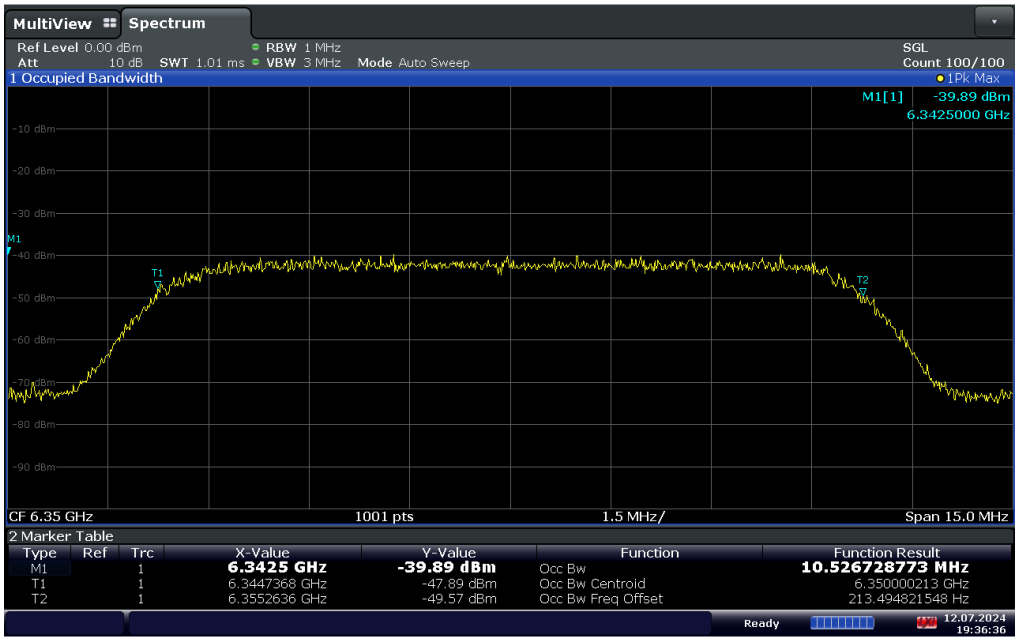
AWGN Plots

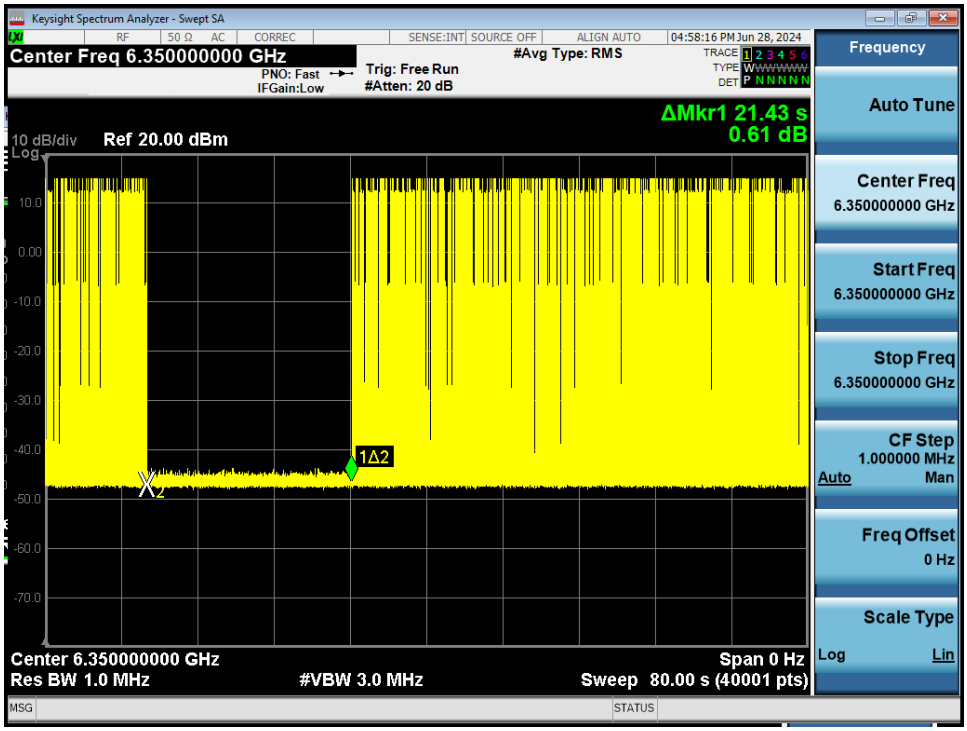
Element



19:36:36 12.07.2024

Plot 7-55. AWGN Signal

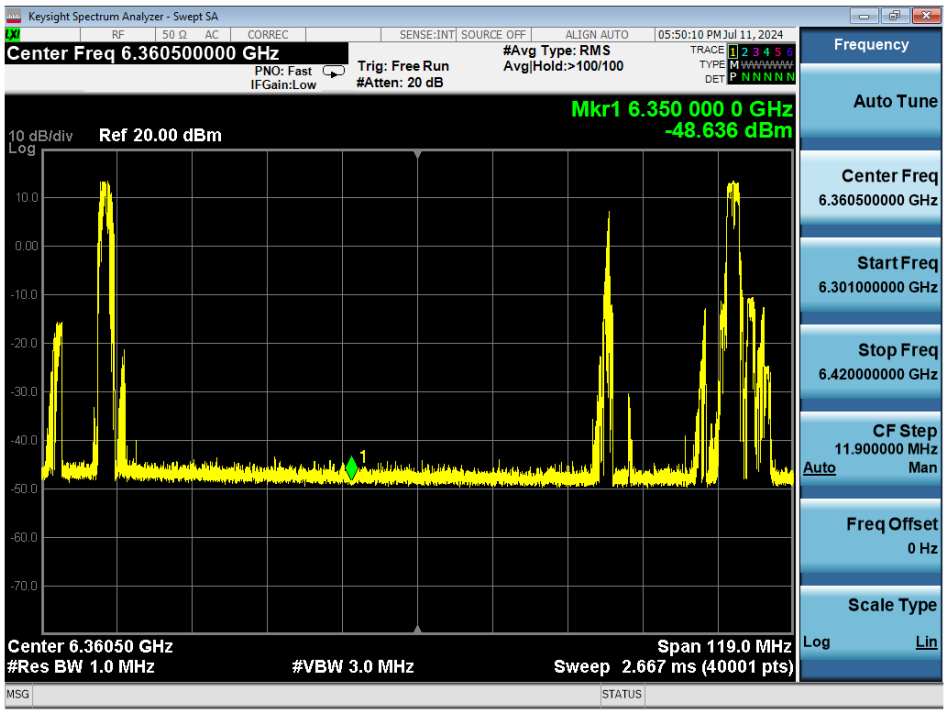
Contention-Based Protocol Timing Plots



Plot 7-56. CBP Timing Plot

Bandwidth Reduction Plots

Plot 7-57. Before AWGN Signal Injected



Plot 7-58. After AWGN Signal Injected at 6350MHz

7.7 Transmit Power Control (TPC)

§15.407(d.10)

Test Overview and Limit

Very low power devices operating in the 5.925-6.425 and 6.525-6.875 GHz bands shall employ a transmit power control (TPC) mechanism. A very low power device is required to have the capability to operate at least 6 dB below the maximum EIRP power spectral density (PSD) value of −5 dBm/MHz.

Test Procedure Used

ANSI C63.10-2020 – Section 12.4.2.7
KDB 789033 D02 v02r01 – Section F

Test Settings

1. Analyzer was set to the center frequency of the UNII channel under investigation
2. Span was set to encompass the entire 99% OBW of the signal
3. RBW = 1MHz
4. VBW ≥ 1 / T, (T refers to the minimum transmissions duration over which the transmitter is on) ≥ 3MHz
5. Number of sweep points > 2 x (span/RBW)
6. Sweep time = No faster than couples (auto) time
7. Detector = peak
8. Trace mode = max hold
9. Trigger was set to free run for all modes
10. Compute power by integrating the spectrum across the 99 %OBW of the signal using the instrument's band-power measurement function with band limits set equal to the OBW band-edges.

Test Setup

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

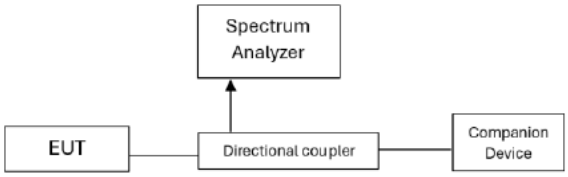


Figure 7-6. Test Instrument & Measurement Setup (No Attenuation)

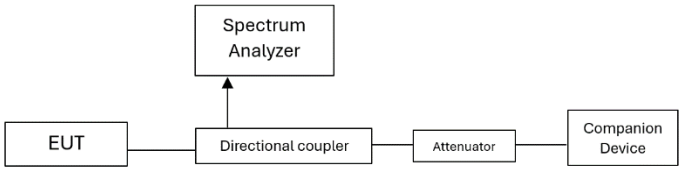


Figure 7-7. Test Instrument & Measurement Setup (With Attenuation)

This test demonstrates the ability of the device to increase and decrease power by the required 6dB as the RSSI is decreased and increased.

1. Configure EUT and companion device for peer-to-peer communication as shown in Figure 7-6. (no attenuation for noise free spectral environment, high RSSI simulation)
2. Establish a link and start communication between EUT and companion device
3. Capture PSD spectrum analyzer
4. Add a 20dB attenuator to the setup as shown in Figure 7-7 (noisy spectral environment, low RSSI simulation)
5. Capture PSD spectrum analyzer
6. Compare the highest PSD captured in step 3 to the highest PSD on step 5 and determine the delta.

Implementation Expectation: Tx power Backoff enabled at -20dBm or stronger RSSI, backoff disabled at -40dBm or weaker RSSI (RSSI updated every second)

Test Notes

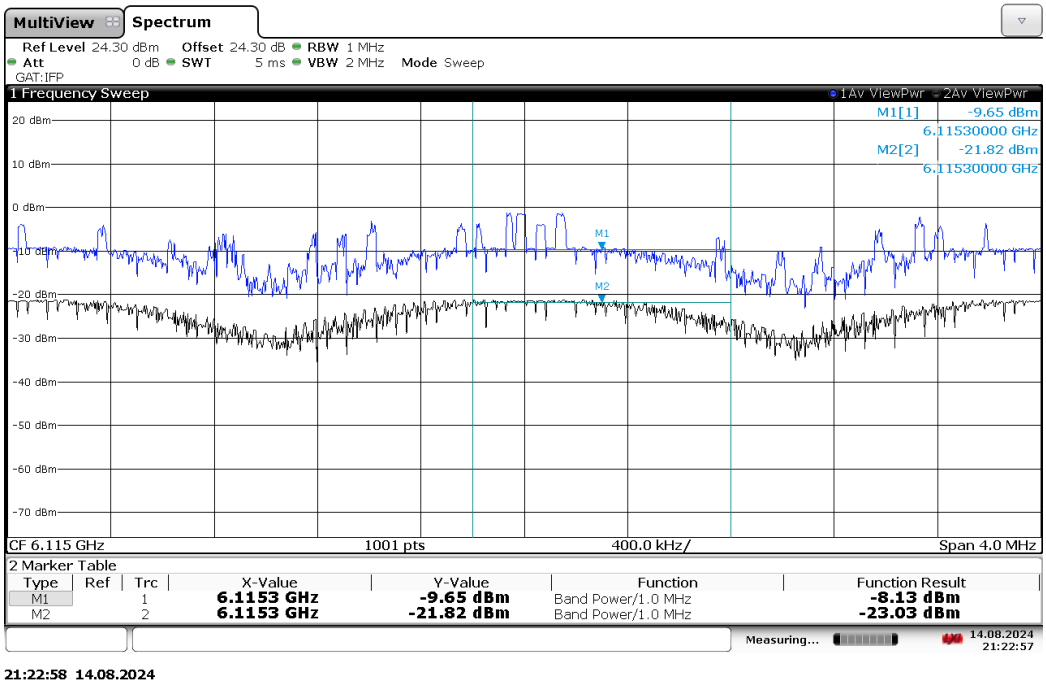
1. Companion device used was model: A2117 (refer to Table 2-4).
2. Per manufacturer's declaration, after establishing communication between the EUT and the companion device, NB UNII HDR is used to maintain communication and traffic. NB UNII BDR and NB UNII LE are used for establishing the initial connection with the companion device.
3. TPC is triggered when a high RSSI is detected. As RSSI detected signal decreases, the transmitters output power will increase back to maximum allowed power.

Frequency [MHz]	Measured Power Density [dBm/MHz]	Antenna Gain [dBi]	e.i.r.p Power Density [dBm/MHz]	TPC e.i.r.p Power Density Limit [dBm/MHz]	Verdict
6115	-8.13	-3.10	-11.23	-5.00	PASS
6236	-9.74	-3.10	-12.84	-5.00	PASS
6377	-7.48	-2.70	-10.18	-5.00	PASS

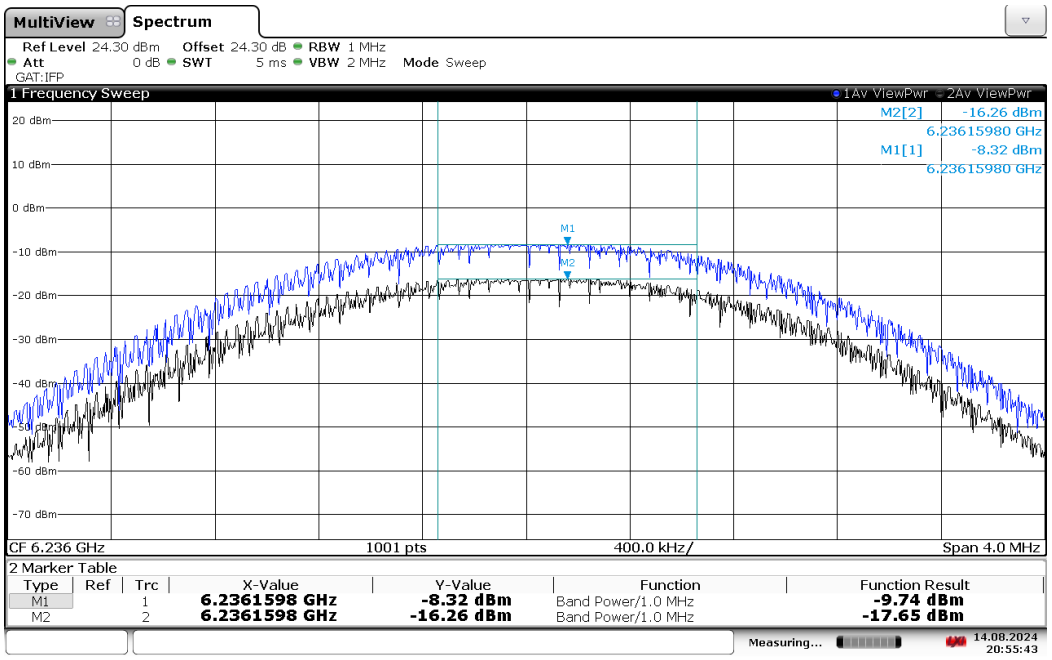
Table 7-8. PSD Measurements (no TPC)

