CERTIFICATION TEST REPORT

Report Number. : 11747590-E1V6

Applicant	:	ENERGOUS CORPORATION 3590 NORTH FIRST STREET SAN JOSE, CA 95134 USA
Model	:	MS-300
FCC ID	:	2ADNG-MS300
EUT Description	:	Wireless charger
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C

Date Of Issue:
December 19, 2017

Prepared by:
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	05/08/17	Initial Issue	C. Vergonio
V2	06/01/17	Updated KDB to latest version in Section 2 and Section 7.1.	C. Vergonio
V3	10/03/17	Revised section 5.1	Michael Heckrotte
V4	12/04/17	Revised section 5.2, section 6 and update NVLAP logo	Dan Coronia
V5	12/13/17	Revised section 1 and section 5.1	Dan Coronia
V6	12/19/17	Revised section 5.1	Dave Weaver

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Energous Corporation
3590 North First Street
San Jose, CA 95134 USA

EUT DESCRIPTION: Wireless charger

MODEL: MS-300

SERIAL NUMBER: MS300-WN003

DATE TESTED: April 25 – May 3, 2017

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

CHARLES VERGONIO
WiSE Project Lead
UL VERIFICATION SERVICES INC.

Prepared By:

KIYA KEDIDA
WiSE Lab Engineer
UL VERIFICATION SERVICES INC.

2. TEST METHODOLOGY

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

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:2324B-4)
☒ Chamber B (IC:2324B-2)	☒ Chamber E (IC:2324B-5)
☐ Chamber C (IC:2324B-3)	☐ Chamber F (IC:2324B-6)
	☐ Chamber G (IC:2324B-7)
	☐ Chamber H (IC:2324B-8)

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.

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%.

5. EQUIPMENT UNDER TEST

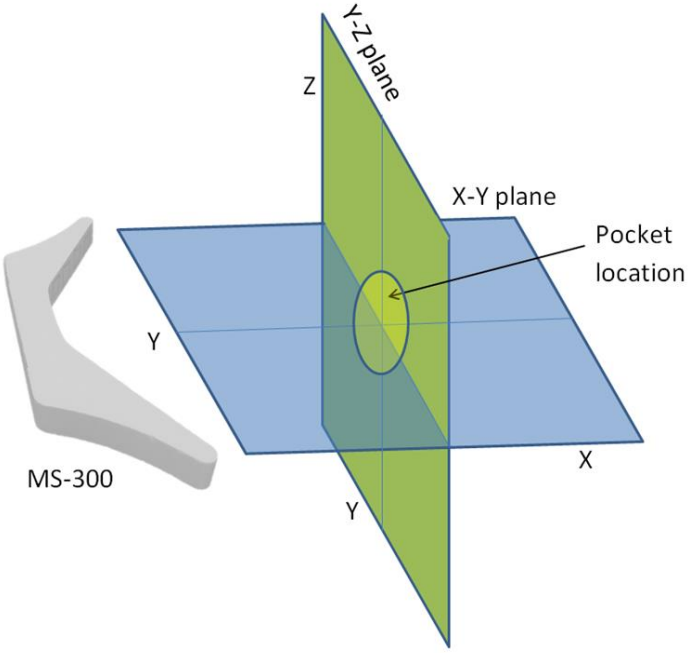
5.1. DESCRIPTION OF EUT

The MS-300 is a wireless power charging system that delivers RF energy to a Client Device seeking to be charged when positioned within the Charging Zone. The Charging Zone of the MS-300 is up to 90 cm for Client Devices placed in front of the MS-300, i.e. Client Devices within 90 cm of the front of the MS-300 may be charged; Client Devices further than 90 cm or outside an angle of ±35° from a centerline projecting from the front of the MS-300 will not be charged.

The MS-300 transfers RF energy at 913MHz. The MS-300 does not transmit information at this frequency. Data communication, for example for the authentication of client devices, is performed through standard 2.4 GHz BLE protocols. The MS-300 will only charge Client Devices that can authenticate.

The MS-300 falls under FCC Part 18.107(c) because it is designed to generate and use RF energy locally to charge domestic consumer electronic devices. The MS-300 transfers RF energy from the front of the transmitter and creates a pocket around the authenticated Client Device that will be charged. The Client Device uses this energy to power itself or charge internal batteries. The MS-300 is intended to be used by the general public in a residential or office environment.

The image below illustrates the RF pocket formed around a Client Device.



The MS-300 has an internal communication system to ensure it is working as designed. Once the MS-300 begins transferring RF energy to an authenticated Client Device, the communication system continues to monitor and track through proprietary fail-safes to ensure proper operation. If any single fail-safe is triggered, the RF transmission from the MS-300 is immediately shut down.

The MS-300 has five fail-safe features:

1) Self-check procedure to ensure proper operation of the motion detection sensors.
2) Self-check procedure to ensure no motion is detected in the Keep-Out Zone.
3) Self-check procedure to ensure proper operation of the BLE.
4) Self-check procedure to ensure proper operation of the MS-300 system.
5) Self-check procedure to determine if the Client Device is in the Charging Zone.

The Keep-Out Zone, is a zone within 50cm of the front of the transmitter where charging is suspended when motion is detected. This zone is established to provide an additional margin of RF safety. The MS-300 motion detection sensors are designed to detect all types of motion including breathing. The sensors are not designed to detect an inanimate object. Once motion is detected in the Keep-Out Zone, a timer in the MS-300 system will hold the transmitter in an off-state for 30 seconds. Any subsequent motion detected will hold the transmitter in an off-state and restart the timer.

The MS-300 will determine if the Client Device is located in the Charging Zone and oriented adequately to receive power. This determination is made by comparing the power received by the Client Device as reported via the BLE link between the Client Device and the MS-300. The reported power must be 30mW or more before the MS-300 will enable energy transfer to the Client Device. The optimum orientation for maximum power transfer is with the Client Device's antenna facing directly towards the MS-300. The receive power decreases as the Client Device orientates toward the edges or back. If the MS-300 determines that the Client Device is not oriented adequately, then power transfer will not occur. Edge and back orientations are below the 30mW threshold and the MS-300 will not enable energy transfer in these configurations. Therefore, these orientations are not applicable for compliance testing.

Ultimately, the Client Device can be charged at any point within the Charging Zone if three conditions are met; all self-checks passed, the device is determined to be positioned in the Charging Zone, and the device is receiving sufficient power to charge.
This report covers the BLE portion of the EUT.

5.2. MAXIMUM OUTPUT POWER

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

Frequency Range (MHz)	Mode	Output Power Per Transmitter *		Total Output Power
		(dBm)	(mW	(mW)
2402 - 2480	BLE	-6.91	0.20	0.40

***NOTE:** The EUT is using two, identical BLE modules installed into either side of the system. As these are identical only one was tested. The margins for spurious emissions and output power have more than 3dB margin to the limit and thus the sum of the emissions from both transmitters would be below the limits.

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio is has a maximum peak gain of 2 dBi.

5.4. SOFTWARE AND FIRMWARE

The software installed in the EUT during testing was 3.0.17.48.

5.5. WORST-CASE CONFIGURATION AND MODE

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

The EUT is a tabletop device. Therefore, all final radiated testing was performed with the EUT in tabletop (X) orientation.

All testing was performed on Antenna port 0 and represents as the worst case port based on the output power results.

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

BLE: 1 Mbps.

5.6. ESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
AC/DC Adapter	Delta Elect. Inc.	MDS-090AAS15 B	861W321001P	N/A
Laptop	Dell	P61G	N/A	N/A

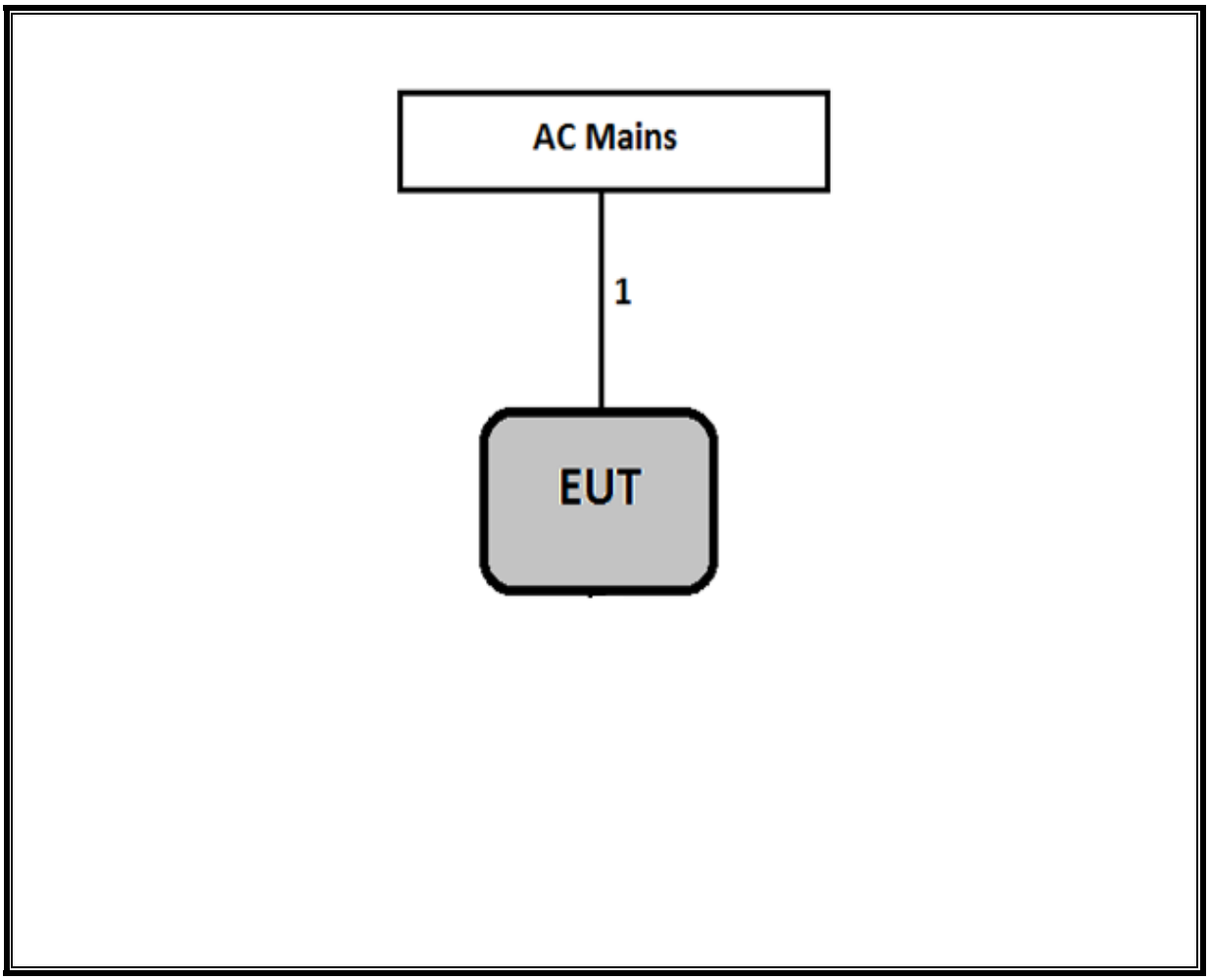
I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC Power	1	2-Prong	Unshielded	1	

TEST SETUP

The EUT is connected to an AC Mains. Test software exercised the EUT.

SETUP DIAGRAM



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, Broadband Hybrid, 30MHz to 2000MHz w/4dB Pad	Sunol Sciences	JB3	T899	06/15/2018
Antenna, Active Loop 9kHz-30MHz	ETS-Lindgren	6502	T1683	02/17/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T346	03/28/2018
Antenna, Horn 18-26.5GHz	ARA	MWH-1826/B	T449	05/26/2017
Amplifier, 1 to 8 GHz	Miteq	AMF-4D-01000800-30-29P	T1156	03/09/2018
Amplifier, 1 to 18 GHz	Miteq	AFS43-00101800-25-S-42	T493	02/15/2018
Pre-Amp 1-26.5 GHz	Agilent	8449B	T404	07/05/2017
RF Amplifier, 30MHz – 1GHz	MITEQ	AFS42-00101800-25-S-42	T493	02/15/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight)	N9030A	T907	01/23/2018
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Agilent (Keysight)	E9030A	T905	01/11/2018
LISN	FISCHER	FCC-LISN-50/250-25-2-01	T1310	06/08/2017
EMI Receiver	Rohde & Schwarz	ESR-EMI	1436	12/19/2017

Test Software List			
Description	**Manufacturer**	**Model**	**Version**
Radiated Software	UL	UL EMC	Ver 9.5, Apr 26, 2016
Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015
Antenna Port Software	UL	UL RF	Ver 5.1.1, July 15, 2016

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 9.1.1.

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.

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

7.2. ON TIME, DUTY CYCLE

LIMITS

None; for reporting purposes only.

