



Element Materials Technology

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MEASUREMENT REPORT FCC PART 15.225 / ISED RSS-210 NFC

Applicant Name:

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

Date of Testing:

6/12/2024 - 7/24/2024

Test Report Issue Date:

8/5/2024

Test Site/Location:

Element Materials Technology, Morgan Hill, CA, USA

Test Report Serial No.:

1C2405230020-10.BCG

FCC ID:

BCG-A2999

IC:

579C-A2999

APPLICANT:

Apple Inc.

Application Type:

Certification

Model/HVIN:

A2999, A3000

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 11

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.

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: WKR0000007077

Reviewed by: WKR0000006164



FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 1 of 37

V 10.5 12/15/2021

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TABLE OF CONTENTS

1.0	INTRODUCTION.....	3
1.1	Scope.....	3
1.2	Element Materials Technology Test Location	3
1.3	Test Facility / Accreditations	3
2.0	PRODUCT INFORMATION	4
2.1	Equipment Description.....	4
2.2	Device Capabilities	4
2.3	Test Support Equipment	5
2.4	Test Configuration	5
2.5	Software and Firmware.....	5
2.6	EMI Suppression Device(s)/Modifications.....	5
3.0	DESCRIPTION OF TEST	6
3.1	Evaluation Procedure.....	6
3.2	AC Line Conducted Emissions	6
3.3	Radiated Emissions	7
3.4	Environmental Conditions	7
4.0	ANTENNA REQUIREMENTS.....	8
5.0	MEASUREMENT UNCERTAINTY	9
6.0	TEST EQUIPMENT CALIBRATION DATA.....	10
7.0	TEST DATA	11
7.1	Summary	11
7.2	Bandwidth Measurement	12
7.3	Frequency Stability Test Data.....	17
7.4	In-Band Radiated Spurious Emissions	20
7.5	Out-of-Band Radiated Spurious Emissions.....	24
7.6	AC Line Conducted Emissions Measurement.....	31
8.0	CONCLUSION	37

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 2 of 37

V 10.5 12/15/2021

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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 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 located in Morgan Hill, CA 95037, U.S.A.

- 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 ISSED Standards (RSS).
- Element Materials Technology facility is a registered (22831) test laboratory with the site description on file with ISSED.
- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISSED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 3 of 37

V 10.5 12/15/2021

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Watch FCC ID: BCG-A2999** and **IC: 579C-A2999**. The test data contained in this report pertains only to the emissions due to the NFC transmitter of the EUT.

Test Device Serial No.: DLCH60000D80000EZL, KRX4K34C79, W6Q7Y0JH2H, QX0FRF41C6, FVMM2FCXPQ

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n WLAN, 802.11a/n UNII, 802.15.4 ab-NB, 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

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 4 of 37

V 10.5 12/15/2021

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2.3 Test Support Equipment

1	Apple Macbook	Model:	A1398	S/N:	FVFDHG8TP3XY
	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:	A3276	S/N:	DQ812910CU008V22F
	w/ Cradle	Model:	N/A	S/N:	CYV10420060A2LE03MP2C
3	Apple Magnetic Charger	Model:	A2515	S/N:	DLC310307CD1NR1AM
	Apple Magnetic Charger	Model:	A2879	S/N:	DLCH5T000ZM00000WB
4	Pathfinder Mocha X3100	Model:	920-13353-01	S/N:	DLCGMW0007D00000N7
	SiP Socket	Model:	P1 N20X B PF 307	S/N:	FN6GUA000JD00000M7
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A
6	Store Sample Wristband	Model:	N/A	S/N:	DLC316300CU1QGKA2

Table 2-2. Test Support Equipment List

2.4 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2020. ANSI C63.10-2020 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 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 11 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.

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 5 of 37

V 10.5 12/15/2021

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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 C63.10-2020) 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.

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 6 of 37

V 10.5 12/15/2021

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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).

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 7 of 37

V 10.5 12/15/2021

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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.

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 8 of 37

V 10.5 12/15/2021

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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)
AC Line Conducted Disturbance	1.91
Radiated Disturbance (<30MHz)	4.12
Radiated Disturbance (30MHz - 1GHz)	4.85

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 9 of 37

V 10.5 12/15/2021

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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-26.5GHz PXA Signal Analyzer	10/18/2023	Annual	10/18/2024	MY55330128
ESPEC	SU-241	Tabletop Temperature Chamber	11/17/2023	Annual	11/17/2024	92009574
Keysight Technology	N9040B	UXA Signal Analyzer	5/28/2024	Annual	5/28/2025	MY57212015
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	5/29/2024	Annual	5/29/2025	101619
Rohde & Schwarz	ESW44	EMI Test Receiver	5/1/2024	Annual	5/1/2025	101867
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz - 8GHz)	7/3/2024	Annual	7/3/2025	102356
Rohde & Schwarz	HFH2-Z2	Loop Antenna	6/21/2024	Annual	6/21/2025	100519
Rohde & Schwarz	ENV216	Two-Line V-Network	4/24/2024	Annual	4/24/2025	101364
Schwarzbeck	VULB 9162	Bilog Antenna (30MHz - 6GHz)	4/29/2024	Annual	4/29/2025	00304

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.

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 10 of 37

V 10.5 12/15/2021

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7.0 TEST DATA

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCG-A2999

IC: 579C-A2999

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.
4. For radiated emissions, the automated measurement software utilized is Rohde & Schwarz EMC32, Version 10.50.40.

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 11 of 37

V 10.5 12/15/2021

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 C63.10-2020 – 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

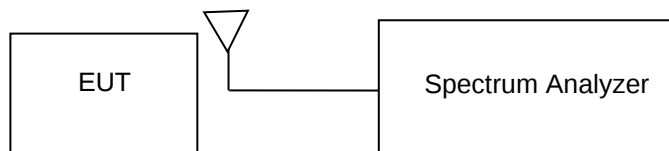


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 12 of 37

V 10.5 12/15/2021

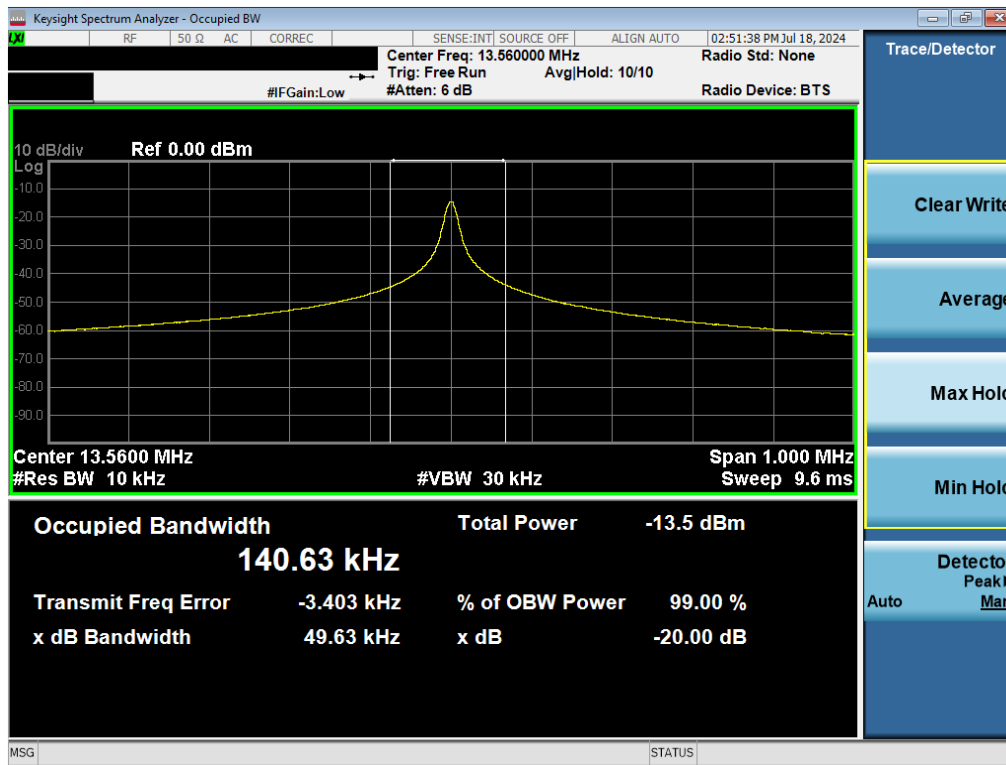
Frequency	Configuration	20dB Bandwidth [kHz]	99% OBW [kHz]
13.56MHz	CE A 106kbps	49.63	140.63
13.56MHz	CE B 106kbps	42.00	96.59
13.56MHz	CE F 212kbps	48.70	152.14
13.56MHz	Reader 10% Ask 1 out of 4	131.70	382.78
13.56MHz	Reader 10% Ask 1 out of 125	132.30	383.06

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

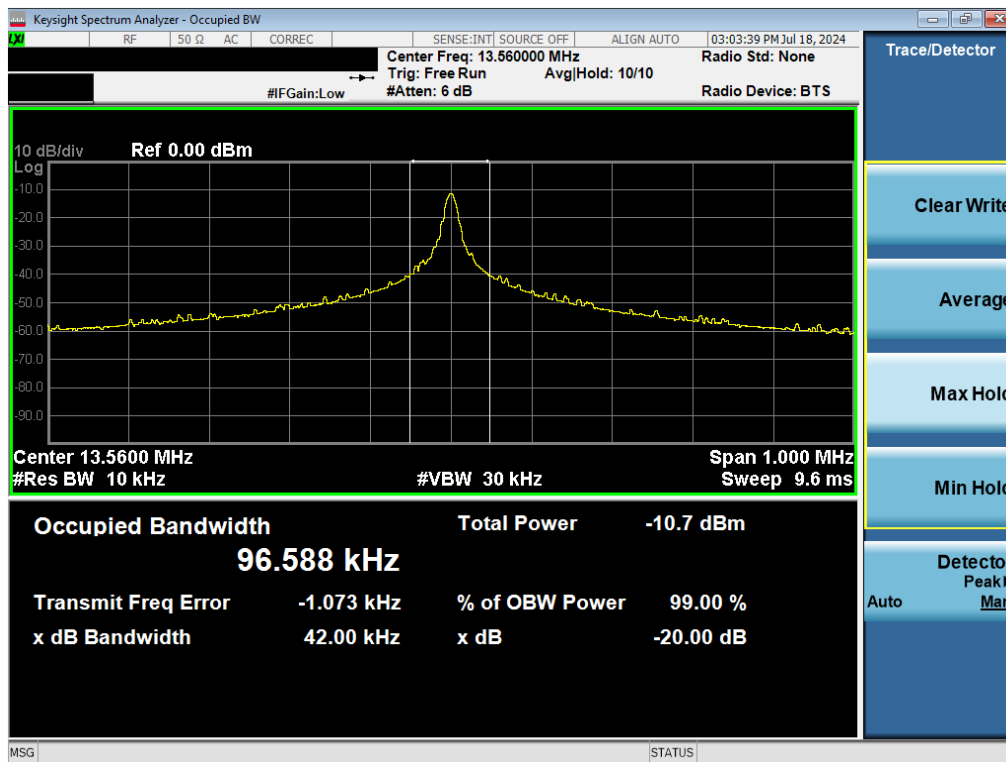
FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 13 of 37

V 10.5 12/15/2021

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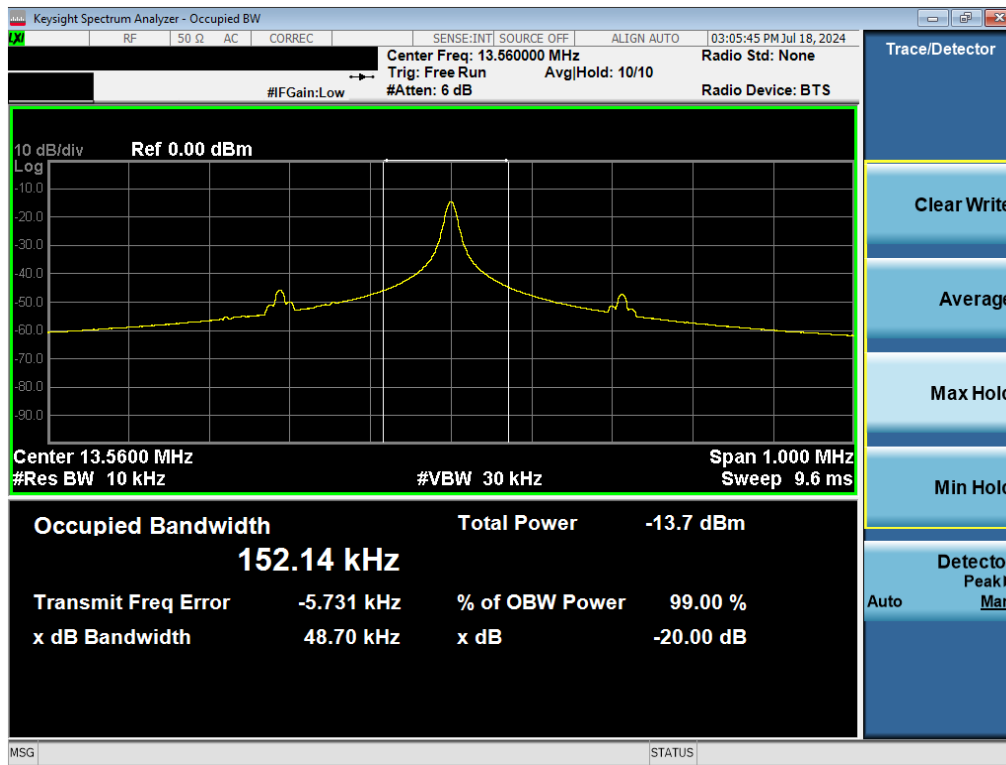


Plot 7-1. 20dB and 99% Bandwidth Plot (CE A 106kbps)



Plot 7-2. 20dB and 99% Bandwidth Plot (CE B 106kbps)

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 14 of 37



Plot 7-3. 20dB and 99% Bandwidth Plot (CE F 212kbps)



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

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 15 of 37

V 10.5 12/15/2021

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Plot 7-5. 20dB and 99% Bandwidth Plot (Reader 10% ASK 1 out of 125)

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 16 of 37

V 10.5 12/15/2021

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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 C63.10-2020. 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 $\pm 0.01\%$ 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. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

Test Setup

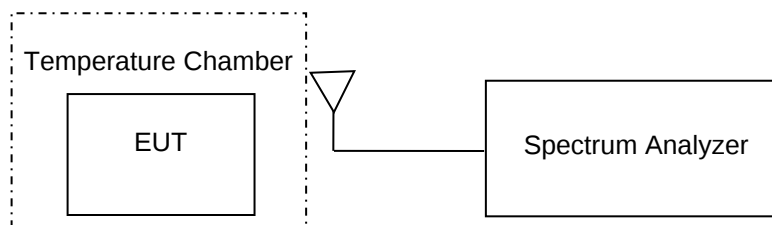


Figure 7-2. Test Instrument & Measurement Setup

Test Notes

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

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 17 of 37

V 10.5 12/15/2021

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Frequency Stability Test Data

§15.225; RSS-210 (B.6)

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 20	13,559,913	-87.5	-0.0006453
100 %		- 10	13,559,890	-110.0	-0.0008112
100 %		0	13,560,607	606.5	0.0044727
100 %		+ 10	13,560,097	96.5	0.0007117
100 %		+ 20	13,560,058	57.5	0.0004240
100 %		+ 30	13,560,058	58.0	0.0004277
100 %		+ 40	13,559,589	-411.0	-0.0030310
100 %		+ 50	13,559,983	-17.5	-0.0001291
85 %	3.23	+ 20	13,559,946	-54.0	-0.0003982
115 %	4.37	+ 20	13,559,767	-233.5	-0.0017220

Table 7-3. Frequency Stability Test Data (CE F 212kbps)

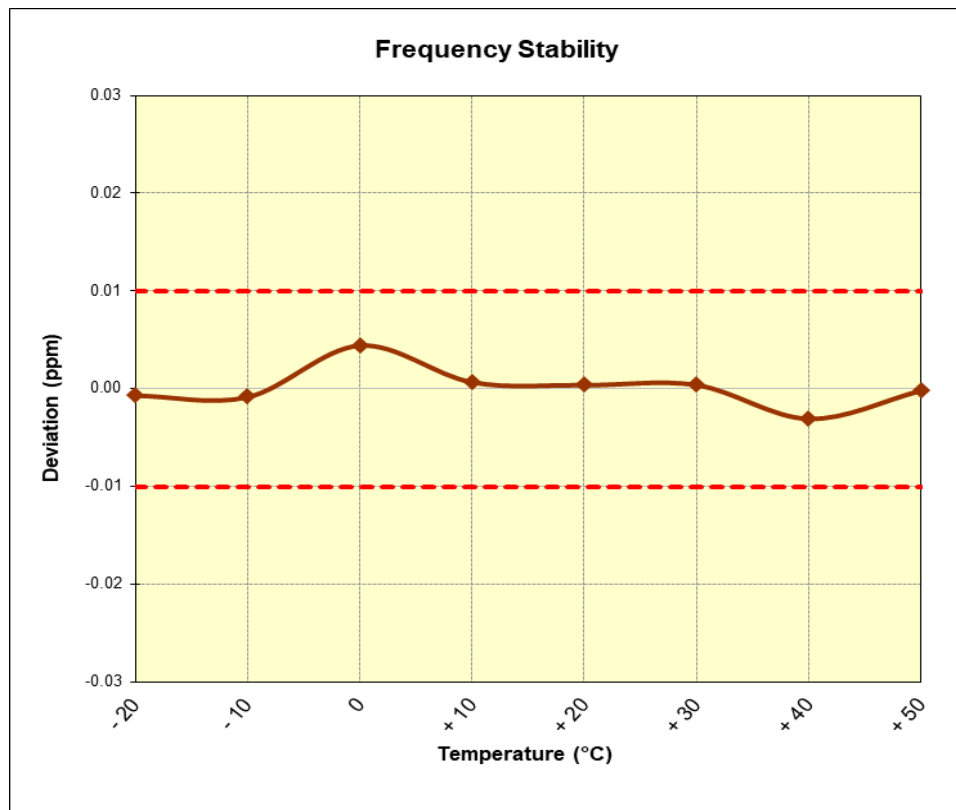


Figure 7-3. Frequency Stability Plot (CE F 212kbps)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 18 of 37

V 10.5 12/15/2021

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VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	3.80	- 20	13,559,677	-323.0	-0.0023820
100 %		- 10	13,560,531	531.0	0.0039159
100 %		0	13,560,218	218.0	0.0016077
100 %		+ 10	13,560,307	306.5	0.0022603
100 %		+ 20	13,559,866	-134.0	-0.0009882
100 %		+ 30	13,560,066	66.0	0.0004867
100 %		+ 40	13,559,696	-304.5	-0.0022456
100 %		+ 50	13,559,679	-321.0	-0.0023673
85 %	3.23	+ 20	13,560,093	93.0	0.0006858
115 %	4.37	+ 20	13,560,080	80.0	0.0005900

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

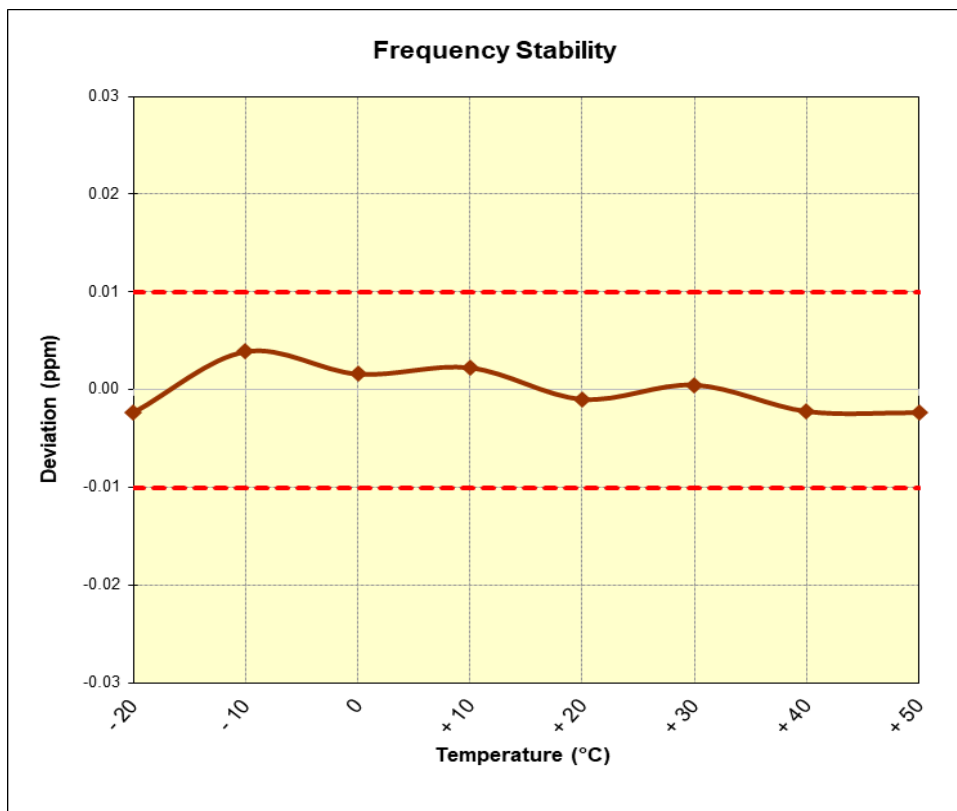


Figure 7-4. Frequency Stability Plot (Reader 10% ASK 1 out of 256)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 19 of 37

V 10.5 12/15/2021

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 C63.10-2020 – 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-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 20 of 37

V 10.5 12/15/2021

Test Setup

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

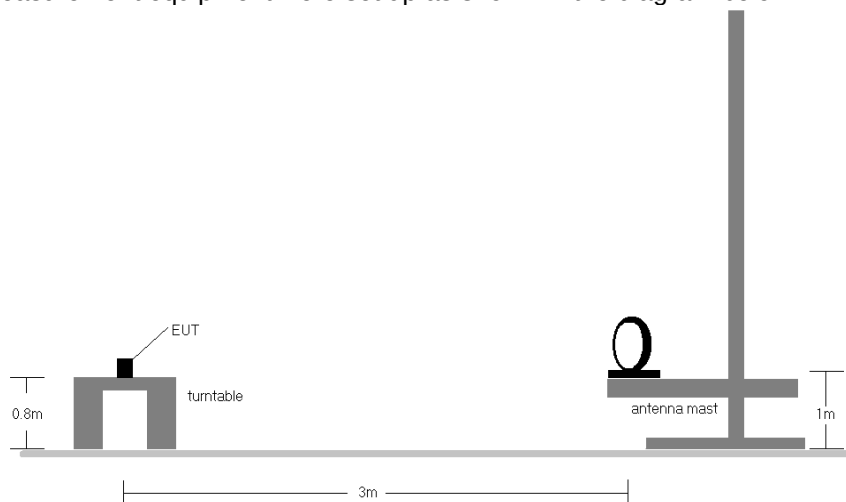


Figure 7-5. Radiated Test Setup

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

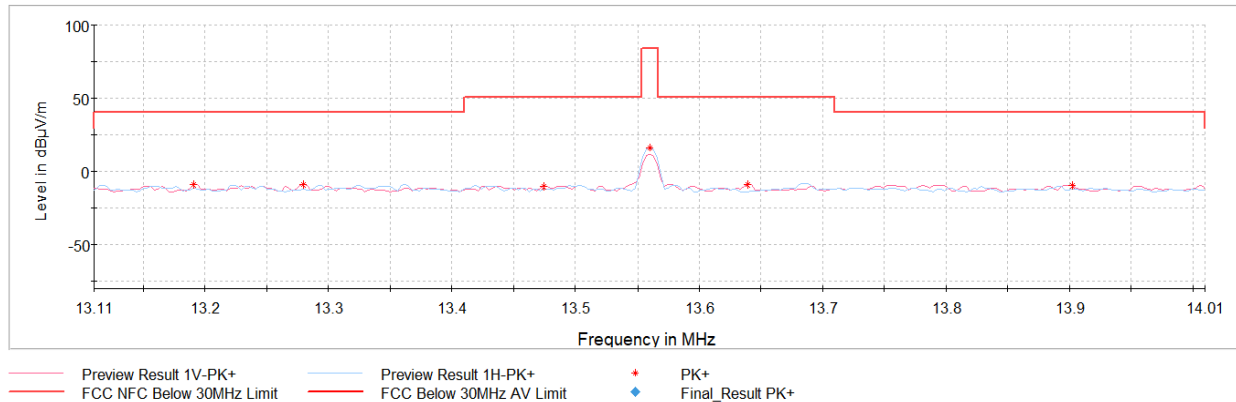
- Field Strength Level $[\text{dB}_{\mu\text{V/m}}] = \text{Analyzer Level} [\text{dBm}] + 107 + \text{AFCL} [\text{dB/m}] + \text{Distance Extrapolation Factor} [\text{dB}]$
- $\text{AFCL} [\text{dB/m}] = (\text{Antenna Factor} [\text{dB/m}] + \text{Cable Loss} [\text{dB}] + \text{Attenuator} [\text{dB}])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

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 21 of 37

V 10.5 12/15/2021

In-Band Radiated Spurious Emission Measurements

§15.225(a)(b)(c); RSS-210 (B.6)

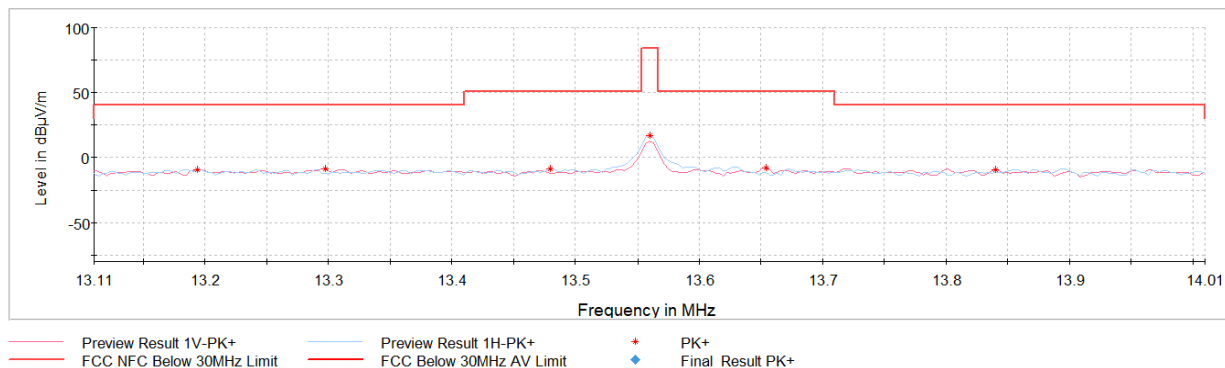


Plot 7-6. In Band Radiated Spurious Emissions (CE F 212kbps, with AC/DC Adapter and Magnetic Charger)

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]
13.191	Max Peak	X	100	44	-97.59	21.10	30.51	-9.49	40.51	-50.00
13.280	Max Peak	Y	100	162	-97.33	21.11	30.78	-9.22	40.51	-49.73
13.474	Max Peak	Y	100	255	-98.38	21.13	29.75	-10.25	50.47	-60.72
13.560	Max Peak	X	100	25	-72.19	21.13	55.94	15.94	84.00	-68.06
13.640	Max Peak	Y	100	5	-97.20	21.14	30.94	-9.06	50.47	-59.53
13.902	Max Peak	Y	100	55	-98.24	21.16	29.92	-10.08	40.51	-50.59

Table 7-6. In-Band Radiated Measurements (CE F 212kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 22 of 37



Plot 7-7. In Band Radiated Spurious Emissions (Reader 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]
13.194	Max Peak	X	100	23	-97.94	21.10	30.16	-9.84	40.51	-50.35
13.297	Max Peak	X	100	135	-97.33	21.11	30.78	-9.22	40.51	-49.73
13.480	Max Peak	X	100	159	-97.08	21.13	31.05	-8.95	50.47	-59.42
13.560	Max Peak	X	100	40	-71.61	21.13	56.52	16.52	84.00	-67.48
13.654	Max Peak	Y	100	118	-96.82	21.14	31.32	-8.68	50.47	-59.15
13.840	Max Peak	Y	100	355	-98.03	21.16	30.13	-9.87	40.51	-50.38

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

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 23 of 37

V 10.5 12/15/2021

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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 C63.10-2020 – 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

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 24 of 37

V 10.5 12/15/2021

Test Setup

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

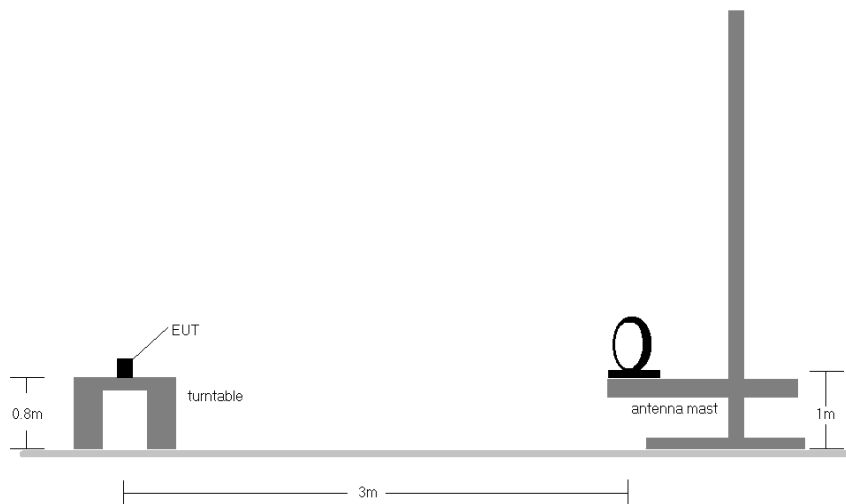


Figure 7-6. Radiated Test Setup < 30MHz

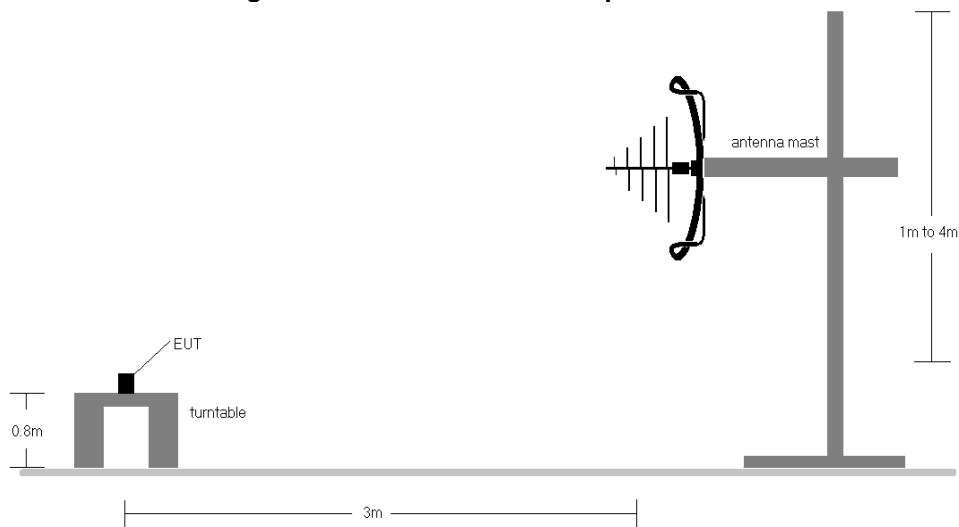


Figure 7-7. Radiated Test Setup > 30MHz

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 25 of 37

V 10.5 12/15/2021

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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] = $20 \log_{10}(300/3)^2 = 80\text{dB}$ [For emissions within 9kHz-490kHz]
 - b. Distance Extrapolation Factor_[dB] = $20 \log_{10}(30/3)^2 = 40\text{dB}$ [For emissions within 490kHz-30MHz]

Sample Calculation

- Field Strength Level_[dBμV/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_[dBμV/m] – Limit_[dBμV/m]

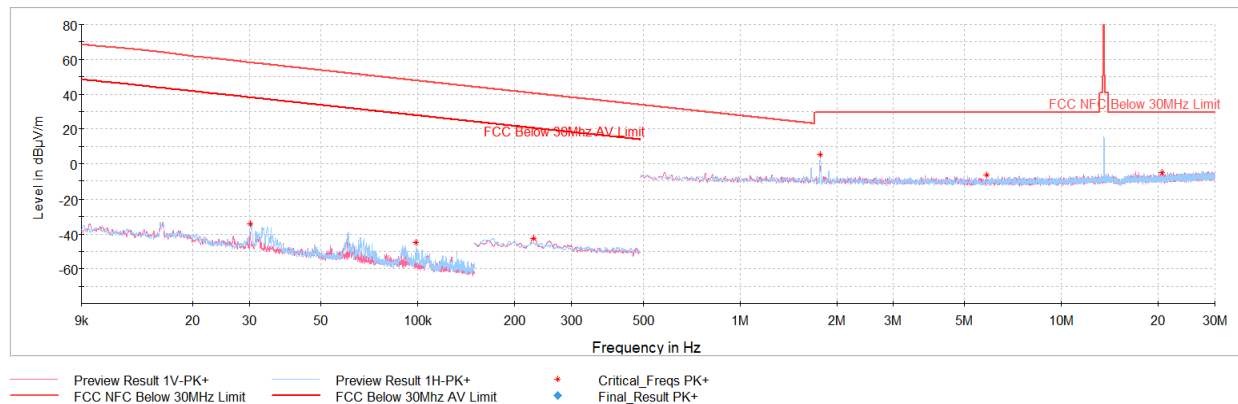
FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 26 of 37

V 10.5 12/15/2021



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 F 212kbps, with AC/DC Adapter and Magnetic Charger)

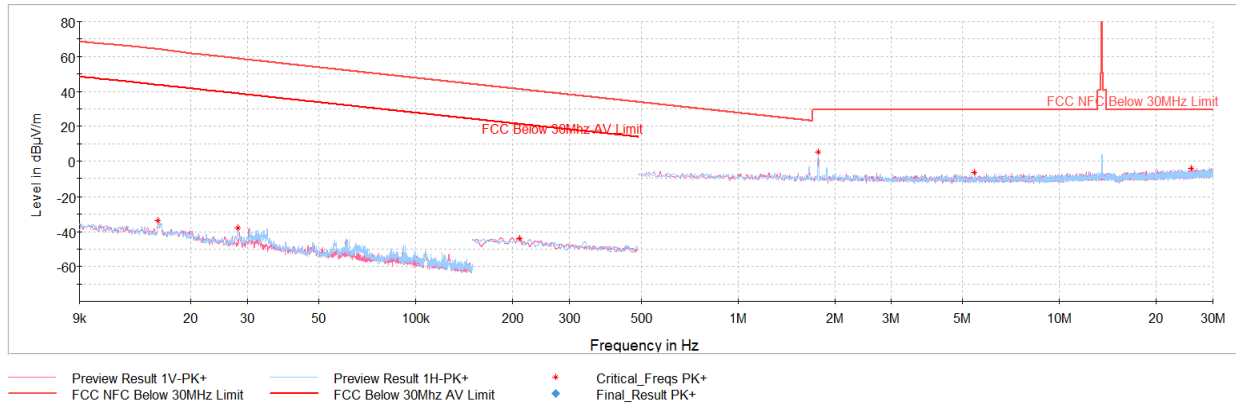
Frequency [MHz]	Detector	Ant. Pol. [X/Y/Z]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength @3m [dBµV/m]	Field Strength @30m [dBµV/m]	Limit @30m [dBµV/m]	Field Strength @300m [dBµV/m]	Limit @300m [dBµV/m]	Margin [dB]
0.030	Max Peak	X	100	94	-81.75	20.42	45.67	-	-	-34.33	58.01	-92.34
0.099	Max Peak	X	100	97	-91.20	19.28	35.08	-	-	-44.92	47.70	-92.62
0.230	Max Peak	X	100	169	-88.90	19.25	37.35	-	-	-42.65	40.37	-83.02
1.777	Max Peak	Y	100	14	-81.83	19.89	45.06	5.06	29.54	-	-	-24.48
5.843	Max Peak	X	100	96	-93.88	20.12	33.24	-6.76	29.54	-	-	-36.30
20.563	Max Peak	X	100	339	-94.06	21.92	34.86	-5.14	29.54	-	-	-34.68

Table 7-9. Radiated Measurements (CE F 212kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 27 of 37

V 10.5 12/15/2021

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

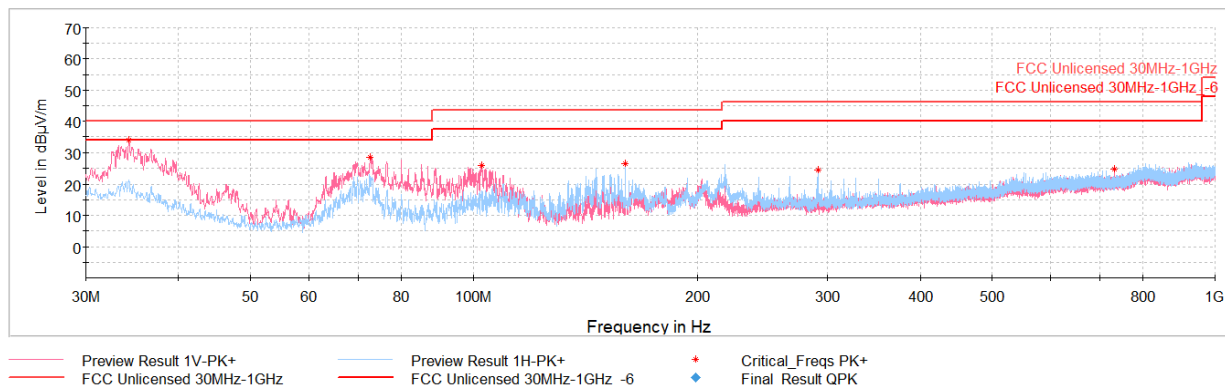
Frequency [MHz]	Detector	Ant. Pol. [X/Y/Z]	Antenna Height [cm]	Turntable Azimuth [degree]	Level [dBm]	AFCL [dB/m]	Field Strength @3m [dBμV/m]	Field Strength @30m [dBμV/m]	Limit @30m [dBμV/m]	Field Strength @300m [dBμV/m]	Limit @300m [dBμV/m]	Margin [dB]
0.016	Max Peak	Y	100	59	-80.29	19.65	46.36	-	-	-33.64	64.10	-97.74
0.028	Max Peak	X	100	107	-84.99	20.26	42.27	-	-	-37.73	58.79	-96.52
0.211	Max Peak	Y	100	117	-90.05	19.27	36.22	-	-	-43.78	41.12	-84.90
1.777	Max Peak	X	100	11	-81.60	19.89	45.29	5.29	29.54	-	-	-24.25
5.445	Max Peak	Y	100	233	-93.83	20.07	33.24	-6.76	29.54	-	-	-36.30
25.730	Max Peak	X	100	193	-93.85	22.59	35.74	-4.26	29.54	-	-	-33.80

Table 7-10. Radiated Measurements (Reader A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 28 of 37

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

§15.209 §15.225(d); RSS-Gen (8.9)



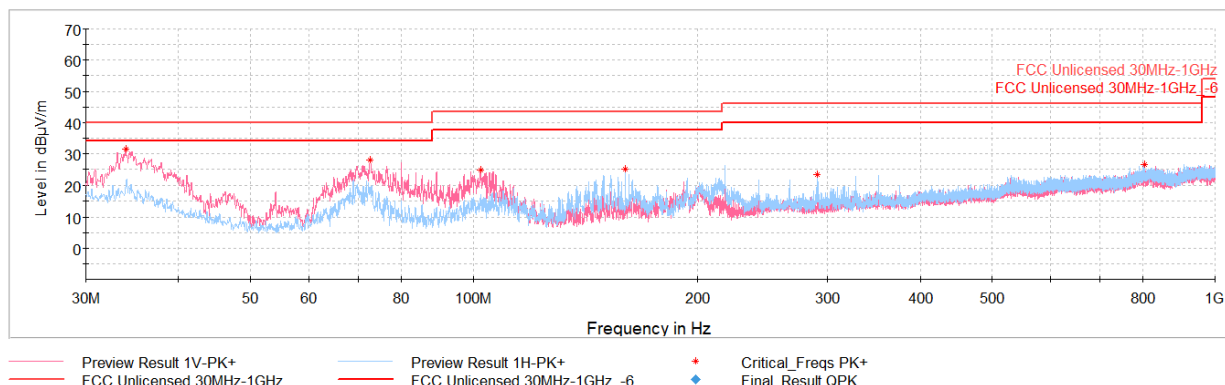
Plot 7-10. Radiated Spurious Emissions 30MHz – 1GHz (CE F 424kbps, with AC/DC Adapter and Magnetic Charger)

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]
290.979	Max Peak	H	100	293	-68.08	-14.72	24.20	46.02	-21.82
159.980	Max Peak	H	200	216	-61.82	-18.74	26.44	43.52	-17.08
732.232	Max Peak	V	100	160	-75.55	-6.76	24.69	46.02	-21.33
34.317	Max Peak	V	100	202	-55.28	-17.93	33.79	40.00	-6.21
72.632	Max Peak	V	100	238	-55.42	-23.13	28.45	40.00	-11.55
102.556	Max Peak	V	100	242	-60.20	-21.05	25.75	43.52	-17.77

Table 7-11. Radiated Measurements (CE F 424kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 29 of 37

V 10.5 12/15/2021



Plot 7-11. Radiated Spurious Emissions 30MHz – 1GHz (Reader 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]
159.980	Max Peak	H	100	0	-63.15	-18.74	25.11	43.52	-18.41
290.833	Max Peak	H	100	267	-69.03	-14.73	23.24	46.02	-22.78
802.363	Max Peak	H	200	269	-77.01	-3.38	26.61	46.02	-19.41
33.977	Max Peak	V	100	128	-57.91	-17.69	31.40	40.00	-8.60
72.680	Max Peak	V	100	175	-56.02	-23.13	27.85	40.00	-12.15
102.314	Max Peak	V	100	221	-61.28	-21.10	24.62	43.52	-18.90

Table 7-12. Radiated Measurements (Reader A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 30 of 37

V 10.5 12/15/2021

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 C63.10-2020, 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

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 31 of 37

V 10.5 12/15/2021

Test Setup

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

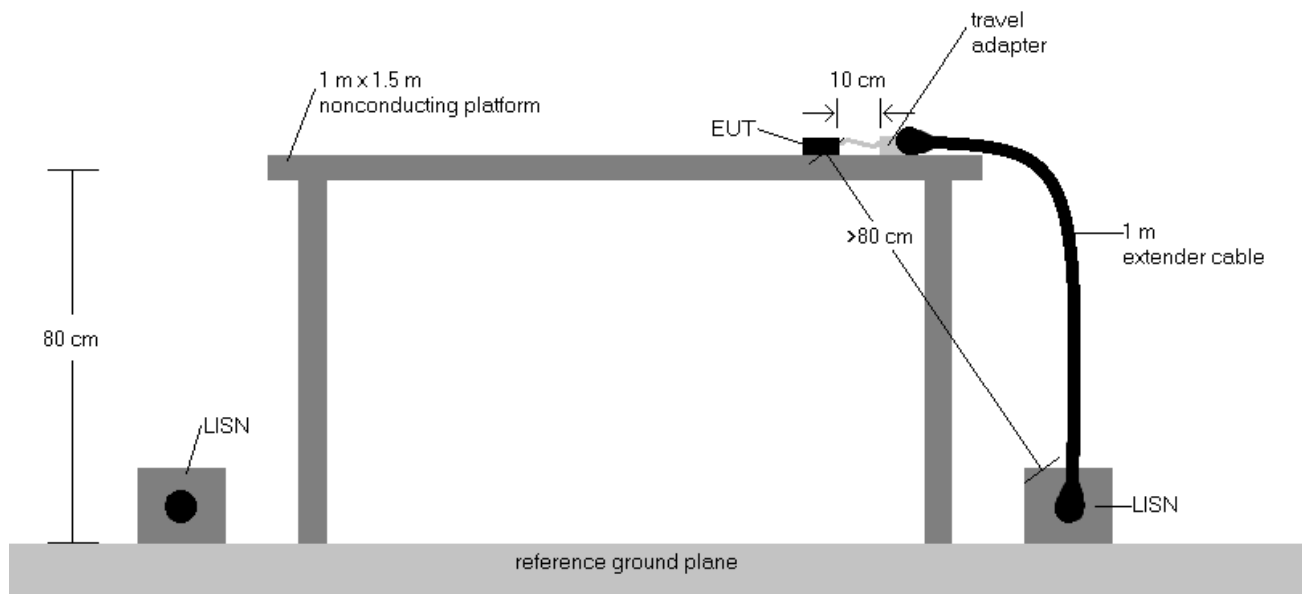


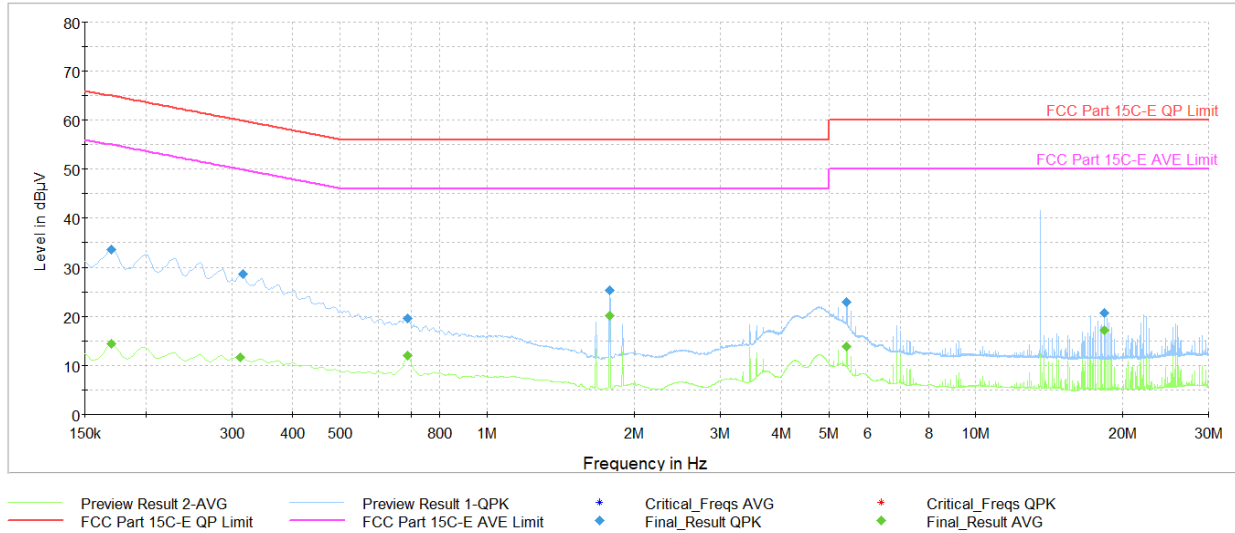
Figure 7-8. Test Instrument & Measurement Setup

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-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 32 of 37

V 10.5 12/15/2021



Plot 7-12. AC Line-Conducted Plot (L1, CE F 424kbps, with AC/DC Adapter and Magnetic Charger)

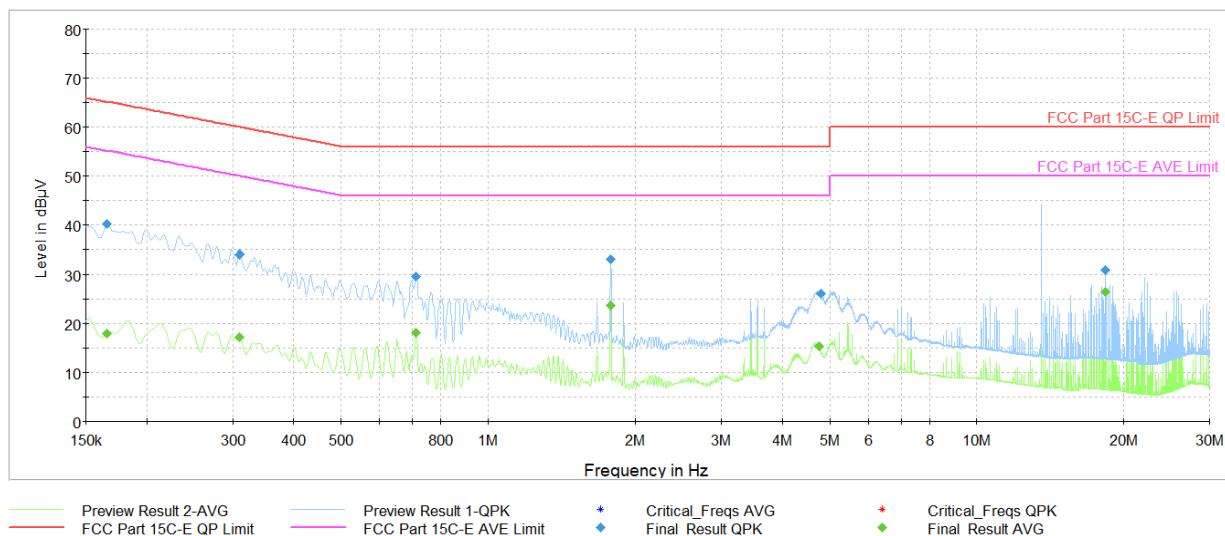
Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.170	FINAL	—	14.49	54.95	-40.46	L1	GND
0.170	FINAL	33.7	—	64.95	-31.21	L1	GND
0.312	FINAL	—	11.64	49.92	-38.28	L1	GND
0.317	FINAL	28.6	—	59.80	-31.18	L1	GND
0.688	FINAL	—	11.97	46.00	-34.03	L1	GND
0.688	FINAL	19.6	—	56.00	-36.44	L1	GND
1.777	FINAL	25.5	—	56.00	-30.55	L1	GND
1.777	FINAL	—	20.17	46.00	-25.83	L1	GND
5.444	FINAL	22.9	—	60.00	-37.11	L1	GND
5.444	FINAL	—	13.82	50.00	-36.18	L1	GND
18.332	FINAL	—	17.26	50.00	-32.74	L1	GND
18.332	FINAL	20.8	—	60.00	-39.24	L1	GND

Table 7-14. AC Line-Conducted Data (L1, CE F 424kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 33 of 37

V 10.5 12/15/2021

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Plot 7-13. AC Line-Conducted Plot (N, CE F 424kbps, with AC/DC Adapter and Magnetic Charger)

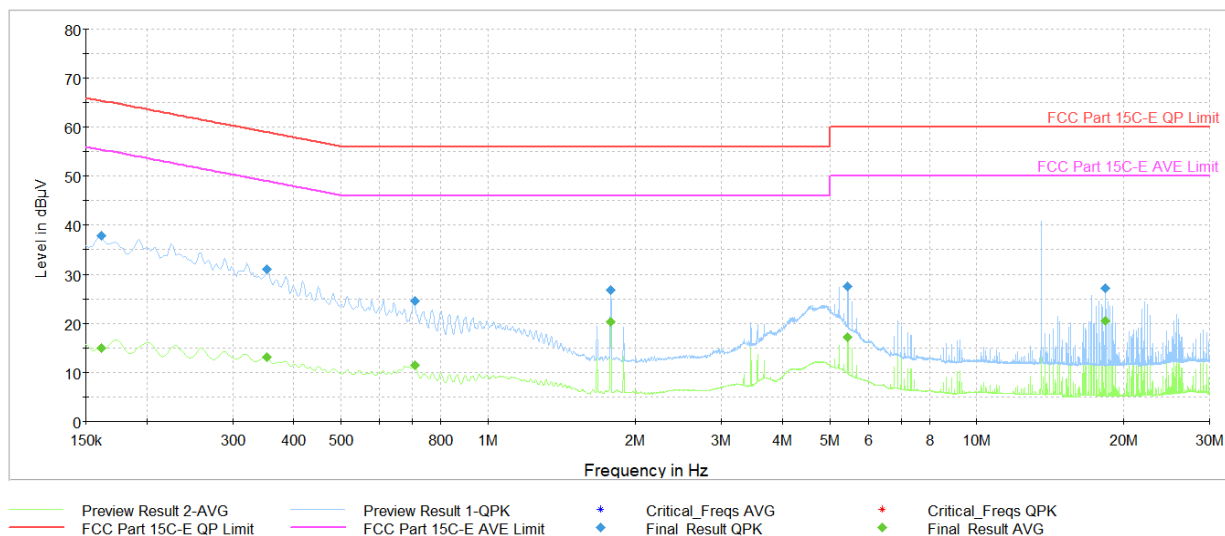
Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.166	FINAL	—	17.96	55.17	-37.21	N	GND
0.166	FINAL	40.2	—	65.17	-24.99	N	GND
0.310	FINAL	—	17.20	49.98	-32.78	N	GND
0.310	FINAL	34.1	—	59.98	-25.85	N	GND
0.713	FINAL	29.7	—	56.00	-26.31	N	GND
0.713	FINAL	—	18.09	46.00	-27.91	N	GND
1.777	FINAL	33.1	—	56.00	-22.92	N	GND
1.777	FINAL	—	23.71	46.00	-22.29	N	GND
4.754	FINAL	—	15.33	46.00	-30.67	N	GND
4.787	FINAL	26.2	—	56.00	-29.81	N	GND
18.332	FINAL	—	26.54	50.00	-23.46	N	GND
18.332	FINAL	30.9	—	60.00	-29.15	N	GND

Table 7-15. AC Line-Conducted Data (N, CE F 424kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 34 of 37

V 10.5 12/15/2021

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

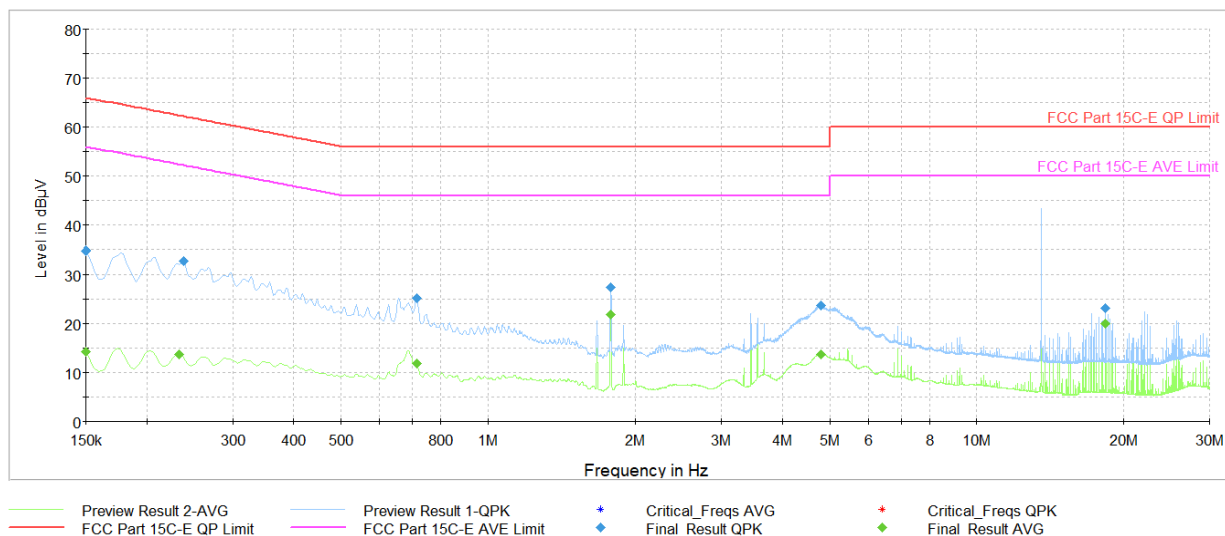
Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.161	FINAL	—	14.92	55.40	-40.48	L1	GND
0.161	FINAL	37.9	—	65.40	-27.55	L1	GND
0.353	FINAL	—	13.07	48.90	-35.83	L1	GND
0.353	FINAL	31.0	—	58.90	-27.86	L1	GND
0.708	FINAL	—	11.57	46.00	-34.43	L1	GND
0.708	FINAL	24.6	—	56.00	-31.45	L1	GND
1.777	FINAL	26.9	—	56.00	-29.07	L1	GND
1.777	FINAL	—	20.31	46.00	-25.69	L1	GND
5.444	FINAL	27.6	—	60.00	-32.45	L1	GND
5.444	FINAL	—	17.27	50.00	-32.73	L1	GND
18.332	FINAL	—	20.62	50.00	-29.38	L1	GND
18.332	FINAL	27.3	—	60.00	-32.69	L1	GND

Table 7-16. AC Line-Conducted Data (L1, Reader A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 35 of 37

V 10.5 12/15/2021

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Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.150	FINAL	—	14.22	56.00	-41.78	N	GND
0.150	FINAL	34.8	—	66.00	-31.19	N	GND
0.233	FINAL	—	13.71	52.33	-38.63	N	GND
0.238	FINAL	32.8	—	62.17	-29.41	N	GND
0.715	FINAL	—	11.94	46.00	-34.06	N	GND
0.715	FINAL	25.1	—	56.00	-30.90	N	GND
1.777	FINAL	27.5	—	56.00	-28.51	N	GND
1.777	FINAL	—	21.94	46.00	-24.06	N	GND
4.787	FINAL	23.6	—	56.00	-32.39	N	GND
4.799	FINAL	—	13.79	46.00	-32.21	N	GND
18.332	FINAL	—	19.97	50.00	-30.03	N	GND
18.332	FINAL	23.1	—	60.00	-36.90	N	GND

Table 7-17. AC Line-Conducted Data (N, Reader A 848kbps, with AC/DC Adapter and Magnetic Charger)

FCC ID: BCG-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 36 of 37

V 10.5 12/15/2021

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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-A2999** and **IC: 579C-A2999** 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-A2999 IC: 579C-A2999		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2405230020-10.BCG	Test Dates: 6/12/2024 - 7/24/2024	EUT Type: Watch	Page 37 of 37