



CERTIFICATION TEST REPORT

Report Number. : 12204475-E11V3

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

Model : A2098

FCC ID : BCG-E3233A

IC : 579C-E3233A

EUT Description : SMARTPHONE

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 9

Date Of Issue:
August 10, 2018

Prepared by:
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	7/17/2018	Intial Issue	Chin Pang
V2	7/19/2018	Address TCB's Questions	Chin Pang
V3	8/10/2018	Address TCB's Questions	Jingang Li

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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: SMARTPHONE

MODEL: A2098

SERIAL NUMBER: C39WF025JVW1

DATE TESTED: MARCH 22, 2018 – MAY 23, 2018

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 15 SUBPART C	Complies
ISED RSS-210 Issue 9, Annex B	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. 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:



Chin Pang
Senior Test Engineer
UL VERIFICATION SERVICES INC.

Prepared By:



Jingang Li
LAB ENGINEER
UL VERIFICATION SERVICES INC.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 5, and RSS-210 Issue 9.

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 (ISED:2324B-1)	☒ Chamber D (ISED:22541-1)
☐ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)
☐ 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 is covered under ISED company address code 2324B with site numbers 2324B -1 through 2324B-3, respectively. Chambers D through H are covered under ISED Canada company address code 22541 with site numbers 22541 -1 through 22541-5, respectively.

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 [NVLAP Lab Search](#).

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

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

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
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 Apple iPhone, is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac, Bluetooth, GPS and NFC. All models support at least one UICC based SIM. The second SIM is either UICC based, electronic SIM (e-SIM), or second SIM is not present. The device has a built-in inductive charging receiver which is not user accessible. The rechargeable battery is not user accessible.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak radiated magnetic field strength as follows:

Frequency Range (MHz)	Mode		Kbps	E Field at 30m distance (dBuV/m)
13.56	Type A	CE	848	19.34
		Reader	848	19.9

5.3. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v16.30.67.7

5.4. WORST-CASE CONFIGURATION AND MODE

The fundamental of the EUT was investigated under three orthogonal orientations X (Flatbed), Y (Landscape), and Z (Portrait). The Y (Landscape orientation) was determined to be the worst-case orientation.

Radiated test was investigated on EUT with power supply and earphones. The worst case was determined to be the EUT with AC/DC adapter; therefore, all final tests were performed on the EUT with AC/DC adapter.

In addition, Type A, B and F with CE mode and Reader mode data rates and ISO 15693 were investigated to determine the worst case based on the highest power and spurious emissions. Type A was determined to be the worst case and therefore Type A was selected for all final tests.

Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788

5.5. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	A1398	C02PM012G3QD	FCC DoC
AC/DC power Adapter	Delta Electronic	A1435	N/A	N/A
EUT AC Adapter	Apple	A1385	D293062F3WVDHLHCF	NA

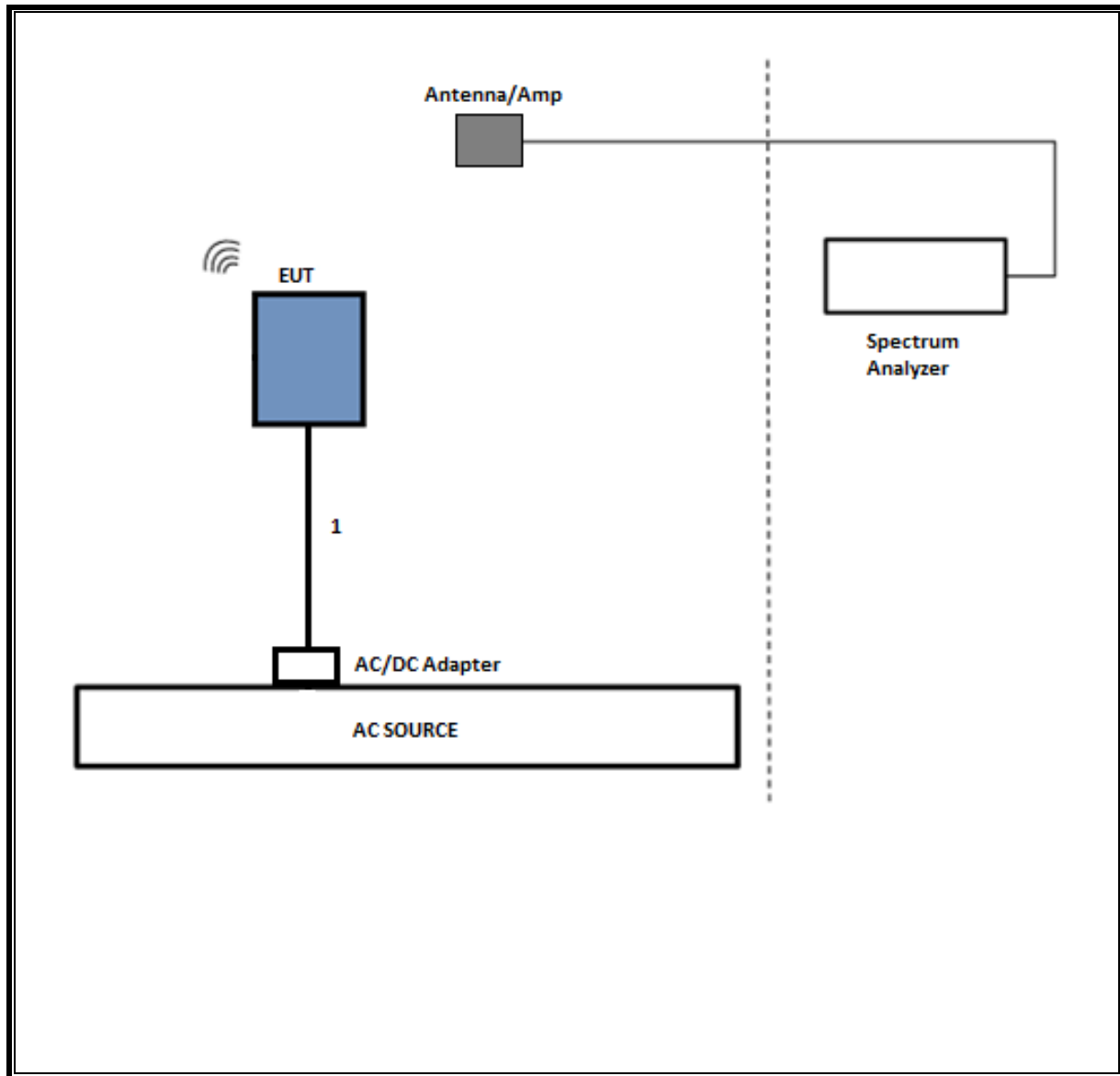
I/O CABLES

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

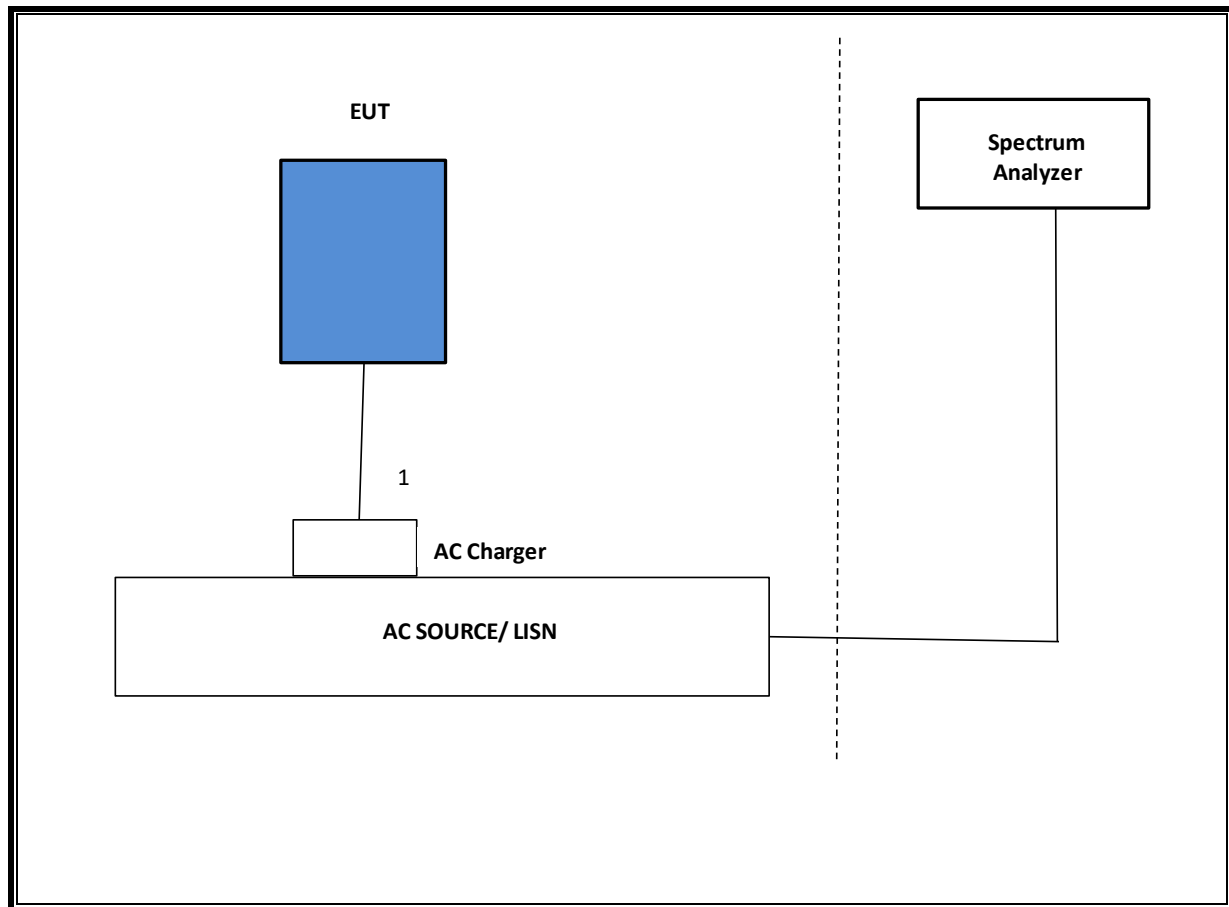
TEST SETUP

The EUT is installed in a host laptop computer during the tests. Test software exercised the EUT.

