


FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 43 of 71

V 10.6 09/01/2023

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7.6 Conducted Spurious Emissions

§15.247(d); RSS-247 [5.5]

Test Overview and Limit

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. For the following out of band conducted spurious emissions plots, the EUT was investigated in all available data rates for “b”, “g”, “n” modes. The worst case spurious emissions for the 2.4GHz band were found while transmitting in “b” mode at 1 Mbps and are shown in the plots below.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 11.11 of ANSI C63.10-2020 and KDB 558074 D01 v05r02.

Test Procedure Used

ANSI C63.10-2020 – Subclause 11.11.3
KDB 558074 D01 v05r02 – Section 8.5

Test Settings


1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

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



Figure 7-5. Test Instrument & Measurement Setup

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 44 of 71

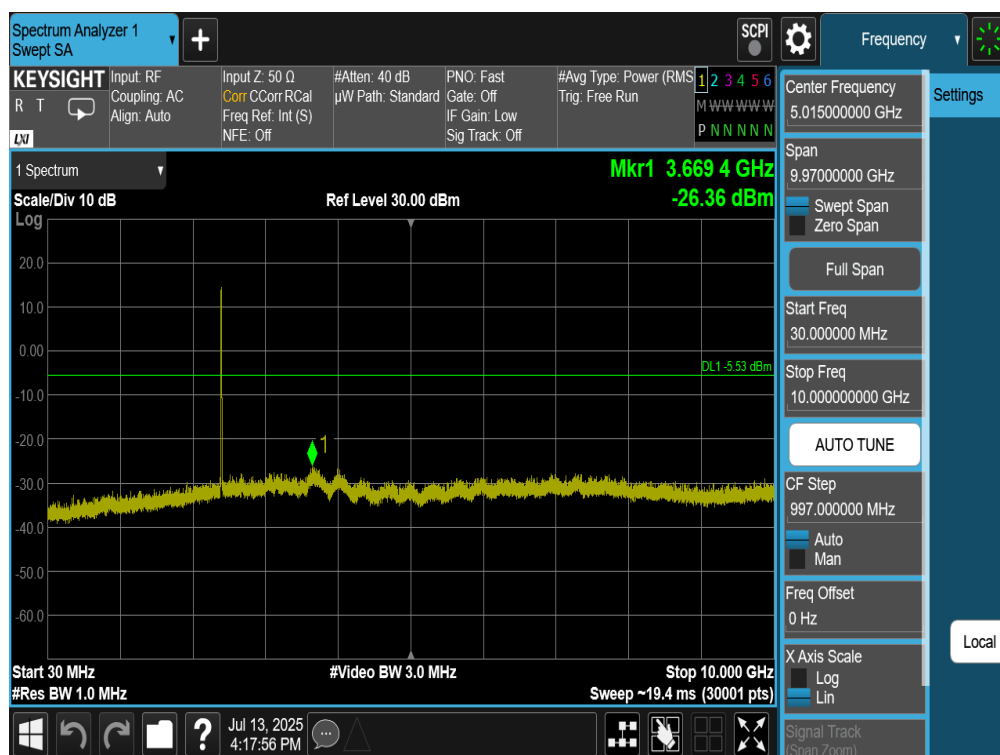
V 10.6 09/01/2023

Test Notes

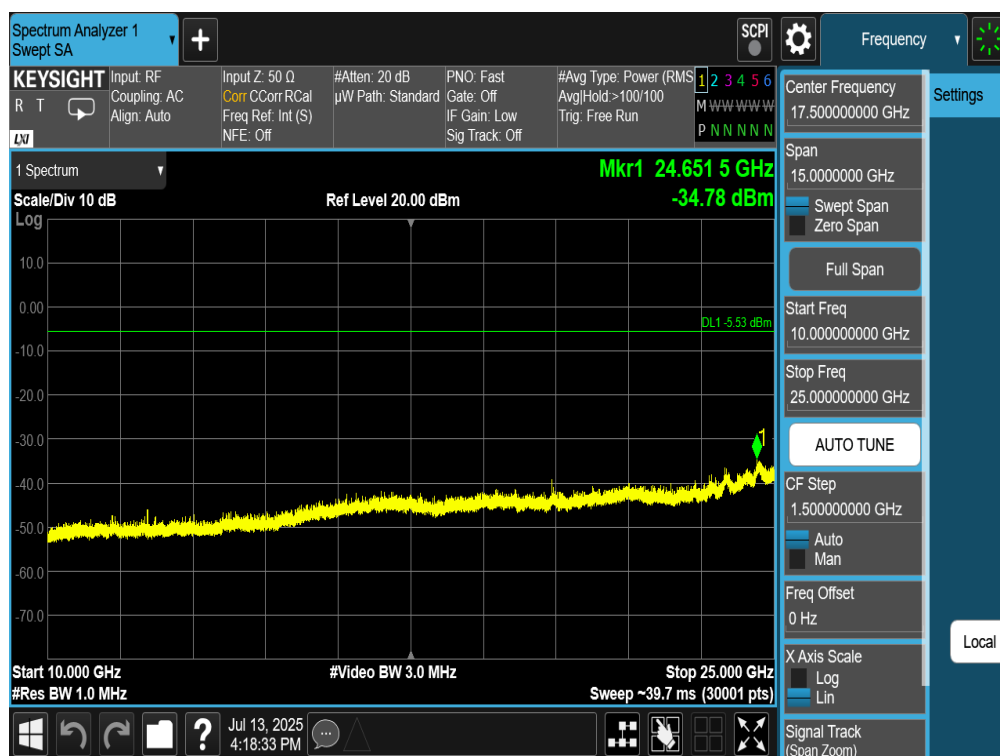
1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.
3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.
4. The conducted spurious emissions were measured to relative limits.
5. The unit was tested with all possible modes and only the highest emission is reported.

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 45 of 71


V 10.6 09/01/2023



Plot 7-45. Conducted Spurious Plot (802.11b – Ch. 1)

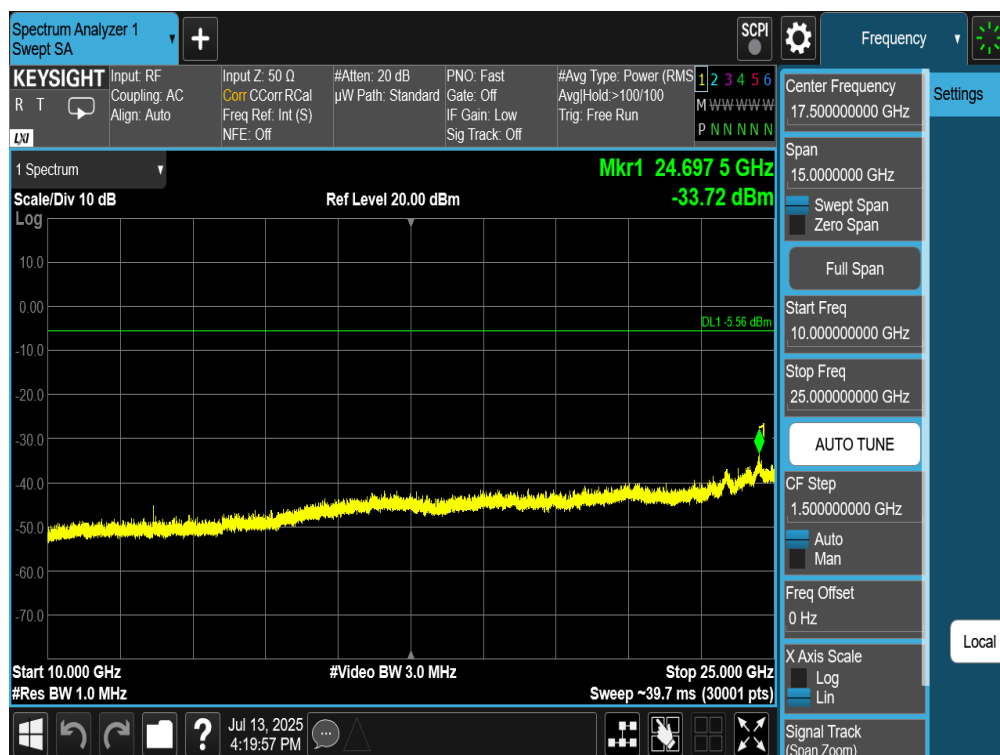
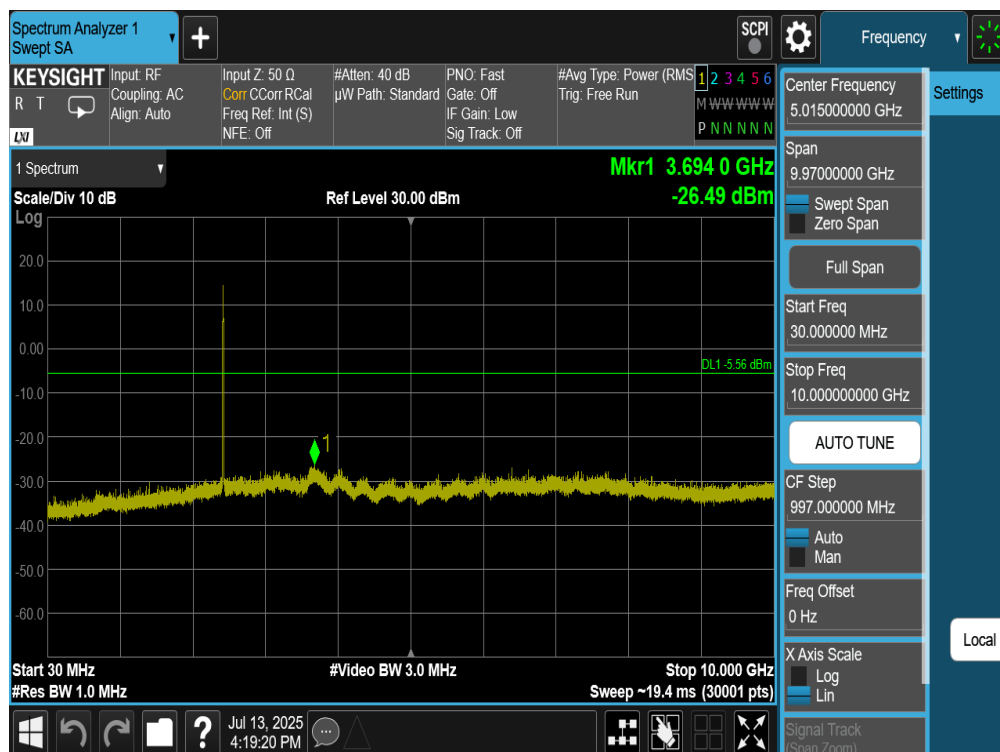