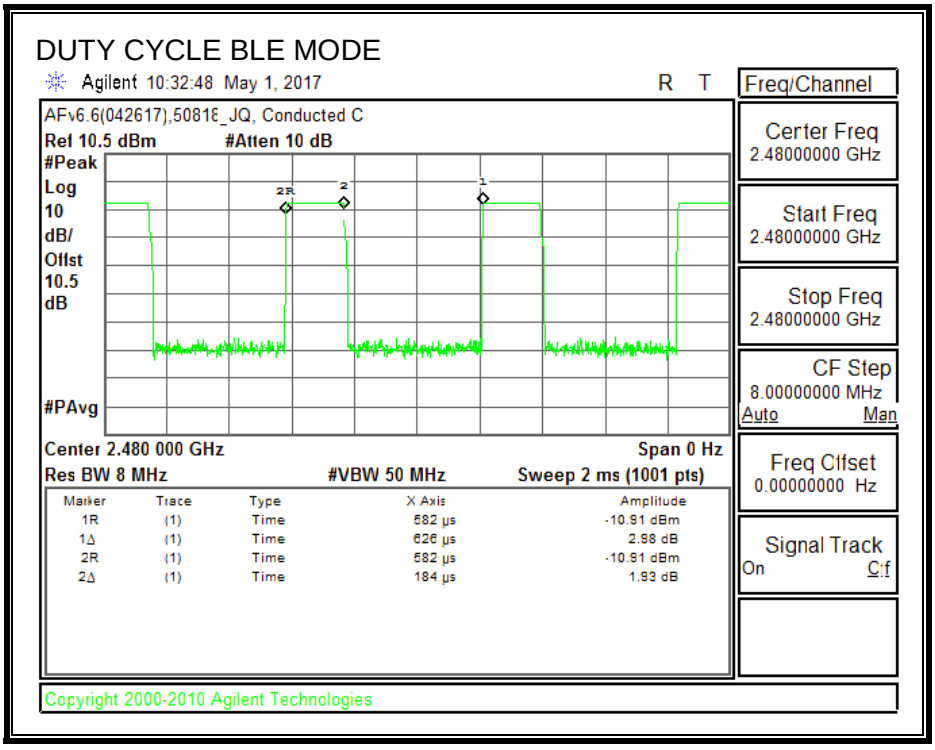
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
0.184	0.626	0.294	29.39%	5.32	5.435

DUTY CYCLE PLOTS



7.3. 6 dB BANDWIDTH

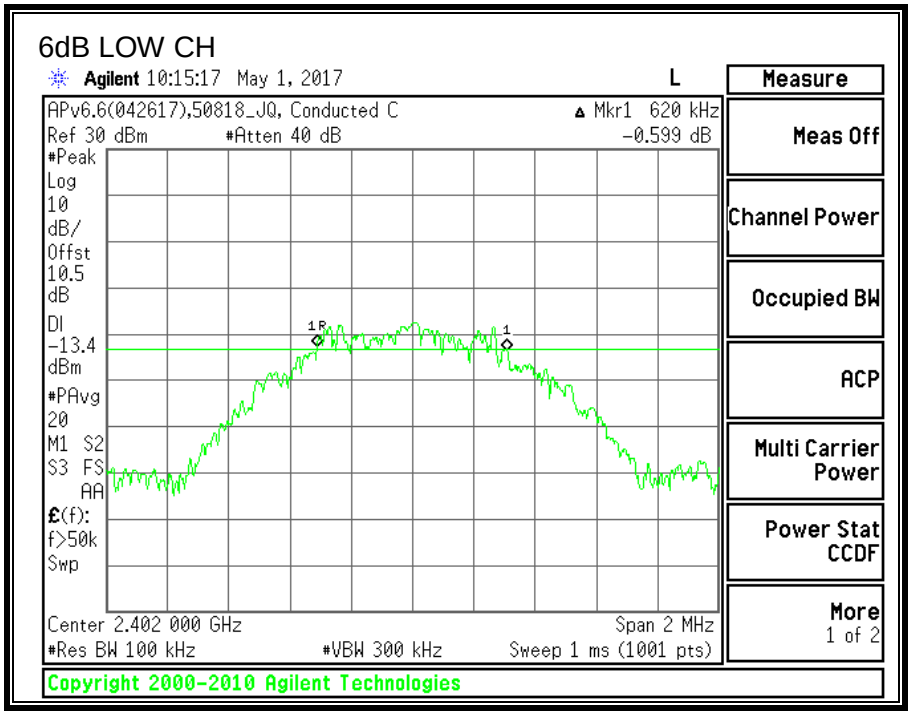
7.3.1. LIMITS

FCC §15.247 (a) (2)

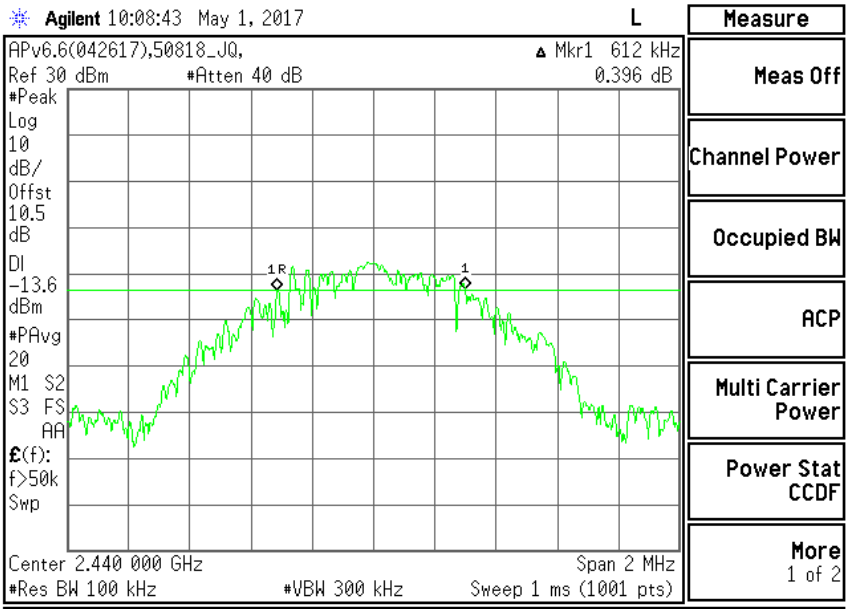
The minimum 6 dB bandwidth shall be at least 500 kHz.

7.3.2. RESULTS

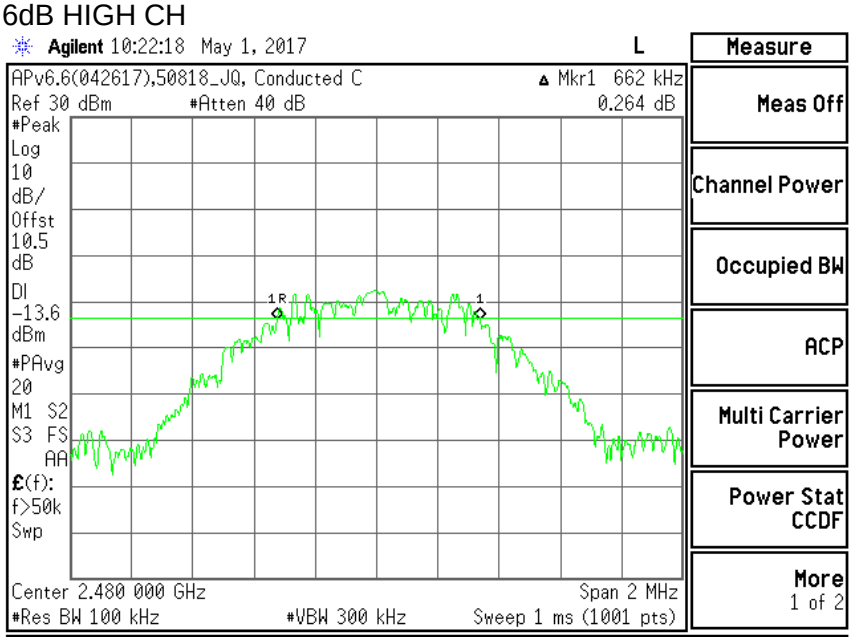
Channel	Frequency	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	.620	0.5
Middle	2440	.612	0.5
High	2480	.662	0.5



6dB MID CH



6dB HIGH CH



7.4. 99% BANDWIDTH

7.4.1. LIMITS

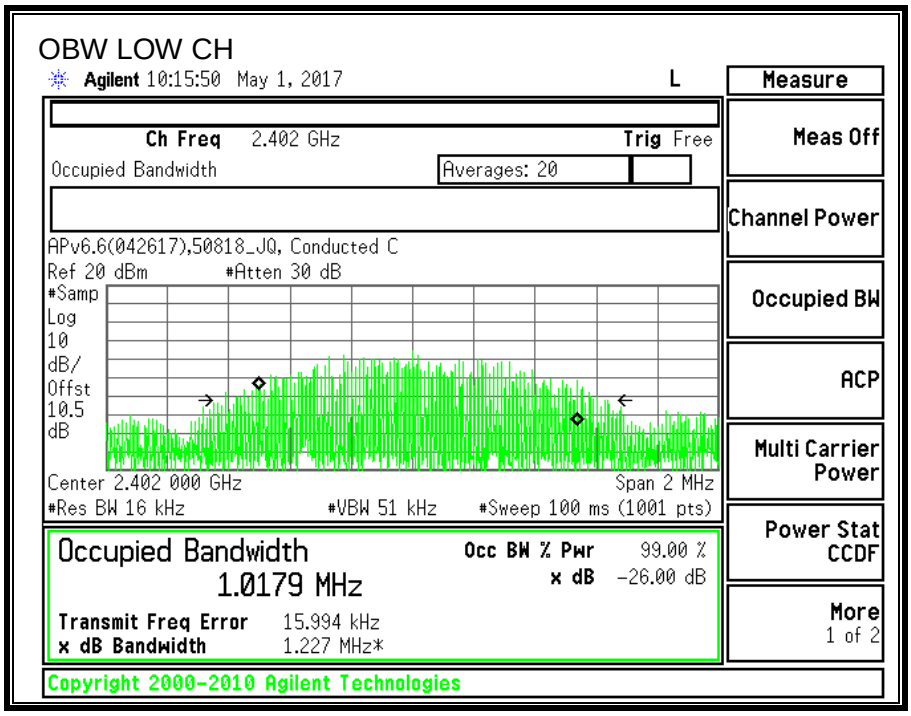
None; for reporting purposes only.

Test Procedure

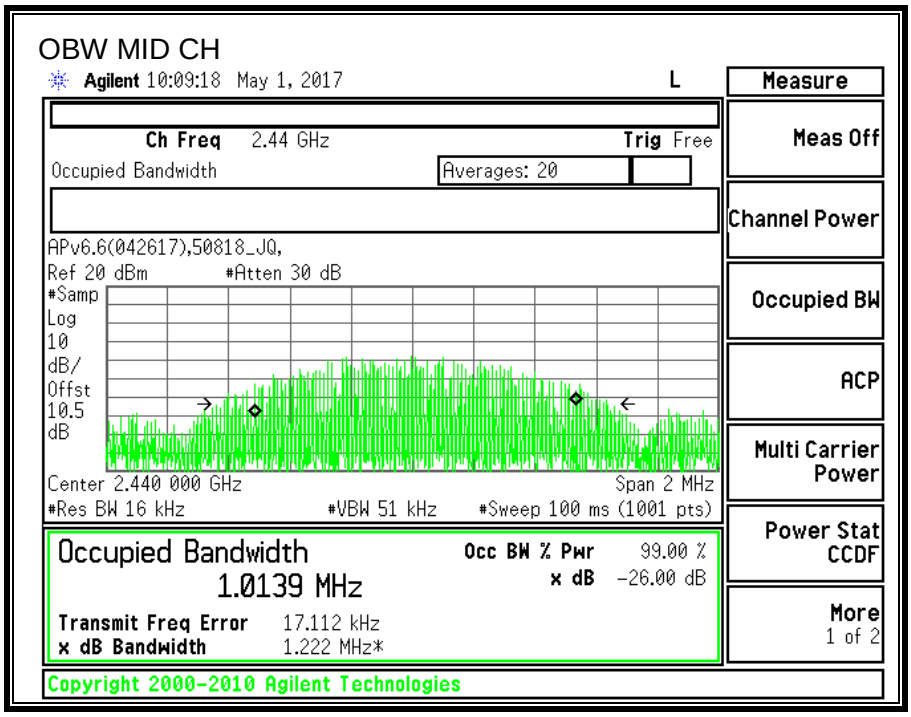
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth and to 1% of the span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

7.4.2. RESULTS

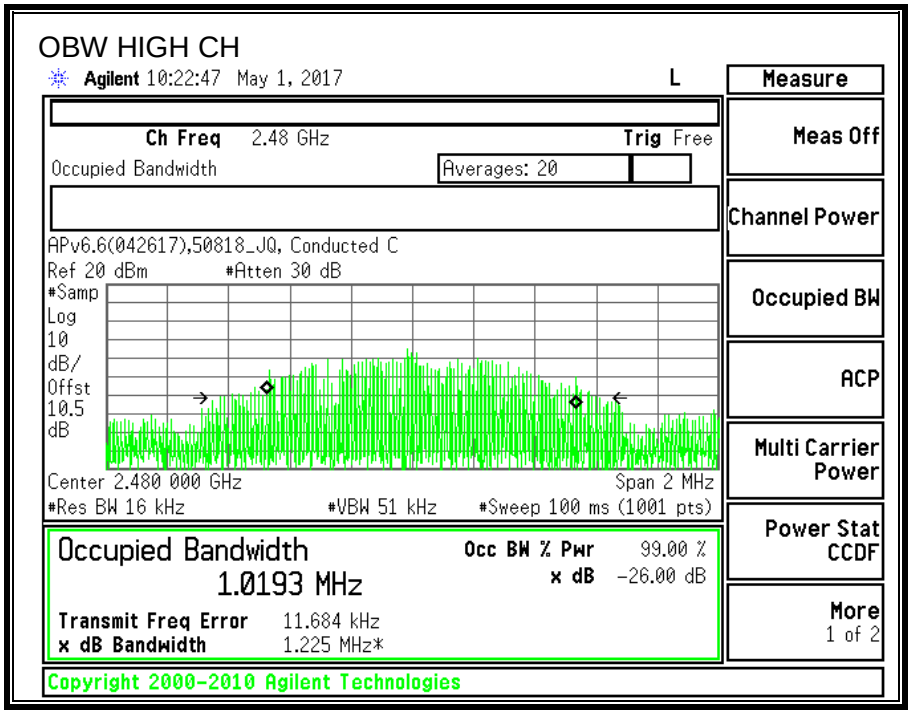
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.018
Middle	2440	1.014
High	2480	1.019



OBW MID CH



OBW HIGH CH



7.5. OUTPUT POWER

7.5.1. LIMITS

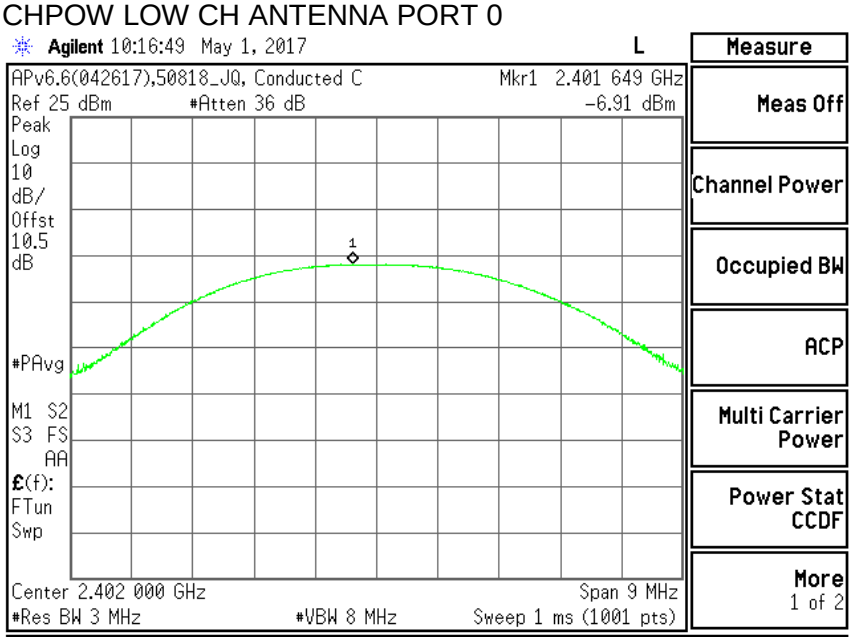
FCC §15.247 (b)

