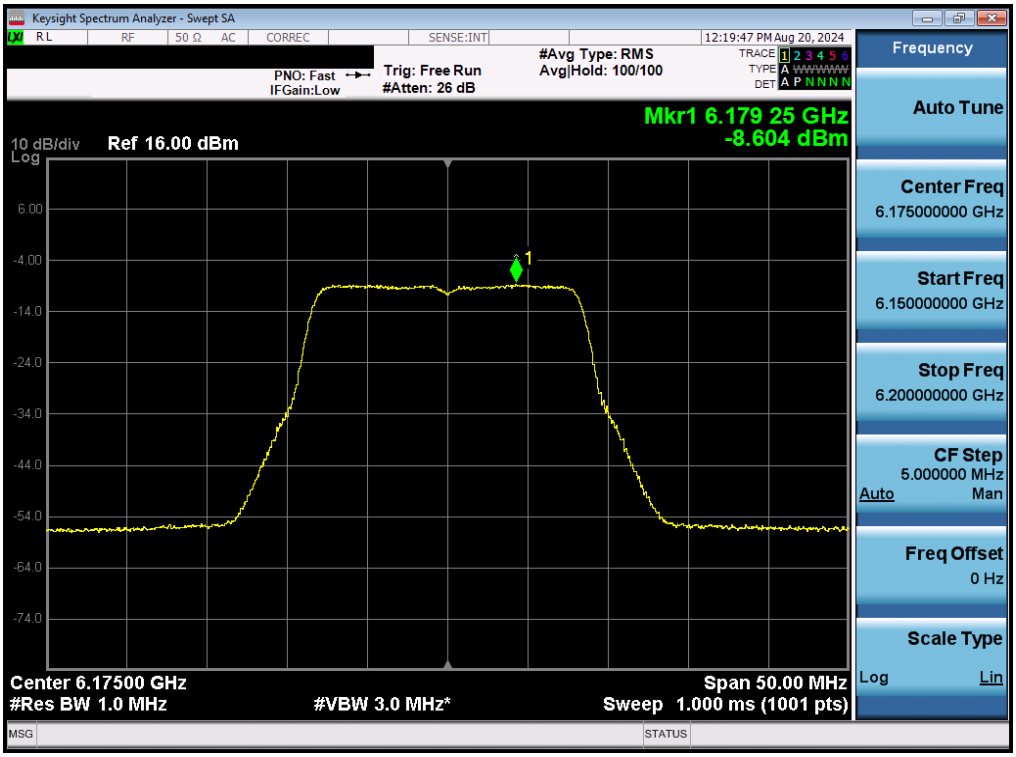
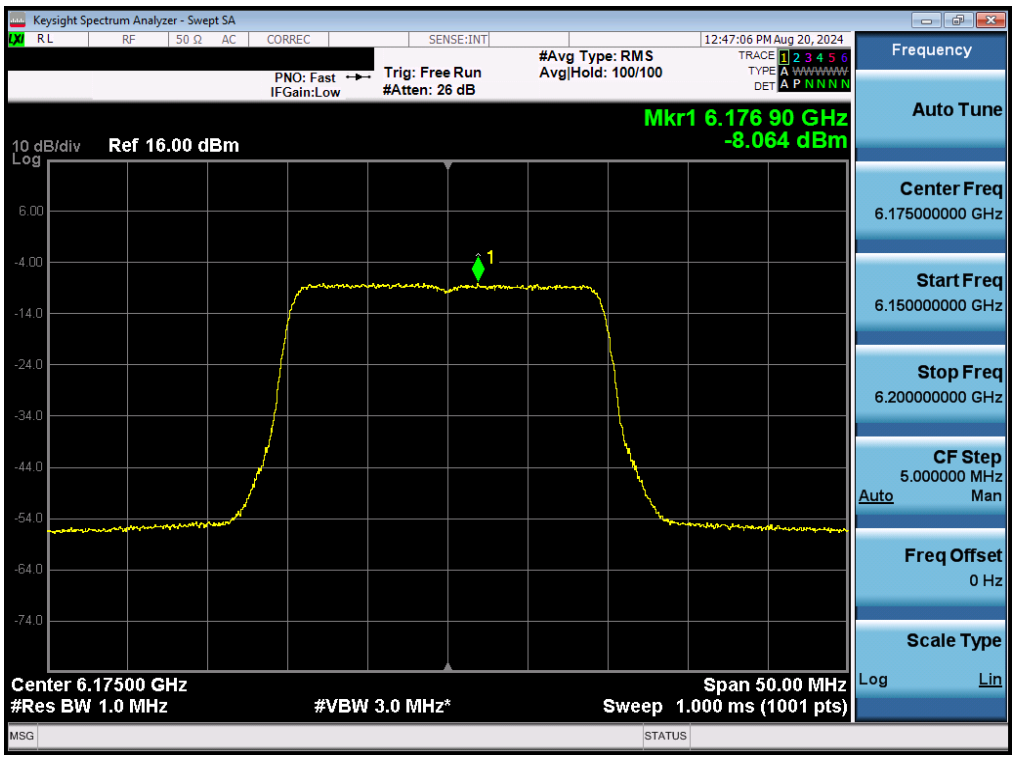
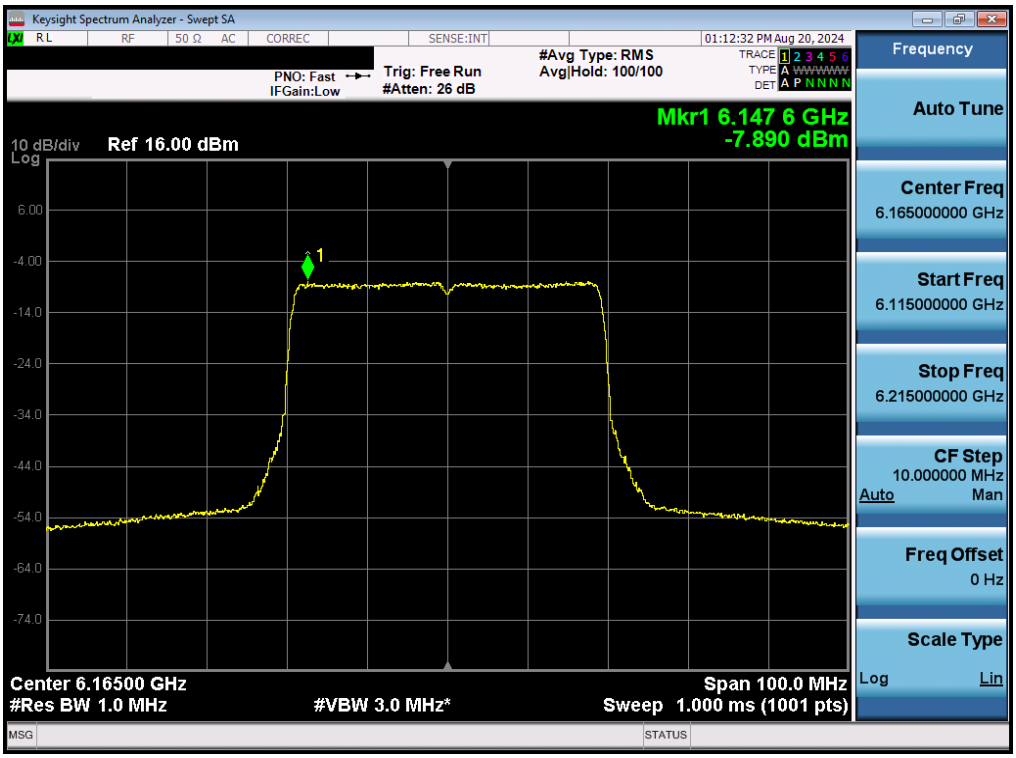
MIMO Antenna-1 Power Spectral Density Measurements – (UNII Band 5) – LPI/SP



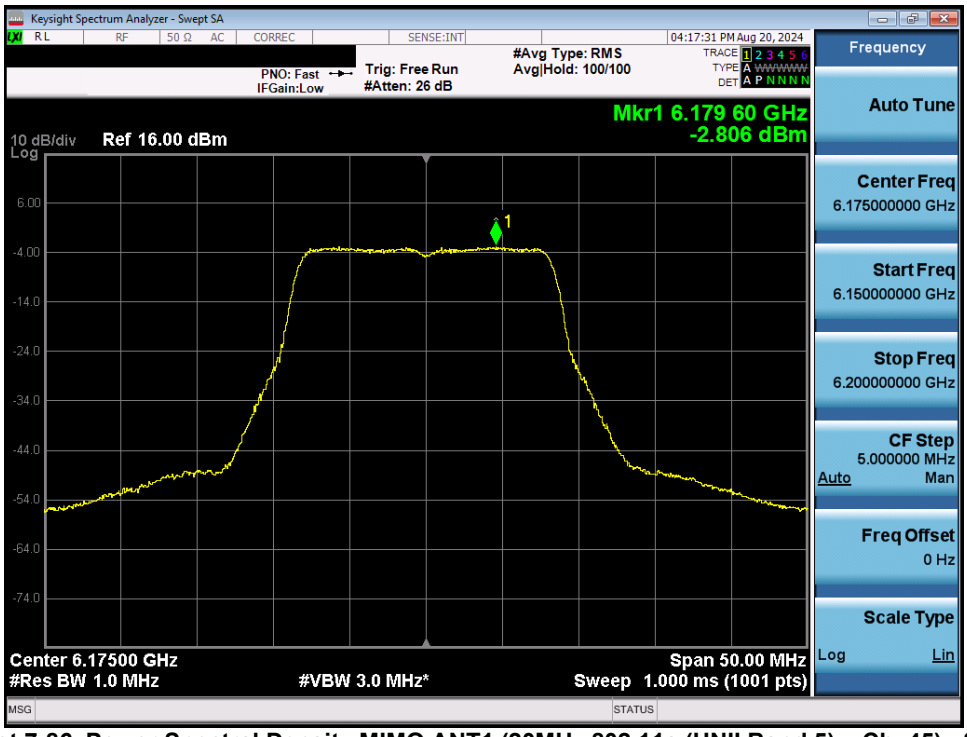
Plot 7-83. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 5) – Ch. 45) - LPI



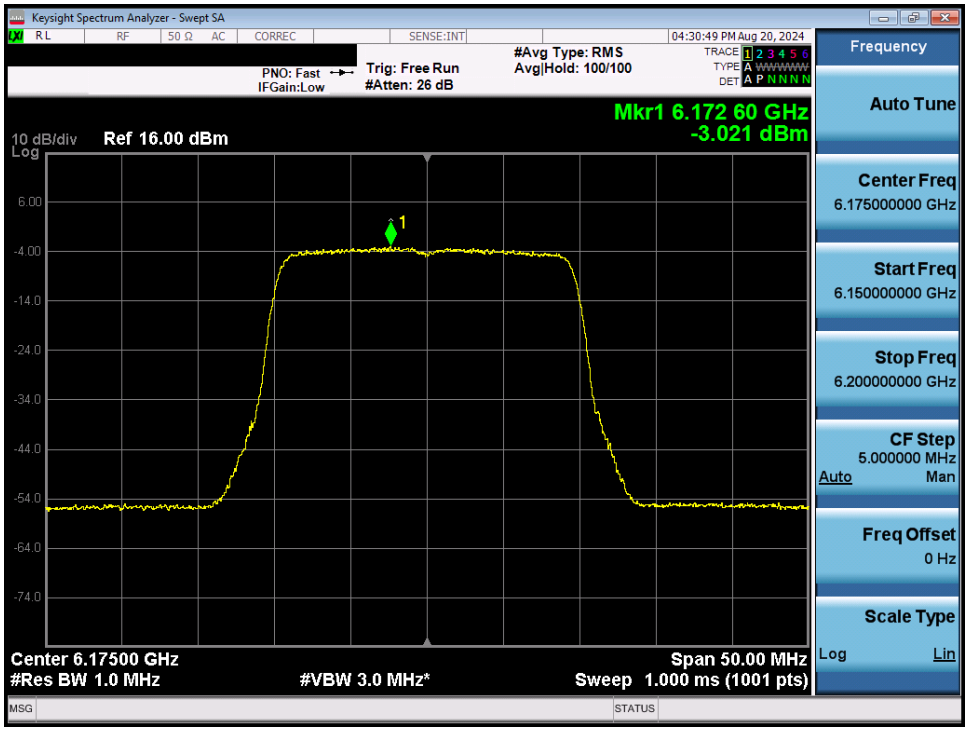
Plot 7-84. Power Spectral Density MIMO ANT1 (20MHz 802.11be (UNII Band 5) – Ch. 45) - LPI



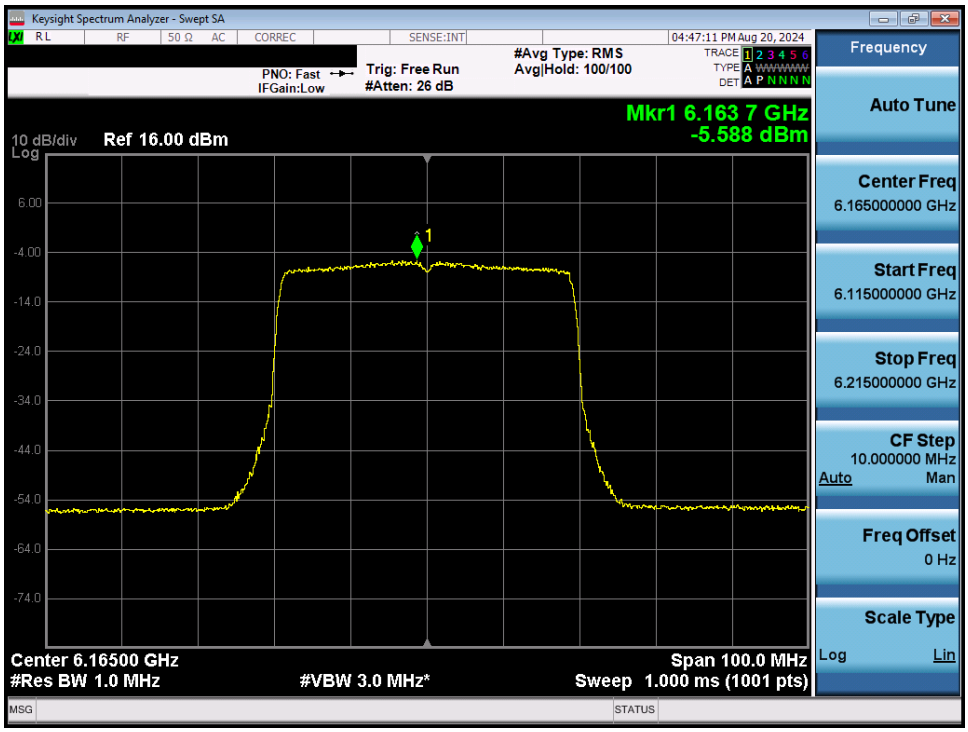
Plot 7-85. Power Spectral Density MIMO ANT1 (40MHz 802.11be (UNII Band 5) – Ch. 43) - LPI



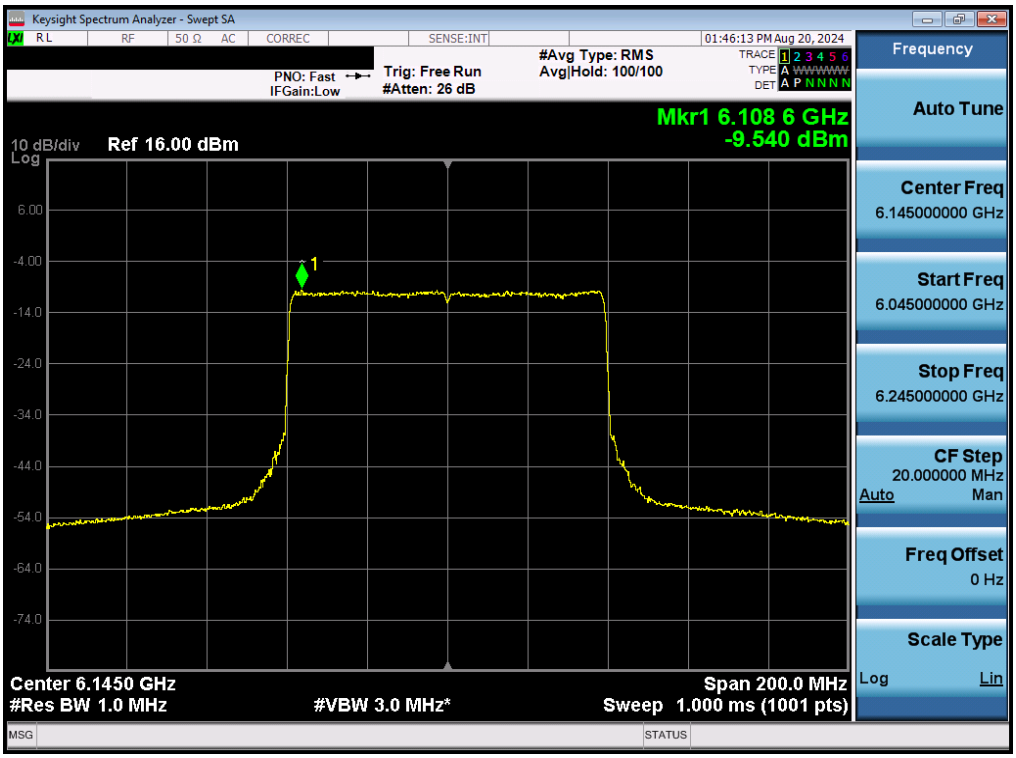
Plot 7-86. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 5) – Ch. 45) - SP



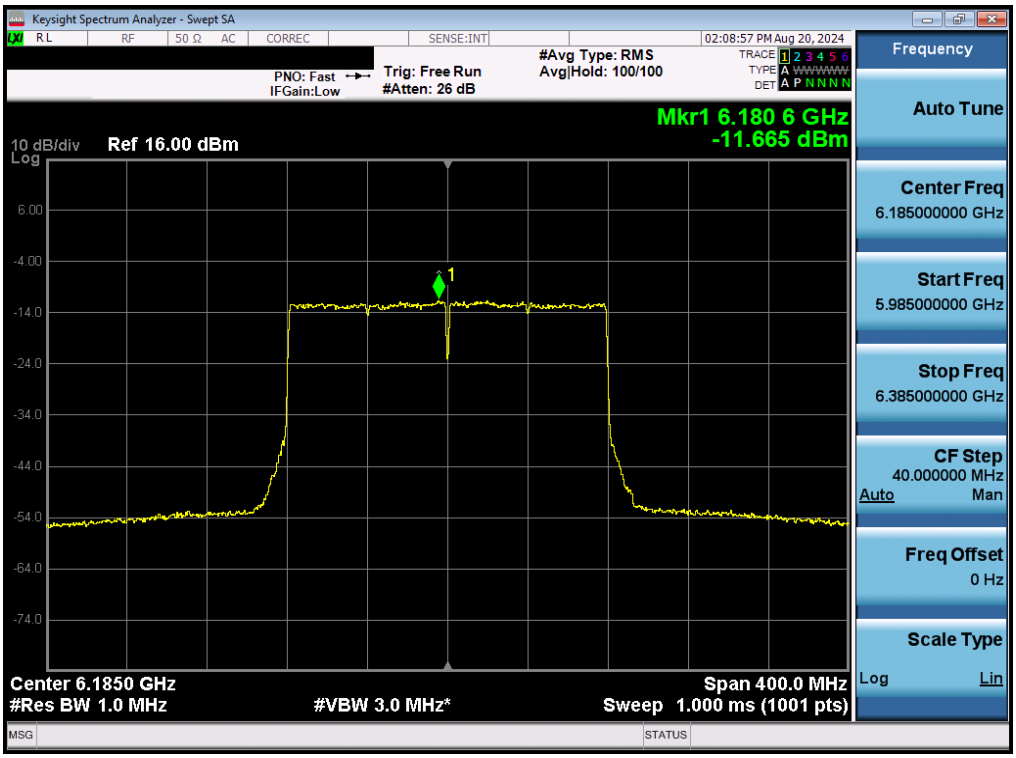
Plot 7-87. Power Spectral Density MIMO ANT1 (20MHz 802.11be (UNII Band 5) – Ch. 45) – SP



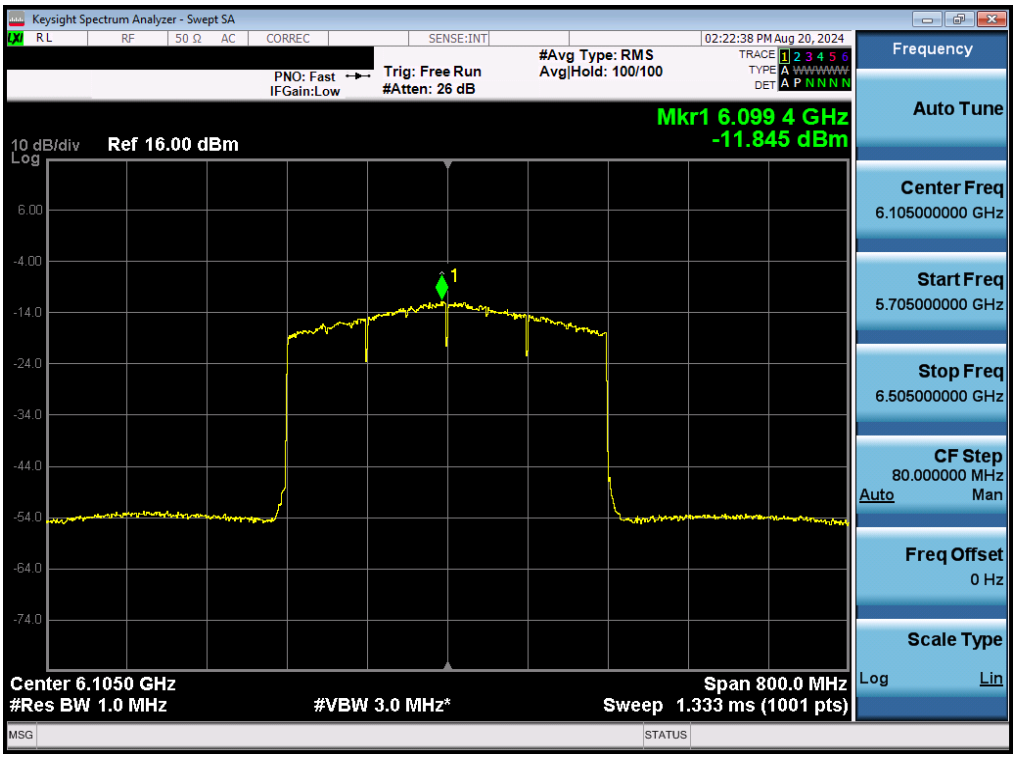
Plot 7-88. Power Spectral Density MIMO ANT1 (40MHz 802.11be (UNII Band 5) – Ch. 43) - SP



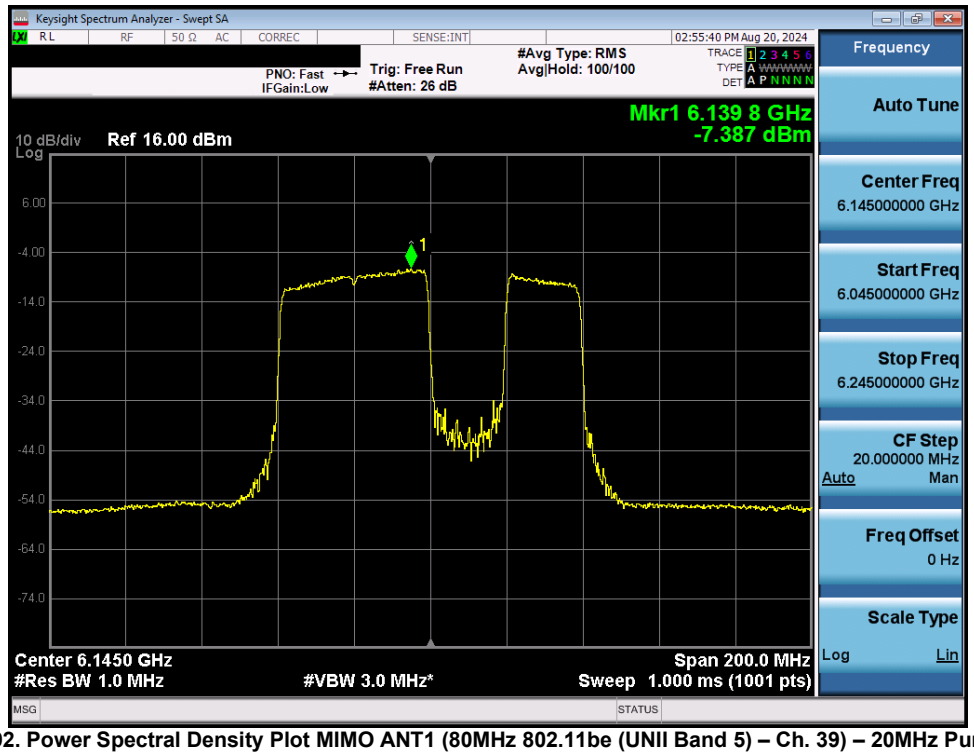
Plot 7-89. Power Spectral Density MIMO ANT1 (80MHz 802.11be (UNII Band 5) – Ch. 39) - LPI/SP



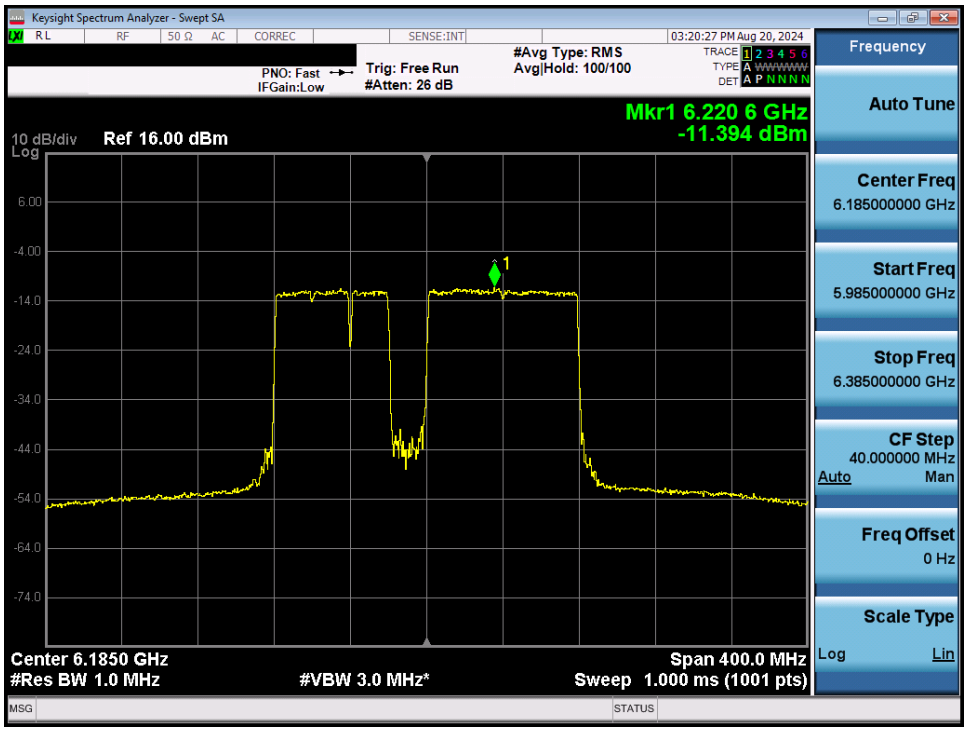
Plot 7-90. Power Spectral Density MIMO ANT1 (160MHz 802.11be (UNII Band 5) – Ch. 47) - LPI/SP



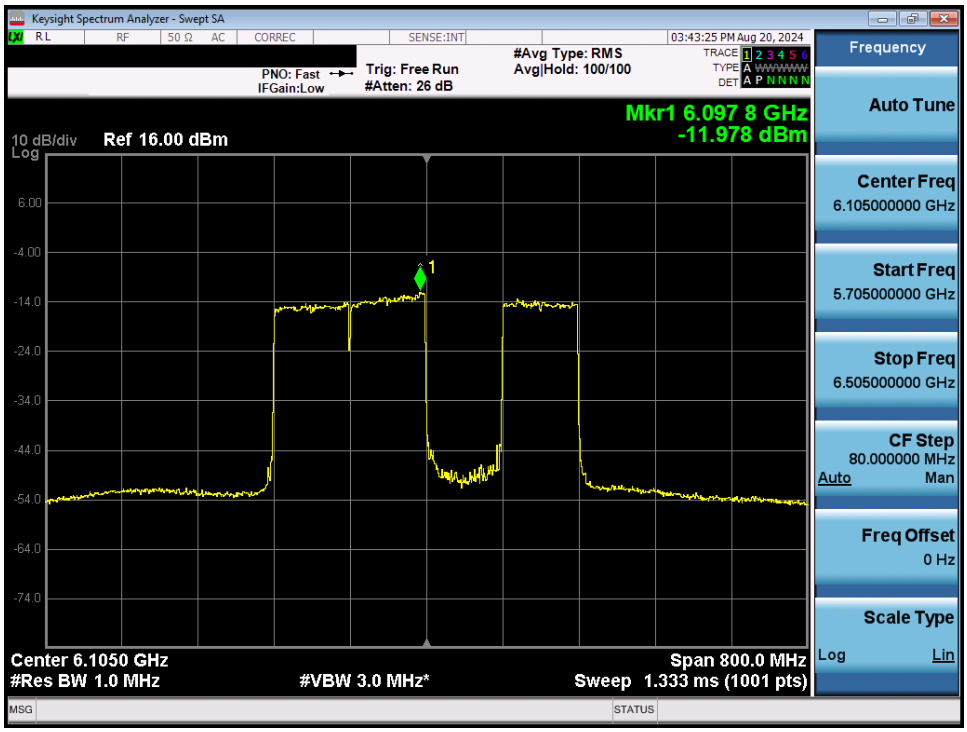
Plot 7-91. Power Spectral Density MIMO ANT1 (320MHz 802.11be (UNII Band 5) – Ch. 31) - LPI/SP



