CERTIFICATION TEST REPORT

Report Number. : 11681248-E1V5

Applicant : ENERGOUS CORPORATION
3590 NORTH FIRST STREET
SAN JOSE, CA 95134 USA

Model : NF-130

FCC ID : 2ADNG-NF130

EUT Description : CHARGER PAD

Test Standard(s) : FCC 47 CFR PART 18 SUBPART C

Date Of Issue:
OCTOBER 27, 2017

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	04/04/2017	Initial Issue	C. Vergonio
V2	04/20/17	Updated Section 5.1, 5.3, 5.5, 7.3.6 and Section 7.3.7.	C. Vergonio
V3	04/21/17	Added Support Equipment table in Section 5.5, Updated Section 7.3.6 and 7.3.7.	C. Vergonio
V4	08/24/17	Revised sections 1, 3, 5.1, 7.3.1	M. Heckrotte
V5	10/27/17	Updated Sections 1, 5, 7.3, 7.4	Tina Chu

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS 4

2. TEST METHODOLOGY 5

3. FACILITIES AND ACCREDITATION 5

4. CALIBRATION AND UNCERTAINTY 5

4.1. MEASURING INSTRUMENT CALIBRATION 5

4.2. SAMPLE CALCULATION 5

4.3. MEASUREMENT UNCERTAINTY 6

5. EQUIPMENT UNDER TEST 7

5.1. DESCRIPTION OF EUT 7

5.2. SOFTWARE AND FIRMWARE 7

5.3. CONFIGURATIONS INVESTIGATED 8

5.4. MODIFICATIONS 8

5.5. DETAILS OF TESTED SYSTEM 8

6. TEST AND MEASUREMENT EQUIPMENT 10

7. APPLICABLE LIMITS AND TEST RESULTS 11

7.1. OPERATING FREQUENCY 11

7.2. EUT CONTROL 12

7.3. RADIATED EMISSIONS 14

7.3.1. SPURIOUS EMISSIONS 9 kHz - 30 MHz 15
7.3.1. SPURIOUS EMISSIONS 30 - 1000 MHz 17
7.3.2. SPURIOUS EMISSIONS 1 - 18 GHz 21
7.3.3. SPURIOUS EMISSIONS 18 - 26 GHz 25
7.3.4. SPURIOUS EMISSIONS 26 - 40 GHz 29
7.3.5. SPURIOUS EMISSIONS 40 - 50 GHz 33
7.3.6. SPURIOUS EMISSIONS 50 - 60 GHz 35

7.4. AC MAINS LINE CONDUCTED EMISSIONS 37

8. SETUP PHOTOS 42

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: ENERGOUS CORPORATION
3590 NORTH FIRST STREET
SAN JOSE, CA 95134 USA

EUT DESCRIPTION: CHARGER PAD

MODEL: NF-130

SERIAL NUMBER: MLKI0239

DATE TESTED: MARCH 21- APRIL 4, 2017

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC PART 18 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:

JASON QIAN
WiSE Lab Engineer
UL VERIFICATION SERVICES INC.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC / OST MP-5, "FCC Methods of Measurements of Radio Noise Emissions from Industrial, Scientific, and Medical Equipment."

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.

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

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

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%.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is an RF based charging system that provides a wireless solution for small-sized and low powered devices. The EUT also includes a Bluetooth Low Energy radio.

This report documents test results of the ISM portion of the Charger Pad.

GENERAL INFORMATION

Power Requirements	5VDC USB type-A
List of frequencies generated or used by the EUT, and purpose	48 MHz: Reference for Synthesizer PLL 10MHz: Reference for Synthesizer PLL Operating Frequency: Hopping from 5854.75 to 5870.95 MHz

5.2. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was NF130T.Rev1.0.
The software installed in the EUT during testing was 3.0.3.23.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

5.3. CONFIGURATIONS INVESTIGATED

Tests were performed over a larger range of gaps than will occur during normal use, yielding worst-case results based on configurations that are more extreme than normal operation. The gap between the TX and RX antenna PCBs ranged from zero to 2 mm.

Maximum power transference occurs when there is no gap. Minimum power transference occurs when there is a maximum gap.

Configuration	Description
Receiver with 0 mm Spacing	Receiver was placed directly on the EUT TX antenna PCB
Receiver with 2 mm Spacing	Receiver was placed on the EUT TX antenna PCB with 2 mm gap in between

5.4. MODIFICATIONS

No modifications were made during testing.

5.5. DETAILS OF TESTED SYSTEM

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
AC/DC Adapter	Zeskit	AD566	N/A	N/A
Receiver	Energous	N/A	nrx2203	N/A

CABLES

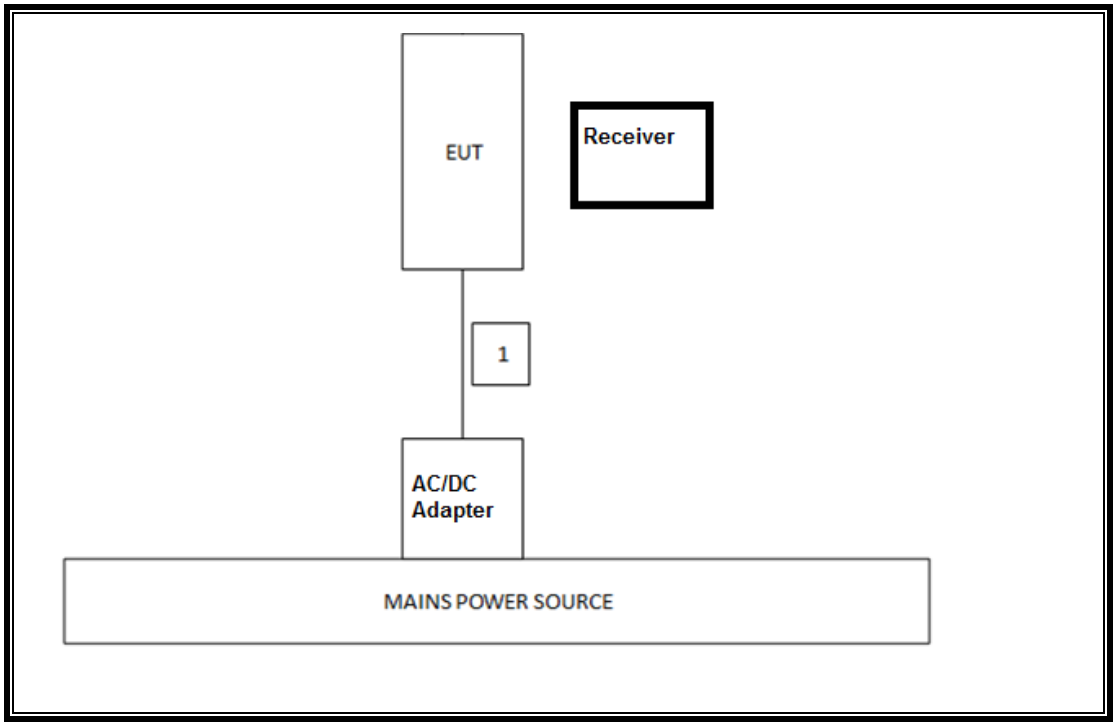
I/O CABLE LIST						
Cable No.	Port	# of Identic Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	USB type-A	SHIELDED	1.5m	Use for Radiated Emission and Conducted AC line Scan

TEST SETUP

The EUT is stand-alone unit powered by AC/DC adapter via USB cable

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

SETUP DIAGRAM FOR TESTS



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

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**	**T Number**	**Cal Due**
Amplifier, 1-18GHz	Miteq	AFS42-00101800-25-S-4	493	03/09/18
Amplifier, 1-8GHz, 35 dB	Miteq	AMF-4D-01000800-30-2	1156	03/09/18
Antenna, Biconolog, 30MHz-1 GHz	Sunol Sciences	JB3	407	04/04/17
Antenna, Horn, 18GHz	ETS Lindgren	3117	120	04/05/17
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	449	05/26/17
Antenna, Horn, 40 GHz	ARA	MWH-2640	90	07/28/17
ESR7 EMI Test Receiver 7GHz	Rohde & Schwarz	ESR	1436	12/19/17
High Pass Filter 3GHz	Micro-Tronics	HPS17543	486	07/20/17
High Pass Filter 6GHz	Micro-Tronics	HPS17542	484	07/20/17
LISN, 30 MHz	FCC	FCC-LISN-50/250-25-2	24	02/09/18
Loop Antenna	ETS Lindgren	6502	757	05/21/17
Low Pass Filter 5GHz	Micro-Tronics	LPS17541	482	03/09/18
Low Pass Filter 5GHz	Micro-Tronics	LPS17541	481	07/20/17
Amplifier, 10KHz to 1GHz, 32dB	Sonoma Instrument	310N	835	06/24/17
RF Preamplifier, 1GHz - 26.5GHz	HP	8449B	404	06/29/17
RF Preamplifier, 26GHz - 40GHz	Miteq	NSP4000-SP2	88	04/07/17
Spectrum Analyzer, 40 GHz	Agilent / HP	8564E	106	08/14/17
Spectrum Analyzer, 44 GHz	Keysight	N9030A	908	04/13/17
Spectrum Analyzer, 50 GHz	Agilent	N9030A	313	08/04/17
Horn Antenna, 50 GHz	ATM	22-442-6	NA	CNR
Low Pass Filter, 50 GHz	SPACEK LABS	LPF5-50-8-22	T1099	06/01/17
RF Preamplifier, 40-50 GHz,	SPACEK LABS	sL4510-33-4W	NA	06/01/17
Horn Antenna, 75 GHz	CMI	HO15R	NA	CNR
Harmonic Mixer, 50 to 80 GHz	Agilent	M1970V	MY51390830	08/12/17
Attenuator, 3dB "N" Type	Mini-Circuits	BW-N3W5+	134762	01/24/18

Test Software List			
Description	Manufacturer	Model	Version
Radiated Software	UL	UL EMC	Ver 9.5, Apr 12, 2016
Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

7. APPLICABLE LIMITS AND TEST RESULTS

7.1. OPERATING FREQUENCY

LIMIT

§18.301 The following frequency bands, in accordance with §2.106 of the rules, are allocated for use by ISM equipment:

ISM frequency	Tolerance
6.78 MHz	±15.0 kHz
13.56 MHz	±7.0 kHz
27.12 MHz	±163.0 kHz
40.68 MHz	±20.0 kHz
915 MHz	±13.0 MHz
2,450 MHz	±50.0 MHz
5,800 MHz	±75.0 MHz
24,125 MHz	±125.0 MHz
61.25 GHz	±250.0 MHz
122.50 GHz	±500.0 MHz
245.00 GHz	±1.0 GHz

NOTE: The use of the 6.78 MHz ±15 kHz frequency band is subject to the conditions of footnote 524 of the Table of Allocations. See §2.106.

TEST PROCEDURE

FCC / OST MP-5

RESULTS

Configuration	Lower Frequency (MHz)	Upper Frequency (MHz)	Lower Limit (MHz)	Upper Limit (MHz)
Load with 0 mm Spacing	5854.75	5870.95	5725	5875
Load with 2 mm Spacing	5854.75	5870.95	5725	5875

NOTE: The device is hopping from 5854.75MHz-5870.95MHz.

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

7.2. EUT CONTROL

LIMIT

Reporting requirement.

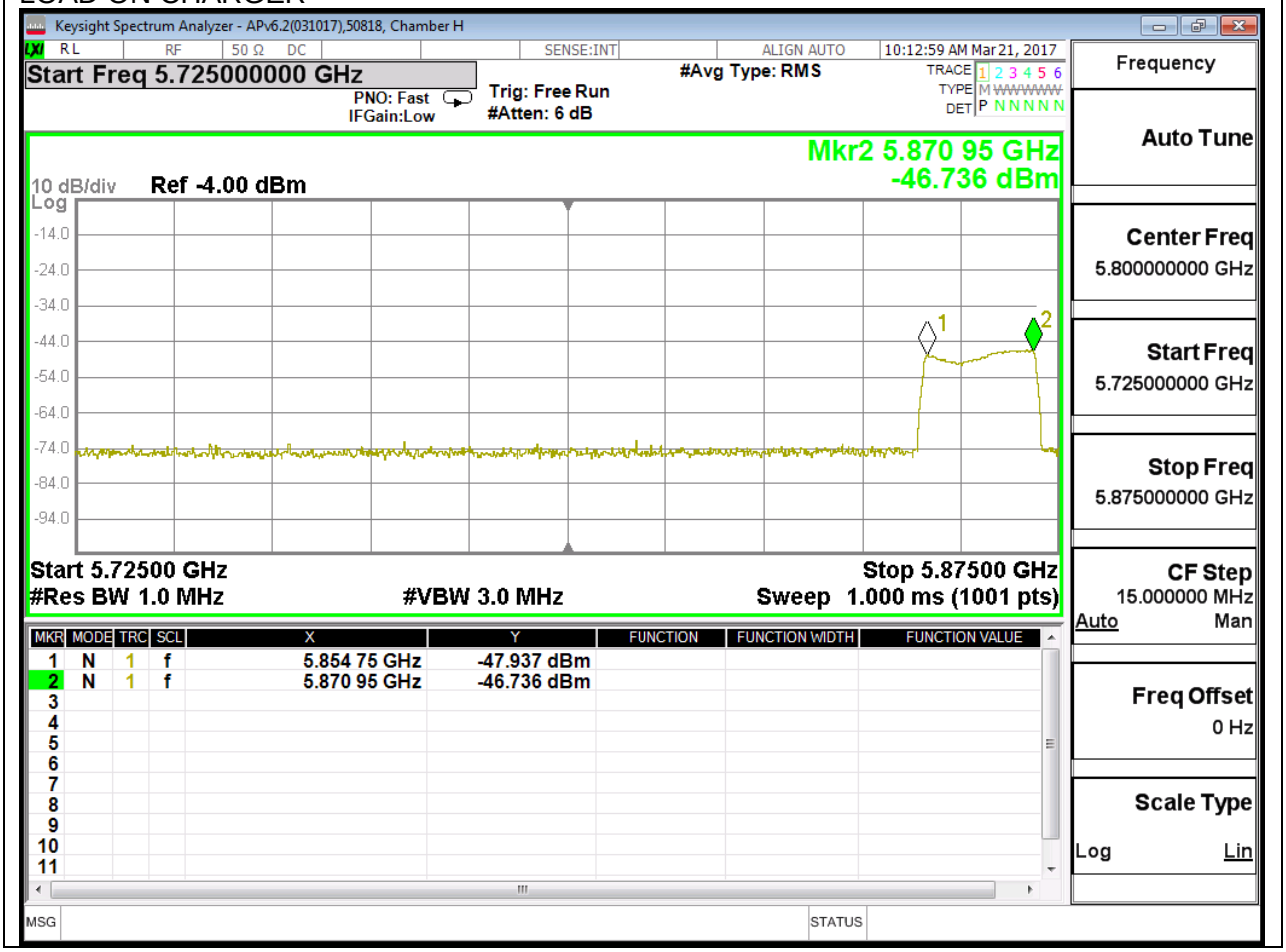
TEST PROCEDURE

Place load on charger, confirm by observation of emissions at fundamental frequency that device is operating.

