

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:

05/01/2020-08/07/2020

Test Site/Location:

PCTEST Lab. Morgan Hill, CA, USA

Test Report Serial No.:

1C2004270021-06.BCG

FCC ID:

BCG-A2351

IC:

579C-A2351

APPLICANT:

Apple Inc.

Application Type:

Certification

Model/HVIN:

A2351

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 17025-2005 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-A2351**. The test data contained in this report pertains only to the emissions due to the NFC transmitter of the EUT.

Test Device Serial No.: DVPCR00DQ7TF, DVPCF04MPWFC

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n WLAN, Bluetooth (1x, EDR, HDR4, HDR8, LE), NFC

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

Table 2-1. NFC Configuration

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2.3 Test Support Equipment

1	Apple MacBook	Model:	A1398	S/N:	C02QT94WG8WP
	w/AC/DC Adapter	Model:	A1435	S/N:	N/A
2	Apple USB Cable	Model:	Kanzi	S/N:	325316
	w/ Charging Dock	Model:	FAPS73	S/N:	17481001022
	w/ Dock	Model:	X241	S/N:	GW17F01ST22
3	USB Lightning Cable	Model:	N/A	S/N:	N/A
	w/ AC Adapter	Model:	A1385	S/N:	N/A
4	Wireless Charging Pad (WCP)	Model:	EVT	S/N:	DLC9223004YLNWL43
5	Test Pathfinder CANMORE Board	Model:	X1456	S/N:	920-06235-01
	w/ Test Socket BANKSY	Model:	EVT X1454	S/N:	920-06373-03
6	DC Power Supply	Model:	KPS3010D	S/N:	N/A

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 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 cable with wireless charger
- EUT powered by host PC via USB cable with wireless charger

2.5 Software and Firmware

The test was conducted with firmware version wOS 7.0. 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 procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) 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.

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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 are **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 C63.10-2013. 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	2.34
Radiated Disturbance (<1GHz)	4.15

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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	3/4/2020	Annual	3/4/2021	MY49430244
COM-POWER	LIN-120A	LISN	3/4/2020	Annual	3/4/2021	241297
ESPEC	SU-241	Tabletop Temperature Chamber	9/3/2019	Annual	9/3/2020	92009574
ETS-Lindgren	3142E-PA	Pre-Amplifier (30MHz - 6GHz)	9/19/2019	Annual	9/19/2020	213236
ETS-Lindgren	3142E	BiConiLog Antenna (30MHz - 6GHz)	1/6/2020	Annual	1/6/2021	224569
Rohde & Schwarz	ESW44	EMI Test Receiver	9/13/2019	Annual	9/13/2020	101570
Rohde & Schwarz	HFH2-Z2	Loop Antenna	3/12/2020	Annual	3/12/2021	100546

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

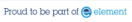
Company Name: Apple Inc.
FCC ID: BCG-A2351
FCC Classification: Low Power Communications Device Transmitter (DXX)
Frequencies Examined: 13.56MHz

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1049	RSS-Gen [6.7]	20 dB Bandwidth	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)	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 20dB 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.

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. $RBW = 1 - 5\% \text{ OBW}$
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