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

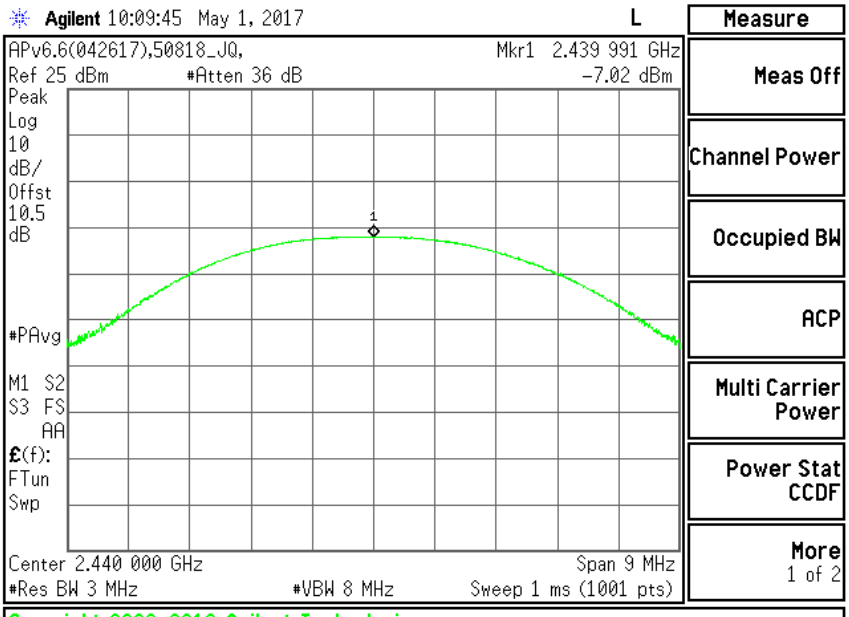
7.5.2. RESULTS

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Antenna Port 0				
Low	2402	-6.91	30	-36.91
Middle	2440	-7.02	30	-37.02
High	2480	-6.97	30	-36.97
Antenna Port 1				
Low	2402	-6.95	30	-36.95
Middle	2440	-7.07	30	-37.07
High	2480	-7.11	30	-37.11

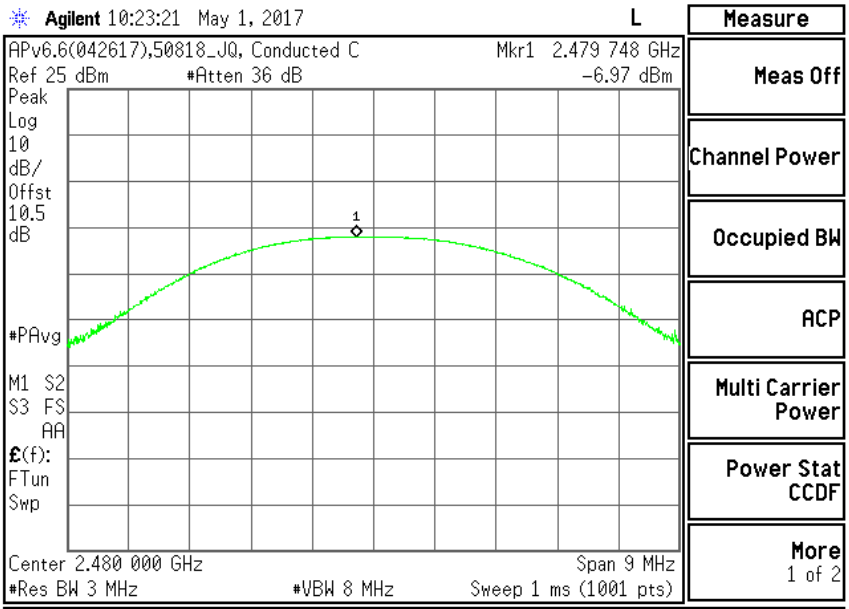
CHPOW LOW CH ANTENNA PORT 0



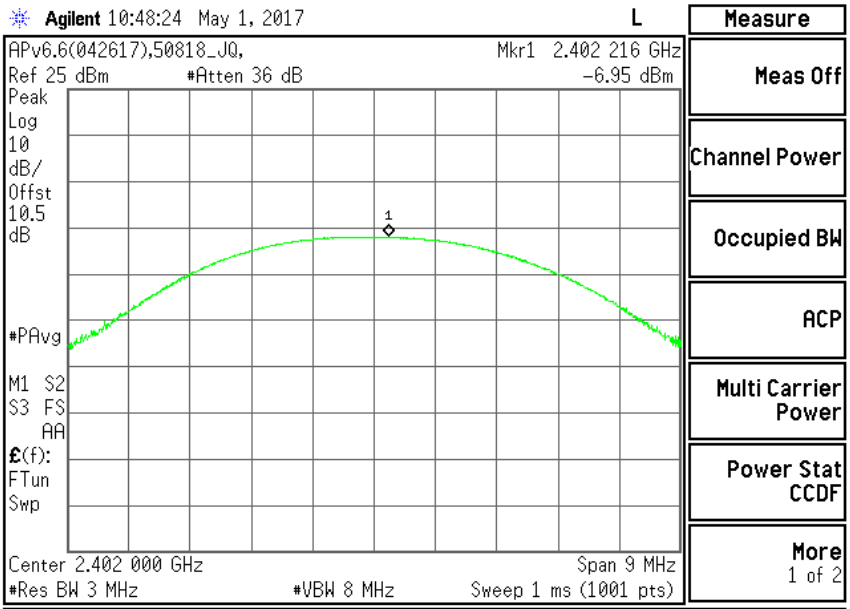
CHPOW MID CH ANTENNA PORT 0



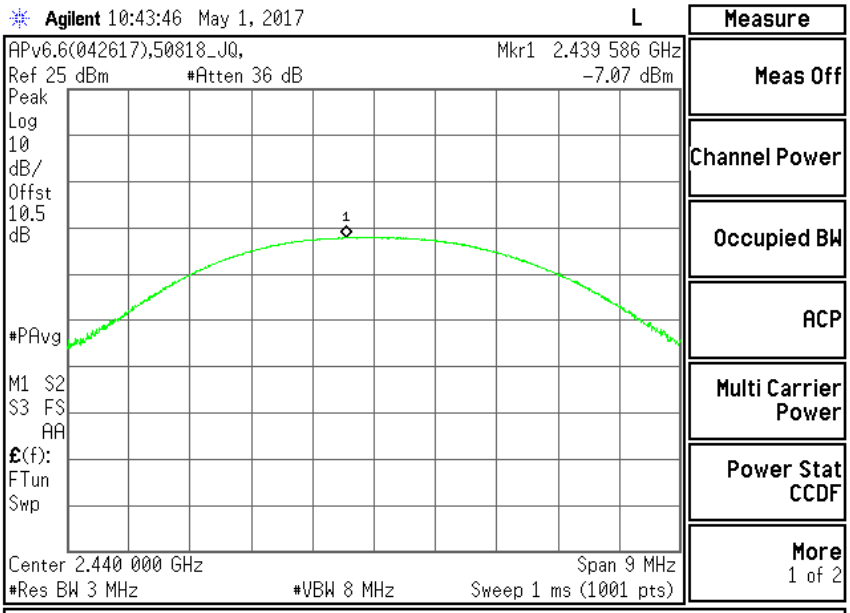
CHPOW HIGH CH ANTENNA PORT 0



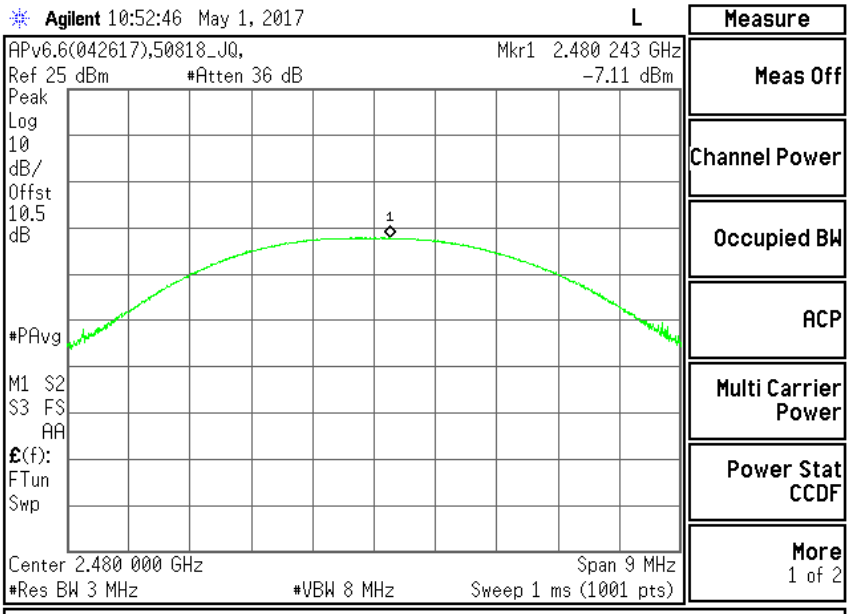
CHPOW LOW CH ANTENNA PORT 1



CHPOW MID CH ANTENNA PORT 1



CHPOW HIGH CH ANTENNA PORT 1



7.6. POWER SPECTRAL DENSITY

7.6.1. LIMITS

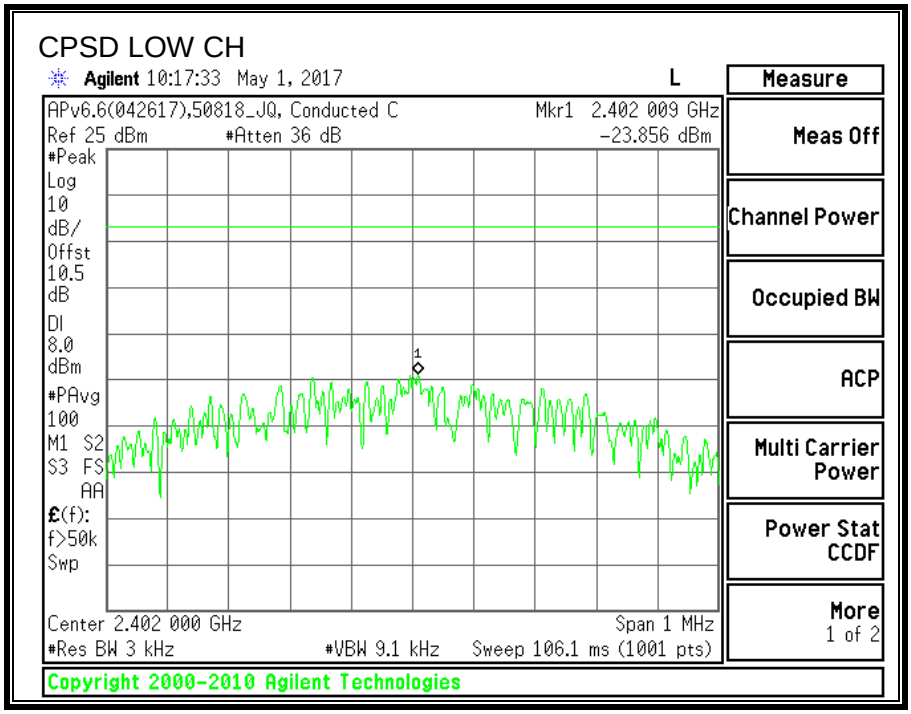
FCC §15.247 (e)

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

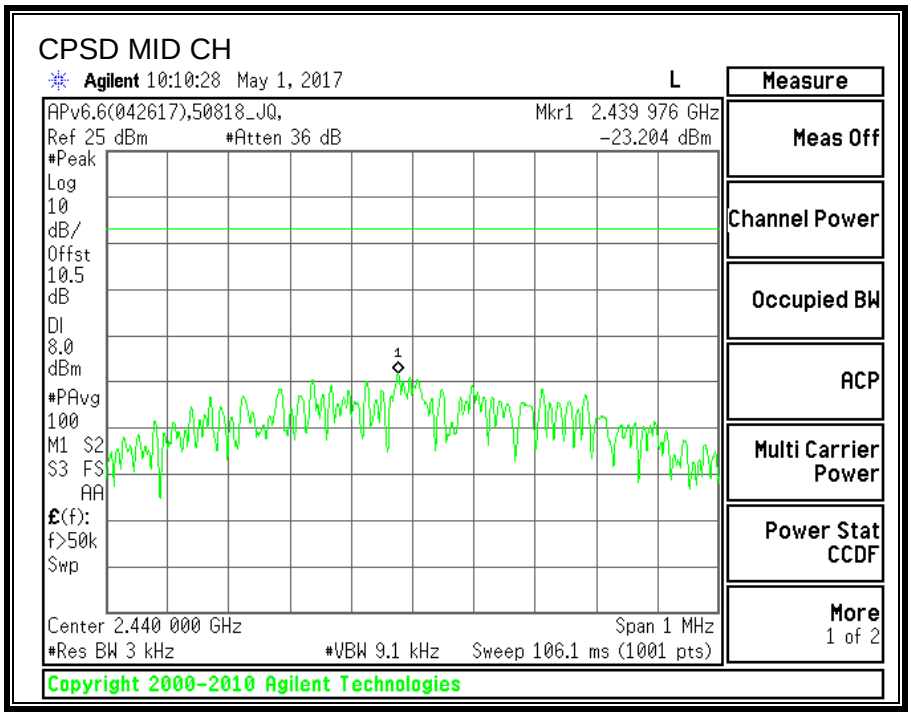
7.6.2. RESULTS

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-23.86	8	31.86
Middle	2440	-23.20	8	-31.20
High	2480	-23.51	8	-31.51

