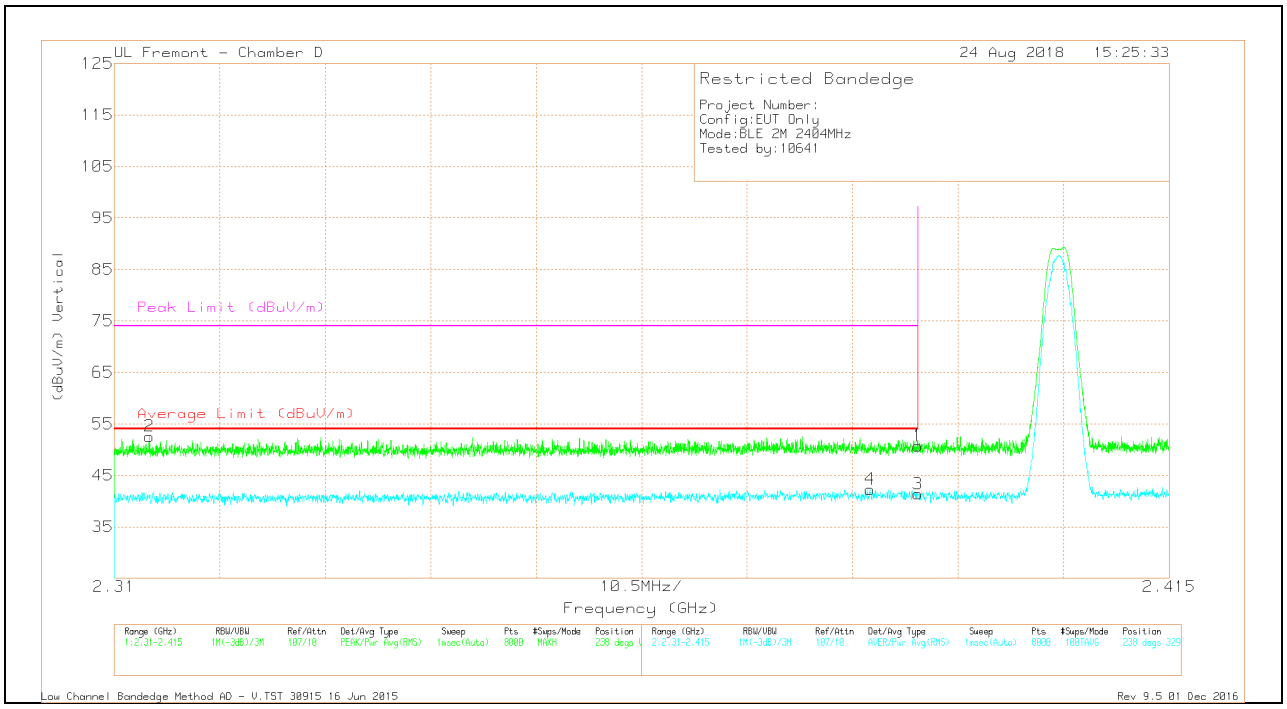
VERTICAL RESULT



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	39.14	Pk	32.1	-20.5	50.74	-	-	74	-23.26	238	329	V
2	* 2.313	41.39	Pk	31.8	-20.6	52.59	-	-	74	-21.41	238	329	V
3	* 2.39	29.8	RMS	32.1	-20.5	41.4	54	-12.6	-	-	238	329	V
4	* 2.385	30.61	RMS	32.2	-20.5	42.31	54	-11.69	-	-	238	329	V

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

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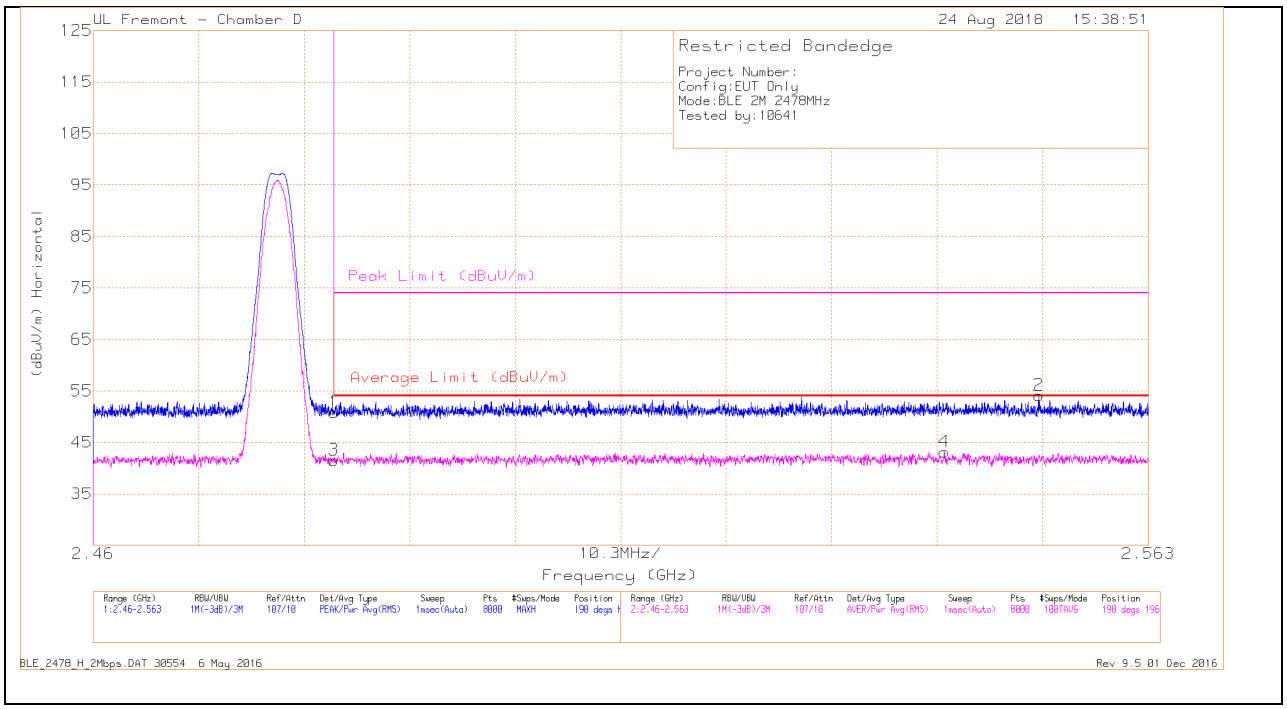
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



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	38.74	Pk	32.5	-20.4	50.84	-	-	74	-23.16	190	196	H
3	* 2.484	29.48	RMS	32.5	-20.4	41.58	54	-12.42	-	-	190	196	H
4	2.543	30.76	RMS	32.7	-20.3	43.16	54	-10.84	-	-	190	196	H
2	2.552	41.96	Pk	32.5	-20.3	54.16	-	-	74	-19.84	190	196	H

