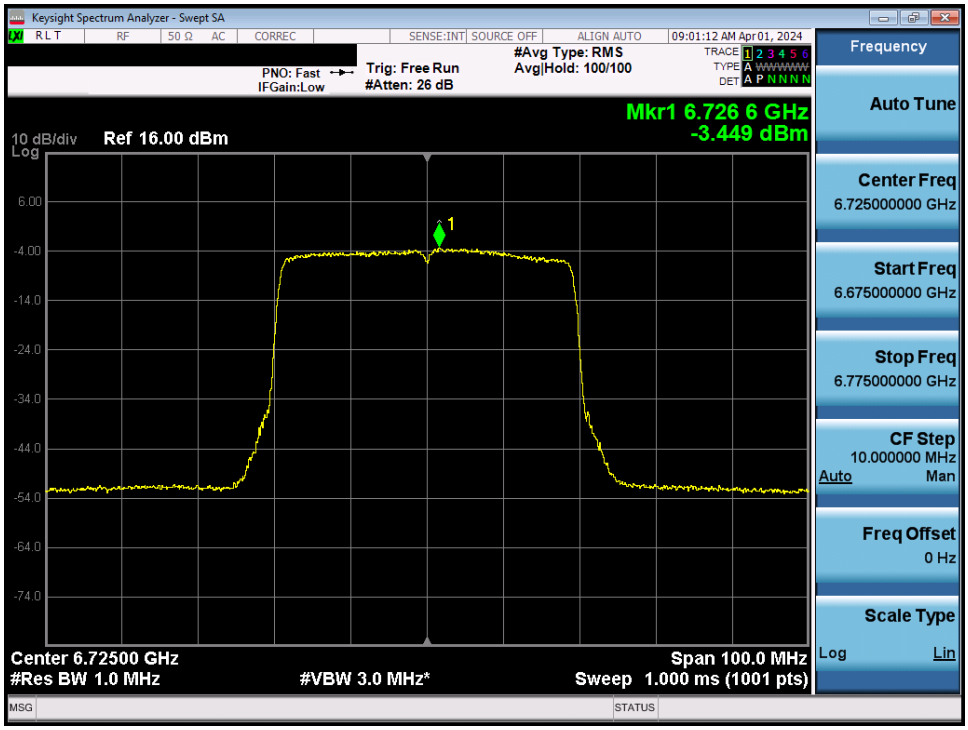
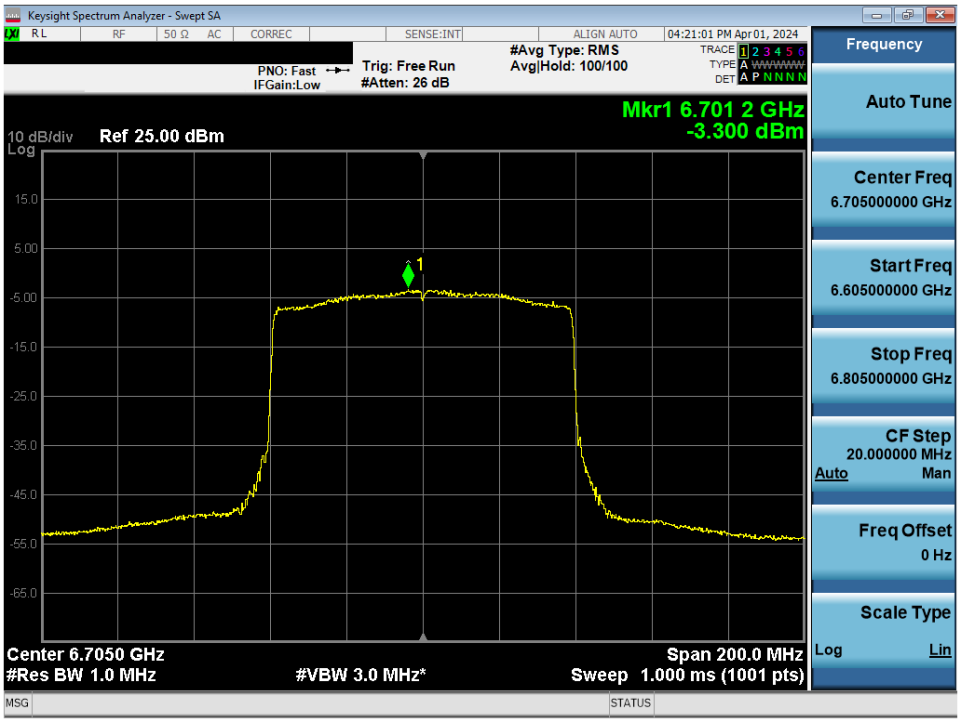
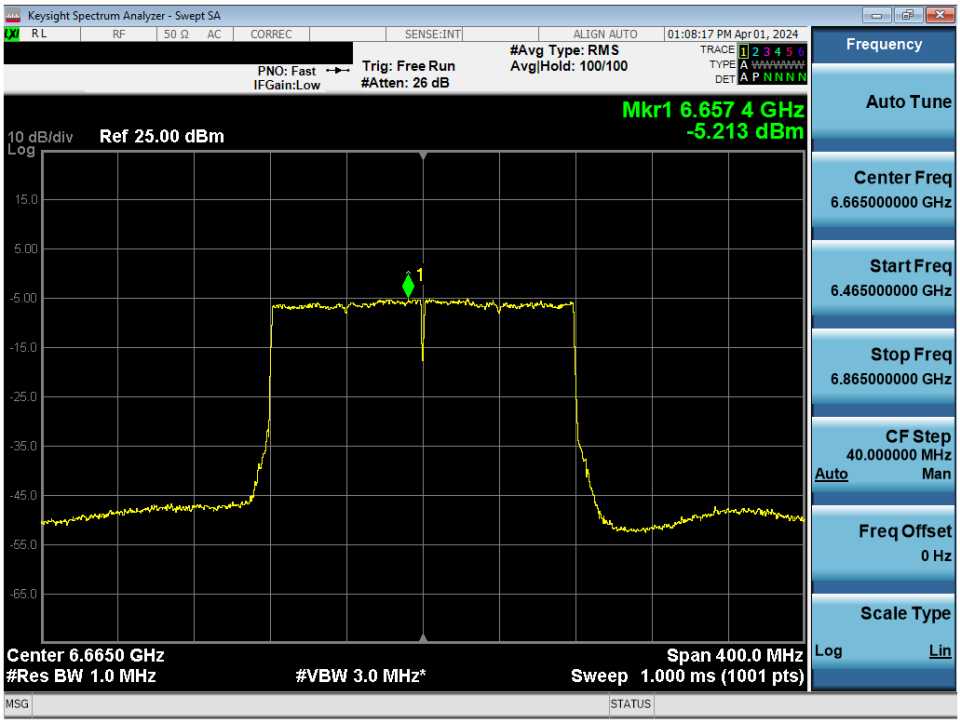


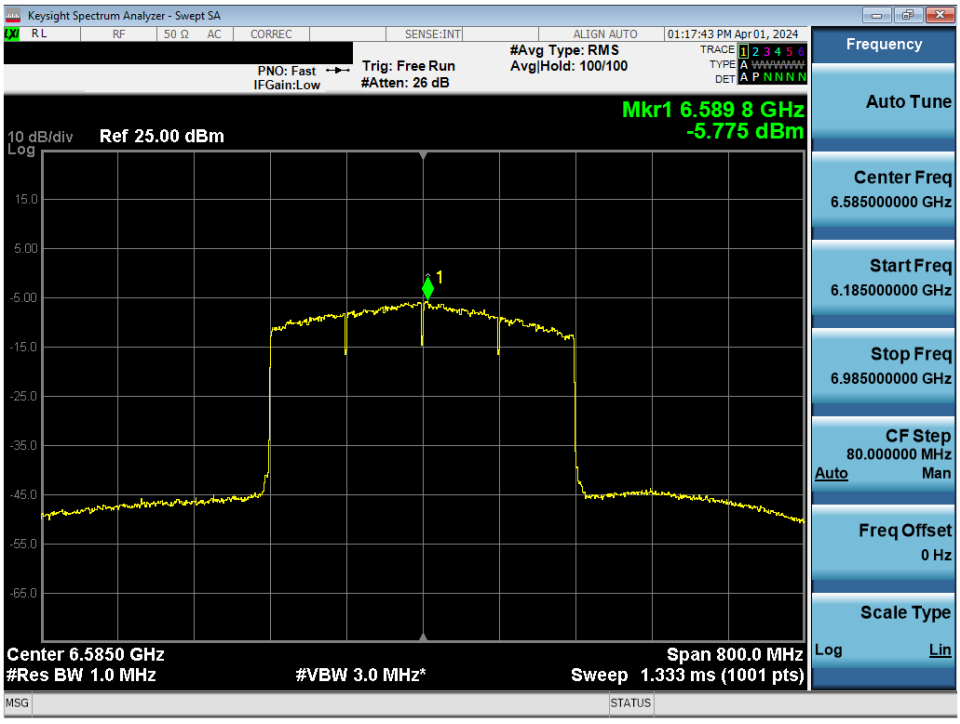
Plot 7-107. Power Spectral Density MIMO ANT2 (40MHz 802.11ax/be (UNII Band 7) – Ch. 155) - LPI



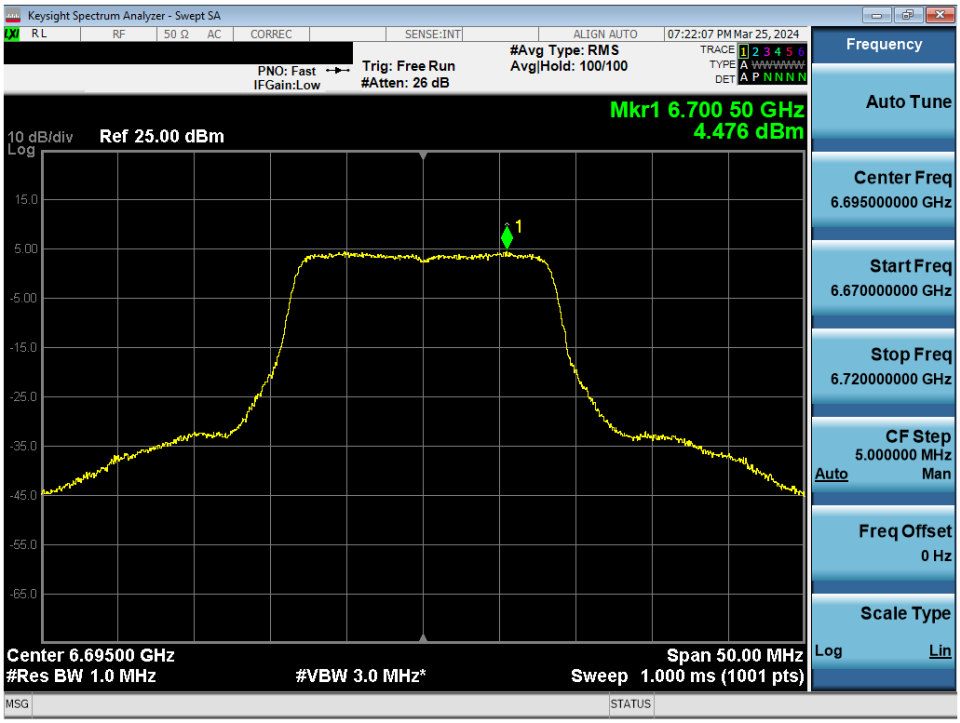
Plot 7-108. Power Spectral Density MIMO ANT2 (80MHz 802.11ax/be (UNII Band 7) – Ch. 151) - LPI



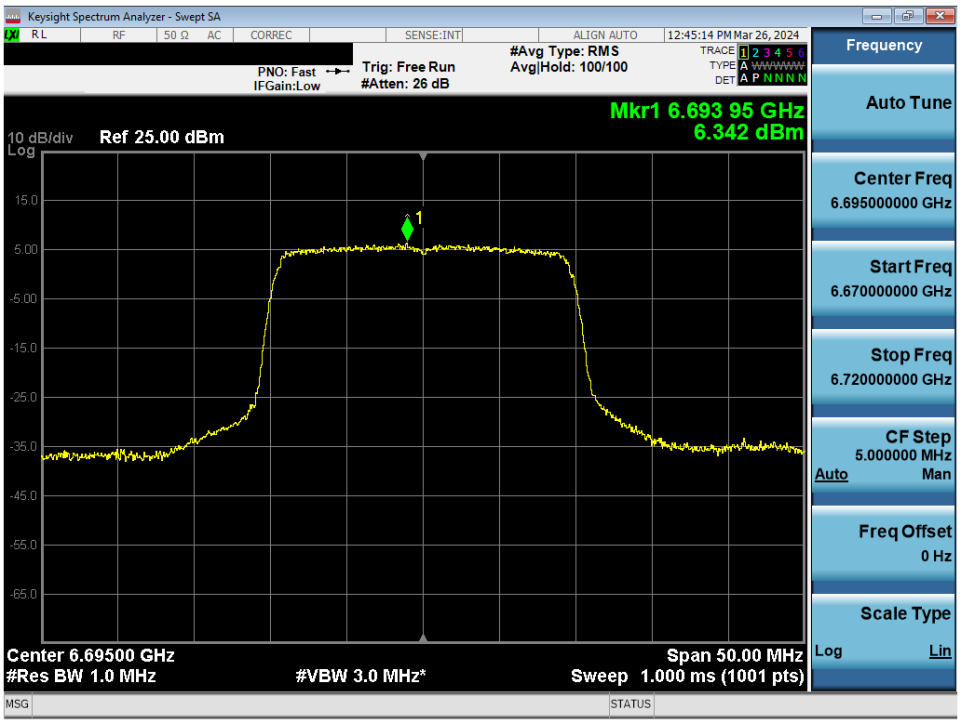
Plot 7-109. Power Spectral Density MIMO ANT2 (160MHz 802.11ax/be (UNII Band 7) – Ch. 143) - LPI



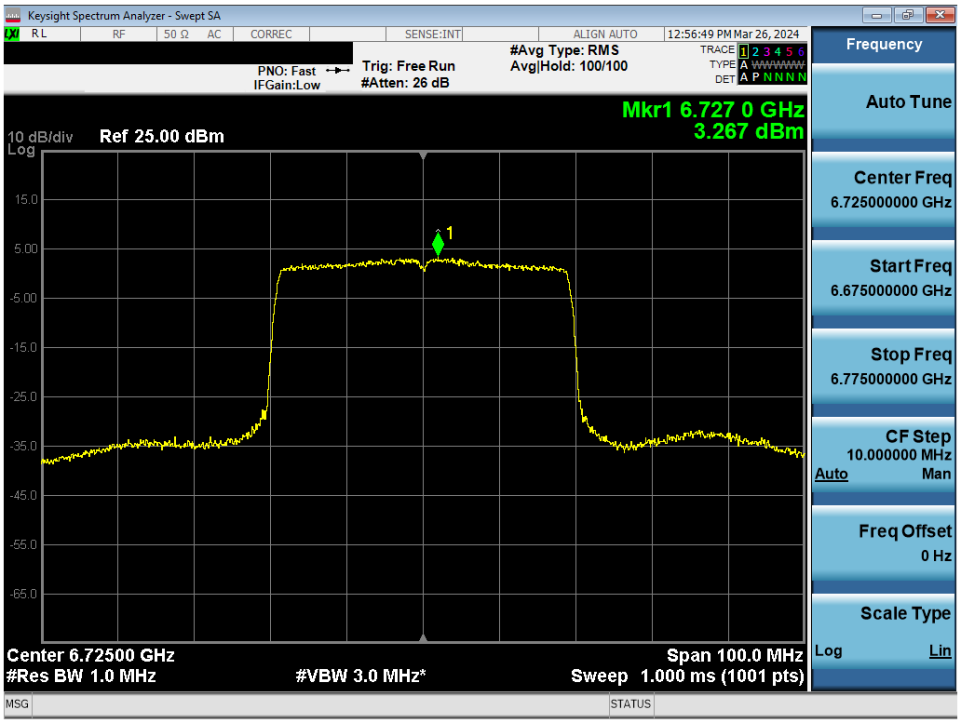
Plot 7-110. Power Spectral Density MIMO ANT2 (320MHz 802.11ax/be (UNII Band 6/7) – Ch. 127) - LPI



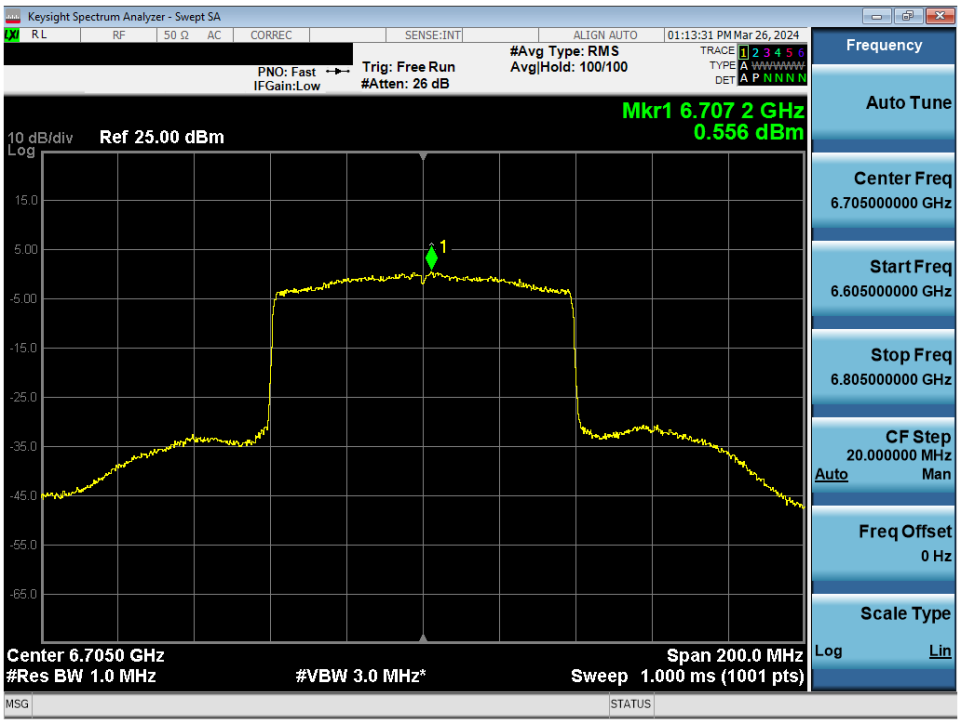
Plot 7-111. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 7) – Ch. 149) - SP



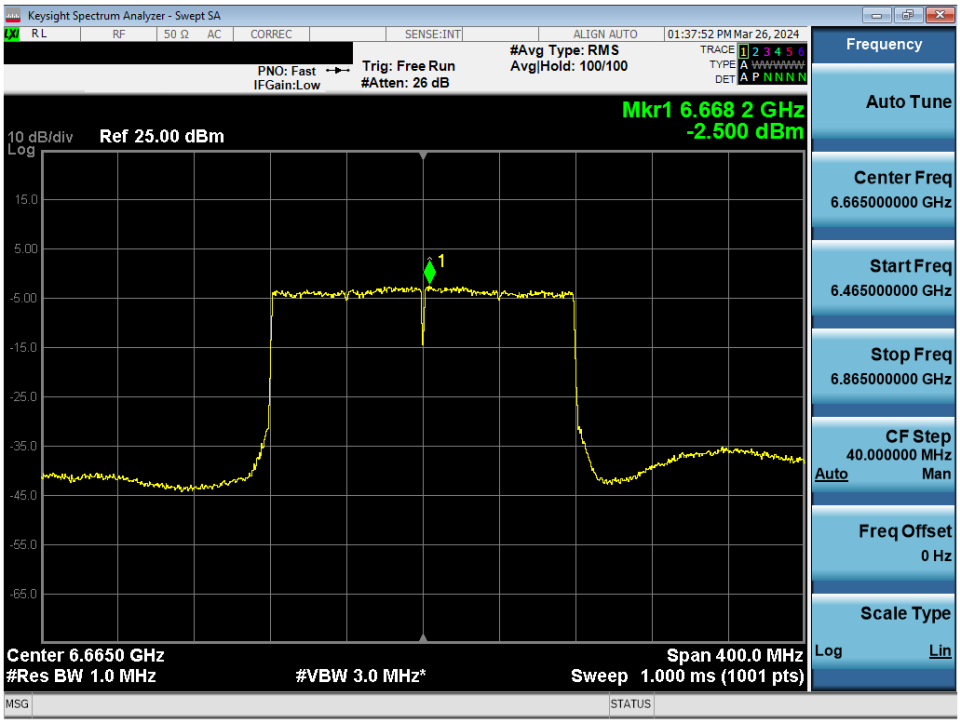
Plot 7-112. Power Spectral Density MIMO ANT2 (20MHz 802.11ax/be (UNII Band 7) – Ch. 149) - SP



Plot 7-113. Power Spectral Density MIMO ANT2 (40MHz 802.11ax/be (UNII Band 7) – Ch. 155) - SP

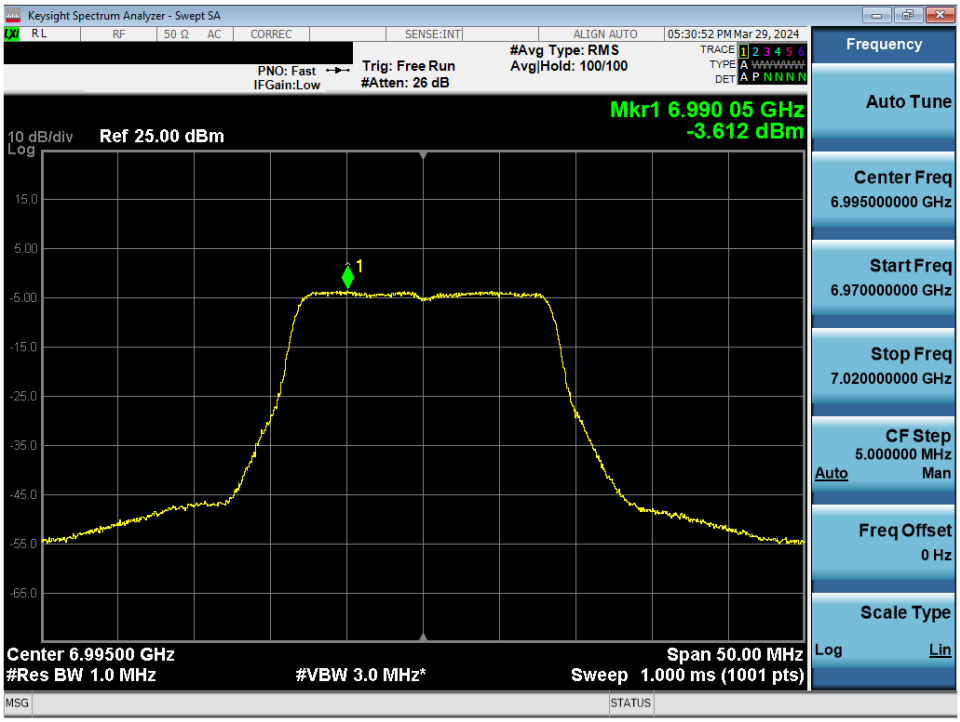


Plot 7-114. Power Spectral Density MIMO ANT2 (80MHz 802.11ax/be (UNII Band 7) – Ch. 151) - SP

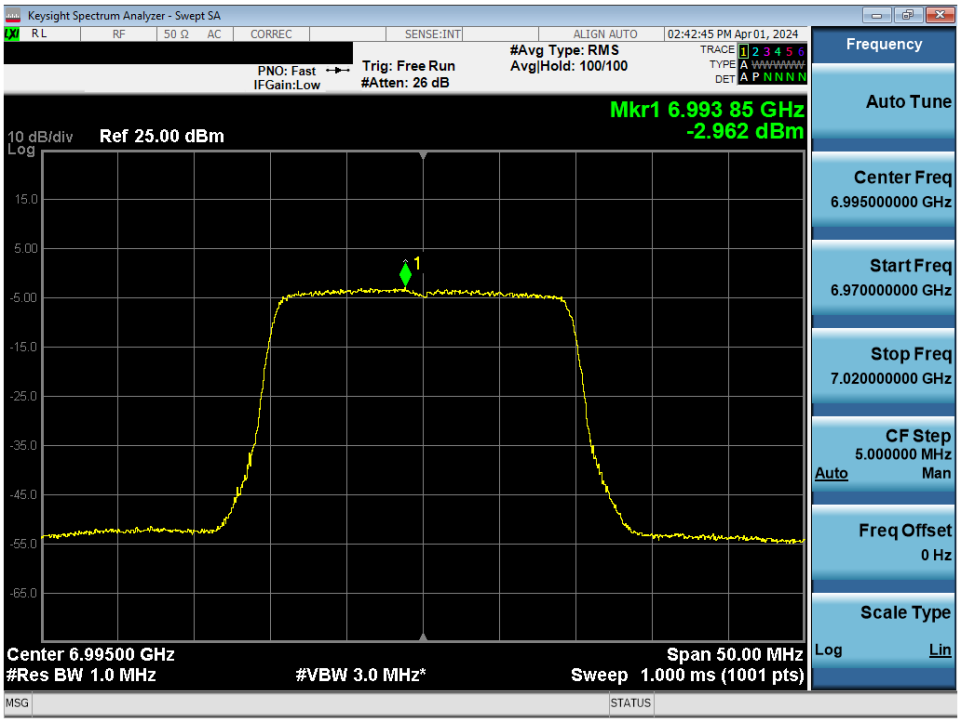


Plot 7-115. Power Spectral Density MIMO ANT2 (160MHz 802.11ax/be (UNII Band 7) – Ch. 143) - SP

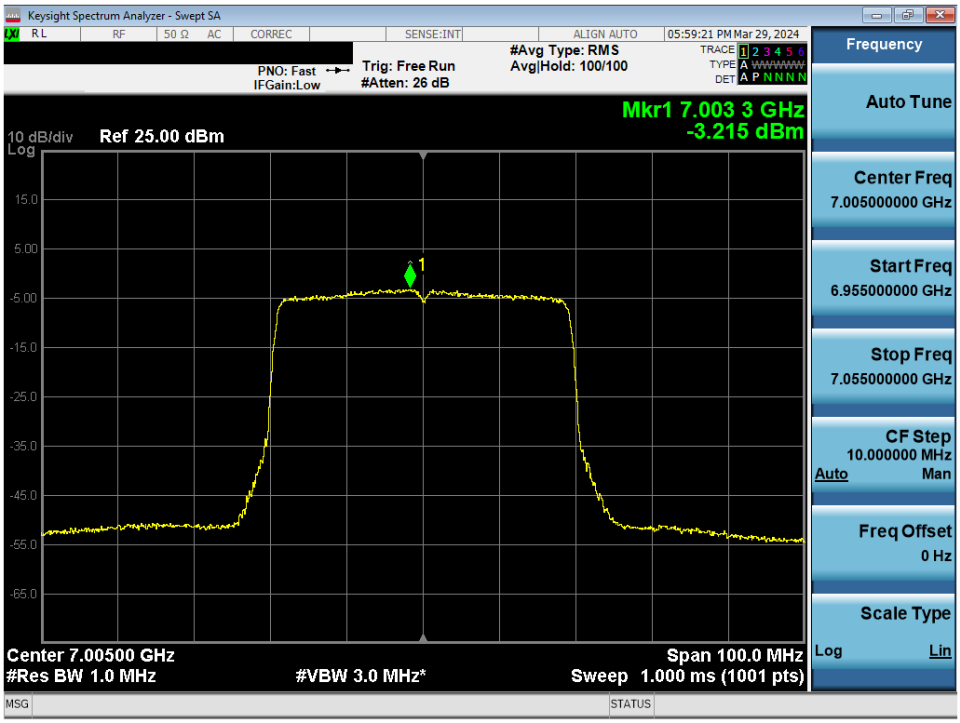
MIMO Antenna-2 Power Spectral Density Measurements - (UNII Band 8)



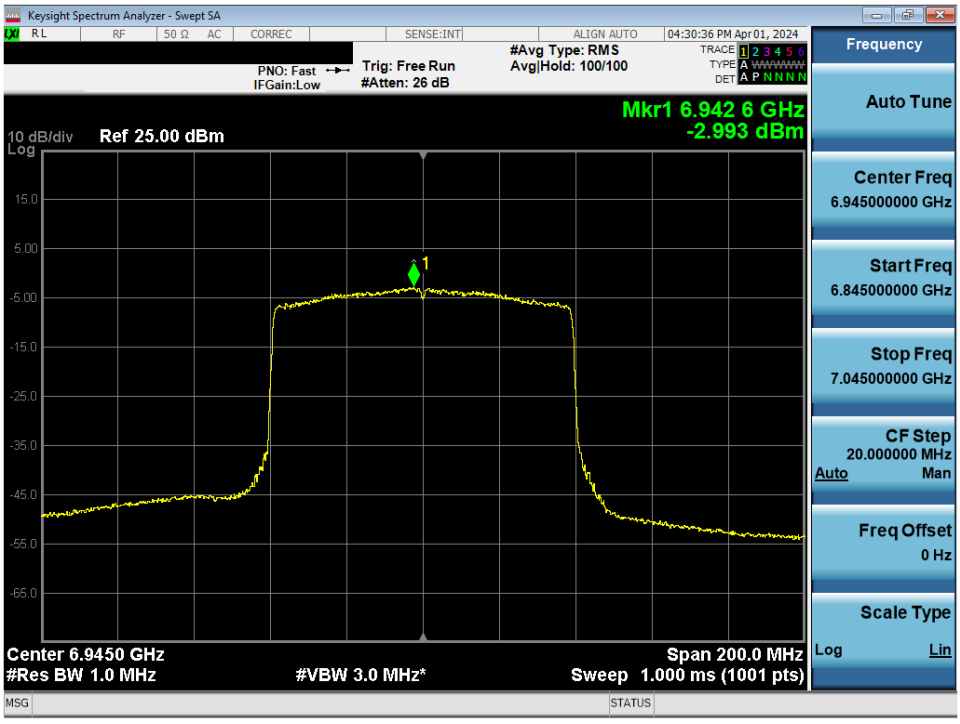
Plot 7-116. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 8) – Ch. 209) - LPI



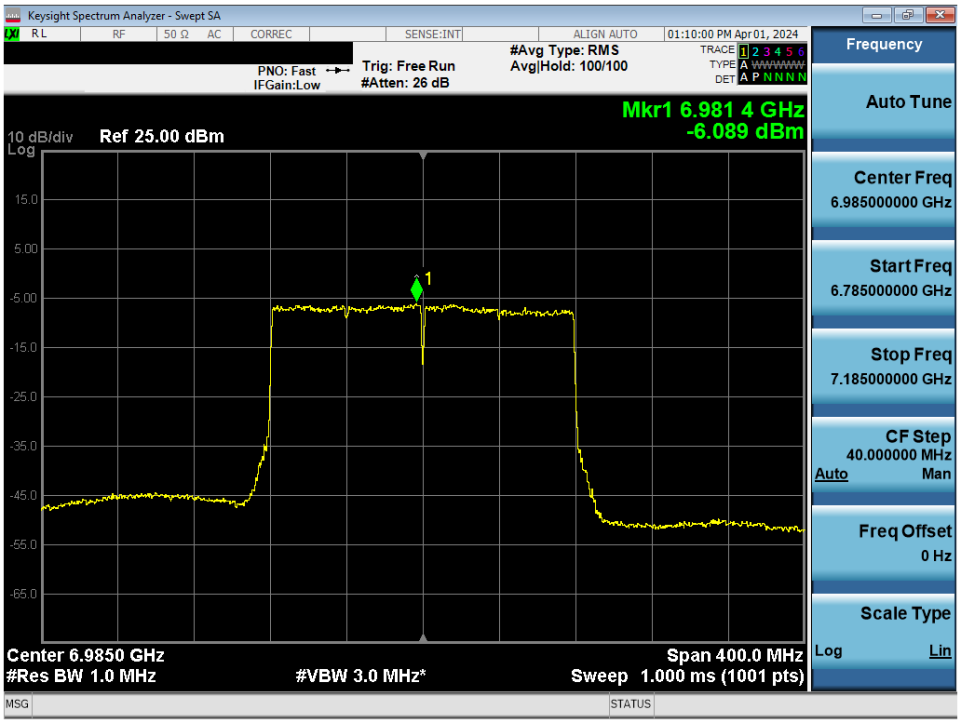
Plot 7-117. Power Spectral Density MIMO ANT2 (20MHz 802.11ax/be (UNII Band 8) – Ch. 209) - LPI



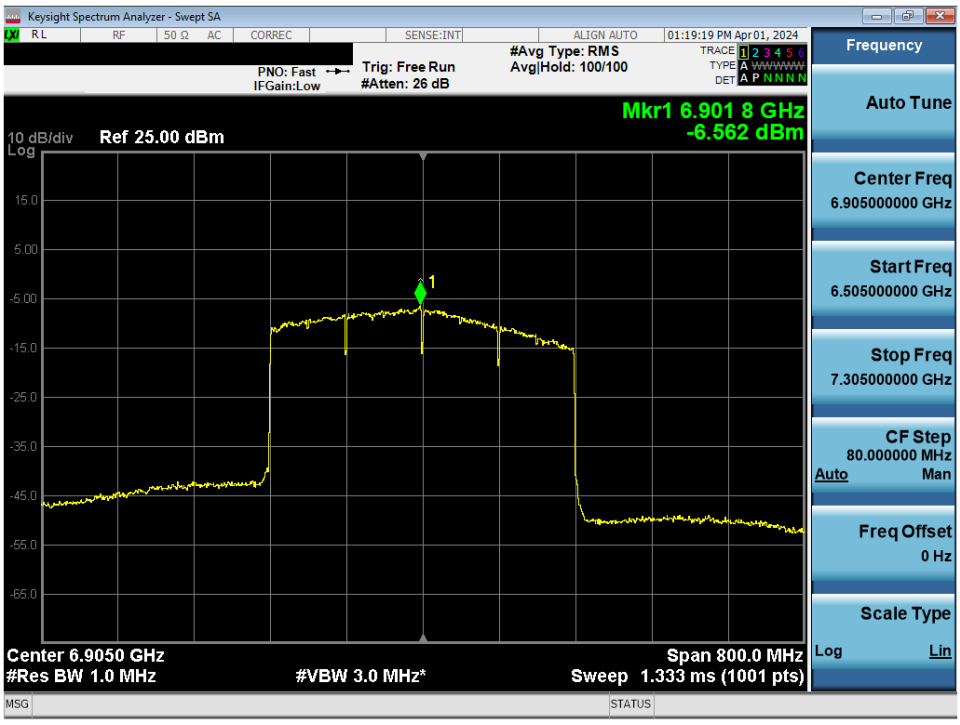
Plot 7-118. Power Spectral Density MIMO ANT2 (40MHz 802.11ax/be (UNII Band 8) – Ch. 211) - LPI



Plot 7-119. Power Spectral Density MIMO ANT2 (80MHz 802.11ax/be (UNII Band 8) – Ch. 199) - LPI



Plot 7-120. Power Spectral Density MIMO ANT2 (160MHz 802.11ax/be (UNII Band 8) – Ch. 207) - LPI



Plot 7-121. Power Spectral Density MIMO ANT2 (320MHz 802.11ax/be (UNII Band 7/8) – Ch. 191) - LPI

Note:

Per ANSI C63.10-2013 Section 14.3.2.2 and KDB 662911 v02r01 Section E)2), the power spectral density at Antenna 1 and Antenna 2 were first measured separately as shown in the section above. The measured values were then summed in linear power units then converted back to dBm.

