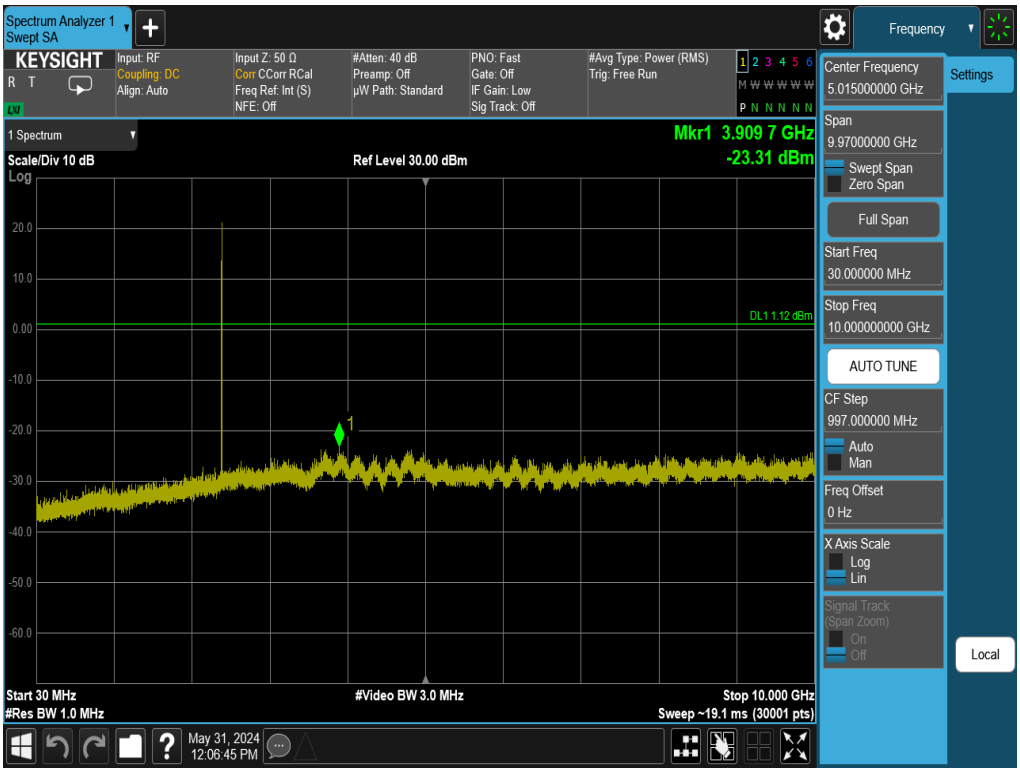
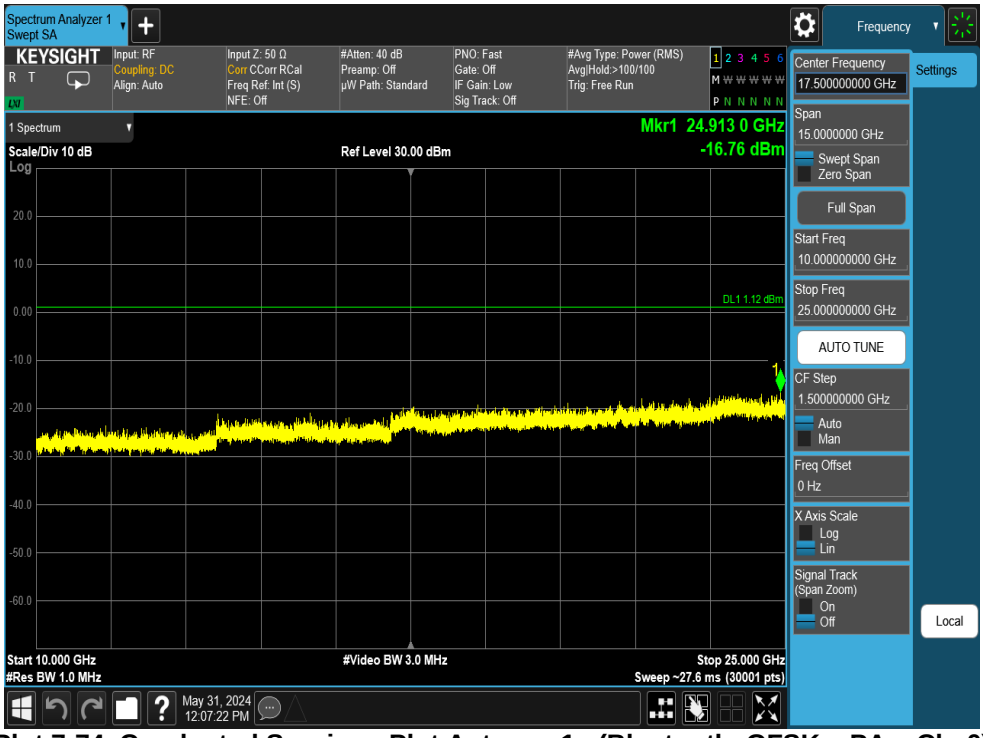
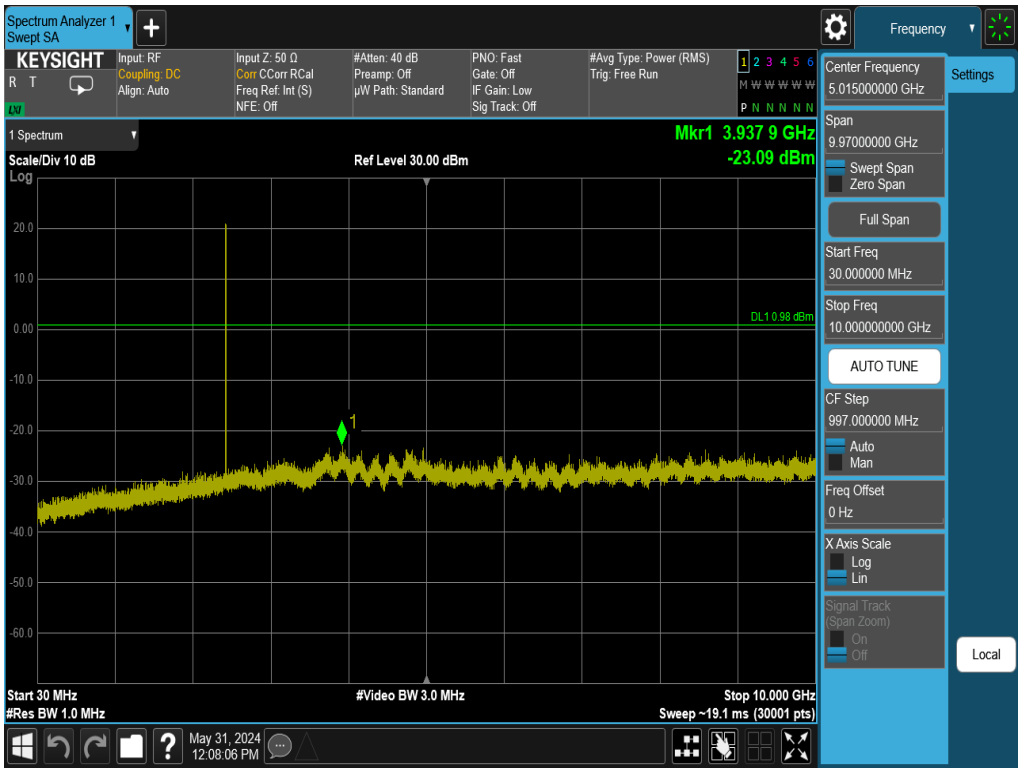
Antenna 1a



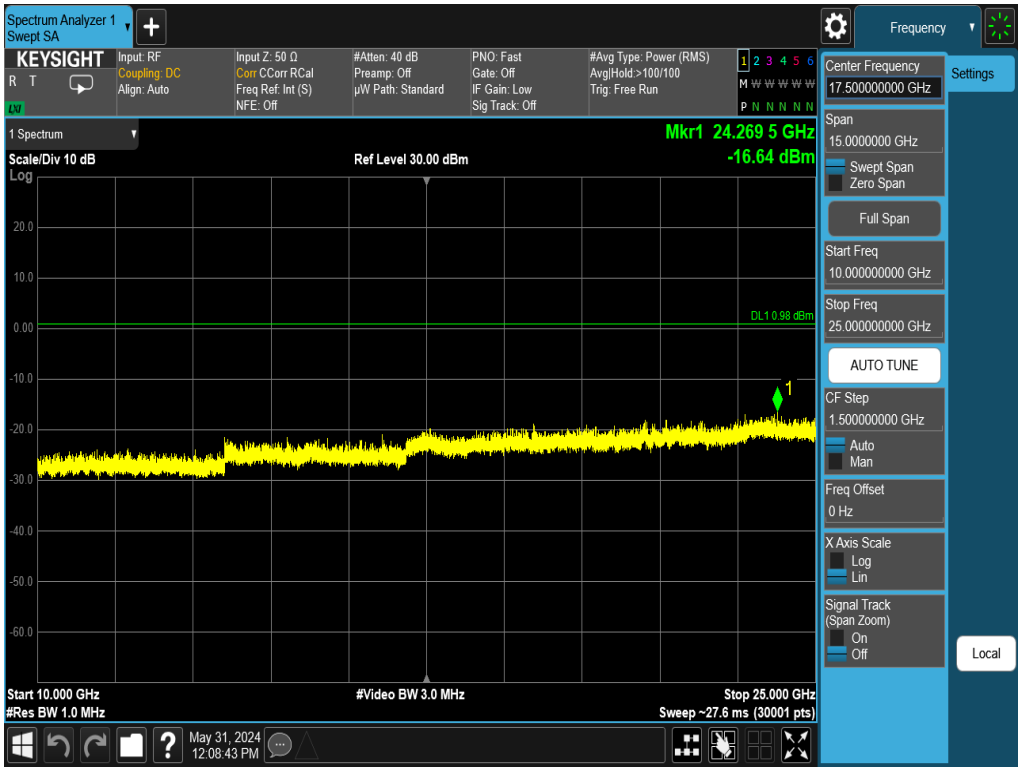
Plot 7-73. Conducted Spurious Plot Antenna 1a (Bluetooth, GFSK, ePA – Ch. 0)



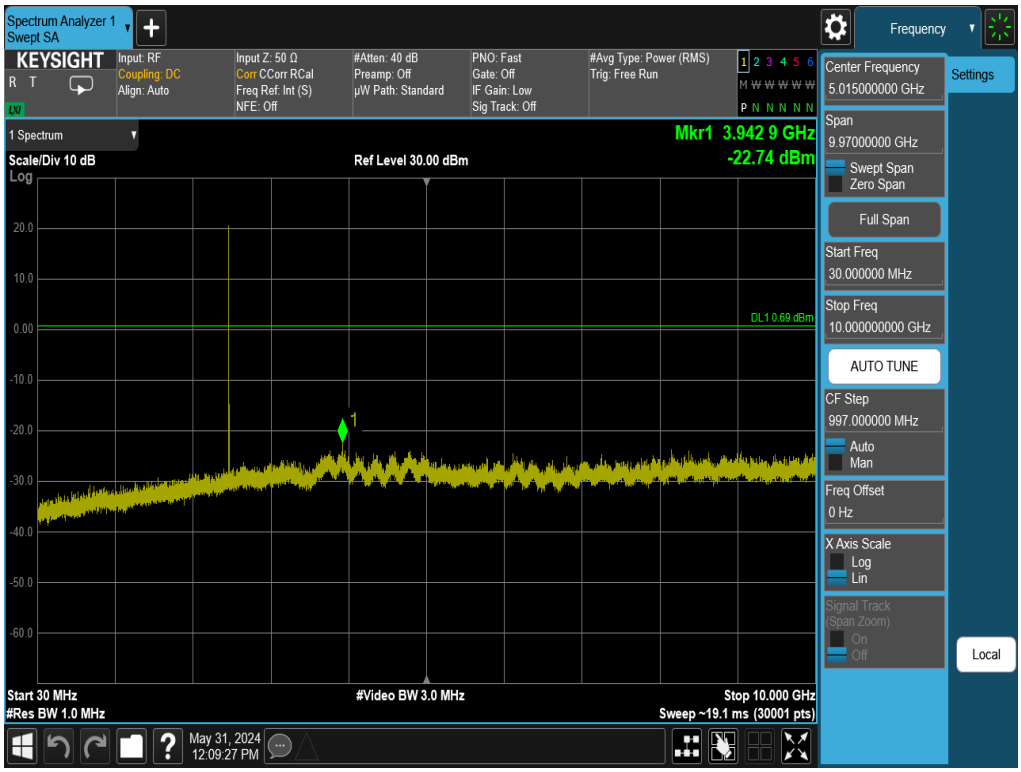
Plot 7-74. Conducted Spurious Plot Antenna 1a (Bluetooth, GFSK, ePA – Ch. 0)