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

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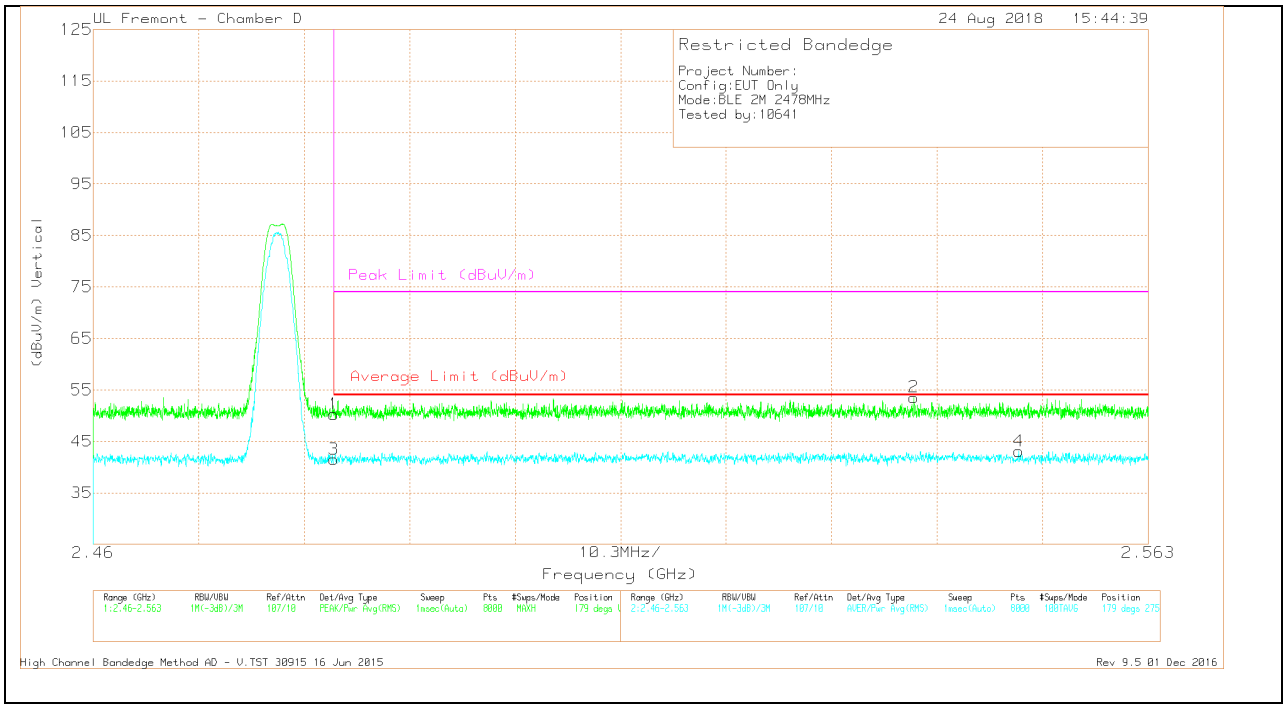
VERTICAL RESULT



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	38.17	Pk	32.5	-20.4	50.27	-	-	74	-23.73	179	275	V
3	* 2.484	29.4	RMS	32.5	-20.4	41.5	54	-12.5	-	-	179	275	V
2	2.54	41.16	Pk	32.7	-20.3	53.56	-	-	74	-20.44	179	275	V
4	2.55	30.98	RMS	32.5	-20.4	43.08	54	-10.92	-	-	179	275	V

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

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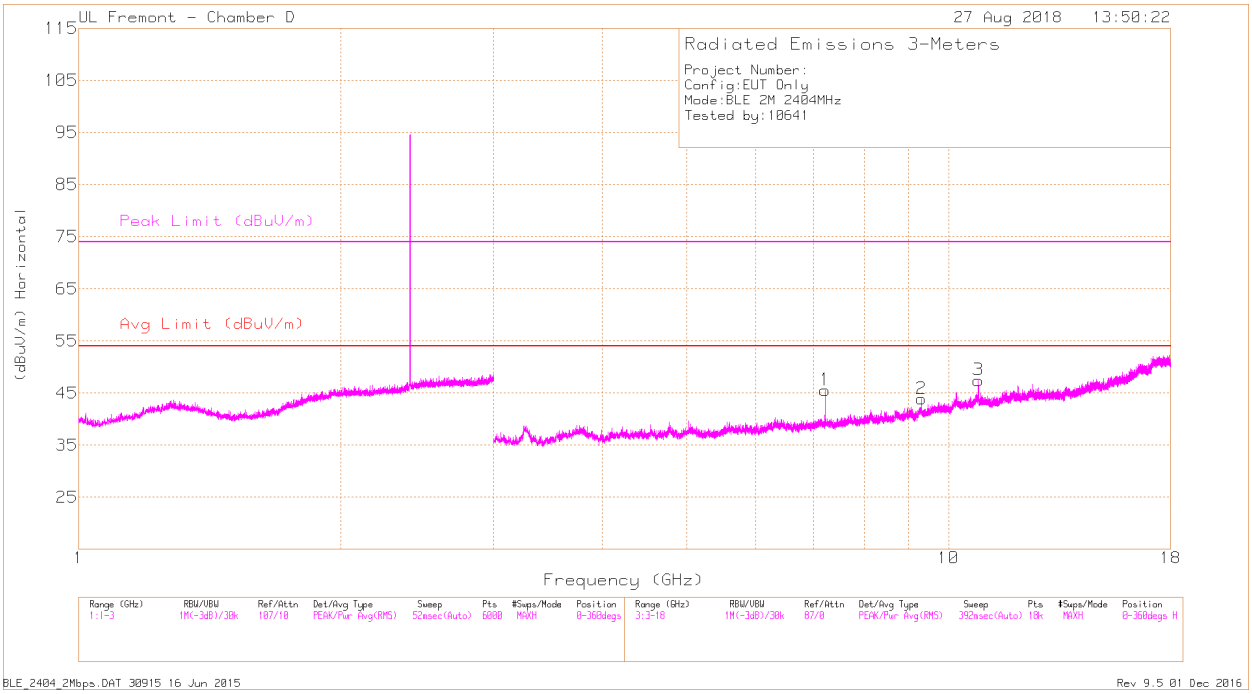
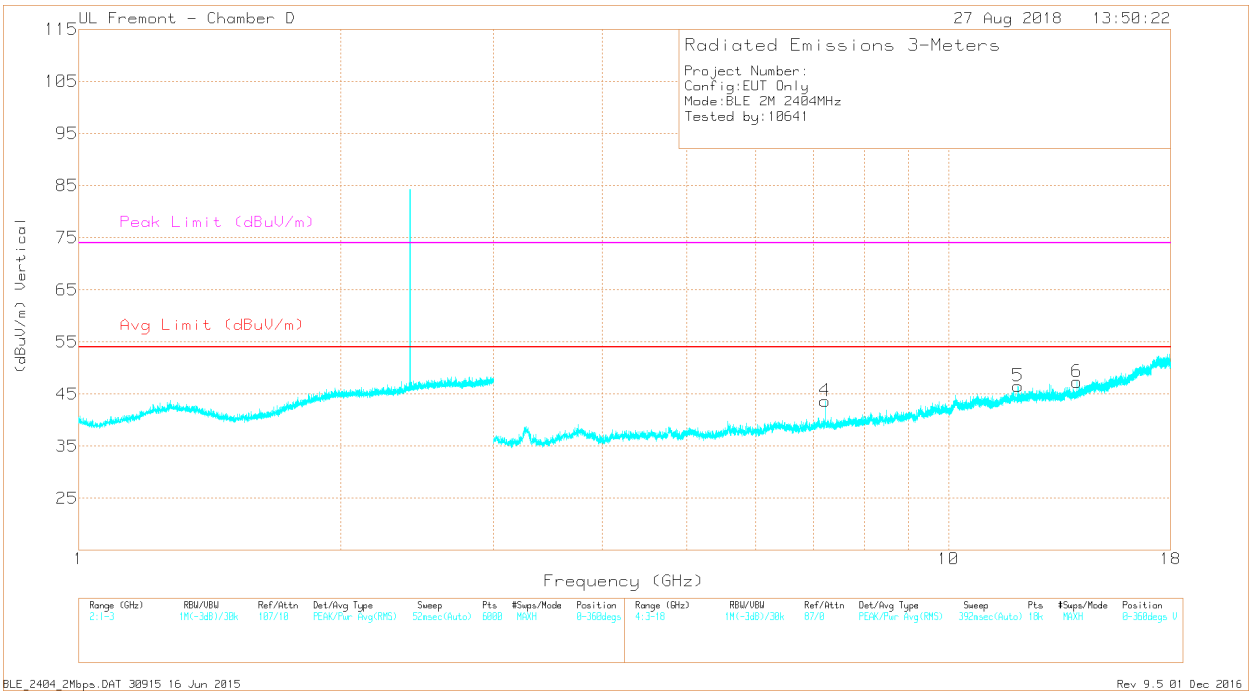
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