Remove load from charger, confirm by observation of emissions at fundamental frequency that device is not operating.

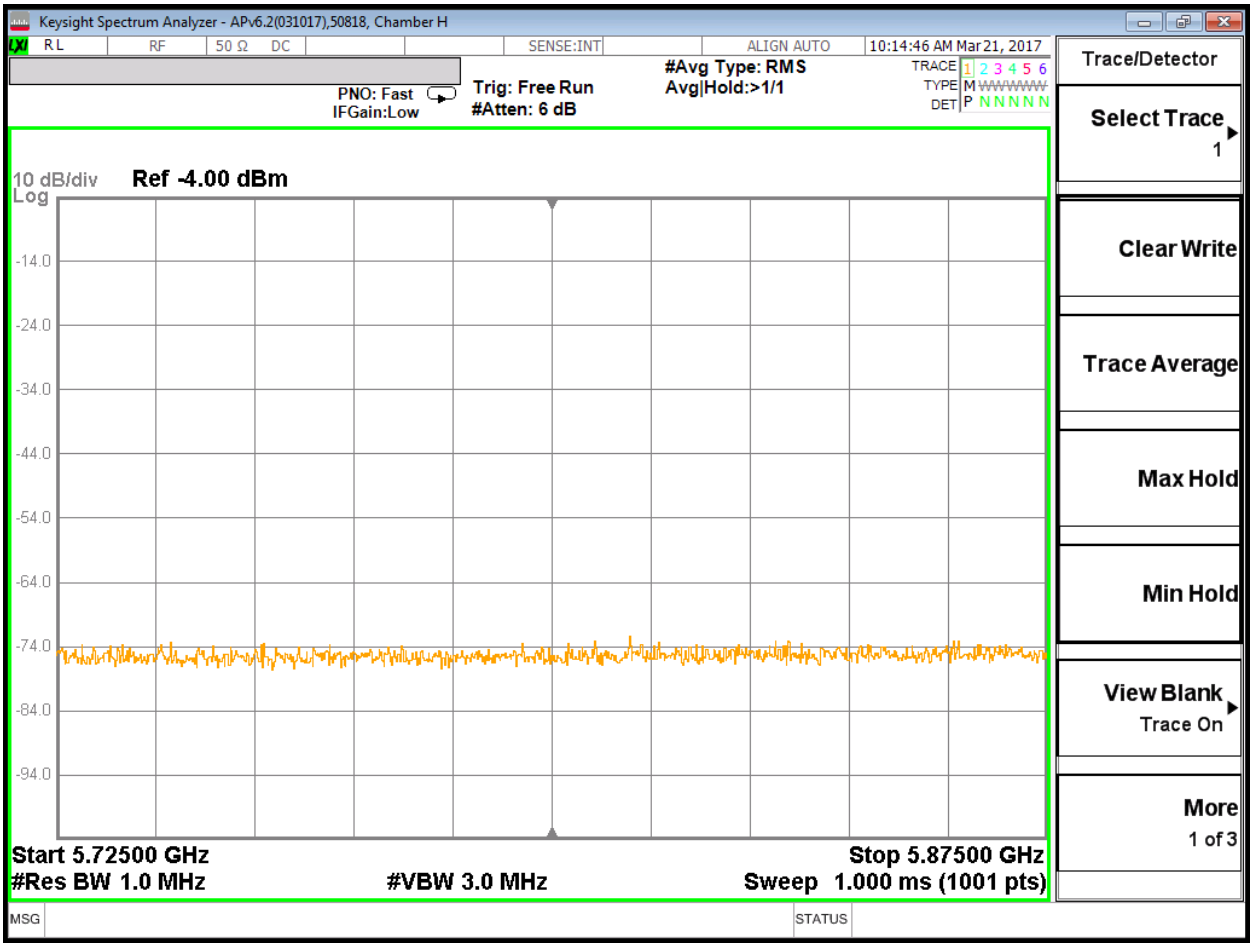
RESULTS

LOAD ON CHARGER



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

LOAD REMOVED FROM CHARGER



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

7.3. RADIATED EMISSIONS

LIMIT

§18.305 (b) The field strength levels of emissions which lie outside the bands specified in §18.301, unless otherwise indicated, shall not exceed the following:

Equipment	Operating frequency	RF Power generated by equipment (watts)	Field strength limit (uV/m)	Distance (meters)
Any type unless otherwise specified (miscellaneous)	Any ISM frequency	Below 500 500 or more	25 25×SQRT (power/500)	300 [1]300

[1]Field strength may not exceed 10 μV/m at 1600 meters. Consumer equipment operating below 1000 MHz is not permitted the increase in field strength otherwise permitted here for power over 500 watts.

The RF Power generated by the equipment is below 500 W therefore the field strength limit is 25 uV/m at 300 m.

TEST PROCEDURE

FCC / OST MP-5

The frequency range was investigated from 9 kHz to 60 GHz.

The device was placed in a test mode that set up continuous operation.

RESULTS

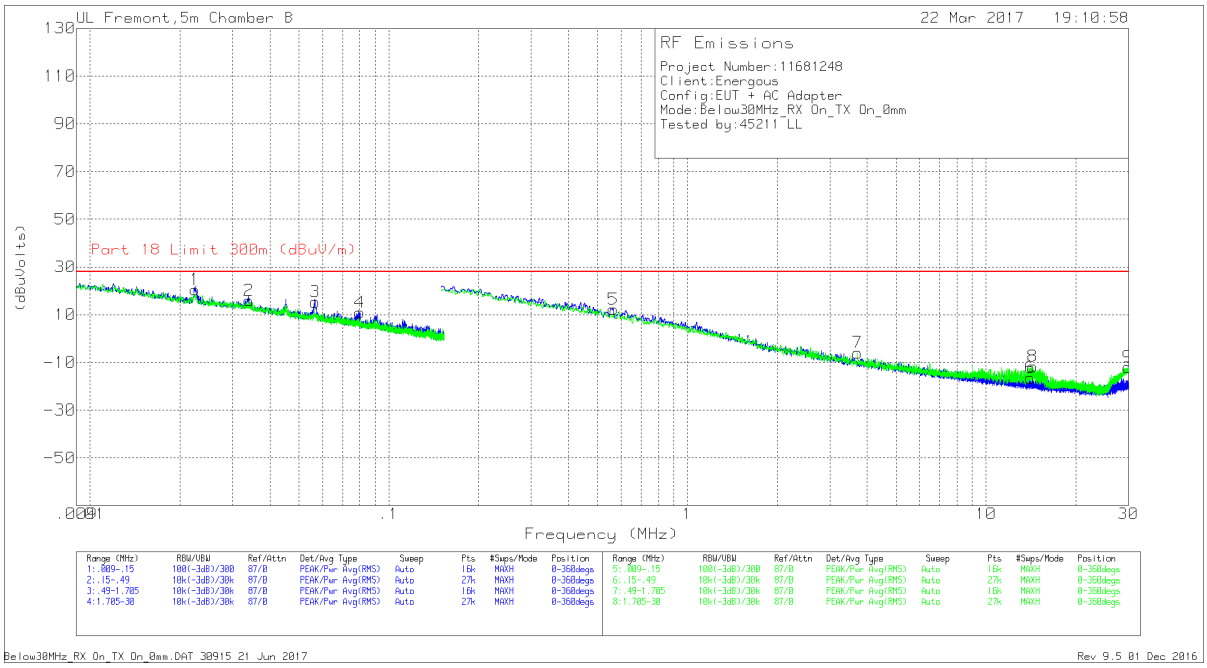
No non-compliance noted:

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

7.3.1. SPURIOUS EMISSIONS 9 kHz - 30 MHz

Configuration 1: Load with 0 mm Spacing

HORIZONTAL & VERTICAL



- 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)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.02246	44.7	Pk	14.4	1.4	-40	-19.5	28	-7.5	0-360
2	.03405	41.1	Pk	13.5	1.4	-40	-24	28	-12	0-360
3	.05679	41.83	Pk	12.1	1.4	-40	-24.67	28	-12.67	0-360
4	.08005	37.68	Pk	11.9	1.4	-40	-29.02	28	-17.02	0-360

Pk - Peak detector

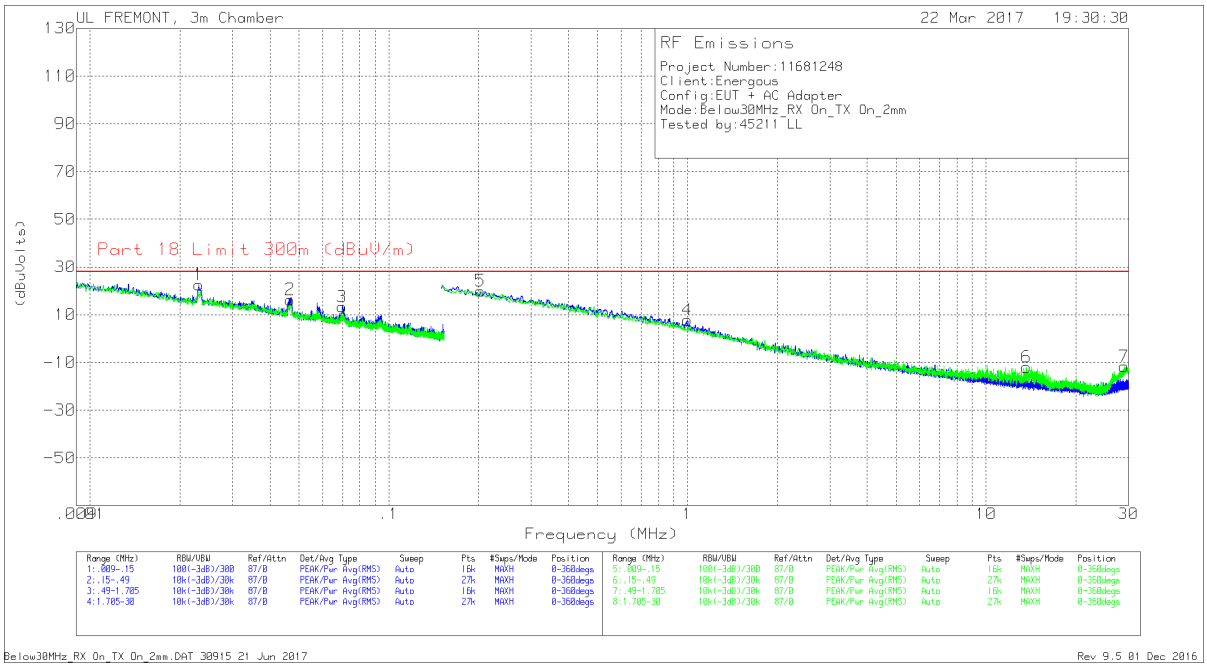
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)
5	.56471	39.12	Pk	11.7	1.5	-40	12.32	28	-15.68	0-360
7	3.71297	20.85	Pk	11.7	1.5	-40	-5.95	28	-33.95	0-360
6	14.05463	11.37	Pk	10.6	1.6	-40	-16.43	28	-44.43	0-360
8	14.35226	16.08	Pk	10.6	1.6	-40	-11.72	28	-39.72	0-360
9	29.85533	17.91	Pk	8.4	1.7	-40	-11.99	28	-39.99	0-360

Pk - Peak detector

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 2: Load with 2 mm Spacing

HORIZONTAL & VERTICAL



- 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)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.0231	46.82	Pk	14.4	1.4	-40	22.62	28	-5.38	0-360
2	.04676	42.41	Pk	12.5	1.4	-40	16.31	28	-11.69	0-360
3	.06973	39.98	Pk	12	1.4	-40	13.38	28	-14.62	0-360
5	.20297	46.8	Pk	11.7	1.5	-40	20	28	-8	0-360

Pk - Peak detector

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)
4	1.00186	34.43	Pk	11.8	1.5	-40	7.73	28	-20.27	0-360
6	13.67054	15.82	Pk	10.6	1.6	-40	-11.98	28	-39.98	0-360
7	28.94933	18.11	Pk	8.5	1.7	-40	-11.69	28	-39.69	0-360