Test Setup

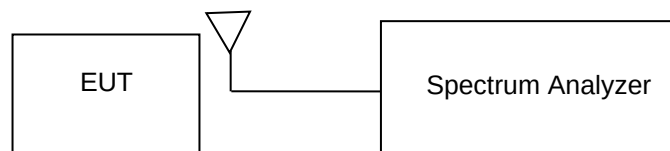


Figure 7-1. Test Instrument & Measurement Setup

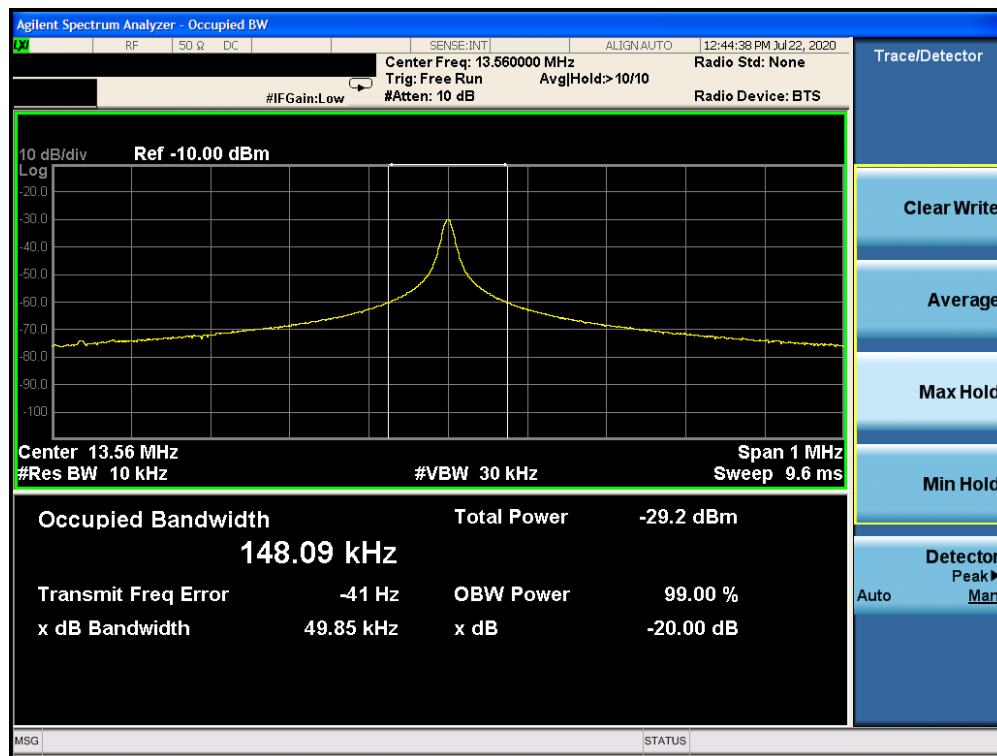
Test Notes

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

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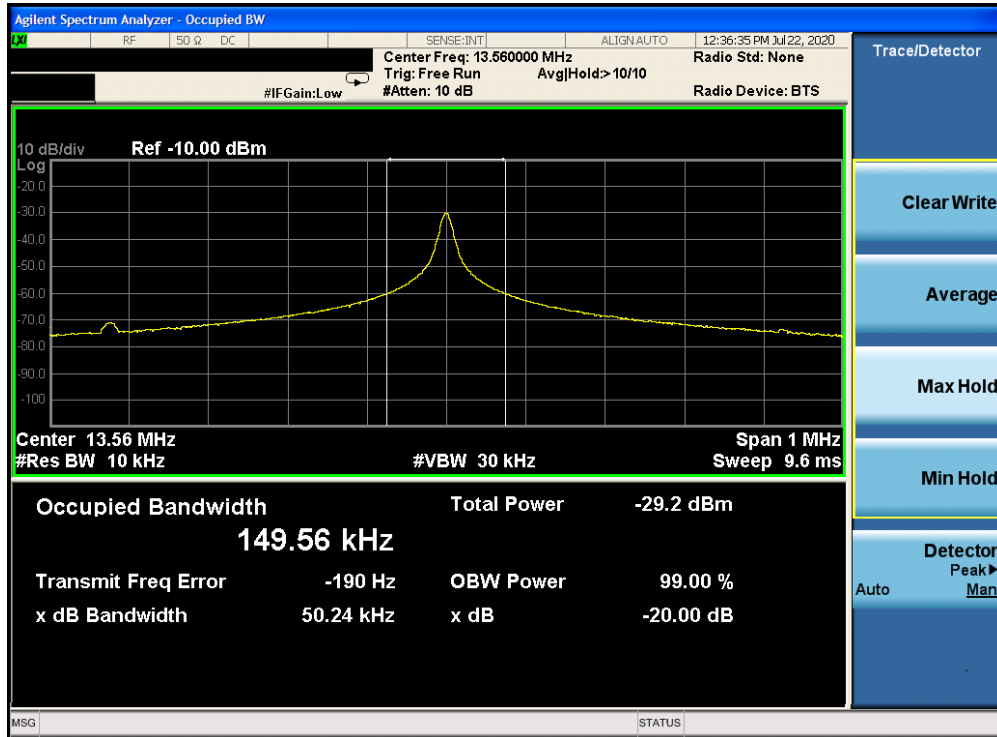
Frequency [MHz]	Configuration	20dB Bandwidth [kHz]
13.56	CE A 848kbps	49.85
13.56	CE B 848kbps	50.24
13.56	CE F 424kbps	50.23
13.56	Reader 10% Ask 1 out of 4	132.60
13.56	Reader 10% Ask 1 out of 256	132.50

Table 7-2. 20dB Bandwidth Measurement

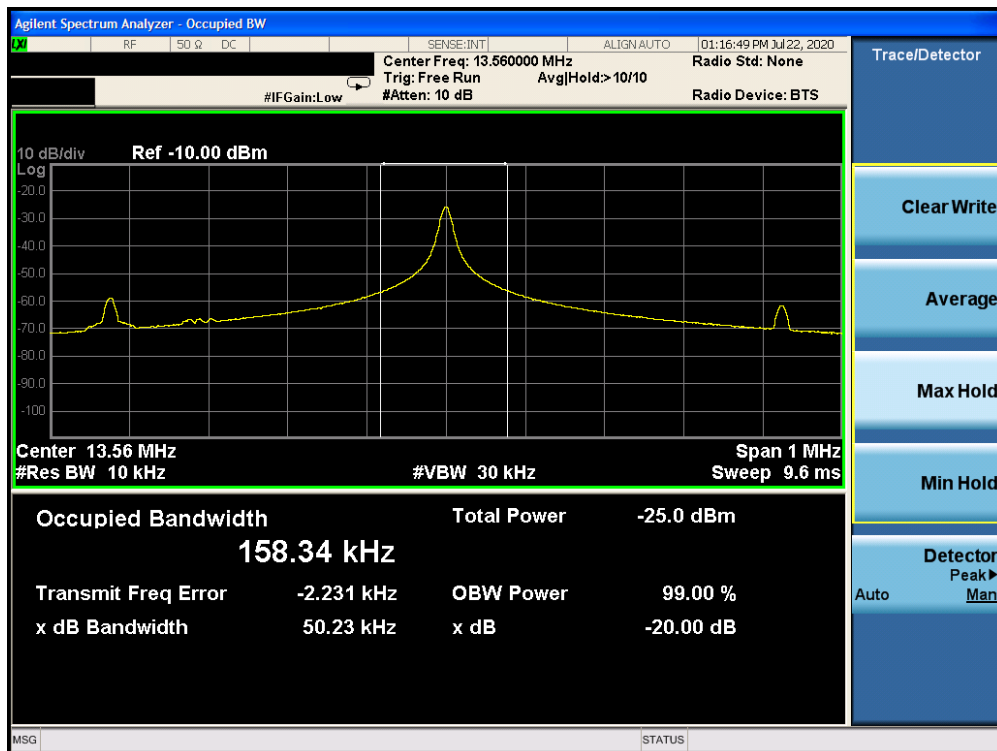


Plot 7-1. 20dB Bandwidth Plot (CE A 848kbps)

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



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

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



Plot 7-5. 20dB 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

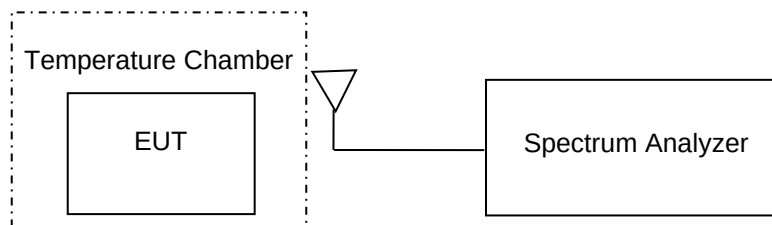


Figure 7-2. Test Instrument & Measurement Setup

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: ± 0.01 % = 1356Hz

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 30	13,559,649	-351	-0.0025854
100 %		- 20	13,559,409	-591	-0.0043553
100 %		- 10	13,559,770	-230	-0.0016962
100 %		0	13,559,769	-231	-0.0017005
100 %		+ 10	13,559,650	-350	-0.0025810
100 %		+ 20	13,559,799	-201	-0.0014793
100 %		+ 30	13,559,739	-261	-0.0019218
100 %		+ 40	13,559,819	-181	-0.0013318
100 %		+ 50	13,559,799	-201	-0.0014793
BATT. ENDPOINT	3.40	+ 20	13,560,581	581	0.0042847

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

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Frequency Stability Test Data

§15.225; RSS-210 (B.6)