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
2	* 9.303	33.46	PK2	36.4	-20.4	49.46	-	-	74	-24.54	61	250	H
	* 9.305	21.81	MAv1	36.3	-20.5	37.61	54	-16.39	-	-	61	250	H
3	* 10.816	35.28	PK2	38.1	-19.8	53.58	-	-	74	-20.42	93	114	H
	* 10.82	25.74	MAv1	38	-19.9	43.84	54	-10.16	-	-	93	114	H
5	* 12.02	33.9	PK2	39.1	-20.5	52.5	-	-	74	-21.5	159	241	V
	* 12.018	22.71	MAv1	39.1	-20.5	41.31	54	-12.69	-	-	159	241	V
4	7.211	39.18	PK2	35.6	-24.6	50.18	-	-	-	-	260	103	V
	7.211	29.73	MAv1	35.6	-24.6	40.73	-	-	-	-	260	103	V
1	7.213	31.32	MAv1	35.7	-24.5	42.52	-	-	-	-	86	113	H
	7.214	40.34	PK2	35.7	-24.5	51.54	-	-	-	-	86	113	H
6	14.049	23.77	MAv1	38.9	-21.5	41.17	-	-	-	-	179	114	V
	14.05	35.63	PK2	38.9	-21.5	53.03	-	-	-	-	179	114	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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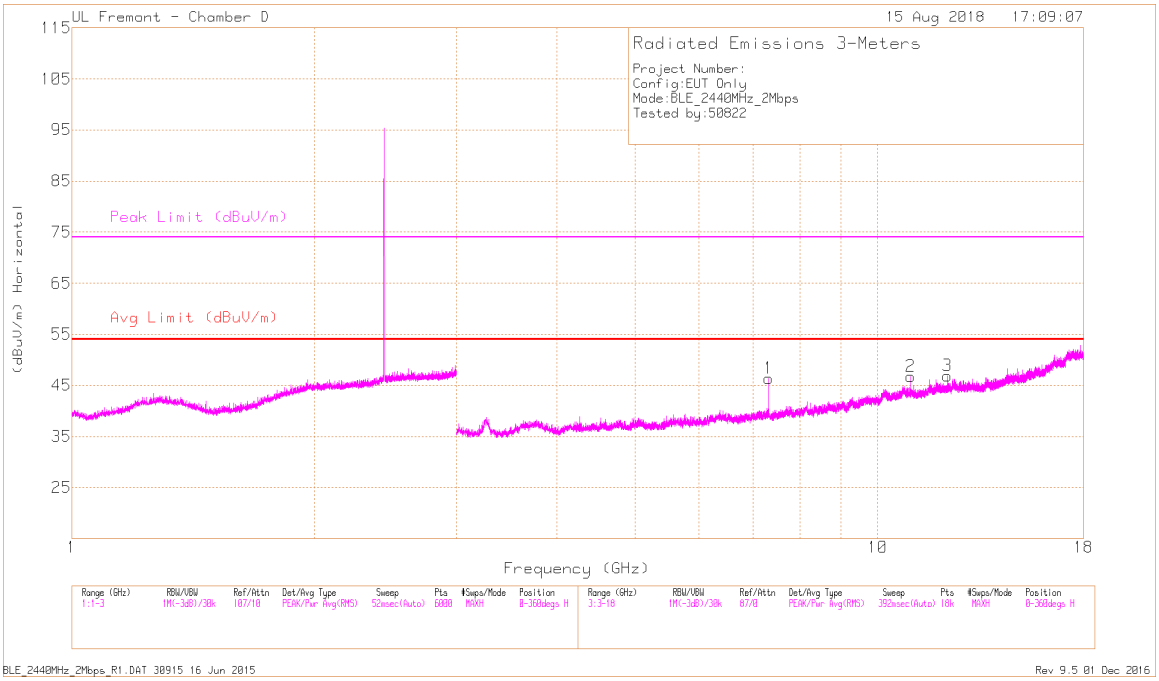
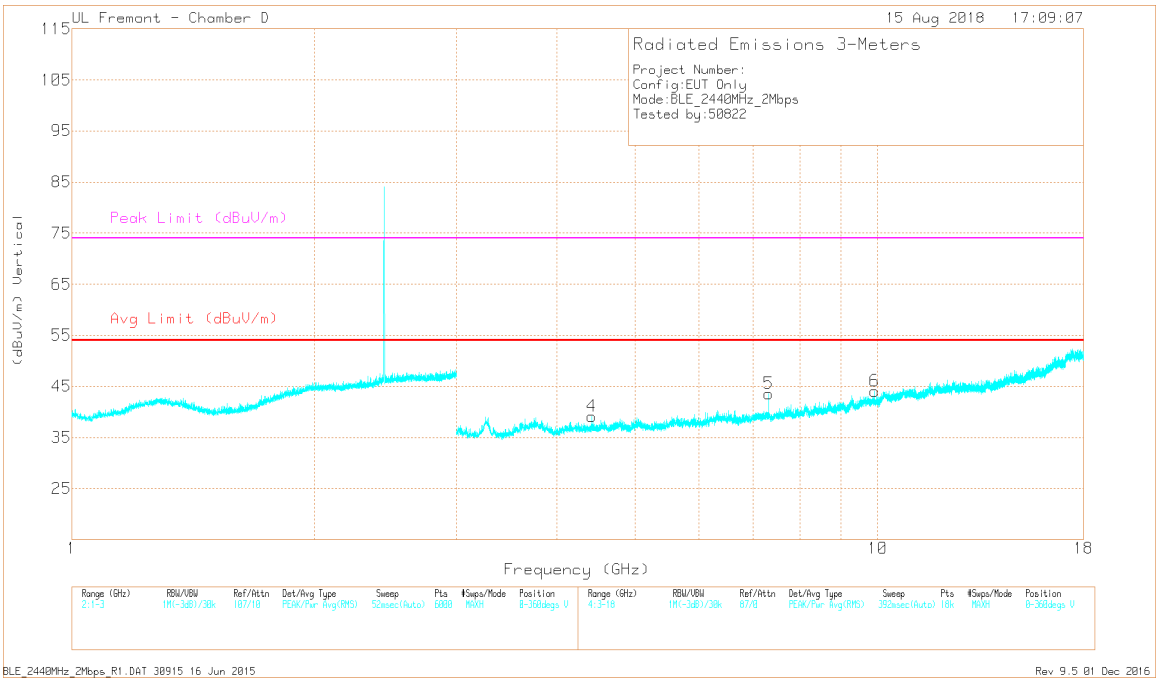
MID CHANNEL RESULTS