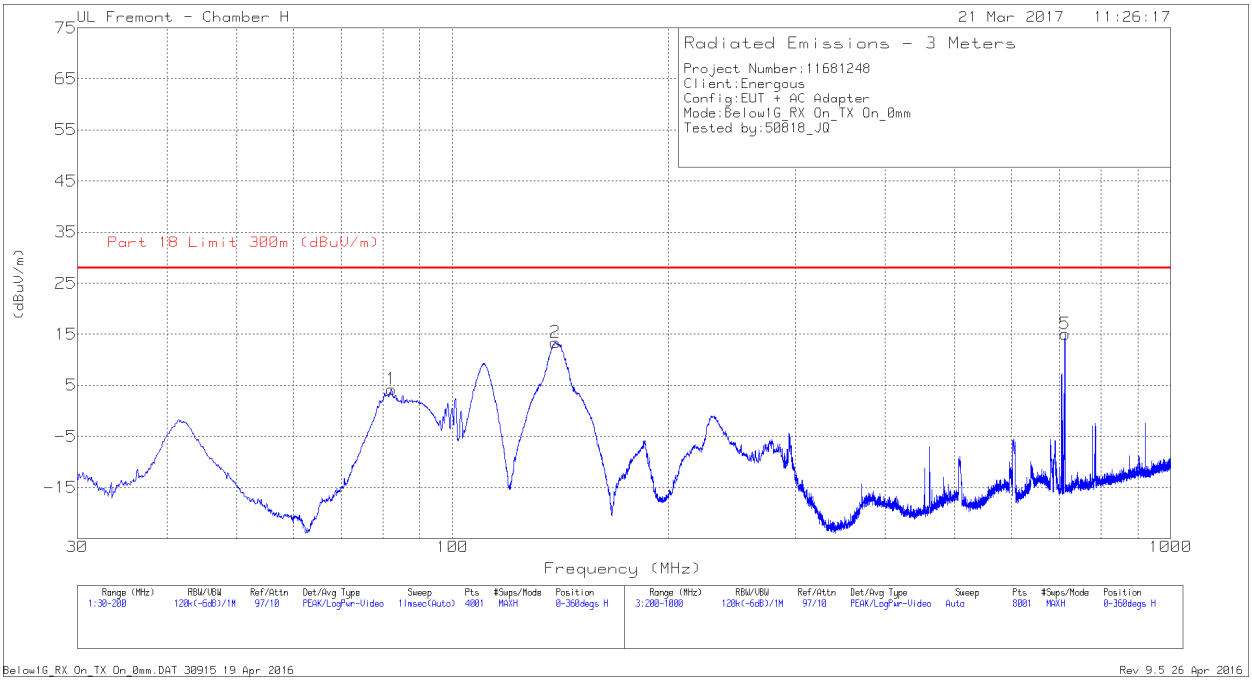
Pk - Peak detector

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

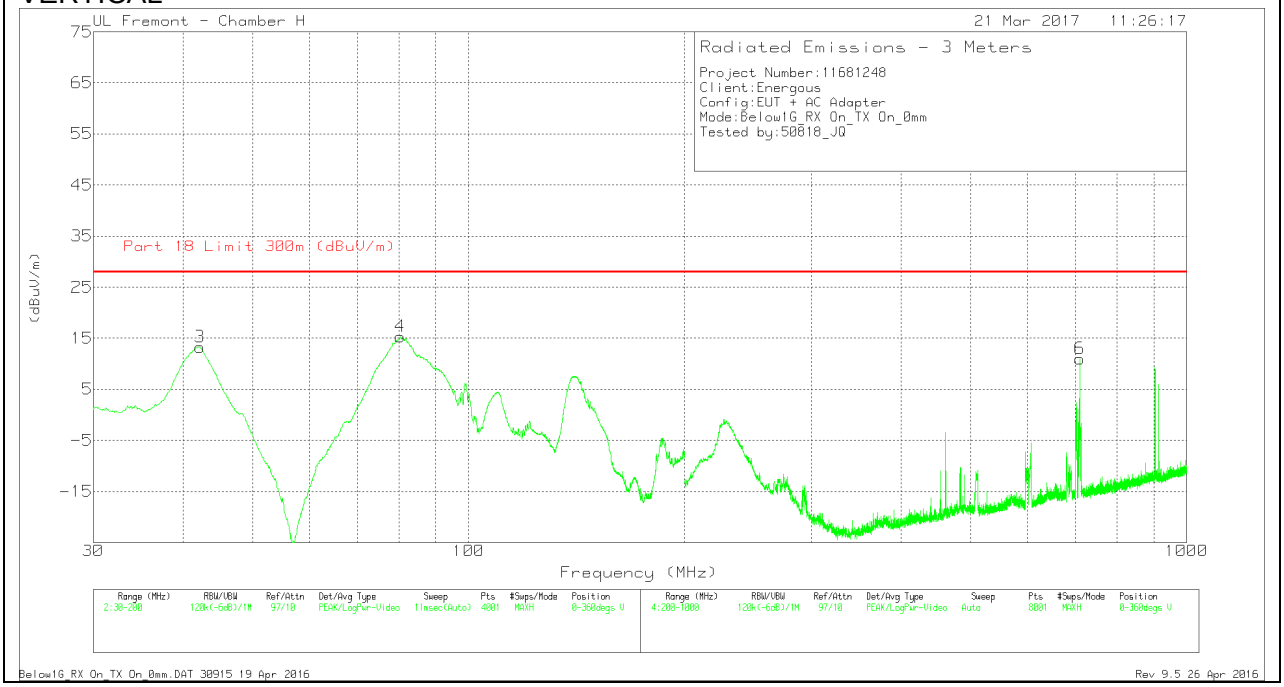
7.3.1. SPURIOUS EMISSIONS 30 - 1000 MHz

Configuration 1: Load with 0 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

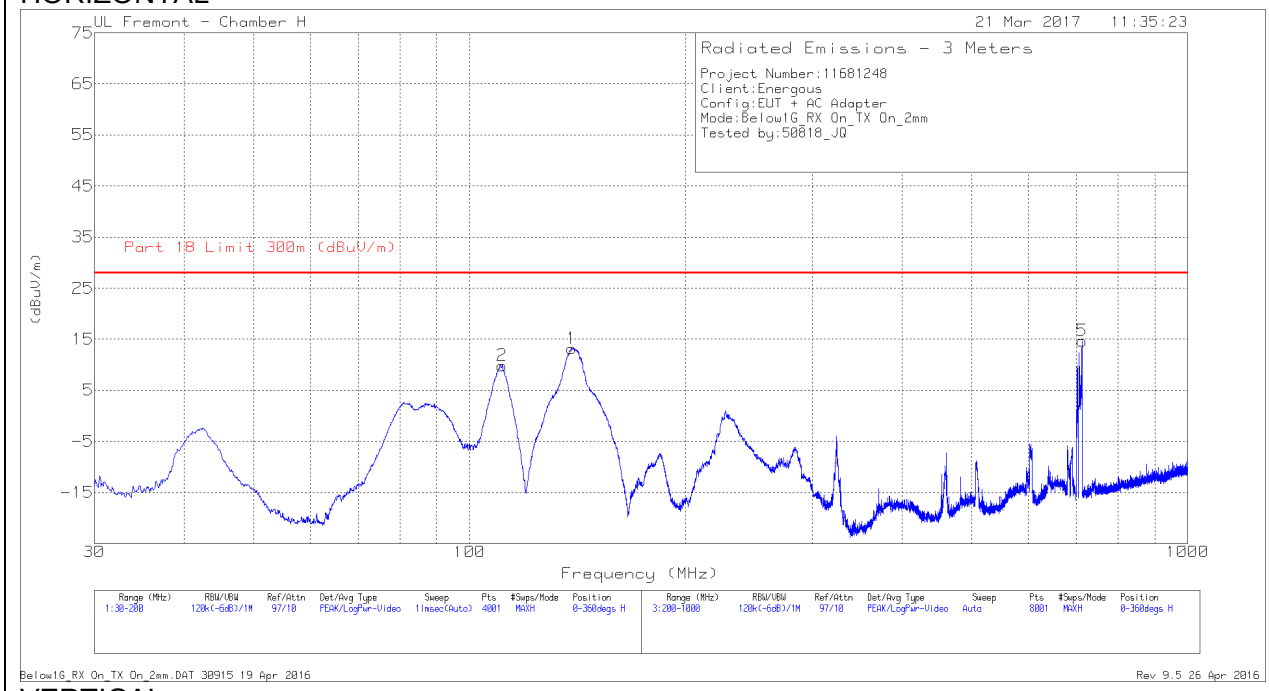
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T407 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuV/m)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	42.24	68.35	Pk	16.1	-31.2	-40	13.25	28	-14.75	0-360	100	V
4	80.32	74.48	Pk	11.5	-30.7	-40	15.28	28	-12.72	0-360	100	V
1	82.1688	63.61	Pk	11.3	-30.7	-40	4.21	28	-23.79	0-360	299	H
2	138.9275	66.56	Pk	16.9	-30.1	-40	13.36	28	-14.64	0-360	199	H
6	710.3	54.39	Pk	24.3	-27.7	-40	10.99	28	-17.01	0-360	201	V
5	712.6	58.3	Pk	24.4	-27.7	-40	15	28	-13	0-360	100	H

Pk - Peak detector

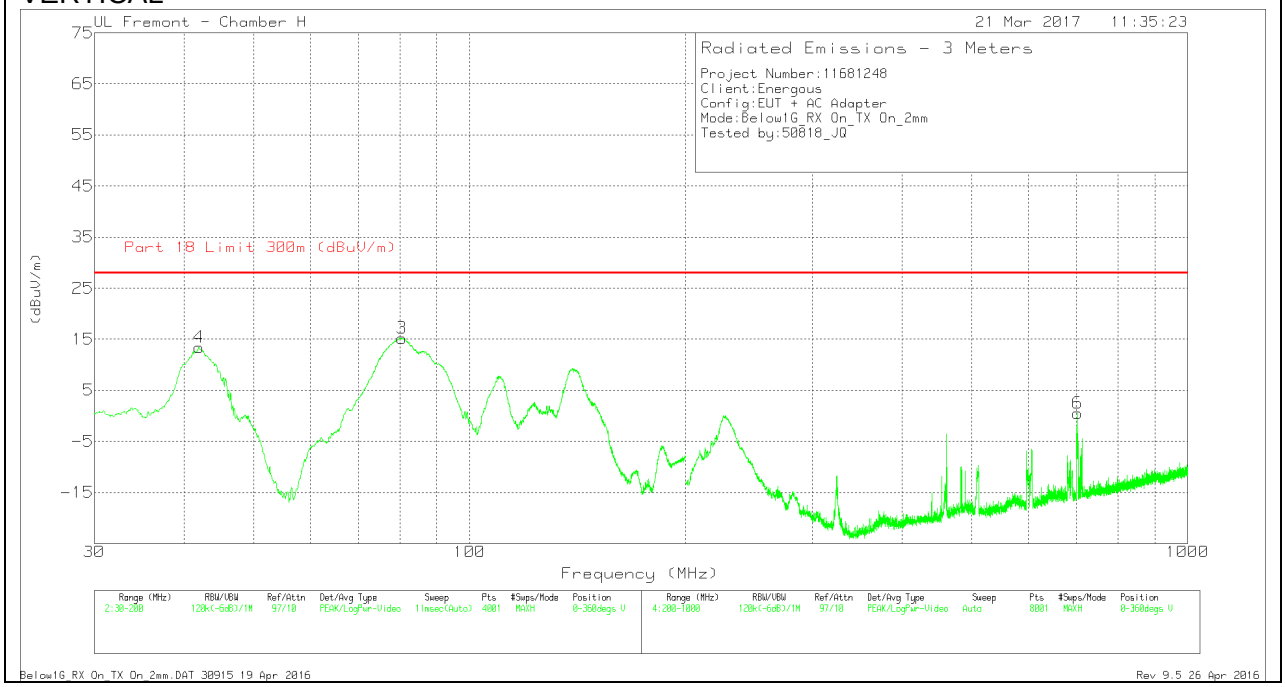
UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 2: Load with 2 mm Spacing

HORIZONTAL



VERTICAL



UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T407 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuV/m)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	41.9638	68.24	Pk	16.3	-31.2	-40	13.34	28	-14.66	0-360	100	V
3	80.49	74.4	Pk	11.5	-30.7	-40	15.2	28	-12.8	0-360	100	V
2	111.005	63.55	Pk	16.7	-30.4	-40	9.85	28	-18.15	0-360	299	H
1	138.885	66.4	Pk	16.9	-30.1	-40	13.2	28	-14.8	0-360	199	H
6	702.55	44.05	Pk	24.2	-27.7	-40	.55	28	-27.45	0-360	201	V
5	712.4	58.1	Pk	24.3	-27.7	-40	14.7	28	-13.3	0-360	100	H