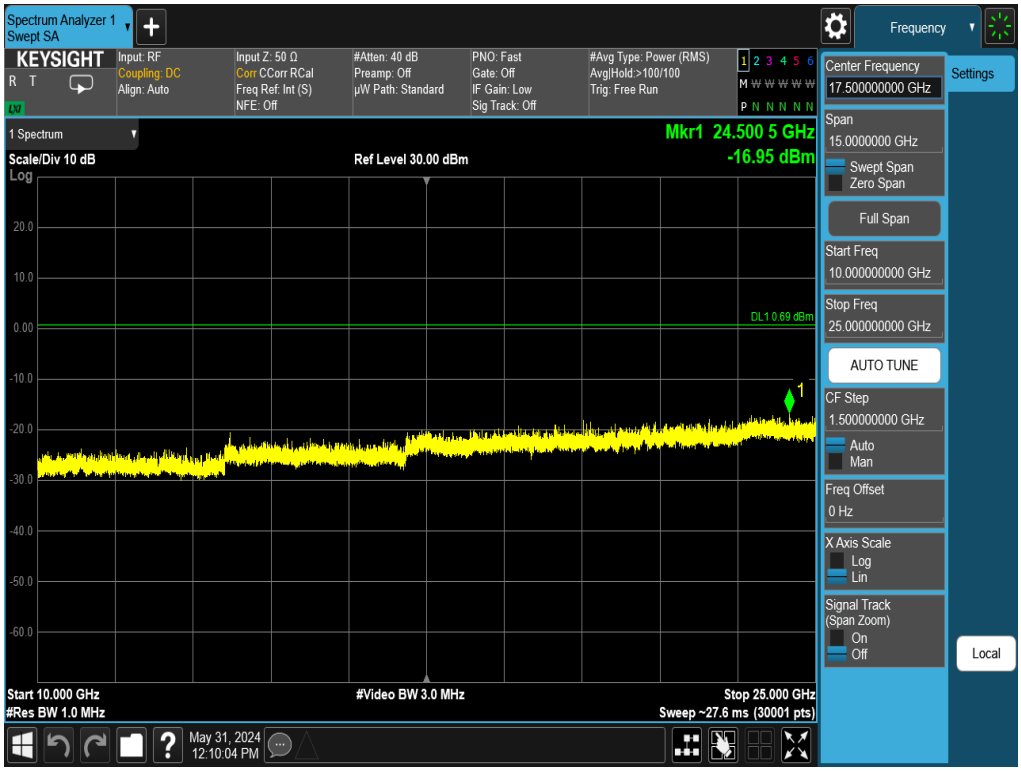
Plot 7-75. Conducted Spurious Plot Antenna 1a (Bluetooth, GFSK, ePA – Ch. 39)



Plot 7-76. Conducted Spurious Plot Antenna 1a (Bluetooth, GFSK, ePA Ch. 39)

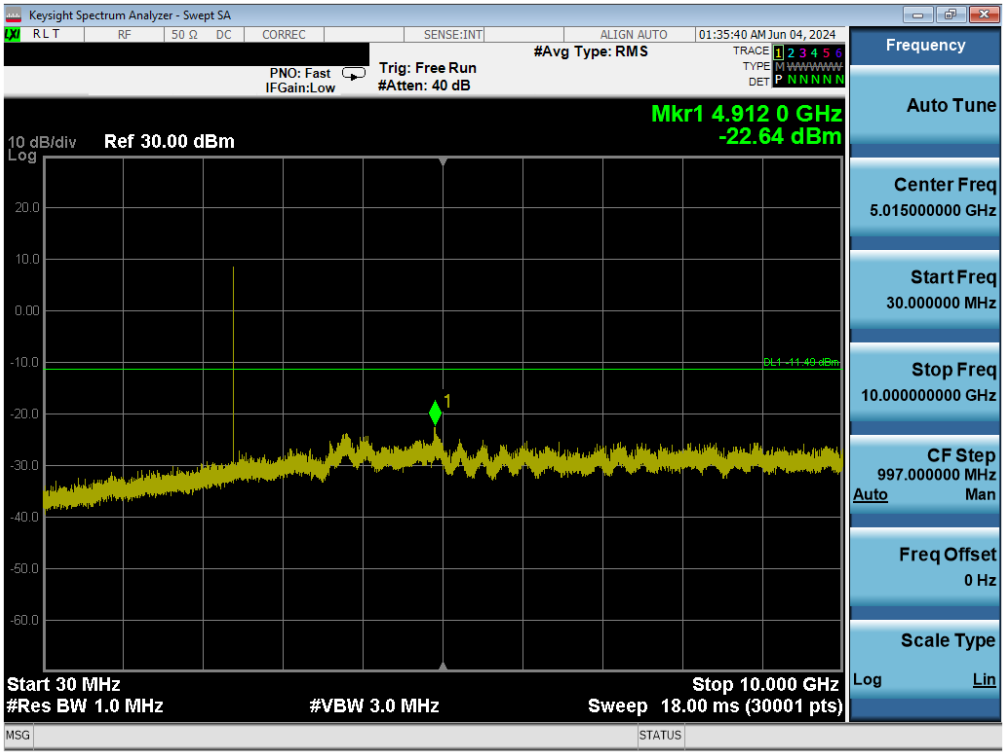


Plot 7-77. Conducted Spurious Plot Antenna 1a (Bluetooth, GFSK, ePA – Ch. 78)

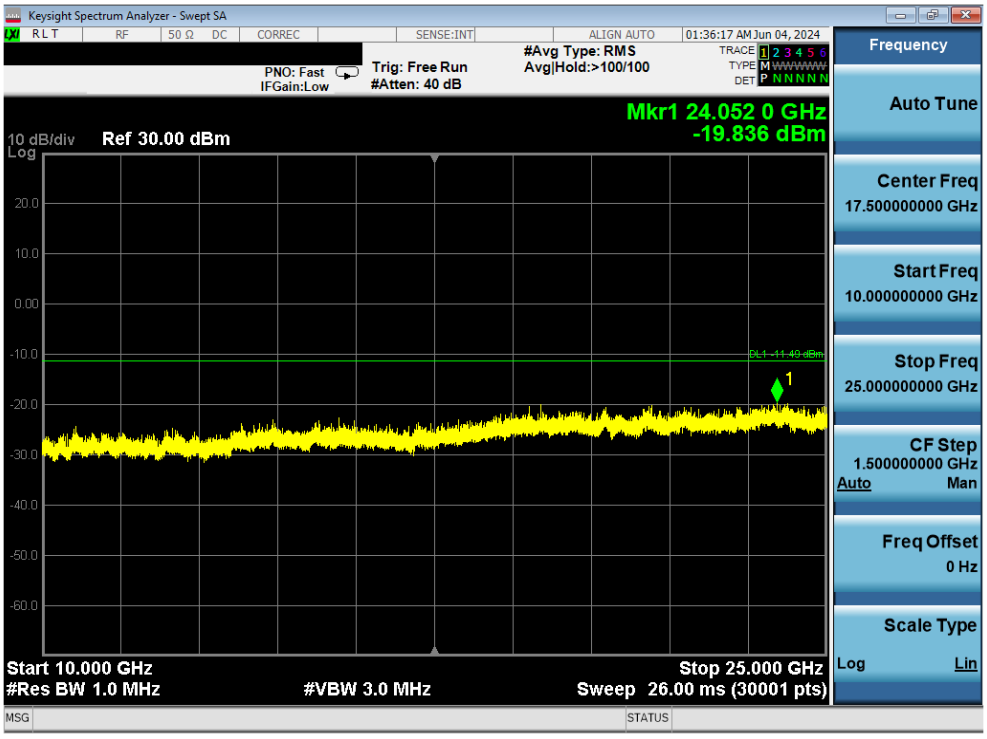


Plot 7-78. Conducted Spurious Plot Antenna 1a (Bluetooth, GFSK, ePA – Ch. 78)

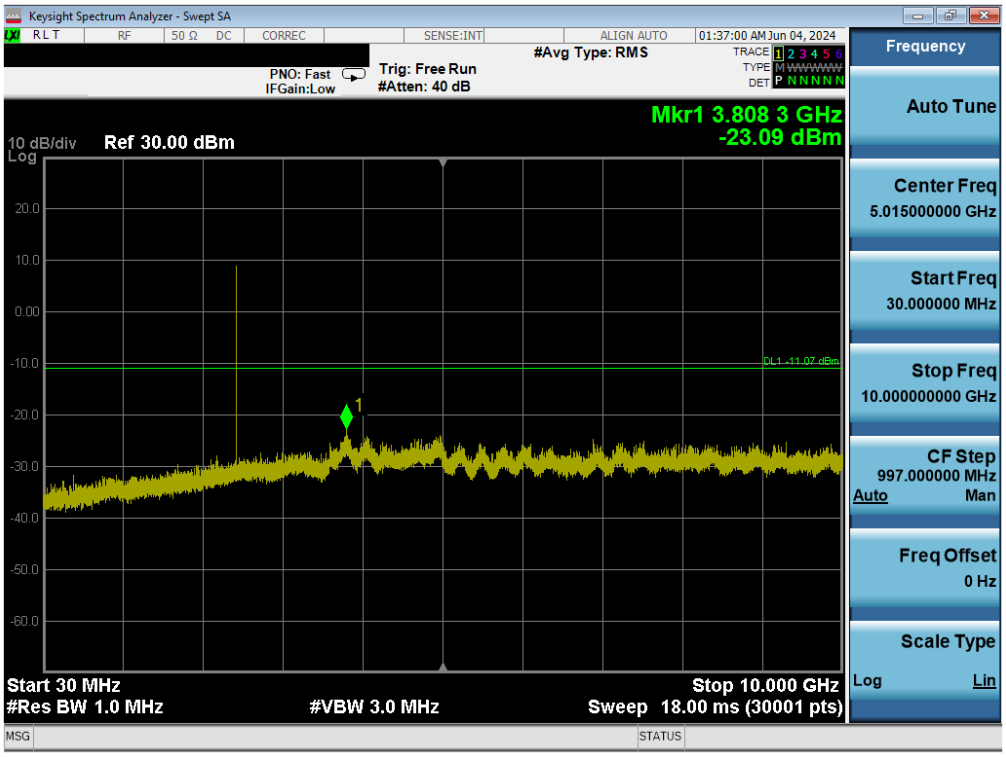
Antenna 4



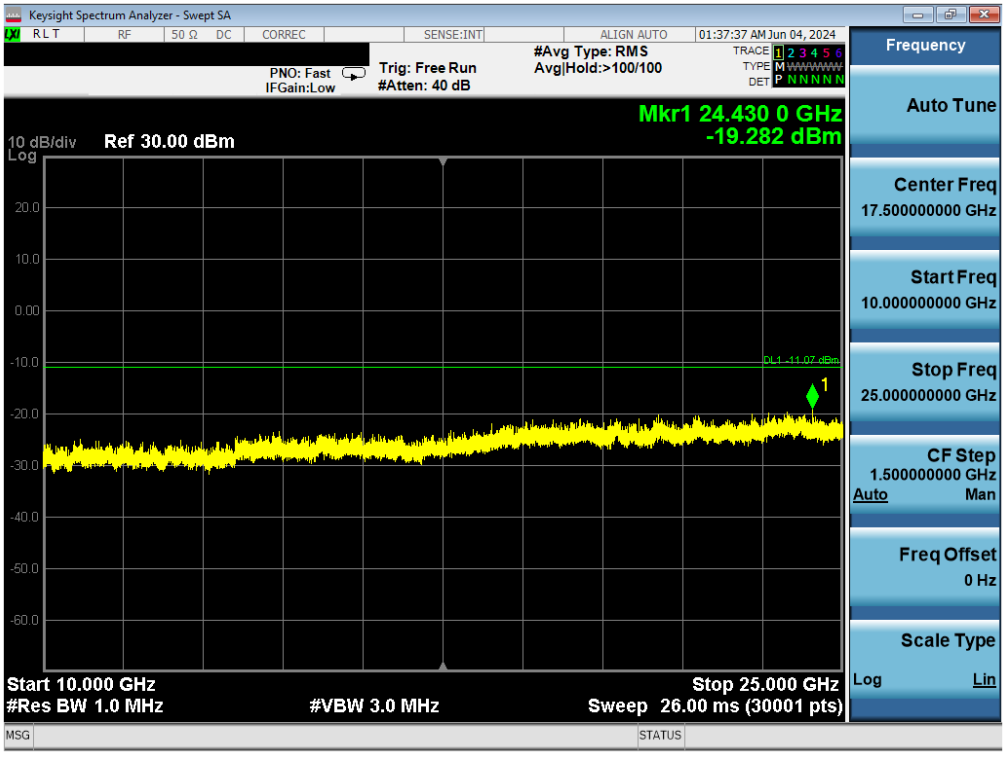
Plot 7-79. Conducted Spurious Plot Antenna 4 (Bluetooth, GFSK, iPA – Ch. 0)