HORIZONTAL



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RADIATED EMISSIONS

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	* 7.321	40.89	PK2	35.8	-24.6	52.09	-	-	74	-21.91	249	108	H
	* 7.321	32.2	MAv1	35.8	-24.6	43.4	54	-10.6	-	-	249	108	H
2	* 10.983	36.19	PK2	38	-20.1	54.09	-	-	74	-19.91	246	108	H
	* 10.982	26.01	MAv1	38	-20.1	43.91	54	-10.09	-	-	246	108	H
3	* 12.198	36.67	PK2	39	-20.1	55.57	-	-	74	-18.43	240	105	H
	* 12.198	25.55	MAv1	39	-20.1	44.45	54	-9.55	-	-	240	105	H
5	* 7.319	38.42	PK2	35.7	-24.7	49.42	-	-	74	-24.58	176	192	V
	* 7.319	28.19	MAv1	35.7	-24.7	39.19	54	-14.81	-	-	176	192	V
4	4.417	37.58	PK2	34	-27.3	44.28	-	-	-	-	44	114	V
6	9.913	33.27	PK2	37.1	-20.1	50.27	-	-	-	-	173	111	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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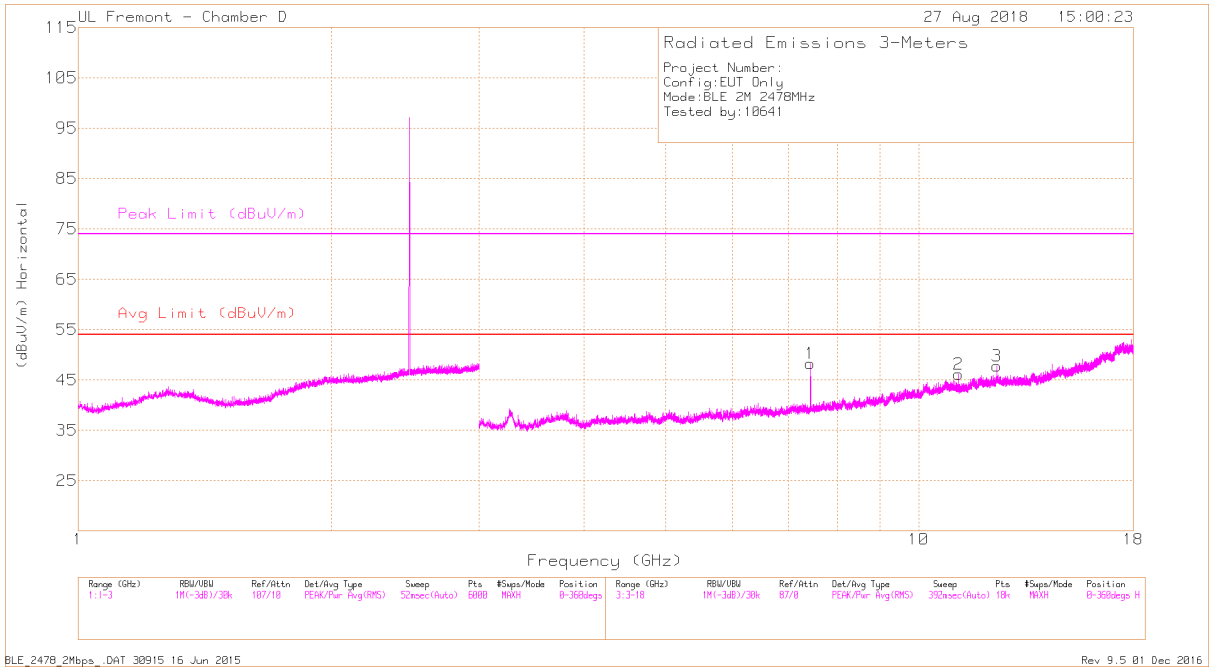
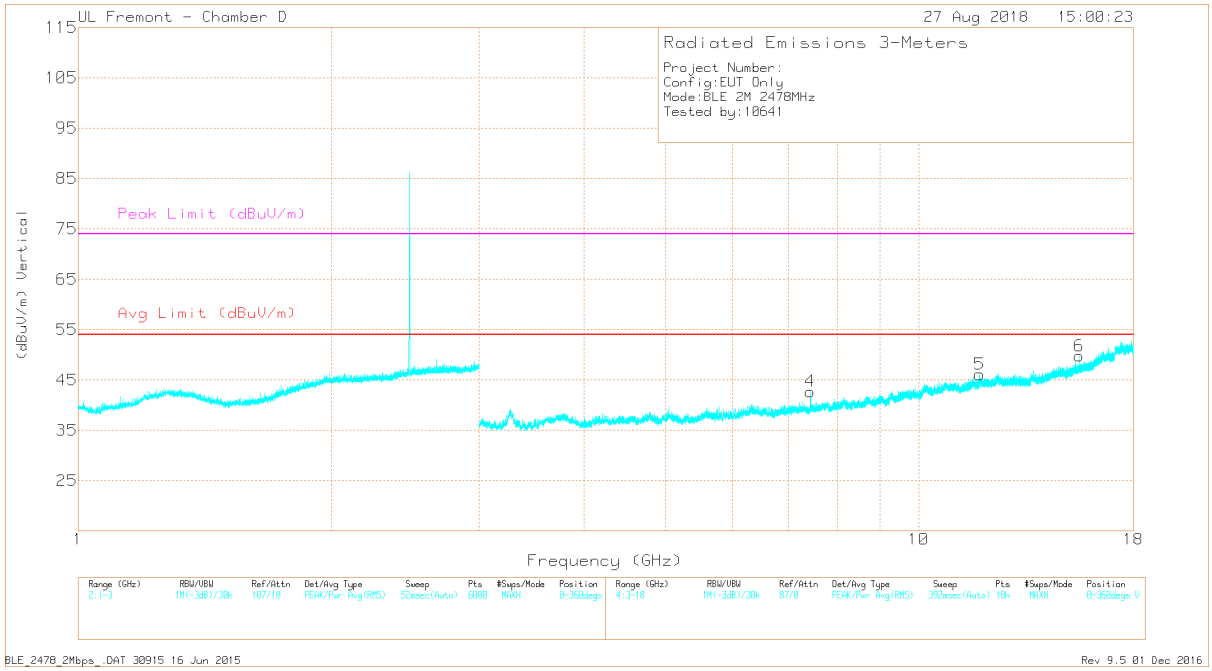
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

