

MEASUREMENT REPORT

FCC PART 15.225 / ISSED RSS-210 NFC

Applicant Name:

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

Date of Testing:

06/08/2021-08/12/2021

Test Site/Location:

PCTEST Lab. Morgan Hill, CA, USA

Test Report Serial No.:

1C2106070046-12.BCG

FCC ID:

BCG-A2478

IC:

579C-A2478

APPLICANT:

Apple Inc.

Application Type:

Certification

Model/HVIN:

A2478

EUT Type:

Watch

Frequency:

13.56MHz

FCC Classification:

Low Power Communications Device Transmitter (DXX)

FCC Rule Part(s):

Part 15 Subpart C (15.225)

ISED Specification:

RSS-210 Issue 10

Test Procedure(s):

ANSI C63.10-2013

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 C63.10-2013. Test results reported herein relate only to the item(s) tested.

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.


Randy Ortanez
President

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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 PCTEST Test Location

These measurement tests were conducted at the PCTEST 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 PCTEST located in Morgan Hill, CA 95037, U.S.A.

- PCTEST 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.
- PCTEST 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 ISSED Standards (RSS).
- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISSED.

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Watch FCC ID: BCG-A2478** and **IC: 579C-A2478**. The test data contained in this report pertains only to the emissions due to the NFC transmitter of the EUT.

Test Device Serial No.: V4LNF32TG4, WNXWNVYCNX, H3695YHQYW

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n WLAN, 802.11a/n UNII, Bluetooth (1x, EDR, HDR4, HDR8, LE1M, LE2M), NFC, UWB, 60.5GHz Transmitter.

Note: The device supports different modes, types, and data rates of NFC signal.

Mode	Type	Data Rate
CE (Card Emulation)	A	848 kbps
	A	424 kbps
	A	212 kbps
	A	106 kbps
	B	848 kbps
	B	424 kbps
	B	212 kbps
	B	106 kbps
	F	424 kbps
	F	212 kbps
Reader	A	848 kbps
	A	424 kbps
	A	212 kbps
	A	106 kbps
	B	848 kbps
	B	424 kbps
	B	212 kbps
	B	106 kbps
	F	424 kbps
	F	212 kbps
	100% ASK 1 out of 4	26.48 kbps
	10 % ASK 1 out of 4	26.48 kbps
	100% ASK 1 out of 256	1.66 kbps
	10 % ASK 1 out of 256	1.66 kbps
	LPCD	0 kbps

Table 2-1. NFC Configuration

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2.3 Test Support Equipment

1	Apple Macbook	Model:	A1398	S/N:	C2QKP008F6F3
	w/AC/DC Adapter	Model:	A1435	S/N:	N/A
2	Apple USB-C cable	Model:	N/A	S/N:	N/A
	w/ Charging Dock	Model:	A2687	S/N:	FV411420544MW6M4H
	w/Dock	Model:	X241	S/N:	N/A
3	Apple Magnetic Charger	Model:	A2515	S/N:	DLC035200UJMF0AJ
	Apple Magnetic Charger	Model:	A2515	S/N:	DLC035202KRMF0A2
4	Pathfinder Falcon	Model:	920-098626-01	S/N:	DLC034200APQ6PM1E
	SiP Socket	Model:	P2 X2011B PF 150	S/N:	DLC0485009D9KPG24
5	Store Bracelet Assy1	Model:	N/A	S/N:	DLC1197001R19G21N

Table 2-2. Test Support Equipment List

2.4 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups.

The worst case configuration was investigated for all combinations of the three materials, aluminum, stainless steel, and titanium and various types of wristbands, metal and non-metal wristbands. The EUT was also investigated with and without wireless charger. The worst case configuration found was used for all testing.

All TX configurations including modes, types and data rates has been investigated and worst case is reported.

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 emission and radiated emission below 1GHz, following configuration were investigated and worst case was reported.

- EUT powered by AC/DC adaptor via USB-C cable with magnetic charger
- EUT powered by host PC via USB-C cable with magnetic charger

2.5 Software and Firmware

The test was conducted with firmware version watchOS 8.0 installed on the EUT.

2.6 EMI Suppression Device(s)/Modifications

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

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3.0 DESCRIPTION OF TEST

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) were 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 65-5. 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 an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI/RFI filters are EPCOS 2X60A Power Line Filter (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.

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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. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

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 above 1GHz, linearly polarized double ridge horn antennas were used. 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 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

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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 is **permanently attached**.
- This unit was tested with its standard battery.

Conclusion:

The EUT complies with the requirement of §15.203.

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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 ($\pm$ dB)
Line Conducted Disturbance	2.75
Radiated Disturbance (<30MHz)	4.06
Radiated Disturbance (30MHz - 1GHz)	4.30

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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
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	3/31/2021	Annual	3/31/2022	MY49430244
ESPEC	SU-241	Tabletop Temperature Chamber	9/28/2020	Annual	9/28/2021	92009574
ETS-Lindgren	3142E	BiConiLog Antenna (30MHz - 6GHz)	9/15/2020	Annual	9/15/2021	208204
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	12/3/2020	Annual	12/3/2021	102327
Rohde & Schwarz	ESW44	EMI Test Receiver	11/9/2020	Annual	11/9/2021	101570
Rohde & Schwarz	HFH2-Z2	Loop Antenna	4/5/2021	Annual	4/5/2022	100519
Rohde & Schwarz	ENV216	Two-Line-V-Network (LISN)	12/7/2020	Annual	12/7/2021	101364

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.

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7.0 TEST DATA

7.1 Summary

Company Name: Apple Inc.
FCC ID: BCG-A2478
IC: 579C-A2478
FCC Classification: Low Power Communications Device Transmitter (DXX)
Frequencies Examined: 13.56MHz

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1049	RSS-Gen [6.7]	Bandwidth Measurement	N/A	RADIATED	N/A	Section 7.2
15.225 (e)	RSS-210 [B.6]	Frequency Stability Tolerance	$\pm 0.01\%$ of Operating Frequency	Temperature Chamber	PASS	Section 7.3
15.225 (a)(b)(c)	RSS-210 [B.6]	In-Band Emissions	15,848 μ V/m @ 30m 13.553 – 13.567 MHz 334 μ V/m @ 30m 13.410 – 13.553 MHz 13.567 – 13.710 MHz 106 μ V/m @ 30m 13.110 – 13.410 MHz 13.710 – 14.010 MHz	RADIATED	PASS	Section 7.4
15.225 (d) 15.209	RSS-Gen [8.9]	Out-of-Band Emissions	Emissions outside of the specified band (13.110 – 14.010 MHz) must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9])		PASS	Section 7.5
15.207	RSS-Gen [8.8]	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits (RSS-Gen)	AC LINE CONDUCTED	PASS	Section 7.6

Table 7-1. Summary of Test Results

Note:

1. This unit was tested with its standard battery.
2. All modes of operation 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.