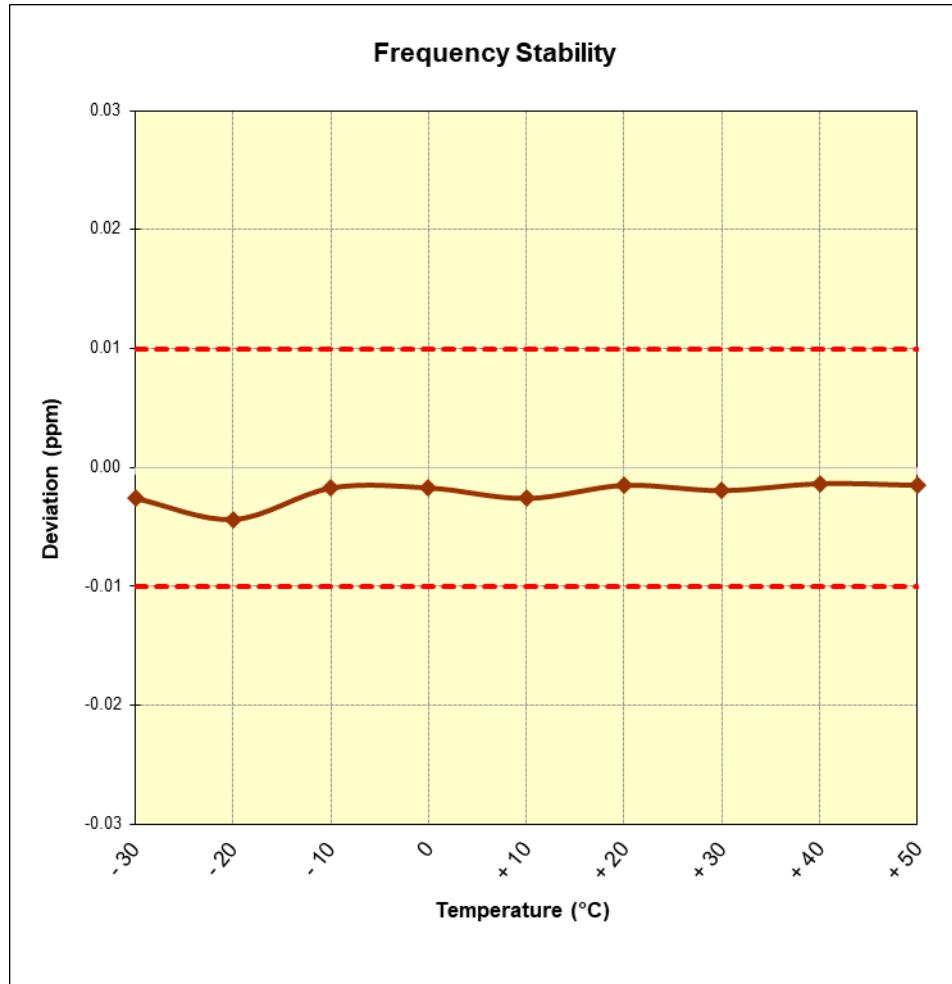


Figure 7-3. Frequency Stability Plot (CE A 848kbps)

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Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 18 of 35

Frequency Stability Test Data

§15.225; RSS-210 (B.6)

OPERATING FREQUENCY: 13,560,000 Hz

REFERENCE VOLTAGE: 3.80 VDC

DEVIATION LIMIT: ± 0.01 % = 1356Hz

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 30	13,559,789	-211	-0.0015530
100 %		- 20	13,559,829	-171	-0.0012581
100 %		- 10	13,559,130	-870	-0.0064160
100 %		0	13,559,769	-231	-0.0017005
100 %		+ 10	13,559,620	-380	-0.0028023
100 %		+ 20	13,559,794	-206	-0.0015185
100 %		+ 30	13,559,769	-231	-0.0017005
100 %		+ 40	13,559,639	-361	-0.0026592
100 %		+ 50	13,559,869	-131	-0.0009631
BATT. ENDPOINT	3.40	+ 20	13,560,739	739	0.0054499

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

FCC ID: BCG-A2351		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 19 of 35

Frequency Stability Test Data

§15.225; RSS-210 (B.6)

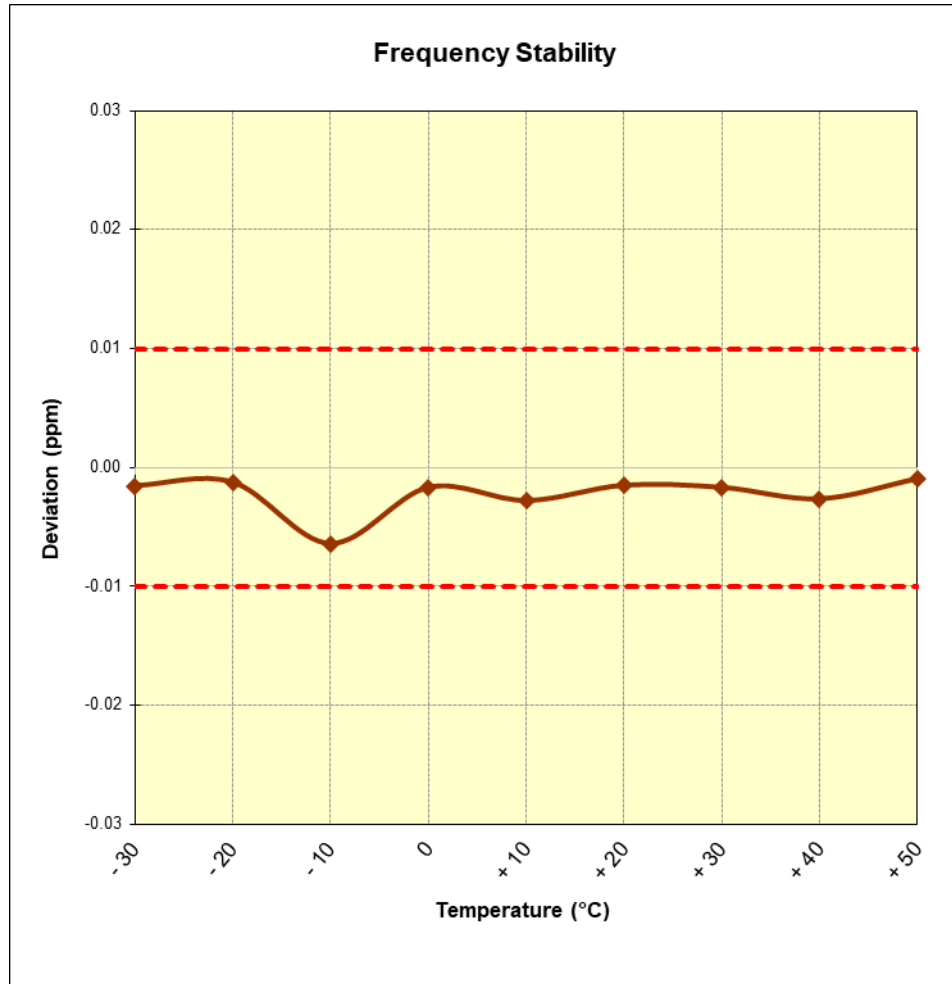


Figure 7-4. Frequency Stability Plot (Reader 10% Ask 1 out of 256)