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	* 7.432	40.1	PK2	35.9	-24.2	51.8	-	-	74	-22.2	113	102	H
	* 7.433	31.57	MAv1	35.9	-24.2	43.27	54	-10.73	-	-	113	102	H
2	* 11.148	35.28	PK2	38.1	-20.4	52.98	-	-	74	-21.02	291	101	H
	* 11.149	23.57	MAv1	38.1	-20.4	41.27	54	-12.73	-	-	291	101	H
3	* 12.392	36.07	PK2	39	-19.7	55.37	-	-	74	-18.63	93	107	H
	* 12.392	25.71	MAv1	39	-19.7	45.01	54	-8.99	-	-	93	107	H
4	* 7.434	37.32	PK2	35.9	-24.2	49.02	-	-	74	-24.98	257	109	V
	* 7.433	27.63	MAv1	35.9	-24.2	39.33	54	-14.67	-	-	257	109	V
5	* 11.815	33.4	PK2	39	-20	52.4	-	-	74	-21.6	194	108	V
	* 11.811	21.67	MAv1	39	-20.1	40.57	54	-13.43	-	-	194	108	V
6	* 15.514	33.9	PK2	40.3	-19.5	54.7	-	-	74	-19.3	9	218	V
	* 15.515	22.56	MAv1	40.4	-19.5	43.46	54	-10.54	-	-	9	218	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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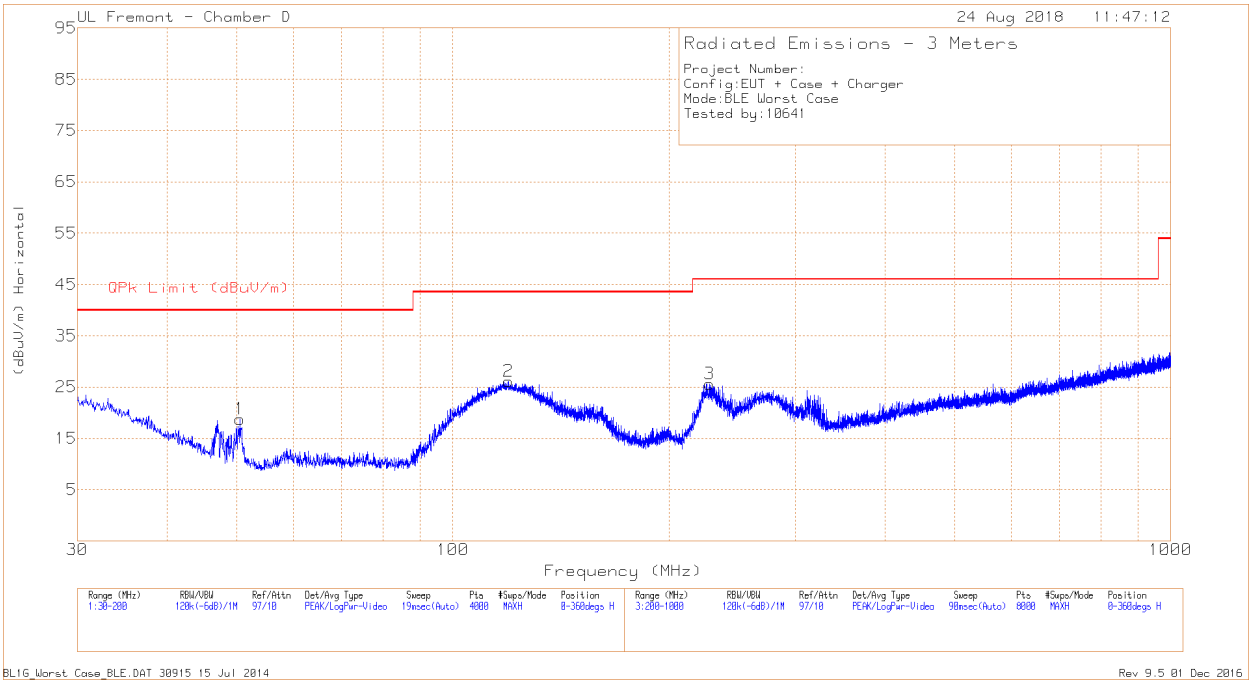
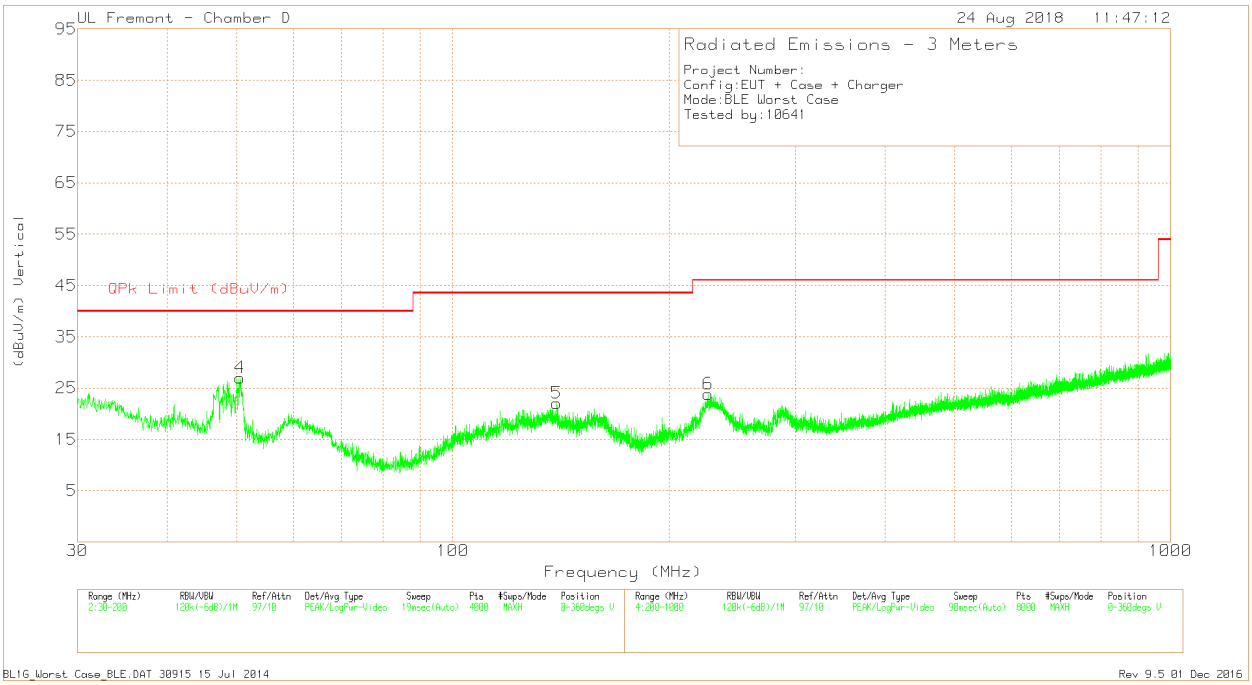
9.3. Worst Case Below 1 GHz

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



HORIZONTAL



VERTICAL

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Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T477 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 119.6132	37.26	Pk	19.6	-30.8	26.06	43.52	-17.46	0-360	199	H
1	50.5328	36.66	Pk	13.6	-31.5	18.76	40	-21.24	0-360	199	H
4	50.5328	44.88	Pk	13.6	-31.5	26.98	40	-13.02	0-360	100	V
5	139.6359	33.91	Pk	18.8	-30.7	22.01	43.52	-21.51	0-360	100	V
6	227.0035	37.05	Pk	16.8	-30	23.85	46.02	-22.17	0-360	101	V
3	227.8036	38.79	Pk	16.8	-30	25.59	46.02	-20.43	0-360	101	H