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7.2 Bandwidth Measurement

§2.1049; RSS-Gen (6.7)

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 Procedure Used

ANSI C63.10-2013 – Section 6.9.2

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 $\geq 3 \times$ 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. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

Test Setup

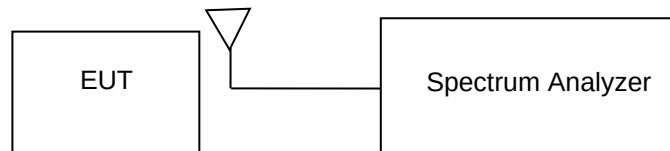


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None

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Frequency	Configuration	20dB Bandwidth [kHz]	99% OBW [kHz]
13.56MHz	CE A 848kbps	48.51	133.16
13.56MHz	CE B 848kbps	50.36	140.25
13.56MHz	CE F 424kbps	50.02	143.99
13.56MHz	Reader 10% Ask 1 out of 4	132.40	391.10
13.56MHz	Reader 10% Ask 1 out of 256	132.30	391.93

Table 7-2. 20dB and 99% Bandwidth Measurement



Plot 7-1. 20dB and 99% Bandwidth Plot (CE A 848kbps)

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Plot 7-2. 20dB and 99% Bandwidth Plot (CE B 848kbps)



Plot 7-3. 20dB and 99% Bandwidth Plot (CE F 424kbps)

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Plot 7-4. 20dB and 99% Bandwidth Plot (Reader 10% ASK 1 out of 4)



Plot 7-5. 20dB and 99% Bandwidth Plot (Reader 10% ASK 1 out of 256)

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7.3 Frequency Stability Test Data

§15.225; RSS-210 (B.6)

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.10-2013. 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 $\pm 0.01\%$ of the center frequency.

Test Procedure Used

ANSI C63.10-2013 – 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. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

Test Setup

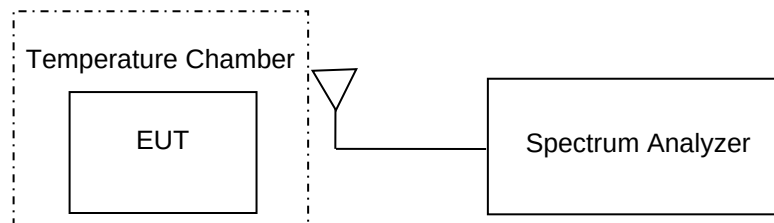


Figure 7-2. Test Instrument & Measurement Setup

Test Notes

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

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Frequency Stability Test Data

§15.225; RSS-210 (B.6)

OPERATING FREQUENCY: 13,560,000 Hz
REFERENCE VOLTAGE: 3.80 VDC
DEVIATION LIMIT: $\pm 0.01\% = 1356\text{Hz}$

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 20	13,559,873	-127	-0.0009347
100 %		- 10	13,560,131	131	0.0009635
100 %		0	13,560,269	269	0.0019853
100 %		+ 10	13,559,754	-246	-0.0018142
100 %		+ 20	13,560,098	98	0.0007242
100 %		+ 30	13,560,230	230	0.0016969
100 %		+ 40	13,560,371	371	0.0027349
100 %		+ 50	13,560,134	134	0.0009912
85 %	3.23	+ 20	13,560,431	431	0.0031781
115 %	4.37	+ 20	13,560,425	425	0.0031350

Table 7-3. Frequency Stability Test Data (CE A 848kbps)

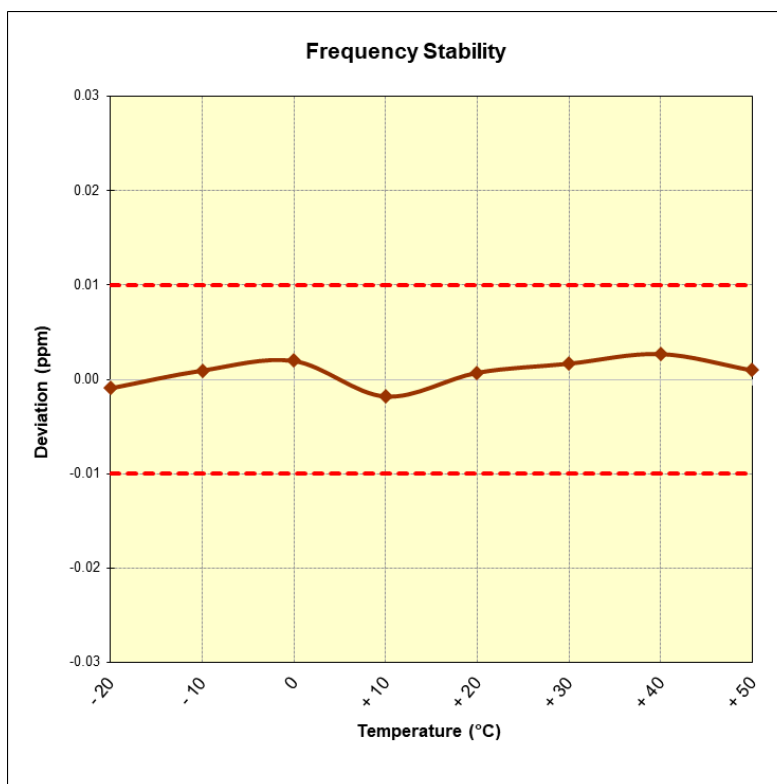


Figure 7-3. Frequency Stability Plot (CE A 848kbps)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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OPERATING FREQUENCY: 13,560,000 Hz
REFERENCE VOLTAGE: 3.80 VDC
DEVIATION LIMIT: $\pm 0.01\% = 1356\text{Hz}$

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 20	13,560,364	364	0.0026871
100 %		- 10	13,560,235	235	0.0017296
100 %		0	13,559,630	-370	-0.0027294
100 %		+ 10	13,560,301	301	0.0022204
100 %		+ 20	13,560,358	358	0.0026423
100 %		+ 30	13,560,333	333	0.0024540
100 %		+ 40	13,559,628	-372	-0.0027410
100 %		+ 50	13,560,450	450	0.0033182
85 %	3.23	+ 20	13,560,439	439	0.0032341
115 %	4.37	+ 20	13,559,431	-569	-0.0041962

Table 7-4. Frequency Stability Test Data (Reader 10% ASK 1 out of 256)

