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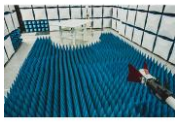


MEASUREMENT REPORT
FCC PART 15.225

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
12/11/2023 - 3/6/2024
Test Report Issue Date:
3/24/2024
Test Site/Location:
Element Materials Technology, Morgan Hill, CA, USA
Test Report Serial No.:
1C2311270063-15-R1.BCG

FCC ID:	**BCGA2902**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model/HVIN:	A2902
EUT Type:	Tablet Device
Frequency:	13.56MHz
FCC Classification:	Low Power Communications Device Transmitter (DXX)
FCC Rule Part(s):	Part 15 Subpart C (15.225)
Test Procedure(s):	ANSI C63.10-2020

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2020. Test results reported herein relate only to the item(s) tested.

This revised Test Report (S/N: 1C2311270063-15-R1.BCG) supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose accordingly.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RJ Ortanez
Executive Vice President

Prepared by: WKR0000010551

Reviewed by: WKR0000005833

ACCREDITED
CERT #2041.02

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 Element Materials Technology Test Location

These measurement tests were conducted at the Element Materials Technology facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Materials Technology.

- Element Materials Technology is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- Element Materials Technology facility is a registered (22831) test laboratory with the site description on file with ISED.

- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2902**. The test data contained in this report pertains only to the emissions due to the wireless power transfer function of the EUT.

Test Device Serial No.: TYPH39N4Q0, X19L76XDKW

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8) 802.11a/ax WIFI 6E, NB UNII (1x, HDR4, HDR8), 802.15.4, WPT

This device supports BT Beamforming.

This device supports different WPT charging rates.

Charging Rate
1.7C
2.6C

Table 2-1. WPT Charging Rate

2.3 Test Support Equipment

1	Apple Macbook Pro	Model:	A2141	S/N:	C02DV7VGMD6T
	w/AC/DC Adapter	Model:	A2166	S/N:	C4H22720425PM0WA1
2	USB-C Cable	Model:	A246C	S/N:	FTL806400FP26GV1J
	w/AC Adapter	Model:	A2935	S/N:	C4H30130NFG24XF43
3	Apple Pencil Battery	Model:	A2538	S/N:	K2QGKWJ4NC
	Apple Pencil Resistive	Model:	A2538	S/N:	KJ7P9LT7RT
4	DC Power Supply	Model:	KPS3010D	S/N:	N/A

Table 2-2. Test Support Equipment List

2.4 Test Configuration

The EUT Tablet Device **FCC ID: BCGA2902**, contains a proprietary wireless power transfer (WPT) module, which uses a magnetic inductive charging system. This feature allows for the Apple Pencil to be wirelessly charged using the tablet device.

All equipment is placed on the test tabletop and arranged in a typical configuration in accordance with ANSI C63.10-2020. For more information, refer to Section 6.0 for test data and the test setup.

All Apple pencils with different configurations were investigated and only the worst-case pencil (Resistive load) was reported in this test report.

All charging rates were investigated and only the worst-case charging rate (2.6C) was reported in this test report.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst-case emissions were reported in this test report.

For AC line conducted and radiated emissions test, with the Apple Pencil wirelessly charging while attached to Tablet Device, following configuration were investigated and worst case was reported.

- Tablet Device powered by AC/DC adapter via USB-C cable with wire charger.
- Tablet Device powered by host PC via USB-C cable with wire charger.

2.5 Software and Firmware

The test was conducted with firmware version 21E11250p on the EUT.

2.6 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

3.0 DESCRIPTION OF TEST

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2020) was used in the measurement of the EUT**.**

Deviation from measurement procedure…….....None

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is EPCOS 2X60A Power Line Filter (100dB Attenuation, 14kHz-18GHz) and the two EPCOs 2X48A filters (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.6. Automated test software was used to perform the AC line conducted emissions testing. Automated measurement software utilized is Rohde & Schwarz EMC32, Version 10.50.40.

3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. An 80cm tall test table made of Styrodur is placed on top of the turn table.

Per KDB 414788, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was rotated about its vertical axis while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.4 Environmental Conditions

The temperature is controlled within range of 15ºC to 35ºC. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

- The antenna of the EUT are **permanently attached.**
- This unit was tested with its standard battery.

Conclusion:

The EUT complies with the requirement of §15.203.

5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
AC Line Conducted Disturbance	1.91
Radiated Disturbance (<30MHz)	4.12
Radiated Disturbance (30MHz-1GHz)	4.85

6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
ESPEC	SU-241	Tabletop Temperature Chamber	11/17/2023	Annual	11/17/2024	92009574
Keysight Technologies	N9040B	UXA Spectrum Analyzer	7/10/2023	Annual	7/10/2024	US57212289
Rohde & Schwarz	ENV216	Two-Line V-Network	6/20/2023	Annual	6/20/2024	101363
Rohde & Schwarz	ESW44	EMI Test Receiver	6/6/2023	Annual	6/6/2024	101668
Rohde & Schwarz	HFH2-Z2	Loop Antenna	5/1/2023	Annual	5/1/2024	100519
Rohde & Schwarz	TS-PR8	Pre-Amplifier - Antenna System (30MHz-8GHz)	8/25/2023	Annual	8/25/2024	102333
Schwarzbeck	VULB 9162	Bilog Antenna (30MHz-6GHz)	9/14/2023	Annual	9/14/2024	00358

Table 6-1. Test Equipment List

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

7.0 TEST DATA

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCGA2902

FCC Classification: Low Power Communications Device Transmitter (DXX)

Frequencies Examined: 13.56MHz

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1049	Bandwidth Measurement	N/A	RADIATED	PASS	Section 7.2
15.225 (a)(b)(c)	In-Band Emissions	15,848µV/m @ 30m 13.553 – 13.567 MHz 334µV/m @ 30m 13.410 – 13.553 MHz 13.567 – 13.710 MHz 106µV/m @ 30m 13.110 – 13.410 MHz 13.710 – 14.010 MHz		PASS	Section 7.4
15.225 (d) 15.209	Out-of-Band Emissions	Emissions outside of the specified band (13.110 – 14.010 MHz) must meet the radiated limits detailed in 15.209		PASS	Section 7.5
15.225 (e)	Frequency Stability Tolerance	± 0.01% of Operating Frequency	Temperature Chamber	PASS	Section 7.3
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits	LINE CONDUCTED	PASS	Section 7.6

Table 7-1. Summary of Test Results

Note:

1. This unit was tested with both its standard battery and dummy battery.
2. All charging rates were investigated. The test results shown in the following sections represent the worst-case emissions.
3. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.