Frequency [MHz]	Measured Power Density [dBm/MHz]	Antenna Gain [dBi]	e.i.r.p Power Density [dBm/MHz]	TPC e.i.r.p Power Density Limit [dBm/MHz]	Verdict
6115	-23.03	-3.10	-26.13	-11.00	PASS
6236	-17.65	-3.10	-20.75	-11.00	PASS
6377	-17.86	-2.70	-20.56	-11.00	PASS

Table 7-9. PSD Measurements (with TPC)

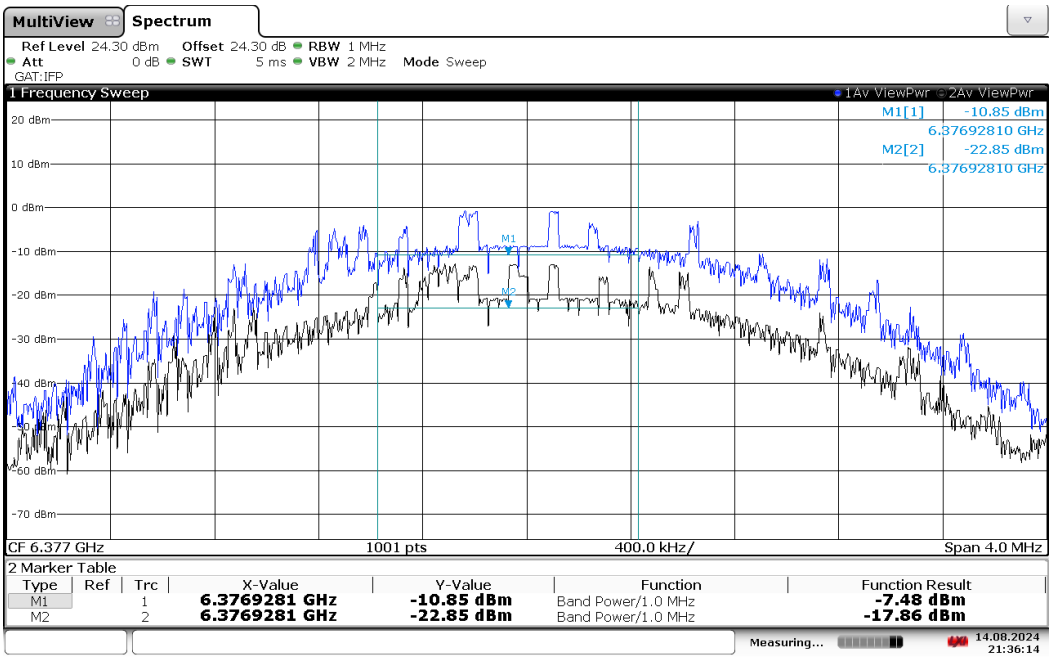


Plot 7-59. Power Density Plot (NB UNII, 6115MHz)



20:55:44 14.08.2024

Plot 7-60. Power Density Plot (NB UNII, 6236MHz)



21:36:14 14.08.2024

Plot 7-61. Power Density Plot (NB UNII, 6377MHz)

7.8 Radiated Spurious Emission – Above 1GHz

§15.407(b) §15.205 §15.209

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 its maximum power control level, as defined in ANSI C63.10-2020 and KDB 789033 D02 v02r01, 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 must not exceed the limits shown in Table 7-13 per Section 15.209.

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

Table 7-10. Radiated Limits

Test Procedures Used

ANSI C63.10-2020 – Sections 12.7.7.2, 12.7.6, 12.7.5
KDB 789033 D02 v02r01 – Section G

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 ≥ 2 x span/RBW)
6. Averaging type = power (RMS)
7. Sweep time = auto couple
8. Trace was averaged over 100 sweeps

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.

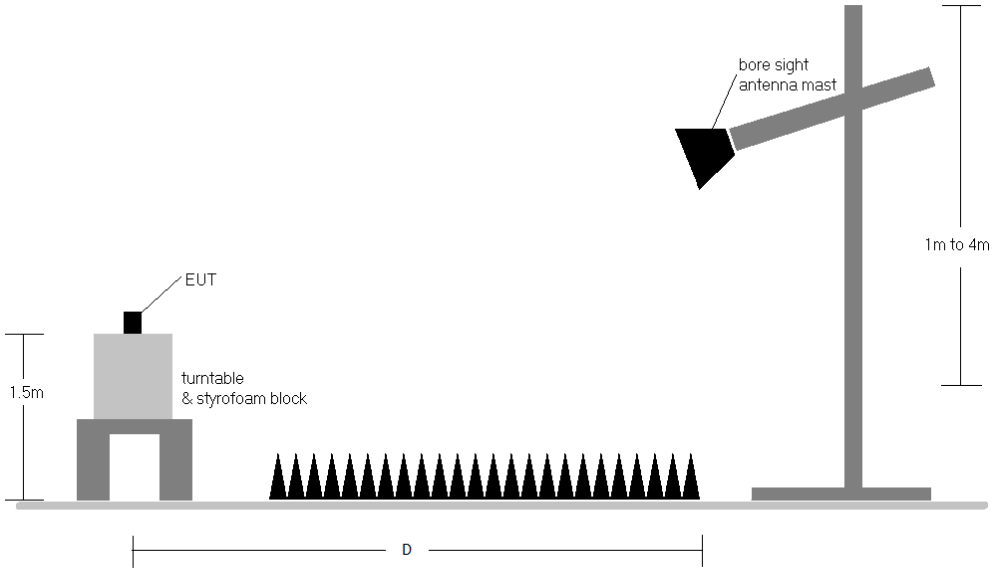


Figure 7-8. Test Instrument & Measurement Setup

Test Notes

1. All emissions that lie in the restricted bands (denoted by a * next to the frequency) specified in §15.205 are below the limit shown in Table 7-10.
2. All spurious emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-10. All spurious emissions that do not lie in a restricted band are subject to a limit of -27dBm/MHz. At a distance of 3 meters, the field strength limit in dBμV/m can be determined by adding a “conversion” factor of 95.2dB to the EIRP limit of -27dBm/MHz to obtain the limit for out of band spurious emissions of 68.2dBμV/m.
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 "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

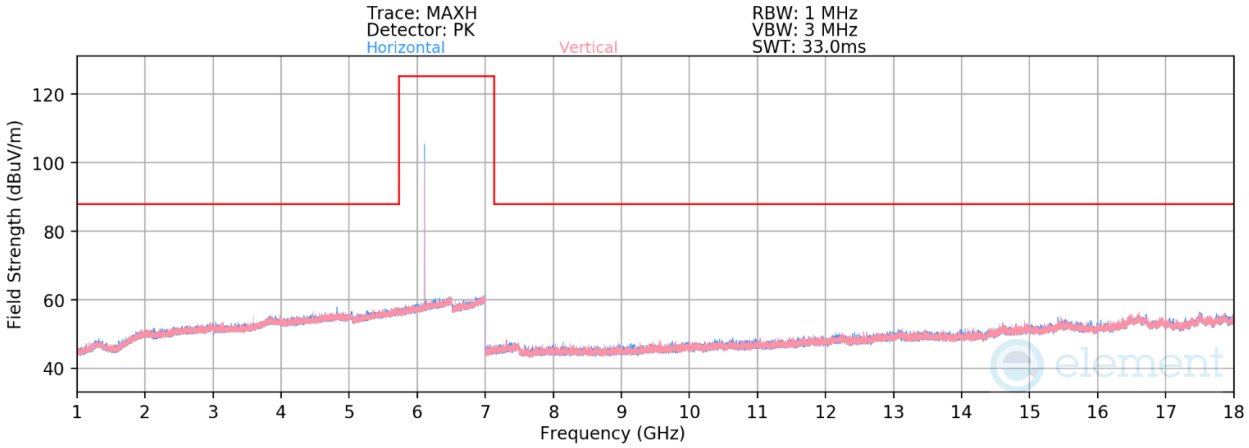
Determining Spurious Emissions Levels

- 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 $_{[dB\mu V/m]}$

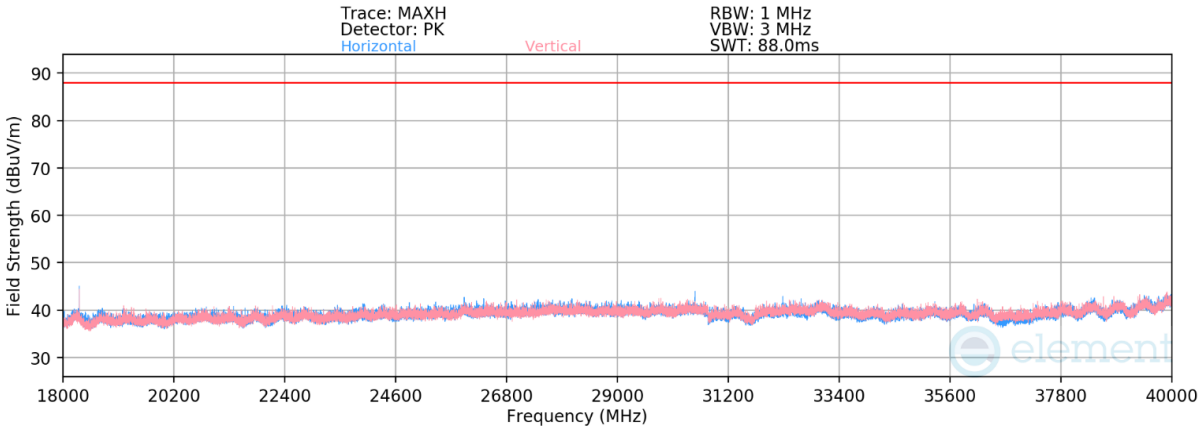
Radiated Band Edge Measurement Offset

- The amplitude offset shown in the radiated restricted band edge plots in Section 7.8.2 was calculated using the formula:
  Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain

7.8.1 Radiated Spurious Emission (Above 1GHz)



Plot 7-62. Radiated Spurious Emissions 1-18GHz (NB UNII BDR – 6108MHz)

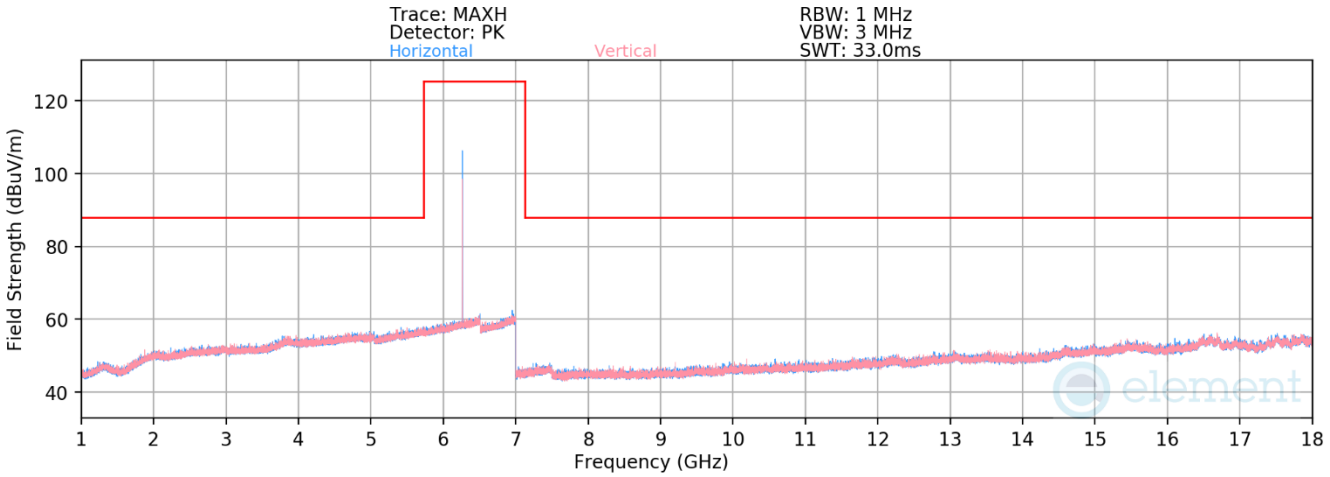


Plot 7-63. Radiated Spurious Emissions 18-40GHz (NB UNII BDR– 6108MHz)

Mode:	NB UNII BDR
Data Rate:	1Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6108MHz

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	12216.00	Avg	H	108	263	-77.42	10.70	1.15	41.43	53.98	-12.55
*	12216.00	Peak	H	108	263	-67.73	10.70	0.00	49.97	73.98	-24.01
*	18324.00	Avg	V	229	145	-62.04	-6.78	1.15	39.33	53.98	-14.65
*	18324.00	Peak	V	229	145	-54.22	-6.78	0.00	46.00	73.98	-27.98
	24432.00	Avg	-	-	-	-71.71	-4.99	0.00	30.30	68.23	-37.93
	24432.00	Peak	-	-	-	-60.39	-4.98	0.00	41.63	88.23	-46.60
	30540.00	Avg	V	352	75	-71.06	-1.80	1.15	35.29	68.23	-32.94
	30540.00	Peak	V	352	75	-61.62	-1.80	0.00	43.58	88.23	-44.65
	36648.00	Avg	-	-	-	-75.15	-1.80	0.00	30.05	68.23	-38.18
	36648.00	Peak	-	-	-	-63.93	-1.80	0.00	41.27	88.23	-46.96