Plot 7-46. Conducted Spurious Plot (802.11b – Ch. 1)

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 46 of 71

V 10.6 09/01/2023

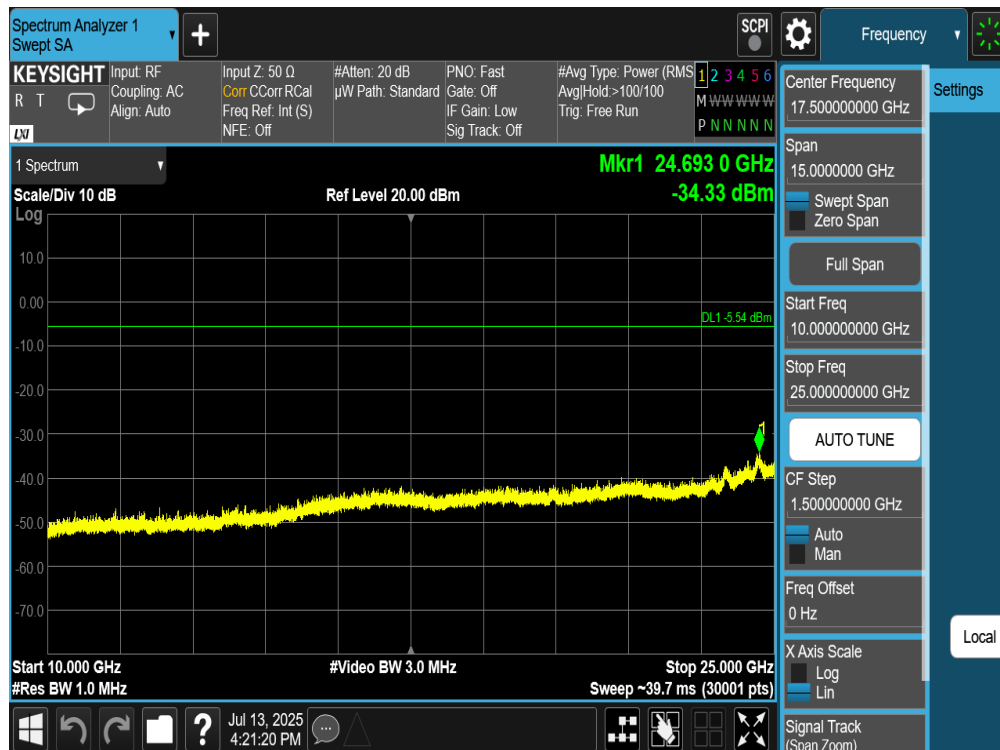
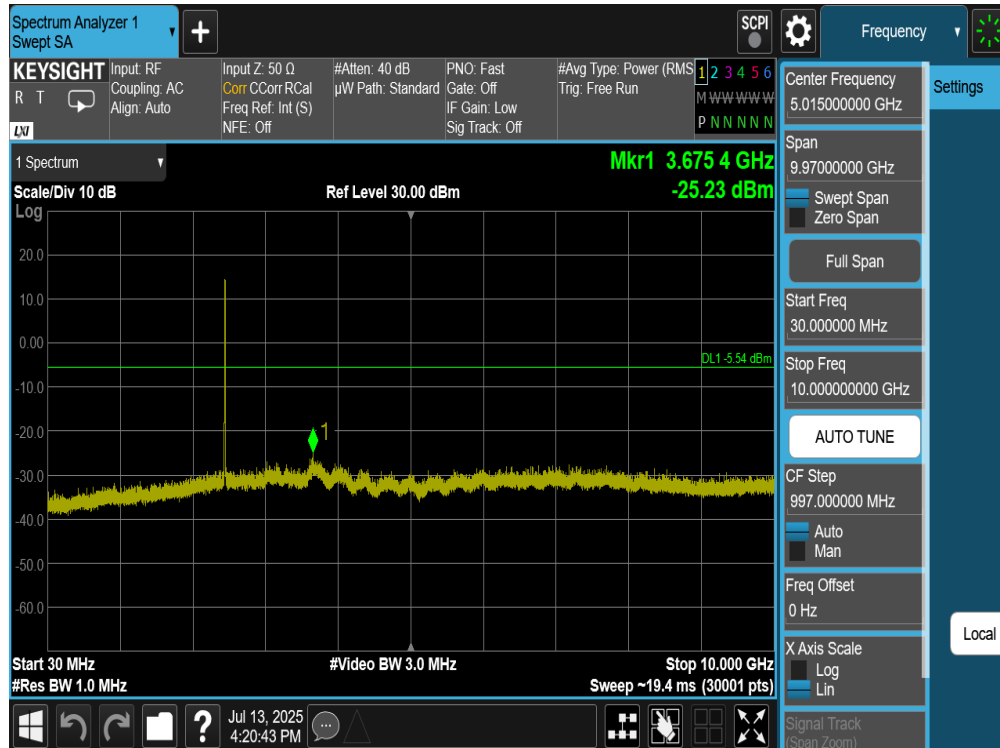
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FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 47 of 71

V 10.6 09/01/2023

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FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 48 of 71

V 10.6 09/01/2023

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7.7 Radiated Spurious Emissions – Above 1 GHz

§15.247(d) §15.205 & §15.209; RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna 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 radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 7 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-6 per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [$\mu\text{V/m}$]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-6. Radiated Limits

Test Procedures Used

ANSI C63.10-2020 – Subclause 6.6.4.3
KDB 558074 D01 v05r02 – Sections 8.6, 8.7

Test Settings

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points = 1001 (Number of points must be $\geq 2 \times \text{span/RBW}$)
6. Sweep time = auto
7. Trace (RMS) averaging was performed over at least 100 traces

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 49 of 71

V 10.6 09/01/2023

Test Setup

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

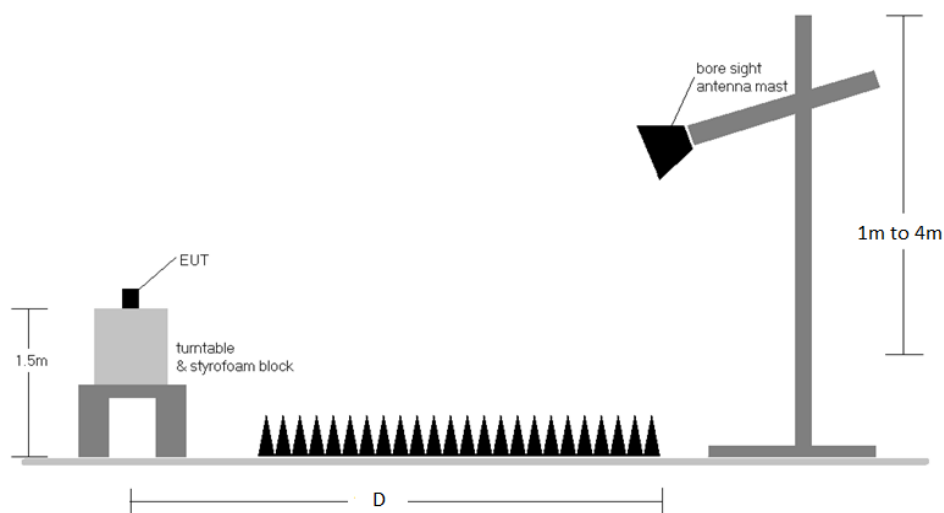



Figure 7-6. Radiated Measurement Setup

Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 D01 v05r02 were not used to evaluate this device for compliance to radiated limits. All Radiated Spurious Emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in Section 15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-6.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas.
6. D is the measurement test distance and emissions 1-18GHz were measured at a 3 meters test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.
8. The "-" shown in the following RSE tables are used to denote a noise floor measurement.
9. The unit was tested with all possible modes and only the highest emission is reported.