Plot 7-92. Power Spectral Density Plot MIMO ANT1 (80MHz 802.11be (UNII Band 5) – Ch. 39) – 20MHz Punctured

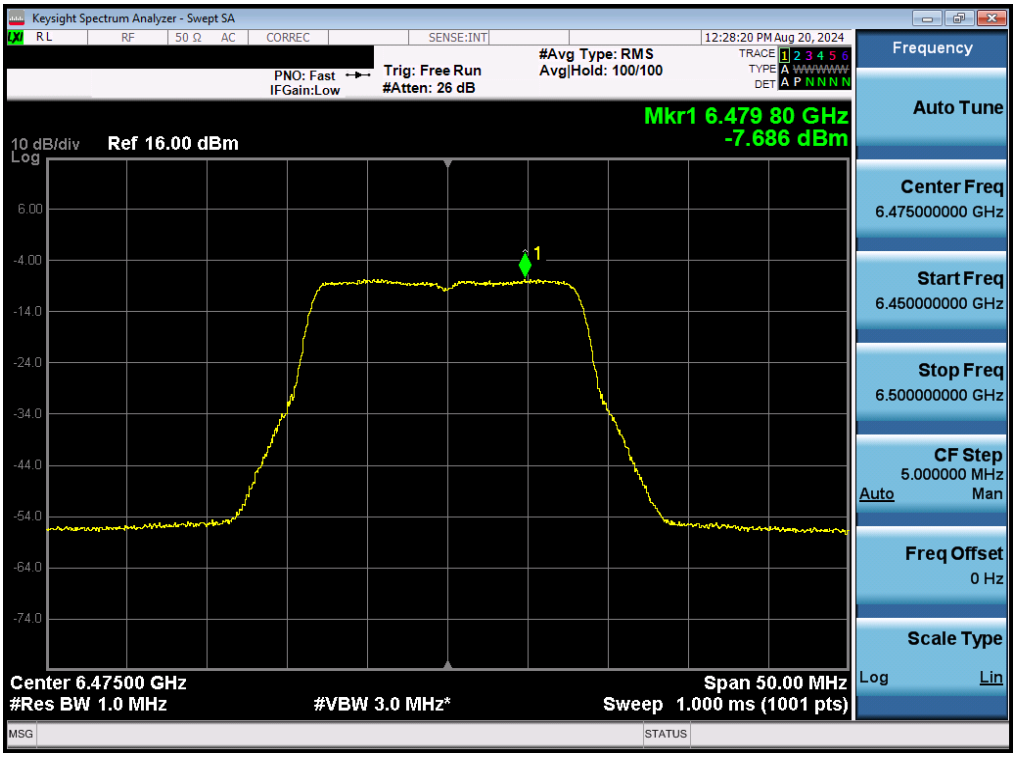


Plot 7-93. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 5) – Ch. 47) – 20MHz Punctured

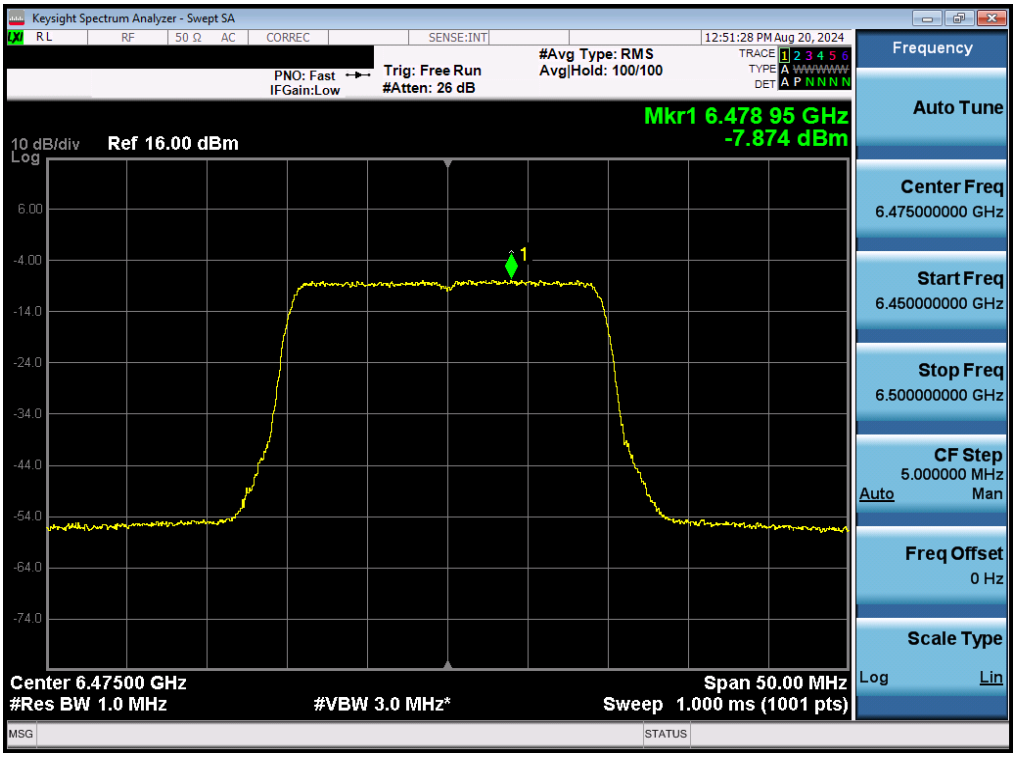


Plot 7-94. Power Spectral Density Plot MIMO ANT1 (320MHz 802.11be (UNII Band 5) – Ch. 31) – 80MHz Punctured

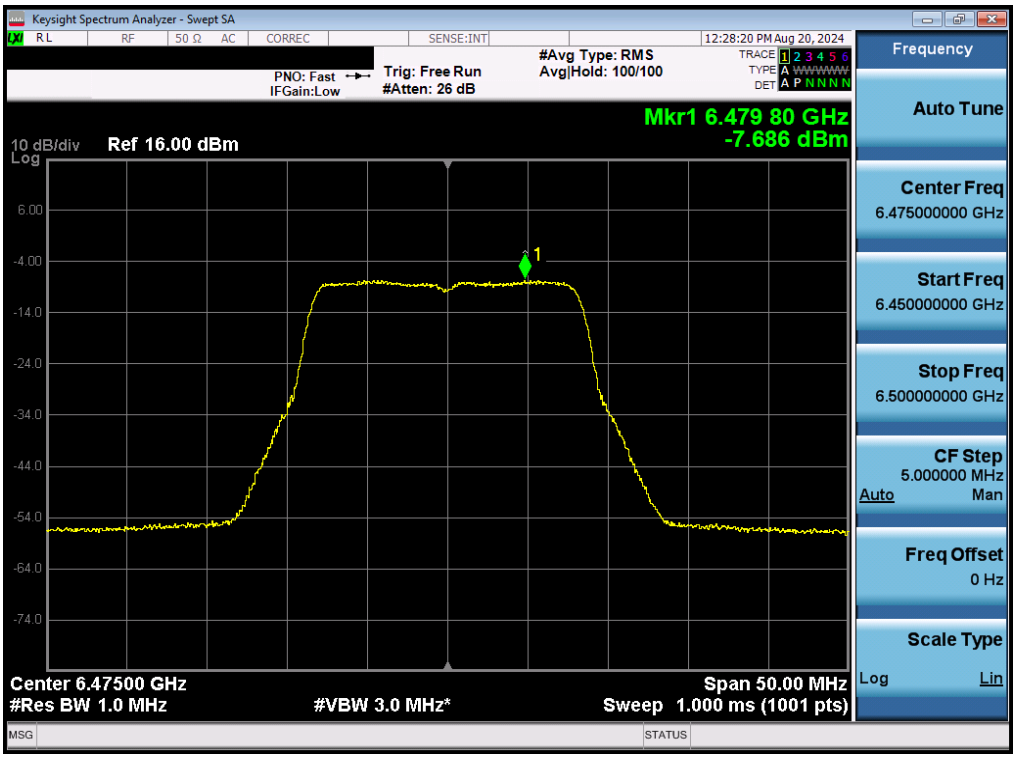
MIMO Antenna-1 Power Spectral Density Measurements – (UNII Band 6) – LPI



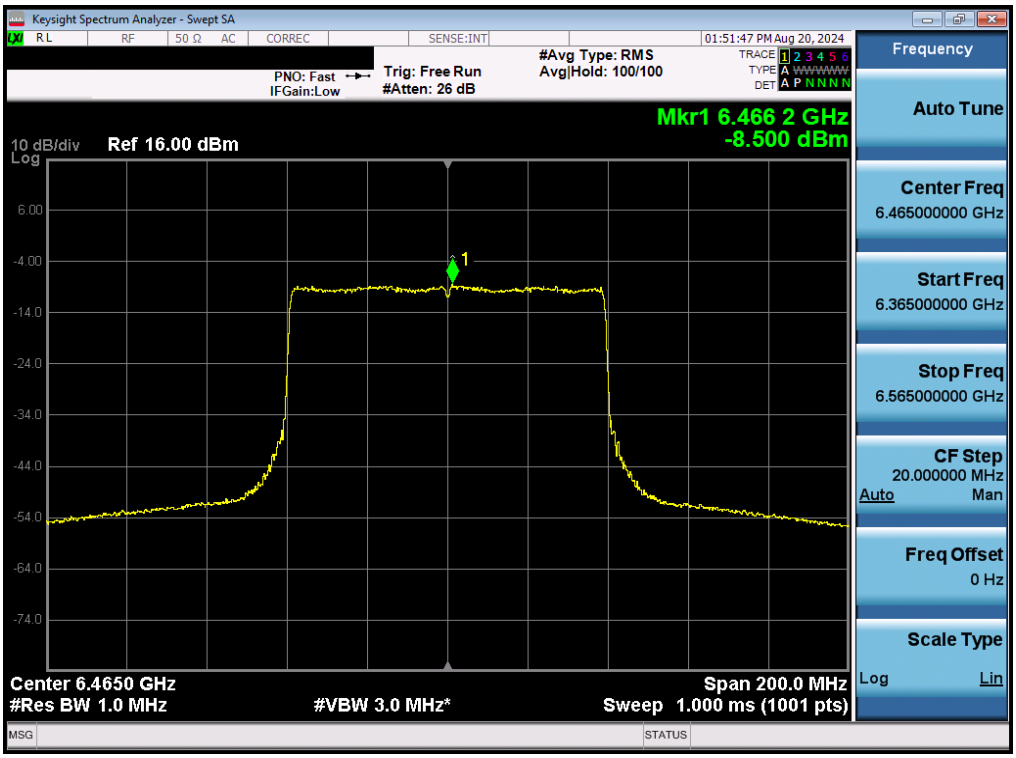
Plot 7-95. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 6) – Ch. 105) - LPI



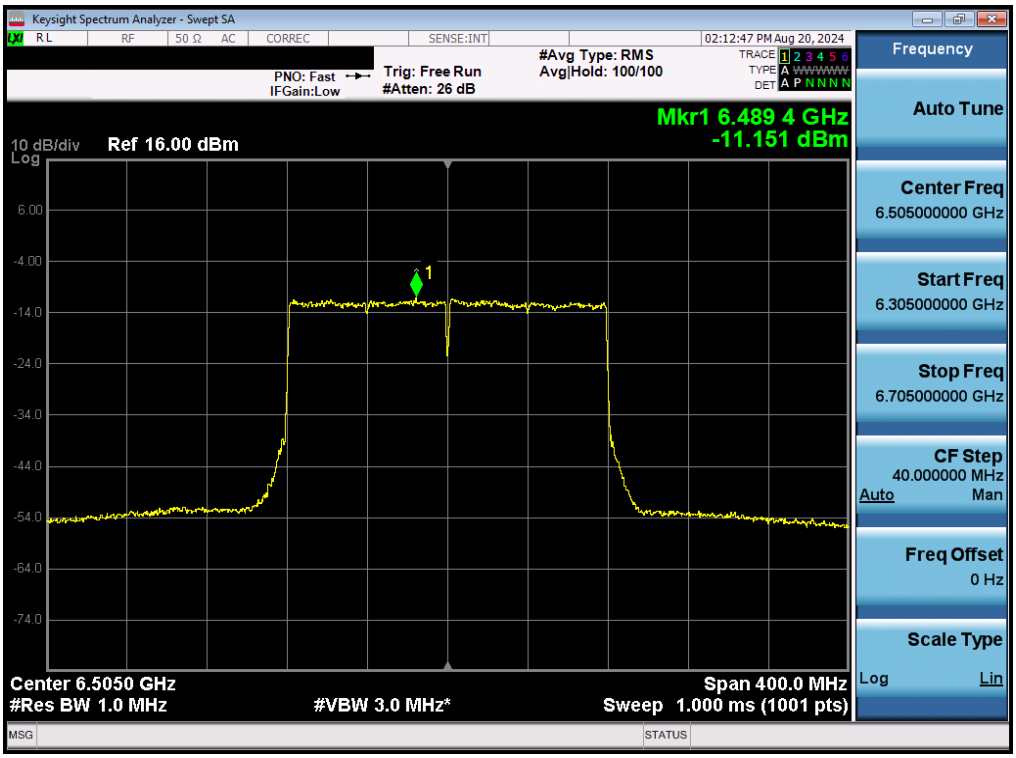
Plot 7-96. Power Spectral Density MIMO ANT1 (20MHz 802.11be (UNII Band 6) – Ch. 105) - LPI



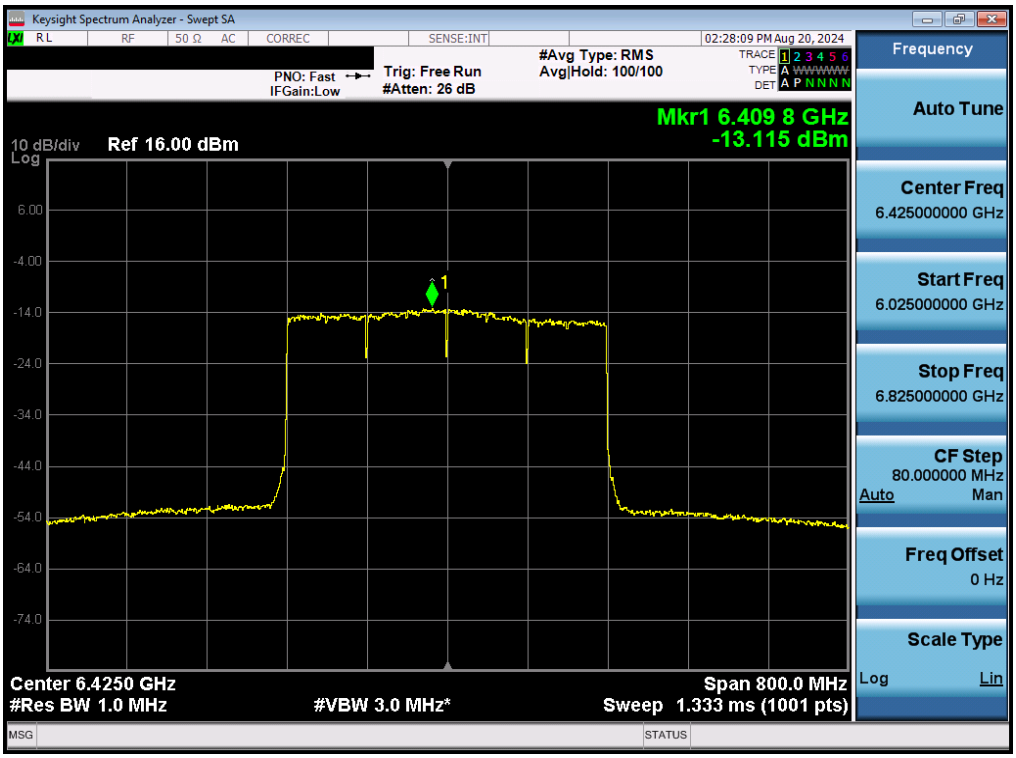
Plot 7-97. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 6) – Ch. 105) - LPI



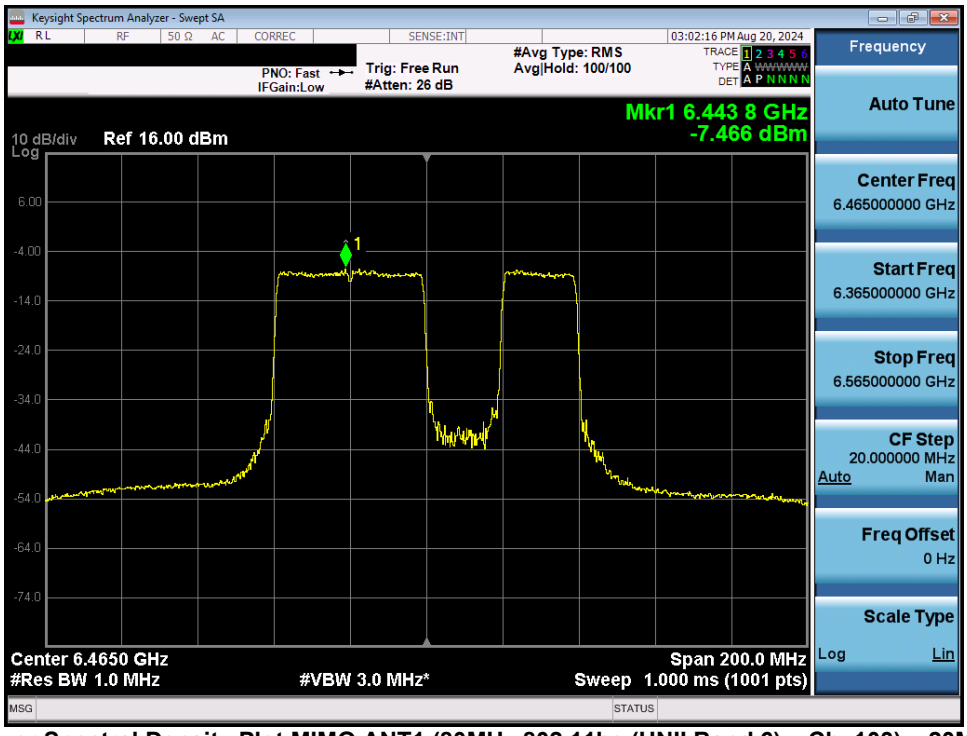
Plot 7-98. Power Spectral Density MIMO ANT1 (80MHz 802.11be (UNII Band 6) – Ch. 103) – LPI



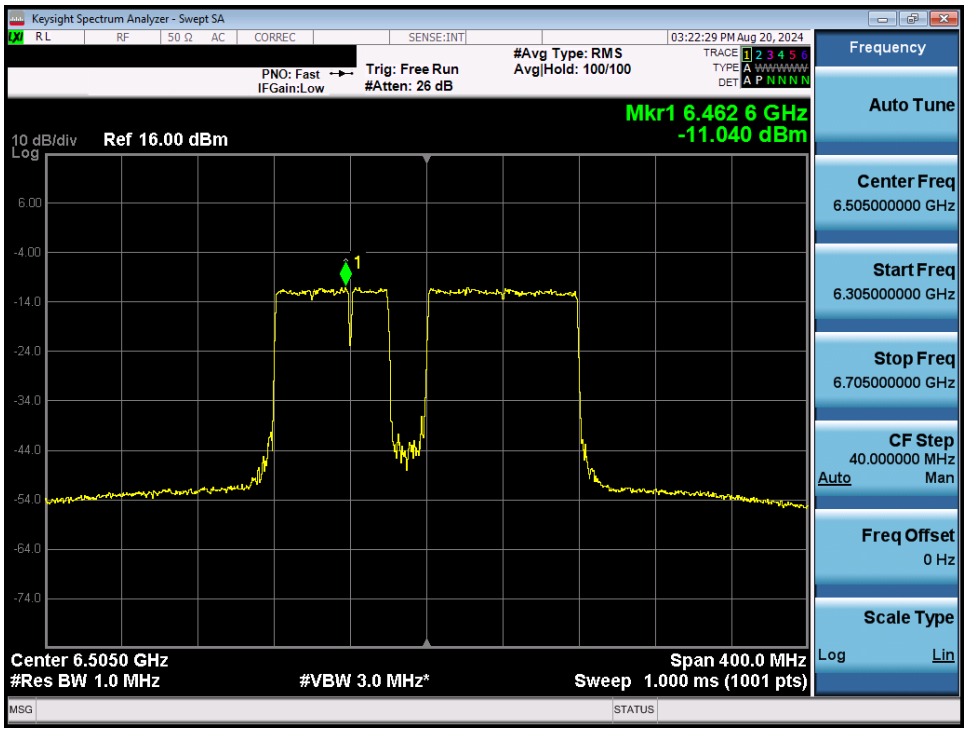
Plot 7-99. Power Spectral Density MIMO ANT1 (160MHz 802.11be (UNII Band 6) – Ch. 111) – LPI



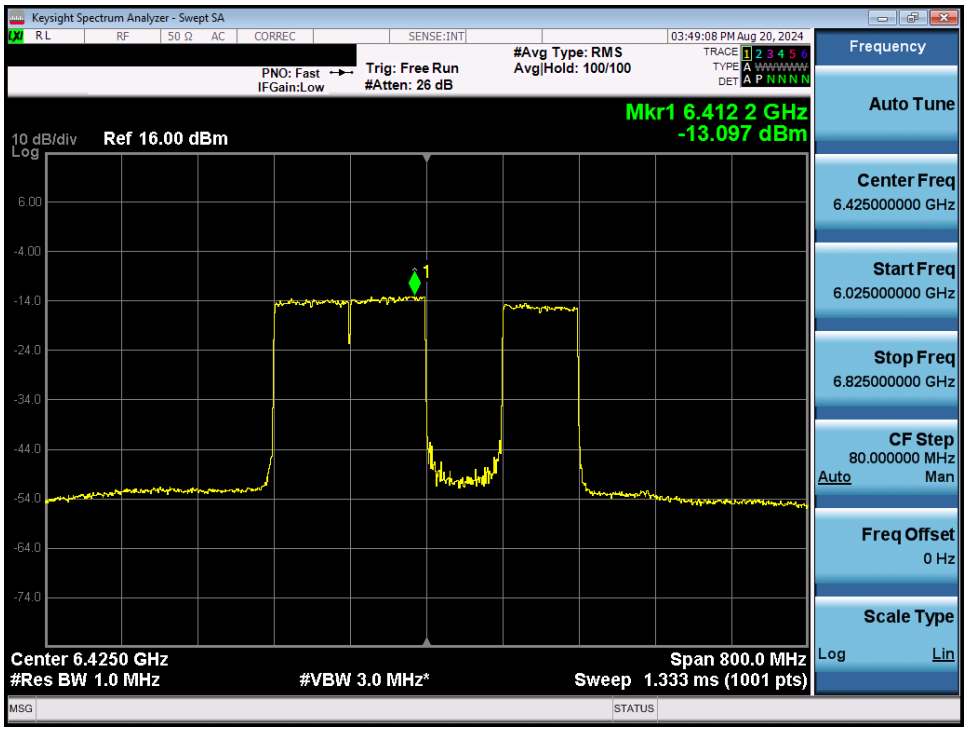
Plot 7-100. Power Spectral Density MIMO ANT1 (320MHz 802.11be (UNII Band 6) – Ch. 95) – LPI



Plot 7-101. Power Spectral Density Plot MIMO ANT1 (80MHz 802.11be (UNII Band 6) – Ch. 103) – 20MHz Punctured

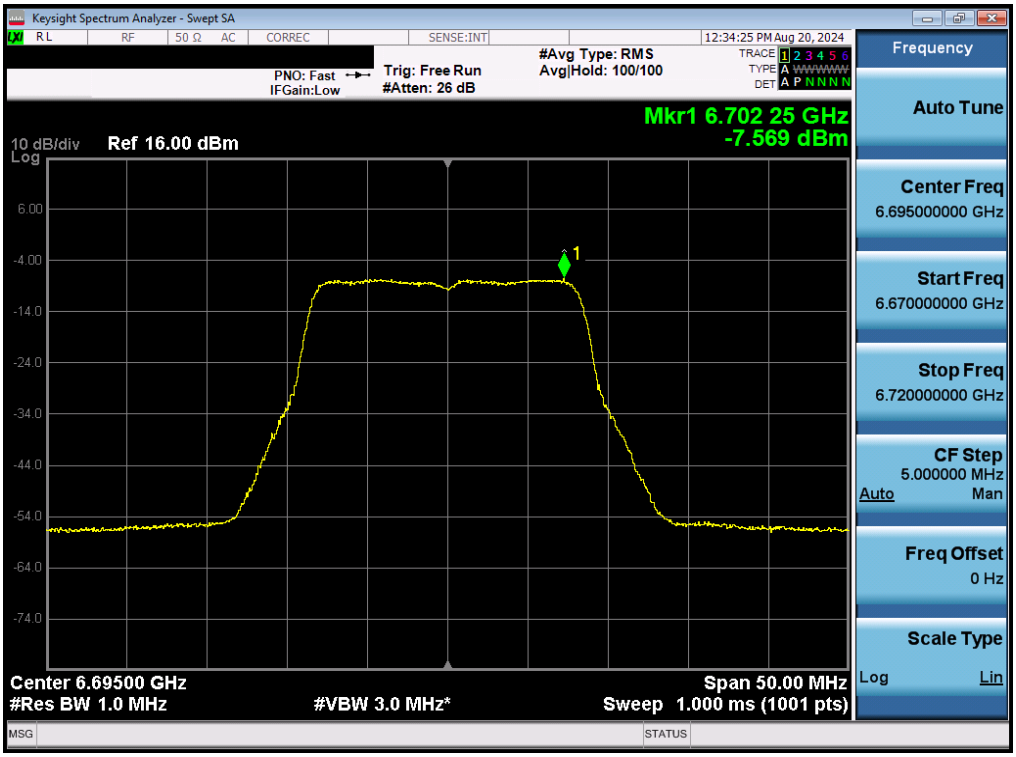


Plot 7-102. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 6) – Ch. 111) – LPI-20MHz Punctured

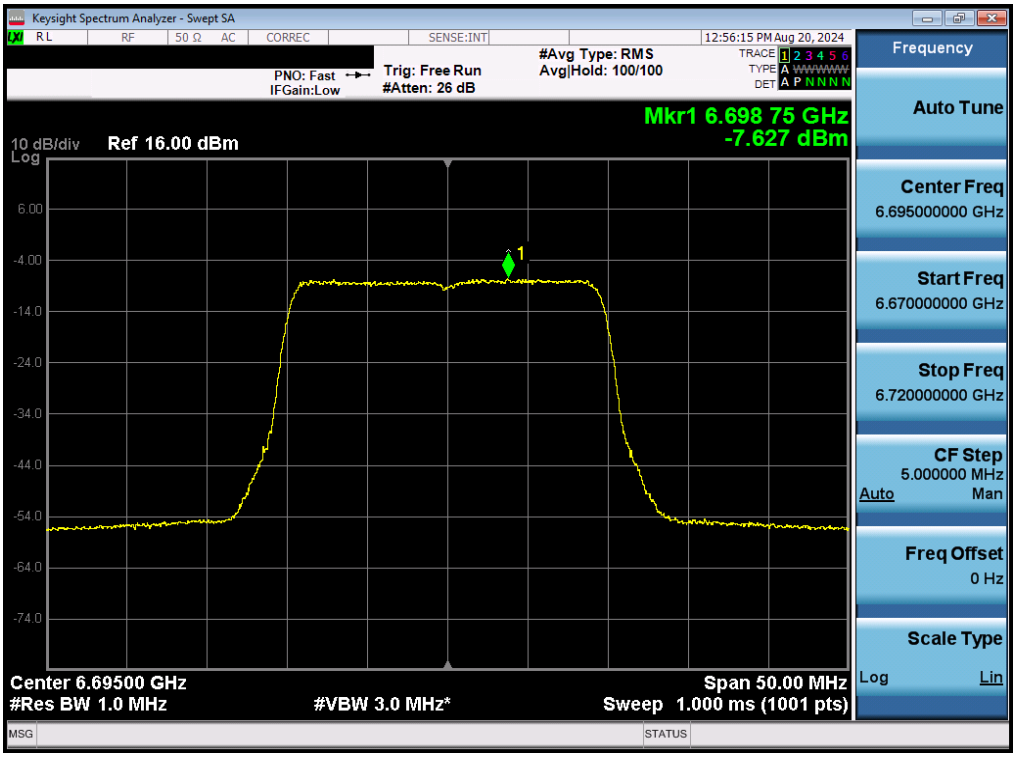


Plot 7-103. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 6) – Ch. 95) – LPI-80MHz Punctured