Table 7-11. Radiated Spurious Emissions Measurements

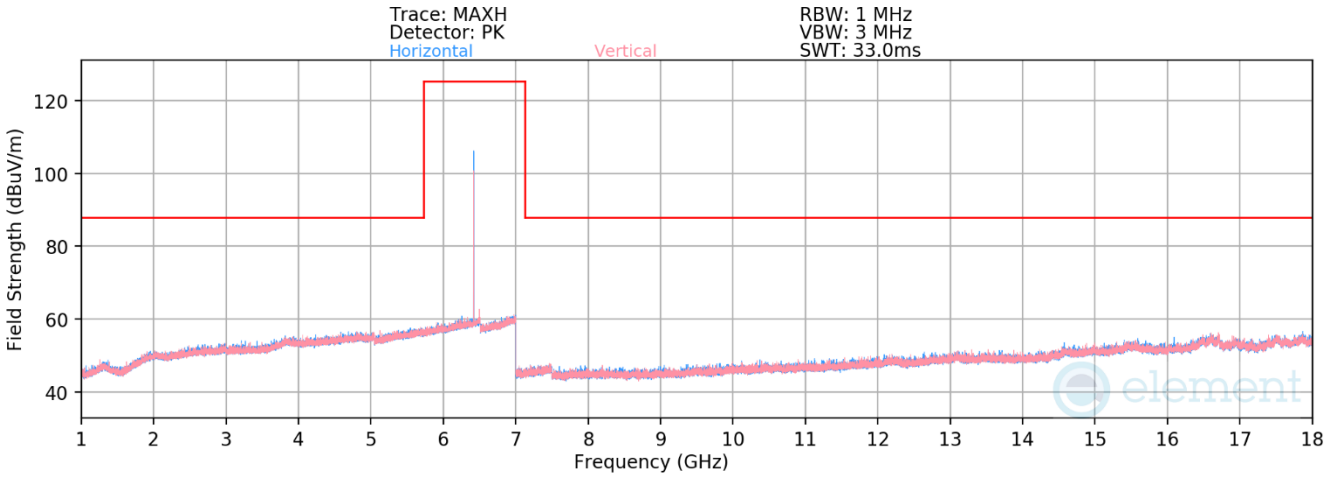


Plot 7-64. Radiated Spurious Emissions 1-18GHz (NB UNII BDR – 6264MHz)

Mode:	NB UNII BDR
Data Rate:	1Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6264MHz

	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]
*	12528.00	Avg	-	-	-	-78.92	10.84	38.92	53.98	-15.06
*	12528.00	Peak	-	-	-	-68.22	10.84	49.62	73.98	-24.36

Table 7-12. Radiated Spurious Emissions Measurements

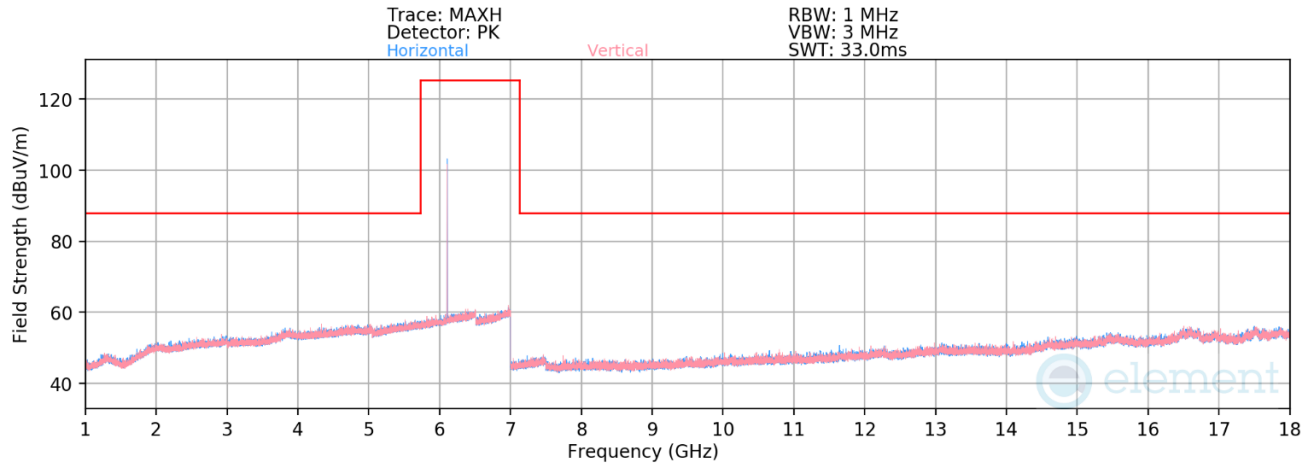


Plot 7-65. Radiated Spurious Emissions 1-18GHz (NB UNII BDR – 6420MHz)

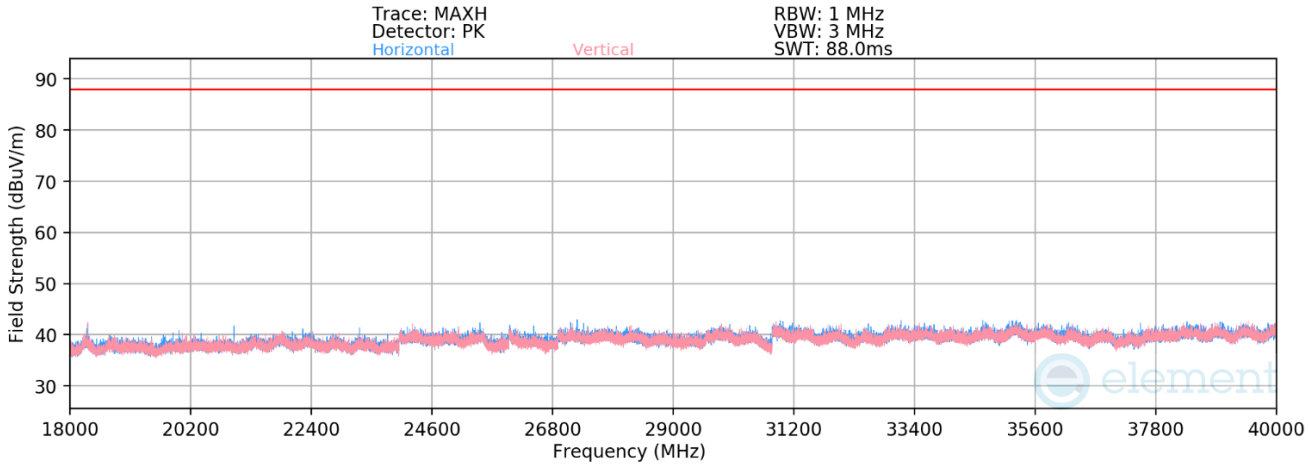
Mode:	NB UNII BDR
Data Rate:	1Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6420MHz

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]
12840.00	Avg	-	-	-	-79.13	11.19	39.06	68.23	-29.17
12840.00	Peak	-	-	-	-68.63	11.19	49.56	88.23	-38.67

Table 7-13. Radiated Spurious Emissions Measurements



Plot 7-66. Radiated Spurious Emissions 1-18GHz (NB UNII (LE2M) – 6108MHz)

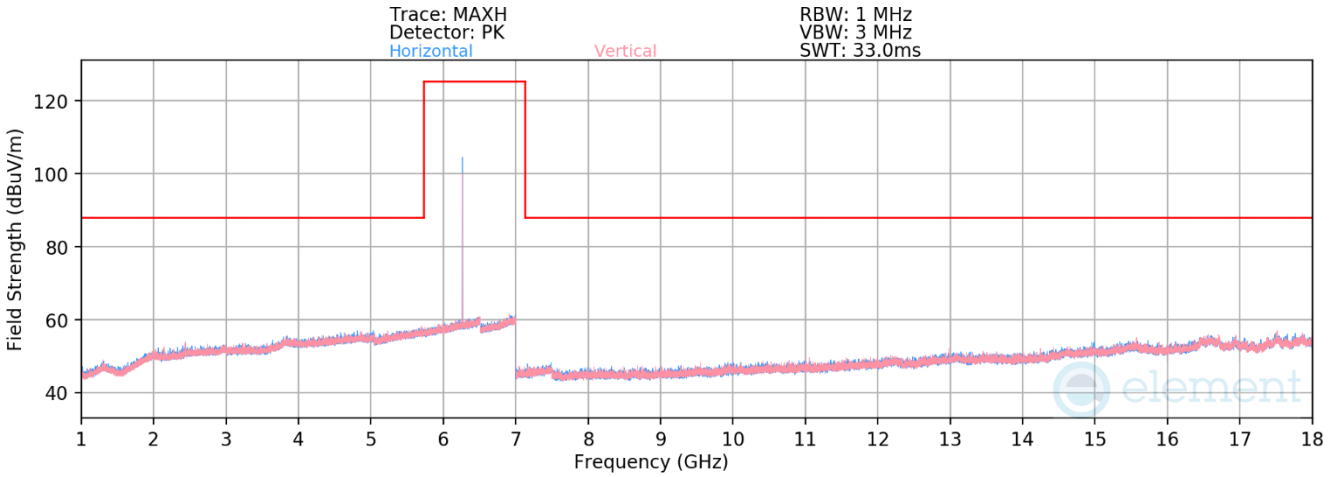


Plot 7-67. Radiated Spurious Emissions 18-40GHz (NB UNII (LE2M)– 6108MHz)

Mode:	NB UNII LE
Data Rate:	2Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6108MHz

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	12216.00	Avg	H	314	85	-78.53	10.70	0.62	39.79	53.98	-14.19
*	12216.00	Peak	H	314	85	-68.04	10.70	0.00	49.66	73.98	-24.32
*	18324.00	Avg	H	339	182	-64.61	-6.78	0.62	36.23	53.98	-17.75
*	18324.00	Peak	H	339	182	-55.62	-6.78	0.00	44.60	73.98	-29.38
	24432.00	Avg	-	-	-	-71.55	-4.98	0.00	30.47	68.23	-37.76
	24432.00	Peak	-	-	-	-60.41	-4.97	0.00	41.62	88.23	-46.61
	30540.00	Avg	H	281	213	-71.10	-1.67	0.62	34.85	68.23	-33.38
	30540.00	Peak	H	281	213	-60.69	-1.80	0.00	44.51	88.23	-43.72
	36648.00	Avg	H	304	169	-69.34	-6.52	0.62	31.76	68.23	-36.47
	36648.00	Peak	H	304	169	-58.59	-6.52	0.00	41.89	88.23	-46.34

Table 7-14. Radiated Spurious Emissions Measurements

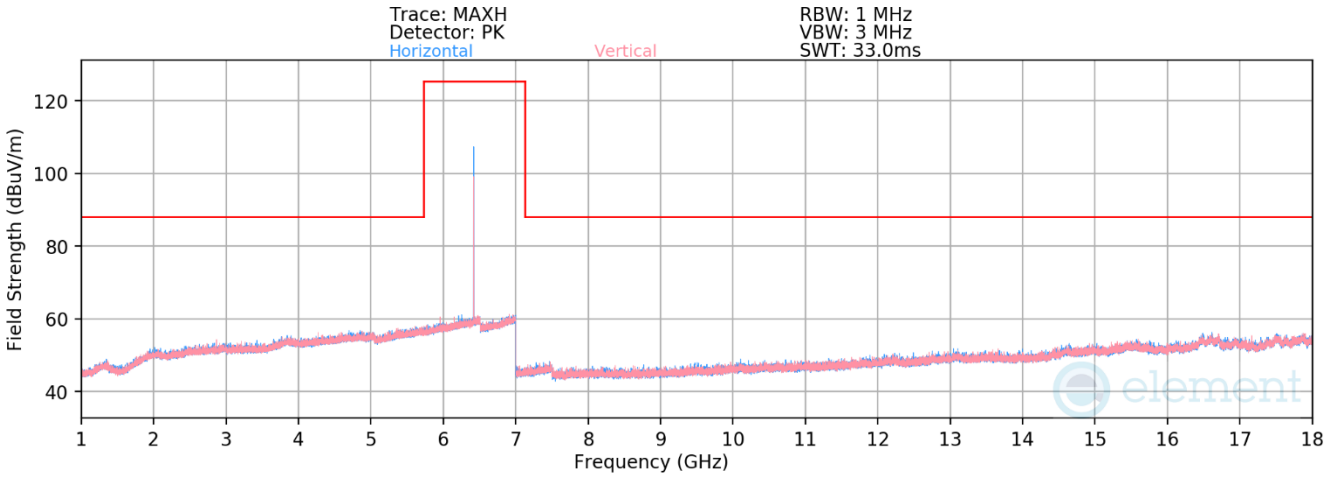


Plot 7-68. Radiated Spurious Emissions 1-18GHz (NB UNII (LE2M) – 6264MHz)

Mode:	NB UNII LE
Data Rate:	2Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6264MHz

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	12528.00	Avg	H	100	53	-79.09	10.84	0.62	39.38	53.98	-14.60
*	12528.00	Peak	H	100	53	-68.47	10.84	0.00	49.37	73.98	-24.61

Table 7-15. Radiated Spurious Emissions Measurements

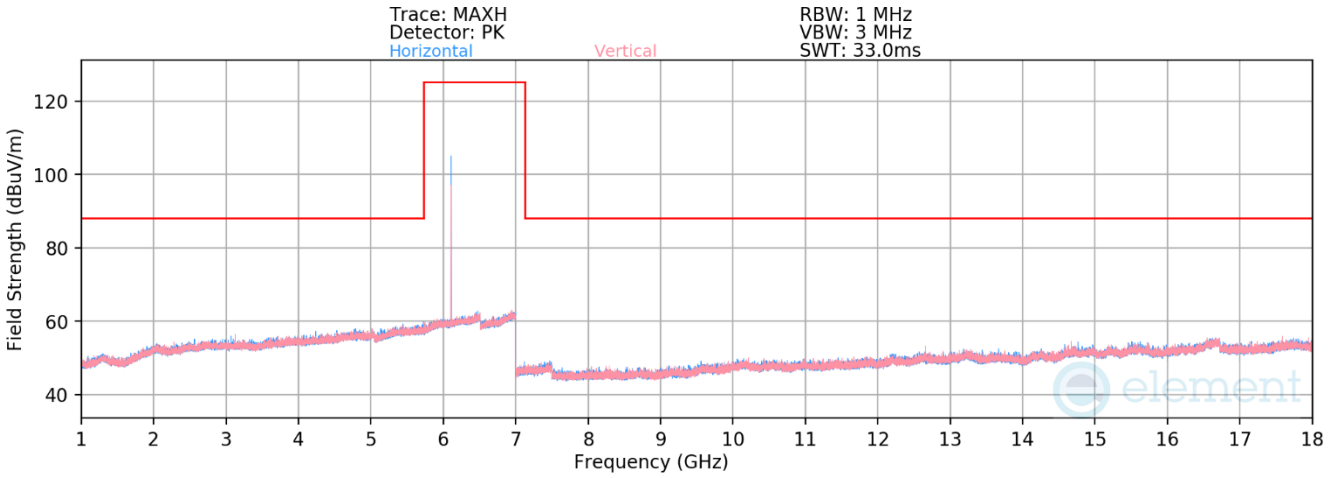


Plot 7-69. Radiated Spurious Emissions 1-18GHz (NB UNII (LE2M) – 6420MHz)

Mode:	NB UNII LE
Data Rate:	2Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6420MHz

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]
12840.00	Avg	-	-	-	-79.28	11.23	38.95	68.23	-29.28
12840.00	Peak	-	-	-	-68.49	11.23	49.74	88.23	-38.49