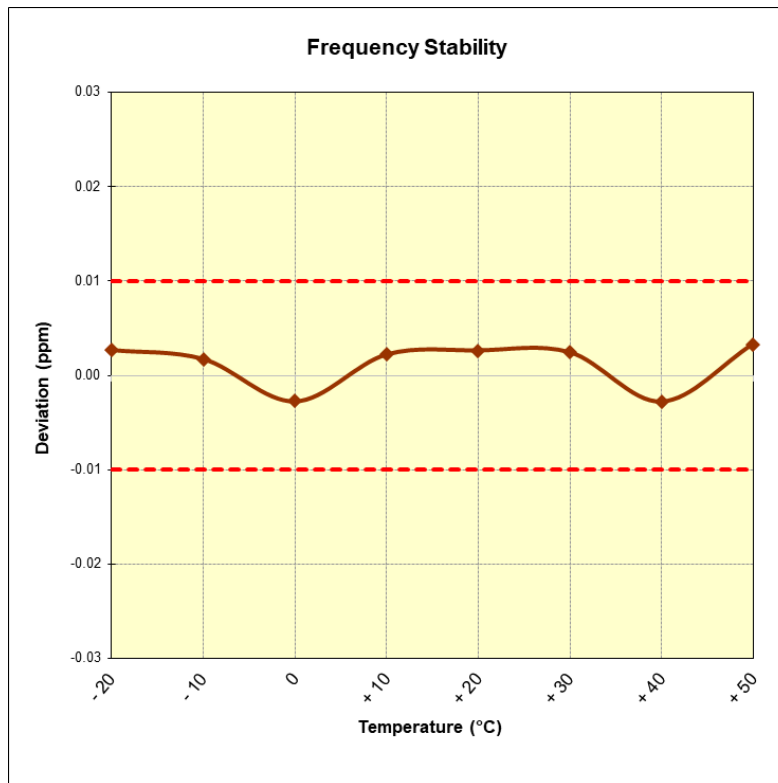


Figure 7-4. Frequency Stability Plot (Reader 10% ASK 1 out of 256)

FCC ID: BCG-A2478 IC: 579C-A2478		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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7.4 In-Band Radiated Spurious Emissions

§15.225(a)(b)(c); RSS-210 (B.6)

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 7-5.

Frequency [MHz]	Field Strength [$\mu\text{V/m}$]	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 7-5. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Section 6.4.7

Test Settings

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

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST [®] Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-12.BCG	Test Dates: 06/08/2021-08/12/2021	EUT Type: Watch	Page 19 of 36

Test Setup

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

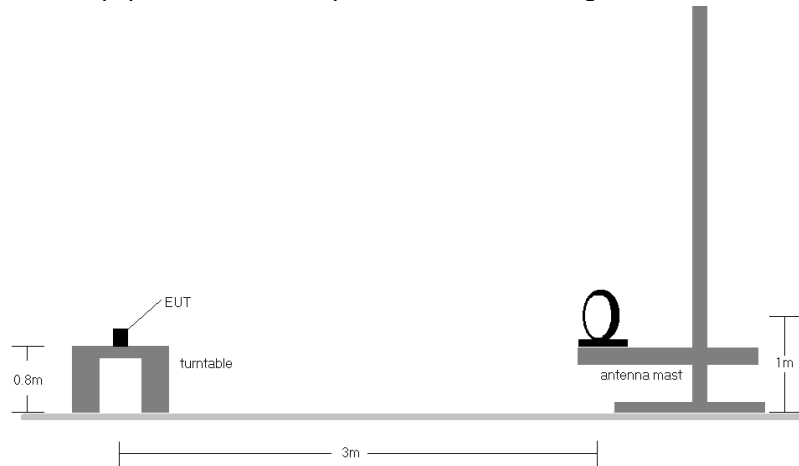


Figure 7-5. Radiated Test Setup

Test Notes:

1. All emissions lying in restricted bands specified in §15.225 and RSS-210 are below the limit shown in Table 7-5.
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. All emissions were greater than 20 dB below the limit.
4. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
5. 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). Distance Extrapolation Factor = $20 \log_{10}(30/3)^2 = 40\text{dB}$.
6. The spectrum was investigated from 9kHz up to 30MHz using the loop antenna. Only the emissions shown in the table below were found to be significant.
7. All measurements were recorded using a spectrum analyzer employing a peak detector unless otherwise noted as quasi-peak for emissions below 960MHz.
8. All possible configurations were investigated and only the worst case is reported.

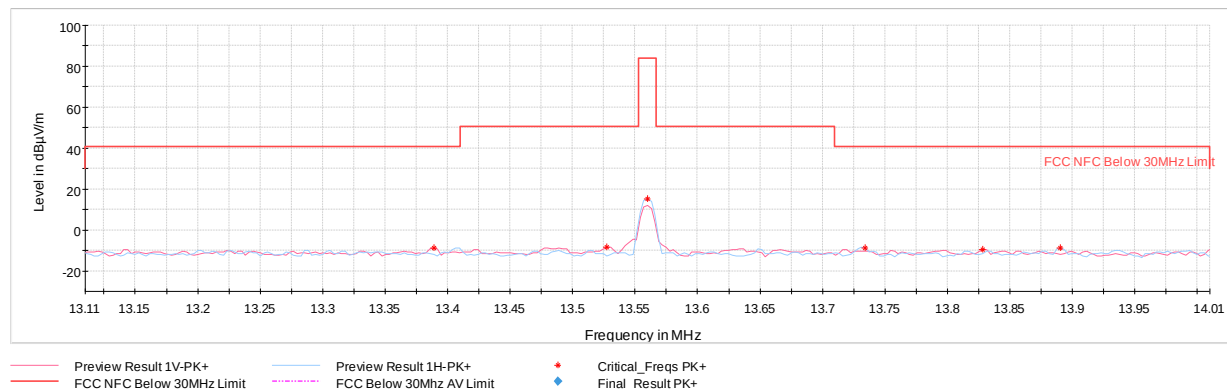
Sample Calculation

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

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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In-Band Radiated Spurious Emission Measurements

§15.225(a)(b)(c); RSS-210 (B.6)

