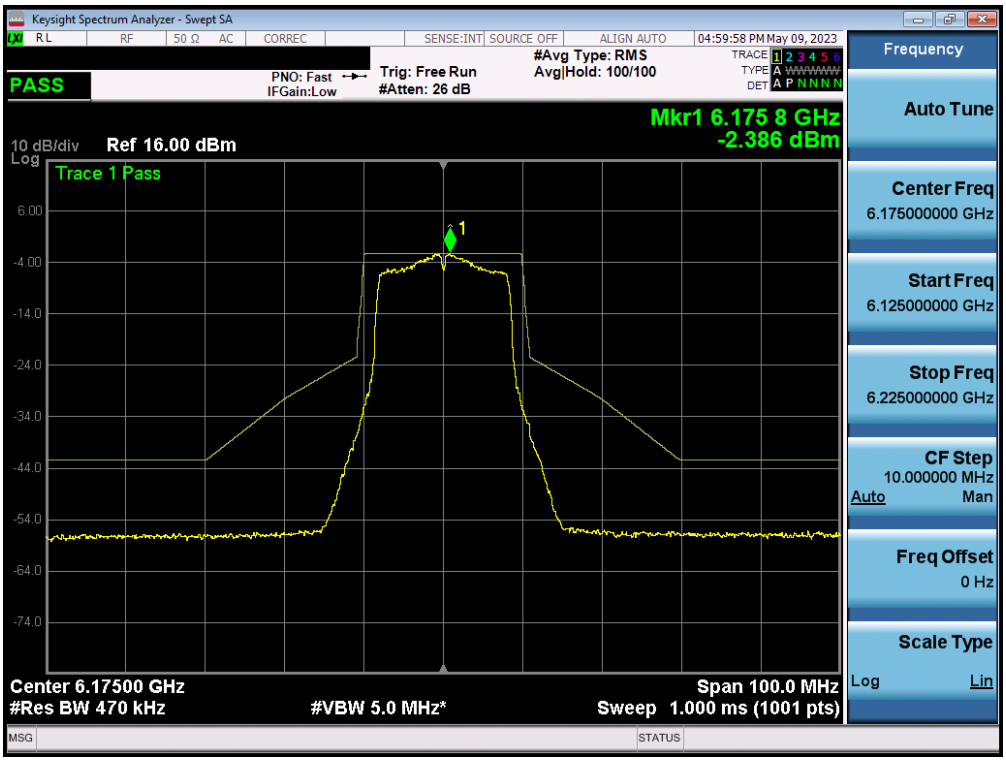
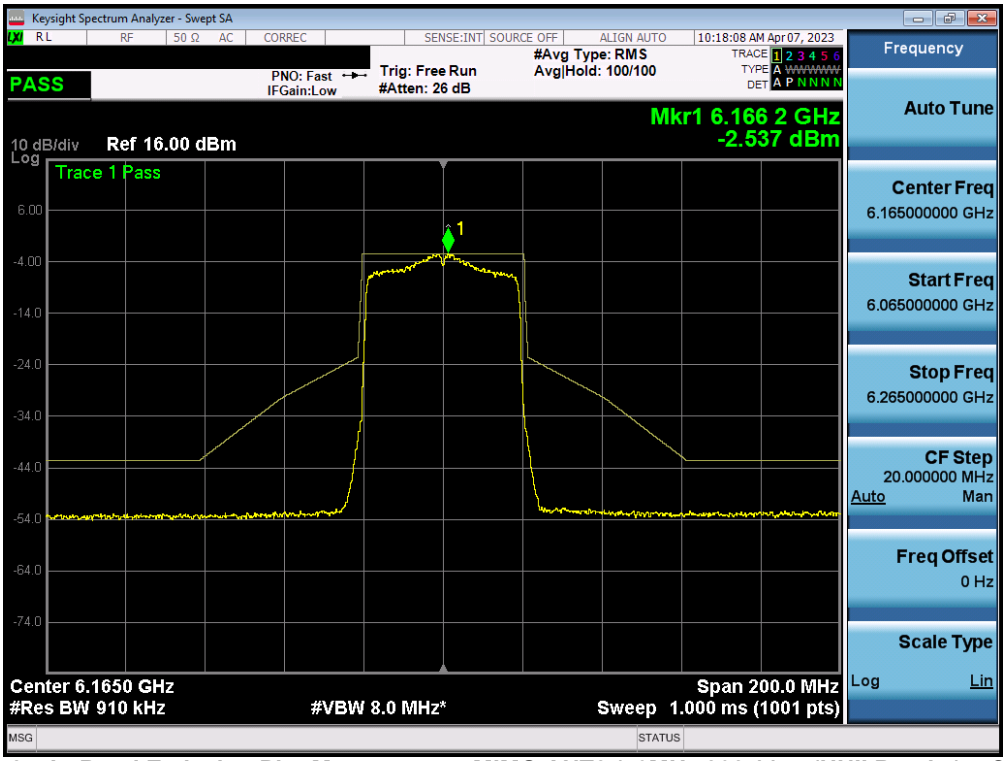
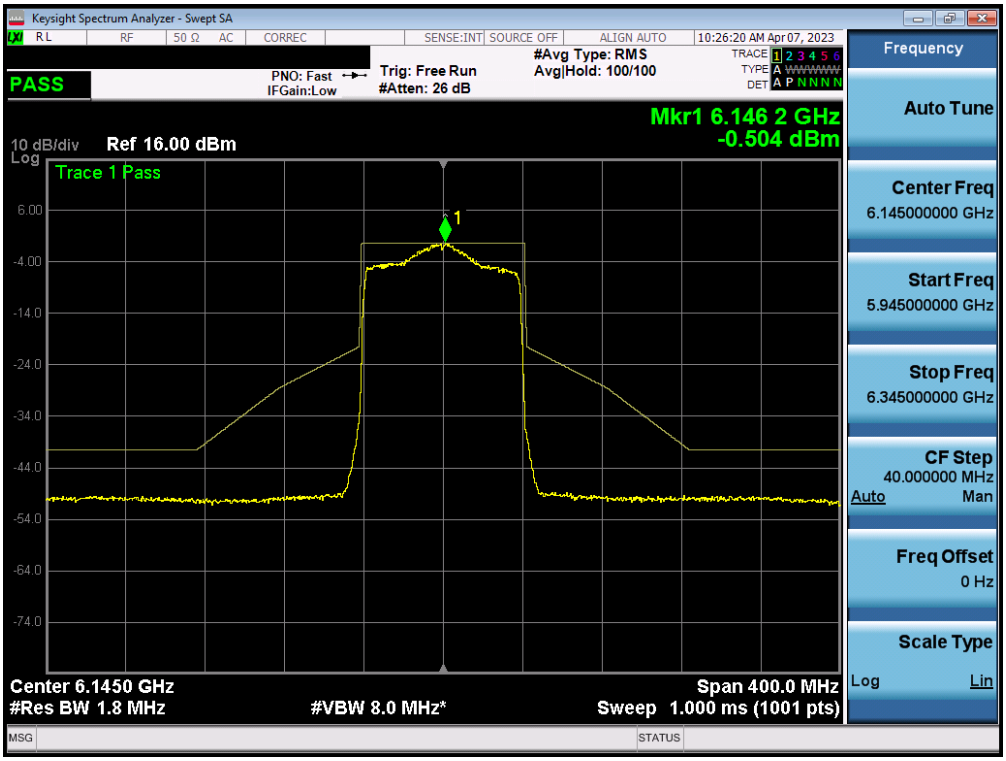
7.5.5 MIMO Antenna-2 In-Band Emission Plot Measurement - (UNII Band 5)



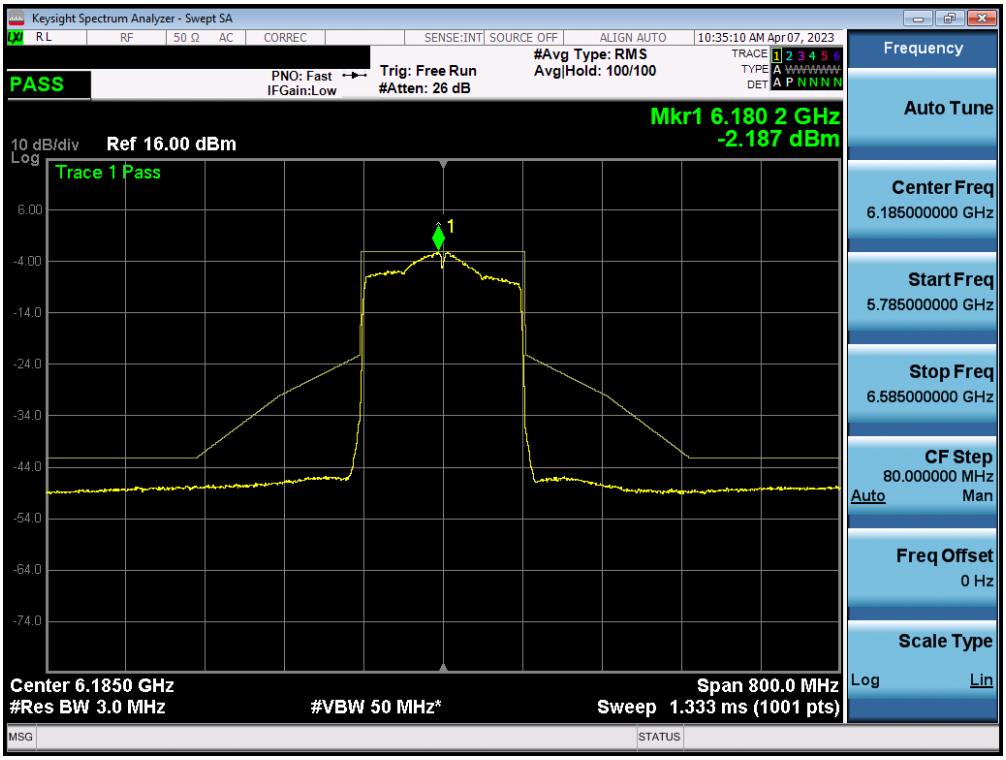
Plot 7-84. In-Band Emission Plot Measurement MIMO ANT2 (20MHz 802.11a (UNII Band 5) – Ch. 45)



Plot 7-85. In-Band Emission Plot Measurement MIMO ANT2 (40MHz 802.11ax (UNII Band 5) – Ch. 43)

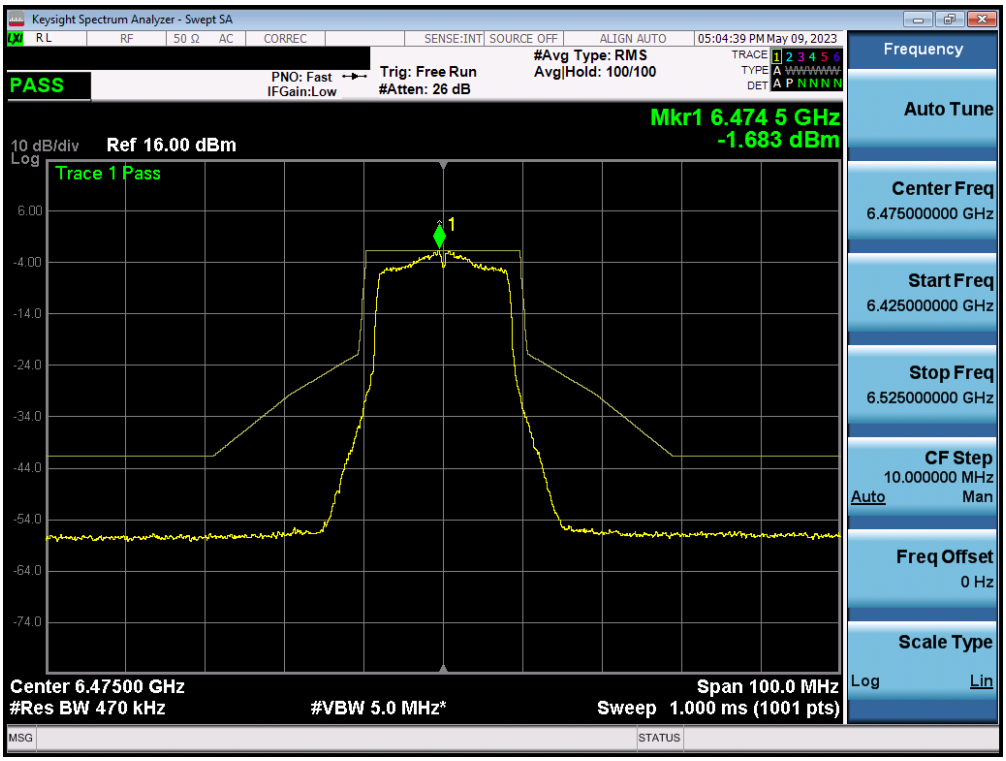


Plot 7-86. In-Band Emission Plot Measurement MIMO ANT2 (80MHz 802.11ax (UNII Band 5) – Ch. 39)

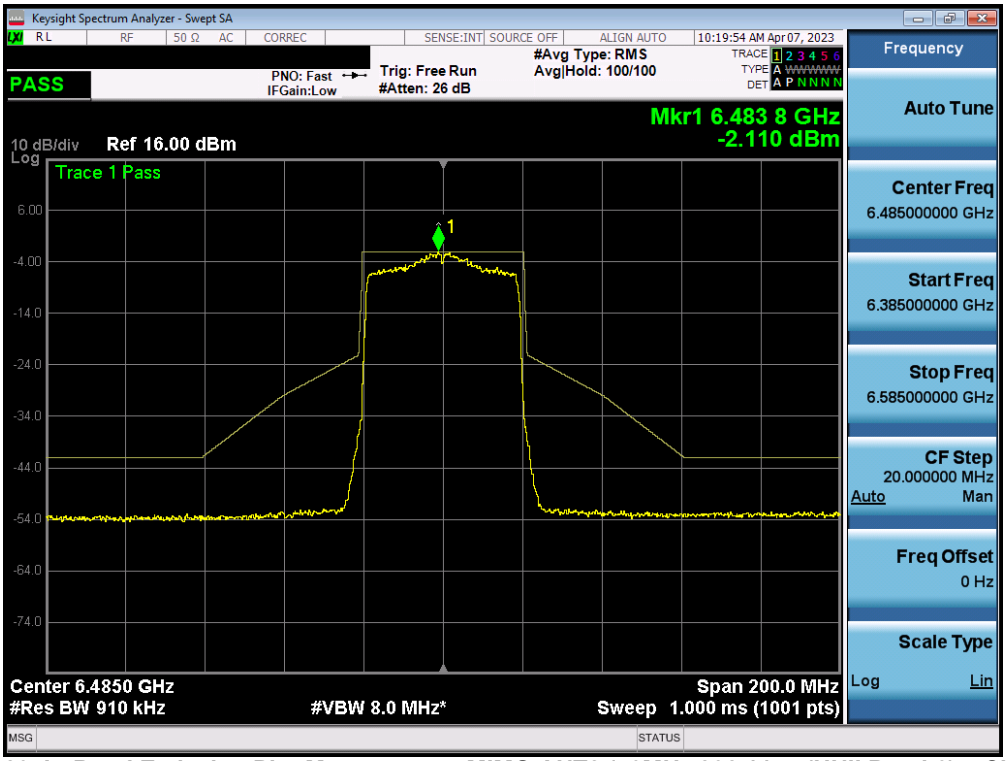


Plot 7-87. In-Band Emission Plot Measurement MIMO ANT2 (160MHz 802.11ax (UNII Band 5) – Ch. 47)

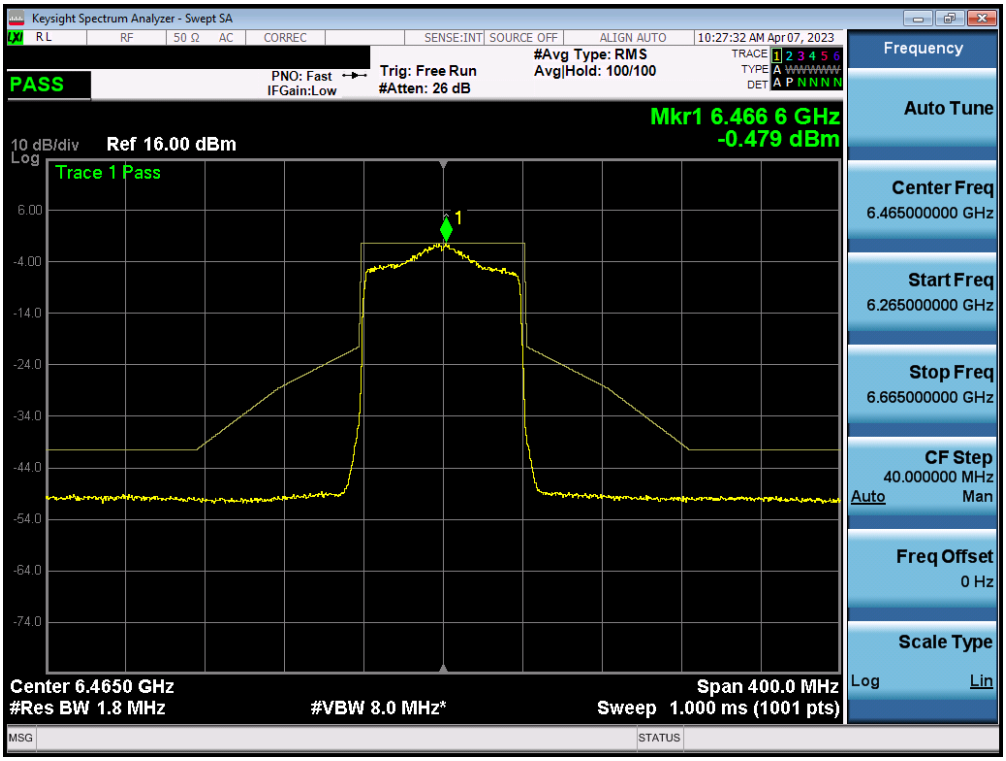
7.5.6 MIMO Antenna-2 In-Band Emission Plot Measurement - (UNII Band 6)



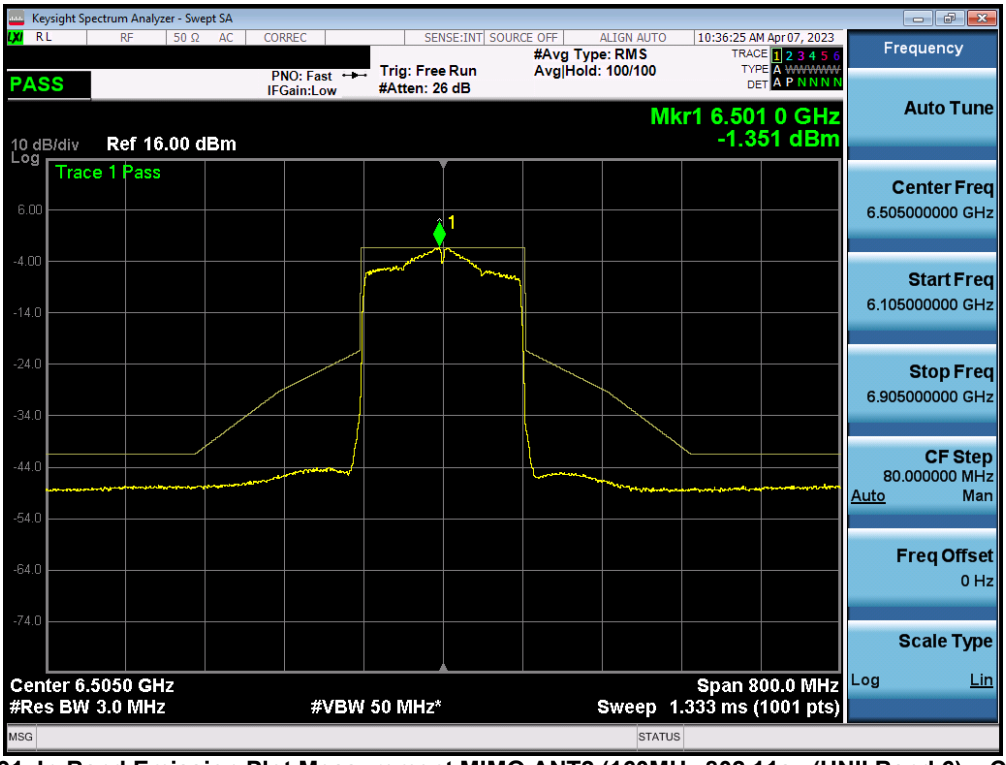
Plot 7-88. In-Band Emission Plot Measurement MIMO ANT2 (20MHz 802.11a (UNII Band 6) – Ch. 105)



Plot 7-89. In-Band Emission Plot Measurement MIMO ANT2 (40MHz 802.11ax (UNII Band 6) – Ch. 107)

