



CERTIFICATION TEST REPORT

Report Number. : 13812998-E4V2

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

Model : A2657

Brand : Apple

FCC ID : BCGA2657

EUT Description : Network adapter

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C

Date Of Issue:

April 19, 2022

Prepared by:

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Revision History

<u>Rev.</u>	<u>Issue Date</u>	<u>Revisions</u>	<u>Revised By</u>
V1	4/8/2022	Initial Issue	Gerardo Abrego
V2	4/19/2022	Updated section 5	Tri Pham

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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: Network adapter

MODEL: A2657

BRAND: Apple

SERIAL NUMBER: QPGPH3PVYM

SAMPLE RECEIPT DATE: February 15, 2022

DATE TESTED: February 23, 2022 – March 17, 2022

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 15 SUBPART C	Complies

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

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

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2013, KDB 414788 D01 Radiated Test Site v01r01, FCC CFR 47 Part 2, FCC CFR 47 Part 15.

3. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, Certificate Number 0751.05, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
<input type="checkbox"/>	Building 1: 47173 Benicia Street Fremont, CA 94538, U.S.A	US0104	2324A	550739
<input checked="" type="checkbox"/>	Building 2: 47266 Benicia Street Fremont, CA 94538, U.S.A	US0104	22541	550739
<input checked="" type="checkbox"/>	Building 4: 47658 Kato Rd Fremont, CA 94538, U.S.A	US0104	2324B	550739

4. DECISION RULES AND MEASUREMENT UNCERTAINTY

4.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

4.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	U _{Lab}
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.78 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.40 dB
Worst Case Radiated Disturbance Loop, 9KHz to 30 MHz	2.87 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.51 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.29 dB
Worst Case Occupied Bandwidth	1.22%

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

4.4. SAMPLE CALCULATION

RADIATED EMISSIONS

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)
 $36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
 $36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} = 46.6 \text{ dBuV}$

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

A2657 is a network adapter. It has an integral battery, two gigabit ethernet ports, USB-C connector and antenna. The device supports IEEE 802.11b/g/n radio, Bluetooth radio, and NFC. The network adapter comes with 32 GB memory storage and 1.5 GB RAM.

5.2. MAXIMUM E-FIELD STRENGTH

The testing was performed at 3 meter. The transmitter maximum E-field at 30m distance was converted from 3 meter data.

5.2.1. EUT WITH AC/DC ADAPTER

Frequency Range (MHz)	Mode		Kbps	E Field at 30m distance (dBuV/m)
13.56	Type A	CE	212	24.30
		Reader	848	20.11

5.3. SOFTWARE AND FIRMWARE

The test utility software used during testing was 19F47.

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 orientation was determined to be the worst-case orientation.

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. Therefore, Type A (CE Mode) with a bit rate of 212 kb/s and Type A (Reader mode) with a bit rate of 848 kb/s were selected for 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	Macbook Pro	C02P41RZG086	FCC DoC
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
AC/DC Adapter	Apple	A1385	D292365CDYADHLC3	NA
10dB Fixed Attenuator	Pasternack	PE7087-10	Label ID: 178584	N/A

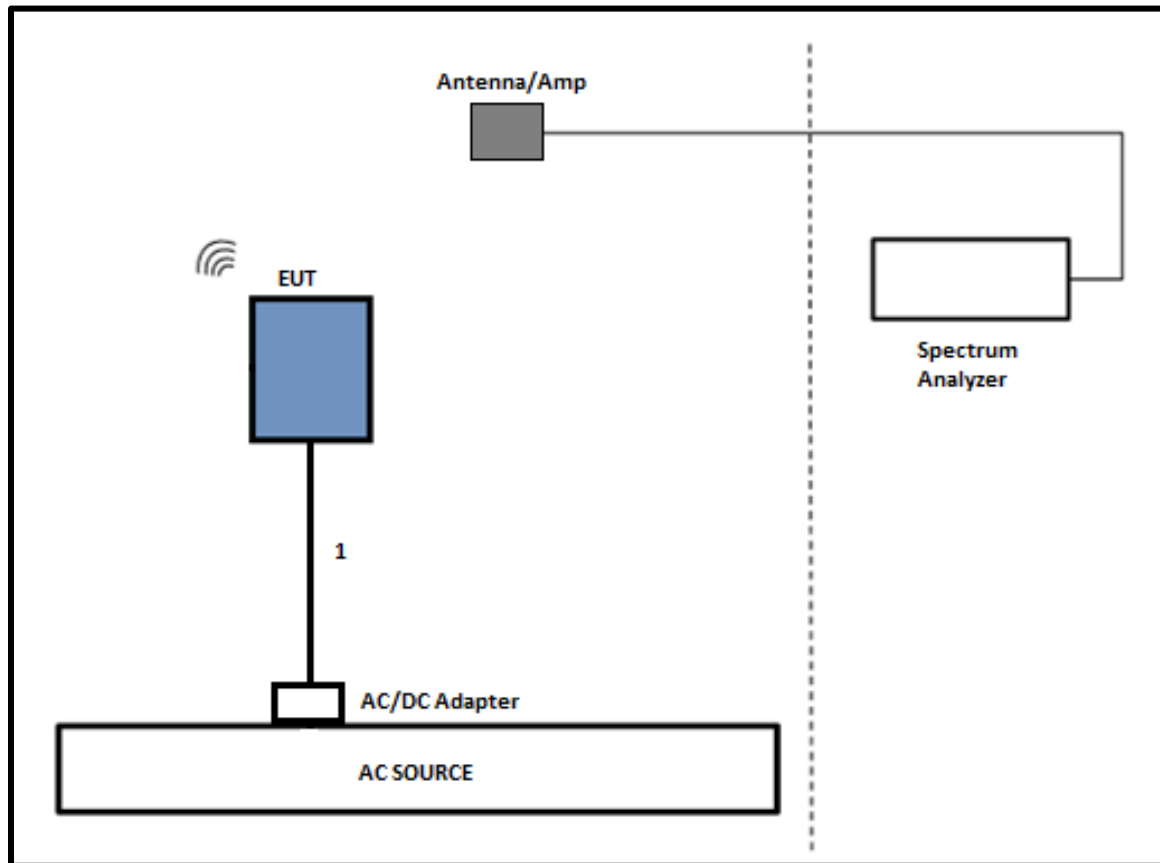
I/O CABLES

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

TEST SETUP

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

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	ID Num	Cal Due	Last Cal
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	175953	02/08/2023	02/08/2022
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179367	02/17/2023	02/17/2022
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	T341	02/02/2023	02/02/2022
Antenna, Passive Loop 9KHz-30MHz	Electro-Metric	EM-6872	170016	06/08/2022	06/08/2021
Antenna, Broadband Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	174373	12/14/2022	12/14/2021
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	170648	02/10/2023	02/10/2022

AC Line Conducted					
Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESR	T1436	02/21/2023	02/21/2022
LISN for Conducted Emissions CISPR-16	FISCHER CUSTOM COMMUNICATIONS	FCC-LISN-50/250-25-2-01-480V	175765	01/26/2023	01/26/2022
UL AUTOMATION SOFTWARE					
Radiated Software	UL	UL EMC	Ver 9.5, Mar 6, 2020		
Conducted Software	UL	UL EMC	2020.2.26		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, February 21, 2020		

7. OCCUPIED BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

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

99% and 20dB BW

Type A (CE Mode)

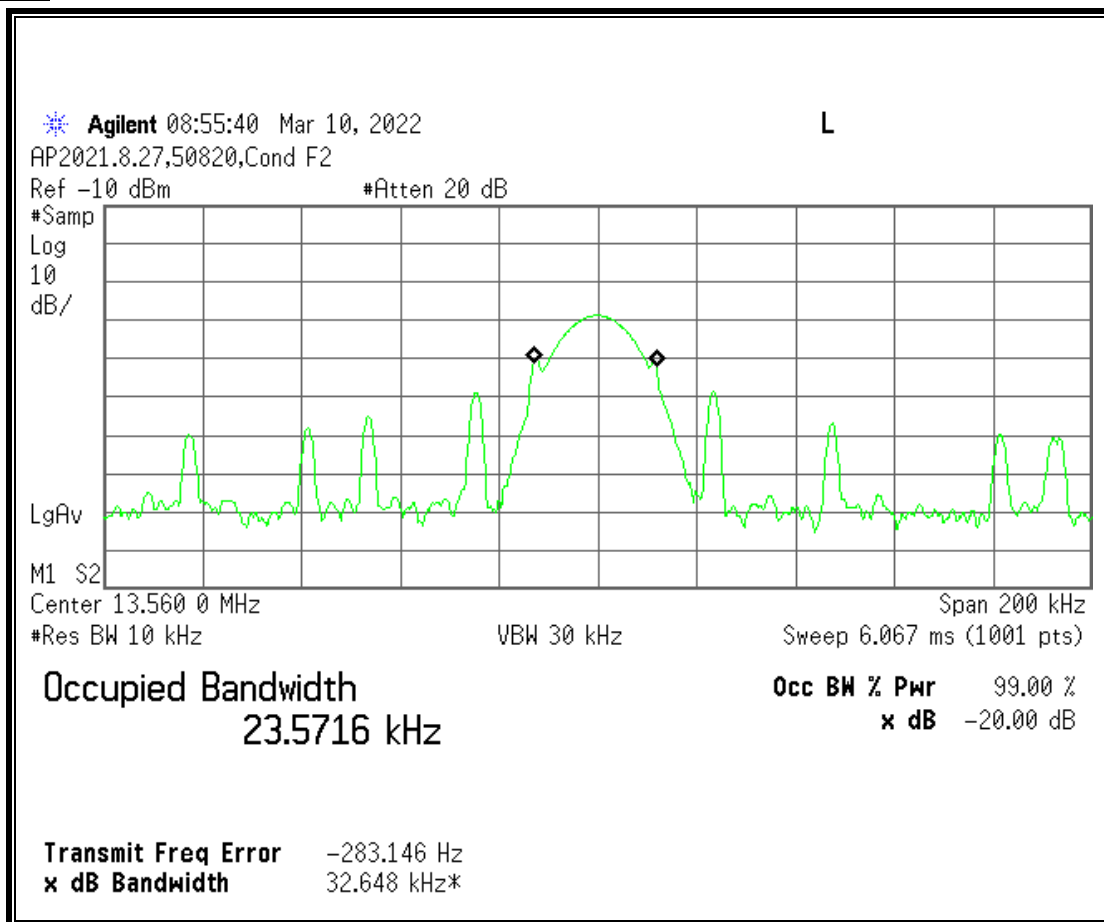
Mode Kbps	Frequency (MHz)	99% Bandwidth (KHz)	20dB Bandwidth (KHz)
212	13.56	23.5716	32.648

Type A (Reader Mode)

Mode Kbps	Frequency (MHz)	99% Bandwidth (KHz)	20dB Bandwidth (KHz)
848	13.56	22.3644	26.273

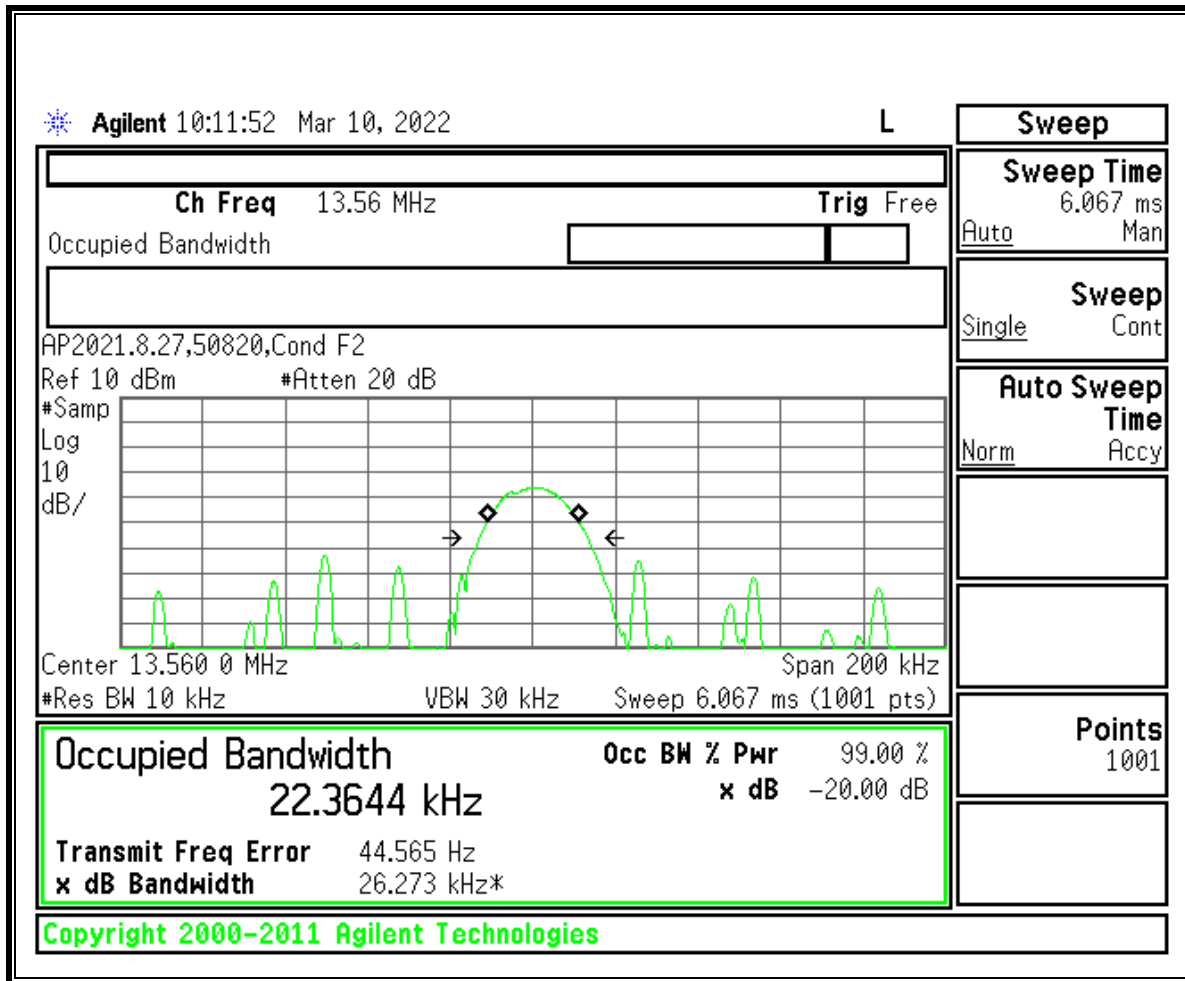
7.1. Type A (CE Mode)

212Kbps



7.2. Type A (Reader Mode)

848Kbps



8. RADIATED EMISSION TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMIT

§15.225

(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 uV/m to dBuV/m is:

Limit (dBuV/m) = 20 log limit (uV/m)

Note: The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as report in the table) using free space impedance of 377 Ohms. For example, the measurement at frequency X kHz resulted in a level of Y dBuV/m, which is equivalent to $Y-51.5 = Z$ dBuA/m, which has the same margin, W dB to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

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

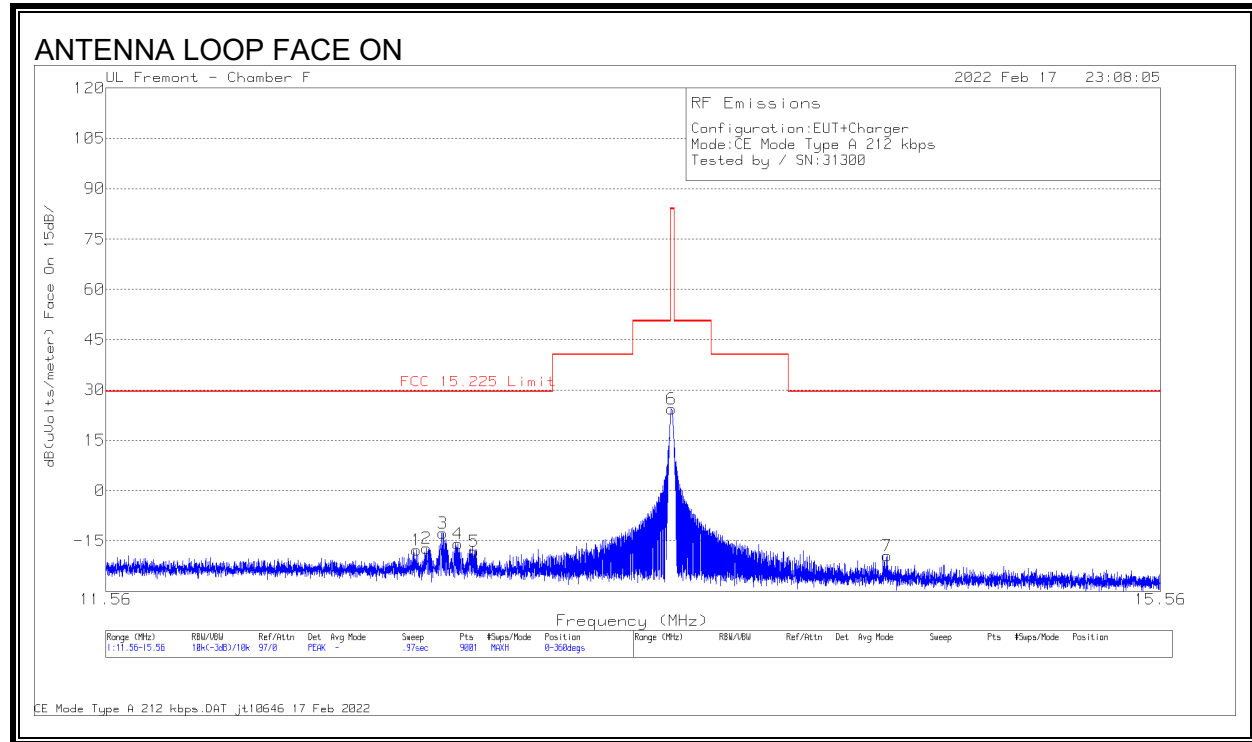
The EUT is an intentional radiator that incorporates a digital device, the highest fundamental frequency generated or used in the device is 13.56 MHz; therefore, the frequency range was investigated from 0.15 MHz to the 10th harmonic of the highest fundamental frequency, or 1000 MHz, whichever is greater.

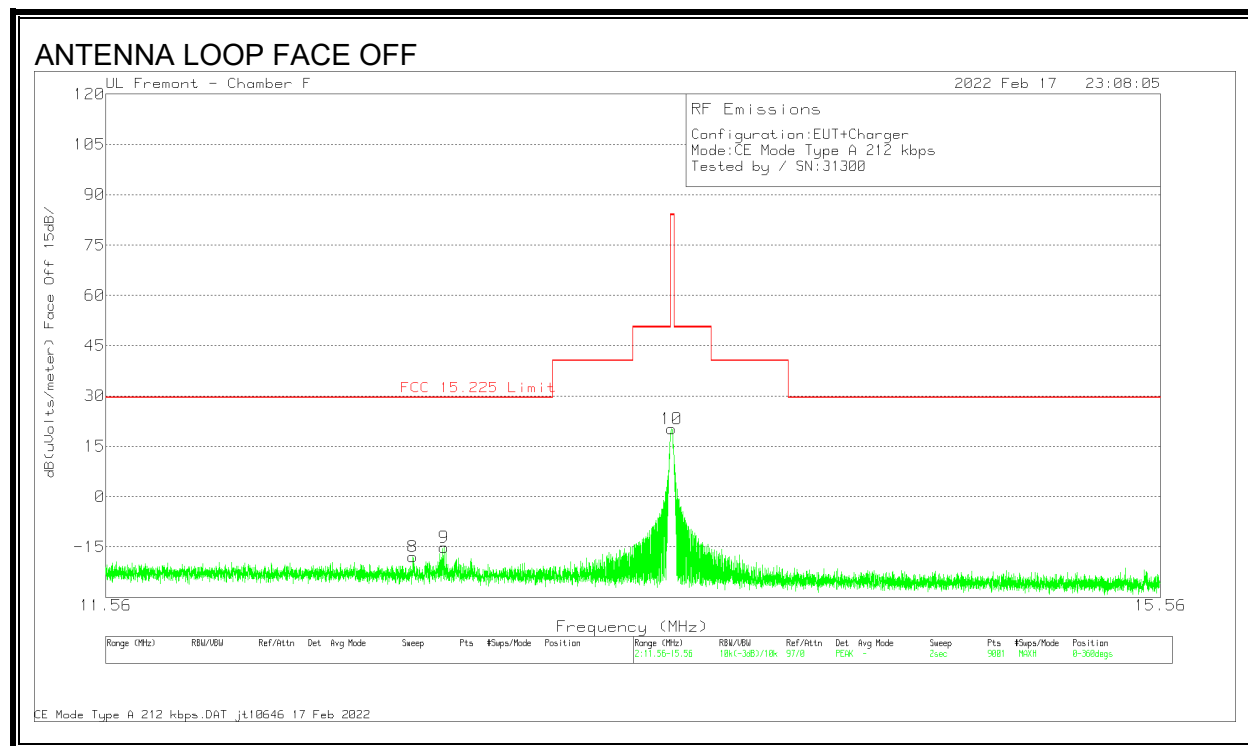
RESULTS

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

8.2.1. Type A (CE Mode)

FUNDAMENTAL 212Kbps



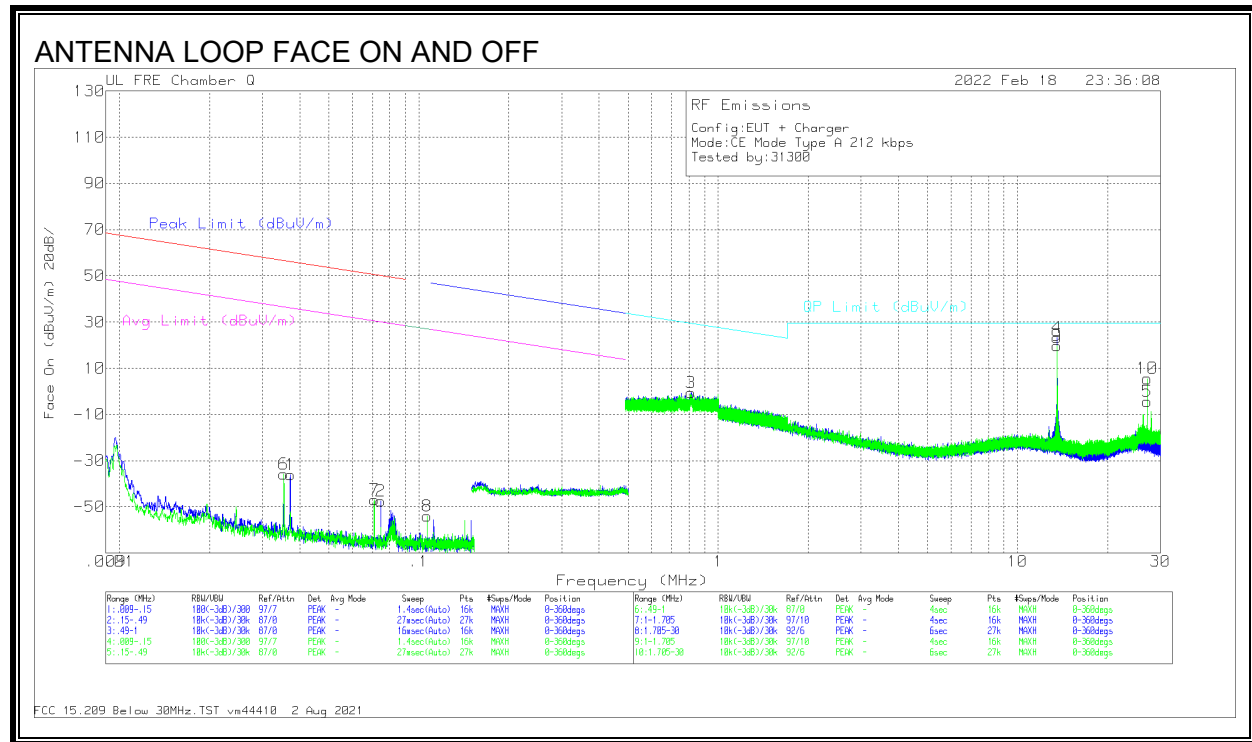


Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading dB(uVolts/m eter)	FCC 15.225 Limit	PK Margin (dB)	Azimuth (Degs)	Polarity
1	12.6176	20.89	Pk	33.9	-32.5	-40	-17.71	29.54	-47.25	0-360	FACE ON
2	12.6545	21.4	Pk	33.9	-32.5	-40	-17.2	29.54	-46.74	0-360	FACE ON
3	12.7122	26	Pk	33.9	-32.5	-40	-12.6	29.54	-42.14	0-360	FACE ON
4	12.7659	22.82	Pk	33.8	-32.5	-40	-15.88	29.54	-45.42	0-360	FACE ON
5	12.8254	20.56	Pk	33.8	-32.5	-40	-18.14	29.54	-47.68	0-360	FACE ON
6	13.5576	63	Pk	33.8	-32.5	-40	24.3	84	-59.7	0-360	FACE ON
7	14.4065	19.11	Pk	33.8	-32.4	-40	-19.49	29.54	-49.03	0-360	FACE ON
8	12.6038	20.75	Pk	33.9	-32.5	-40	-17.85	29.54	-47.39	0-360	FACE OFF
9	12.7162	23.43	Pk	33.9	-32.5	-40	-15.17	29.54	-44.71	0-360	FACE OFF
10	13.5584	58.92	Pk	33.8	-32.5	-40	20.22	84	-63.78	0-360	FACE OFF

Pk - Peak detector

SPURIOUS EMISSION 212Kbps



DATA

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 300m	Corrected Reading (dBuV/m)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity
6	.0354	19.38	Pk	57.5	-32.7	-80	-35.82	56.61	-92.43	36.61	-72.43	-	-	0-360	Face-off
1	.0372	19.28	Pk	57.4	-32.7	-80	-36.02	56.17	-92.19	36.17	-72.19	-	-	0-360	Face-on
7	.071	10.02	Pk	56	-32.8	-80	-46.78	50.56	-97.34	30.56	-77.34	-	-	0-360	Face-off
2	.0747	9.53	Pk	55.9	-32.8	-80	-47.37	50.12	-97.49	30.12	-77.49	-	-	0-360	Face-on
8	.1066	3.3	Pk	55.6	-32.8	-80	-53.9	-	-	-	-	27.07	-80.97	0-360	Face-off

Pk - Peak detector

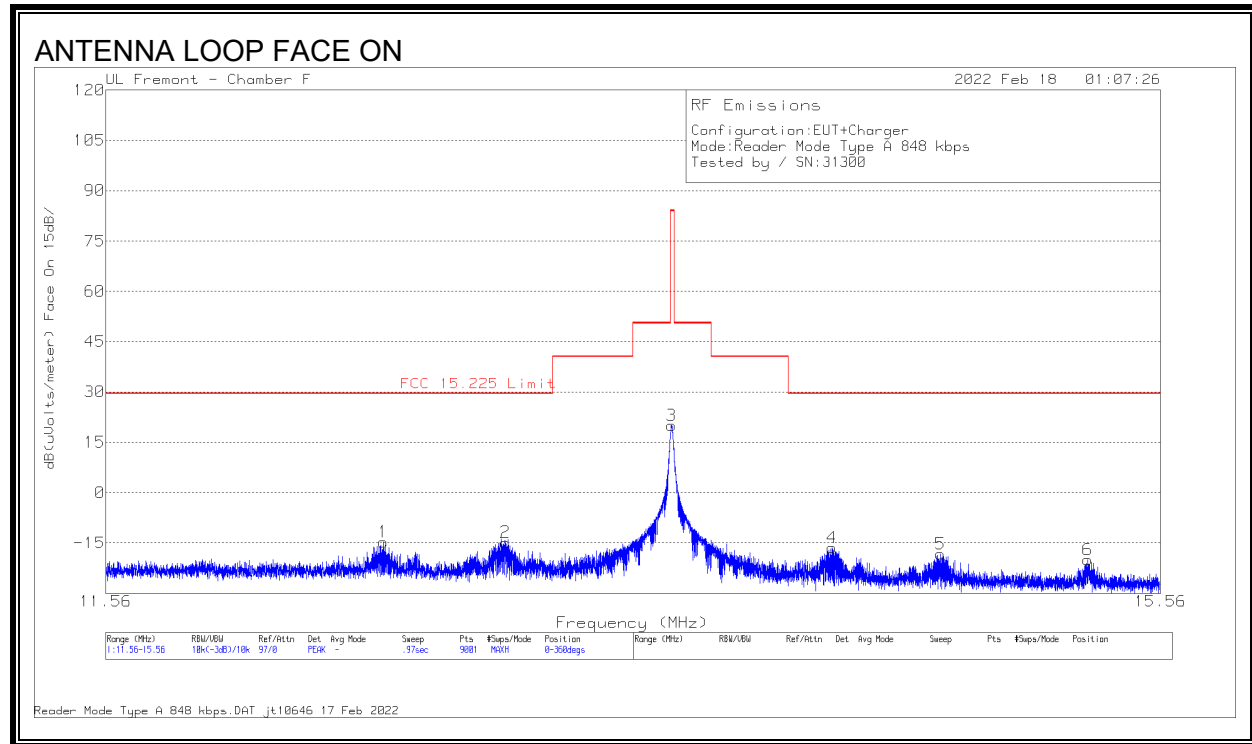
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Polarity
3	.8108	16.09	Pk	56.2	-32.8	-40	-51	29.44	-29.95	0-360	Face-On
4	13.5589	62.03	Pk	33.8	-32.5	-40	23.33	29.5	-6.17	0-360	Face-On
9	13.56	58.43	Pk	33.8	-32.5	-40	19.73	29.5	-9.77	0-360	Face-off
10	27.118	44.65	Pk	33.2	-32.3	-40	5.55	29.5	-23.95	0-360	Face-off
5	27.1232	34.72	Pk	33.2	-32.3	-40	-4.38	29.5	-33.88	0-360	Face-on

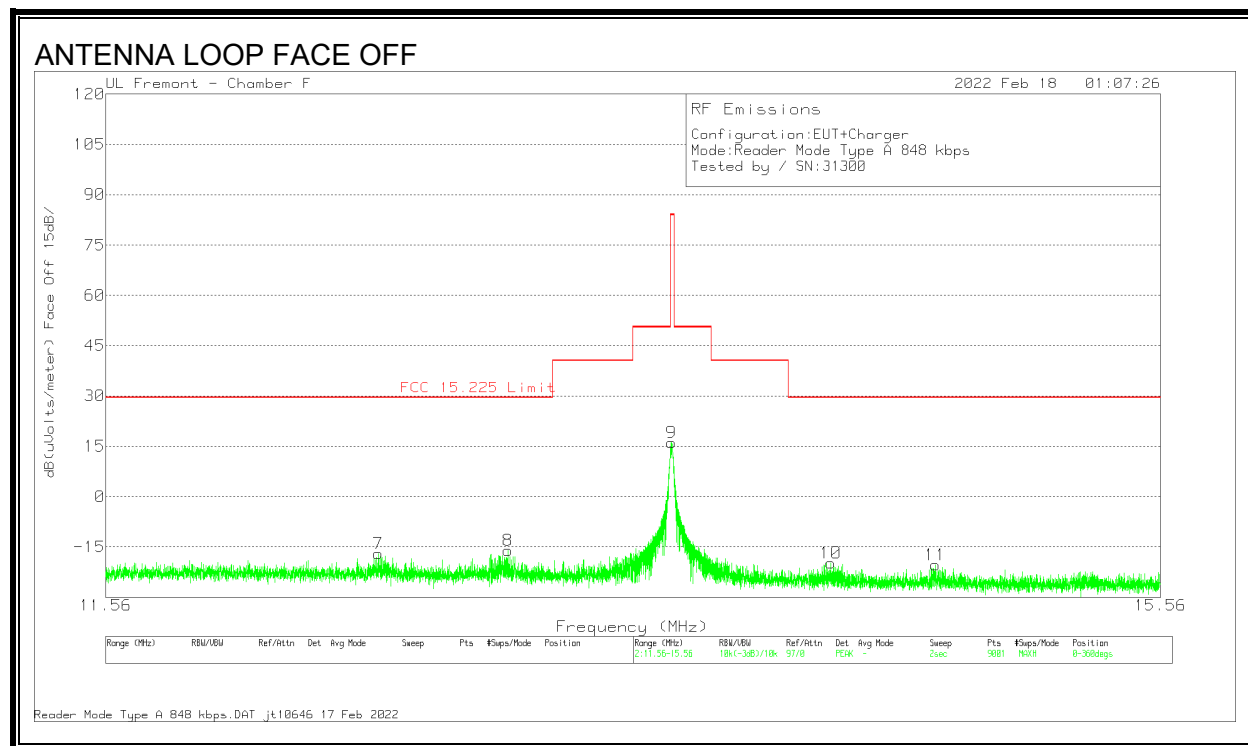
Pk - Peak detector

Note: Marker 4 and 9 are fundamental signals.

8.2.2. Type A (Reader Mode)

FUNDAMENTAL 848Kbps



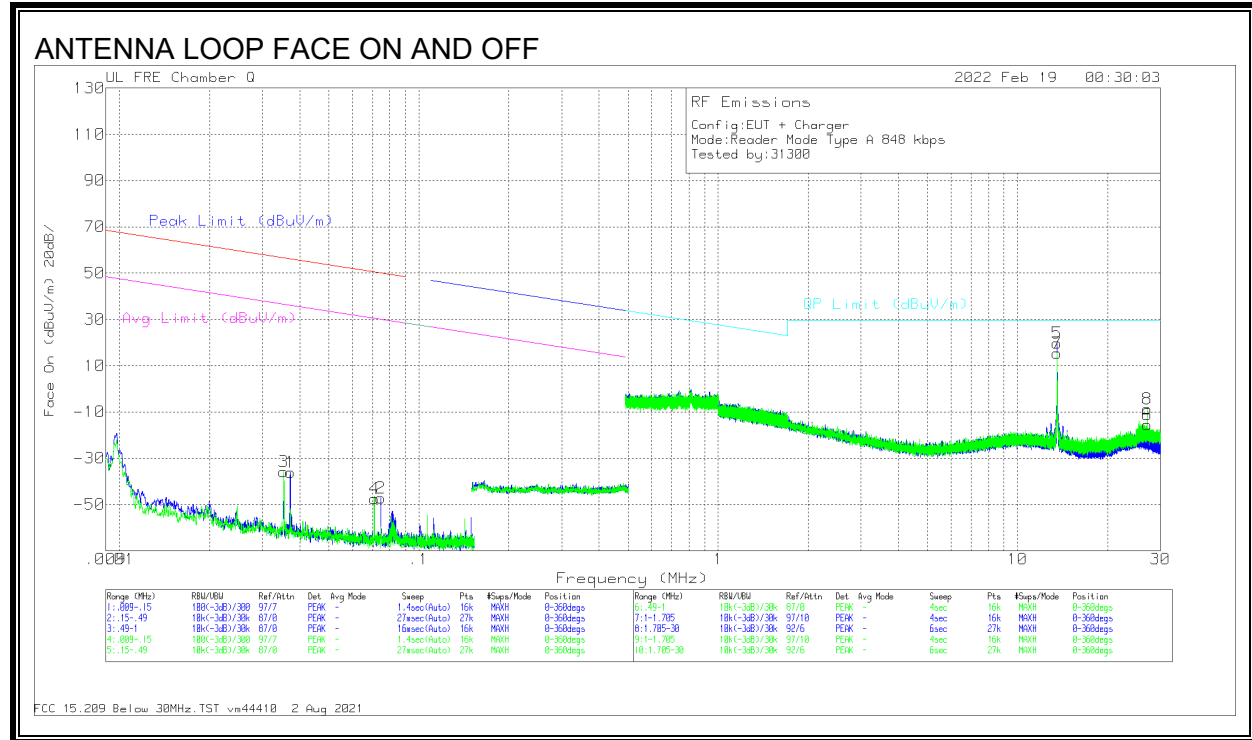


DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading dB(uVolts/m eter)	FCC 15.225 Limit	PK Margin (dB)	Azimuth (Degs)	Polarity
1	12.5004	23.95	Pk	33.9	-32.5	-40	-14.65	29.54	-44.19	0-360	Face ON
2	12.9391	23.87	Pk	33.8	-32.5	-40	-14.83	29.54	-44.37	0-360	Face ON
3	13.5571	58.81	Pk	33.8	-32.5	-40	20.11	84	-63.89	0-360	Face ON
4	14.1858	22.16	Pk	33.8	-32.4	-40	-16.44	29.54	-45.98	0-360	Face ON
5	14.624	20.29	Pk	33.8	-32.4	-40	-18.31	29.54	-47.85	0-360	Face ON
6	15.2439	18.66	Pk	33.8	-32.4	-40	-19.94	29.54	-49.48	0-360	Face ON
7	12.4831	21.56	Pk	33.9	-32.5	-40	-17.04	29.54	-46.58	0-360	Face OFF
8	12.9471	22.61	Pk	33.8	-32.5	-40	-16.09	29.54	-45.63	0-360	Face OFF
9	13.5576	54.85	Pk	33.8	-32.5	-40	16.15	84	-67.85	0-360	Face OFF
10	14.1809	18.76	Pk	33.8	-32.4	-40	-19.84	29.54	-49.38	0-360	Face OFF
11	14.6036	18.18	Pk	33.8	-32.4	-40	-20.42	29.54	-49.96	0-360	Face OFF

Pk - Peak detector

SPURIOUS EMISSION 848Kbps



DATA

Marker	Frequency (MHz)	Meter Reading (dBUV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 300m	Corrected Reading (dBUV/m)	Peak Limit (dBUV/m)	Margin (dB)	Avg Limit (dBUV/m)	Margin (dB)	Azimuth (Degs)	Polarity
3	.0354	19.47	Pk	57.5	-32.7	-80	-35.73	56.61	-92.34	36.61	-72.34	0-360	Face-on
1	.0372	19.29	Pk	57.4	-32.7	-80	-36.01	56.17	-92.18	36.17	-72.18	0-360	Face-on
4	.071	9.3	Pk	56	-32.8	-80	-47.5	50.56	-98.06	30.56	-78.06	0-360	Face-on
2	.0747	9.79	Pk	55.9	-32.8	-80	-47.11	50.12	-97.23	30.12	-77.23	0-360	Face-on

Pk - Peak detector

Marker	Frequency (MHz)	Meter Reading (dBUV)	Det	Loop Antenna (E ACF)	Amp/Cbl (dB)	Dist Corr 30m (dB) 40Log	Corrected Reading (dBUV/m)	QP Limit (dBUV/m)	Margin (dB)	Azimuth (Degs)	Polarity
6	27.1169	23.58	Pk	33.2	-32.3	-40	-15.52	29.5	-45.02	0-360	Face-off
7	13.5589	54.21	Pk	33.8	-32.5	-40	15.51	29.5	-13.99	0-360	Face-off
8	27.1232	30.45	Pk	33.2	-32.3	-40	-8.65	29.5	-38.15	0-360	Face-off
5	13.56	58.53	Pk	33.8	-32.5	-40	19.83	29.5	-9.67	0-360	Face-off

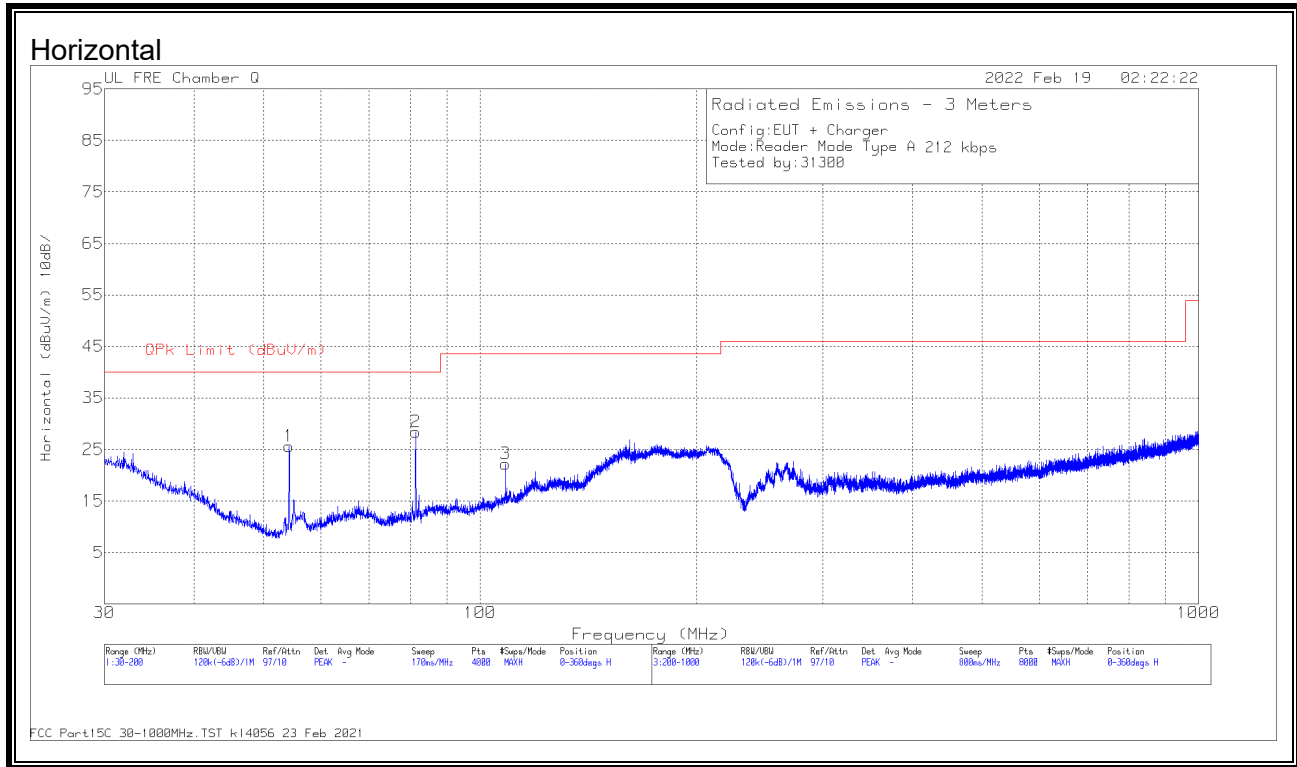
Pk - Peak detector

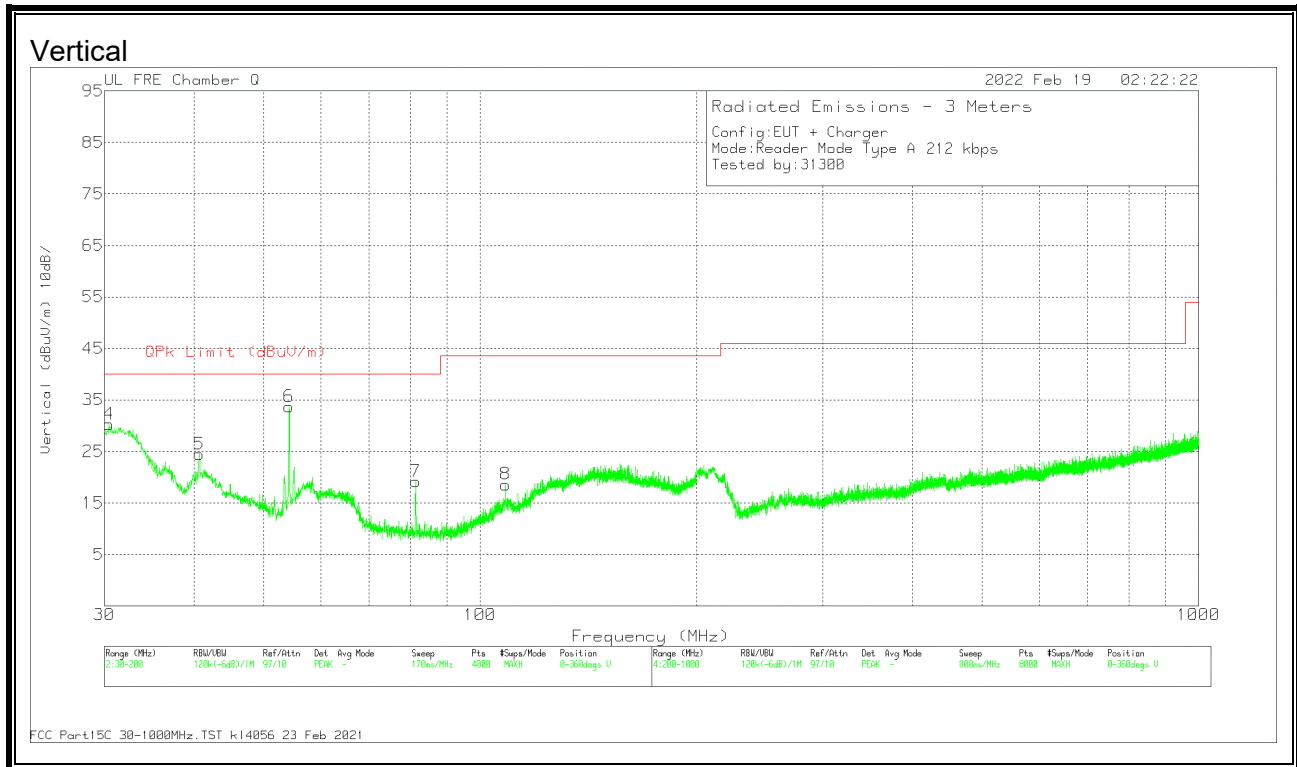
Note: Marker 5 and 7 are fundamental signals.

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

8.3.1. CE Mode, Type A

SPURIOUS EMISSION 212 Kbps





DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE018 4971 (dB/m)	Amp Cbl (Db)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	* 108.518	36.08	Pk	17.9	-31.8	22.18	43.52	-21.34	0-360	201	H
8	* 108.475	32.5	Pk	17.9	-31.8	18.6	43.52	-24.92	0-360	100	V
4	30.4251	36.3	Pk	26.4	-32.4	30.3	40	-9.7	0-360	100	V
5	40.6278	37.47	Pk	19.3	-32.3	24.47	40	-15.53	0-360	100	V
1	54.2313	44.97	Pk	12.9	-32.2	25.67	40	-14.33	0-360	301	H
6	54.2313	52.98	Pk	12.9	-32.2	33.68	40	-6.32	0-360	100	V
	54.2409	52.41	Qp	12.9	-32.2	33.11	40	-6.89	23	101	V
2	81.3533	46.86	Pk	13.4	-31.9	28.36	40	-11.64	0-360	100	H
7	81.3533	37.64	Pk	13.4	-31.9	19.14	40	-20.86	0-360	100	V

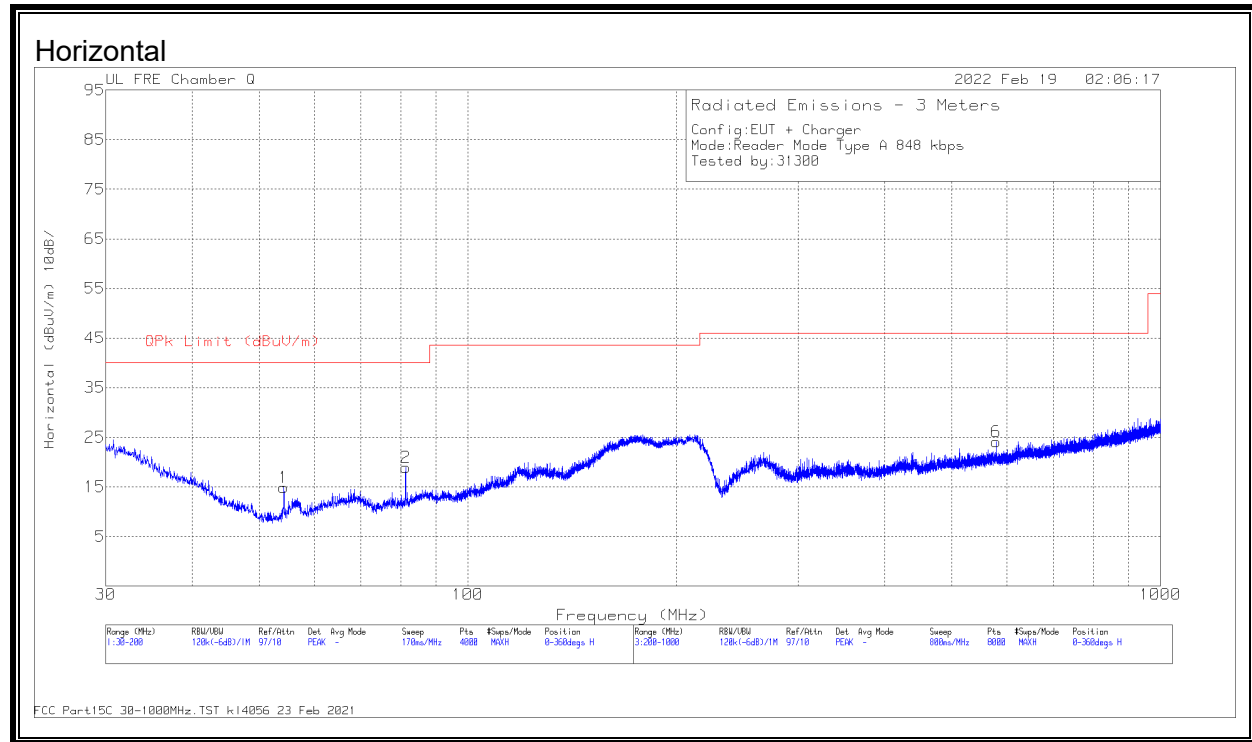
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

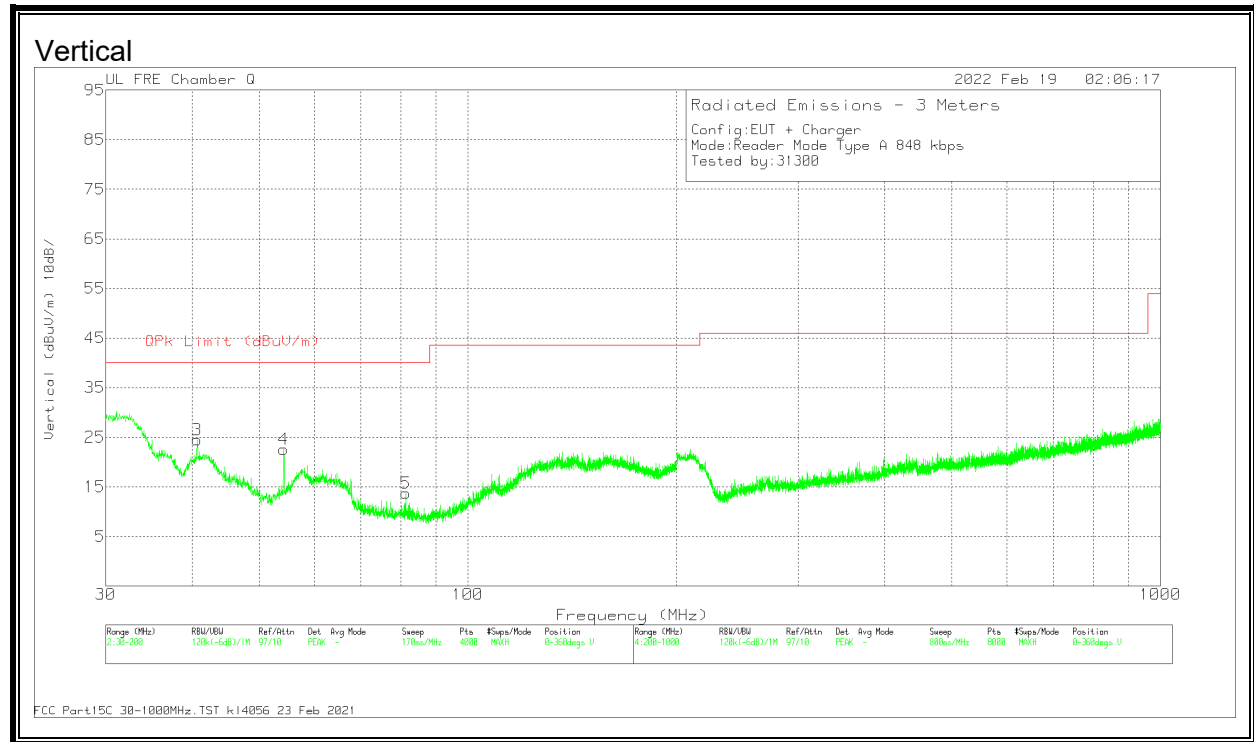
Pk - Peak detector

Qp - Quasi-Peak detector

8.3.2. Reader Mode, Type A

SPURIOUS EMISSION 848 Kbps





Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (Db)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	40.6703	37.45	Pk	19.3	-32.3	24.45	40	-15.55	0-360	100	V
1	54.2313	34.16	Pk	12.9	-32.2	14.86	40	-25.14	0-360	201	H
4	54.2313	41.94	Pk	12.9	-32.2	22.64	40	-17.36	0-360	100	V
2	81.3533	37.37	Pk	13.4	-31.9	18.87	40	-21.13	0-360	100	H
5	81.3533	32.2	Pk	13.4	-31.9	13.7	40	-26.3	0-360	100	V
6	579.749	29.98	Pk	24.2	-30.1	24.08	46.02	-21.94	0-360	100	H

Pk - Peak detector

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.

TEST PROCEDURE

ANSI C63.10-2013 Clause 6.8

RESULTS

No non-compliance noted.

9.1. Type A

9.1.1. CE Mode

212Kbps

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 (MHz)	Delta (ppm)	@ 2 mins (MHz)	Delta (ppm)	@ 5 mins (MHz)	Delta (ppm)	@ 10 mins (MHz)	Delta (ppm)	Limit (ppm)
3.80	35	13.56024038	-0.440	13.56028448	-3.693	13.56027482	-2.980	13.5602289	0.407	± 100
	30	13.56035673	-9.021	13.56033134	-7.148	13.56026047	-1.921	13.56027717	-3.153	± 100
	20	13.56023441	0.000	13.5602239	0.776	13.56016423	5.176	13.56024611	-0.862	± 100
	10	13.56028571	-3.783	13.56028186	-3.499	13.56030765	-5.401	13.56024595	-0.851	± 100
	0	13.56030521	-5.221	13.56027438	-2.947	13.56035994	-9.257	13.56032826	-6.921	± 100
3.23	20	13.56000959	16.580	13.56010634	9.445	13.56008381	11.106	13.56005235	13.427	± 100
4.37	20	13.55995847	20.350	13.56010681	9.410	13.56000300	17.066	13.56006725	12.328	± 100

9.1.2. 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 (MHz)	Delta (ppm)	@ 2 mins (MHz)	Delta (ppm)	@ 5 mins (MHz)	Delta (ppm)	@ 10 mins (MHz)	Delta (ppm)	Limit (ppm)
3.80	35	13.56021259	0.774	13.56021656	0.482	13.56017439	3.592	13.56018146	3.070	± 100
	30	13.56015663	4.901	13.5601646	4.314	13.56011136	8.240	13.56021344	0.712	± 100
	20	13.5602231	0.000	13.56020884	1.052	13.56023703	-1.027	13.56021263	0.772	± 100
	10	13.56022682	-0.275	13.56020382	1.422	13.56025928	-2.668	13.56018079	3.120	± 100
	0	13.56023281	-0.716	13.56024773	-1.817	13.56010934	8.389	13.560254	-2.279	± 100
3.23	20	13.56009259	9.624	13.56022627	-0.234	13.56008233	10.381	13.56005154	12.651	± 100
4.37	20	13.5602322	-0.671	13.55997584	18.234	13.56022768	-0.338	13.56021251	0.781	± 100

10. AC MAINS LINE CONDUCTED EMISSIONS

LIMITS

§15.207

(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

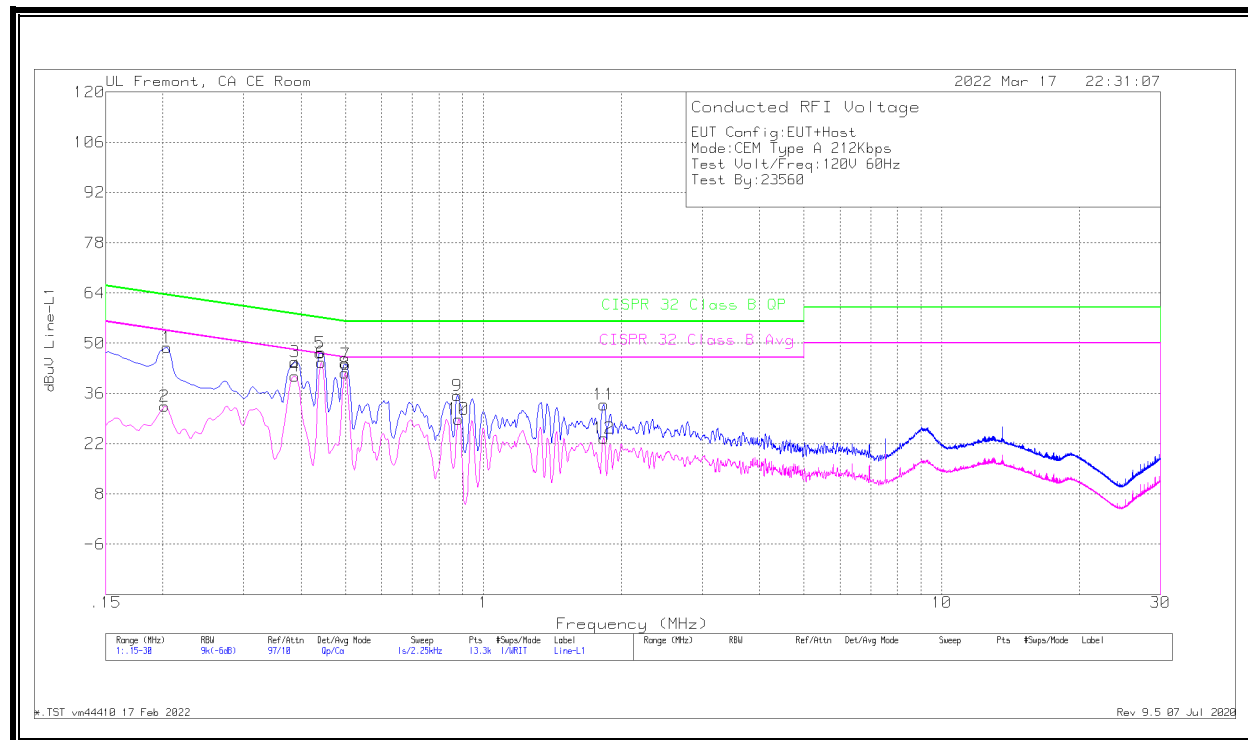
RESULTS

No non-compliance noted:

10.1. Type A (CE Mode)

10.1.1. NORMAL OPERATION WITH ANTENNA PORT TERMINATED, 212Kbps

LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L1	C1&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
2	.20175	23.15	Ca	0	0	9.3	32.45	-	-	53.54	-21.09
4	.3885	31.52	Ca	0	0	9.3	40.82	-	-	48.1	-7.28
6	.4425	35.3	Ca	0	0	9.3	44.6	-	-	47.01	-2.41
8	.49875	32.45	Ca	0	0	9.3	41.75	-	-	46.02	-4.27
10	.8835	19.48	Ca	0	.1	9.3	28.88	-	-	46	-17.12
12	1.83075	14.21	Ca	0	.1	9.3	23.61	-	-	46	-22.39
1	.204	39.5	Qp	0	0	9.3	48.8	63.45	-14.65	-	-
3	.3885	35.52	Qp	0	0	9.3	44.82	58.1	-13.28	-	-
5	.44025	37.96	Qp	0	0	9.3	47.26	57.06	-9.8	-	-
7	.501	34.81	Qp	0	0	9.3	44.11	56	-11.89	-	-
9	.87675	26.01	Qp	0	.1	9.3	35.41	56	-20.59	-	-
11	1.83075	23.5	Qp	0	.1	9.3	32.9	56	-23.1	-	-

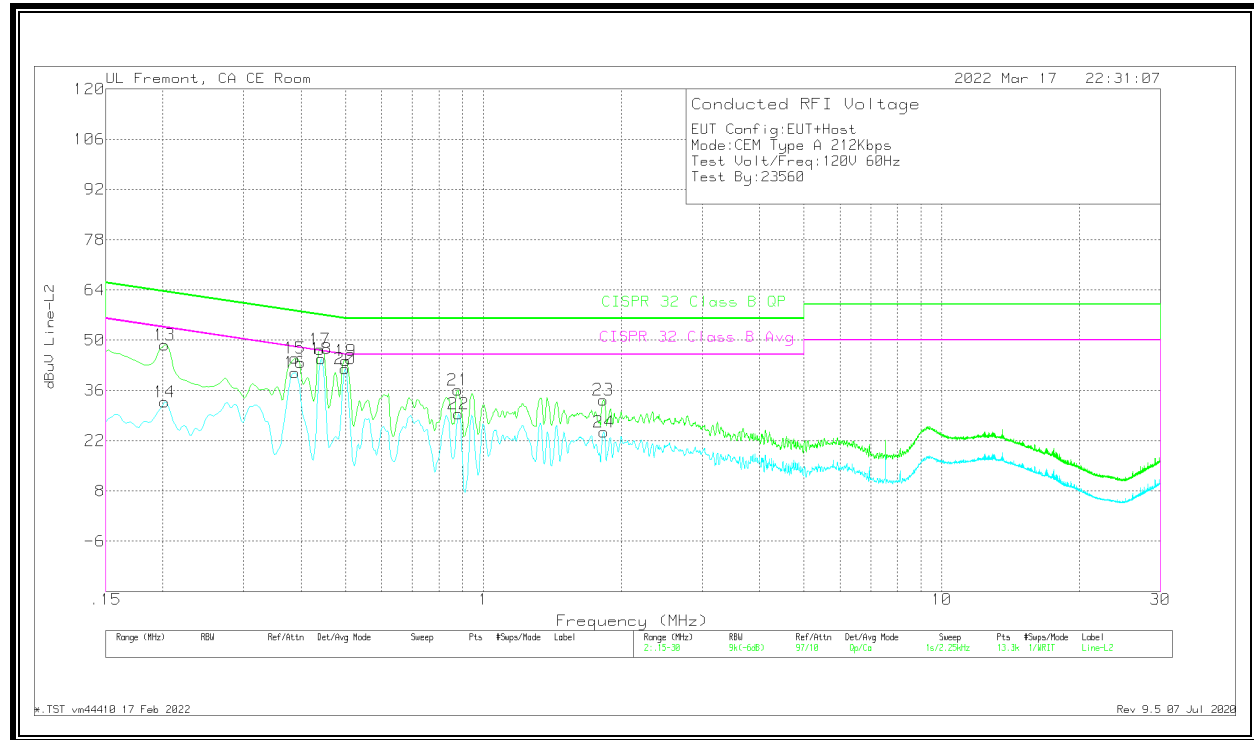
Qp - Quasi-Peak detector

Ca - CISPR average detection

Worst Emission

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

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L2	C2&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
14	.20175	23.48	Ca	0	0	9.3	32.78	-	-	53.54	-20.76
16	.3885	31.67	Ca	0	0	9.3	40.97	-	-	48.1	-7.13
18	.4425	35.54	Ca	0	0	9.3	44.84	-	-	47.01	-2.17
20	.49875	32.69	Ca	0	0	9.3	41.99	-	-	46.02	-4.03
22	.8835	20.02	Ca	0	.1	9.3	29.42	-	-	46	-16.58
24	1.83075	14.97	Ca	0	.1	9.3	24.37	-	-	46	-21.63
13	.20175	39.44	Qp	0	0	9.3	48.74	63.54	-14.8	-	-
15	.3885	35.65	Qp	0	0	9.3	44.95	58.1	-13.15	-	-
17	.44025	38.15	Qp	0	0	9.3	47.45	57.06	-9.61	-	-
19	.501	35.02	Qp	0	0	9.3	44.32	56	-11.68	-	-
21	.879	26.65	Qp	0	.1	9.3	36.05	56	-19.95	-	-
23	1.8285	24.01	Qp	0	.1	9.3	33.41	56	-22.59	-	-

Qp - Quasi-Peak detector

Ca - CISPR average detection

*TST vm44410 17 Feb 2022

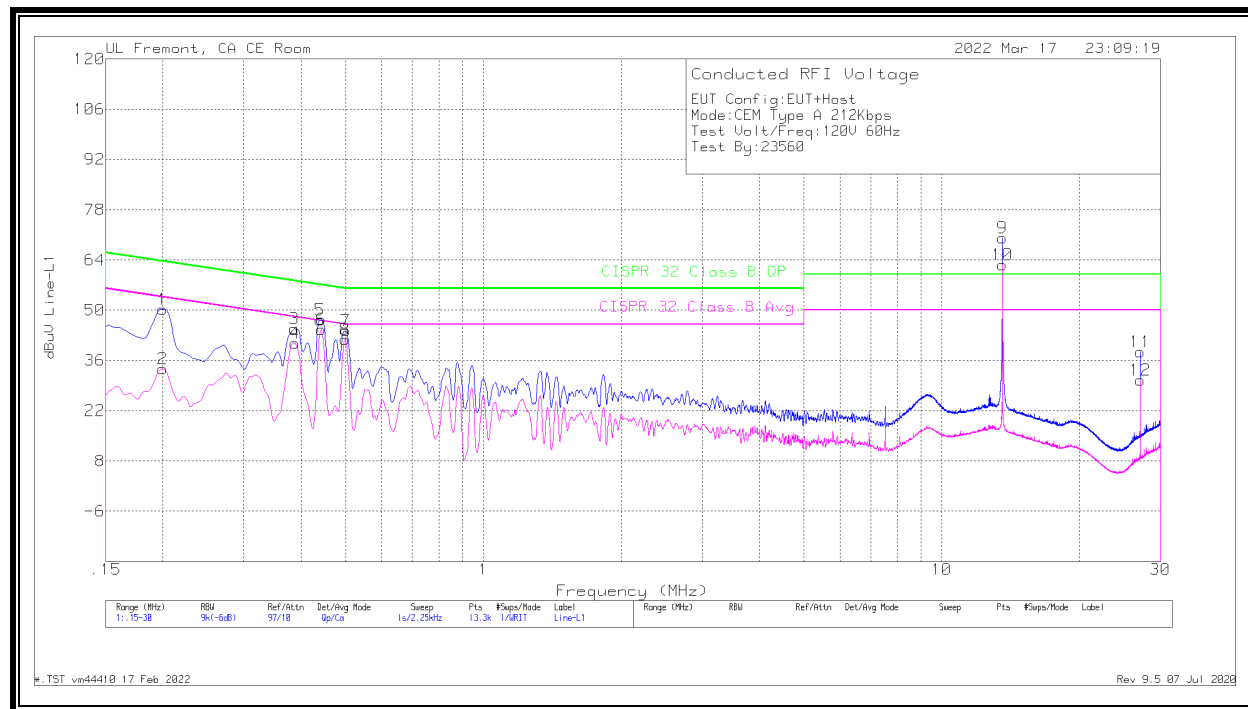
Rev 9.5 07 Jul 2020

Worst Emission

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

10.1.2. NORMAL OPERATION, 212Kbps

LINE 1 RESULTS



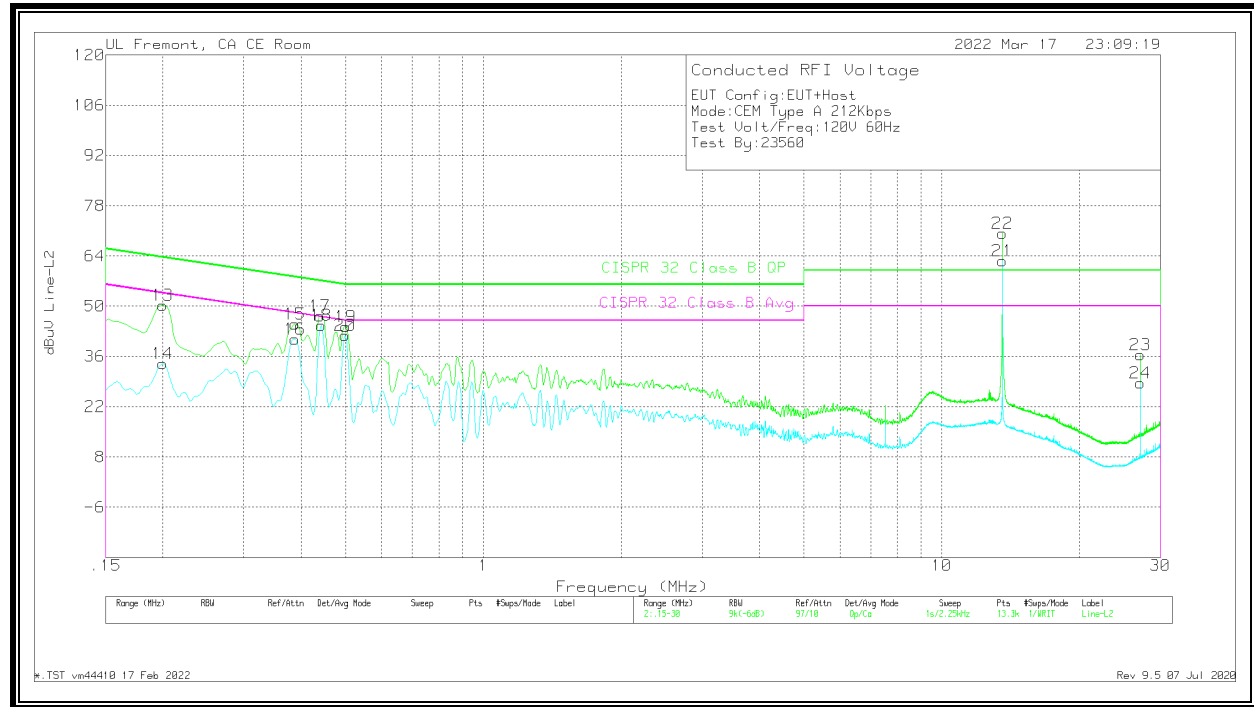
Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L1	C1&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
2	.1995	24.26	Ca	.1	0	9.3	33.66	-	-	53.63	-19.97
4	.3885	31.48	Ca	0	0	9.3	40.78	-	-	48.1	-7.32
6	.4425	35.37	Ca	0	0	9.3	44.67	-	-	47.01	-2.34
8	.49875	32.58	Ca	0	0	9.3	41.88	-	-	46.02	-4.14
10	13.56	53.05	Ca	.1	.2	9.3	62.65	-	-	50	12.65
12	27.12075	20.71	Ca	.2	.3	9.4	30.61	-	-	50	-19.39
1	.1995	40.91	Qp	.1	0	9.3	50.31	63.63	-13.32	-	-
3	.38625	35.62	Qp	0	0	9.3	44.92	58.14	-13.22	-	-
5	.44025	37.98	Qp	0	0	9.3	47.28	57.06	-9.78	-	-
7	.501	34.97	Qp	0	0	9.3	44.27	56	-11.73	-	-
9	13.56	60.62	Qp	.1	.2	9.3	70.22	60	10.22	-	-
11	27.11963	28.56	Qp	.2	.3	9.4	38.46	60	-21.54	-	-

Qp - Quasi-Peak detector
Ca - CISPR average detection

Worst Emission

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

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L2	C2&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
14	.1995	24.69	Ca	0	0	9.3	33.99	-	-	53.63	-19.64
16	.3885	31.6	Ca	0	0	9.3	40.9	-	-	48.1	-7.2
18	.4425	35.32	Ca	0	0	9.3	44.62	-	-	47.01	-2.39
20	.49875	32.56	Ca	0	0	9.3	41.86	-	-	46.02	-4.16
21	13.56	53.12	Ca	.1	.2	9.3	62.72	-	-	50	12.72
24	27.1185	18.78	Ca	.2	.3	9.4	28.68	-	-	50	-21.32
13	.1995	40.99	Qp	0	0	9.3	50.29	63.63	-13.34	-	-
15	.3885	35.71	Qp	0	0	9.3	45.01	58.1	-13.09	-	-
17	.44025	37.94	Qp	0	0	9.3	47.24	57.06	-9.82	-	-
19	.501	34.99	Qp	0	0	9.3	44.29	56	-11.71	-	-
22	13.56	60.69	Qp	.1	.2	9.3	70.29	60	10.29	-	-
23	27.1185	26.58	Qp	.2	.3	9.4	36.48	60	-23.52	-	-

Qp - Quasi-Peak detector

Ca - CISPR average detection

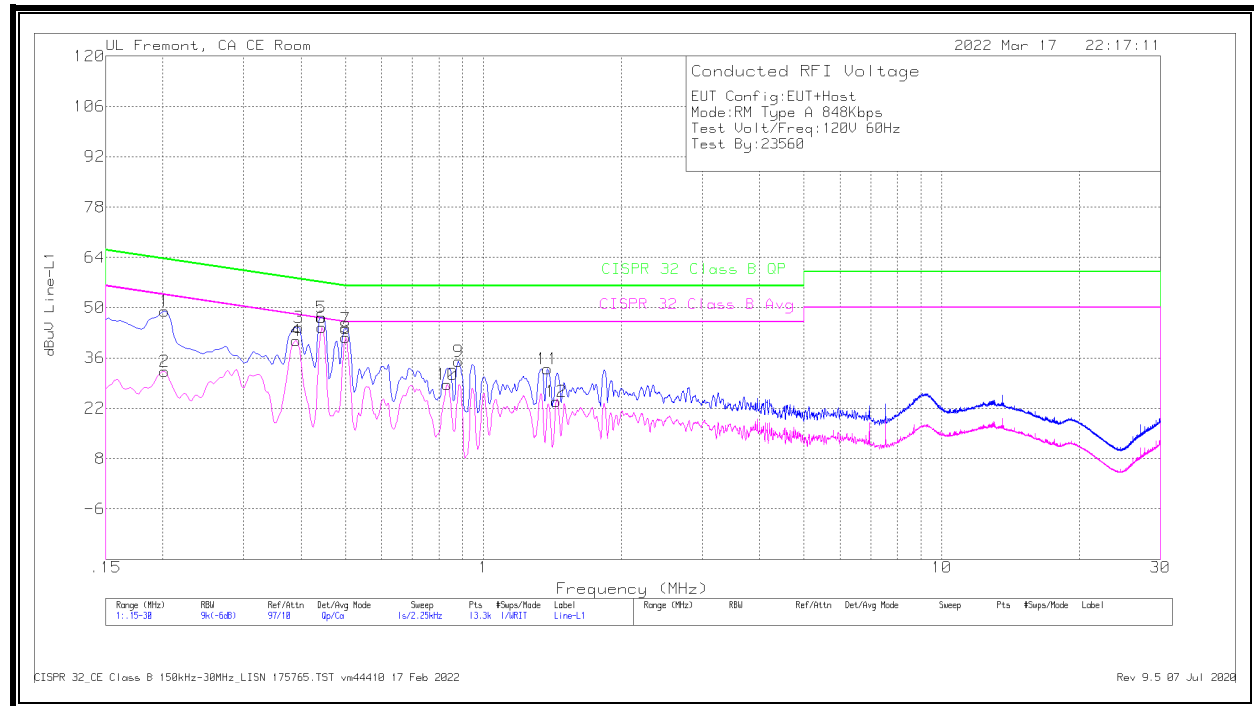
Worst Emission

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

10.2. Type A (Reader Mode)

10.2.1. NORMAL OPERATION WITH ANTENNA PORT TERMINATED, 848Kbps

LINE 1 RESULTS

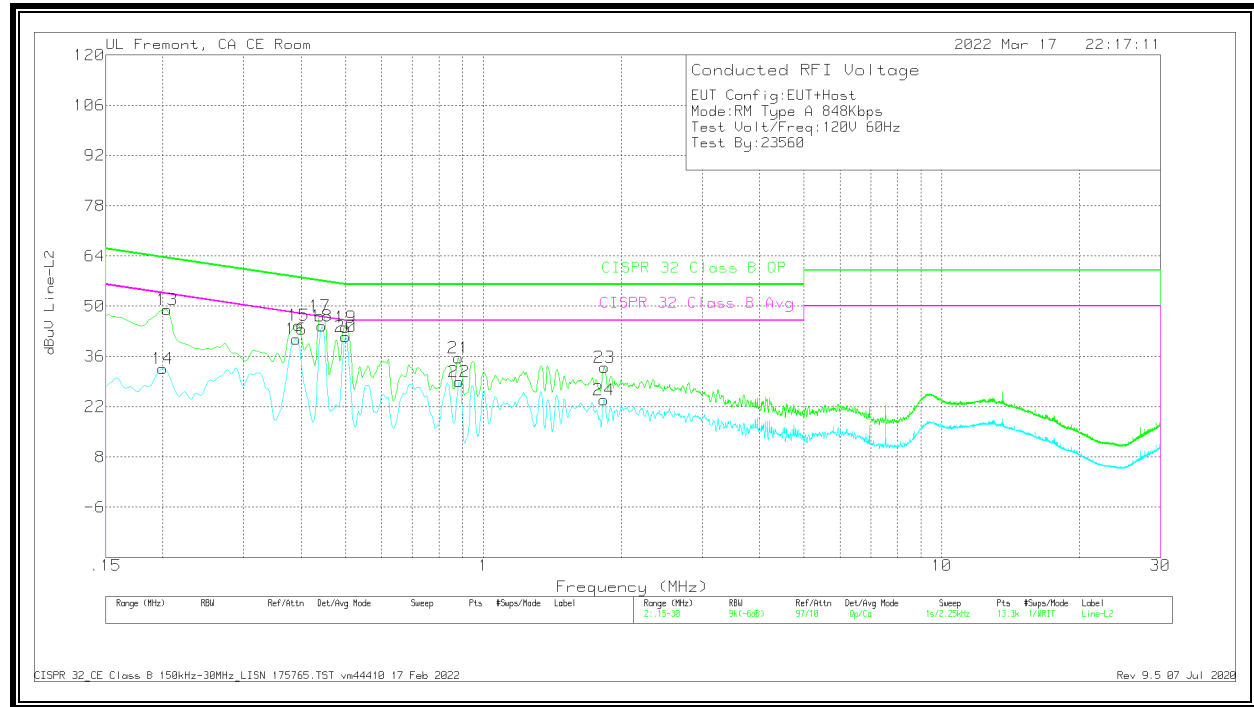


Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L1	C1&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
2	.20175	22.94	Ca	0	0	9.3	32.24	-	-	53.54	-21.3
4	.39075	31.54	Ca	0	0	9.3	40.84	-	-	48.05	-7.21
6	.44475	35.17	Ca	0	0	9.3	44.47	-	-	46.97	-2.5
8	.501	32.37	Ca	0	0	9.3	41.67	-	-	46	-4.33
10	.834	19.2	Ca	0	.1	9.3	28.6	-	-	46	-17.4
12	1.4415	14.44	Ca	0	.1	9.3	23.84	-	-	46	-22.16
1	.20175	39.77	Qp	0	0	9.3	49.07	63.54	-14.47	-	-
3	.39525	35.27	Qp	0	0	9.3	44.57	57.95	-13.38	-	-
5	.4425	37.97	Qp	0	0	9.3	47.27	57.01	-9.74	-	-
7	.501	34.91	Qp	0	0	9.3	44.21	56	-11.79	-	-
9	.88125	25.74	Qp	0	.1	9.3	35.14	56	-20.86	-	-
11	1.3785	23.63	Qp	0	.1	9.3	33.03	56	-22.97	-	-

Worst Emission

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

LINE 2 RESULTS



Range 2: Line-L2 15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L2	C2&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
14	.1995	23.28	Ca	0	0	9.3	32.58	-	-	53.63	-21.05
16	.39075	31.59	Ca	0	0	9.3	40.89	-	-	48.05	-7.16
18	.44475	35.14	Ca	0	0	9.3	44.44	-	-	46.97	-2.53
20	.501	32.31	Ca	0	0	9.3	41.61	-	-	46	-4.39
22	.88575	19.57	Ca	0	.1	9.3	28.97	-	-	46	-17.03
24	1.833	14.58	Ca	0	.1	9.3	23.98	-	-	46	-22.02
13	.204	39.74	Qp	0	0	9.3	49.04	63.45	-14.41	-	-
15	.39525	35.35	Qp	0	0	9.3	44.65	57.95	-13.3	-	-
17	.44025	37.99	Qp	0	0	9.3	47.29	57.06	-9.77	-	-
19	.501	34.89	Qp	0	0	9.3	44.19	56	-11.81	-	-
21	.88125	26.19	Qp	0	.1	9.3	35.59	56	-20.41	-	-
23	1.83525	23.55	Qp	0	.1	9.3	32.95	56	-23.05	-	-

Qp - Quasi-Peak detector

Ca - CISPR average detection

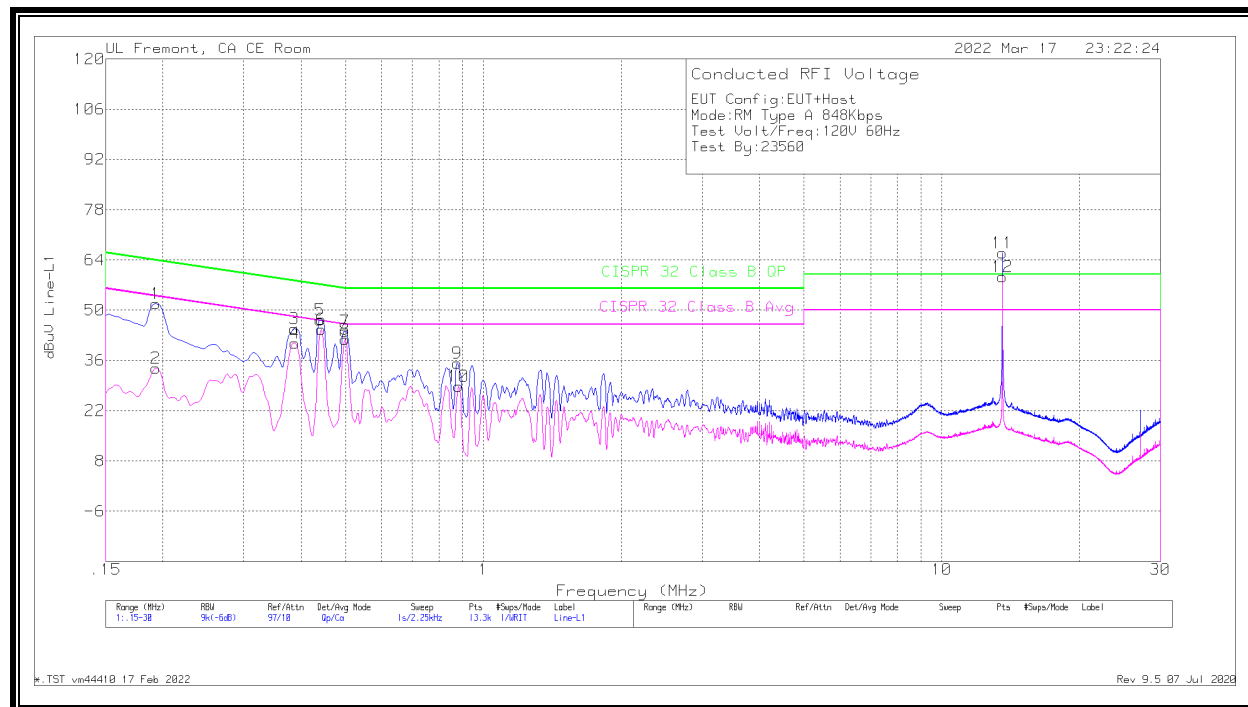
FCC15 CE Class B 150kHz-30MHz Stepping_LISN 175765.TST vm44410 17 Feb 2022
Rev 9.5 07 Jul 2020

Worst Emission

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

10.2.2. NORMAL OPERATION, 848Kbps

LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L1	C1&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
2	.19275	24.48	Ca	.1	0	9.3	33.88	-	-	53.92	-20.04
4	.3885	31.57	Ca	0	0	9.3	40.87	-	-	48.1	-7.23
6	.4425	35.39	Ca	0	0	9.3	44.69	-	-	47.01	-2.32
8	.49875	32.56	Ca	0	0	9.3	41.86	-	-	46.02	-4.16
10	.8835	19.41	Ca	0	.1	9.3	28.81	-	-	46	-17.19
12	13.56	49.65	Ca	.1	.2	9.3	59.25	-	-	50	9.25
1	.19275	42.37	Qp	.1	0	9.3	51.77	63.92	-12.15	-	-
3	.38625	35.59	Qp	0	0	9.3	44.89	58.14	-13.25	-	-
5	.44025	38.04	Qp	0	0	9.3	47.34	57.06	-9.72	-	-
7	.49875	34.87	Qp	0	0	9.3	44.17	56.02	-11.85	-	-
9	.87675	25.78	Qp	0	.1	9.3	35.18	56	-20.82	-	-
11	13.56	56.38	Qp	.1	.2	9.3	65.98	60	5.98	-	-

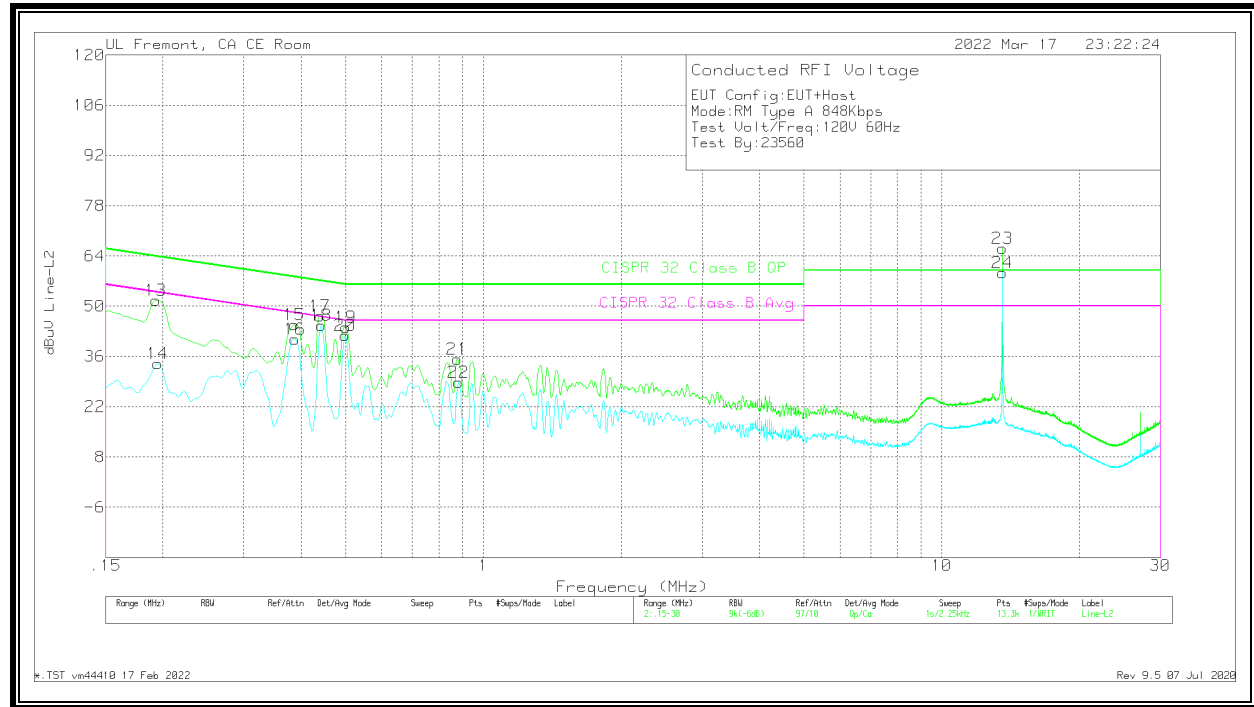
Qp - Quasi-Peak detector

Ca - CISPR average detection

Worst Emission

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

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	175765 LISN L2	C2&C3 cable	TekBox Limiter TBFL1 Model 207	Corrected Reading dBuV	CISPR 32 Class B QP	Margin (dB)	CISPR 32 Class B Avg	Margin (dB)
14	.195	24.66	Ca	0	0	9.3	33.96	-	-	53.82	-19.86
16	.3885	31.61	Ca	0	0	9.3	40.91	-	-	48.1	-7.19
18	.4425	35.37	Ca	0	0	9.3	44.67	-	-	47.01	-2.34
20	.49875	32.53	Ca	0	0	9.3	41.83	-	-	46.02	-4.19
22	.8835	19.42	Ca	0	.1	9.3	28.82	-	-	46	-17.18
24	13.56	49.74	Ca	.1	.2	9.3	59.34	-	-	50	9.34
13	.19275	42.36	Qp	0	0	9.3	51.66	63.92	-12.26	-	-
15	.38625	35.62	Qp	0	0	9.3	44.92	58.14	-13.22	-	-
17	.44025	38.04	Qp	0	0	9.3	47.34	57.06	-9.72	-	-
19	.501	34.85	Qp	0	0	9.3	44.15	56	-11.85	-	-
21	.87675	25.89	Qp	0	.1	9.3	35.29	56	-20.71	-	-
23	13.56	56.46	Qp	.1	.2	9.3	66.06	60	6.06	-	-

Qp - Quasi-Peak detector

Ca - CISPR average detection

Worst Emission

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

11. SETUP PHOTOS

Please refer to 13812998-EP1 for setup photos

END OF TEST REPORT