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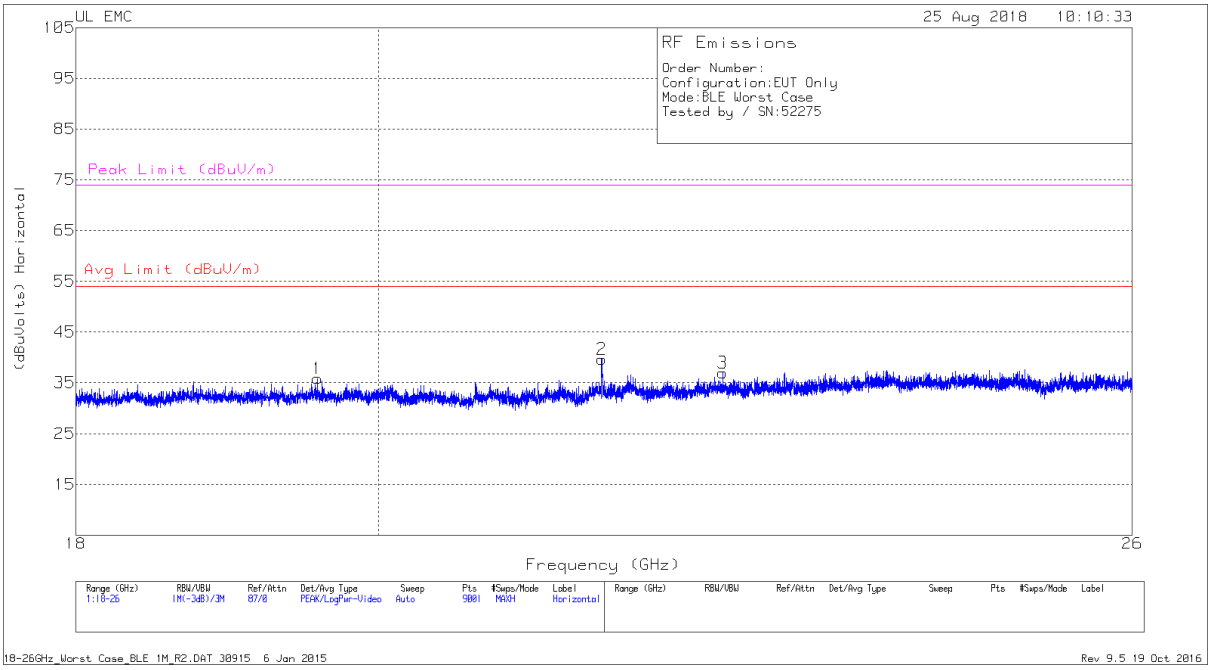
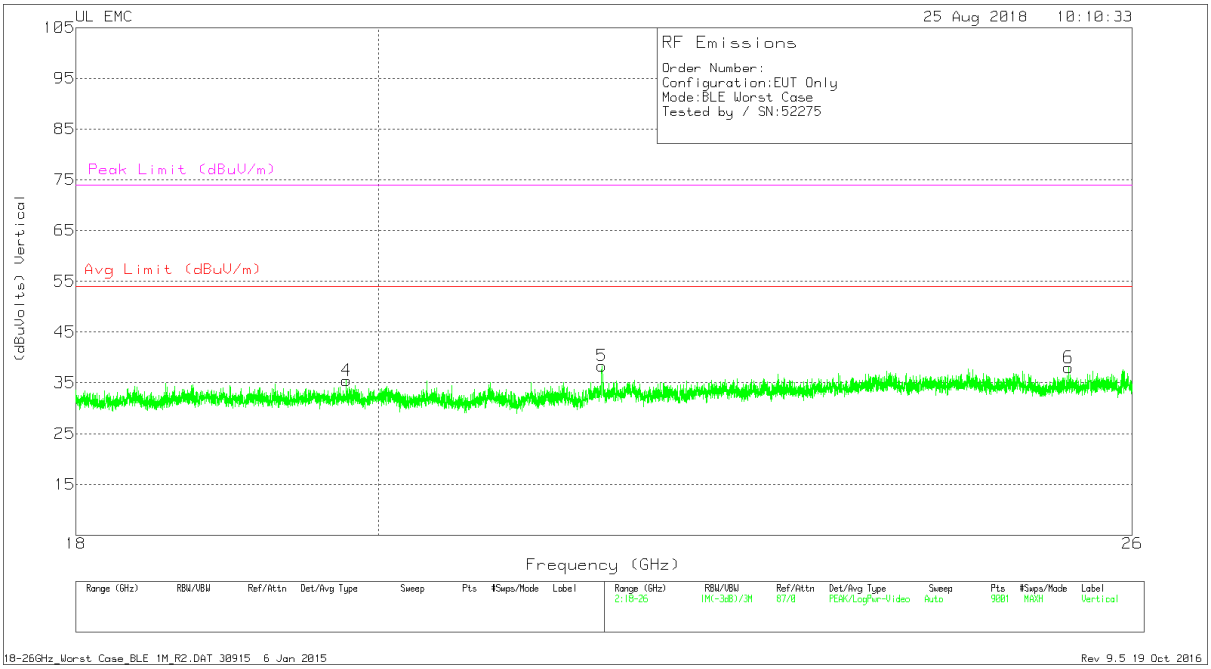
9.4. Worst Case 18-26 GHz

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



HORIZONTAL



VERTICAL

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18 – 26GHz 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	19.58	38.07	Pk	32.5	-25.2	-9.5	35.87			74	-38.13
	19.215	26.08	Av	32.3	-24.9	-9.5	23.98	54	-30.02		
2	21.616	41.13	Pk	33.2	-25.2	-9.5	39.63			74	-34.37
	21.616	32.47	Av	33.2	-25.2	-9.5	30.97	54	-23.03		
3	22.546	38.04	Pk	33.4	-25	-9.5	36.94			74	-37.06
	22.48	24.05	Av	33.3	-24.8	-9.5	23.05	54	-30.95		
4	19.777	37.07	Pk	32.6	-24.7	-9.5	35.47	54	-18.53	74	-38.53
5	21.616	39.86	Pk	33.2	-25.2	-9.5	38.36	54	-15.64	74	-35.64
	21.617	34.51	Av	33.2	-25.2	-9.5	33.01	54	-20.99		
6	25.429	37.99	Pk	33.8	-24.3	-9.5	37.99	54	-16.01	74	-36.01

Pk - Peak detector

Av - Average detection

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10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

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

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

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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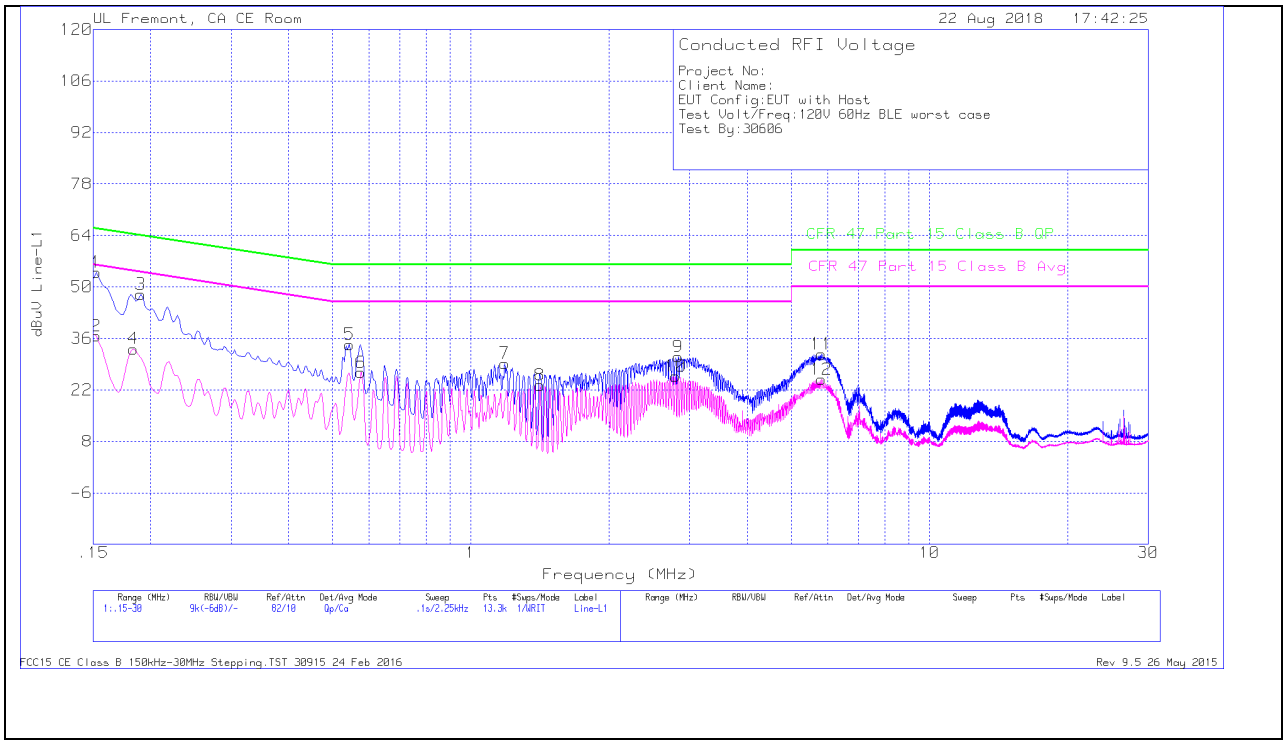
10.1. EUT POWERED BY HOST PC VIA USB CABLE