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 50 of 71

V 10.6 09/01/2023

Sample Calculations

Determining Spurious Emissions Levels

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

Radiated Band Edge Measurement Offset

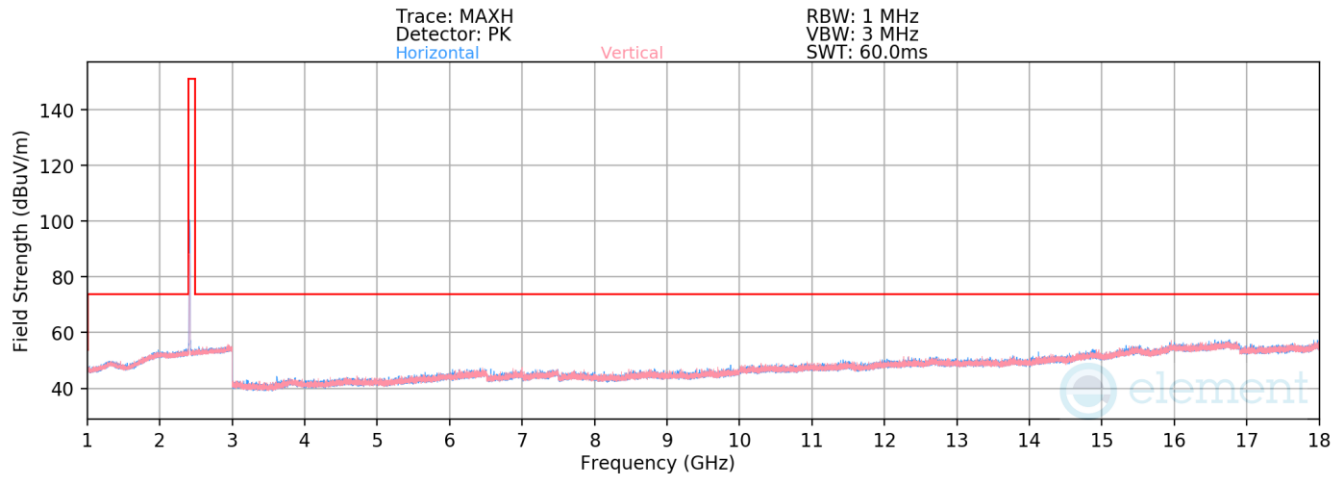
- The amplitude offset shown in the radiated restricted band edge plots was calculated using the formula:
Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch		Page 51 of 71

V 10.6 09/01/2023

Radiated Spurious Emission Measurements

\$15.247(d) §15.205 & §15.209; RSS-Gen [8.9]



Plot 7-51. Radiated Spurious Emissions above 1GHz (802.11b – Ch. 1)

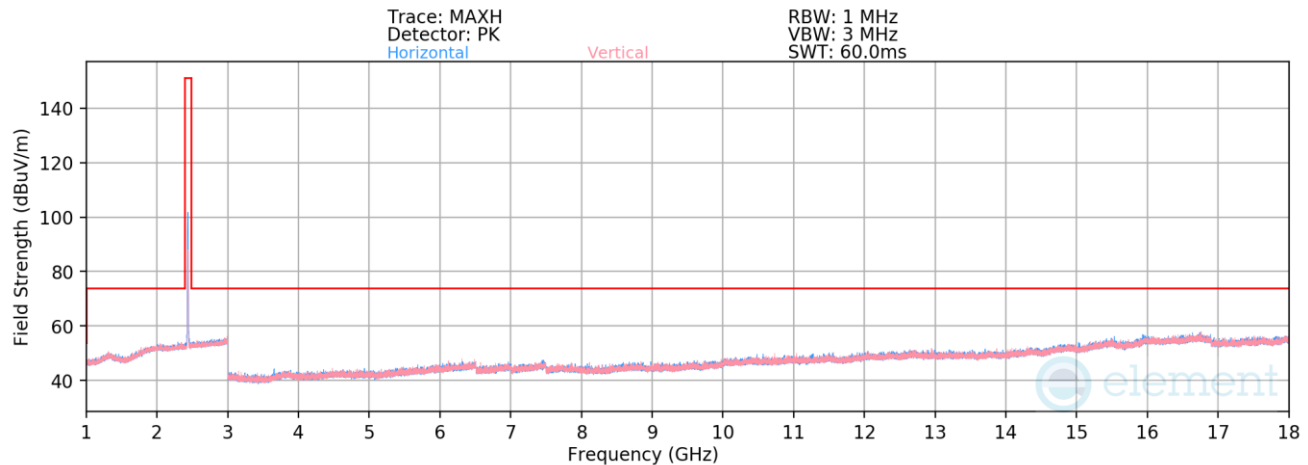
Mode: 802.11b
Data Rate: 1Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 2412MHz
Channel: 01

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBuV/m]	Limit [dBuV/m]	Margin [dB]
4824.00	Avg	V	-	-	-76.58	2.33	33.91	53.98	-20.07
4824.00	Peak	V	-	-	-64.51	2.34	45.48	73.98	-28.50
12060.00	Avg	V	-	-	-79.23	11.38	41.09	53.98	-12.89
12060.00	Peak	V	-	-	-68.06	11.24	52.43	73.98	-21.55

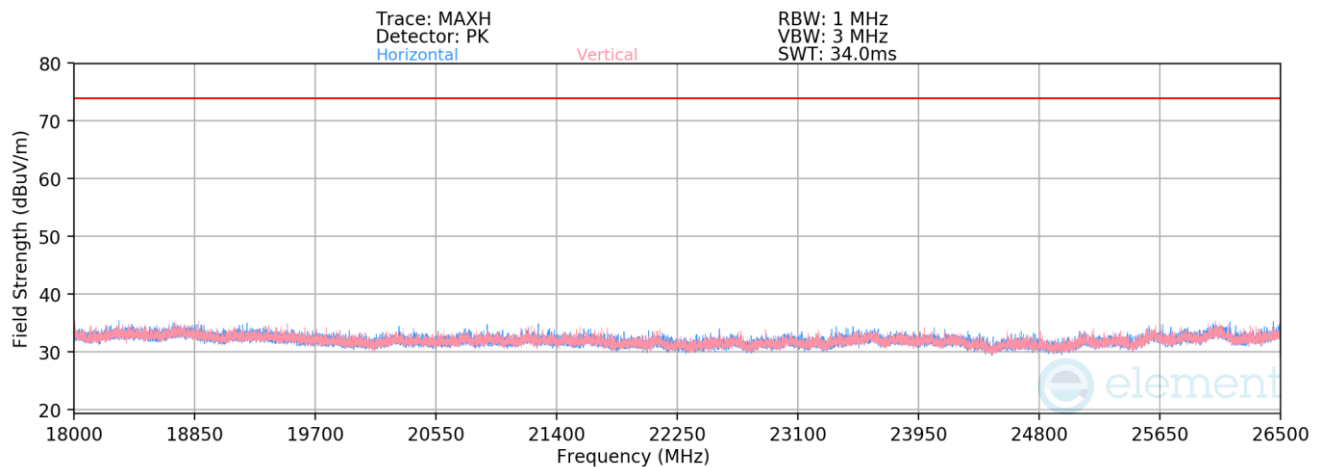
Table 7-7. Radiated Measurements

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 52 of 71

V 10.6 09/01/2023



Plot 7-52. Radiated Spurious Emissions above 1GHz (802.11b – Ch. 6)



Plot 7-53. Radiated Spurious Emissions Above 18GHz (802.11b – Ch. 6)

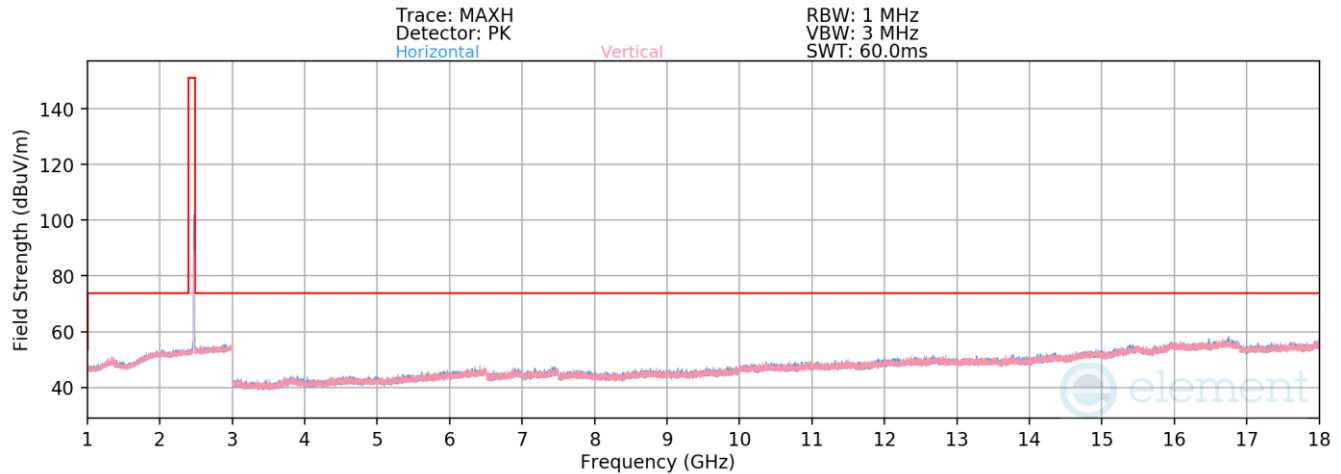
Mode: 802.11b
Data Rate: 1Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 2437MHz
Channel: 06

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBuV/m]	Limit [dBuV/m]	Margin [dB]
4874.00	Avg	V	-	-	-76.96	2.51	33.80	53.98	-20.18
4874.00	Peak	V	-	-	-65.46	2.66	45.44	73.98	-28.54
7311.00	Avg	V	-	-	-77.58	5.40	36.05	53.98	-17.93
7311.00	Peak	V	-	-	-65.48	5.43	47.17	73.98	-26.81
12185.00	Avg	V	-	-	-79.69	11.57	40.23	53.98	-13.75
12185.00	Peak	V	-	-	-68.51	11.53	51.85	73.98	-22.13

Table 7-8. Radiated Measurements

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 53 of 71

V 10.6 09/01/2023



Plot 7-54. Radiated Spurious Emissions above 1GHz (802.11b – Ch. 11)

Mode: 802.11b
Data Rate: 1Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 2462MHz
Channel: 11

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBuV/m]	Limit [dBuV/m]	Margin [dB]
4924.00	Avg	V	-	-	-76.84	2.42	33.82	53.98	-20.16
4924.00	Peak	V	-	-	-65.65	2.71	45.47	73.98	-28.51
7386.00	Avg	V	-	-	-77.14	5.50	36.72	53.98	-17.26
7386.00	Peak	V	-	-	-65.81	5.50	48.00	73.98	-25.98
12310.00	Avg	V	-	-	-79.81	12.21	41.18	53.98	-12.80
12310.00	Peak	V	-	-	-69.02	12.21	53.34	73.98	-20.64

Table 7-9. Radiated Measurements

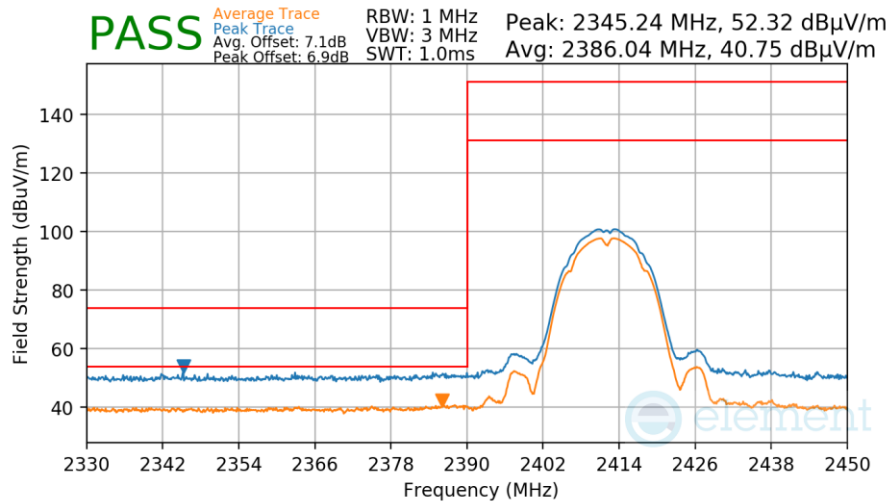
FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 54 of 71

V 10.6 09/01/2023

Radiated Spurious Emission Measurements

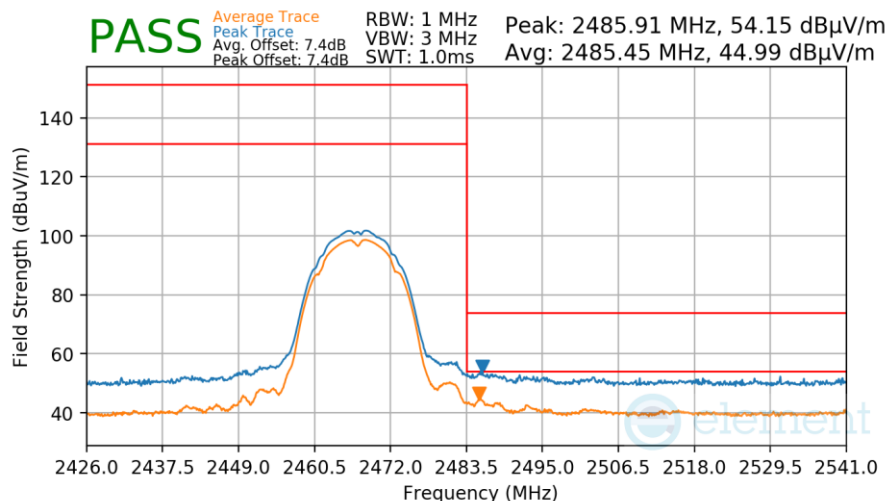
\$15.205 \$15.209; RSS-Gen [8.9]

Mode: 802.11b
Data Rate: 1Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 2412MHz
Channel: 1



Plot 7-55. Radiated Restricted Lower Band Edge Measurement

Mode: 802.11b
Data Rate: 1Mbps
Distance of Measurements: 3 Meters
Operating Frequency: 2467MHz
Channel: 12

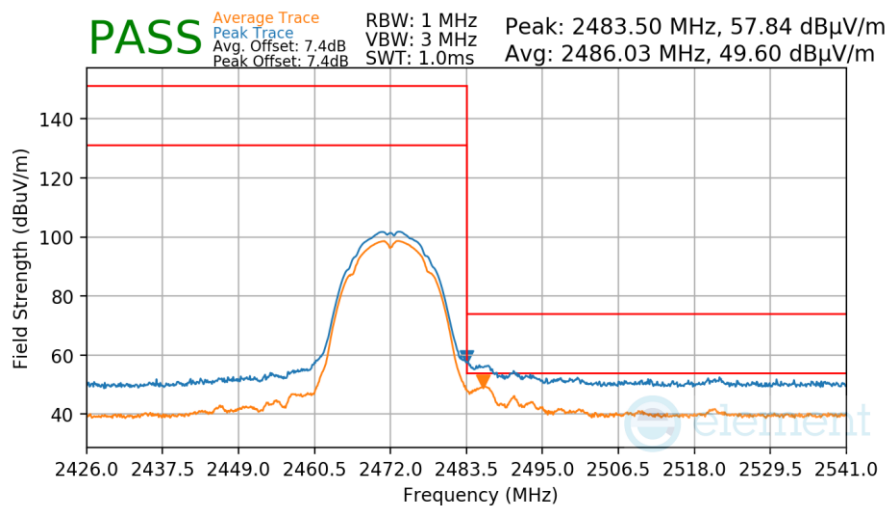


Plot 7-56. Radiated Restricted Upper Band Edge Measurement


FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 55 of 71

V 10.6 09/01/2023

Mode: 802.11b
 Data Rate: 1Mbps
 Distance of Measurements: 3 Meters
 Operating Frequency: 2472MHz
 Channel: 13

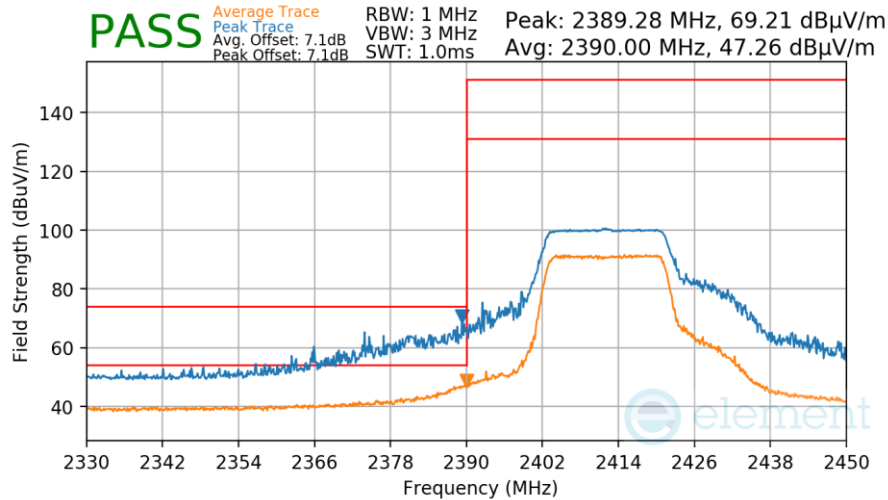


Plot 7-57. Radiated Restricted Upper Band Edge Measurement

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 56 of 71

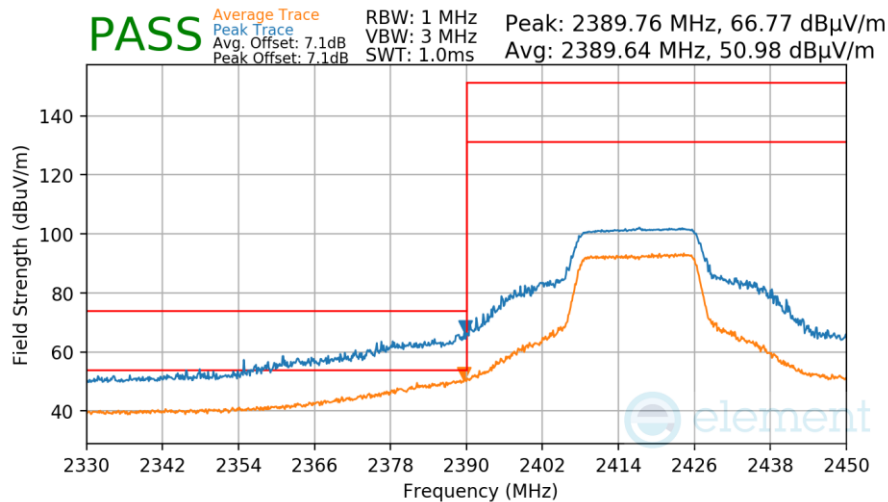
V 10.6 09/01/2023

Mode: 802.11n
Data Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 2412MHz
Channel: 1



Plot 7-58. Radiated Restricted Lower Band Edge Measurement

Mode: 802.11n
Data Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 2417MHz
Channel: 2

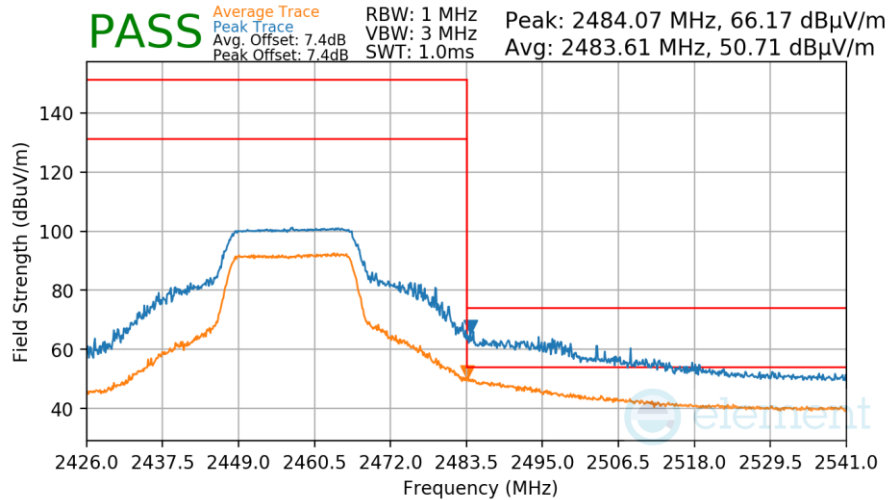


Plot 7-59. Radiated Restricted Lower Band Edge Measurement

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 57 of 71

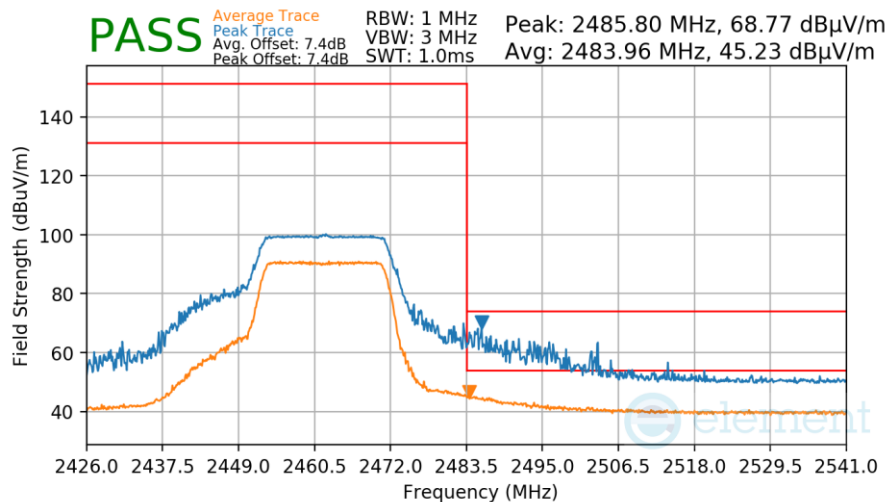
V 10.6 09/01/2023

Mode: 802.11n
Data Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 2457MHz
Channel: 10



Plot 7-60. Radiated Restricted Upper Band Edge Measurement

Mode: 802.11n
Data Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 2462MHz
Channel: 11

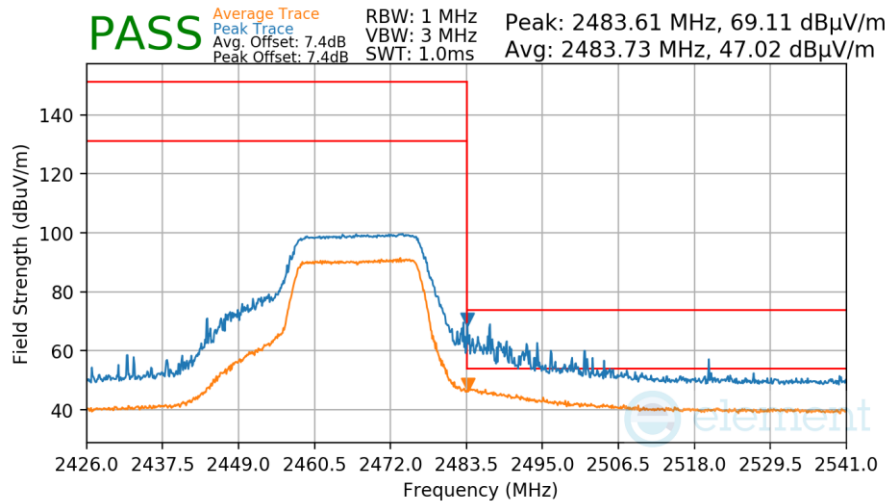


Plot 7-61. Radiated Restricted Upper Band Edge Measurement

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 58 of 71

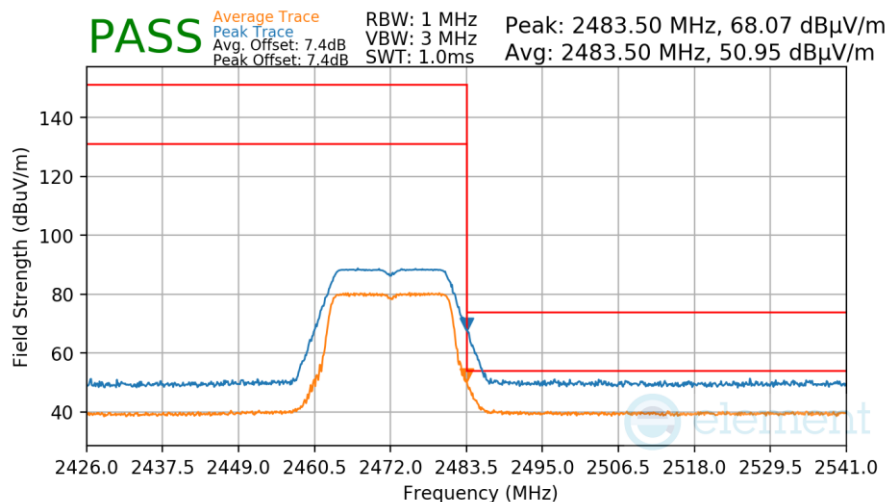
V 10.6 09/01/2023

Mode: 802.11n
Data Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 2467MHz
Channel: 12



Plot 7-62. Radiated Restricted Upper Band Edge Measurement

Mode: 802.11n
Data Rate: MCS0
Distance of Measurements: 3 Meters
Operating Frequency: 2472MHz
Channel: 13

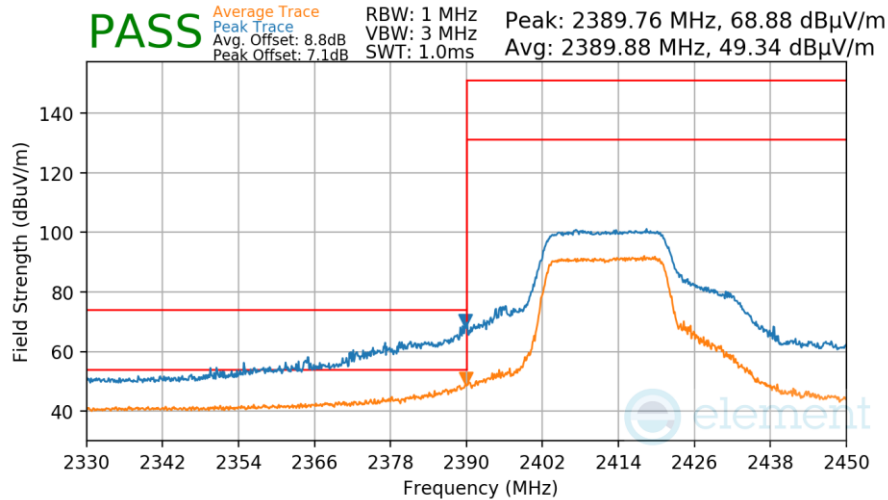


Plot 7-63. Radiated Restricted Upper Band Edge Measurement

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 59 of 71

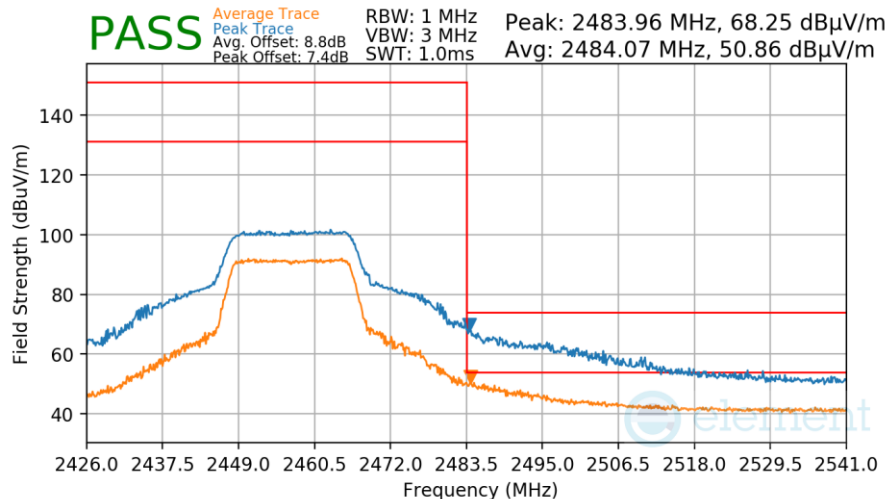
V 10.6 09/01/2023

Mode: 802.11n
Data Rate: MCS7
Distance of Measurements: 3 Meters
Operating Frequency: 2412MHz
Channel: 1



Plot 7-64. Radiated Restricted Lower Band Edge Measurement

Mode: 802.11n
Data Rate: MCS7
Distance of Measurements: 3 Meters
Operating Frequency: 2457MHz
Channel: 10

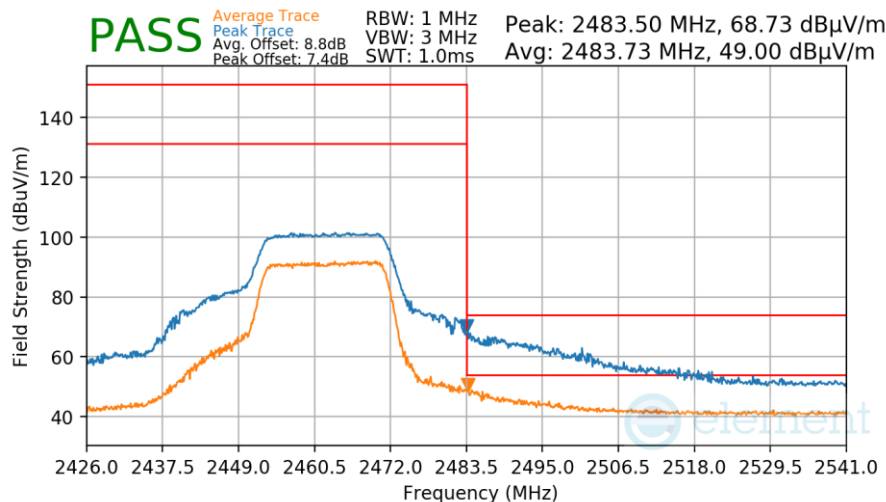


Plot 7-65. Radiated Restricted Upper Band Edge Measurement

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 60 of 71

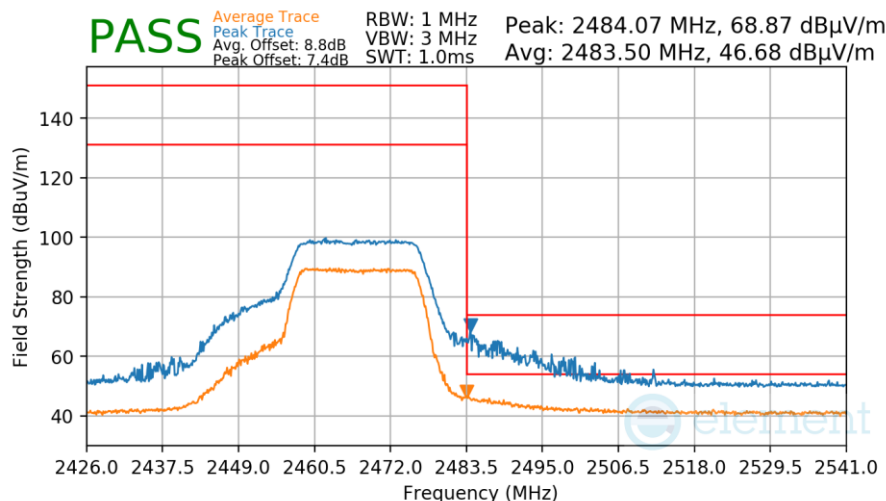
V 10.6 09/01/2023

Mode: 802.11n
Data Rate: MCS7
Distance of Measurements: 3 Meters
Operating Frequency: 2462MHz
Channel: 11



Plot 7-66. Radiated Restricted Upper Band Edge Measurement

Mode: 802.11n
Data Rate: MCS7
Distance of Measurements: 3 Meters
Operating Frequency: 2467MHz
Channel: 12

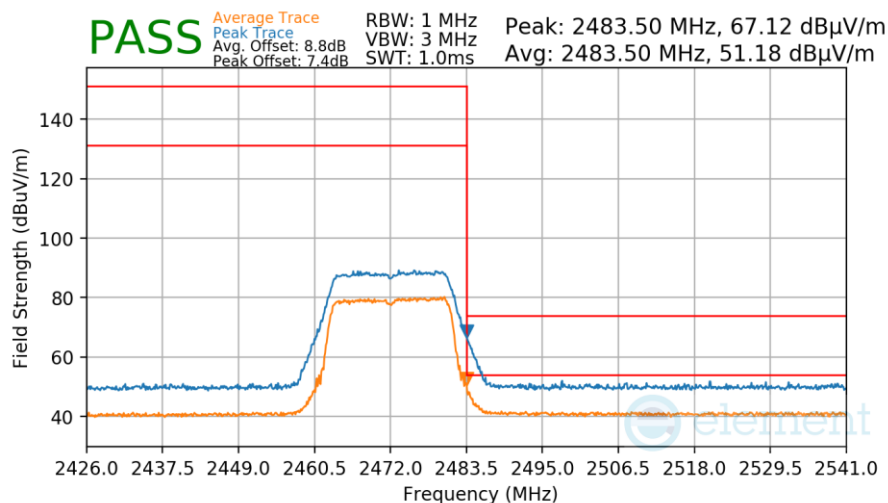


Plot 7-67. Radiated Restricted Upper Band Edge Measurement


FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 61 of 71

V 10.6 09/01/2023

Mode: 802.11n
 Data Rate: MCS7
 Distance of Measurements: 3 Meters
 Operating Frequency: 2472MHz
 Channel: 13



Plot 7-68. Radiated Restricted Upper Band Edge Measurement

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 62 of 71

V 10.6 09/01/2023

7.8 Radiated Spurious Emissions – Below 1GHz

§15.209; RSS-Gen [8.9]

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna 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 radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 7 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-10 per Section 15.209 and RSS-Gen (8.9).

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 7-10. Radiated Limits

Test Procedures Used

ANSI C63.10-2020

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. VBW = 300kHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 63 of 71

V 10.6 09/01/2023

Test Setup

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

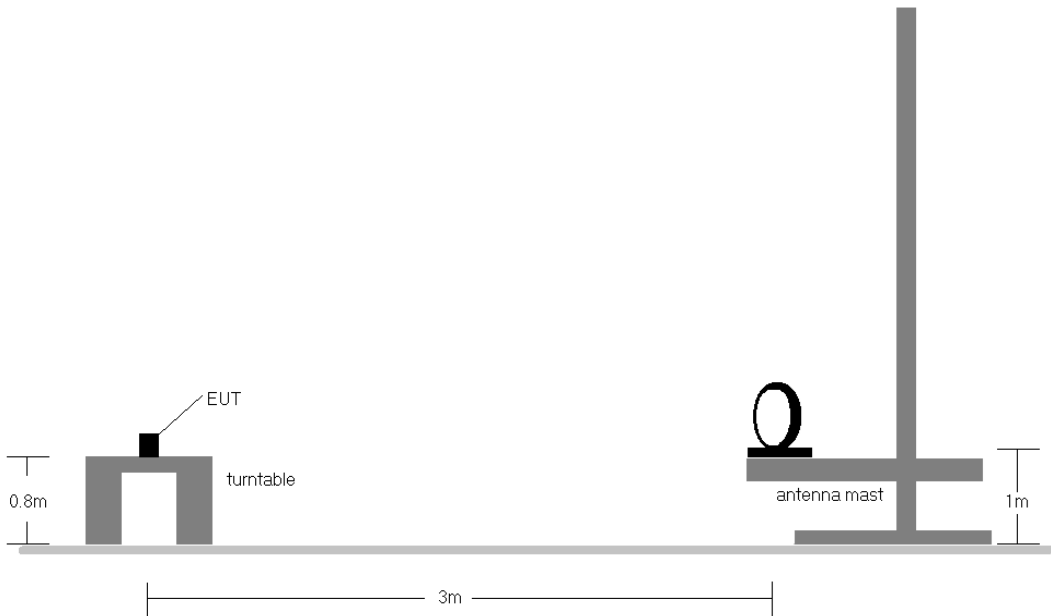


Figure 7-7. Radiated Test Setup < 30Mhz

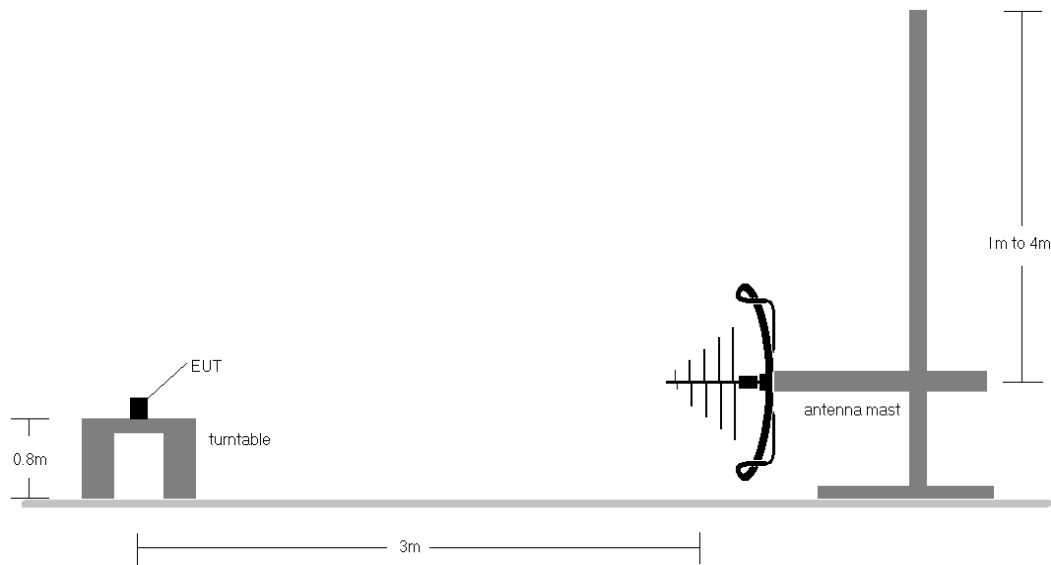



Figure 7-8. Radiated Test Setup < 1GHz

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 64 of 71

V 10.6 09/01/2023

Test Notes

1. All emissions lying in restricted bands specified in §15.205 and RSS-Gen(8.10) are below the limit shown in Table 7-10.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes. For 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. This unit was tested with its standard battery.
4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector for emissions within 6dB of the limit.
5. Emissions were measured at a 3 meter test distance.
6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
7. No spurious emissions were detected within 20dB of the limit below 30MHz.
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
9. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
10. The unit was tested with all possible modes and only the highest emission is reported.

Sample Calculations

Determining Spurious Emissions Levels

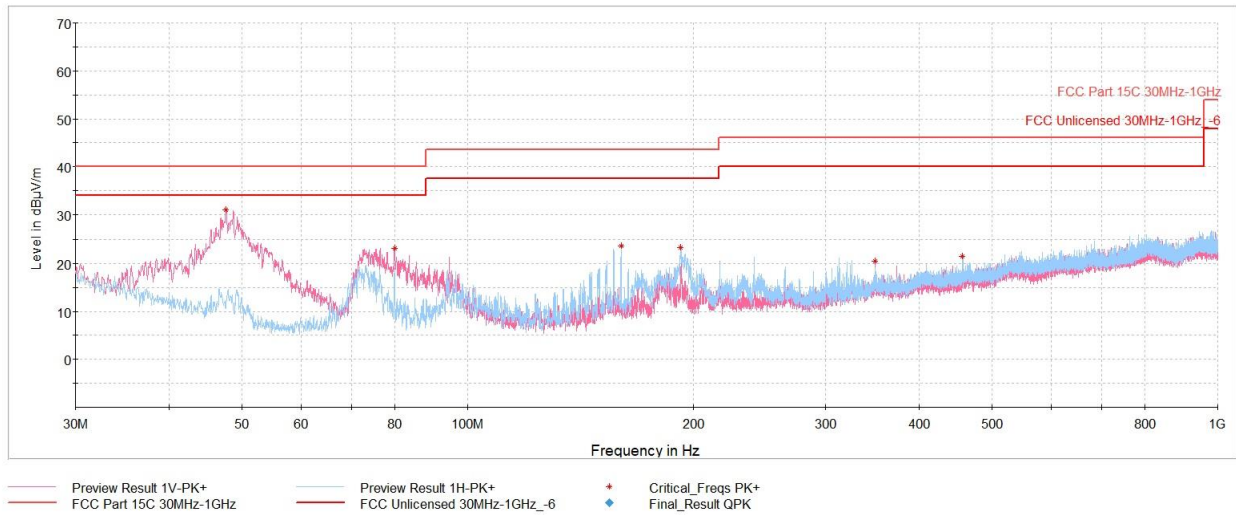
- Field Strength Level $_{[dB\mu V/m]} = \text{Analyzer Level }_{[dBm]} + 107 + \text{AFCL }_{[dB/m]}$
- $\text{AFCL }_{[dB/m]} = \text{Antenna Factor }_{[dB/m]} + \text{Cable Loss }_{[dB]} - \text{Preamplifier Gain }_{[dB]}$
- $\text{Margin }_{[dB]} = \text{Field Strength Level }_{[dB\mu V/m]} - \text{Limit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

FCC ID: BCG-A3333 IC: 579C-A3333	 MEASUREMENT REPORT (CERTIFICATION)		Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 65 of 71

V 10.6 09/01/2023

Radiated Spurious Emissions Measurements (Below 1GHz)

\$15.209; RSS-Gen [8.9]



Plot 7-69. Radiated Spurious Emissions below 1GHz 11b Ch.6, with AC/DC Adapter via USB-C cable with 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]
47.65	MaxPeak	V	100	341	-52.81	-23.19	31.00	40.00	-9.00
79.96	MaxPeak	V	100	215	-60.92	-23.01	23.07	40.00	-16.93
159.93	MaxPeak	H	200	0	-64.92	-18.46	23.62	43.52	-19.90
191.99	MaxPeak	H	100	208	-65.55	-18.19	23.26	43.52	-20.26
349.18	MaxPeak	V	100	195	-73.44	-13.11	20.45	46.02	-25.57
456.90	MaxPeak	H	300	289	-75.22	-10.30	21.48	46.02	-24.54

Table 7-11. Radiated Spurious Emissions below 1GHz 11b Ch.6, with AC/DC Adapter via USB-C cable with magnetic charger

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 66 of 71

V 10.6 09/01/2023

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7.9 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 (dB μ V)	
	Quasi-peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

Table 7-12. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2020, Subclause 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-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 67 of 71

V 10.6 09/01/2023

Test Setup

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

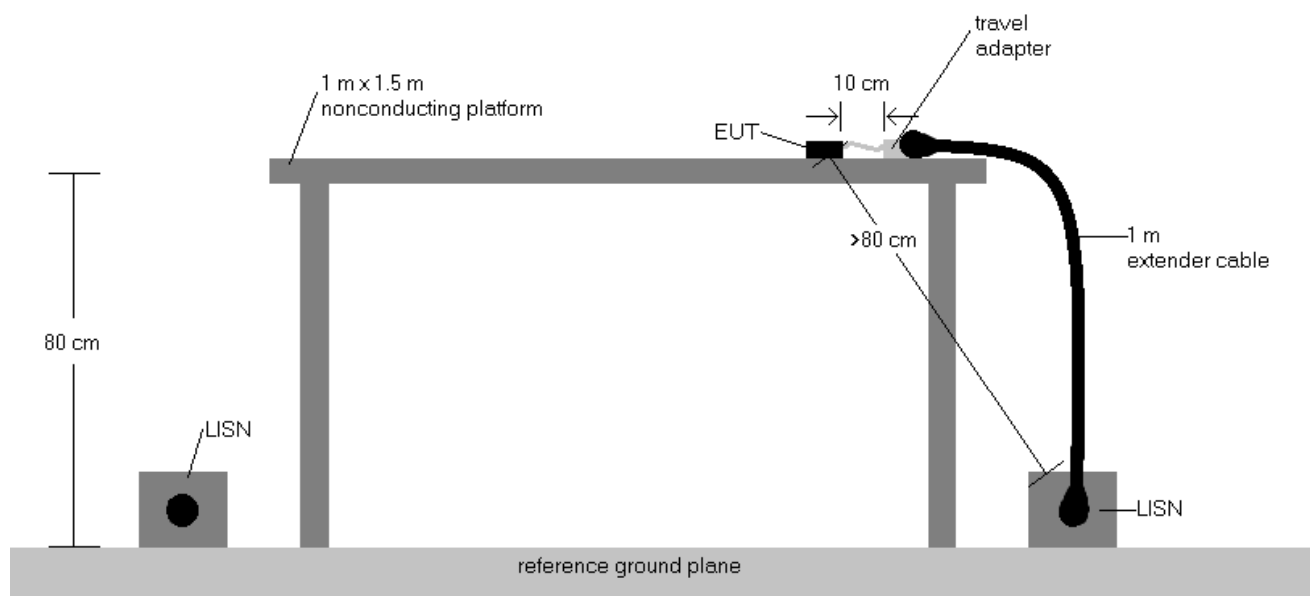



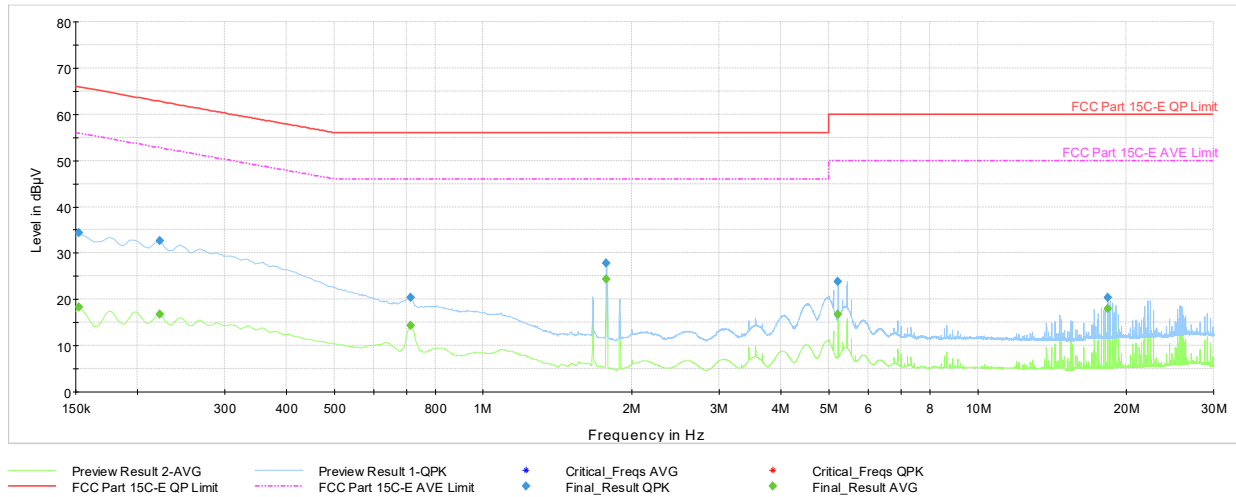
Figure 7-9. Test Instrument & Measurement Setup

Test Notes

1. All modes of operation were investigated and the worst-case emissions are reported. The emissions found were not affected by the choice of channel used during testing.
2. 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
3. The limit for an intentional radiator from 150kHz to 30MHz are specified in Part 15.207 and RSS-Gen(8.8).
4. $\text{Corr. (dB)} = \text{Cable loss (dB)} + \text{LISN insertion factor (dB)}$
5. $\text{QP/AV Level (dB}\mu\text{V)} = \text{QP/AV Analyzer/Receiver Level (dB}\mu\text{V)} + \text{Corr. (dB)}$
6. $\text{Margin (dB)} = \text{QP/AV Level (dB}\mu\text{V)} - \text{QP/AV Limit (dB}\mu\text{V)}$
7. Traces shown in plot are made using quasi peak and average detectors.
8. Deviations to the Specifications: None.

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 68 of 71

V 10.6 09/01/2023



Plot 7-70. AC Line Conducted Plot 802.11b - Ch.6 (L1, with AC/DC adaptor via USB-C cable with magnetic charger)

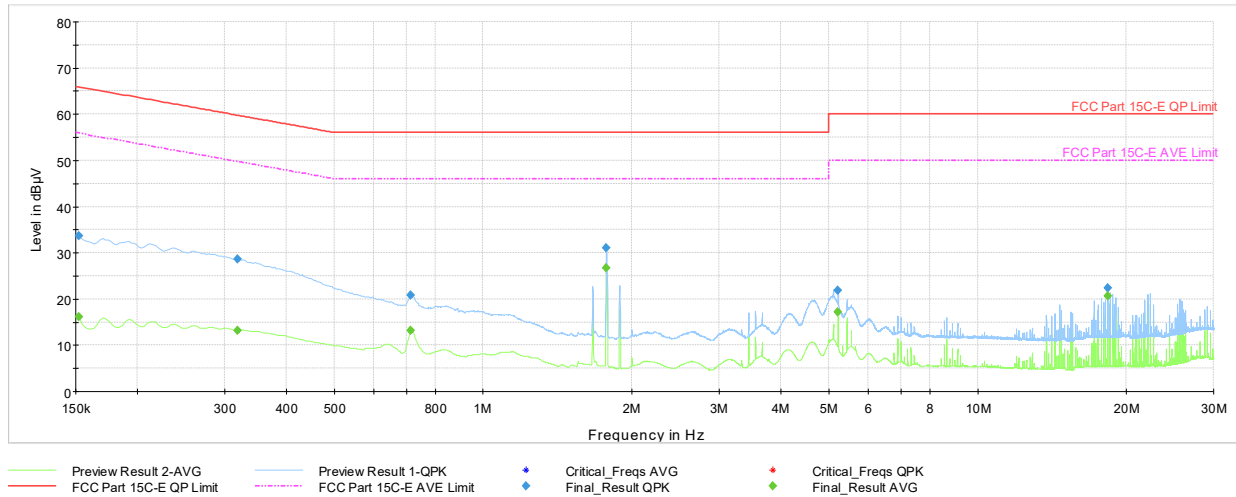
Frequency [MHz]	Process State	QuasiPeak [dBμV]	Average [dBμV]	Limit [dBμV]	Margin [dB]	Line	PE
0.152	FINAL	—	18.37	55.88	-37.50	L1	GND
0.152	FINAL	34.4	—	65.88	-31.49	L1	GND
0.222	FINAL	—	16.76	52.74	-35.98	L1	GND
0.222	FINAL	32.6	—	62.74	-30.16	L1	GND
0.713	FINAL	—	14.28	46.00	-31.72	L1	GND
0.713	FINAL	20.4	—	56.00	-35.59	L1	GND
1.777	FINAL	27.8	—	56.00	-28.21	L1	GND
1.777	FINAL	—	24.33	46.00	-21.67	L1	GND
5.222	FINAL	23.8	—	60.00	-36.17	L1	GND
5.222	FINAL	—	16.80	50.00	-33.20	L1	GND
18.332	FINAL	—	18.05	50.00	-31.95	L1	GND
18.332	FINAL	20.4	—	60.00	-39.57	L1	GND

Table 7-13. AC Line Conducted Data 802.11b - Ch.6 (L1, with AC/DC adaptor via USB-C cable with magnetic charger)

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 69 of 71

V 10.6 09/01/2023

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Plot 7-71. AC Line Conducted Plot 802.11b - Ch.6 (N, with AC/DC adaptor via USB-C cable with magnetic charger)

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.152	FINAL	—	16.08	55.88	-39.80	N	GND
0.152	FINAL	33.7	—	65.88	-32.14	N	GND
0.319	FINAL	—	13.25	49.74	-36.49	N	GND
0.319	FINAL	28.6	—	59.74	-31.15	N	GND
0.715	FINAL	—	13.15	46.00	-32.85	N	GND
0.715	FINAL	20.7	—	56.00	-35.26	N	GND
1.777	FINAL	31.0	—	56.00	-24.97	N	GND
1.777	FINAL	—	26.74	46.00	-19.26	N	GND
5.222	FINAL	21.8	—	60.00	-38.21	N	GND
5.222	FINAL	—	17.14	50.00	-32.86	N	GND
18.332	FINAL	—	20.69	50.00	-29.31	N	GND
18.332	FINAL	22.4	—	60.00	-37.57	N	GND

Table 7-14. AC Line Conducted Data 802.11b - Ch.6 (N, with AC/DC adaptor via USB-C cable with magnetic charger)


FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 70 of 71

V 10.6 09/01/2023

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8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Apple Watch FCC ID: BCG-A3333, IC: 579C-A3333** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules and RSS-247 of the Innovation, Science and Economic Development Canada Rules.

FCC ID: BCG-A3333 IC: 579C-A3333		MEASUREMENT REPORT (CERTIFICATION)	Approved by: Technical Manager
Test Report S/N: 1C2503270031-01.BCG	Test Dates: 6/10/2025 - 7/22/2025	EUT Type: Watch	Page 71 of 71

V 10.6 09/01/2023

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