7.2 Bandwidth Measurement

§2.1049

Test Overview and Limit

The bandwidth at 20dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequency. The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation were investigated and the worst case configuration results are reported in this section.

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 20dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 20. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% OBW
3. VBW ≥ 3 x RBW
4. Reference level set to keep signal from exceeding maximum input mixer level for linear operation.
5. Detector = Peak
6. Trace mode = max hold
7. Sweep = auto couple
8. The trace was allowed to stabilize
9. Using the 99% power bandwidth function of the instrument and report the measured bandwidth.

Test Setup

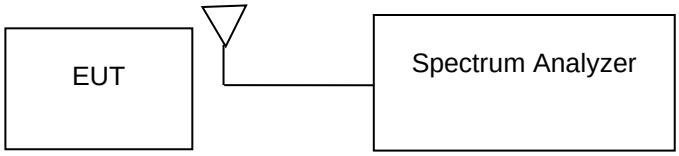


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None.

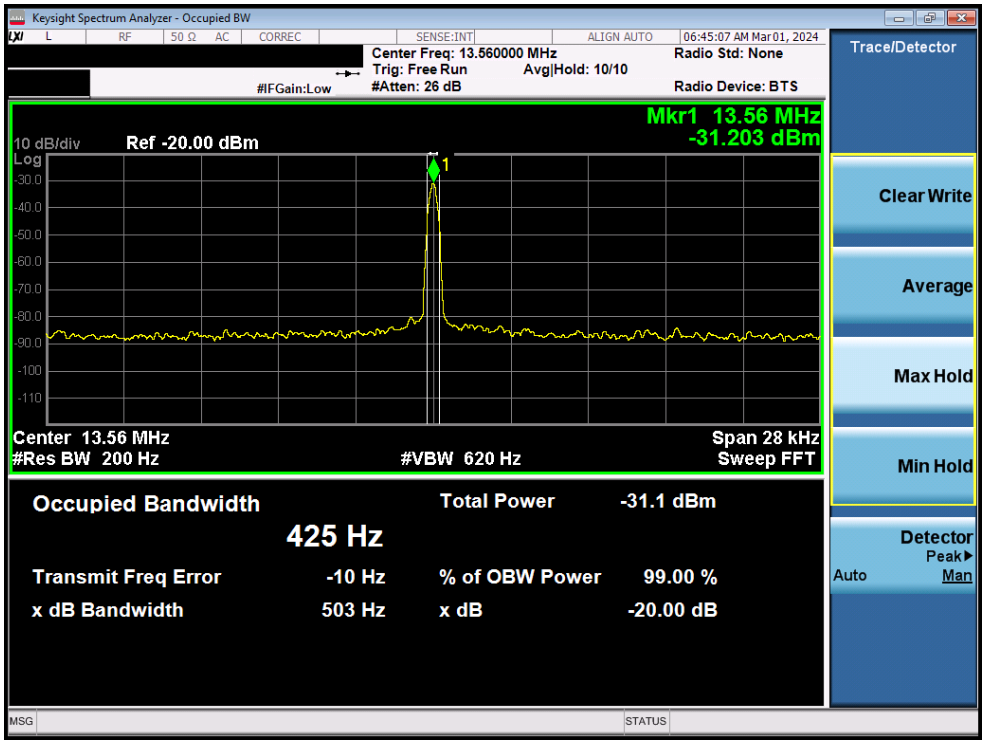


Figure 7-2. 20dB and 99% Bandwidth WPT Plot (Charging Rate 2.6C)

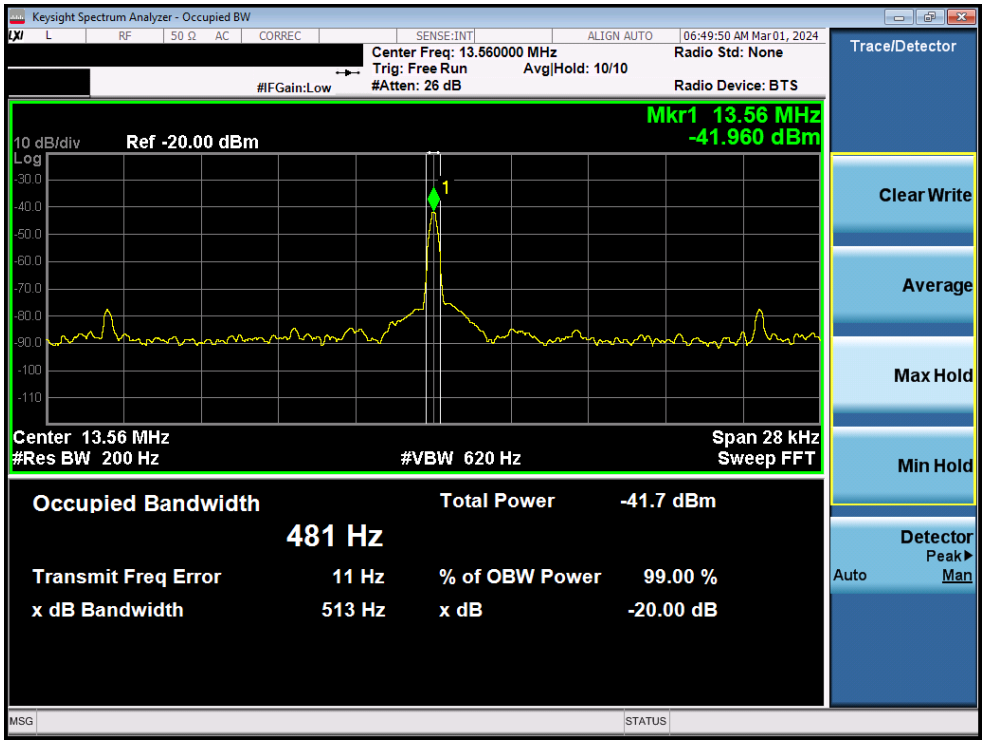


Figure 7-3. 20dB and 99% Bandwidth Communication Mode Plot

7.3 Frequency Stability Test Data

§15.225

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.10-2020. The frequency stability of the transmitter is measured by:

a.) **Temperature:** The temperature is varied from -20°C to +50°C in 10°C increments using an environmental chamber.

b.) **Primary Supply Voltage:** The primary supply voltage is varied from 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

For Part 15.225, the frequency stability of the transmitter shall be maintained within ±0.01% of the center frequency.