Per ANSI C63.10-2013 Section 14.4.3, the directional gain is calculated using the following formula, where GN is the gain of the nth antenna and NANT, the total number of antennas used.

$$\text{Directional gain} = 10 \log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}] \text{ dBi}$$

Sample MIMO Calculation:

At 5935MHz in 802.11a (20MHz BW) mode, the average conducted power spectral density was measured to be -5.69 dBm for Antenna-1 and -6.13 dBm for Antenna-2.

Antenna 1 + Antenna 2 = MIMO

(-5.69 dBm + -6.13 dBm) = (0.270 mW + 0.244 mW) = 0.514 mW = -2.89 dBm

Sample e.i.r.p Power Spectral Density Calculation:

At 5935 MHz in 802.11a (20MHz BW) mode, the average MIMO power density was calculated to be -2.89 dBm with directional gain of -0.61 dBi.

e.i.r.p. Power Spectral Density(dBm) = Power Spectral Density (dBm) + Ant gain (dBi)

-2.89 dBm + -0.61 dBi = -3.51 dBm

7.5 In-Band Emissions

Test Overview and Limit

The spectrum analyzer was connected to the antenna terminal while the EUT was operating at its maximum duty cycle, at its maximum power control level, as defined in ANSI C63.10-2013, and at the appropriate frequencies.

For transmitters operating within the 5.925-7.125 GHz bands: Power spectral density must be suppressed by 20 dB at 1 MHz outside of channel edge, by 28 dB at one channel bandwidth from the channel center, and by 40 dB at one- and one-half times the channel bandwidth away from channel center. At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits must be linearly interpolated between 20 dB and 28 dB suppression, and at frequencies between one and one- and one-half times an unlicensed device's channel bandwidth, the limits must be linearly interpolated between 28 dB and 40 dB suppression. Emissions removed from the channel center by more than one- and one-half times the channel bandwidth must be suppressed by at least 40 dB.

Test Procedure Used

KDB 987594 D02 v02r01

Test Settings

1. Connect output of the antenna port to a spectrum analyzer or EMI receiver, with appropriate attenuation, as to not damage the instrumentation.
2. Set the reference level of the measuring equipment in accordance with procedure 4.1.5.2 of ANSI C63.10- 2013.
3. Measure the 26 dB EBW using the test procedure 12.4.1 of ANSI C63.10-2013. (This will be used to determine the channel edge.)
4. Measure the power spectral density (which will be used for emissions mask reference) using the following procedure:
    a) Set the span to encompass the entire 26 dB EBW of the signal.
    b) Set RBW = same RBW used for 26 dB EBW measurement.
    c) Set VBW ≥ 3 X RBW
    d) Number of points in sweep ≥ [2 X span / RBW].
    e) Sweep time = auto.
    f) Detector = RMS (i.e., power averaging)
    g) Trace average at least 100 traces in power averaging (rms) mode.
    h) Use the peak search function on the instrument to find the peak of the spectrum.
5. For the purposes of developing the emission mask, the channel bandwidth is defined as the 26 dB EBW.
6. Using the measuring equipment limit line function, develop the emissions mask based on the following requirements. The emissions power spectral density must be reduced below the peak power spectral density (in dB) as follows:
    i) Suppressed by 20 dB at 1 MHz outside of the channel edge. (The channel edge is defined as the 26-dB point on either side of the carrier center frequency.)
    j) Suppressed by 28 dB at one channel bandwidth from the channel center.
    k) Suppressed by 40 dB at one- and one-half times the channel bandwidth from the channel center.
7. Adjust the span to encompass the entire mask as necessary.
8. Clear trace.
9. Trace average at least 100 traces in power averaging (rms) mode.
10. Adjust the reference level as necessary so that the crest of the channel touches the top of the emission mask.

Test Setup

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

Figure 7-4. Test Instrument & Measurement Setup

Test Notes

None.

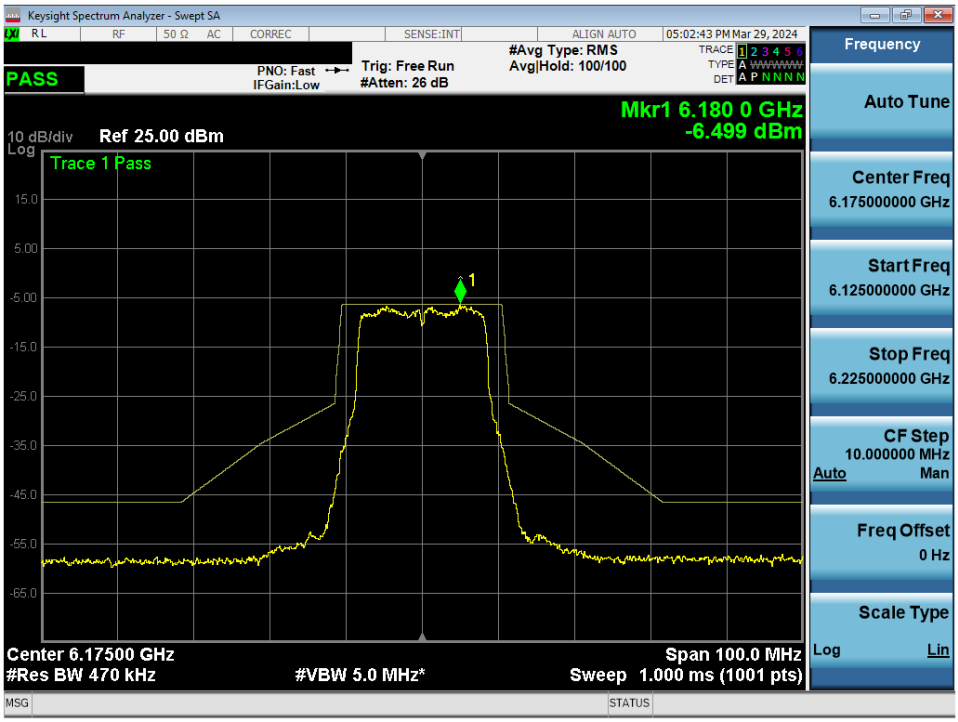
	Frequency [MHz]	Channel	802.11 MODE	Antenna-1 In-Band Emission	Antenna-2 In-Band Emission
Band 5	5935	2	a	Pass	Pass
	6175	45	a	Pass	Pass
	6415	93	a	Pass	Pass
	5935	2	be (20MHz)	Pass	Pass
	6175	45	be (20MHz)	Pass	Pass
	6415	93	be (20MHz)	Pass	Pass
	5965	3	be (40MHz)	Pass	Pass
	6165	43	be (40MHz)	Pass	Pass
	6405	91	be (40MHz)	Pass	Pass
	5985	7	be (80MHz)	Pass	Pass
	6145	39	be (80MHz)	Pass	Pass
	6385	87	be (80MHz)	Pass	Pass
	6025	15	be (160MHz)	Pass	Pass
	6185	47	be (160MHz)	Pass	Pass
	6345	79	be (160MHz)	Pass	Pass
	6105	31	be (320MHz)	Pass	Pass
	6265	63	be (320MHz)	Pass	Pass
Band 6	6435	97	a	Pass	Pass
	6475	105	a	Pass	Pass
	6515	113	a	Pass	Pass
	6435	97	be (20MHz)	Pass	Pass
	6475	105	be (20MHz)	Pass	Pass
	6515	113	be (20MHz)	Pass	Pass
	6445	99	be (40MHz)	Pass	Pass
	6485	107	be (40MHz)	Pass	Pass
	6525	115	be (40MHz)	Pass	Pass
	6465	103	be (80MHz)	Pass	Pass
	6505	111	be (160MHz)	Pass	Pass
Band 5/6/7	6425	95	be (320MHz)	Pass	Pass
Band 7	6535	117	a	Pass	Pass
	6695	149	a	Pass	Pass
	6875	185	a	Pass	Pass
	6535	117	be (20MHz)	Pass	Pass
	6695	149	be (20MHz)	Pass	Pass
	6875	185	be (20MHz)	Pass	Pass
	6565	123	be (40MHz)	Pass	Pass
	6725	155	be (40MHz)	Pass	Pass
	6885	179	be (40MHz)	Pass	Pass
	6545	119	be (80MHz)	Pass	Pass
	6705	151	be (80MHz)	Pass	Pass
	6865	183	be (80MHz)	Pass	Pass
	6665	143	be (160MHz)	Pass	Pass
	6825	175	be (160MHz)	Pass	Pass
Band 6/7	6665	143	be (160MHz)	Pass	Pass
Band 7/8	6825	175	be (160MHz)	Pass	Pass
Band 8	6895	189	a	Pass	Pass
	6995	209	a	Pass	Pass
	7115	233	a	Pass	Pass
	6895	189	be (20MHz)	Pass	Pass
	6995	209	be (20MHz)	Pass	Pass
	7115	233	be (20MHz)	Pass	Pass
	6925	187	be (40MHz)	Pass	Pass
	7005	211	be (40MHz)	Pass	Pass
	7085	227	be (40MHz)	Pass	Pass
	6945	199	be (80MHz)	Pass	Pass
	7025	215	be (80MHz)	Pass	Pass
	6985	207	be (160MHz)	Pass	Pass
Band 7/8	6905	191	be (320MHz)	Pass	Pass

Table 7-40. In- Band Emissions Test Result – LPI

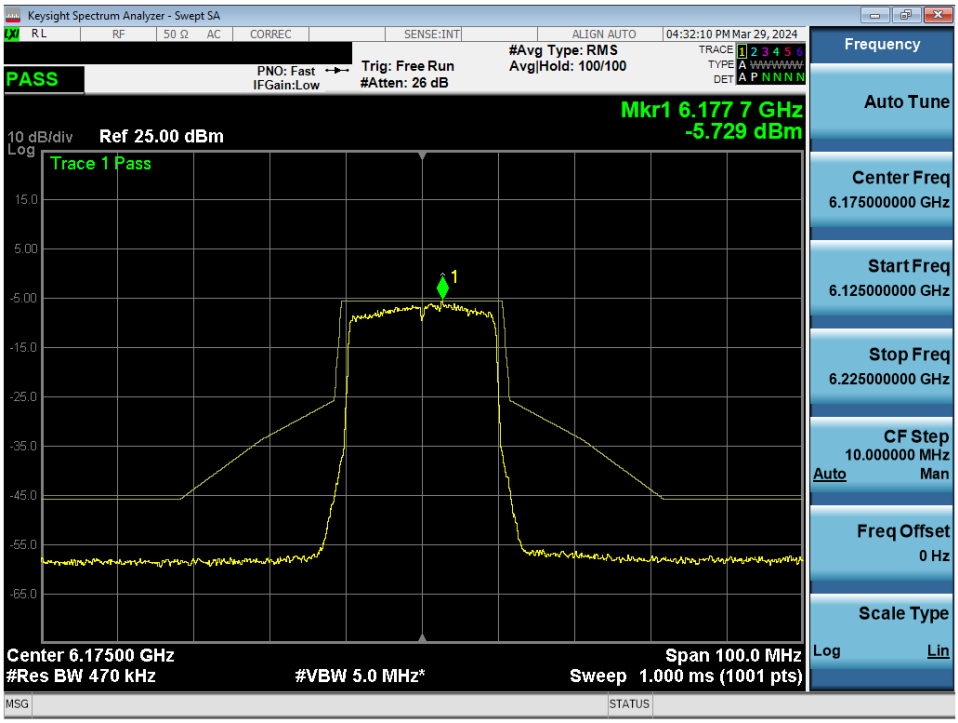
	Frequency [MHz]	Channel	802.11 MODE	In-Band Emission Ant1	In-Band Emission Ant2
Band 5	5935	2	a	Pass	Pass
	6175	45	a	Pass	Pass
	6415	93	a	Pass	Pass
	5935	2	be (20MHz)	Pass	Pass
	6175	45	be (20MHz)	Pass	Pass
	6415	93	be (20MHz)	Pass	Pass
	5695	3	be (40MHz)	Pass	Pass
	6165	43	be (40MHz)	Pass	Pass
	6405	91	be (40MHz)	Pass	Pass
	5985	7	be (80MHz)	Pass	Pass
	6145	39	be (80MHz)	Pass	Pass
	6385	87	be (80MHz)	Pass	Pass
	6025	15	be (160MHz)	Pass	Pass
	6185	47	be (160MHz)	Pass	Pass
	6345	79	be (160MHz)	Pass	Pass
	6105	31	be (320MHz)	Pass	Pass
Band 7	6535	117	a	Pass	Pass
	6695	149	a	Pass	Pass
	6875	185	a	Pass	Pass
	6535	117	be (20MHz)	Pass	Pass
	6695	149	be (20MHz)	Pass	Pass
	6875	185	be (20MHz)	Pass	Pass
	6565	123	be (40MHz)	Pass	Pass
	6725	155	be (40MHz)	Pass	Pass
	6885	179	be (40MHz)	Pass	Pass
	6545	119	be (80MHz)	Pass	Pass
	6705	151	be (80MHz)	Pass	Pass
	6865	183	be (80MHz)	Pass	Pass
	6665	143	be (160MHz)	Pass	Pass
	6825	175	be (160MHz)	Pass	Pass

Table 7-41. In- Band Emissions Test Result – SP

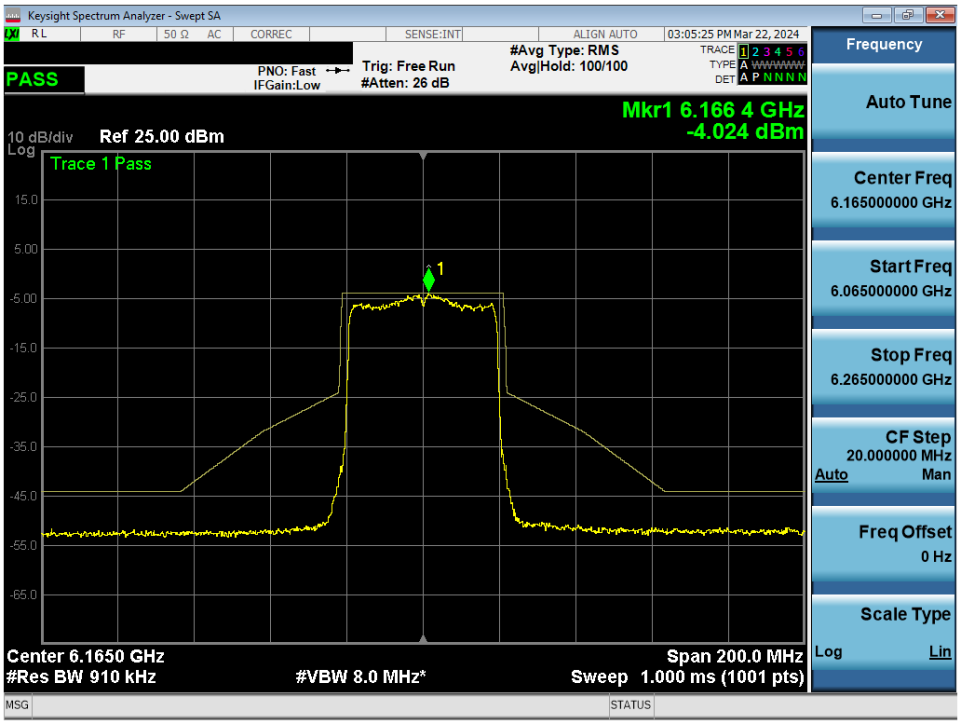
MIMO Antenna-1 In-Band Emission Measurements - (UNII Band 5)



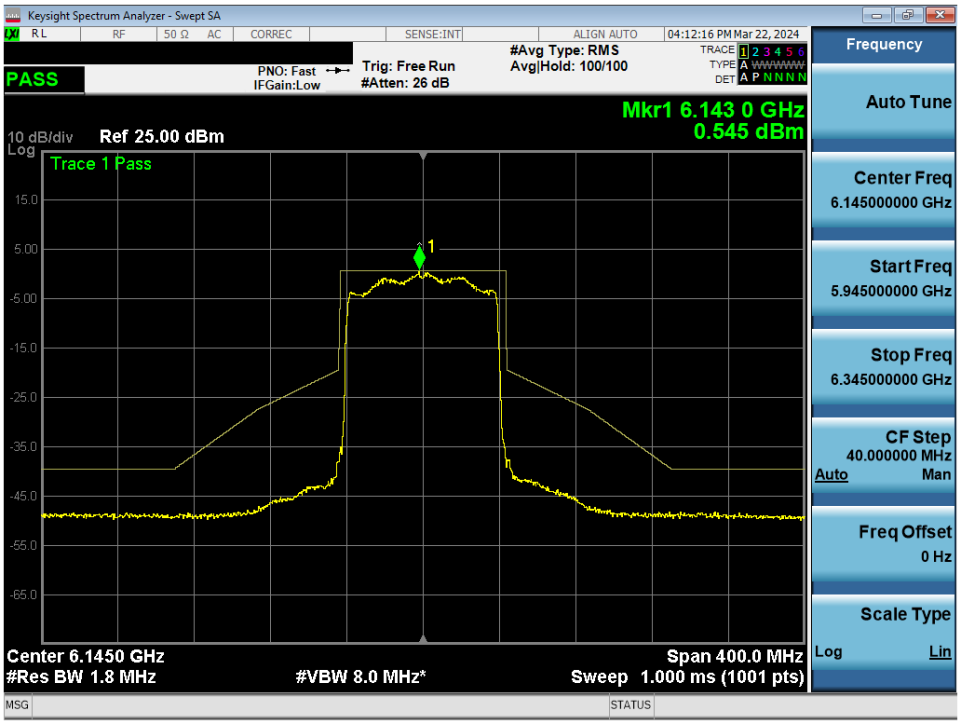
Plot 7-122. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 5) – Ch. 45)



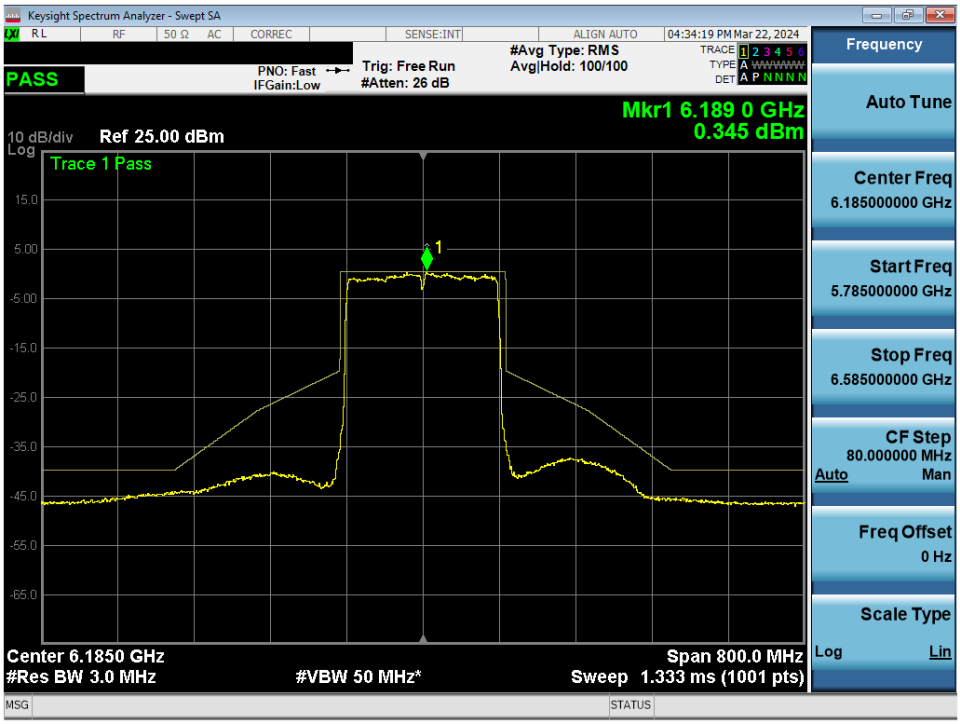
Plot 7-123. In-Band Emission MIMO ANT1 (20MHz 802.11ax/be (UNII Band 5) – Ch. 45)



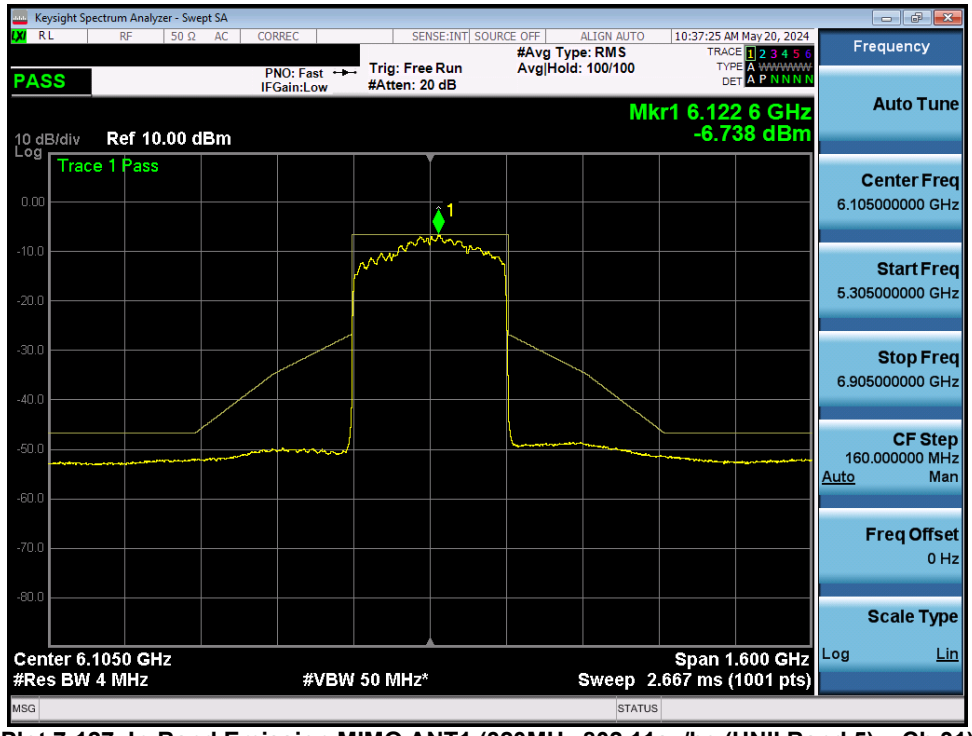
Plot 7-124. In-Band Emission MIMO ANT1 (40MHz 802.11ax/be (UNII Band 5) – Ch. 43)



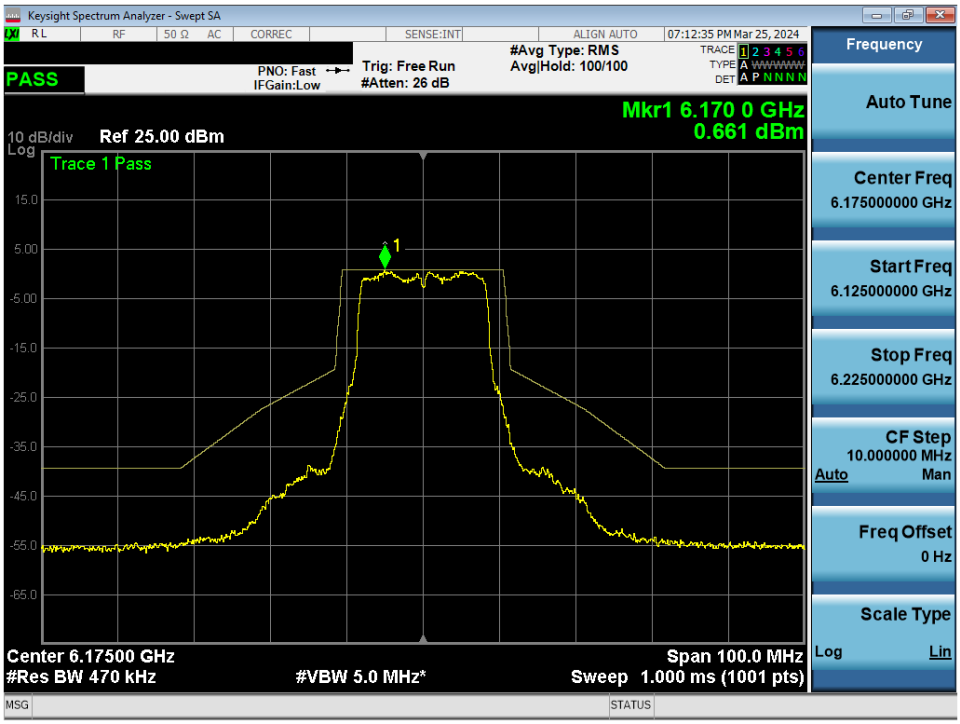
Plot 7-125. In-Band Emission MIMO ANT1 (80MHz 802.11ax/be (UNII Band 5) – Ch. 39)



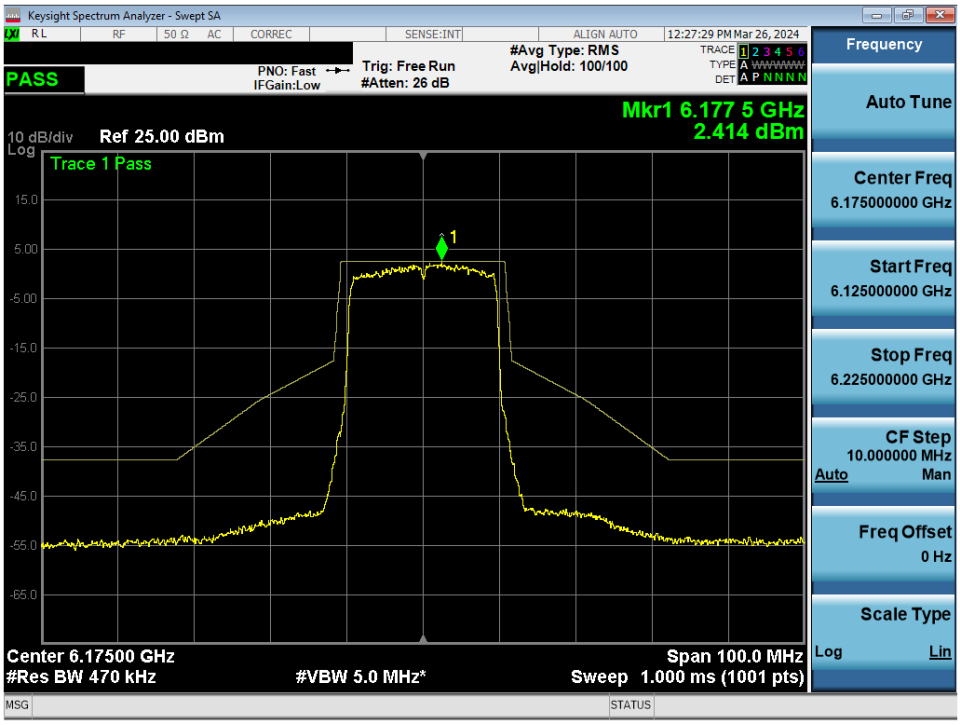
Plot 7-126. In-Band Emission MIMO ANT1 (160MHz 802.11ax/be (UNII Band 5) – Ch. 47)



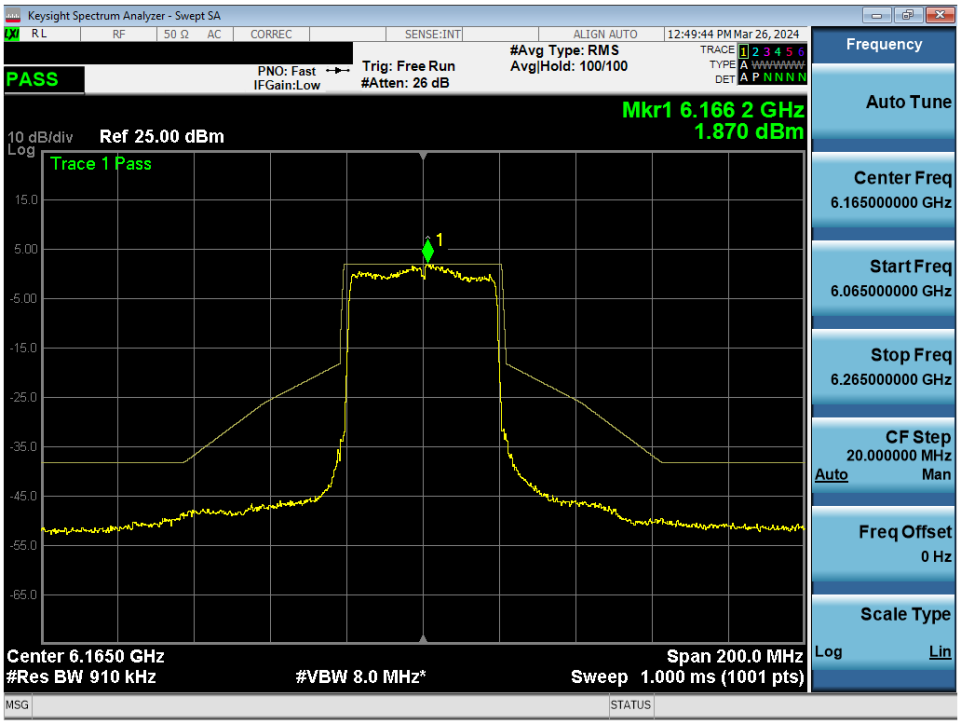
Plot 7-127. In-Band Emission MIMO ANT1 (320MHz 802.11ax/be (UNII Band 5) – Ch.31)