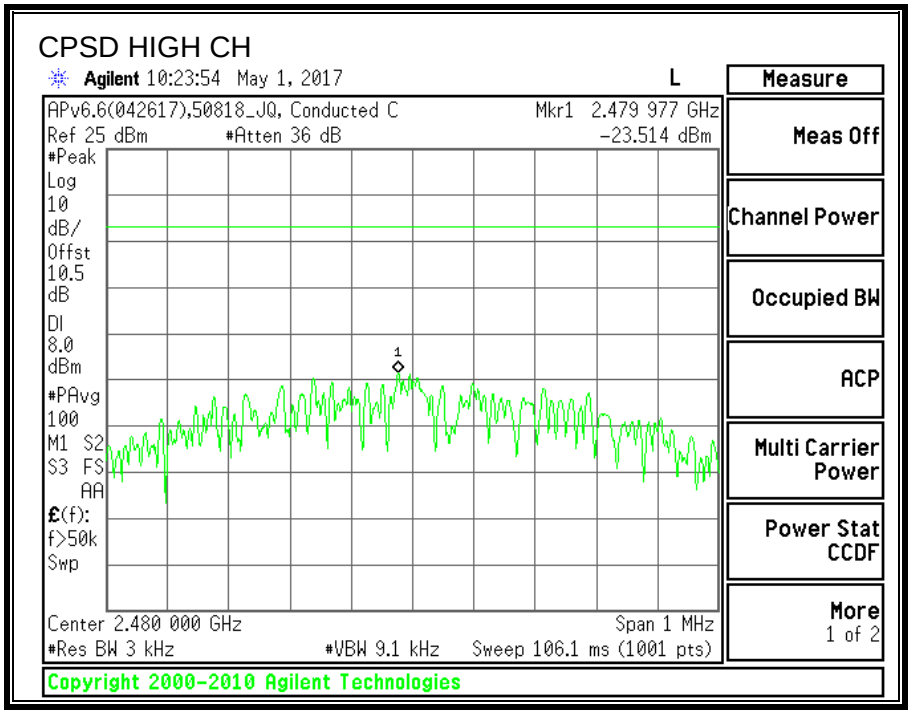
CPSD LOW CH



CPSD MID CH



CPSD HIGH CH



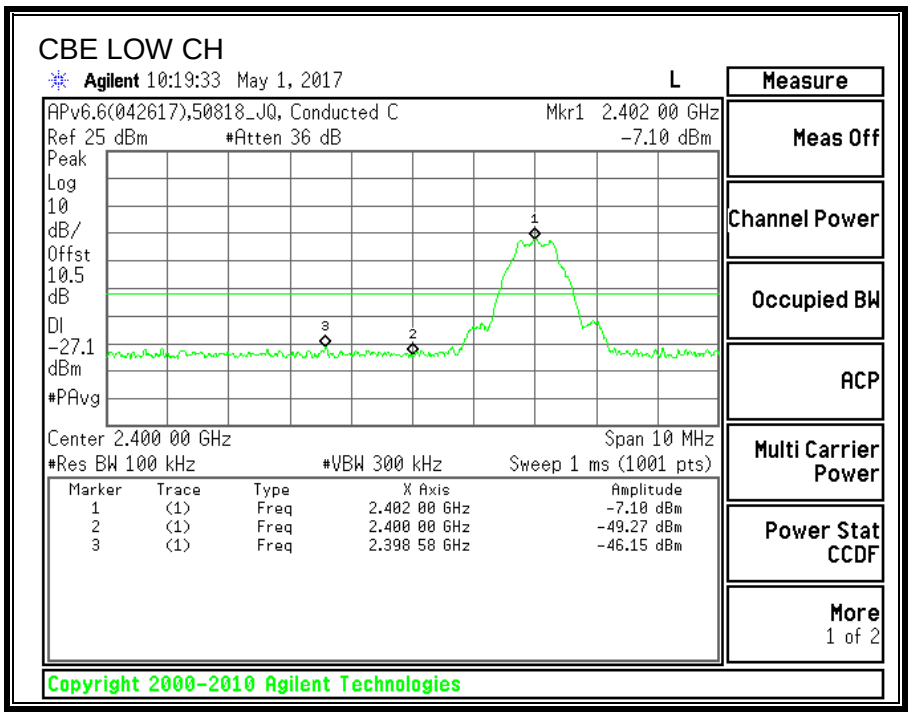
7.7. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

7.7.1. LIMITS

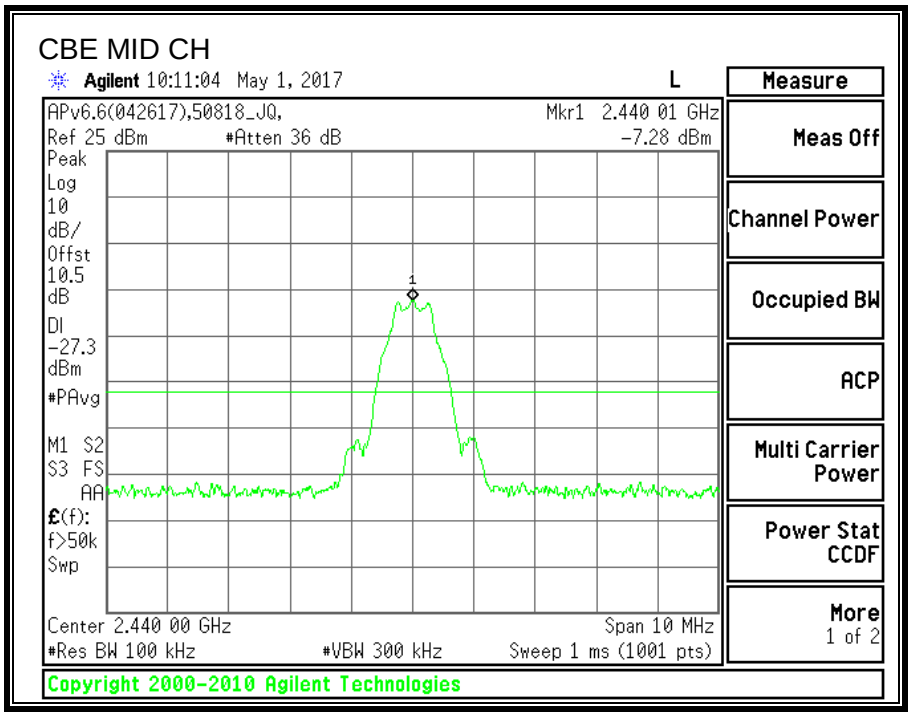
FCC §15.247 (d)

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

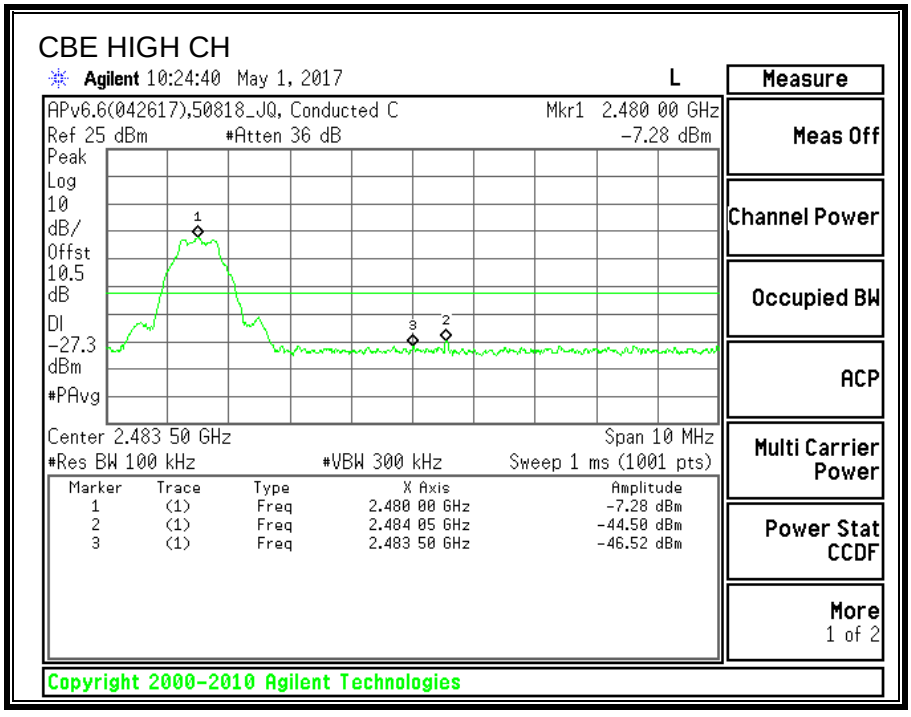
7.7.2. RESULTS



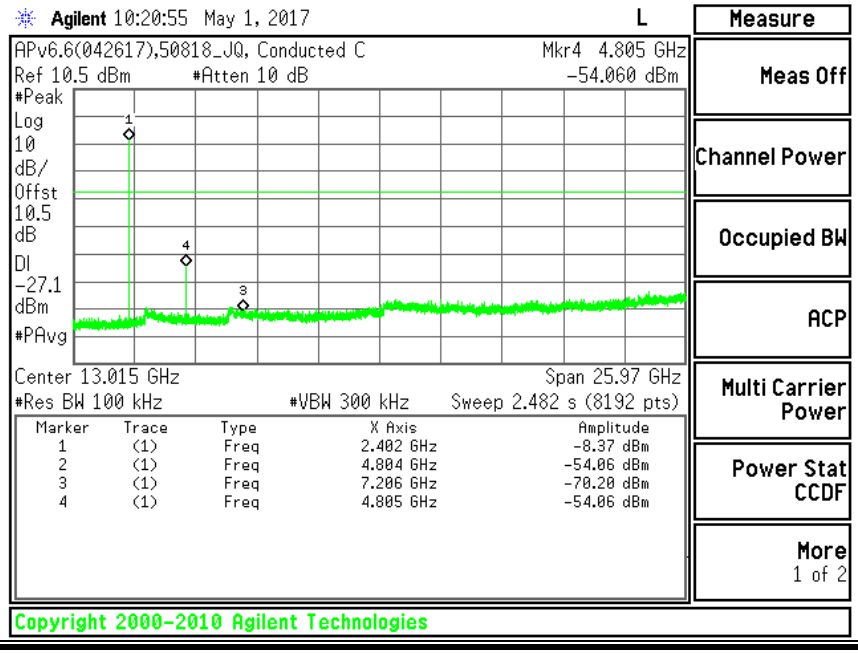
CBE MID CH



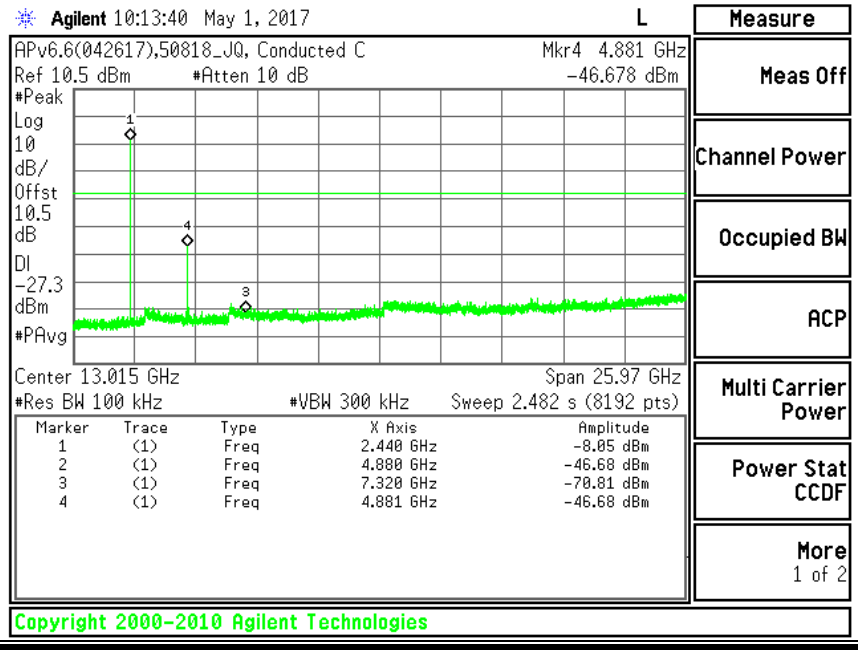
CBE HIGH CH

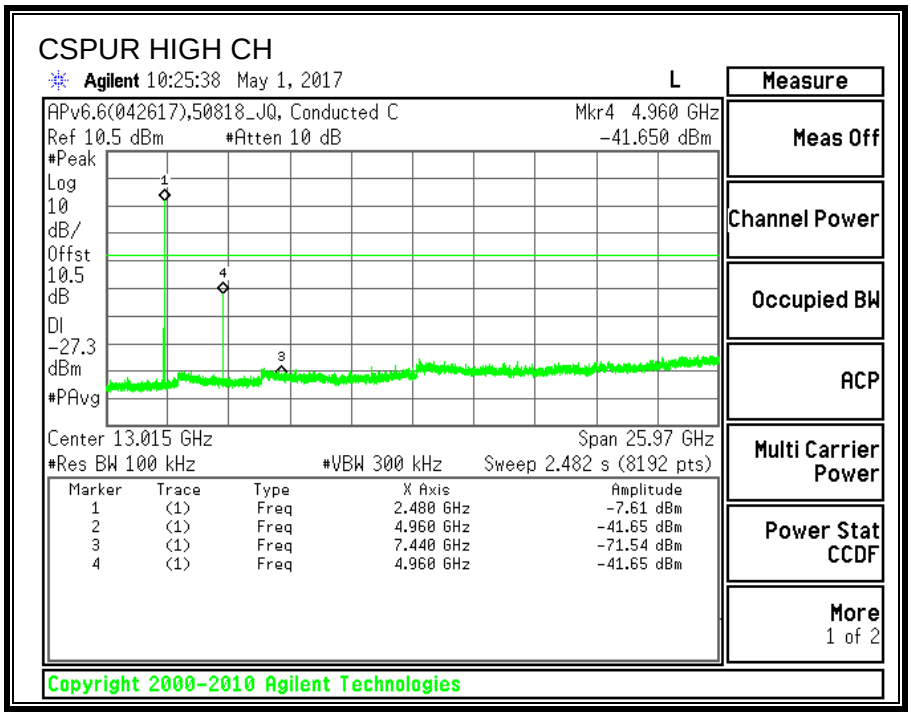


CSPUR LOW CH



CSPUR MID CH





8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

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) @ 300m	-
0.490-1.705	24000/F(kHz) @ 30m	-
1.705-30.0	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.