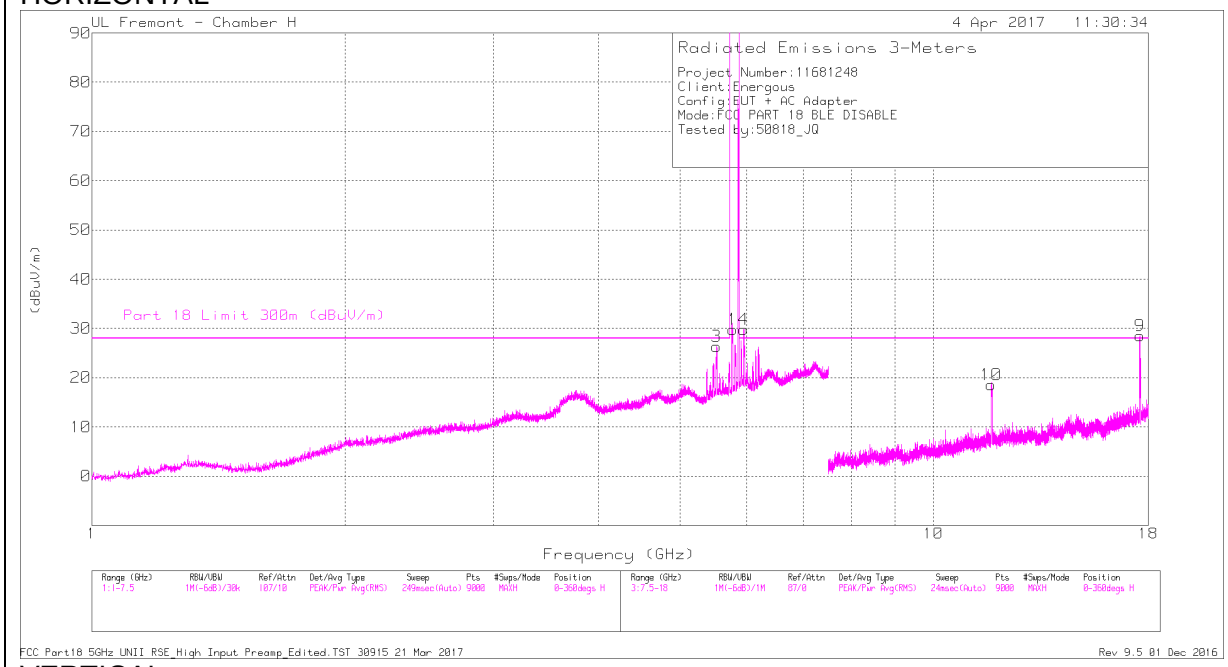
Pk - Peak detector

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

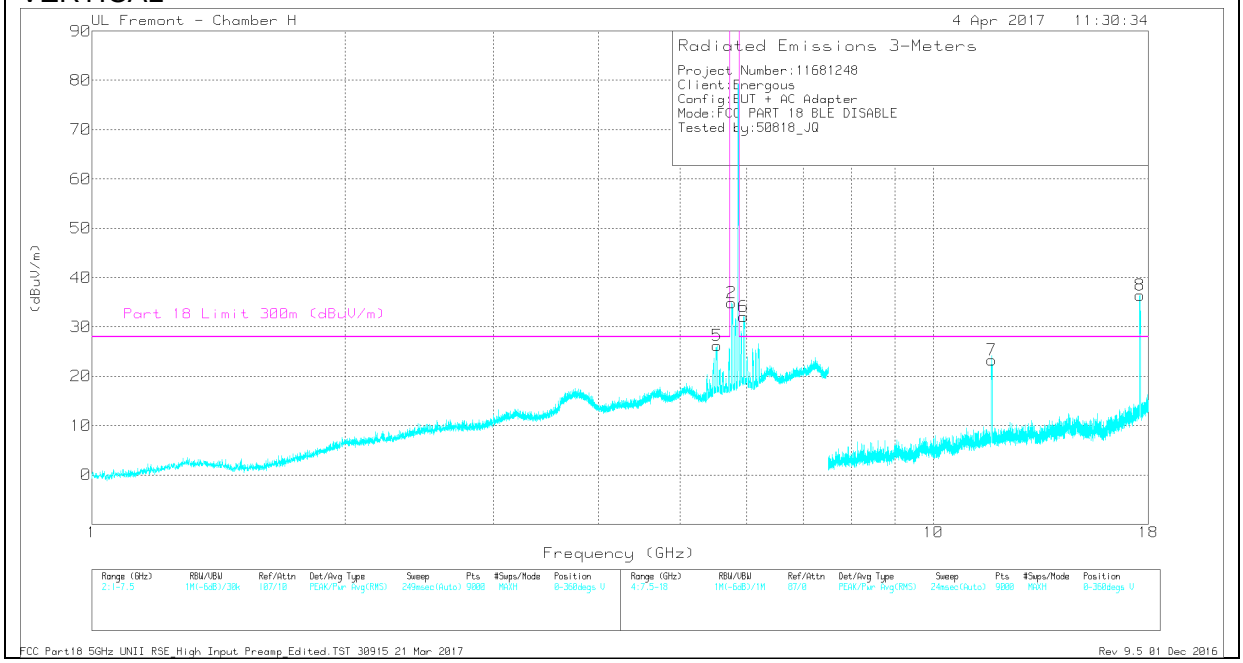
7.3.2. SPURIOUS EMISSIONS 1 - 18 GHz

Configuration 1: Load with 0 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	3dB Pad (dB)	Dist Corr (dB)	Corrected Reading (dBuV/m)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	5.529	40.23	Pk	34.7	-11.6	3	-40	26.33	-	-	0-360	201	H
5	5.531	40.09	Pk	34.7	-11.6	3	-40	26.19	-	-	0-360	201	V
2	5.759	48.08	Pk	34.9	-11.1	3	-40	34.88	-	-	0-360	201	V
1	5.774	42.9	Pk	34.9	-11	3	-40	29.8	-	-	0-360	201	H
6	5.951	44.3	Pk	35.3	-10.5	3	-40	32.1	-	-	0-360	100	V
4	5.953	42.03	Pk	35.3	-10.5	3	-40	29.83	-	-	0-360	201	H
10	11.712	43.28	Pk	39	-26.7	3	-40	18.58	28	-9.42	0-360	201	H
7	11.735	48.06	Pk	39	-26.8	3	-40	23.26	28	-4.74	0-360	99	V
9	17.583	47.36	Pk	40.7	-22.5	3	-40	28.56	-	-	0-360	99	H
8	17.589	55.19	Pk	40.7	-22.5	3	-40	36.39	-	-	0-360	99	V

Pk - Peak detector

Radiated Emissions

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	3dB Pad (dB)	Dist Corr (dB)	Corrected Reading (dBuV/m)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
5.533	27.69	ADR	34.7	-11.6	3	-40	13.79	28	-14.21	87	223	H
5.534	31.26	ADR	34.7	-11.7	3	-40	17.26	28	-10.74	227	187	V
5.952	34.12	ADR	35.3	-10.5	3	-40	21.92	28	-6.08	222	207	V
5.954	30.78	ADR	35.3	-10.5	3	-40	18.58	28	-9.42	312	231	H
11.717	32.79	ADR	39	-26.7	3	-40	8.09	28	-19.91	34	157	H
11.729	37.06	ADR	39	-26.8	3	-40	12.26	28	-15.74	268	145	V
17.571	42.05	ADR	40.6	-22.4	3	-40	23.25	28	-4.75	43	161	V
17.592	31.67	ADR	40.7	-22.5	3	-40	12.87	28	-15.13	104	139	H

ADR - RMS average

Note:

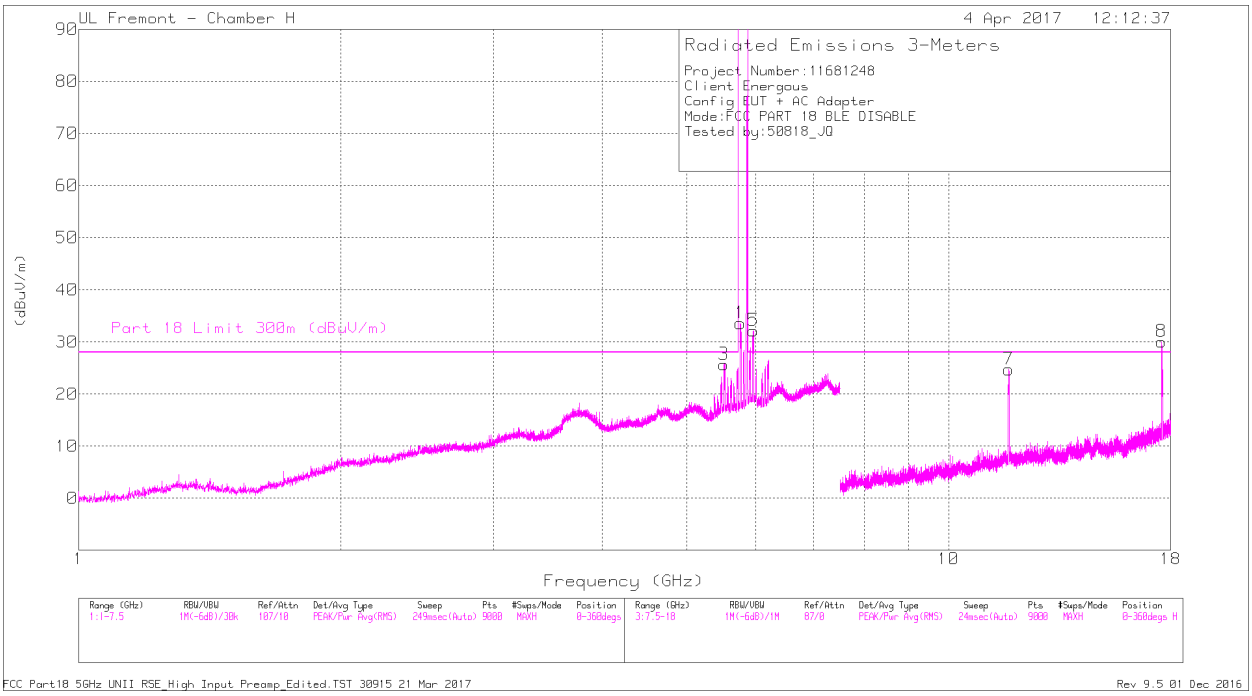
For pre-scans 1 – 7.5 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements and 7.5 - 18 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 1 MHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for average measurements where the values are represented in the Radiated Emissions table.

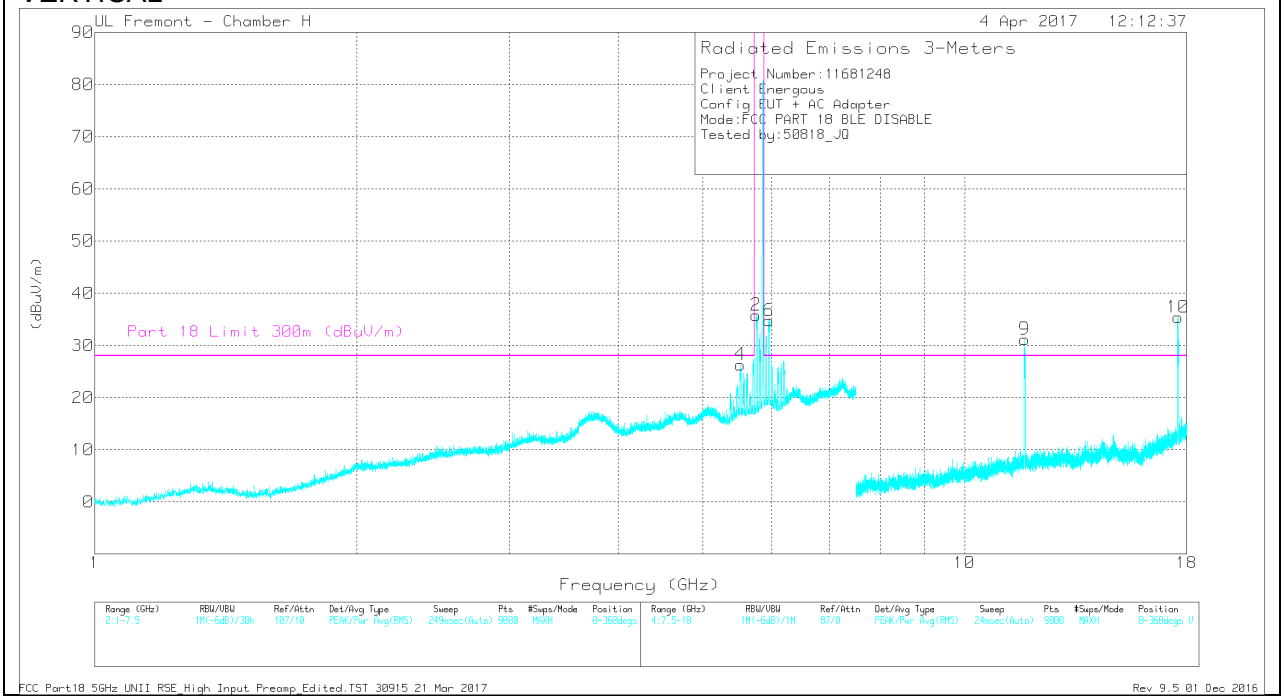
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 2: Load with 2 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	3dB Pad (dB)	Dist Corr (dB)	Corrected Reading (dBuV/m)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	5.519	39.57	Pk	34.7	-11.6	3	-40	25.67	-	-	0-360	201	H
4	5.527	40.32	Pk	34.7	-11.7	3	-40	26.32	-	-	0-360	201	V
2	5.761	48.98	Pk	34.9	-11.1	3	-40	35.78	-	-	0-360	201	V
1	5.763	46.8	Pk	34.9	-11.1	3	-40	33.6	-	-	0-360	201	H
6	5.958	46.97	Pk	35.3	-10.5	3	-40	34.77	-	-	0-360	99	V
5	5.966	44.37	Pk	35.3	-10.5	3	-40	32.17	-	-	0-360	201	H
7	11.724	49.53	Pk	39	-26.8	3	-40	24.73	28	-3.27	0-360	201	H
9	11.726	55.96	Pk	39	-26.8	3	-40	31.16	-	-	0-360	99	V
8	17.573	48.86	Pk	40.6	-22.4	3	-40	30.06	-	-	0-360	99	H
10	17.594	54.09	Pk	40.7	-22.4	3	-40	35.39	-	-	0-360	99	V

Pk - Peak detector

Radiated Emissions

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T120 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	3dB Pad (dB)	Dist Corr (dB)	Corrected Reading (dBuV/m)	Part 18 Limit 300m (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
5.521	30.93	ADR	34.7	-11.6	3	-40	17.03	28	-10.97	24	189	V
5.533	30.1	ADR	34.7	-11.6	3	-40	16.2	28	-11.8	286	209	H
5.953	36.75	ADR	35.3	-10.5	3	-40	24.55	28	-3.45	21	179	V
5.964	34.1	ADR	35.3	-10.5	3	-40	21.9	28	-6.1	305	215	H
11.719	43.7	ADR	39	-26.7	3	-40	19	28	-9	269	153	V
11.72	39.31	ADR	39	-26.7	3	-40	14.61	28	-13.39	260	159	H
17.573	39.64	ADR	40.6	-22.4	3	-40	20.84	28	-7.16	309	100	V
17.58	31.18	ADR	40.7	-22.4	3	-40	12.48	28	-15.52	81	101	H

ADR - RMS average

Note:

For pre-scans 1 – 7.5 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements and 7.5 - 18 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 1 MHz for peak measurements.