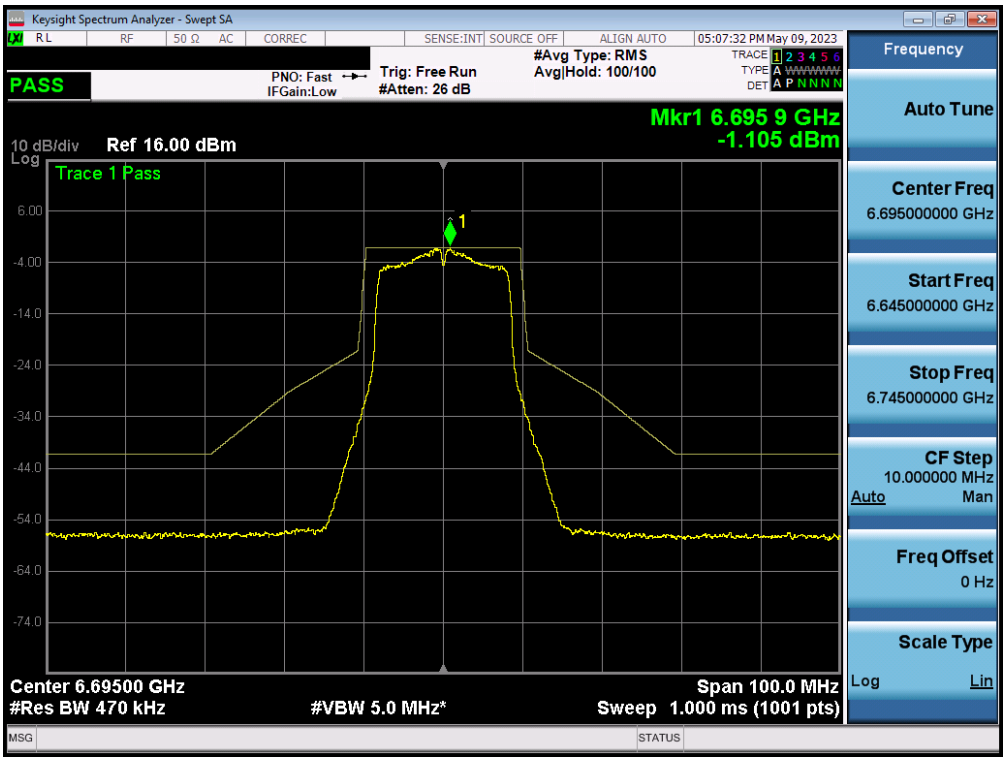


Plot 7-90. In-Band Emission Plot Measurement MIMO ANT2 (80MHz 802.11ax (UNII Band 6) – Ch. 103)

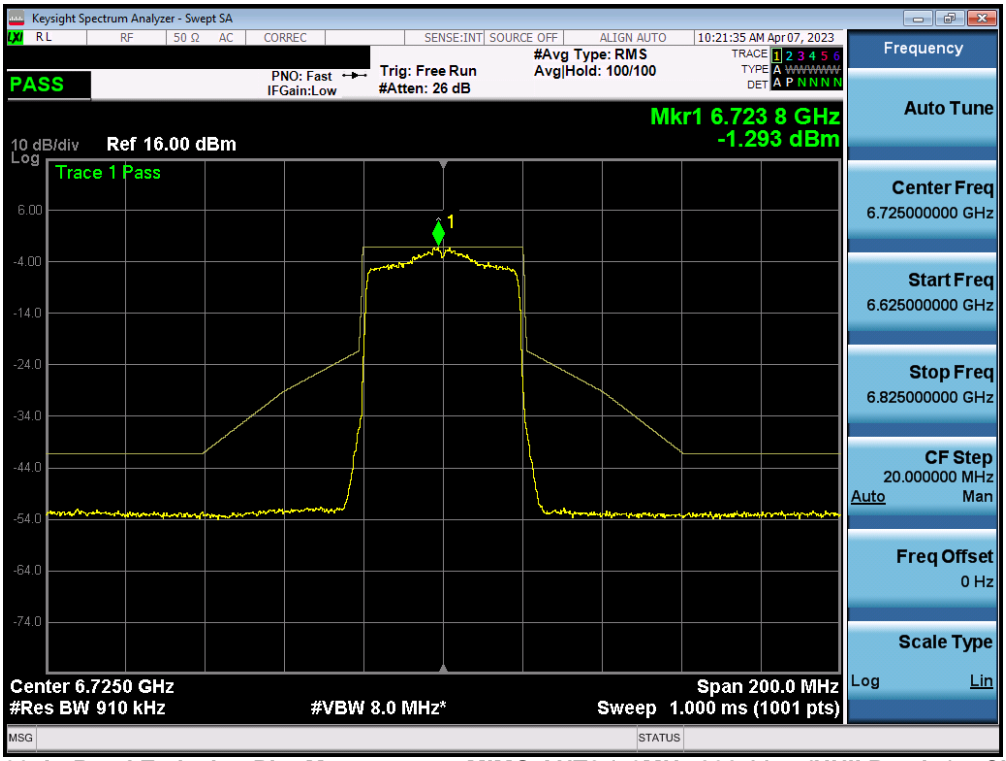


Plot 7-91. In-Band Emission Plot Measurement MIMO ANT2 (160MHz 802.11ax (UNII Band 6) – Ch. 111)

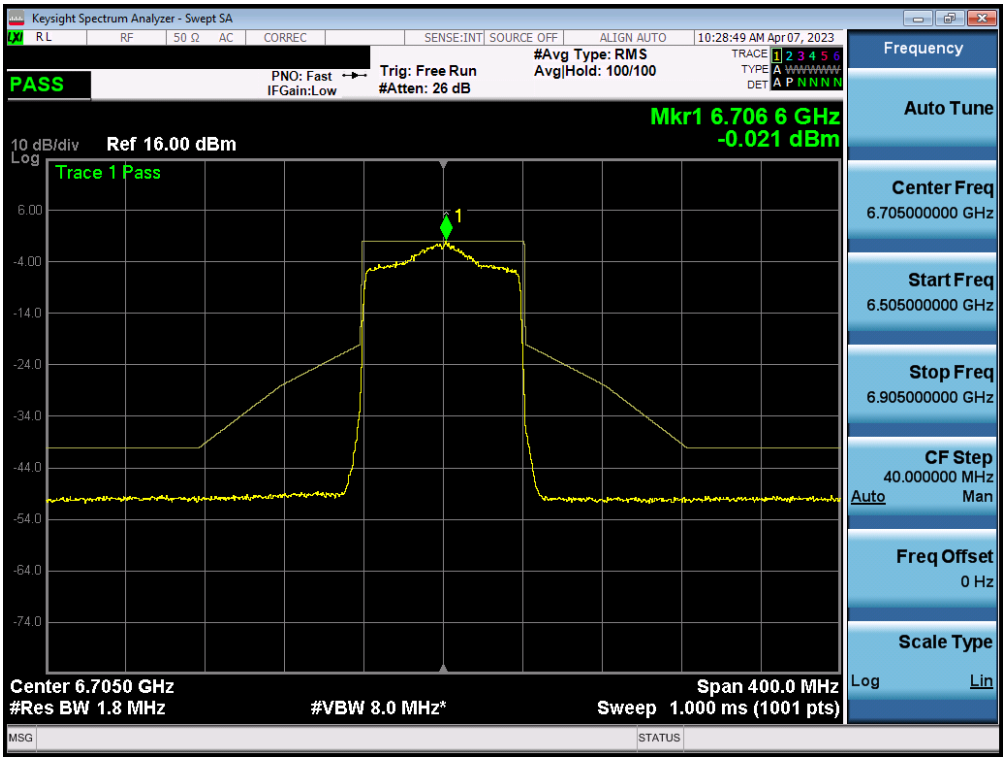
7.5.7 MIMO Antenna-2 In-Band Emission Plot Measurement - (UNII Band 7)



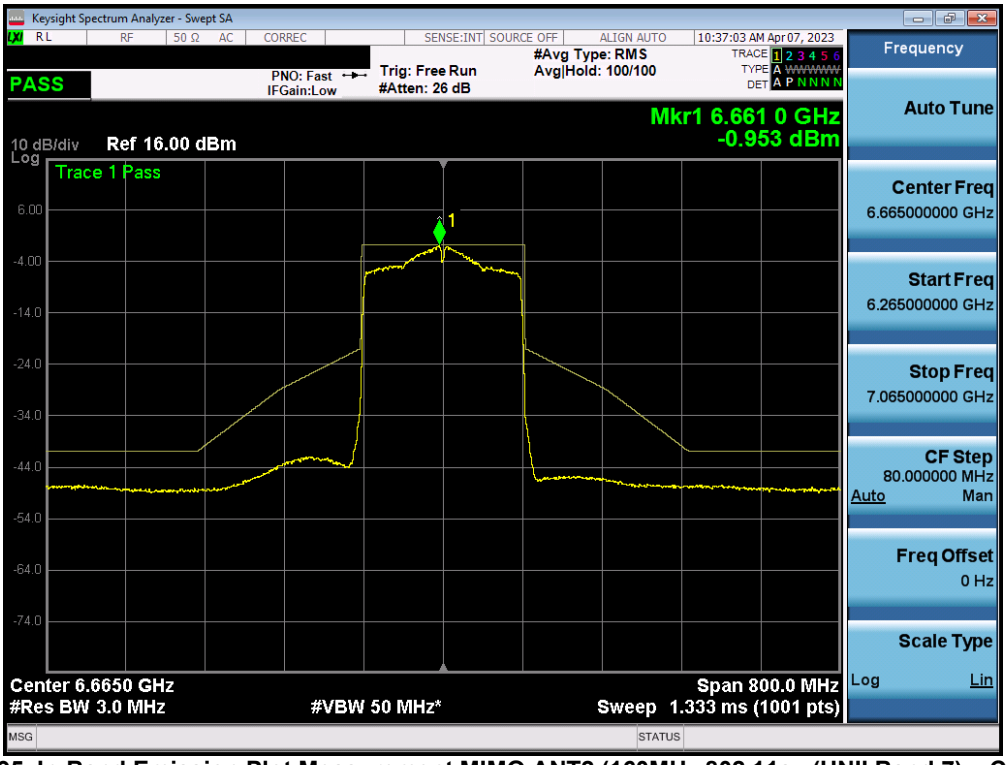
Plot 7-92. In-Band Emission Plot Measurement MIMO ANT2 (20MHz 802.11a (UNII Band 7) – Ch. 149)



Plot 7-93. In-Band Emission Plot Measurement MIMO ANT2 (40MHz 802.11ax (UNII Band 7) – Ch. 155)

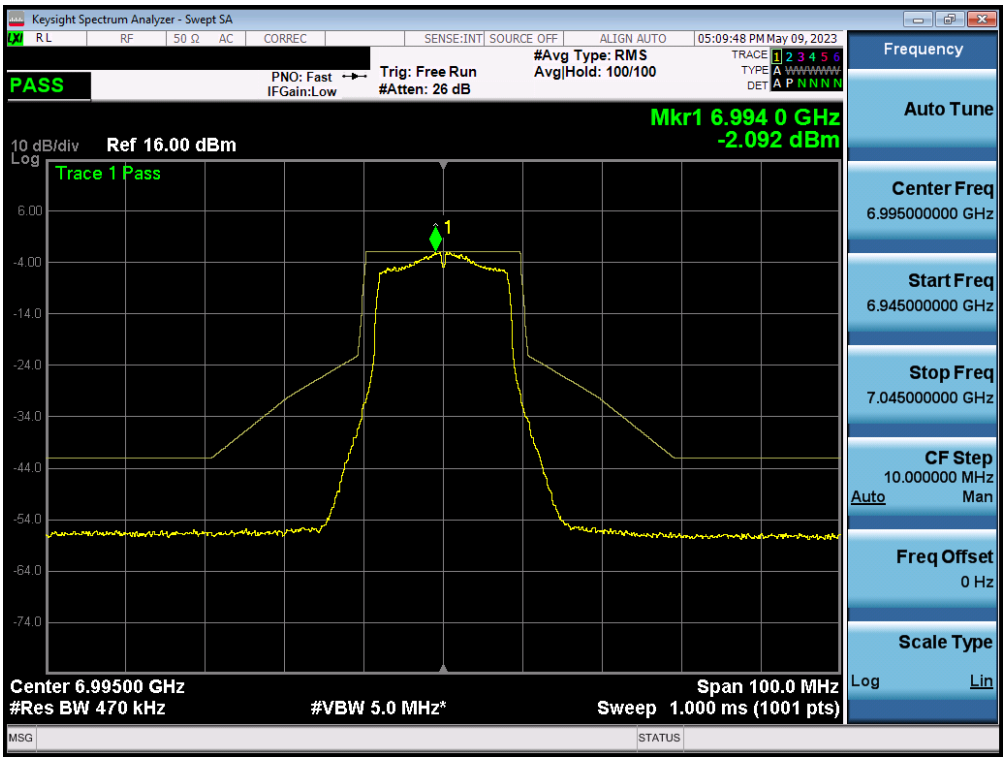


Plot 7-94. In-Band Emission Plot Measurement MIMO ANT2 (80MHz 802.11ax (UNII Band 7) – Ch. 151)

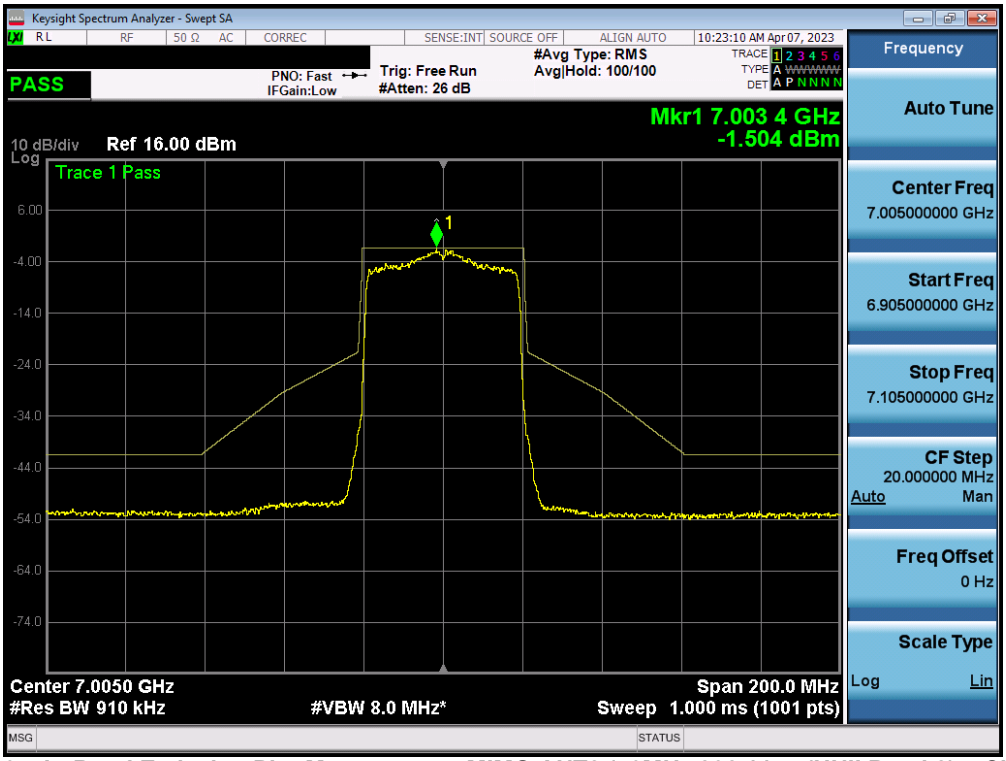


Plot 7-95. In-Band Emission Plot Measurement MIMO ANT2 (160MHz 802.11ax (UNII Band 7) – Ch. 143)

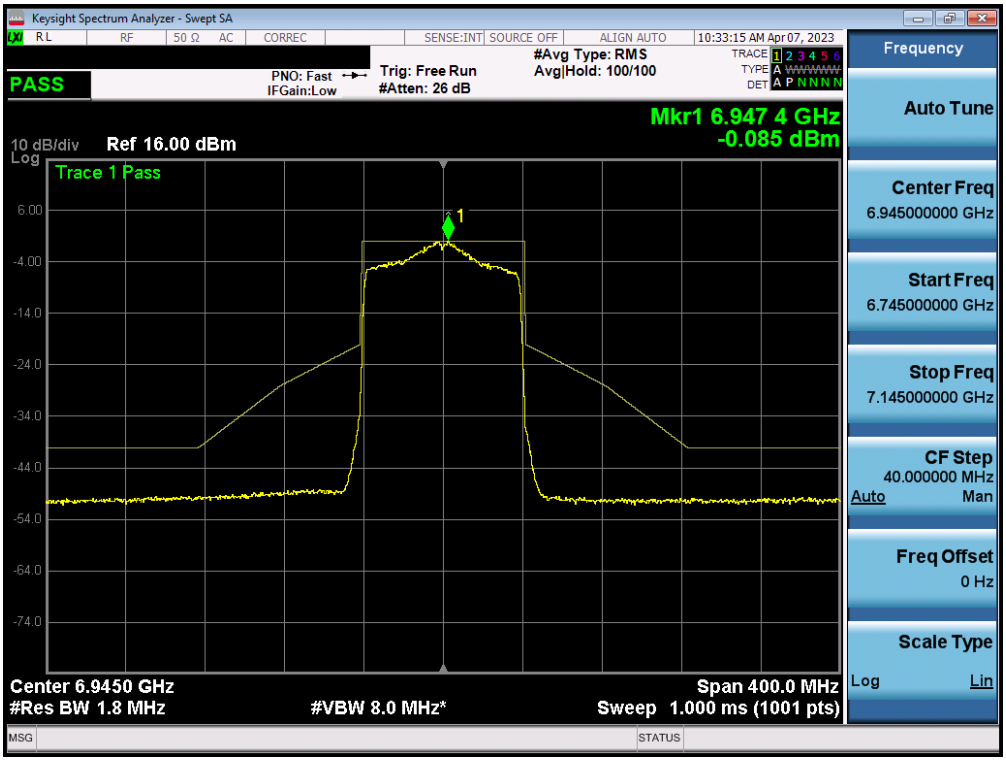
7.5.8 MIMO Antenna-2 In-Band Emission Plot Measurement - (UNII Band 8)



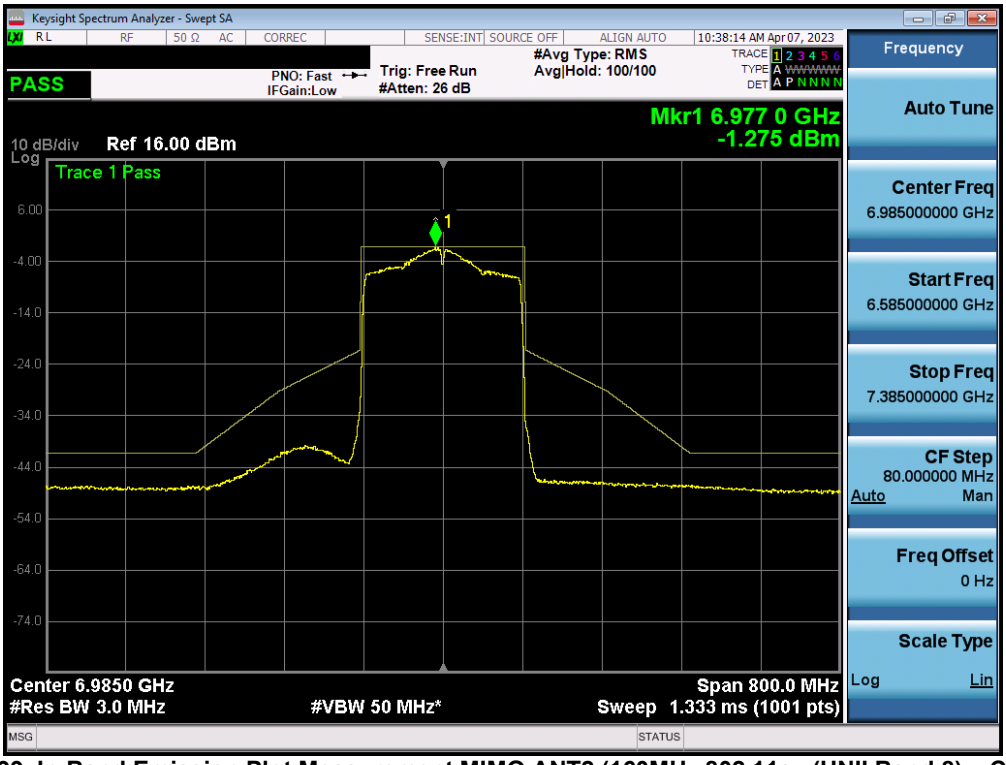
Plot 7-96. In-Band Emission Plot Measurement MIMO ANT2 (20MHz 802.11a (UNII Band 8) – Ch. 209)



Plot 7-97. In-Band Emission Plot Measurement MIMO ANT2 (40MHz 802.11ax (UNII Band 8) – Ch. 211)



Plot 7-98. In-Band Emission Plot Measurement MIMO ANT2 (80MHz 802.11ax (UNII Band 8) – Ch. 199)



Plot 7-99. In-Band Emission Plot Measurement MIMO ANT2 (160MHz 802.11ax (UNII Band 8) – Ch. 207)

7.6 Contention Based Protocol

Test Overview and Limit

Indoor access points, subordinate devices and client devices operating in the 5.925-7.125 GHz band (herein referred to as unlicensed devices) are required to use technologies that include a contention-based protocol to avoid co-channel interference with incumbent devices sharing the band. To ensure incumbent co-channel operations are detected in a technology-agnostic manner, unlicensed devices are required to detect co-channel radio frequency energy (energy detect) and avoid simultaneous transmission.