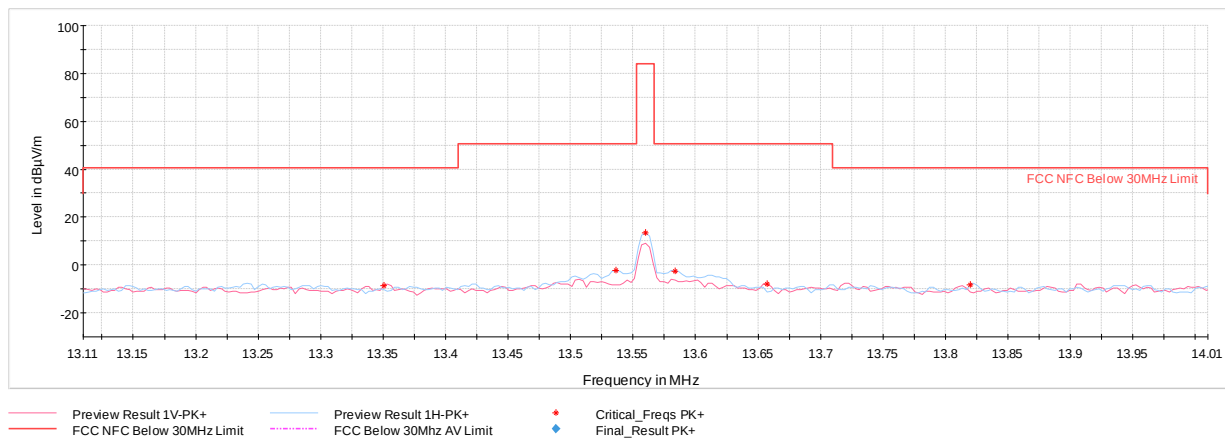


Plot 7-6. In Band Radiated Spurious Emissions (CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

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]
13.389	Max Peak	X	100	48	-96.37	20.60	31.23	-8.77	40.51	-49.28
13.528	Max Peak	X	100	50	-96.15	20.60	31.45	-8.55	50.47	-59.03
13.560	Max Peak	X	100	302	-72.39	20.60	55.21	15.21	84.00	-68.79
13.734	Max Peak	X	100	184	-96.51	20.60	31.09	-8.91	40.51	-49.42
13.829	Max Peak	X	100	40	-97.10	20.60	30.50	-9.50	40.51	-50.01
13.890	Max Peak	X	100	95	-96.30	20.60	31.30	-8.70	40.51	-49.20

Table 7-6. In-Band Radiated Measurements (CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Plot 7-7. In Band Radiated Spurious Emissions (Reader 10% ASK 1 out of 256, AC/DC Adapter and Magnetic Charger)

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]
13.350	Max Peak	X	100	43	-96.24	20.60	31.36	-8.64	40.51	-49.15
13.536	Max Peak	X	100	279	-89.84	20.60	37.76	-2.24	50.47	-52.72
13.560	Max Peak	X	100	95	-74.22	20.60	53.38	13.38	84.00	-70.62
13.584	Max Peak	X	100	279	-90.08	20.60	37.52	-2.48	50.47	-52.95
13.657	Max Peak	X	100	352	-95.54	20.60	32.06	-7.94	50.47	-58.42
13.820	Max Peak	X	100	92	-95.72	20.60	31.88	-8.12	40.51	-48.63

7-7. In-Band Radiated Measurements (Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2106070046-12.BCG	Test Dates: 06/08/2021-08/12/2021	EUT Type: Watch	Page 22 of 36

7.5 Out-of-Band Radiated Spurious Emissions

§15.209 §15.225(d); RSS-Gen (8.9)

Test Overview and Limit

The EUT was tested from 9kHz up to the 1GHz excluding the band 13.110 – 14.010 MHz. All measurements were recorded using a spectrum analyzer employing a peak detector unless otherwise noted as quasi-peak for emissions below 960MHz.

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 7-8 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 7-8. Radiated Limits – Out of band

Test Procedures Used

ANSI C63.10-2013 – 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

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Test Setup

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

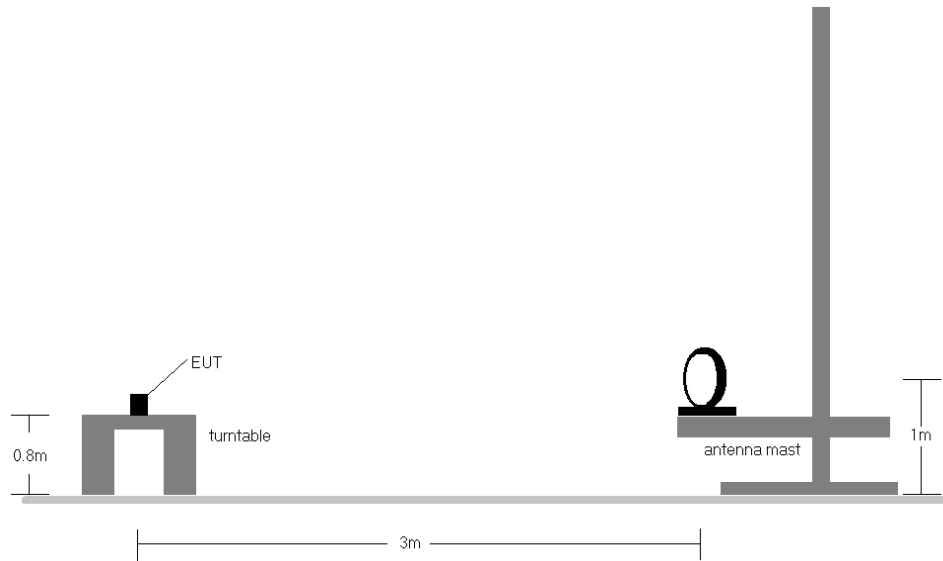


Figure 7-6. Radiated Test Setup < 30MHz

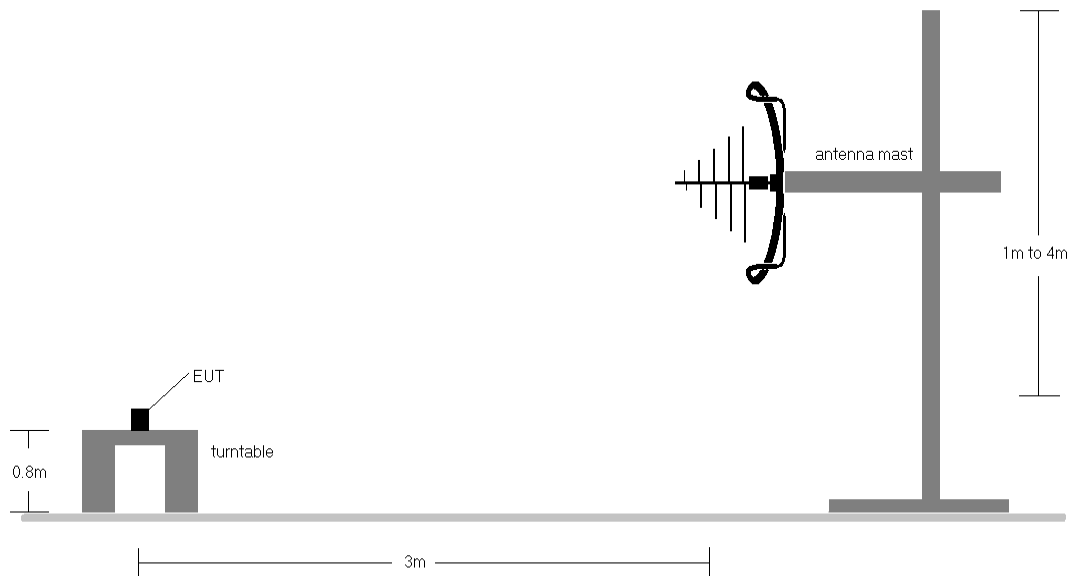


Figure 7-7. Radiated Test Setup > 30MHz

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Test Notes:

1. A loop antenna was used to investigate emissions below 30MHz.
2. 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.
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. EUT powered by AC/DC adaptor via USB-C cable with magnetic charger
 - b. EUT powered by host PC via USB-C cable with magnetic 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 7-8. 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]

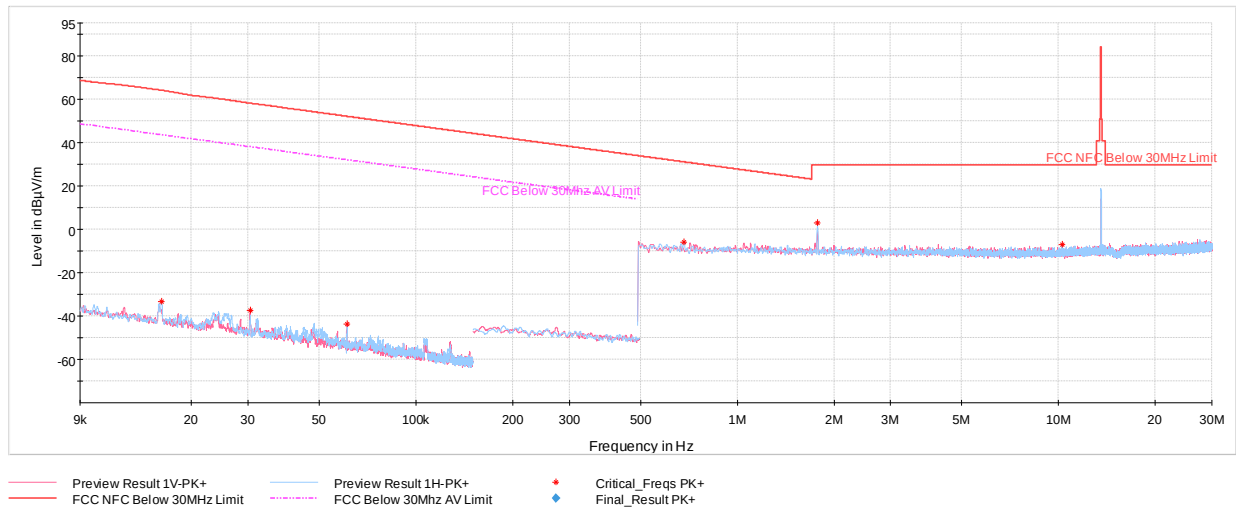
Sample Calculation

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

FCC ID: BCG-A2478 IC: 579C-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
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Out-of-Band Radiated Spurious Emissions – Below 30MHz

§15.209 §15.225(d); RSS-Gen (8.9)

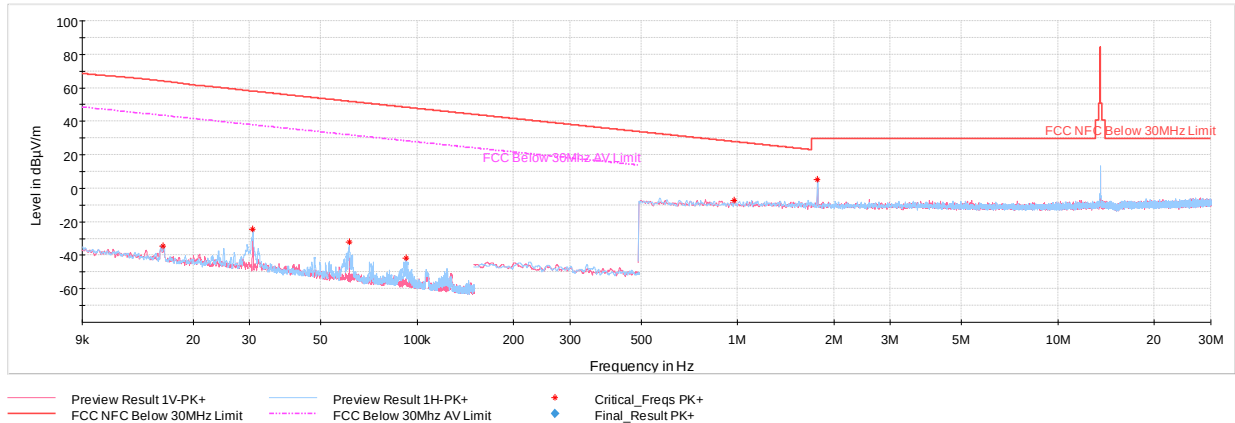


Plot 7-8. Radiated Spurious Emissions 9kHz – 30MHz (CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

Frequency [MHz]	Detector	Ant. Pol. [H/V]	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]
0.016	Max Peak	X	100	143	-80.54	19.99	46.45	-	-	-33.55	63.91	-97.46
0.030	Max Peak	X	100	73	-85.28	20.88	42.60	-	-	-37.40	57.94	-95.34
0.061	Max Peak	X	100	350	-90.75	19.98	36.23	-	-	-43.77	51.91	-95.68
0.682	Max Peak	X	100	10	-92.58	19.63	34.05	-5.95	30.93	-	-	-36.88
1.777	Max Peak	X	100	25	-84.05	19.92	42.87	2.87	29.54	-	-	-26.67
10.284	Max Peak	X	100	71	-94.44	20.44	33.00	-7.00	29.54	-	-	-36.54

Table 7-9. Radiated Measurements (CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Plot 7-9. Radiated Spurious Emissions 9kHz – 30MHz (Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