SETUP DIAGRAM FOR RADIATED TESTS



SETUP DIAGRAM FOR LINE CONDUCTED TESTS



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Description	Manufacturer	Model	ID Num	Cal Due
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T477	07/07/2018
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T286	06/2/2018
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	09/14/2018
Chamber, Environmental	Cincinnati Sub Zero	ZPHS-8-3.5-SCT/WC	T754	09/05/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T342	02/22/2019

AC Line Conducted				
EMI Test Receiver 9KHz-7GHz	Rohde & Schwarz	ESC17	T1436	01/25/2019
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/15/2018
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2018
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/15/2018
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016	
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

7. OCCUPIED BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Type A with highest data rate. The transmitter output is connected to the spectrum analyzer. The RBW is set to 10kHz. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

Note: Because the measured signal is CW or CW-like adjusting the RBW per C63.10 would not be practical since measured bandwidth will always follow the RBW and the result will be approximately twice the RBW

RESULTS

ID:	50822	Date:	4/12/18
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99% and 20dB BW

CE MODE

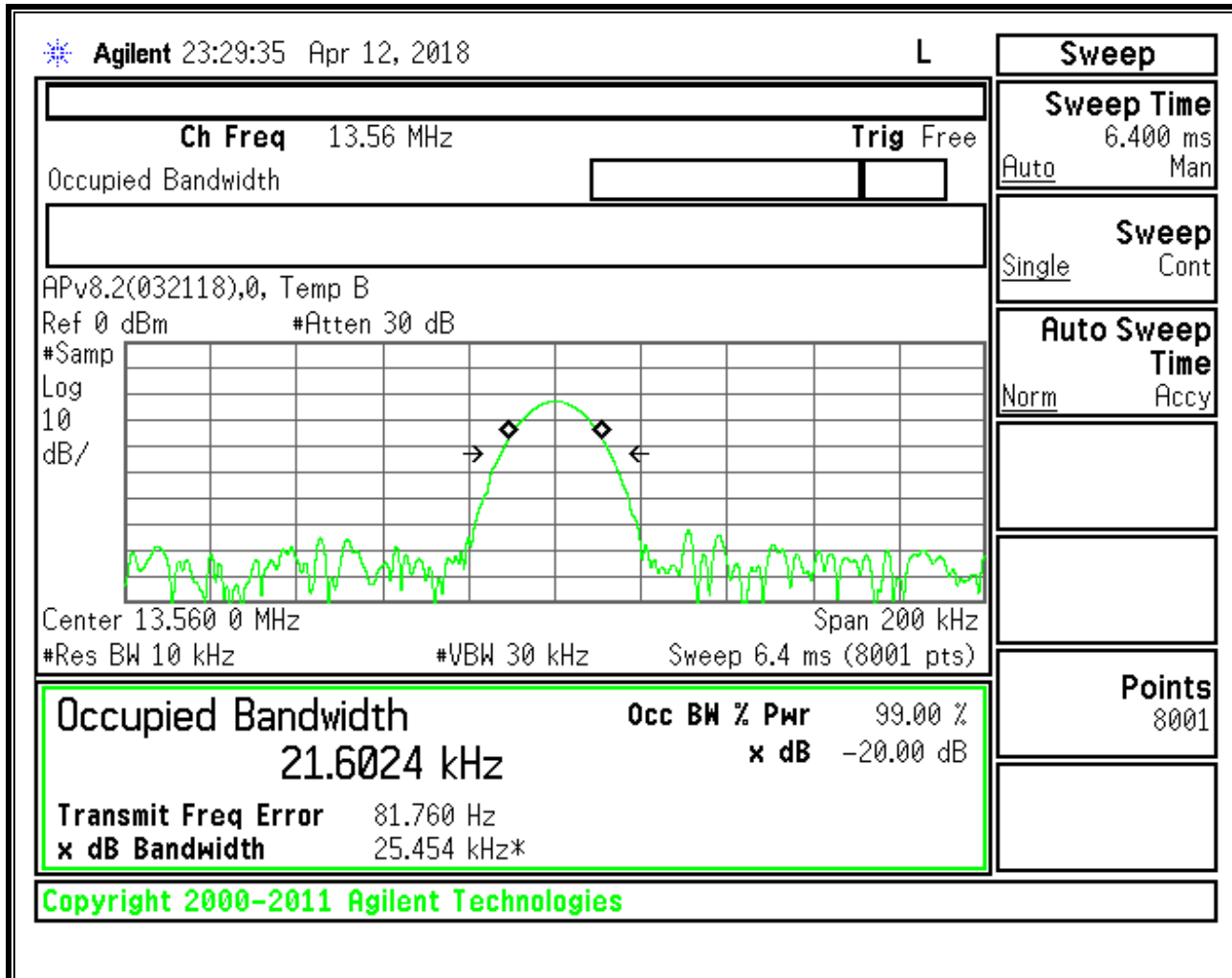
Mode Kbps	Frequency (MHz)	99% Bandwidth (KHz)	20dB Bandwidth (KHz)
848	13.56	21.602	25.454

READER MODE

Mode Kbps	Frequency (MHz)	99% Bandwidth (KHz)	20dB Bandwidth (KHz)
848	13.56	21.751	25.370

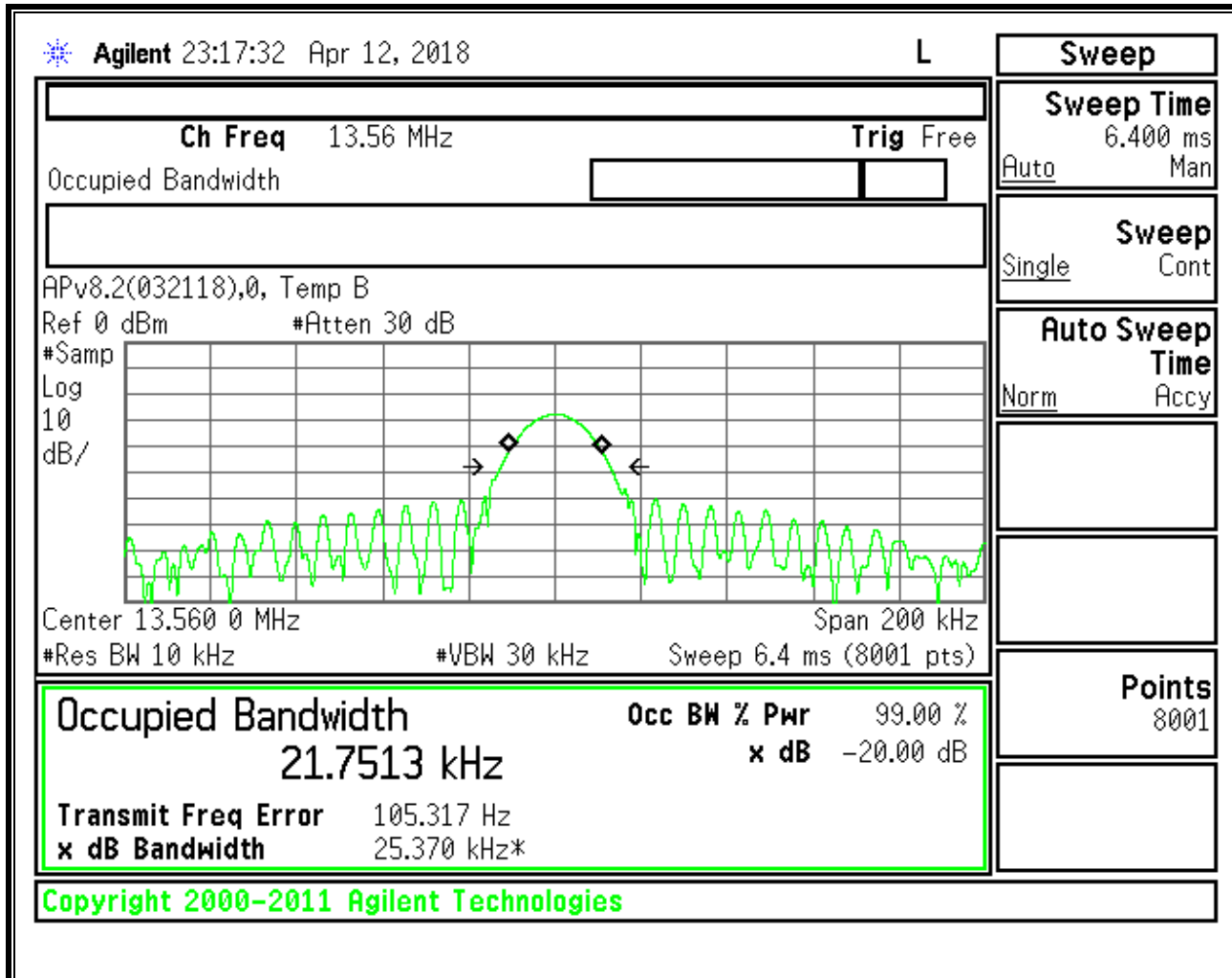
7.1. CE MODE

848Kbps



7.2. READER MODE

848Kbps



8. RADIATED EMISSION TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMIT

§15.225

IC RSS-210, Annex B.6

IC RSS-GEN, Section 8.9 (Transmitter)

(a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15,848 microvolts/ meter at 30 meters.

(b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110– 14.010 MHz and shall not exceed the general radiated emission limits in § 15.209 as follows:

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Limits for radiated disturbance of an intentional radiator		
Frequency range (MHz)	Limits (µV/m)	Measurement Distance (m)
0.009 – 0.490	2400 / F (kHz)	300
0.490 – 1.705	24000 / F (kHz)	30
1.705 – 30.0	30	30
30 – 88	100**	3
88 - 216	150**	3
216 – 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g. §§ 15.231 and 15.241.

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

Formula for converting the field strength from µV/m to dBµV/m is:

Limit (dBµV/m) = 20 log limit (µV/m)

In addition:

§15.209 (d) The emission limits shown the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector.

§15.209 (d) The provisions in §§ 15.225, measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

TEST PROCEDURE

ANSI C63.10, 2013

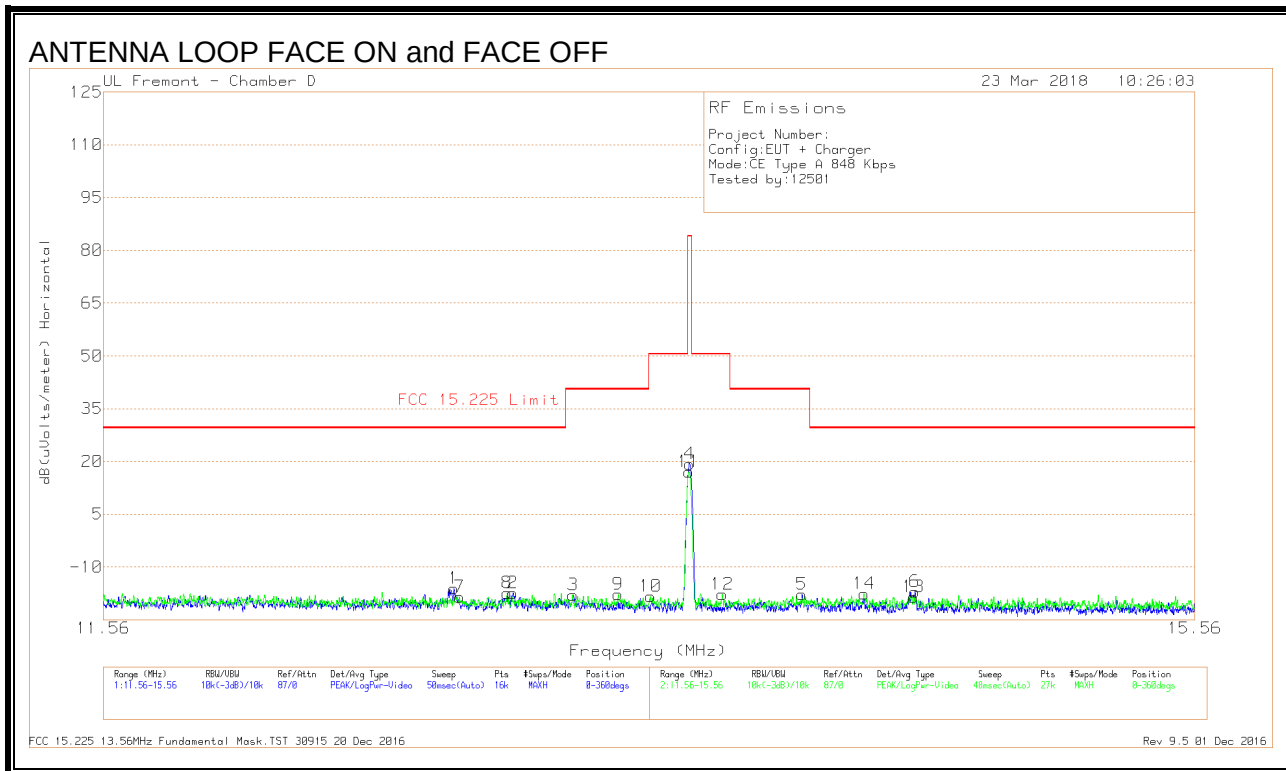
The EUT is an intentional radiator that incorporates a digital device, the highest fundamental frequency generated or used in the device is 13.56 MHz; therefore, the frequency range was investigated from 0.15 MHz to the 10th harmonic of the highest fundamental frequency, or 1000 MHz, whichever is greater.