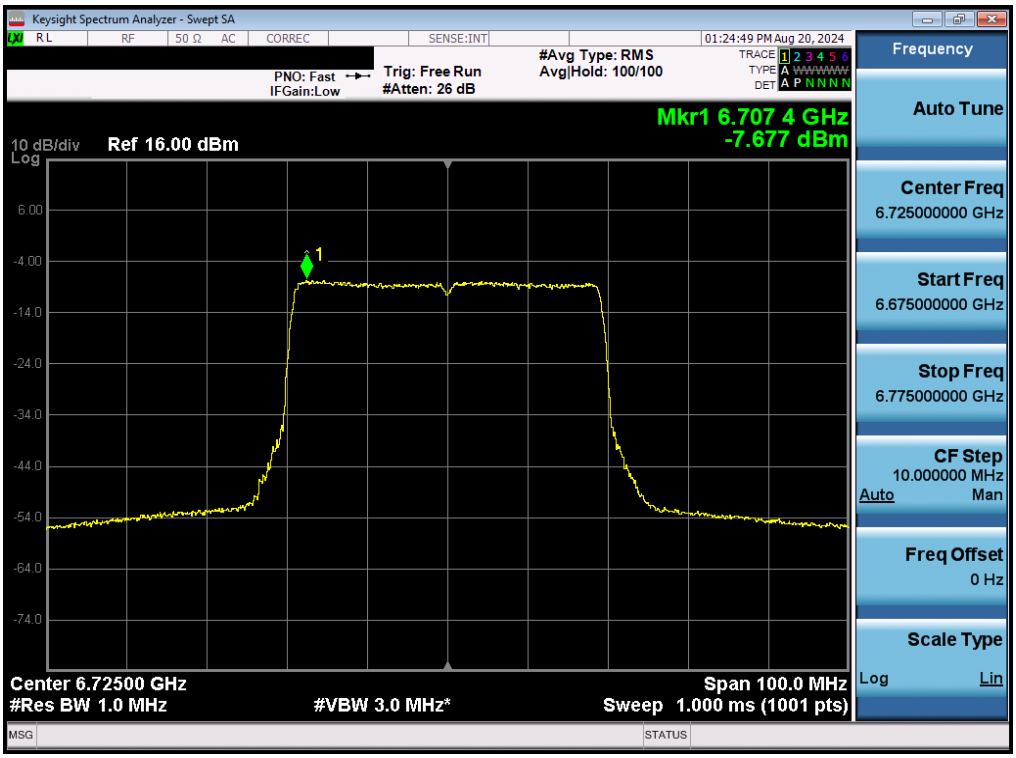
MIMO Antenna-1 Power Spectral Density Measurements – (UNII Band 7) – LPI/SP



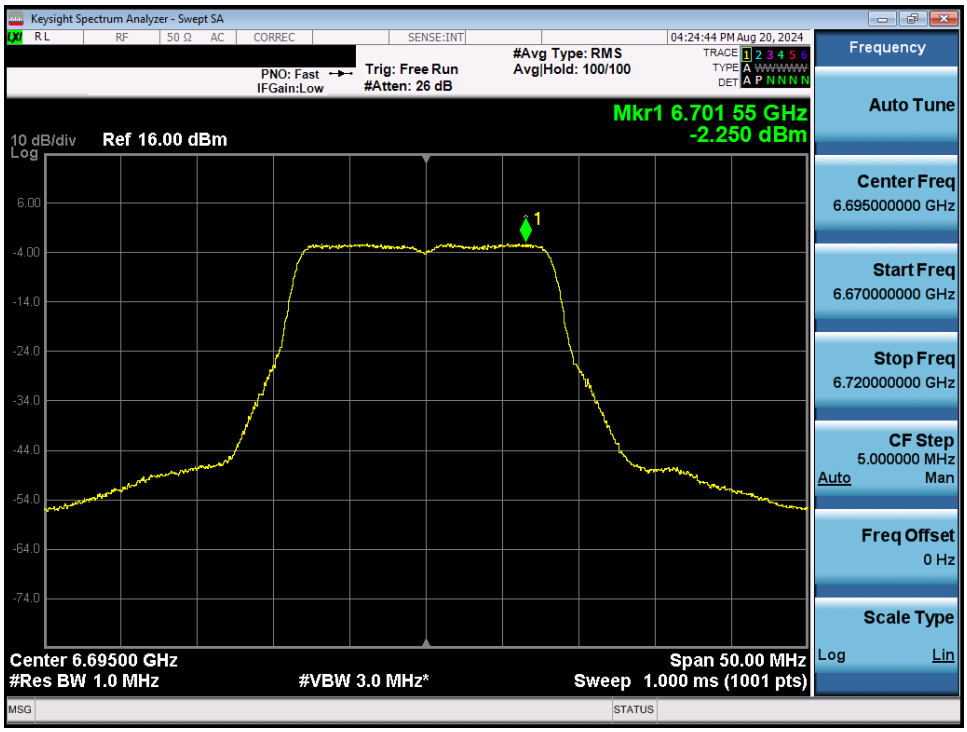
Plot 7-104. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 7) – Ch. 149) - LPI



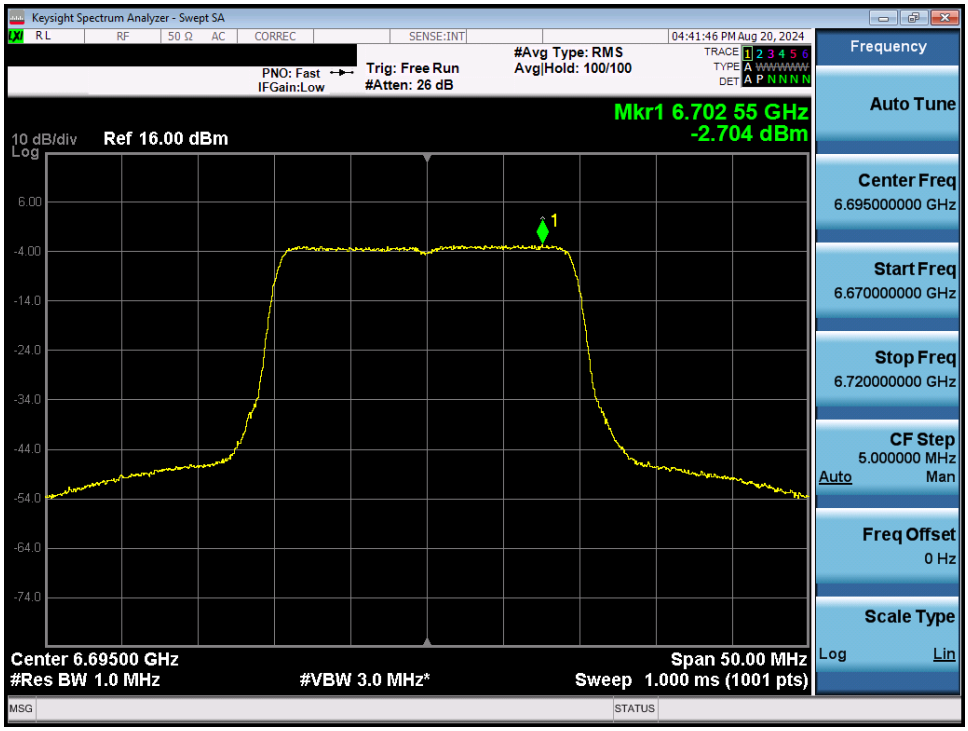
Plot 7-105. Power Spectral Density MIMO ANT1 (20MHz 802.11be (UNII Band 7) – Ch. 149) - LPI



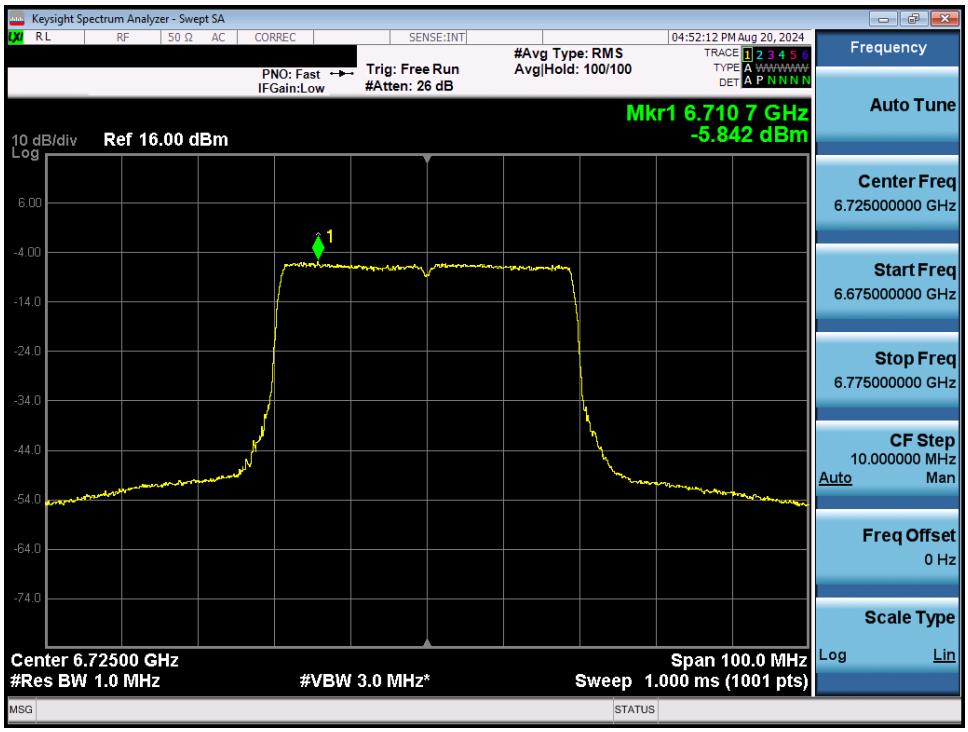
Plot 7-106. Power Spectral Density MIMO ANT1 (40MHz 802.11be (UNII Band 7) – Ch. 155) - LPI



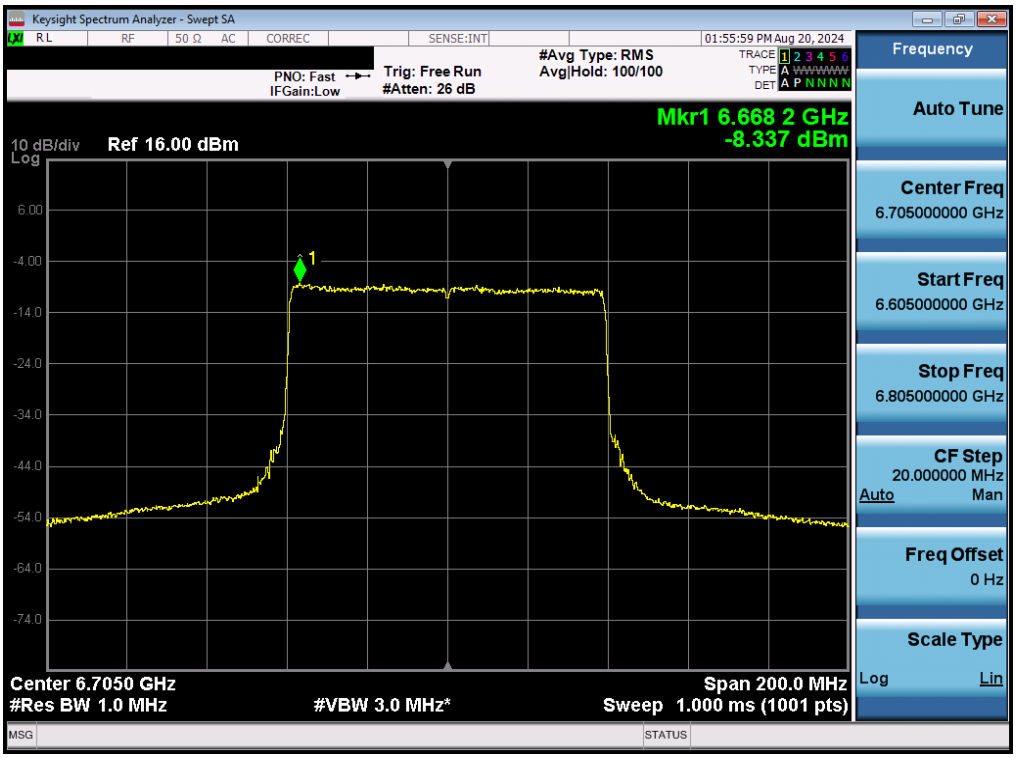
Plot 7-107. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 7) – Ch. 149) - SP



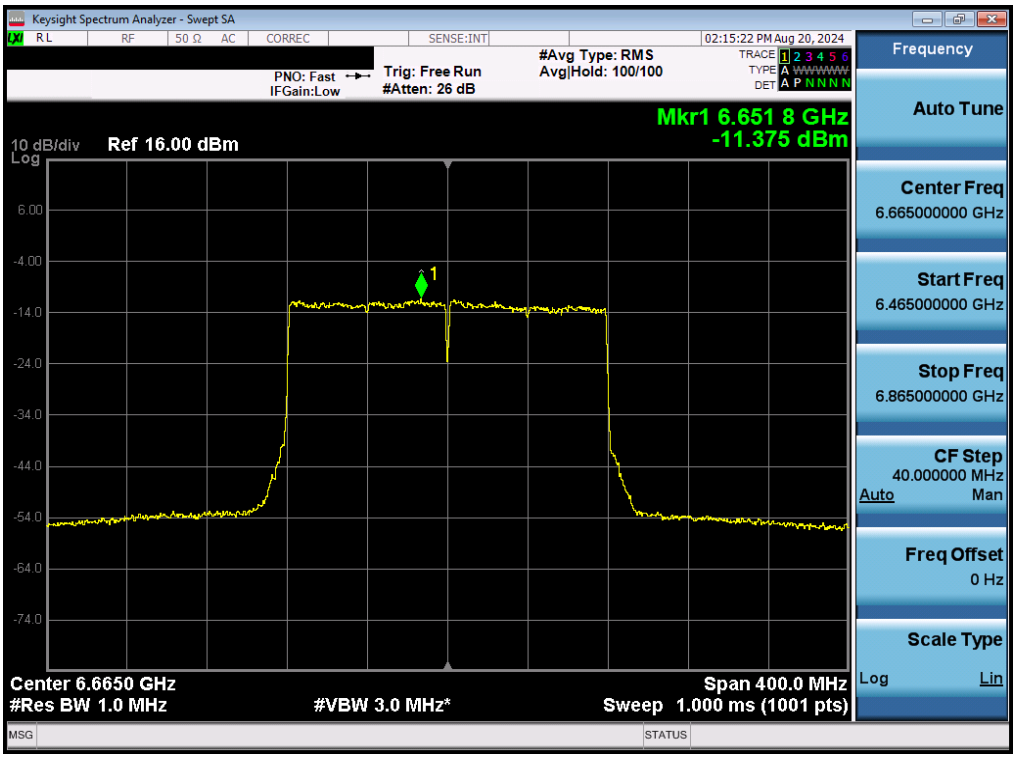
Plot 7-108. Power Spectral Density MIMO ANT1 (20MHz 802.11be (UNII Band 7) – Ch. 149) - SP



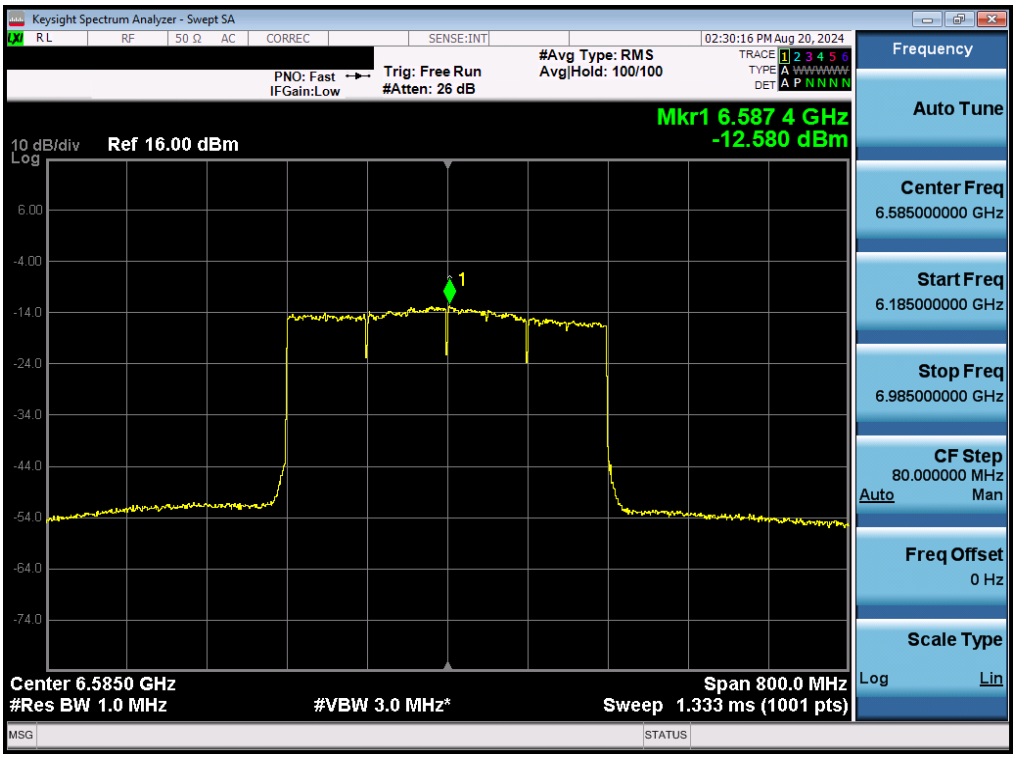
Plot 7-109. Power Spectral Density MIMO ANT1 (40MHz 802.11be (UNII Band 7) – Ch. 155) - SP



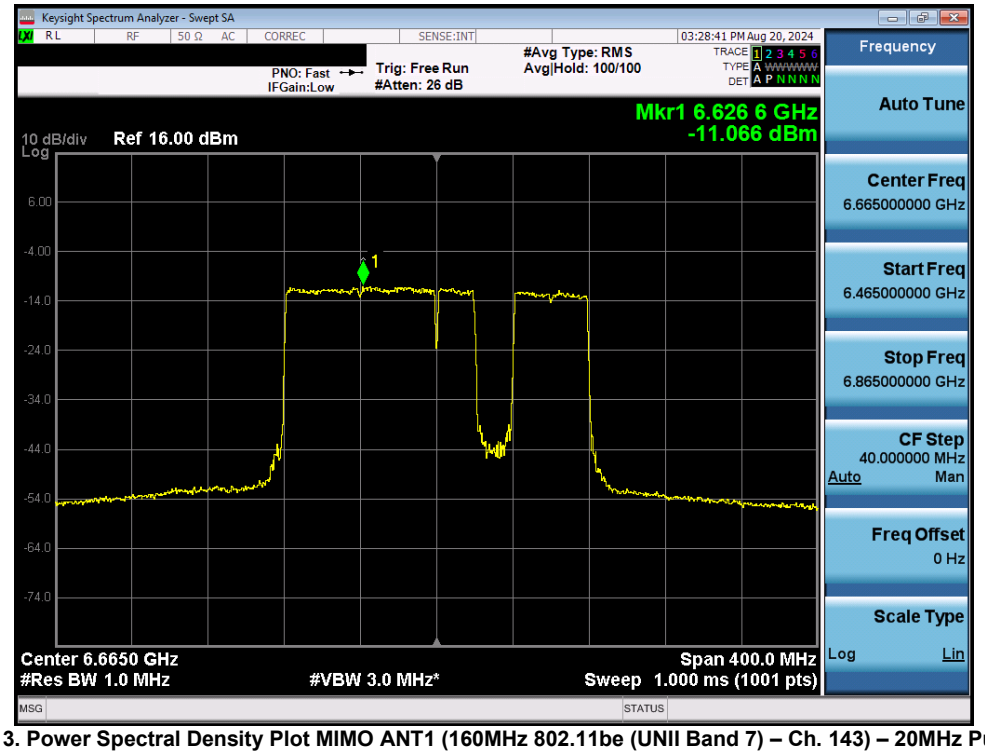
Plot 7-110. Power Spectral Density MIMO ANT1 (80MHz 802.11be (UNII Band 7) – Ch. 151) - LPI/SP



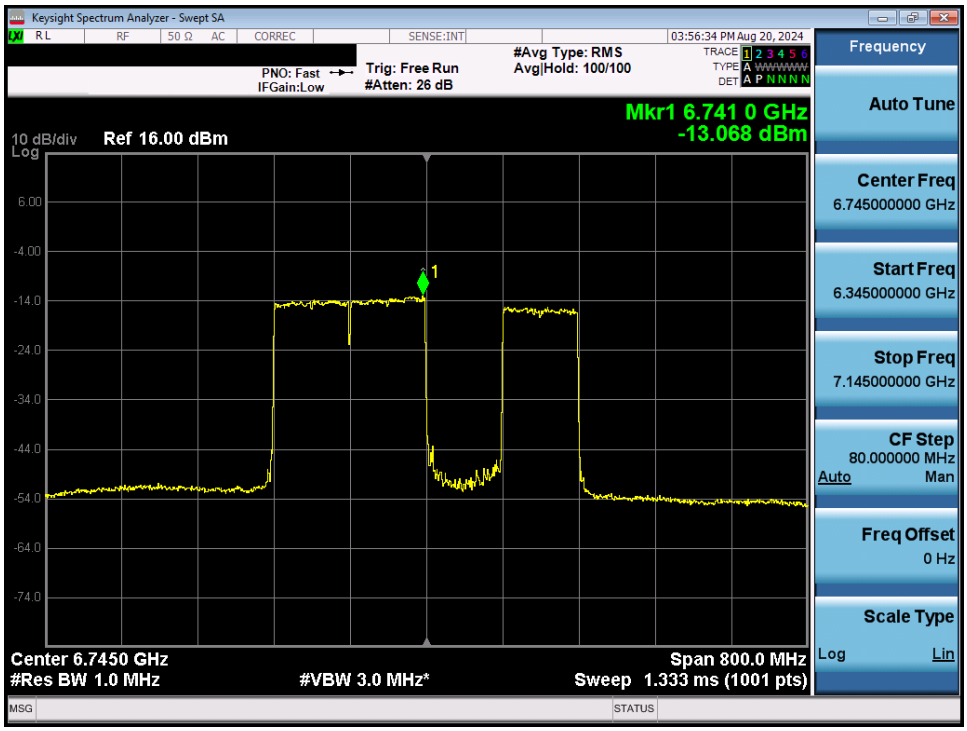
Plot 7-111. Power Spectral Density MIMO ANT1 (160MHz 802.11be (UNII Band 7) – Ch. 143) - LPI/SP



Plot 7-112. Power Spectral Density MIMO ANT1 (320MHz 802.11be (UNII Band 6/7) – Ch. 127) - LPI/SP

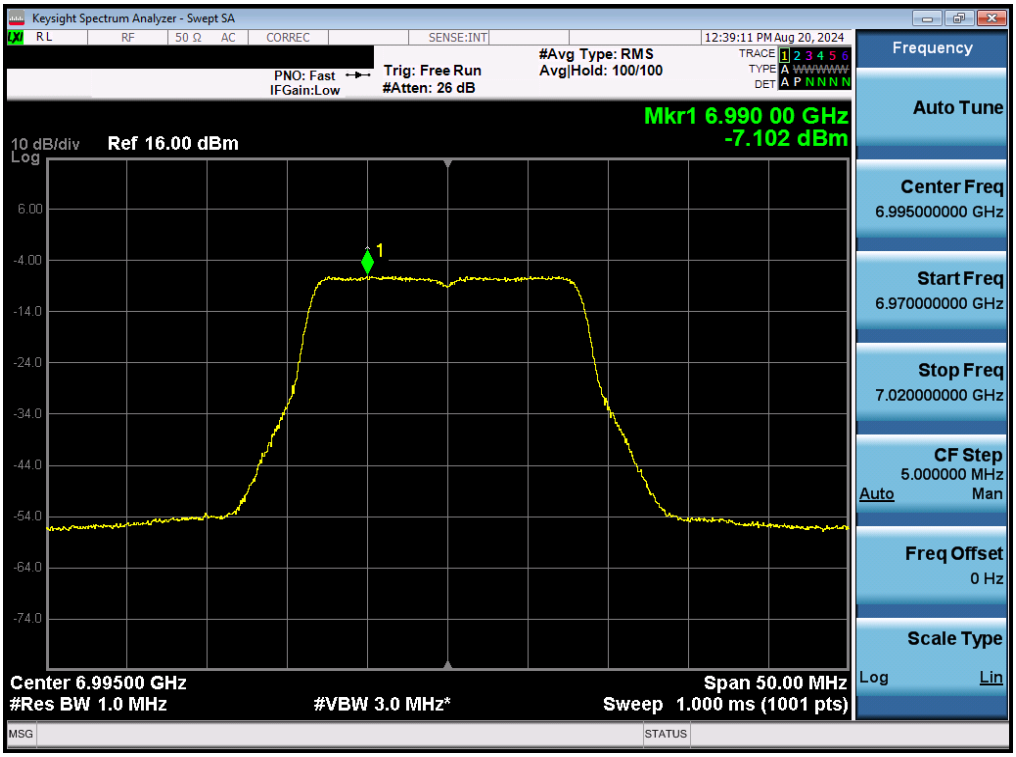


Plot 7-113. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 7) – Ch. 143) – 20MHz Punctured

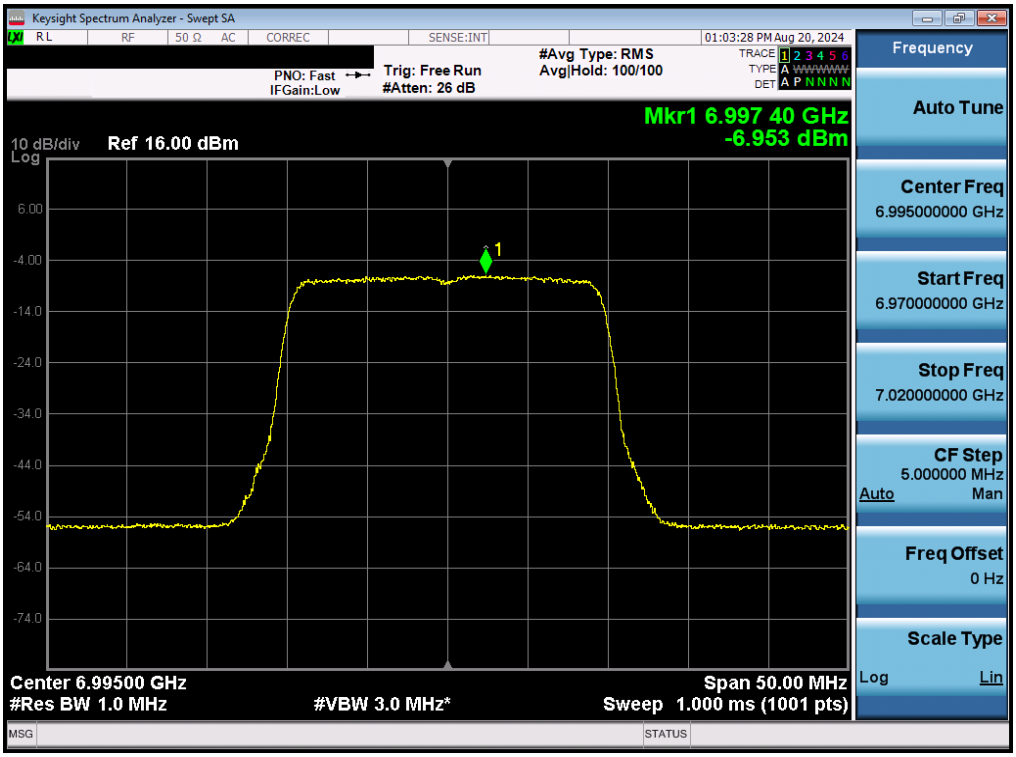


Plot 7-114. Power Spectral Density Plot MIMO ANT1 (320MHz 802.11be (UNII Band 7) – Ch. 159) – 80MHz Punctured

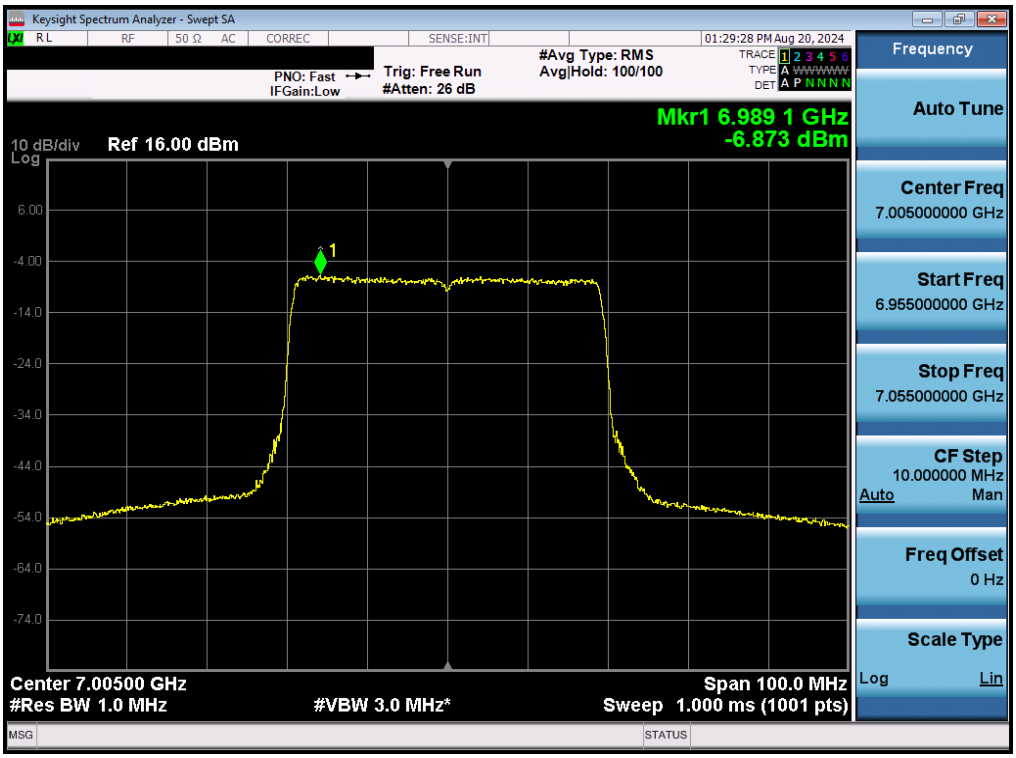
MIMO Antenna-1 Power Spectral Density Measurements – (UNII Band 8) – LPI