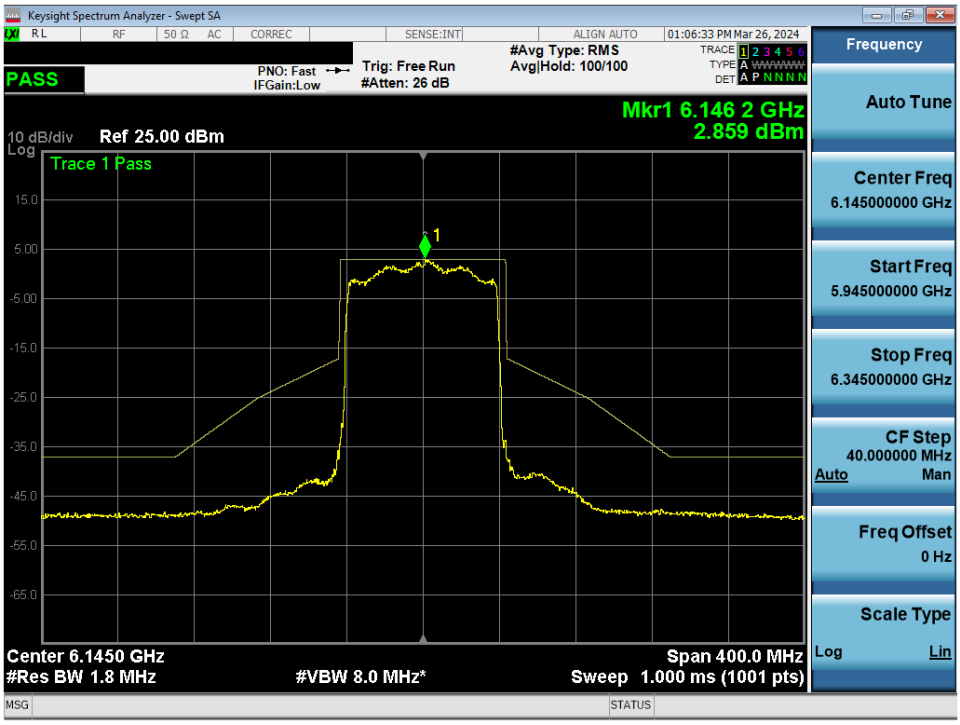
Plot 7-128. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 5) – Ch. 45) - SP



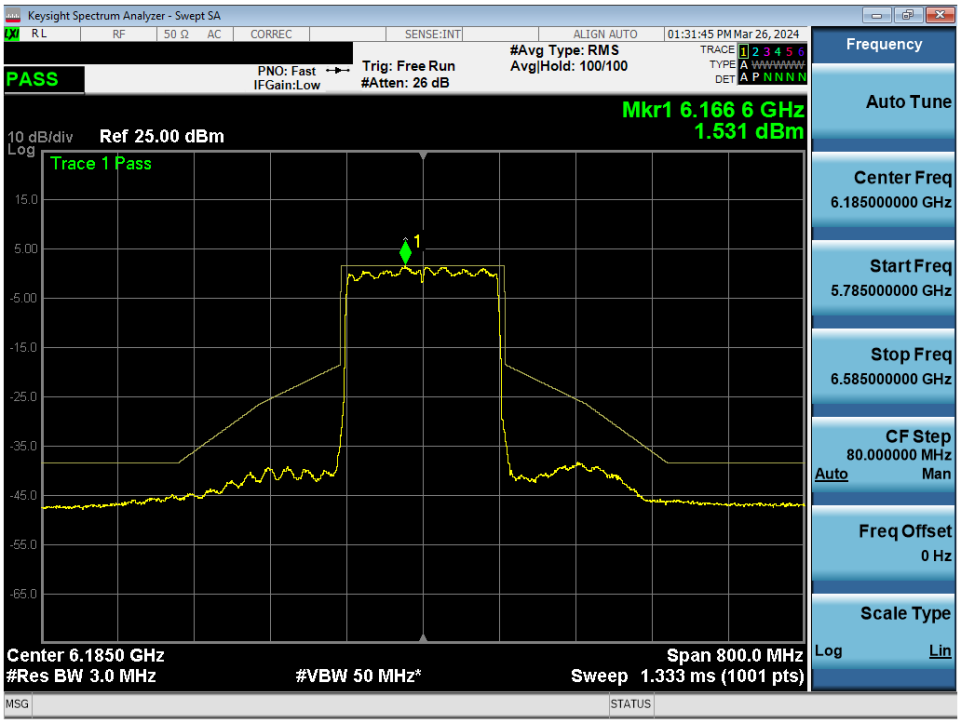
Plot 7-129. In-Band Emission MIMO ANT1 (20MHz 802.11ax/be (UNII Band 5) – Ch. 45) - SP



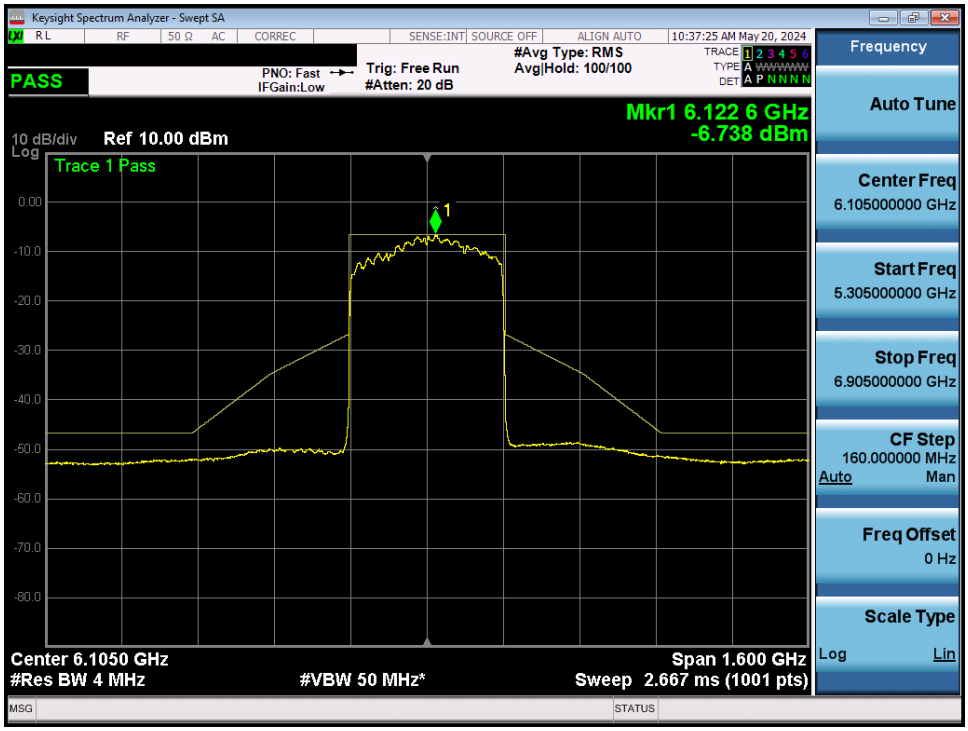
Plot 7-130. In-Band Emission MIMO ANT1 (40MHz 802.11ax/be (UNII Band 5) – Ch. 43) - SP



Plot 7-131. In-Band Emission MIMO ANT1 (80MHz 802.11ax/be (UNII Band 5) – Ch. 39) - SP

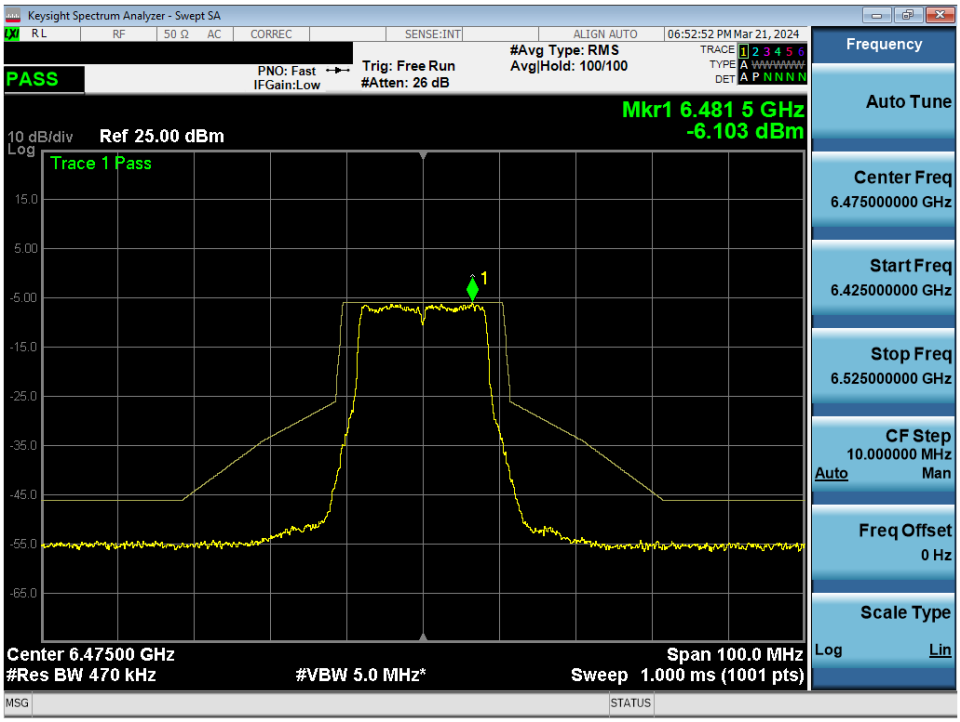


Plot 7-132. In-Band Emission MIMO ANT1 (160MHz 802.11ax/be (UNII Band 5) – Ch. 47) - SP

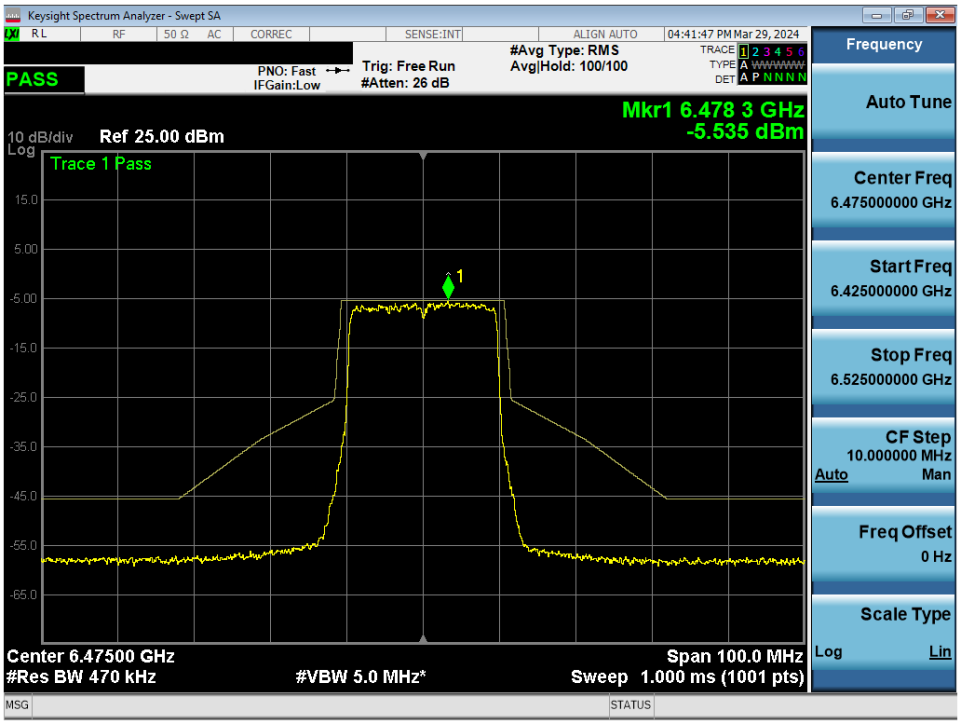


Plot 7-133. In-Band Emission MIMO ANT1 (320MHz 802.11ax/be (UNII Band 5) – Ch.31) - SP

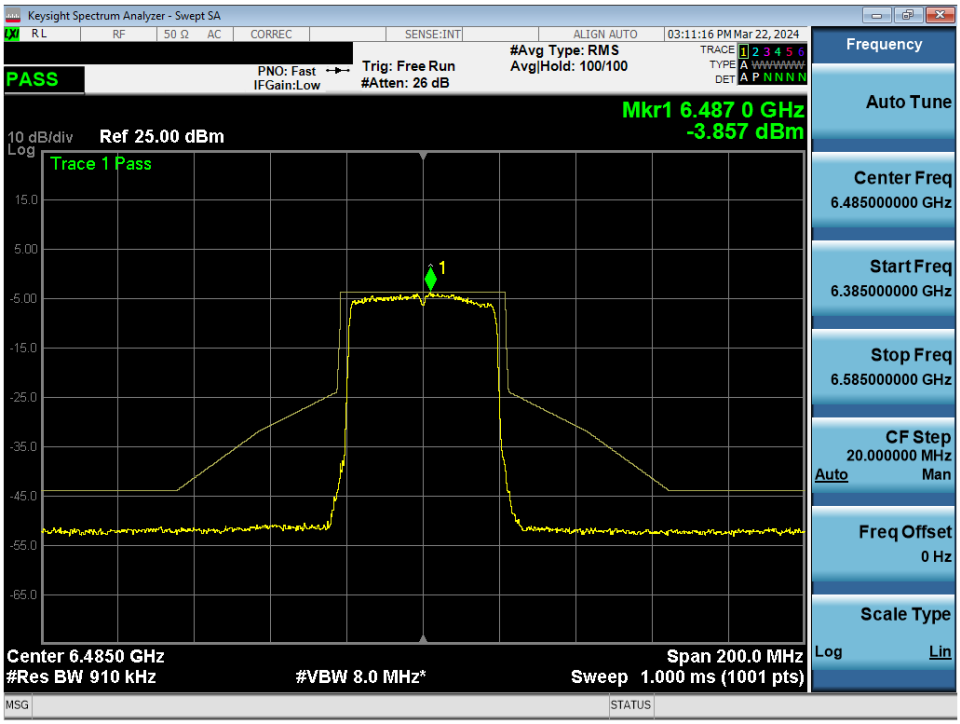
MIMO Antenna-1 In-Band Emission Measurements - (UNII Band 6)



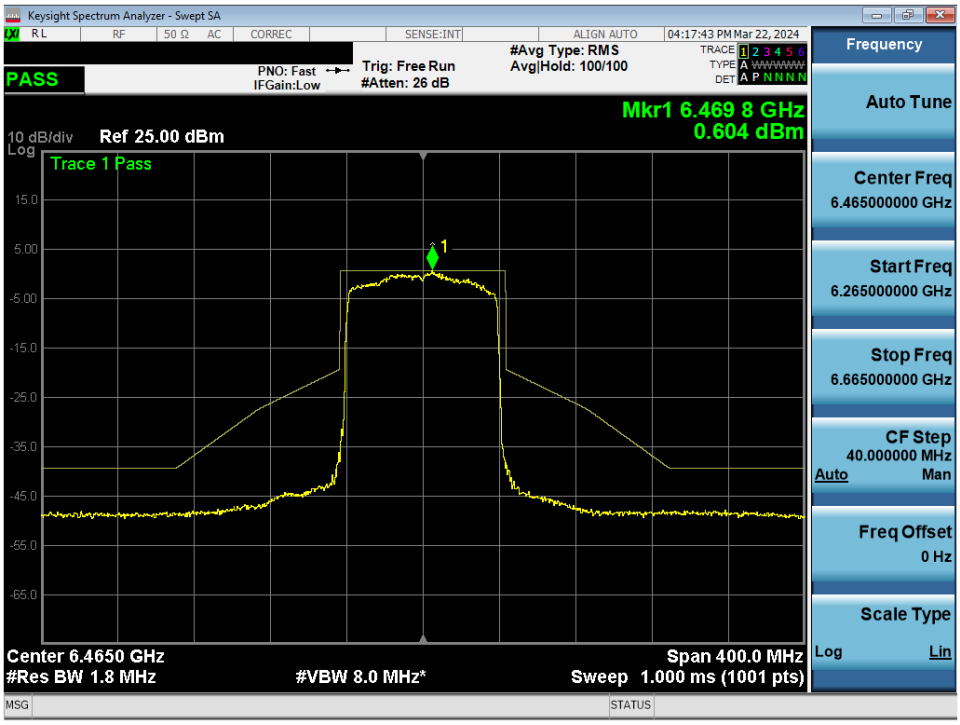
Plot 7-134. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 6) – Ch. 105)



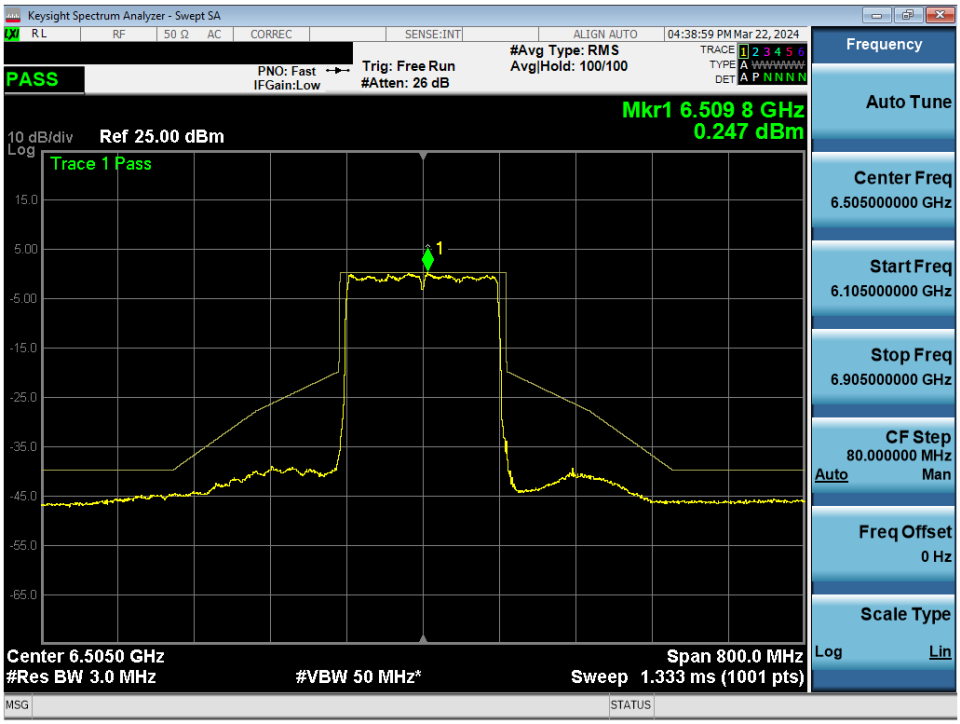
Plot 7-135. In-Band Emission MIMO ANT1 (20MHz 802.11ax/be (UNII Band 6) – Ch. 105)



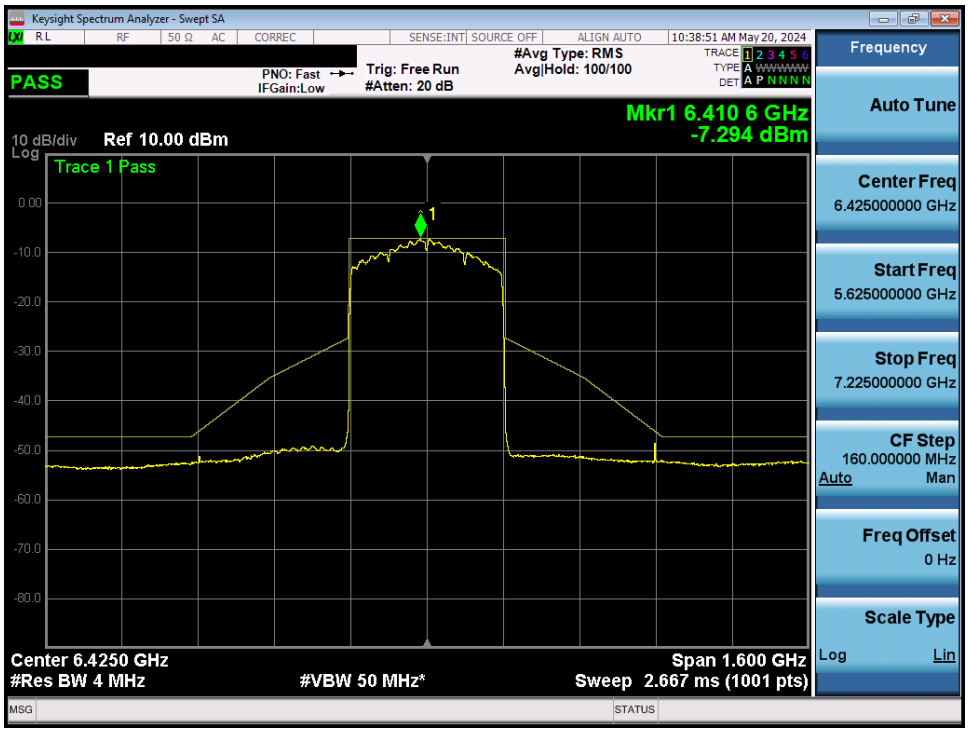
Plot 7-136. In-Band Emission MIMO ANT1 (40MHz 802.11ax/be (UNII Band 6) – Ch. 107)



Plot 7-137. In-Band Emission MIMO ANT1 (80MHz 802.11ax/be (UNII Band 6) – Ch. 103)

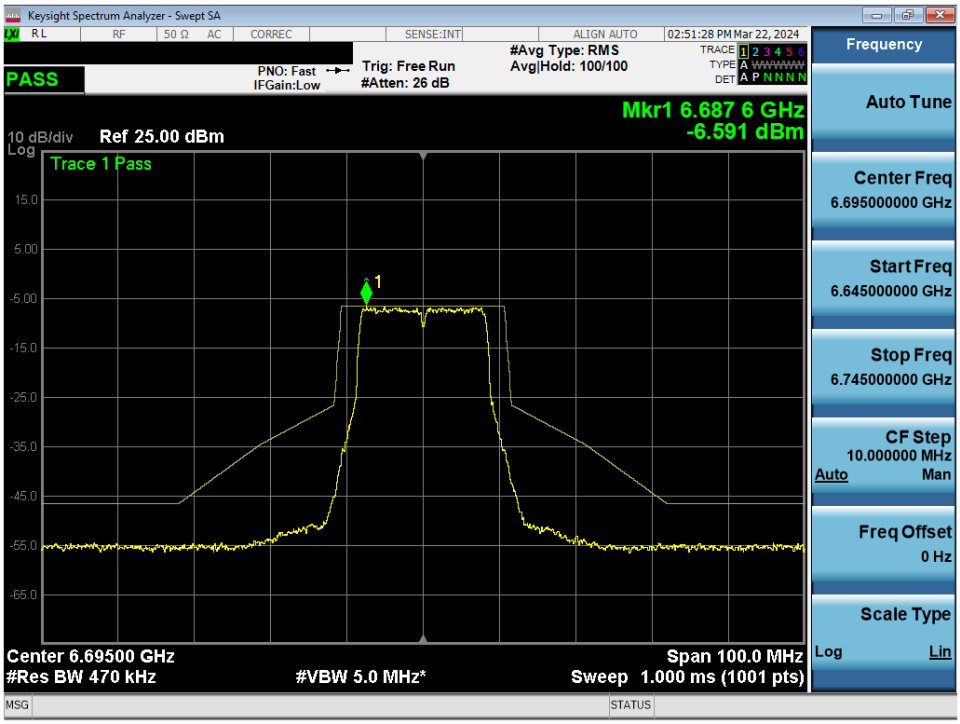


Plot 7-138. In-Band Emission MIMO ANT1 (160MHz 802.11ax/be (UNII Band 6) – Ch. 111)

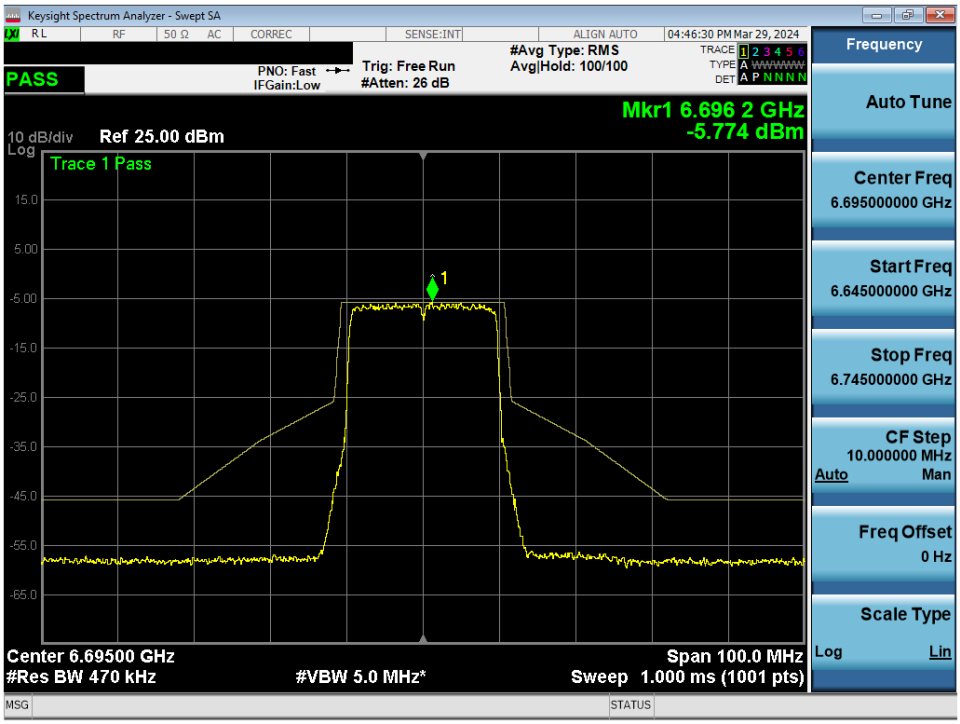


Plot 7-139. In-Band Emission MIMO ANT1 (320MHz 802.11ax/be (UNII Band 5/6/7) – Ch. 95)

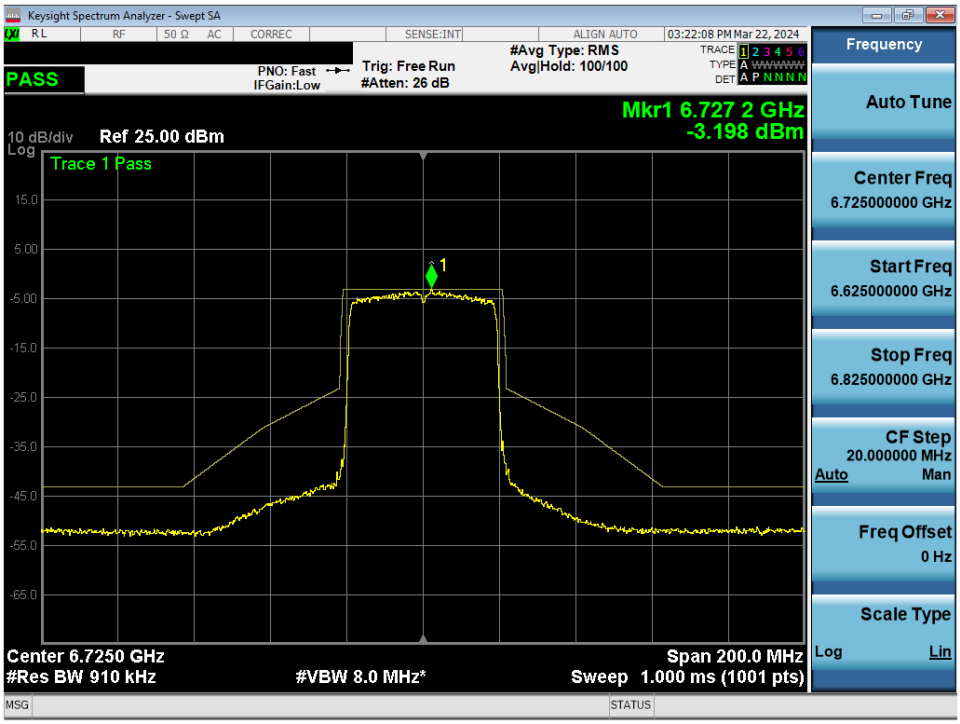
MIMO Antenna-1 In-Band Emission Measurements - (UNII Band 7)



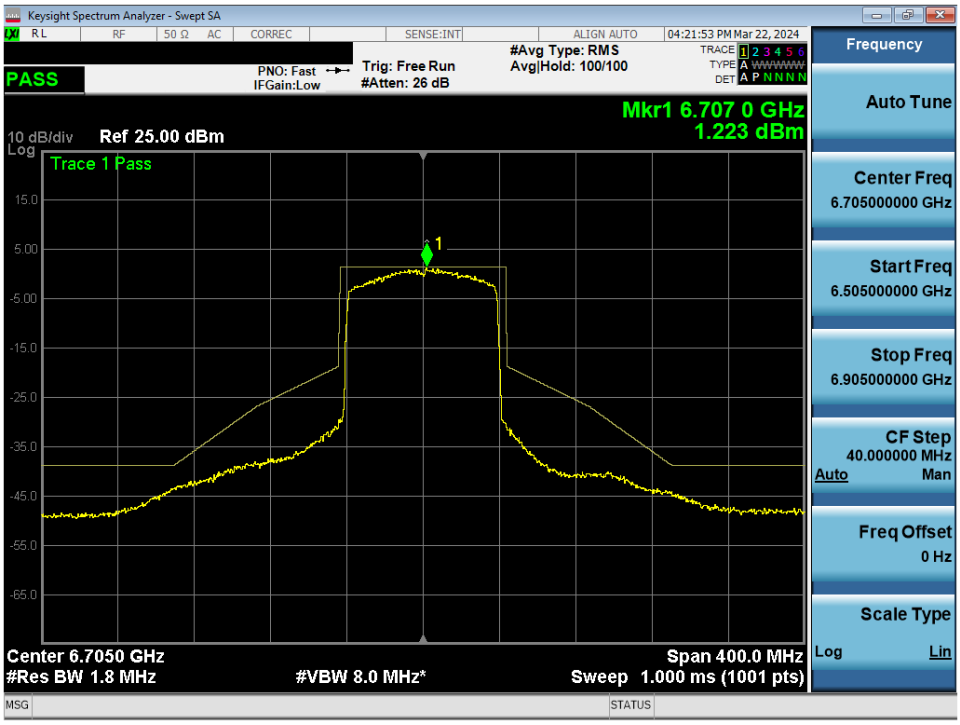
Plot 7-140. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 7) – Ch. 149)