Test Procedure Used

ANSI C63.10-2020 – Section 6.8

Test Settings

1. The carrier frequency of the transmitter is measured at room temperature (20°C to provide a reference).
2. The equipment is turned on in a "standby" condition for fifteen minutes before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.
3. Frequency measurements are made at 10°C intervals ranging from -20°C to +50°C. Measurements were taken at startup, at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized at each temperature level.

Test Setup

The EUT was connected via an RF cable to a spectrum analyzer with the EUT placed inside an environmental chamber.

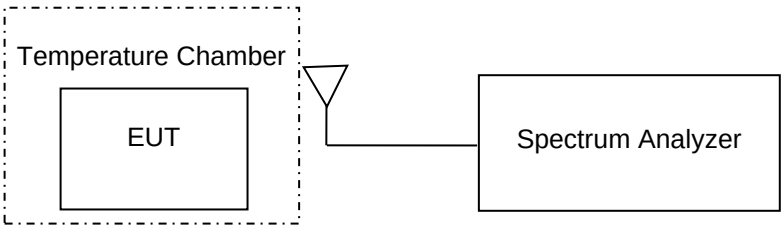


Figure 7-4. Test Instrument & Measurement Setup

Test Notes

All possible configurations were investigated and only the worst case is reported.

Frequency Stability Test Data
§15.225

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 20	13,559,911	-89.5	-0.0006600
100 %		- 10	13,559,881	-119.0	-0.0008776
100 %		0	13,559,893	-107.5	-0.0007928
100 %		+ 10	13,559,917	-83.5	-0.0006158
100 %		+ 20	13,559,964	-36.5	-0.0002692
100 %		+ 30	13,560,010	10.0	0.0000737
100 %		+ 40	13,560,035	34.5	0.0002544
100 %		+ 50	13,560,039	38.5	0.0002839
85 %	3.40	+ 20	13,559,779	-221.0	-0.0016298
115 %	4.37	+ 20	13,559,811	-189.5	-0.0013975

Table 7-2. Frequency Stability Test Data (Charging Rate 2.6C)

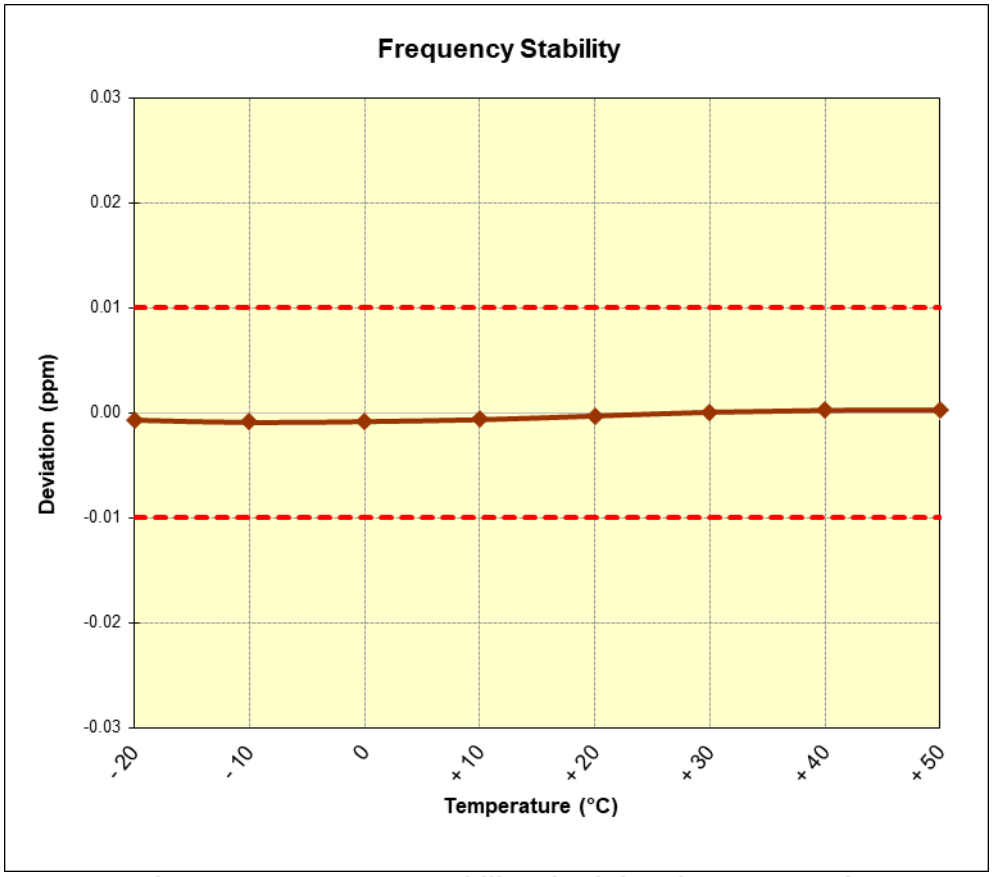


Figure 7-5. Frequency Stability Plot (Charging Rate 2.6C)

7.4 In-Band Radiated Spurious Emission Measurements

§15.225(a)(b)(c)

Test Overview and Limit

The EUT was tested from 13.110 – 14.010 MHz. All in-band radiated spurious emissions are measured with a spectrum analyzer connected to a loop antenna while the EUT is operating at appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All in-band emissions appearing in a restricted band as specified in Section 15.225 of the Title 47 CFR must not exceed the limits shown in Table 7-3.