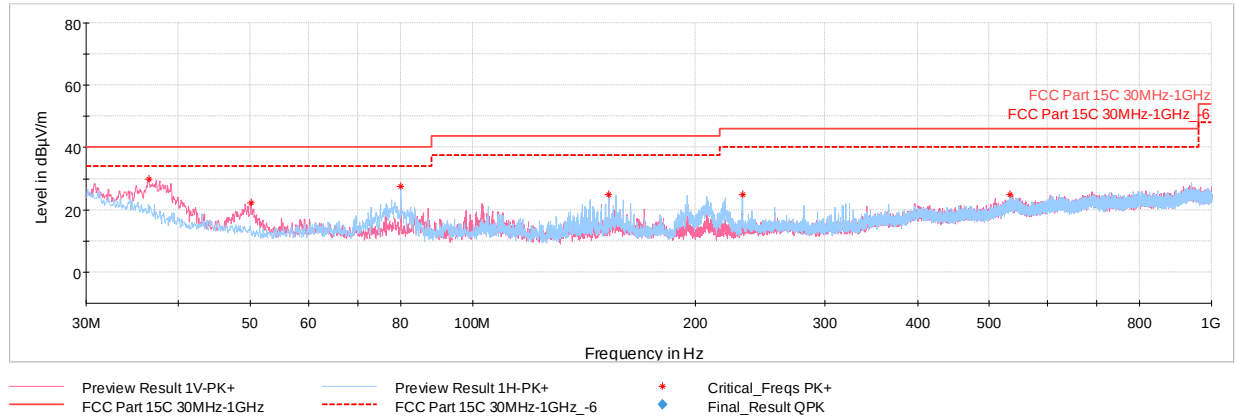
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength @3m [dBμV/m]	Field Strength @30m [dBμV/m]	Limit @30m [dBμV/m]	Field Strength @300m [dBμV/m]	Limit @300m [dBμV/m]	Margin [dB]
0.016	Max Peak	X	100	222	-81.60	20.15	45.55	-	-	-34.45	63.93	-98.38
0.031	Max Peak	X	100	171	-72.37	20.88	55.51	-	-	-24.49	57.90	-82.39
0.061	Max Peak	X	100	144	-79.56	20.21	47.65	-	-	-32.35	51.86	-84.20
0.092	Max Peak	X	100	144	-88.64	19.85	38.21	-	-	-41.79	48.33	-90.11
0.974	Max Peak	X	100	279	-94.27	19.92	32.65	-7.35	27.83	-	-	-35.19
1.777	Max Peak	X	100	25	-81.57	19.80	45.23	5.23	29.54	-	-	-24.32

Table 7-10. Radiated Measurements (Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Out-of-Band Radiated Spurious Emissions – 30MHz-1GHz

§15.209 §15.225(d); RSS-Gen (8.9)

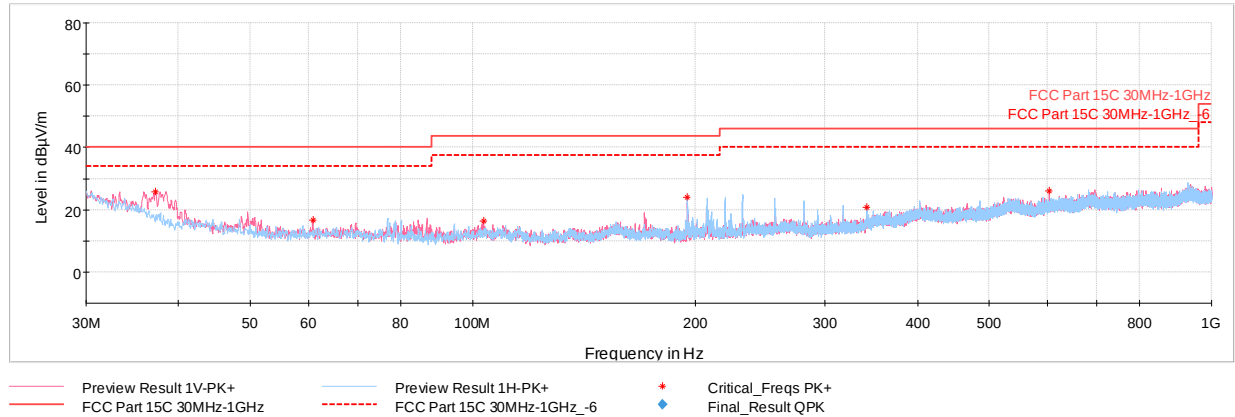


Plot 7-10. Radiated Spurious Emissions 30MHz – 1GHz (CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

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]
36.45	Max Peak	V	100	72	-62.05	-14.99	29.96	40.00	-10.04
50.13	Max Peak	V	100	31	-63.84	-21.01	22.15	40.00	-17.85
80.00	Max Peak	H	250	283	-58.45	-21.12	27.43	40.00	-12.57
152.90	Max Peak	V	100	13	-65.42	-16.55	25.03	43.52	-18.49
231.81	Max Peak	H	100	192	-67.04	-15.22	24.74	46.02	-21.28
533.09	Max Peak	H	100	41	-77.56	-4.65	24.79	46.02	-21.23

Table 7-11. Radiated Measurements (CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Plot 7-11. Radiated Spurious Emissions 30MHz – 1GHz (Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

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]
37.28	Max Peak	V	100	358	-65.50	-15.63	25.87	40.00	-14.13
60.80	Max Peak	V	250	150	-69.32	-21.00	16.68	40.00	-23.32
103.43	Max Peak	V	100	11	-71.96	-18.69	16.35	43.52	-27.17
195.29	Max Peak	H	100	180	-65.92	-16.99	24.09	43.52	-19.43
341.95	Max Peak	H	100	166	-74.73	-11.52	20.75	46.02	-25.27
602.40	Max Peak	V	100	276	-77.13	-3.87	26.00	46.02	-20.02

Table 7-12. Radiated Measurements (Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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7.6 AC Line Conducted Emissions Measurement

§15.207; RSS-Gen (8.8)

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 and RSS-Gen (8.8).

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 7-13. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, 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

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST Proud to be part of  element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Test Setup