FCC ID: BCG-A2351	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 20 of 35

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-A2351	 PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 21 of 35

Test Setup

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

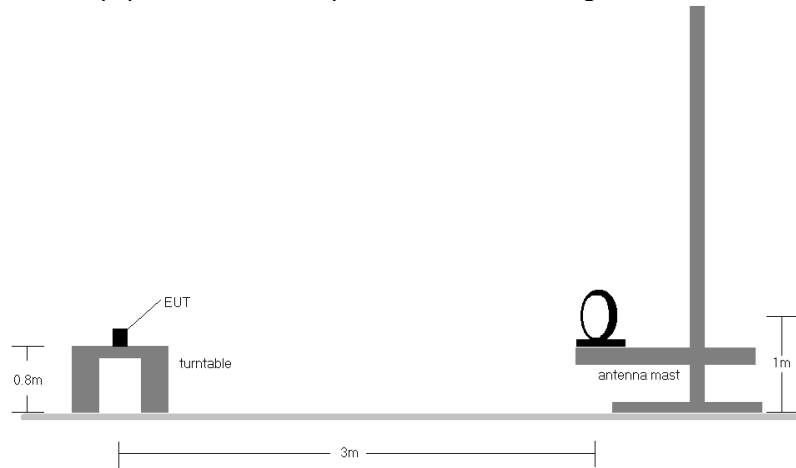


Figure 7-5. Radiated Test Setup

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). 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. The "-" shown in the following RSE tables are used to denote a noise floor measurement.
9. All possible configurations were investigated and only the worst case is reported.

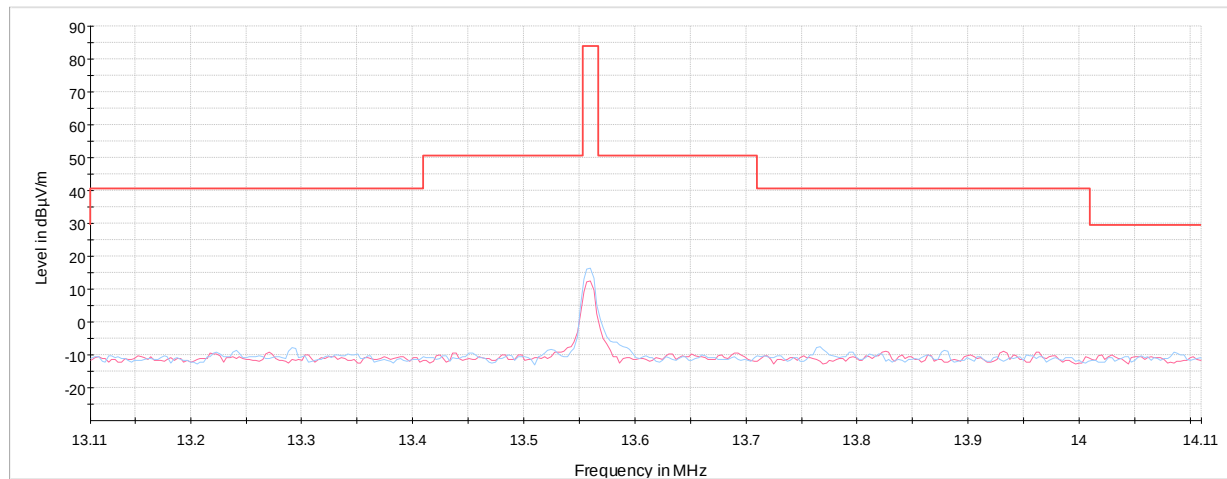
Sample Calculation

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

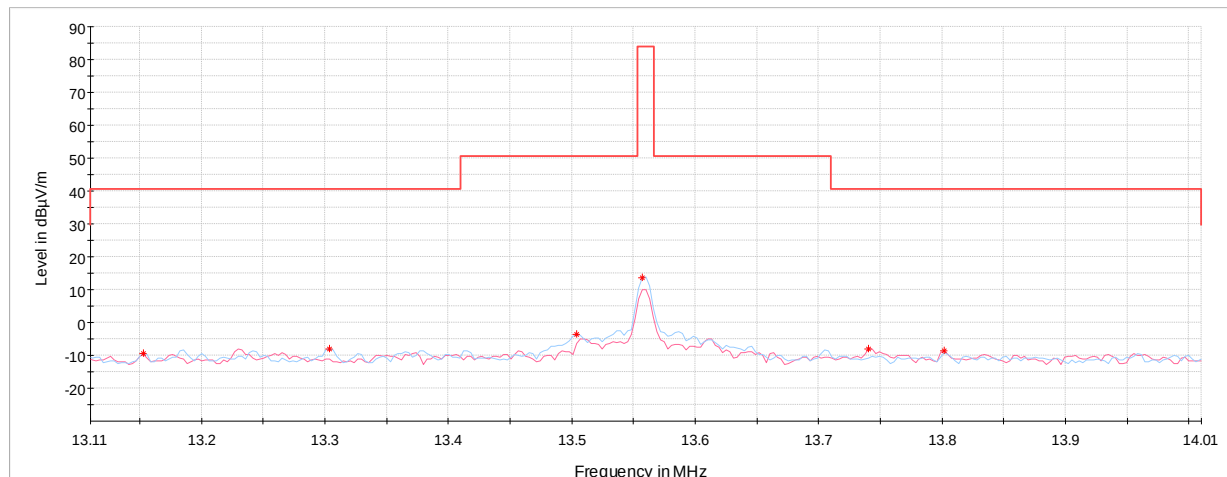
FCC ID: BCG-A2351		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 22 of 35

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 WCP + AC/DC Adapter)



Plot 7-7. In Band Radiated Spurious Emissions (Reader 10% Ask 1 out of 256, with WCP + AC/DC Adapter)

FCC ID: BCG-A2351		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 23 of 35