Unlicensed indoor low-power devices must detect co-channel radio frequency power that is at least -62 dBm or lower. Upon detection of energy in the band, unlicensed low power indoor devices must vacate the channel and stay off the channel if detected radio frequency power is equal to or greater than the threshold (-62 dBm). The -62 dBm (or lower) threshold is referenced to a 0 dBi antenna gain.

To ensure incumbent operations are reliably detected in the band, low power indoor devices must detect RF energy throughout their intended operating channel.

Test Procedure Used

KDB 987594 D02 v01r01

Test Settings

1. Configure the EUT to transmit with a constant duty cycle.
2. Set the operating parameters of the EUT including power level, operating frequency, modulation, and bandwidth.
3. Set the signal analyzer center frequency to the nominal EUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT. Connect the output port of the EUT to the signal analyzer 2. Ensure that the attenuator 2 provides enough attenuation to not overload the signal analyzer 2 receiver.
4. Monitoring the signal analyzer 2, verify the EUT is operating and transmitting with the parameters set at step two.
5. Using an AWGN signal source, generate (but do not transmit, i.e., RF OFF) a 10 MHz-wide AWGN signal. Use Table 1 to determine the center frequency of the 10 MHz AWGN signal relative to the EUT's channel bandwidth and center frequency.
6. Set the AWGN signal power to an extremely low level (more than 20 dB below the -62 dBm threshold). Connect the AWGN signal source, via a 3-dB splitter, to the signal analyzer 1 and the EUT as shown in Figure 2.
7. Transmit the AWGN signal (RF ON) and verify its characteristics on the signal analyzer 1.
8. Monitor the signal analyzer 2 to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.
9. (Including all losses in the RF paths) Determine and record the AWGN signal power level (at the EUT's antenna port) at which the EUT ceased transmission. Repeat the procedure at least 10 times to verify the EUT can detect an AWGN signal with 90% (or better) level of certainty.
10. Refer to Table 1 of KDB 987594 D02 v01r01 to determine the number of times the detection threshold testing needs to be repeated. If testing is required more than once, then go back to step 5, choose a different center frequency for the AWGN signal, and repeat the process.

Test Setup

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

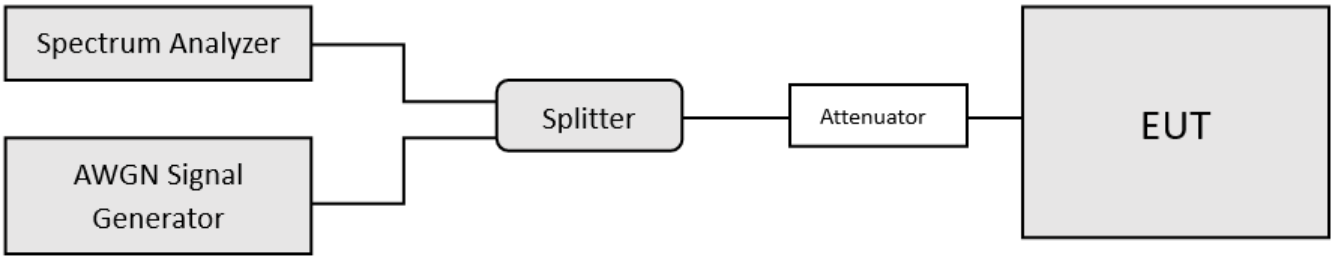


Figure 7-5. Contention-based protocol test setup conducted method.

Test Notes

1. Per guidance from KDB 987594 D02 v01r01, contention-based protocol was tested using an AWGN signal with a bandwidth of 10MHz. The amplitude of the signal was increased until detected by the EUT, signaled by the ceasing of transmission, M1 indicates the point at which the AWGN signal is introduced. D1 indicates where the AWGN signal is terminated, at least 10 seconds following M1.
2. 15 trials were run to assure that at least 90% of certainty was met.
3. Per Guidance from KDB 987594 D04 v01, contention-based protocol was tested with receiver with the lowest antenna gain.
4. All CBP Timing Plots shown are for the ceased condition. Some spikes that may be shown are from adjacent portions of the spectrum that are still transmitting.
5. Only one AWGN plot is shown in this section as a representative plot for the AWGN signal used to execute the Contention Based Protocol testing per KDB 987594 D02.

Detection Level = Injected AWGN Power (dBm) – Antenna Gain (dBi) + Path Loss (dB)

Equation 7-1. Detection Level Calculation

Band	Channel	Channel Freq [MHz]	Channel BW [MHz]	Incumbent Freq [MHz]	Injected (AWGN) [dBm]	Antenna Gain [dBi]	Adjusted Power Level [dBm]	Detection Limit [dBm]	Margin [dB]
UNII Band 5	53	6215	20	6215	-78.50	-10.95	-67.55	-62.0	-5.55
	47	6185	160	6110	-88.95	-10.95	-78.00	-62.0	-16.00
				6185	-84.24	-10.95	-73.29	-62.0	-11.29
				6260	-87.33	-10.95	-76.38	-62.0	-14.38
UNII Band 6	101	6455	20	6455	-78.87	-10.77	-68.10	-62.0	-6.10
	111	6505	160	6430	-84.24	-10.77	-73.47	-62.0	-11.47
				6505	-79.59	-10.77	-68.82	-62.0	-6.82
				6580	-84.27	-10.77	-73.50	-62.0	-11.50
UNII Band 7	149	6695	20	6695	-78.49	-10.77	-67.72	-62.0	-5.72
	175	6825	160	6750	-83.76	-10.77	-72.99	-62.0	-10.99
				6825	-80.71	-10.77	-69.94	-62.0	-7.94
				6900	-82.03	-10.77	-71.26	-62.0	-9.26
UNII Band 8	197	6935	20	6935	-76.65	-10.74	-65.91	-62.0	-3.91
	207	6985	160	6910	-82.33	-10.74	-71.59	-62.0	-9.59
				6985	-79.11	-10.74	-68.37	-62.0	-6.37
				7060	-83.53	-10.74	-72.79	-62.0	-10.79

Table 7-10. Contention Based Protocol – Incumbent Detection Results

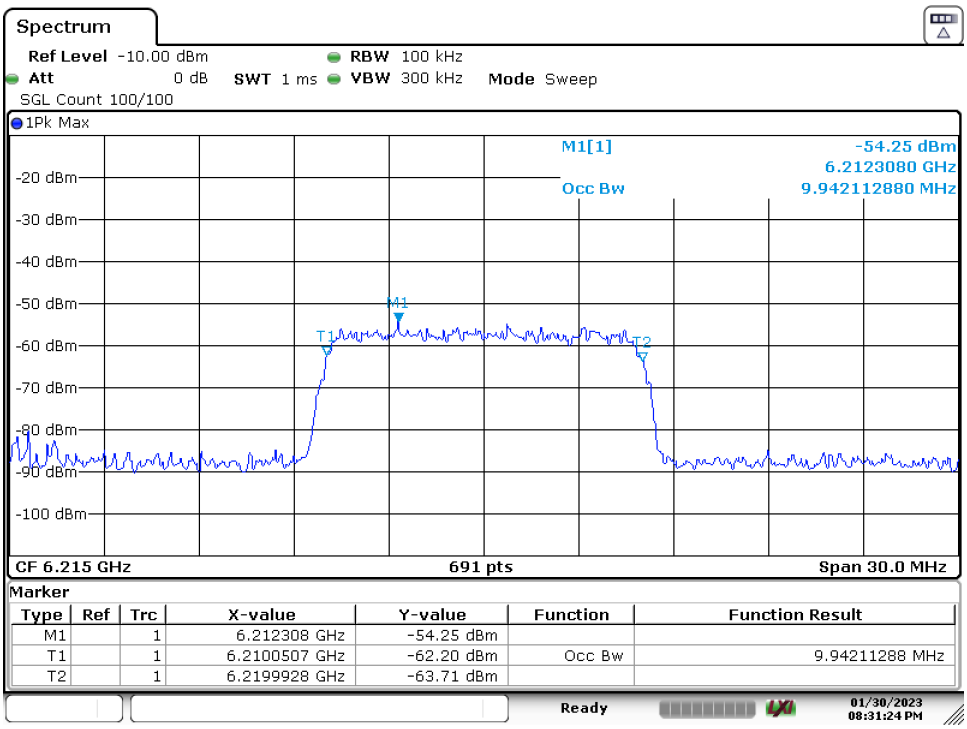
Band	Channel	Channel Freq [MHz]	Channel BW [MHz]	Incumbent Freq [MHz]	Antenna Gain [dBi]	EUT Transmission Status Adjusted AWGN Power (dBm)			Detection Limit [dBm]	Margin [dB]
						Normal	Minimal	Ceased		
UNII Band 5	53	6215	20	6215	-10.95	-71.35	-68.65	-67.55	-62.0	-5.55
	47	6185	160	6110	-10.95	-81.80	-79.10	-78.00	-62.0	-16.00
				6185	-10.95	-77.09	-74.39	-73.29	-62.0	-11.29
				6260	-10.95	-80.18	-77.48	-76.38	-62.0	-14.38
UNII Band 6	101	6455	20	6455	-10.77	-71.90	-69.20	-68.10	-62.0	-6.10
	111	6505	160	6430	-10.77	-77.27	-74.57	-73.47	-62.0	-11.47
				6505	-10.77	-72.62	-69.92	-68.82	-62.0	-6.82
				6580	-10.77	-77.30	-74.60	-73.50	-62.0	-11.50
UNII Band 7	149	6695	20	6695	-10.77	-71.52	-68.82	-67.72	-62.0	-5.72
	175	6825	160	6750	-10.77	-76.79	-74.09	-72.99	-62.0	-10.99
				6825	-10.77	-73.74	-71.04	-69.94	-62.0	-7.94
				6900	-10.77	-75.06	-72.36	-71.26	-62.0	-9.26
UNII Band 8	197	6935	20	6935	-10.74	-69.71	-67.01	-65.91	-62.0	-3.91
	207	6985	160	6910	-10.74	-75.39	-72.69	-71.59	-62.0	-9.59
				6985	-10.74	-72.17	-69.47	-68.37	-62.0	-6.37
				7060	-10.74	-76.59	-73.89	-72.79	-62.0	-10.79

Table 7-11. Contention Based Protocol – Detection Results – All Tx Cases

Band	Channel	Channel Freq [MHz]	Channel BW [MHz]	Incumbent Freq [MHz]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Detection Rate (%)
UNII Band 5	53	6215	20	6215	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	47	6185	160	6110	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6185	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6260	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
UNII Band 6	101	6455	20	6455	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	111	6505	160	6430	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6505	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6580	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
UNII Band 7	149	6695	20	6695	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	175	6825	160	6750	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6825	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6900	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
UNII Band 8	197	6935	20	6935	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	207	6985	160	6910	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				6985	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				7060	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100

Table 7-12. Contention Based Protocol – Incumbent Detection Trial Results

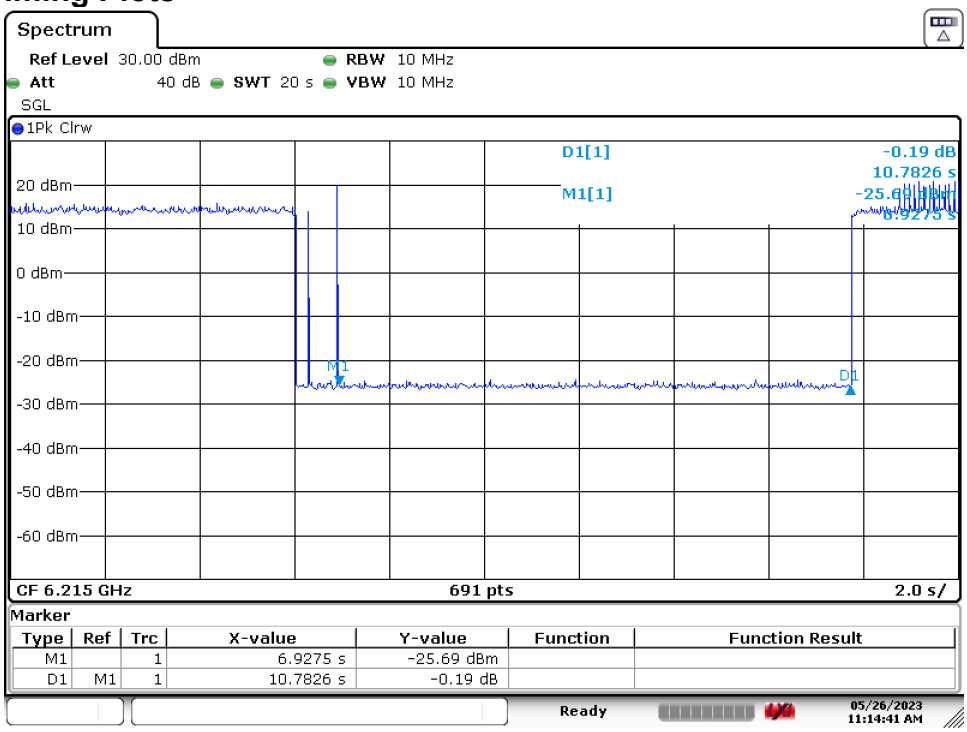
7.6.1 AWGN



Date: 30.JAN.2023 20:31:24

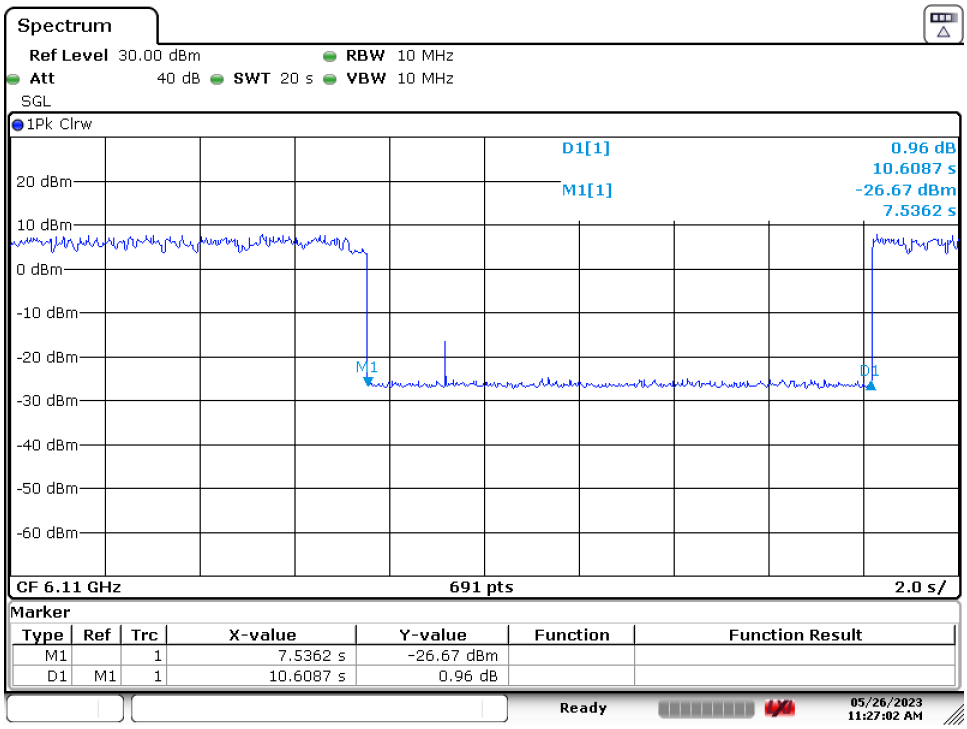
Plot 7-100. AWGN Signal (Demonstration)

7.6.2 CBP Timing Plots



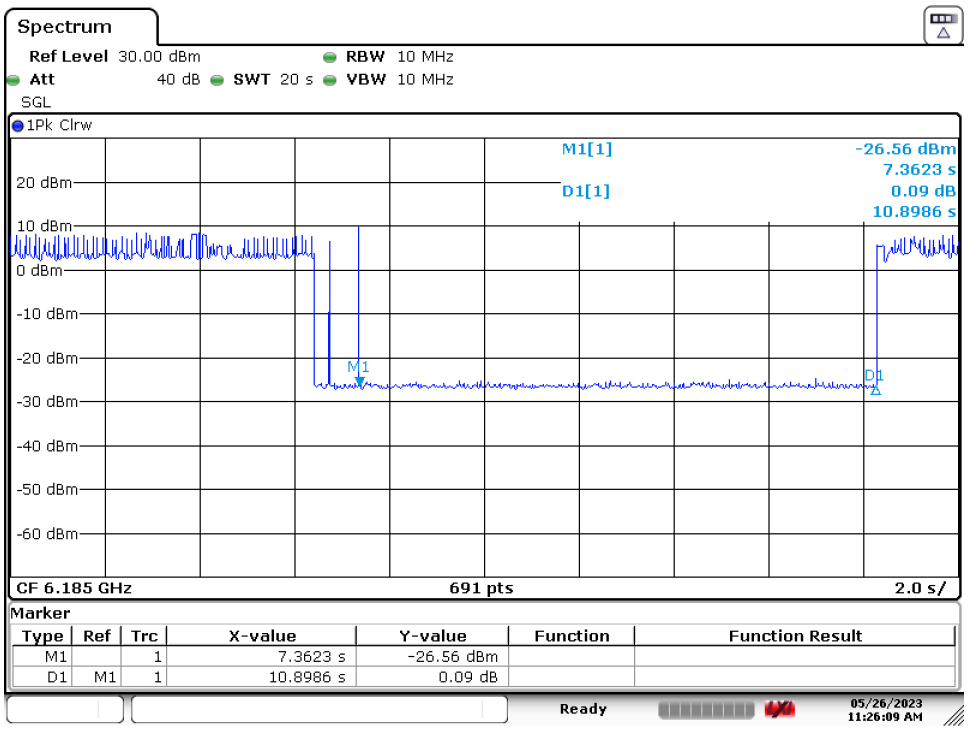
Date: 26.MAY.2023 11:14:41

Plot 7-101. Contention Based Protocol Timing Plot (20MHz (UNII Band 5) – Ch. 53)



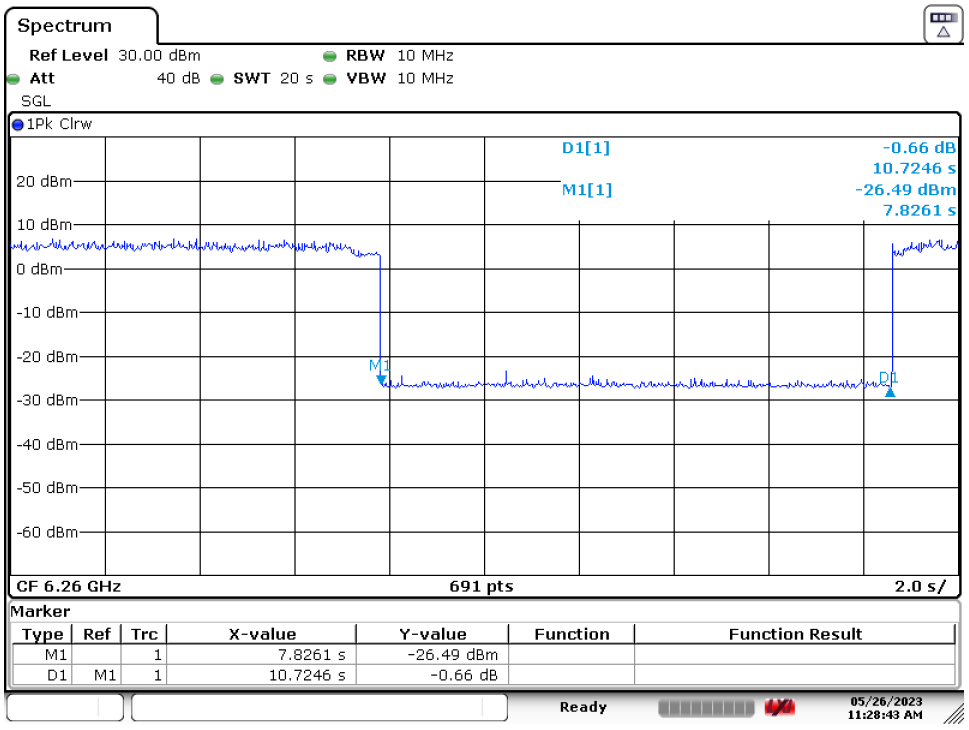
Date: 26.MAY.2023 11:27:02

Plot 7-102. Contention Based Protocol Timing Plot (160MHz (UNII Band 5) – Ch. 47 Low)