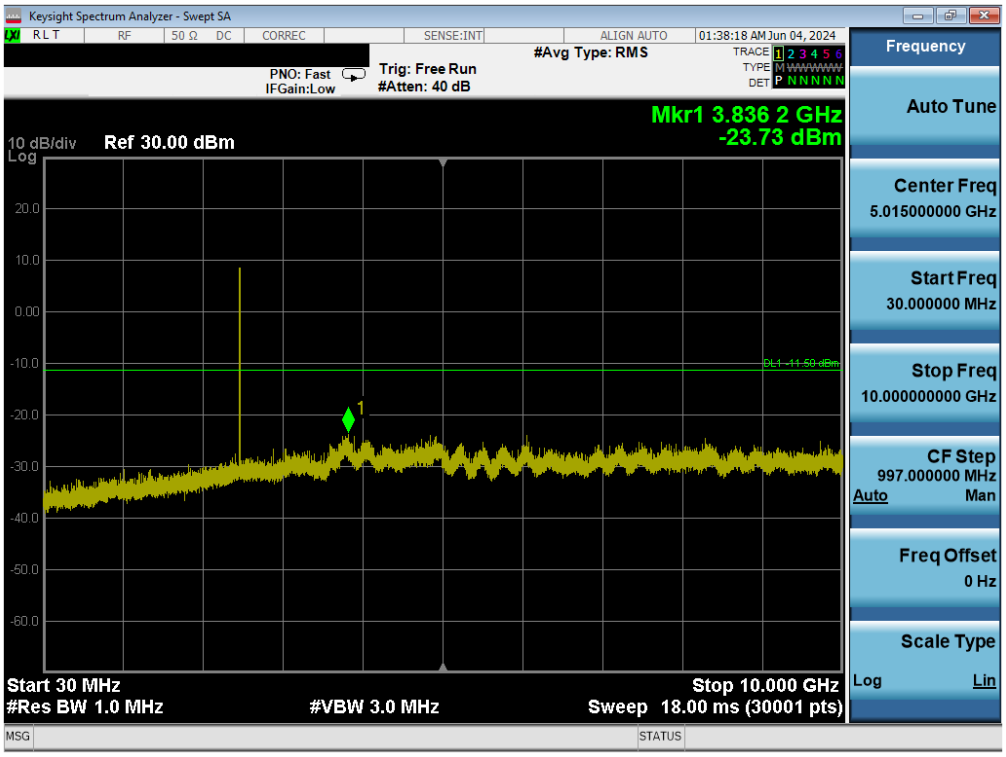
Plot 7-80. Conducted Spurious Plot Antenna 4 (Bluetooth, GFSK, iPA – Ch. 0)



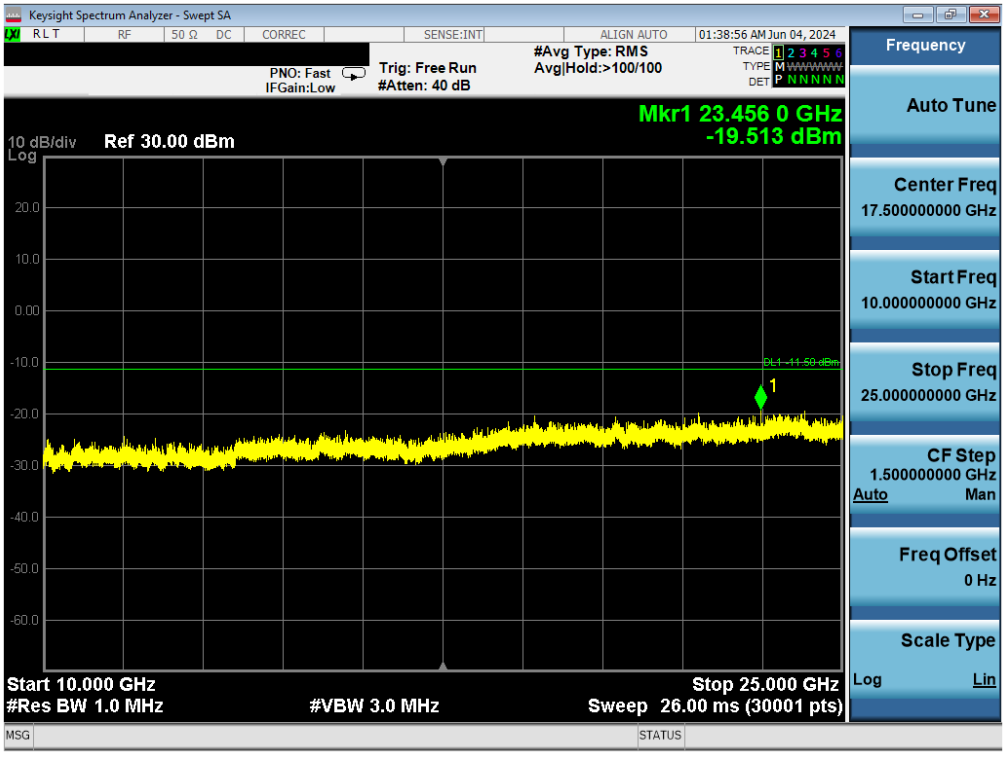
Plot 7-81. Conducted Spurious Plot Antenna 4 (Bluetooth, GFSK, iPA – Ch. 39)



Plot 7-82. Conducted Spurious Plot Antenna 4 (Bluetooth, GFSK, iPA Ch. 39)



Plot 7-83. Conducted Spurious Plot Antenna 4 (Bluetooth, GFSK, iPA – Ch. 78)

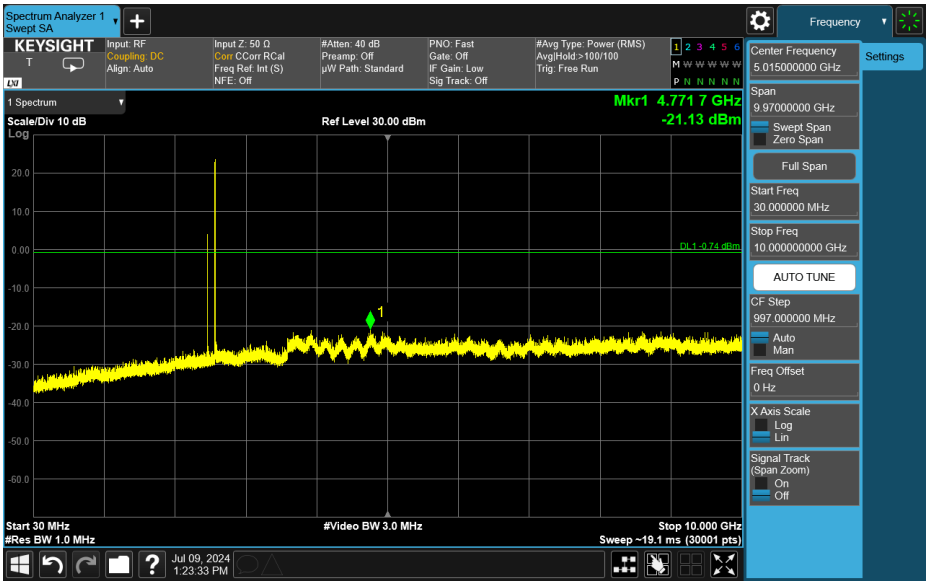


Plot 7-84. Conducted Spurious Plot Antenna 4 (Bluetooth, GFSK, iPA – Ch. 78)

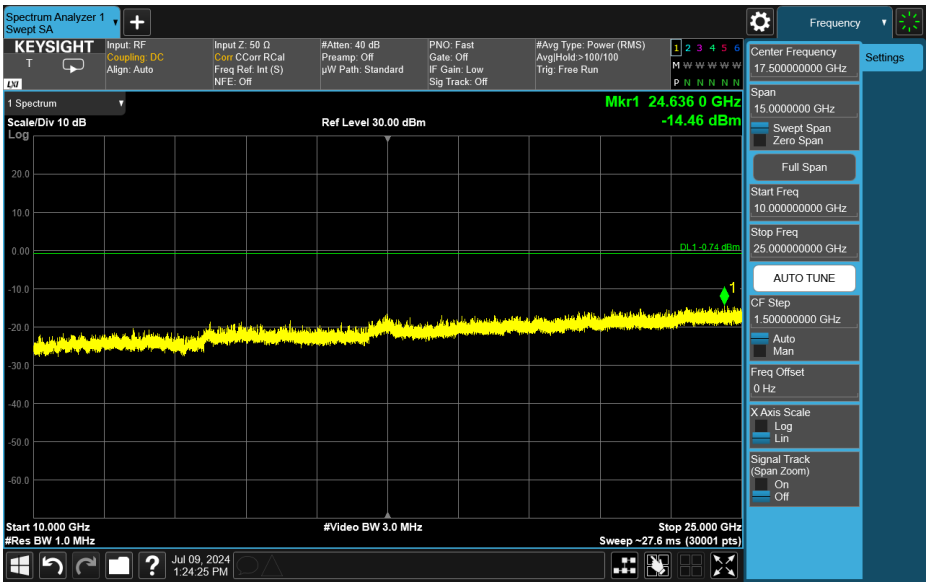
Simultaneous Tx

Description	FR1 n41	Bluetooth
Antenna	Antenna 4	Antenna 4
Channel	501204	78
Operating Frequency (MHz)	2506	2480
Mode/Modulation	QPSK/1RB/20MHz	GFSK iPA

Table 7-16. Worst Case Simultaneous Transmission Configuration



Plot 7-85. Conducted Simultaneous Tx Spurious Plots Antenna 4 (Bluetooth + FR1 n41)



Plot 7-86. Conducted Simultaneous Tx Spurious Plots Antenna 4 (Bluetooth + FR1 n41)

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.

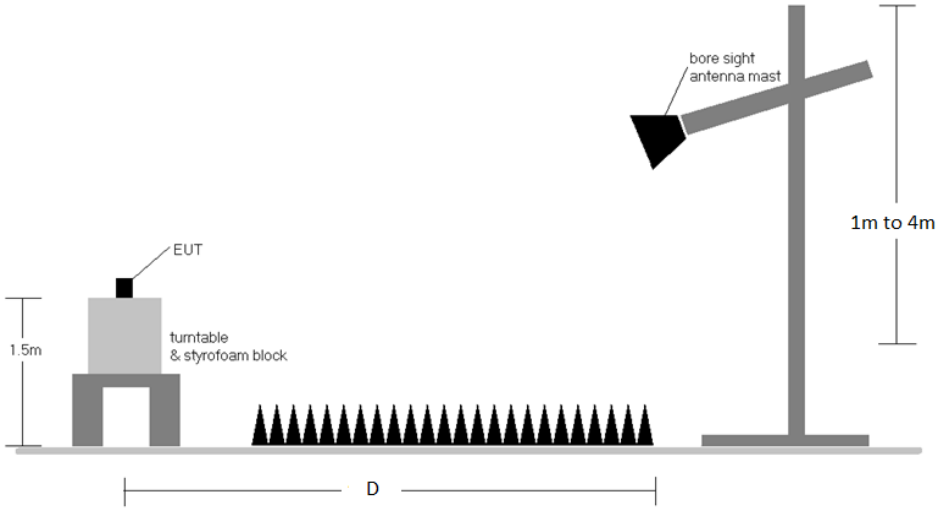


Figure 7-8. Radiated Test Setup >1GHz

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 10th 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

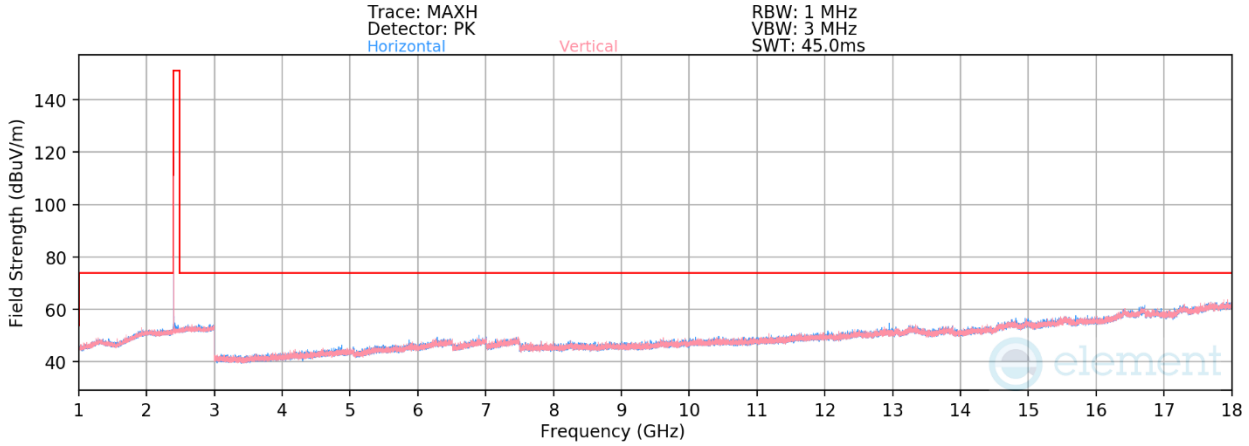
- The amplitude offset shown in the radiated restricted band edge plots in Section 7.9.6 was calculated using the formula:

  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 3a

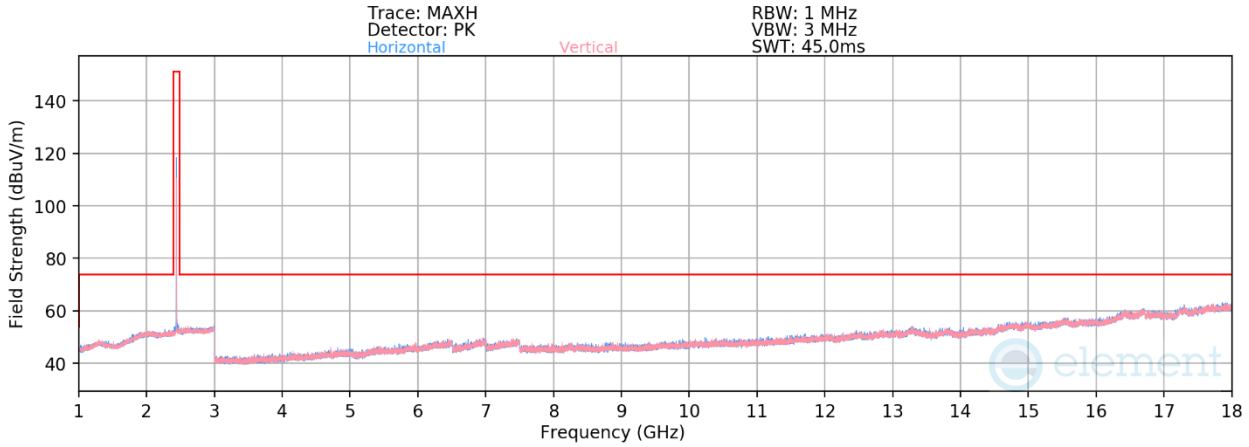


Plot 7-87. Radiated Spurious Emissions above 1GHz Antenna 3a (BT GFSK ePA – Ch. 0)