RESULTS

8.2. FUNDAMENTAL AND SPURIOUS EMISSIONS (0.15 - 30 MHz), EUT WITH AC/DC ADAPTER

8.2.1. CE MODE

FUNDAMENTAL 848Kbps



DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cables (dB)	Dist Corr 30m	Corrected Reading dB(uVolts/meter)	FCC 15.225 Limit	PK Margin (dB)	Azimuth (Degs)
1	12.71775	13.09	Pk	10.4	.4	-40	-16.11	29.54	-45.65	0-360
7	12.7369	10.63	Pk	10.4	.4	-40	-18.57	29.54	-48.11	0-360
8	12.90377	11.71	Pk	10.4	.4	-40	-17.49	29.54	-47.03	0-360
2	12.92413	11.95	Pk	10.3	.4	-40	-17.35	29.54	-46.89	0-360
3	13.13688	11.33	Pk	10.3	.4	-40	-17.97	40.51	-58.48	0-360
9	13.29967	11.49	Pk	10.3	.4	-40	-17.81	40.51	-58.32	0-360
10	13.41703	10.9	Pk	10.3	.4	-40	-18.4	50.5	-68.9	0-360
11	13.55807	46.4	Pk	10.3	.4	-40	17.1	84	-66.9	0-360
4	13.56063	48.64	Pk	10.3	.4	-40	19.34	84	-64.66	0-360
12	13.68195	11.58	Pk	10.3	.4	-40	-17.72	50.5	-68.22	0-360
5	13.98225	11.55	Pk	10.2	.4	-40	-17.85	40.51	-58.36	0-360
14	14.21993	11.87	Pk	10.2	.4	-40	-17.53	29.54	-47.07	0-360
13	14.41366	10.88	Pk	10.2	.4	-40	-18.52	29.54	-48.06	0-360
6	14.41838	12.35	Pk	10.2	.4	-40	-17.05	29.54	-46.59	0-360

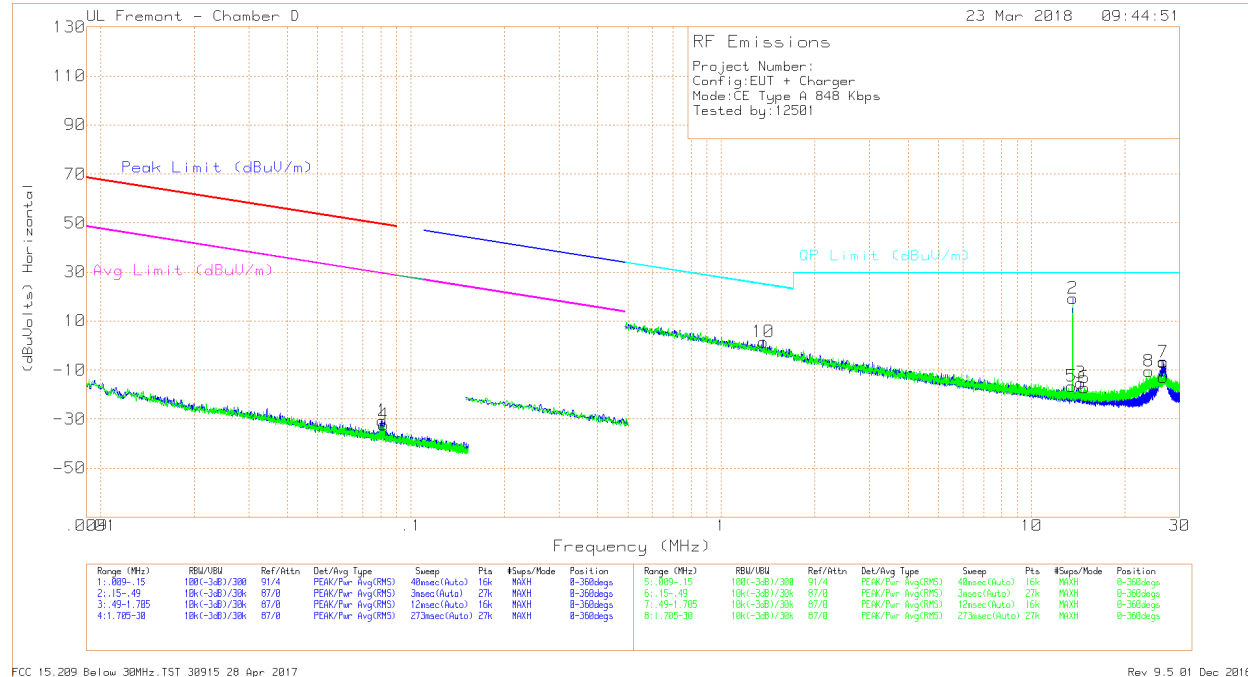
Pk - Peak detector

FCC 15.225 13.56MHz Fundamental Mask.TST 30915 20 Dec 2016

Rev 9.5 01 Dec 2016

SPURIOUS EMISSION 848Kbps

ANTENNA LOOP FACE ON and FACE OFF



DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cables (dB)	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.08099	37.5	Pk	11.9	0	-80	-30.6	49.42	-80.02	29.42	-60.02	0-360
4	.08147	35.9	Pk	11.8	0	-80	-32.3	49.37	-81.67	29.37	-61.67	0-360

Pk - Peak detector

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cables (dB)	Dist Corr 30m	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
10	1.365	29.63	Pk	11.6	.2	-40	1.43	24.92	-23.49	0-360
3	14.42	14.15	Pk	10.2	.4	-40	-15.25	29.5	-44.75	0-360
6	14.78	12.44	Pk	10.1	.4	-40	-17.06	29.5	-46.56	0-360
8	23.93	20.08	Pk	8.9	.5	-40	-10.52	29.5	-40.02	0-360
9	26.52	18.1	Pk	8.5	.5	-40	-12.9	29.5	-42.4	0-360
7	26.58	24.14	Pk	8.5	.5	-40	-6.86	29.5	-36.36	0-360