LINE 1 RESULTS



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	.15225	43.77	Qp	.1	0	10.1	53.97	65.88	-11.91	-	-
2	.15225	26.48	Ca	.1	0	10.1	36.68	-	-	55.88	-19.2
3	.1905	37.89	Qp	0	0	10.1	47.99	64.01	-16.02	-	-
4	.18375	23.06	Ca	0	0	10.1	33.16	-	-	54.31	-21.15
5	.54375	24.24	Qp	0	0	10.1	34.34	56	-21.66	-	-
6	.57525	16.62	Ca	0	0	10.1	26.72	-	-	46	-19.28
7	1.185	18.99	Qp	0	.1	10.1	29.19	56	-26.81	-	-
8	1.4145	13.06	Ca	0	.1	10.1	23.26	-	-	46	-22.74
9	2.83425	20.78	Qp	0	.1	10.1	30.98	56	-25.02	-	-
10	2.79375	15.52	Ca	0	.1	10.1	25.72	-	-	46	-20.28
11	5.81325	21.33	Qp	0	.2	10.2	31.73	60	-28.27	-	-
12	5.81325	14.44	Ca	0	.2	10.2	24.84	-	-	50	-25.16

Qp - Quasi-Peak detector
Ca - CISPR average detection

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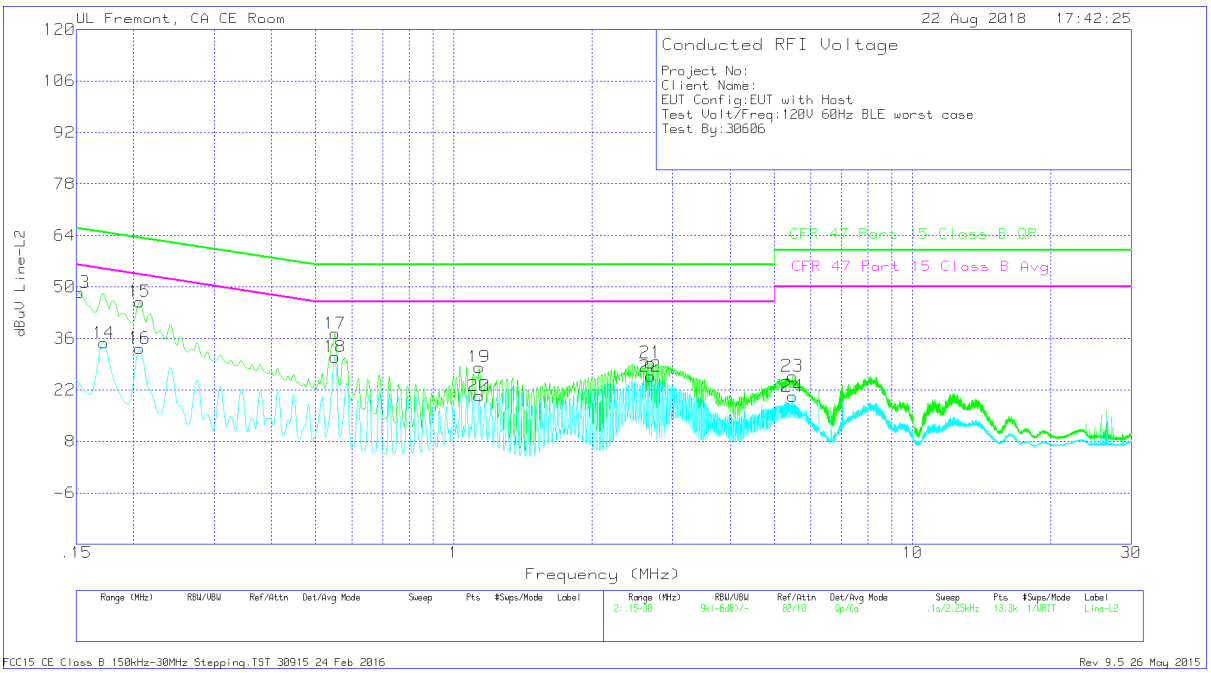
LINE 2 RESULTS



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	.15225	38.29	Qp	.1	0	10.1	48.49	65.88	-17.39	-	-
14	.1725	24.64	Ca	0	0	10.1	34.74	-	-	54.84	-20.1
15	.20625	35.89	Qp	0	0	10.1	45.99	63.35	-17.36	-	-
16	.20625	23.19	Ca	0	0	10.1	33.29	-	-	53.35	-20.06
17	.5505	27.21	Qp	0	0	10.1	37.31	56	-18.69	-	-
18	.5505	20.87	Ca	0	0	10.1	30.97	-	-	46	-15.03
19	1.1355	18	Qp	0	.1	10.1	28.2	56	-27.8	-	-
20	1.1355	10.2	Ca	0	.1	10.1	20.4	-	-	46	-25.6
21	2.6835	19.17	Qp	0	.1	10.1	29.37	56	-26.63	-	-
22	2.6835	15.5	Ca	0	.1	10.1	25.7	-	-	46	-20.3
23	5.469	15.57	Qp	0	.1	10.1	25.77	60	-34.23	-	-
24	5.469	10.08	Ca	0	.1	10.1	20.28	-	-	50	-29.72