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	100	200	-66.32	5.73	46.41	73.98	-27.57
12010.00	Peak	H	-	-	-70.27	15.00	51.73	73.98	-22.25

Table 7-18. Radiated Spurious Emission Measurements Antenna 3a

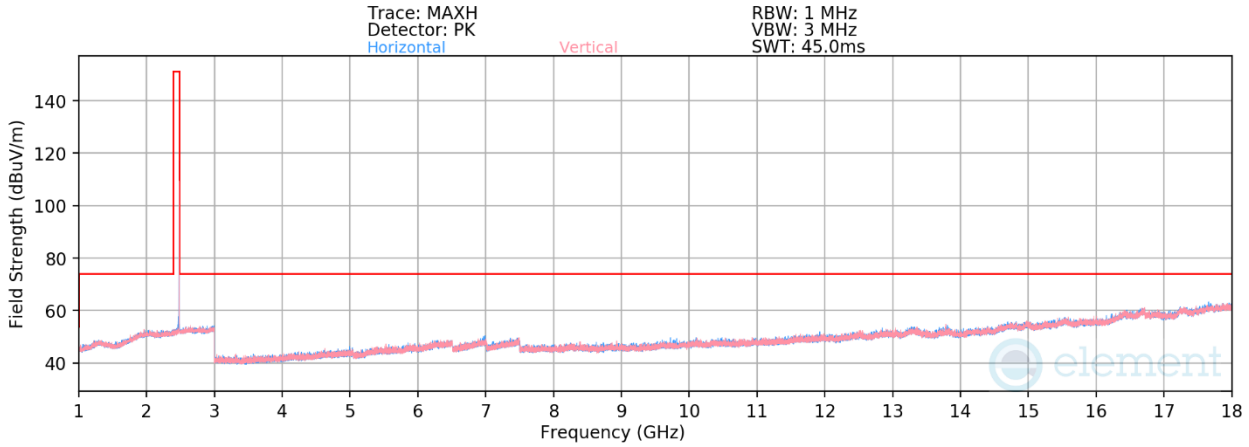


Plot 7-88. Radiated Spurious Emissions above 1GHz Antenna 3a (BT GFSK ePA – Ch. 39)

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	112	205	-66.27	6.36	47.09	73.98	-26.89
7323.00	Peak	H	-	-	-68.20	10.10	48.90	73.98	-25.08
12205.00	Peak	H	-	-	-70.80	15.02	51.22	73.98	-22.76

Table 7-19. Radiated Spurious Emission Measurements Antenna 3a



Plot 7-89. Radiated Spurious Emissions above 1GHz Antenna 3a (BT GFSK ePA – Ch. 78)

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

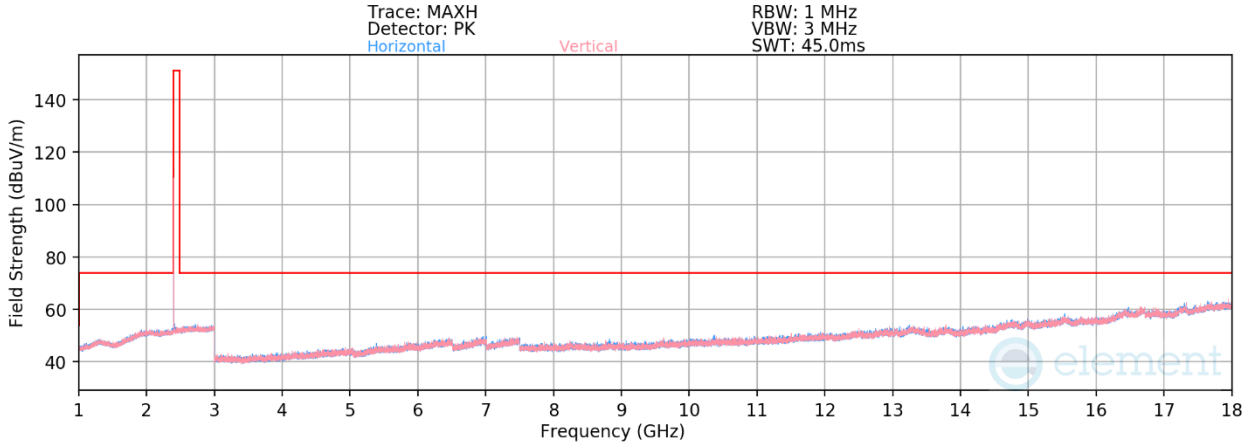
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Peak	H	-	-	-68.06	6.39	45.33	73.98	-28.65
7440.00	Peak	H	-	-	-67.13	9.96	49.83	73.98	-24.15
12400.00	Peak	H	-	-	-70.52	15.01	51.49	73.98	-22.49

Table 7-20. Radiated Spurious Emission Measurements Antenna 3a

7.9.2 Radiated Spurious Emission Measurements (1 – 18GHz)

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

Antenna 1a

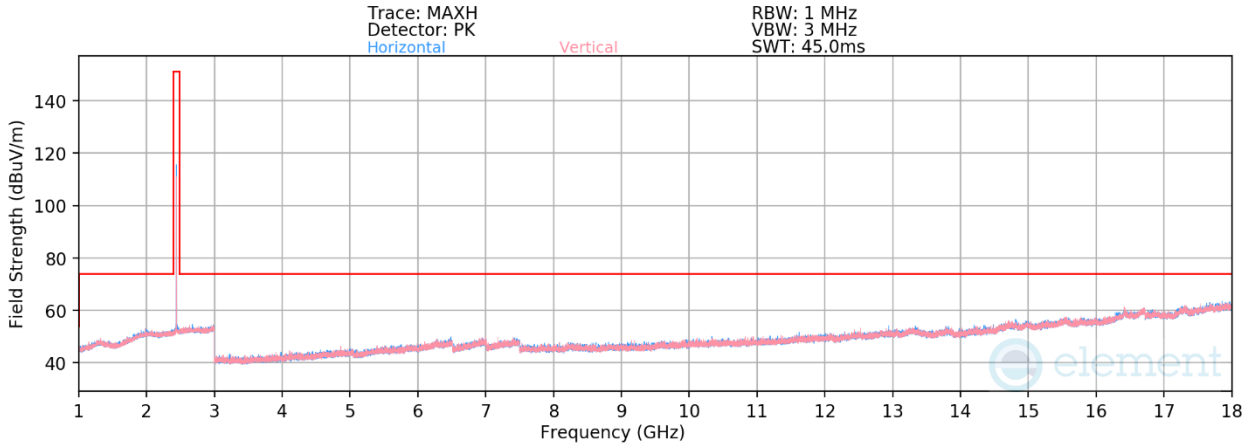


Plot 7-90. Radiated Spurious Emissions above 1GHz Antenna 1a (BT GFSK ePA – Ch. 0)

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	-	-	-67.56	5.60	45.04	73.98	-28.94
12010.00	Peak	V	-	-	-70.64	14.81	51.17	73.98	-22.81

Table 7-21. Radiated Spurious Emission Measurements Antenna 1a

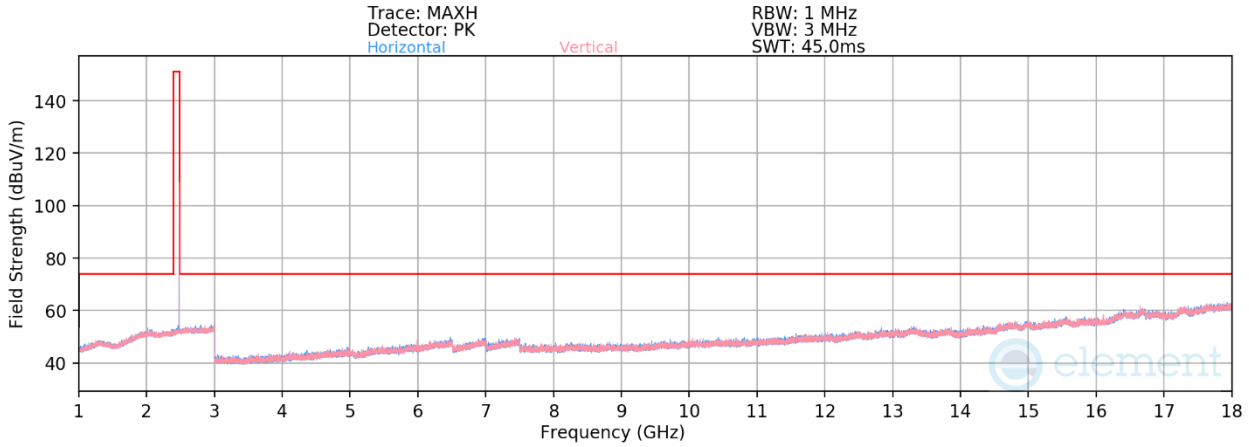


Plot 7-91. Radiated Spurious Emissions above 1GHz Antenna 1a (BT GFSK ePA – Ch. 39)

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	-	-	-67.71	6.26	45.55	73.98	-28.43
7323.00	Peak	V	-	-	-68.28	10.10	48.82	73.98	-25.16
12205.00	Peak	V	-	-	-71.43	14.83	50.40	73.98	-23.58

Table 7-22. Radiated Spurious Emission Measurements Antenna 1a



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

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

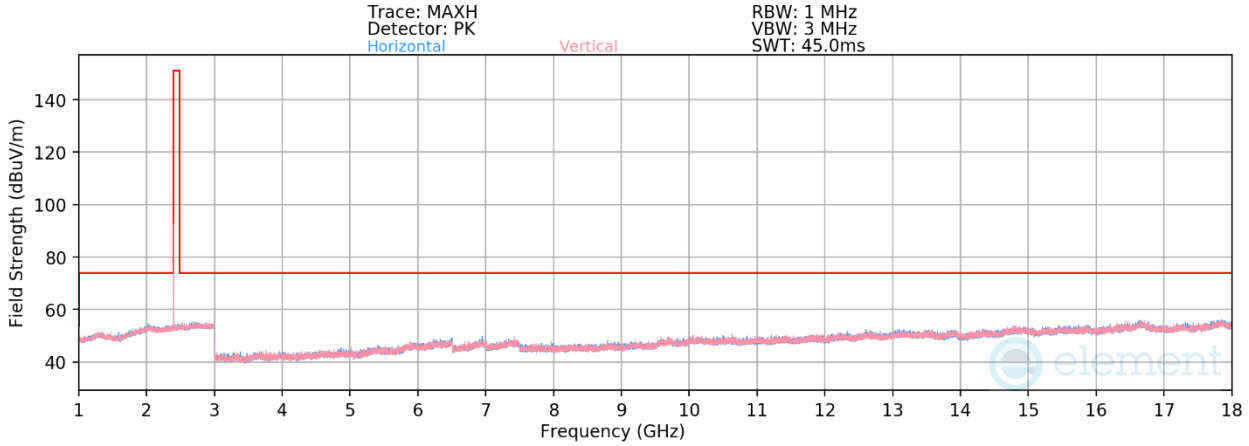
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Peak	V	-	-	-68.12	6.39	45.27	73.98	-28.71
7440.00	Peak	V	-	-	-67.91	10.02	49.11	73.98	-24.87
12400.00	Peak	V	-	-	-71.35	15.48	51.13	73.98	-22.85

Table 7-23. Radiated Spurious Emission Measurements Antenna 1a

7.9.3 Radiated Spurious Emission Measurements (1 – 18GHz)

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

Antenna 4

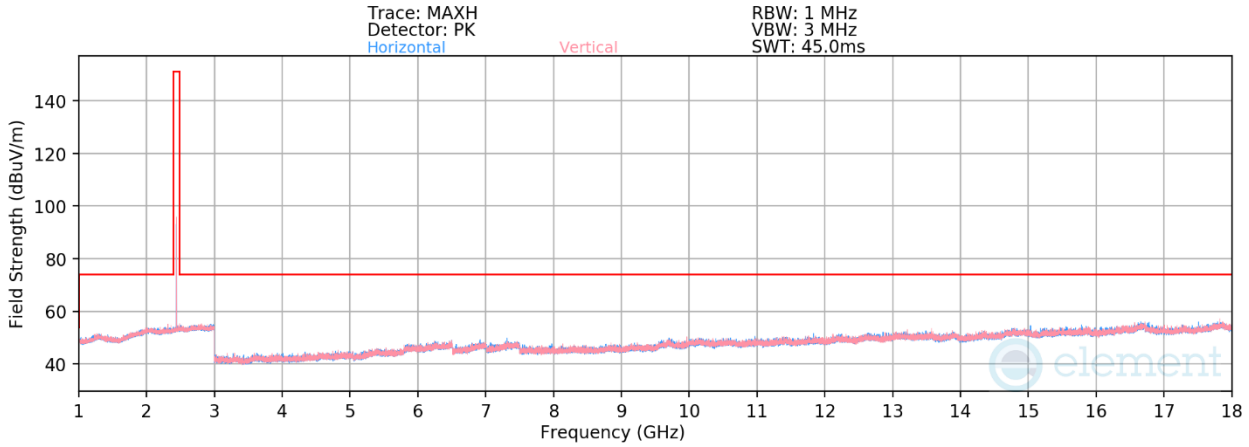


Plot 7-93. Radiated Spurious Emissions above 1GHz Antenna 4 (BT GFSK iPA – Ch. 0)