Table 7-16. Radiated Spurious Emissions Measurements

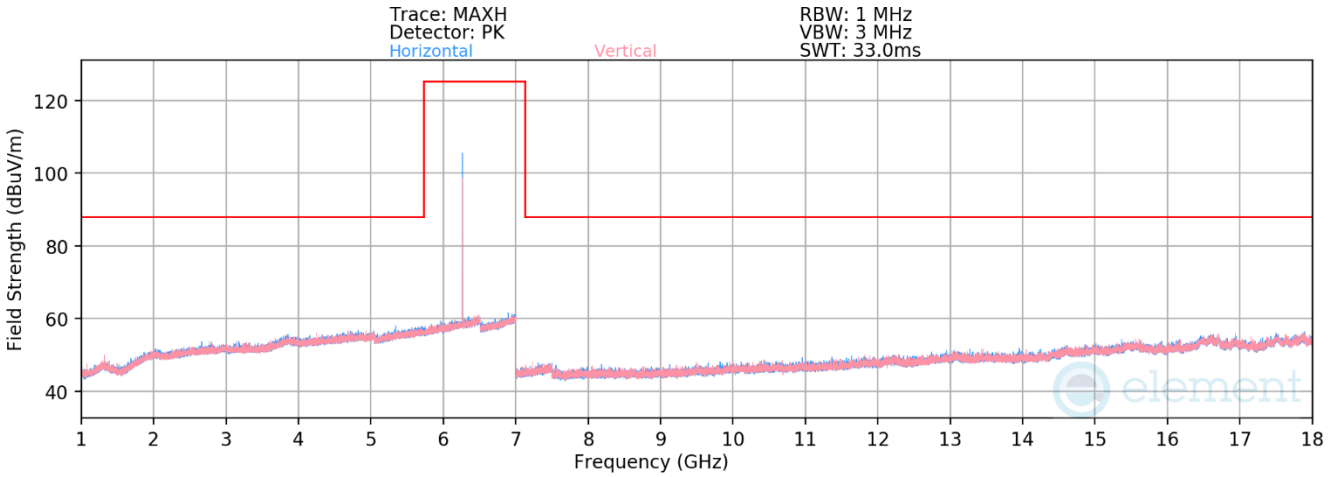


Plot 7-70. Radiated Spurious Emissions 1-18GHz (NB UNII HDR4 – 6108MHz)

Mode:	NB UNII HDR4
Data Rate:	4Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6108MHz

	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]
*	12216.00	Avg	-	-	-	-80.62	13.52	39.89	53.98	-14.09
*	12216.00	Peak	-	-	-	-69.88	13.52	50.64	73.98	-23.34

Table 7-17. Radiated Spurious Emissions Measurements

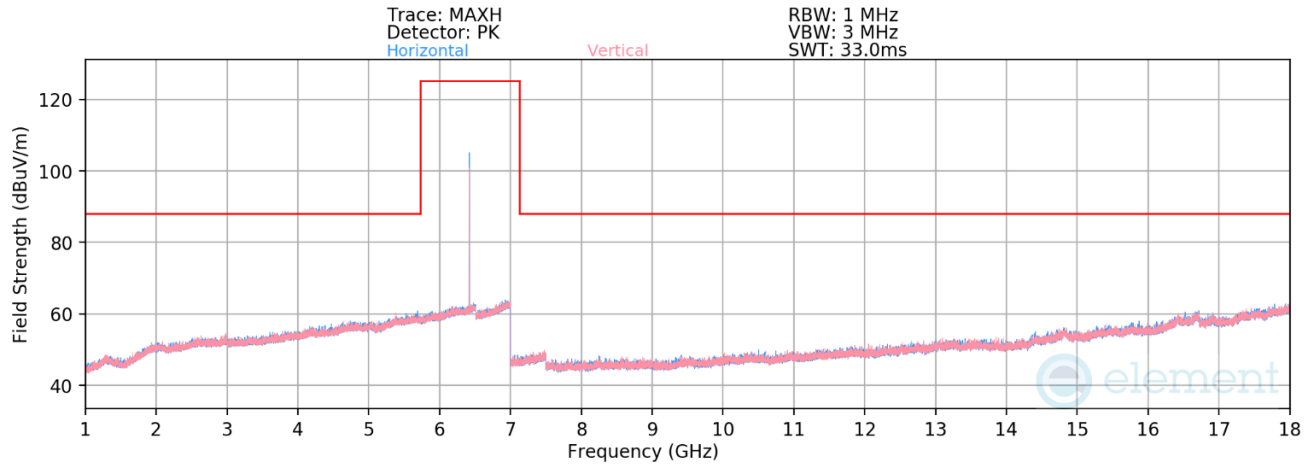


Plot 7-71. Radiated Spurious Emissions 1-18GHz (NB UNII HDR4 – 6264MHz)

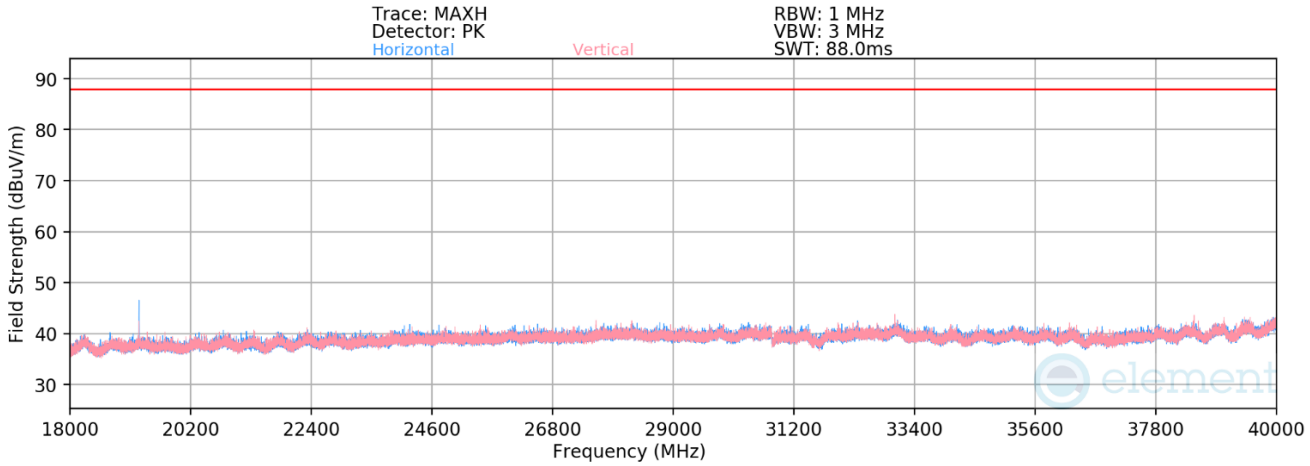
Mode:	NB UNII HDR4
Data Rate:	4Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6264MHz

	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]
*	12528.00	Avg	-	-	-	-78.90	10.71	38.81	53.98	-15.17
*	12528.00	Peak	-	-	-	-67.98	10.82	49.84	73.98	-24.14

Table 7-18. Radiated Spurious Emissions Measurements



Plot 7-72. Radiated Spurious Emissions 1-18GHz (NB UNII HDR4 – 6420MHz)

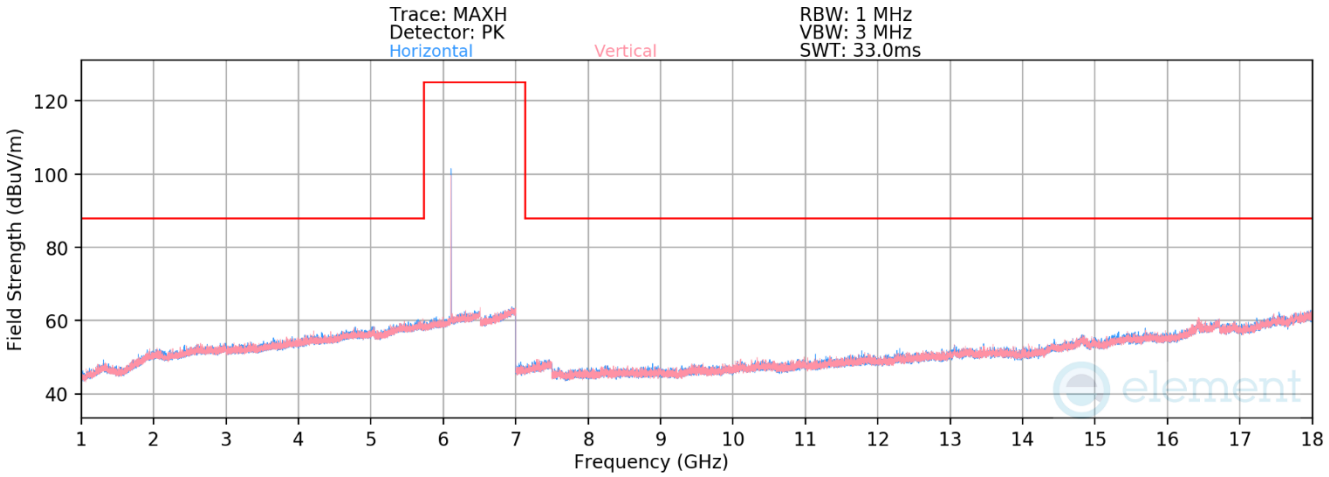


Plot 7-73. Radiated Spurious Emissions Above 18GHz (NB UNII HDR4 – 6420MHz)

Mode:	NB UNII HDR4
Data Rate:	4Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6420MHz

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	12840.00	Avg	-	-	-	-91.76	25.31	0.00	40.55	68.23	-27.68
	12840.00	Peak	-	-	-	-80.95	25.31	0.00	51.36	88.23	-36.87
*	19260.00	Avg	H	350	222	-60.50	-7.31	1.08	40.27	53.98	-13.71
*	19260.00	Peak	H	350	222	-50.08	-7.31	0.00	49.61	73.98	-24.37
	25680.00	Avg	-	-	-	-72.31	-4.97	0.00	29.72	68.23	-38.51
	25680.00	Peak	-	-	-	-61.11	-4.97	0.00	40.92	88.23	-47.31
	32100.00	Avg	V	336	152	-72.42	-2.20	1.08	33.46	68.23	-34.77
	32100.00	Peak	V	336	152	-60.99	-2.20	0.00	43.81	88.23	-44.42
	38520.00	Avg	-	-	-	-72.31	-3.21	0.00	31.48	68.23	-36.75
	38520.00	Peak	-	-	-	-60.79	-3.21	0.00	43.00	88.23	-45.23

Table 7-19. Radiated Spurious Emissions Measurements

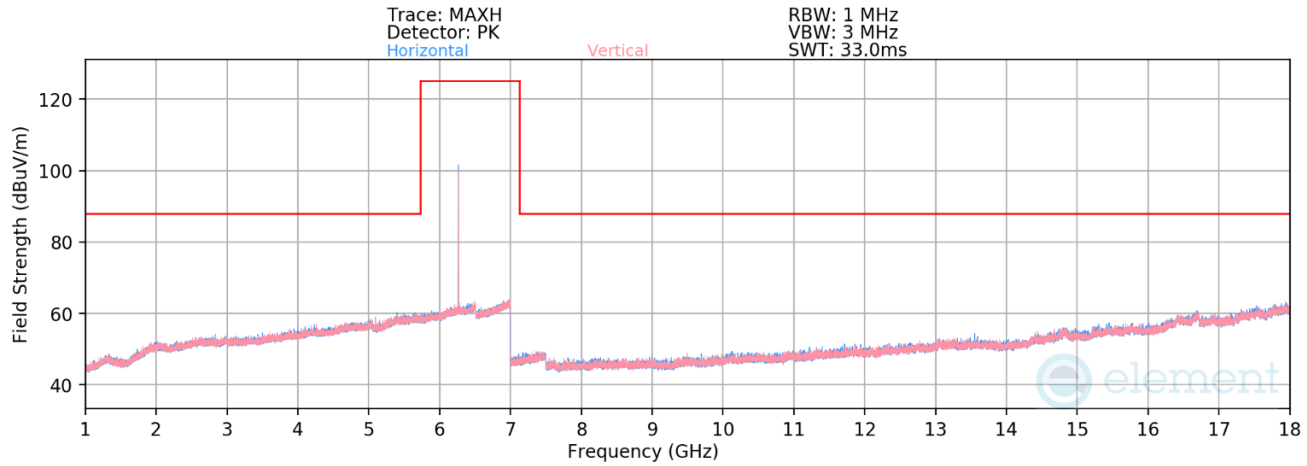


Plot 7-74. Radiated Spurious Emissions 1-18GHz (NB UNII HDRp4 – 6108MHz)

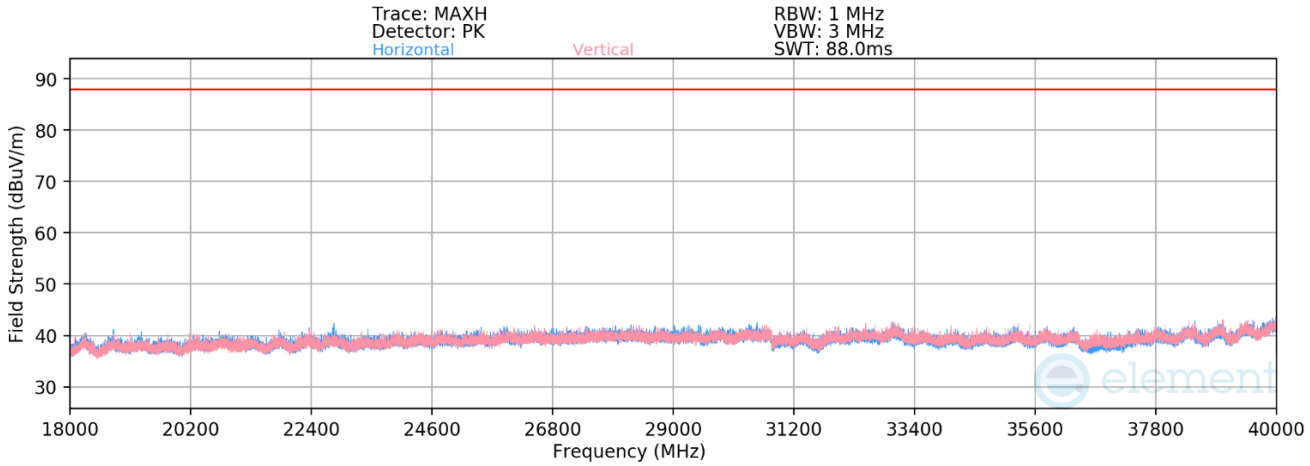
Mode:	NB UNII HDRp4
Data Rate:	4Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6108MHz

	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]
*	12216.00	Avg	-	-	-	-92.17	24.53	39.36	53.98	-14.62
*	12216.00	Peak	-	-	-	-80.64	24.53	50.89	73.98	-23.09