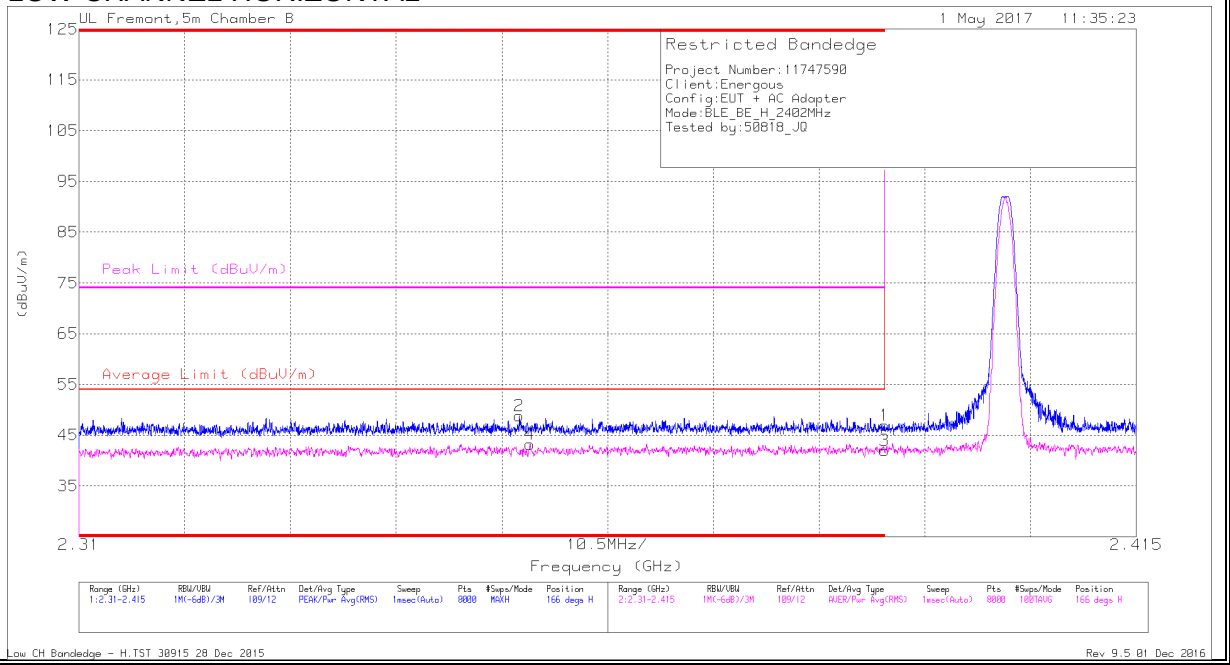
For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

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.

8.2. RESTRICTED BANDEDGE (LOW CHANNEL)

LOW CHANNEL HORIZONTAL



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	36.27	Pk	32	-21.3	0	46.97	-	-	74	-27.03	166	288	H
2	* 2.354	38.19	Pk	31.9	-21.3	0	48.79	-	-	74	-25.21	166	288	H
3	* 2.39	25.9	RMS	32	-21.3	5.32	41.92	54	-12.08	-	-	166	288	H
4	* 2.355	27.2	RMS	31.9	-21.2	5.32	43.22	54	-10.78	-	-	166	288	H

* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
Pk - Peak detector
RMS - RMS detection

LOW CHANNEL VERTICAL

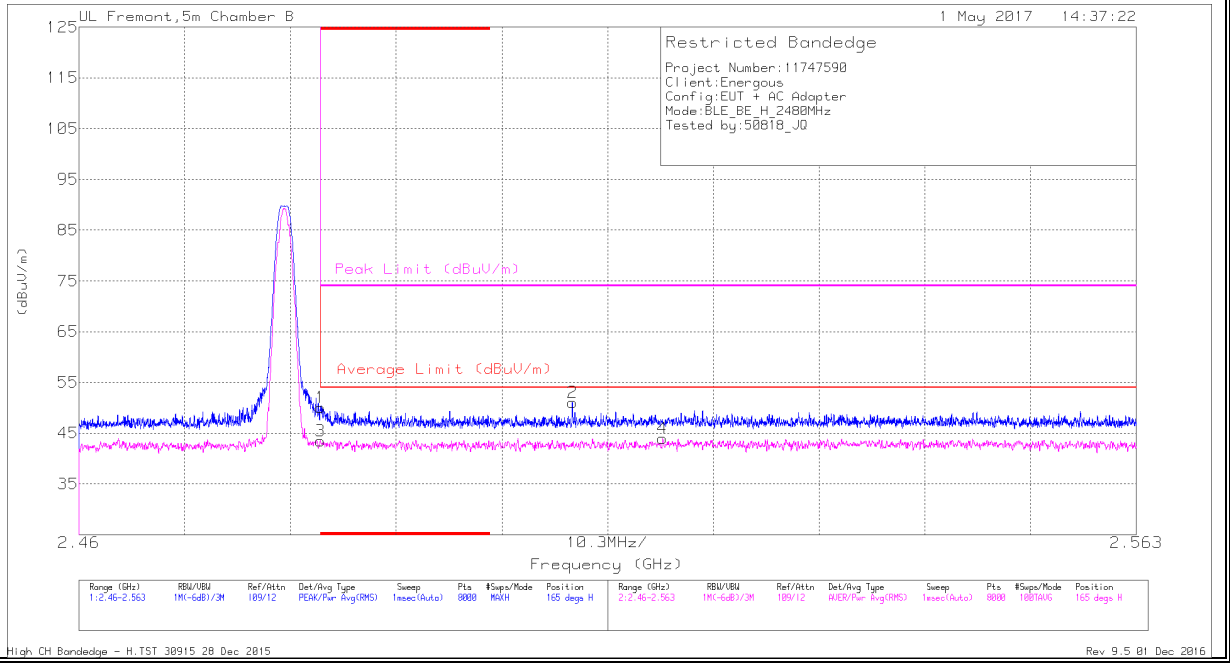
Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.33	38.58	Pk	31.8	-21.3	0	49.08	-	-	74	-24.92	184	228	V
4	* 2.382	27.59	RMS	31.9	-21.3	5.32	43.51	54	-10.49	-	-	184	228	V
1	* 2.39	35.4	Pk	32	-21.3	0	46.1	-	-	74	-27.9	184	228	V
3	* 2.39	25.91	RMS	32	-21.3	5.32	41.93	54	-12.07	-	-	184	228	V

* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
Pk - Peak detector
RMS - RMS detection

8.3. AUTHORIZED BANDEDGE (HIGH CHANNEL)

HIGH CHANNEL HORIZONTAL

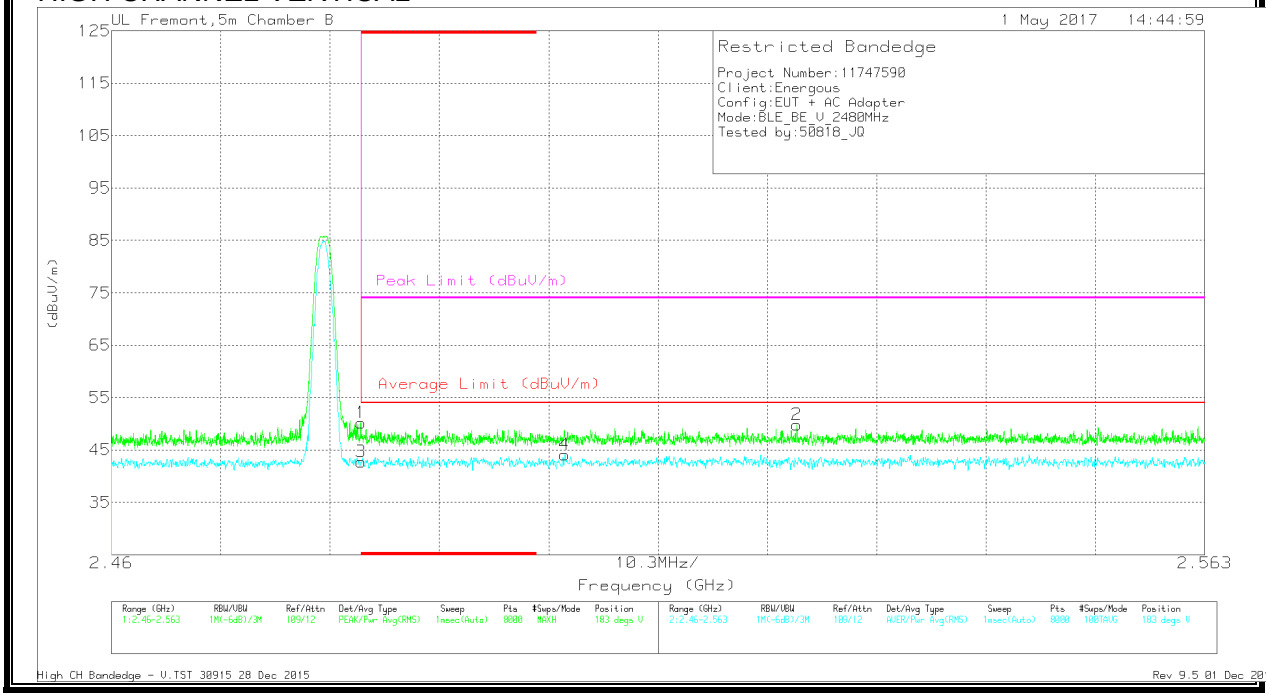


Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	39.12	Pk	32.1	-21.2	0	50.02	-	-	74	-23.98	165	211	H
3	* 2.484	27.26	RMS	32.1	-21.2	5.32	43.48	54	-10.52	-	-	165	211	H
2	2.508	40.15	Pk	32.1	-21.2	0	51.05	-	-	74	-22.95	165	211	H
4	2.517	27.6	RMS	32.1	-21.1	5.32	43.92	54	-10.08	-	-	165	211	H

* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
Pk - Peak detector
RMS - RMS detection

HIGH CHANNEL VERTICAL



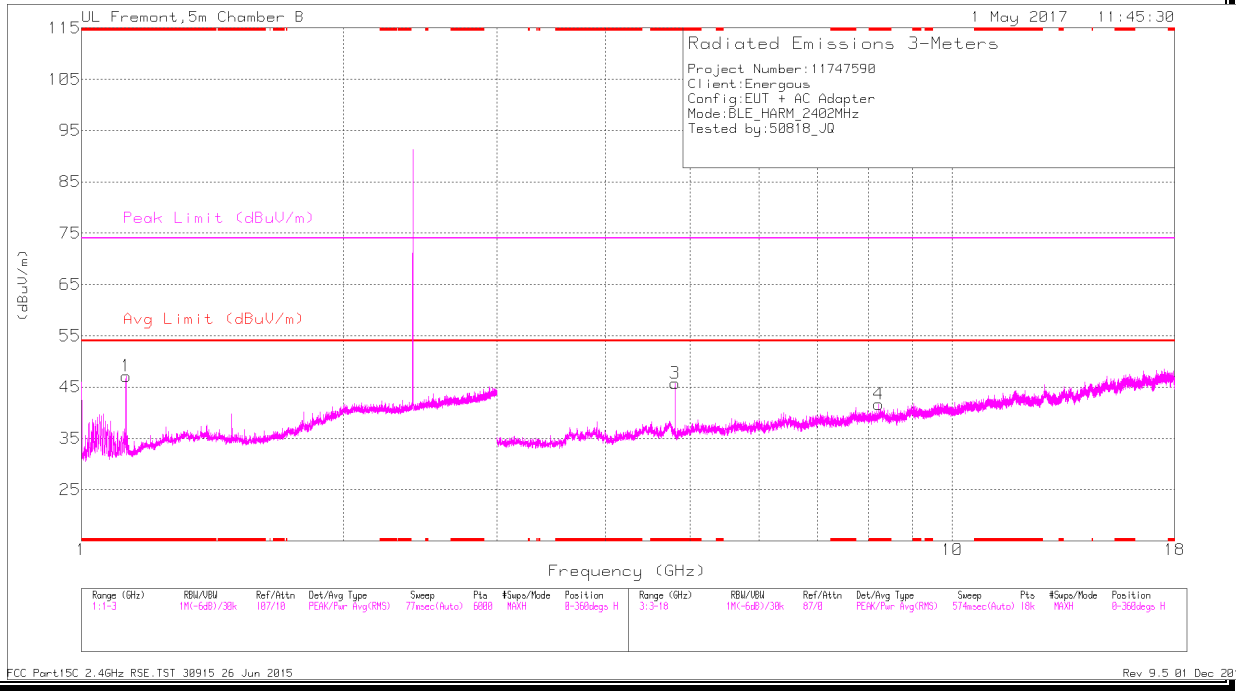
Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	39.29	Pk	32.1	-21.2	0	50.19	-	-	74	-23.81	183	160	V
3	* 2.484	26.49	RMS	32.1	-21.2	5.32	42.71	54	-11.29	-	-	183	160	V
4	2.503	27.87	RMS	32.1	-21.2	5.32	44.09	54	-9.91	-	-	183	160	V
2	2.525	38.74	Pk	32.1	-21.1	0	49.74	-	-	74	-24.26	183	160	V