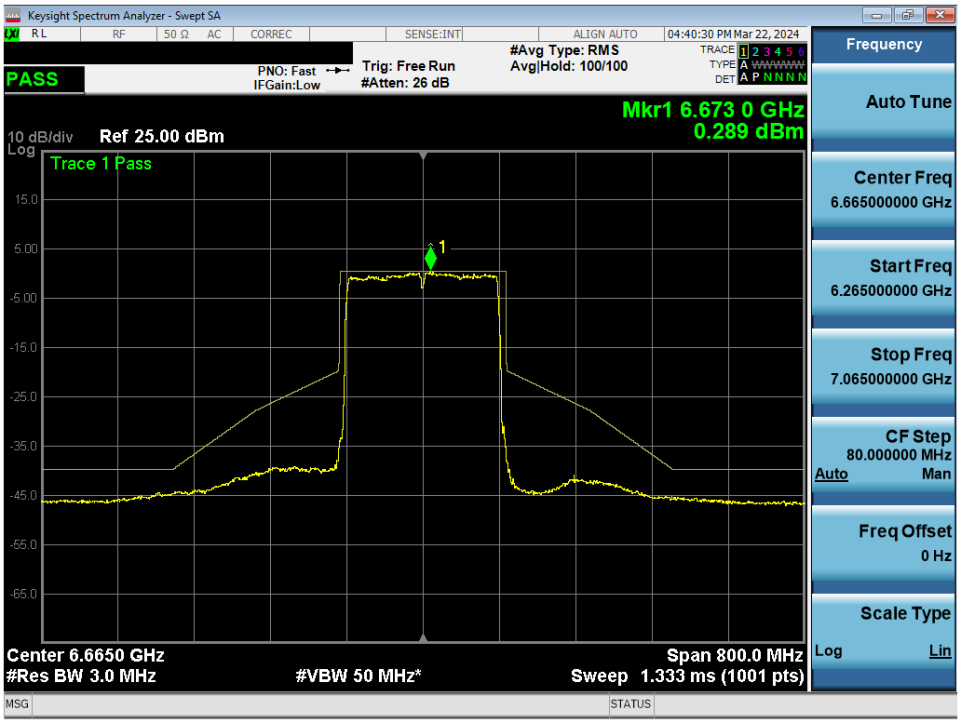
Plot 7-141. In-Band Emission MIMO ANT1 (20MHz 802.11ax/be (UNII Band 7) – Ch. 149)



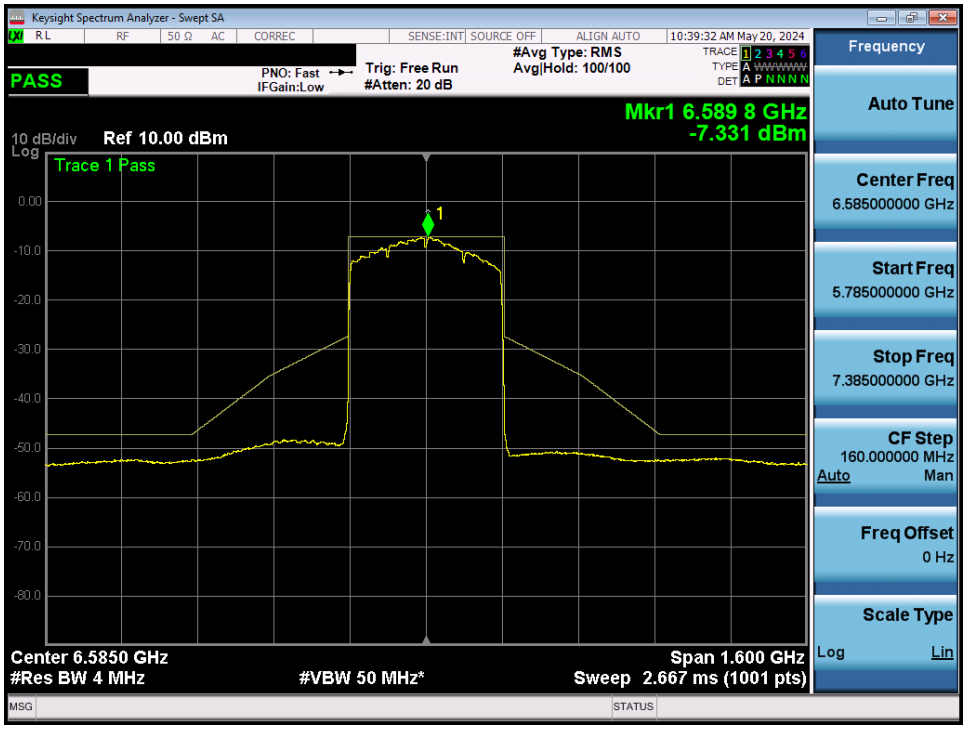
Plot 7-142. In-Band Emission MIMO ANT1 (40MHz 802.11ax/be (UNII Band 7) – Ch. 155)



Plot 7-143. In-Band Emission MIMO ANT1 (80MHz 802.11ax/be (UNII Band 7) – Ch. 151)

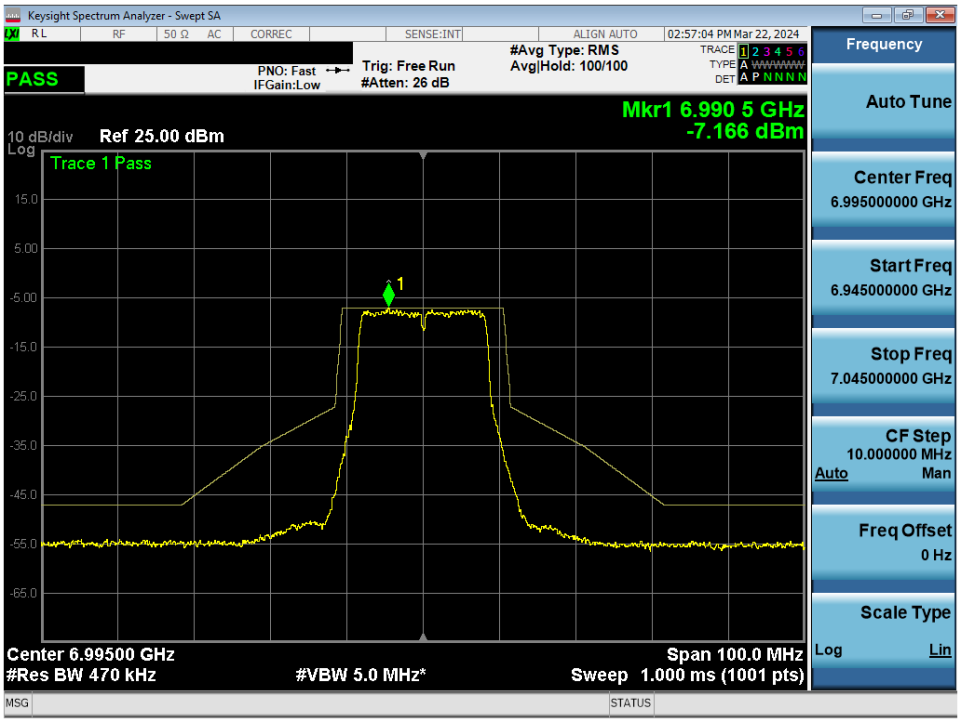


Plot 7-144. In-Band Emission MIMO ANT1 (160MHz 802.11ax/be (UNII Band 7) – Ch. 143)

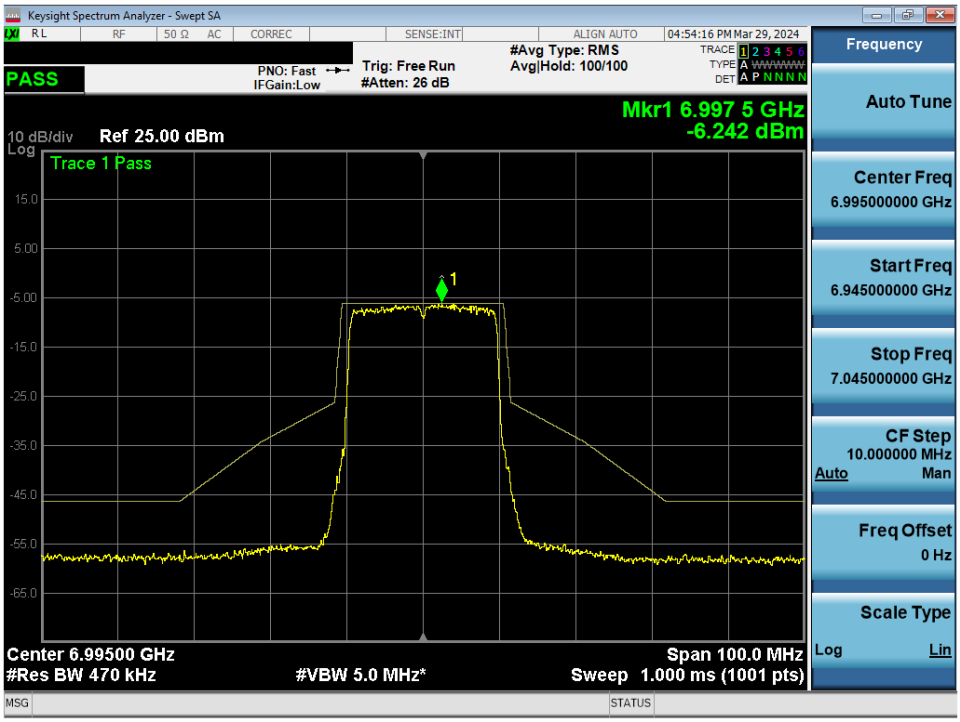


Plot 7-145. In-Band Emission MIMO ANT1 (320MHz 802.11ax/be (UNII Band 6/7) – Ch. 127)

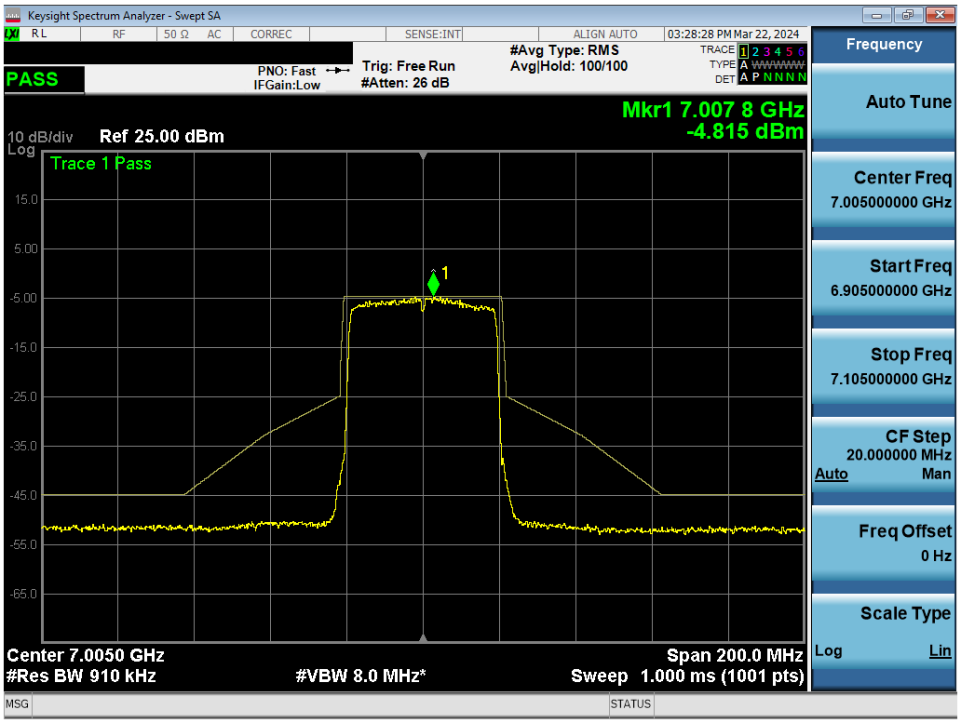
MIMO Antenna-1 In-Band Emission Measurements - (UNII Band 8)



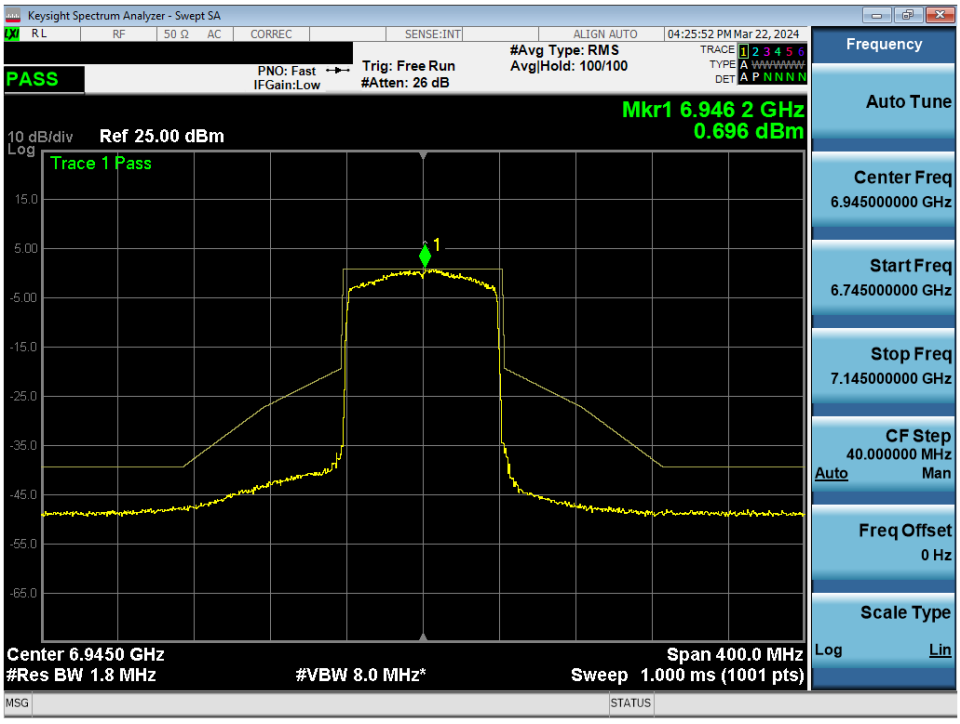
Plot 7-146. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 8) – Ch. 209)



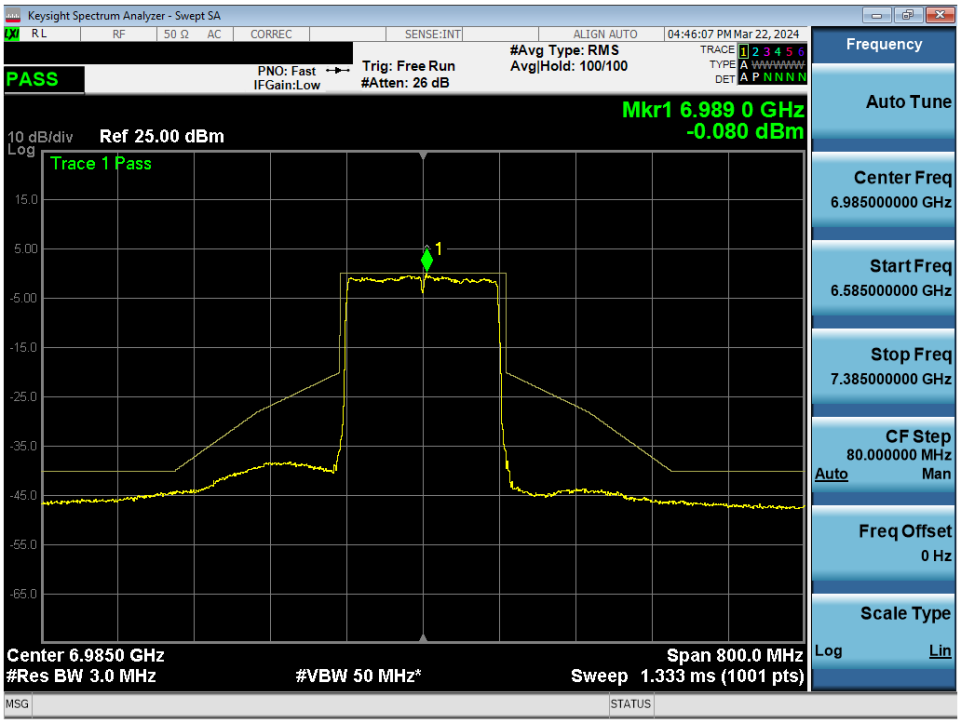
Plot 7-147. In-Band Emission MIMO ANT1 (20MHz 802.11ax/be (UNII Band 8) – Ch. 209)



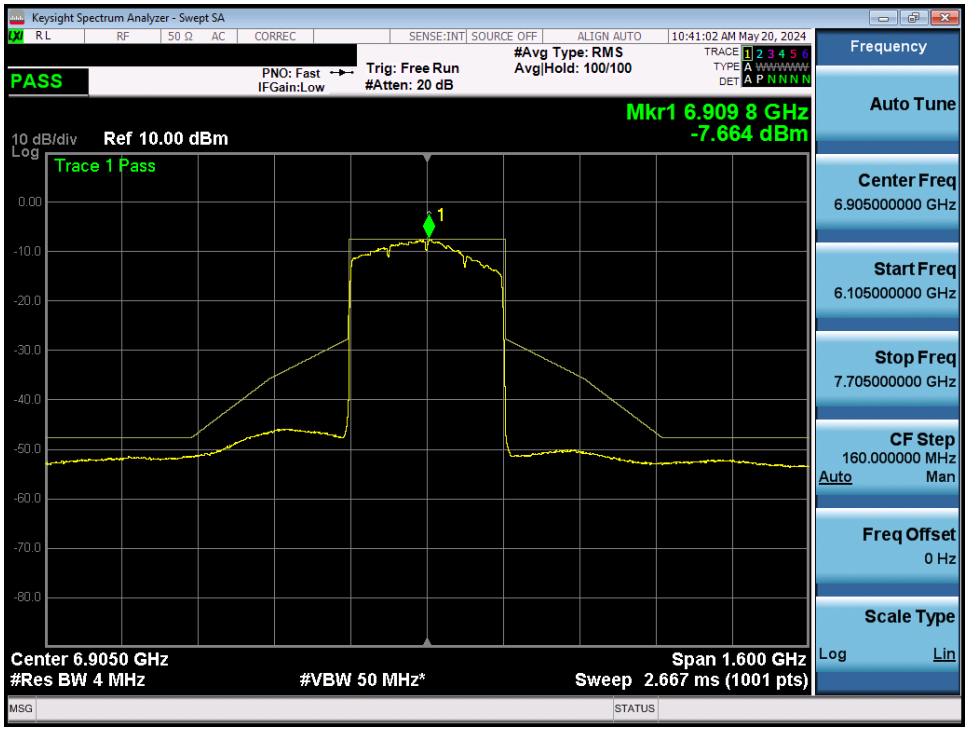
Plot 7-148. In-Band Emission MIMO ANT1 (40MHz 802.11ax/be (UNII Band 8) – Ch. 211)



Plot 7-149. In-Band Emission MIMO ANT1 (80MHz 802.11ax/be (UNII Band 8) – Ch. 199)

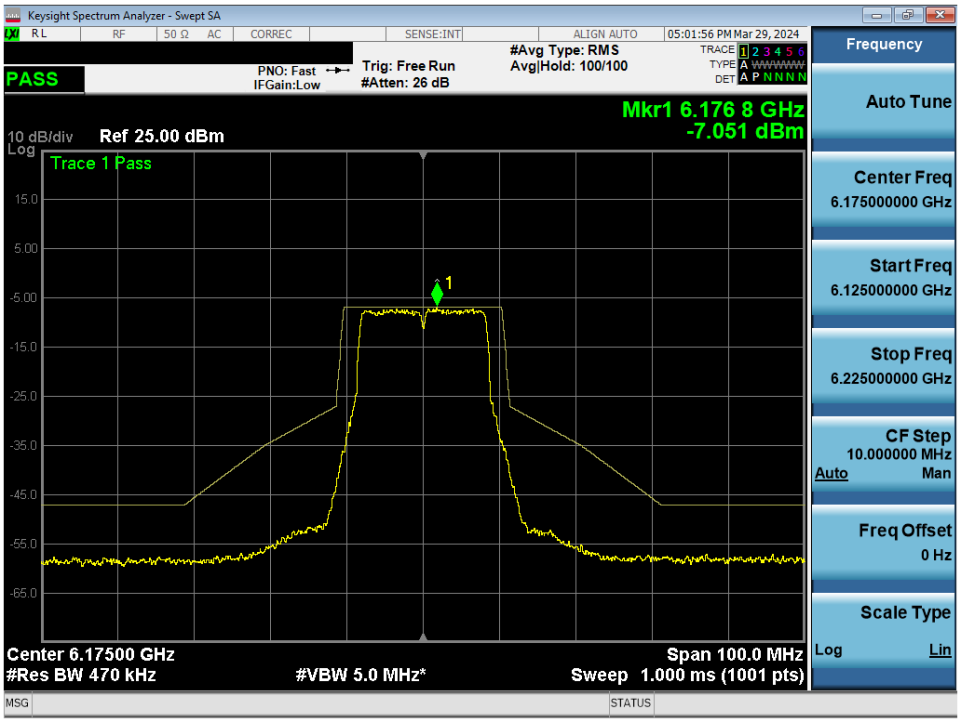


Plot 7-150. In-Band Emission MIMO ANT1 (160MHz 802.11ax/be (UNII Band 8) – Ch. 207)

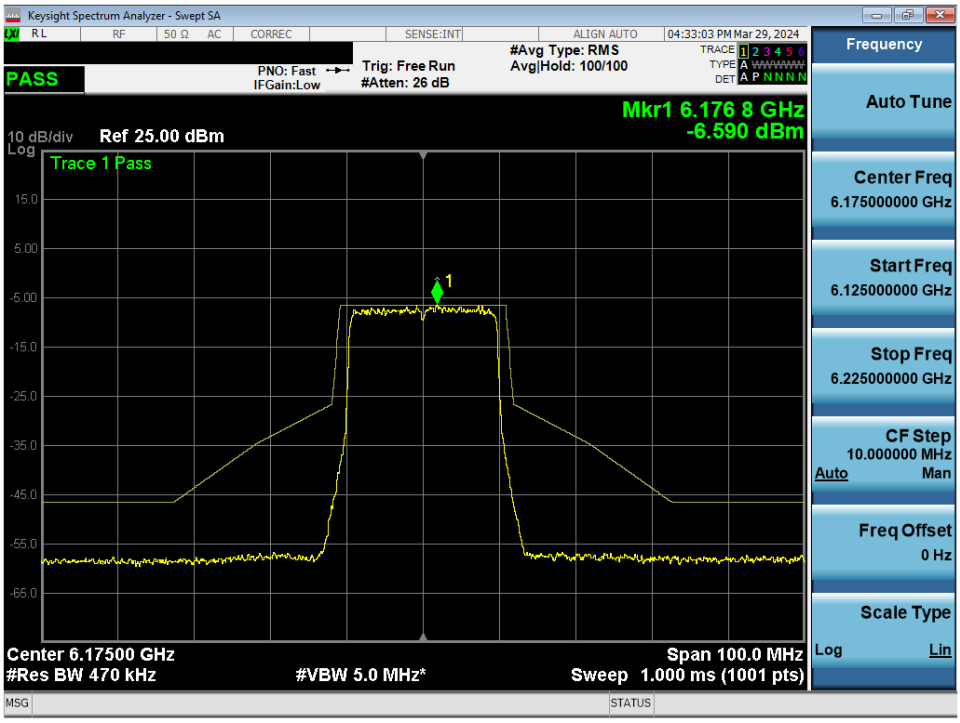


Plot 7-151. In-Band Emission MIMO ANT1 (320MHz 802.11ax/be (UNII Band 7/8) – Ch. 191)

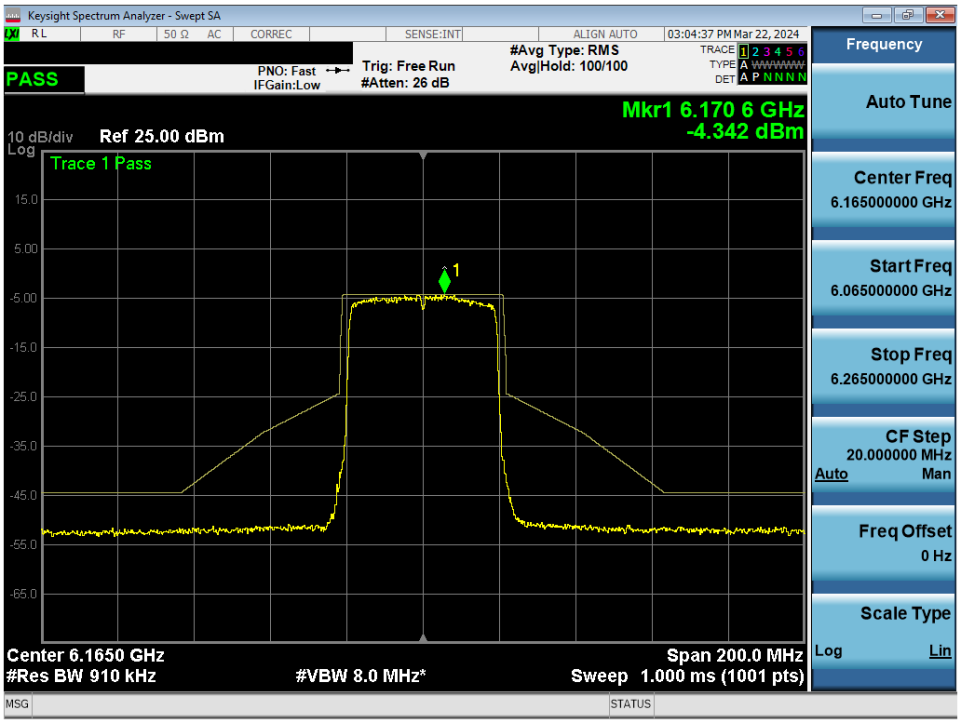
MIMO Antenna-2 In-Band Emission Measurements - (UNII Band 5)



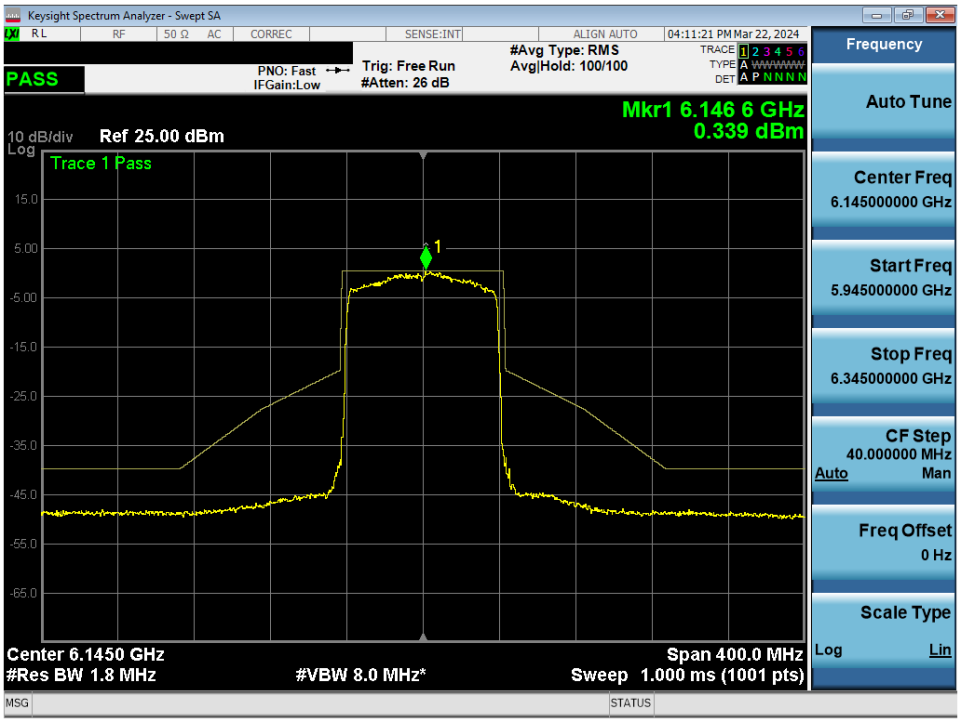
Plot 7-152. In-Band Emission MIMO ANT2 (20MHz 802.11a (UNII Band 5) – Ch. 45)



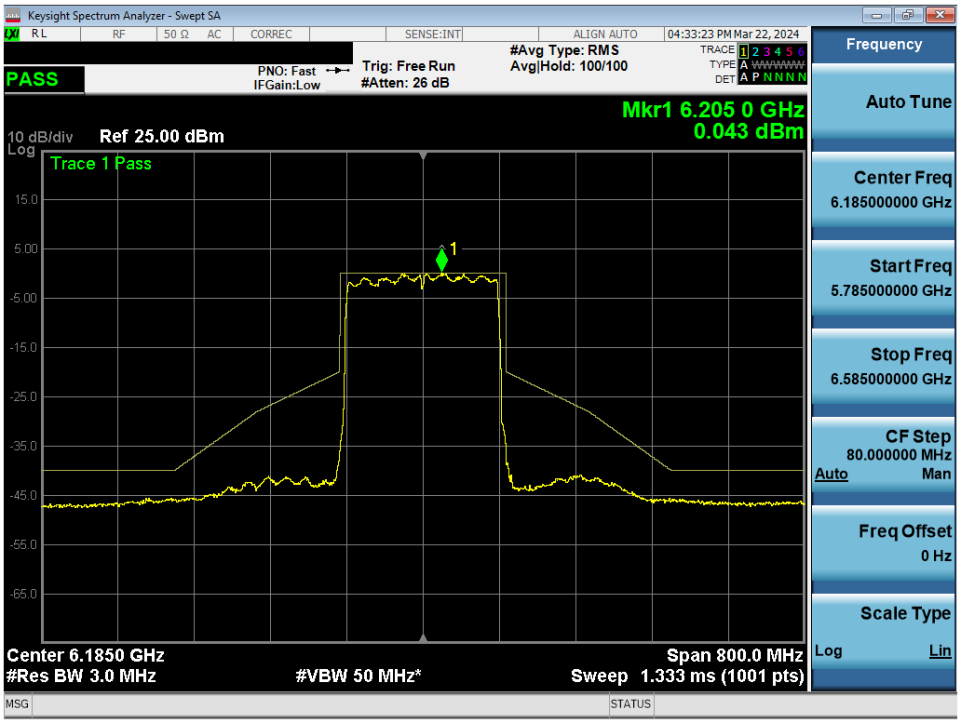
Plot 7-153. In-Band Emission MIMO ANT2 (20MHz 802.11ax/be (UNII Band 5) – Ch. 45)



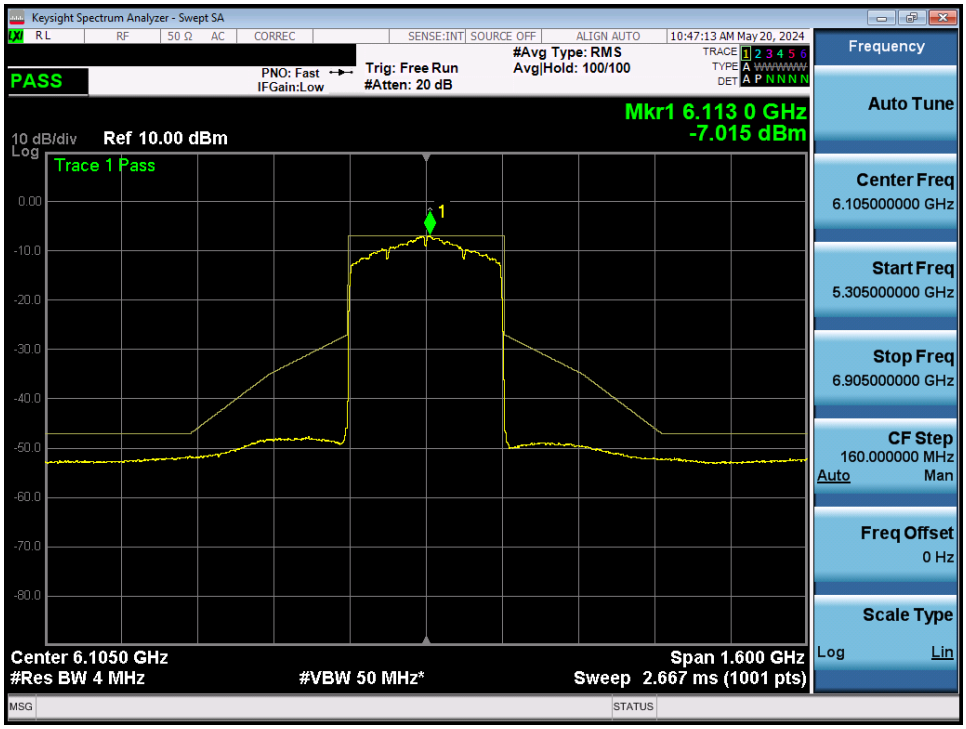
Plot 7-154. In-Band Emission MIMO ANT2 (40MHz 802.11ax/be (UNII Band 5) – Ch. 43)