Table 7-20. Radiated Spurious Emissions Measurements



Plot 7-75. Radiated Spurious Emissions 1-18GHz (NB UNII HDRp4 – 6264MHz)

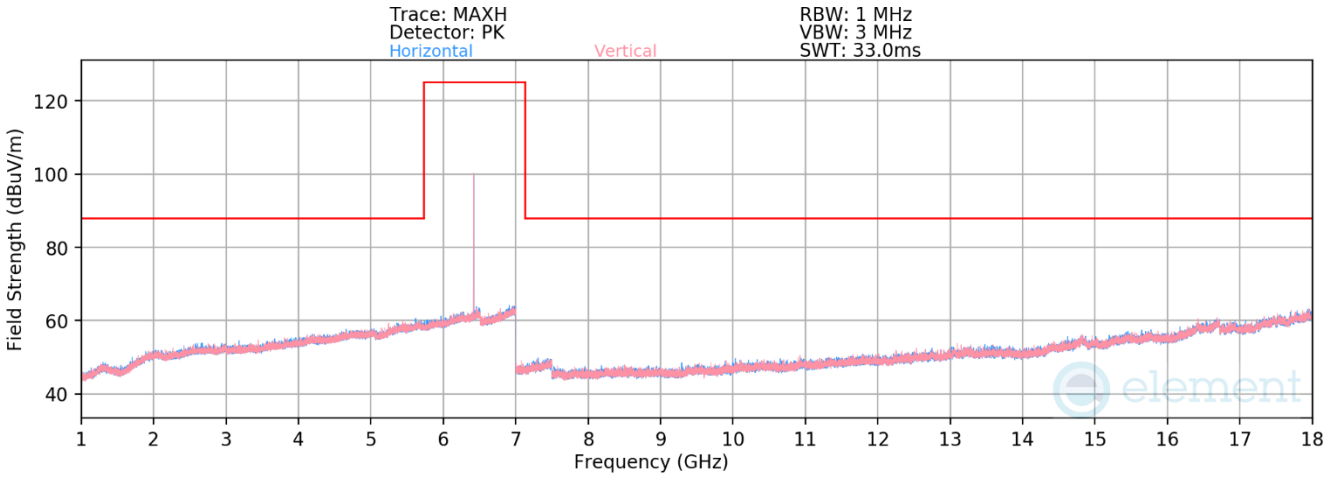


Plot 7-76. Radiated Spurious Emissions Above 18GHz (NB UNII HDRp4 – 6264MHz)

Mode:	NB UNII HDRp4
Data Rate:	4Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6264MHz

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	12528.00	Avg	-	-	-	-91.42	24.79	0.00	40.37	53.98	-13.61
*	12528.00	Peak	-	-	-	-80.75	24.79	0.00	51.04	73.98	-22.94
*	18792.00	Avg	V	327	116	-64.05	-6.88	0.59	36.66	53.98	-17.32
*	18792.00	Peak	V	327	116	-54.28	-6.88	0.00	45.84	73.98	-28.14
	25056.00	Avg	-	-	-	-72.00	-4.99	0.00	30.01	68.23	-38.22
	25056.00	Peak	-	-	-	-60.27	-4.99	0.00	41.74	88.23	-46.49
	31320.00	Avg	V	52	126	-72.78	-1.67	0.59	33.14	68.23	-35.09
	31320.00	Peak	V	52	126	-61.95	-1.67	0.00	43.38	88.23	-44.85
	37584.00	Avg	-	-	-	-70.45	-6.50	0.00	30.05	68.23	-38.18
	37584.00	Peak	-	-	-	-58.48	-6.50	0.00	42.02	88.23	-46.21

Table 7-21. Radiated Spurious Emissions Measurements



Plot 7-77. Radiated Spurious Emissions 1-18GHz (NB UNII HDRp4 – 6420MHz)

Mode:	NB UNII HDRp4
Data Rate:	4Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	6420MHz

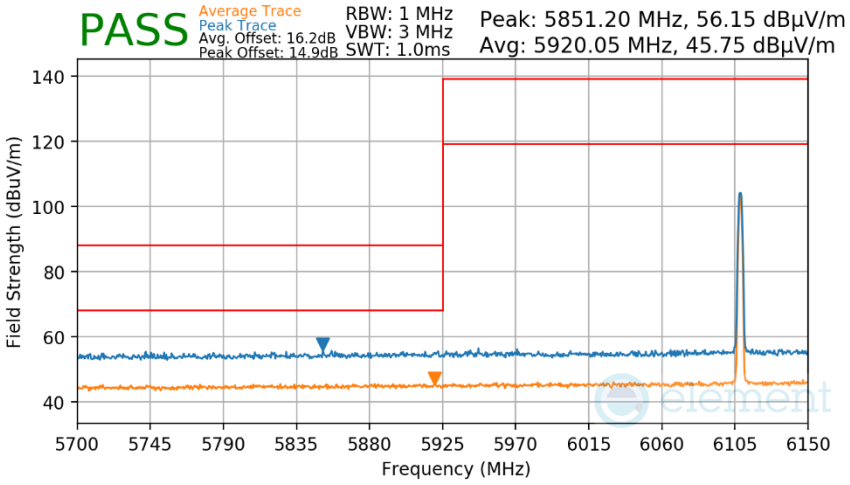
Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
12840.00	Avg	-	-	-	-91.77	25.31	40.54	68.23	-27.69
12840.00	Peak	-	-	-	-80.81	25.31	51.50	88.23	-36.73

Table 7-22. Radiated Spurious Emissions Measurements

7.8.2 Radiated Band Edge Measurements

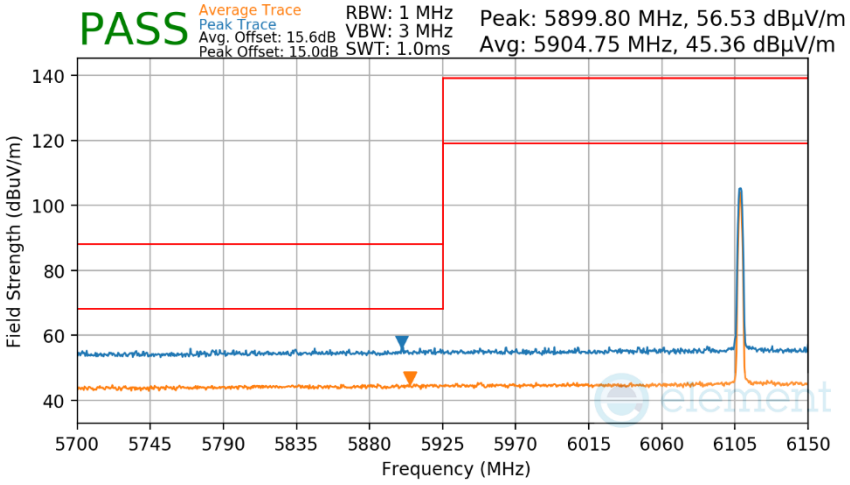
§15.407(b) §15.205 §15.209

Mode:	NB UNII BDR
Measurement Distance:	3 Meters
Operating Frequency:	6108MHz



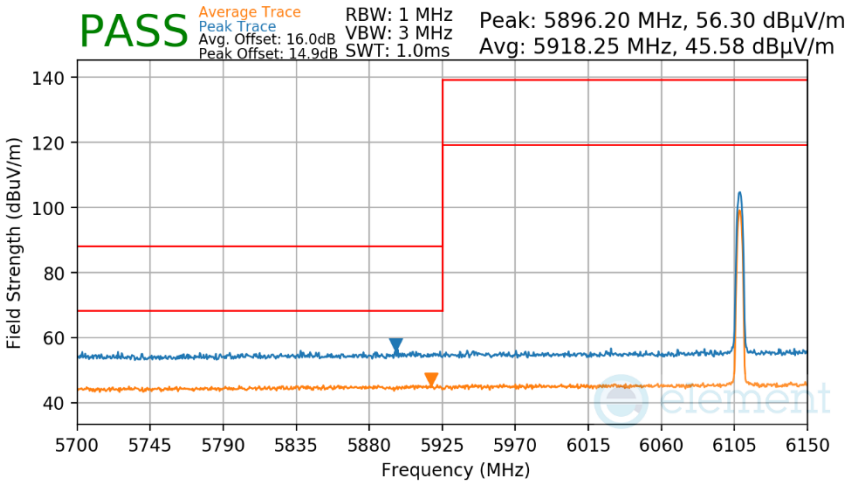
Plot 7-78. Radiated Lower Band Edge Measurement

Mode:	NB UNII LE
Data Rate:	2Mbps
Measurement Distance:	3 Meters
Operating Frequency:	6108MHz



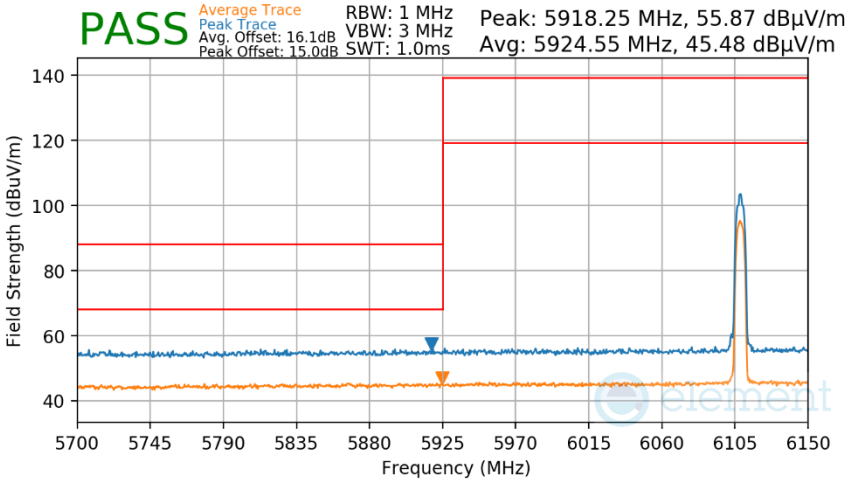
Plot 7-79. Radiated Lower Band Edge Measurement

Mode:	NB UNII HDR4
Measurement Distance:	3 Meters
Operating Frequency:	6108MHz



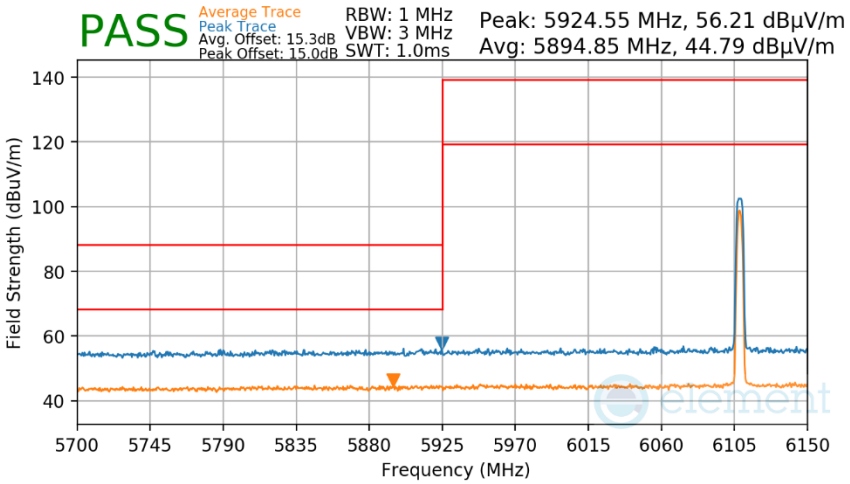
Plot 7-80. Radiated Lower Band Edge Measurement

Mode:	NB UNII HDR8
Measurement Distance:	3 Meters
Operating Frequency:	6108MHz



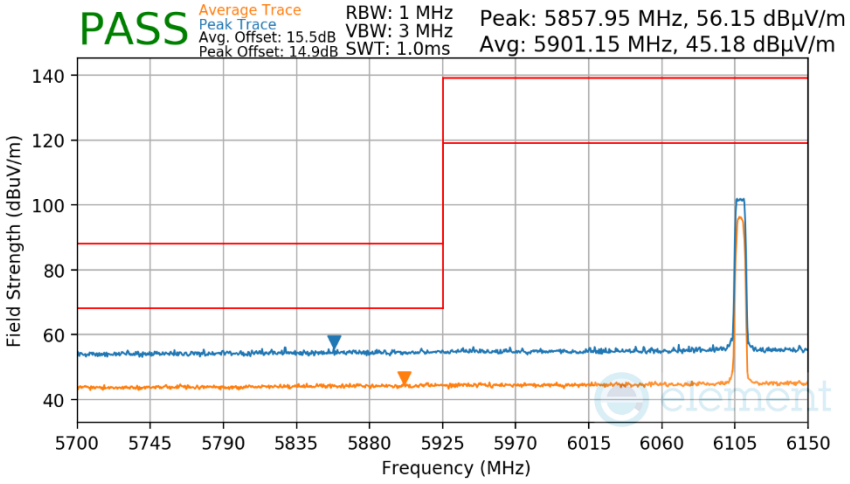
Plot 7-81. Radiated Lower Band Edge Measurement

Mode:	NB UNII HDRp4
Measurement Distance:	3 Meters
Operating Frequency:	6108MHz



Plot 7-82. Radiated Lower Band Edge Measurement

Mode:	NB UNII HDRp8
Measurement Distance:	3 Meters
Operating Frequency:	6108MHz



Plot 7-83. Radiated Lower Band Edge Measurement

7.9 Radiated Spurious Emissions – Below 1GHz

§15.209

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 must not exceed the limits shown in Table 7-23 per Section 15.209.

Frequency	Field Strength [µV/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-23. 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.