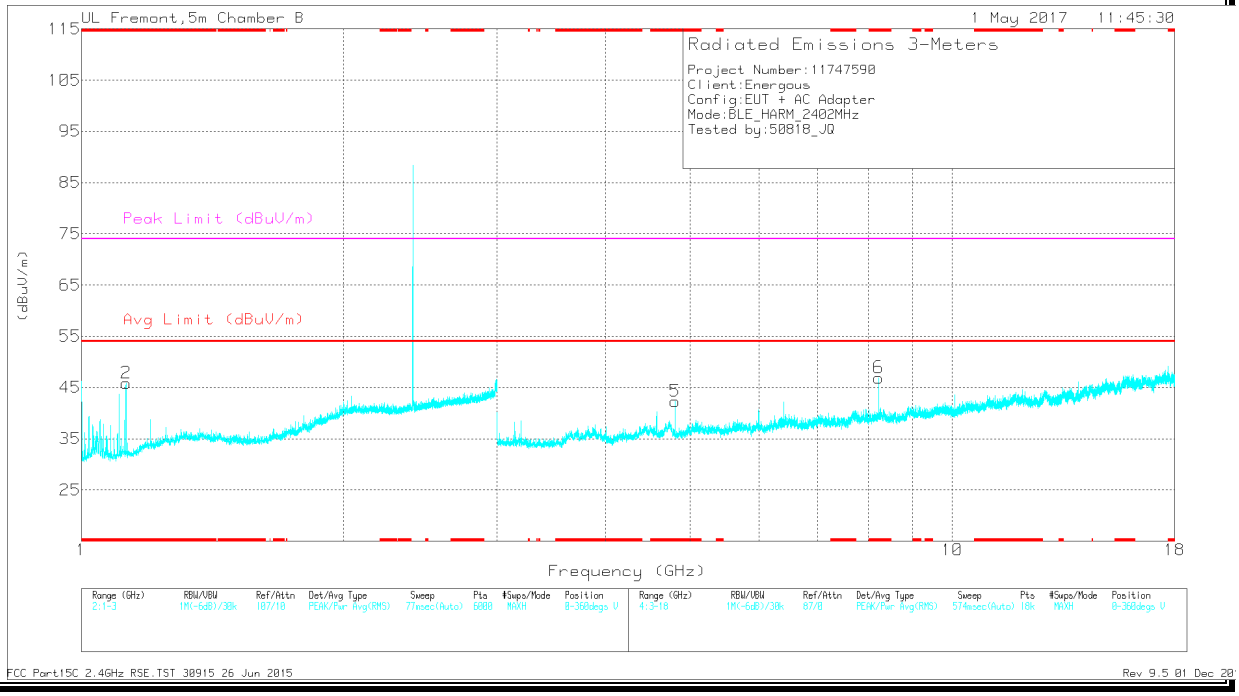
* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
Pk - Peak detector
RMS - RMS detection

8.4. HARMONICS AND SPURIOUS EMISSIONS 1 TO 18 GHz

LOW CHANNEL HORIZONTAL



LOW CHANNEL VERTICAL

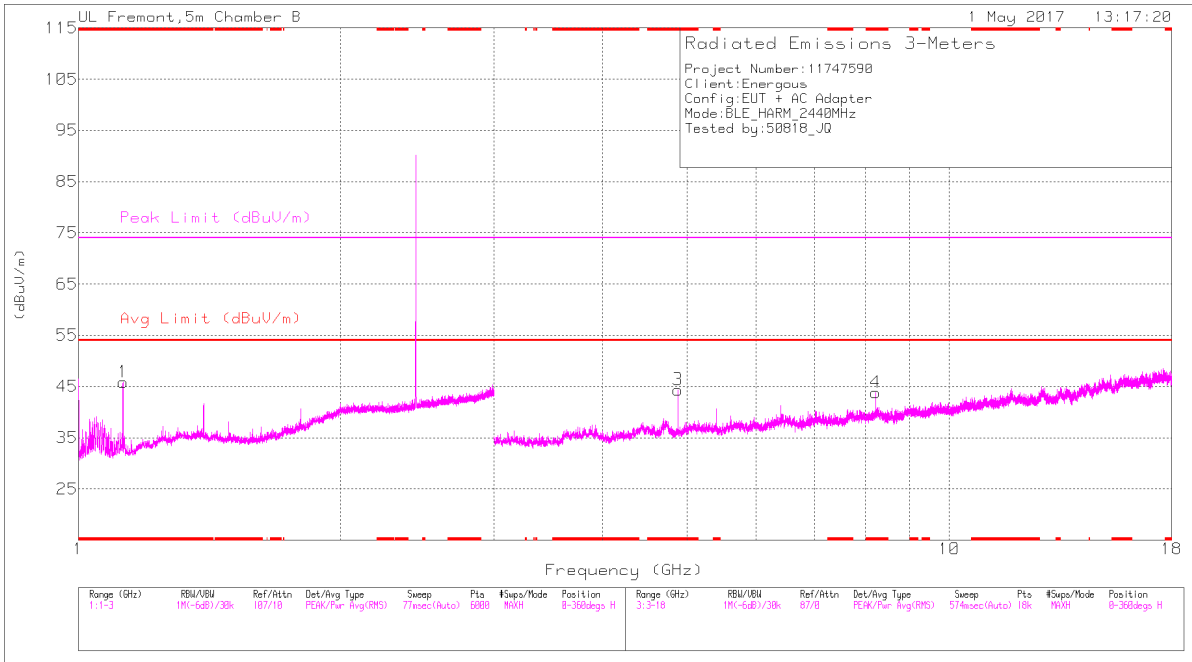


Radiated Emissions

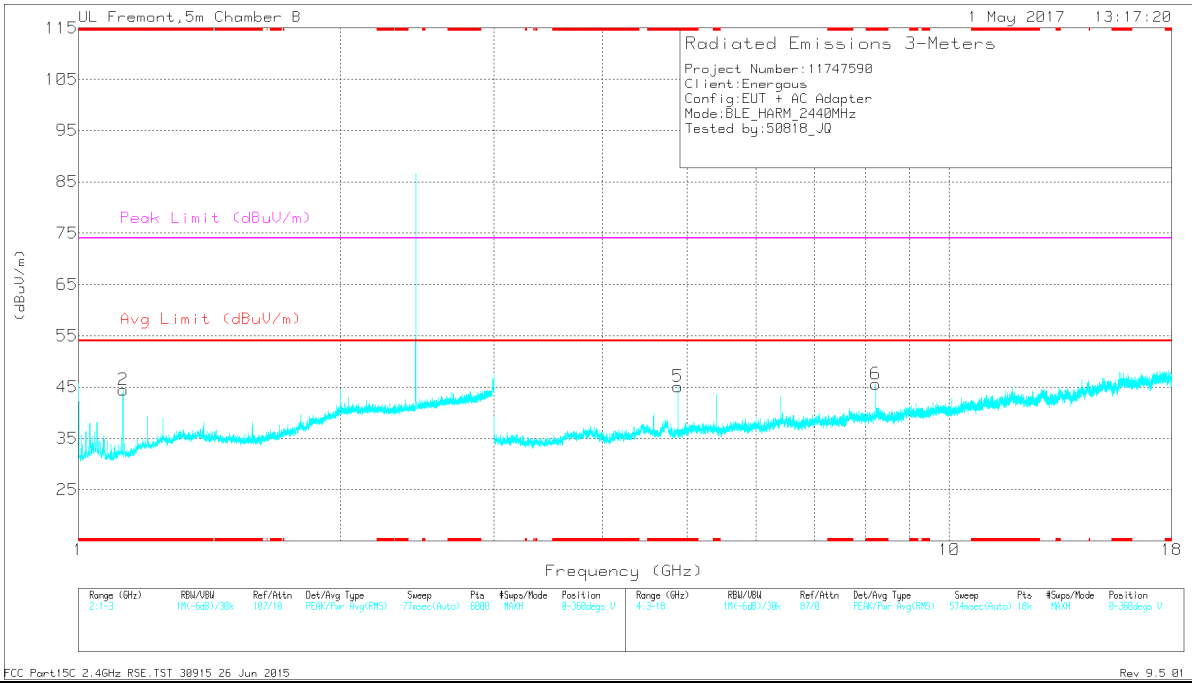
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.125	46.29	PK2	26.7	-22.9	0	50.09	-	-	74	-23.91	339	209	H
* 1.125	40.76	MAv1	26.7	-22.9	5.32	49.88	54	-4.12	-	-	339	209	H
* 1.125	44.52	PK2	26.7	-22.9	0	48.32	-	-	74	-25.68	235	186	V
* 1.125	38.63	MAv1	26.7	-22.9	5.32	47.75	54	-6.25	-	-	235	186	V
* 4.804	46.76	PK2	34.4	-29	0	52.16	-	-	74	-21.84	185	388	H
* 4.804	32.77	MAv1	34.4	-29	5.32	43.49	54	-10.51	-	-	185	388	H
* 8.235	39.47	PK2	36.5	-26.5	0	49.47	-	-	74	-24.53	311	395	H
* 8.235	32.26	MAv1	36.5	-26.5	5.32	47.58	54	-6.42	-	-	311	395	H
* 4.804	45.48	PK2	34.4	-29	0	50.88	-	-	74	-23.12	222	154	V
* 4.804	30.89	MAv1	34.4	-29	5.32	41.61	54	-12.39	-	-	222	154	V
* 8.235	40.82	PK2	36.5	-26.5	0	50.82	-	-	74	-23.18	182	190	V
* 8.235	34.71	MAv1	36.5	-26.5	5.32	50.03	54	-3.97	-	-	182	190	V

* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

MID CHANNEL HORIZONTAL



MID CHANNEL VERTICAL

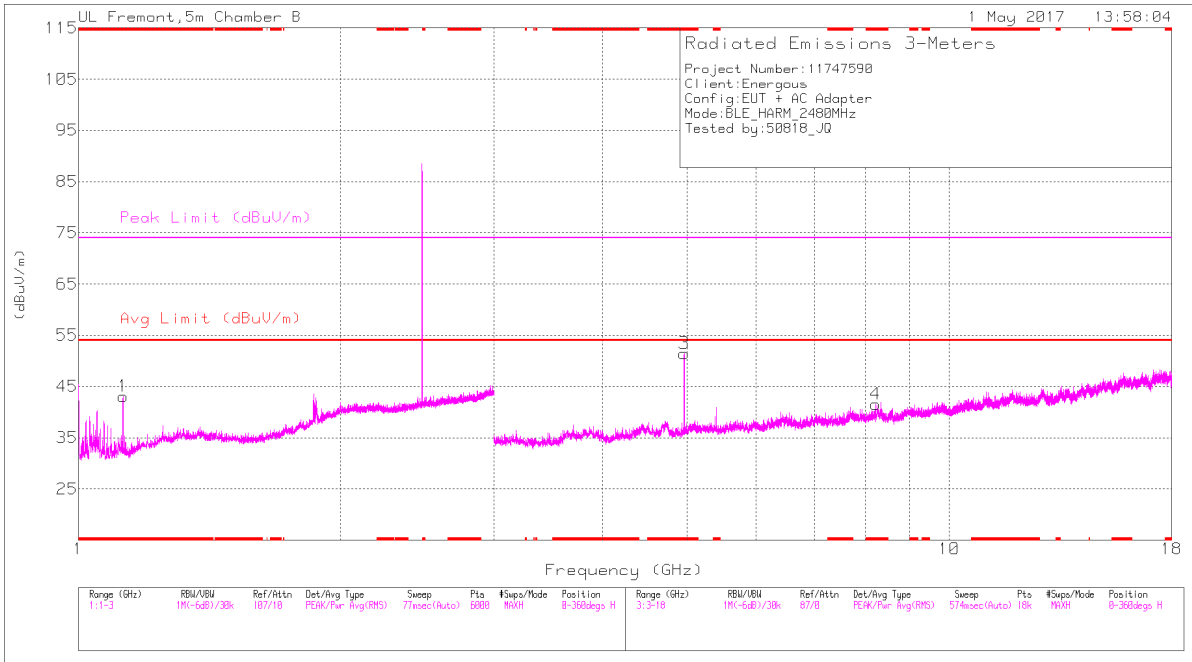


Radiated Emissions

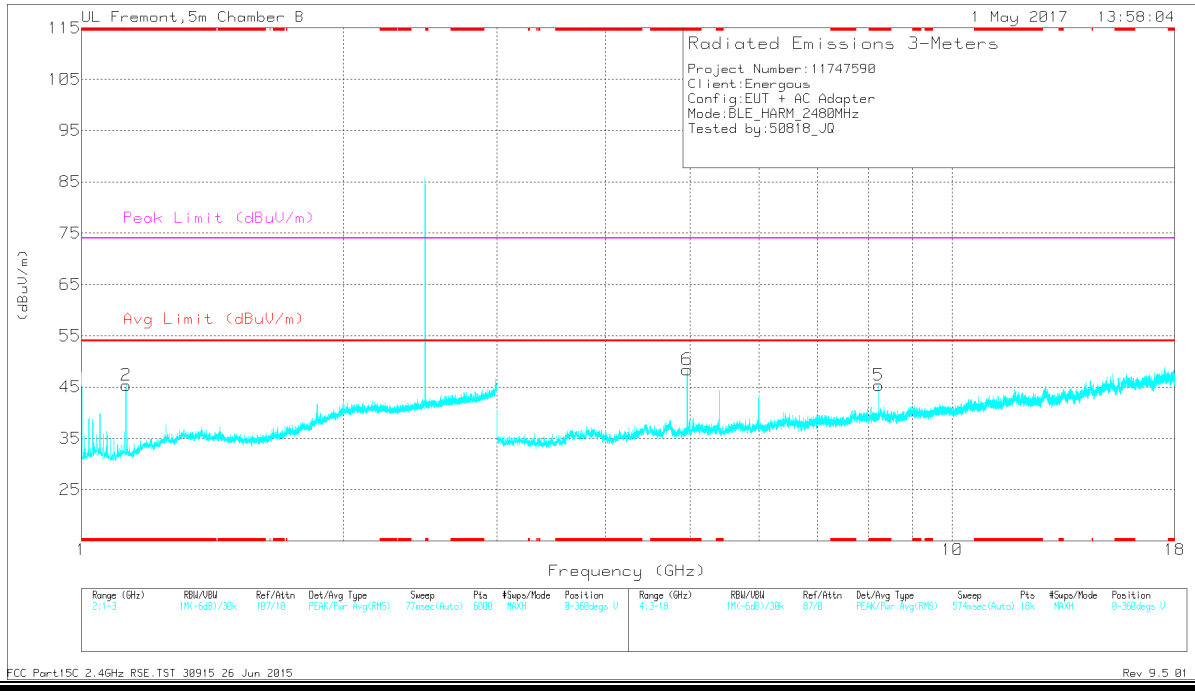
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.125	45.42	PK2	26.7	-22.9	0	49.22	-	-	74	-24.78	338	206	H
* 1.125	39.39	MAv1	26.7	-22.9	5.32	48.51	54	-5.49	-	-	338	206	H
* 1.125	43.57	PK2	26.7	-22.9	0	47.37	-	-	74	-26.63	231	201	V
* 1.125	37.62	MAv1	26.7	-22.9	5.32	46.74	54	-7.26	-	-	231	201	V
* 4.88	50.32	PK2	34.5	-30.4	0	54.42	-	-	74	-19.58	191	106	H
* 4.88	34.22	MAv1	34.5	-30.4	5.32	43.64	54	-10.36	-	-	191	106	H
* 8.235	39.09	PK2	36.5	-26.5	0	49.09	-	-	74	-24.91	309	154	H
* 8.235	32.18	MAv1	36.5	-26.5	5.32	47.5	54	-6.5	-	-	309	154	H
* 4.88	47.78	PK2	34.5	-30.5	0	51.78	-	-	74	-22.22	221	217	V
* 4.88	32.37	MAv1	34.5	-30.4	5.32	41.79	54	-12.21	-	-	221	217	V
* 8.235	41.15	PK2	36.5	-26.5	0	51.15	-	-	74	-22.85	183	198	V
* 8.235	34.24	MAv1	36.5	-26.5	5.32	49.56	54	-4.44	-	-	183	198	V

* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

HIGH CHANNEL HORIZONTAL



HIGH CHANNEL VERTICAL



Radiated Emissions

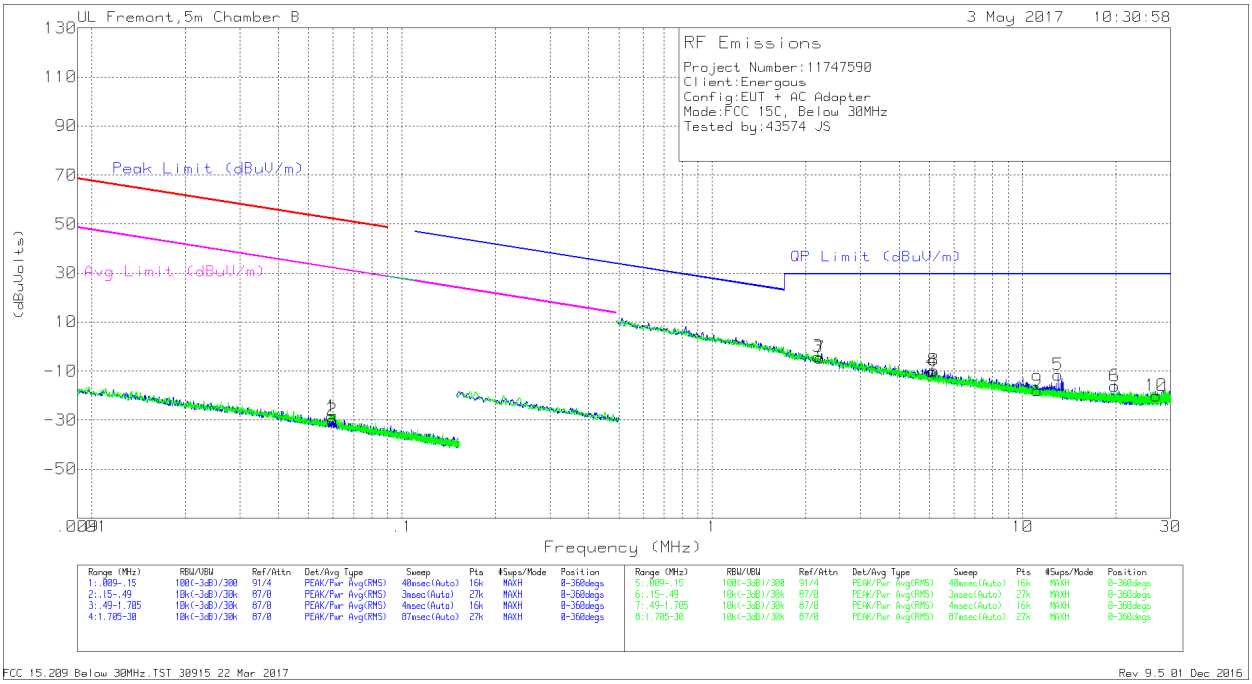
Frequency (GHz)	Meter Reading (dBuV)	Det	AF T346 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
* 1.125	42.13	PK2	26.7	-22.9	0	45.93	-	-	74	-28.07	202	254	H
* 1.125	35.28	MAv1	26.7	-22.9	5.32	44.4	54	-9.6	-	-	202	254	H
* 1.125	43.06	PK2	26.7	-22.9	0	46.86	-	-	74	-27.14	116	222	V
* 1.125	37.31	MAv1	26.7	-22.9	5.32	46.43	54	-7.57	-	-	116	222	V
* 4.96	54.21	PK2	34.5	-29.7	0	59.01	-	-	74	-14.99	190	110	H
* 4.96	37.12	MAv1	34.5	-29.7	5.32	47.24	54	-6.76	-	-	190	110	H
* 8.235	39.2	PK2	36.5	-26.5	0	49.2	-	-	74	-24.8	241	400	H
* 8.235	30.59	MAv1	36.5	-26.5	5.32	45.91	54	-8.09	-	-	241	400	H
* 8.235	40.16	PK2	36.5	-26.5	0	50.16	-	-	74	-23.84	186	178	V
* 8.235	33.91	MAv1	36.5	-26.5	5.32	49.23	54	-4.77	-	-	186	178	V
* 4.96	52.86	PK2	34.5	-29.7	0	57.66	-	-	74	-16.34	205	354	V
* 4.96	35.95	MAv1	34.5	-29.7	5.32	46.07	54	-7.93	-	-	205	354	V

* - indicates frequency in CFR15.205/RSS-GEN 8.10 -Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

8.5. WORST-CASE BELOW 30 MHz

SPURIOUS EMISSIONS BELOW 30MHz (WORST-CASE CONFIGURATION)

HORIZONTAL AND VERTICAL PLOTS



NOTE: KDB 414788 OATS and Chamber Correlation Justification

- Based on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.
- OATs and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0594	38.01	Pk	12	1.4	-80	-28.59	52.11	-80.7	32.11	-60.7	0-360
2	.0596	36.59	Pk	12	1.4	-80	-30.01	52.08	-82.09	32.08	-62.09	0-360

Pk - Peak detector

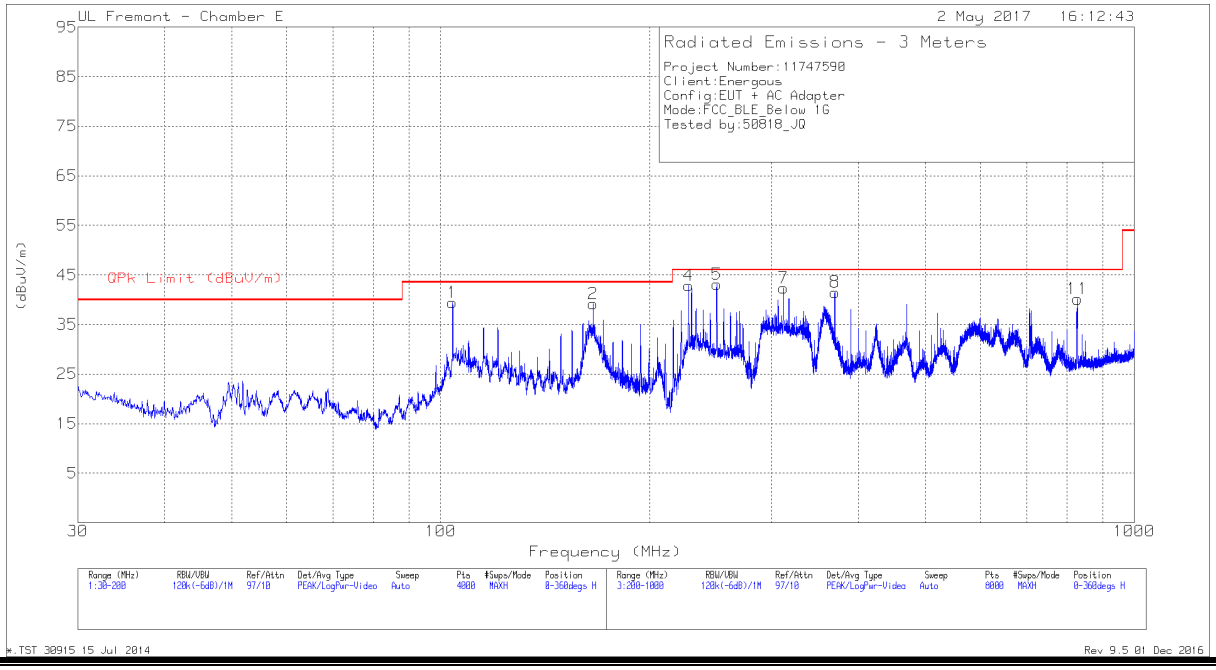
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cbl (dB)	Dist Corr 30m	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
3	2.19232	22.66	Pk	11.7	1.5	-40	-4.14	29.5	-33.64	0-360
7	2.21957	22.01	Pk	11.7	1.5	-40	-4.79	29.5	-34.29	0-360
4	5.11362	17.01	Pk	11.3	1.5	-40	-10.19	29.5	-39.69	0-360
8	5.17912	17.6	Pk	11.3	1.5	-40	-9.6	29.5	-39.1	0-360
9	11.1501	9.73	Pk	10.7	1.6	-40	-17.97	29.5	-47.47	0-360
5	13.0213	16.44	Pk	10.5	1.6	-40	-11.46	29.5	-40.96	0-360
6	19.79348	12.63	Pk	9.7	1.6	-40	-16.07	29.5	-45.57	0-360
10	26.9508	9.48	Pk	8.8	1.7	-40	-20.02	29.5	-49.52	0-360

Pk - Peak detector

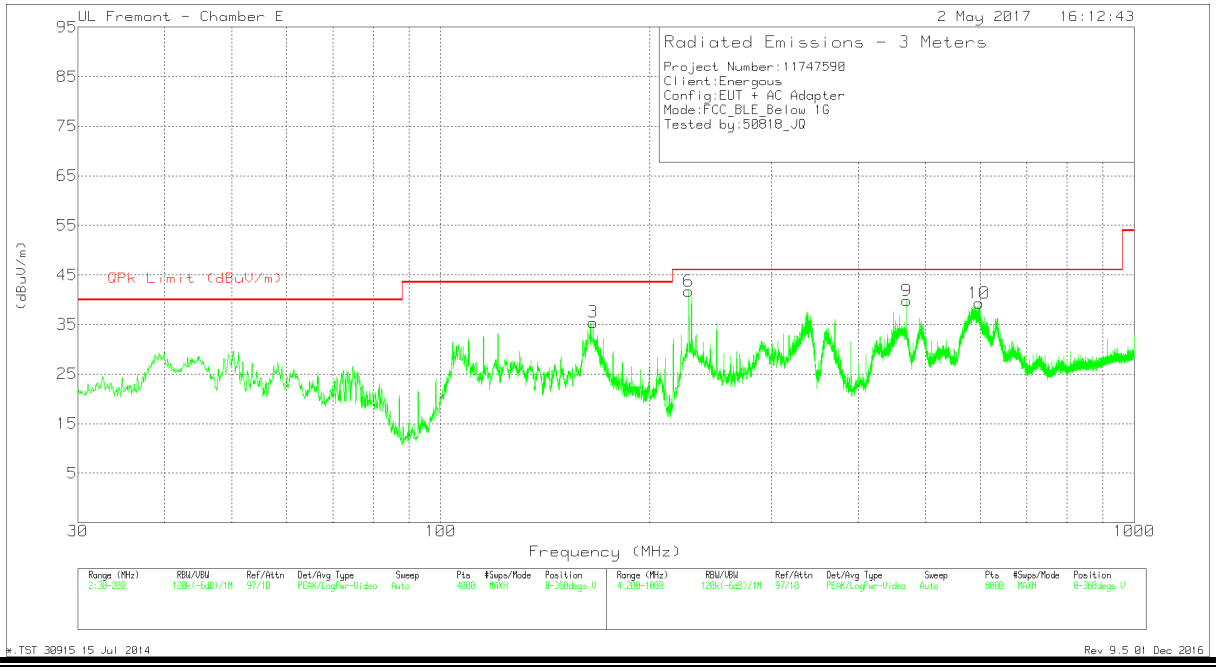
8.6. WORST-CASE BELOW 1 GHz

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

HORIZONTAL PLOT



VERTICAL PLOT



DATA

Trace Markers

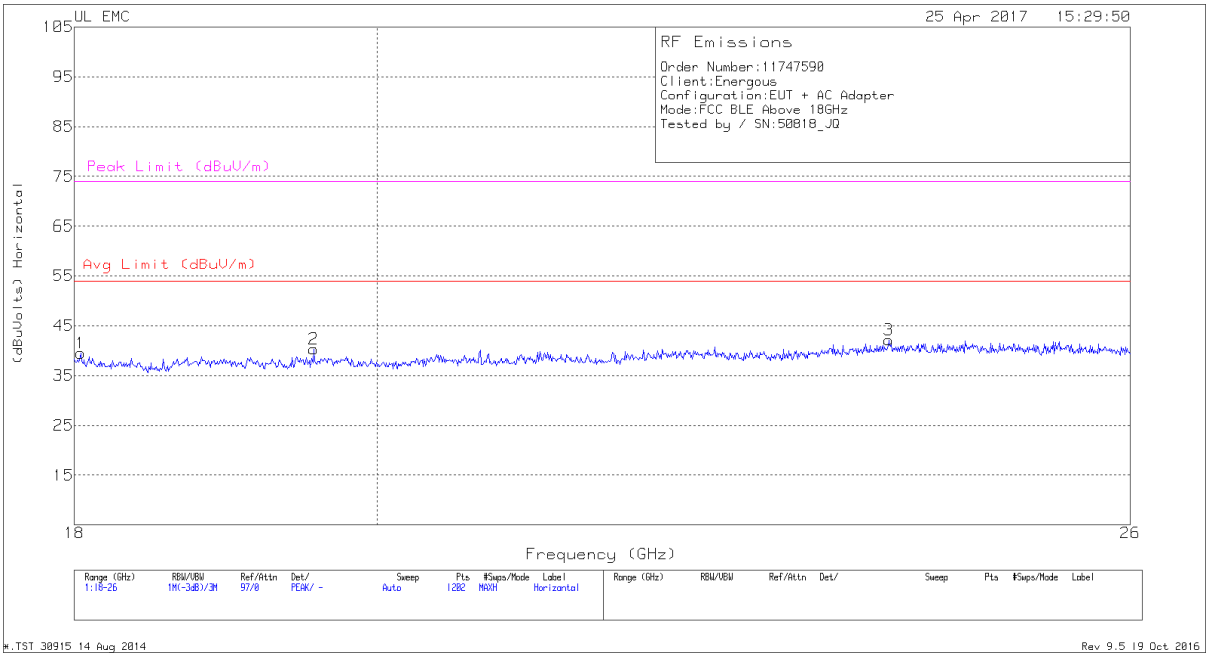
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T899 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	165.9077	53.84	Pk	15.7	-30.3	39.24	43.52	-4.28	0-360	200	H
		52.53	Qp	15.7	-30.3	37.93	43.52	-5.59	41	177	H
3	165.9927	50.04	Pk	15.7	-30.3	35.44	43.52	-8.08	0-360	100	V
5	250.0065	57.46	Pk	15.4	-29.7	43.16	46.02	-2.86	0-360	100	H
		57.01	Qp	15.4	-29.7	42.71	46.02	-3.31	164	100	H
1	104.0542	54.79	Pk	15.4	-30.8	39.39	43.52	-4.13	0-360	299	H
		53.29	Qp	15.4	-30.8	37.89	43.52	-5.63	44	308	H
4	227.8036	58.09	Pk	14.6	-29.8	42.89	46.02	-3.13	0-360	100	H
		57.04	Qp	14.6	-29.8	41.84	46.02	-4.18	0	149	H
6	227.8036	56.96	Pk	14.6	-29.8	41.76	46.02	-4.26	0-360	200	V
		55.3	Qp	14.6	-29.8	40.1	46.02	-5.92	284	189	V
7	312.2146	53.87	Pk	17.7	-29.2	42.37	46.02	-3.65	0-360	100	H
		50.65	Qp	17.7	-29.2	39.15	46.02	-6.87	197	128	H
8	370.0221	51.43	Pk	18.9	-28.8	41.53	46.02	-4.49	0-360	100	H
		51.1	Qp	18.9	-28.8	41.2	46.02	-4.82	141	101	H
9	470.0351	47.03	Pk	21.3	-28.5	39.83	46.02	-6.19	0-360	100	V
10	596.8016	44.83	Pk	22.3	-27.8	39.33	46.02	-6.69	0-360	100	V
11	828.0816	40.94	Pk	25.8	-26.6	40.14	46.02	-5.88	0-360	100	H
		22.46	Qp	25.8	-26.6	21.66	46.02	-24.36	225	254	H