Frequency [MHz]	Field Strength [μV/m]	Measured Distance [Meters]
13.553-13.567 MHz	15,848	30
13.410-13.553 MHz and 13.567-13.710 MHz	334	30
13.110-13.410 MHz and 13.710-14.010 MHz	106	30

Table 7-3. Radiated Limits

Test Procedures Used

ANSI C63.10-2020 – Section 6.4.7

Test Settings

1. RBW = 9kHz
2. VBW ≥ 3 x RBW
3. Detector = peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

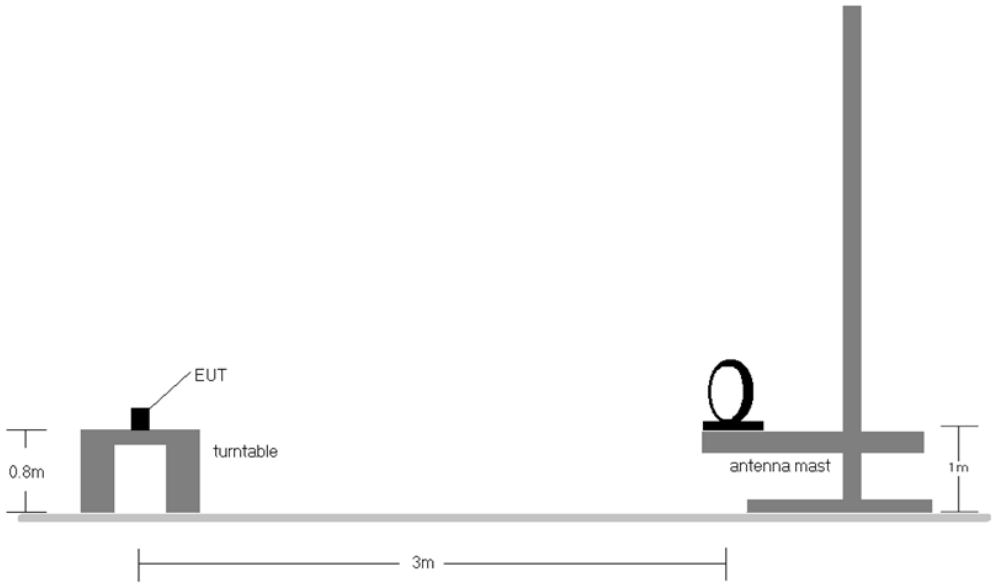


Figure 7-6. Radiated Test Setup

Test Notes:

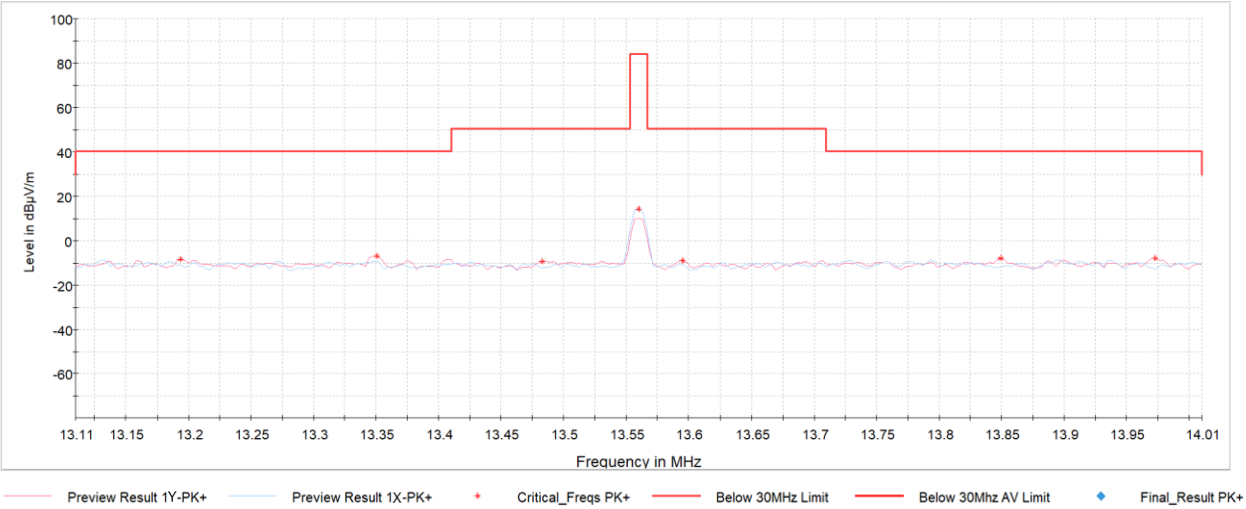
1. All emissions lying in restricted bands specified in §15.225 are below the limit shown in Table 7-3.
2. All measurements were performed using a loop antenna. The antenna was positioned in three orthogonal positions (X front, Y side, Z top) and the position with the highest emission level was recorded.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. Measurements were performed at 3m and the data was extrapolated to the specified measurement distance of 30m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)(2). Extrapolation Factor = 20 $\log_{10}(30/3)^2$ = 40dB.
5. The spectrum was investigated from 13.110MHz – 14.010MHz using the loop antenna. Only the emissions shown in the table below were found to be significant.
6. All measurements were recorded using a spectrum analyzer employing a peak detector.
7. The "-" shown in the following RSE tables are used to denote a noise floor measurement.
8. All possible configurations were investigated and only the worst case is reported.