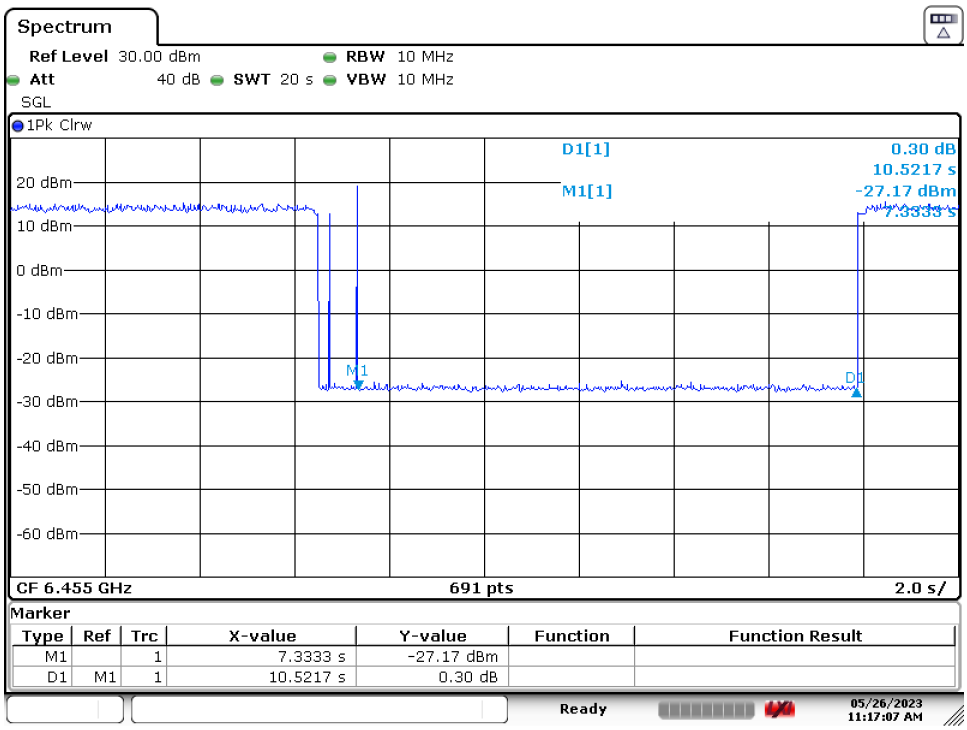
Date: 26.MAY.2023 11:26:10

Plot 7-103. Contention Based Protocol Timing Plot (160MHz (UNII Band 5) – Ch. 47 Mid)



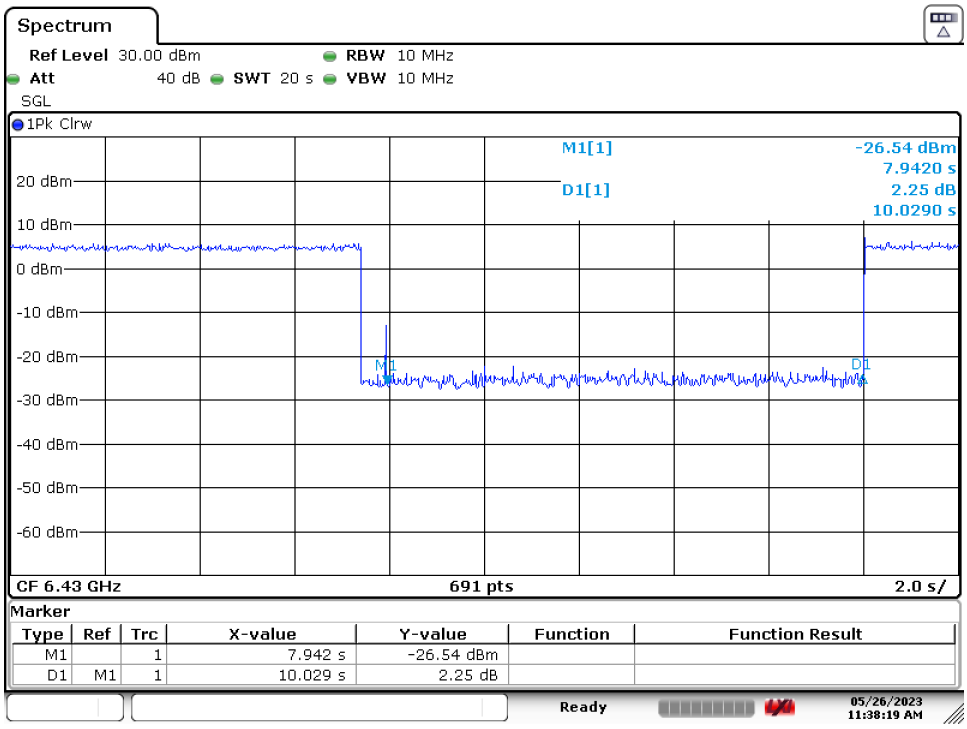
Date: 26.MAY.2023 11:28:43

Plot 7-104. Contention Based Protocol Timing Plot (160MHz (UNII Band 5) – Ch. 47 High)



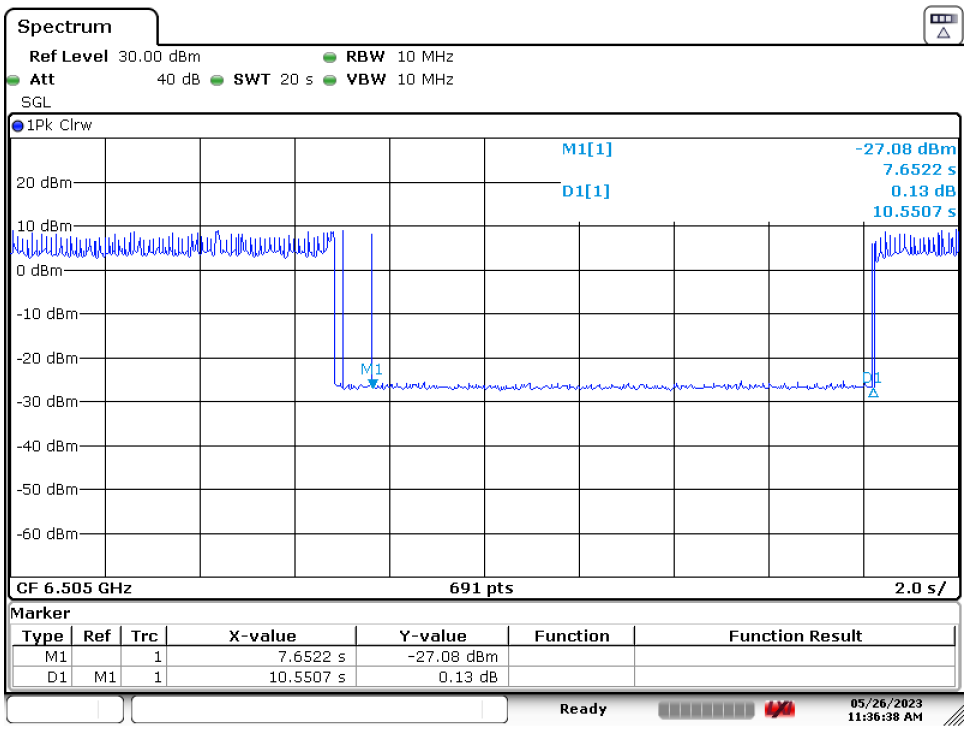
Date: 26.MAY.2023 11:17:07

Plot 7-105. Contention Based Protocol Timing Plot (20MHz (UNII Band 6) – Ch. 101)



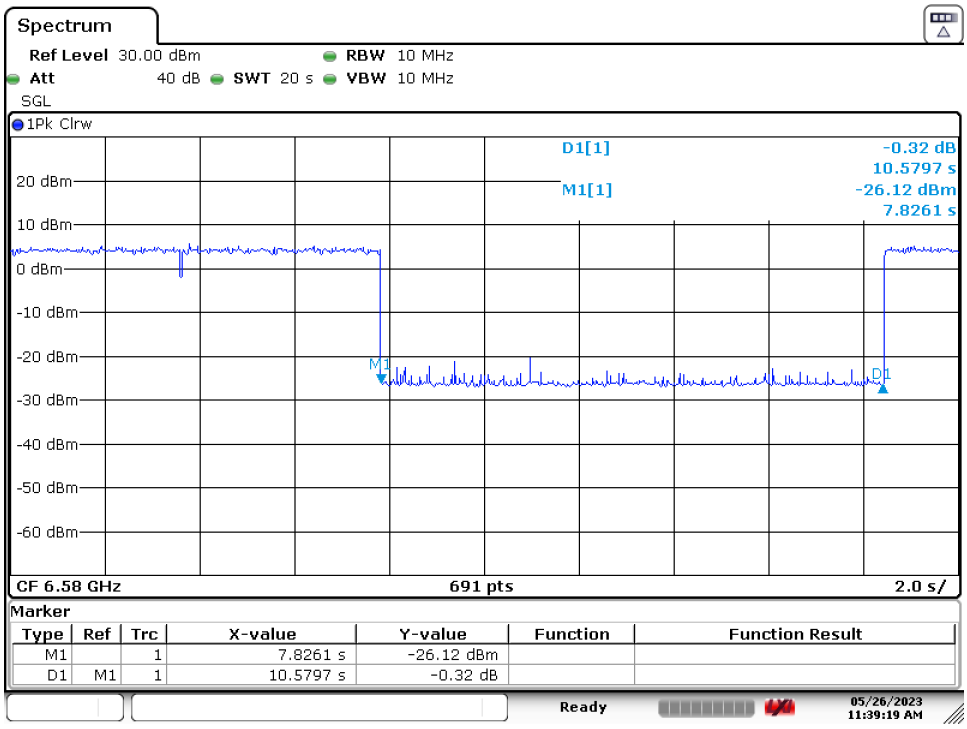
Date: 26.MAY.2023 11:38:19

Plot 7-106. Contention Based Protocol Timing Plot (160MHz (UNII Band 6) – Ch. 111 Low)



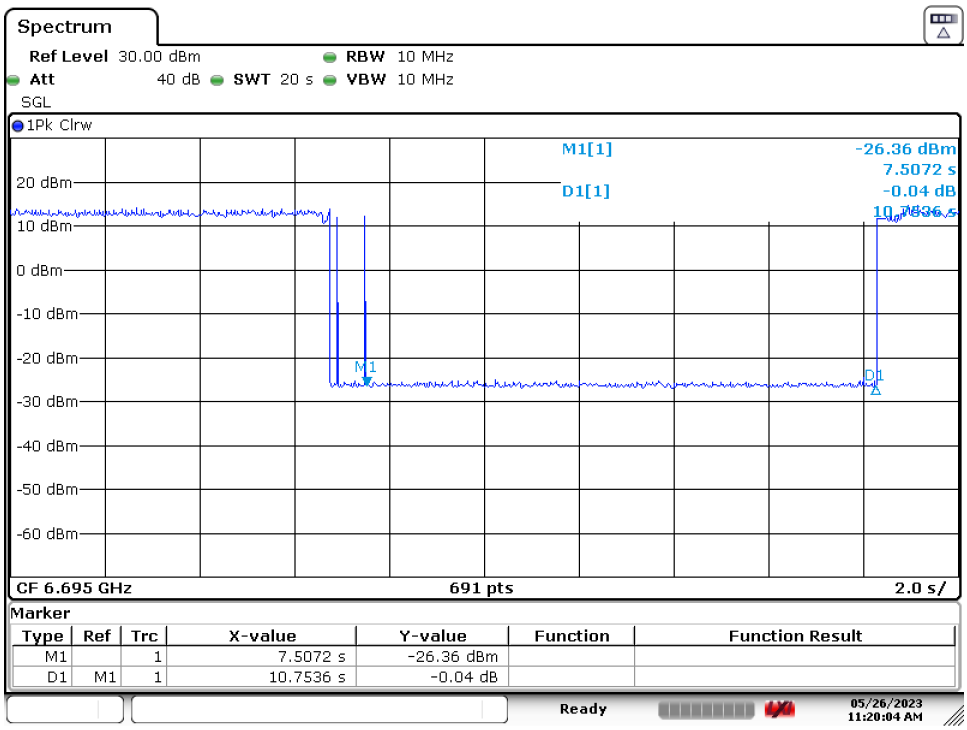
Date: 26.MAY.2023 11:36:38

Plot 7-107. Contention Based Protocol Timing Plot (160MHz (UNII Band 6) – Ch. 111 Mid)



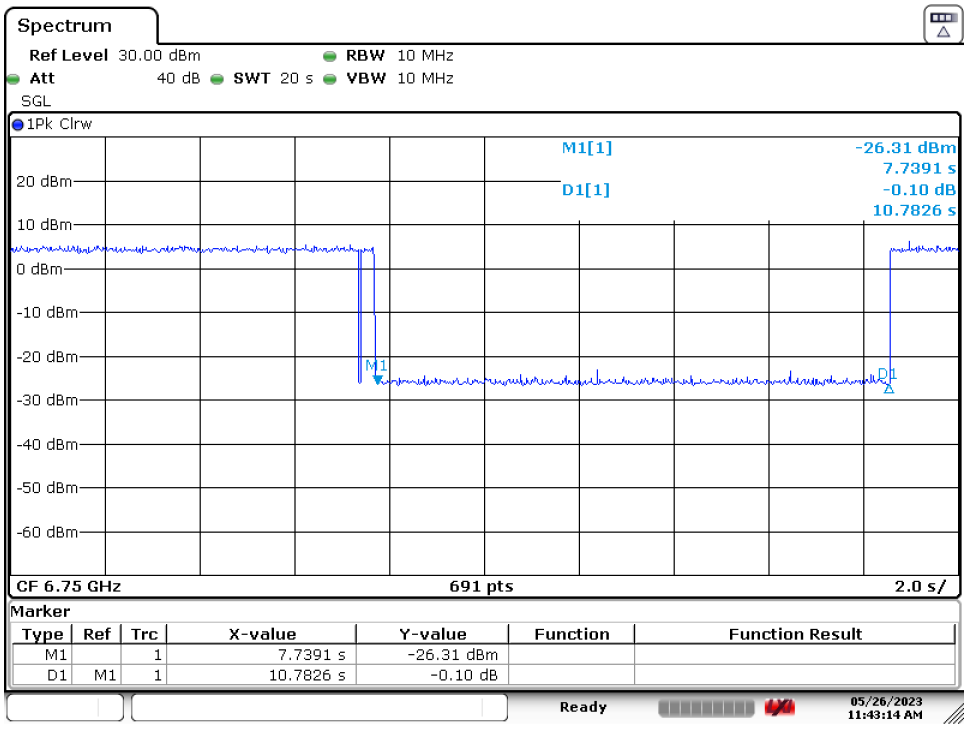
Date: 26.MAY.2023 11:39:19

Plot 7-108. Contention Based Protocol Timing Plot (160MHz (UNII Band 6) – Ch. 111 High)



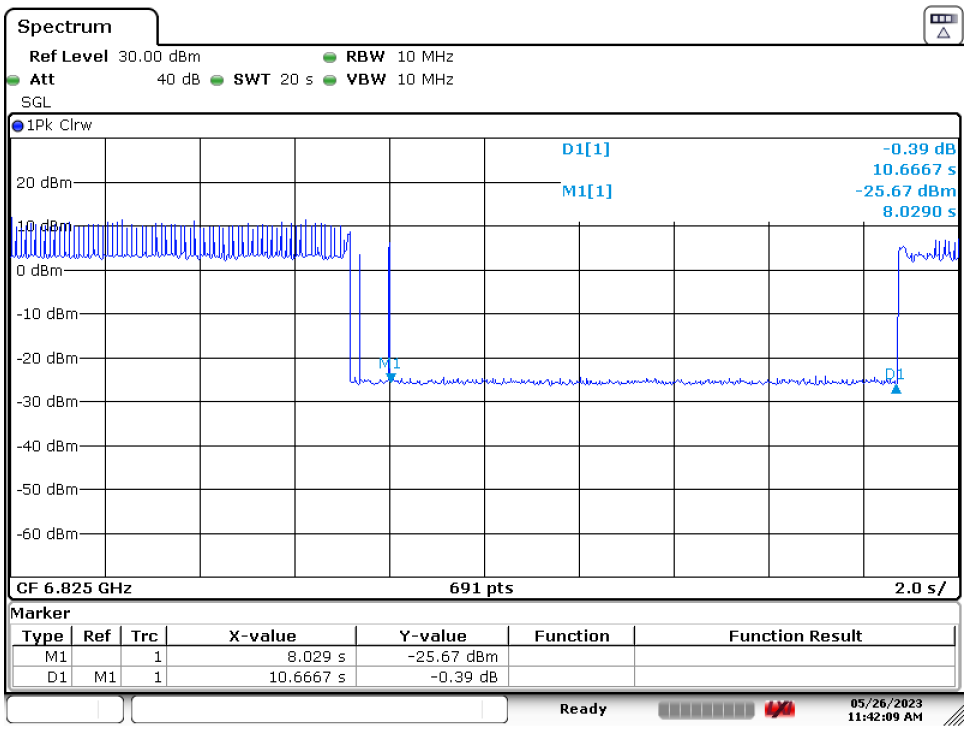
Date: 26.MAY.2023 11:20:04

Plot 7-109. Contention Based Protocol Timing Plot (20MHz (UNII Band 7) – Ch. 149)



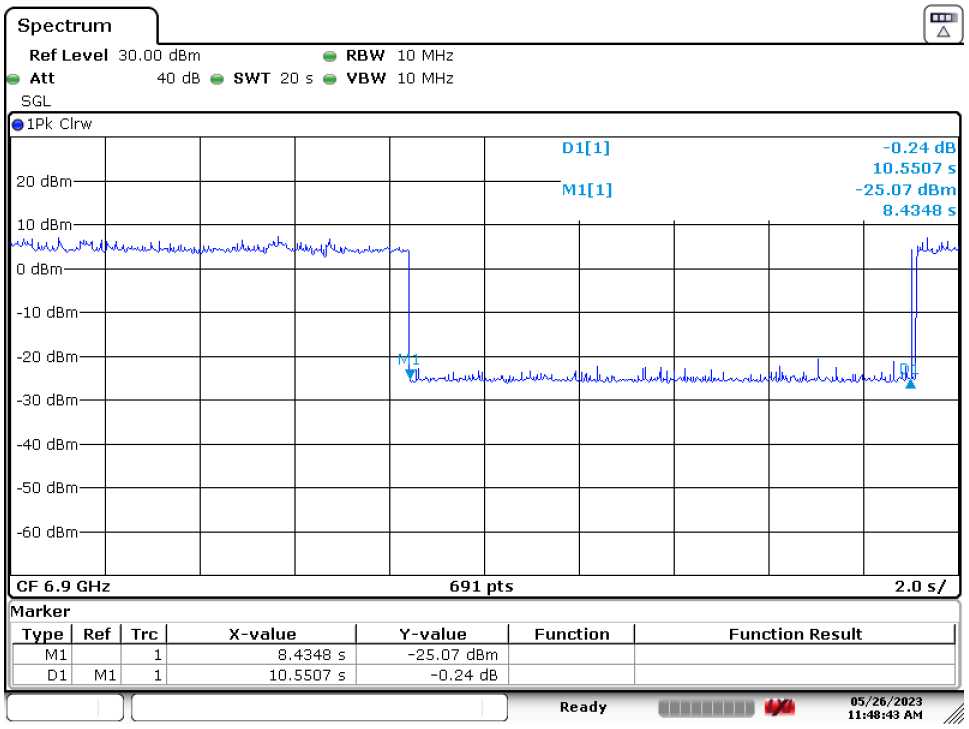
Date: 26.MAY.2023 11:43:14

Plot 7-110. Contention Based Protocol Timing Plot (160MHz (UNII Band 7) – Ch. 175 Low)