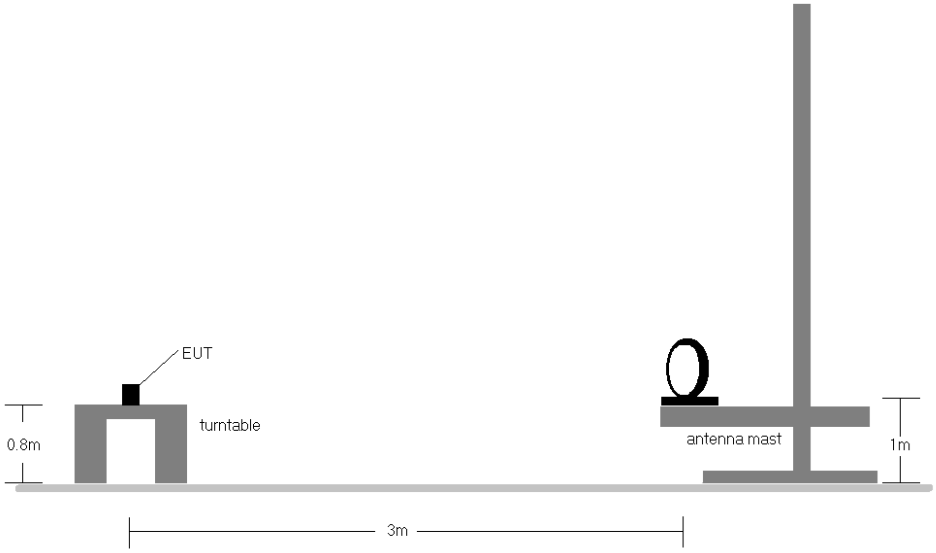


Figure 7-9. Radiated Test Setup < 30MHz

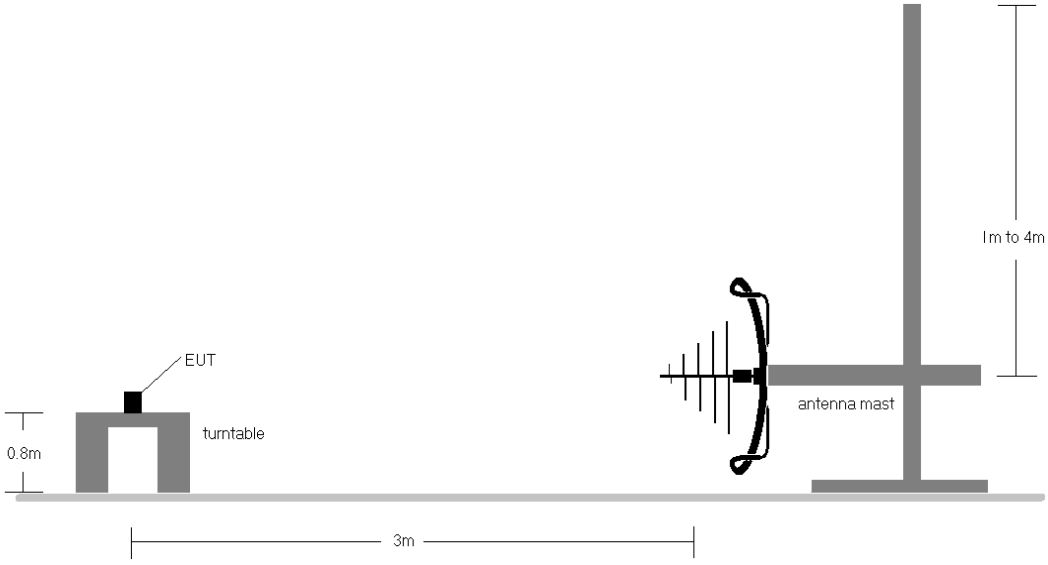


Figure 7-10. Radiated Test Setup < 1GHz

Test Notes

1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-23.
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. 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. Both configurations below were investigated, and the worst case has been reported.
    a. EUT charged by charging case and powered by AC/DC adaptor with USB-C cable.
    b. EUT charged by charging case and powered by host PC with USB-C cable.

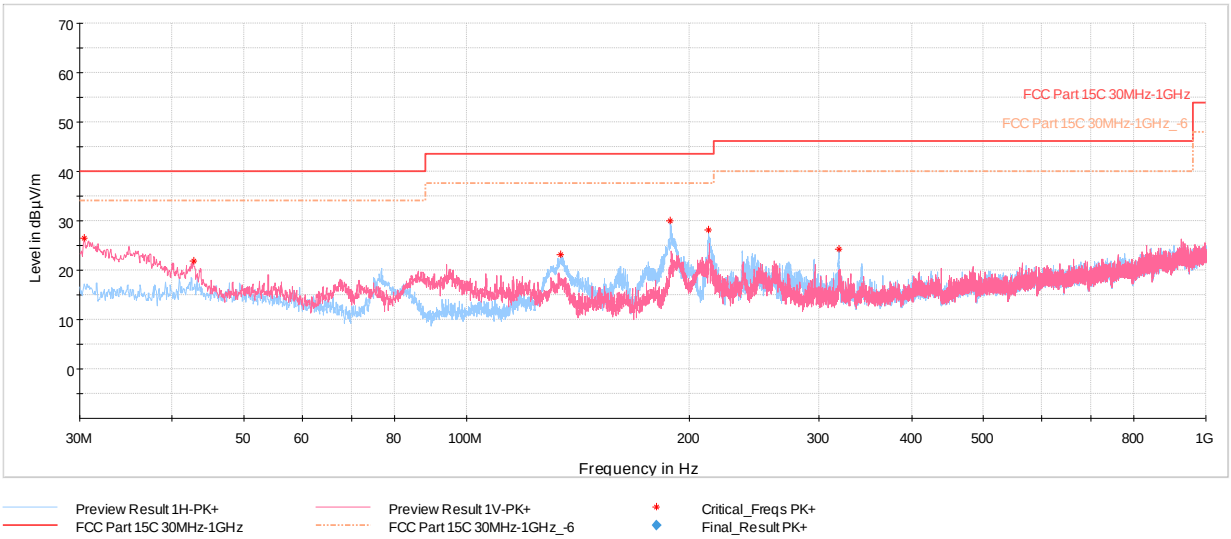
Sample Calculations

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 (Below 1GHz)

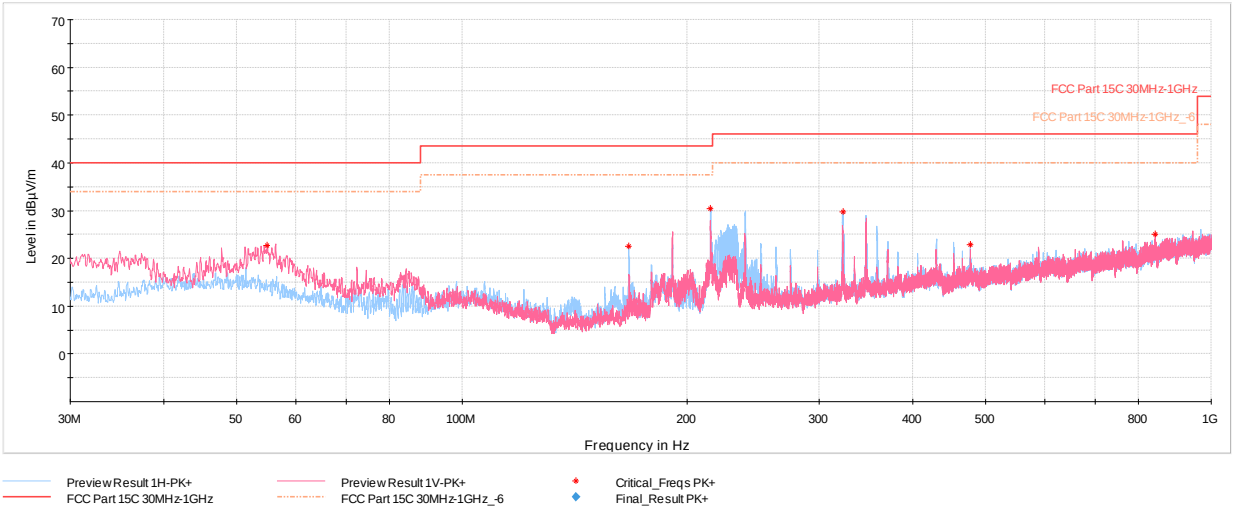
§15.209



Plot 7-84. Radiated Spurious Emissions Below 1GHz (NB UNII BDR – 6108MHz), with host PC with 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]
30.44	Max Peak	V	100	229	-64.13	-16.48	26.39	40.00	-13.61
42.76	Max Peak	V	100	81	-71.41	-13.78	21.81	40.00	-18.19
134.18	Max Peak	H	200	18	-63.20	-20.57	23.23	43.52	-20.29
188.79	Max Peak	H	200	218	-58.77	-18.32	29.91	43.52	-13.61
212.46	Max Peak	H	100	243	-61.22	-17.71	28.07	43.52	-15.45
318.72	Max Peak	H	100	12	-68.19	-14.51	24.30	46.02	-21.72

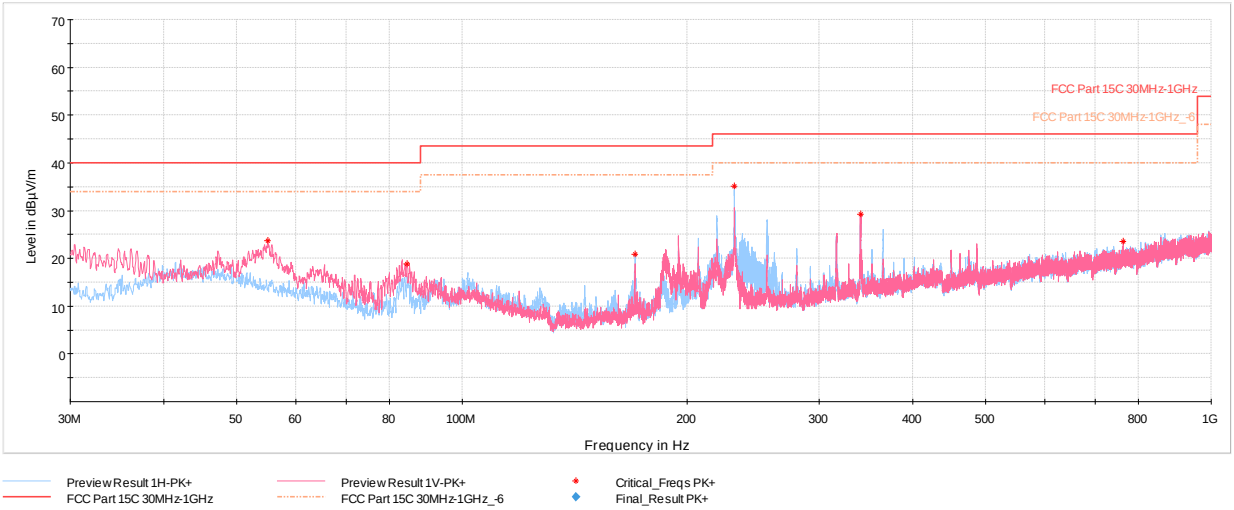
Table 7-24. Radiated Spurious Emissions Below 1GHz (NB UNII BDR – 6108MHz), with host PC with USB-C cable



Plot 7-85. Radiated Spurious Emissions Below 1GHz (NB UNII (LE2M) – 6108MHz), with AC/DC adaptor with 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]
54.98	Max Peak	V	100	4	-69.71	-14.51	22.78	40.00	-17.22
167.01	Max Peak	H	200	198	-64.71	-19.83	22.46	43.52	-21.06
214.79	Max Peak	H	100	314	-58.94	-17.57	30.49	43.52	-13.03
322.41	Max Peak	H	100	133	-62.88	-14.39	29.73	46.02	-16.29
477.22	Max Peak	H	200	238	-73.24	-10.95	22.81	46.02	-23.21
842.04	Max Peak	V	200	284	-77.52	-4.43	25.05	46.02	-20.97

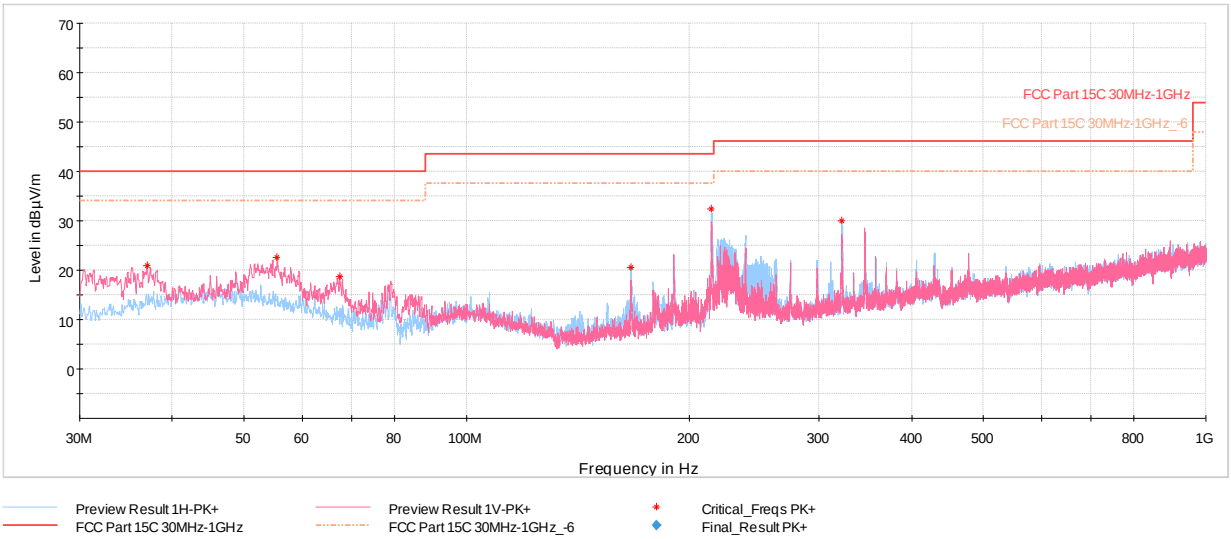
Table 7-25. Radiated Spurious Emissions Below 1GHz (NB UNII (LE2M) – 6108MHz), with AC/DC adaptor with USB-C cable



Plot 7-86. Radiated Spurious Emissions Below 1GHz (NB UNII HDR4 – 6264MHz), with AC/DC adaptor with 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]
55.07	Max Peak	V	100	56	-68.81	-14.50	23.69	40.00	-16.31
84.42	Max Peak	V	100	223	-67.51	-20.60	18.89	40.00	-21.11
170.21	Max Peak	H	200	204	-66.50	-19.70	20.80	43.52	-22.72
230.89	Max Peak	H	100	327	-55.31	-16.60	35.09	46.02	-10.93
340.40	Max Peak	V	100	265	-64.09	-13.60	29.31	46.02	-16.71
762.25	Max Peak	V	300	15	-77.43	-6.10	23.47	46.02	-22.55

Table 7-26. Radiated Spurious Emissions Below 1GHz (NB UNII HDR4 – 6264MHz), with AC/DC adaptor with USB-C cable



Plot 7-87. Radiated Spurious Emissions Below 1GHz (NB UNII HDRp4 – 6264MHz), with AC/DC adaptor with 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]
36.98	Max Peak	V	100	355	-70.77	-15.31	20.92	40.00	-19.08
55.46	Max Peak	V	100	355	-69.79	-14.62	22.59	40.00	-17.41
67.39	Max Peak	V	200	143	-70.13	-18.24	18.63	40.00	-21.37
167.01	Max Peak	H	200	191	-66.64	-19.83	20.53	43.52	-22.99
214.59	Max Peak	H	100	323	-57.06	-17.59	32.35	43.52	-11.17
321.97	Max Peak	H	100	314	-62.63	-14.38	29.99	46.02	-16.03

Table 7-27. Radiated Spurious Emissions Below 1GHz (NB UNII HDRp4 – 6264MHz), with AC/DC adaptor with USB-C cable

7.10 AC Line Conducted Emissions Measurement

§15.207

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. All data rates and modes were investigated for AC Line conducted spurious emissions.