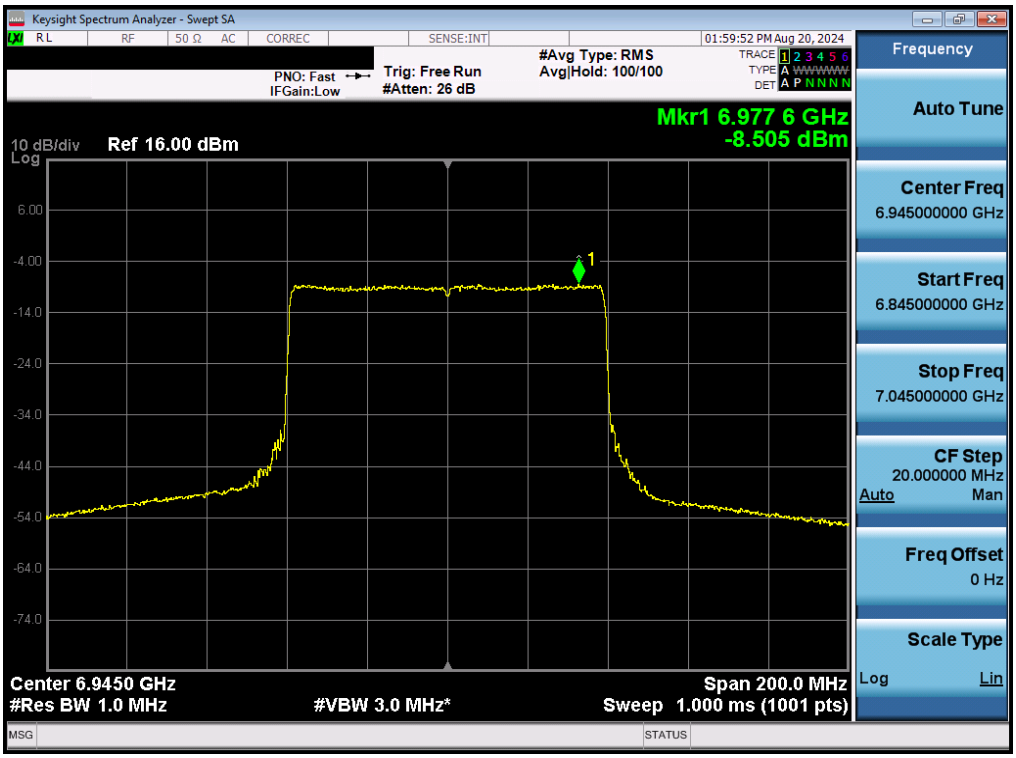
Plot 7-115. Power Spectral Density MIMO ANT1 (20MHz 802.11a (UNII Band 8) – Ch. 209) - LPI



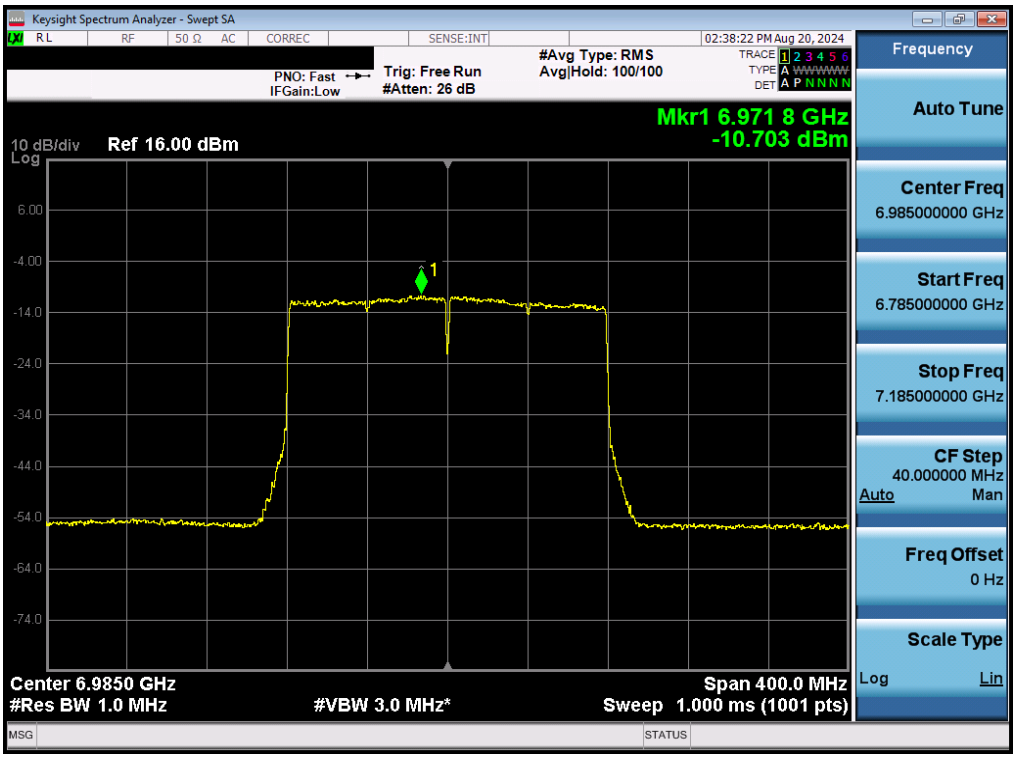
Plot 7-116. Power Spectral Density MIMO ANT1 (20MHz 802.11be (UNII Band 8) – Ch. 209) - LPI



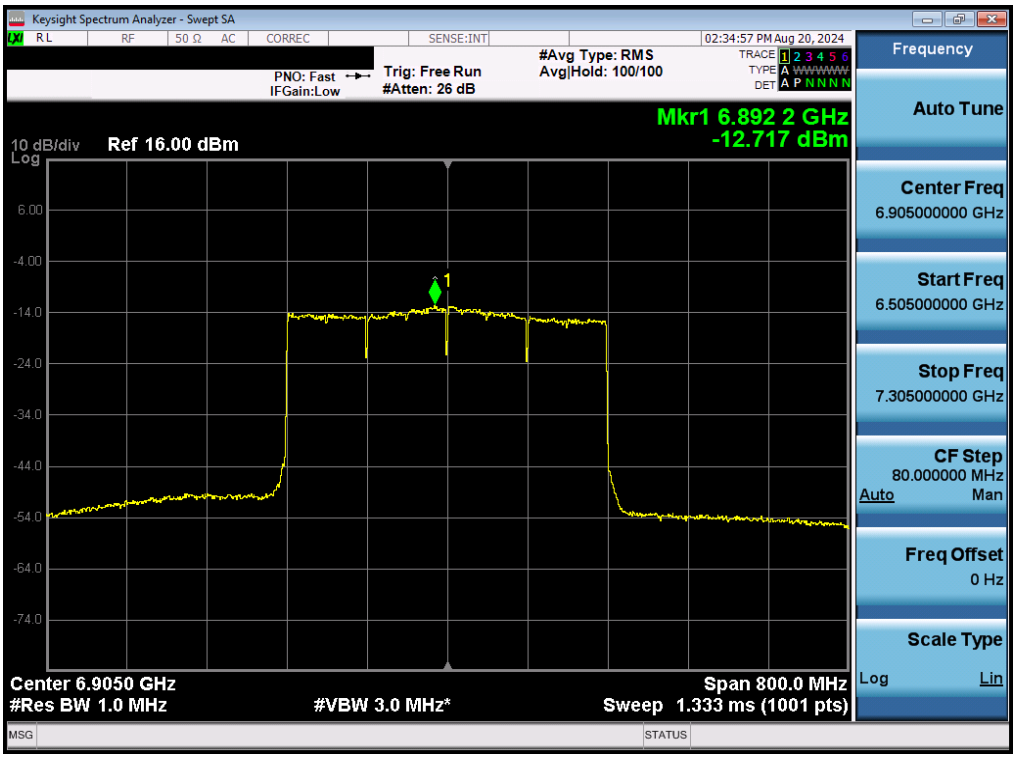
Plot 7-117. Power Spectral Density MIMO ANT1 (40MHz 802.11be (UNII Band 8) – Ch. 211) - LPI



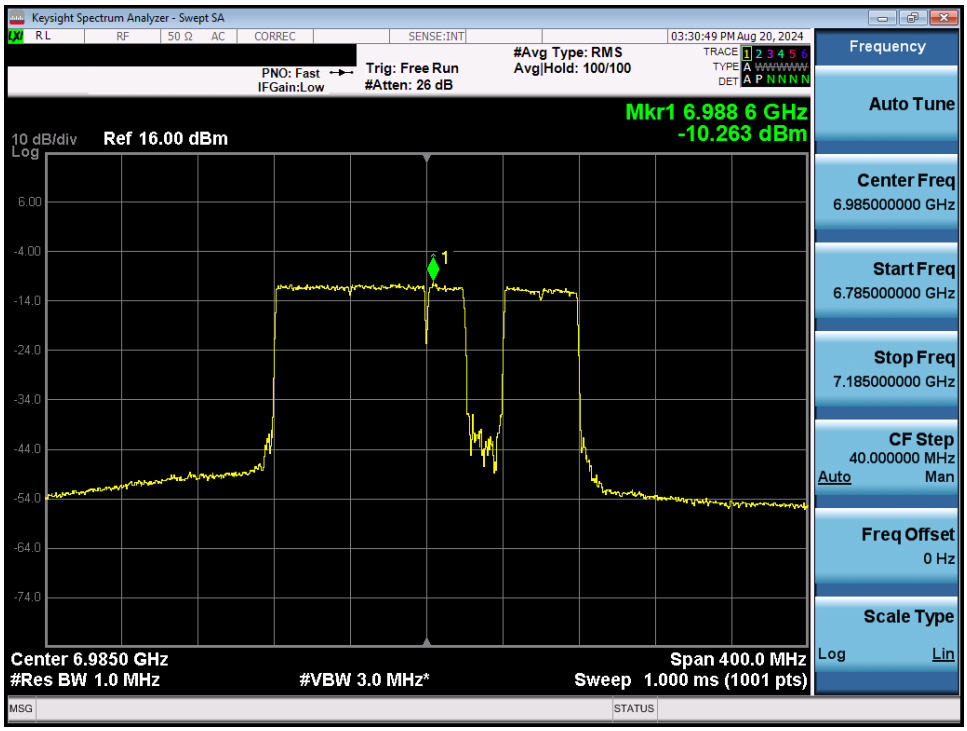
Plot 7-118. Power Spectral Density MIMO ANT1 (80MHz 802.11be (UNII Band 8) – Ch. 199) - LPI



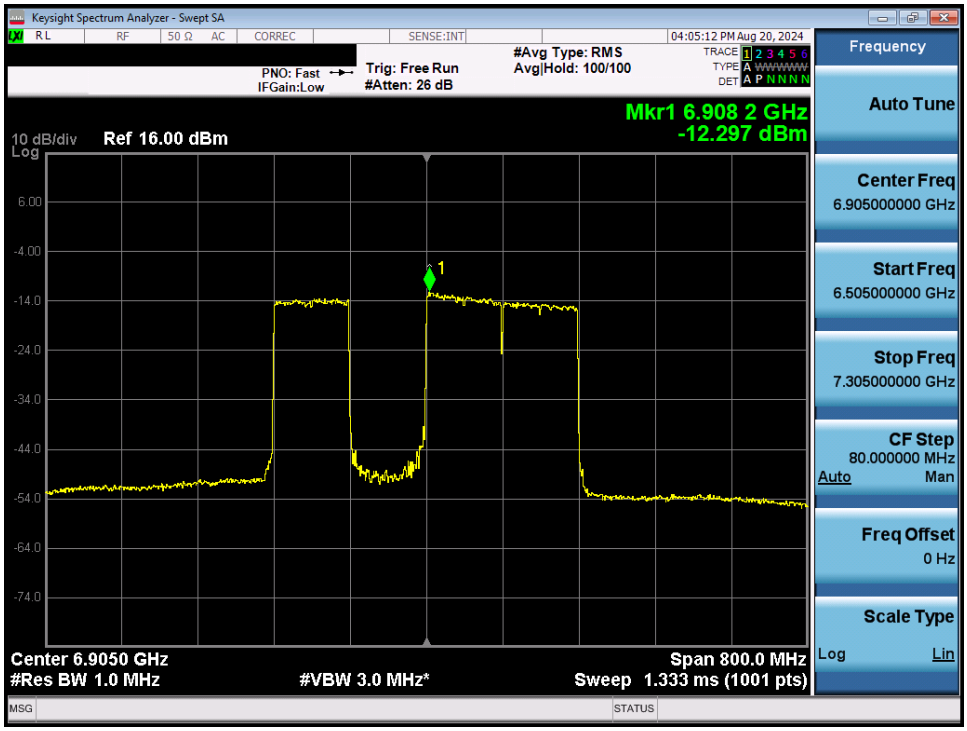
Plot 7-119. Power Spectral Density MIMO ANT1 (160MHz 802.11be (UNII Band 8) – Ch. 207) – LPI



Plot 7-120. Power Spectral Density MIMO ANT1 (320MHz 802.11be (UNII Band 7/8) – Ch. 191) – LPI

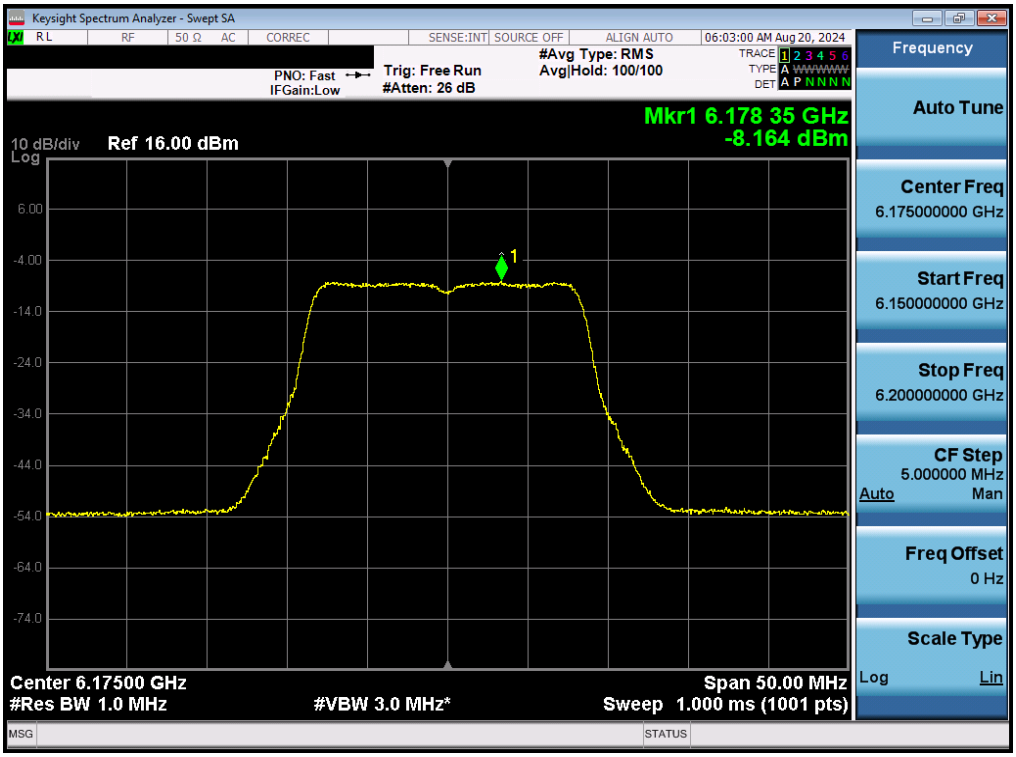


Plot 7-121. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 8) – Ch. 207) – LPI - 20MHz Punctured

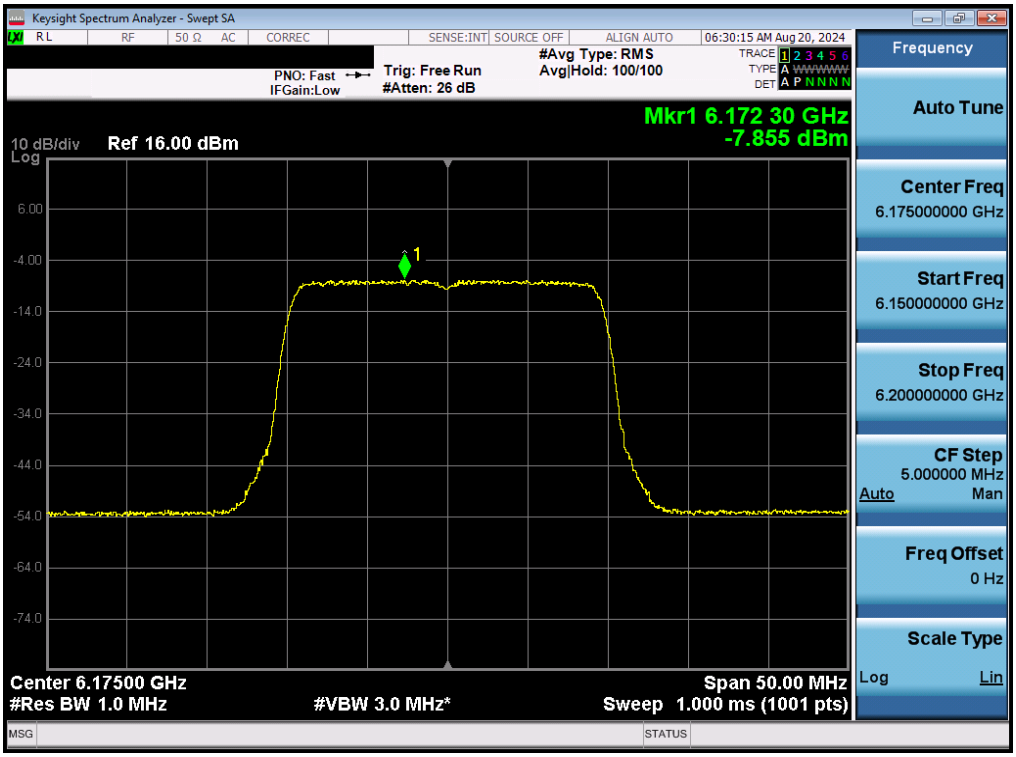


Plot 7-122. Power Spectral Density Plot MIMO ANT1 (320MHz 802.11be (UNII Band 8) – Ch. 191) – LPI - 80MHz Punctured

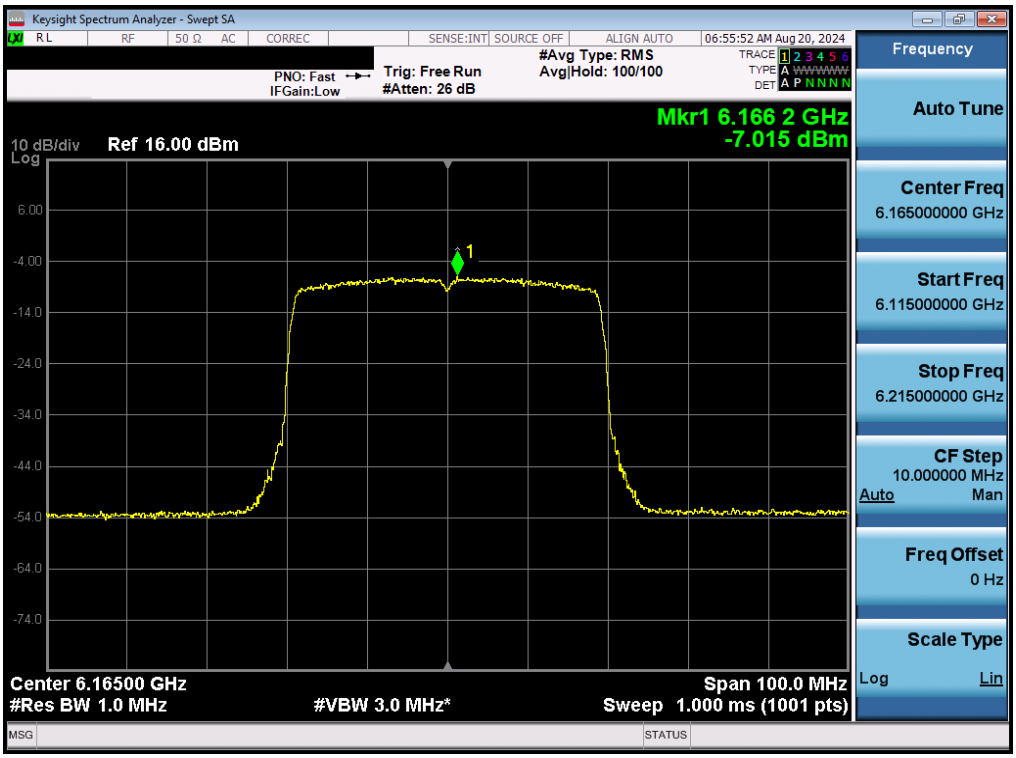
MIMO Antenna-2 Power Spectral Density Measurements - (UNII Band 5)



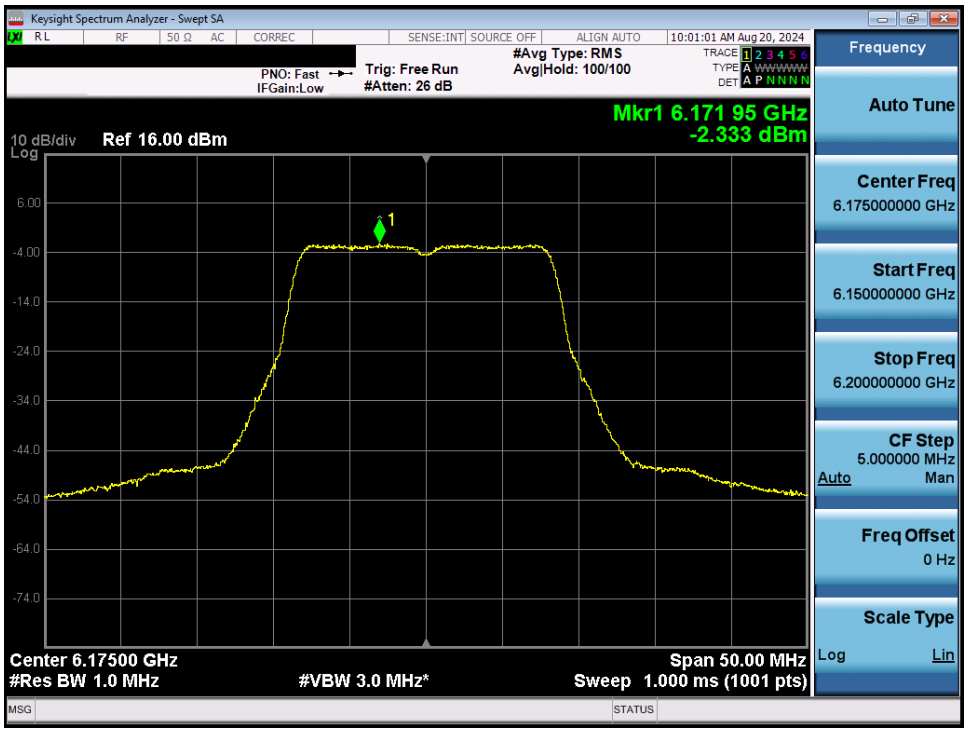
Plot 7-123. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 5) – Ch. 45) - LPI



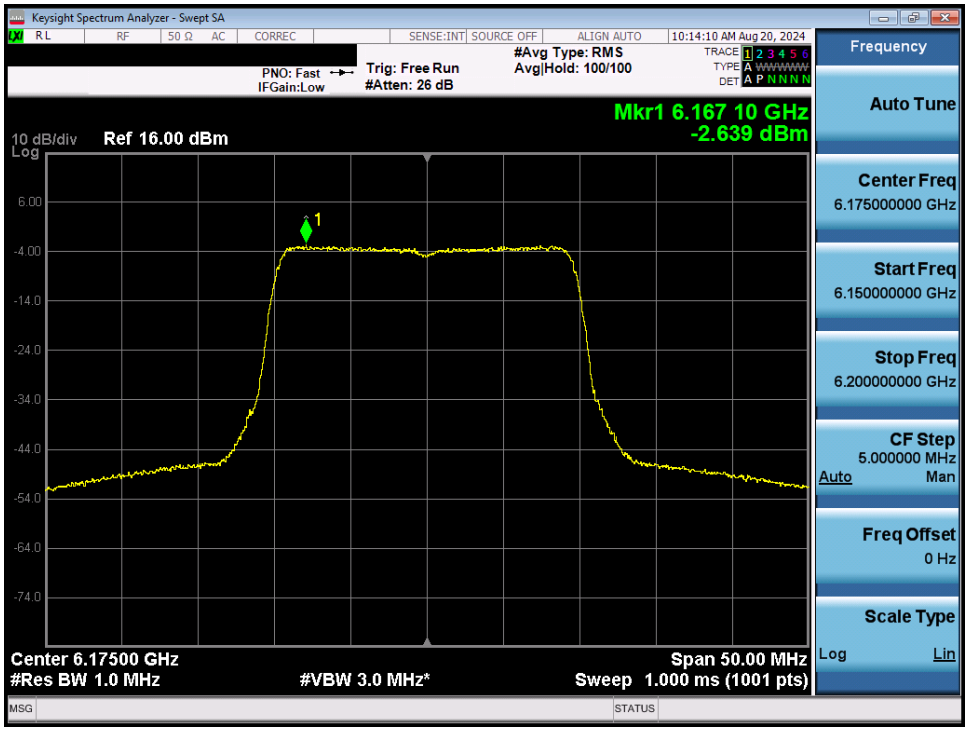
Plot 7-124. Power Spectral Density MIMO ANT2 (20MHz 802.11be (UNII Band 5) – Ch. 45) - LPI



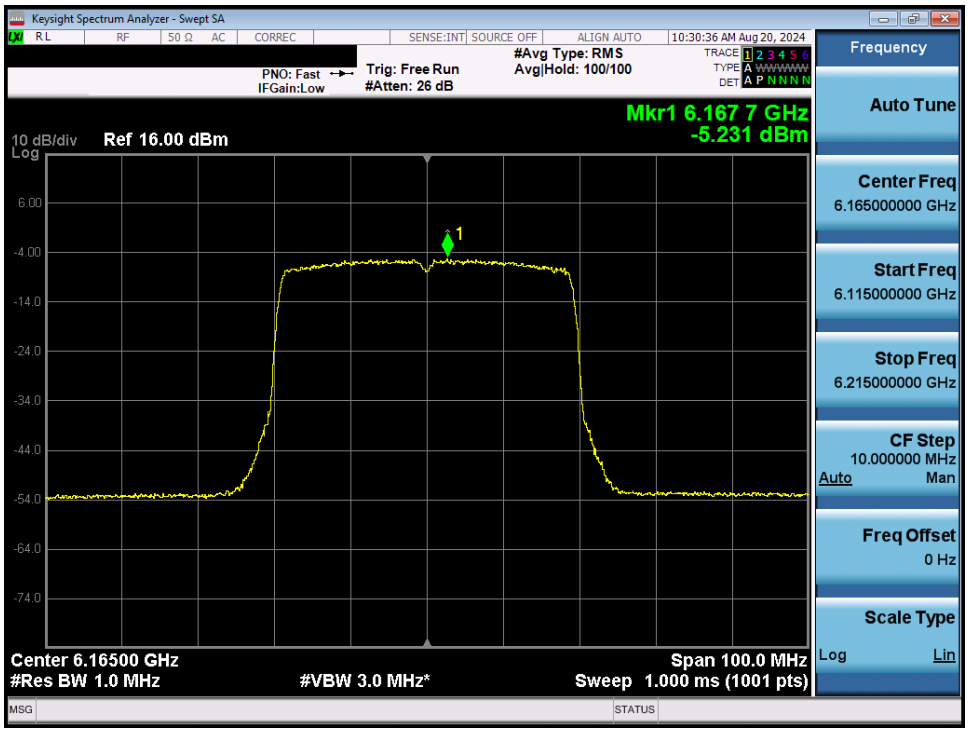
Plot 7-125. Power Spectral Density MIMO ANT2 (40MHz 802.11be (UNII Band 5) – Ch. 43) - LPI