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

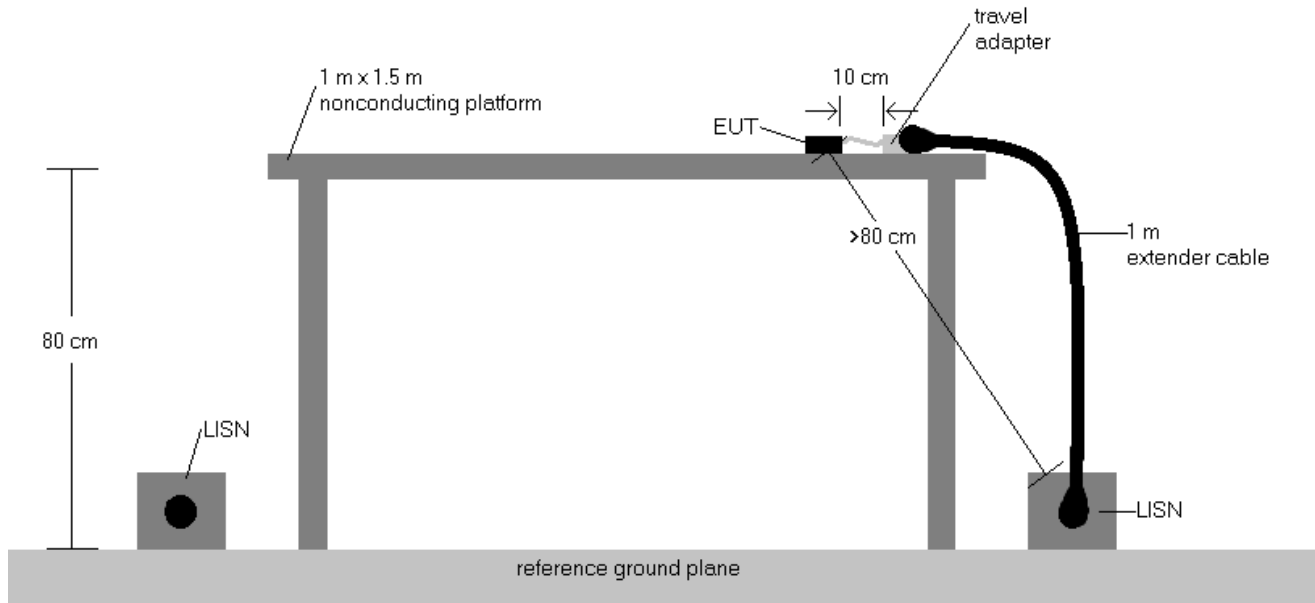
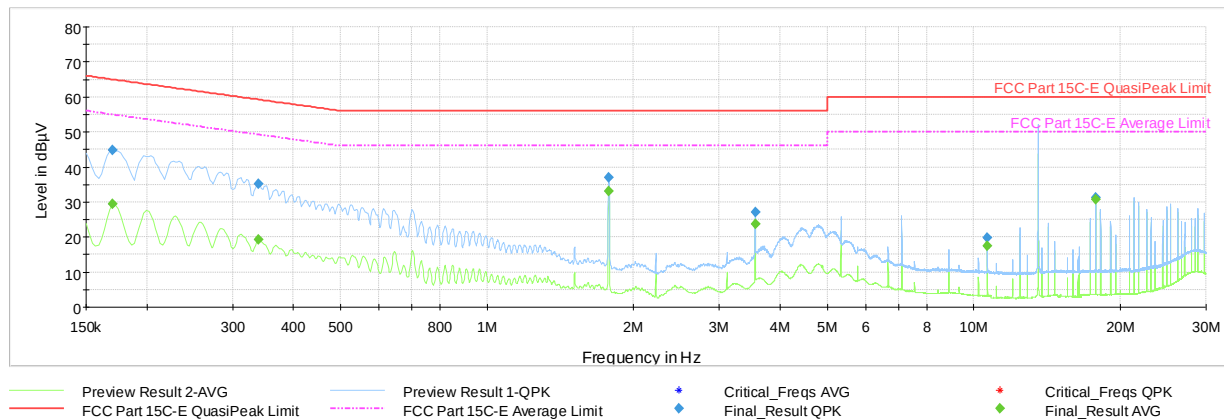


Figure 7-8. Test Instrument & Measurement Setup

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 and RSS-Gen (8.8).
3. $\text{Corr. (dB)} = \text{Cable loss (dB)} + \text{LISN insertion factor (dB)}$
4. $\text{QP/AV Level (dB}\mu\text{V)} = \text{QP/AV Analyzer/Receiver Level (dB}\mu\text{V)} + \text{Corr. (dB)}$
5. $\text{Margin (dB)} = \text{QP/AV Level (dB}\mu\text{V)} - \text{QP/AV Limit (dB}\mu\text{V)}$
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. EUT powered by AC/DC adaptor via USB-C cable with magnetic charger
 - b. EUT powered by host PC via USB-C cable with magnetic charger

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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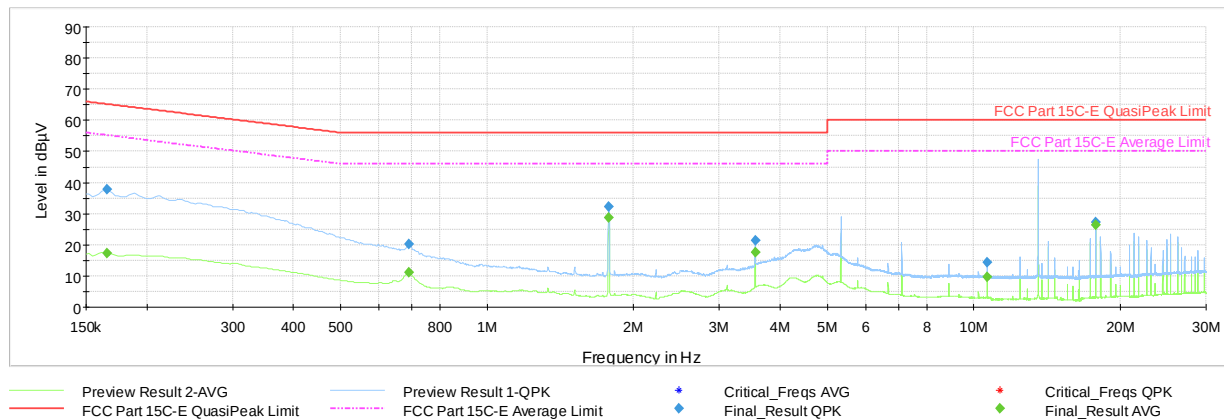


Plot 7-12. AC Line-Conducted Plot (L1, CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.170	FINAL	44.9	—	64.95	-20.10	L1	GND
0.170	FINAL	—	29.37	54.95	-25.58	L1	GND
0.339	FINAL	35.2	—	59.23	-24.01	L1	GND
0.339	FINAL	—	19.16	49.23	-30.07	L1	GND
1.777	FINAL	37.1	—	56.00	-18.90	L1	GND
1.777	FINAL	—	33.12	46.00	-12.88	L1	GND
3.557	FINAL	—	23.74	46.00	-22.26	L1	GND
3.557	FINAL	27.1	—	56.00	-28.86	L1	GND
10.667	FINAL	—	17.39	50.00	-32.61	L1	GND
10.667	FINAL	19.9	—	60.00	-40.07	L1	GND
17.777	FINAL	31.2	—	60.00	-28.80	L1	GND
17.777	FINAL	—	30.62	50.00	-19.38	L1	GND