All conducted emissions must not exceed the limits shown in the table below, per Section 15.207.

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 7-28. 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.

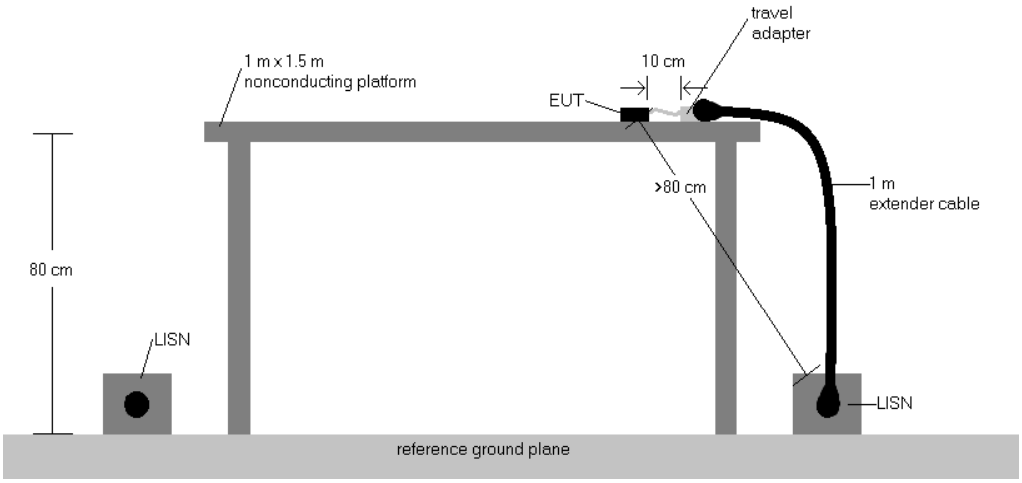
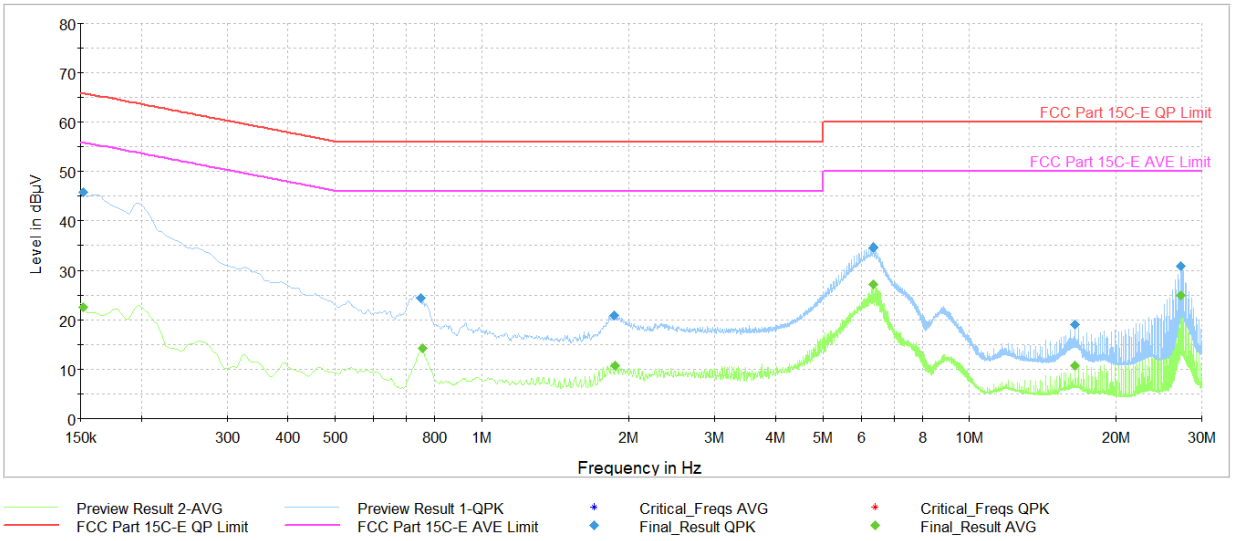


Figure 7-11. Test Instrument & Measurement Setup

Test Notes

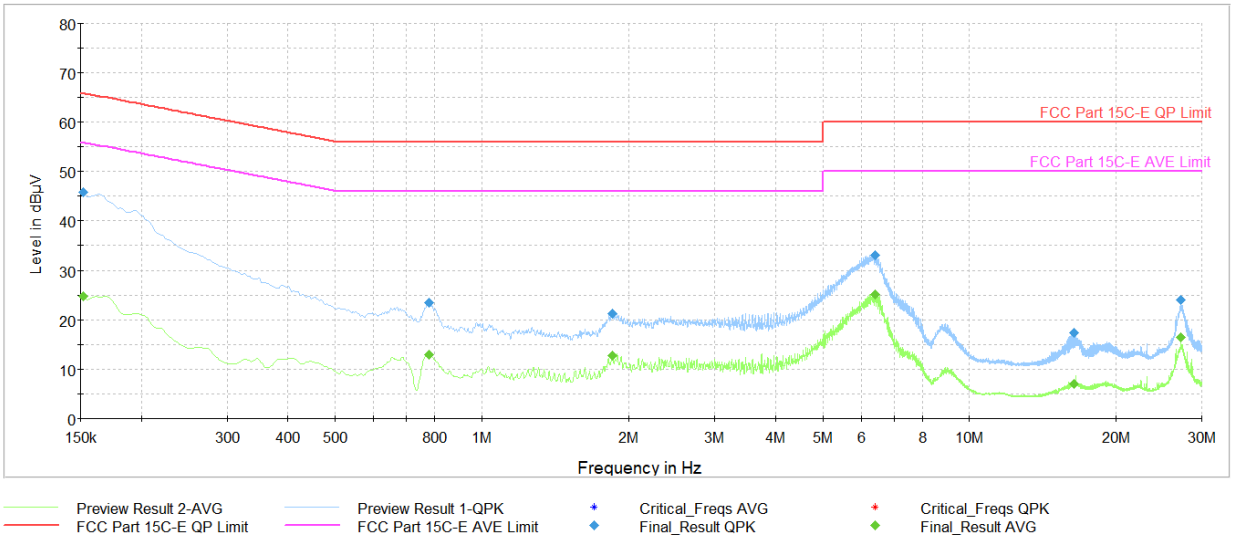
1. All modes of operation were investigated and the worst-case emissions are reported. The emissions found were not affected by the choice of channel used during testing.
2. Both configurations below were investigated, and the worst case has been reported.
    a. EUT charged by charging case and powered by AC/DC adaptor with USB-C cable.
    b. EUT charged by charging case and powered by host PC with USB-C cable.
3. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207.
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 plots are made using quasi-peak and average detectors.
8. Deviations to the Specifications: None.



Plot 7-88. AC Line Conducted Plot (NB UNII BDR – 6108MHz) (L1) with host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.152	FINAL	—	22.68	55.88	-33.20	L1	GND
0.152	FINAL	45.7	—	65.88	-20.20	L1	GND
0.751	FINAL	24.4	—	56.00	-31.63	L1	GND
0.755	FINAL	—	14.17	46.00	-31.83	L1	GND
1.865	FINAL	20.9	—	56.00	-35.09	L1	GND
1.874	FINAL	—	10.82	46.00	-35.18	L1	GND
6.344	FINAL	34.7	—	60.00	-25.33	L1	GND
6.356	FINAL	—	27.22	50.00	-22.78	L1	GND
16.447	FINAL	19.2	—	60.00	-40.85	L1	GND
16.447	FINAL	—	10.72	50.00	-39.28	L1	GND
27.224	FINAL	—	25.00	50.00	-25.00	L1	GND
27.224	FINAL	30.9	—	60.00	-29.14	L1	GND

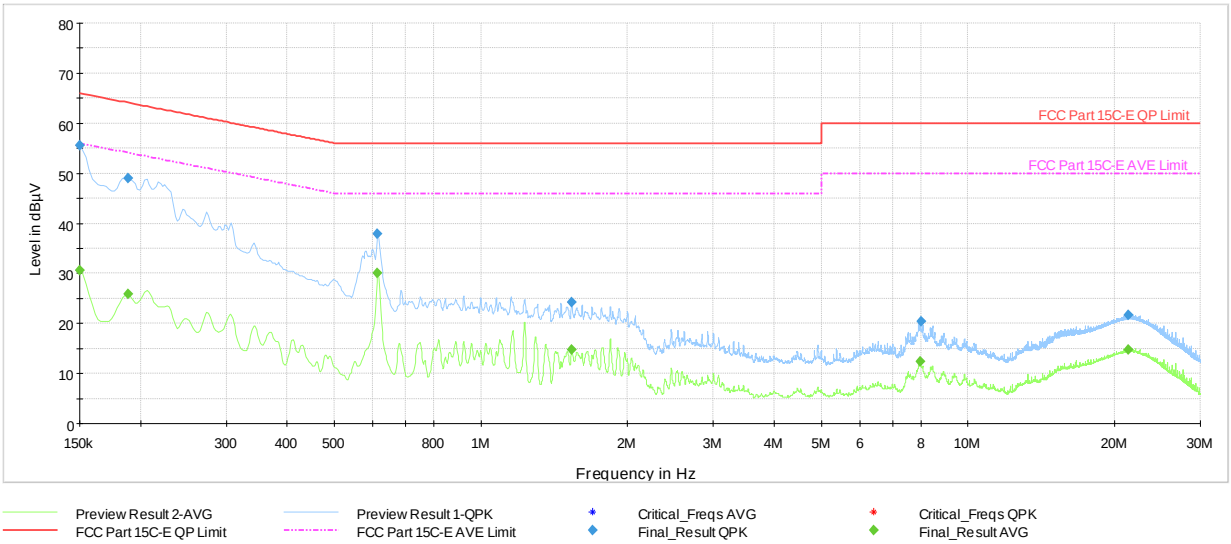
Table 7-29. AC Line Conducted Data (NB UNII BDR – 6108MHz) (L1) with host PC with USB-C cable



Plot 7-89. AC Line Conducted Plot (NB UNII BDR – 6108MHz) (N) with host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.152	FINAL	—	24.77	55.88	-31.10	N	GND
0.152	FINAL	45.7	—	65.88	-20.15	N	GND
0.780	FINAL	—	13.04	46.00	-32.96	N	GND
0.780	FINAL	23.5	—	56.00	-32.46	N	GND
1.844	FINAL	21.4	—	56.00	-34.65	N	GND
1.847	FINAL	—	12.85	46.00	-33.15	N	GND
6.394	FINAL	—	25.20	50.00	-24.80	N	GND
6.396	FINAL	33.2	—	60.00	-26.79	N	GND
16.375	FINAL	17.3	—	60.00	-42.68	N	GND
16.431	FINAL	—	7.02	50.00	-42.98	N	GND
27.159	FINAL	—	16.40	50.00	-33.60	N	GND
27.159	FINAL	24.0	—	60.00	-35.98	N	GND

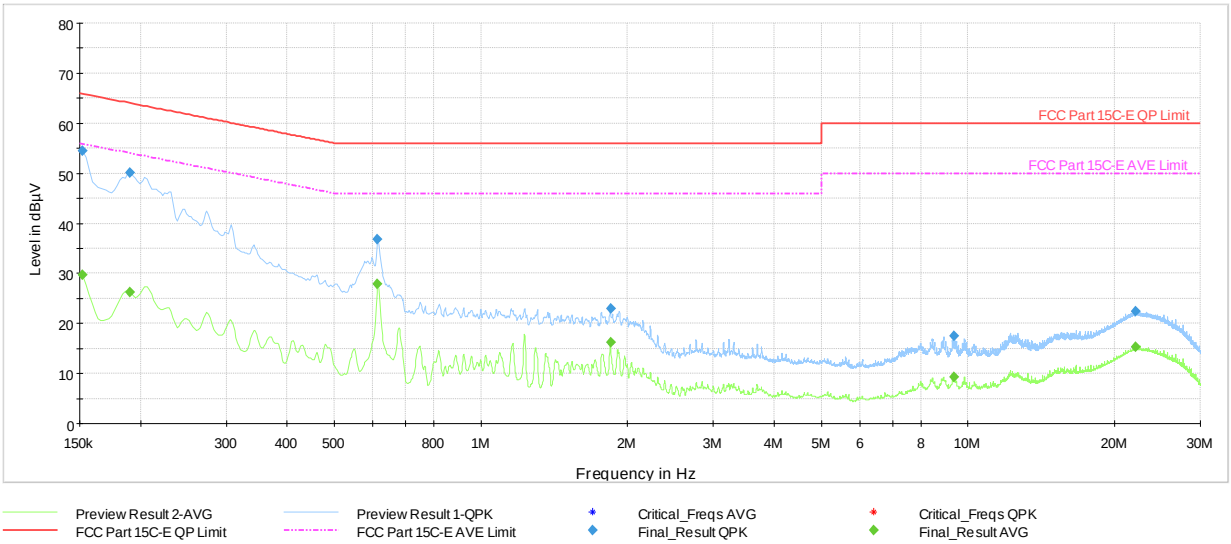
Table 7-30. AC Line Conducted Data (NB UNII BDR – 6108MHz) (N) with host PC with USB-C cable



Plot 7-90. AC Line Conducted Plot (NB UNII (LE2M) – 6108MHz) (L1) with Host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.150	FINAL	—	30.55	56.00	-25.45	L1	GND
0.150	FINAL	55.7	—	66.00	-10.35	L1	GND
0.188	FINAL	—	25.93	54.11	-28.18	L1	GND
0.188	FINAL	49.0	—	64.11	-15.07	L1	GND
0.614	FINAL	37.9	—	56.00	-18.09	L1	GND
0.614	FINAL	—	29.98	46.00	-16.02	L1	GND
1.536	FINAL	24.3	—	56.00	-31.72	L1	GND
1.536	FINAL	—	14.78	46.00	-31.22	L1	GND
7.989	FINAL	—	12.42	50.00	-37.58	L1	GND
8.009	FINAL	20.5	—	60.00	-39.55	L1	GND
21.329	FINAL	—	14.78	50.00	-35.22	L1	GND
21.332	FINAL	21.7	—	60.00	-38.34	L1	GND