Qp - Quasi-Peak detector
Ca - CISPR average detection

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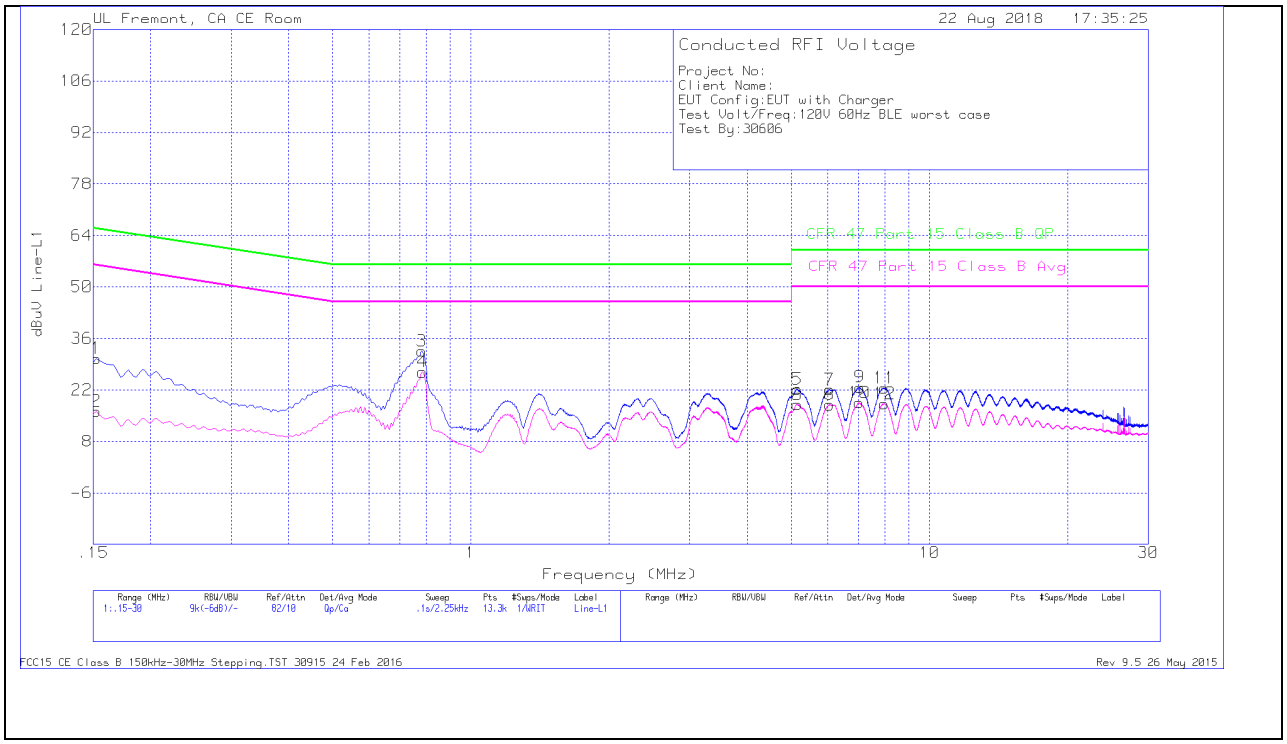
10.2. EUT POWERED BY AC/DC ADAPTER VIA USB CABLE

LINE 1 RESULTS



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	.15225	20.38	Qp	.1	0	10.1	30.58	65.88	-35.3	-	-
2	.15225	6	Ca	.1	0	10.1	16.2	-	-	55.88	-39.68
3	.78225	22.42	Qp	0	0	10.1	32.52	56	-23.48	-	-
4	.7845	16.76	Ca	0	0	10.1	26.86	-	-	46	-19.14
5	5.14725	11.97	Qp	0	.1	10.1	22.17	60	-37.83	-	-
6	5.1495	7.86	Ca	0	.1	10.1	18.06	-	-	50	-31.94
7	6.0585	11.74	Qp	0	.2	10.2	22.14	60	-37.86	-	-
8	6.0585	7.57	Ca	0	.2	10.2	17.97	-	-	50	-32.03
9	7.0395	12.32	Qp	0	.2	10.2	22.72	60	-37.28	-	-
10	7.0305	8.1	Ca	0	.2	10.2	18.5	-	-	50	-31.5
11	7.96425	12.1	Qp	0	.2	10.2	22.5	60	-37.5	-	-
12	7.97775	7.82	Ca	0	.2	10.2	18.22	-	-	50	-31.78

Qp - Quasi-Peak detector
Ca - CISPR average detection

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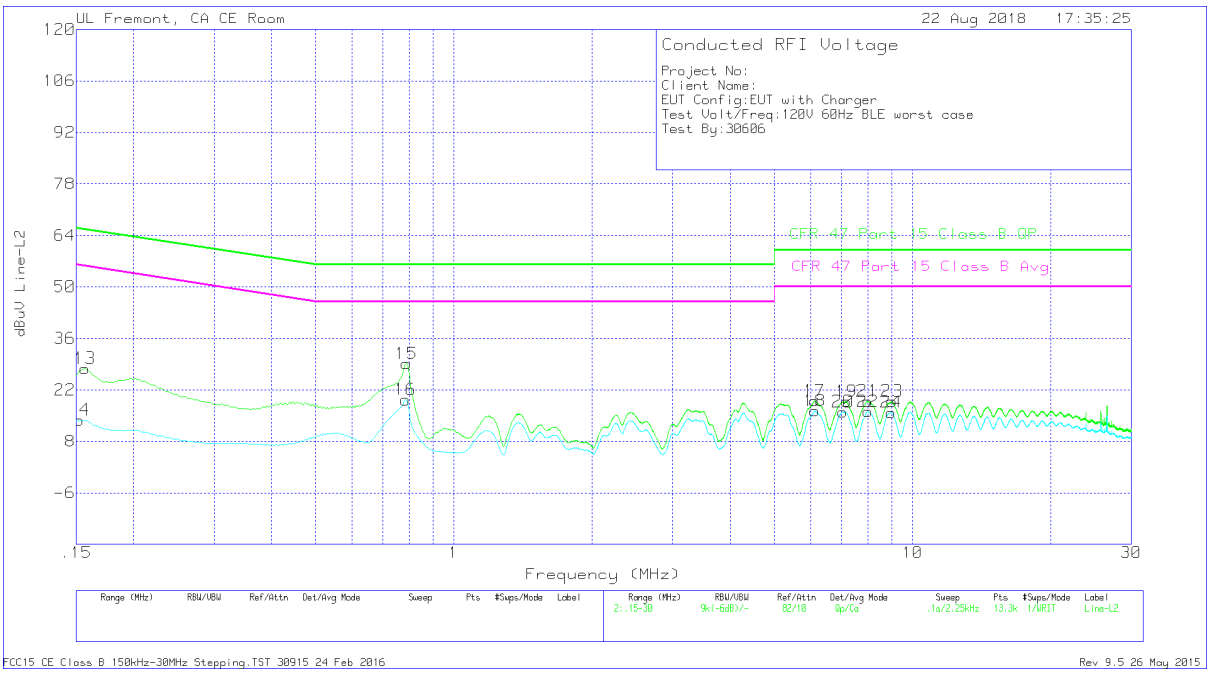
LINE 2 RESULTS



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	.15675	17.6	Qp	.1	0	10.1	27.8	65.63	-37.83	-	-
14	.15225	3.62	Ca	.1	0	10.1	13.82	-	-	55.88	-42.06
15	.78787	19.01	Qp	0	0	10.1	29.11	56	-26.89	-	-
16	.7845	9.23	Ca	0	0	10.1	19.33	-	-	46	-26.67
17	6.11588	8.64	Qp	0	.2	10.2	19.04	60	-40.96	-	-
18	6.12375	5.89	Ca	0	.2	10.2	16.29	-	-	50	-33.71
19	7.17788	8.46	Qp	0	.2	10.2	18.86	60	-41.14	-	-
20	7.053	5.63	Ca	0	.2	10.2	16.03	-	-	50	-33.97
21	7.989	8.53	Qp	0	.2	10.2	18.93	60	-41.07	-	-
22	7.99125	5.7	Ca	0	.2	10.2	16.1	-	-	50	-33.9
23	9.02625	8.51	Qp	0	.2	10.2	18.91	60	-41.09	-	-
24	8.988	5.48	Ca	0	.2	10.2	15.88	-	-	50	-34.12

Qp - Quasi-Peak detector
Ca - CISPR average detection

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11. SETUP PHOTOS

Please refer to 12458150-EP1V1 for setup photos

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