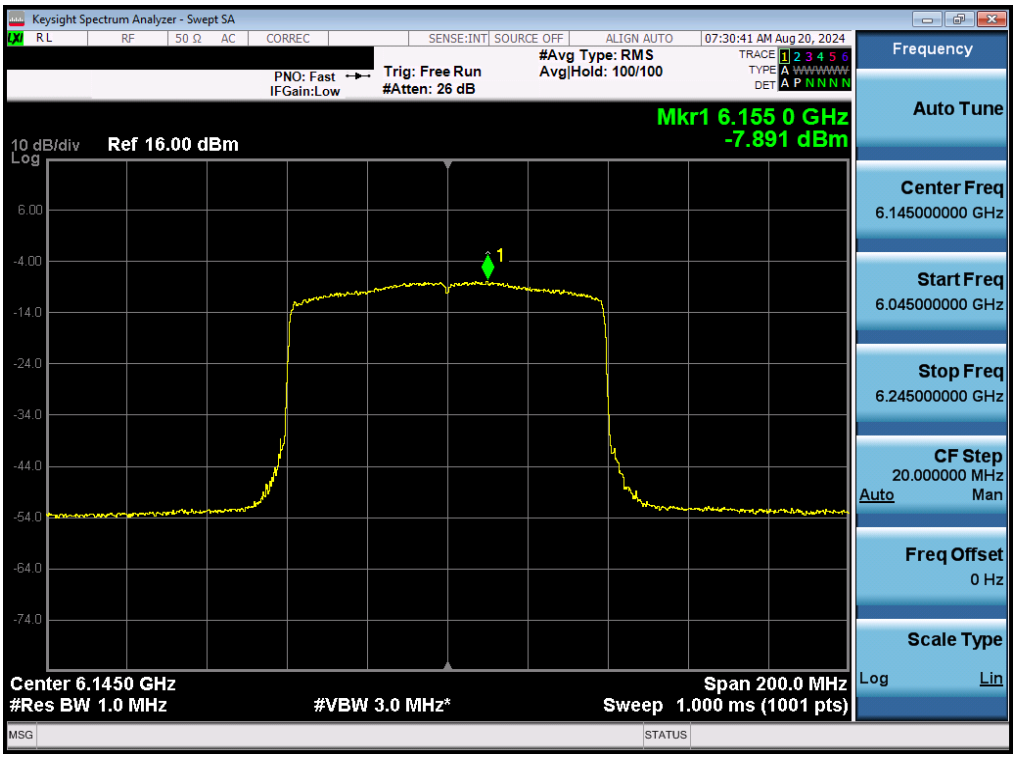
Plot 7-126. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 5) – Ch. 45) - SP



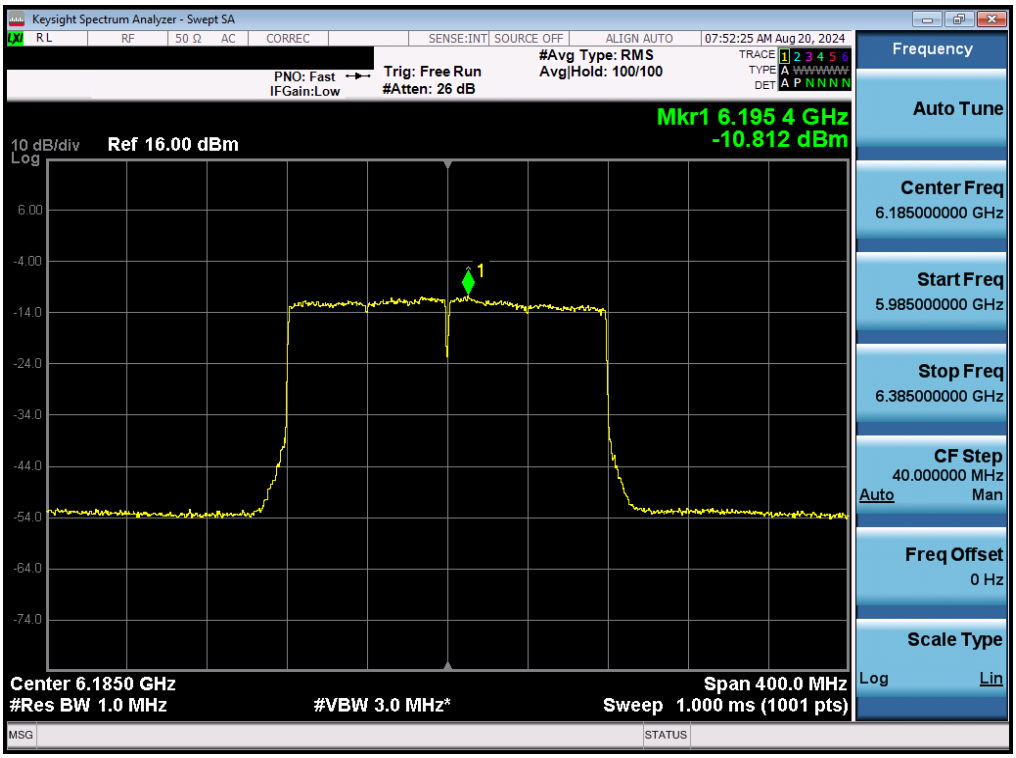
Plot 7-127. Power Spectral Density MIMO ANT2 (20MHz 802.11be (UNII Band 5) – Ch. 45) – SP



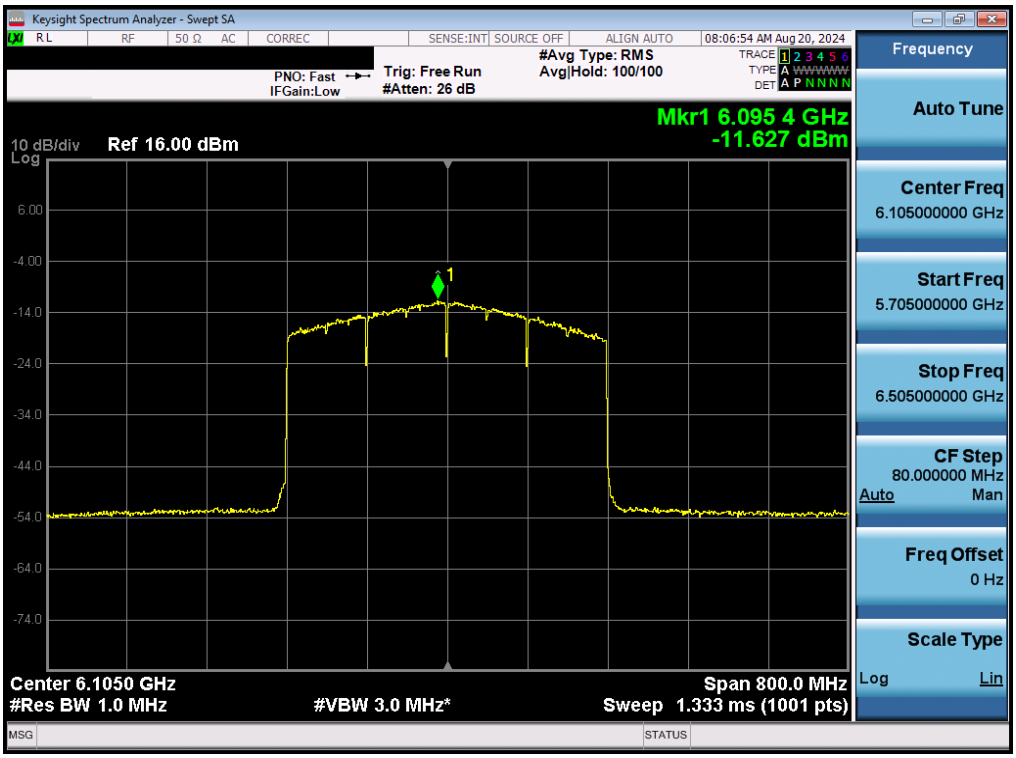
Plot 7-128. Power Spectral Density MIMO ANT2 (40MHz 802.11be (UNII Band 5) – Ch. 43) - SP



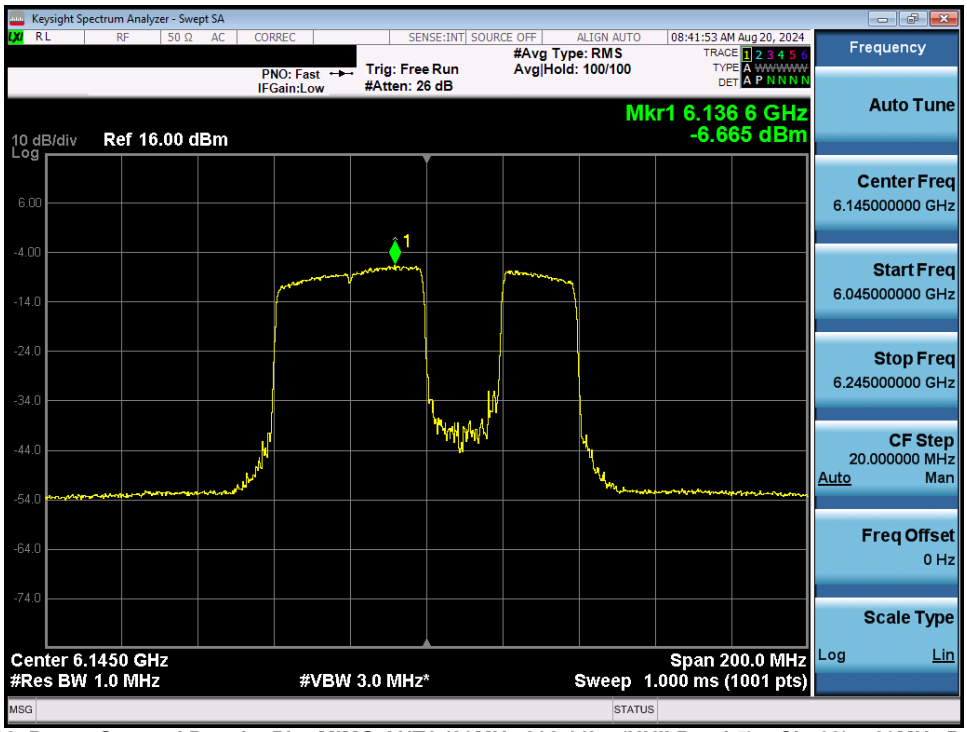
Plot 7-129. Power Spectral Density MIMO ANT2 (80MHz 802.11be (UNII Band 5) – Ch. 39) - LPI/SP



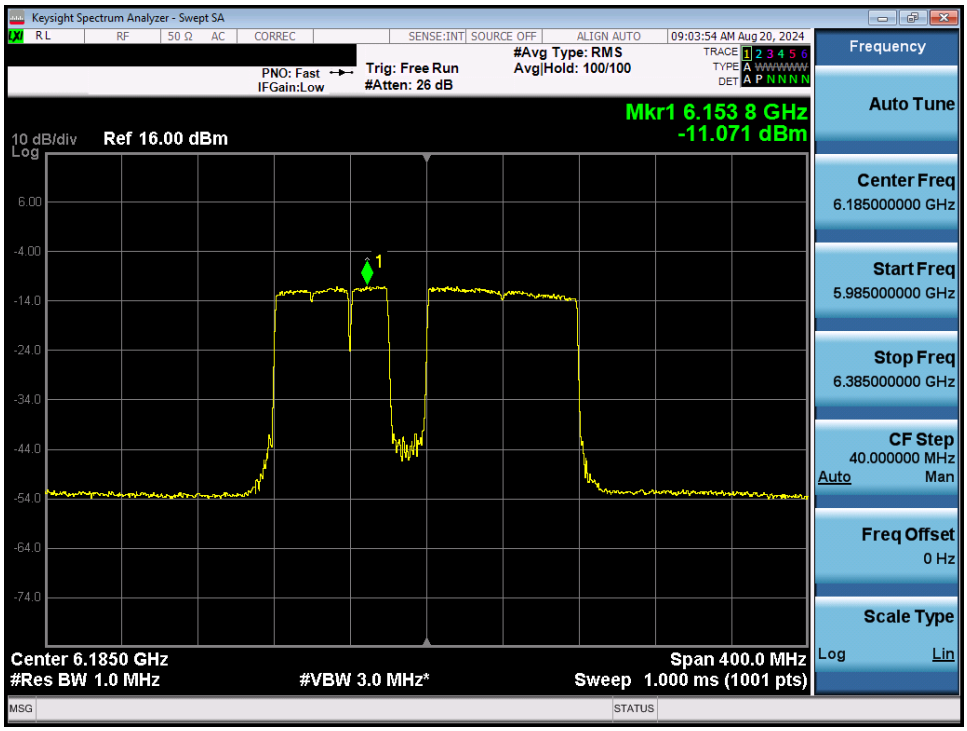
Plot 7-130. Power Spectral Density MIMO ANT2 (160MHz 802.11be (UNII Band 5) – Ch. 47) - LPI/SP



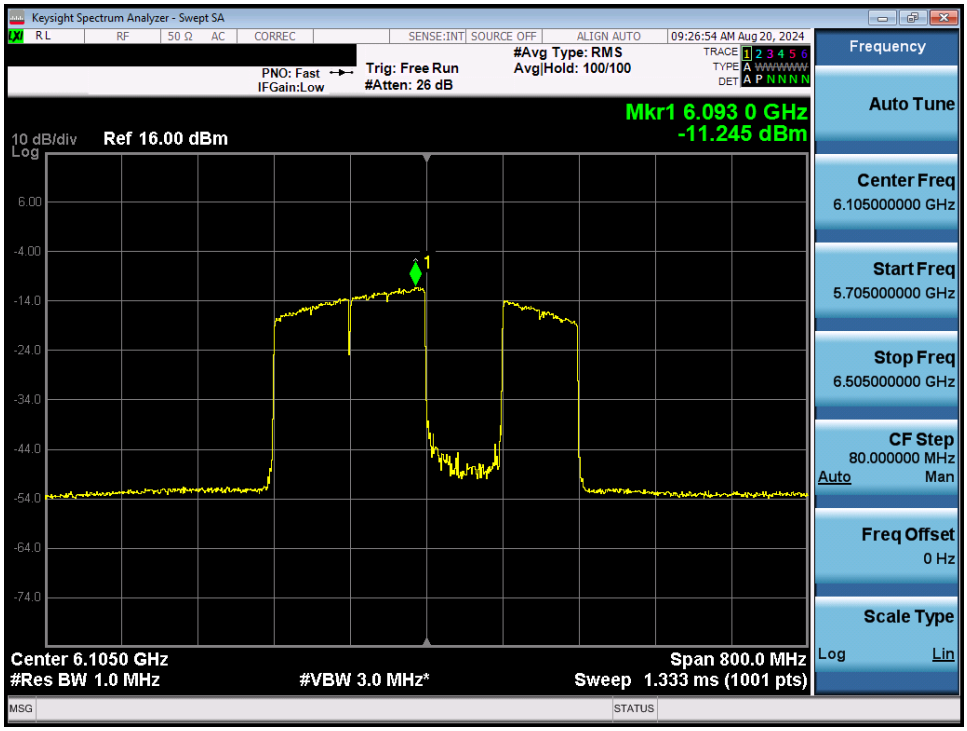
Plot 7-131. Power Spectral Density MIMO ANT2 (320MHz 802.11be (UNII Band 5) – Ch. 31) - LPI/SP



Plot 7-132. Power Spectral Density Plot MIMO ANT2 (80MHz 802.11be (UNII Band 5) – Ch. 39) – 20MHz Punctured

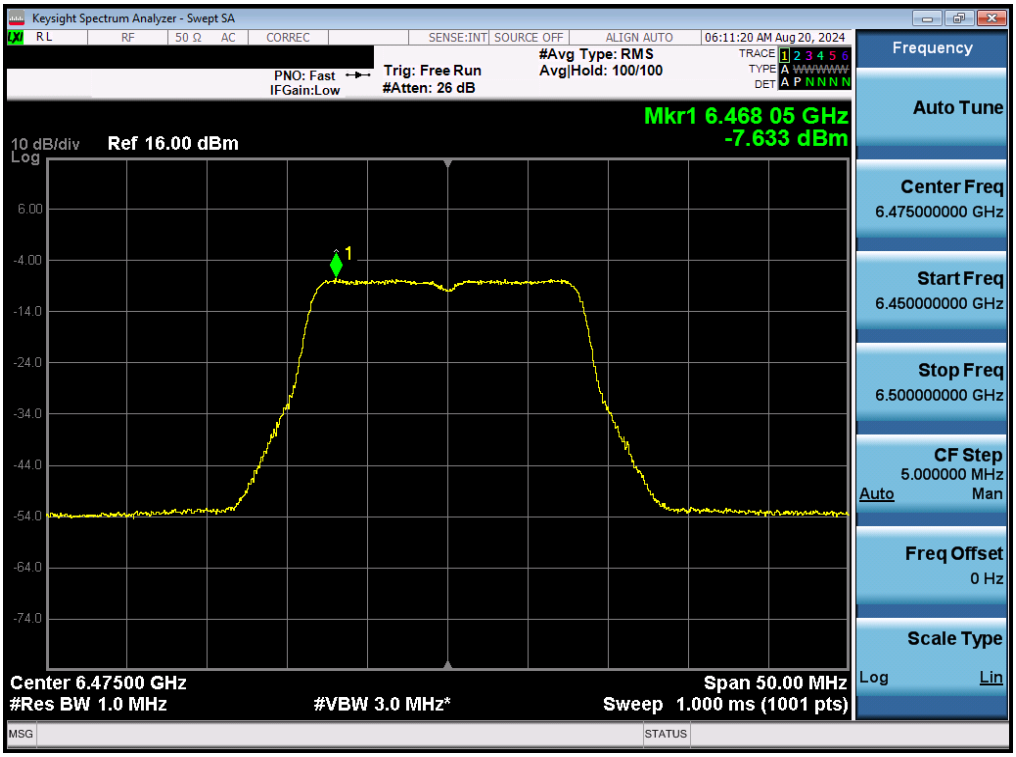


Plot 7-133. Power Spectral Density Plot MIMO ANT2 (160MHz 802.11be (UNII Band 5) – Ch. 47) – 20MHz Punctured

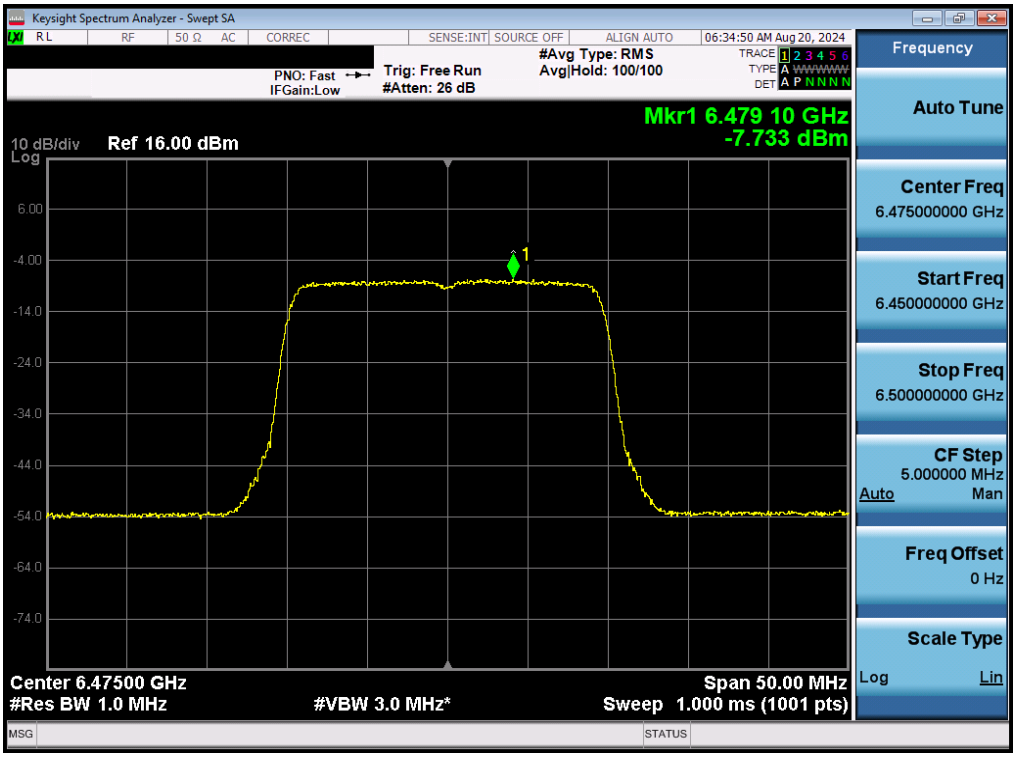


Plot 7-134. Power Spectral Density Plot MIMO ANT2 (320MHz 802.11be (UNII Band 5) – Ch. 31) – 80MHz Punctured

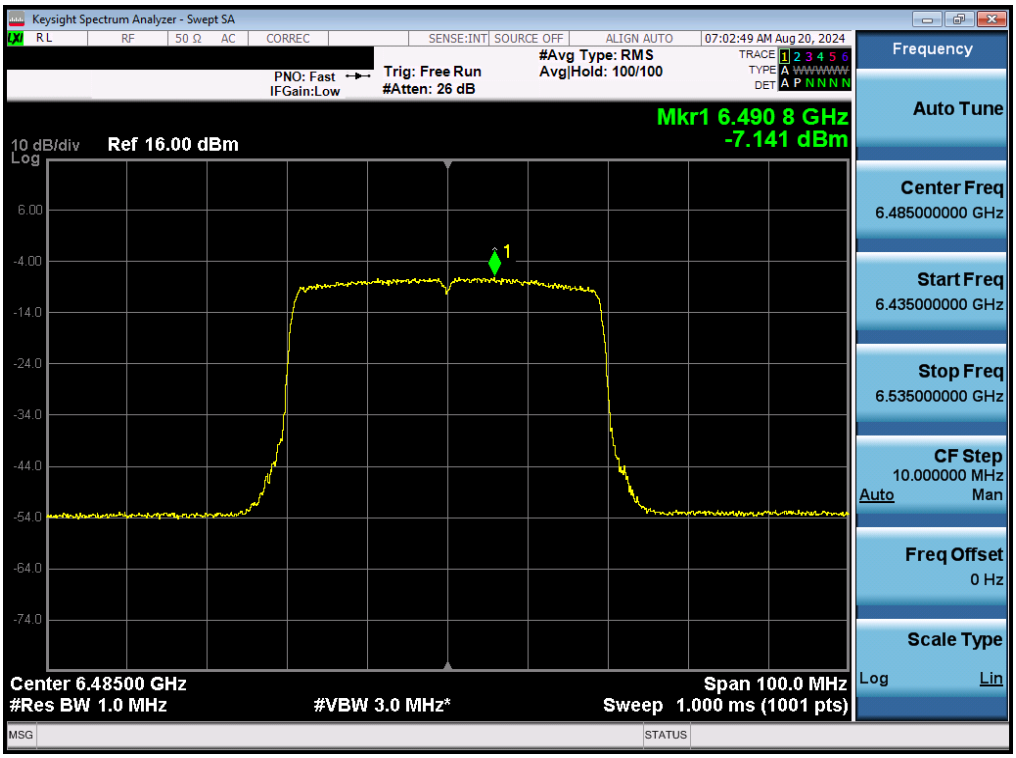
MIMO Antenna-2 Power Spectral Density Measurements – (UNII Band 6) – LPI



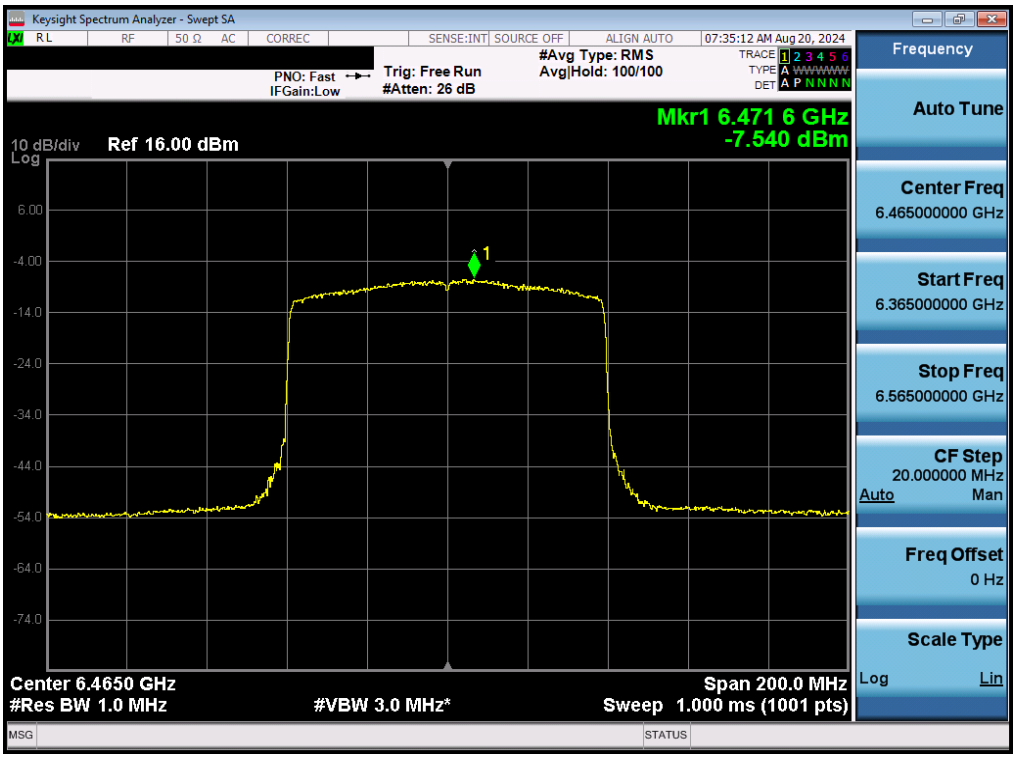
Plot 7-135. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 6) – Ch. 105) - LPI



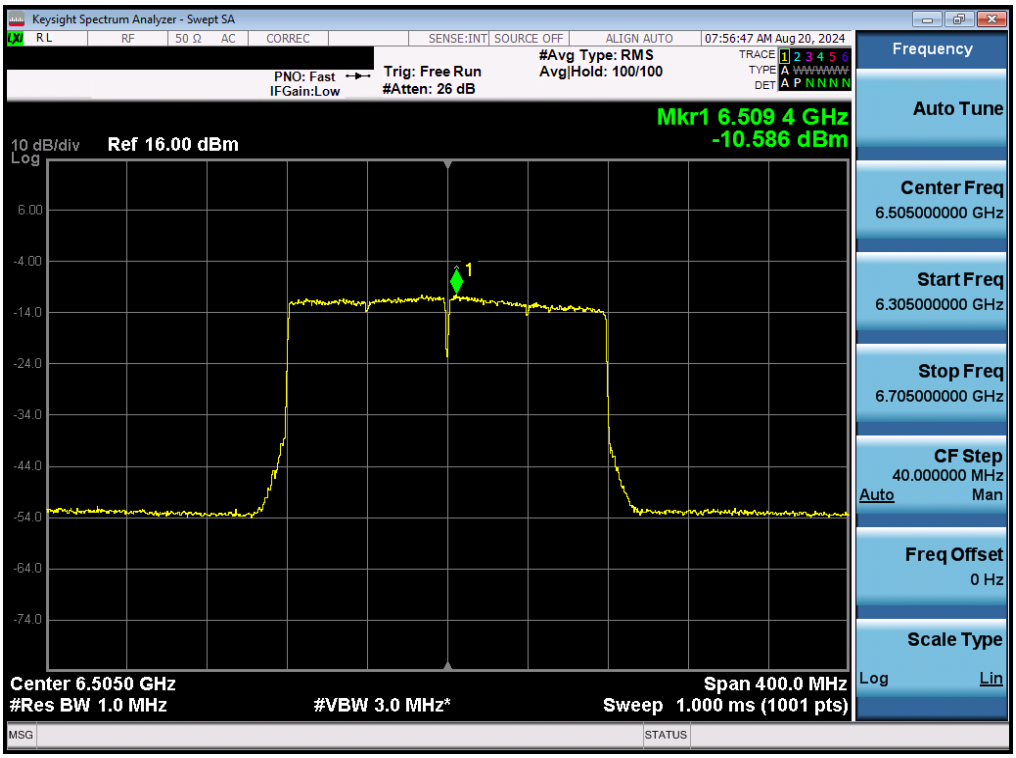
Plot 7-136. Power Spectral Density MIMO ANT2 (20MHz 802.11be (UNII Band 6) – Ch. 105) - LPI