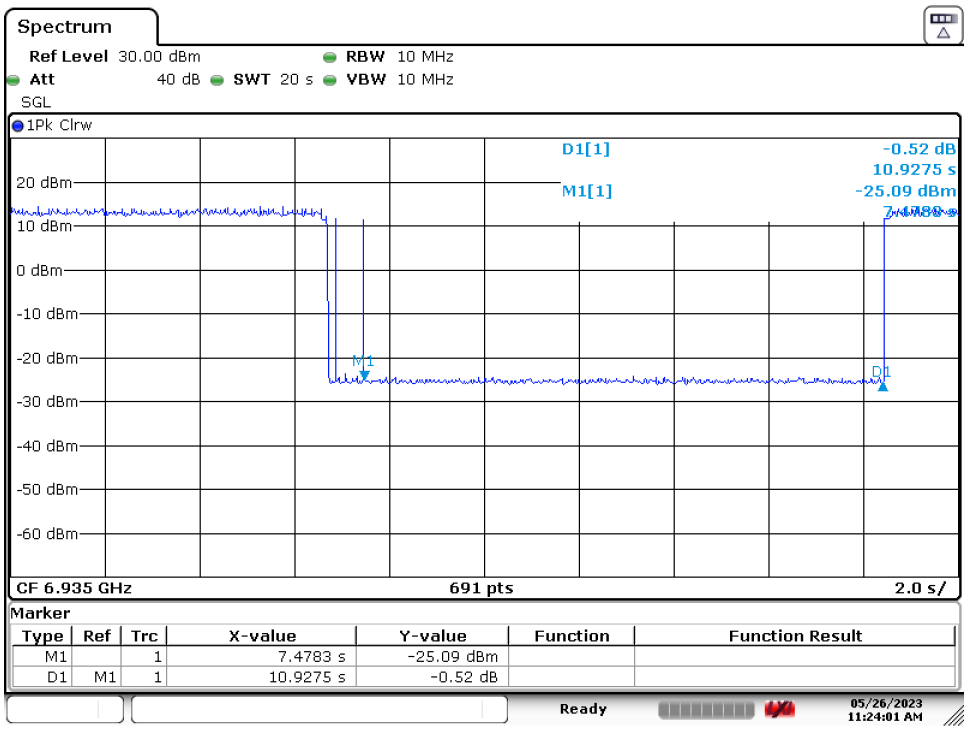
Date: 26.MAY.2023 11:42:09

Plot 7-111. Contention Based Protocol Timing Plot (160MHz (UNII Band 7) – Ch. 175 Mid)



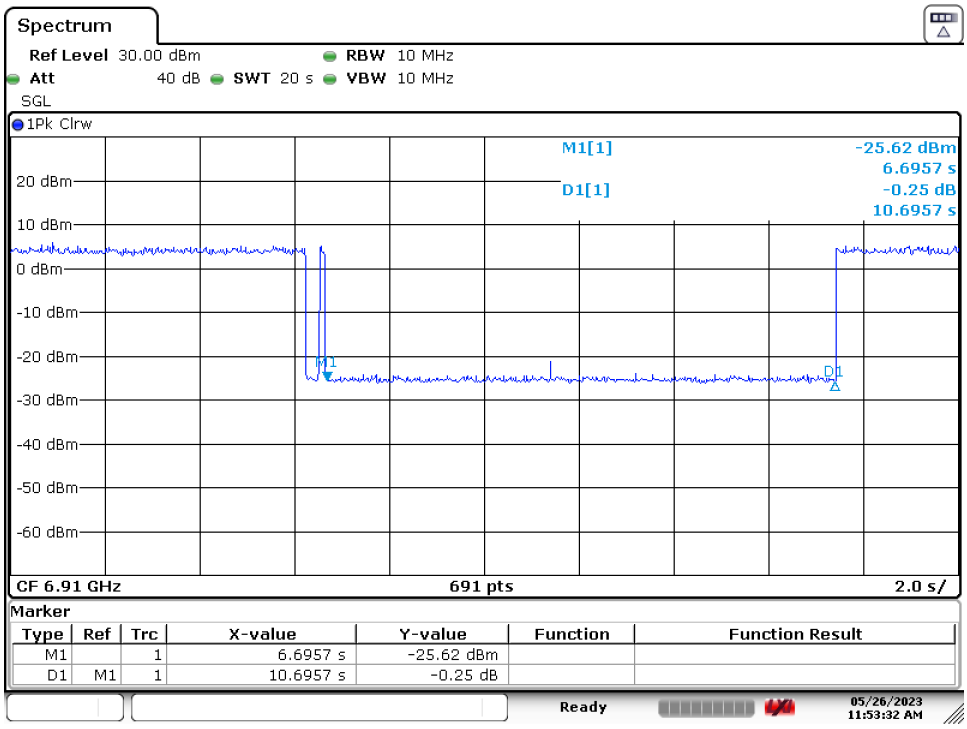
Date: 26.MAY.2023 11:48:43

Plot 7-112. Contention Based Protocol Timing Plot (160MHz (UNII Band 7) – Ch. 175 High)



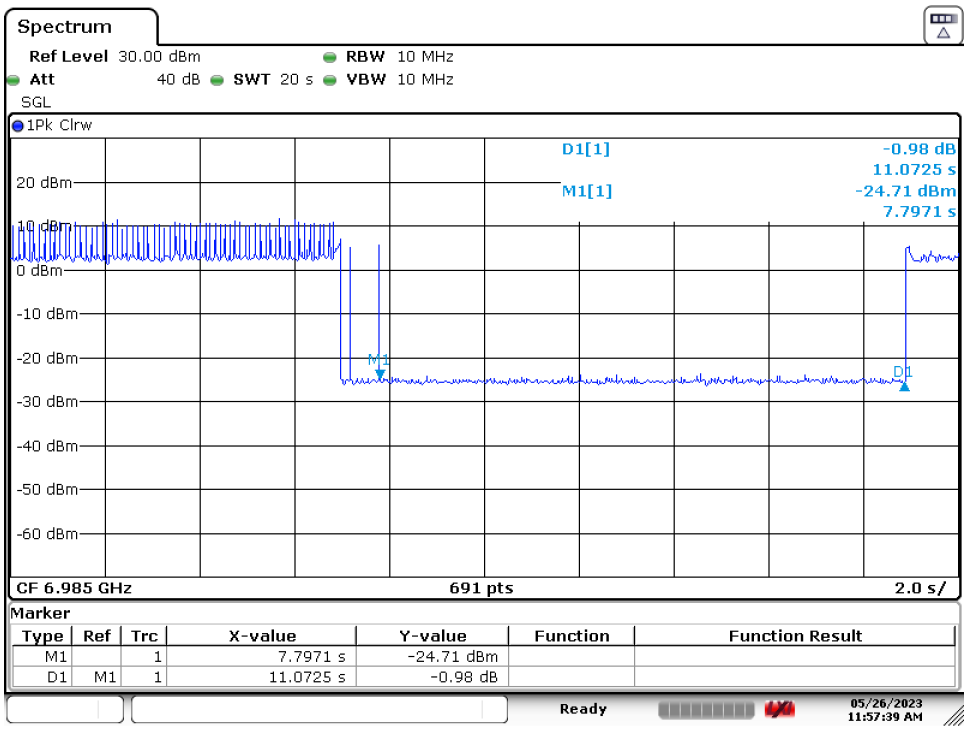
Date: 26.MAY.2023 11:24:01

Plot 7-113. Contention Based Protocol Timing Plot (20MHz (UNII Band 8) – Ch. 197)



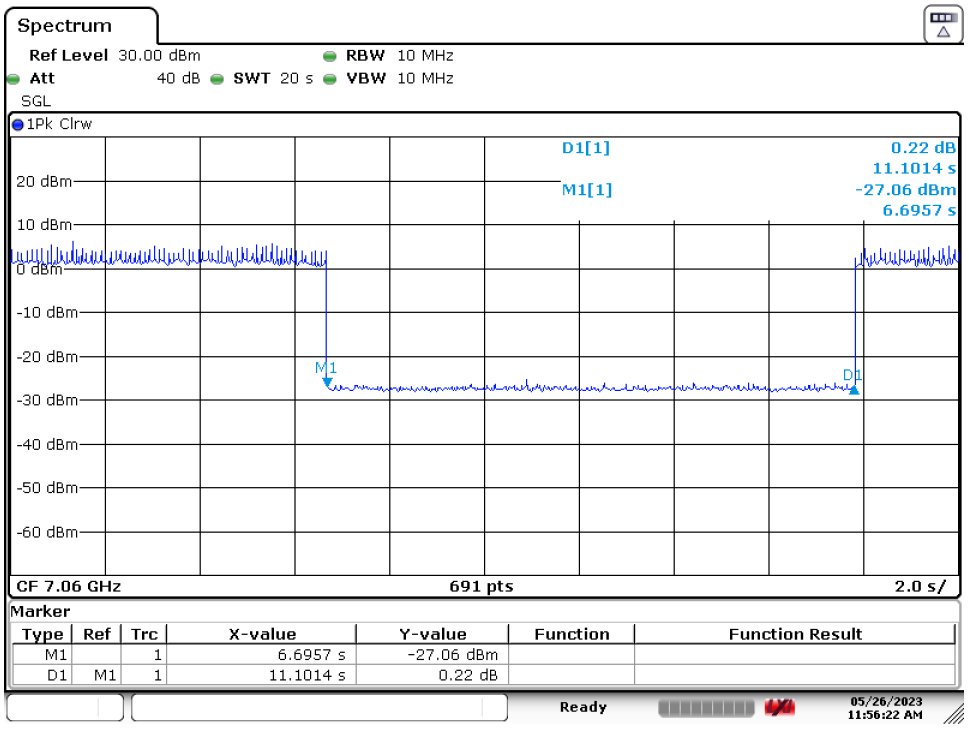
Date: 26.MAY.2023 11:53:32

Plot 7-114. Contention Based Protocol Timing Plot (160MHz (UNII Band 8) – Ch. 207 Low)



Date: 26.MAY.2023 11:57:39

Plot 7-115. Contention Based Protocol Timing Plot (160MHz (UNII Band 8) – Ch. 207 Mid)



Date: 26.MAY.2023 11:56:22

Plot 7-116. Contention Based Protocol Timing Plot (160MHz (UNII Band 8) – Ch. 207 High)

7.7 Radiated Emission Measurements

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 C63.10-2013, and at the appropriate frequencies. All channels, modes (e.g. 802.11a, 802.11ax (20/40/80/160MHz), and modulations/data rates were investigated among all UNII bands. Only the radiated emissions of the configuration that produced the worst-case emissions are reported in this section.

For transmitters operating in the 5.925-7.125 GHz band: All emissions outside of the 5.925-7.125 GHz band shall not exceed an EIRP of -27dBm/MHz (68.2dBuV/m at a 3m distance). Emissions found in a restricted band are subject to the limits of 15.209 as shown in the table below.

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 7-13. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Sections 12.7.7.2, 12.7.6, 12.7.5

Test Settings – Above 1GHz

Average Field Strength Measurements (Method AD – Average Detection)

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. Sweep time = auto
7. Trace (RMS) averaging was performed over at least 100 traces.

Peak Field Strength Measurements

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

Test Settings – Below 1GHz

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.

Test Setup

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

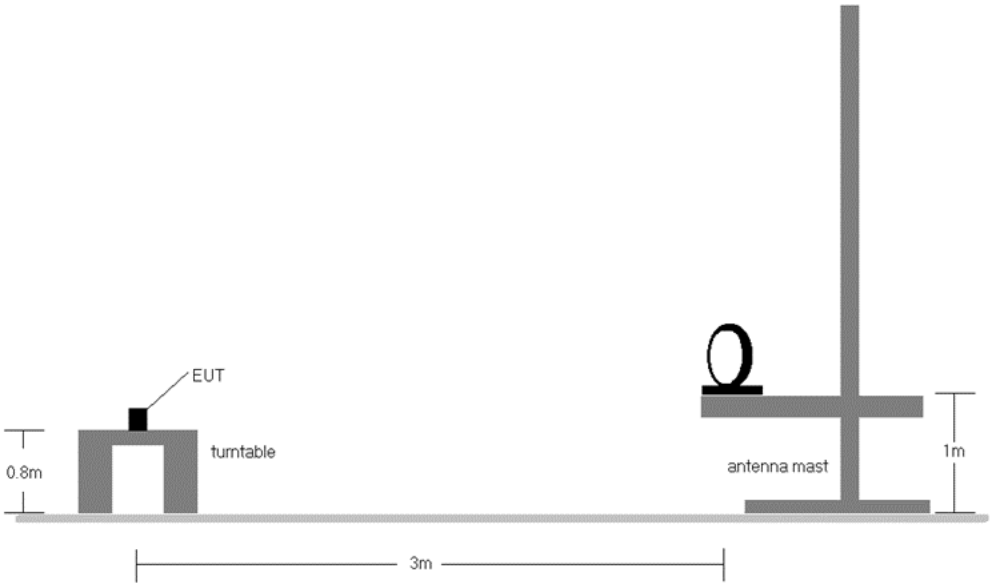


Figure 7-6. Radiated Test Setup < 30Mhz

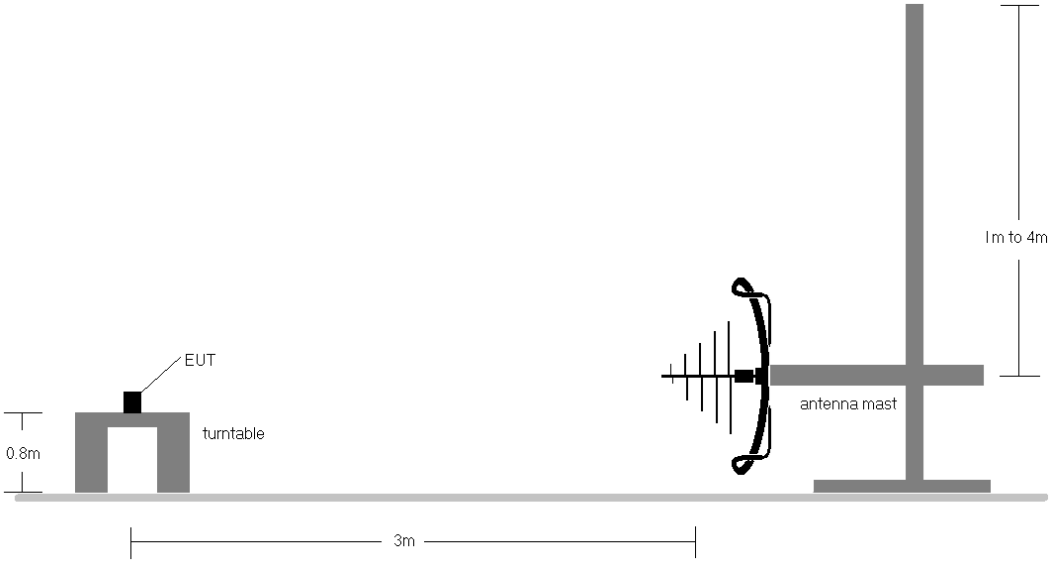


Figure 7-7. Radiated Test Setup < 1GHz

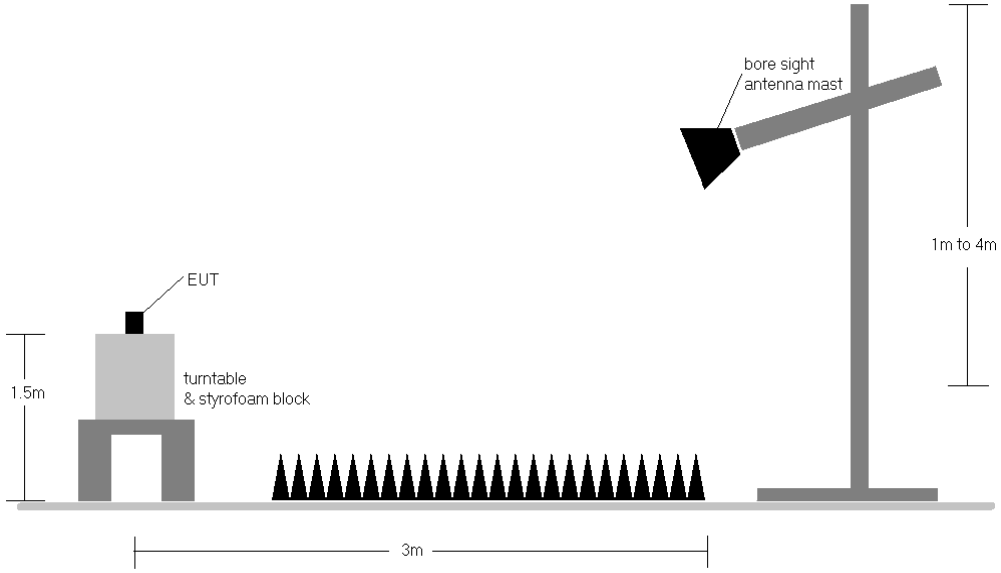


Figure 7-8. Radiated Test Setup > 1GHz

Test Notes

1. All spurious emissions lying in restricted bands specified in §15.205 are below the limits specified in §15.209. All spurious emissions that do not lie in a restricted band are subject to an average limit of -27dBm/MHz. At 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.
2. All spurious emissions that do not lie in a restricted band are subject to a peak limit not to exceed 20dB of the average limit [68.2dBμV/m]. If a peak measurement passes the average limit, it was determined no further investigation is necessary.
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. The worst-case emissions are reported, however emissions whose levels were not within 20dB of the respective limits were not reported.
6. Emissions below 18GHz were measured at a 3-meter test distance while emissions above 18GHz were measured at a 1-meter test distance with the application of a distance correction factor.
7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section. The "-" shown in the following RSE tables are used to denote a noise floor measurement.
8. In the case where a peak-detector measurement passed the given RMS limit it was determined sufficient to demonstrate compliance.
9. The results recorded using the broadband antenna are 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.

Sample Calculations

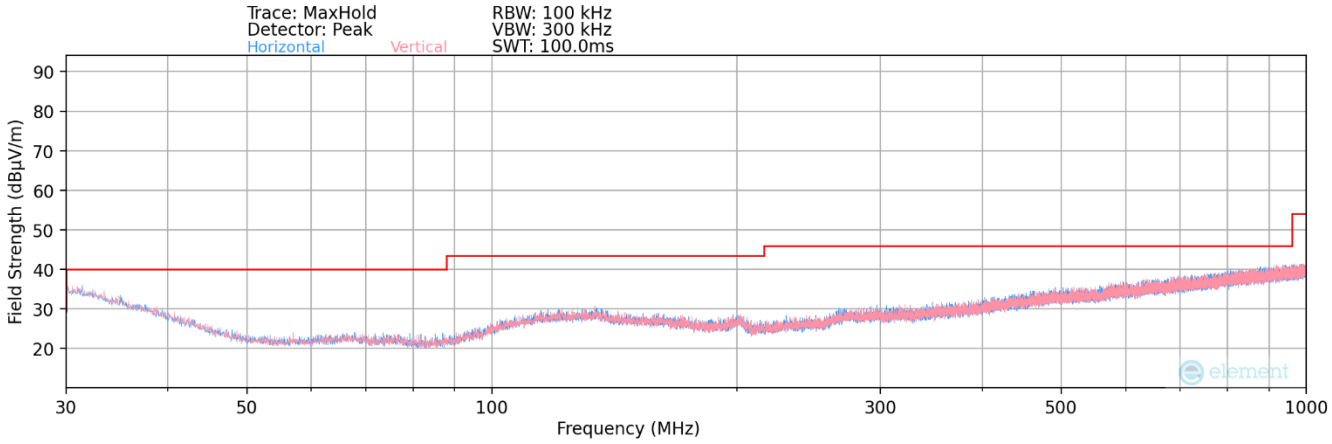
Determining Spurious Emissions Levels

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

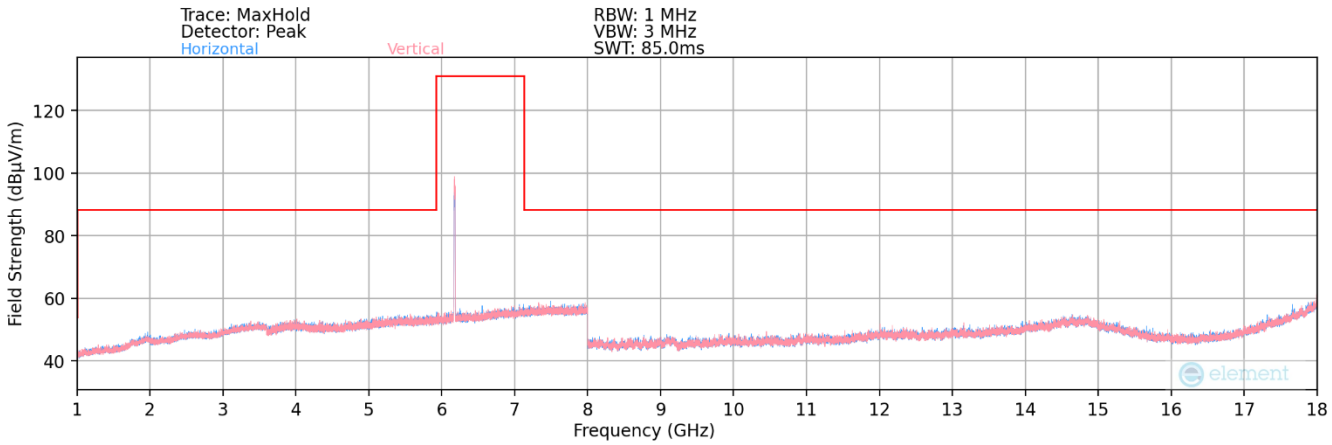
Radiated Band Edge Measurement Offset

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

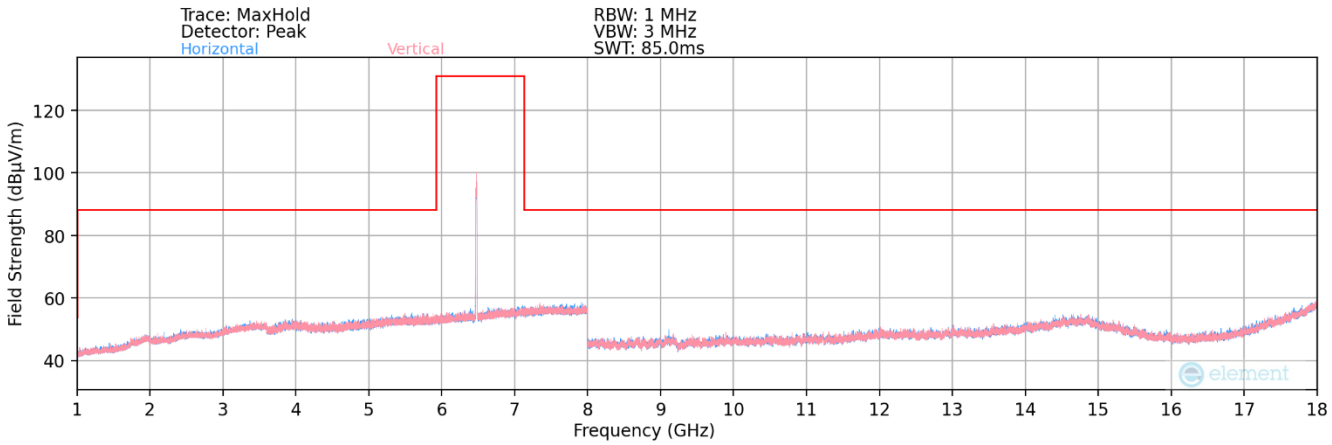
7.7.1 MIMO Radiated Spurious Emission Measurements