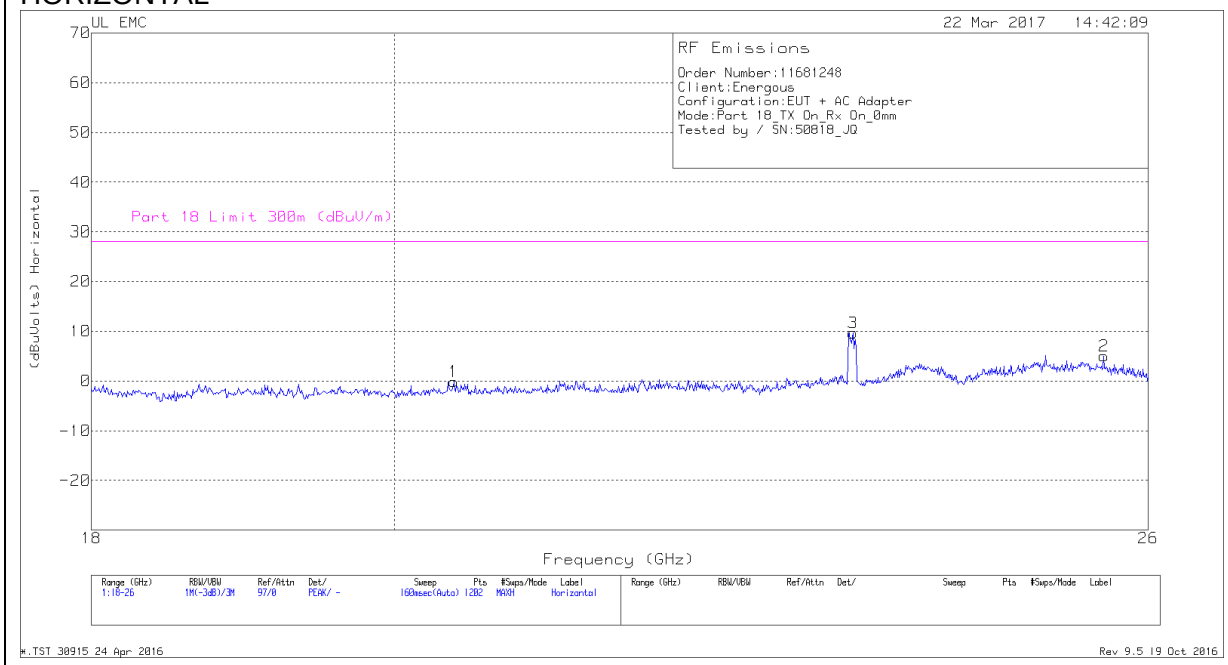
For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for average measurements where the values are represented in the Radiated Emissions table.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

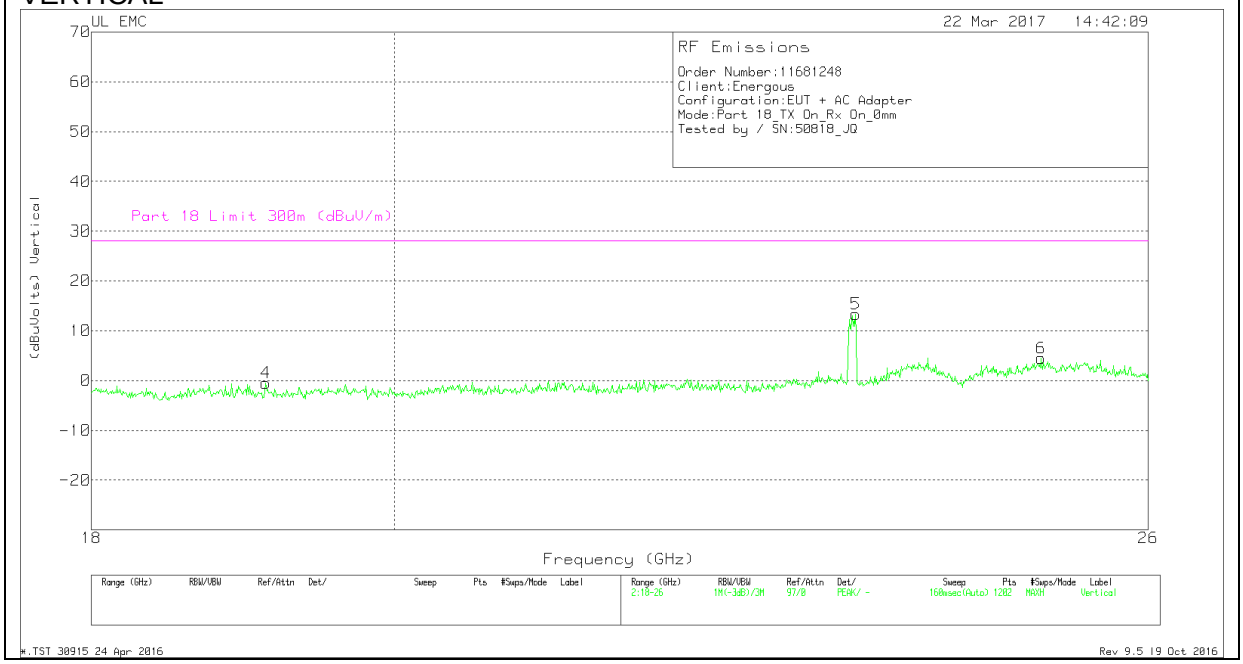
7.3.3. SPURIOUS EMISSIONS 18 - 26 GHz

Configuration 1: Load with 0 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

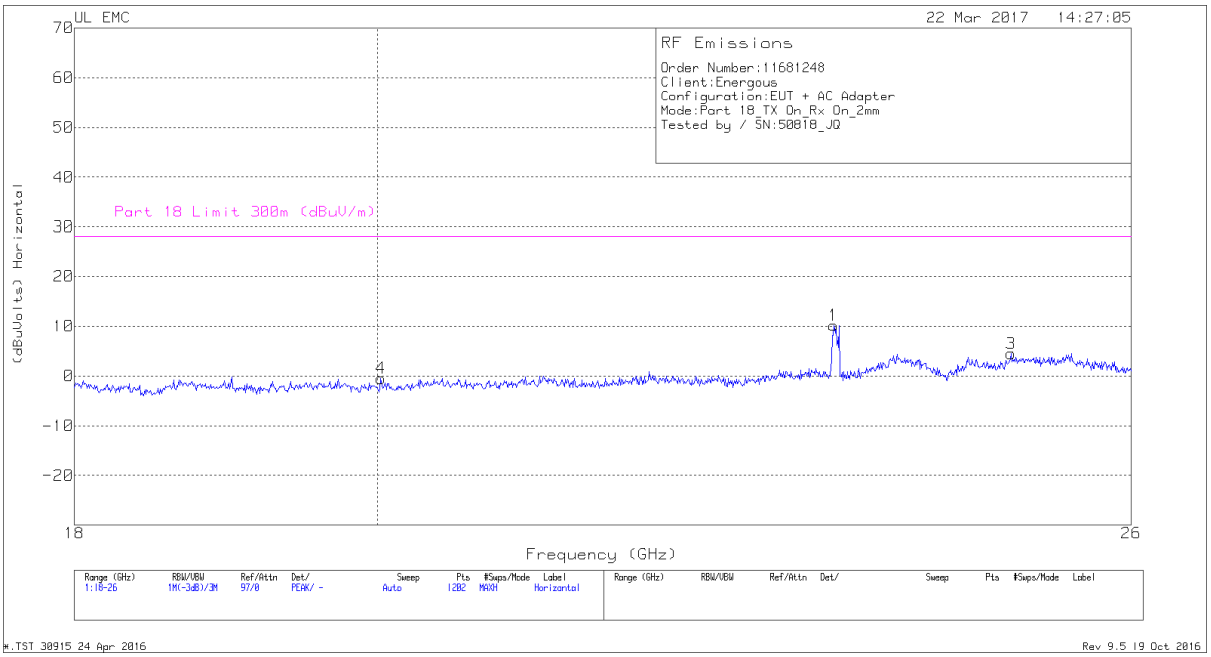
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T449 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Part 18 Limit 300m (dBuV/m)	Margin (dB)
1	20.418	41.63	Pk	32.9	-25.2	-49.5	-.1667	28	-28.1667
2	25.6	45.1	Pk	34.3	-24.9	-49.5	5	28	-23
3	23.462	50.07	Pk	33.7	-24.6	-49.5	9.667	28	-18.333
4	19.126	40.7	Pk	32.7	-24.4	-49.5	-.5	28	-28.5
5	23.482	53.53	Pk	33.7	-24.4	-49.5	13.333	28	-14.667
6	25.047	44.4	Pk	34.3	-24.7	-49.5	4.5	28	-23.5

Pk - Peak detector

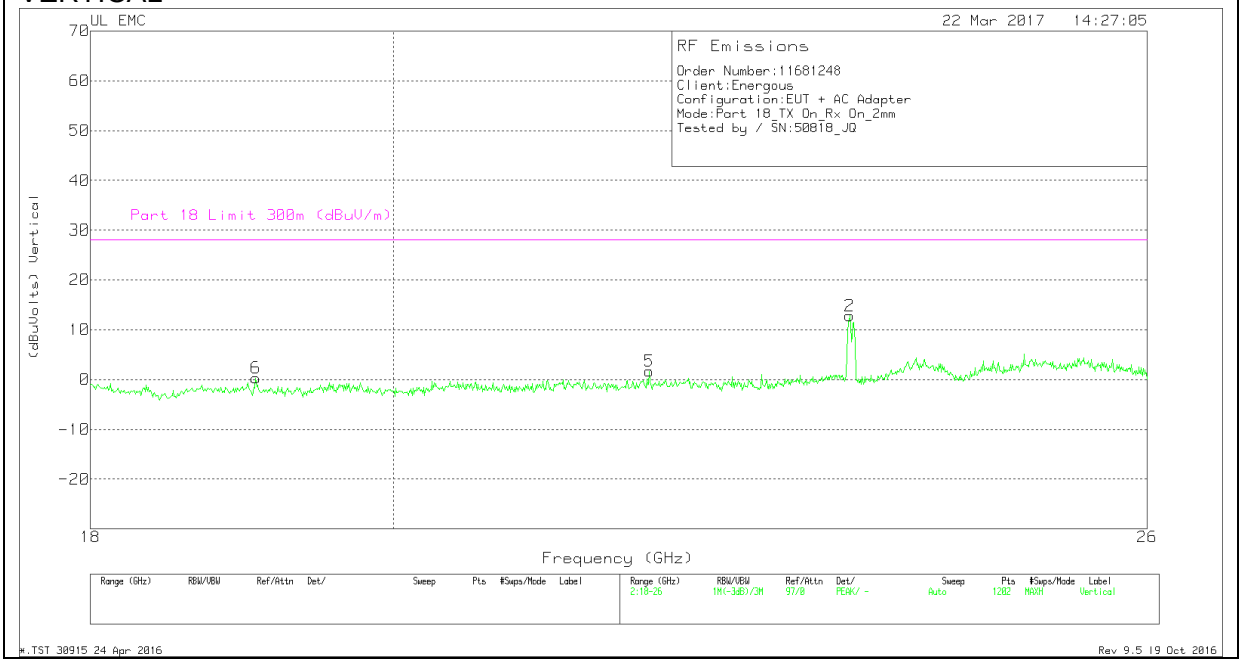
UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 2: Load with 2 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T449 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Part 18 Limit 300m (dBuV/m)	Margin (dB)
1	23.442	50.57	Pk	33.7	-24.6	-49.5	10.1667	28	-17.8333
3	24.934	44.2	Pk	34.2	-24.4	-49.5	4.5	28	-23.5
4	20.025	41.6	Pk	32.6	-25.2	-49.5	-.5	28	-28.5
2	23.442	53.23	Pk	33.7	-24.6	-49.5	12.8333	28	-15.1667
5	21.863	42.47	Pk	33.3	-24.6	-49.5	1.6667	28	-26.3333
6	19.066	42.23	Pk	32.6	-25	-49.5	.3333	28	-27.6667