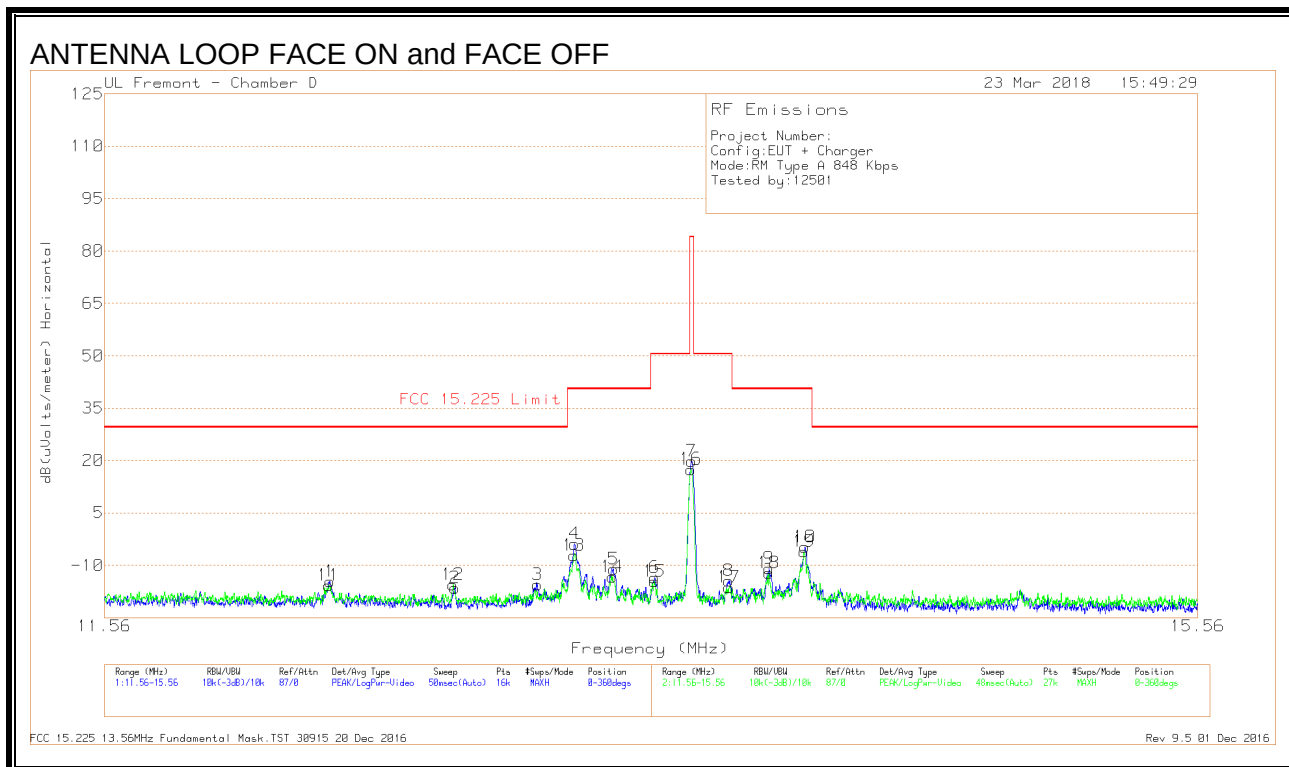
Pk - Peak detector

FCC 15.209 Below 30MHz.TST 30915 28 Apr 2017
Rev 9.5 01 Dec 2016

Note: Marker 2 and 5 are the fundamental signal

8.2.2. READER MODE

FUNDAMENTAL 848Kbps



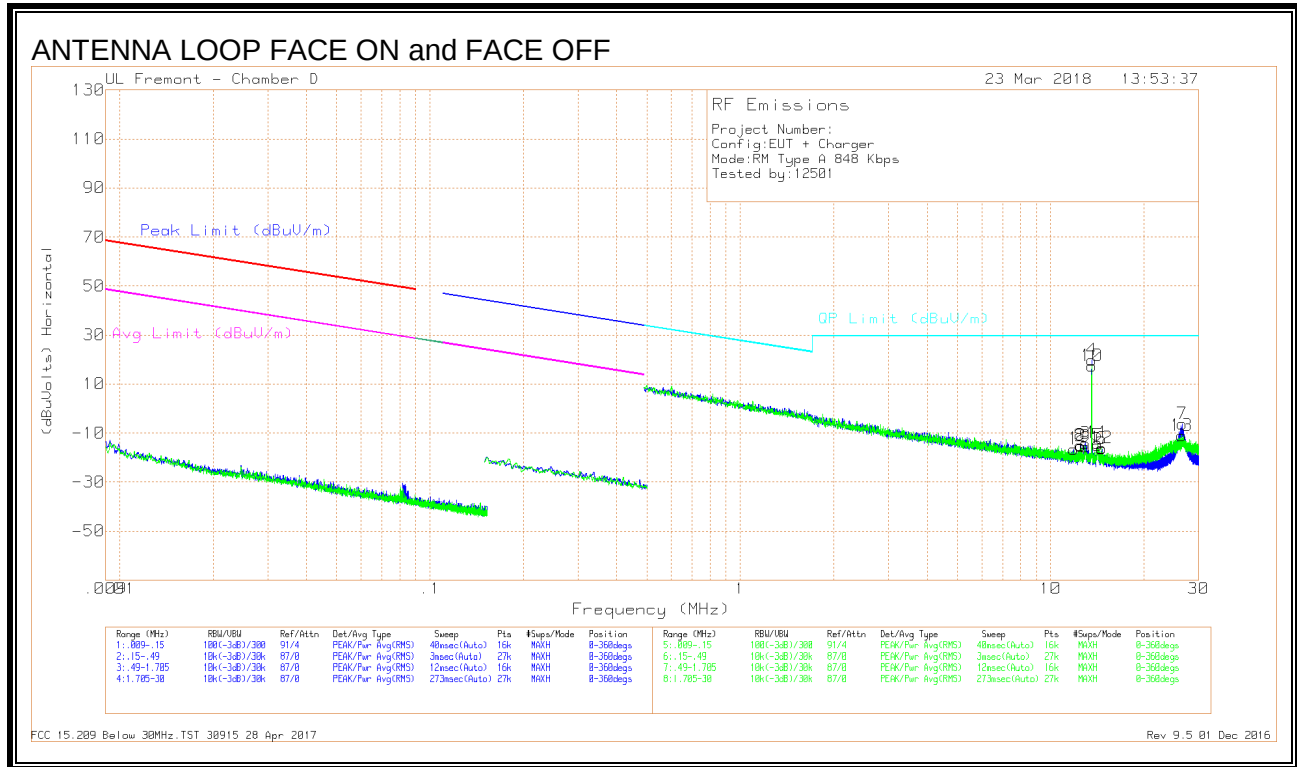
DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cables (dB)	Dist Corr 30m	Corrected Reading dB(uVolts/meter)	FCC 15.225 Limit	PK Margin (dB)	Azimuth (Degs)
11	12.28742	13.38	Pk	10.4	.4	-40	-15.82	29.54	-45.36	0-360
1	12.29038	14.62	Pk	10.4	.4	-40	-14.58	29.54	-44.12	0-360
12	12.70929	13.63	Pk	10.4	.4	-40	-15.57	29.54	-45.11	0-360
2	12.71463	12.68	Pk	10.4	.4	-40	-16.52	29.54	-46.06	0-360
3	13.00313	13.67	Pk	10.3	.4	-40	-15.63	29.54	-45.17	0-360
13	13.13405	22.15	Pk	10.3	.4	-40	-7.15	40.51	-47.66	0-360
4	13.13588	25.39	Pk	10.3	.4	-40	-3.91	40.51	-44.42	0-360
14	13.27177	16	Pk	10.3	.4	-40	-13.3	40.51	-53.81	0-360
5	13.27463	18.28	Pk	10.3	.4	-40	-11.02	40.51	-51.53	0-360
15	13.42354	14.65	Pk	10.3	.4	-40	-14.65	50.5	-65.15	0-360
6	13.42438	15.75	Pk	10.3	.4	-40	-13.55	50.5	-64.05	0-360
16	13.55837	46.8	Pk	10.3	.4	-40	17.5	84	-66.5	0-360
7	13.56038	49.2	Pk	10.3	.4	-40	19.9	84	-64.1	0-360
8	13.69713	14.91	Pk	10.3	.4	-40	-14.39	50.5	-64.89	0-360
17	13.6989	12.96	Pk	10.3	.4	-40	-16.34	50.5	-66.84	0-360
18	13.84815	17.15	Pk	10.2	.4	-40	-12.25	40.51	-52.76	0-360
9	13.84888	18.58	Pk	10.2	.4	-40	-10.82	40.51	-51.33	0-360
19	13.98091	23.3	Pk	10.2	.4	-40	-6.1	40.51	-46.61	0-360
10	13.98463	24.6	Pk	10.2	.4	-40	-4.8	40.51	-45.31	0-360

Pk - Peak detector

FCC 15.225 13.56MHz Fundamental Mask.TST 30915 20 Dec 2016
Rev 9.5 01 Dec 2016

SPURIOUS EMISSION 848Kbps



DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (dB/m)	Cables (dB)	Dist Corr 30m	Corrected Reading (dBuVolts)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	11.86641	12.6	Pk	10.5	.4	-40	-16.5	29.5	-46	0-360
8	12.47896	14.13	Pk	10.4	.4	-40	-15.07	29.5	-44.57	0-360
2	12.49206	13.84	Pk	10.4	.4	-40	-15.36	29.5	-44.86	0-360
9	12.92489	13.7	Pk	10.3	.4	-40	-15.6	29.5	-45.1	0-360
3	12.93327	15.06	Pk	10.3	.4	-40	-14.24	29.5	-43.74	0-360
11	14.18039	15.3	Pk	10.2	.4	-40	-14.1	29.5	-43.6	0-360
5	14.18144	14.26	Pk	10.2	.4	-40	-15.14	29.5	-44.64	0-360
12	14.61269	13.5	Pk	10.1	.4	-40	-16	29.5	-45.5	0-360
6	14.6216	13.12	Pk	10.1	.4	-40	-16.38	29.5	-45.88	0-360
13	26.44199	19.97	Pk	8.5	.5	-40	-11.03	29.5	-40.53	0-360
7	26.55937	24.65	Pk	8.5	.5	-40	-6.35	29.5	-35.85	0-360

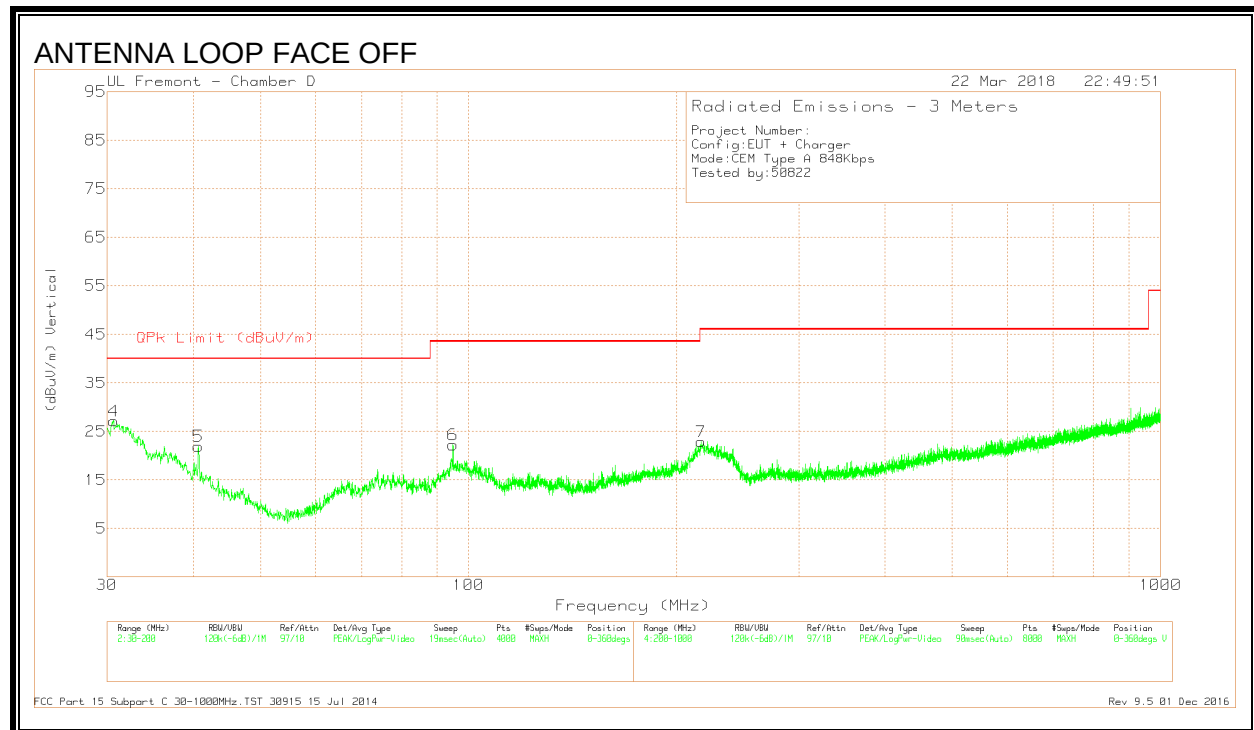
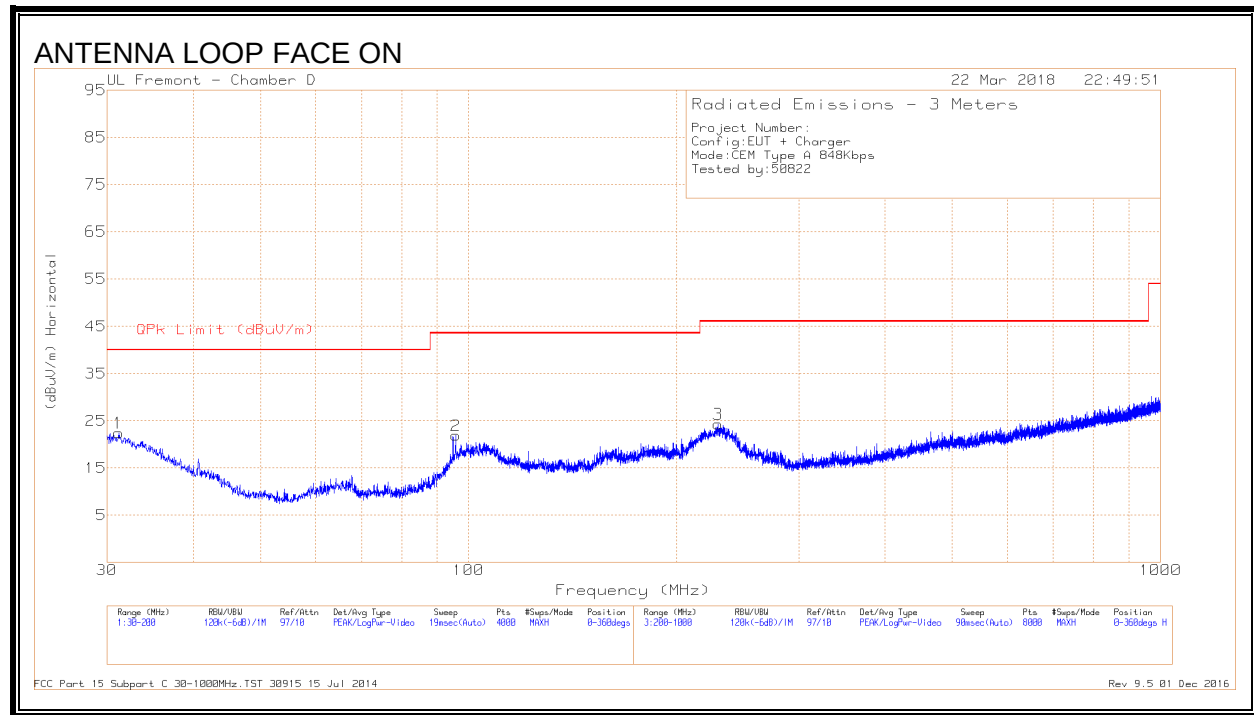
Pk - Peak detector

FCC 15.209 Below 30MHz.TST 30915 28 Apr 2017
Rev 9.5 01 Dec 2016

Note: Marker 4 and 10 are the fundamental signal.