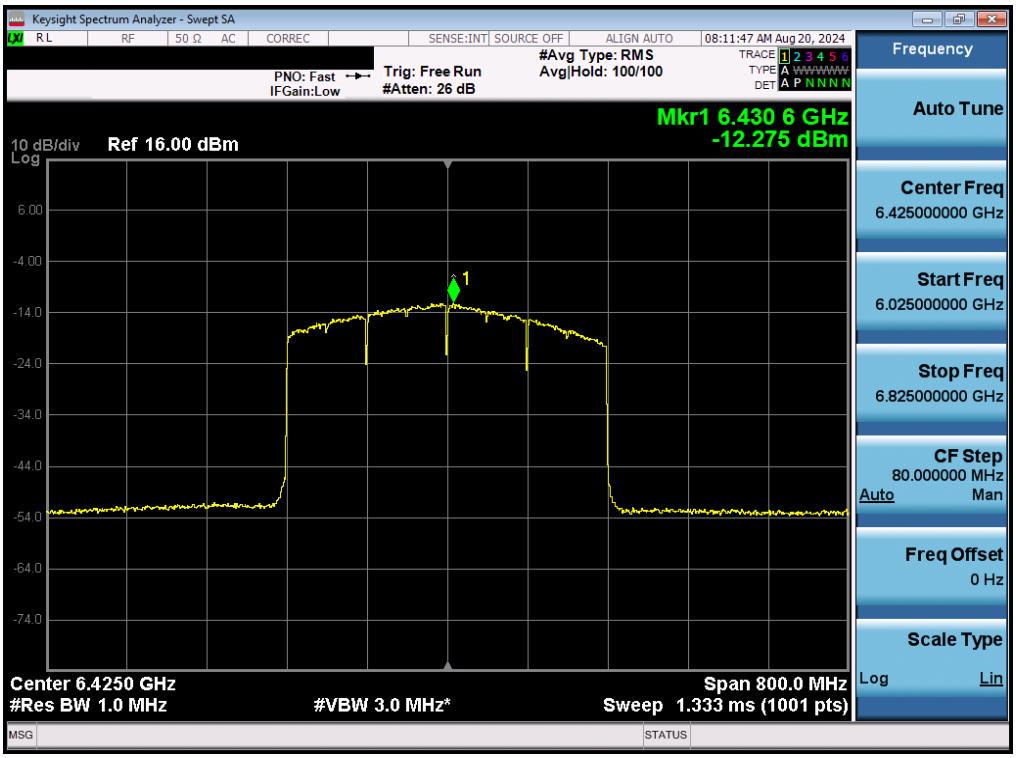
Plot 7-137. Power Spectral Density MIMO ANT2 (40MHz 802.11be (UNII Band 6) – Ch. 107) - LPI



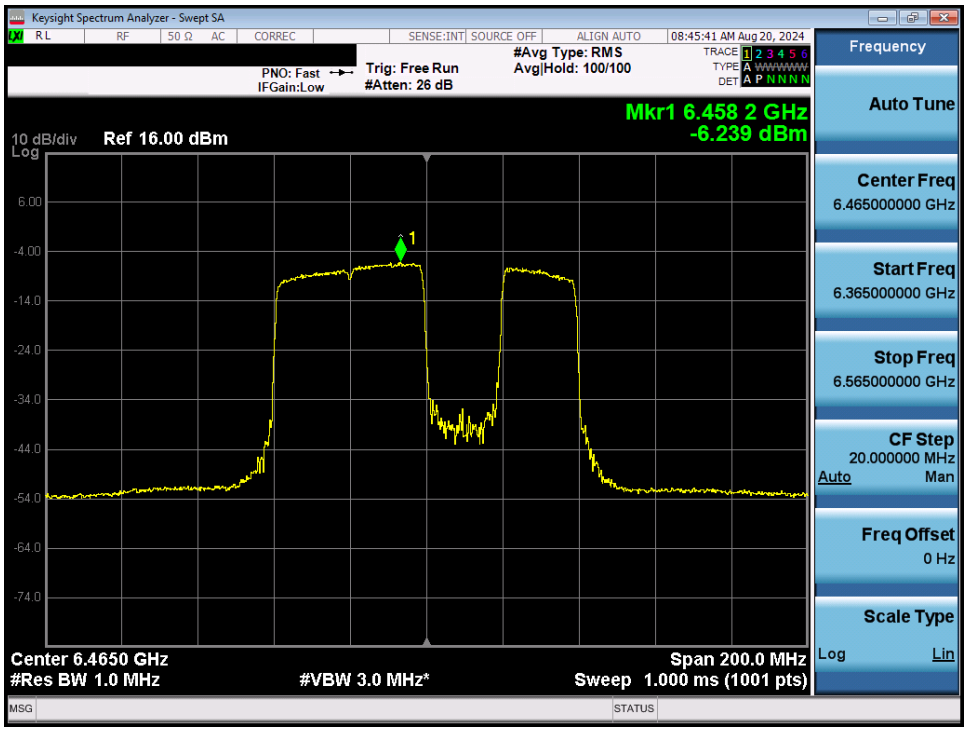
Plot 7-138. Power Spectral Density MIMO ANT2 (80MHz 802.11be (UNII Band 6) – Ch. 103) - LPI



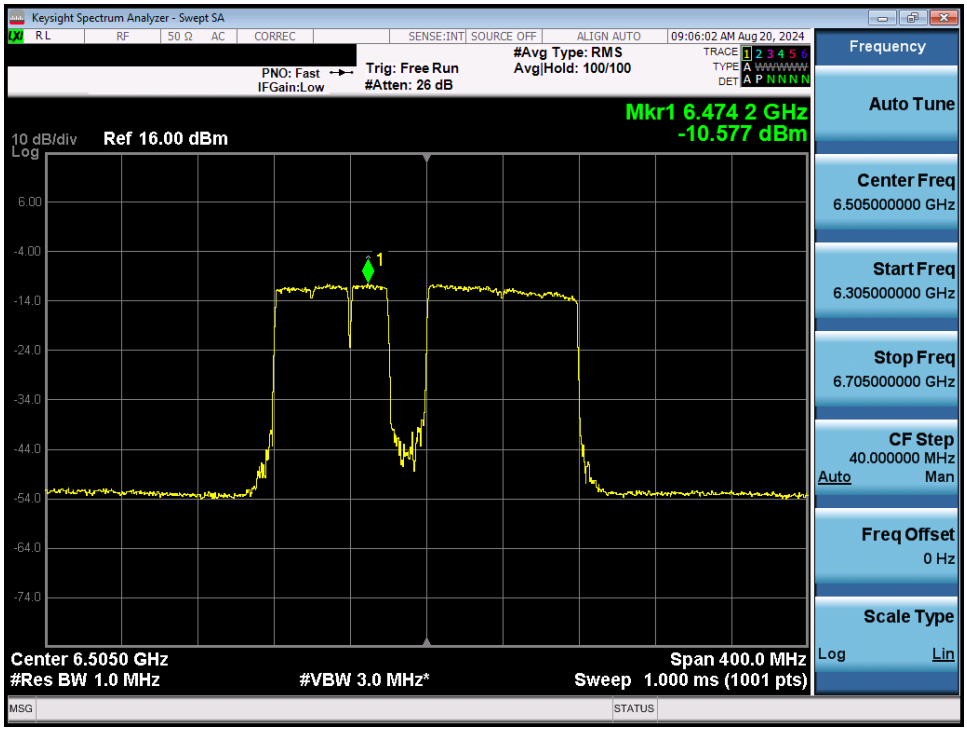
Plot 7-139. Power Spectral Density MIMO ANT2 (160MHz 802.11be (UNII Band 6) – Ch. 111) – LPI



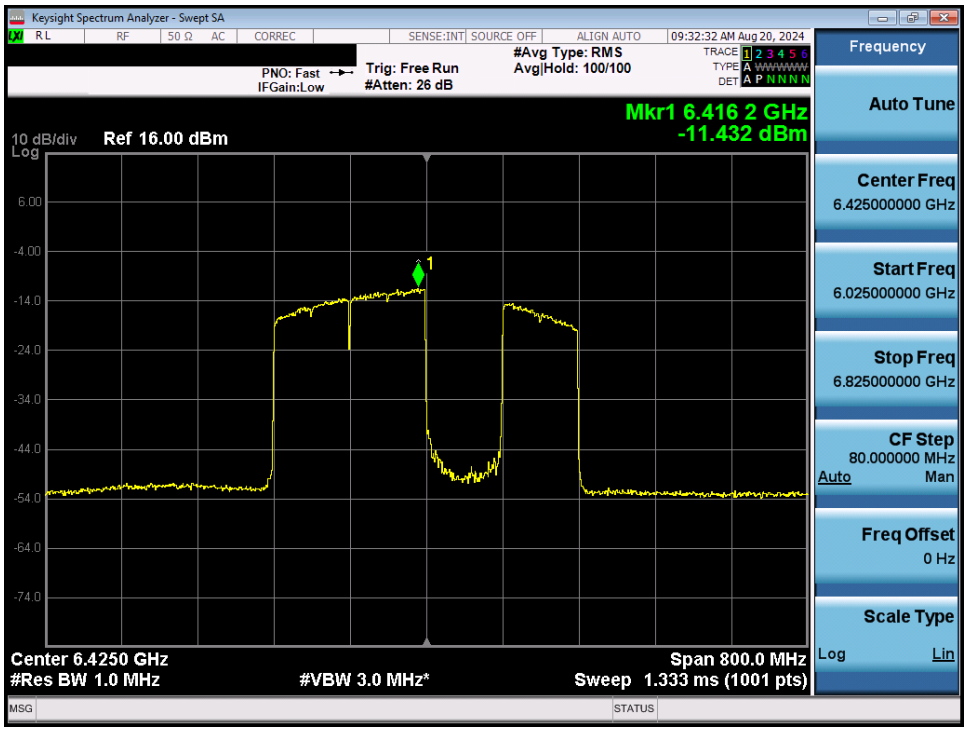
Plot 7-140. Power Spectral Density MIMO ANT1 (320MHz 802.11be (UNII Band 6) – Ch. 95) – LPI



Plot 7-141. Power Spectral Density Plot MIMO ANT1 (80MHz 802.11be (UNII Band 6) – Ch. 103) – 20MHz Punctured

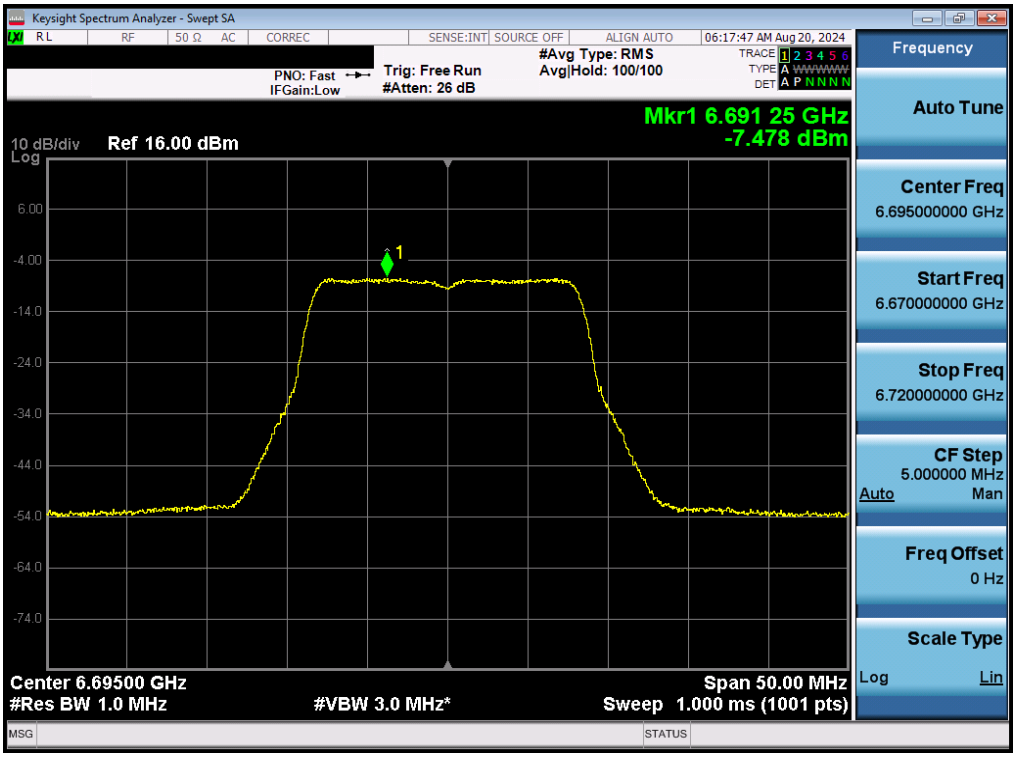


Plot 7-142. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 6) – Ch. 111) – 20MHz Punctured

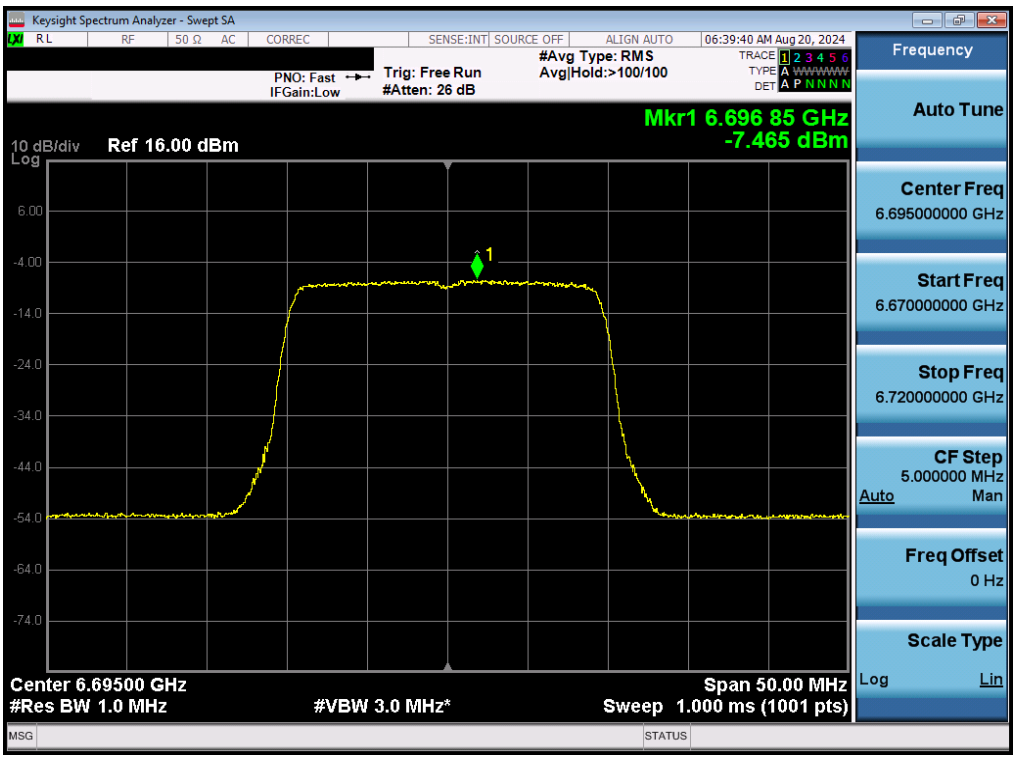


Plot 7-143. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 6) – Ch. 95) – 80MHz Punctured

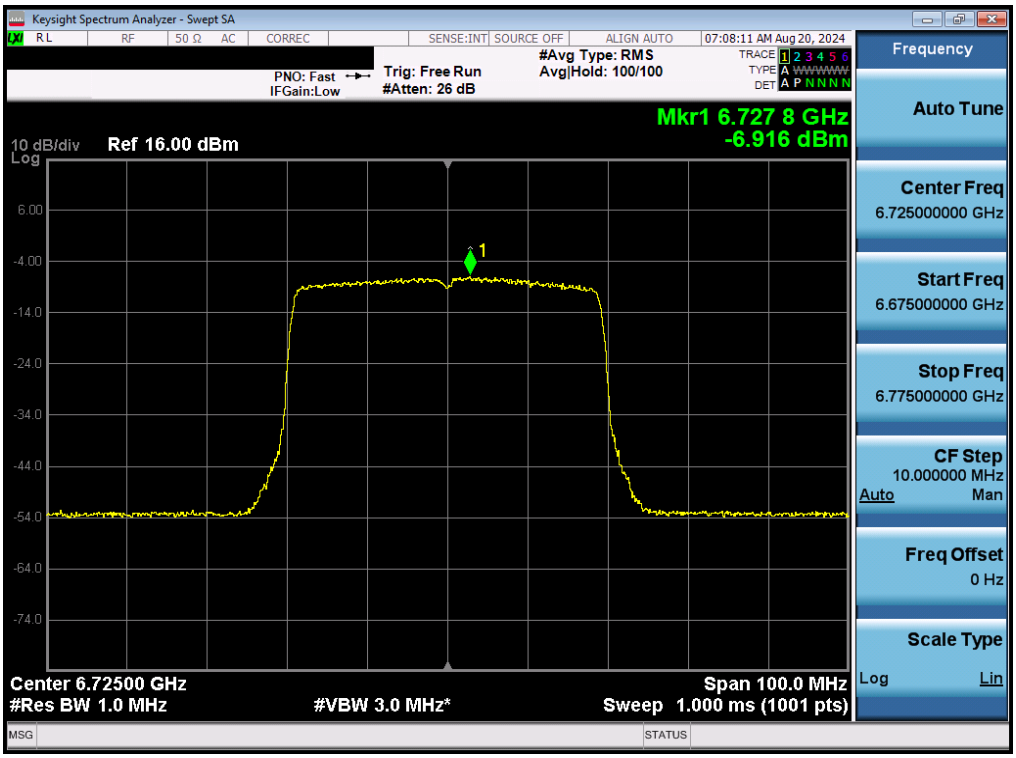
MIMO Antenna-2 Power Spectral Density Measurements – (UNII Band 7) – LPI/SP



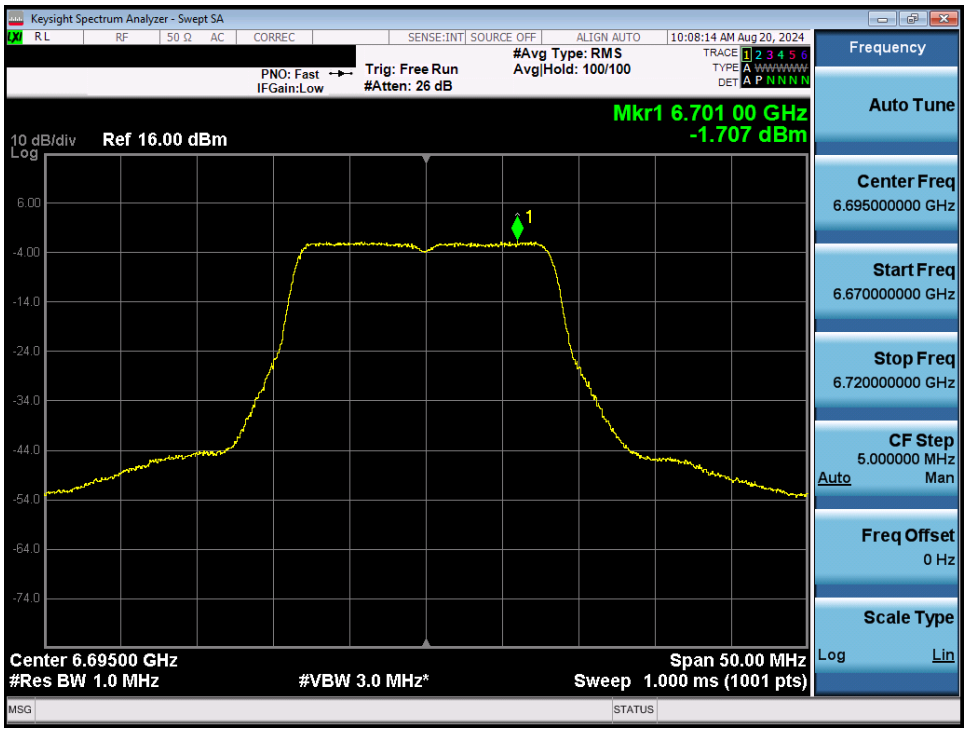
Plot 7-144. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 7) – Ch. 149) - LPI



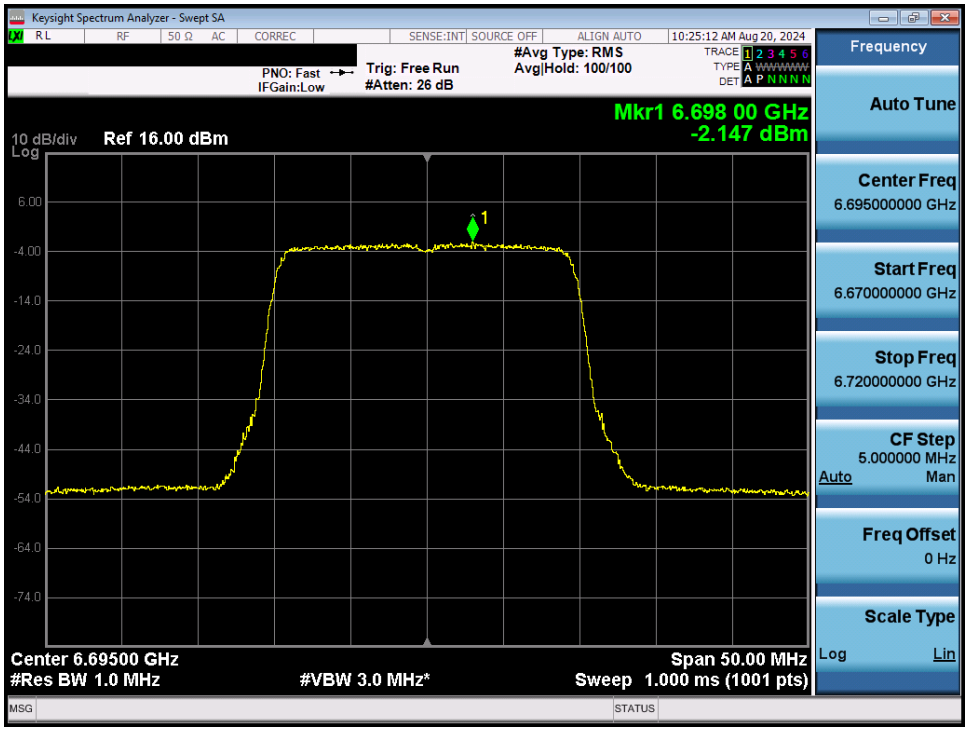
Plot 7-145. Power Spectral Density MIMO ANT2 (20MHz 802.11be (UNII Band 7) – Ch. 149) - LPI



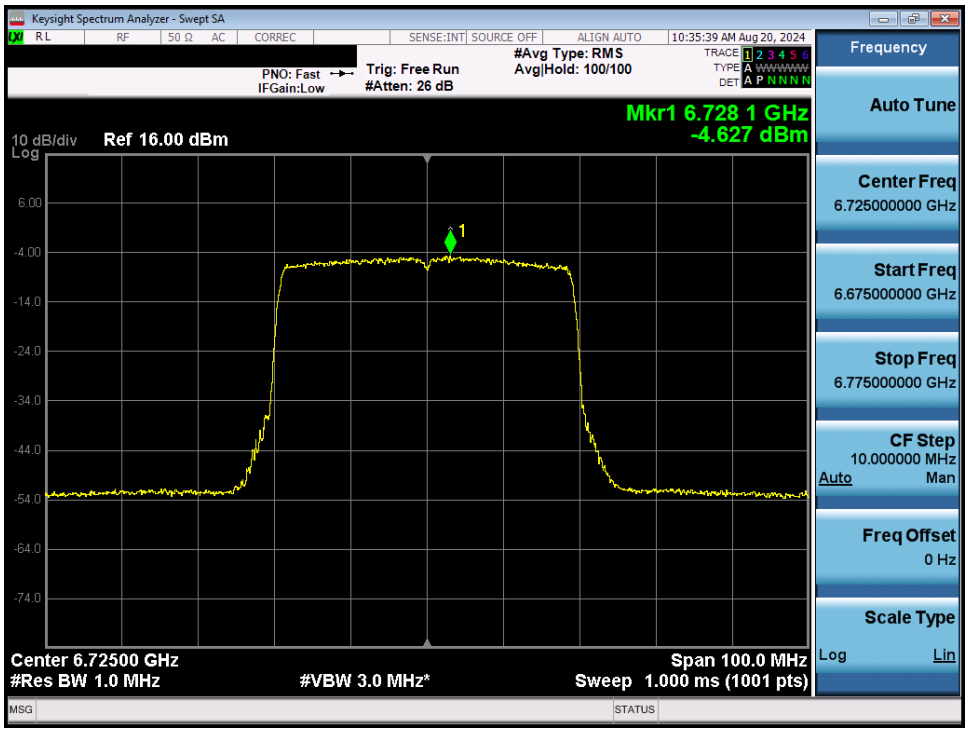
Plot 7-146. Power Spectral Density MIMO ANT2 (40MHz 802.11be (UNII Band 7) – Ch. 155) - LPI



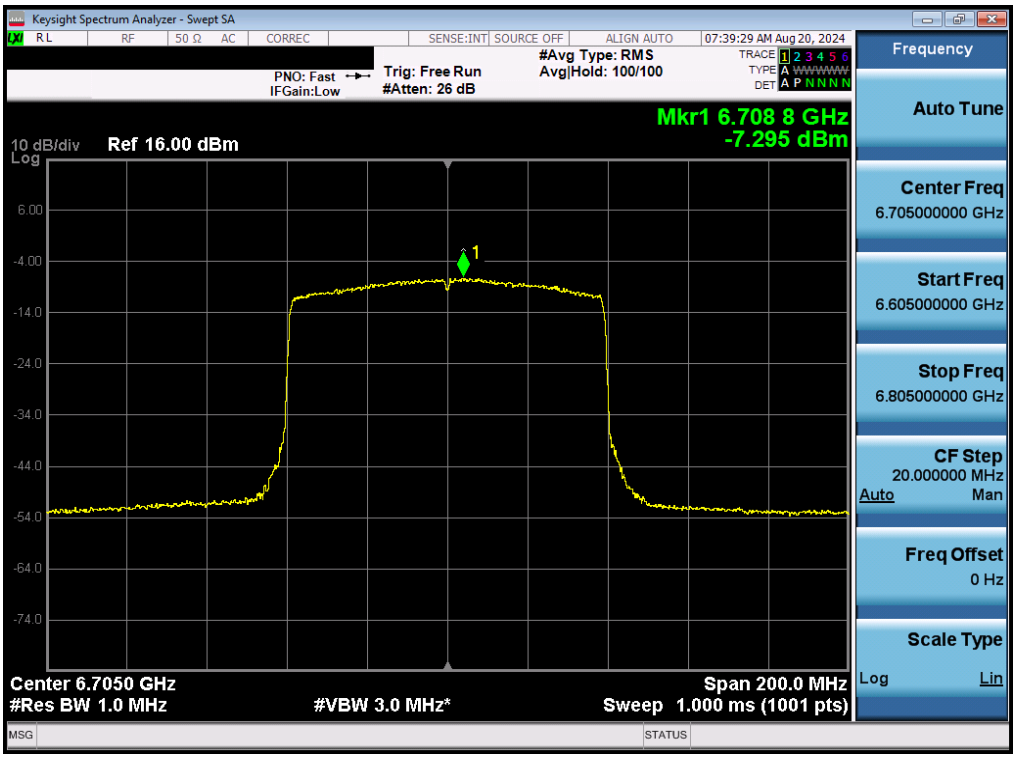
Plot 7-147. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 7) – Ch. 149) - SP



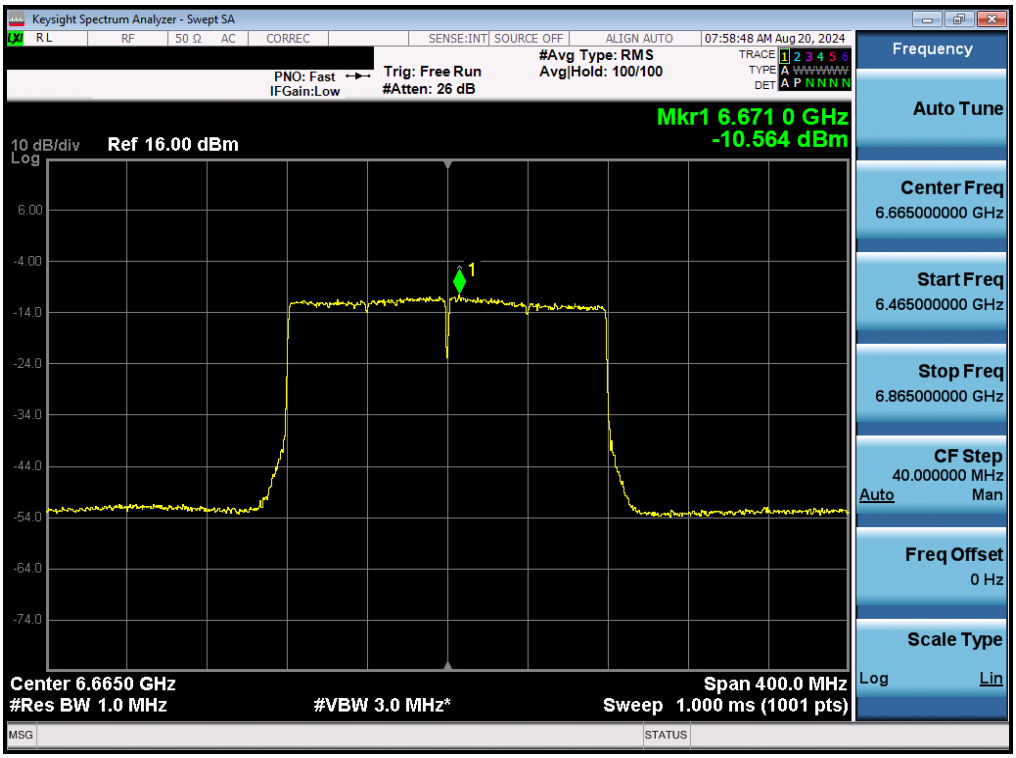
Plot 7-148. Power Spectral Density MIMO ANT2 (20MHz 802.11be (UNII Band 7) – Ch. 149) - SP