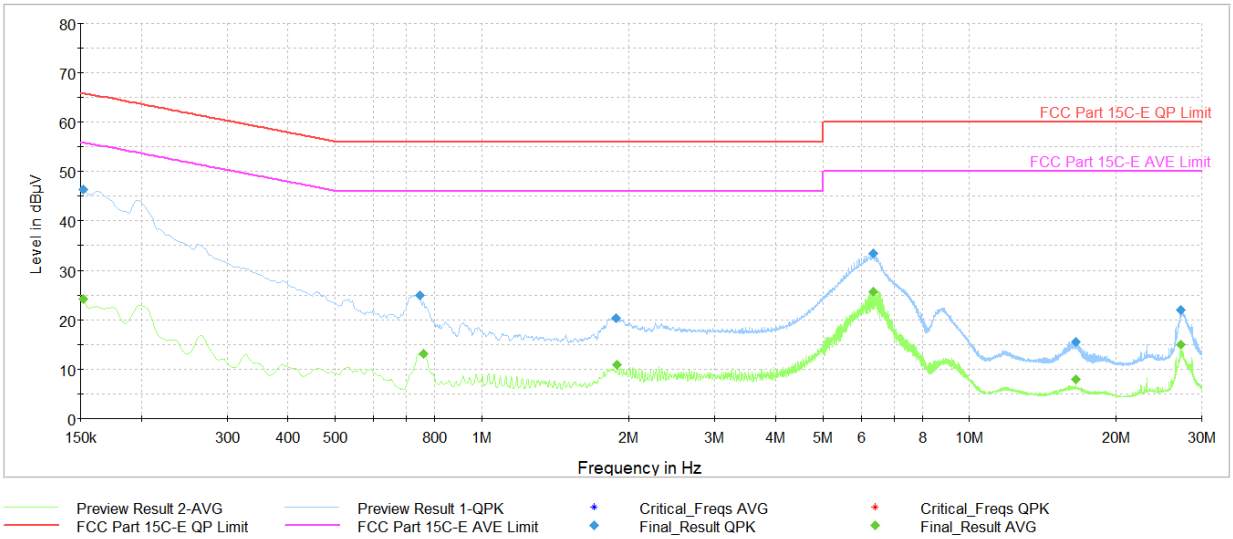
Table 7-31. AC Line Conducted Data (NB UNII (LE2M) – 6108MHz) (L1) with Host PC with USB-C cable



Plot 7-91. AC Line Conducted Data (NB UNII (LE2M) – 6108MHz) (N) with Host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.152	FINAL	—	29.77	55.88	-26.11	N	GND
0.152	FINAL	54.5	—	65.88	-11.34	N	GND
0.191	FINAL	—	26.23	54.02	-27.78	N	GND
0.191	FINAL	50.1	—	64.02	-13.90	N	GND
0.614	FINAL	—	27.80	46.00	-18.20	N	GND
0.614	FINAL	36.9	—	56.00	-19.11	N	GND
1.844	FINAL	22.9	—	56.00	-33.08	N	GND
1.844	FINAL	—	16.17	46.00	-29.83	N	GND
9.368	FINAL	17.5	—	60.00	-42.49	N	GND
9.373	FINAL	—	9.29	50.00	-40.71	N	GND
22.049	FINAL	—	15.27	50.00	-34.73	N	GND
22.049	FINAL	22.5	—	60.00	-37.51	N	GND

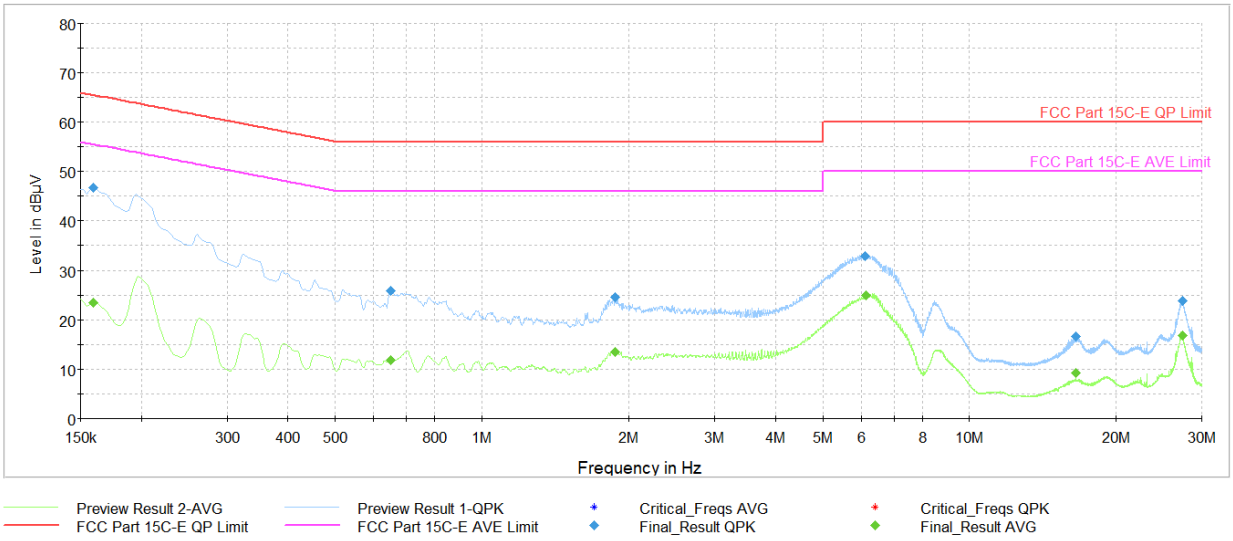
Table 7-32. AC Line Conducted Data (NB UNII (LE2M) – 6108MHz) (N) with Host PC with USB-C cable



Plot 7-92. AC Line Conducted Plot (NB UNII HDR4 – 6264MHz) (L1) with Host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.152	FINAL	—	24.25	55.88	-31.63	L1	GND
0.152	FINAL	46.4	—	65.88	-19.49	L1	GND
0.746	FINAL	25.0	—	56.00	-31.03	L1	GND
0.760	FINAL	—	13.20	46.00	-32.80	L1	GND
1.883	FINAL	20.4	—	56.00	-35.57	L1	GND
1.889	FINAL	—	10.91	46.00	-35.09	L1	GND
6.349	FINAL	33.5	—	60.00	-26.46	L1	GND
6.353	FINAL	—	25.66	50.00	-24.34	L1	GND
16.526	FINAL	—	8.02	50.00	-41.98	L1	GND
16.528	FINAL	15.6	—	60.00	-44.41	L1	GND
27.159	FINAL	—	15.01	50.00	-34.99	L1	GND
27.159	FINAL	22.1	—	60.00	-37.90	L1	GND

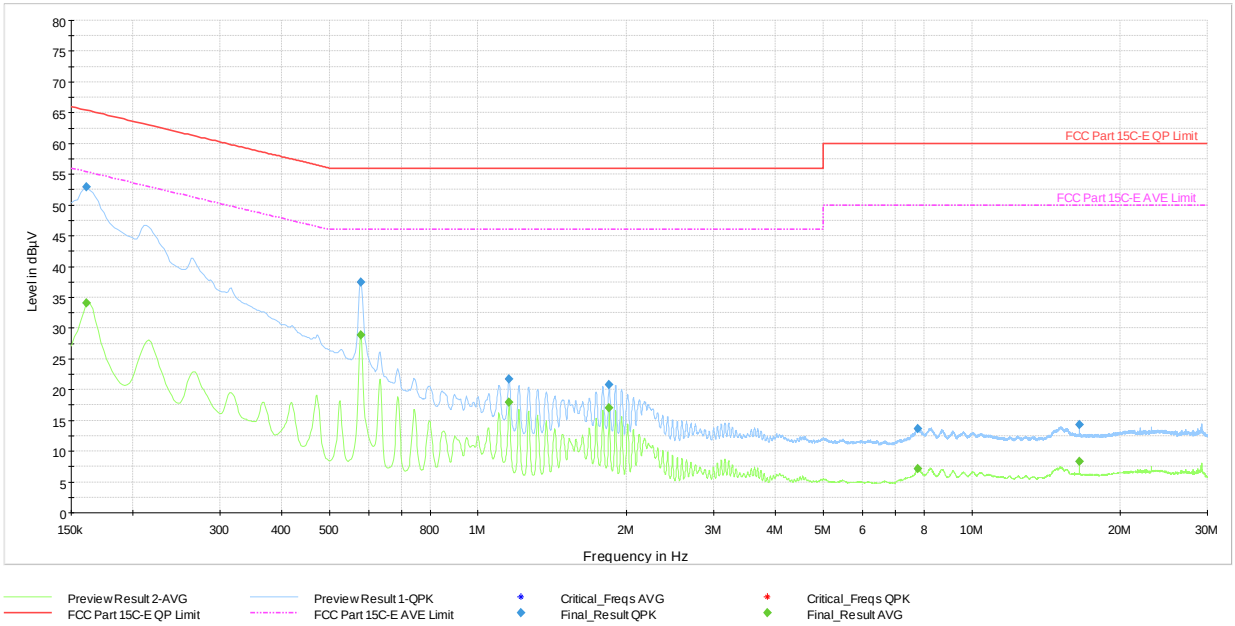
Table 7-33. AC Line Conducted Data (NB UNII HDR4 – 6264MHz) (L1) with Host PC with USB-C cable



Plot 7-93. AC Line Conducted Plot (NB UNII HDR4 – 6264MHz) (N) with Host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.159	FINAL	—	23.58	55.52	-31.94	N	GND
0.159	FINAL	46.6	—	65.52	-18.89	N	GND
0.650	FINAL	—	11.86	46.00	-34.14	N	GND
0.650	FINAL	26.0	—	56.00	-30.03	N	GND
1.871	FINAL	—	13.54	46.00	-32.46	N	GND
1.874	FINAL	24.7	—	56.00	-31.35	N	GND
6.101	FINAL	33.0	—	60.00	-26.98	N	GND
6.119	FINAL	—	25.07	50.00	-24.93	N	GND
16.521	FINAL	16.7	—	60.00	-43.32	N	GND
16.523	FINAL	—	9.29	50.00	-40.71	N	GND
27.344	FINAL	—	16.88	50.00	-33.12	N	GND
27.344	FINAL	23.9	—	60.00	-36.10	N	GND

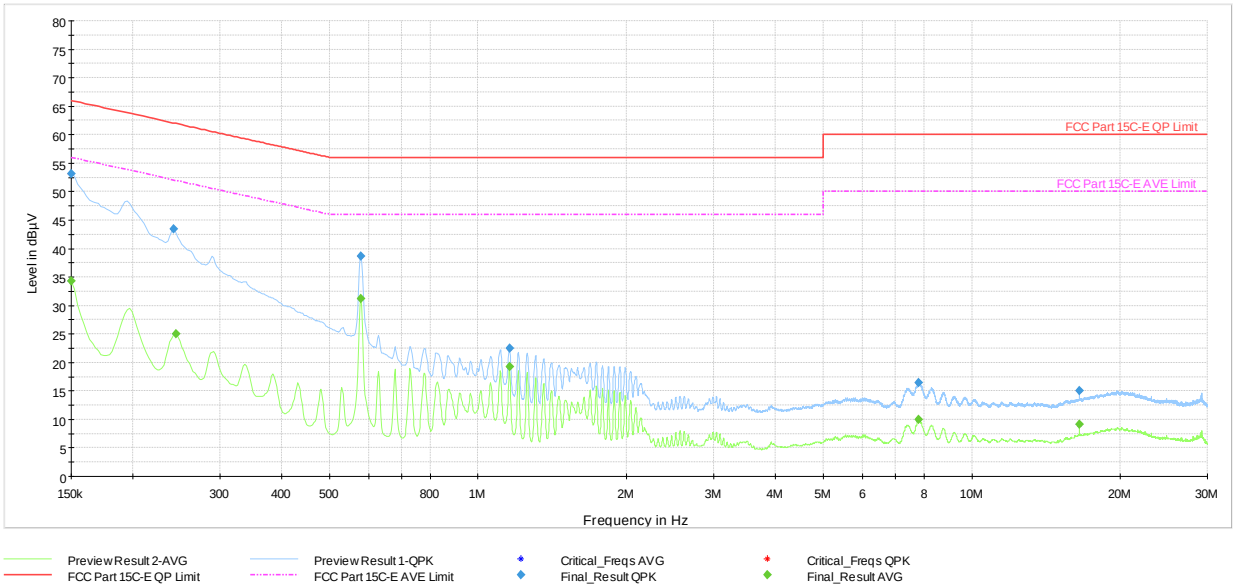
Table 7-34. AC Line Conducted Data (NB UNII HDR4 – 6264MHz) (N) with Host PC with USB-C cable



Plot 7-94. AC Line Conducted Plot (NB UNII HDRp4 – 6264MHz) (L1) with Host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.161	FINAL	—	34.03	55.40	-21.37	L1	GND
0.161	FINAL	53.0	—	65.40	-12.45	L1	GND
0.580	FINAL	—	28.90	46.00	-17.10	L1	GND
0.580	FINAL	37.5	—	56.00	-18.49	L1	GND
1.156	FINAL	—	17.94	46.00	-28.06	L1	GND
1.156	FINAL	21.7	—	56.00	-34.32	L1	GND
1.842	FINAL	20.8	—	56.00	-35.19	L1	GND
1.844	FINAL	—	17.00	46.00	-29.00	L1	GND
7.762	FINAL	—	7.11	50.00	-42.89	L1	GND
7.769	FINAL	13.7	—	60.00	-46.32	L1	GND
16.508	FINAL	—	8.34	50.00	-41.66	L1	GND
16.508	FINAL	14.3	—	60.00	-45.66	L1	GND

Table 7-35. AC Line Conducted Data (NB UNII HDRp4 – 6264MHz) (L1) with Host PC with USB-C cable



Plot 7-95. AC Line Conducted Plot (NB UNII HDRp4 – 6264MHz) (N) with Host PC with USB-C cable

Frequency [MHz]	Process State	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Line	PE
0.150	FINAL	—	34.30	56.00	-21.70	N	GND
0.150	FINAL	53.2	—	66.00	-12.82	N	GND
0.242	FINAL	43.4	—	62.02	-18.59	N	GND
0.245	FINAL	—	25.02	51.94	-26.93	N	GND
0.580	FINAL	—	31.26	46.00	-14.74	N	GND
0.580	FINAL	38.7	—	56.00	-17.34	N	GND
1.158	FINAL	22.5	—	56.00	-33.54	N	GND
1.158	FINAL	—	19.31	46.00	-26.69	N	GND
7.793	FINAL	16.4	—	60.00	-43.61	N	GND
7.802	FINAL	—	10.00	50.00	-40.00	N	GND
16.508	FINAL	—	9.14	50.00	-40.86	N	GND
16.508	FINAL	15.1	—	60.00	-44.90	N	GND

Table 7-36. AC Line Conducted Data (NB UNII HDRp4 – 6264MHz) (N) with Host PC with USB-C cable

8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **Apple Wireless Right Earbud FCC ID: BCG-A3055** is in compliance with Part 15 Subpart E (15.407) of the FCC Rules.