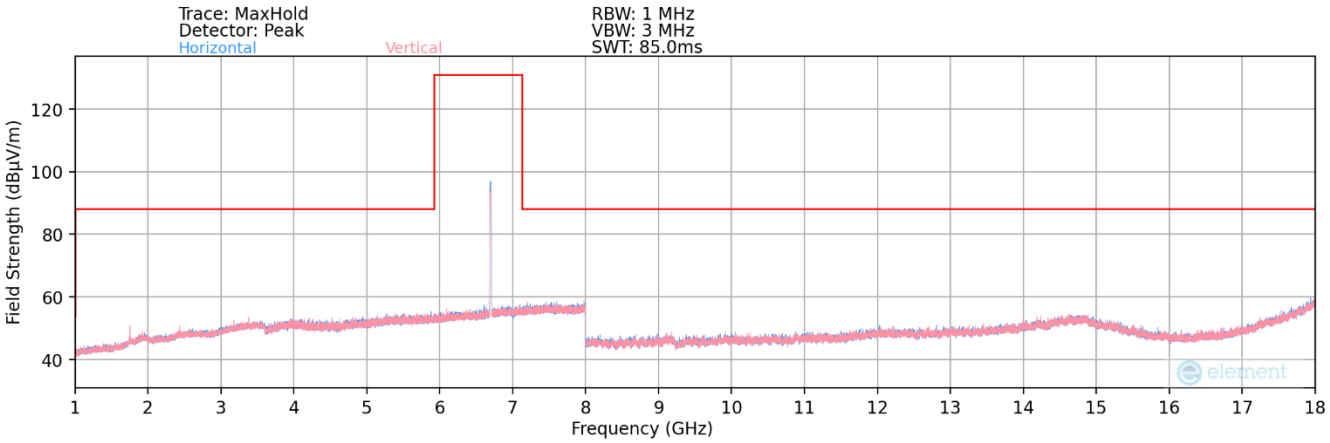
Plot 7-117. Radiated Spurious Plot below 1GHz MIMO (802.11ax) – Closed



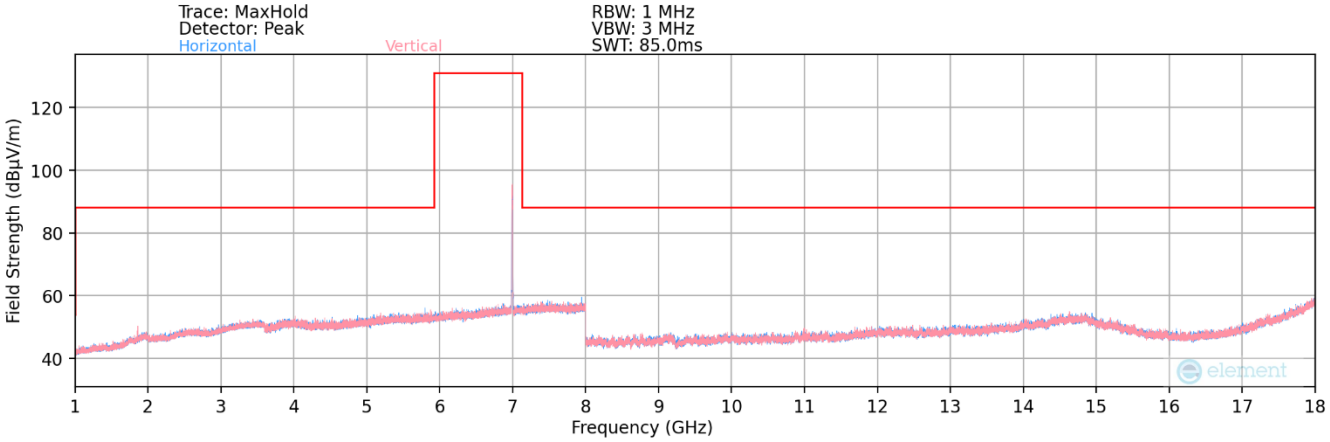
Plot 7-118. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 5 Ch. 45) – Closed



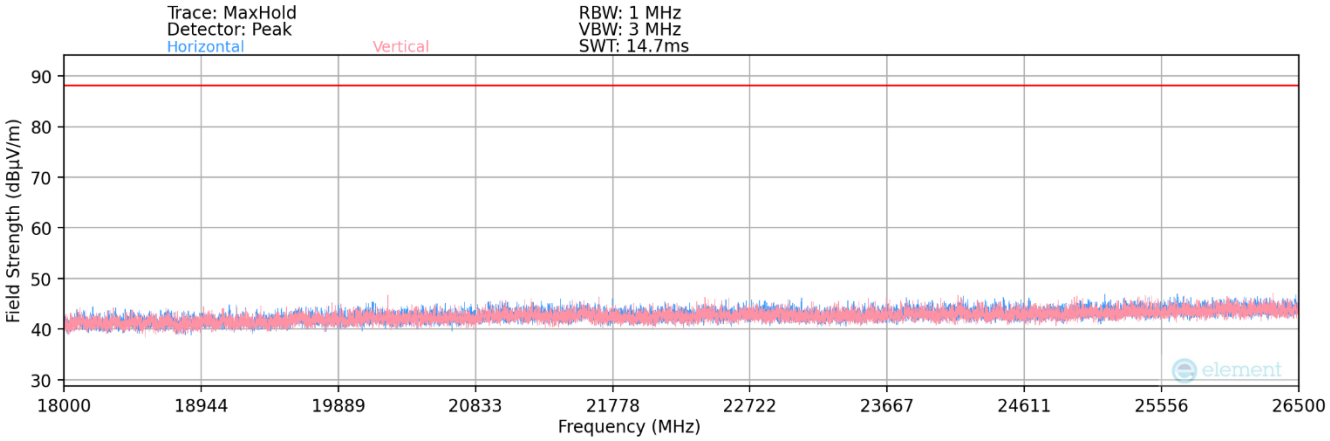
Plot 7-119. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 6 Ch. 105) – Closed



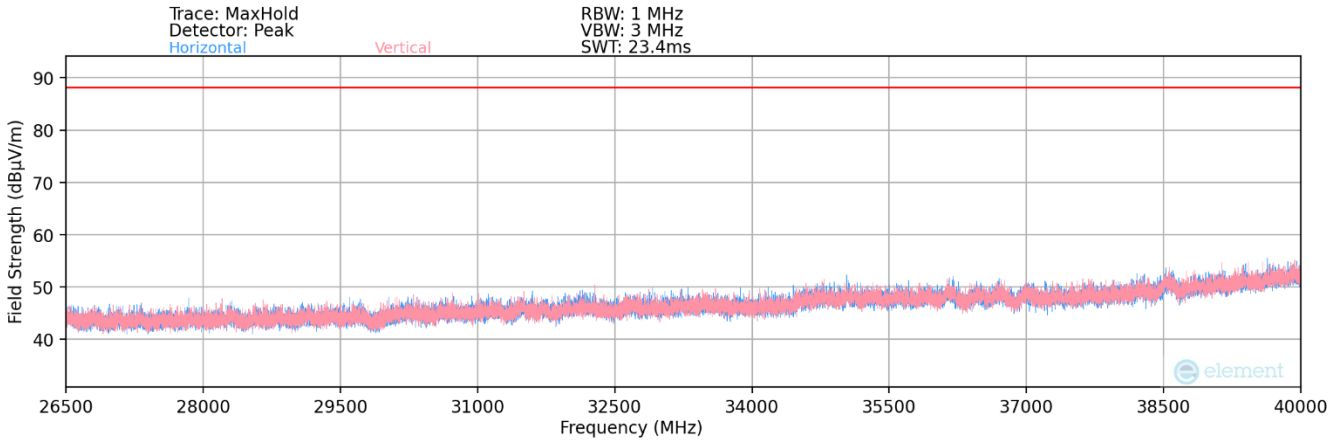
Plot 7-120. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 7 Ch. 149) – Closed



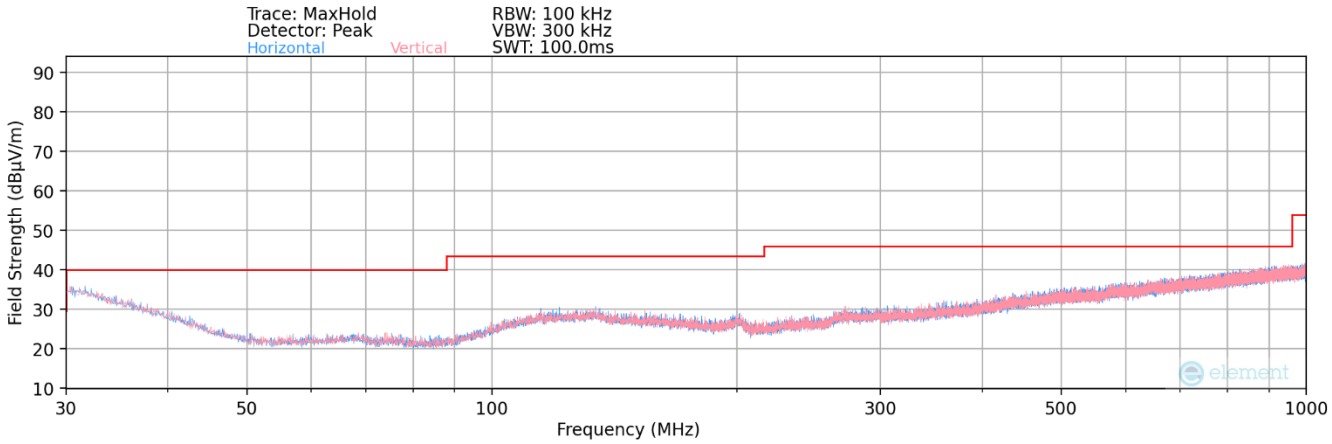
Plot 7-121. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – U Band 8 Ch. 209) – Closed



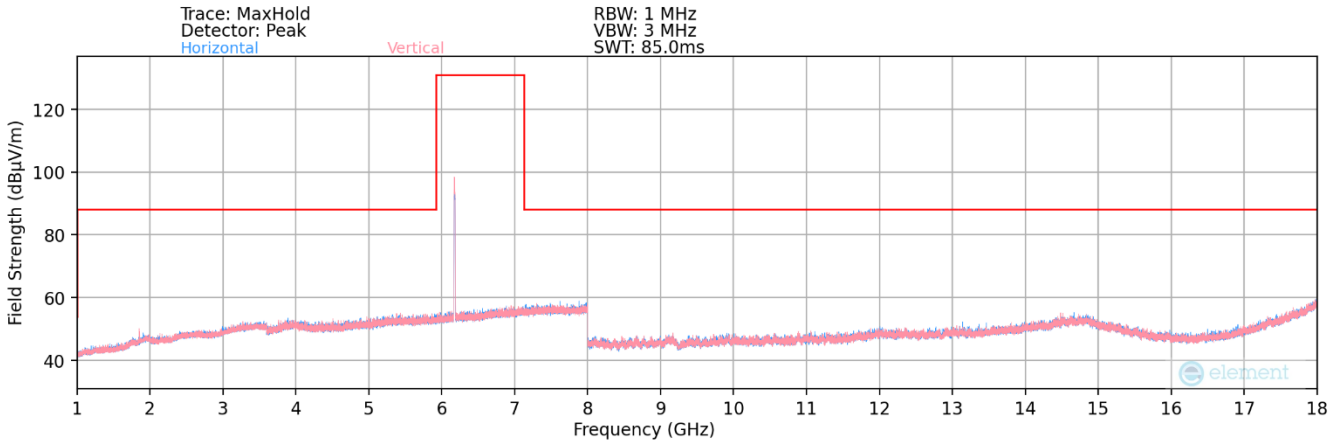
Plot 7-122. Radiated Spurious Plot 18GHz - 26.5GHz (802.11ax) – Closed



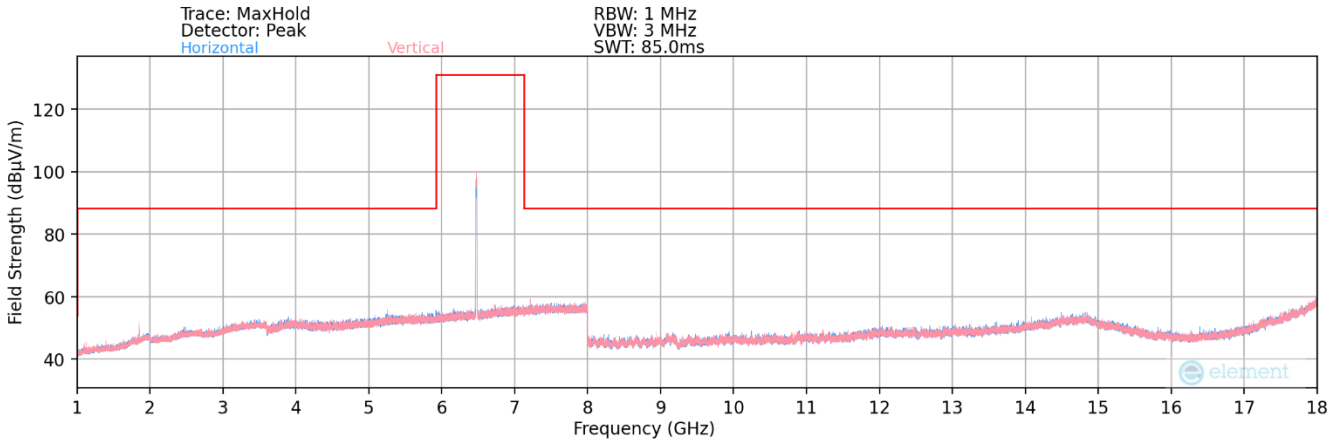
Plot 7-123. Radiated Spurious Plot 26.5GHz - 40GHz (802.11ax) – Closed



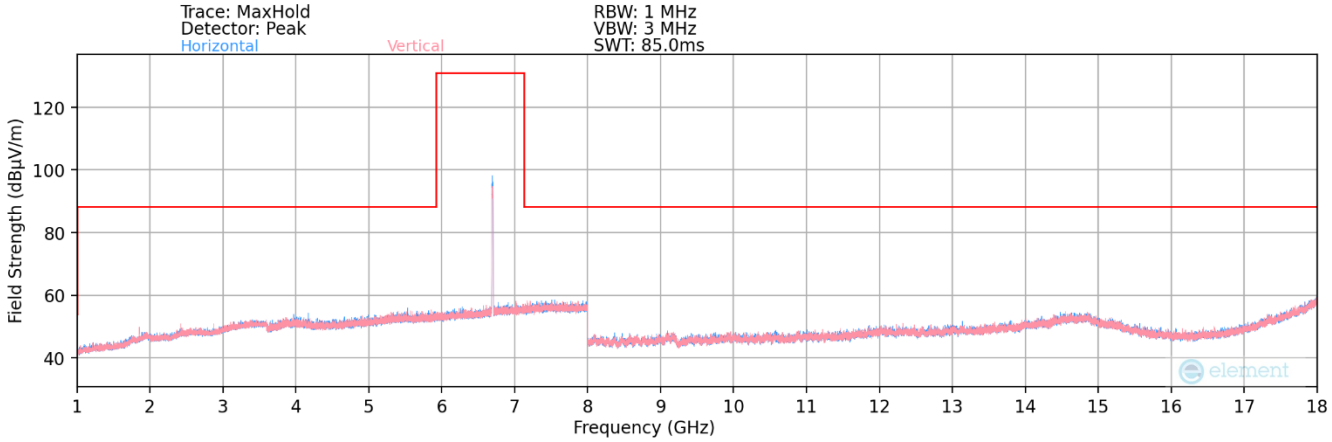
Plot 7-124. Radiated Spurious Plot below 1GHz MIMO (802.11ax) – Half Open



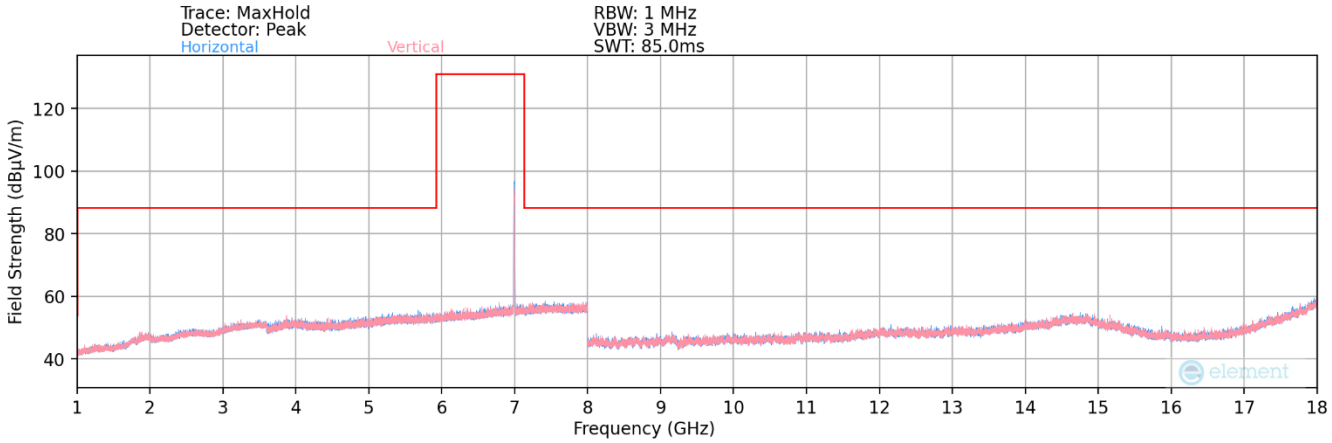
Plot 7-125. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 5 Ch. 45) – Half Open



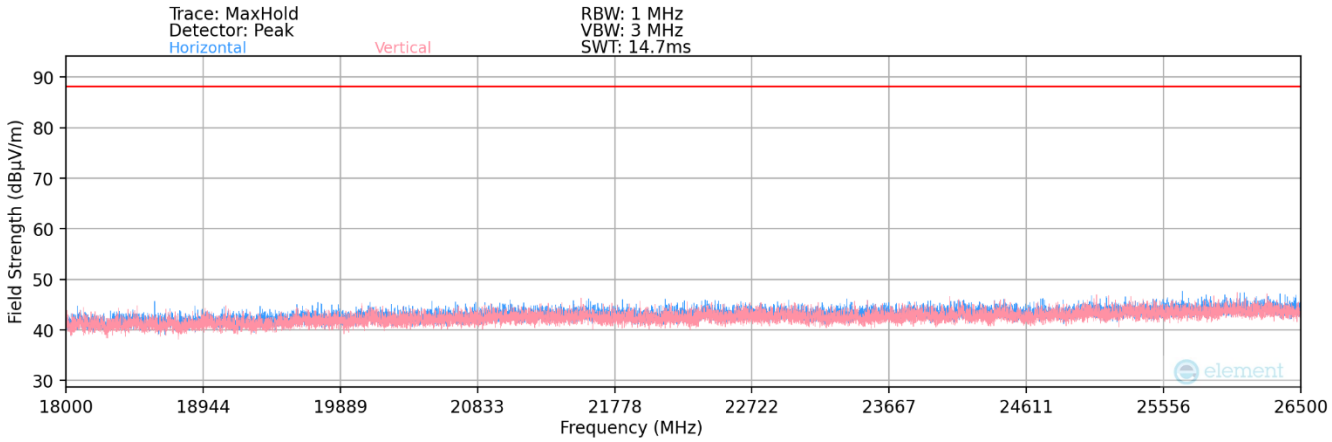
Plot 7-126. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 6 Ch. 105) – Half Open