Table 7-14. AC Line-Conducted Data (L1, CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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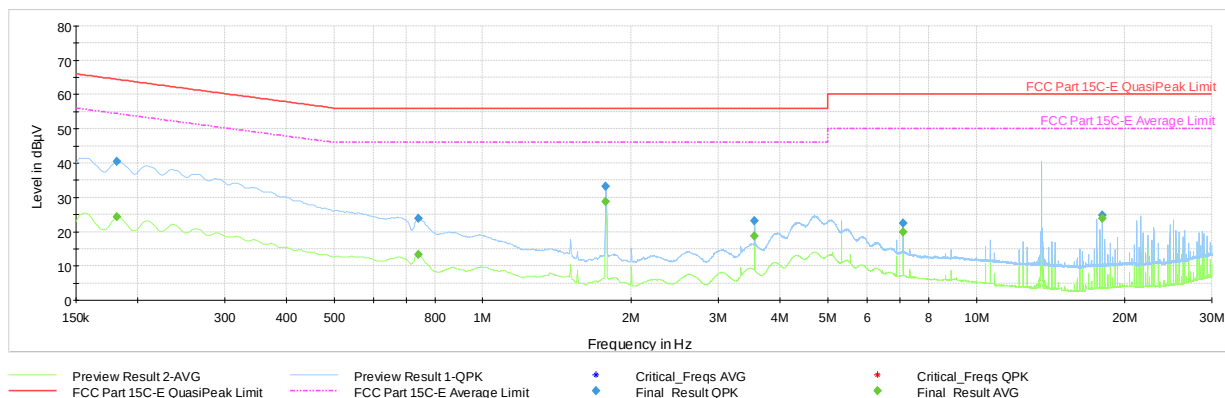


Plot 7-13. AC Line-Conducted Plot (N, CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.166	FINAL	37.7	—	65.17	-27.47	N	GND
0.166	FINAL	—	17.42	55.17	-37.75	N	GND
0.692	FINAL	20.1	—	56.00	-35.89	N	GND
0.692	FINAL	—	11.18	46.00	-34.82	N	GND
1.777	FINAL	32.4	—	56.00	-23.65	N	GND
1.777	FINAL	—	28.65	46.00	-17.35	N	GND
3.557	FINAL	—	17.68	46.00	-28.32	N	GND
3.557	FINAL	21.3	—	56.00	-34.73	N	GND
10.667	FINAL	—	9.57	50.00	-40.43	N	GND
10.667	FINAL	14.3	—	60.00	-45.67	N	GND
17.777	FINAL	27.2	—	60.00	-32.80	N	GND
17.777	FINAL	—	26.47	50.00	-23.53	N	GND

Table 7-15. AC Line-Conducted Data (N, CE A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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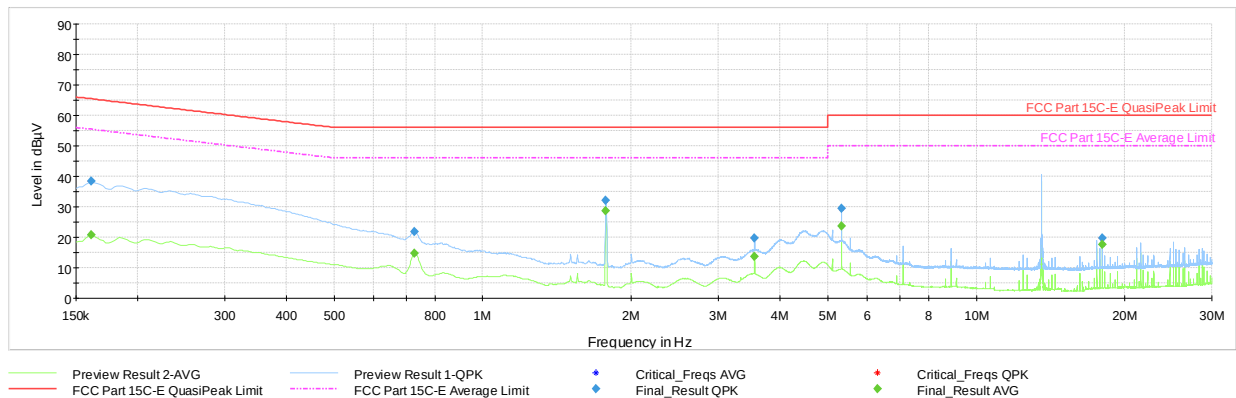


Plot 7-14. AC Line-Conducted Plot (L1, Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.182	FINAL	40.4	—	64.42	-24.01	L1	GND
0.182	FINAL	—	24.39	54.42	-30.03	L1	GND
0.740	FINAL	—	13.38	46.00	-32.62	L1	GND
0.742	FINAL	23.9	—	56.00	-32.06	L1	GND
1.777	FINAL	33.3	—	56.00	-22.75	L1	GND
1.777	FINAL	—	28.72	46.00	-17.28	L1	GND
3.557	FINAL	—	18.81	46.00	-27.19	L1	GND
3.557	FINAL	23.1	—	56.00	-32.88	L1	GND
7.112	FINAL	—	19.84	50.00	-30.16	L1	GND
7.112	FINAL	22.4	—	60.00	-37.62	L1	GND
17.999	FINAL	24.9	—	60.00	-35.15	L1	GND
17.999	FINAL	—	23.94	50.00	-26.06	L1	GND

Table 7-16. AC Line-Conducted Data (L1, Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Plot 7-15. AC Line-Conducted Plot (N, Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.162	FINAL	38.3	—	65.40	27.11	N	GND
0.162	FINAL	—	20.81	55.40	34.56	N	GND
0.726	FINAL	21.8	—	56.00	34.25	N	GND
0.726	FINAL	—	14.59	46.00	31.37	N	GND
1.777	FINAL	32.0	—	56.00	24.03	N	GND
1.777	FINAL	—	28.76	46.00	17.27	N	GND
3.554	FINAL	—	13.73	46.00	32.27	N	GND
3.554	FINAL	19.7	—	56.00	36.35	N	GND
5.336	FINAL	—	23.55	50.00	26.43	N	GND
5.336	FINAL	29.4	—	60.00	30.65	N	GND
17.999	FINAL	19.8	—	60.00	40.19	N	GND
17.999	FINAL	—	17.72	50.00	32.31	N	GND

Table 7-17. AC Line-Conducted Data (N, Reader 10% ASK 1 out of 256, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2478 IC: 579C-A2478	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Watch FCC ID: BCG-A2478** and **IC: 579C-A2478** has been tested to show compliance with Part 15 Subpart C (15.225) of the FCC Rules and RSS-210 of the Innovation, Science and Economic Development Canada Rules.

FCC ID: BCG-A2478 IC: 579C-A2478	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2106070046-12.BCG	Test Dates: 06/08/2021-08/12/2021	EUT Type: Watch	Page 36 of 36