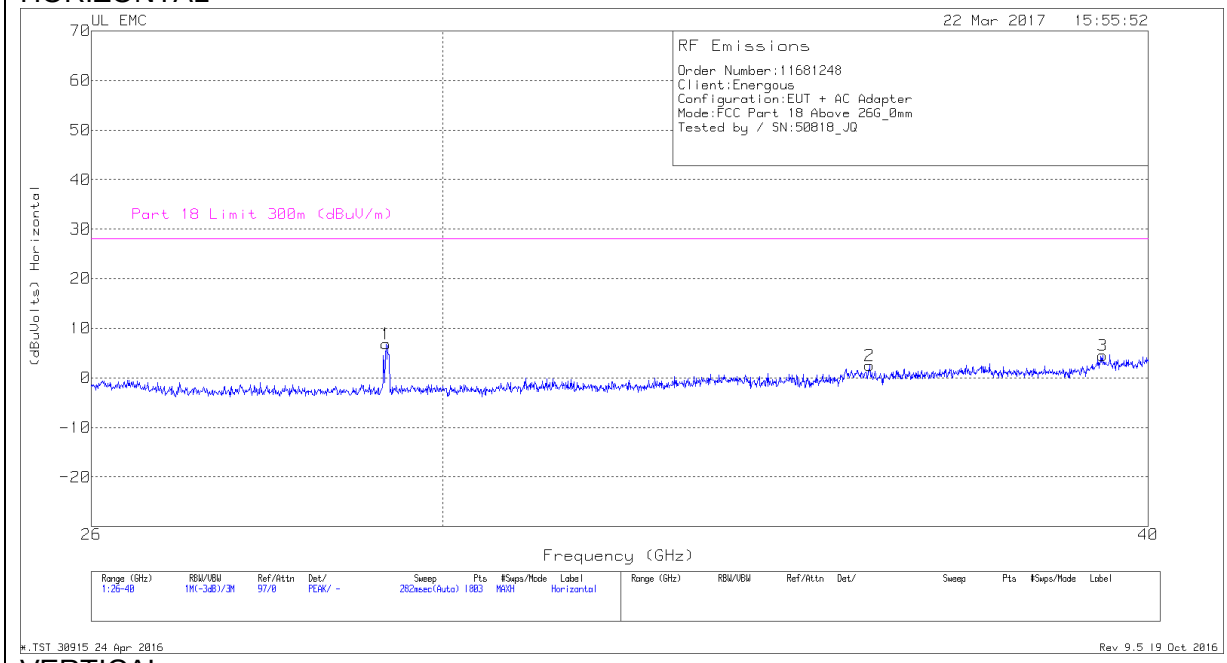
Pk - Peak detector

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

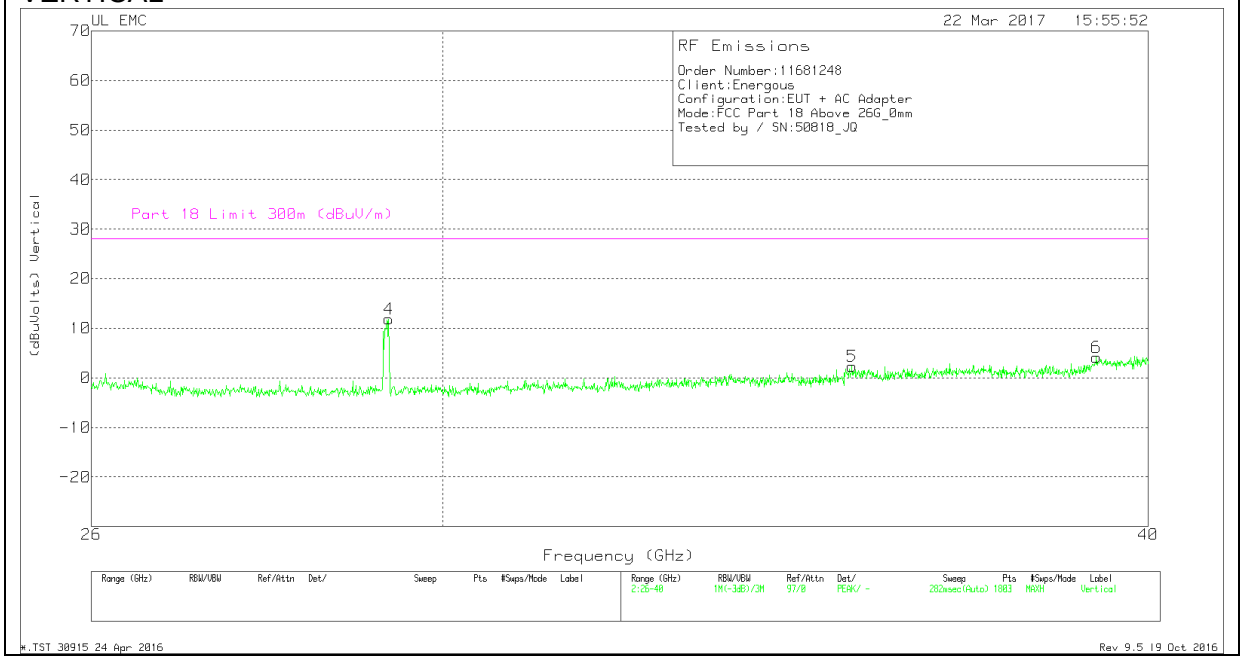
7.3.4. SPURIOUS EMISSIONS 26 - 40 GHz

Configuration 1: Load with 0 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

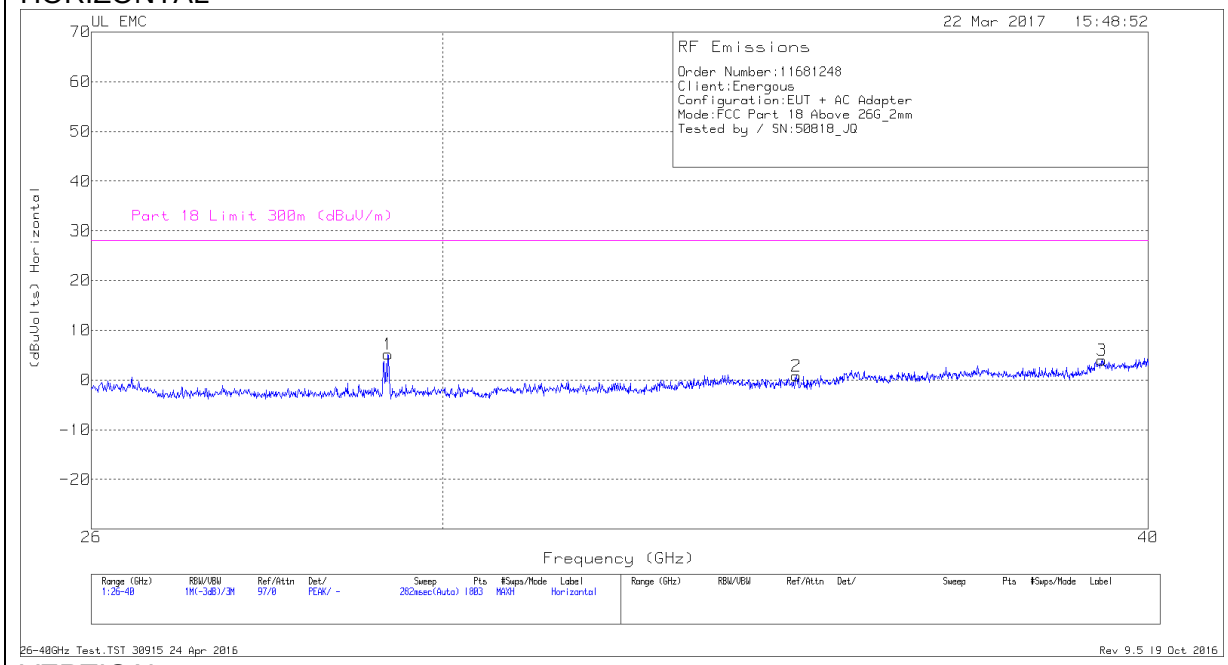
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	T90 AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Part 18 Limit 300m (dBuV/m)	Margin (dB)
1	29.317	53.13	Pk	35.9	-32.7	-49.5	6.83	28	-21.16
2	35.704	48.9	Pk	37.3	-34.2	-49.5	2.5	28	-25.5
3	39.262	47.8	Pk	38.6	-32.4	-49.5	4.5	28	-23.5
4	29.349	57.93	Pk	35.9	-32.5	-49.5	11.83	28	-16.16
5	35.447	47.73	Pk	37.9	-33.8	-49.5	2.33	28	-25.66
6	39.161	48.07	Pk	38.1	-32.5	-49.5	4.166	28	-23.83

Pk - Peak detector

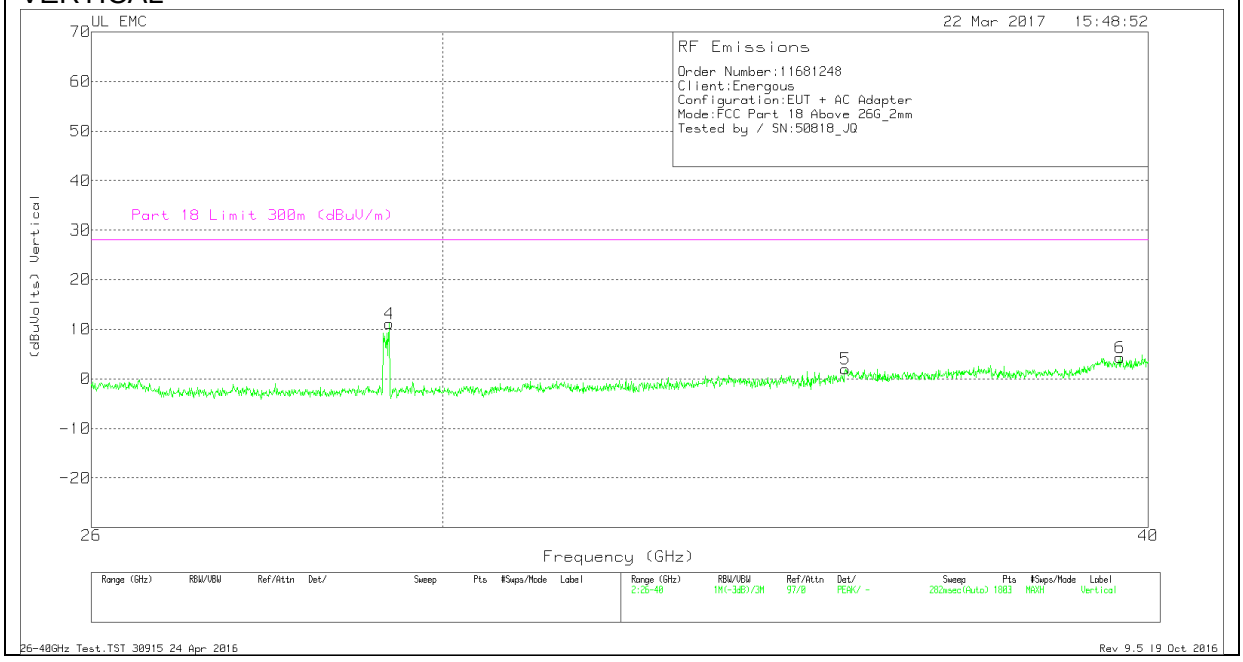
UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 2: Load with 2 mm Spacing

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	T90 AF (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Part 18 Limit 300m (dBuV/m)	Margin (dB)
1	29.341	51.27	Pk	35.9	-32.5	-49.5	5.16	28	-22.83
2	34.655	46.83	Pk	37.3	-33.8	-49.5	.83	28	-27.16
3	39.254	47.3	Pk	38.6	-32.4	-49.5	4	28	-24
4	29.356	57.37	Pk	35.9	-32.6	-49.5	11.16	28	-16.83
5	35.354	47.3	Pk	37.8	-33.6	-49.5	2	28	-26
6	39.542	48.63	Pk	37.3	-32.1	-49.5	4.33	28	-23.66