8.3. TX SPURIOUS EMISSION 30 TO 1000 MHz, EUT WITH AC/DC ADAPTER

8.3.1. CE MODE



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
4	30.6802	33.56	Pk	25.5	-31.9	27.16	40	-12.84	0-360	100	V
1	31.1903	29.13	Pk	25.2	-31.9	22.43	40	-17.57	0-360	98	H
5	40.6703	35.63	Pk	18.1	-31.8	21.93	40	-18.07	0-360	100	V
6	94.9143	40.24	Pk	13.4	-31.4	22.24	43.52	-21.28	0-360	100	V
2	95.7645	39.69	Pk	13.6	-31.4	21.89	43.52	-21.63	0-360	299	H
7	216.9022	38.59	Pk	15	-30.7	22.89	46.02	-23.13	0-360	101	V
3	229.5038	39.32	Pk	15.6	-30.6	24.32	46.02	-21.7	0-360	101	H

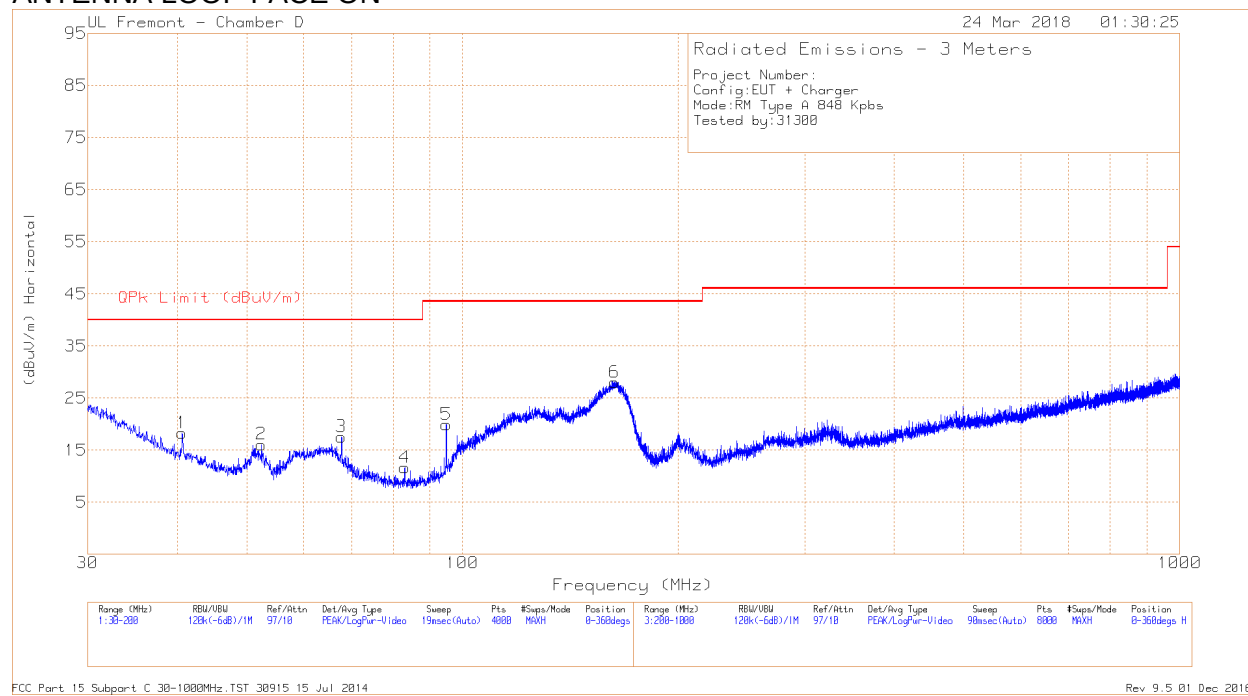
Pk - Peak detector

FCC Part 15 Subpart C 30-1000MHz.TST 30915 15 Jul 2014

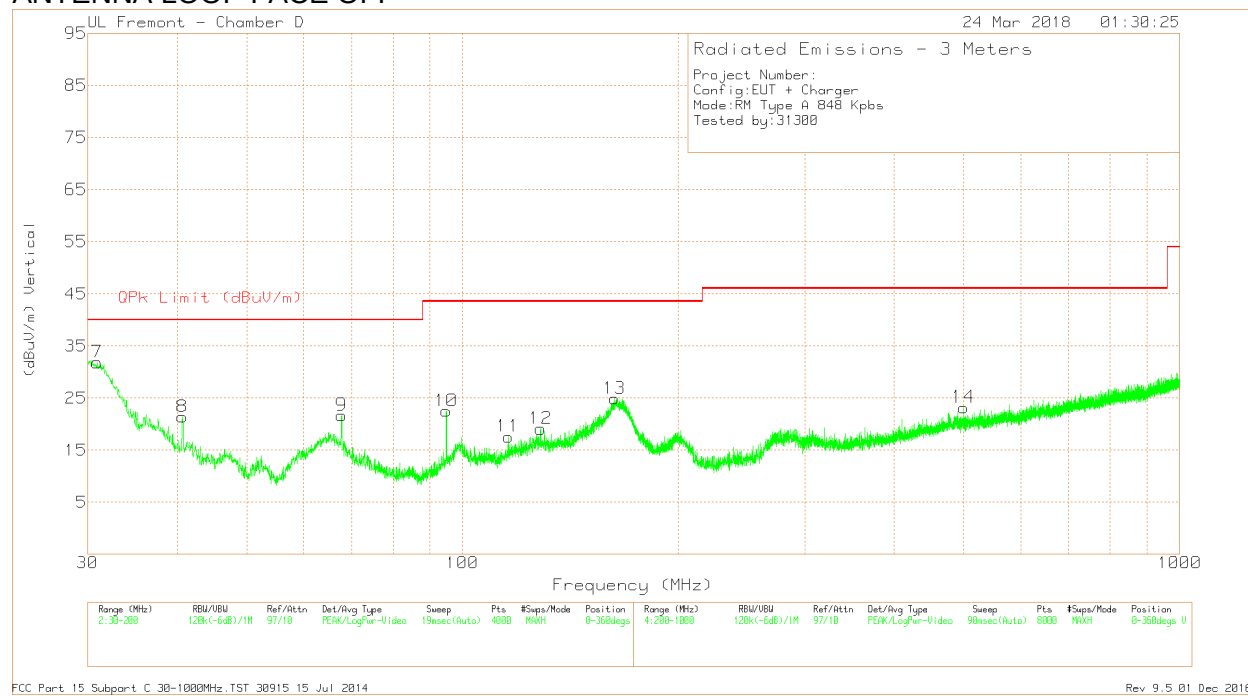
Rev 9.5 01 Dec 2016

8.3.2. READER MODE

ANTENNA LOOP FACE ON



ANTENNA LOOP FACE OFF



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
6	* 162.8894	42.62	Pk	16.4	-31	28.02	43.52	-15.5	0-360	98	H
11	* 115.7872	30.99	Pk	17.9	-31.3	17.59	43.52	-25.93	0-360	100	V
12	* 128.498	31.92	Pk	18.3	-31.1	19.12	43.52	-24.4	0-360	100	V
13	* 162.9319	39.47	Pk	16.4	-31	24.87	43.52	-18.65	0-360	100	V
7	30.9352	38.34	Pk	25.4	-31.9	31.84	40	-8.16	0-360	100	V
1	40.6278	31.96	Pk	18.1	-31.8	18.26	40	-21.74	0-360	399	H
8	40.6703	35.07	Pk	18.1	-31.8	21.37	40	-18.63	0-360	100	V
2	52.4458	35.69	Pk	12.1	-31.7	16.09	40	-23.91	0-360	399	H
3	67.7923	36.35	Pk	12.8	-31.6	17.55	40	-22.45	0-360	299	H
9	67.8348	40.47	Pk	12.8	-31.6	21.67	40	-18.33	0-360	100	V
4	83.0537	31.35	Pk	11.8	-31.5	11.65	40	-28.35	0-360	399	H
10	94.9143	40.54	Pk	13.4	-31.4	22.54	43.52	-20.98	0-360	100	V
5	94.9356	37.89	Pk	13.4	-31.4	19.89	43.52	-23.63	0-360	199	H
14	499.4389	30.6	Pk	22.2	-29.6	23.2	46.02	-22.82	0-360	199	V

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

Pk - Peak detector

FCC Part 15 Subpart C 30-1000MHz.TST 30915 15 Jul 2014

Rev 9.5 01 Dec 2016

9. FREQUENCY STABILITY

LIMIT

§15.225 (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency, over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

IC RSS-210, Annex B.6

Carrier frequency stability shall be maintained to $\pm 0.01\%$ (± 100 ppm).

TEST PROCEDURE

ANSI C63.10-2013 Clause 6.8

RESULTS

No non-compliance noted.

ID:	38602	Date:	3/29/18
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9.1. CE MODE

848Kbps

Reference Frequency: EUT Channel 13.56 MHz @ 20°C										
Limit: ± 100 ppm = 1.35600 KHz										
Power Supply	Envir. Temp	Frequency Deviation Measured with Time Elapse								
(VAC)	(°C)	Startup (KHz)	Delta (ppm)	@ 2 mins (KHz)	Delta (ppm)	@ 5 mins (KHz)	Delta (ppm)	@ 10 mins (KHz)	Delta (ppm)	Limit (ppm)
3.80	50	13.5600795	0.917	13.5600812	0.792	13.5600842	0.570	13.5600884	0.259	± 100
	40	13.5600796	0.905	13.5600791	0.946	13.5600787	0.972	13.5600787	0.974	± 100
	30	13.5600907	0.090	13.5600892	0.203	13.5600875	0.324	13.5600860	0.439	± 100
	20	13.5600919	0.000	13.5600941	-0.163	13.5600967	-0.357	13.5600995	-0.561	± 100
	10	13.5600953	-0.252	13.5601020	-0.741	13.5601097	-1.308	13.5601175	-1.885	± 100
	0	13.5601322	-2.971	13.5601359	-3.247	13.5601398	-3.533	13.5601434	-3.799	± 100
	-10	13.5601535	-4.541	13.5601553	-4.677	13.5601571	-4.805	13.5601585	-4.915	± 100
	-20	13.5601602	-5.039	13.5601597	-5.002	13.5601589	-4.942	13.5601579	-4.865	± 100
3.23	20	13.5601175	-1.888	13.5601142	-1.644	13.5601106	-1.381	13.5601072	-1.129	± 100
4.37	20	13.5600925	-0.047	13.5600951	-0.235	13.5600977	-0.430	13.5601002	-0.613	± 100

9.2. READER MODE

848Kbps

Reference Frequency: EUT Channel 13.56 MHz @ 20°C										
Limit: ± 100 ppm = 1.35600 KHz										
Power Supply	Envir. Temp	Frequency Deviation Measured with Time Elapse								
(VAC)	(°C)	Startup (KHz)	Delta (ppm)	@ 2 mins (KHz)	Delta (ppm)	@ 5 mins (KHz)	Delta (ppm)	@ 10 mins (KHz)	Delta (ppm)	Limit (ppm)
3.80	50	13.5601209	-2.888	13.5601281	-3.420	13.5601370	-4.075	13.5601475	-4.847	± 100
	40	13.5600873	-0.407	13.5600898	-0.594	13.5600930	-0.831	13.5600968	-1.109	± 100
	30	13.5600784	0.244	13.5600784	0.250	13.5600786	0.236	13.5600790	0.202	± 100
	20	13.5600818	0.000	13.5600813	0.035	13.5600817	0.004	13.5600824	-0.049	± 100
	10	13.5600876	-0.430	13.5600901	-0.618	13.5600931	-0.838	13.5600962	-1.067	± 100
	0	13.5601068	-1.844	13.5601106	-2.126	13.5601146	-2.425	13.5601184	-2.700	± 100
	-10	13.5601313	-3.652	13.5601343	-3.874	13.5601370	-4.075	13.5601386	-4.194	± 100
	-20	13.5601494	-4.987	13.5601510	-5.106	13.5601524	-5.211	13.5601535	-5.292	± 100
3.23	20	13.5600968	-1.113	13.5600898	-0.591	13.5600863	-0.338	13.5600839	-0.159	± 100
4.37	20	13.5600790	0.200	13.5600782	0.263	13.5600784	0.249	13.5600795	0.163	± 100

10. AC MAINS LINE CONDUCTED EMISSIONS

LIMITS

§15.207

IC RSS-GEN, Section 8.8

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is 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, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency range (MHz)	Limits (dB μ V)	
	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

Notes:

1. The lower limit shall apply at the transition frequencies
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

TEST PROCEDURE

ANSI C63.10:2013

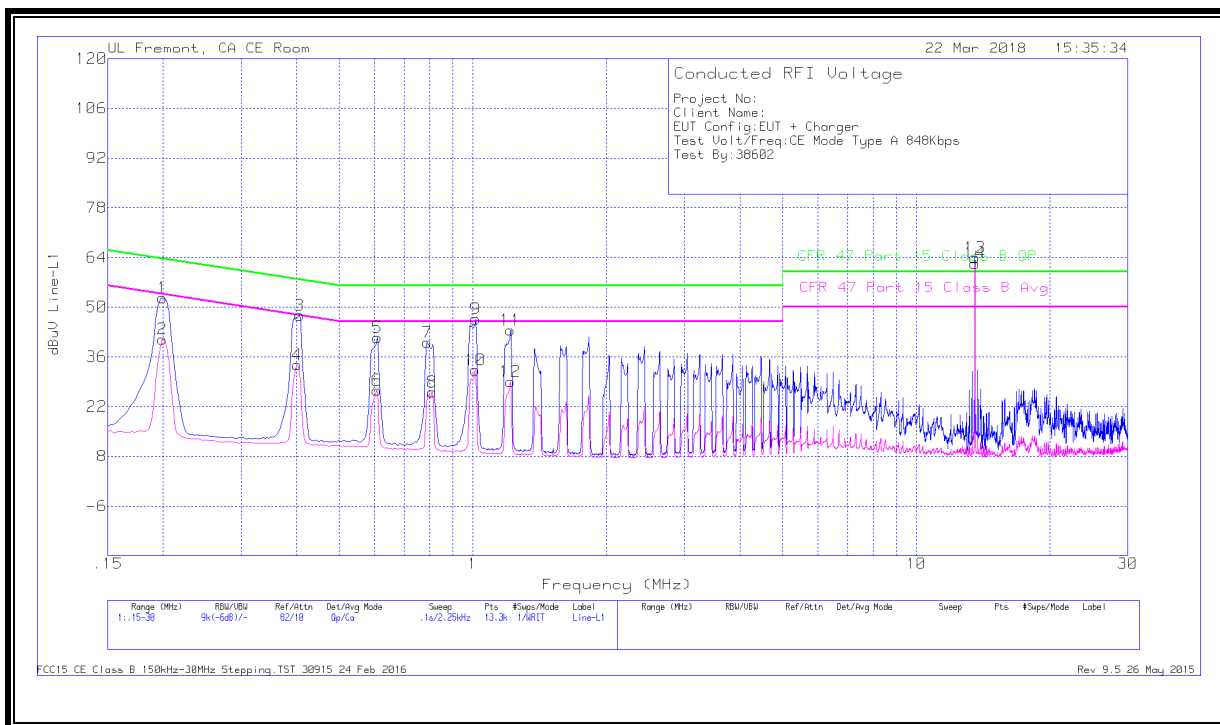
RESULTS

No non-compliance noted:

10.1. CE MODE

10.1.1. NORMAL OPERATION, 848 KBPS

LINE 1 RESULTS



WORST EMISSIONS

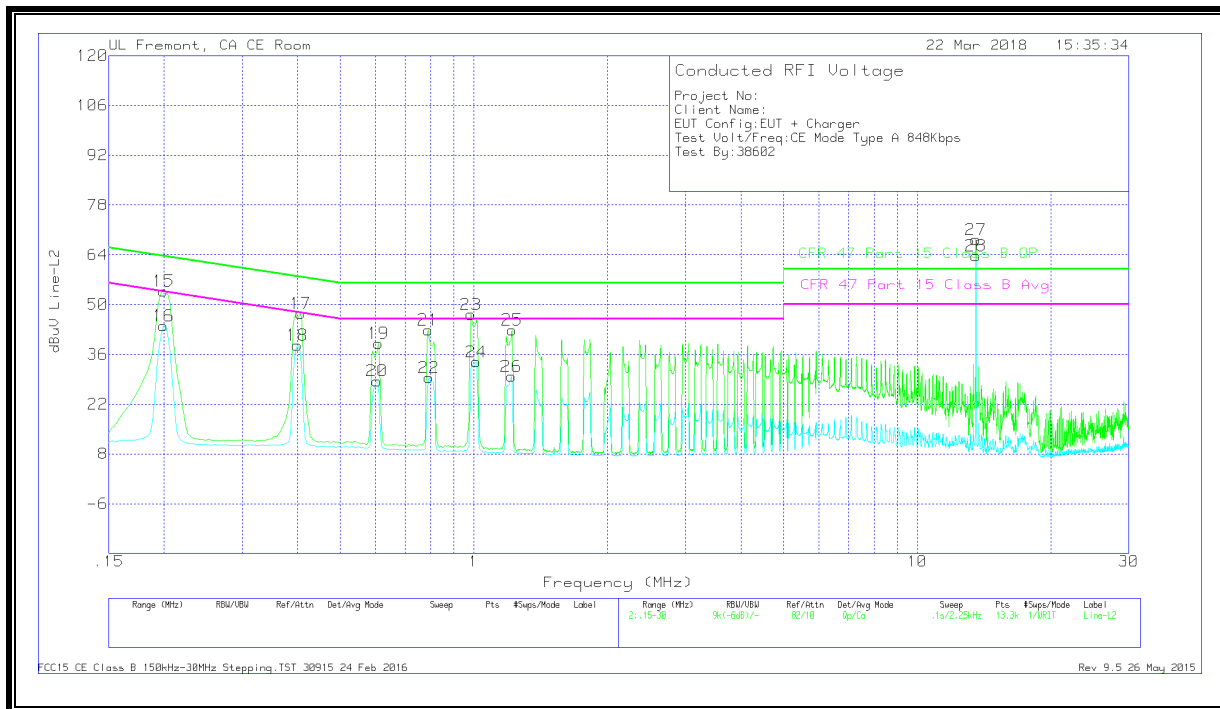
Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
1	.1995	42.56	Qp	0	0	10.1	52.66	63.63	-10.97	-	-
2	.1995	30.92	Ca	0	0	10.1	41.02	-	-	53.63	-12.61
3	.4065	37.62	Qp	0	0	10.1	47.72	57.72	-10	-	-
4	.402	23.7	Ca	0	0	10.1	33.8	-	-	47.81	-14.01
5	.609	31.38	Qp	0	0	10.1	41.48	56	-14.52	-	-
6	.60675	16.54	Ca	0	0	10.1	26.64	-	-	46	-19.36
7	.789	29.94	Qp	0	0	10.1	40.04	56	-15.96	-	-
8	.80925	16.01	Ca	0	0	10.1	26.11	-	-	46	-19.89
9	1.014	36.48	Qp	0	.1	10.1	46.68	56	-9.32	-	-
10	1.01175	22.14	Ca	0	.1	10.1	32.34	-	-	46	-13.66
11	1.2165	33.38	Qp	0	.1	10.1	43.58	56	-12.42	-	-
12	1.21425	18.85	Ca	0	.1	10.1	29.05	-	-	46	-16.95
13	13.56	53.46	Qp	.1	.2	10.2	63.96	60	3.96	-	-
14	13.56	51.9	Ca	.1	.2	10.2	62.4	-	-	50	12.4

Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT.

LINE 2 RESULTS



WORST EMISSIONS

Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBμV)	Det	LISN L2	LC Cables C2&C3	Limiter (dB)	Corrected Reading dBμV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
15	.1995	43.74	Qp	0	0	10.1	53.84	63.63	-9.79	-	-
16	.1995	33.96	Ca	0	0	10.1	44.06	-	-	53.63	-9.57
17	.4065	37.39	Qp	0	0	10.1	47.49	57.72	-10.23	-	-
18	.39975	28.48	Ca	0	0	10.1	38.58	-	-	47.86	-9.28
19	.609	29.02	Qp	0	0	10.1	39.12	56	-16.88	-	-
20	.6045	18.44	Ca	0	0	10.1	28.54	-	-	46	-17.46
21	.789	32.79	Qp	0	0	10.1	42.89	56	-13.11	-	-
22	.79125	19.38	Ca	0	0	10.1	29.48	-	-	46	-16.52
23	.98475	37.02	Qp	0	.1	10.1	47.22	56	-8.78	-	-
24	1.01175	23.7	Ca	0	.1	10.1	33.9	-	-	46	-12.1
25	1.21875	32.67	Qp	0	.1	10.1	42.87	56	-13.13	-	-
26	1.21425	19.58	Ca	0	.1	10.1	29.78	-	-	46	-16.22
27	13.56	57.79	Qp	.1	.2	10.2	68.29	60	8.29	-	-
28	13.56	53.26	Ca	.1	.2	10.2	63.76	-	-	50	13.76

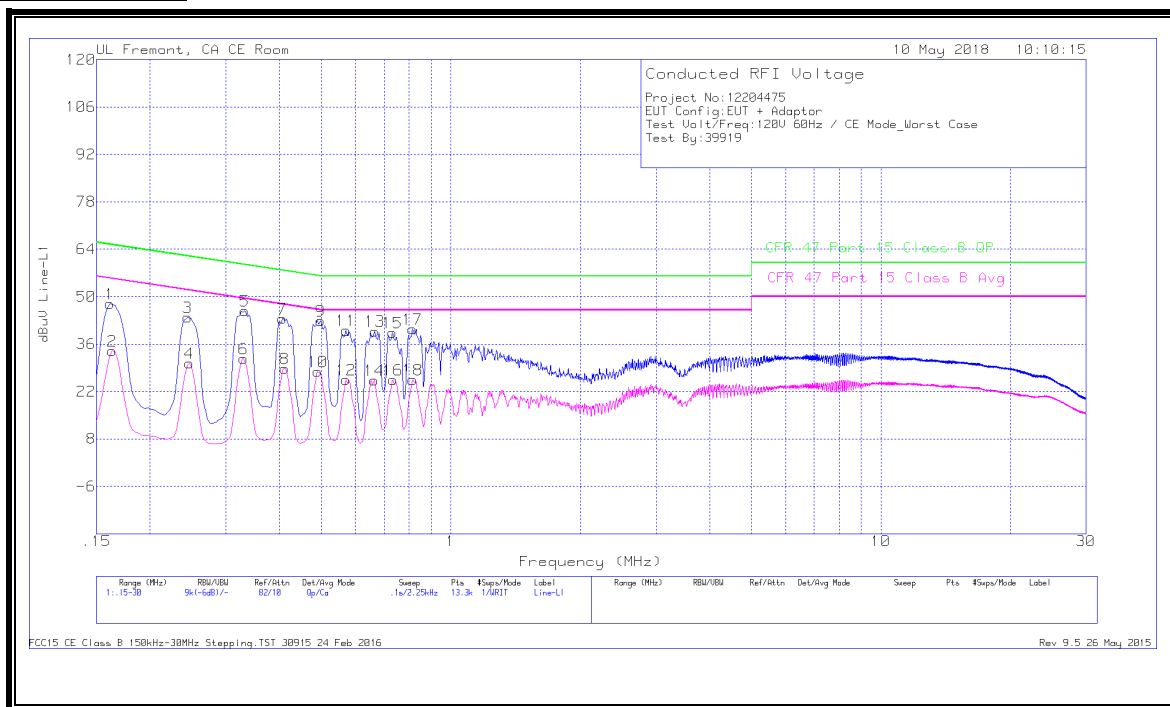
Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT.