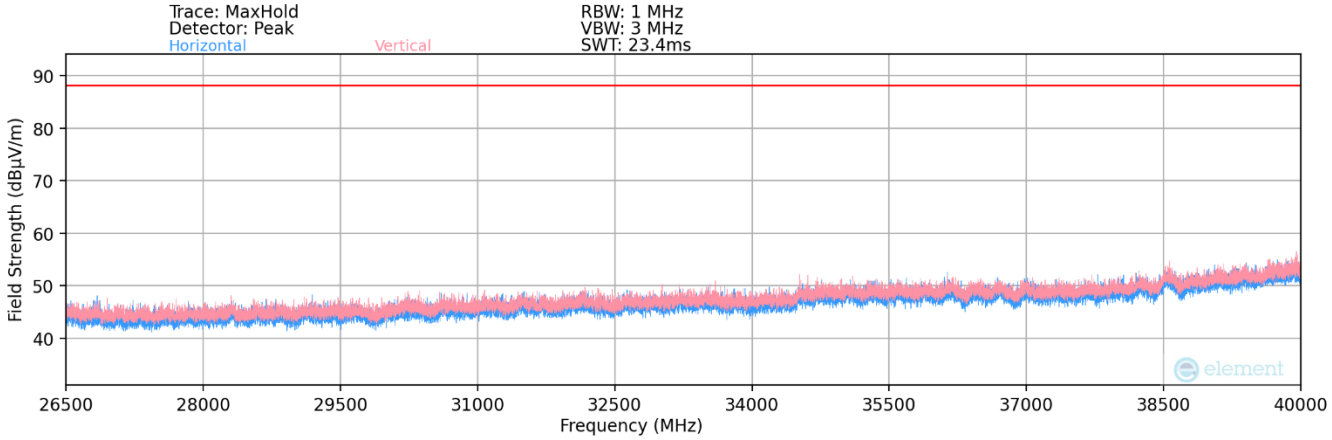
Plot 7-127. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 7 Ch. 149) – Half Open



Plot 7-128. Radiated Spurious Plot 1GHz – 18GHz MIMO (802.11ax – UNII Band 8 Ch. 209) – Half Open



Plot 7-129. Radiated Spurious Plot 18GHz - 26.5GHz (802.11ax) – Half Open



Plot 7-130. Radiated Spurious Plot 26.5GHz - 40GHz (802.11ax) – Half Open

MIMO Radiated Spurious Emission Measurements – UNII Band 5

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5935MHz
Channel:	2

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	11870.00	Average	H	-	-	-79.00	9.32	0.00	37.32	53.98	-16.66
*	11870.00	Peak	H	-	-	-66.93	9.32	0.00	49.39	73.98	-24.59
*	17805.00	Average	H	-	-	-77.61	15.72	0.00	45.11	53.98	-8.87
*	17805.00	Peak	H	-	-	-65.47	15.72	0.00	57.25	73.98	-16.73
*	23740.00	Average	H	-	-	-67.22	3.96	-9.54	34.20	53.98	-19.78
*	23740.00	Peak	H	-	-	-56.38	3.96	-9.54	45.03	73.98	-28.95
	29675.00	Peak	H	-	-	-58.59	5.90	-9.54	44.77	68.20	-23.43

Table 7-14. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6175MHz
Channel:	45

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	12350.00	Average	H	-	-	-81.21	9.61	0.00	35.40	53.98	-18.58
*	12350.00	Peak	H	-	-	-68.85	9.67	0.00	47.82	73.98	-26.16
*	18525.00	Average	H	100	75	-59.32	1.55	-9.54	39.69	53.98	-14.29
*	18525.00	Peak	H	100	75	-49.16	1.55	-9.54	49.84	73.98	-24.14
	24700.00	Peak	H	-	-	-66.94	4.20	-9.54	34.72	68.20	-33.48
	30875.00	Peak	H	-	-	-57.08	6.77	-9.54	47.15	68.20	-21.05

Table 7-15. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6415MHz
Channel:	93

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	12830.00	Peak	H	-	-	-66.24	9.64	0.00	50.40	68.20	-17.80
*	19245.00	Average	H	-	-	-66.64	2.35	-9.54	33.18	53.98	-20.80
*	19245.00	Peak	H	-	-	-56.34	2.35	-9.54	43.48	73.98	-30.50
	25660.00	Peak	H	-	-	-56.49	4.41	-9.54	45.37	68.20	-22.83
	32075.00	Peak	H	-	-	-57.26	7.43	-9.54	47.64	68.20	-20.56

Table 7-16. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	5935MHz
Channel:	2

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	11870.00	Average	H	-	-	-79.03	9.32	0.00	37.29	53.98	-16.69
*	11870.00	Peak	H	-	-	-65.99	9.32	0.00	50.33	73.98	-23.65
*	17805.00	Average	H	-	-	-78.03	15.72	0.00	44.69	53.98	-9.29
*	17805.00	Peak	H	-	-	-65.71	15.72	0.00	57.01	73.98	-16.97
*	23740.00	Average	H	-	-	-67.00	3.96	-9.54	34.41	53.98	-19.57
*	23740.00	Peak	H	-	-	-57.03	3.96	-9.54	44.38	73.98	-29.60
	29675.00	Peak	H	-	-	-57.98	5.90	-9.54	45.38	68.20	-22.82

Table 7-17. Radiated Measurements MIMO with WCP

MIMO Radiated Spurious Emission Measurements

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6435MHz
Channel:	97

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	12870.00	Peak	H	-	-	-66.72	10.05	0.00	50.33	68.20	-17.87
*	19305.00	Average	H	-	-	-66.62	2.13	-9.54	32.97	53.98	-21.01
*	19305.00	Peak	H	-	-	-56.64	2.13	-9.54	42.95	73.98	-31.03
	25740.00	Peak	H	-	-	-56.34	4.51	-9.54	45.63	68.20	-22.57
	32175.00	Peak	H	-	-	-58.25	7.53	-9.54	46.74	68.20	-21.46

Table 7-18. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6475MHz
Channel:	105

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	12950.00	Peak	H	-	-	-67.40	10.13	0.00	49.73	68.20	-18.47
*	19425.00	Average	H	-	-	-66.77	2.22	-9.54	32.91	53.98	-21.07
*	19425.00	Peak	H	-	-	-56.31	2.22	-9.54	43.37	73.98	-30.61
	25900.00	Peak	H	-	-	-57.03	4.57	-9.54	45.00	68.20	-23.20
	32375.00	Peak	H	-	-	-58.16	7.29	-9.54	46.59	68.20	-21.61

Table 7-19. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6515MHz
Channel:	113

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	13030.00	Peak	H	-	-	-68.34	10.12	0.00	48.78	68.20	-19.42
*	19545.00	Average	H	-	-	-66.60	2.37	-9.54	33.23	53.98	-20.75
*	19545.00	Peak	H	-	-	-56.37	2.37	-9.54	43.46	73.98	-30.52
	26060.00	Peak	H	-	-	-57.76	4.80	-9.54	44.50	68.20	-23.70
	32575.00	Peak	H	-	-	-56.94	6.85	-9.54	47.37	68.20	-20.83

Table 7-20. Radiated Measurements MIMO

MIMO Radiated Spurious Emission Measurements – UNII Band 7

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6535MHz
Channel:	117

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	13070.00	Peak	H	-	-	-68.61	10.15	0.00	48.54	68.20	-19.66
*	19605.00	Average	H	-	-	-66.65	2.64	-9.54	33.45	53.98	-20.53
*	19605.00	Peak	H	-	-	-56.08	2.64	-9.54	44.02	73.98	-29.96
	26140.00	Peak	H	-	-	-55.99	4.56	-9.54	46.02	68.20	-22.18
	32675.00	Peak	H	-	-	-57.49	7.03	-9.54	47.00	68.20	-21.20

Table 7-21. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6695MHz
Channel:	149

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	13390.00	Average	H	-	-	-79.58	10.35	0.00	37.77	53.98	-16.21
*	13390.00	Peak	H	-	-	-68.99	10.35	0.00	48.36	73.98	-25.62
*	20085.00	Average	H	-	-	-66.71	3.01	-9.54	33.76	53.98	-20.22
*	20085.00	Peak	H	-	-	-56.48	3.01	-9.54	43.99	73.98	-29.99
	26780.00	Peak	H	-	-	-57.39	4.57	-9.54	44.65	68.20	-23.55
	33475.00	Peak	H	-	-	-57.11	7.57	-9.54	47.92	68.20	-20.28

Table 7-22. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6875MHz
Channel:	185

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	13750.00	Peak	H	-	-	-65.61	11.07	0.00	52.46	68.20	-15.74
*	20625.00	Average	H	-	-	-67.13	3.42	-9.54	33.75	53.98	-20.23
*	20625.00	Peak	H	-	-	-56.12	3.42	-9.54	44.76	73.98	-29.22
	27500.00	Peak	H	-	-	-56.58	4.54	-9.54	45.42	68.20	-22.78
	34375.00	Peak	H	-	-	-57.48	8.08	-9.54	48.06	68.20	-20.14

Table 7-23. Radiated Measurements MIMO

MIMO Radiated Spurious Emission Measurements – UNII Band 8

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6895MHz
Channel:	189

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	13790.00	Peak	H	-	-	-65.48	11.00	0.00	52.52	68.20	-15.68
*	20685.00	Average	H	-	-	-67.05	3.67	-9.54	34.08	53.98	-19.90
*	20685.00	Peak	H	-	-	-56.86	3.67	-9.54	44.26	73.98	-29.72
	27580.00	Peak	H	-	-	-57.16	4.68	-9.54	44.98	68.20	-23.22
	34475.00	Peak	H	-	-	-57.58	7.83	-9.54	47.71	68.20	-20.49

Table 7-24. Radiated Measurements MIMO

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	6995MHz
Channel:	209

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	13990.00	Peak	H	-	-	-65.86	11.26	0.00	52.40	68.20	-15.80
*	20985.00	Average	H	-	-	-67.44	3.59	-9.54	33.61	53.98	-20.37
*	20985.00	Peak	H	-	-	-56.81	3.59	-9.54	44.24	73.98	-29.74
	27980.00	Peak	H	-	-	-57.24	5.05	-9.54	45.27	68.20	-22.93
	34975.00	Peak	H	-	-	-57.36	8.24	-9.54	48.34	68.20	-19.86

Table 7-25. Radiated Measurements MIMO

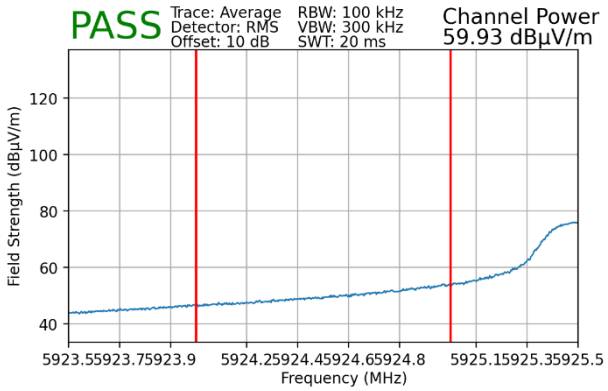
Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	1 & 3 Meters
Operating Frequency:	7115MHz
Channel:	233

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Distance Correction Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
	14230.00	Peak	H	-	-	-69.23	12.13	0.00	49.90	68.20	-18.30
*	21345.00	Average	H	-	-	-67.20	4.08	-9.54	34.34	53.98	-19.64
*	21345.00	Peak	H	-	-	-56.57	4.08	-9.54	44.97	73.98	-29.01
	28460.00	Peak	H	-	-	-57.50	5.14	-9.54	45.09	68.20	-23.11
	35575.00	Peak	H	-	-	-57.31	8.16	-9.54	48.31	68.20	-19.89

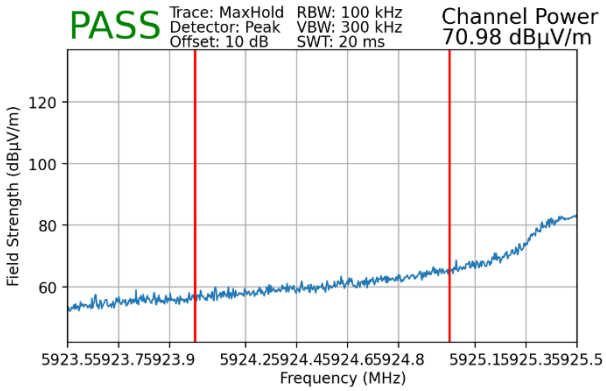
Table 7-26. Radiated Measurements MIMO

7.7.2 MIMO Radiated Band Edge Measurements (20MHz BW)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5935MHz
Channel:	2

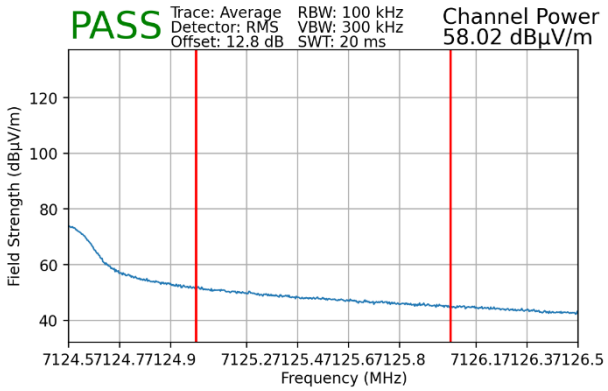


Plot 7-131. Radiated Lower Band Edge Plot MIMO (Average – UNII Band 5)

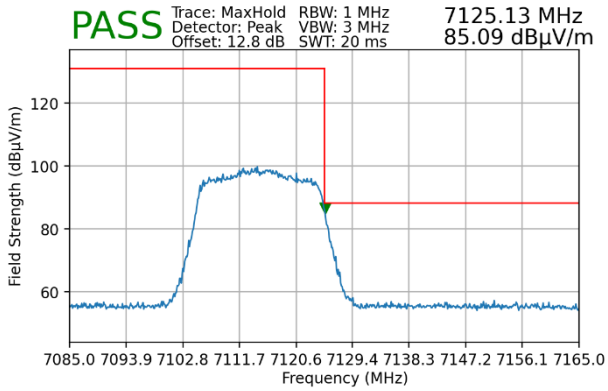


Plot 7-132. Radiated Lower Band Edge Plot MIMO (Peak – UNII Band 5)

Worst Case Mode:	802.11a
Worst Case Transfer Rate:	6Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	7115MHz
Channel:	233

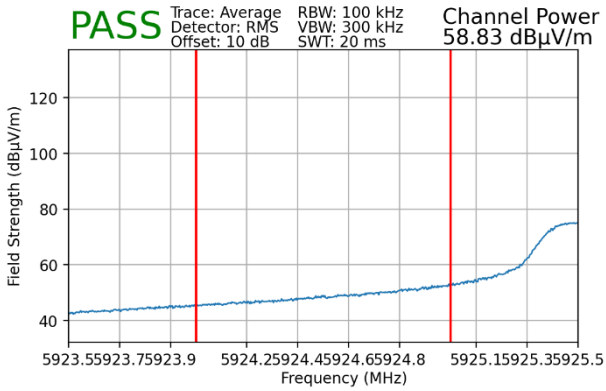


Plot 7-133. Radiated Upper Band Edge Plot MIMO (Average – UNII Band 8)

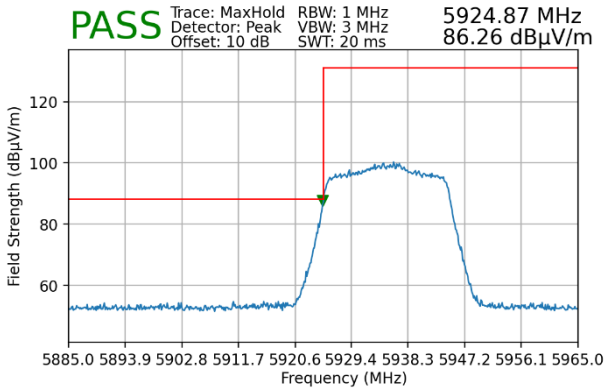


Plot 7-134. Radiated Upper Band Edge Plot MIMO (Peak – UNII Band 8)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5935MHz
Channel:	2



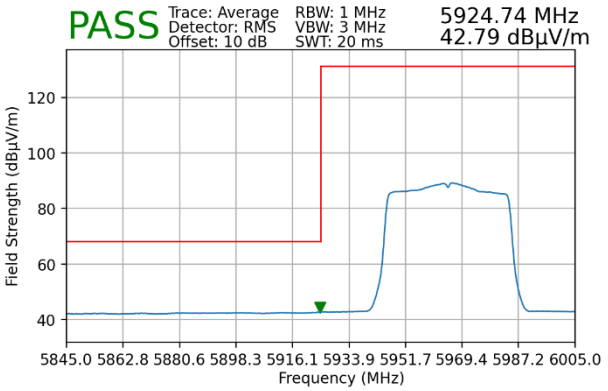
Plot 7-135. Radiated Lower Band Edge Plot MIMO (Average – UNII Band 5) with WCP



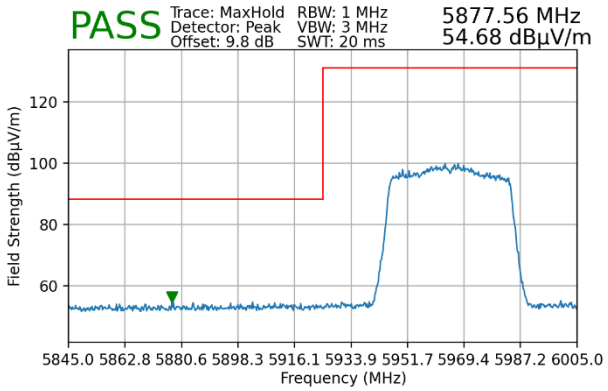
Plot 7-136. Radiated Lower Band Edge Plot MIMO (Peak – UNII Band 5) with WCP

7.7.3 MIMO Radiated Band Edge Measurements (40MHz BW)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5965MHz
Channel:	3

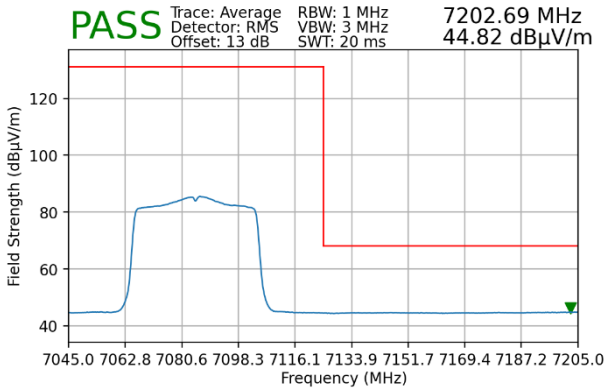


Plot 7-137. Radiated Lower Band Edge Plot MIMO (Average – UNII Band 5)

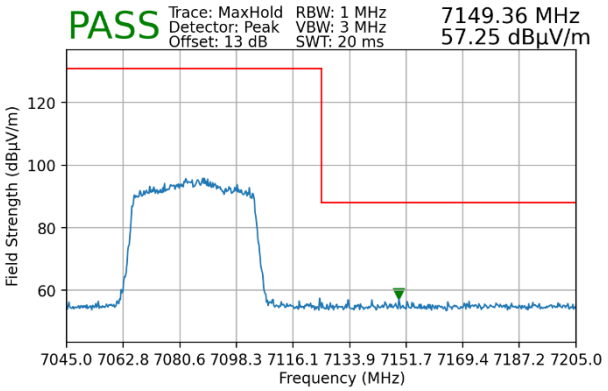


Plot 7-138. Radiated Lower Band Edge Plot MIMO (Peak – UNII Band 5)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	7085MHz
Channel:	227



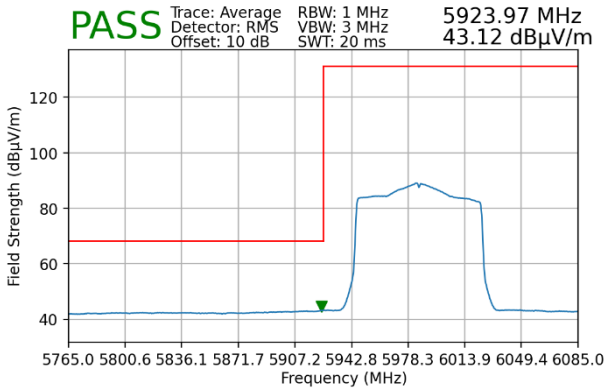
Plot 7-139. Radiated Upper Band Edge Plot MIMO (Average – UNII Band 8)