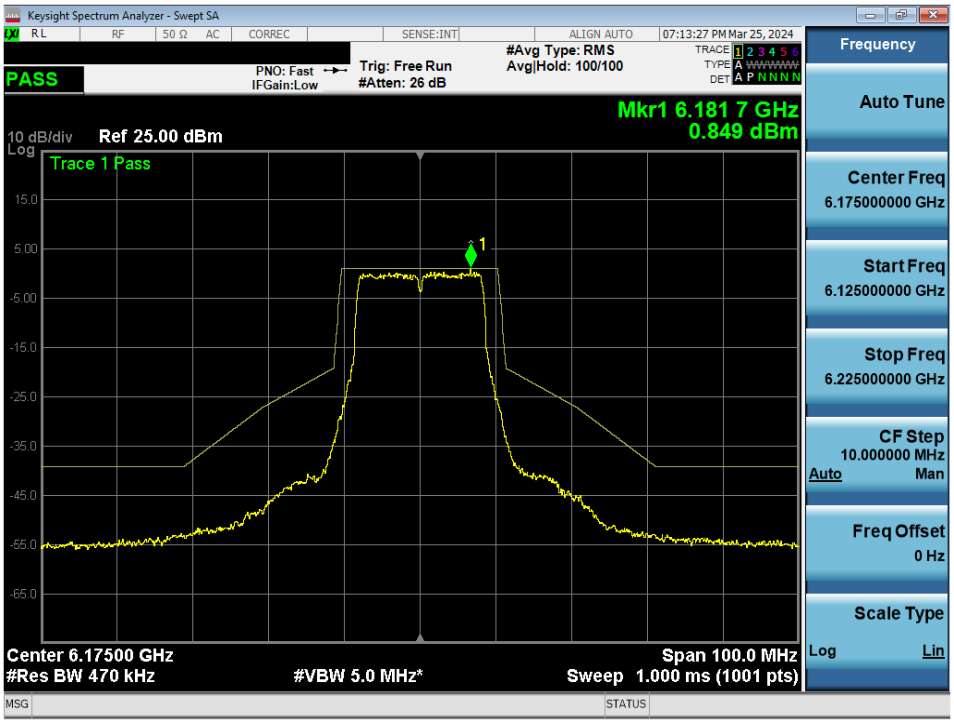
Plot 7-155. In-Band Emission MIMO ANT2 (80MHz 802.11ax/be (UNII Band 5) – Ch. 39)



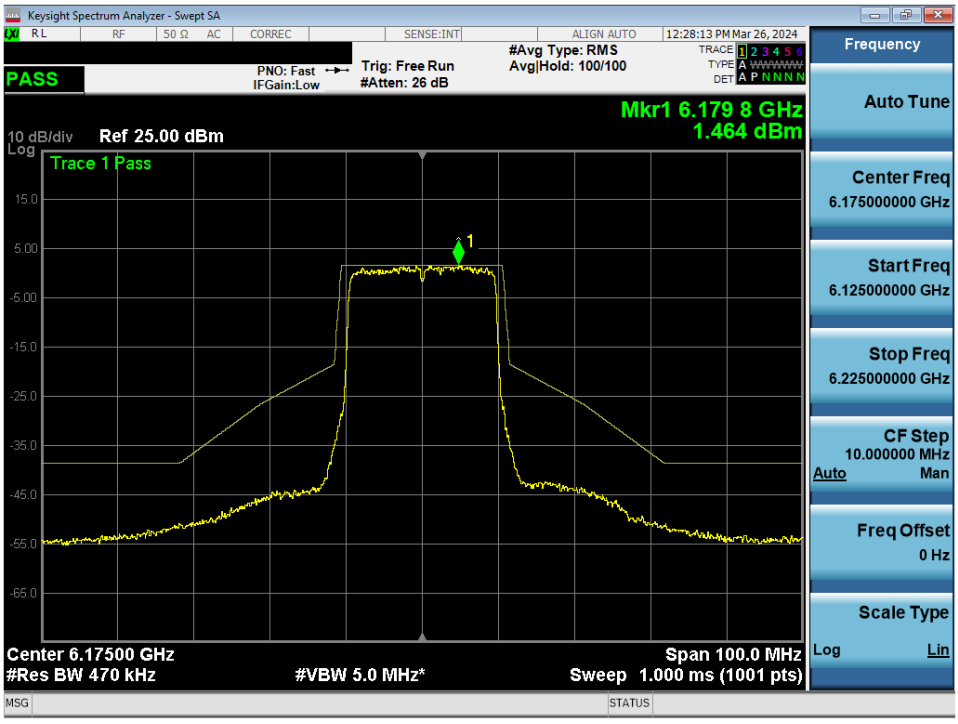
Plot 7-156. In-Band Emission MIMO ANT2 (160MHz 802.11ax/be (UNII Band 5) – Ch. 47)



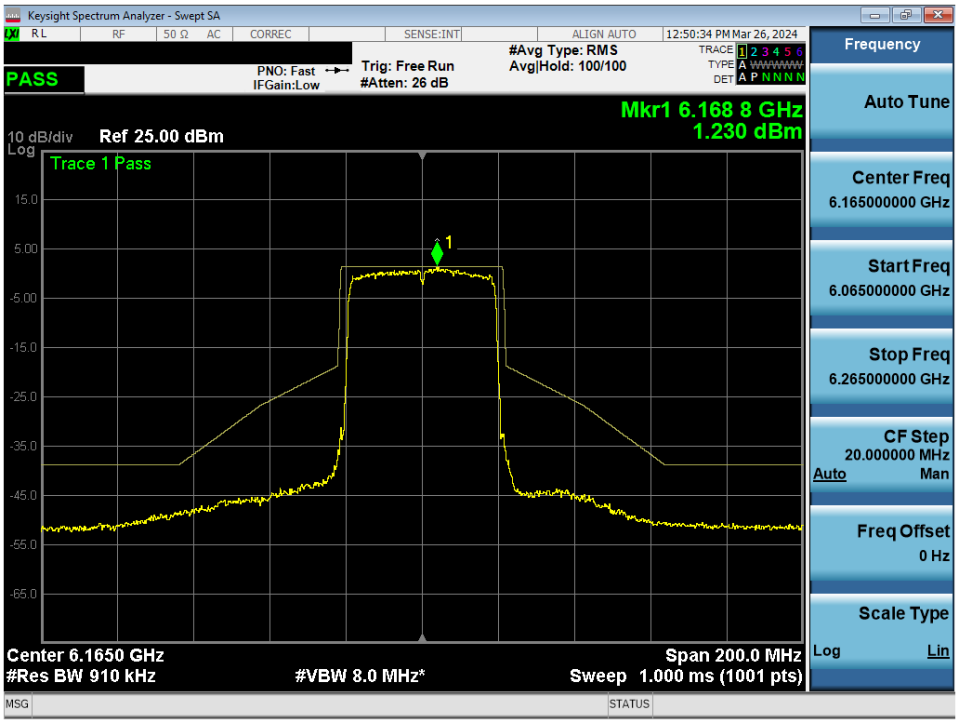
Plot 7-157. In-Band Emission MIMO ANT2 (320MHz 802.11be (UNII Band 5) – Ch.31)



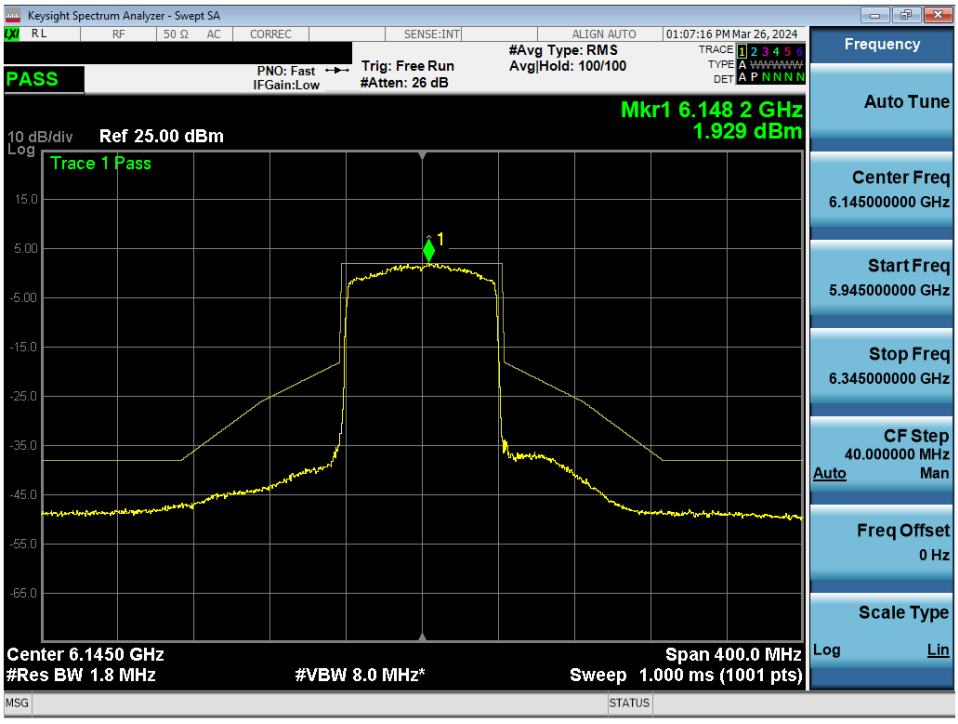
Plot 7-158. In-Band Emission MIMO ANT2 (20MHz 802.11a (UNII Band 5) – Ch. 45) - SP



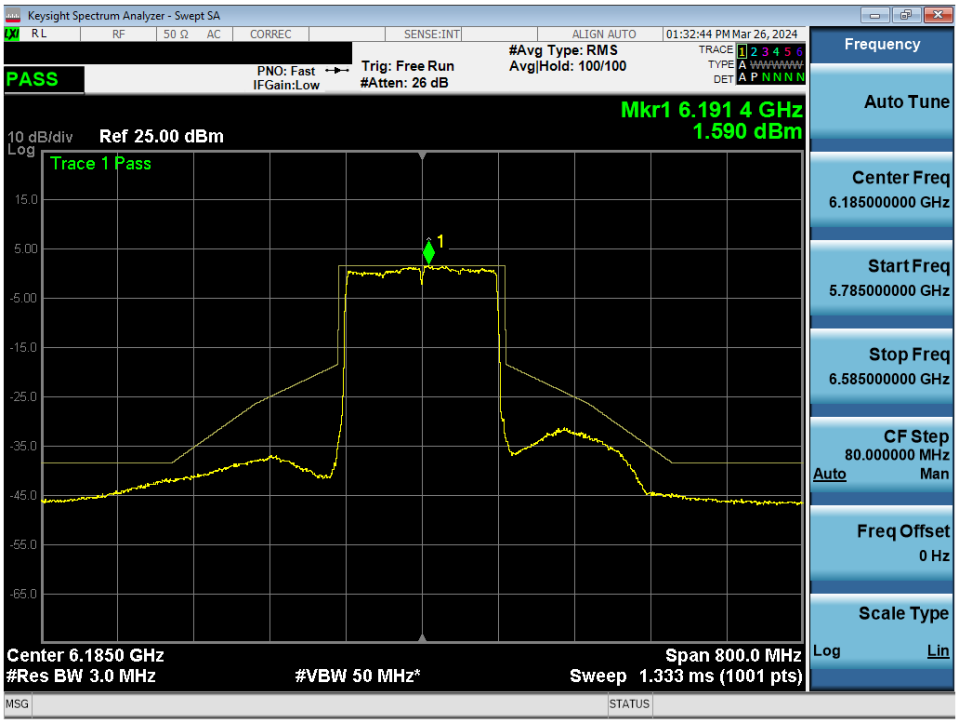
Plot 7-159. In-Band Emission MIMO ANT2 (20MHz 802.11ax/be (UNII Band 5) – Ch. 45) - SP



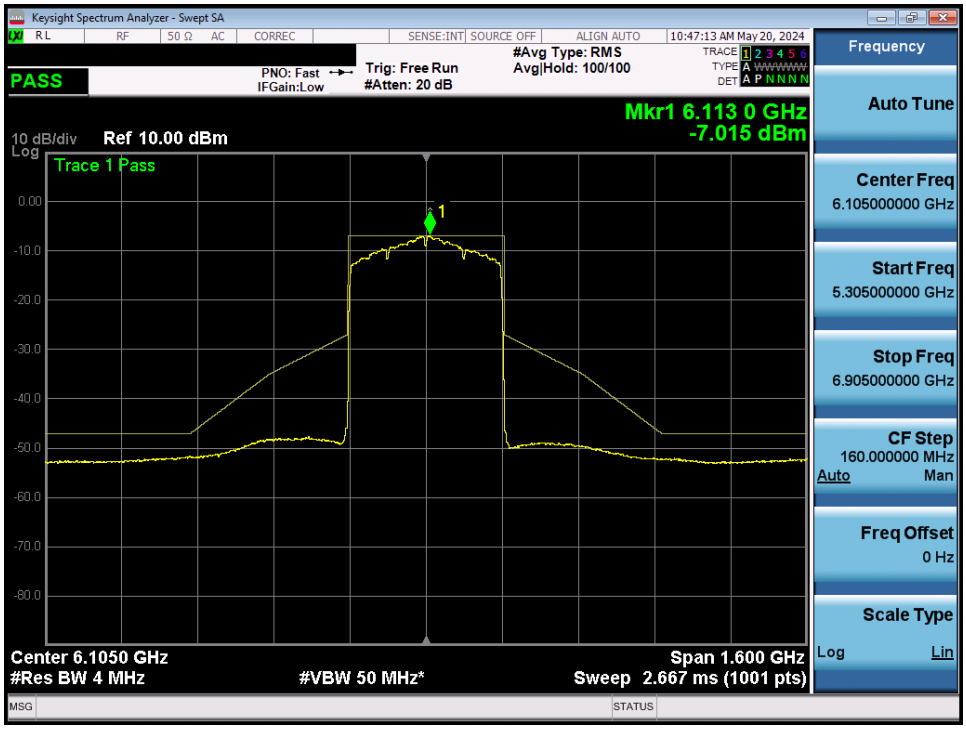
Plot 7-160. In-Band Emission MIMO ANT2 (40MHz 802.11ax/be (UNII Band 5) – Ch. 43) - SP



Plot 7-161. In-Band Emission MIMO ANT2 (80MHz 802.11ax/be (UNII Band 5) – Ch. 39) - SP

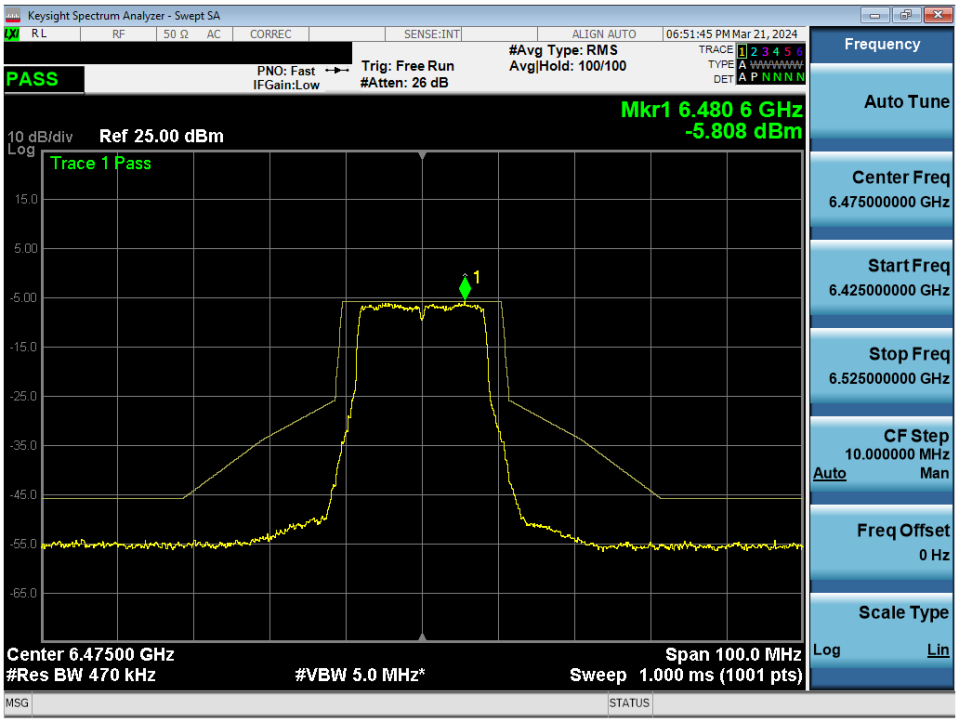


Plot 7-162. In-Band Emission MIMO ANT2 (160MHz 802.11ax/be (UNII Band 5) – Ch. 47) - SP

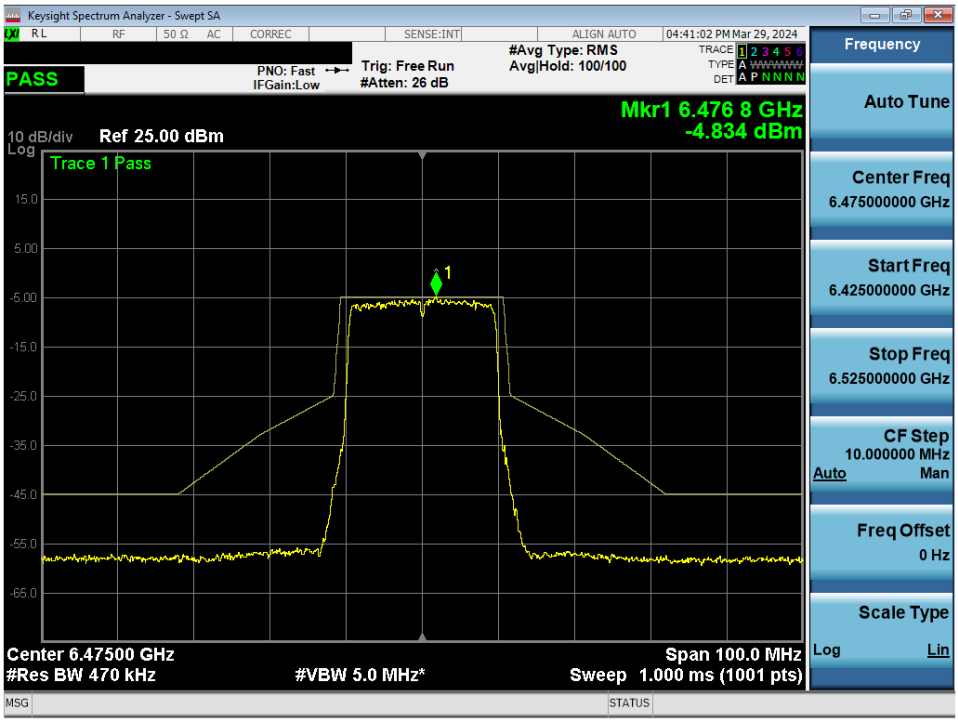


Plot 7-163. In-Band Emission MIMO ANT2 (320MHz 802.11ax/be (UNII Band 5) – Ch.31) - SP

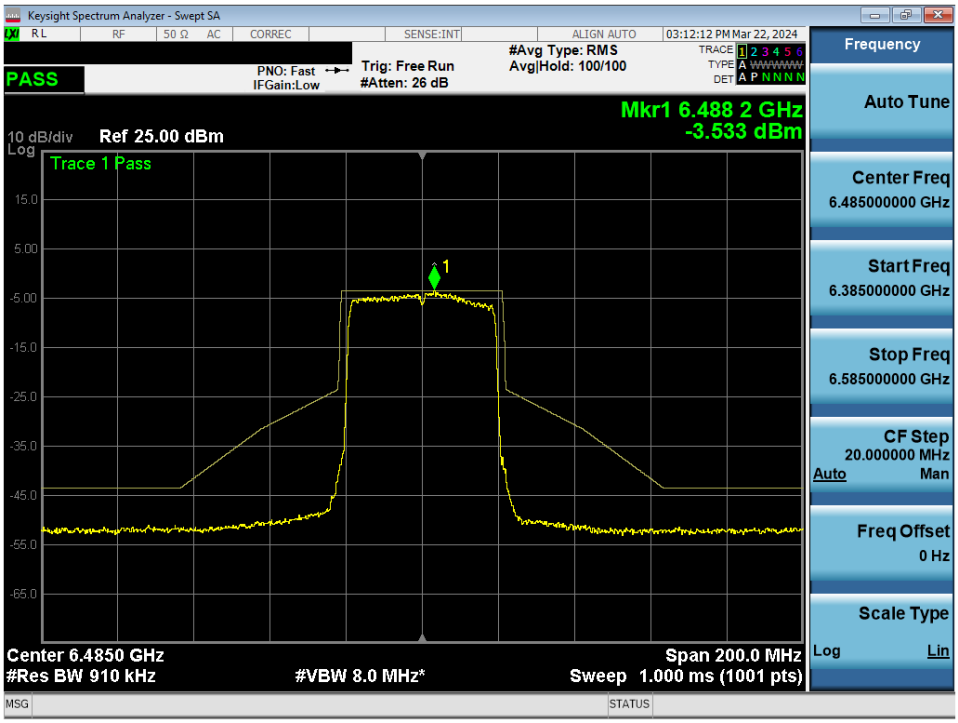
MIMO Antenna-2 In-Band Emission Measurements - (UNII Band 6)



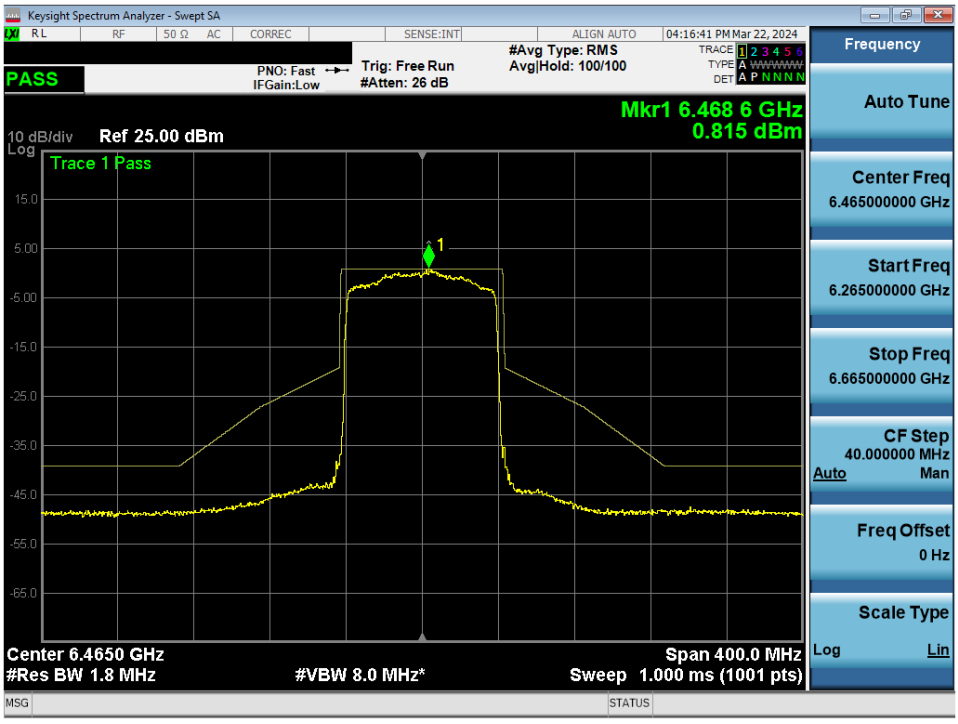
Plot 7-164. In-Band Emission MIMO ANT2 (20MHz 802.11a (UNII Band 6) – Ch. 105)



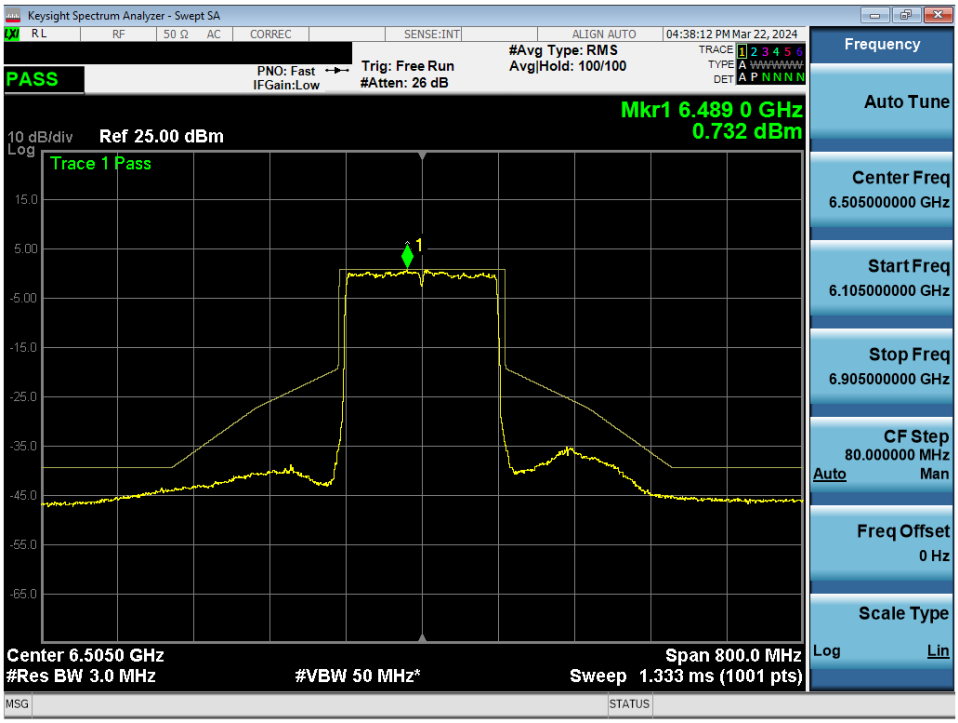
Plot 7-165. In-Band Emission MIMO ANT2 (20MHz 802.11ax/be (UNII Band 6) – Ch. 105)



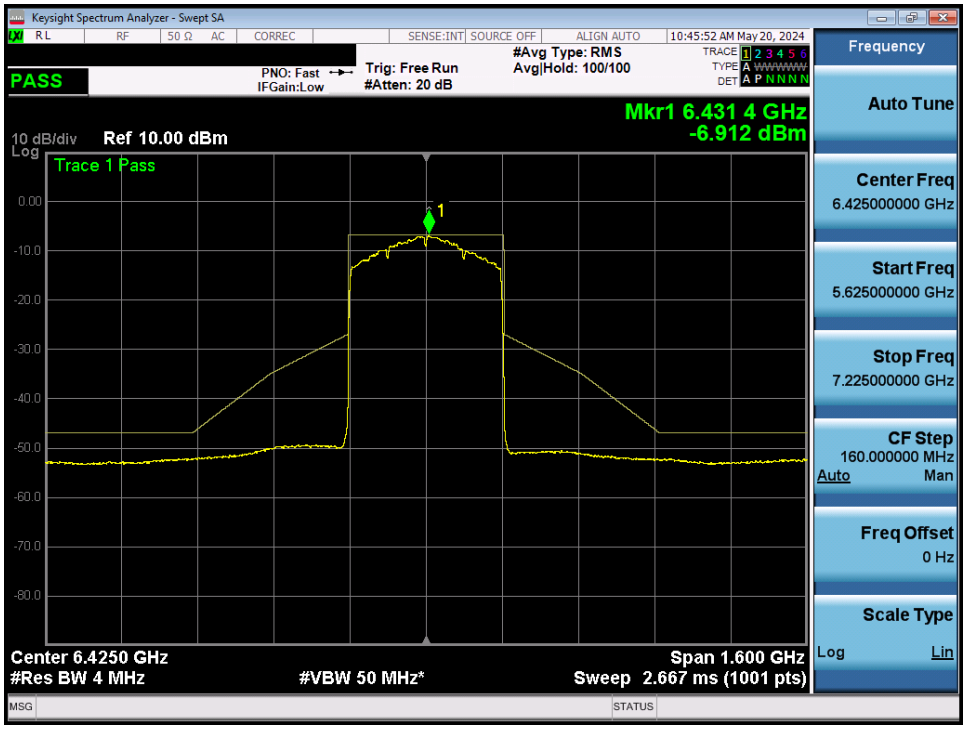
Plot 7-166. In-Band Emission MIMO ANT2 (40MHz 802.11ax/be (UNII Band 6) – Ch. 107)



Plot 7-167. In-Band Emission MIMO ANT2 (80MHz 802.11ax/be (UNII Band 6) – Ch. 103)

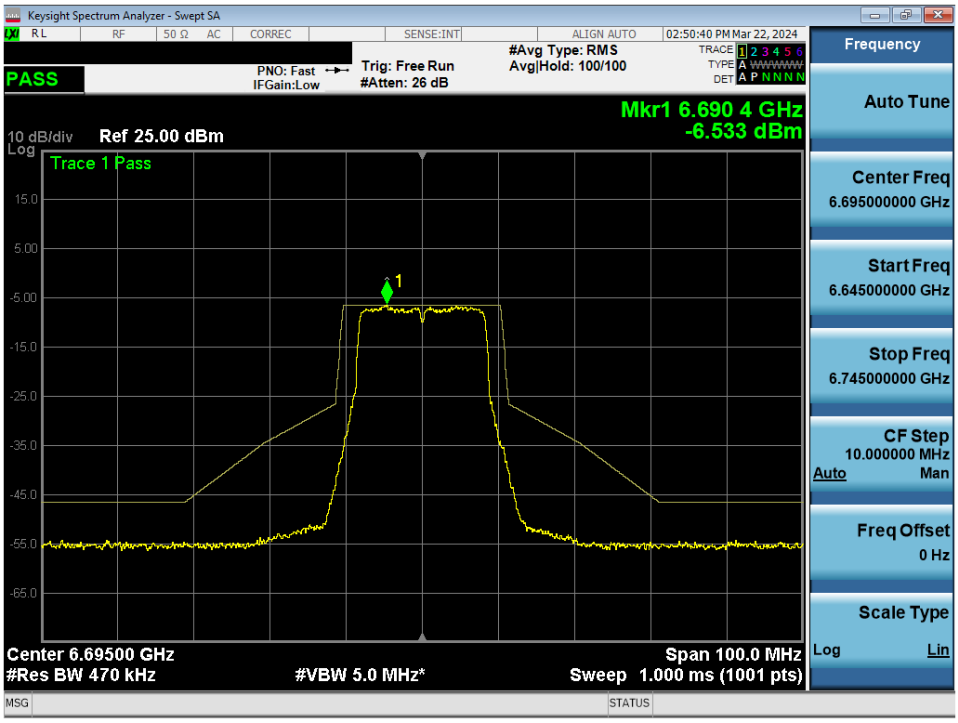


Plot 7-168. In-Band Emission MIMO ANT2 (160MHz 802.11ax/be (UNII Band 6) – Ch. 111)

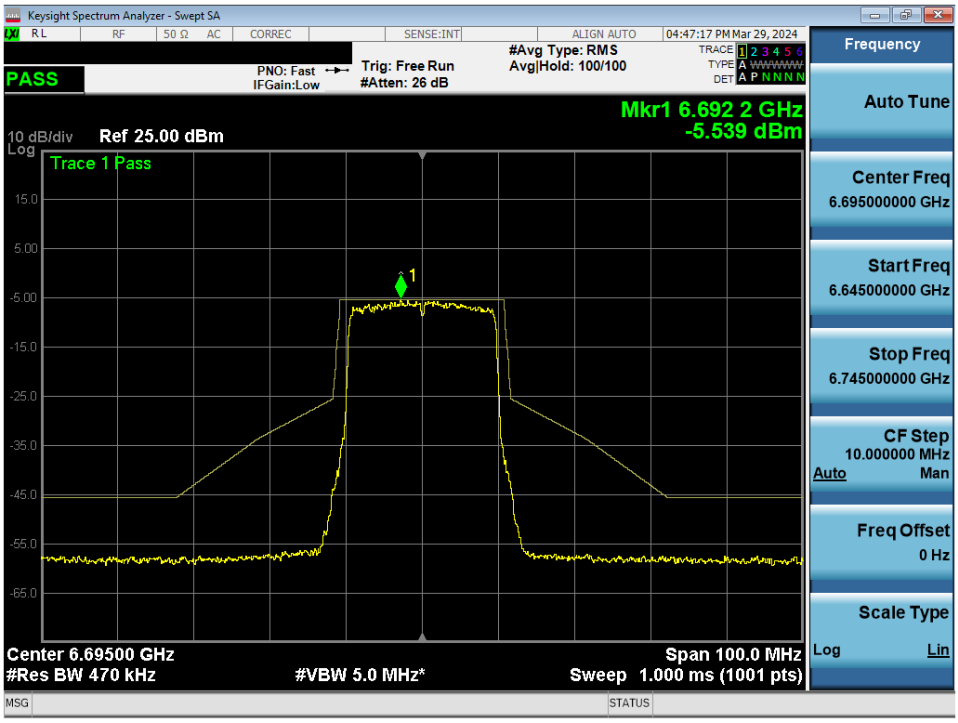


Plot 7-169. In-Band Emission MIMO ANT2 (320MHz 802.11ax/be (UNII Band 5/6/7) – Ch. 95)

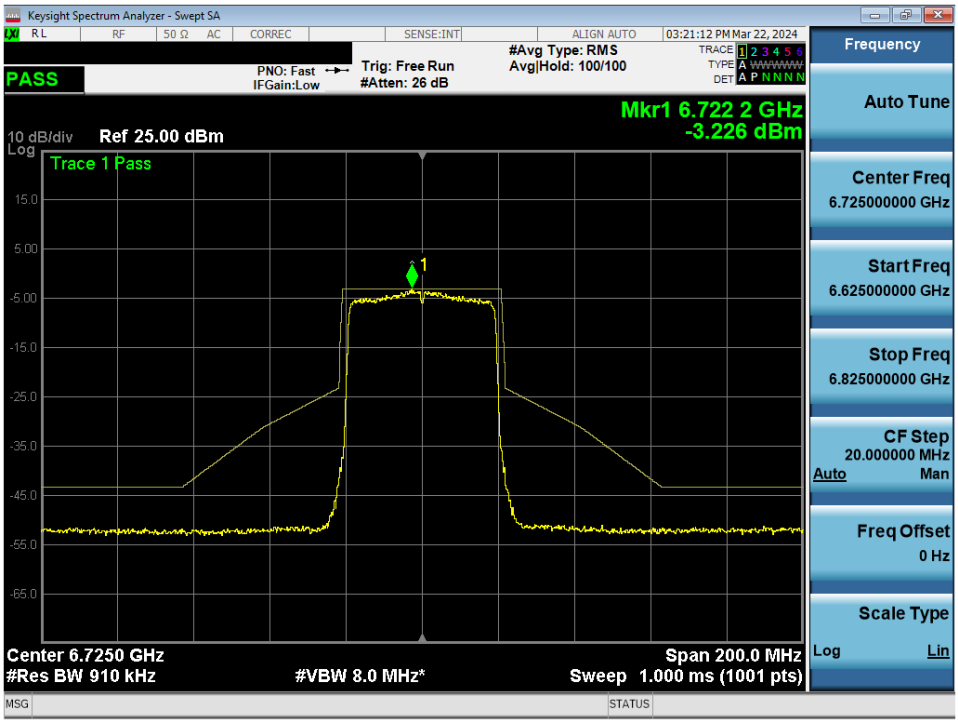
MIMO Antenna-2 In-Band Emission Measurements - (UNII Band 7)



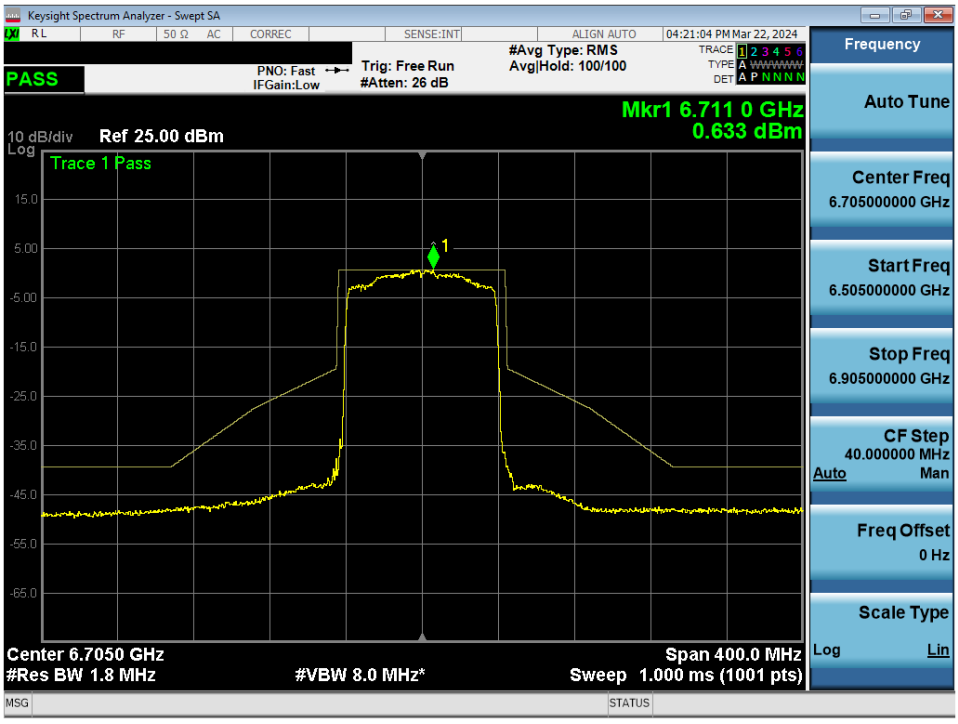
Plot 7-170. In-Band Emission MIMO ANT2 (20MHz 802.11a (UNII Band 7) – Ch. 149)



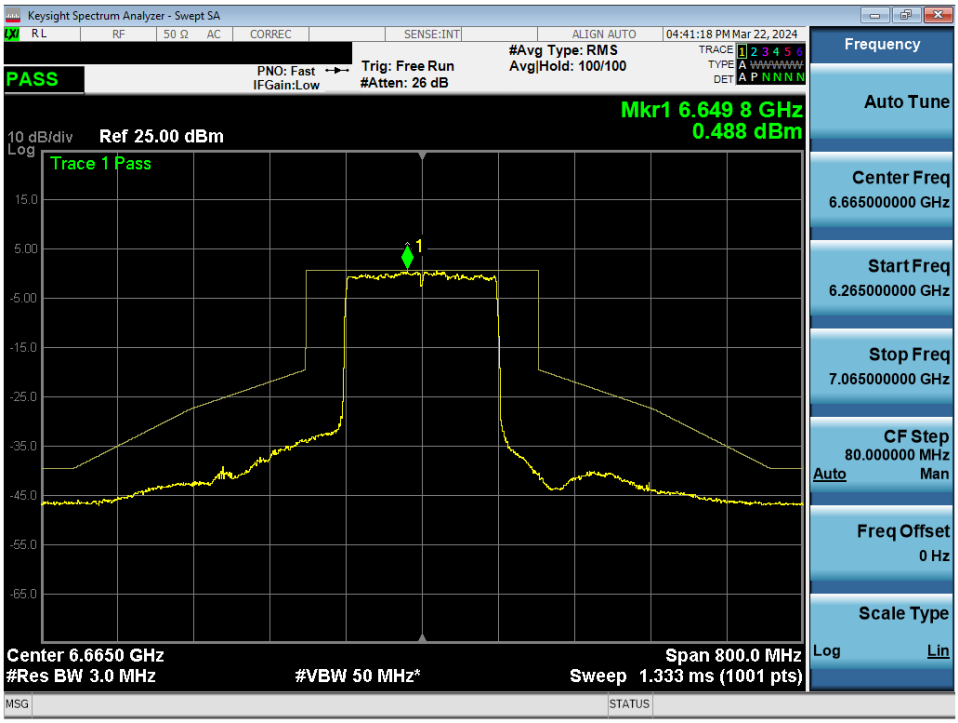
Plot 7-171. In-Band Emission MIMO ANT2 (20MHz 802.11ax/be (UNII Band 7) – Ch. 149)



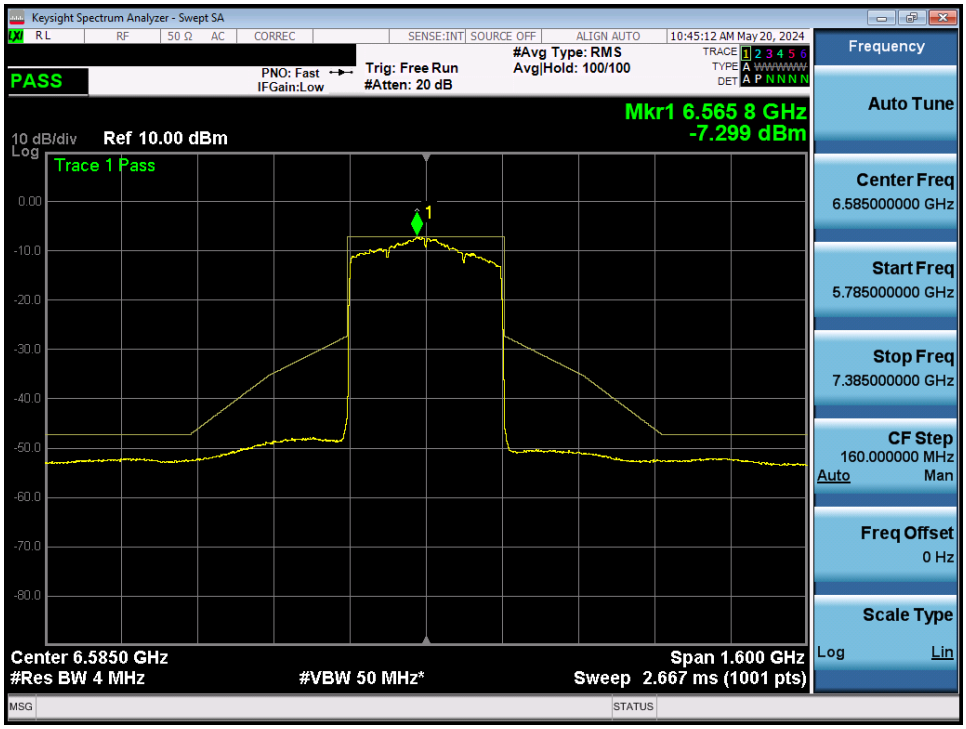
Plot 7-172. In-Band Emission MIMO ANT2 (40MHz 802.11ax/be (UNII Band 7) – Ch. 155)



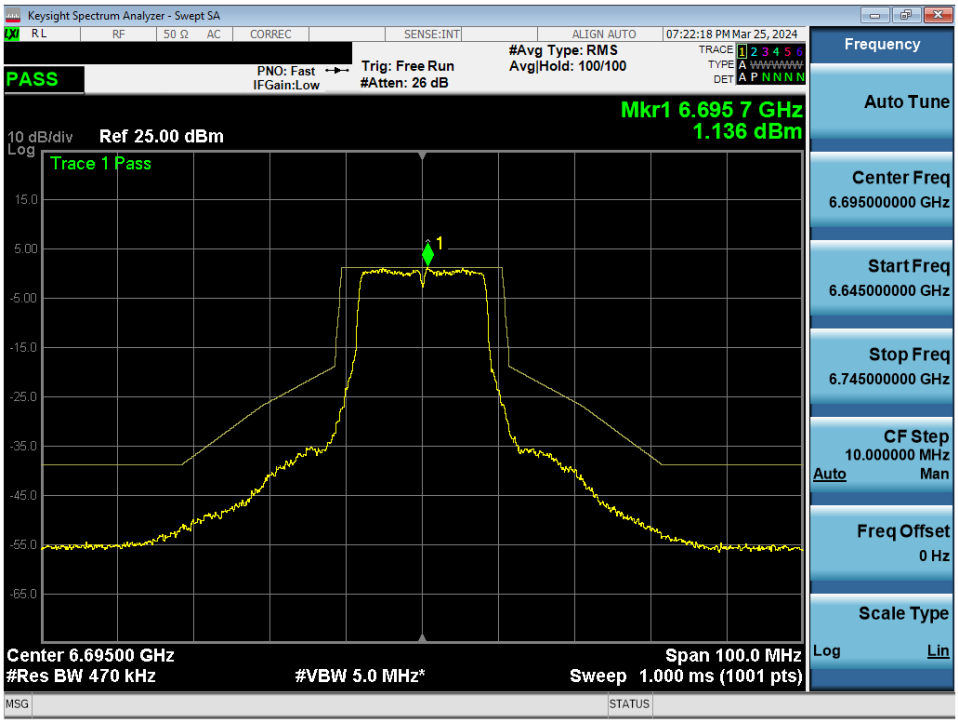
Plot 7-173. In-Band Emission MIMO ANT2 (80MHz 802.11ax/be (UNII Band 7) – Ch. 151)



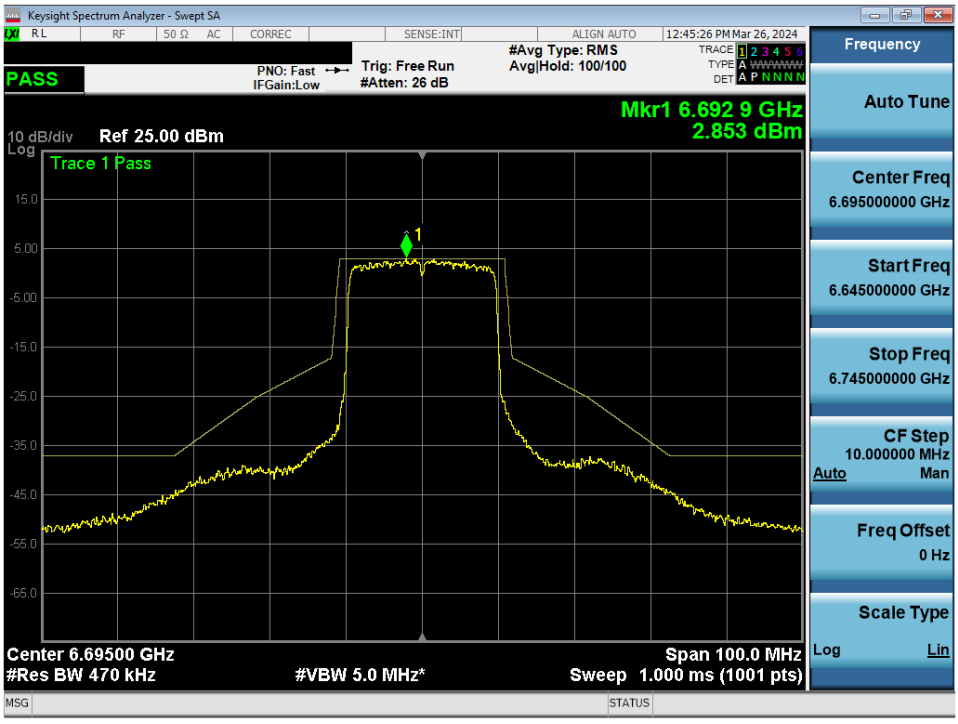
Plot 7-174. In-Band Emission MIMO ANT2 (160MHz 802.11ax/be (UNII Band 7) – Ch. 143)



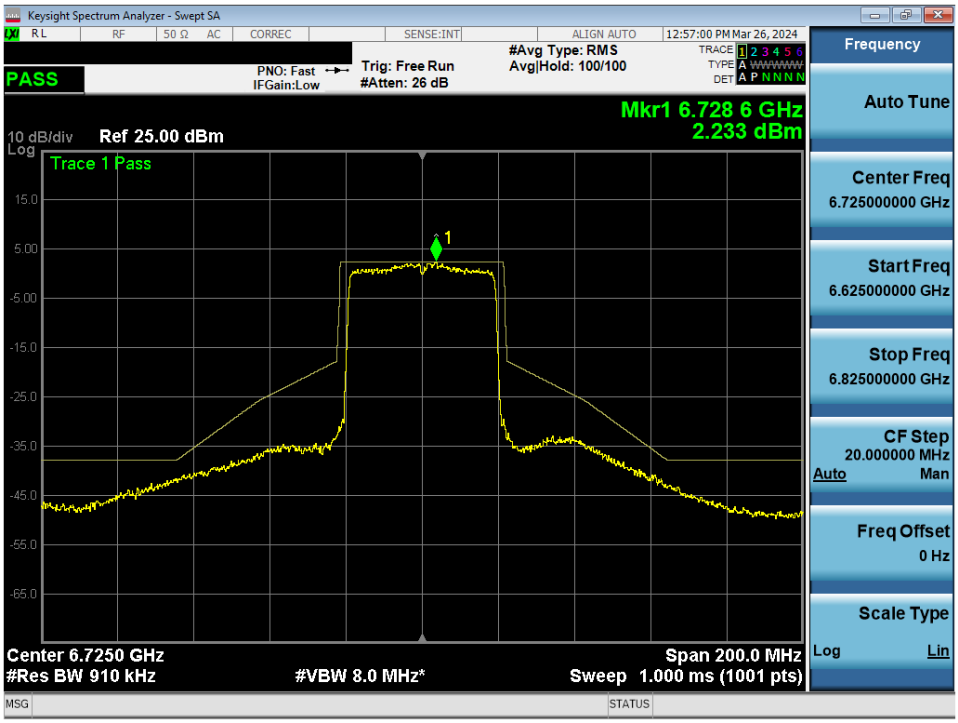
Plot 7-175. In-Band Emission MIMO ANT2 (320MHz 802.11ax/be (UNII Band 6/7) – Ch. 127)



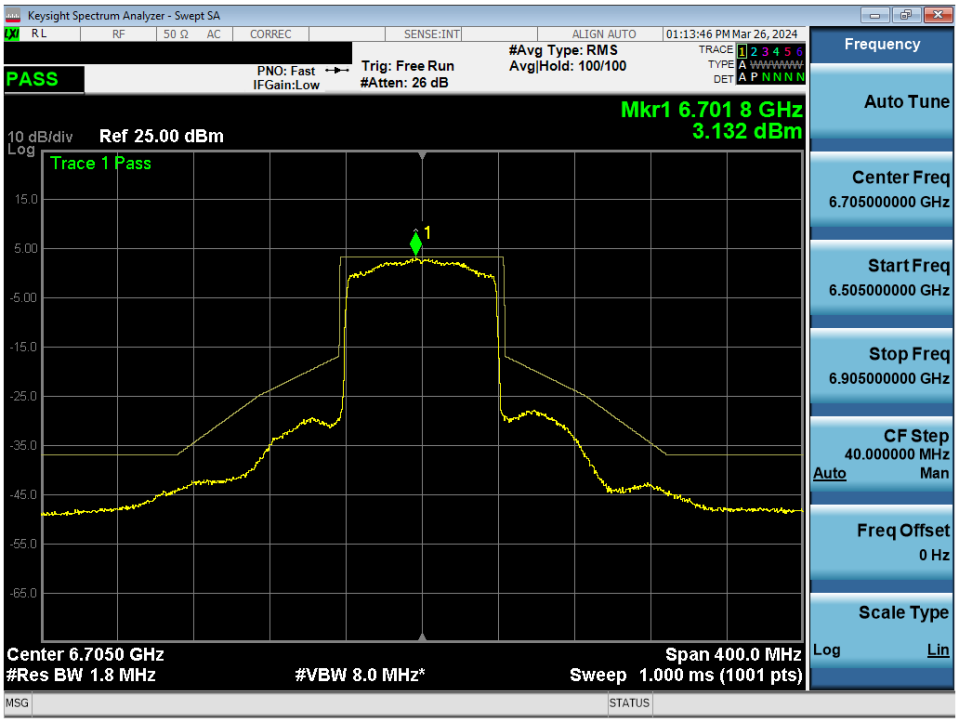
Plot 7-176. In-Band Emission MIMO ANT2 (20MHz 802.11a (UNII Band 7) – Ch. 149) - SP



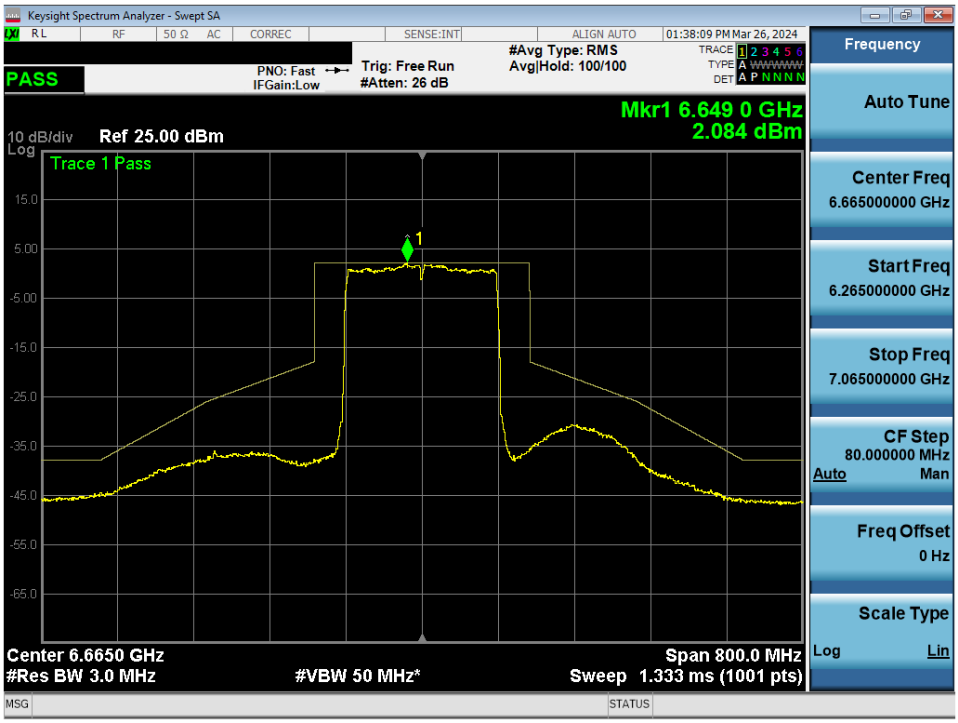
Plot 7-177. In-Band Emission MIMO ANT2 (20MHz 802.11ax/be (UNII Band 7) – Ch. 149) - SP



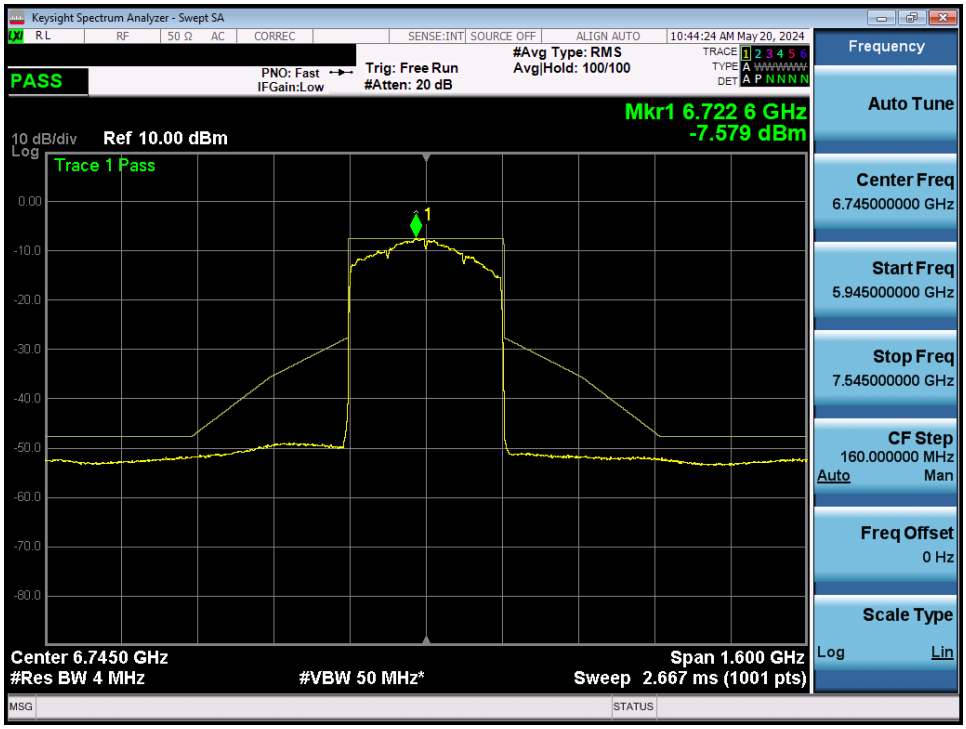
Plot 7-178. In-Band Emission MIMO ANT2 (40MHz 802.11ax/be (UNII Band 7) – Ch. 155) - SP



Plot 7-179. In-Band Emission MIMO ANT2 (80MHz 802.11ax/be (UNII Band 7) – Ch. 151) - SP

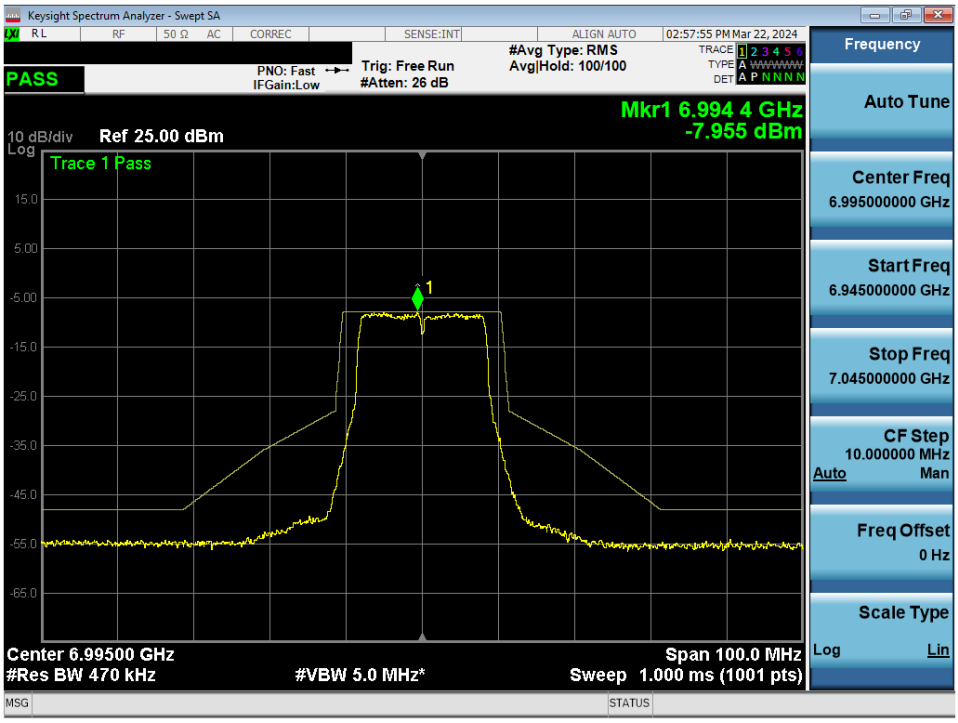


Plot 7-180. In-Band Emission MIMO ANT2 (160MHz 802.11ax/be (UNII Band 7) – Ch. 143) - SP

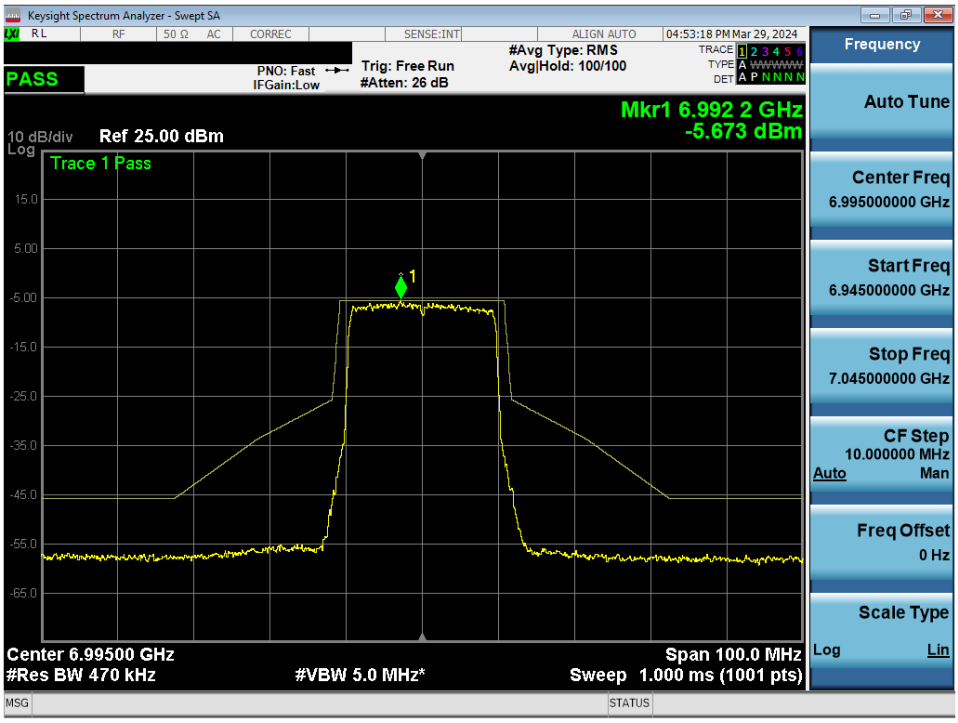


Plot 7-181. In-Band Emission MIMO ANT2 (320MHz 802.11ax/be (UNII Band 6/7) – Ch. 159) - SP

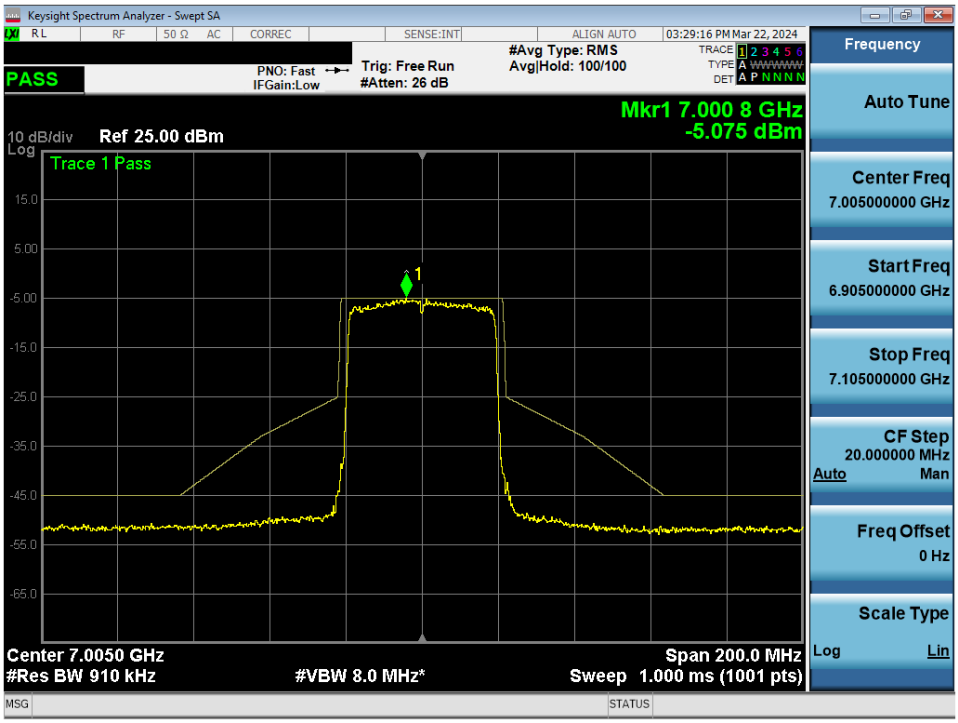
MIMO Antenna-2 In-Band Emission Measurements - (UNII Band 8)