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	-	-	-66.56	4.40	44.84	73.98	-29.14
12010.00	Peak	V	-	-	-70.40	13.35	49.95	73.98	-24.03

Table 7-24. Radiated Spurious Emission Measurements Antenna 4

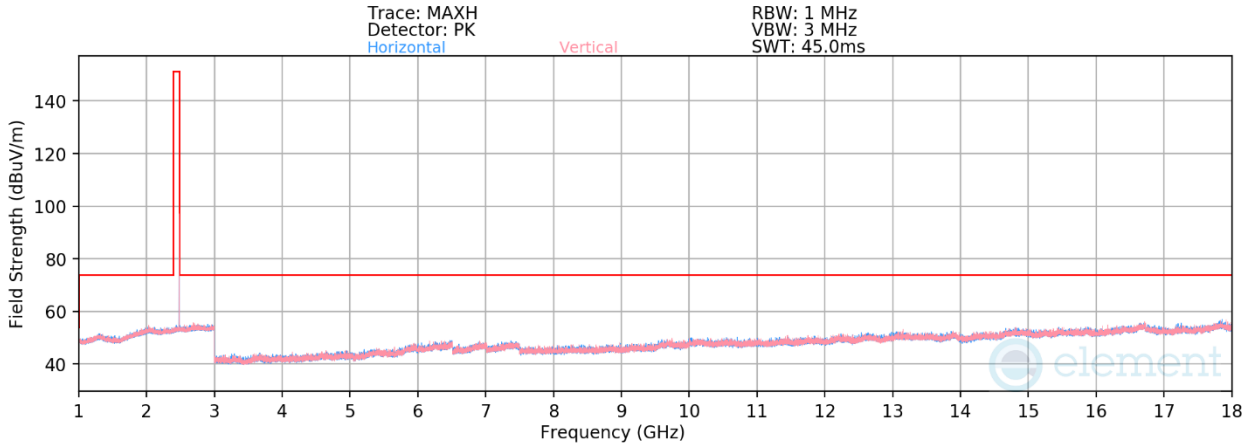


Plot 7-94. Radiated Spurious Emissions above 1GHz Antenna 4 (BT GFSK iPA – Ch. 39)

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	-	-	-65.96	4.90	45.94	73.98	-28.04
7323.00	Peak	V	-	-	-68.18	9.55	48.37	73.98	-25.61
12205.00	Peak	V	-	-	-71.51	15.08	50.57	73.98	-23.41

Table 7-25. Radiated Spurious Emission Measurements Antenna 4



Plot 7-95. Radiated Spurious Emissions above 1GHz Antenna 4 (BT GFSK iPA – Ch. 78)

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

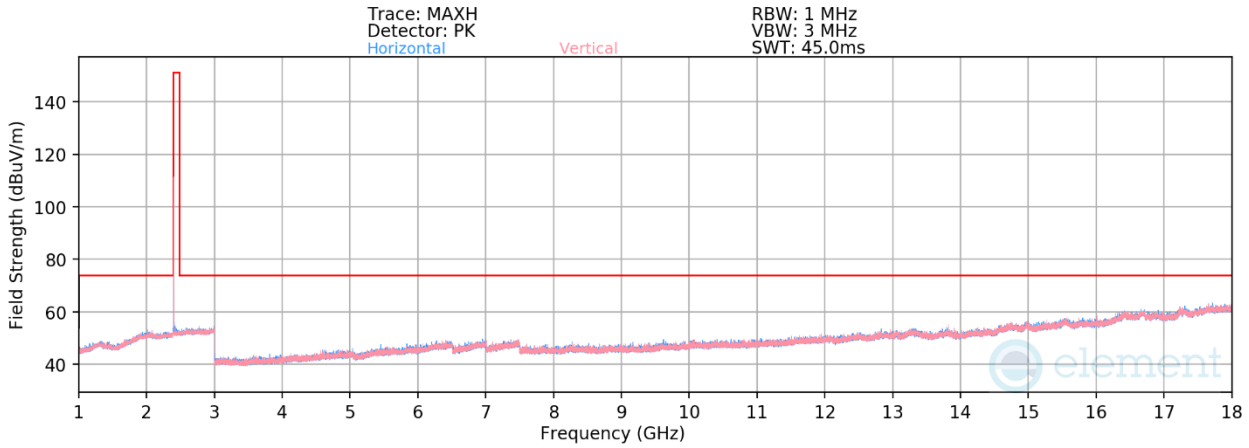
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Peak	V	-	-	-67.34	4.75	44.41	73.98	-29.57
7440.00	Peak	V	-	-	-68.44	9.48	48.04	73.98	-25.94
12400.00	Peak	V	-	-	-71.35	14.08	49.73	73.98	-24.25

Table 7-26. Radiated Spurious Emission Measurements Antenna 4

7.9.4 Radiated Spurious Emission Measurements (Above 1GHz)

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

TxBF

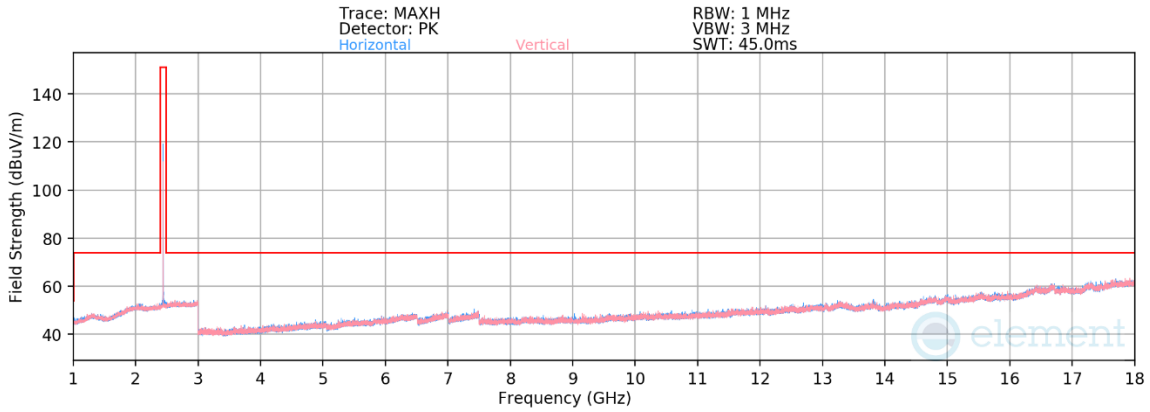


Plot 7-96. Radiated Spurious Emissions above 1GHz TxBF (BT GFSK ePA – Ch. 0)

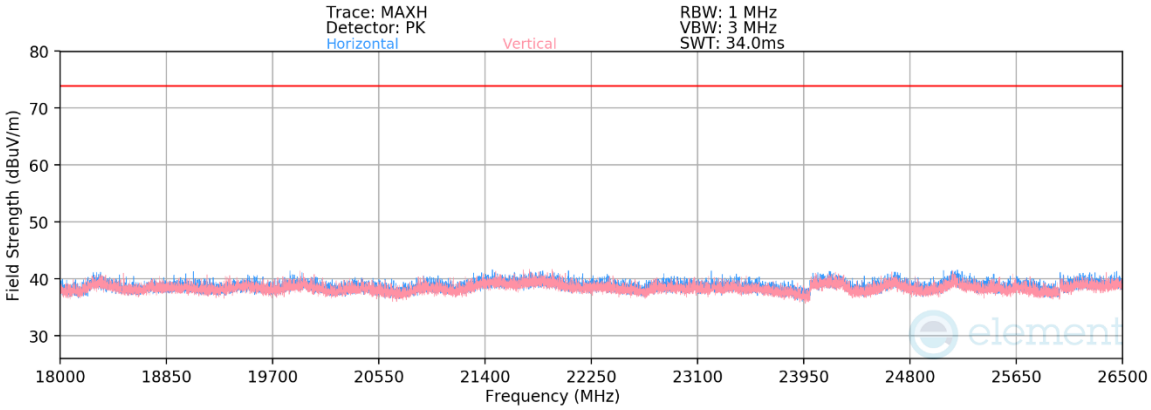
Bluetooth Mode:	GFSK
Data Rate:	1Mbps
Power Scheme	ePA
Distance of Measurements:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

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	115	202	-66.43	5.73	46.30	73.98	-27.68
12010.00	Peak	H	-	-	-71.09	15.00	50.91	73.98	-23.07

Table 7-27. Radiated Spurious Emission Measurements TxBF



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

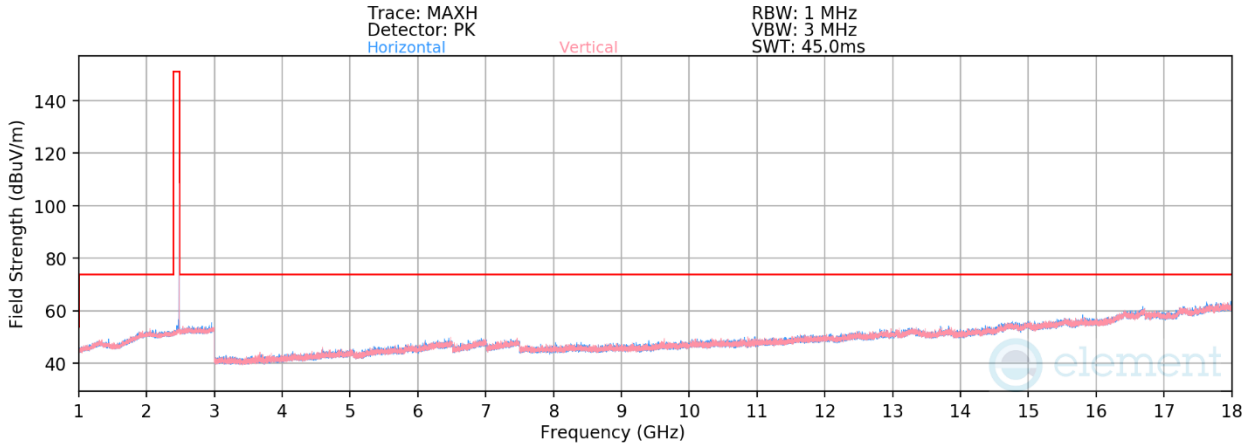


Plot 7-98. Radiated Spurious Emissions above 18GHz TxBF (BT GFSK ePA – Ch. 39)

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	104	202	-66.20	6.36	47.16	73.98	-26.82
7323.00	Peak	H	-	-	-68.02	10.10	49.08	73.98	-24.90
12205.00	Peak	H	-	-	-71.15	14.83	50.68	73.98	-23.30

Table 7-28. Radiated Spurious Emission 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	-	-	-68.03	6.39	45.36	73.98	-28.62
7440.00	Peak	H	-	-	-67.75	10.02	49.27	73.98	-24.71
12400.00	Peak	H	-	-	-71.25	15.49	51.24	73.98	-22.74

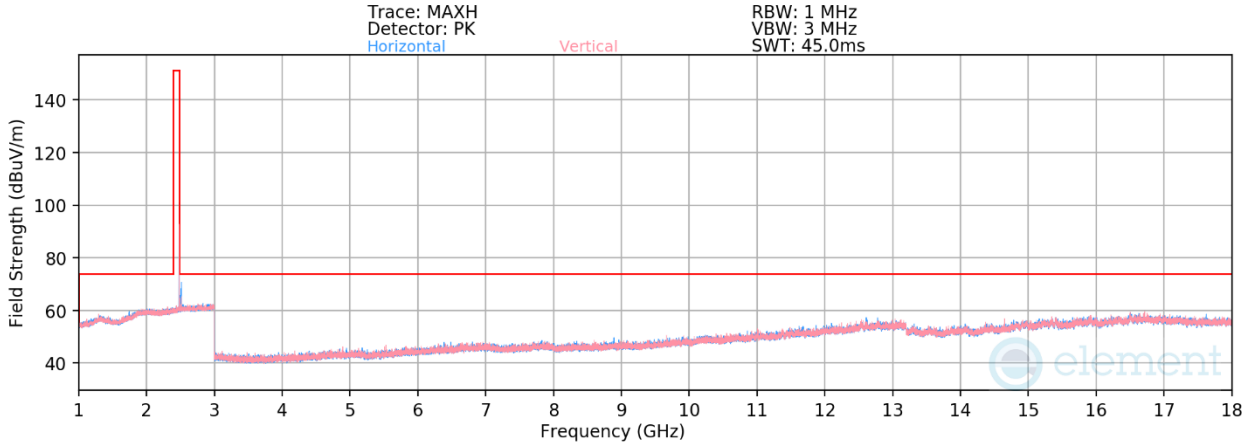
Table 7-29. Radiated Spurious Emission Measurements TxBF