Sample Calculation

- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$ + Distance Extrapolation Factor $_{[dB]}$
- AFCL $_{[dB/m]}$ = (Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$ + Attenuator $_{[dB]}$) – Preamplifier Gain $_{[dB]}$
- Limit $_{[dB\mu V/m]}$ = 20*Log (Limit $_{[\mu V/m]}$)
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V/m]}$ – Limit $_{[dB\mu V/m]}$

In-Band Radiated Spurious Emission Measurements

§15.225(a)(b)(c)



Plot 7-1. In Band Radiated Spurious Emissions (Charging Rate 2.6C, with AC/DC Adapter)

Frequency [MHz]	Detector	Ant. Pol. [X/Y/Z]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength @3m [dBµV/m]	Field Strength @30m [dBµV/m]	Limit @30m [dBµV/m]	Margin [dB]
13.194	Max Peak	Y	100	204	-95.55	20.24	31.69	-8.31	40.51	-48.82
13.350	Max Peak	Y	100	295	-94.04	20.26	33.22	-6.78	40.51	-47.29
13.483	Max Peak	Y	100	71	-96.59	20.28	30.69	-9.31	50.47	-59.78
13.560	Max Peak	X	100	234	-73.14	20.29	54.15	14.15	84.00	-69.85
13.595	Max Peak	Y	100	187	-96.34	20.30	30.96	-9.04	50.47	-59.51
13.849	Max Peak	Y	100	244	-95.35	20.34	31.99	-8.01	40.51	-48.52
13.973	Max Peak	Y	100	305	-95.43	20.36	31.93	-8.07	40.51	-48.58

Table 7-4. In-Band Radiated Measurements (Charging Rate 2.6C, with AC/DC Adapter)

7.5 Radiated Spurious Emission Measurements, Out-of-Band

§15.209 §15.225(d)

Test Overview and Limit

The EUT was tested from 9kHz up to the 1GHz excluding the band 13.110 – 14.010 MHz. All measurements up to 960MHz were recorded with a spectrum analyzer employing a peak detector.

All out-of-band emissions appearing in a restricted band as specified in Section 15.225 of the Title 47 CFR must not exceed the limits shown in Table 7-5 per Section 15.209.

Frequency	Field Strength [µV/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-5. Radiated Limits – Out of band

Test Procedures Used

ANSI C63.10-2020 – Section 6.5.4

Test Settings

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 9kHz for emissions below 30MHz and 100kHz for emissions between 30MHz and 1GHz
3. VBW ≥ 3 x RBW
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

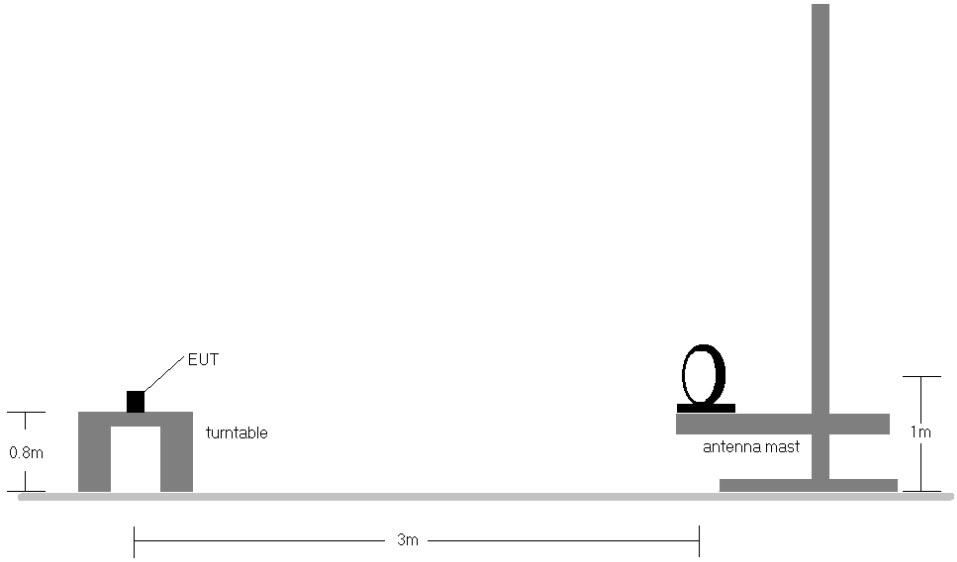


Figure 7-7. Radiated Test Setup < 30MHz

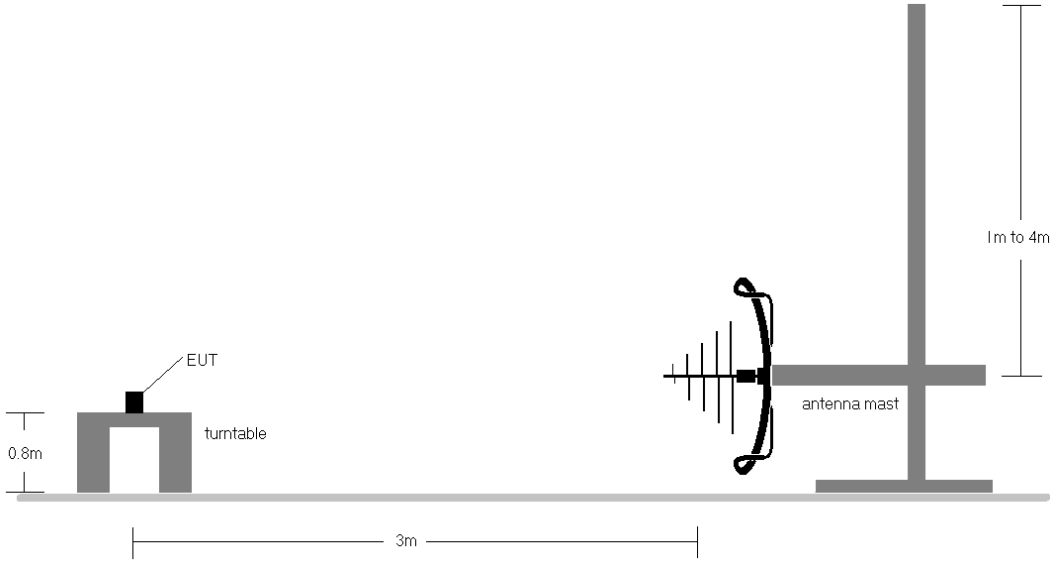


Figure 7-8. Radiated Test Setup > 30MHz

Test Notes:

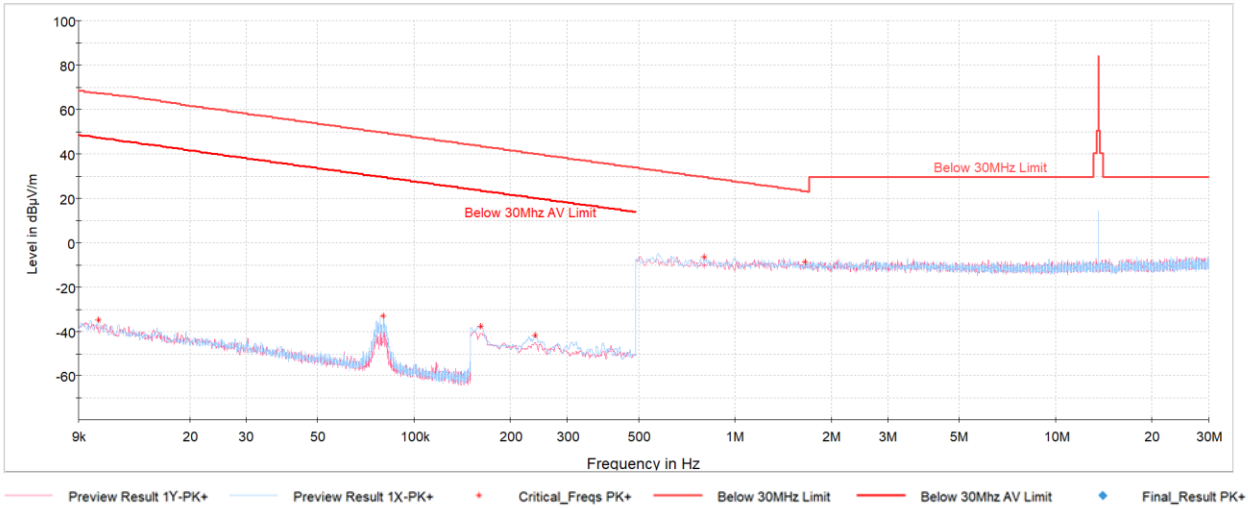
1. Radiated measurements below 30MHz were measured using a loop antenna. The antenna was positioned in three orthogonal planes (X front, Y side, Z top) and the position with the highest emission level is reported.
2. For measurements made below 1GHz, the results recorded using the broadband antenna are known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antennas was found to be less than 2:1.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. Both configurations below were investigated, and the worst case has been reported.
    a. Tablet Device powered by AC/DC adapter via USB-C cable with wire charger
    b. Tablet Device powered by host PC via USB-C cable with wire charger
5. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported.
6. No spurious emissions levels were found to be greater than the level of the fundamental.
7. All possible configurations were investigated and only the worst case is reported.
8. The radiated limits for intentional radiators are shown in Table 7-6. At frequencies below 30 MHz, measurements were performed at 3m and the data was extrapolated to the specified measurement distance using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)(2).
    a. Distance Extrapolation Factor $_{dB]}$ = 20 $\log_{10}(300/3)^2$ = 80dB [For emissions within 9kHz-490kHz]
    b. Distance Extrapolation Factor$_{[dB]}$ = 20 $\log_{10}(30/3)^2$ = 40dB [For emissions within 490kHz-30MHz]

Sample Calculation

- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$ + Distance Extrapolation Factor $_{[dB]}$
- Distance Extrapolation Factor $_{[dB]}$ will be added only when applicable.
- AFCL $_{[dB/m]}$ = (Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$ + Attenuator $_{[dB]}$) – Preamplifier Gain $_{[dB]}$
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V/m]}$ – Limit $_{[dB\mu V/m]}$

Out-of-Band Radiated Spurious – Below 30MHz

§15.209 §15.225(d)



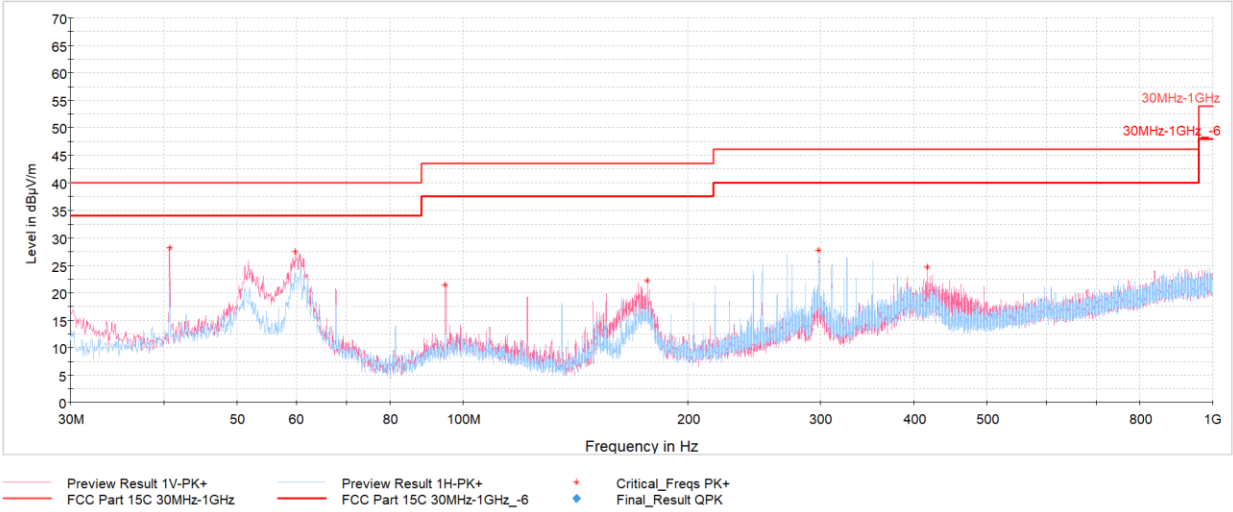
Plot 7-2. Radiated Spurious Plot 9kHz – 30MHz (Charging Rate 2.6C, with AC/DC Adapter)