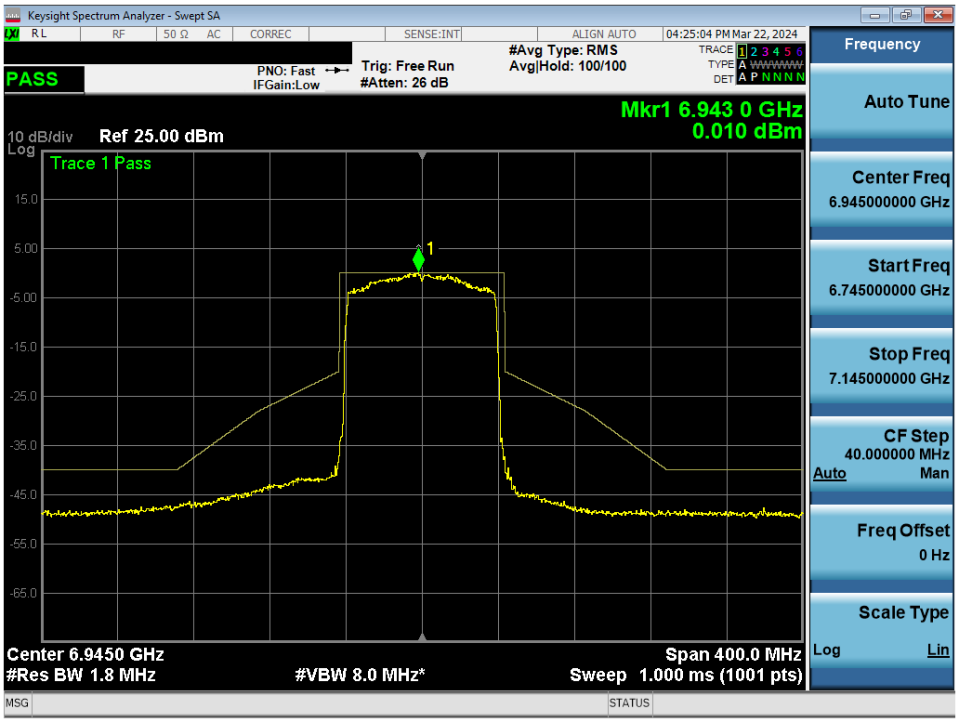
Plot 7-182. In-Band Emission MIMO ANT2 (20MHz 802.11a (UNII Band 8) – Ch. 209)



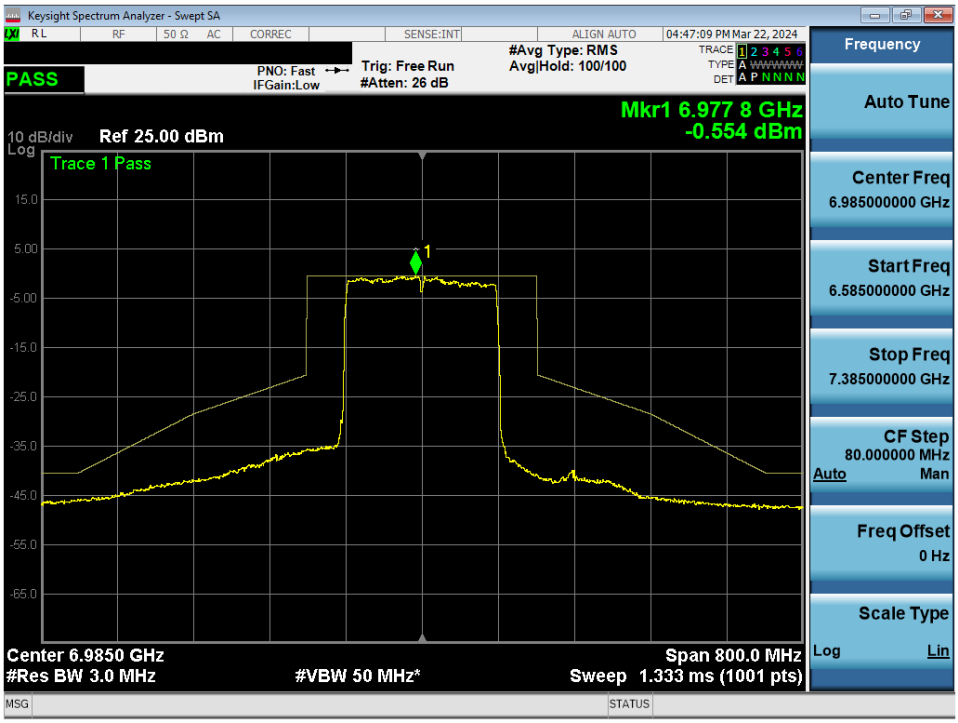
Plot 7-183. In-Band Emission MIMO ANT2 (20MHz 802.11ax/be (UNII Band 8) – Ch. 209)



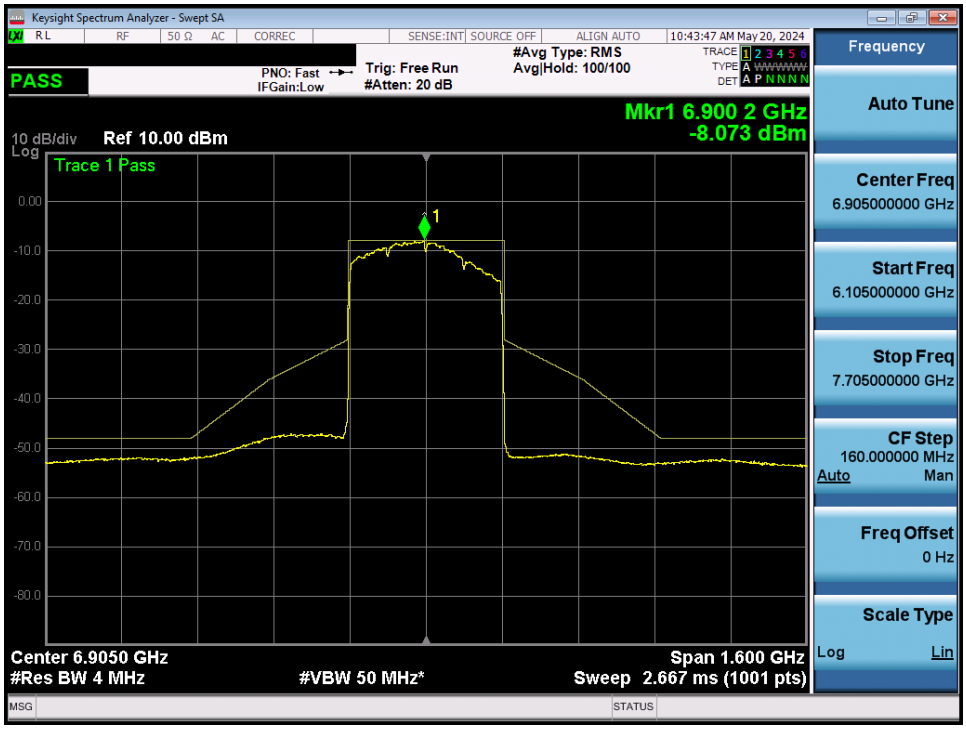
Plot 7-184. In-Band Emission MIMO ANT2 (40MHz 802.11ax/be (UNII Band 8) – Ch. 211)



Plot 7-185. In-Band Emission MIMO ANT2 (80MHz 802.11ax/be (UNII Band 8) – Ch. 199)



Plot 7-186. In-Band Emission MIMO ANT2 (160MHz 802.11ax/be (UNII Band 8) – Ch. 207)



Plot 7-187. In-Band Emission MIMO ANT2 (320MHz 802.11ax/be (UNII Band 7/8) – Ch. 191)

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 v02r01

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 v02r01 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.

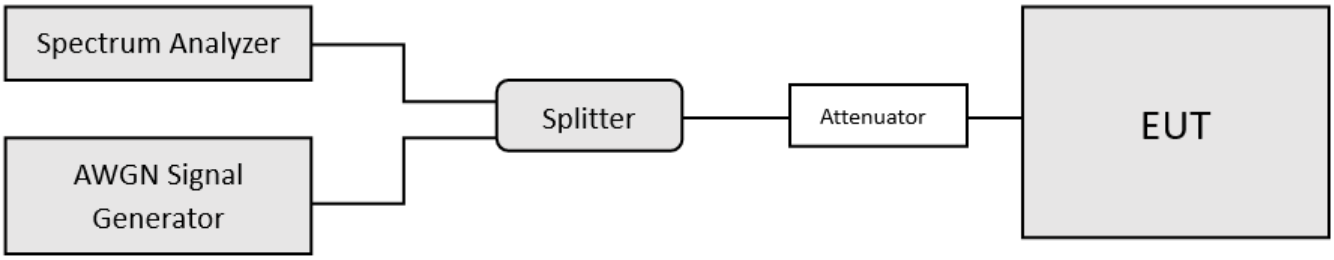


Figure 7-5. Contention-based protocol test setup conducted method.

Test Notes

1. Per guidance from KDB 987594 D02 v02r01, contention-based protocol was tested using an AWGN signal with a bandwidth of 10MHz (see Plot 7-192). The amplitude of the signal was increased until detected by the EUT, signaled by the ceasing of transmission (see Plot 7-193), 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. In the presence of an AWGN signal, the EUT was shown to either completely move out of the channel or to reduce its bandwidth for the purpose of incumbent avoidance. Representative channel move plots are included for one sub-band to show how the channel reduces when the AWGN is injected at the lower edge, the center, and the upper edge of a channel.
6. This device only punctures to optimize network performance and never to avoid licensed incumbents.
7. For the channel move demonstration in Section 7.6.3, only plots from UNII-5 band are included. Additionally, the AWGN signal is not visible because the AWGN level is well below the noise floor.

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]	Path Loss (dB)	Adjusted Power Level [dBm]	Detection Limit [dBm]	Margin [dB]
UNII Band 5	53	6215	20	6215	-70.31	-3.67	1.31	-65.33	-62.0	-3.33
	31	6265	320	6110	-69.04	-3.67	1.31	-64.06	-62.0	-2.06
				6265	-72.11	-3.67	1.31	-67.13	-62.0	-5.13
				6420	-71.36	-3.67	1.31	-66.38	-62.0	-4.38
UNII Band 6	101	6455	20	6455	-68.58	-3.21	1.31	-64.06	-62.0	-2.06
	95	6425	320	6270	-72.79	-3.21	1.31	-68.27	-62.0	-6.27
				6425	-70.73	-3.21	1.31	-66.21	-62.0	-4.21
				6580	-68.65	-3.21	1.31	-64.13	-62.0	-2.13
UNII Band 7	149	6695	20	6695	-70.44	-4.11	1.31	-65.02	-62.0	-3.02
	159	6745	320	6590	-72.95	-4.11	1.31	-67.53	-62.0	-5.53
				6745	-70.01	-4.11	1.31	-64.59	-62.0	-2.59
				6900	-71.74	-4.11	1.31	-66.32	-62.0	-4.32
UNII Band 8	197	6935	20	6935	-75.05	-4.31	1.31	-69.43	-62.0	-7.43
	191	6905	320	6750	-72.82	-4.31	1.31	-67.20	-62.0	-5.20
				6905	-69.79	-4.31	1.31	-64.17	-62.0	-2.17
				7060	-73.89	-4.31	1.31	-68.27	-62.0	-6.27

Table 7-42. Contention Based Protocol – Incumbent Detection Results

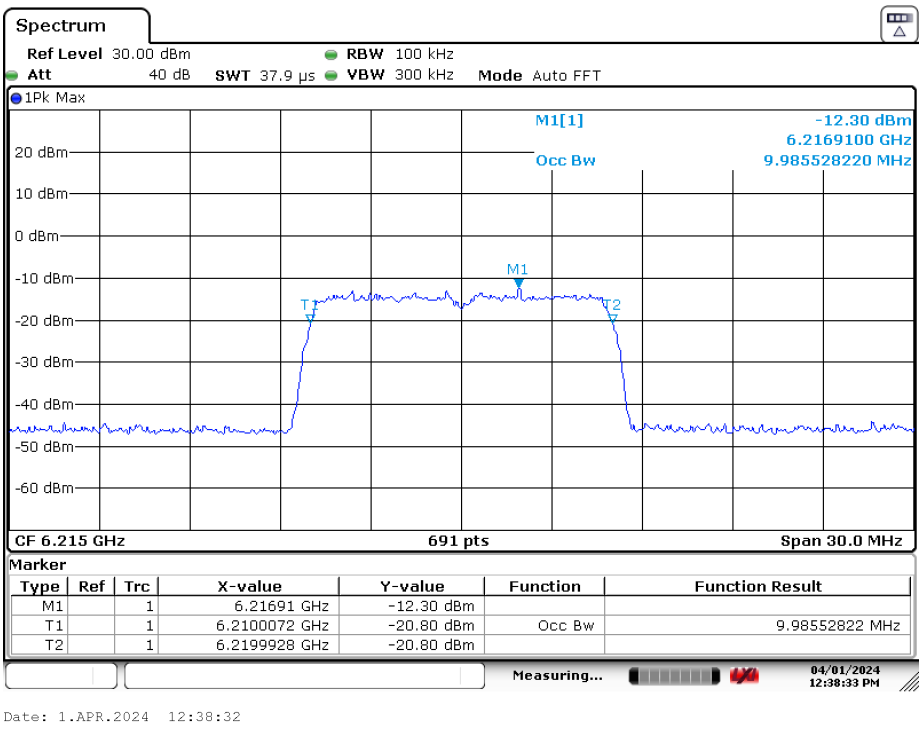
Band	Channel	Channel Freq [MHz]	Channel BW [MHz]	Incumbent Freq [MHz]	Antenna Gain [dBi]	EUT Transmission Status Adjusted AWGN Power (dBm)			Detection Limit [dBm]	Margin [dB]
						Normal	Minimal	Ceased		
UNII Band 5	53	6215	20	6215	-3.67	-68.33	-66.43	-65.33	-62.0	-3.33
	31	6265	320	6110	-3.67	-65.30	-64.38	-64.06	-62.0	-2.06
				6265	-3.67	-70.43	-68.03	-67.13	-62.0	-5.13
				6340	-3.67	-69.77	-67.29	-66.38	-62.0	-4.38
UNII Band 6	101	6455	20	6455	-3.21	-65.16	-64.26	-64.06	-62.0	-2.06
	95	6425	320	6350	-3.21	-69.57	-68.97	-68.27	-62.0	-6.27
				6425	-3.21	-67.51	-66.61	-66.21	-62.0	-4.21
				6500	-3.21	-65.82	-64.88	-64.13	-62.0	-2.13
UNII Band 7	149	6695	20	6695	-4.11	-65.82	-64.62	-65.02	-62.0	-3.02
	159	6745	320	6670	-4.11	-68.83	-68.03	-67.53	-62.0	-5.53
				6745	-4.11	-66.07	-65.29	-64.59	-62.0	-2.59
				6820	-4.11	-67.58	-67.14	-66.32	-62.0	-4.32
UNII Band 8	197	6935	20	6935	-4.31	-72.57	-70.47	-69.43	-62.0	-7.43
	191	6905	320	6830	-4.31	-68.60	-67.93	-67.20	-62.0	-5.20
				6905	-4.31	-65.42	-63.97	-64.17	-62.0	-2.17
				6980	-4.31	-70.59	-68.67	-68.27	-62.0	-6.27

Table 7-43. Contention Based Protocol – Detection Results – All Tx Cases

Band	Channel	Channel Freq [MHz]	Channel BW [MHz]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Detection Rate (%)
UNII Band 5	53	6215	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	31	6265	320	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
UNII Band 6	101	6455	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	95	6425	320	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
UNII Band 7	149	6695	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	159	6745	320	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
UNII Band 8	197	6935	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
	191	6905	320	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100

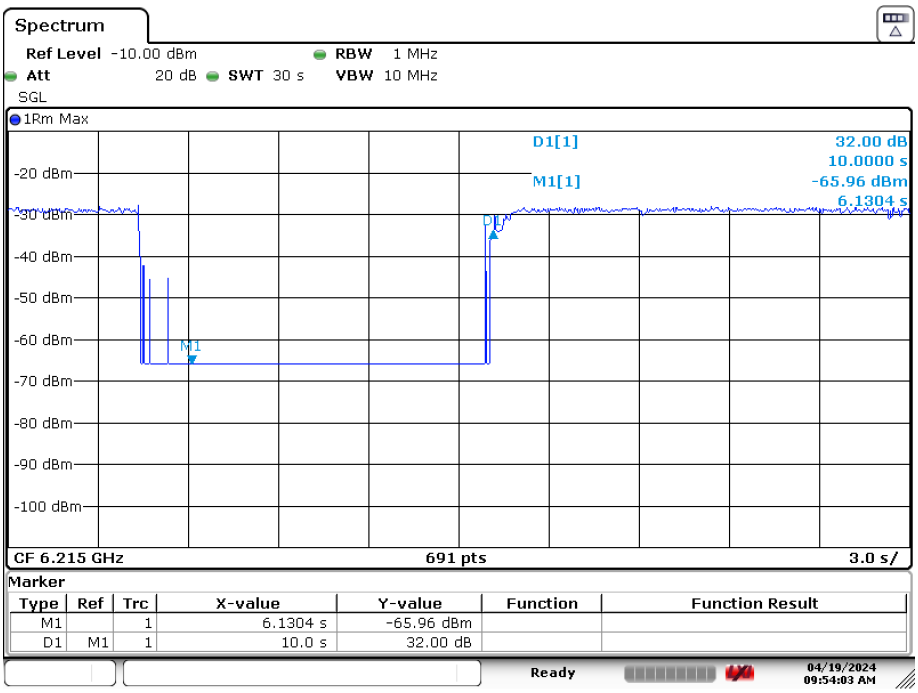
Table 7-44. Contention Based Protocol – Incumbent Detection Trial Results

7.6.1 AWGN Plots



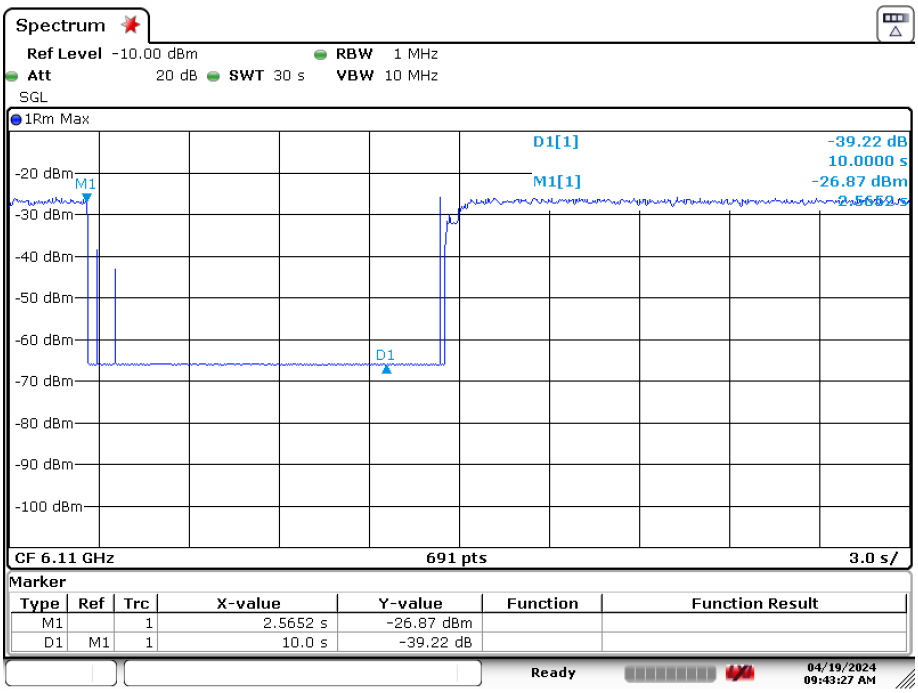
Plot 7-188. AWGN Signal (Demonstration)

7.6.2 CBP Timing Plots



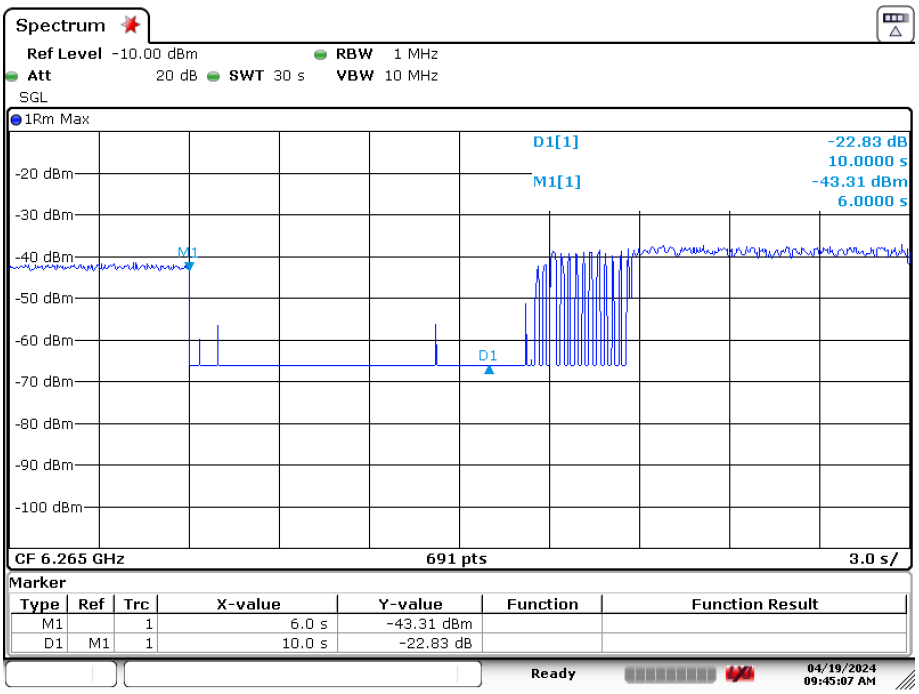
Date: 19.APR.2024 09:54:03

Plot 7-189. Contention Based Protocol Timing Plot (20MHz (UNII Band 5) – Ch. 53)



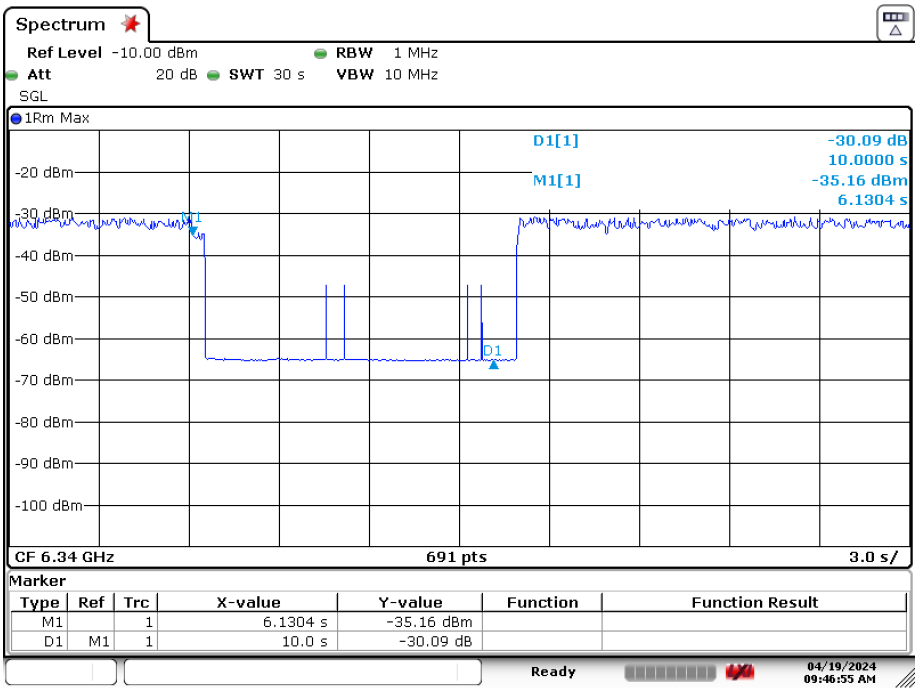
Date: 19.APR.2024 09:43:27

Plot 7-190. Contention Based Protocol Timing Plot (320MHz (UNII Band 5) – Ch. 31 Low)



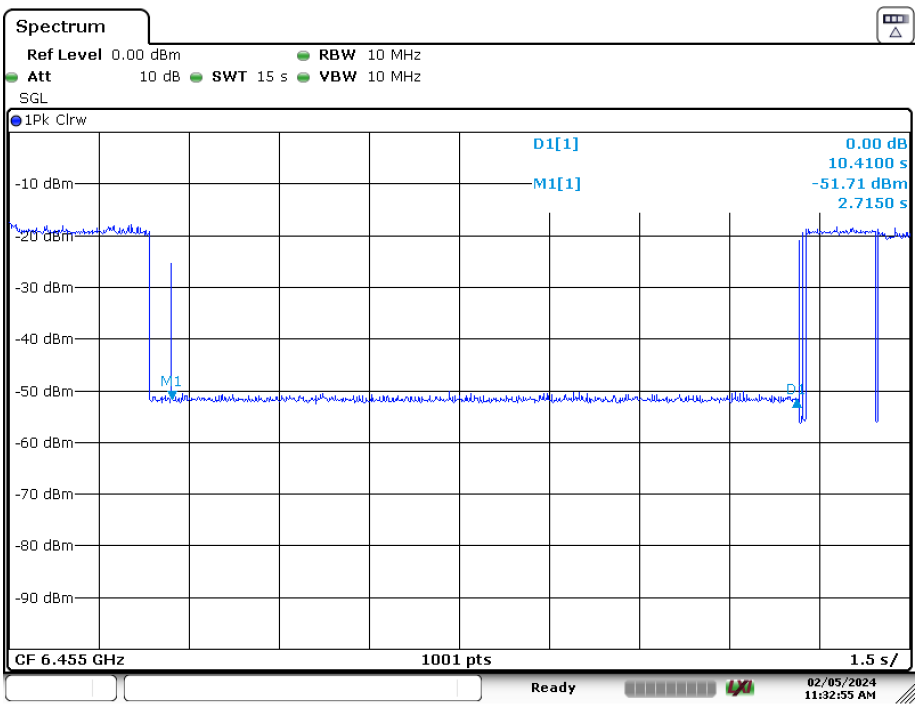
Date: 19.APR.2024 09:45:07

Plot 7-191. Contention Based Protocol Timing Plot (320MHz (UNII Band 5) – Ch. 31 Mid)



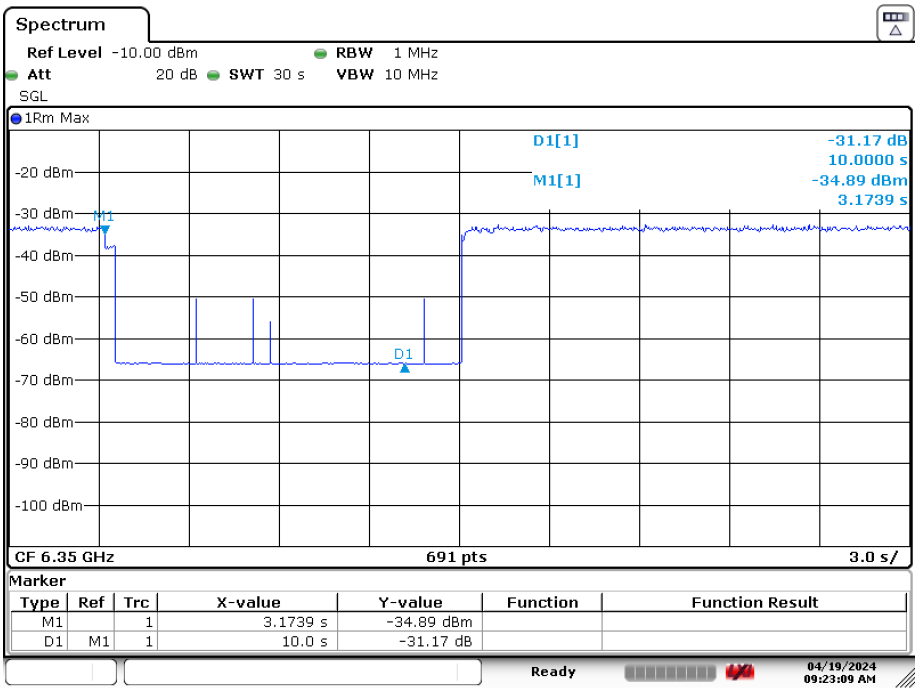
Date: 19.APR.2024 09:46:55

Plot 7-192. Contention Based Protocol Timing Plot (320MHz (UNII Band 5) – Ch. 31 High)



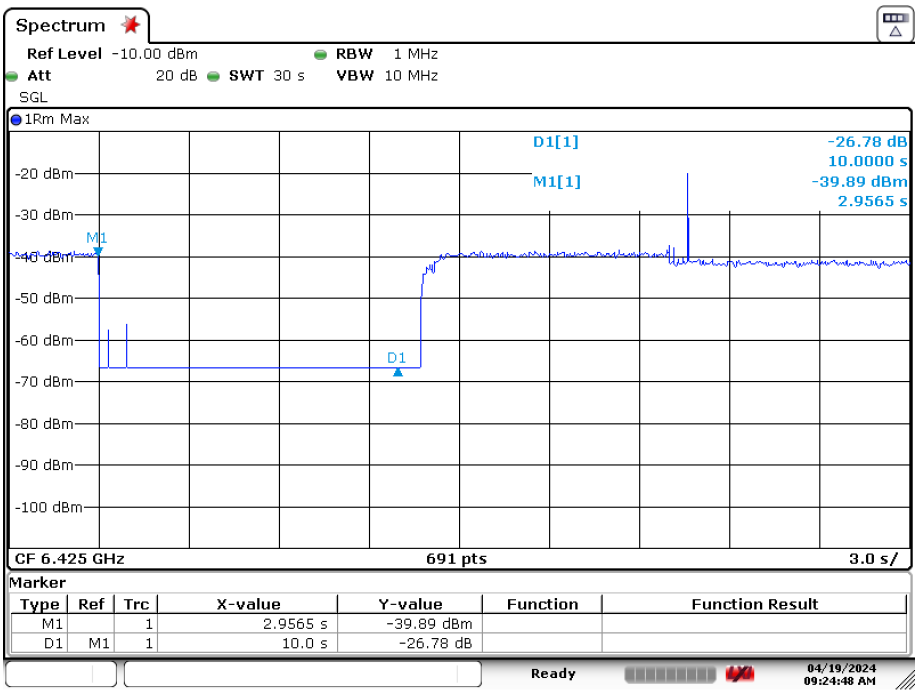
Date: 5.FEB.2024 11:32:55

Plot 7-193. Contention Based Protocol Timing Plot (20MHz (UNII Band 6) – Ch. 101)



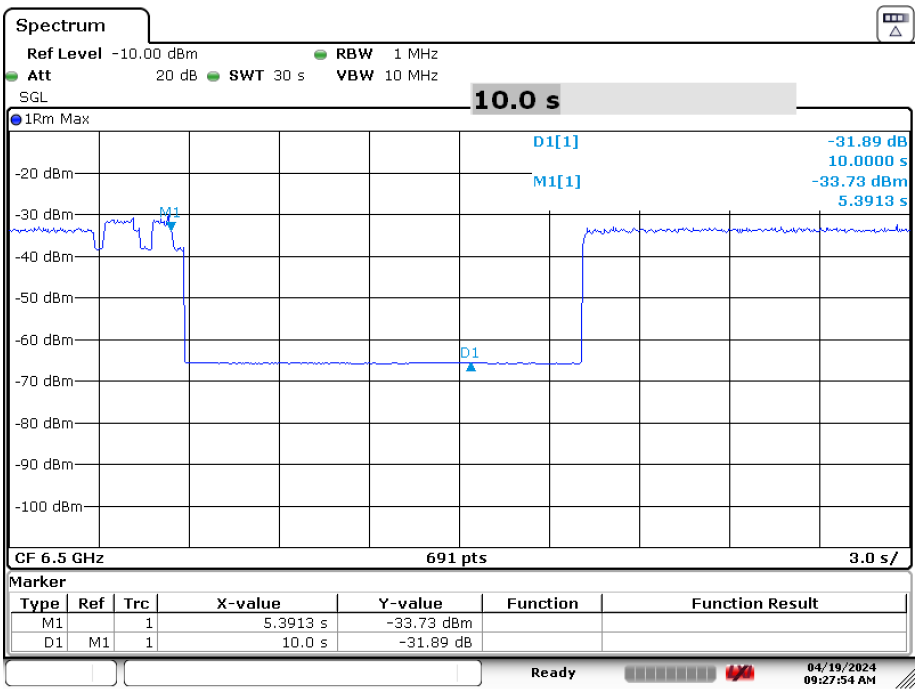
Date: 19.APR.2024 09:23:09

Plot 7-194. Contention Based Protocol Timing Plot (320MHz (UNII Band 6) – Ch. 95 Low)