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

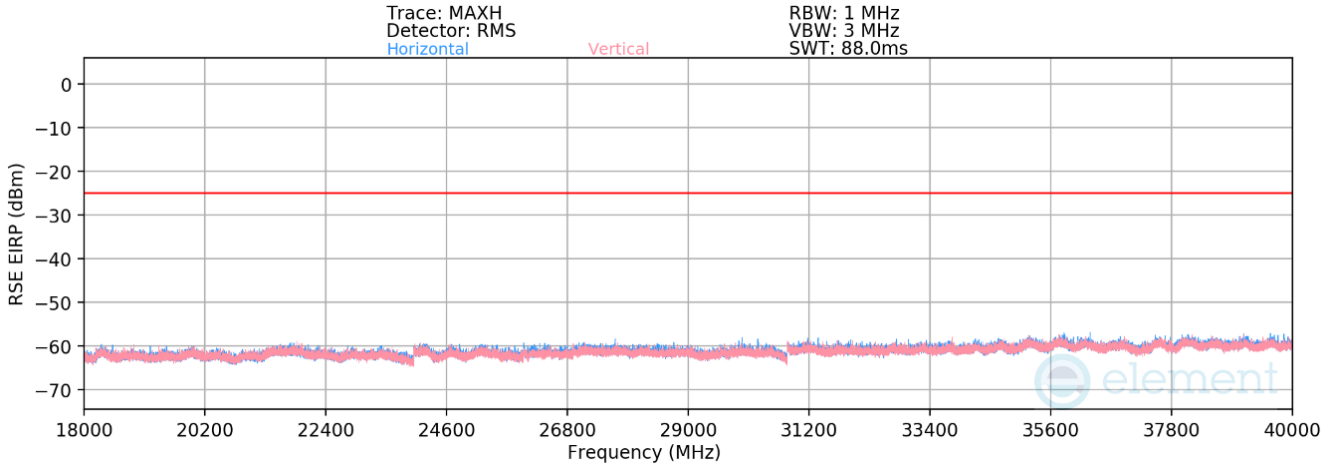
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Description	FR1 n41	Bluetooth
Antenna	Antenna 4	Antenna 4
Channel	501204	78
Operating Frequency (MHz)	2506	2480
Mode/Modulation	QPSK/1RB/20MHz	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	-	-	-68.74	19.04	57.30	73.98	-16.68
7440.00	Peak	H	-	-	-70.67	22.72	59.05	73.98	-14.93
12400.00	Peak	H	-	-	-71.68	30.73	66.05	73.98	-7.93

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

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dBm]	Field Strength [dBµV/m]	EIRP Spurious Emission Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]
4994.00	H	-	-	-79.93	19.10	46.17	-49.06	-25.00	-24.06
7491.00	H	-	-	-81.35	22.74	48.39	-46.84	-25.00	-21.84
9988.00	H	-	-	-81.88	25.78	50.90	-44.33	-25.00	-19.33
12485.00	H	-	-	-83.13	31.01	54.88	-40.35	-25.00	-15.35
2463.00*	H	-	-	-77.58	13.98	43.40	-51.83	-25.00	-26.83
2514.00*	H	101	21	-65.66	20.98	62.32	-32.91	33.00	-65.91

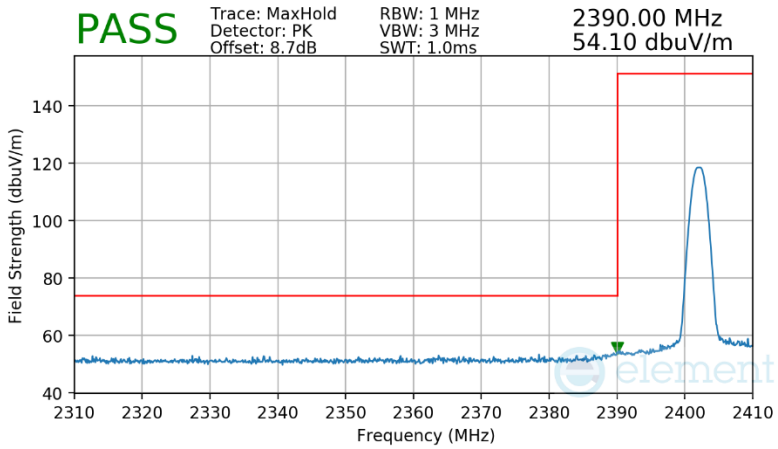
Table 7-32. FR1 Harmonics and Intermodulation (*) Emissions Measurements in Simultaneous Transmission Mode

7.9.6 Radiated Restricted Band Edge Measurements

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

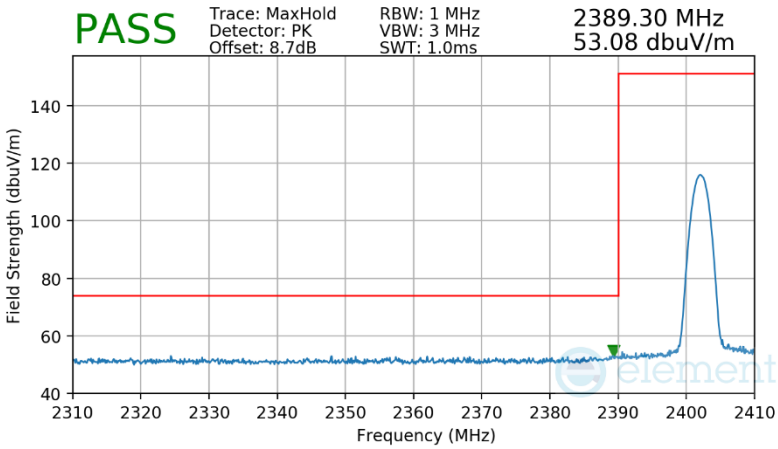
Antenna 3a

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 3a

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

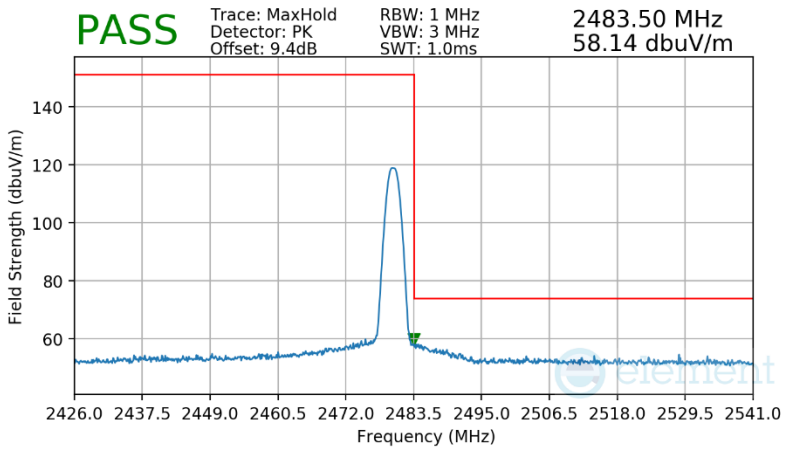


Plot 7-103. Radiated Restricted Lower Band Edge Measurement Antenna 3a

Radiated Restricted Band Edge Measurements

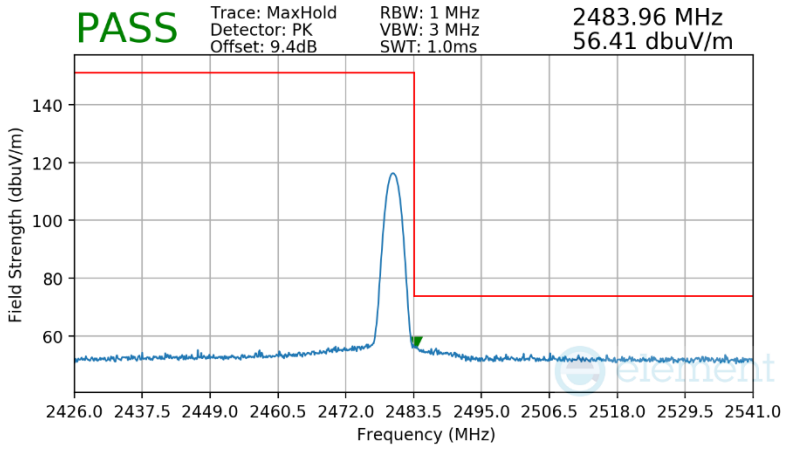
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

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 3a

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



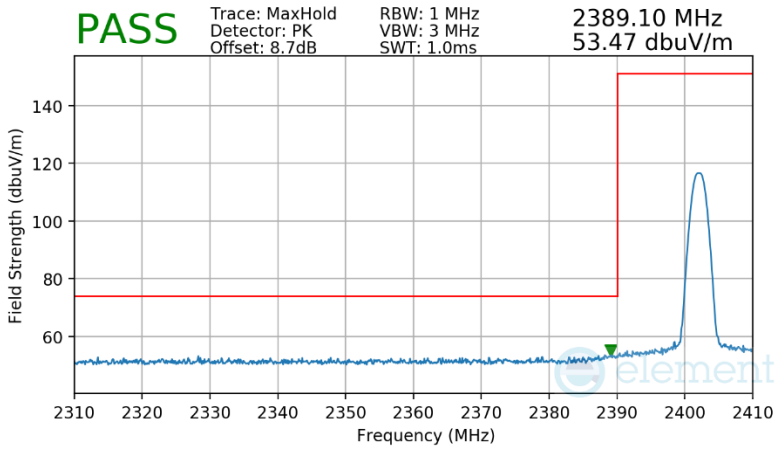
Plot 7-105. Radiated Restricted Upper Band Edge Measurement Antenna 3a

Radiated Restricted Band Edge Measurements

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

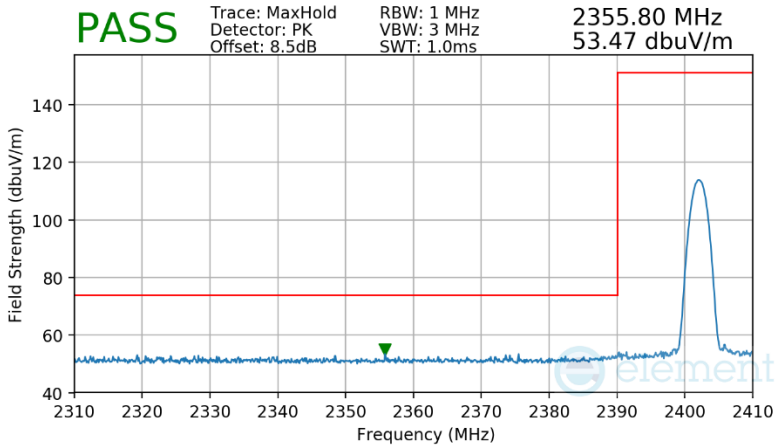
Antenna 1a

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 1a

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

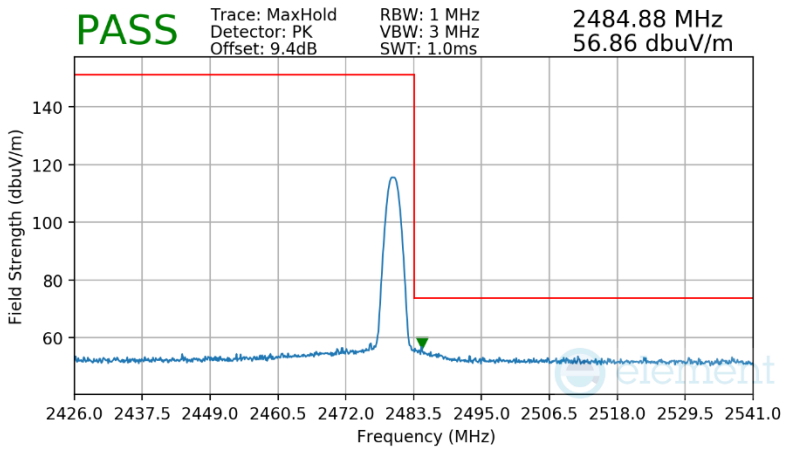


Plot 7-107. Radiated Restricted Lower Band Edge Measurement Antenna 1a

Radiated Restricted Band Edge Measurements

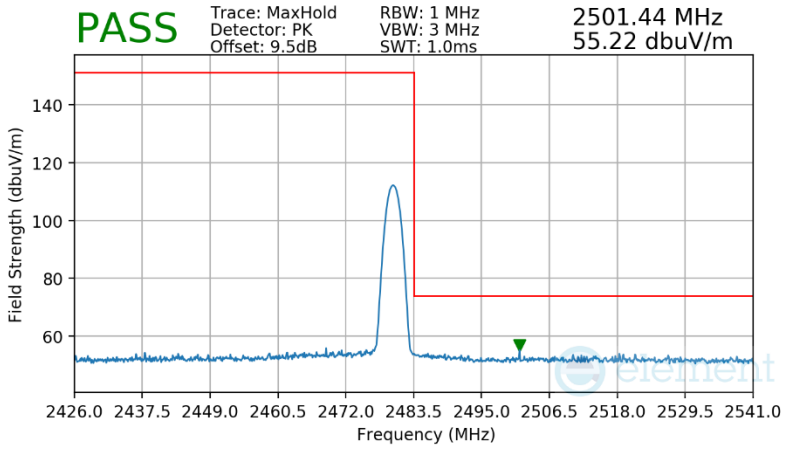
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