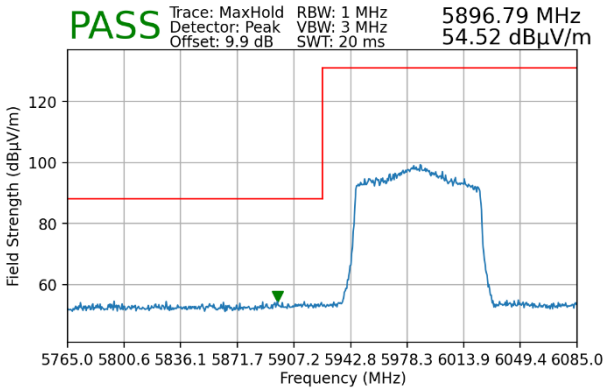
Plot 7-140. Radiated Upper Band Edge Plot MIMO (Peak – UNII Band 8)

7.7.4 MIMO Radiated Band Edge Measurements (80MHz BW)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5985MHz
Channel:	7

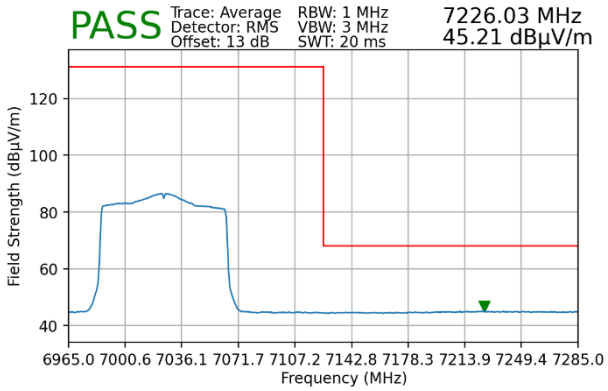


Plot 7-141. Radiated Lower Band Edge Plot MIMO (Average – UNII Band 5)

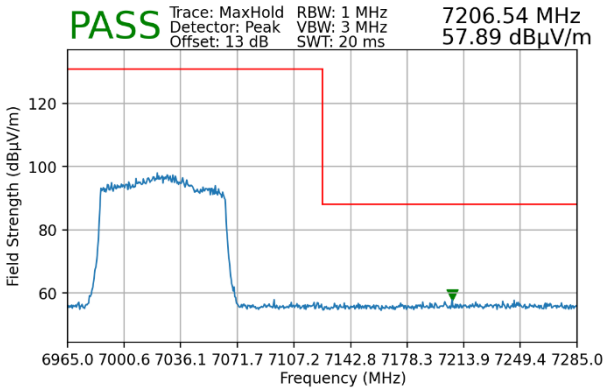


Plot 7-142. Radiated Lower Band Edge Plot MIMO (Peak – UNII Band 5)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	7025MHz
Channel:	215



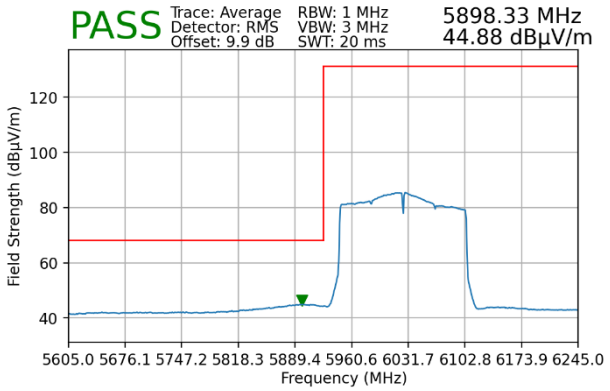
Plot 7-143. Radiated Upper Band Edge Plot MIMO (Average – UNII Band 8)



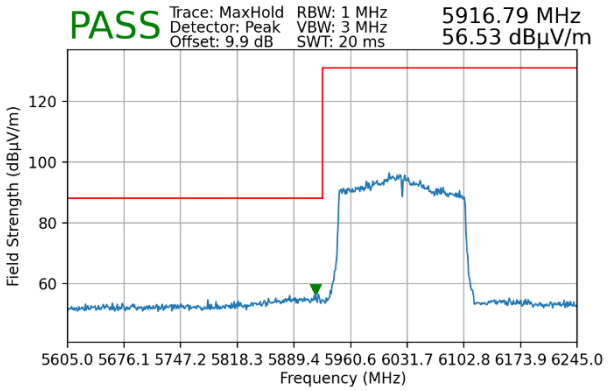
Plot 7-144. Radiated Upper Band Edge Plot MIMO (Peak – UNII Band 8)

7.7.5 MIMO Radiated Band Edge Measurements (160MHz BW)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	6025MHz
Channel:	15

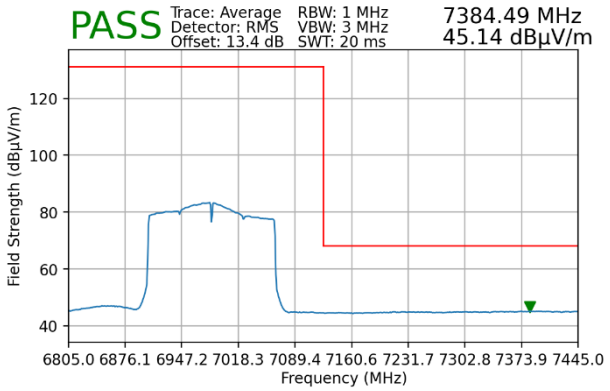


Plot 7-145. Radiated Lower Band Edge Plot MIMO (Average – UNII Band 5)

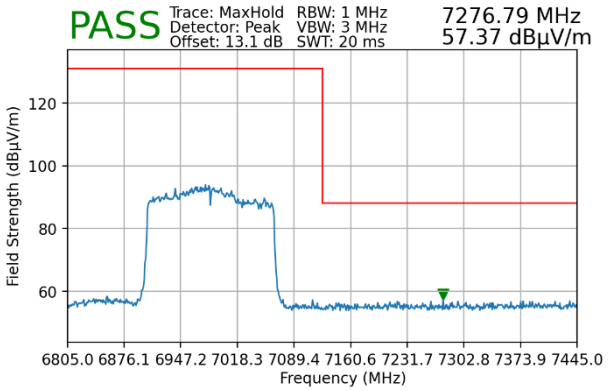


Plot 7-146. Radiated Lower Band Edge Plot MIMO (Peak – UNII Band 5)

Worst Case Mode:	802.11ax
Worst Case Transfer Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	6985MHz
Channel:	207



Plot 7-147. Radiated Upper Band Edge Plot MIMO (Average – UNII Band 8)



Plot 7-148. Radiated Upper Band Edge Plot MIMO (Peak – UNII Band 8)

7.8 Line Conducted Test Data

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 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.

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 7-27. Conducted Limits

*Decreases with the logarithm of the frequency.

Test Procedures Used

ANSI C63.10-2013, Section 6.2

Test Settings

Quasi-Peak Field Strength 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 Field Strength 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.

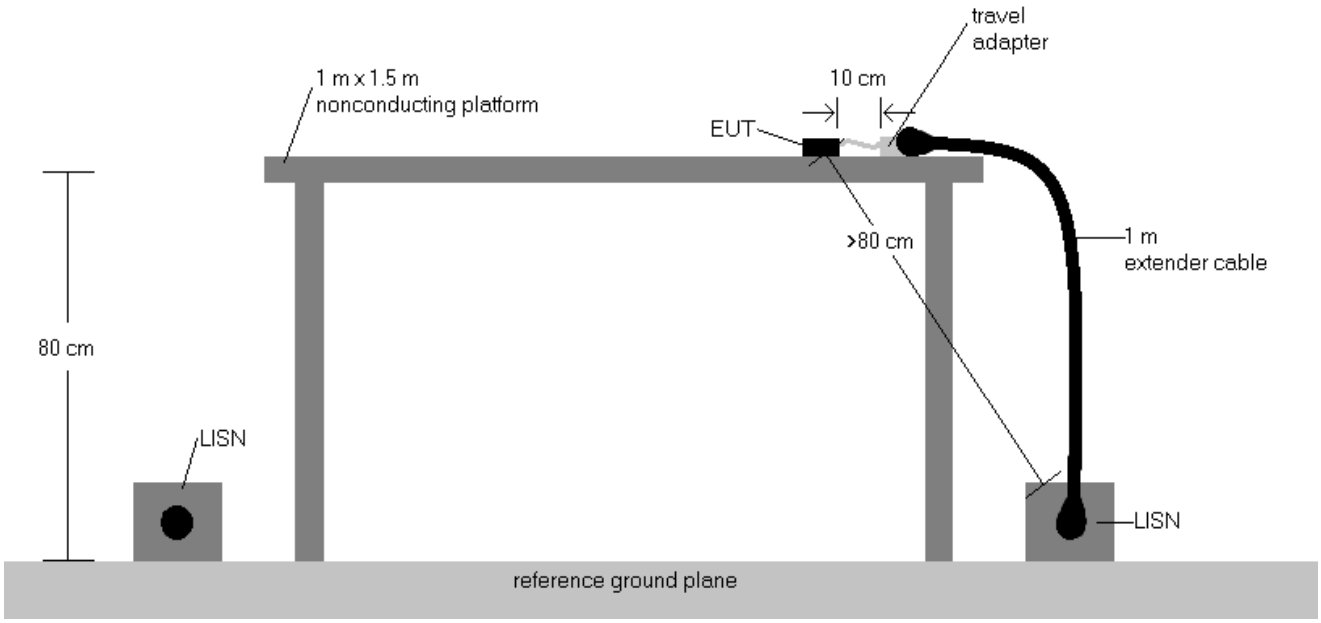
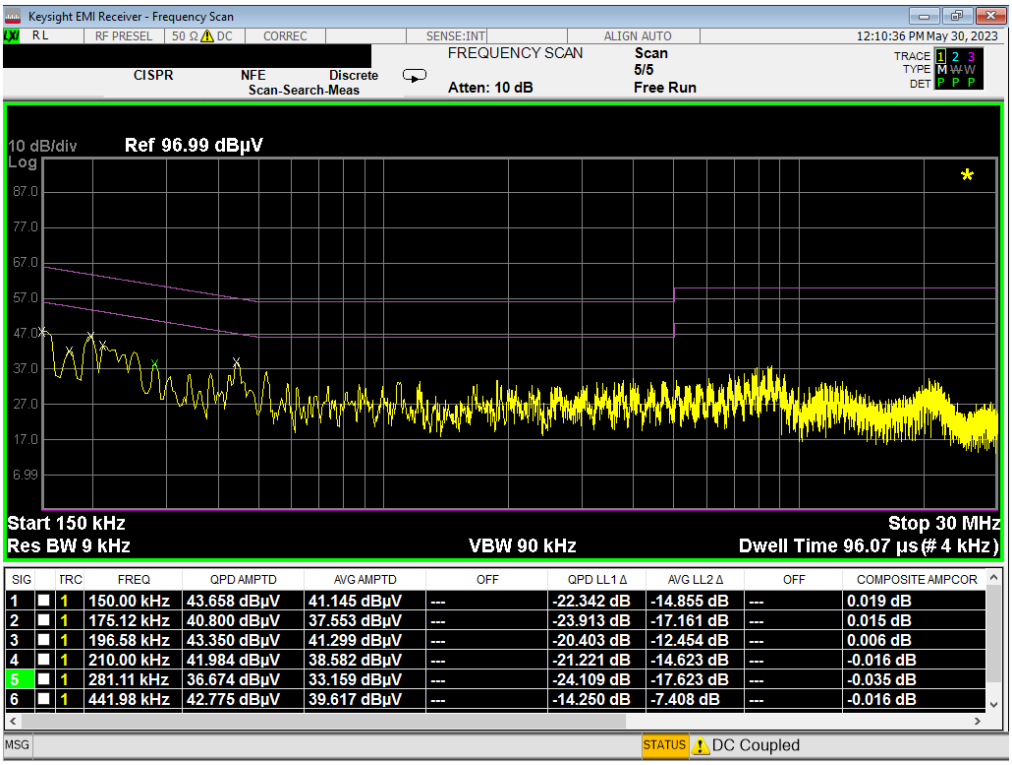


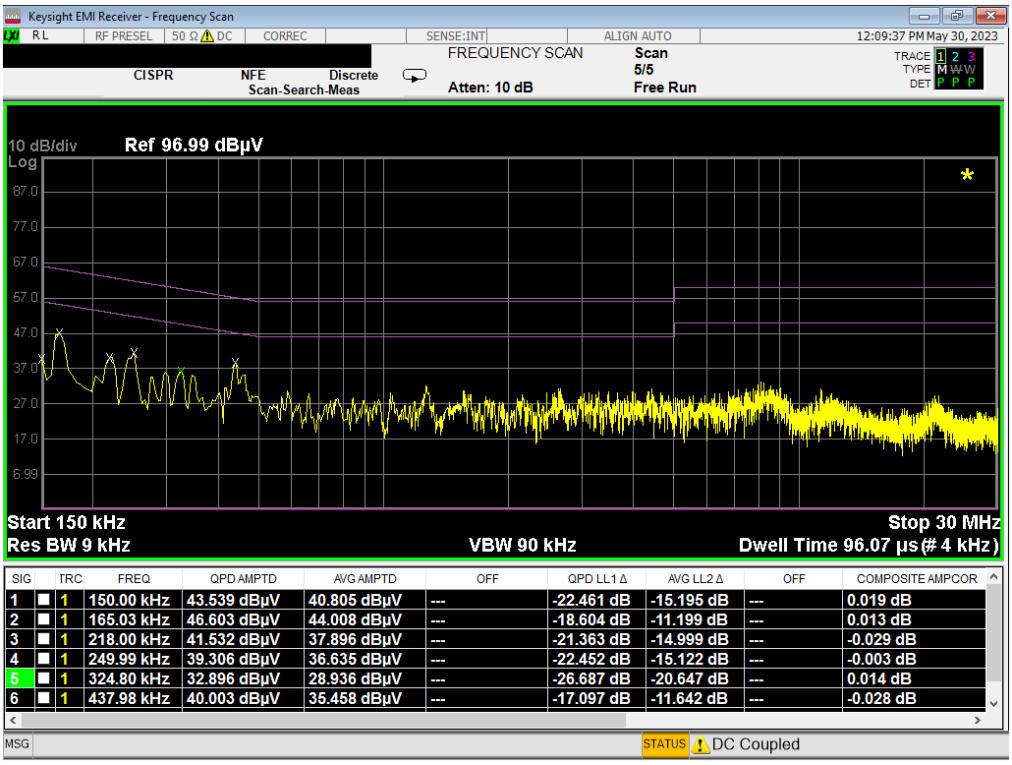
Figure 7-9. Test Instrument & Measurement Setup

Test Notes

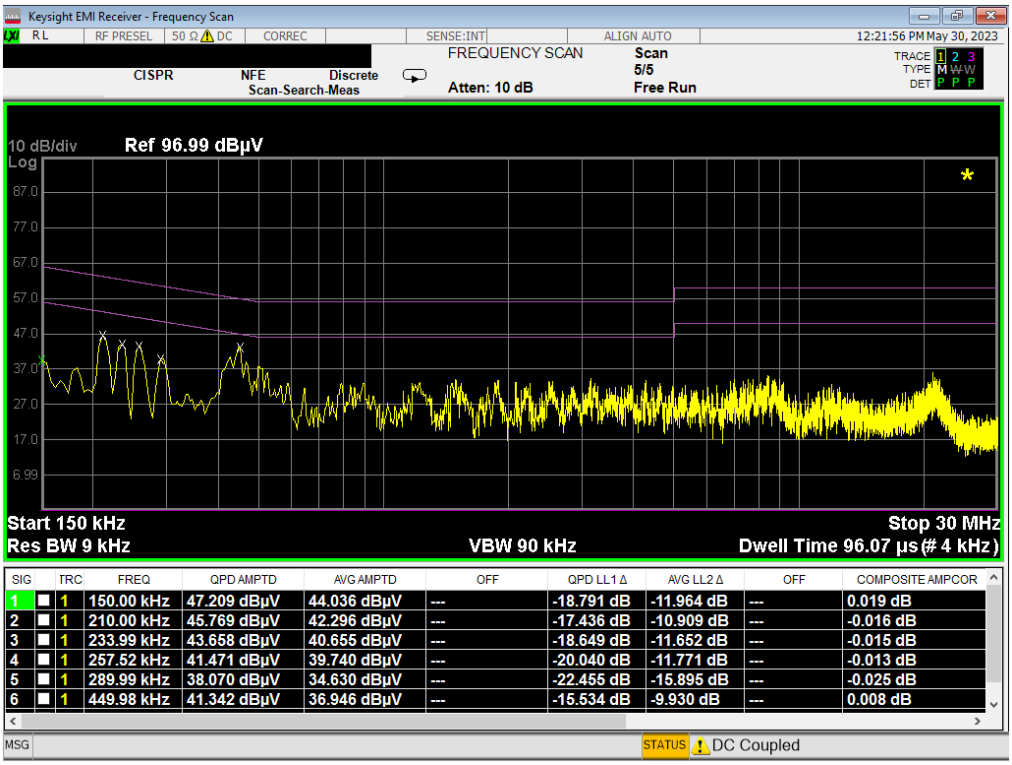
1. All modes of operation were investigated, and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
2. The limit for an intentional radiator from 150kHz to 30MHz is specified in 15.207.
3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
4. QP/AV Level (dBμV) = QP/AV Analyzer/Receiver Level (dBμV) + Corr. (dB)
5. Margin (dB) = QP/AV Limit (dBμV) - QP/AV Level (dBμV)
6. Traces shown in plot are made using a peak detector.
7. Deviations to the Specifications: None.



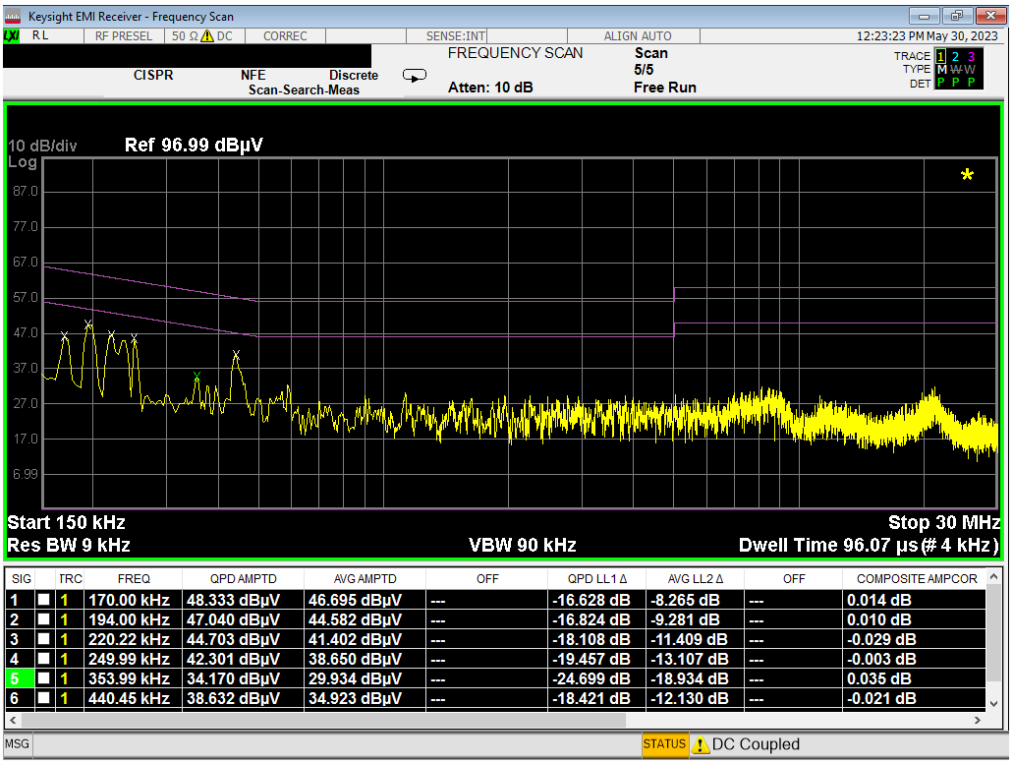
Plot 7-149. Line Conducted Plot with 802.11a UNII Band 5 (L1)



Plot 7-150. Line Conducted Plot with 802.11a UNII Band 5 (N)



Plot 7-151. Line Conducted Plot with 802.11a UNII Band 6 (L1)



Plot 7-152. Line Conducted Plot with 802.11a UNII Band 6 (N)