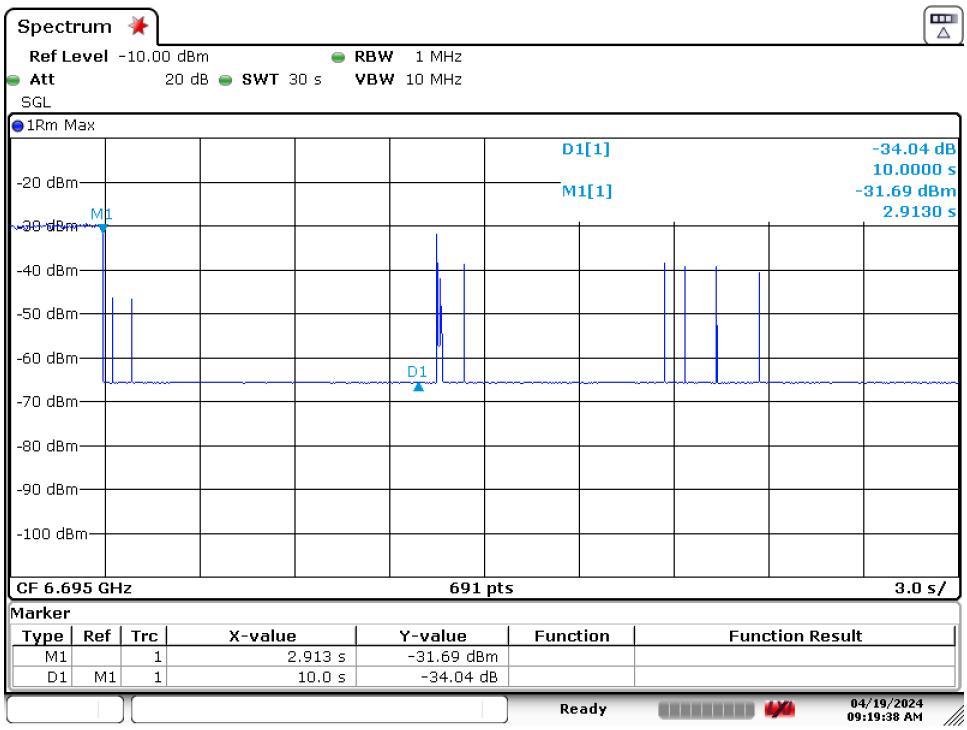
Date: 19.APR.2024 09:24:48

Plot 7-195. Contention Based Protocol Timing Plot (320MHz (UNII Band 6) – Ch. 95 Mid)



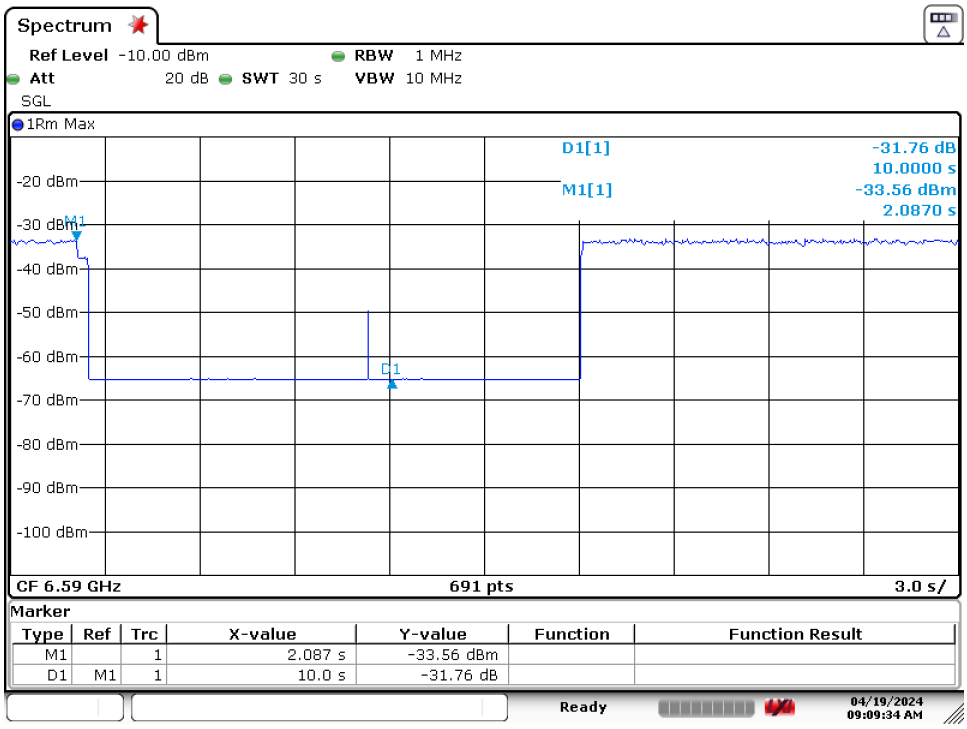
Date: 19.APR.2024 09:27:54

Plot 7-196. Contention Based Protocol Timing Plot (320MHz (UNII Band 6) – Ch. 95 High)



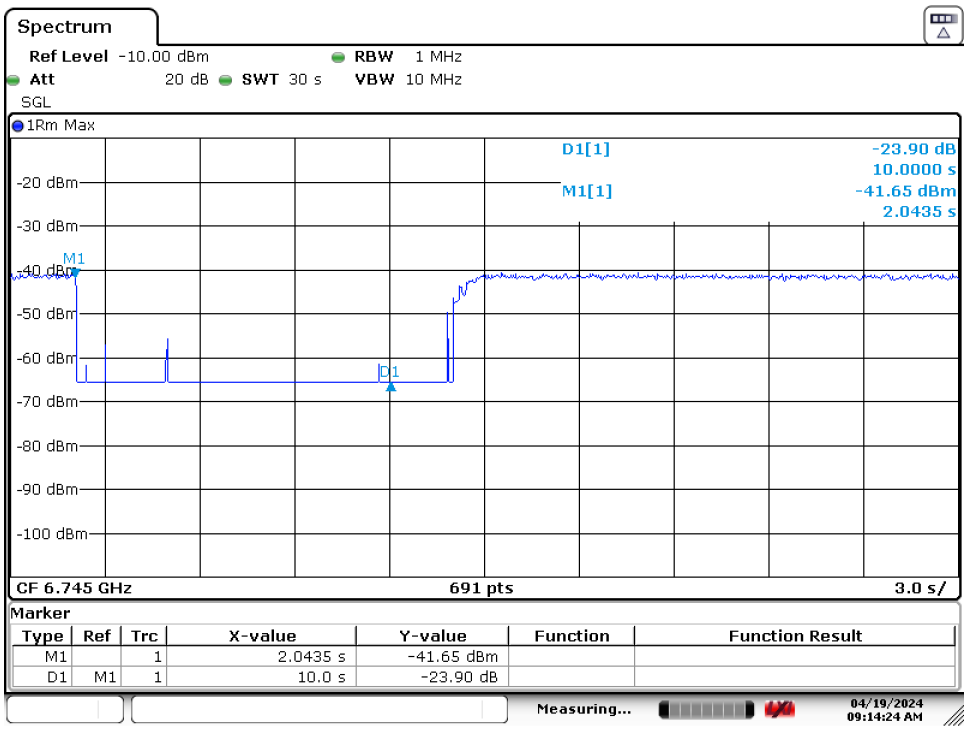
Date: 19.APR.2024 09:19:38

Plot 7-197. Contention Based Protocol Timing Plot (20MHz (UNII Band 7) – Ch. 149)



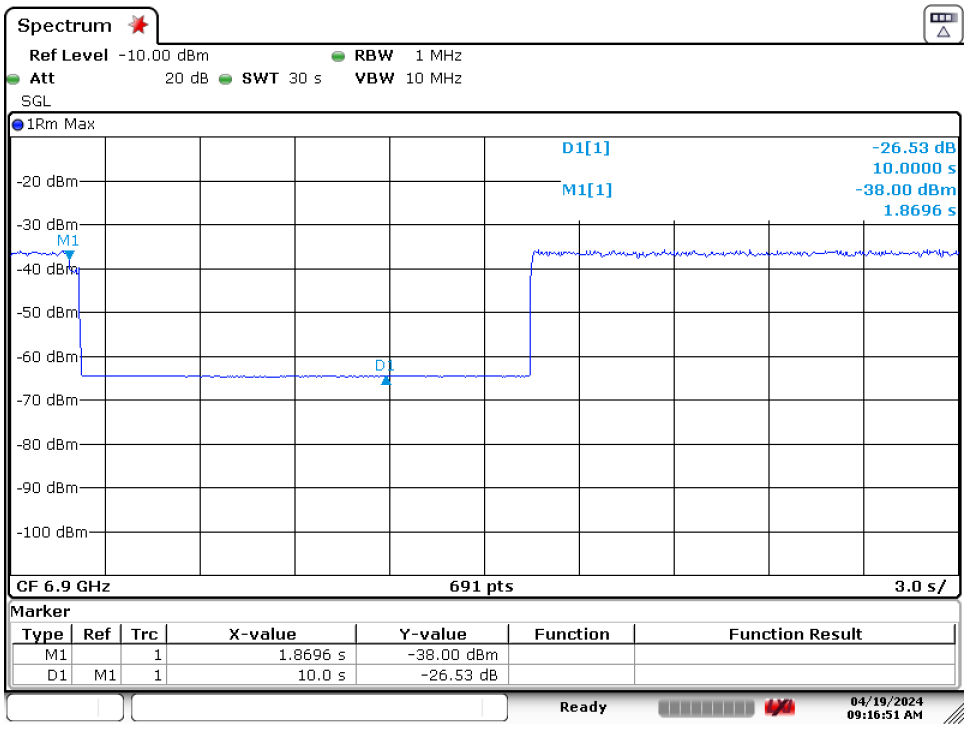
Date: 19.APR.2024 09:09:34

Plot 7-198. Contention Based Protocol Timing Plot (320MHz (UNII Band 7) – Ch. 159 Low)



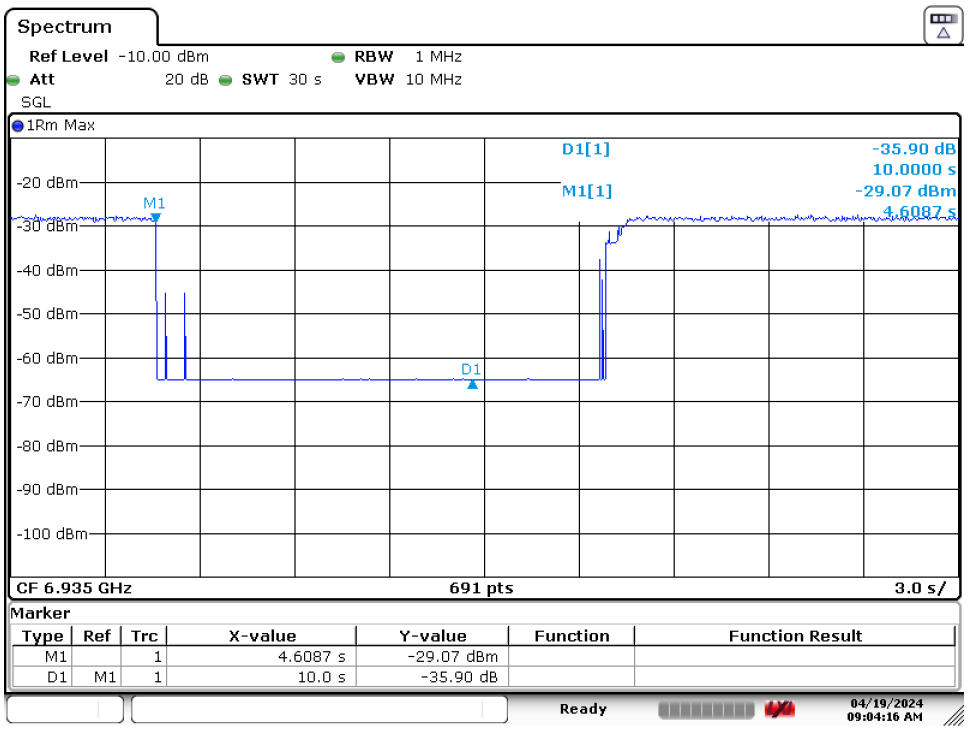
Date: 19.APR.2024 09:14:24

Plot 7-199. Contention Based Protocol Timing Plot (320MHz (UNII Band 7) – Ch. 159 Mid)



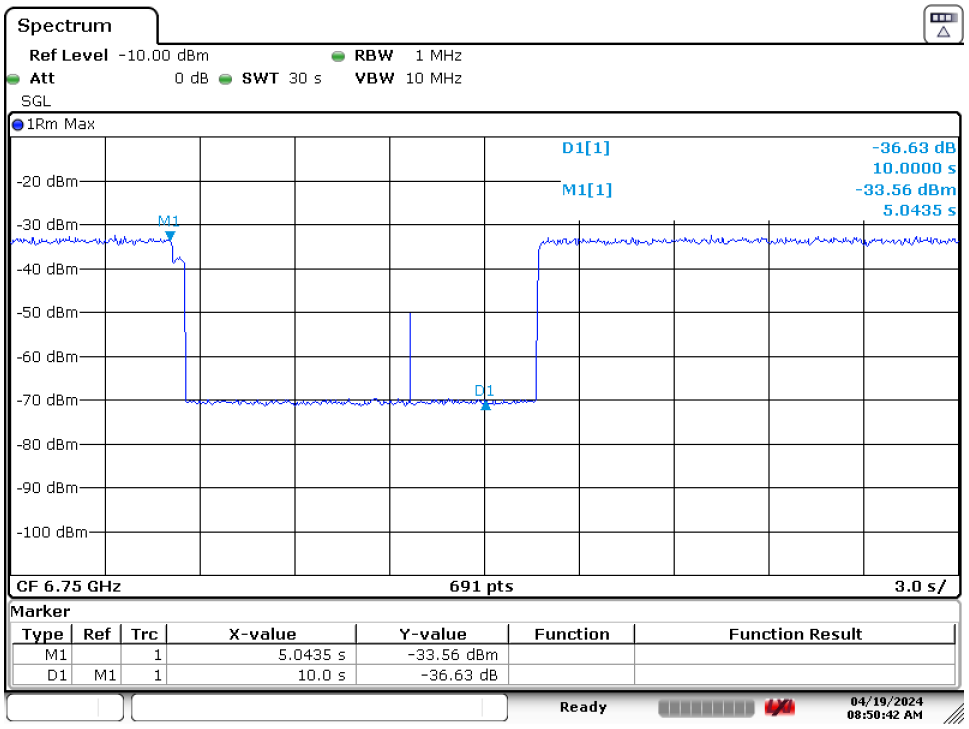
Date: 19.APR.2024 09:16:51

Plot 7-200. Contention Based Protocol Timing Plot (320MHz (UNII Band 7) – Ch. 159 High)



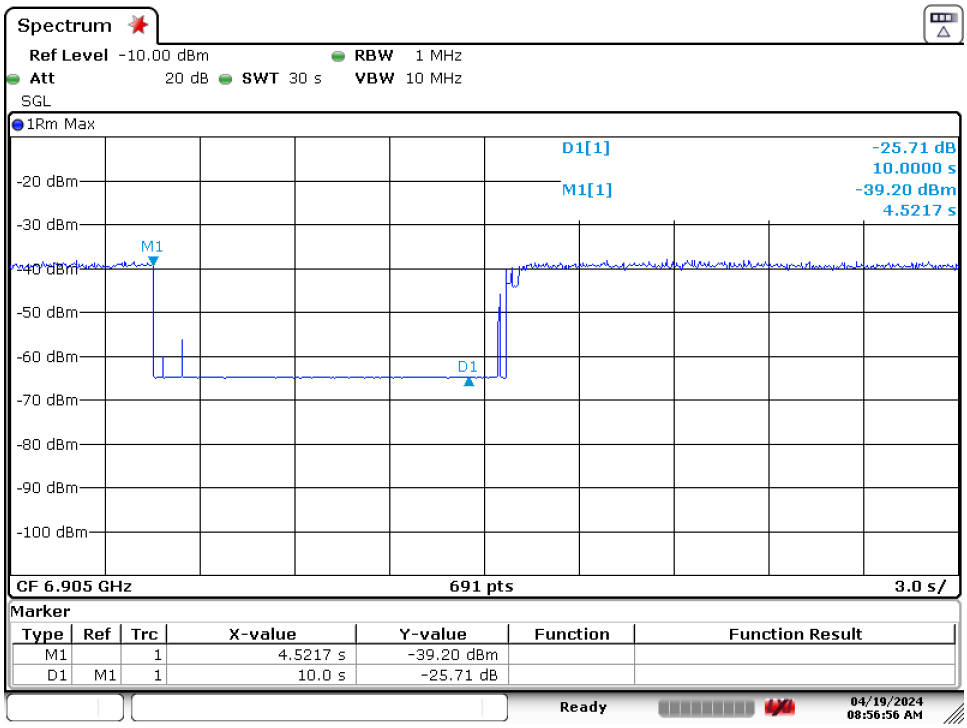
Date: 19.APR.2024 09:04:17

Plot 7-201. Contention Based Protocol Timing Plot (20MHz (UNII Band 8) – Ch. 197)



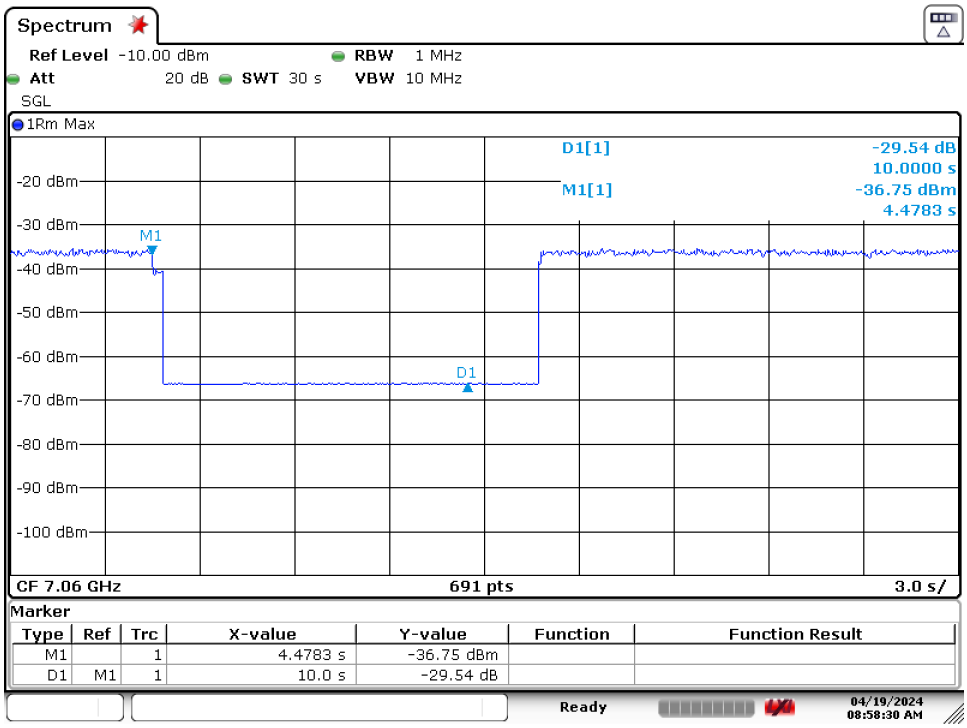
Date: 19.APR.2024 08:50:42

Plot 7-202. Contention Based Protocol Timing Plot (320MHz (UNII Band 8) – Ch. 191 Low)



Date: 19.APR.2024 08:56:56

Plot 7-203. Contention Based Protocol Timing Plot (320MHz (UNII Band 8) – Ch. 191 Mid)



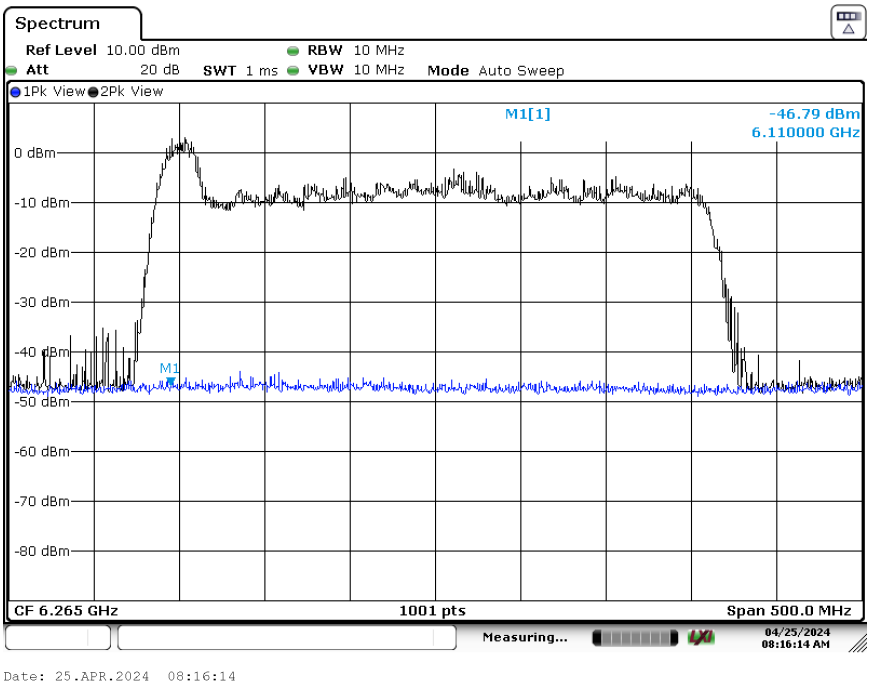
Date: 19.APR.2024 08:58:30

Plot 7-204. Contention Based Protocol Timing Plot (320MHz (UNII Band 8) – Ch. 191 High)

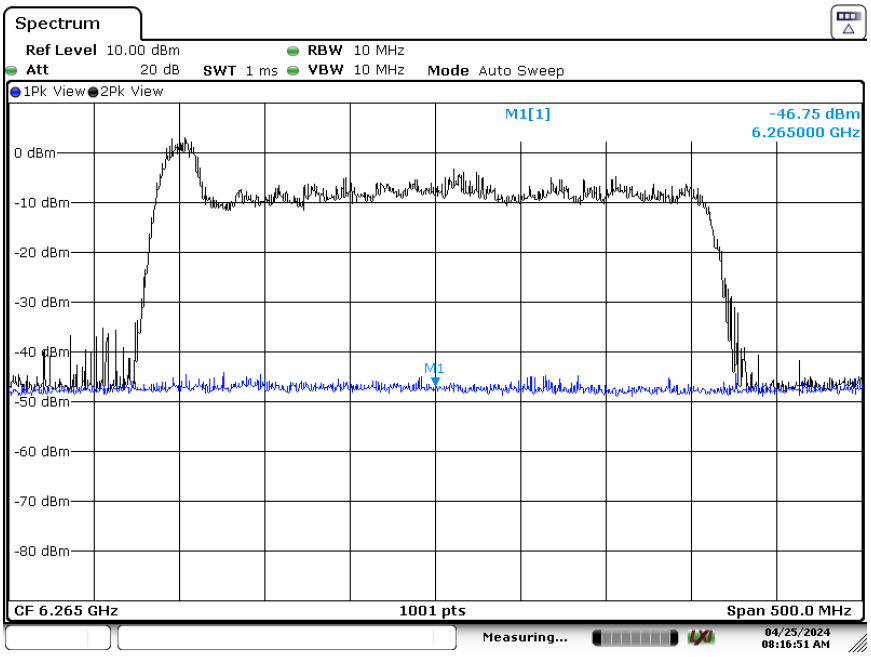
7.6.3 Channel Move Plots

This section demonstrates the effect of injecting the AWGN signal at various locations throughout the 320MHz signal. The black trace shows the full 320MHz signal prior to AWGN injection while the blue trace shows the spectrum following AWGN injection. The following items were observed as demonstrated in the three plots shown below:

- When a 10 MHz AWGN signal centered at 6110 MHz (lower edge of channel) is injected, the channel completely stops transmitting.
- When a 10 MHz AWGN signal centered at 6265 MHz (middle of channel) is injected, the channel completely stops transmitting.
- When a 10 MHz AWGN signal centered at 6420 MHz (upper edge of channel) is injected, the channel reduces its bandwidth down to 160MHz operation at the lower end of the channel.

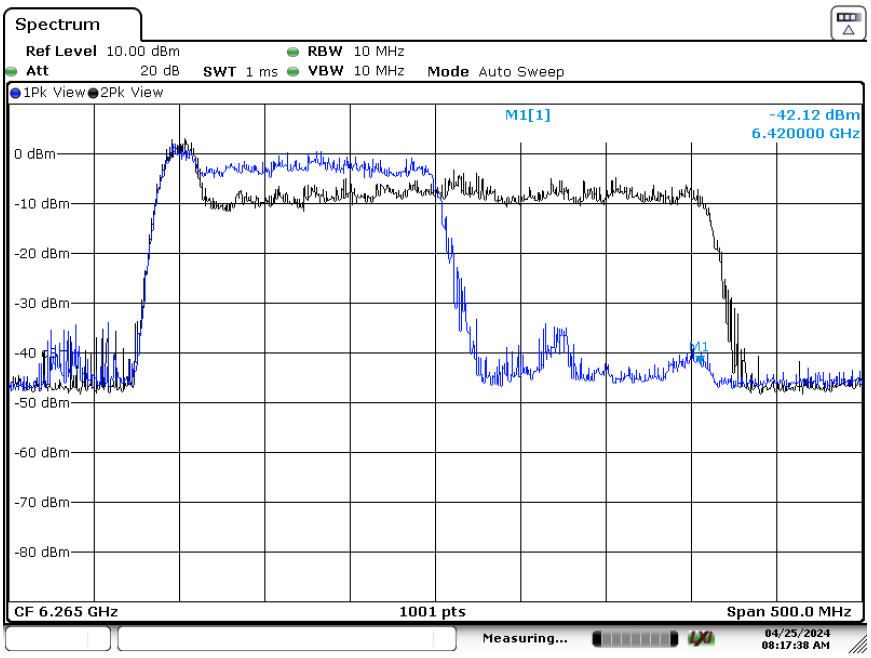


Plot 7-205. CBP 320MHz Channel - Injection Lower Edge – [6110 MHz]



Date: 25.APR.2024 08:16:51

Plot 7-206. CBP 320MHz Channel - Injection Center – [6265 MHz]



Date: 25.APR.2024 08:17:38

Plot 7-207. CBP 320MHz Channel - Injection Upper Edge – [6420 MHz]

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 7-45. 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.

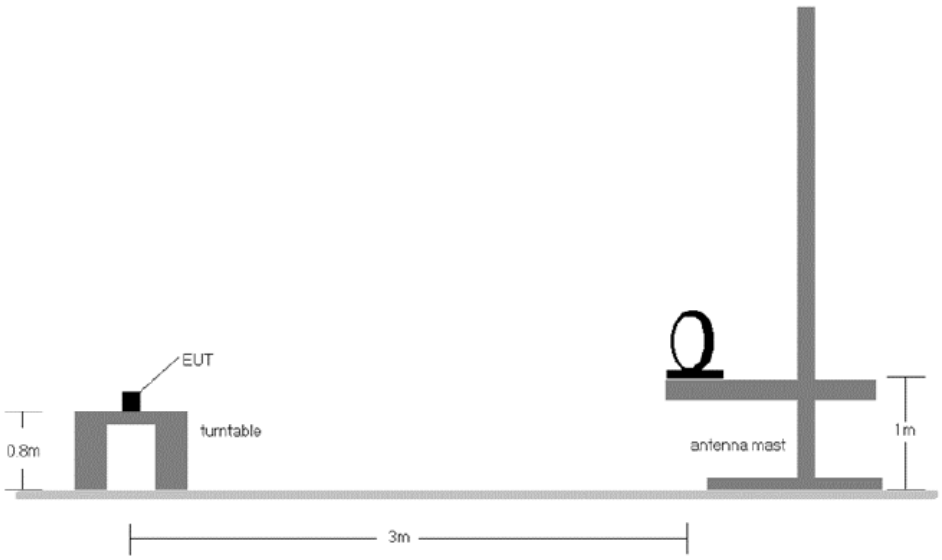


Figure 7-6. Radiated Test Setup < 30MHz

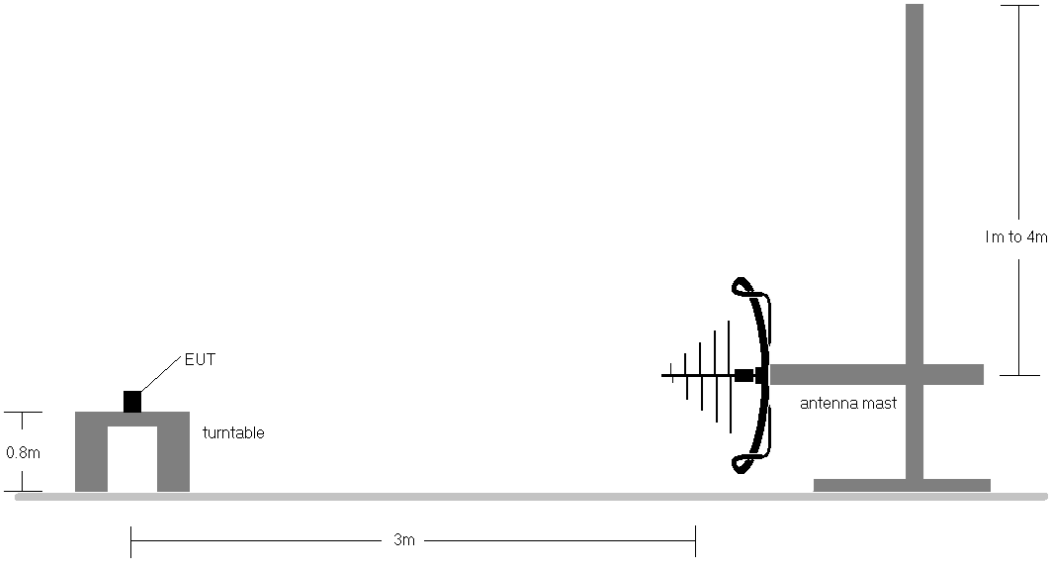


Figure 7-7. Radiated Test Setup < 1GHz

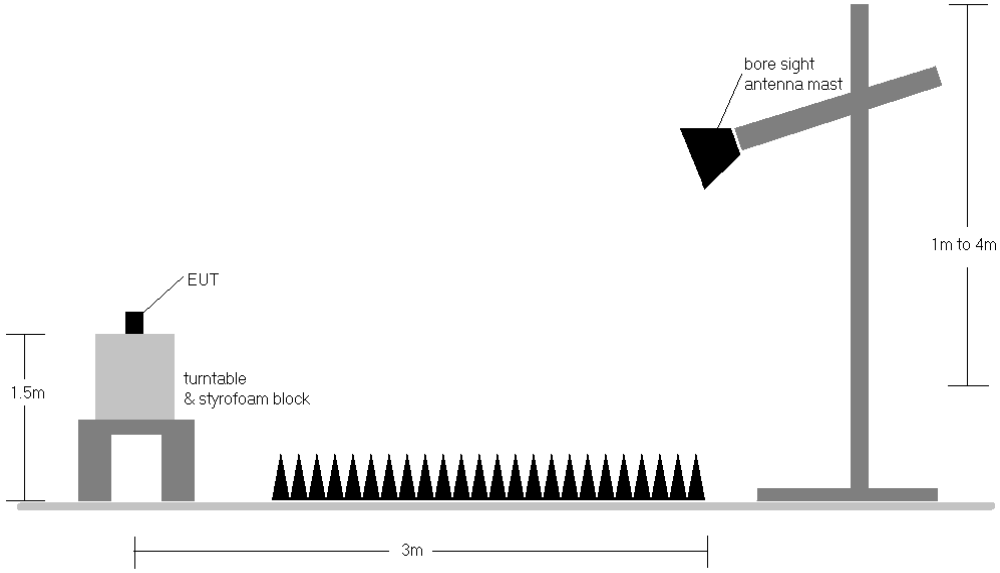


Figure 7-8. Radiated Test Setup > 1GHz

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