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 1a

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



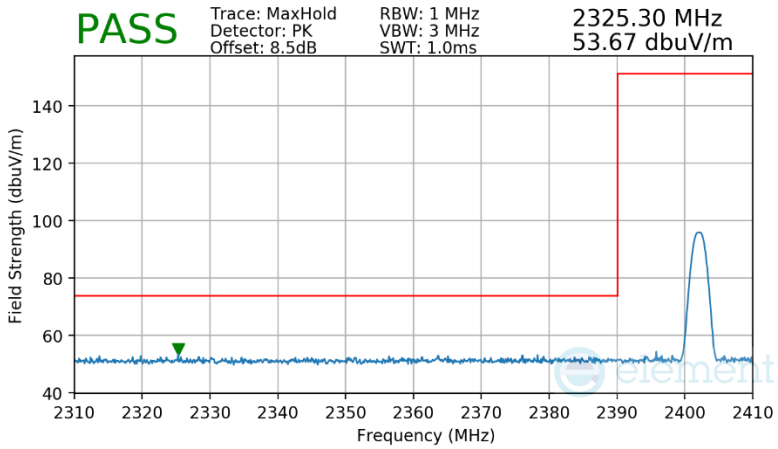
Plot 7-109. Radiated Restricted Upper Band Edge Measurement Antenna 1a

Radiated Restricted Band Edge Measurements

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

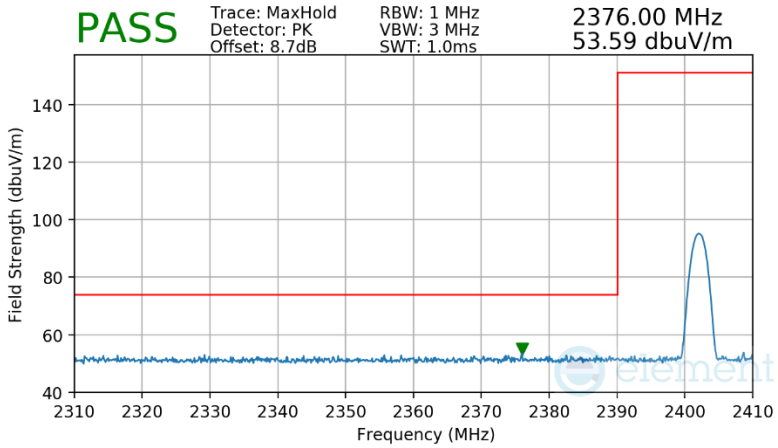
Antenna 4

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 4

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

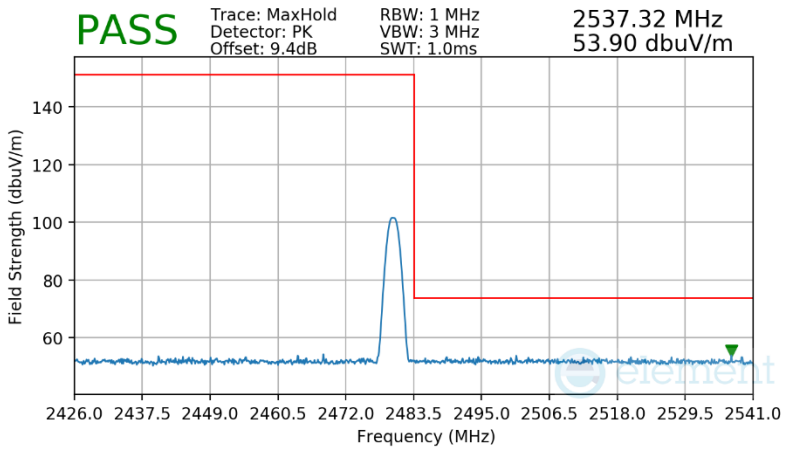


Plot 7-111. Radiated Restricted Lower Band Edge Measurement Antenna 4

Radiated Restricted Band Edge Measurements

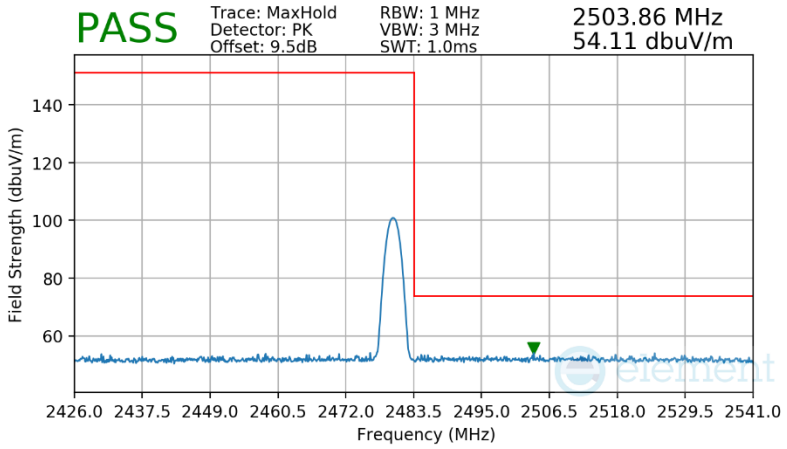
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

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 4

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



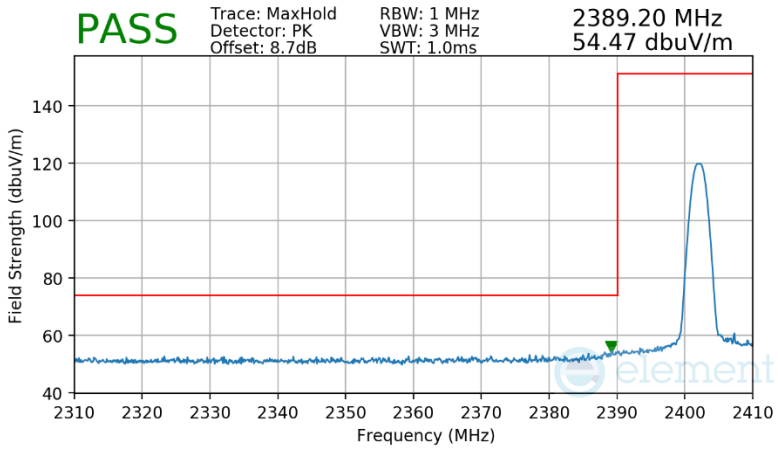
Plot 7-113. Radiated Restricted Upper Band Edge Measurement Antenna 4

Radiated Restricted Band Edge Measurements

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

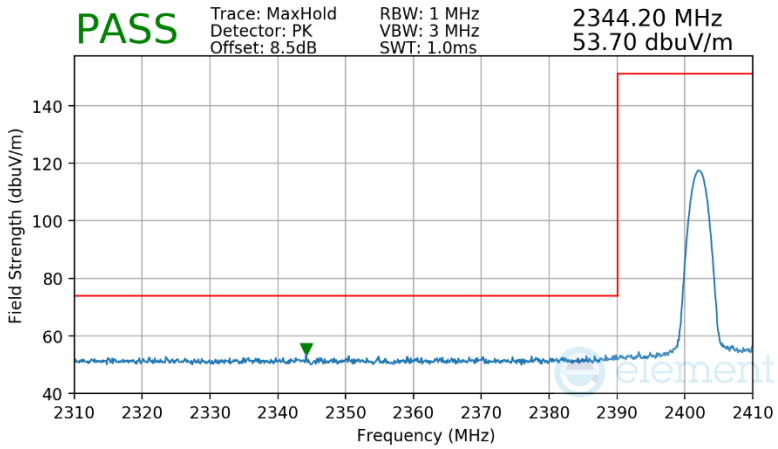
TxBF

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

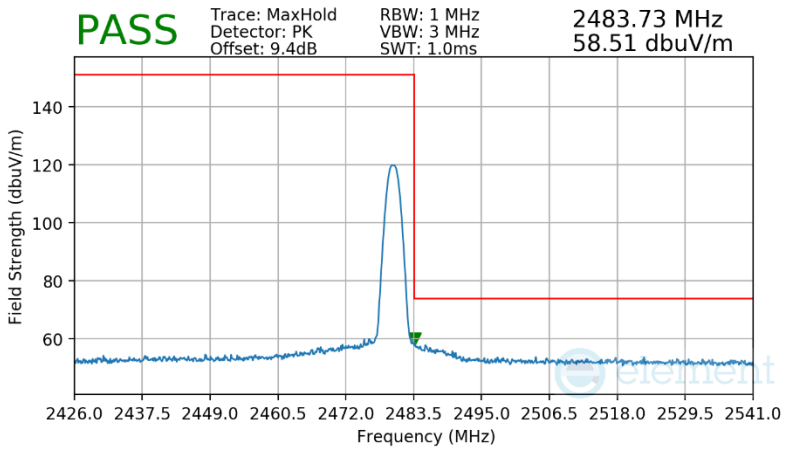


Plot 7-115. Radiated Restricted Lower Band Edge Measurement TxBF

Radiated Restricted Band Edge Measurements

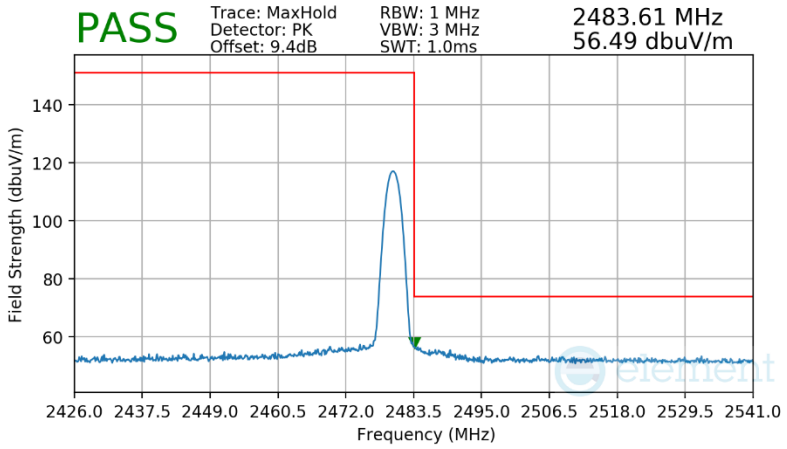
§15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

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.

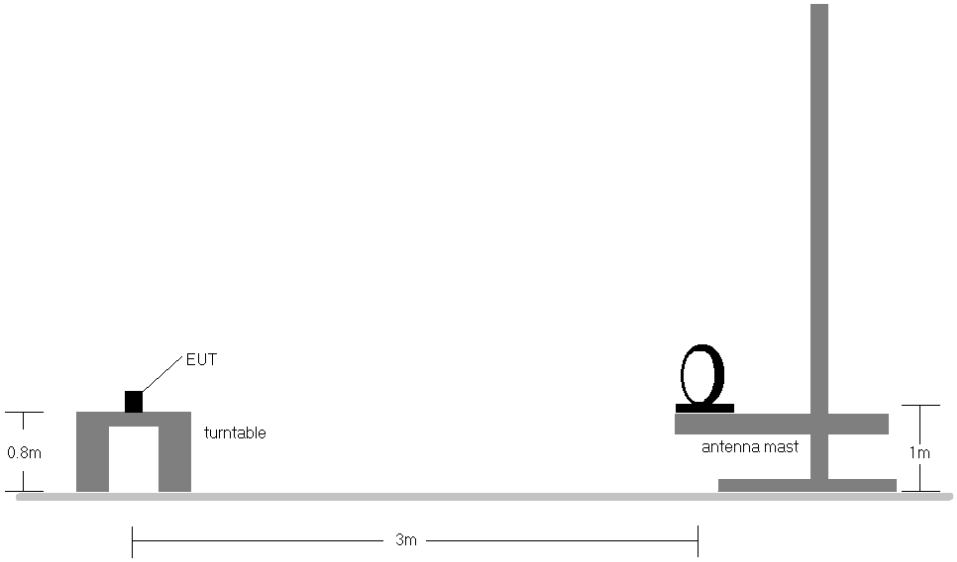


Figure 7-9. Radiated Test Setup < 30MHz

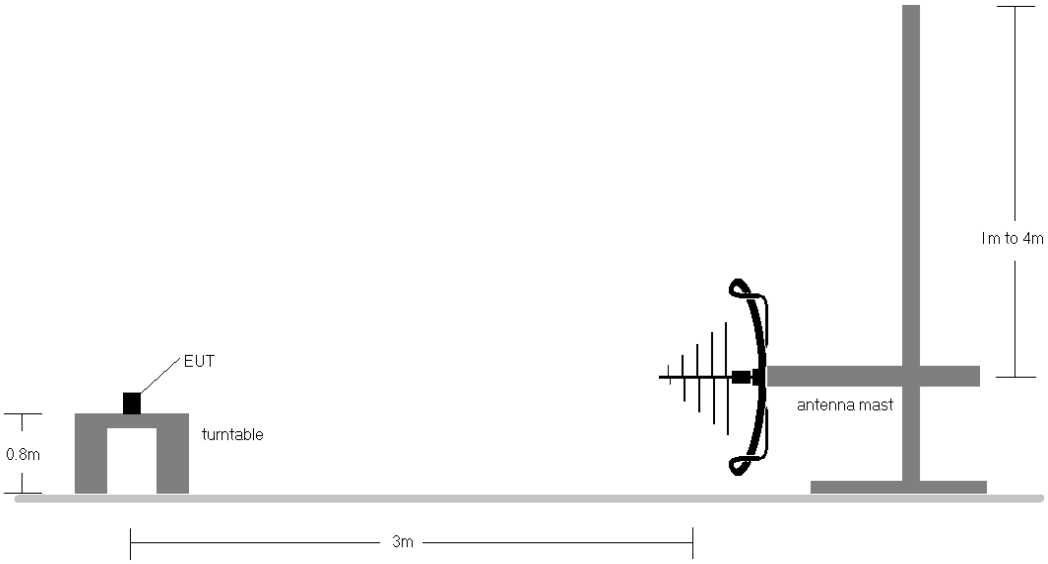


Figure 7-10. Radiated Test Setup < 1GHz

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

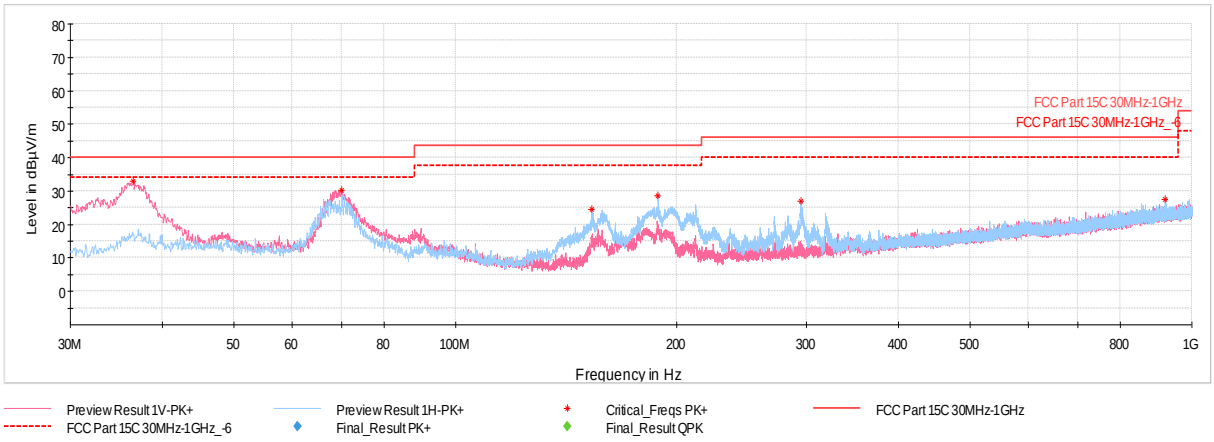
Determining Spurious Emissions Levels

- 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 and USB-C Cable)