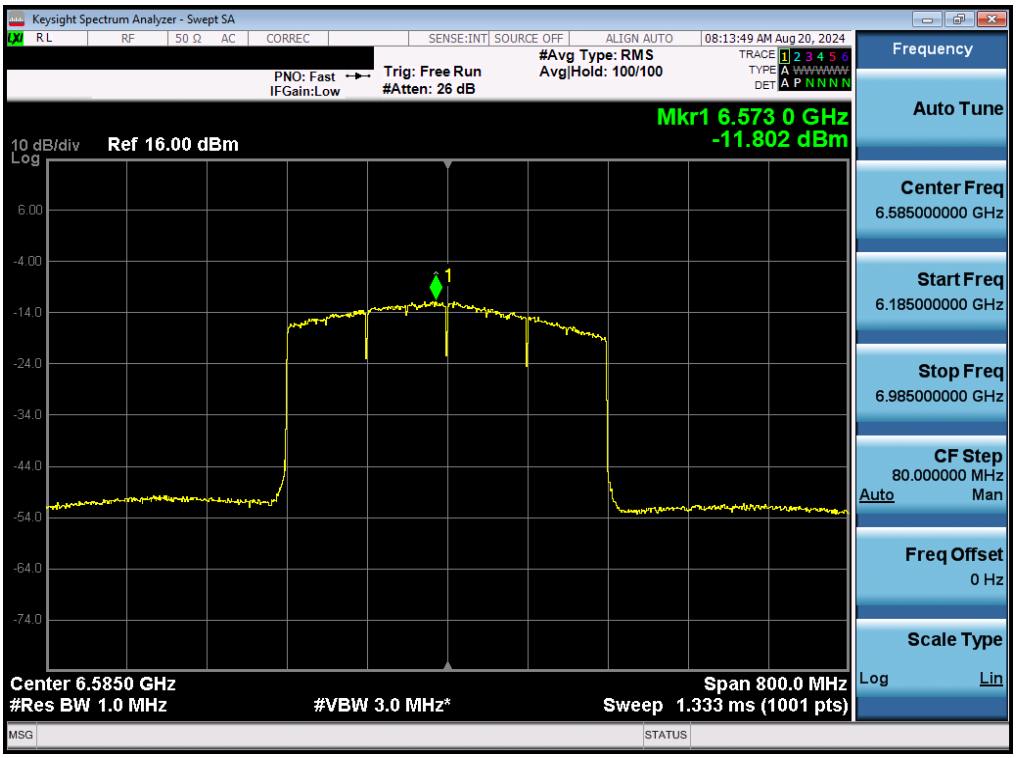
Plot 7-149. Power Spectral Density MIMO ANT2 (40MHz 802.11be (UNII Band 7) – Ch. 155) - SP



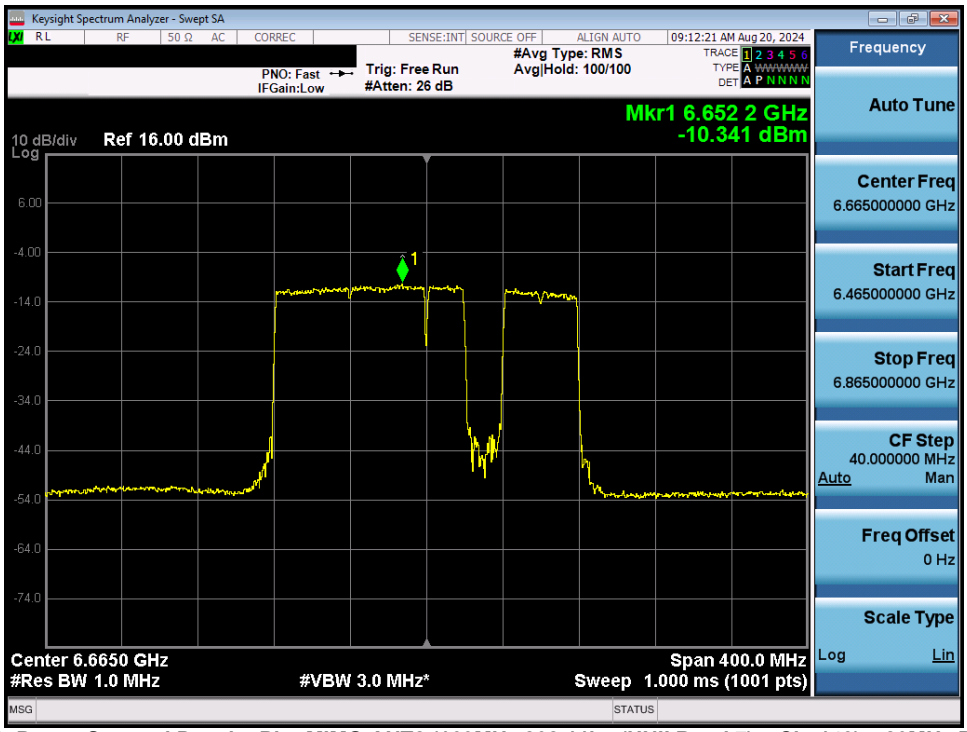
Plot 7-150. Power Spectral Density MIMO ANT2 (80MHz 802.11be (UNII Band 7) – Ch. 151) - LPI/SP



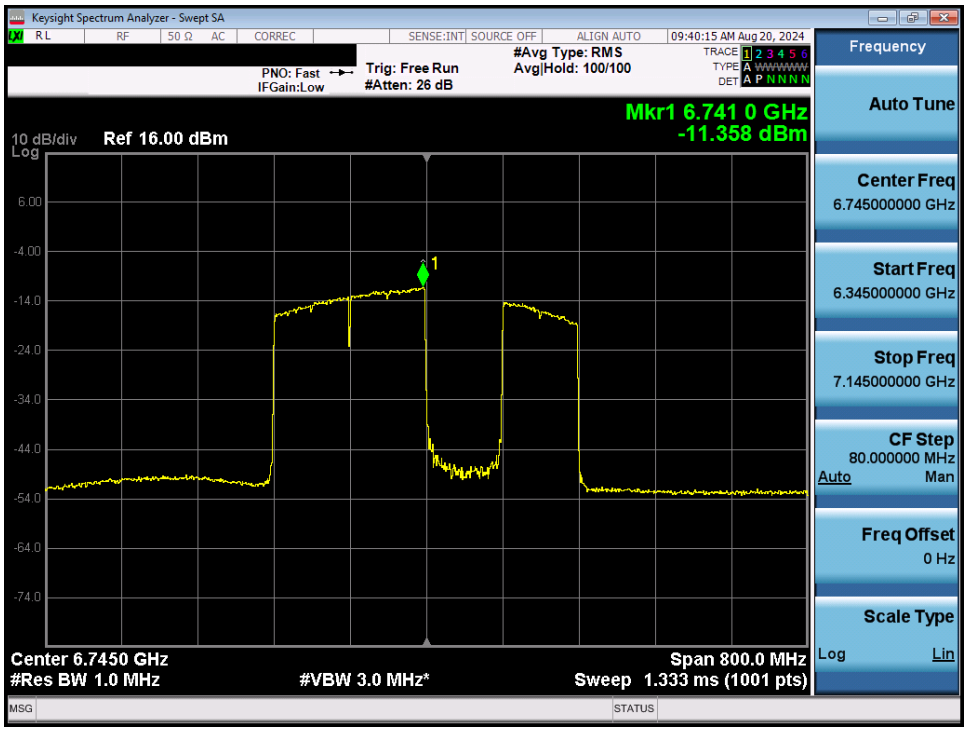
Plot 7-151. Power Spectral Density MIMO ANT2 (160MHz 802.11be (UNII Band 7) – Ch. 143) - LPI/SP



Plot 7-152. Power Spectral Density MIMO ANT2 (320MHz 802.11be (UNII Band 6/7) – Ch. 127) - LPI/SP

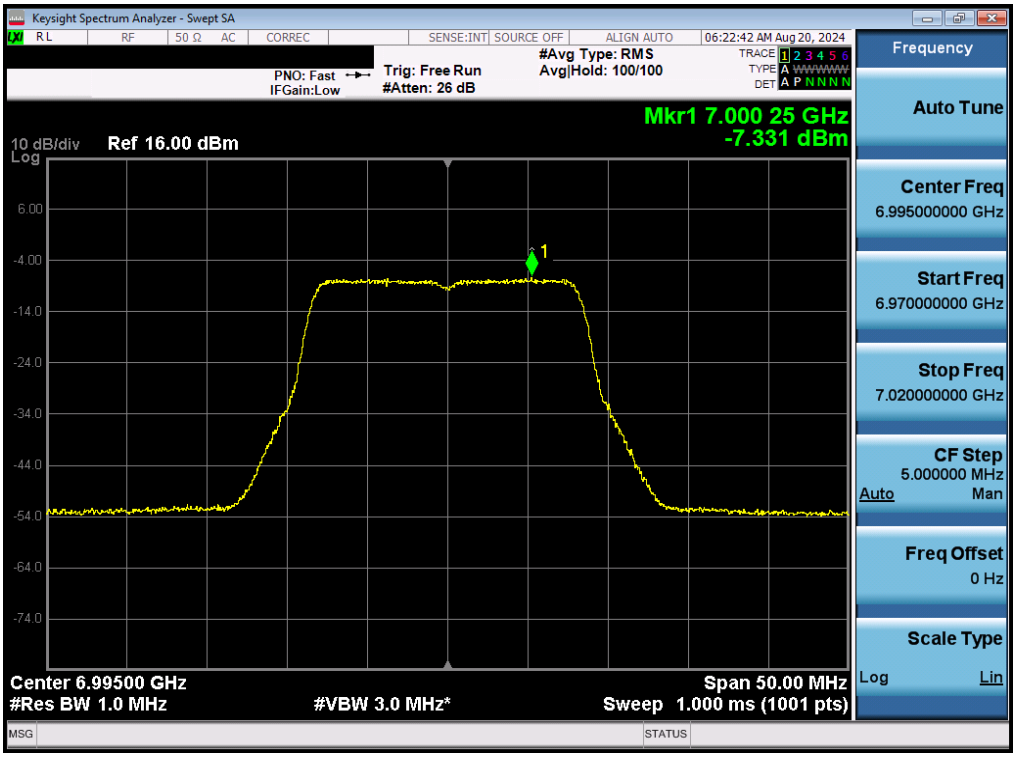


Plot 7-153. Power Spectral Density Plot MIMO ANT2 (160MHz 802.11be (UNII Band 7) – Ch. 143) – 20MHz Punctured

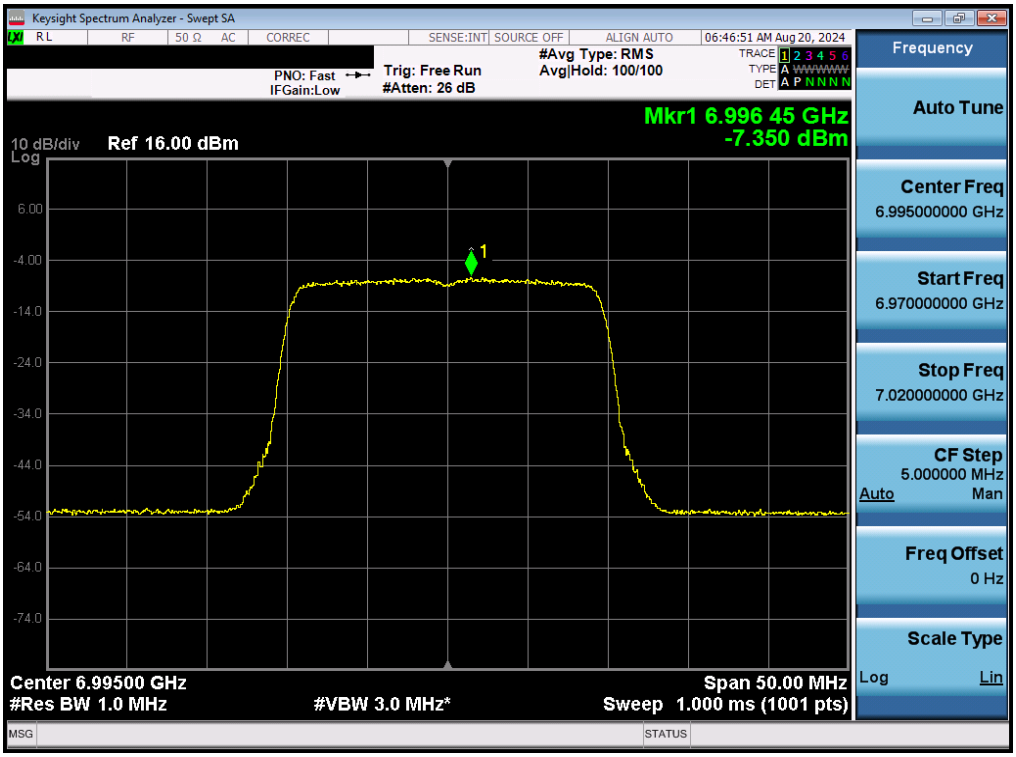


Plot 7-154. Power Spectral Density Plot MIMO ANT2 (320MHz 802.11be (UNII Band 7) – Ch. 159) – 80MHz Punctured

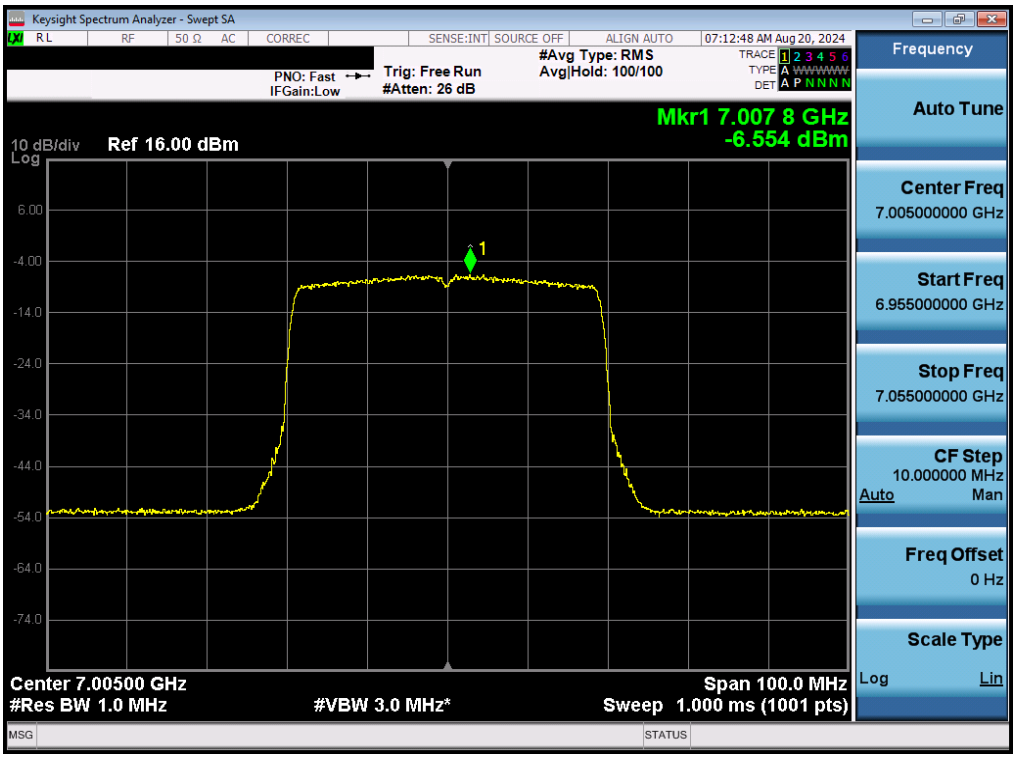
MIMO Antenna-2 Power Spectral Density Measurements – (UNII Band 8) – LPI



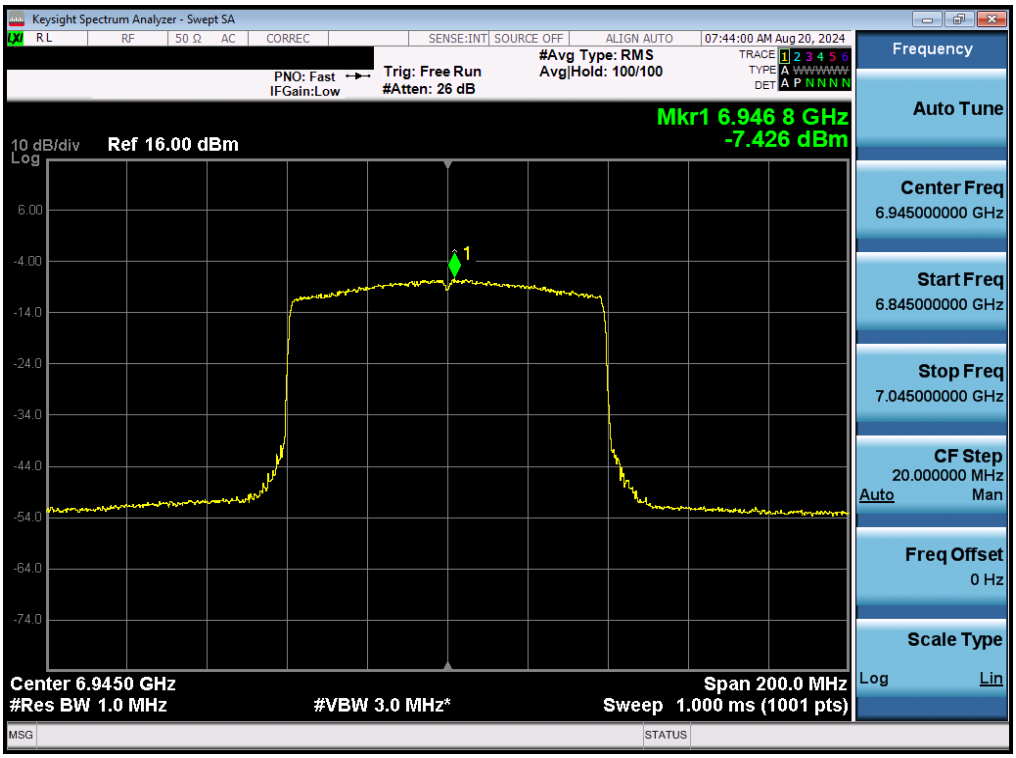
Plot 7-155. Power Spectral Density MIMO ANT2 (20MHz 802.11a (UNII Band 8) – Ch. 209) - LPI



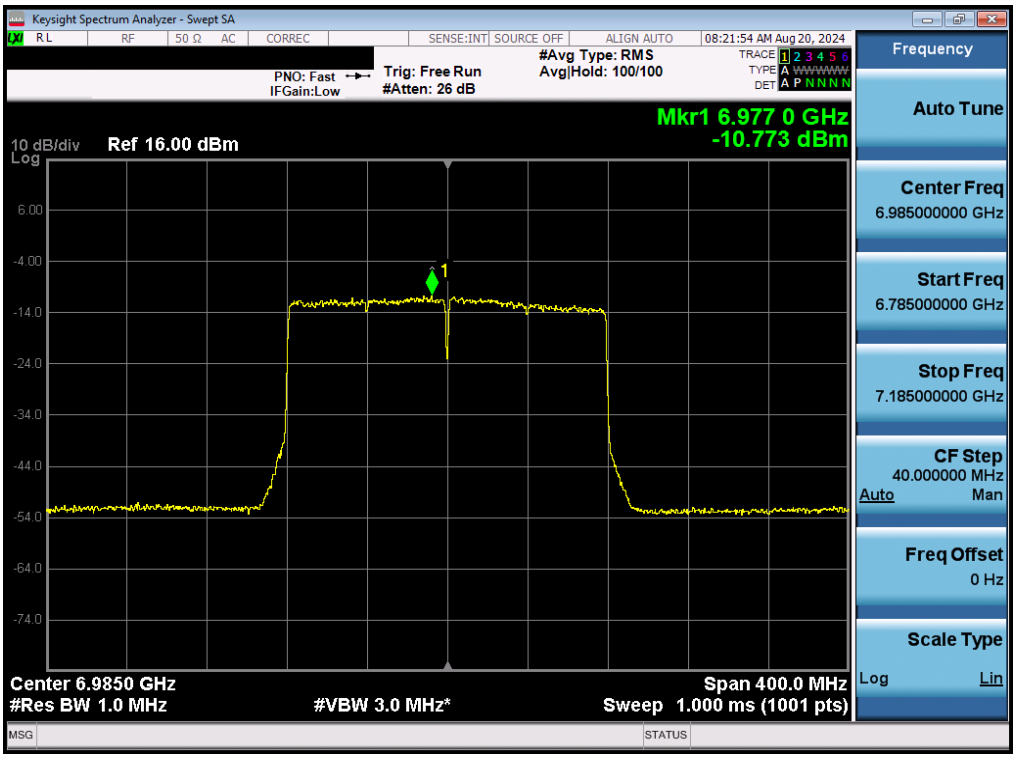
Plot 7-156. Power Spectral Density MIMO ANT2 (20MHz 802.11be (UNII Band 8) – Ch. 209) - LPI



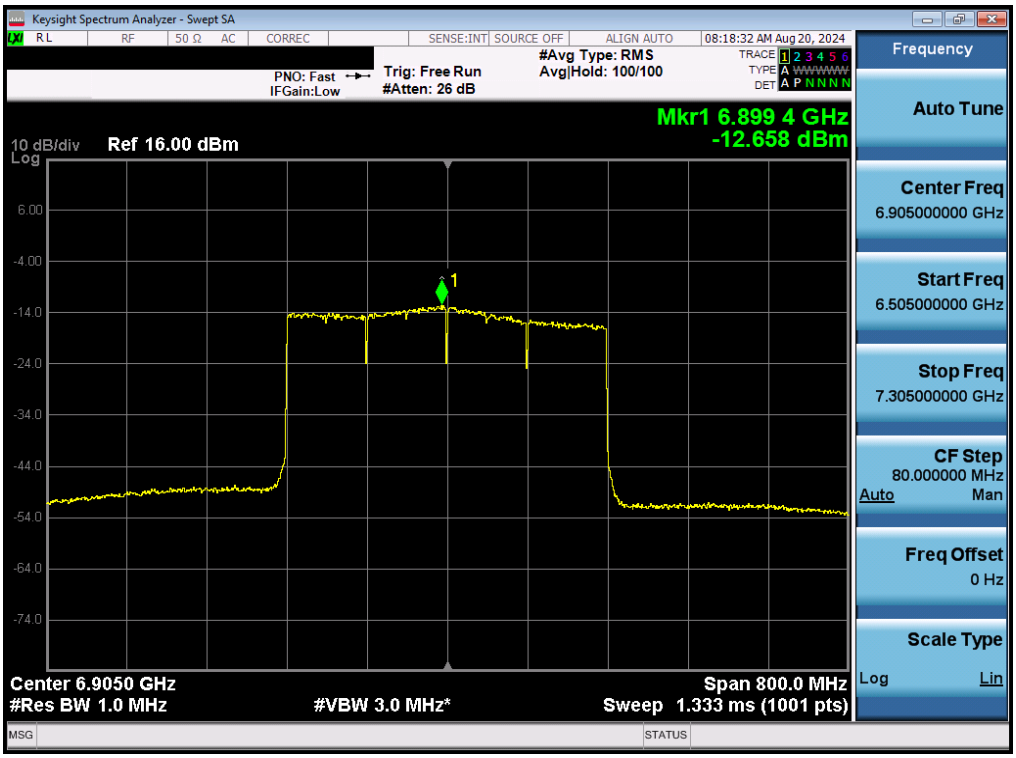
Plot 7-157. Power Spectral Density MIMO ANT2 (40MHz 802.11be (UNII Band 8) – Ch. 211) - LPI



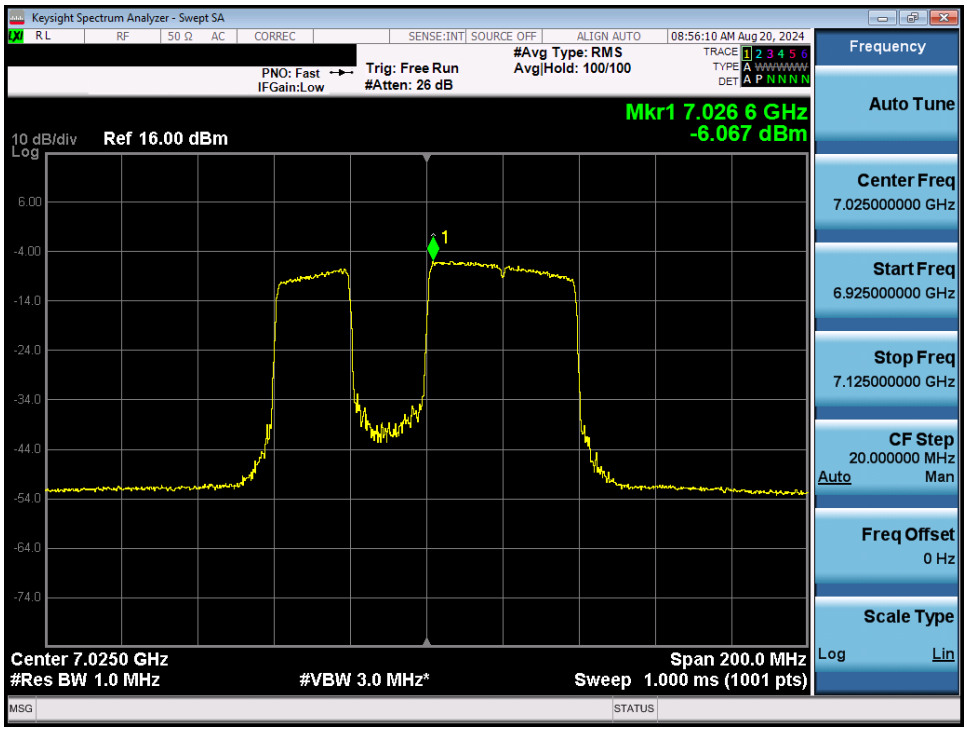
Plot 7-158. Power Spectral Density MIMO ANT2 (80MHz 802.11be (UNII Band 8) – Ch. 199) - LP



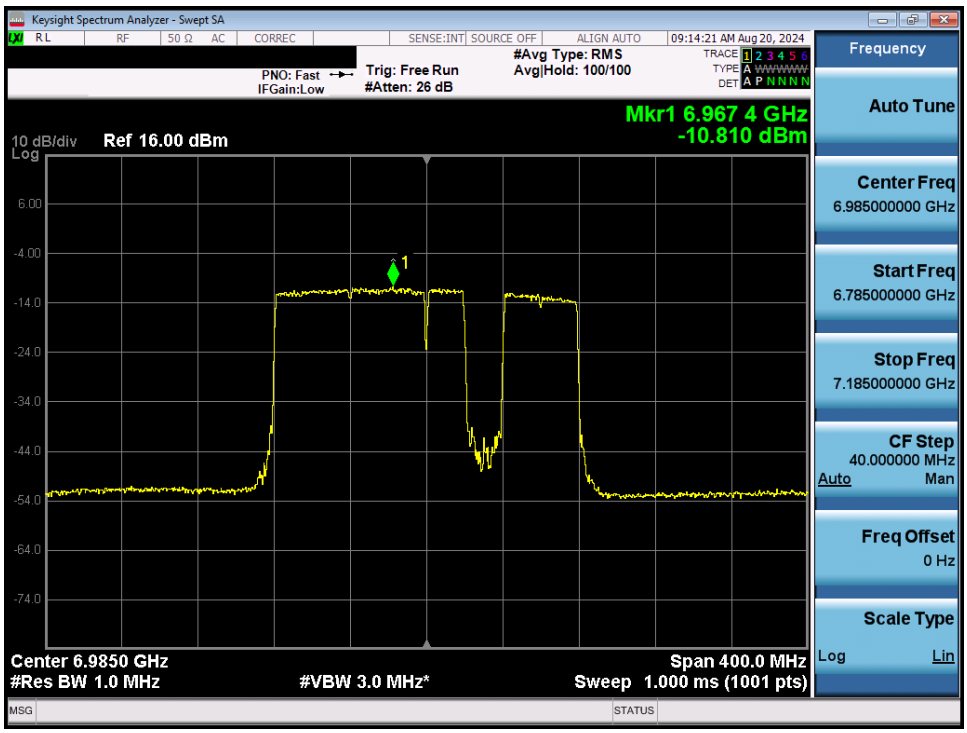
Plot 7-159. Power Spectral Density MIMO ANT2 (160MHz 802.11be (UNII Band 8) – Ch. 207) – LPI



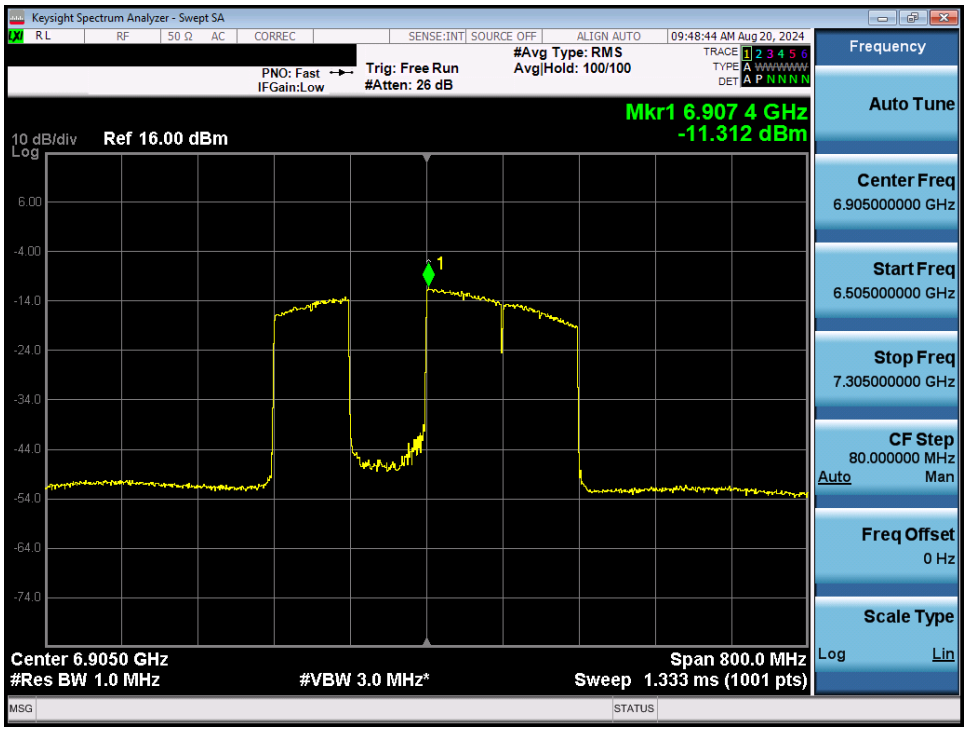
Plot 7-160. Power Spectral Density MIMO ANT2 (320MHz 802.11be (UNII Band 7/8) – Ch. 191) – LPI



Plot 7-161. Power Spectral Density Plot MIMO ANT1 (80MHz 802.11be (UNII Band 8) – Ch. 199) – 20MHz Punctured



Plot 7-162. Power Spectral Density Plot MIMO ANT1 (160MHz 802.11be (UNII Band 8) – Ch. 207) – 20MHz Punctured



Plot 7-163. Power Spectral Density Plot MIMO ANT1 (320MHz 802.11be (UNII Band 8) – Ch. 191) – 80MHz Punctured

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 -10.27 dBm for Antenna-1 and –9.56 dBm for Antenna-2.