Pk - Peak detector
Qp - Quasi-Peak detector

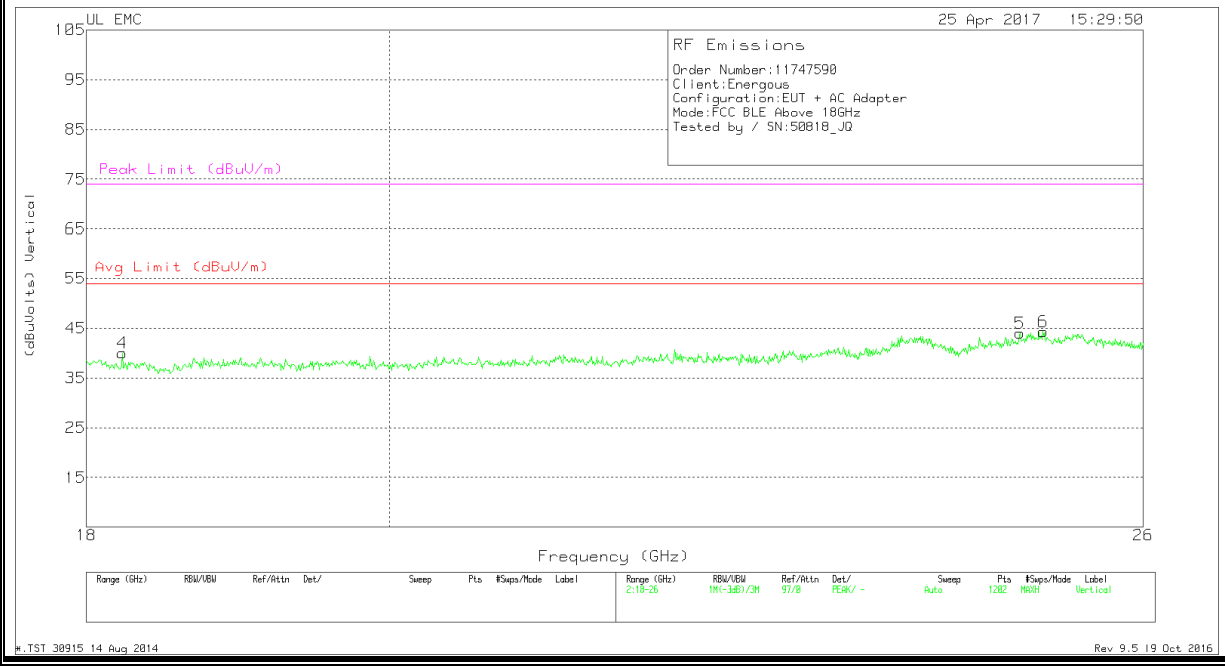
8.7. WORST-CASE ABOVE 18 GHz

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

HORIZONTAL PLOT



VERTICAL PLOT



Data

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T449 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	18.04	41.6	Pk	32.6	-25.2	-9.5	39.5	54	-14.5	74	-34.5
2	19.565	42.23	Pk	32.7	-25.1	-9.5	40.33	54	-13.67	74	-33.67
3	23.902	41.57	Pk	34	-23.9	-9.5	42.17	54	-11.83	74	-31.83
4	18.226	42.5	Pk	32.4	-25.4	-9.5	40	54	-14	74	-34
5	24.908	43.6	Pk	34.2	-24.3	-9.5	44	54	-10	74	-30
6	25.107	44.03	Pk	34.3	-24.5	-9.5	44.33	54	-9.67	74	-29.67

Pk - Peak detector

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

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.

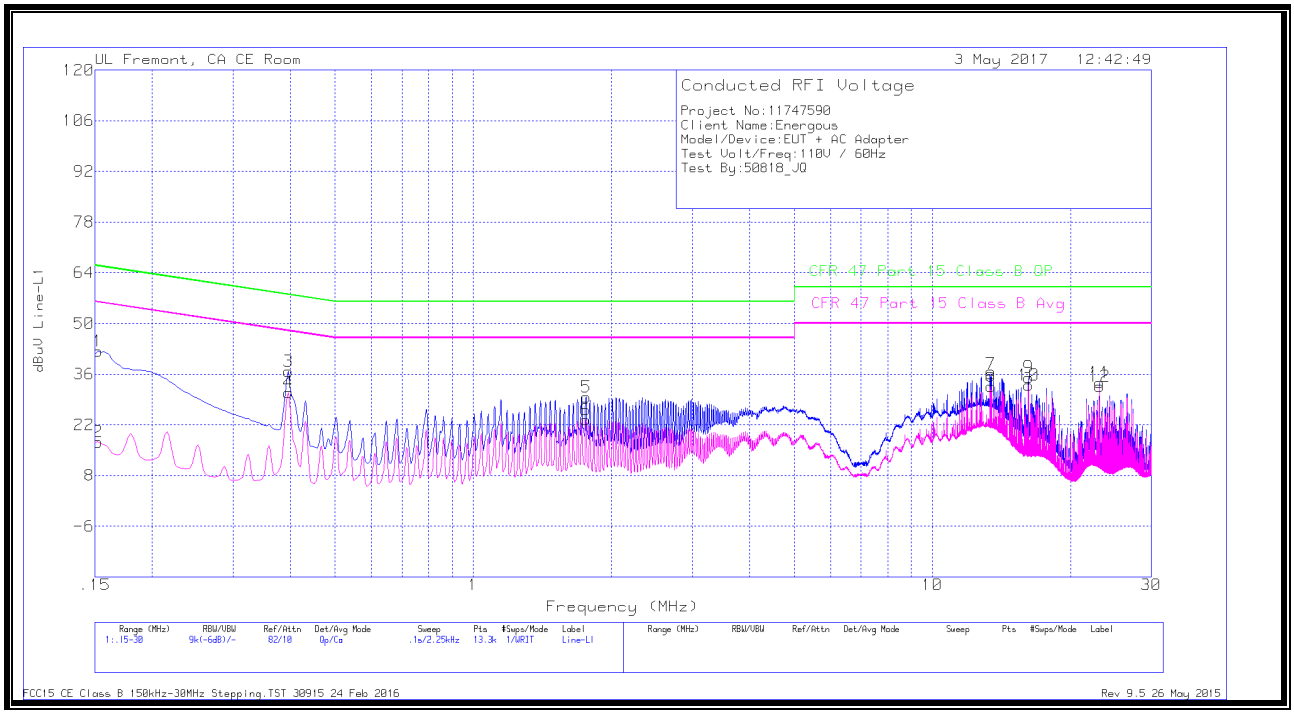
The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL (Line 1) and HOT (Line 2).

RESULTS

9.1. EUT POWERED BY HOST PC VIA USB CABLE

LINE 1 RESULTS



WORST EMISSIONS

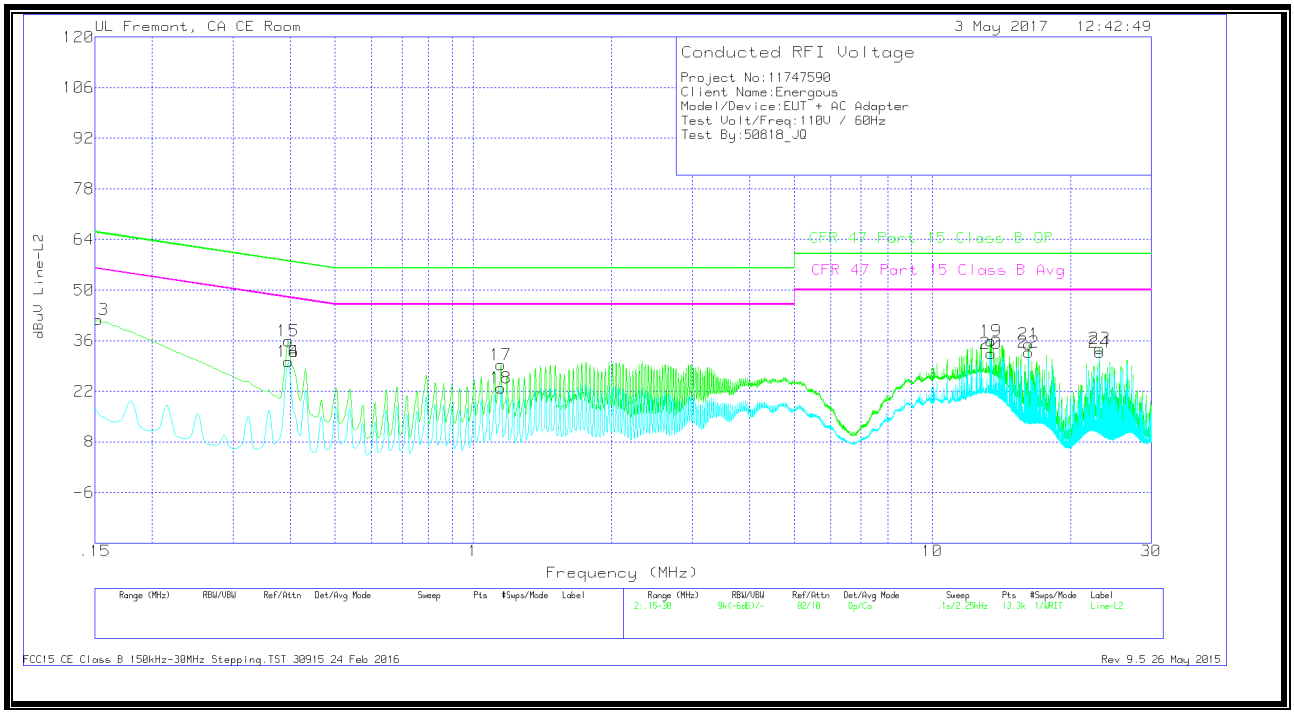
Range 1: Line-L1 .15 - 30MHz

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	.15225	32.09	Qp	.1	.1	10.1	42.39	65.88	-23.49	-	-
2	.15225	6.94	Ca	.1	.1	10.1	17.24	-	-	55.88	-38.64
3	.39525	26.56	Qp	0	.1	10.1	36.76	57.95	-21.19	-	-
4	.39525	20.7	Ca	0	.1	10.1	30.9	-	-	47.95	-17.05
5	1.761	19.41	Qp	0	.1	10.1	29.61	56	-26.39	-	-
6	1.75875	13.14	Ca	0	.1	10.1	23.34	-	-	46	-22.66
7	13.41825	25.66	Qp	.1	.2	10.2	36.16	60	-23.84	-	-
8	13.41825	22.04	Ca	.1	.2	10.2	32.54	-	-	50	-17.46
9	16.2285	24.63	Qp	0	.2	10.3	35.13	60	-24.87	-	-
10	16.2285	22.39	Ca	0	.2	10.3	32.89	-	-	50	-17.11
11	23.127	22.88	Qp	.1	.3	10.4	33.68	60	-26.32	-	-
12	23.127	21.81	Ca	.1	.3	10.4	32.61	-	-	50	-17.39

Qp - Quasi-Peak detector

Ca - CISPR average detection

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	.15225	31.66	Qp	0	0	10.1	41.76	65.88	-24.12	-	-
14	.39525	19.92	Ca	0	.1	10.1	30.12	-	-	47.95	-17.83
15	.39525	25.75	Qp	0	.1	10.1	35.95	57.95	-22	-	-
16	.39525	19.92	Ca	0	.1	10.1	30.12	-	-	47.95	-17.83
17	1.149	19.16	Qp	0	.1	10.1	29.36	56	-26.64	-	-
18	1.149	12.73	Ca	0	.1	10.1	22.93	-	-	46	-23.07
19	13.41825	25.47	Qp	.1	.2	10.2	35.97	60	-24.03	-	-
20	13.41825	21.87	Ca	.1	.2	10.2	32.37	-	-	50	-17.63
21	16.2285	24.57	Qp	0	.2	10.3	35.07	60	-24.93	-	-
22	16.2285	22.28	Ca	0	.2	10.3	32.78	-	-	50	-17.22
23	23.127	23.09	Qp	.1	.3	10.4	33.89	60	-26.11	-	-
24	23.127	22.03	Ca	.1	.3	10.4	32.83	-	-	50	-17.17

Qp - Quasi-Peak detector

Ca - CISPR average detection