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
36.55	Max Peak	V	100	43	-59.38	-14.73	32.89	40.00	-7.11
70.16	Max Peak	V	200	163	-58.23	-18.42	30.35	40.00	-9.65
153.19	Max Peak	H	200	169	-63.02	-19.42	24.56	43.52	-18.96
188.45	Max Peak	H	100	181	-61.31	-17.18	28.51	43.52	-15.01
294.62	Max Peak	H	100	259	-65.90	-14.08	27.02	46.02	-19.00
918.81	Max Peak	H	200	36	-77.55	-1.97	27.48	46.02	-18.54

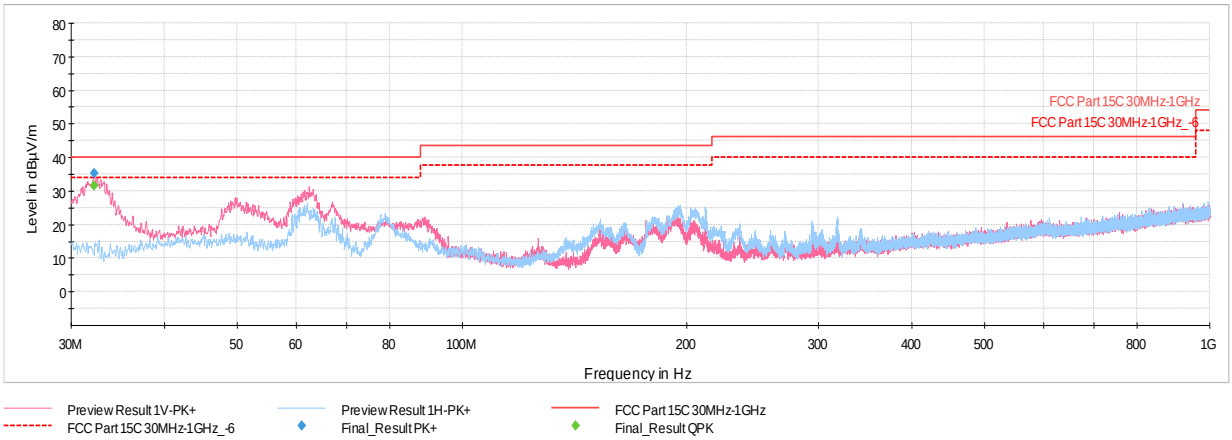
Table 7-34. Radiated Spurious Emissions Below 1GHz TxBF (GFSK ePA – Ch.39 with AC/DC Adapter and USB-C Cable)

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

§15.209; RSS-Gen [8.9]

Description	FR1 n41	Bluetooth
Antenna	Antenna 4	Antenna 4
Channel	501204	78
Operating Frequency (MHz)	2506	2480
Mode/Modulation	QPSK/1RB/20MHz	GFSK iPA

Table 7-35. Worst Case Simultaneous Transmission Configuration



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

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]
32.18	Quasi Peak	V	100	159	-59.39	-15.96	31.65	40.00	-8.35
62.45	Max Peak	V	100	230	-60.00	-15.65	31.35	40.00	-8.65
89.17	Max Peak	V	100	159	-66.51	-18.24	22.25	43.52	-21.27
194.90	Max Peak	H	100	148	-65.13	-16.13	25.74	43.52	-17.78
317.70	Max Peak	H	100	92	-71.36	-13.29	22.35	46.02	-23.67
920.07	Max Peak	H	300	291	-78.51	-1.89	26.60	46.02	-19.42

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

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.

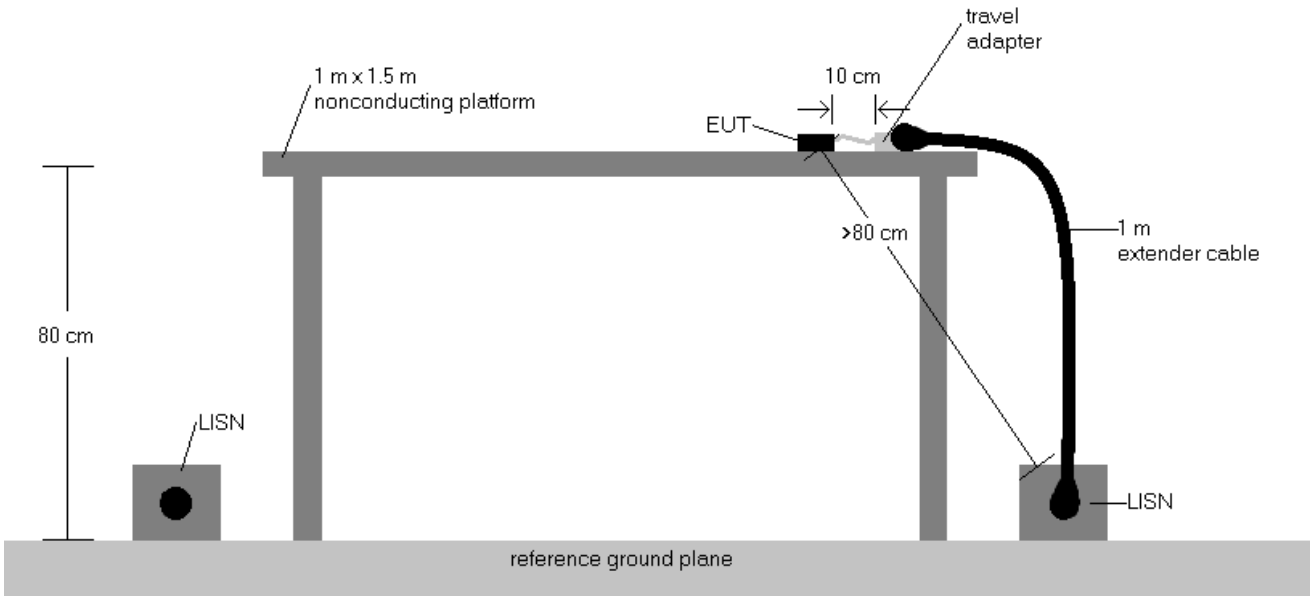
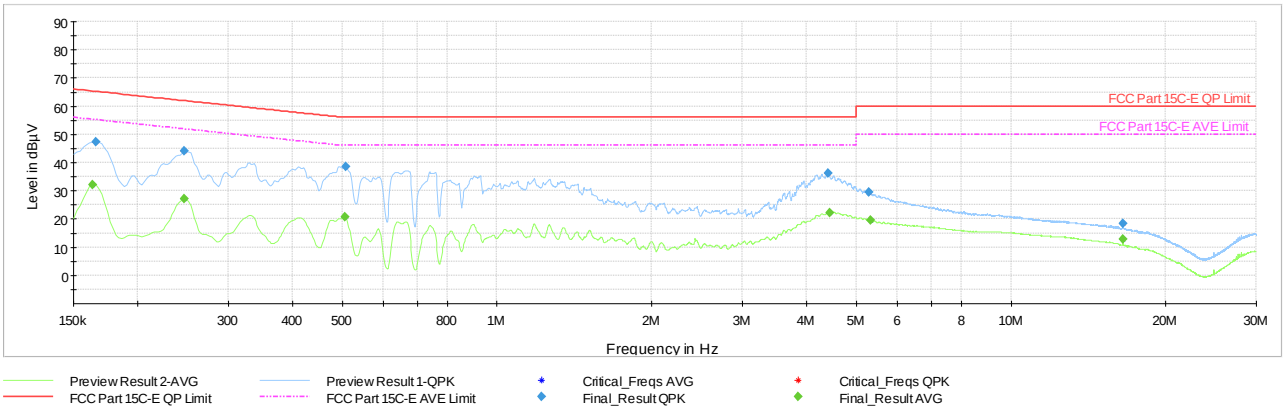


Figure 7-11. Test Instrument & Measurement Setup

Test Notes

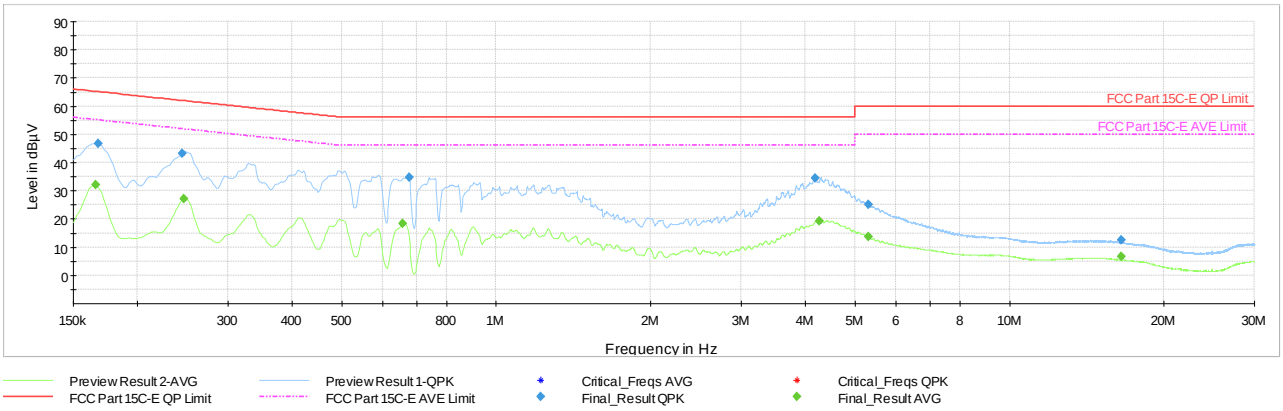
1. All modes of operation were investigated and the worst-case emissions are reported. The emissions found were not affected by the choice of channel used during testing.
2. Both configurations below were investigated, and the worst case has been reported.
    a. EUT powered by AC/DC adaptor via USB-C 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 and USB-C Cable)

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.164	FINAL	—	32.13	55.28	-23.15	L1	GND
0.166	FINAL	47.4	—	65.17	-17.81	L1	GND
0.247	FINAL	—	27.19	51.87	-24.68	L1	GND
0.247	FINAL	44.1	—	61.87	-17.77	L1	GND
0.506	FINAL	—	20.73	46.00	-25.27	L1	GND
0.508	FINAL	38.6	—	56.00	-17.45	L1	GND
4.403	FINAL	36.2	—	56.00	-19.84	L1	GND
4.448	FINAL	—	22.15	46.00	-23.85	L1	GND
5.298	FINAL	29.4	—	60.00	-30.63	L1	GND
5.330	FINAL	—	19.52	50.00	-30.48	L1	GND
16.521	FINAL	—	12.84	50.00	-37.16	L1	GND
16.521	FINAL	18.4	—	60.00	-41.57	L1	GND

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



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

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.166	FINAL	—	32.10	55.17	-23.07	N	GND
0.168	FINAL	46.7	—	65.06	-18.39	N	GND
0.245	FINAL	43.3	—	61.94	-18.63	N	GND
0.247	FINAL	—	27.26	51.87	-24.60	N	GND
0.659	FINAL	—	18.31	46.00	-27.70	N	GND
0.677	FINAL	34.7	—	56.00	-21.35	N	GND
4.187	FINAL	34.4	—	56.00	-21.60	N	GND
4.270	FINAL	—	19.17	46.00	-26.83	N	GND
5.307	FINAL	25.1	—	60.00	-34.86	N	GND
5.307	FINAL	—	13.73	50.00	-36.27	N	GND
16.521	FINAL	—	6.65	50.00	-43.35	N	GND
16.521	FINAL	12.5	—	60.00	-47.48	N	GND

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

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Apple Tablet Device FCC ID: BCGA2995 and IC: 579C-A2995** 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.