Frequency: 13.56MHz

Measurement Distance: 3 Meters

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]
13.241	Max Peak	X	100	341	-96.45	-19.29	31.26	-8.74	40.51	-49.25
13.291	Max Peak	X	100	123	-95.43	-19.28	32.29	-7.71	40.51	-48.22
13.436	Max Peak	X	100	181	-97.28	-19.27	30.45	-9.55	50.47	-60.02
13.560	Max Peak	X	100	34	-71.50	-19.25	56.25	16.25	84.00	-67.75
13.764	Max Peak	X	100	257	-95.60	-19.23	32.17	-7.83	40.51	-48.34
13.932	Max Peak	X	100	5	-96.66	-19.22	31.12	-8.88	40.51	-49.39

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

Frequency: 13.56MHz

Measurement Distance: 3 Meters

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]
13.153	Max Peak	X	100	298	-97.28	-19.29	30.43	-9.57	40.51	-50.08
13.303	Max Peak	X	100	95	-95.65	-19.28	32.07	-7.93	40.51	-48.44
13.504	Max Peak	X	100	212	-91.47	-19.26	36.27	-3.73	50.47	-54.20
13.560	Max Peak	X	100	26	-74.05	-19.25	53.70	13.70	84.00	-70.30
13.740	Max Peak	X	100	106	-95.94	-19.24	31.82	-8.18	40.51	-48.69
13.802	Max Peak	X	100	189	-96.49	-19.23	31.28	-8.72	40.51	-49.23

Table 7-7. In-Band Radiated Measurements (Reader 10% Ask 1 out of 256, with WCP + AC/DC Adapter)

FCC ID: BCG-A2351	 PCTEST Proud to be part of  element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 24 of 35

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 [$\mu\text{V/m}$]	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 $\geq 3 \times$ RBW
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

FCC ID: BCG-A2351	 PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 25 of 35

Test Setup

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

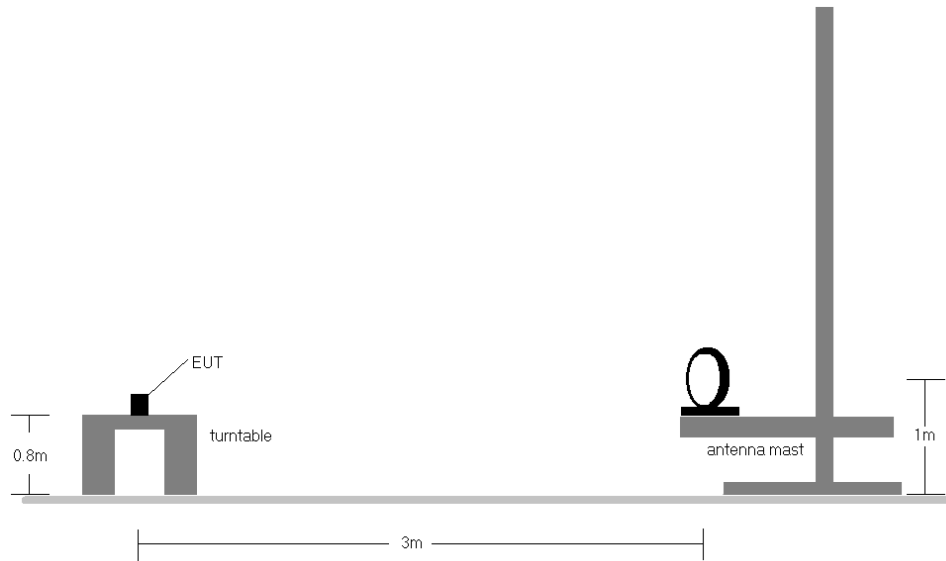


Figure 7-6. Radiated Test Setup < 30MHz

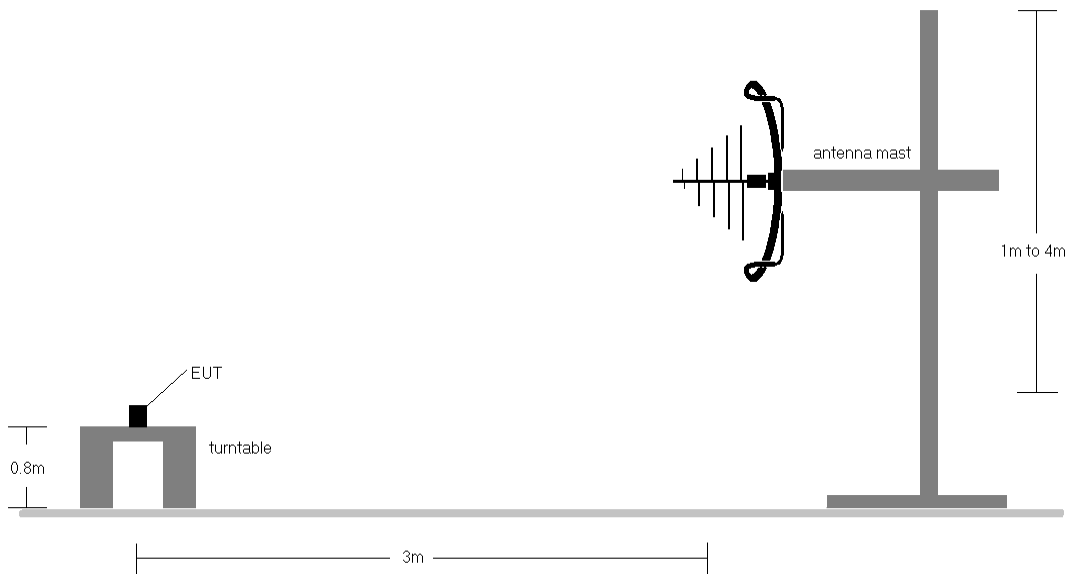


Figure 7-7. Radiated Test Setup > 30MHz

FCC ID: BCG-A2351	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 26 of 35

Test Notes:

1. A loop antenna was used to investigate emissions below 30MHz.
2. Both Vertical and Horizontal polarities of the receive antenna were evaluated with the worst case emissions being reported. Below 30MHz the loop antenna was positioned in 3 orthogonal planes (X front, Y side, Z top) to determine the orientation resulting in the worst case emissions.
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 cable with wireless charger
 - b. EUT powered by host PC via USB cable with wireless 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. 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.
9. 9kHz - 30MHz Pre-scan plots show no significant emissions.

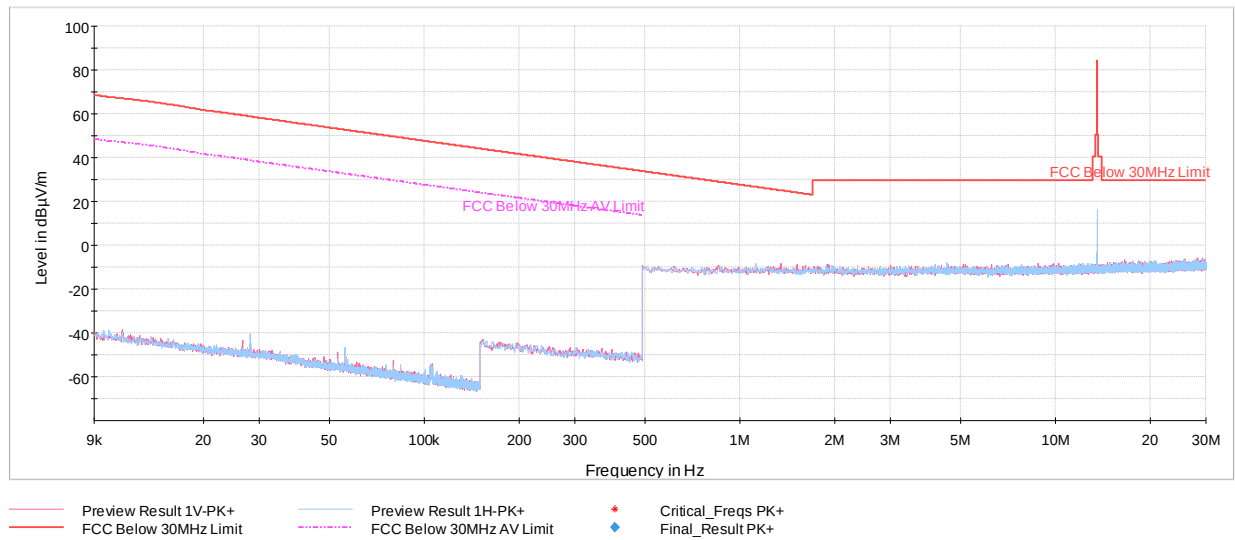
Sample Calculation

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

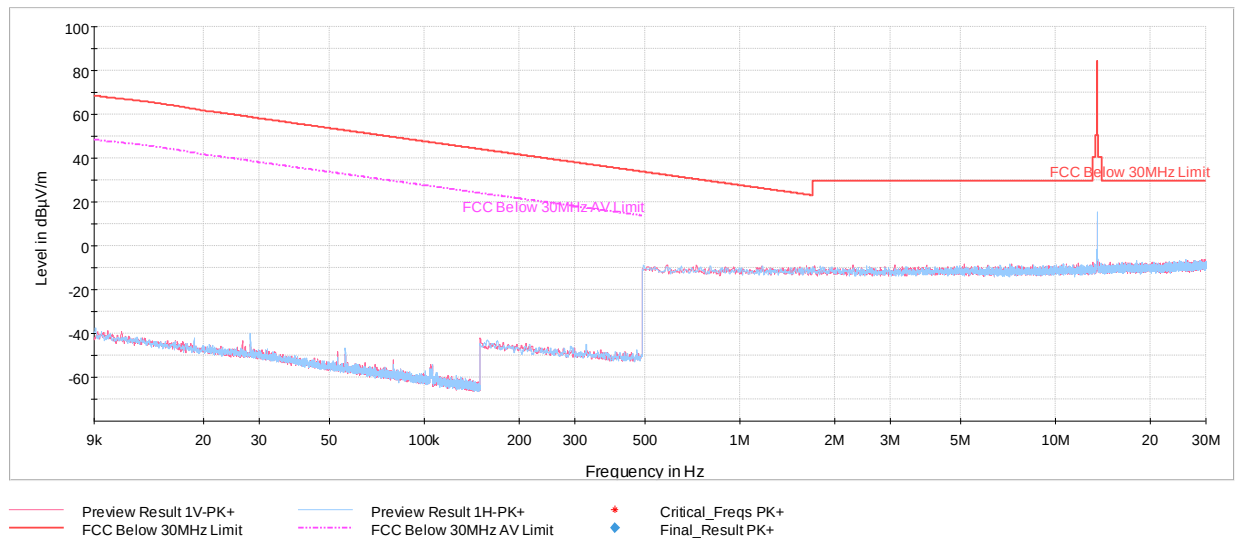
FCC ID: BCG-A2351	 Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 27 of 35

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 WCP + AC/DC Adapter)

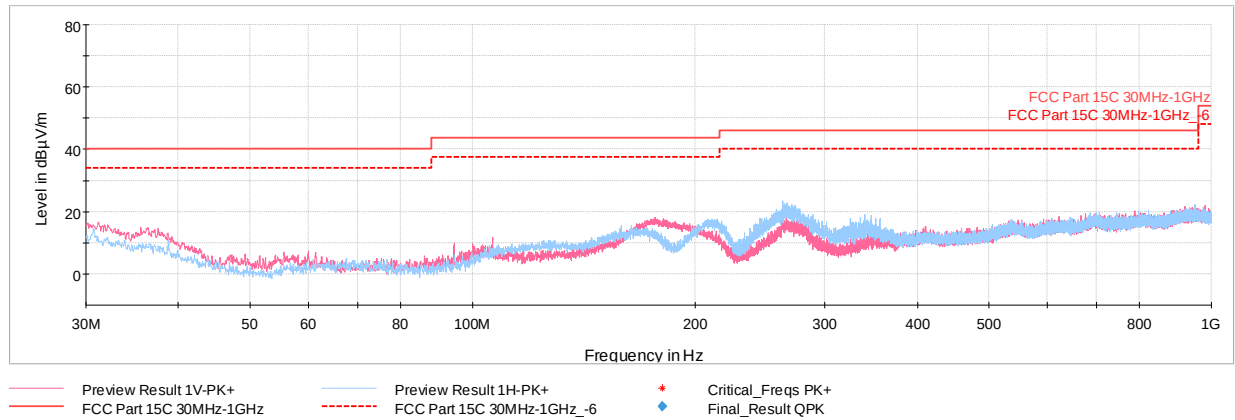


Plot 7-9. Radiated Spurious Emissions 9kHz – 30MHz (Reader 10% Ask 1 out of 256, with WCP + AC/DC Adapter)

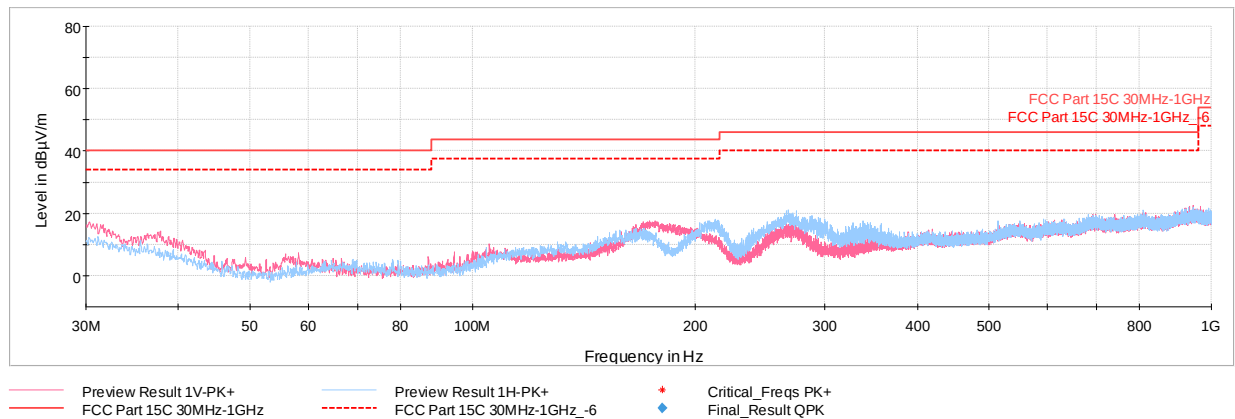
FCC ID: BCG-A2351	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Out-of-Band Radiated Spurious Emissions – 30MHz-1GHz

§15.209 §15.225(d); RSS-Gen (8.9)



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



Plot 7-11. Radiated Spurious Emissions 30MHz – 1GHz (Reader 10% Ask 1 out of 256, with WCP + AC/DC Adapter)

FCC ID: BCG-A2351		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 29 of 35

Radiated Spurious Emission Measurements, Out-of-Band

§15.209 §15.225(d); RSS-Gen (8.9)

Tx Frequency 13.56MHz

Measurement Distance: 3 Meters

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
27.12	Max Peak	V	100	270	-70.67	-21.73	14.60	40.00	-25.40
40.68	Max Peak	V	100	146	-70.95	-26.02	10.03	43.52	-33.49
54.24	Max Peak	V	100	160	-70.38	-24.92	11.70	43.52	-31.82
67.80	Max Peak	H	100	156	-67.64	-21.79	17.57	43.52	-25.95
81.36	Max Peak	H	100	128	-64.68	-18.79	23.53	46.02	-22.49
94.92	Max Peak	H	100	33	-79.54	-5.10	22.36	46.02	-23.66

Table 7-9. Radiated Measurements (CE A 848kbps, with WCP + AC/DC Adapter)

Tx Frequency 13.56MHz

Measurement Distance: 3 Meters

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
30.68	Max Peak	V	100	113	-72.46	-17.77	16.77	40.00	-23.23
37.52	Max Peak	V	100	324	-71.30	-21.73	13.97	40.00	-26.03
94.51	Max Peak	V	100	44	-73.53	-26.01	7.46	43.52	-36.06
170.12	Max Peak	V	100	76	-66.57	-23.17	17.26	43.52	-26.26
209.26	Max Peak	H	100	162	-67.77	-21.78	17.45	43.52	-26.07
274.29	Max Peak	H	100	144	-66.87	-19.25	20.88	46.02	-25.14

Table 7-10. Radiated Measurements (Reader 10% Ask 1 out of 256, with WCP + AC/DC Adapter)

FCC ID: BCG-A2351	 Proud to be part of 	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 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 7-11. 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-A2351	 PCTEST Proud to be part of  element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 31 of 35

Test Setup

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

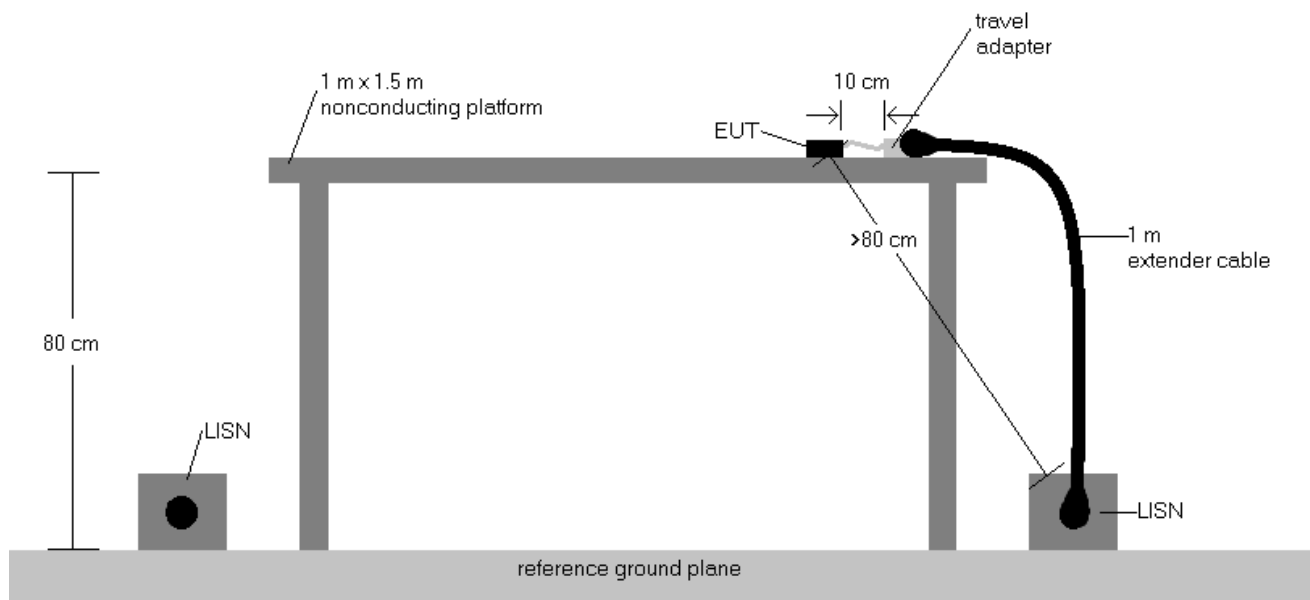
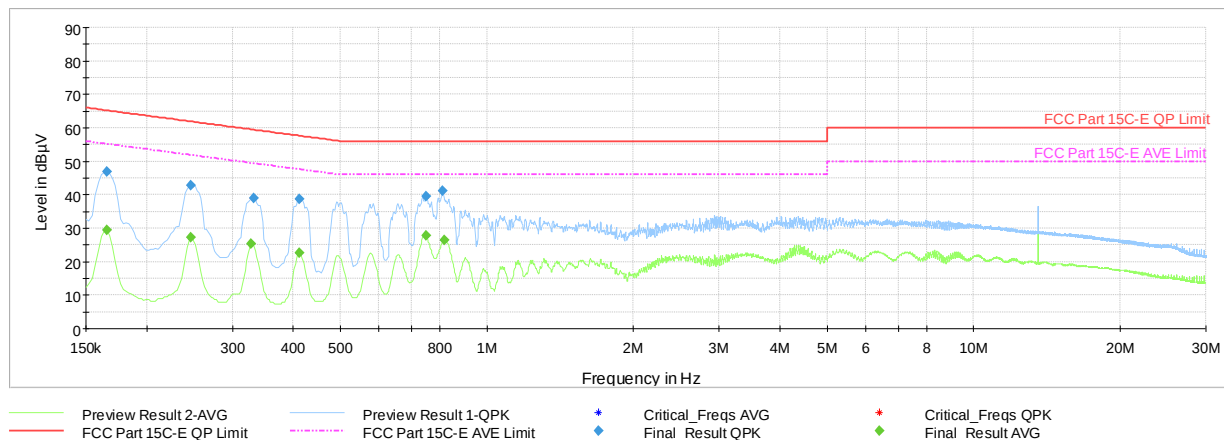


Figure 7-8. Test Instrument & Measurement Setup

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 cable with wireless charger
 - b. EUT powered by host PC via USB cable with wireless charger
9. All possible configurations were investigated and only the worst case is reported.

FCC ID: BCG-A2351	 PCTEST Proud to be part of 	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 32 of 35

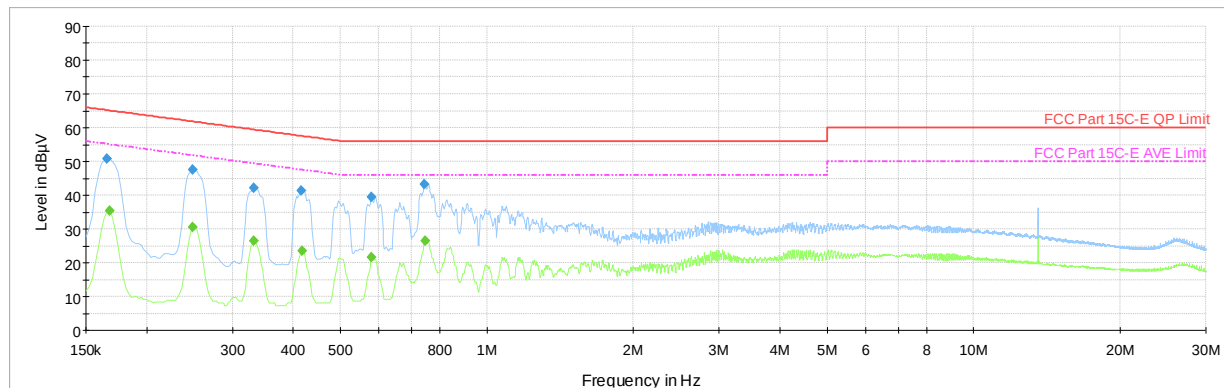


Plot 7-12. AC Line-Conducted Test Plot (L1, CE A 848kbps, with WCP + AC/DC Adapter)

Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.166	FINAL	46.9	—	65.17	-18.32	L1	GND
0.166	FINAL	—	29.53	55.17	-25.64	L1	GND
0.247	FINAL	42.8	—	61.87	-19.06	L1	GND
0.247	FINAL	—	27.21	51.87	-24.65	L1	GND
0.328	FINAL	—	25.44	49.51	-24.07	L1	GND
0.332	FINAL	38.9	—	59.40	-20.49	L1	GND
0.411	FINAL	—	22.56	47.63	-25.06	L1	GND
0.411	FINAL	38.7	—	57.63	-18.97	L1	GND
0.749	FINAL	—	27.79	46.00	-18.21	L1	GND
0.751	FINAL	39.5	—	56.00	-16.49	L1	GND
0.812	FINAL	41.1	—	56.00	-14.88	L1	GND
0.816	FINAL	—	26.48	46.00	-19.52	L1	GND

Table 7-12. AC Line-Conducted Test Data (L1, CE A 848kbps, with WCP + AC/DC Adapter)

FCC ID: BCG-A2351	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
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Preview Result 2-AVG Preview Result 1-QPK Critical_Freqs AVG Critical_Freqs QPK
FCC Part 15C-E QP Limit FCC Part 15C-E AVE Limit Final_Result QPK Final_Result AVG

Plot 7-13. AC Line-Conducted Test Plot (N, CE A 848kbps, with WCP + AC/DC Adapter)

Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.166	FINAL	50.9	—	65.17	-14.23	N	GND
0.168	FINAL	—	35.30	55.06	-19.76	N	GND
0.249	FINAL	47.7	—	61.79	-14.14	N	GND
0.249	FINAL	—	30.64	51.79	-21.15	N	GND
0.332	FINAL	42.2	—	59.40	-17.20	N	GND
0.332	FINAL	—	26.37	49.40	-23.02	N	GND
0.416	FINAL	41.3	—	57.54	-16.25	N	GND
0.418	FINAL	—	23.39	47.49	-24.11	N	GND
0.580	FINAL	—	21.62	46.00	-24.38	N	GND
0.580	FINAL	39.4	—	56.00	-16.61	N	GND
0.744	FINAL	43.3	—	56.00	-12.67	N	GND
0.746	FINAL	—	26.49	46.00	-19.51	N	GND

Table 7-13. AC Line-Conducted Test Data (N, CE A 848kbps, with WCP + AC/DC Adapter)

FCC ID: BCG-A2351	PCTEST Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 34 of 35

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Watch FCC ID: BCG-A2351** 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-A2351	 Proud to be part of element	MEASUREMENT REPORT (CERTIFICATION)	Approved by: Quality Manager
Test Report S/N: 1C2004270021-06.BCG	Test Dates: 05/01/2020-08/07/2020	EUT Type: Watch	Page 35 of 35