10.1.2. NORMAL OPERATION WITH ANTENNA PORT TERMINATED, 848Kbps

LINE 1 RESULTS



WORST EMISSIONS

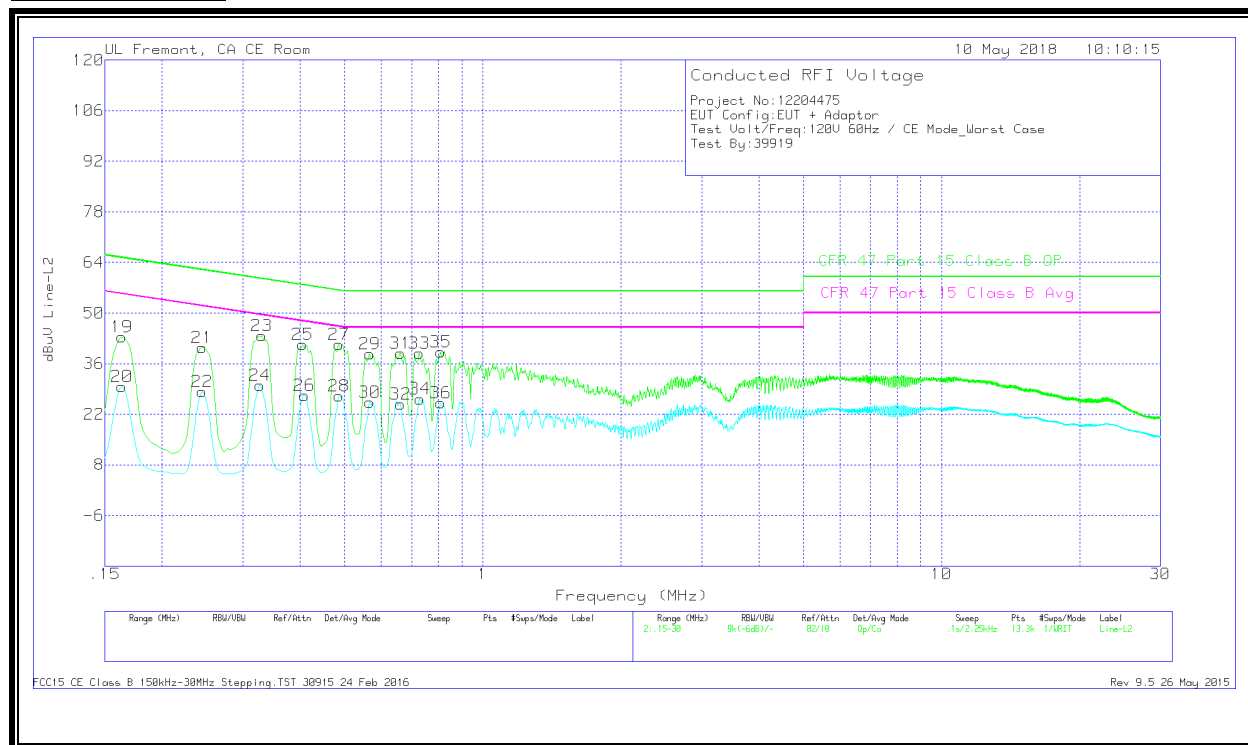
Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
1	.16125	37.72	Qp	.1	0	10.1	47.92	65.4	-17.48	-	-
2	.1635	23.74	Ca	.1	0	10.1	33.94	-	-	55.28	-21.34
3	.2445	33.75	Qp	0	0	10.1	43.85	61.94	-18.09	-	-
4	.24675	20.21	Ca	0	0	10.1	30.31	-	-	51.87	-21.56
5	.33225	35.8	Qp	0	0	10.1	45.9	59.39	-13.49	-	-
6	.33	21.67	Ca	0	0	10.1	31.77	-	-	49.45	-17.68
7	.4065	33.53	Qp	0	0	10.1	43.63	57.72	-14.09	-	-
8	.411	18.74	Ca	0	0	10.1	28.84	-	-	47.63	-18.79
9	.49875	32.84	Qp	0	0	10.1	42.94	56.02	-13.08	-	-
10	.48975	17.82	Ca	0	0	10.1	27.92	-	-	46.17	-18.25
11	.57075	29.91	Qp	0	0	10.1	40.01	56	-15.99	-	-
12	.57075	15.41	Ca	0	0	10.1	25.51	-	-	46	-20.49
13	.66525	29.73	Qp	0	0	10.1	39.83	56	-16.17	-	-
14	.663	15.14	Ca	0	0	10.1	25.24	-	-	46	-20.76
15	.73275	29.35	Qp	0	0	10.1	39.45	56	-16.55	-	-
16	.735	15.33	Ca	0	0	10.1	25.43	-	-	46	-20.57
17	.81375	30.31	Qp	0	0	10.1	40.41	56	-15.59	-	-
18	.816	15.33	Ca	0	0	10.1	25.43	-	-	46	-20.57

Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT. Data documented in above section, indicate that when the antenna terminal is terminated the fundamental amplitude is lowering below the limit line.

LINE 2 RESULTS



WORST EMISSIONS

Range 2: Line-L2 .15 - 30MHz											
Marker	Frequenc y (MHz)	Meter Reading (dBuV)	Det	LISN L2	LC Cables C2&C3	Limiter (dB)	Correcte d Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
19	.1635	33.25	Qp	0	0	10.1	43.35	65.28	-21.93	-	-
20	.1635	19.51	Ca	0	0	10.1	29.61	-	-	55.28	-25.67
21	.2445	30.41	Qp	0	0	10.1	40.51	61.94	-21.43	-	-
22	.2445	18.21	Ca	0	0	10.1	28.31	-	-	51.94	-23.63
23	.33	33.69	Qp	0	0	10.1	43.79	59.45	-15.66	-	-
24	.32662	19.94	Ca	0	0	10.1	30.04	-	-	49.54	-19.5
25	.40425	31.25	Qp	0	0	10.1	41.35	57.77	-16.42	-	-
26	.40875	17.11	Ca	0	0	10.1	27.21	-	-	47.67	-20.46
27	.48525	31.28	Qp	0	0	10.1	41.38	56.25	-14.87	-	-
28	.48525	17.01	Ca	0	0	10.1	27.11	-	-	46.25	-19.14
29	.56625	28.62	Qp	0	0	10.1	38.72	56	-17.28	-	-
30	.56625	15.23	Ca	0	0	10.1	25.33	-	-	46	-20.67
31	.66075	28.72	Qp	0	0	10.1	38.82	56	-17.18	-	-
32	.66075	14.62	Ca	0	0	10.1	24.72	-	-	46	-21.28
33	.72825	28.72	Qp	0	0	10.1	38.82	56	-17.18	-	-
34	.7305	16.17	Ca	0	0	10.1	26.27	-	-	46	-19.73
35	.80925	29.16	Qp	0	0	10.1	39.26	56	-16.74	-	-
36	.80925	15.04	Ca	0	0	10.1	25.14	-	-	46	-20.86

Qp - Quasi-Peak detector

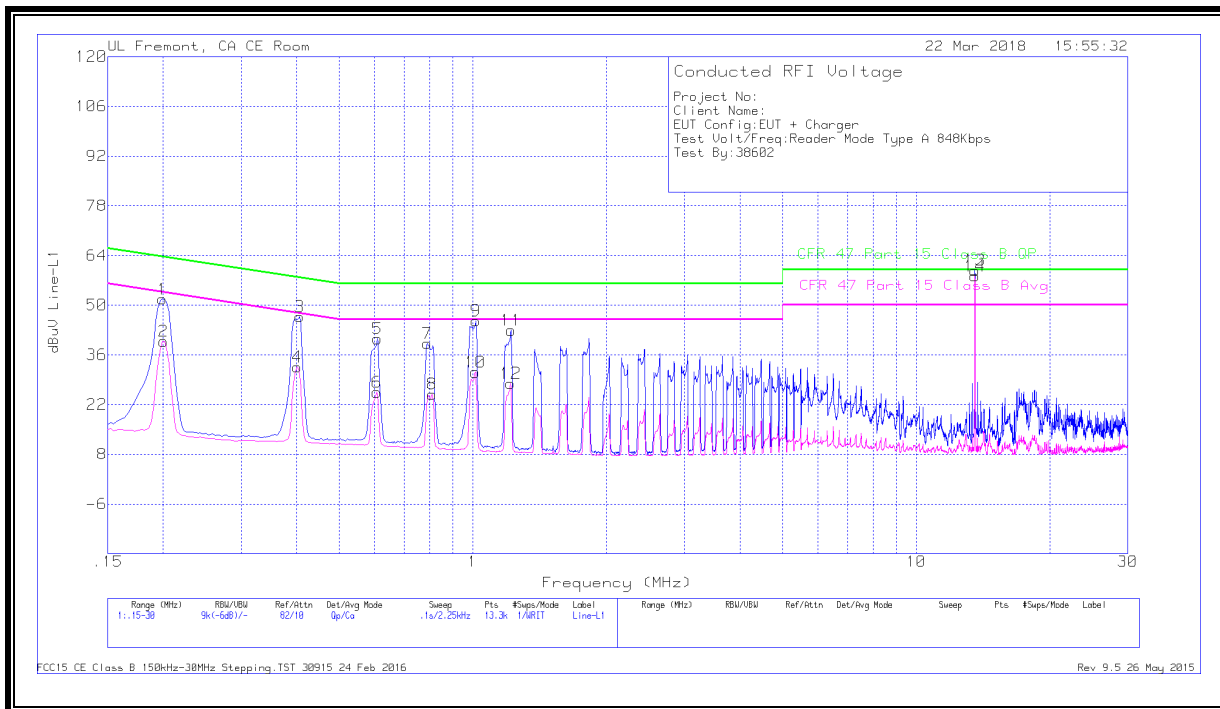
Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT. Data documented in above section, indicate that when the antenna terminal is terminated the fundamental amplitude is lowering below the limit line.

10.2. READER MODE

10.2.1. NORMAL OPERATION, 848 KBPS

LINE 1 RESULTS



WORST EMISSIONS

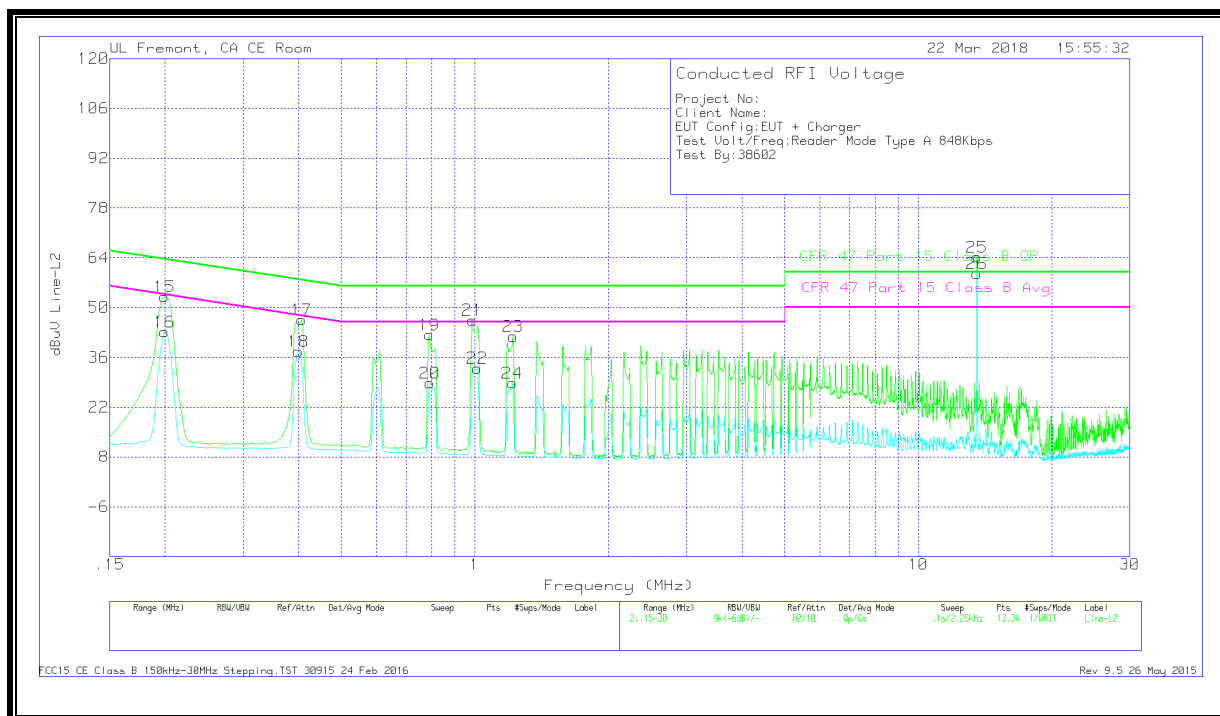
Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
1	.1995	41.57	Qp	0	0	10.1	51.67	63.63	-11.96	-	-
2	.20063	29.74	Ca	0	0	10.1	39.84	-	-	53.58	-13.74
3	.4065	36.69	Qp	0	0	10.1	46.79	57.72	-10.93	-	-
4	.402	22.5	Ca	0	0	10.1	32.6	-	-	47.81	-15.21
5	.609	30.45	Qp	0	0	10.1	40.55	56	-15.45	-	-
6	.60675	15.39	Ca	0	0	10.1	25.49	-	-	46	-20.51
7	.789	29.11	Qp	0	0	10.1	39.21	56	-16.79	-	-
8	.80925	14.84	Ca	0	0	10.1	24.94	-	-	46	-21.06
9	1.01625	35.42	Qp	0	.1	10.1	45.62	56	-10.38	-	-
10	1.01175	20.93	Ca	0	.1	10.1	31.13	-	-	46	-14.87
11	1.21875	32.73	Qp	0	.1	10.1	42.93	56	-13.07	-	-
12	1.2165	17.77	Ca	0	.1	10.1	27.97	-	-	46	-18.03
13	13.56	49.33	Qp	.1	.2	10.2	59.83	60	-17	-	-
14	13.56	47.71	Ca	.1	.2	10.2	58.21	-	-	50	8.21

Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT

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)
15	.1995	42.99	Qp	0	0	10.1	53.09	63.63	-10.54	-	-
16	.1995	33.04	Ca	0	0	10.1	43.14	-	-	53.63	-10.49
17	.4065	36.45	Qp	0	0	10.1	46.55	57.72	-11.17	-	-
18	.39975	27.6	Ca	0	0	10.1	37.7	-	-	47.86	-10.16
19	.789	32.17	Qp	0	0	10.1	42.27	56	-13.73	-	-
20	.79125	18.67	Ca	0	0	10.1	28.77	-	-	46	-17.23
21	.987	36.28	Qp	0	.1	10.1	46.48	56	-9.52	-	-
22	1.01175	22.76	Ca	0	.1	10.1	32.96	-	-	46	-13.04
23	1.21875	31.71	Qp	0	.1	10.1	41.91	56	-14.09	-	-
24	1.21425	18.55	Ca	0	.1	10.1	28.75	-	-	46	-17.25
25	13.56	53.68	Qp	.1	.2	10.2	64.18	60	4.18	-	-
26	13.56	49.06	Ca	.1	.2	10.2	59.56	-	-	50	9.56

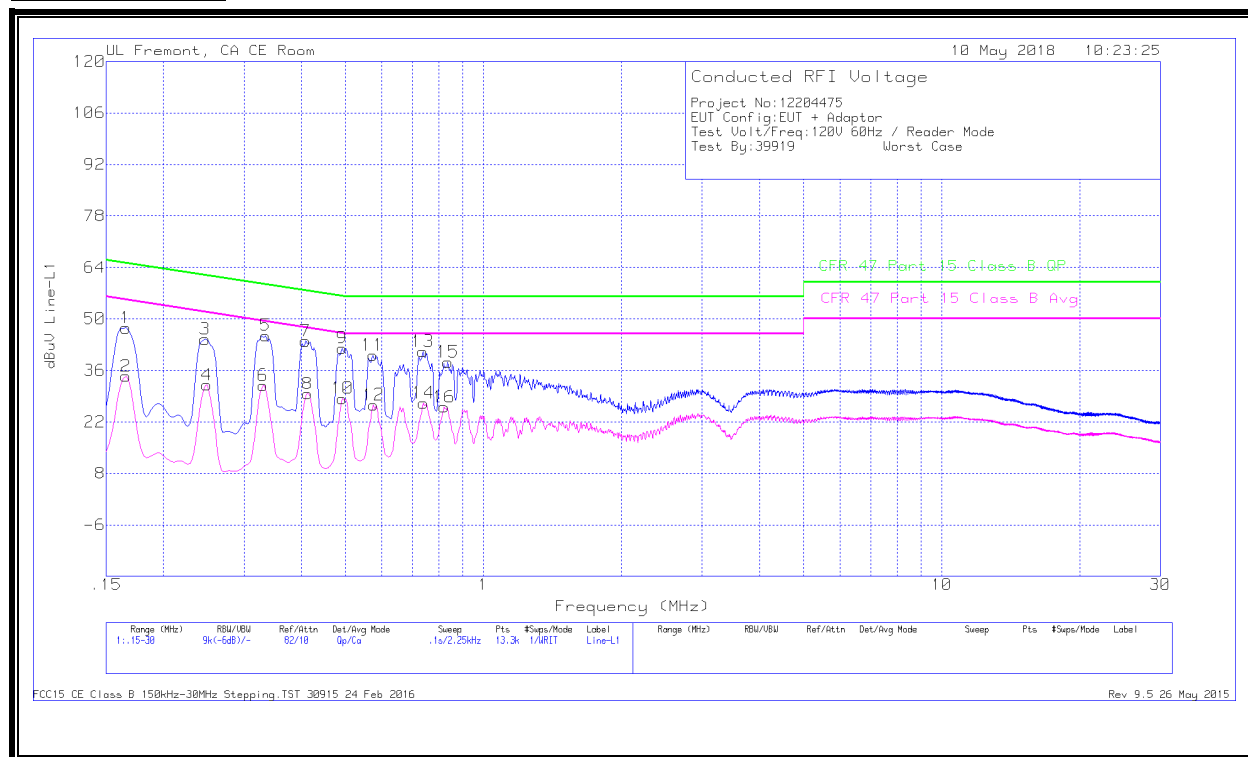
Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT.

10.2.2. NORMAL OPERATION WITH ANTENNA PORT TERMINATED, 848Kbps

LINE 1 RESULTS



WORST EMISSIONS

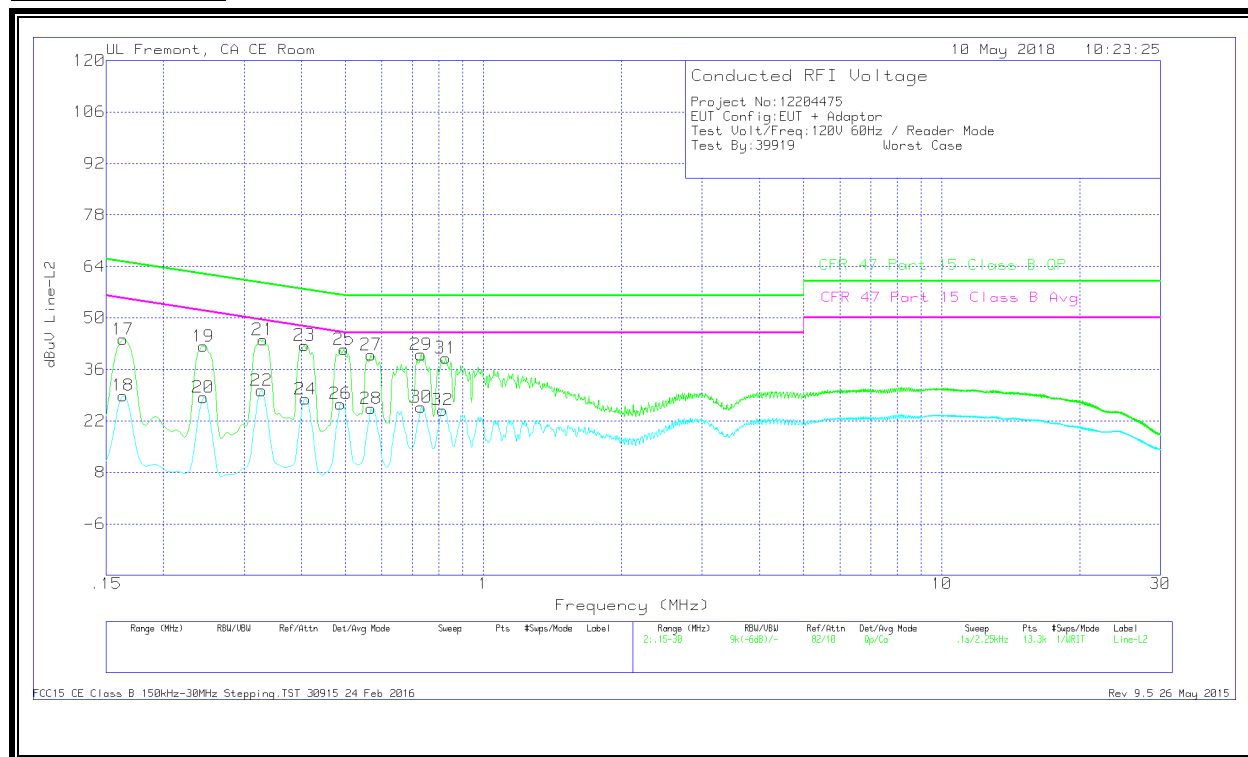
Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
1	.16575	37.36	Qp	.1	0	10.1	47.56	65.17	-17.61	-	-
2	.16575	24.23	Ca	.1	0	10.1	34.43	-	-	55.17	-20.74
3	.24675	34.37	Qp	0	0	10.1	44.47	61.87	-17.4	-	-
4	.249	21.96	Ca	0	0	10.1	32.06	-	-	51.79	-19.73
5	.3345	35.37	Qp	0	0	10.1	45.47	59.34	-13.87	-	-
6	.33	21.8	Ca	0	0	10.1	31.9	-	-	49.45	-17.55
7	.40875	33.87	Qp	0	0	10.1	43.97	57.67	-13.7	-	-
8	.41325	19.56	Ca	0	0	10.1	29.66	-	-	47.58	-17.92
9	.492	31.95	Qp	0	0	10.1	42.05	56.13	-14.08	-	-
10	.492	18.27	Ca	0	0	10.1	28.37	-	-	46.13	-17.76
11	.573	30.06	Qp	0	0	10.1	40.16	56	-15.84	-	-
12	.57525	16.5	Ca	0	0	10.1	26.6	-	-	46	-19.4
13	.73725	31.04	Qp	0	0	10.1	41.14	56	-14.86	-	-
14	.7395	17.04	Ca	0	0	10.1	27.14	-	-	46	-18.86
15	.83625	28.17	Qp	0	0	10.1	38.27	56	-17.73	-	-
16	.8205	15.93	Ca	0	0	10.1	26.03	-	-	46	-19.97

Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT. Data documented in above section, indicate that when the antenna terminal is terminated the fundamental amplitude is lowering below the limit line.

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)
17	.1635	34.07	Qp	0	0	10.1	44.17	65.28	-21.11	-	-
18	.1635	18.78	Ca	0	0	10.1	28.88	-	-	55.28	-26.4
19	.2445	32.17	Qp	0	0	10.1	42.27	61.94	-19.67	-	-
20	.2445	18.28	Ca	0	0	10.1	28.38	-	-	51.94	-23.56
21	.33	33.98	Qp	0	0	10.1	44.08	59.45	-15.37	-	-
22	.32775	20.17	Ca	0	0	10.1	30.27	-	-	49.51	-19.24
23	.4065	32.43	Qp	0	0	10.1	42.53	57.72	-15.19	-	-
24	.40875	17.83	Ca	0	0	10.1	27.93	-	-	47.67	-19.74
25	.4965	31.31	Qp	0	0	10.1	41.41	56.06	-14.65	-	-
26	.4875	16.55	Ca	0	0	10.1	26.65	-	-	46.21	-19.56
27	.5685	29.86	Qp	0	0	10.1	39.96	56	-16.04	-	-
28	.5685	15.26	Ca	0	0	10.1	25.36	-	-	46	-20.64
29	.7305	29.93	Qp	0	0	10.1	40.03	56	-15.97	-	-
30	.7305	15.68	Ca	0	0	10.1	25.78	-	-	46	-20.22
31	.82725	28.99	Qp	0	0	10.1	39.09	56	-16.91	-	-
32	.81375	14.84	Ca	0	0	10.1	24.94	-	-	46	-21.06

Qp - Quasi-Peak detector

Ca - CISPR average detection

Note: 13.56MHz is a fundamental frequency of the EUT. Data documented in above section, indicate that when the antenna terminal is terminated the fundamental amplitude is lowering below the limit line.

END OF REPORT

11. SETUP PHOTOS

Please refer to 12204475-EP1V1 for setup photos