Frequency [MHz]	Detector	Ant. Pol. [X/Y/Z]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength @3m [dBµV/m]	Field Strength @30m [dBµV/m]	Limit @30m [dBµV/m]	Field Strength @300m [dBµV/m]	Limit @300m [dBµV/m]	Margin [dB]
0.010	Max Peak	X	100	44	-82.37	20.29	44.92	-	-	-35.08	67.37	-102.45
0.080	Max Peak	X	100	262	-79.72	19.67	46.95	-	-	-33.05	49.54	-82.59
0.161	Max Peak	X	100	238	-84.20	19.44	42.24	-	-	-37.76	43.45	-81.21
0.238	Max Peak	X	100	268	-88.10	19.38	38.28	-	-	-41.72	40.07	-81.79
0.800	Max Peak	X	100	313	-92.91	19.48	33.57	-6.43	29.54	-	-	-35.97
1.659	Max Peak	Y	100	210	-95.50	19.80	31.30	-8.70	23.21	-	-	-31.91

Table 7-6. Radiated Measurements (Charging Rate 2.6C, with AC/DC Adapter)

Out-of-Band Radiated Spurious Emissions – 30MHz-1GHz

§15.209 §15.225(d)



Plot 7-3. Radiated Spurious Emissions 30MHz – 1GHz (Charging Rate 2.6C, with Laptop)

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
40.67	Max Peak	V	100	290	-64.90	-13.87	28.23	40.00	-11.77
59.92	Max Peak	V	200	319	-64.30	-15.19	27.51	40.00	-12.49
94.89	Max Peak	V	100	111	-68.17	-17.34	21.49	43.52	-22.03
176.28	Max Peak	V	100	325	-65.84	-18.94	22.22	43.52	-21.30
298.30	Max Peak	H	100	0	-64.70	-14.58	27.72	46.02	-18.30
416.25	Max Peak	V	100	238	-71.06	-11.27	24.67	46.02	-21.35

Table 7-7. Radiated Measurements (Charging Rate 2.6C, with Laptop)

7.6 AC Line Conducted Emissions Measurement

§15.207

Test Overview and Limit

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for AC Line conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

All conducted emissions must not exceed the limits shown in the table below, per Section 15.207.

Frequency of emission (MHz)	Conducted Limit (dBμV)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

Table 7-8. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2020, Section 6.2

Test Settings

Quasi-Peak Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Average Measurements

1. Analyzer center frequency was set to the frequency of the spurious emission of interest
2. RBW = 9kHz (for emissions from 150kHz – 30MHz)
3. Detector = RMS
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

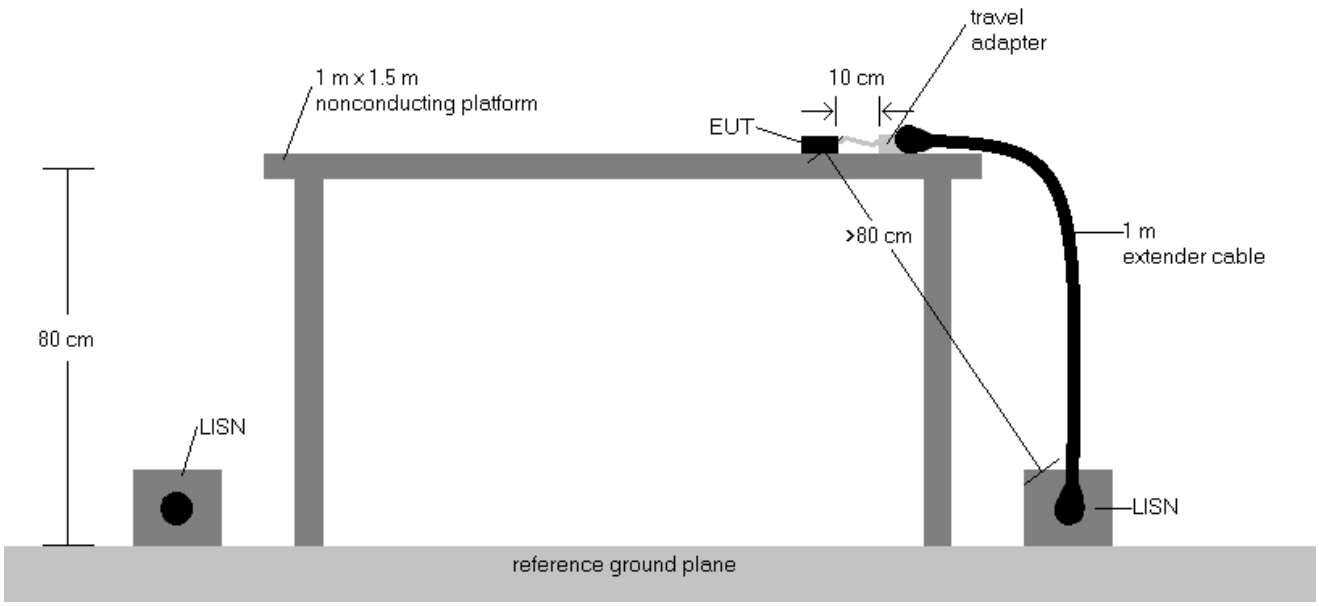
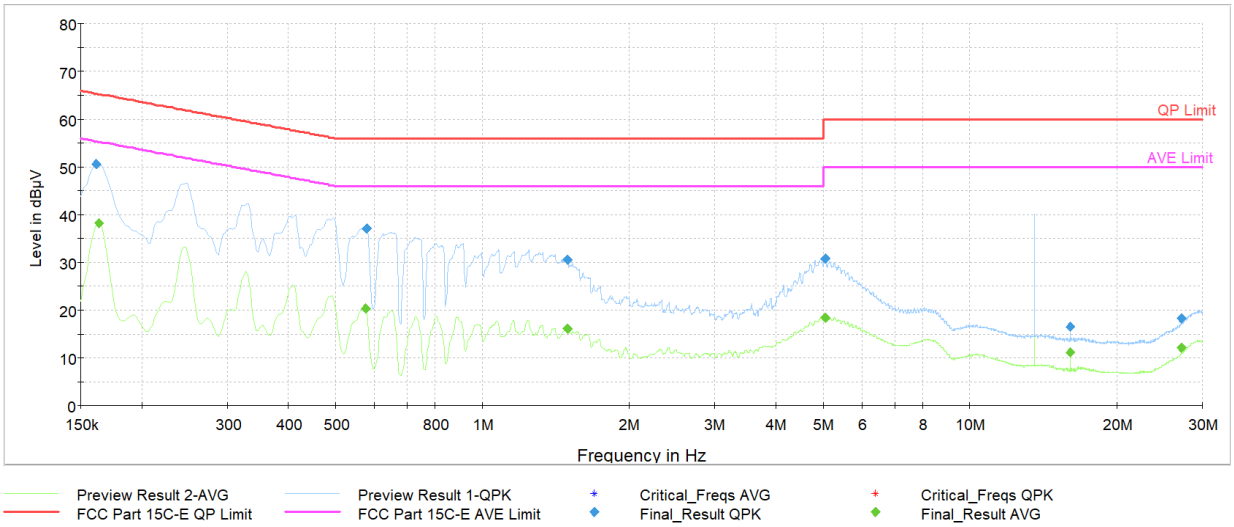