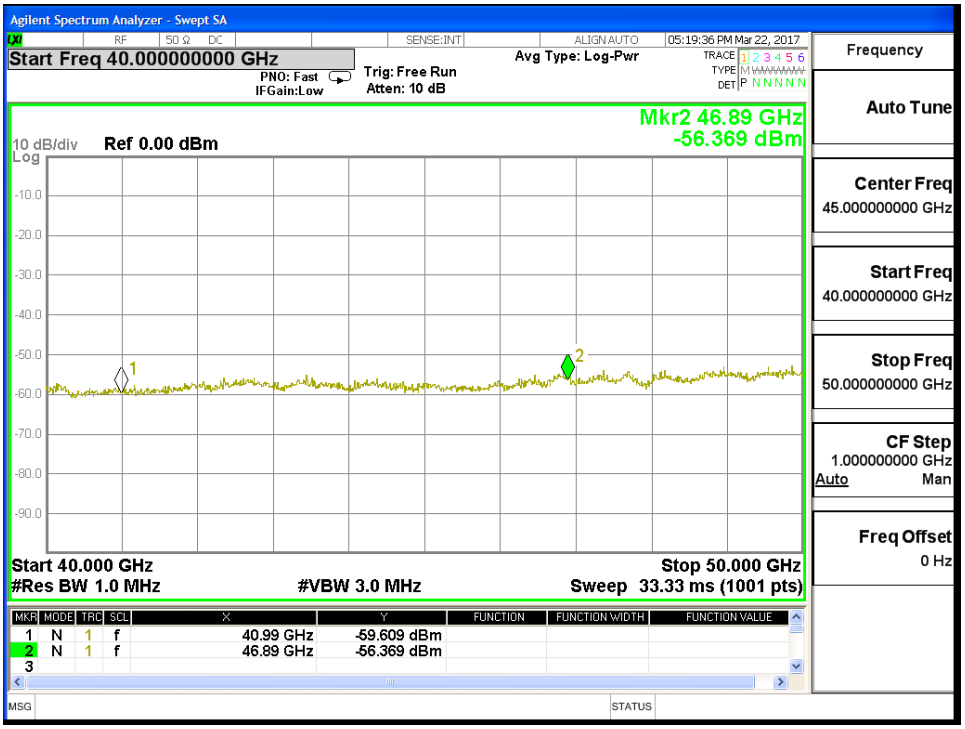
Pk - Peak detector

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

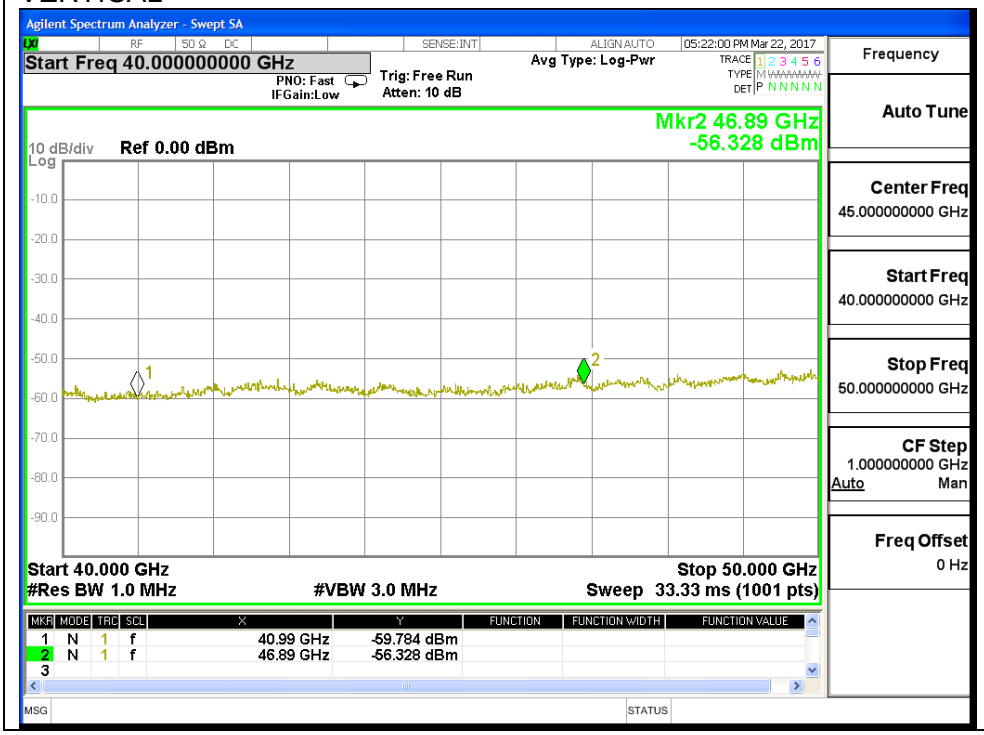
7.3.5. SPURIOUS EMISSIONS 40 - 50 GHz

No emissions observed above noise floor in any of the Configurations. The measurements below were performed with 0 mm spacing.

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Noise floor / Emissions levels at harmonics of fundamental; peak levels compared to average limits.

7th Harmonic (Horizontal)

Frequency (GHz)	Measurement Distance (m)	Peak Power (dBm)	Antenna Assy Gain (dBi)	EIRP (dBm)
40.99	1.0	-59.61	49.00	-43.9
Field Strength (dBuV/m @ 1 m)	**Specification Distance (m)**	**Field Strength (dBuV/m @ 300 m)**	**F.S. Limit (dBuV/m @ 300 m)**	**Margin (dB)**
51.3	300	1.74	27.96	-26.22

8th Harmonic (Horizontal)

Frequency (GHz)	Measurement Distance (m)	Peak Power (dBm)	Antenna Assy Gain (dBi)	EIRP (dBm)
46.89	1.0	-56.37	48.50	-39.0
Field Strength (dBuV/m @ 1 m)	**Specification Distance (m)**	**Field Strength (dBuV/m @ 300 m)**	**F.S. Limit (dBuV/m @ 300 m)**	**Margin (dB)**
56.2	300	6.65	27.96	-21.31

7th Harmonic (Vertical)

Frequency (GHz)	Measurement Distance (m)	Peak Power (dBm)	Antenna Assy Gain (dBi)	EIRP (dBm)
40.99	1.0	-59.78	49.00	-44.1
Field Strength (dBuV/m @ 1 m)	**Specification Distance (m)**	**Field Strength (dBuV/m @ 300 m)**	**F.S. Limit (dBuV/m @ 300 m)**	**Margin (dB)**
51.1	300	1.56	27.96	-26.39

8th Harmonic (Vertical)

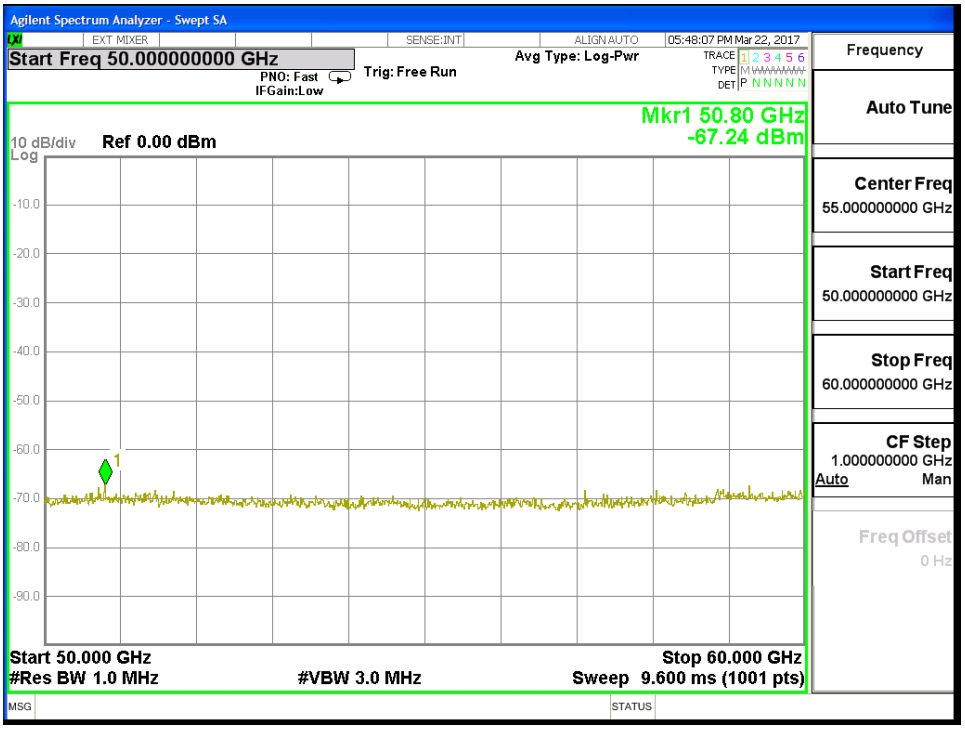
Frequency (GHz)	Measurement Distance (m)	Peak Power (dBm)	Antenna Assy Gain (dBi)	EIRP (dBm)
46.89	1.0	-56.33	48.50	-39.0
Field Strength (dBuV/m @ 1 m)	**Specification Distance (m)**	**Field Strength (dBuV/m @ 300 m)**	**F.S. Limit (dBuV/m @ 300 m)**	**Margin (dB)**
56.2	300	6.69	27.96	-21.27

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

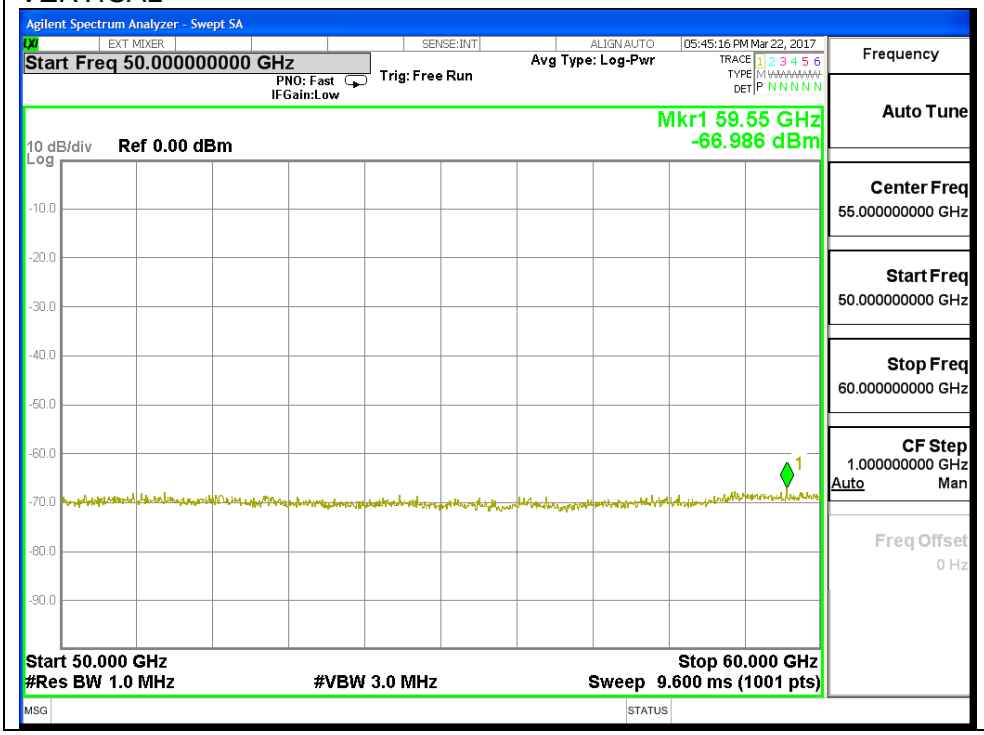
7.3.6. SPURIOUS EMISSIONS 50 - 60 GHz

No emissions observed above noise floor in any of the Configurations. The measurements below were performed with 0 mm spacing.

HORIZONTAL



VERTICAL



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Noise floor / Emissions levels at harmonics of fundamental; peak levels compared to average limits.

Horizontal				
Frequency (GHz)	**Measurement Distance (m)**	**Peak Power (dBm)**	**Antenna Assy Gain (dBi)**	**EIRP (dBm)**
50.8	3.0	-67.24	40.00	-31.1
Field Strength (dBuV/m @ 1 m)	**Specification Distance (m)**	**Field Strength (dBuV/m @ 300 m)**	**F.S. Limit (dBuV/m @ 300 m)**	**Margin (dB)**
64.1	300	14.51	27.96	-13.44

Vertical				
Frequency (GHz)	**Measurement Distance (m)**	**Peak Power (dBm)**	**Antenna Assy Gain (dBi)**	**EIRP (dBm)**
59.55	3.0	-66.99	40.00	-29.5
Field Strength (dBuV/m @ 1 m)	**Specification Distance (m)**	**Field Strength (dBuV/m @ 300 m)**	**F.S. Limit (dBuV/m @ 300 m)**	**Margin (dB)**
65.7	300	16.15	27.96	-11.81

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

7.4. AC MAINS LINE CONDUCTED EMISSIONS

LIMIT

§ 18.307 For the following equipment, when designed to be connected to the public utility (AC) power line the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies shall not exceed the limits in the following table. Compliance with the provisions of this paragraph shall be based on the measurements of the radio frequency voltage between each power line and ground at the power terminal using a 50 µH/50 ohms line impedance stabilization network (LISN).
.
§ 18.307 (b) All other Part 18 consumer devices:

Frequency range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50
* Decreases with the logarithm of the frequency.		

TEST PROCEDURE

FCC / OST MP-5

The device was placed in a test mode that set up continuous operation.

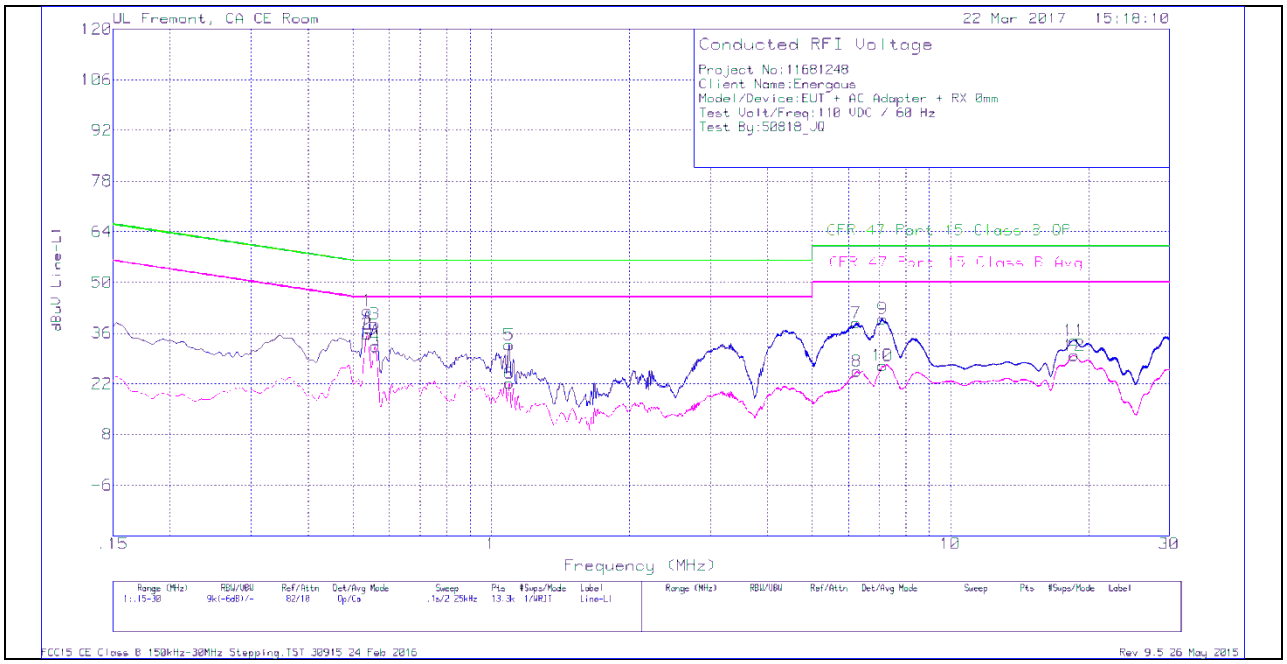
RESULTS

No non-compliance noted:

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 1: Load with 0 mm Spacing

LINE 1 PLOT



LINE 1 RESULTS

Range 1: Line-L1 .15 - 30MHz

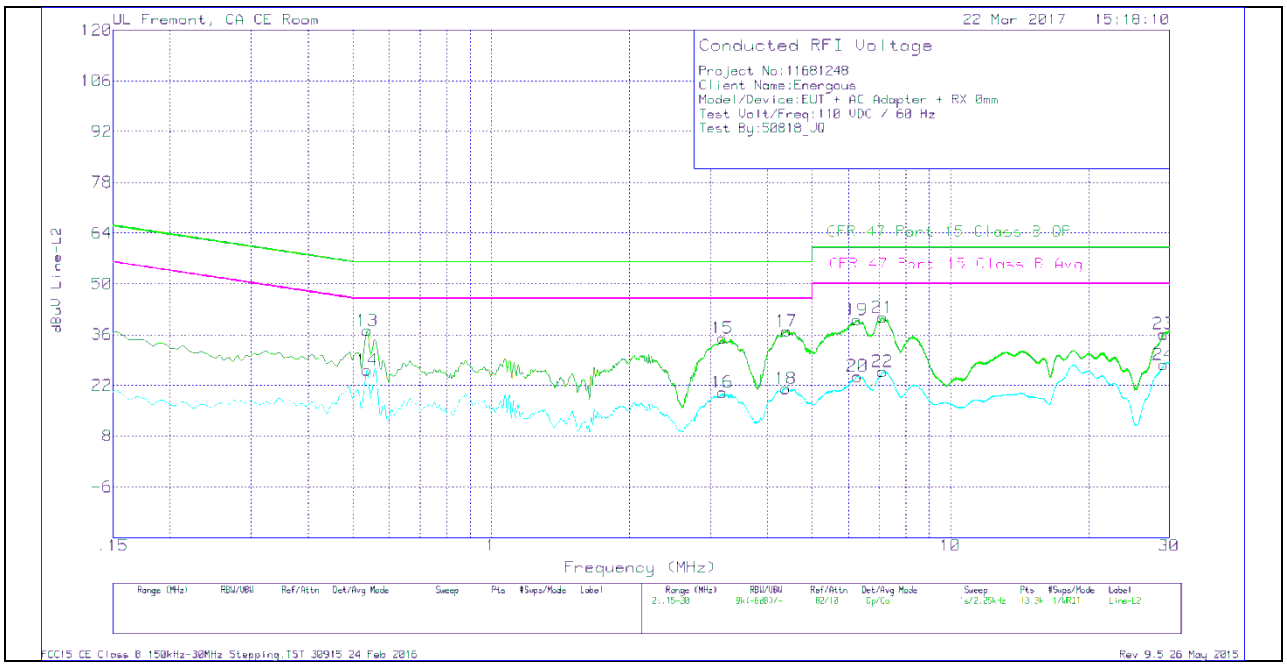
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
1	.537	32.04	Qp	0	.1	10.1	42.24	56	-13.76	-	-
2	.537	25.61	Ca	0	.1	10.1	35.81	-	-	46	-10.19
3	.55725	28.39	Qp	0	.1	10.1	38.59	56	-17.41	-	-
4	.5595	22.16	Ca	0	.1	10.1	32.36	-	-	46	-13.64
5	1.09388	22.53	Qp	0	.1	10.1	32.73	56	-23.27	-	-
6	1.095	12.02	Ca	0	.1	10.1	22.22	-	-	46	-23.78
7	6.234	28.54	Qp	0	.2	10.2	38.94	60	-21.06	-	-
8	6.252	15.03	Ca	0	.2	10.2	25.43	-	-	50	-24.57
9	7.13175	29.46	Qp	0	.2	10.2	39.86	60	-20.14	-	-
10	7.13175	16.62	Ca	0	.2	10.2	27.02	-	-	50	-22.98
11	18.62925	23.47	Qp	0	.3	10.3	34.07	60	-25.93	-	-
12	18.6225	19.27	Ca	0	.3	10.3	29.87	-	-	50	-20.13

Qp - Quasi-Peak detector

Ca - CISPR average detection

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

LINE 2 PLOT



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	.537	26.89	Qp	0	.1	10.1	37.09	56	-18.91	-	-
14	.537	15.93	Ca	0	.1	10.1	26.13	-	-	46	-19.87
15	3.192	24.85	Qp	0	.1	10.1	35.05	56	-20.95	-	-
16	3.192	9.91	Ca	0	.1	10.1	20.11	-	-	46	-25.89
17	4.39575	26.8	Qp	0	.1	10.1	37	56	-19	-	-
18	4.389	10.95	Ca	0	.1	10.1	21.15	-	-	46	-24.85
19	6.25875	29.74	Qp	0	.2	10.2	40.14	60	-19.86	-	-
20	6.27225	14.13	Ca	0	.2	10.2	24.53	-	-	50	-25.47
21	7.12275	30.38	Qp	0	.2	10.2	40.78	60	-19.22	-	-
22	7.125	15.37	Ca	0	.2	10.2	25.77	-	-	50	-24.23
23	29.15025	25.38	Qp	.1	.3	10.4	36.18	60	-23.82	-	-
24	29.1525	16.92	Ca	.1	.3	10.4	27.72	-	-	50	-22.28

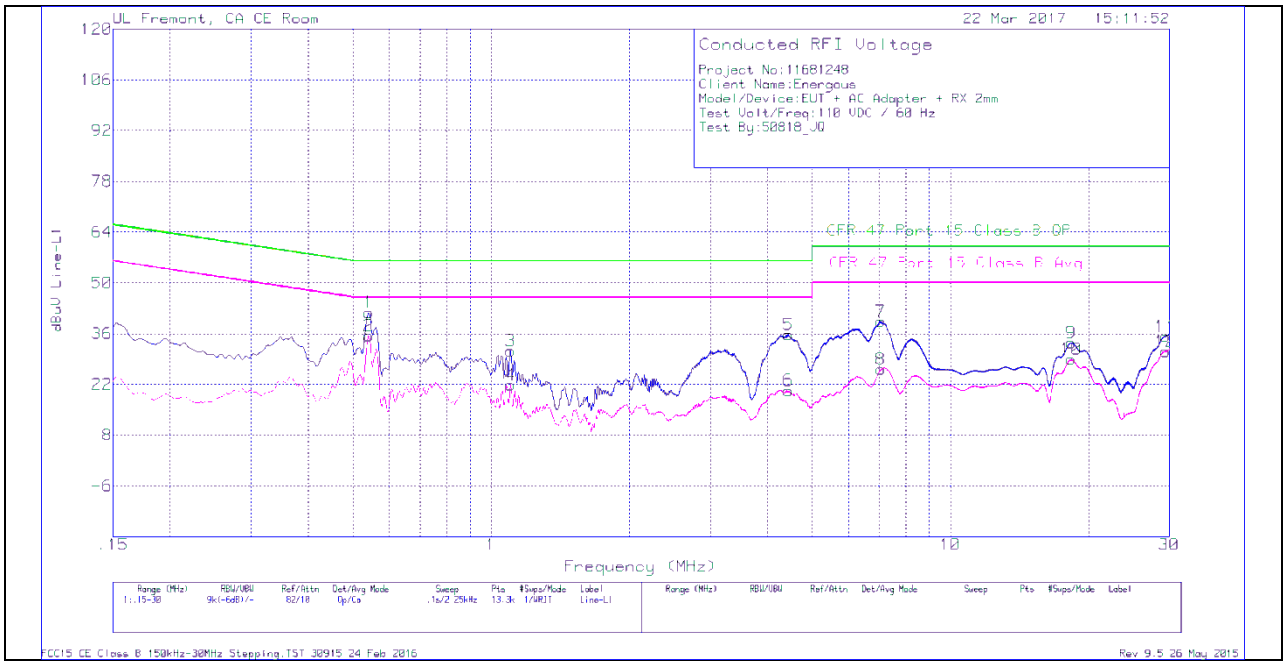
Qp - Quasi-Peak detector

Ca - CISPR average detection

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

Configuration 2: Load with 2 mm Spacing

LINE 1 PLOT



LINE 1 RESULTS

Range 1: Line-L1 .15 - 30MHz

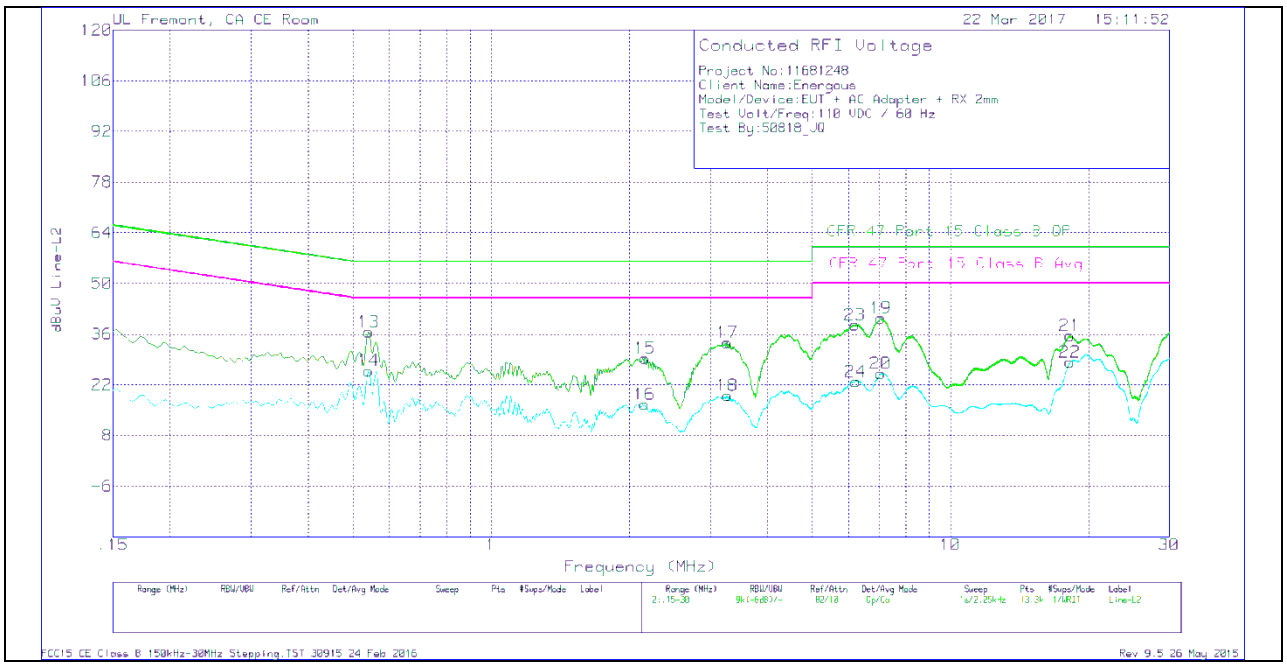
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
1	.5415	31.57	Qp	0	.1	10.1	41.77	56	-14.23	-	-
2	.5415	25.25	Ca	0	.1	10.1	35.45	-	-	46	-10.55
3	1.10175	21.1	Qp	0	.1	10.1	31.3	56	-24.7	-	-
4	1.10175	11.69	Ca	0	.1	10.1	21.89	-	-	46	-24.11
5	4.4385	25.6	Qp	0	.1	10.1	35.8	56	-20.2	-	-
6	4.43625	10.16	Ca	0	.1	10.1	20.36	-	-	46	-25.64
7	7.0575	28.96	Qp	0	.2	10.2	39.36	60	-20.64	-	-
8	7.05525	15.74	Ca	0	.2	10.2	26.14	-	-	50	-23.86
9	18.3345	22.93	Qp	0	.3	10.3	33.53	60	-26.47	-	-
10	18.3345	18.32	Ca	0	.3	10.3	28.92	-	-	50	-21.08
11	29.42588	24.47	Qp	.1	.3	10.4	35.27	60	-24.73	-	-
12	29.418	20.31	Ca	.1	.3	10.4	31.11	-	-	50	-18.89

Qp - Quasi-Peak detector

Ca - CISPR average detection

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..

LINE 2 PLOT



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	.5415	26.46	Qp	0	.1	10.1	36.66	56	-19.34	-	-
14	.5415	15.72	Ca	0	.1	10.1	25.92	-	-	46	-20.08
15	2.1615	19.12	Qp	0	.1	10.1	29.32	56	-26.68	-	-
16	2.157	6.44	Ca	0	.1	10.1	16.64	-	-	46	-29.36
17	3.273	23.41	Qp	0	.1	10.1	33.61	56	-22.39	-	-
18	3.273	8.82	Ca	0	.1	10.1	19.02	-	-	46	-26.98
19	7.05975	30.05	Qp	0	.2	10.2	40.45	60	-19.55	-	-
20	7.062	14.74	Ca	0	.2	10.2	25.14	-	-	50	-24.86
21	18.23325	25.01	Qp	0	.3	10.3	35.61	60	-24.39	-	-
22	18.23325	17.6	Ca	0	.3	10.3	28.2	-	-	50	-21.8
23	6.2025	28.12	Qp	0	.2	10.2	38.52	60	-21.48	-	-
24	6.21375	12.55	Ca	0	.2	10.2	22.95	-	-	50	-27.05

Qp - Quasi-Peak detector

Ca - CISPR average detection

UL VERIFICATION SERVICES INC. FORM NO: CCSUP470I
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc..