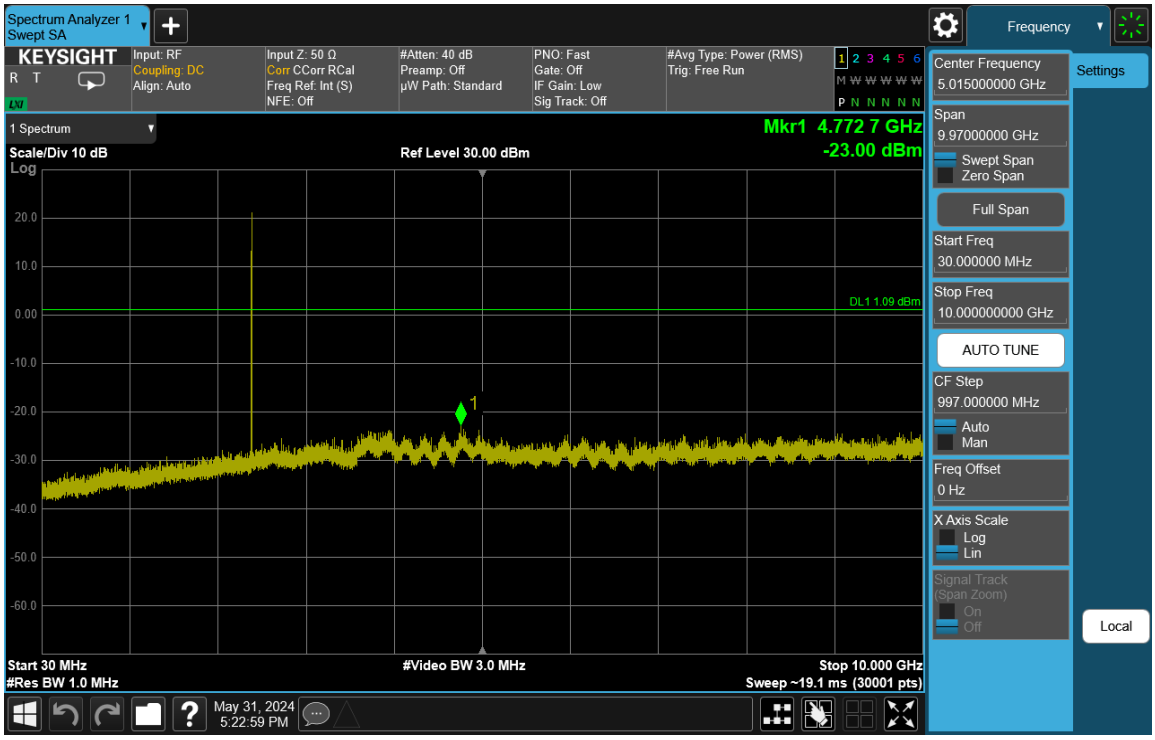
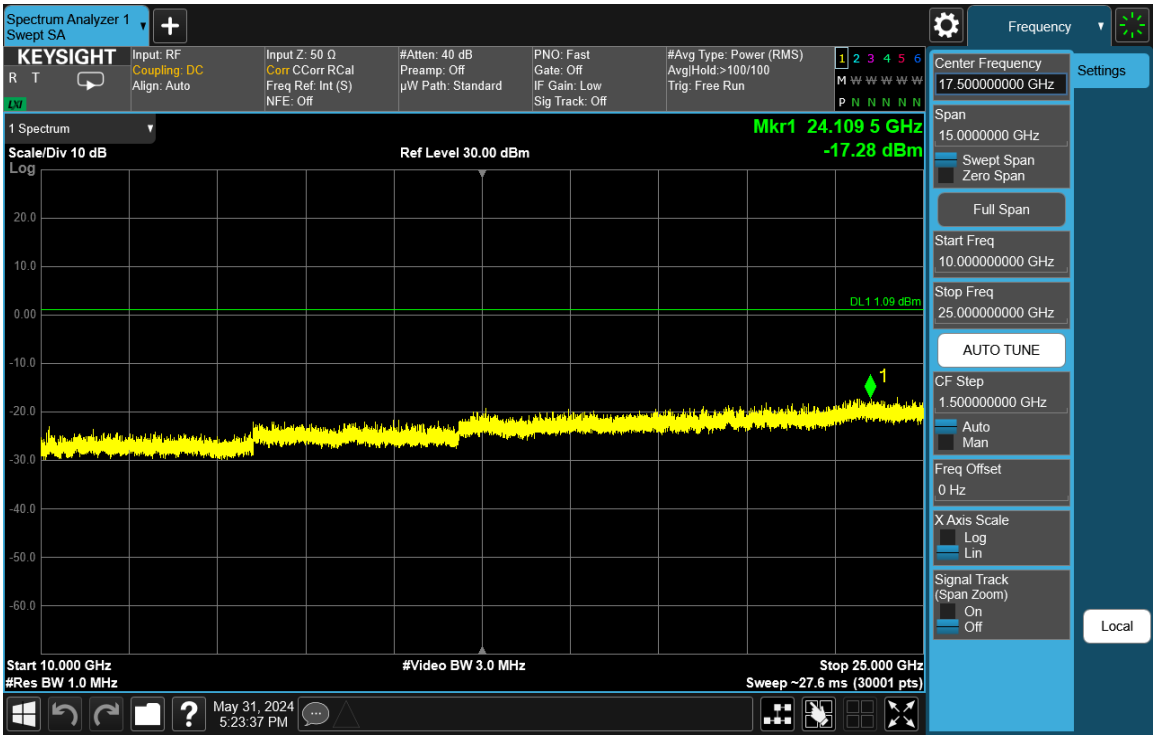
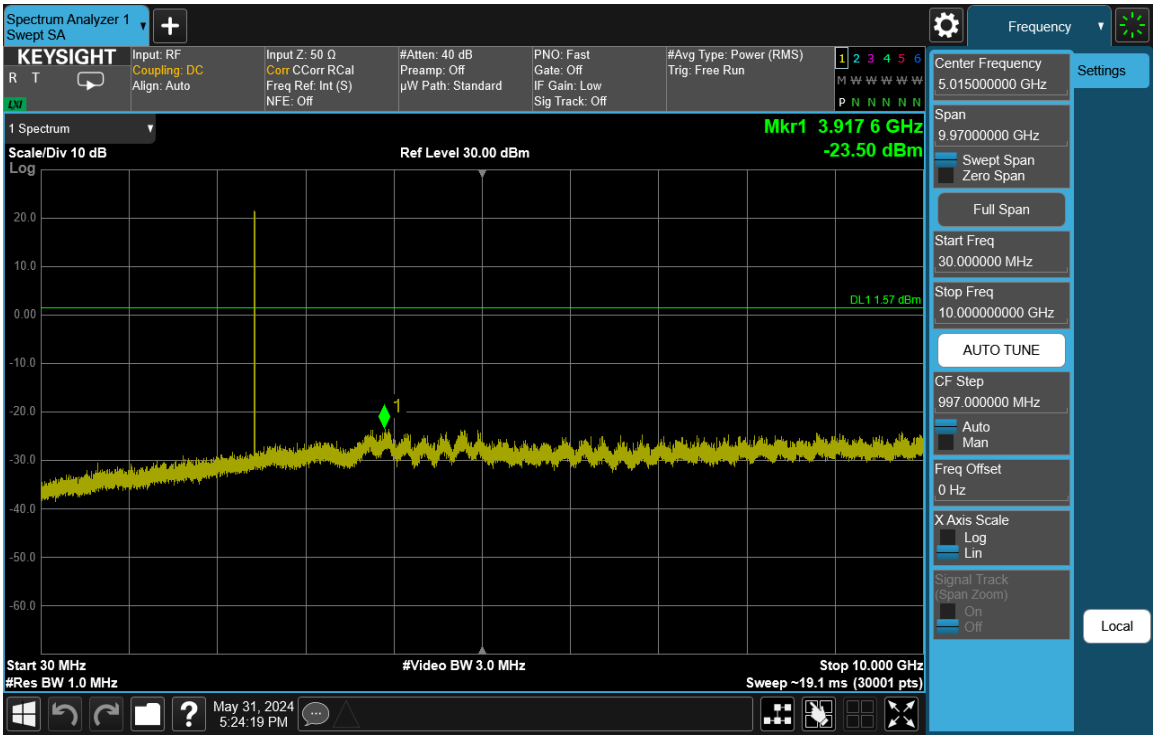
## Antenna WF7



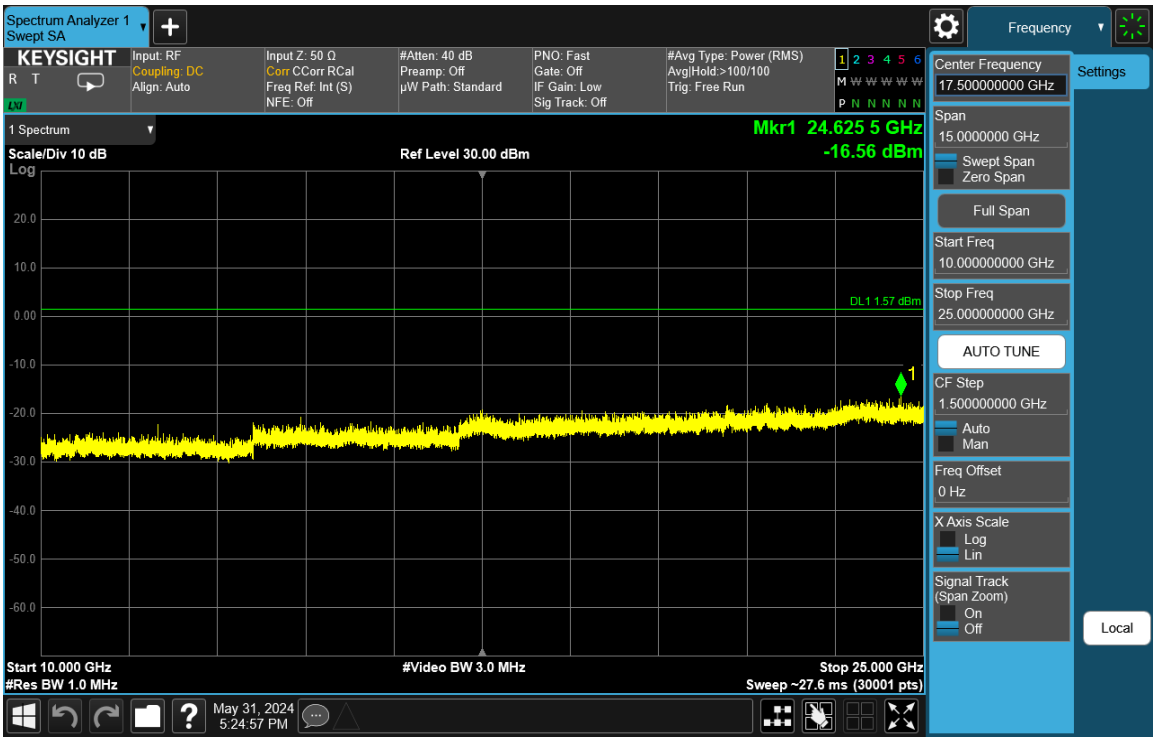

**Plot 7-73. Conducted Spurious Plot Antenna WF7 (Bluetooth, GFSK, ePA – Ch. 0)**



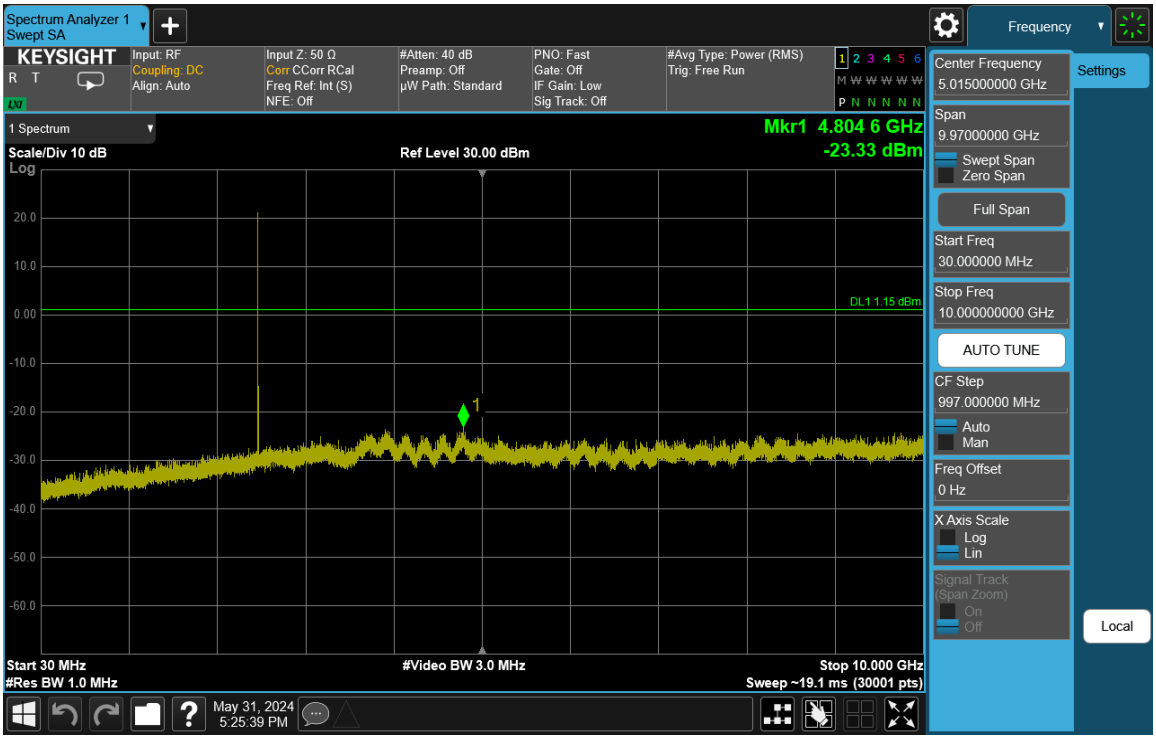

**Plot 7-74. Conducted Spurious Plot Antenna WF7 (Bluetooth, GFSK, ePA – Ch. 0)**



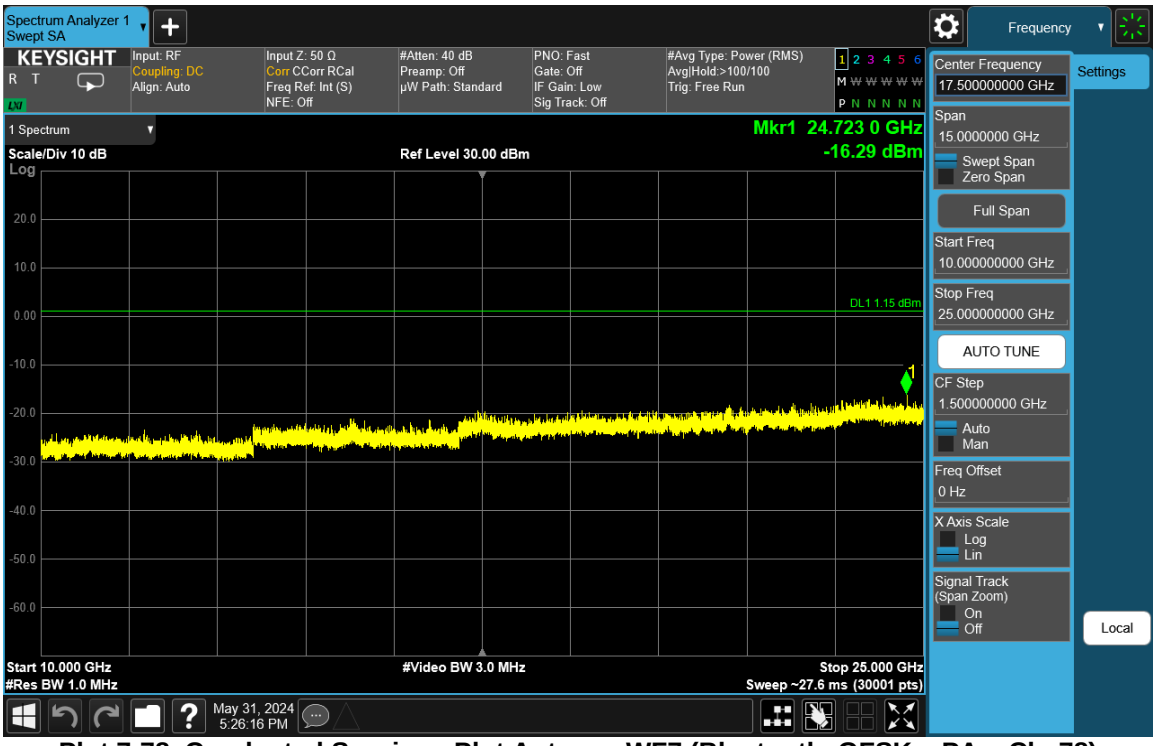

**Plot 7-75. Conducted Spurious Plot Antenna WF7 (Bluetooth, GFSK, ePA – Ch. 39)**




**Plot 7-76. Conducted Spurious Plot Antenna WF7 (Bluetooth, GFSK, ePA Ch. 39)**

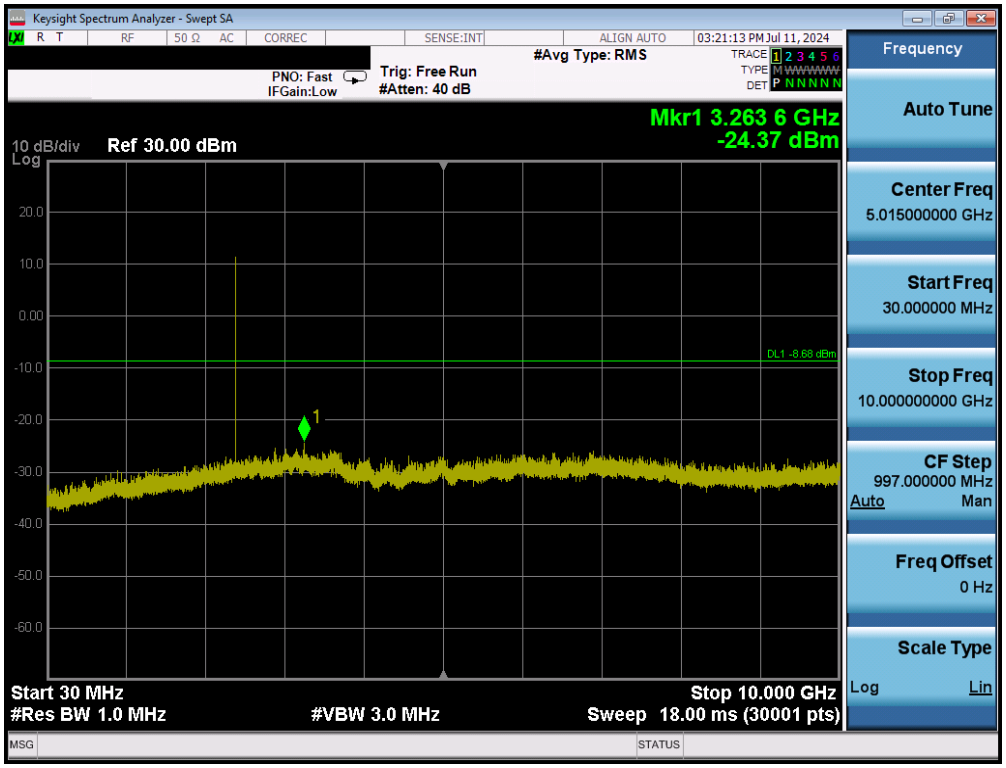



**Plot 7-77. Conducted Spurious Plot Antenna WF7 (Bluetooth, GFSK, ePA – Ch. 78)**

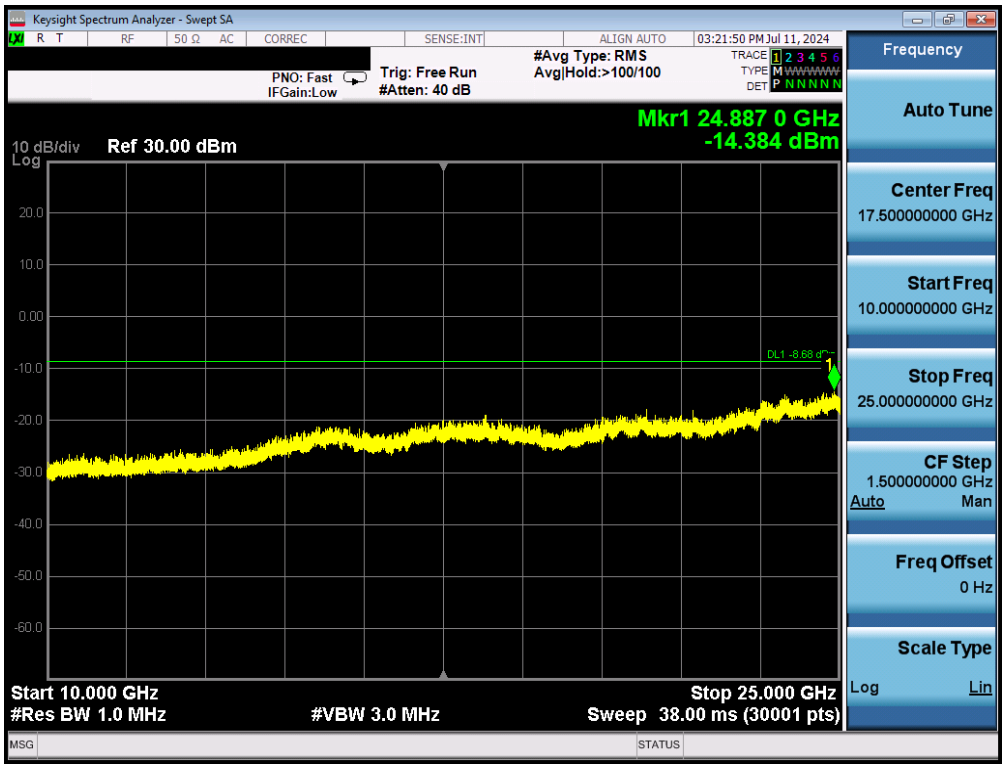



**Plot 7-78. Conducted Spurious Plot Antenna WF7 (Bluetooth, GFSK, ePA – Ch. 78)**

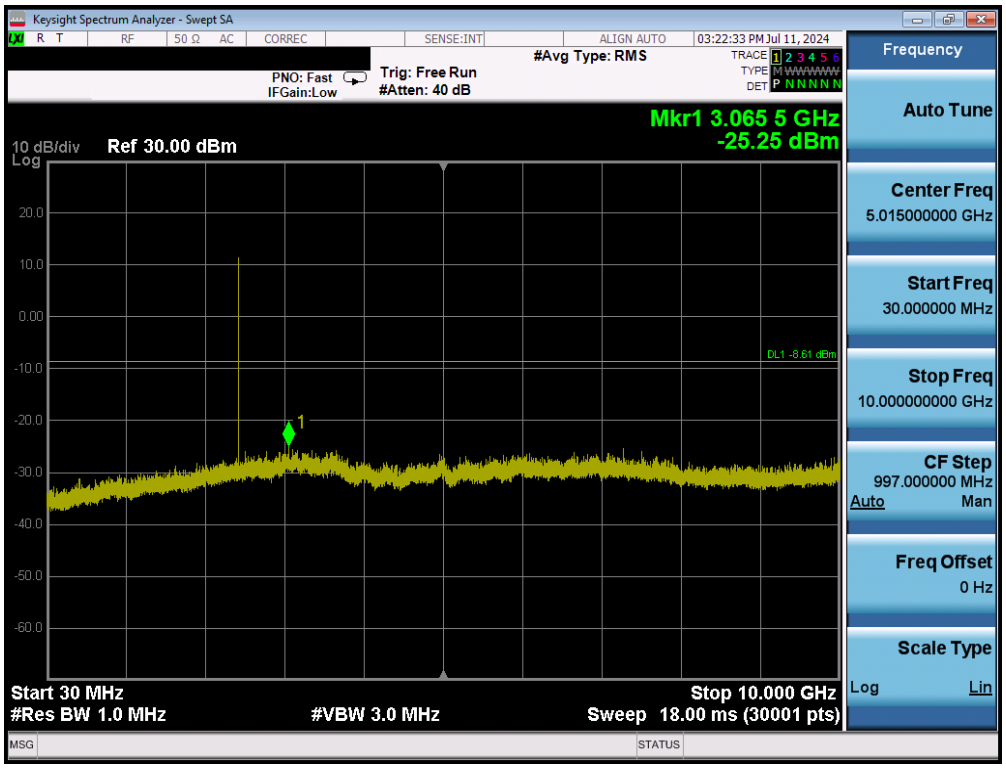
## Antenna WF2



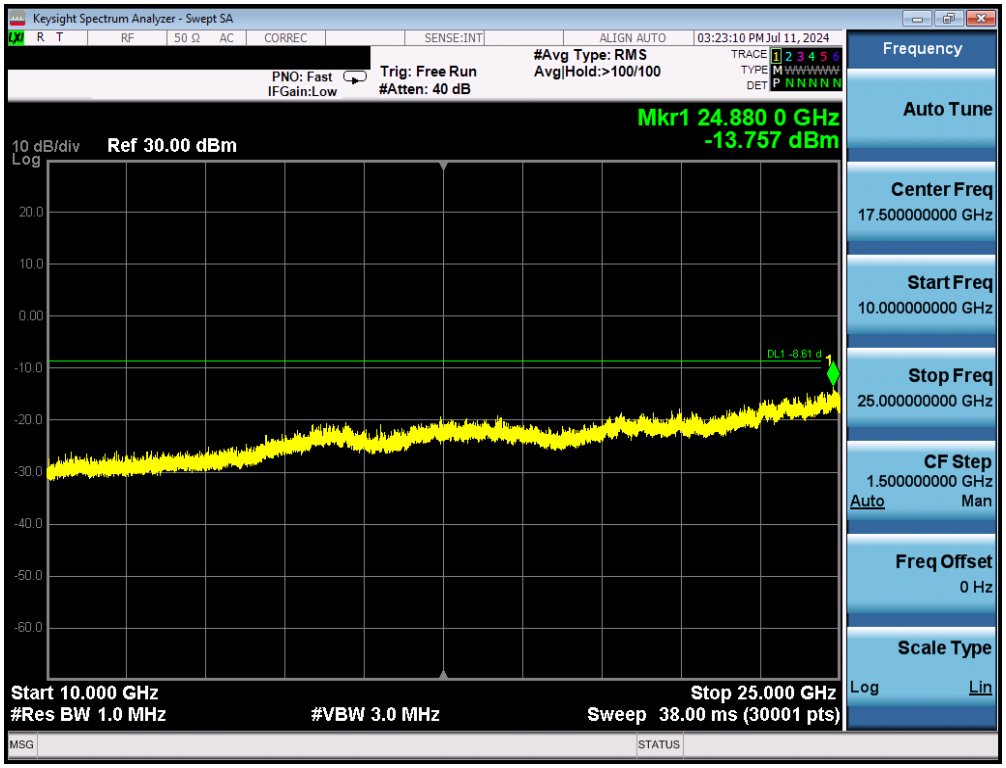

**Plot 7-79. Conducted Spurious Plot Antenna WF2 (Bluetooth, GFSK, iPA – Ch. 0)**



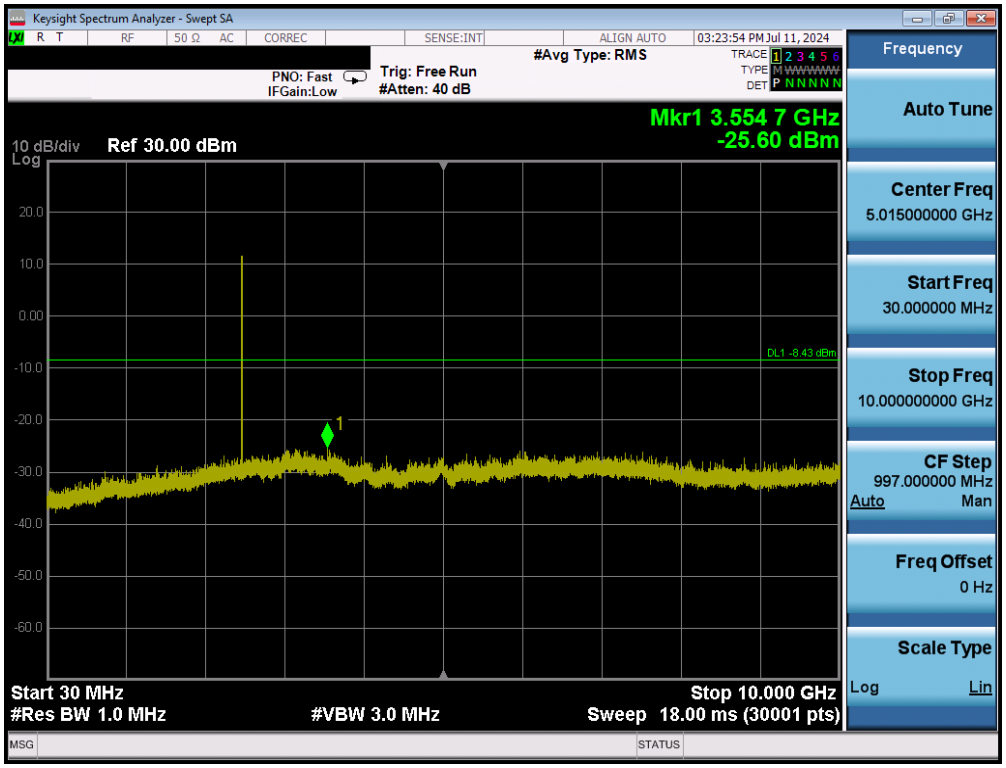

**Plot 7-80. Conducted Spurious Plot Antenna WF2 (Bluetooth, GFSK, iPA – Ch. 0)**



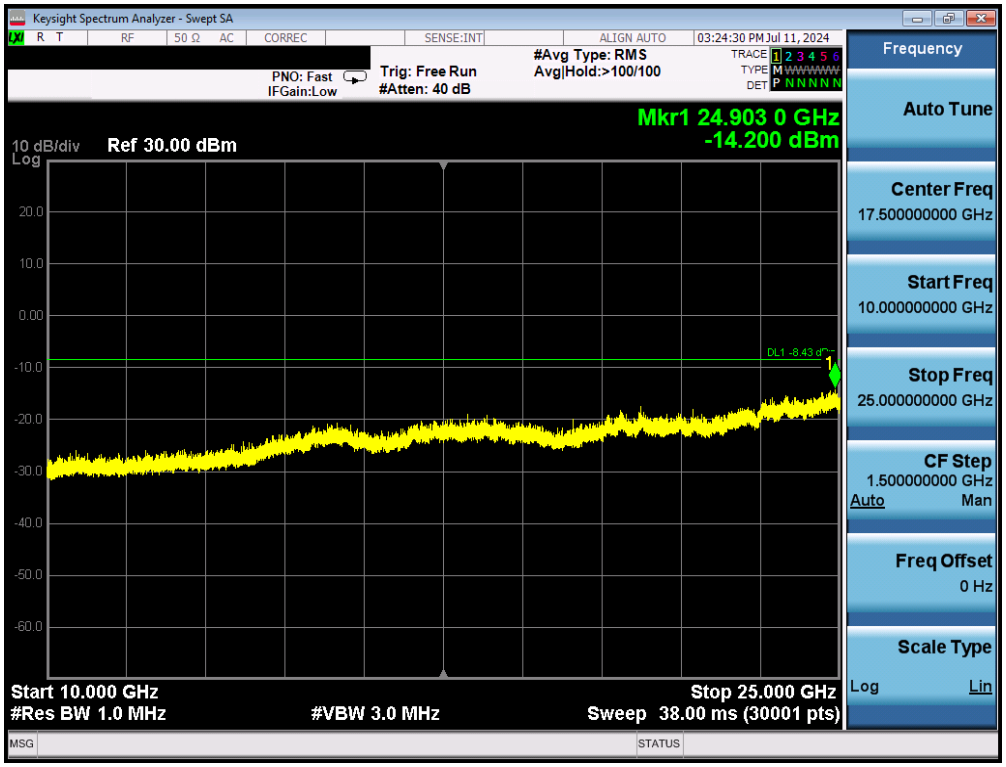

**Plot 7-81. Conducted Spurious Plot Antenna WF2 (Bluetooth, GFSK, iPA – Ch. 39)**




**Plot 7-82. Conducted Spurious Plot Antenna WF2 (Bluetooth, GFSK, iPA Ch. 39)**




**Plot 7-83. Conducted Spurious Plot Antenna WF2 (Bluetooth, GFSK, iPA – Ch. 78)**

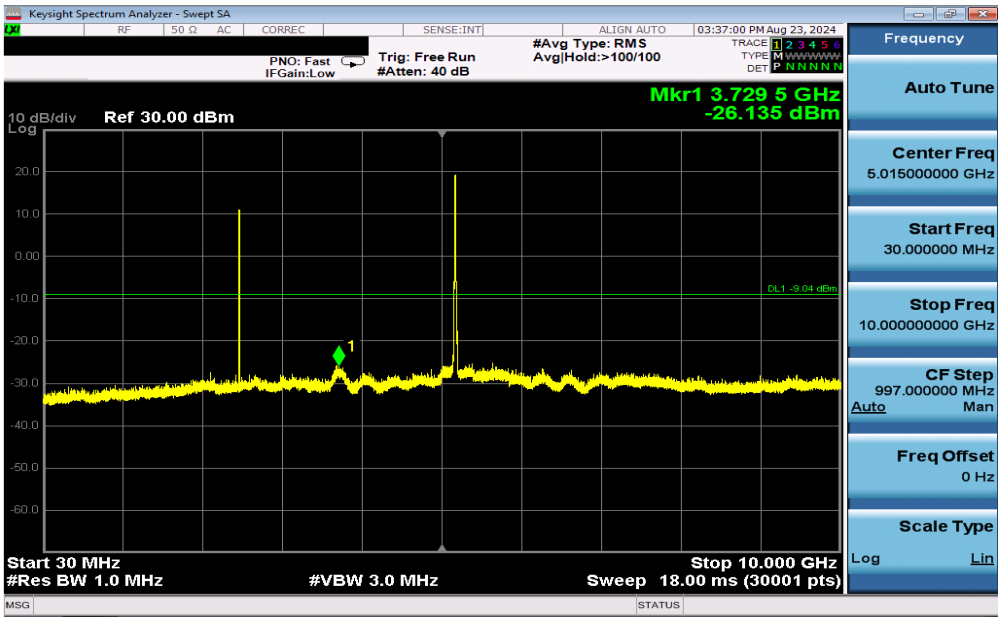



**Plot 7-84. Conducted Spurious Plot Antenna WF2 (Bluetooth, GFSK, iPA – Ch. 78)**

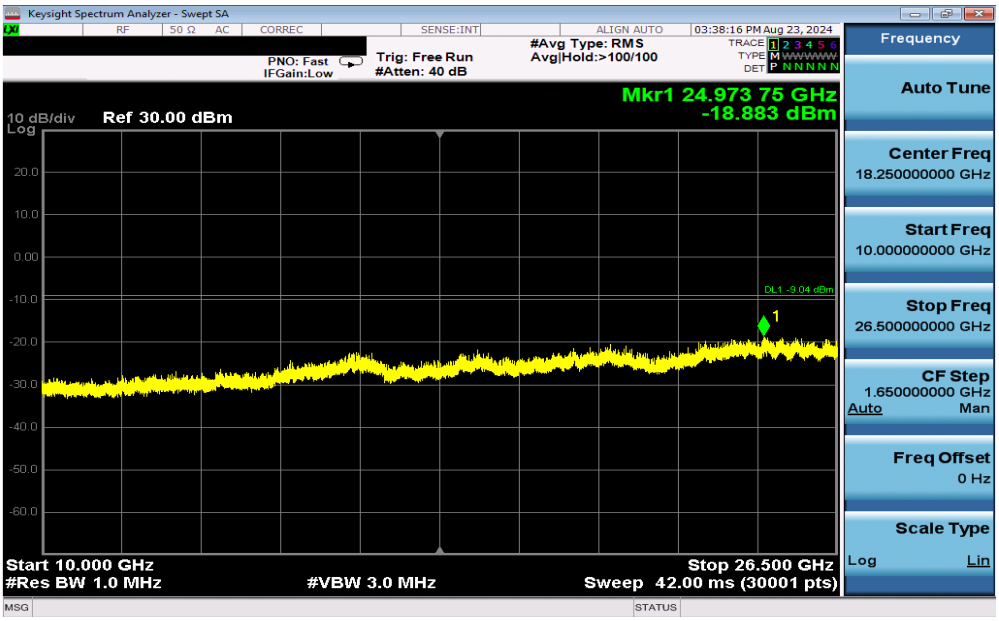
## Simultaneous Tx

| Description | UNII | Bluetooth |
|---|---|---|
| Antenna | Antenna WF2 | Antenna WF2 |
| Channel | 36 | 78 |
| Operating Frequency (MHz) | 5180 | 2480 |
| Mode/Modulation | 802.11n | GFSK iPa |

**Table 7-16. Worst Case Simultaneous Transmission Configuration**




**Plot 7-85. Conducted Simultaneous Tx Spurious Plot Antenna WF2 (Bluetooth + UNII)**




**Plot 7-86. Conducted Simultaneous Tx Spurious Plot Antenna WF2 (Bluetooth + UNII)**

## 7.9 Radiated Spurious Emissions – Above 1GHz

**§15.205 §15.209 §15.247 (d); 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 maximum power and at the appropriate frequencies. 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 7-17 per Section 15.209 and RSS-Gen (8.9).***

| Frequency | Field Strength [μV/m] | Measured Distance [Meters] |
|---|---|---|
| Above 960.0 MHz | 500 | 3 |

**Table 7-17. Radiated Limits**

### Test Procedure Used

ANSI C63.10-2020 – Section 6.6.4.3

### Test Settings

### 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

## Test Setup

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

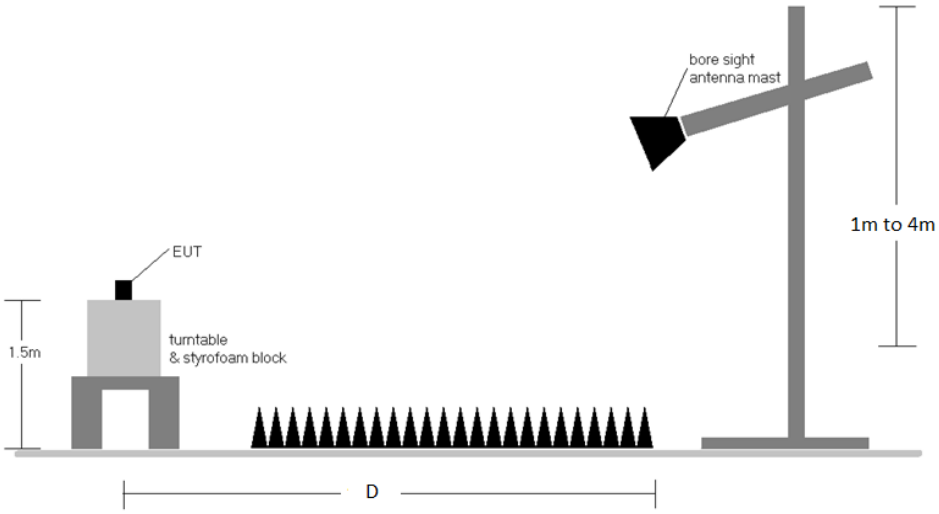



**Figure 7-8. Radiated Test Setup >1GHz**

## Test Notes

1. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-17.
2. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
3. This unit was tested with its standard battery.
4. The spectrum is measured from 9kHz to the 10$^{th}$ harmonic and the worst-case emissions are reported.
5. 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.
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 "-" shown in the following RSE tables are used to denote a noise floor measurement.
8. All supported modulation, antenna (including TxBF mode) and power schemes have been tested on the unit and only worst case configuration is reported.
9. Average emissions were not reported since the duty cycle correction factor was greater than 20dB.

## Sample Calculation

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

## Duty Cycle Correction Factor Calculation

- Channel hop rate = 800 hops/second (AFH Mode)
- Adjusted channel hop rate for DH5 mode **=** 133.33 hops/second
- Time per channel hop **=** 1 / 133.33 hops/second = 7.50 ms
- Time to cycle through all channels = 7.50 x 20 channels = 150 ms
- Number of times transmitter hits on one channel = 100 ms / 150 ms = 1 time(s)
- Worst case dwell time = 7.5 ms

Duty cycle correction factor = $20\log_{10}(7.5ms/100ms)$ = -22.5 dB

## Average Emission Calculation

- Average Emission = Measured Peak Emissions $_{[dB\mu V/m]}$ – Duty Cycle Correction Factor $_{[dB]}$

## Radiated Band Edge Measurement Offset

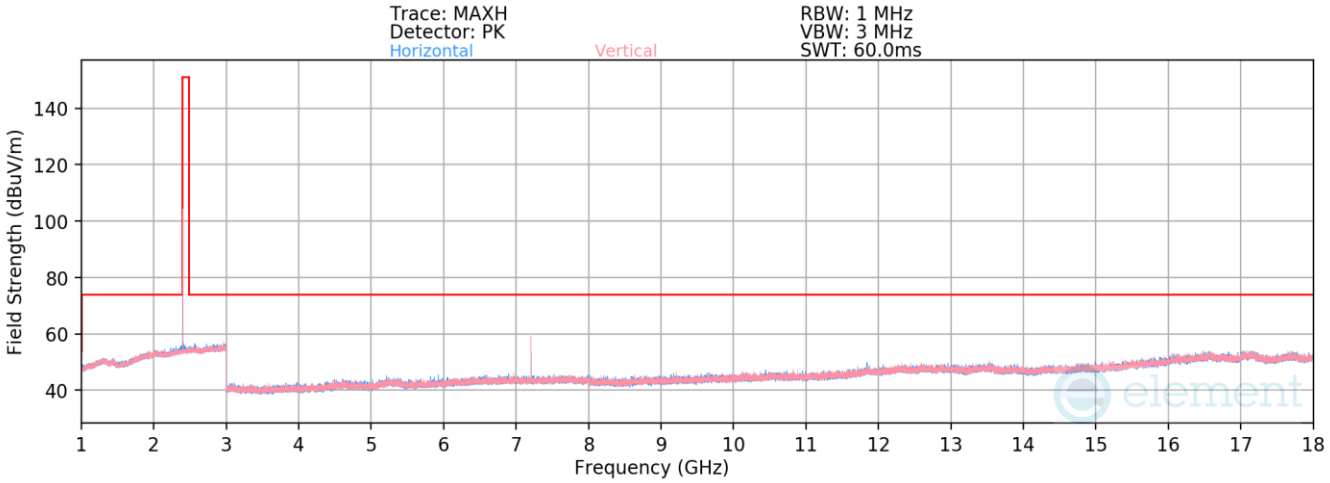
- The amplitude offset shown in the radiated restricted band edge plots in Section 7.9.6 was calculated using the formula:

  Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain

## 7.9.1 Radiated Spurious Emission Measurements (1 – 18GHz)

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

## Antenna WF8

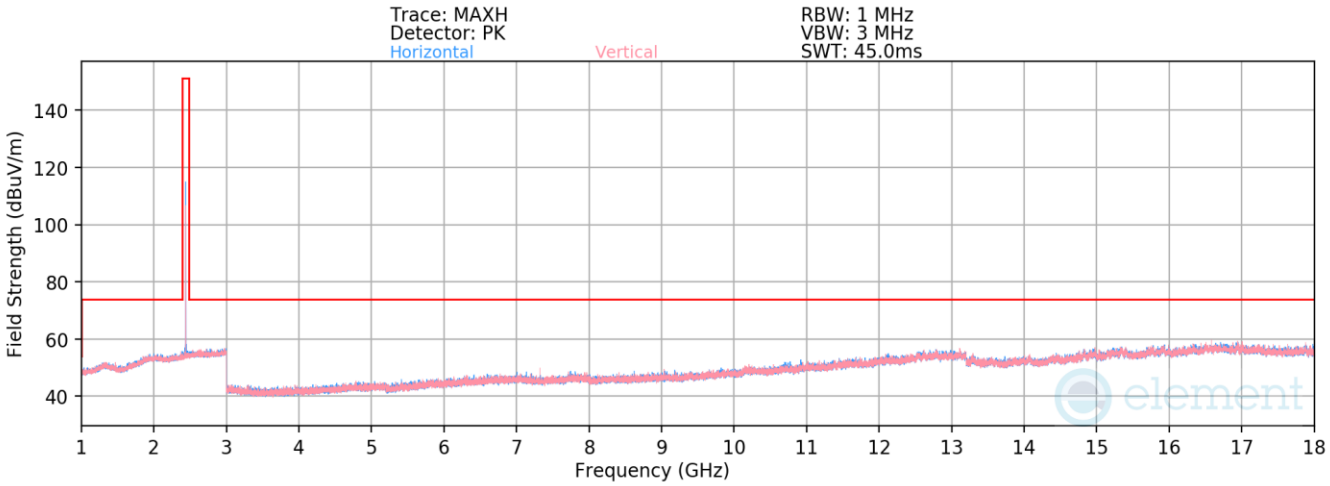



**Plot 7-87. Radiated Spurious Emissions above 1GHz Antenna WF8 (BT GFSK ePA – Ch. 0)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | Peak | V | - | - | -65.91 | 2.82 | 43.91 | 73.98 | -30.07 |
| 12010.00 | Peak | V | - | - | -68.16 | 9.96 | 48.80 | 73.98 | -25.18 |

**Table 7-18. Radiated Spurious Emissions Measurements Antenna WF8**

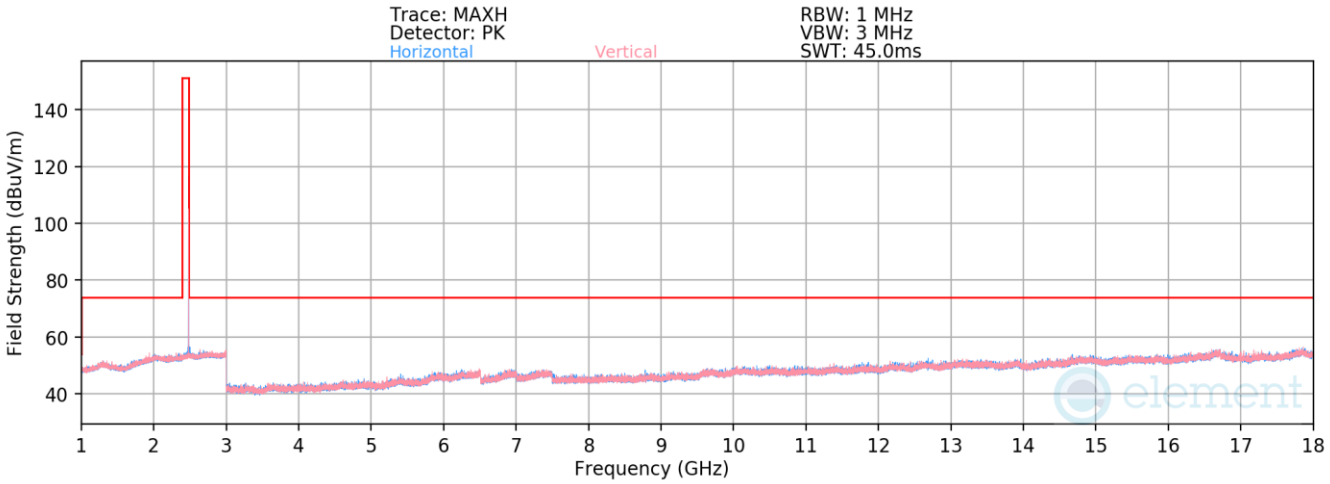



**Plot 7-88. Radiated Spurious Emissions above 1GHz Antenna WF8 (BT GFSK ePA – Ch. 39)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2441MHz |
| Channel: | 39 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | Peak | V | - | - | -69.02 | 7.37 | 45.35 | 73.98 | -28.63 |
| 7323.00 | Peak | V | 101 | 208 | -66.24 | 10.87 | 51.63 | 73.98 | -22.35 |
| 12205.00 | Peak | V | - | - | -72.34 | 18.64 | 53.30 | 73.98 | -20.68 |

**Table 7-19. Radiated Spurious Emissions Measurements Antenna WF8**




**Plot 7-89. Radiated Spurious Emissions above 1GHz Antenna WF8 (BT GFSK ePA – Ch. 78)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |

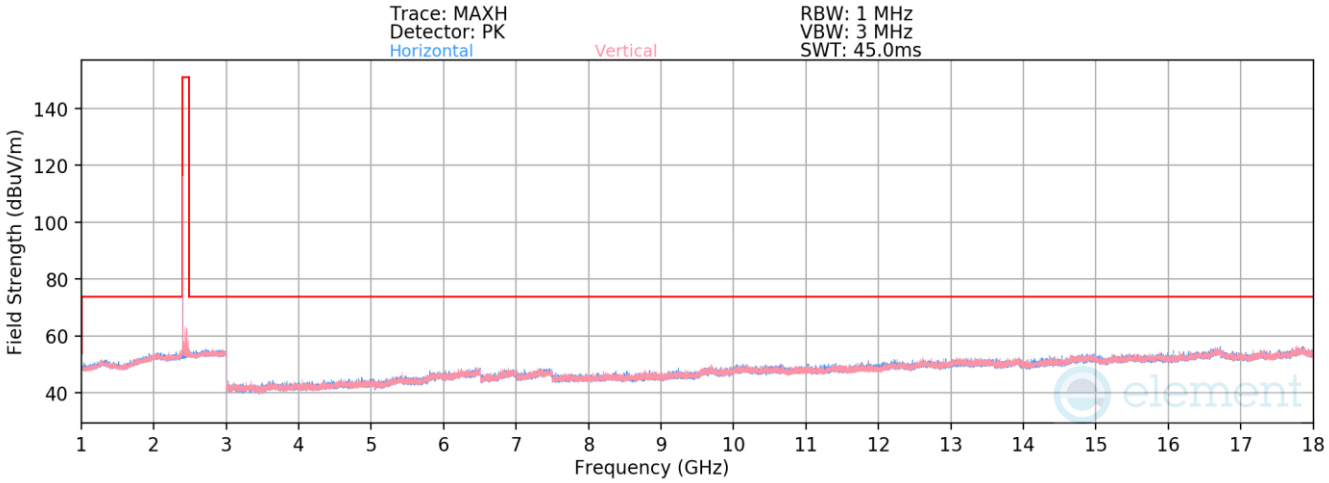
| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | Peak | V | - | - | -66.96 | 4.81 | 44.85 | 73.98 | -29.13 |
| 7440.00 | Peak | V | - | - | -67.96 | 9.43 | 48.47 | 73.98 | -25.51 |
| 12400.00 | Peak | V | - | - | -70.34 | 14.08 | 50.74 | 73.98 | -23.24 |

**Table 7-20. Radiated Spurious Emissions Measurements Antenna WF8**

## 7.9.2 Radiated Spurious Emission Measurements (1 – 18GHz)

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

## Antenna WF7

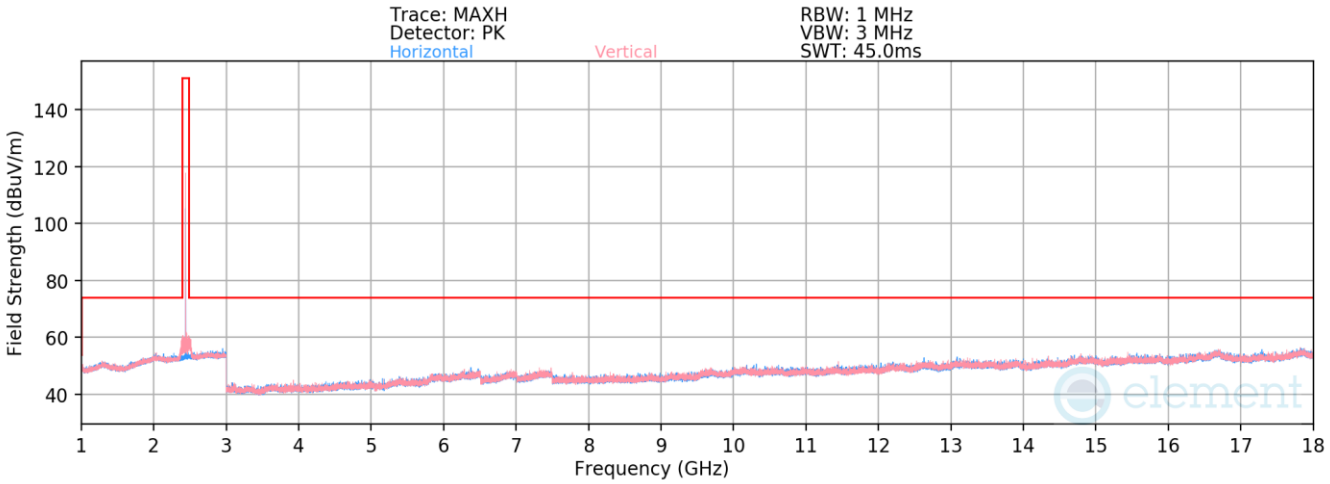



**Plot 7-90. Radiated Spurious Emissions above 1GHz Antenna WF7 (BT GFSK ePA – Ch. 0)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | Peak | V | - | - | -66.17 | 4.35 | 45.18 | 73.98 | -28.80 |
| 12010.00 | Peak | V | - | - | -70.58 | 13.35 | 49.77 | 73.98 | -24.21 |

**Table 7-21. Radiated Spurious Emissions Measurements Antenna WF7**

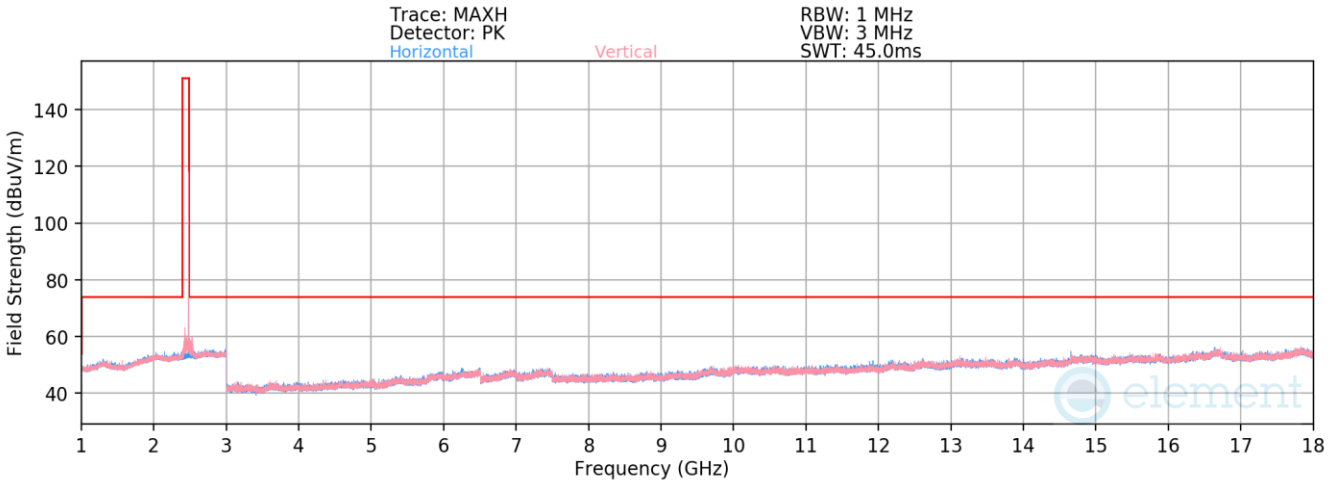



**Plot 7-91. Radiated Spurious Emissions above 1GHz Antenna WF7 (BT GFSK ePA – Ch. 39)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2441MHz |
| Channel: | 39 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | Peak | V | - | - | -66.53 | 4.90 | 45.37 | 73.98 | -28.61 |
| 7323.00 | Peak | V | 157 | 144 | -67.62 | 9.55 | 48.93 | 73.98 | -25.05 |
| 12205.00 | Peak | V | - | - | -70.98 | 15.08 | 51.10 | 73.98 | -22.88 |

**Table 7-22. Radiated Spurious Emissions Measurements Antenna WF7**




**Plot 7-92. Radiated Spurious Emissions above 1GHz Antenna WF7 (BT GFSK ePA – Ch. 78)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |

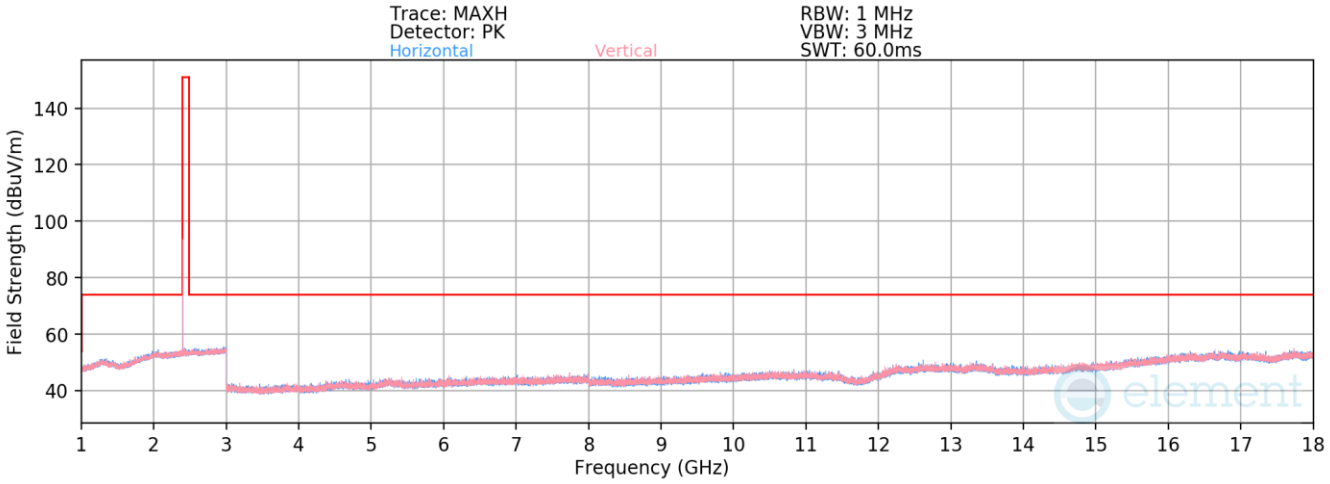
| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | Peak | V | - | - | -67.04 | 4.94 | 44.90 | 73.98 | -29.08 |
| 7440.00 | Peak | V | 275 | 238 | -66.31 | 9.48 | 50.17 | 73.98 | -23.81 |
| 12400.00 | Peak | V | - | - | -70.51 | 14.08 | 50.57 | 73.98 | -23.41 |

**Table 7-23. Radiated Spurious Emissions Measurements Antenna WF7**

## 7.9.3 Radiated Spurious Emission Measurements (1 – 18GHz)

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

## Antenna WF2

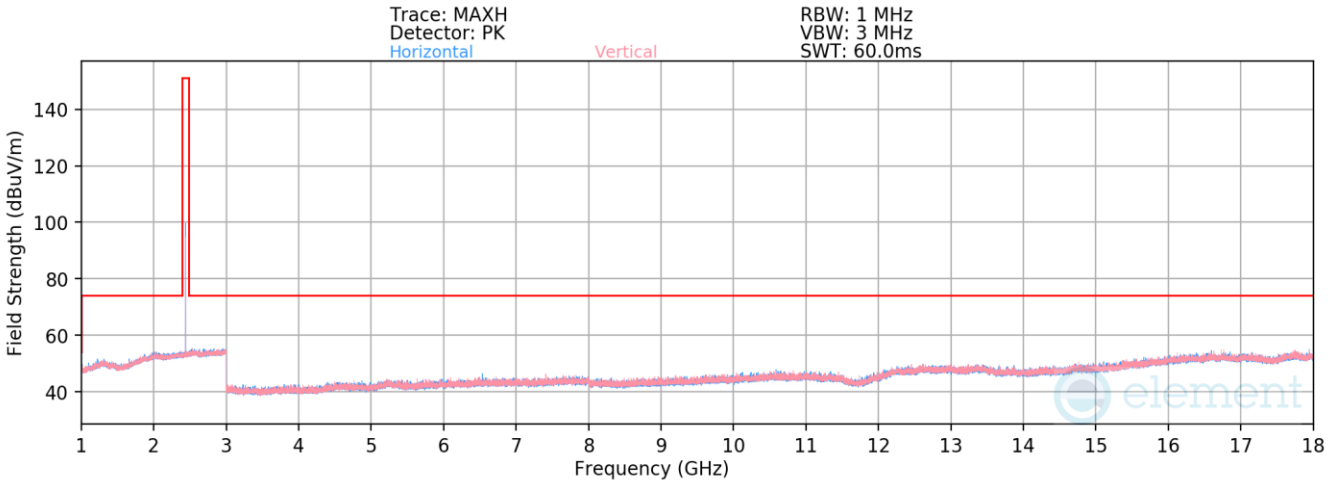



**Plot 7-93. Radiated Spurious Emissions above 1GHz Antenna WF2 (BT GFSK iPA – Ch. 0)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | iPA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | Peak | V | - | - | -65.68 | 2.87 | 44.19 | 73.98 | -29.79 |
| 12010.00 | Peak | V | - | - | -70.18 | 9.96 | 46.78 | 73.98 | -27.20 |

**Table 7-24. Radiated Spurious Emissions Measurements Antenna WF2**

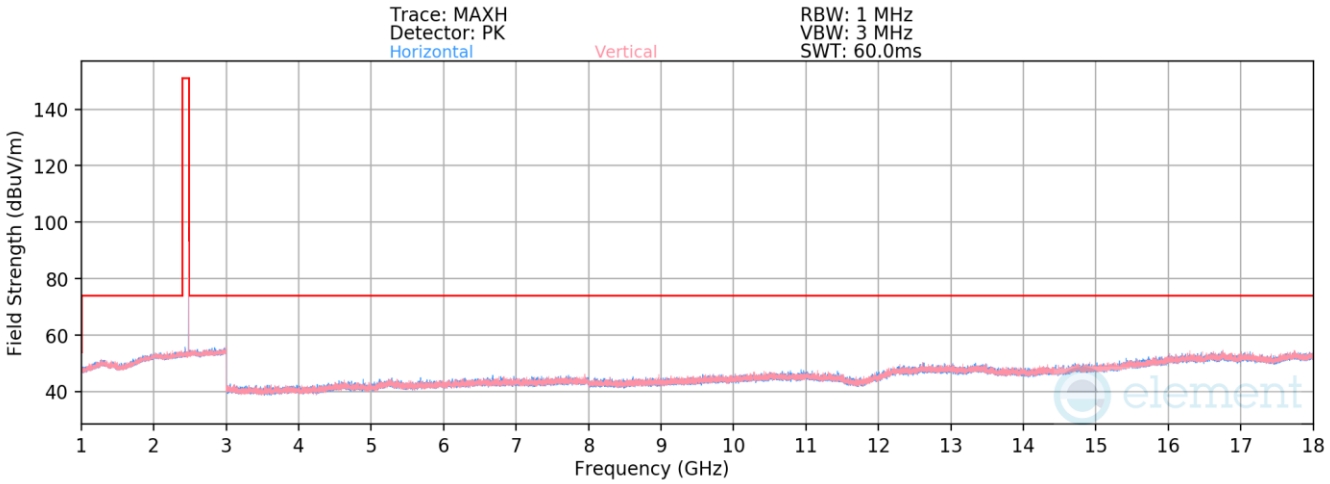



**Plot 7-94. Radiated Spurious Emissions above 1GHz Antenna WF2 (BT GFSK iPA – Ch. 39)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | iPA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2441MHz |
| Channel: | 39 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | Peak | V | - | - | -66.37 | 2.88 | 43.51 | 73.98 | -30.47 |
| 7323.00 | Peak | V | - | - | -66.61 | 5.06 | 45.45 | 73.98 | -28.53 |
| 12205.00 | Peak | V | - | - | -69.15 | 10.98 | 48.83 | 73.98 | -25.15 |

**Table 7-25. Radiated Spurious Emissions Measurements Antenna WF2**




**Plot 7-95. Radiated Spurious Emissions above 1GHz Antenna WF2 (BT GFSK iPA – Ch. 78)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | iPA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |

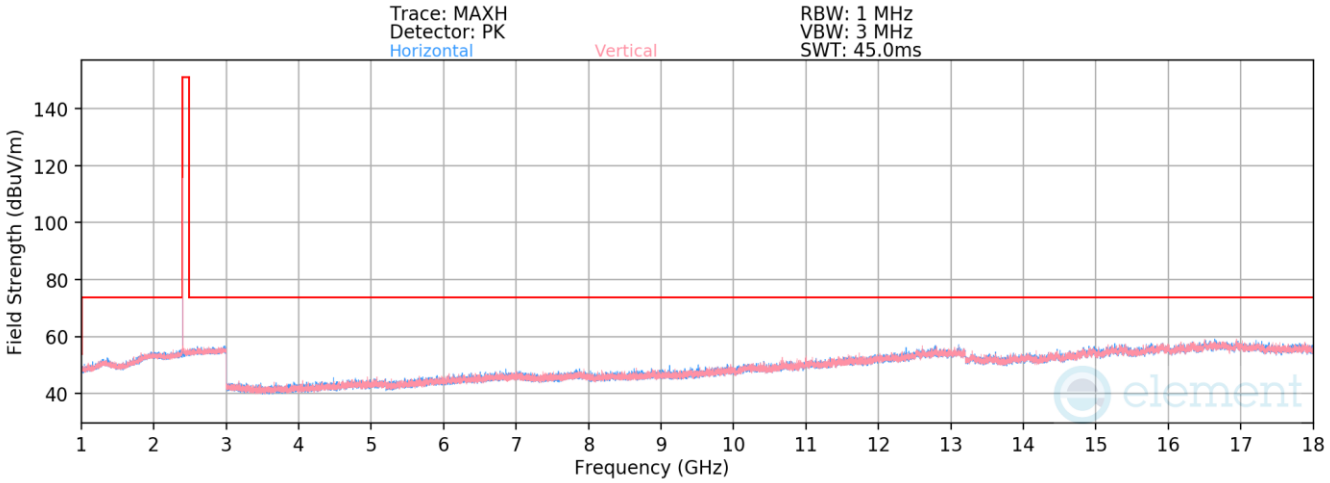
| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | Peak | V | - | - | -66.13 | 2.71 | 43.58 | 73.98 | -30.40 |
| 7440.00 | Peak | V | - | - | -67.41 | 5.64 | 45.23 | 73.98 | -28.75 |
| 12400.00 | Peak | V | - | - | -68.13 | 10.77 | 49.64 | 73.98 | -24.34 |

**Table 7-26. Radiated Spurious Emissions Measurements Antenna WF2**

## 7.9.4 Radiated Spurious Emission Measurements (Above 1GHz)

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

## TxBF

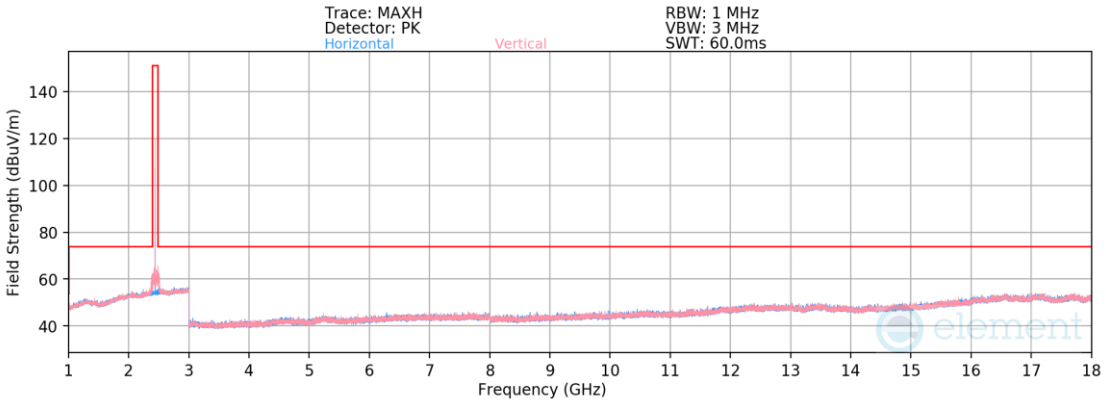



**Plot 7-96. Radiated Spurious Emissions above 1GHz TxBF (BT GFSK ePA – Ch. 0)**

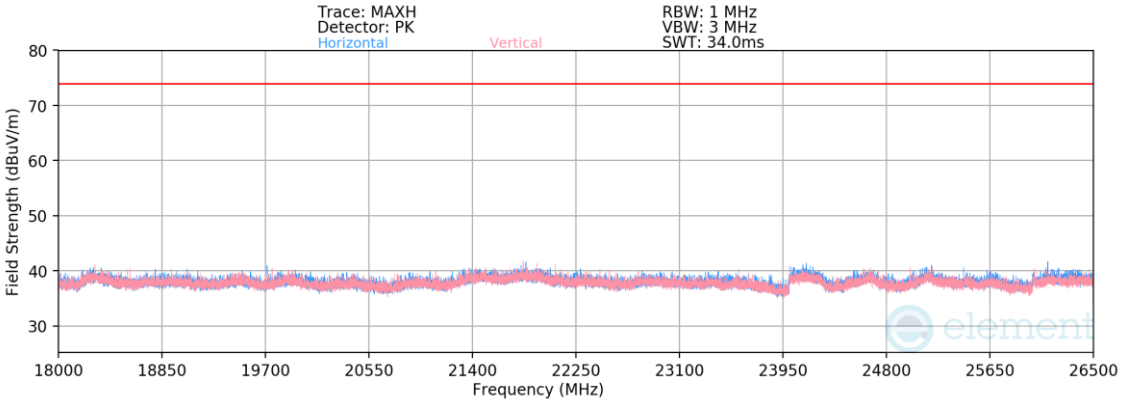
| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | Peak | H | - | - | -68.97 | 7.63 | 45.66 | 73.98 | -28.32 |
| 12010.00 | Peak | H | - | - | -72.20 | 18.62 | 53.42 | 73.98 | -20.56 |

**Table 7-27. Radiated Spurious Emissions Measurements TxBF**




**Plot 7-97. Radiated Spurious Emissions above 1GHz TxBF (BT GFSK ePA – Ch. 39)**

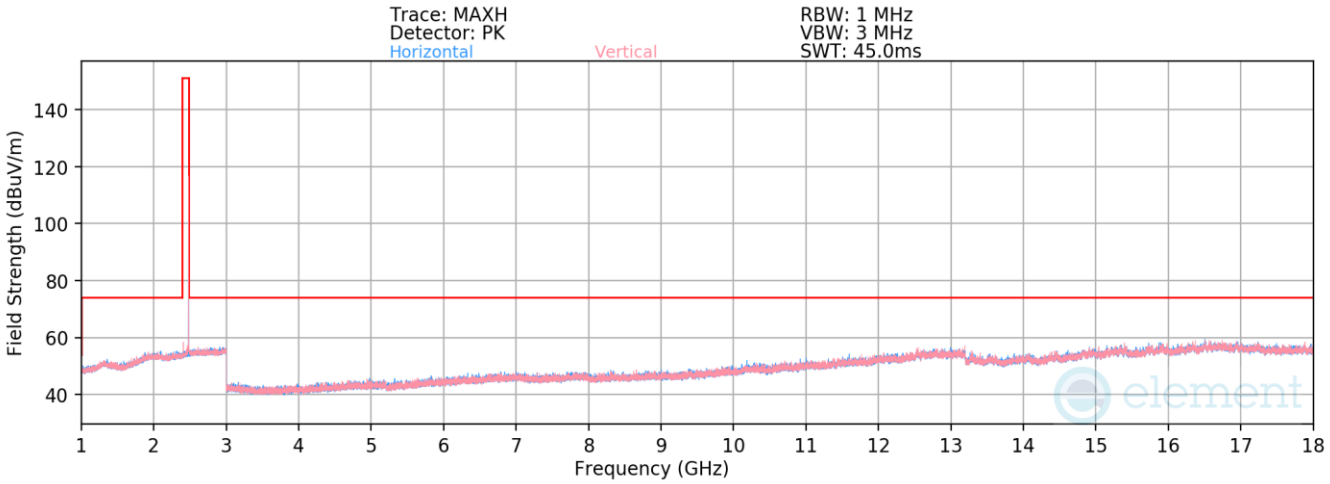



**Plot 7-98. Radiated Spurious Emissions above 18GHz TxBF (BT GFSK ePA – Ch. 39)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2441MHz |
| Channel: | 39 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4882.00 | Peak | H | - | - | -65.69 | 2.74 | 44.05 | 73.98 | -29.93 |
| 7323.00 | Peak | H | - | - | -66.00 | 5.06 | 46.06 | 73.98 | -27.92 |
| 12205.00 | Peak | H | - | - | -68.26 | 10.91 | 49.65 | 73.98 | -24.33 |

**Table 7-28. Radiated Spurious Emissions Measurements TxBF**




**Plot 7-99. Radiated Spurious Emissions above 1GHz TxBF (BT GFSK ePA – Ch. 78)**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Data Rate: | 1Mbps |
| Power Scheme | ePA |
| Distance of Measurements: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | Peak | H | - | - | -69.31 | 7.06 | 44.75 | 73.98 | -29.23 |
| 7440.00 | Peak | H | - | - | -71.31 | 10.98 | 46.67 | 73.98 | -27.31 |
| 12400.00 | Peak | H | - | - | -73.27 | 19.40 | 53.13 | 73.98 | -20.85 |

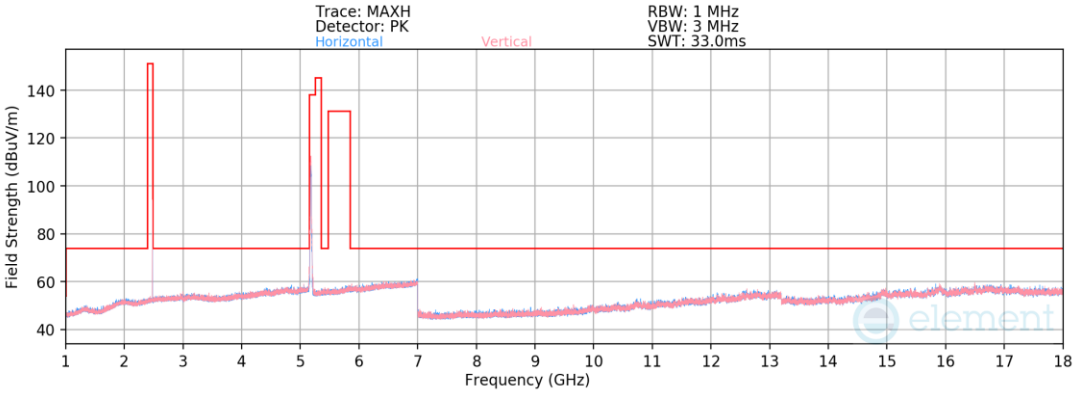
**Table 7-29. Radiated Spurious Emissions Measurements TxBF**

## 7.9.5 Simultaneous Tx Radiated Spurious Emission Measurements (Above 1GHz)

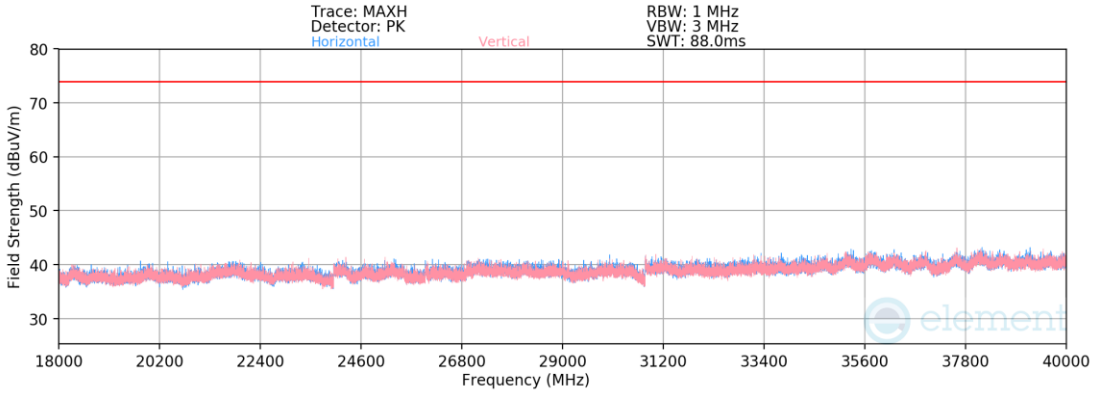
**§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]**

| Description | UNII | Bluetooth |
|---|---|---|
| Antenna | Antenna WF2 | Antenna WF2 |
| Channel | 36 | 78 |
| Operating Frequency (MHz) | 5180 | 2480 |
| Mode/Modulation | 802.11n | GFSK iPa |

**Table 7-30. Worst Case Simultaneous Transmission Configuration**




**Plot 7-100. Radiated Spurious Emissions Simultaneous Transmission (1-18GHz)**




**Plot 7-101. Radiated Spurious Emissions Simultaneous Transmission (Above 18GHz)**

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | Peak | H | - | - | -68.62 | 16.88 | 55.26 | 73.98 | -18.72 |
| 7440.00 | Peak | H | - | - | -70.10 | 11.45 | 48.35 | 73.98 | -25.63 |
| 12400.00 | Peak | H | - | - | -73.03 | 18.90 | 52.87 | 73.98 | -21.11 |

**Table 7-31. Bluetooth Harmonics Emissions Measurements in Simultaneous Transmission Mode**

| | 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] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10360.00 | Peak | H | - | - | -71.95 | 15.31 | 50.36 | 68.23 | -17.87 |
| * | 15540.00 | Avg | H | - | - | -84.98 | 23.06 | 45.08 | 53.98 | -8.90 |
| * | 15540.00 | Peak | H | - | - | -73.69 | 23.06 | 56.37 | 73.98 | -17.61 |

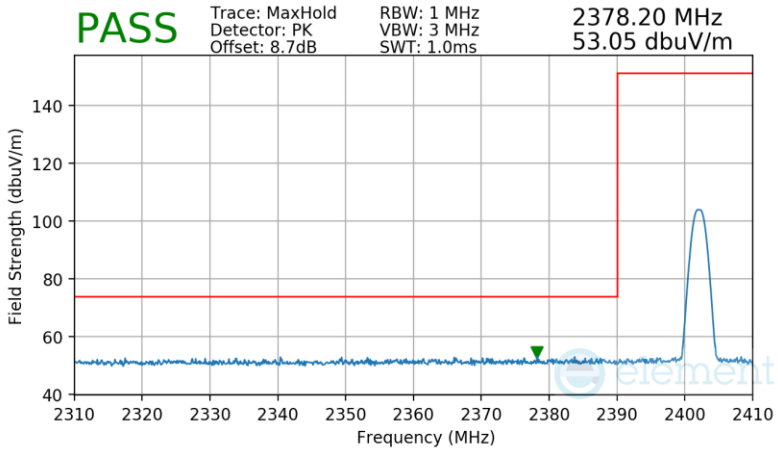
**Table 7-32. UNII Harmonics Emissions Measurements in Simultaneous Transmission Mode**

## 7.9.6 Radiated Restricted Band Edge Measurements

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

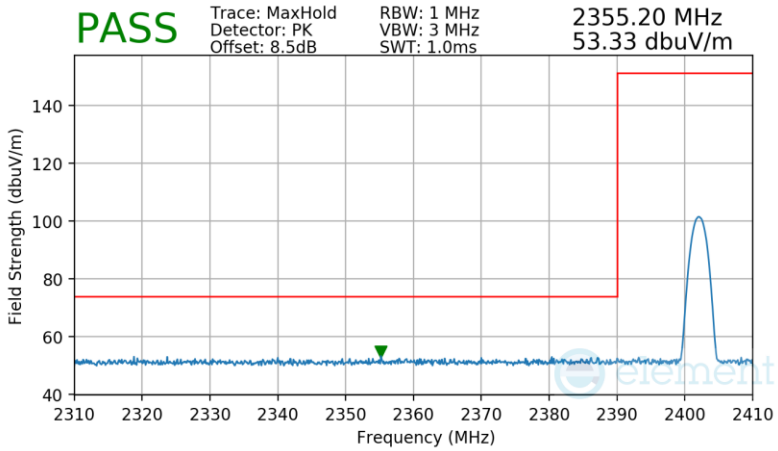
## Antenna WF8

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |




**Plot 7-102. Radiated Restricted Lower Band Edge Measurement Antenna WF8**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

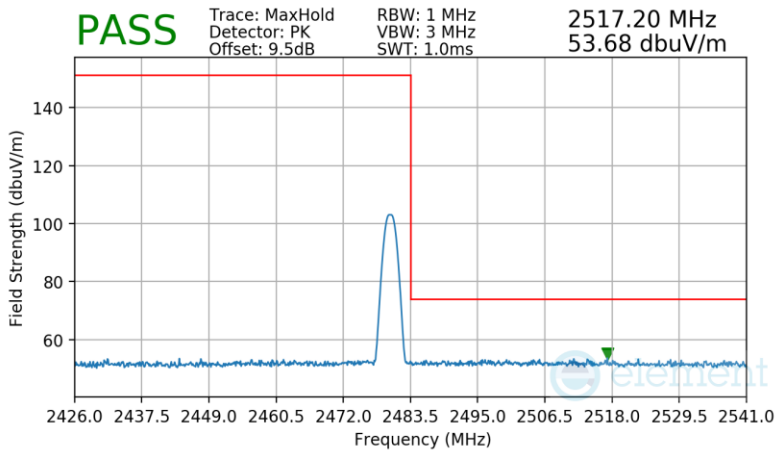



**Plot 7-103. Radiated Restricted Lower Band Edge Measurement Antenna WF8**

## Radiated Restricted Band Edge Measurements

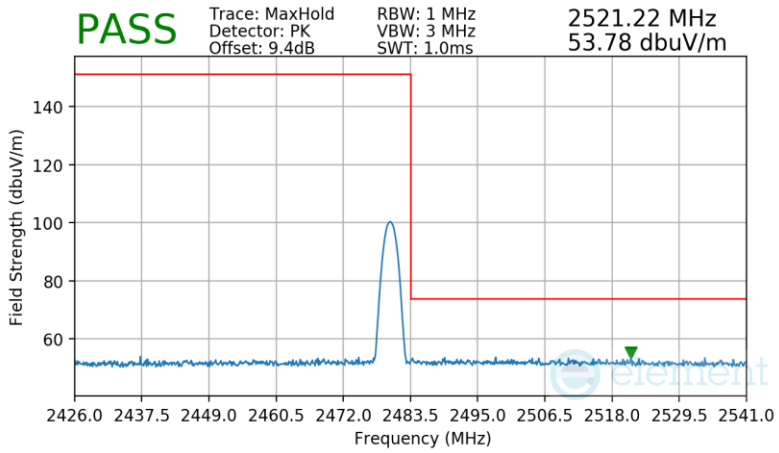
**§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |




**Plot 7-104. Radiated Restricted Upper Band Edge Measurement Antenna WF8**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |



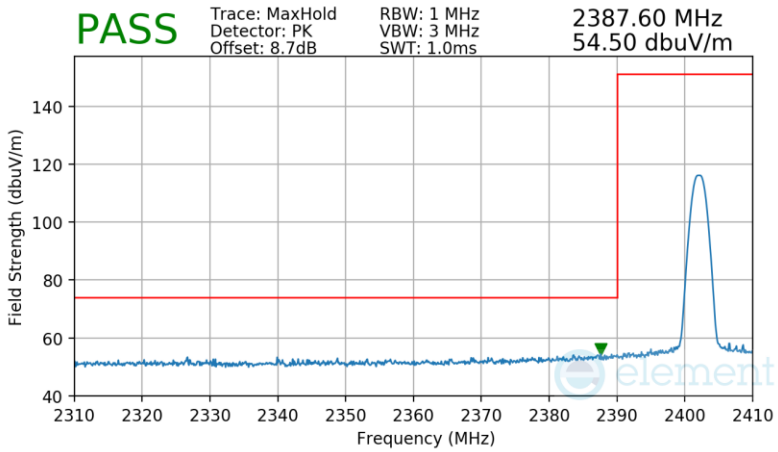

**Plot 7-105. Radiated Restricted Upper Band Edge Measurement Antenna WF8**

## Radiated Restricted Band Edge Measurements

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

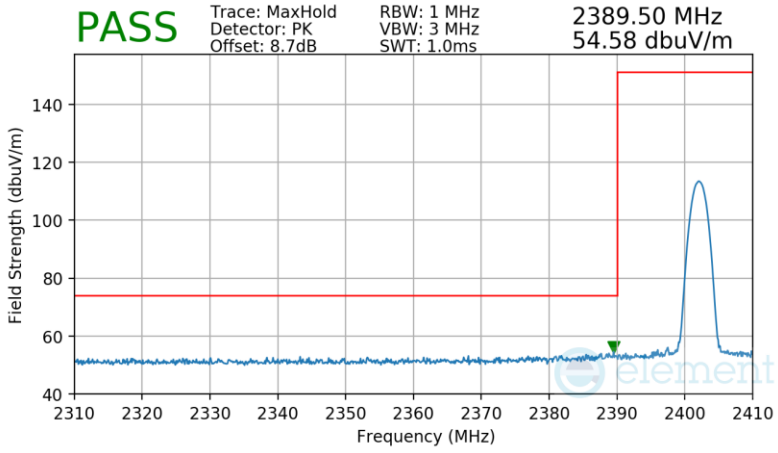
## Antenna WF7

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |




**Plot 7-106. Radiated Restricted Lower Band Edge Measurement Antenna WF7**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

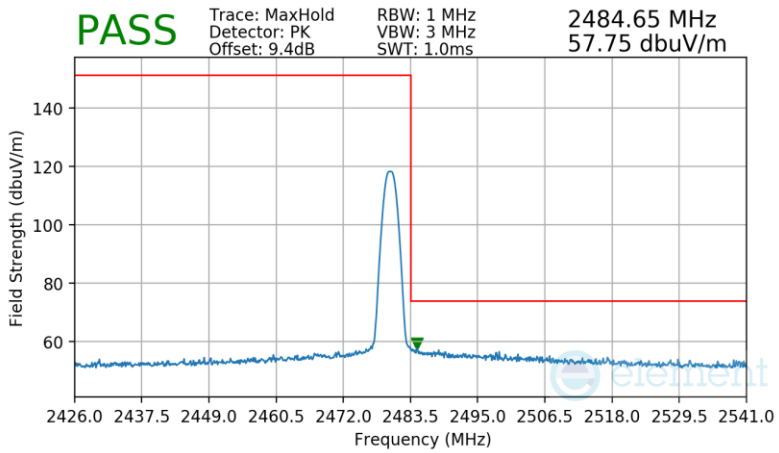



**Plot 7-107. Radiated Restricted Lower Band Edge Measurement Antenna WF7**

## Radiated Restricted Band Edge Measurements

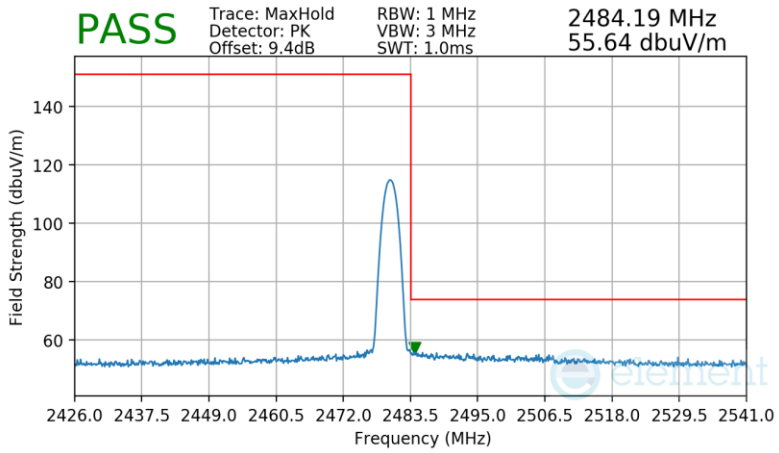
**§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |




**Plot 7-108. Radiated Restricted Upper Band Edge Measurement Antenna WF7**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |



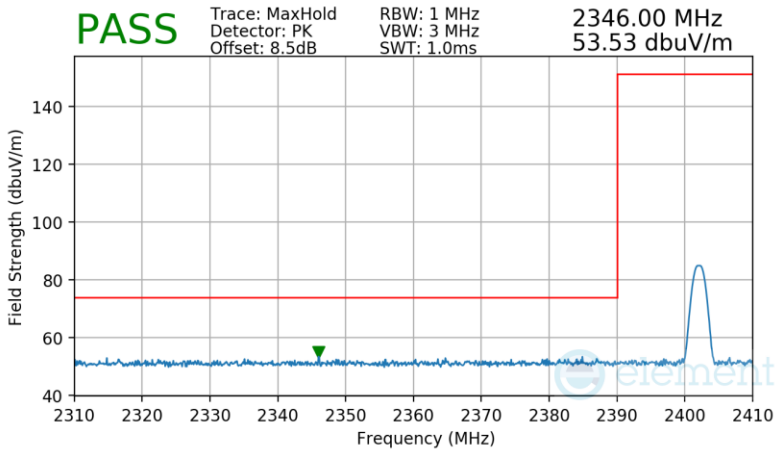

**Plot 7-109. Radiated Restricted Upper Band Edge Measurement Antenna WF7**

## Radiated Restricted Band Edge Measurements

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

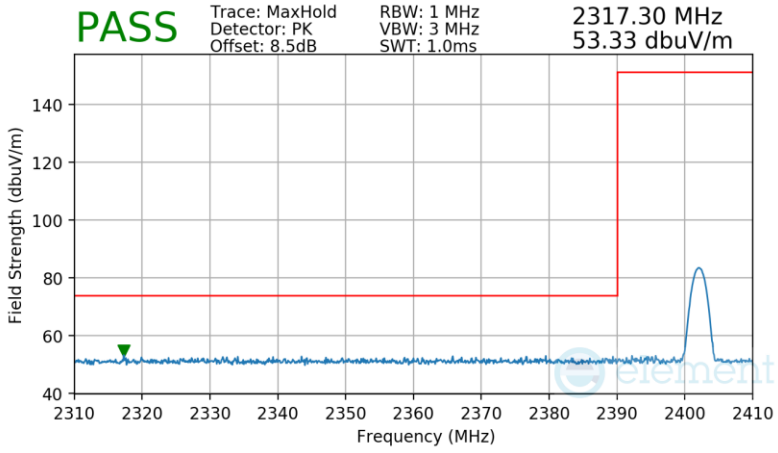
## Antenna WF2

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | iPA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |




**Plot 7-110. Radiated Restricted Lower Band Edge Measurement Antenna WF2**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | iPA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

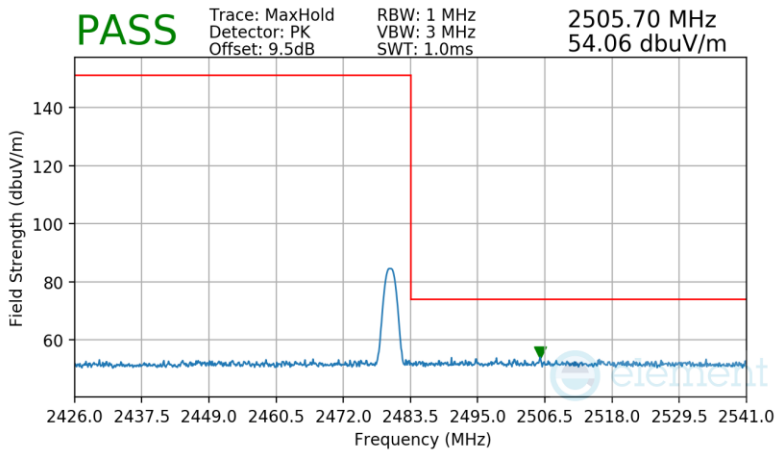



**Plot 7-111. Radiated Restricted Lower Band Edge Measurement Antenna WF2**

## Radiated Restricted Band Edge Measurements

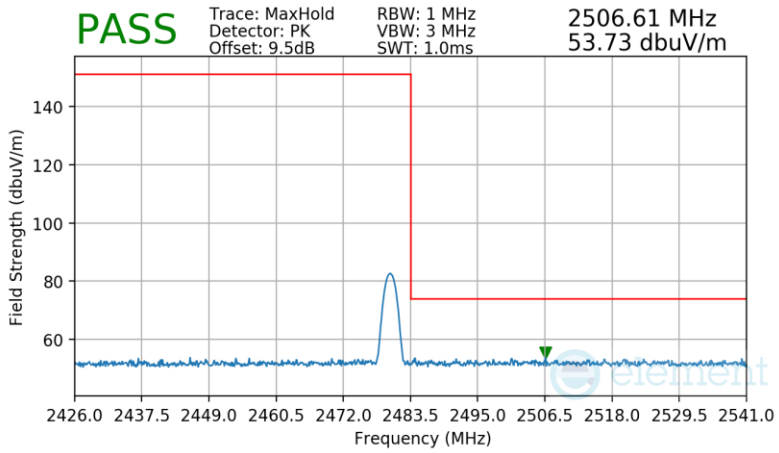
**§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | iPA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |




**Plot 7-112. Radiated Restricted Upper Band Edge Measurement Antenna WF2**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | iPA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |



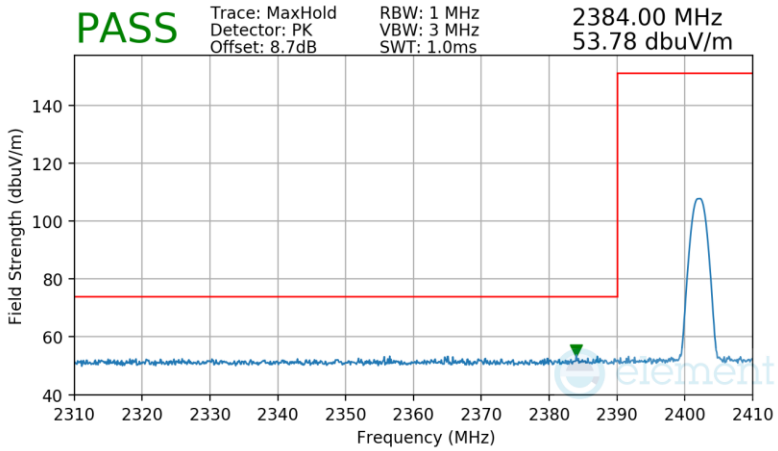

**Plot 7-113. Radiated Restricted Upper Band Edge Measurement Antenna WF2**

## Radiated Restricted Band Edge Measurements

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

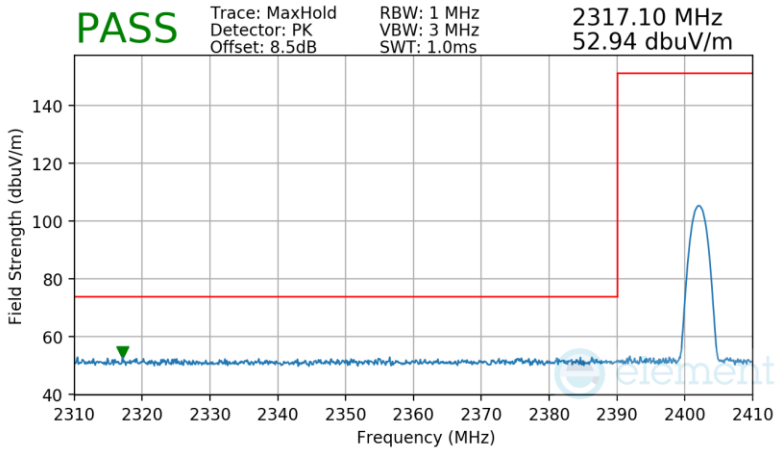
## TxBF

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |




**Plot 7-114. Radiated Restricted Lower Band Edge Measurement TxBF**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2402MHz |
| Channel: | 0 |

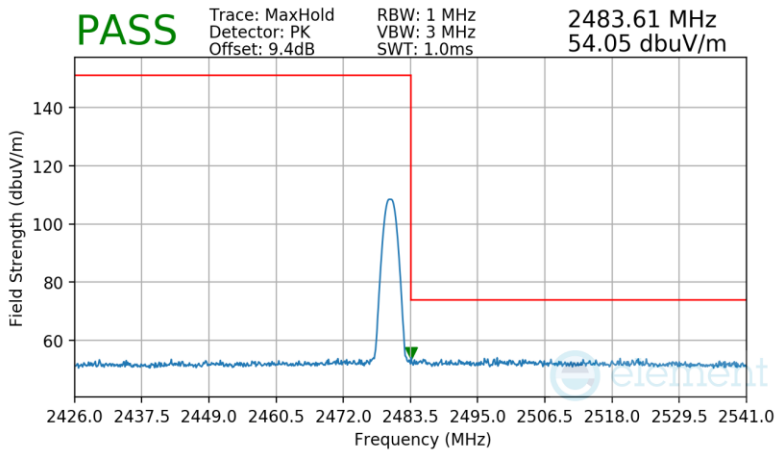



**Plot 7-115. Radiated Restricted Lower Band Edge Measurement TxBF**

## Radiated Restricted Band Edge Measurements

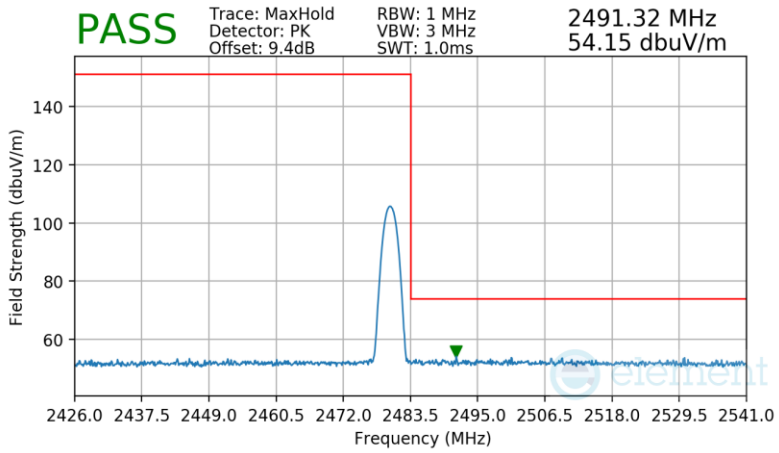
**§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]**

| | |
|---|---|
| Bluetooth Mode: | GFSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |




**Plot 7-116. Radiated Restricted Upper Band Edge Measurement TxBF**

| | |
|---|---|
| Bluetooth Mode: | 8DPSK |
| Power Scheme: | ePA |
| Measurement Distance: | 3 Meters |
| Operating Frequency: | 2480MHz |
| Channel: | 78 |




**Plot 7-117. Radiated Restricted Upper Band Edge Measurement TxBF**

## 7.10 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 7-33 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 7-33. 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
7. Trace was allowed to stabilize

## Test Setup

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

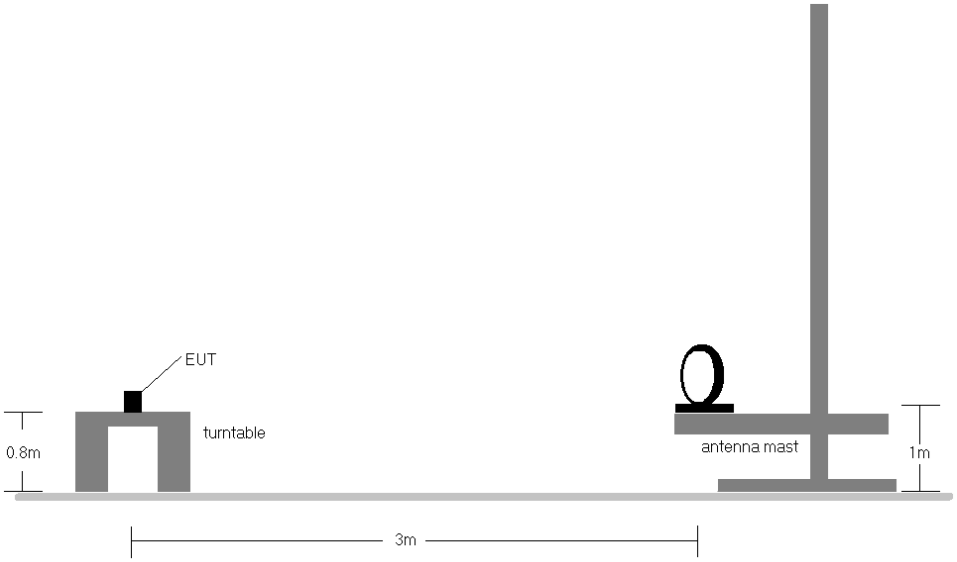



**Figure 7-9. Radiated Test Setup < 30MHz**

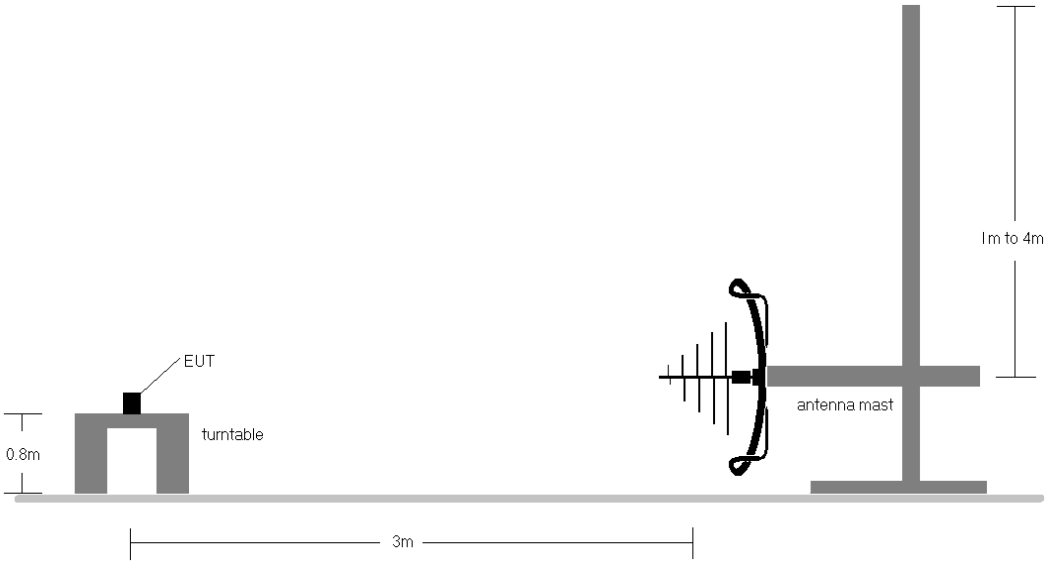



**Figure 7-10. Radiated Test Setup < 1GHz**

## 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 7-33.
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 on emissions that were 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. 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.
9. All supported modulation, antenna (including TxBF mode) and power schemes have been tested on the unit and only worst case configuration is reported.
10. Both configurations below were investigated, and the worst case has been reported.
    a. EUT powered by AC/DC adaptor via USB-C cable with wire charger
    b. EUT powered by host PC via USB-C cable with wire charger

## Sample Calculations

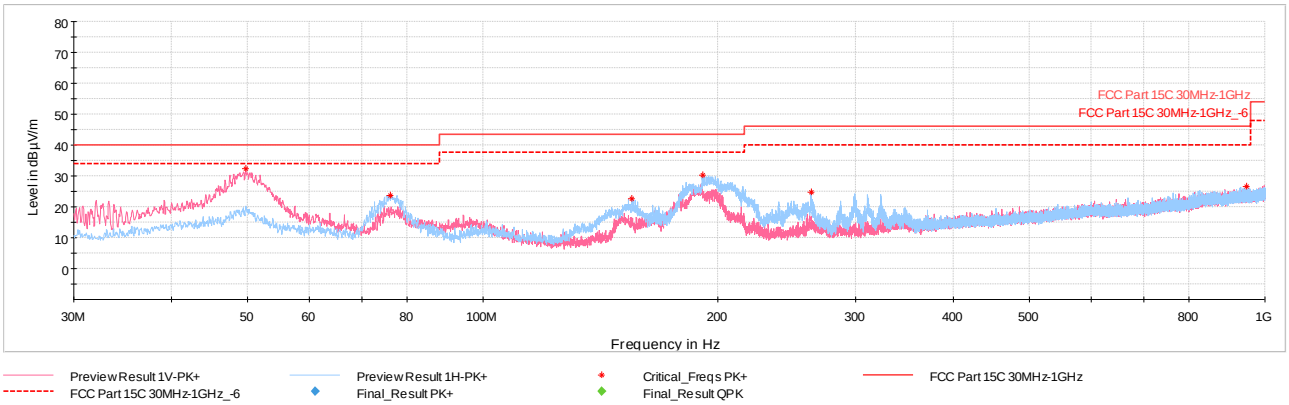
### Determining Spurious Emissions Levels

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

## Radiated Spurious Emissions Measurements (Below 1GHz)

**§15.209; RSS-Gen [8.9]**

## TxBF




**Plot 7-118. Radiated Spurious Emissions Below 1GHz TxBF (GFSK ePA – Ch.39, with AC/DC Adapter)**

| 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] |
|---|---|---|---|---|---|---|---|---|---|
| 49.79 | Max Peak | V | 100 | 59 | -61.87 | -12.80 | 32.33 | 40.00 | -7.67 |
| 76.27 | Max Peak | H | 200 | 259 | -62.72 | -20.66 | 23.62 | 40.00 | -16.38 |
| 155.18 | Max Peak | H | 200 | 143 | -64.99 | -19.32 | 22.69 | 43.52 | -20.83 |
| 191.02 | Max Peak | H | 200 | 319 | -59.84 | -16.81 | 30.35 | 43.52 | -13.17 |
| 262.90 | Max Peak | H | 100 | 235 | -67.59 | -14.70 | 24.71 | 46.02 | -21.31 |
| 947.43 | Max Peak | H | 200 | 206 | -78.55 | -1.77 | 26.68 | 46.02 | -19.34 |

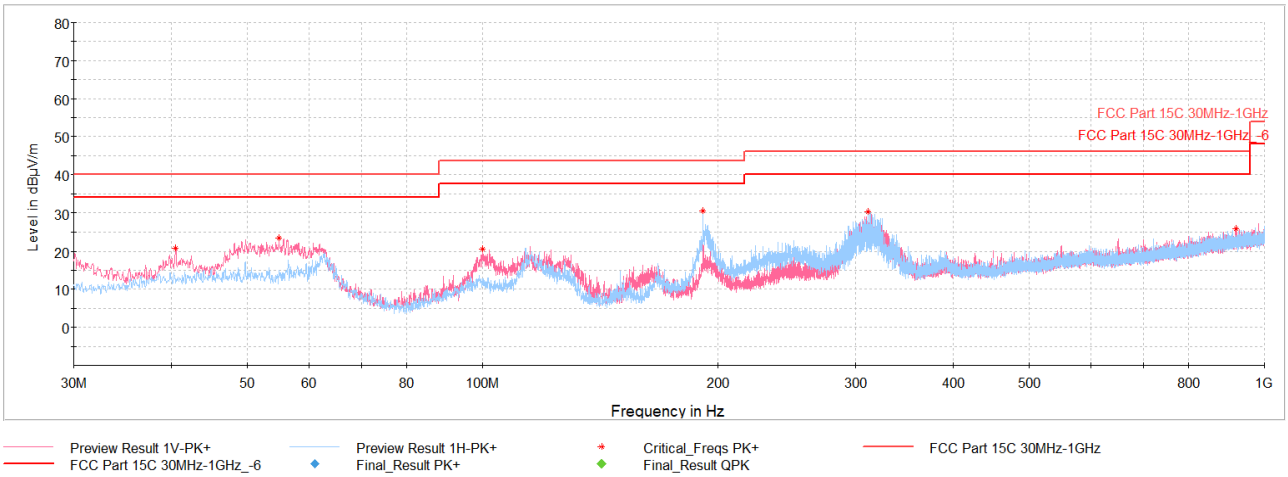
**Table 7-34. Radiated Spurious Emissions Below 1GHz TxBF (GFSK ePA – Ch.39 with AC/DC Adapter)**

## 7.10.1 Simultaneous Tx Radiated Spurious Emissions Measurements (Below 1GHz)

**§15.209; RSS-Gen [8.9]**

| Description | Bluetooth | UNII |
|---|---|---|
| Antenna | Antenna WF2 | Antenna WF2 |
| Channel | 78 | 36 |
| Operating Frequency (MHz) | 2480 | 5180 |
| Mode/Modulation | GFSK iPA | 802.11n |

**Table 7-35. Worst Case Simultaneous Transmission Configuration**




**Plot 7-119. Radiated Spurious Emissions - Simultaneous Transmission Below 1GHz (with AC/DC Adapter)**

| Frequency [MHz] | Detector | Ant. Pol. [H/V] | Antenna Height [cm] | Turntable Azimuth [degree] | Analyzer Level [dBm] | AFCL [dB/m] | Field Strength [dBµV/m] | Limit [dBµV/m] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|---|
| 40.52 | Max Peak | V | 100 | 268 | -72.48 | -13.67 | 20.85 | 40.00 | -19.15 |
| 54.93 | Max Peak | V | 100 | 268 | -69.85 | -13.55 | 23.60 | 40.00 | -16.40 |
| 100.13 | Max Peak | V | 100 | 217 | -70.27 | -16.10 | 20.63 | 43.52 | -22.89 |
| 191.17 | Max Peak | H | 100 | 189 | -59.74 | -16.78 | 30.48 | 43.52 | -13.04 |
| 310.72 | Max Peak | H | 100 | 223 | -63.11 | -13.59 | 30.30 | 46.02 | -15.72 |
| 920.85 | Max Peak | V | 200 | 8 | -79.23 | -1.89 | 25.88 | 46.02 | -20.14 |

**Table 7-36. Radiated Spurious Emissions - Simultaneous Transmission Below 1GHz (with AC/DC Adapter)**

## 7.11 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 7-37. Conducted Limits**

*Decreases with the logarithm of the frequency.

### Test Procedures Used

ANSI C63.10-2020, Section 6.2

### Test Settings

#### Quasi-Peak Measurements

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

#### Average Measurements

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

## Test Setup

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

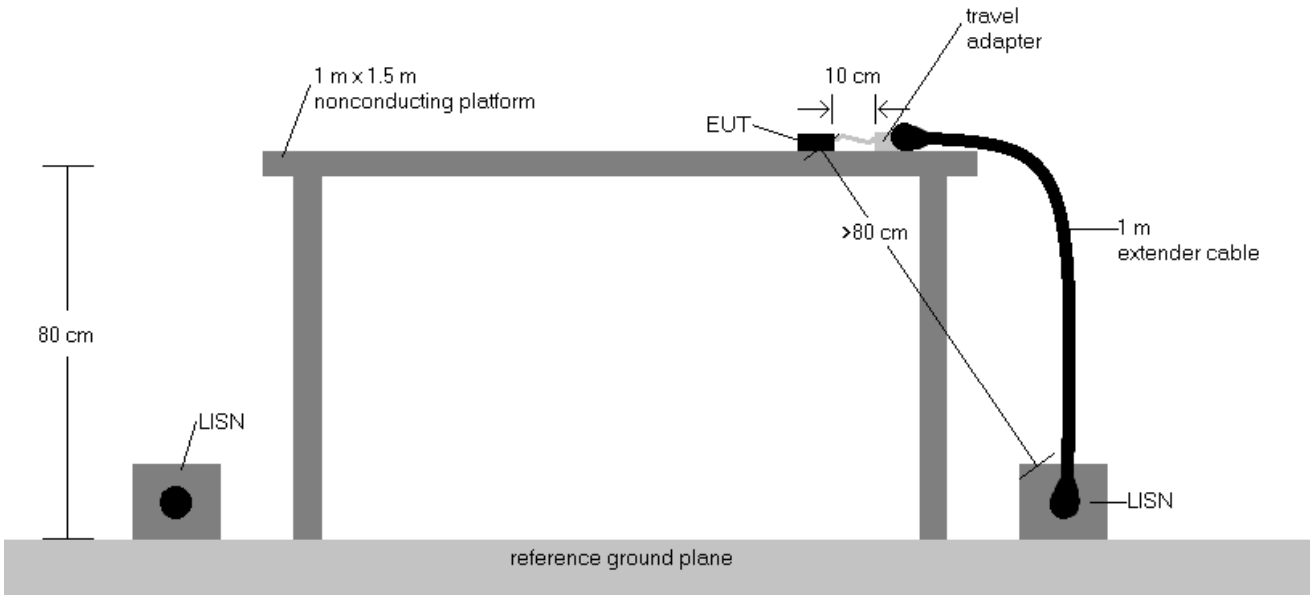
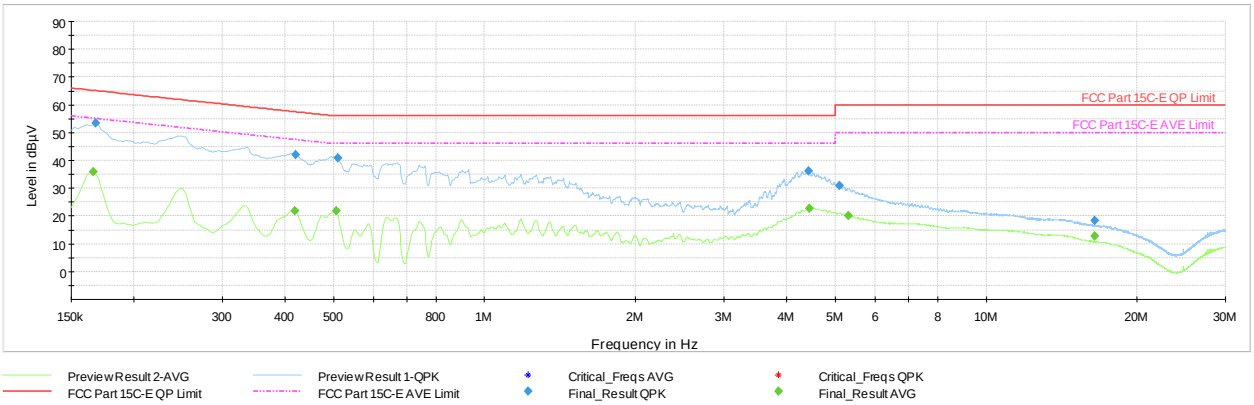



**Figure 7-11. Test Instrument & Measurement Setup**

## Test Notes

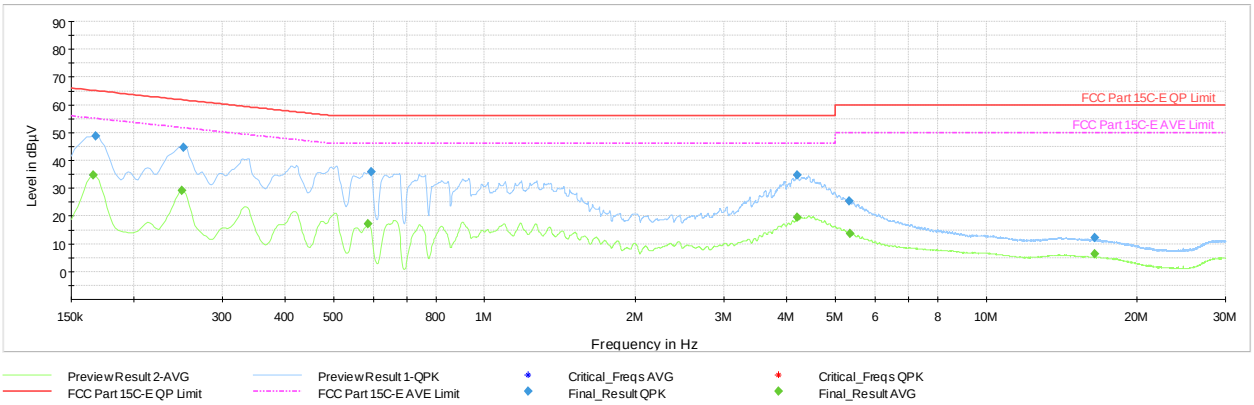
1. All modes of operation were investigated and the worst-case emissions are reported. The emissions found were not affected by the choice of channel used during testing.
2. Both configurations below were investigated, and the worst case has been reported.
    a. EUT powered by AC/DC adaptor via USB-C cable with wire charger
    b. EUT powered by host PC via USB-C cable with wire charger
3. The limit for an intentional radiator from 150kHz to 30MHz are specified in Part 15.207 and RSS-Gen (8.8).
4. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
5. QP/AV Level (dBµV) = QP/AV Analyzer/Receiver Level (dBµV) + Correction Factor (dB)
6. Margin (dB) = QP/AV Level (dBµV) - QP/AV Limit (dBµV)
7. Traces shown in plot are made using a quasi peak and average detectors.
8. Deviations to the Specifications: None.




**Plot 7-120. AC Line-Conducted Test Plot TxBF (L1, GFSK ePA – Ch.39, with AC/DC Adapter)**

| Frequency [MHz] | Process State | QuasiPeak [dBµV] | Average [dBµV] | Limit [dBµV] | Margin [dB] | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.166 | FINAL | — | 35.92 | 55.17 | -19.25 | L1 | GND |
| 0.168 | FINAL | 53.3 | — | 65.06 | -11.73 | L1 | GND |
| 0.418 | FINAL | — | 21.97 | 47.49 | -25.52 | L1 | GND |
| 0.420 | FINAL | 42.1 | — | 57.45 | -15.35 | L1 | GND |
| 0.506 | FINAL | — | 21.80 | 46.00 | -24.20 | L1 | GND |
| 0.510 | FINAL | 40.8 | — | 56.00 | -15.20 | L1 | GND |
| 4.432 | FINAL | 36.1 | — | 56.00 | -19.91 | L1 | GND |
| 4.448 | FINAL | — | 22.81 | 46.00 | -23.19 | L1 | GND |
| 5.105 | FINAL | 30.9 | — | 60.00 | -29.14 | L1 | GND |
| 5.305 | FINAL | — | 20.14 | 50.00 | -29.86 | L1 | GND |
| 16.469 | FINAL | — | 12.70 | 50.00 | -37.30 | L1 | GND |
| 16.469 | FINAL | 18.2 | — | 60.00 | -41.76 | L1 | GND |

**Table 7-38. AC Line-Conducted Test Data TxBF (L1, GFSK ePA – Ch. 39, with AC/DC Adapter)**




**Plot 7-121. AC Line-Conducted Test Plot TxBF (N, GFSK ePA – Ch.39, with AC/DC Adapter)**

| Frequency [MHz] | Process State | QuasiPeak [dBµV] | Average [dBµV] | Limit [dBµV] | Margin [dB] | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.166 | FINAL | — | 34.64 | 55.17 | -20.54 | N | GND |
| 0.168 | FINAL | 48.9 | — | 65.06 | -16.20 | N | GND |
| 0.249 | FINAL | — | 29.11 | 51.79 | -22.68 | N | GND |
| 0.251 | FINAL | 44.8 | — | 61.72 | -16.92 | N | GND |
| 0.587 | FINAL | — | 17.30 | 46.00 | -28.70 | N | GND |
| 0.593 | FINAL | 35.8 | — | 56.00 | -20.22 | N | GND |
| 4.196 | FINAL | — | 19.48 | 46.00 | -26.52 | N | GND |
| 4.202 | FINAL | 34.8 | — | 56.00 | -21.19 | N | GND |
| 5.330 | FINAL | 25.4 | — | 60.00 | -34.62 | N | GND |
| 5.354 | FINAL | — | 13.82 | 50.00 | -36.18 | N | GND |
| 16.472 | FINAL | — | 6.33 | 50.00 | -43.67 | N | GND |
| 16.472 | FINAL | 12.3 | — | 60.00 | -47.68 | N | GND |

**Table 7-39. AC Line-Conducted Test Data TxBF (N, GFSK ePA – Ch.39, with AC/DC Adapter)**

# 8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Tablet Device FCC ID: BCGA2993 and IC: 579C-A2993** 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.