Figure 7-9. Test Instrument & Measurement Setup

Test Notes

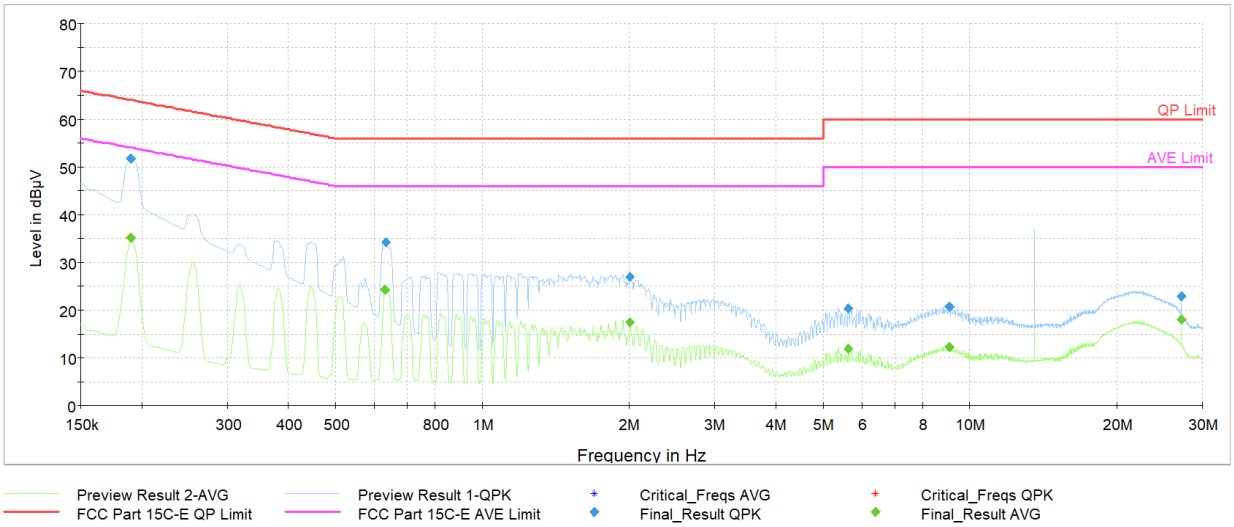
1. All modes of operation were investigated and the worst-case emissions are reported.
2. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207.
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dBμV) = QP/AV Analyzer/Receiver Level (dBμV) + Corr. (dB)
5. Margin (dB) = QP/AV Level (dBμV) - QP/AV Limit (dBμV)
6. Traces shown in plot are made using a Quasi-peak and Average detectors.
7. Deviations to the Specifications: None.
8. Both configurations below were investigated, and the worst case has been reported.
    a. Tablet Device powered by AC/DC adapter via USB-C cable with wire charger
    b. Tablet Device powered by host PC via USB-C cable with wire charger



Plot 7-4. AC Line-Conducted Plot (L1, Charging Rate 2.6C, with AC/DC Adapter)

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.161	FINAL	50.6	—	65.40	-14.82	L1	GND
0.164	FINAL	—	38.20	55.28	-17.08	L1	GND
0.575	FINAL	—	20.40	46.00	-25.60	L1	GND
0.580	FINAL	37.1	—	56.00	-18.90	L1	GND
1.496	FINAL	—	16.23	46.00	-29.77	L1	GND
1.496	FINAL	30.7	—	56.00	-25.35	L1	GND
5.048	FINAL	30.8	—	60.00	-29.18	L1	GND
5.048	FINAL	—	18.56	50.00	-31.44	L1	GND
16.062	FINAL	16.6	—	60.00	-43.44	L1	GND
16.062	FINAL	—	11.18	50.00	-38.82	L1	GND
27.121	FINAL	—	12.17	50.00	-37.83	L1	GND
27.121	FINAL	18.3	—	60.00	-41.71	L1	GND

Table 7-9. AC Line-Conducted Data (L1, Charging Rate 2.6C, with AC/DC Adapter)



Plot 7-5. AC Line-Conducted Plot (N, Charging Rate 2.6C, with Laptop)

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.191	FINAL	—	35.10	54.02	-18.91	N	GND
0.191	FINAL	51.7	—	64.02	-12.36	N	GND
0.632	FINAL	—	24.19	46.00	-21.81	N	GND
0.634	FINAL	34.2	—	56.00	-21.85	N	GND
2.002	FINAL	27.0	—	56.00	-28.99	N	GND
2.006	FINAL	—	17.44	46.00	-28.56	N	GND
5.631	FINAL	20.4	—	60.00	-39.58	N	GND
5.633	FINAL	—	12.01	50.00	-37.99	N	GND
9.062	FINAL	20.7	—	60.00	-39.32	N	GND
9.067	FINAL	—	12.23	50.00	-37.77	N	GND
27.121	FINAL	—	18.14	50.00	-31.86	N	GND
27.121	FINAL	22.9	—	60.00	-37.10	N	GND

Table 7-10. AC Line-Conducted Data (N, Charging Rate 2.6C, with Laptop)

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Tablet Device FCC ID: BCGA2902** has been tested to show compliance with Part 15 Subpart C (15.225) of the FCC Rules.