Antenna 1 + Antenna 2 = MIMO

(-10.27 dBm + -9.56 dBm) = (0.094 mW + 0.110 mW) = 0.204 mW = -6.89 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 -6.89 dBm with directional gain of 2.53 dBi.

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

-6.86 dBm + 2.53 dBi = -1.17 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	127	be (320MHz)	PASS	PASS
Band 7/8	6745	159	be (320MHz)	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 7-28. In- Band Emissions Test Result – LPI/SP

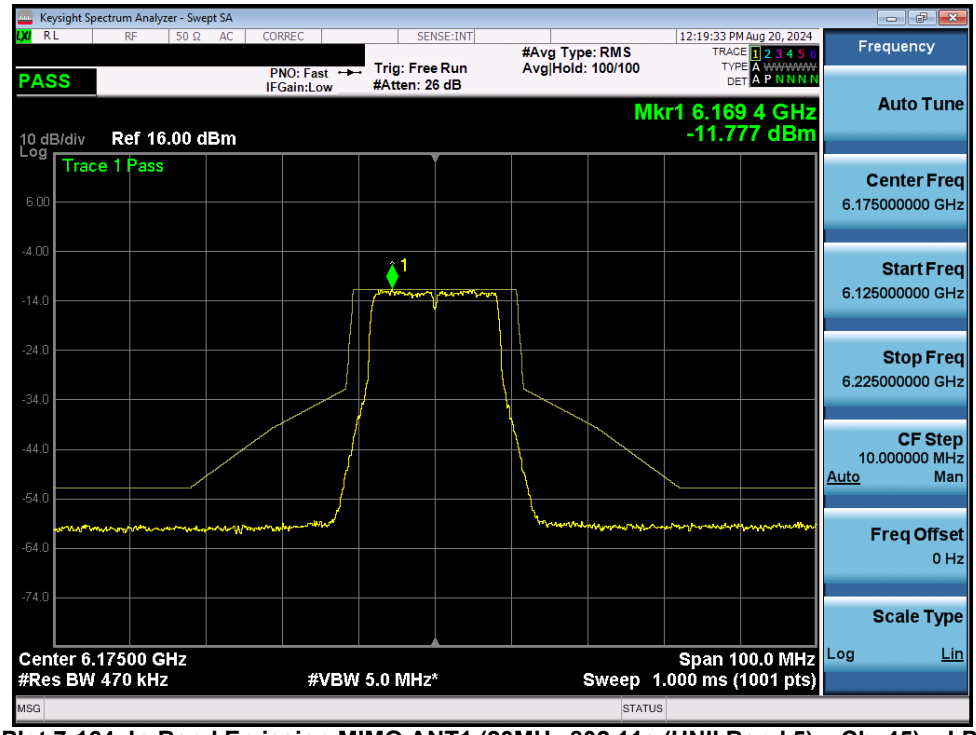
	Frequency [MHz]	Channel	802.11 MODE	Antenna-1 In-Band Emission	Antenna-2 In-Band Emission
Band 5	5935	2	a	PASS	PASS
	6175	45	a	PASS	PASS
	6415	93	a	PASS	PASS
	5935	2	be (20MHz)	PASS	PASS
	6175	45	be (20MHz)	PASS	PASS
	6415	93	be (20MHz)	PASS	PASS
	5965	3	be (40MHz)	PASS	PASS
	6165	43	be (40MHz)	PASS	PASS
	6405	91	be (40MHz)	PASS	PASS
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

Table 7-29. In- Band Emissions Test Result – SP

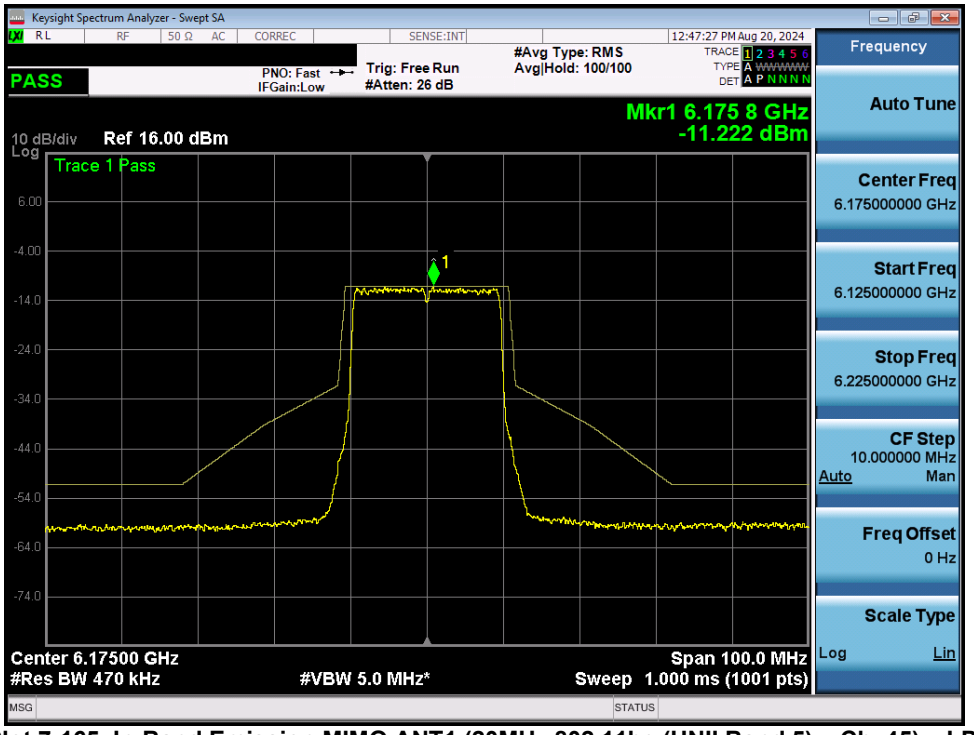
	Frequency [MHz]	Channel	802.11 MODE	Puncture Size	Antenna-1 In-Band Emission	Antenna-2 In-Band Emission
Band 5	6145	39	be (80MHz)	20MHz	PASS	PASS
	6185	47	be (160MHz)	20MHz	PASS	PASS
	6185	47	be (160MHz)	40MHz	PASS	PASS
	6465	103	be (80MHz)	20MHz	PASS	PASS
	6505	111	be (160MHz)	20MHz	PASS	PASS
	6505	111	be (160MHz)	40MHz	PASS	PASS
Band 7	6705	151	be (80MHz)	20MHz	PASS	PASS
	6665	143	be (160MHz)	20MHz	PASS	PASS
	6665	143	be (160MHz)	40MHz	PASS	PASS
Band 8	6945	199	be (80MHz)	20MHz	PASS	PASS
	6985	207	be (160MHz)	20MHz	PASS	PASS
	6985	207	be (160MHz)	40MHz	PASS	PASS

Table 7-30. In- Band Emissions Test Result – LPI/SP -Punctured

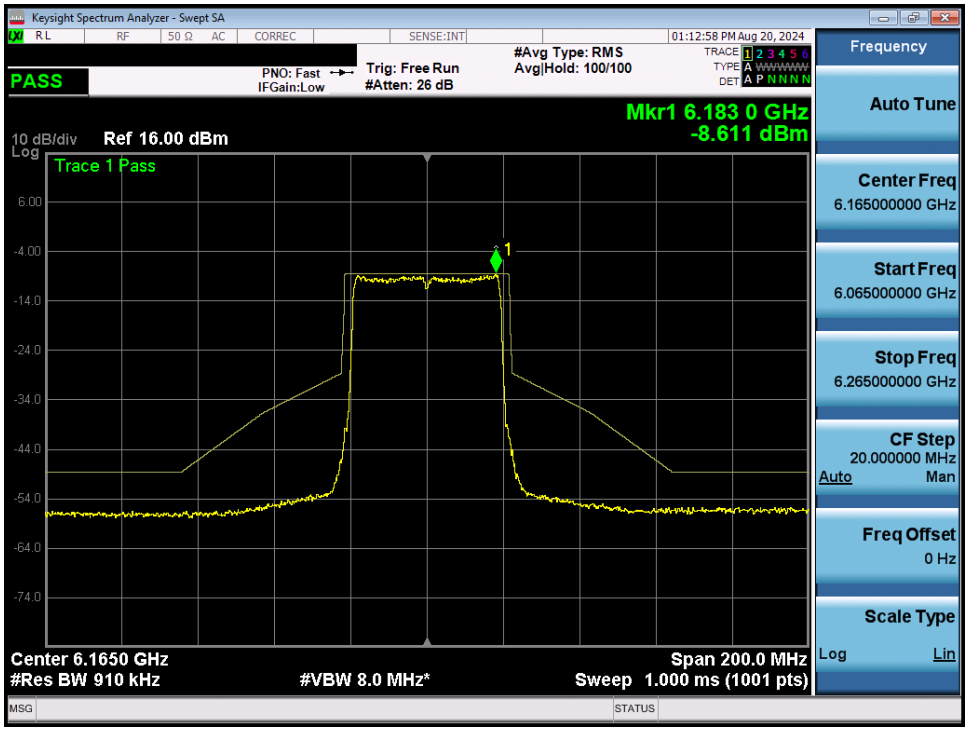
MIMO Antenna-1 In-Band Emission Measurements - (UNII Band 5)



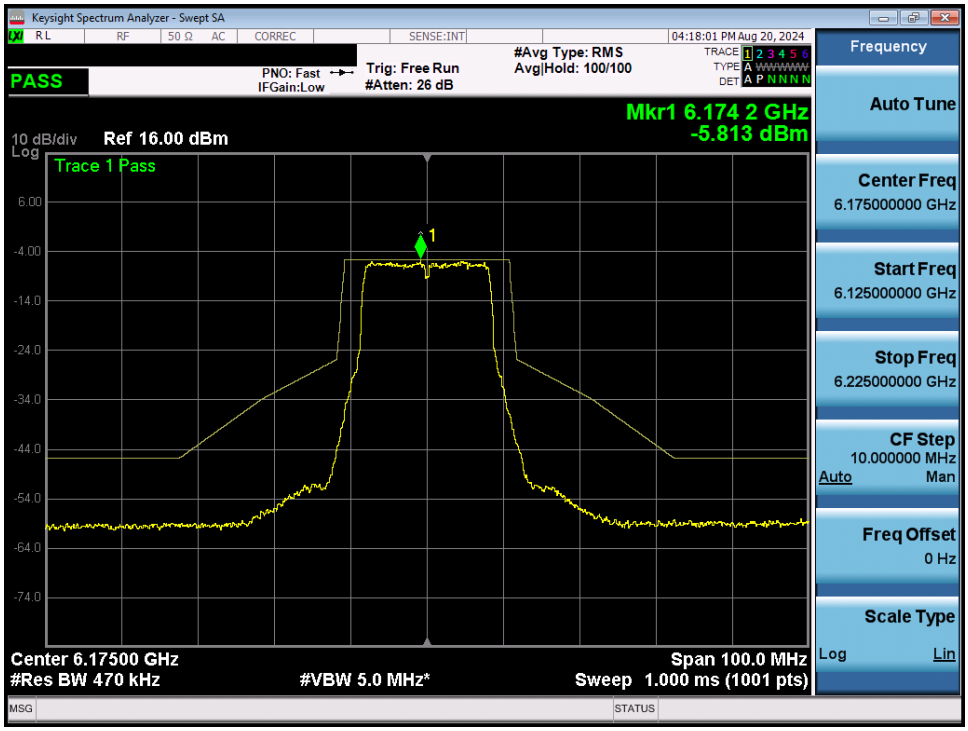
Plot 7-164. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 5) – Ch. 45) – LPI



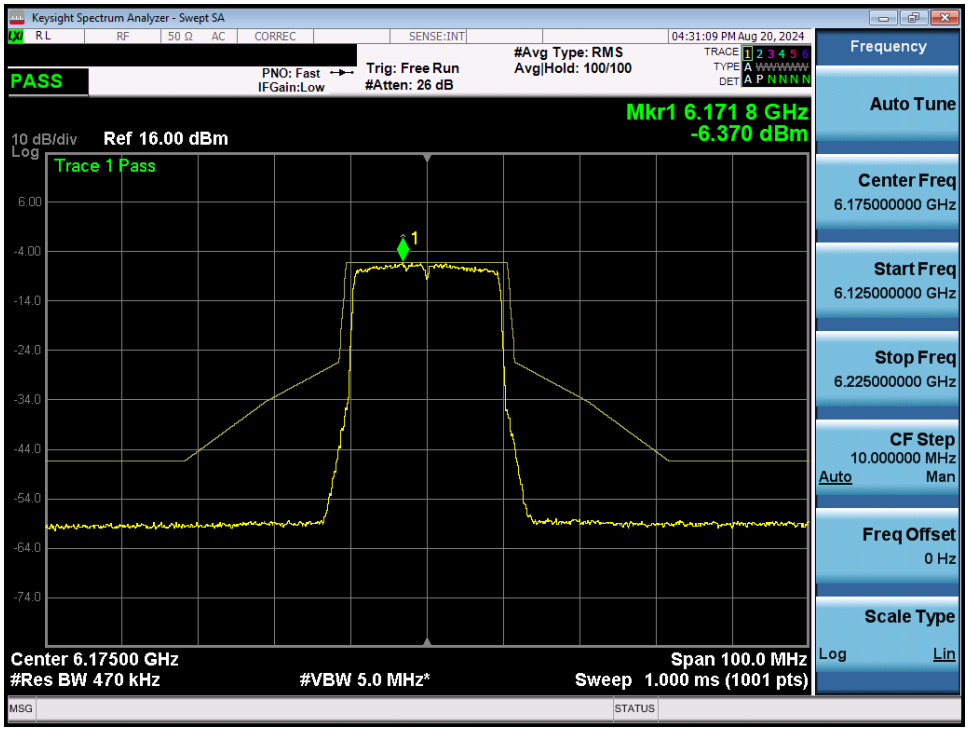
Plot 7-165. In-Band Emission MIMO ANT1 (20MHz 802.11be (UNII Band 5) – Ch. 45) – LPI



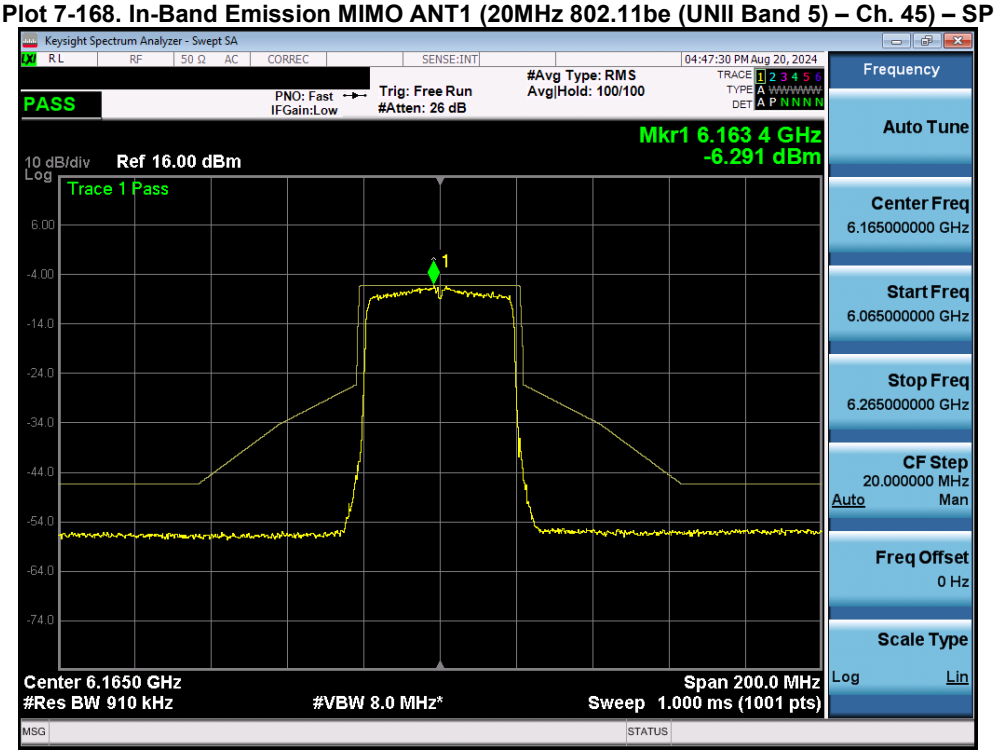
Plot 7-166. In-Band Emission MIMO ANT1 (40MHz 802.11be (UNII Band 5) – Ch. 43) – LPI



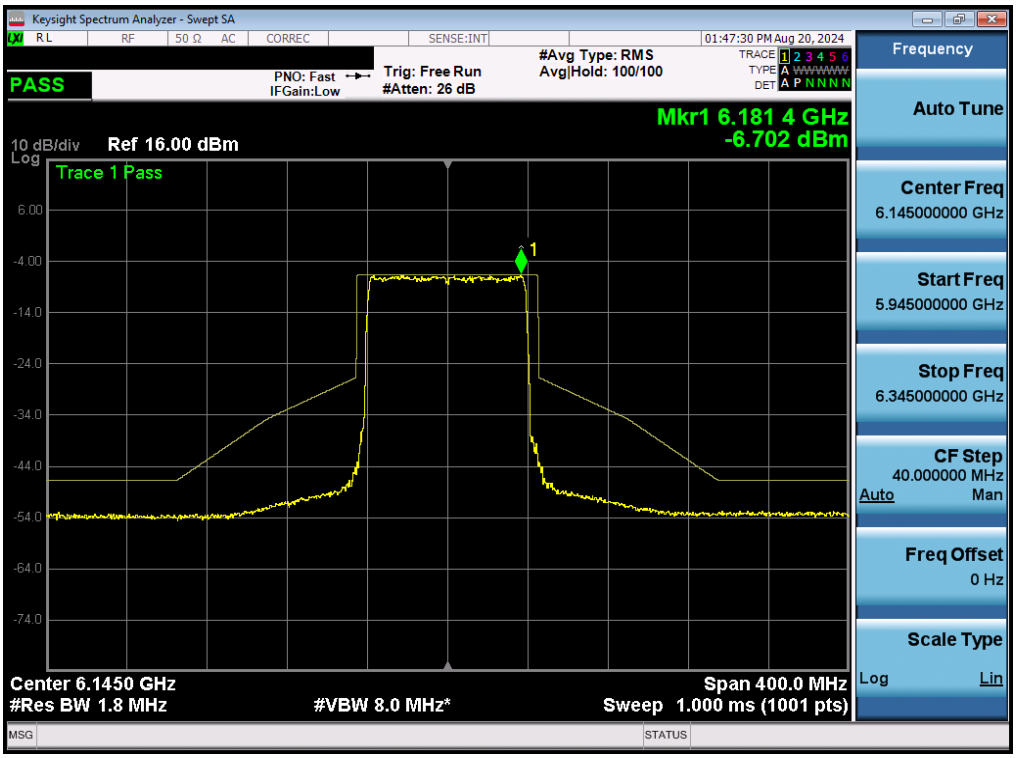
Plot 7-167. In-Band Emission MIMO ANT1 (20MHz 802.11a (UNII Band 5) – Ch. 45) – SP



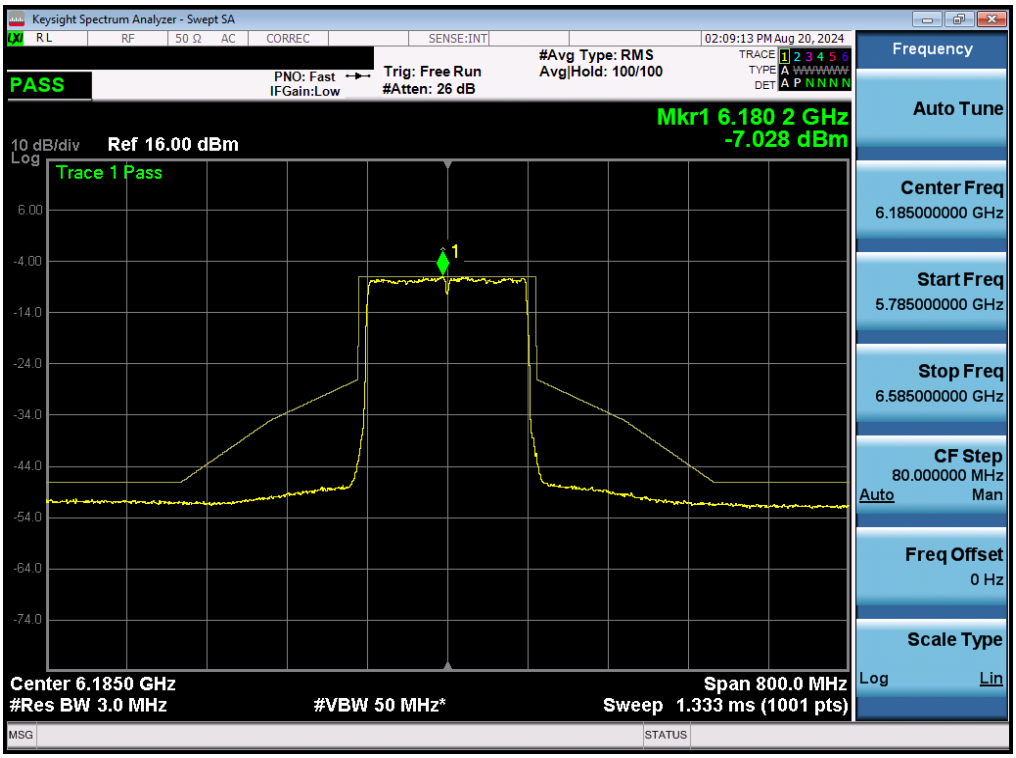
Plot 7-168. In-Band Emission MIMO ANT1 (20MHz 802.11be (UNII Band 5) – Ch. 45) – SP



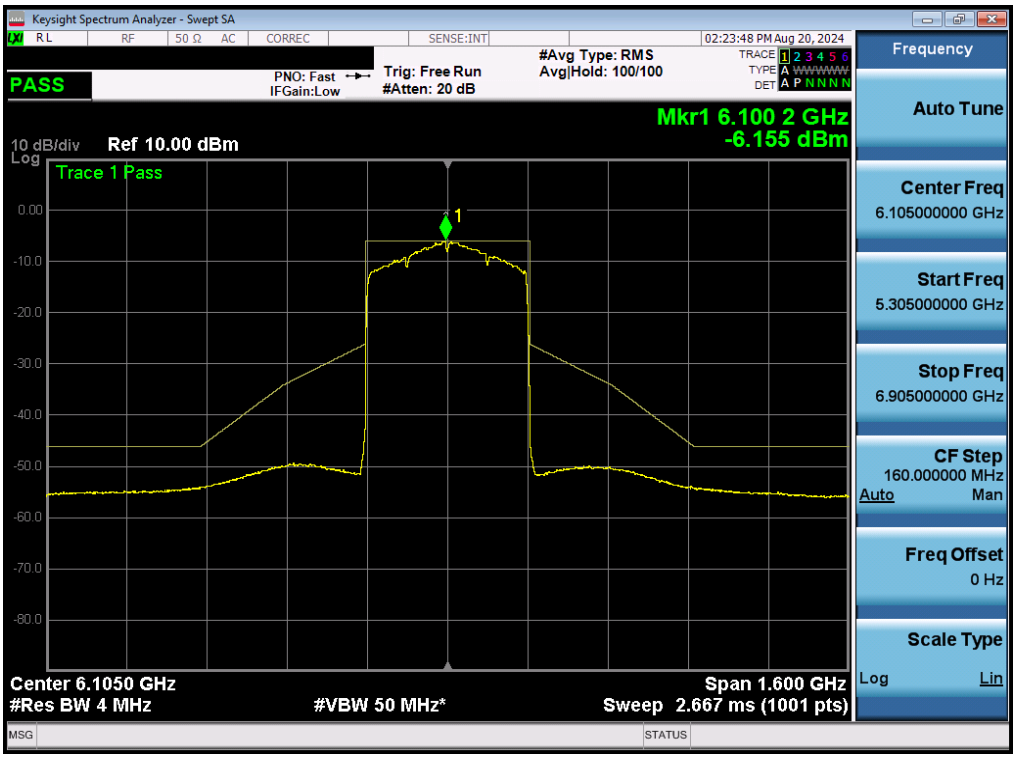
Plot 7-169. In-Band Emission MIMO ANT1 (40MHz 802.11be (UNII Band 5) – Ch. 43) – SP



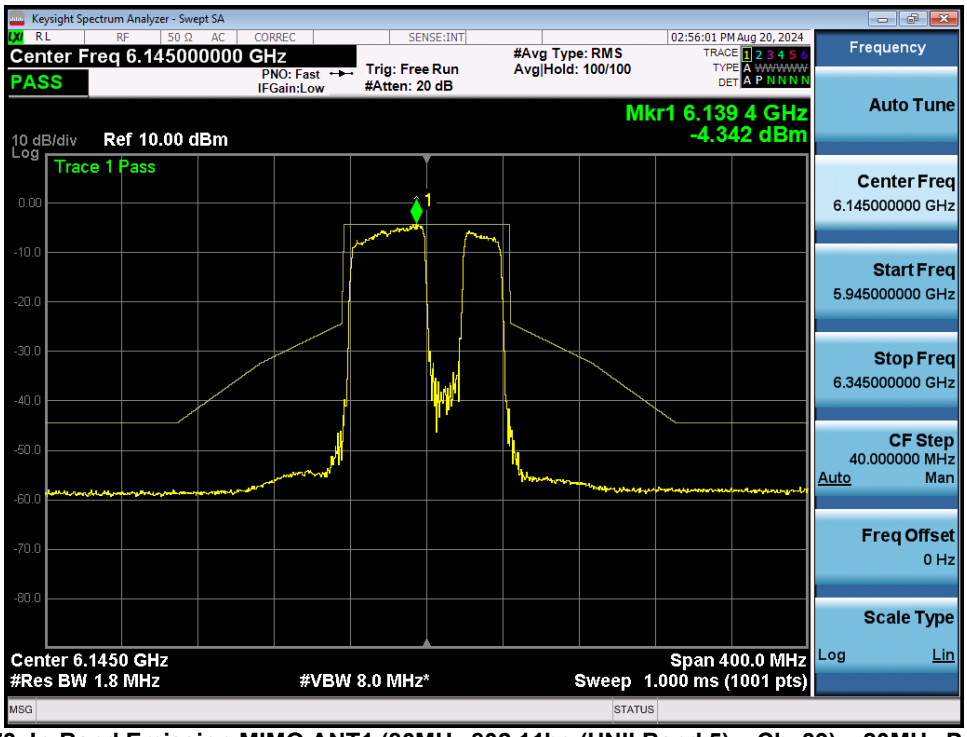
Plot 7-170. In-Band Emission MIMO ANT1 (80MHz 802.11be (UNII Band 5) – Ch. 39) – LPI/SP



Plot 7-171. In-Band Emission MIMO ANT1 (160MHz 802.11be (UNII Band 5) – Ch. 47) – LPI/SP



Plot 7-172. In-Band Emission MIMO ANT1 (320MHz 802.11be (UNII Band 5) – Ch. 31) – LPI/SP



Plot 7-173. In-Band Emission MIMO ANT1 (80MHz 802.11be (UNII Band 5) – Ch. 39) – 20MHz Punctured