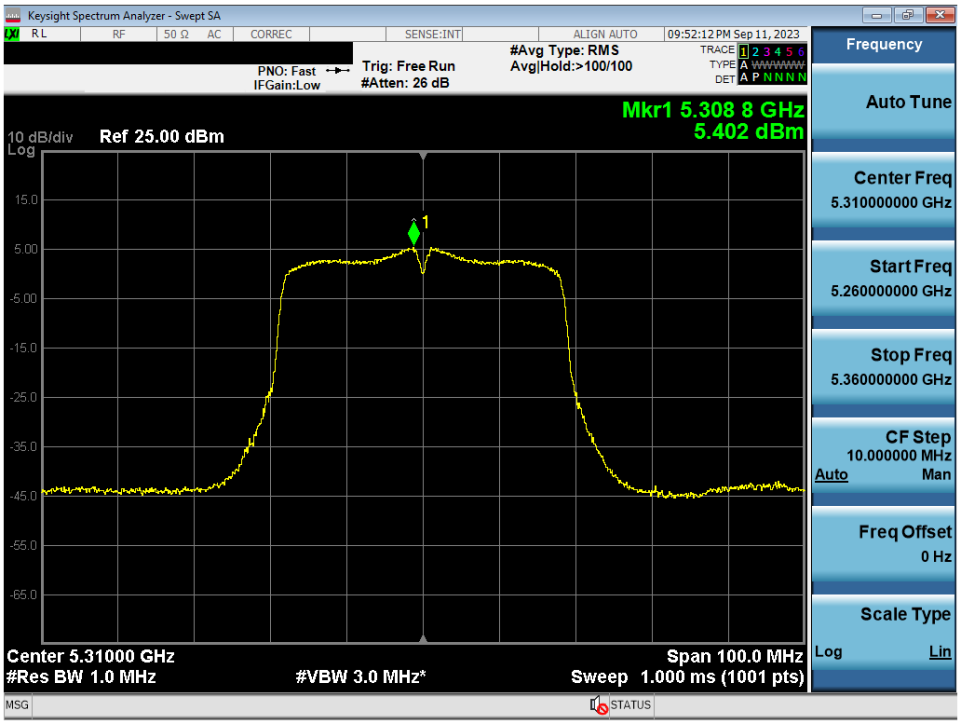
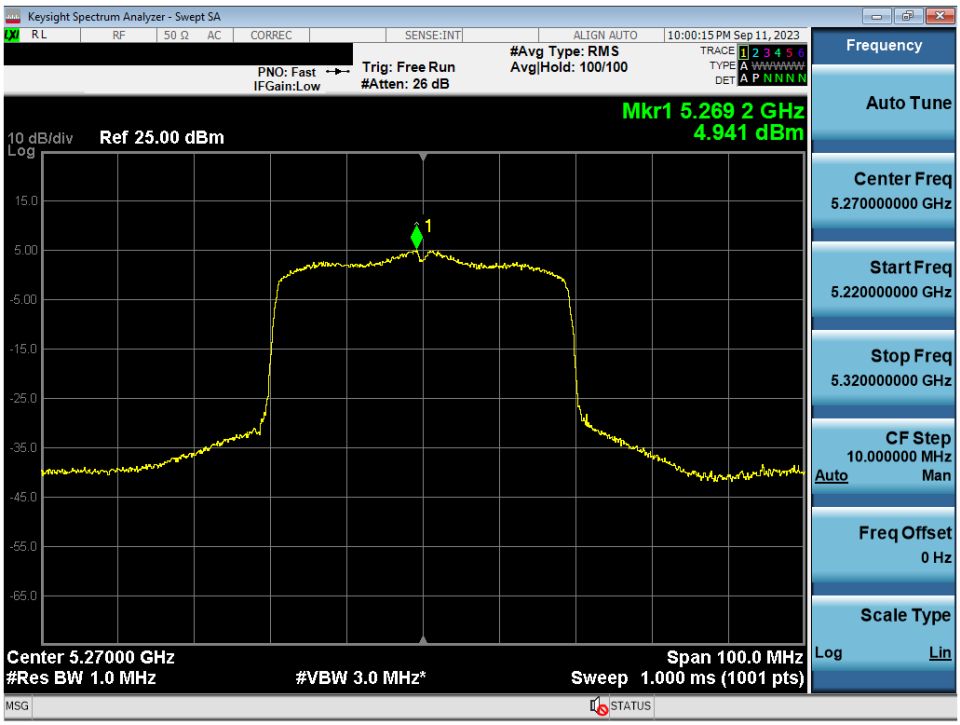
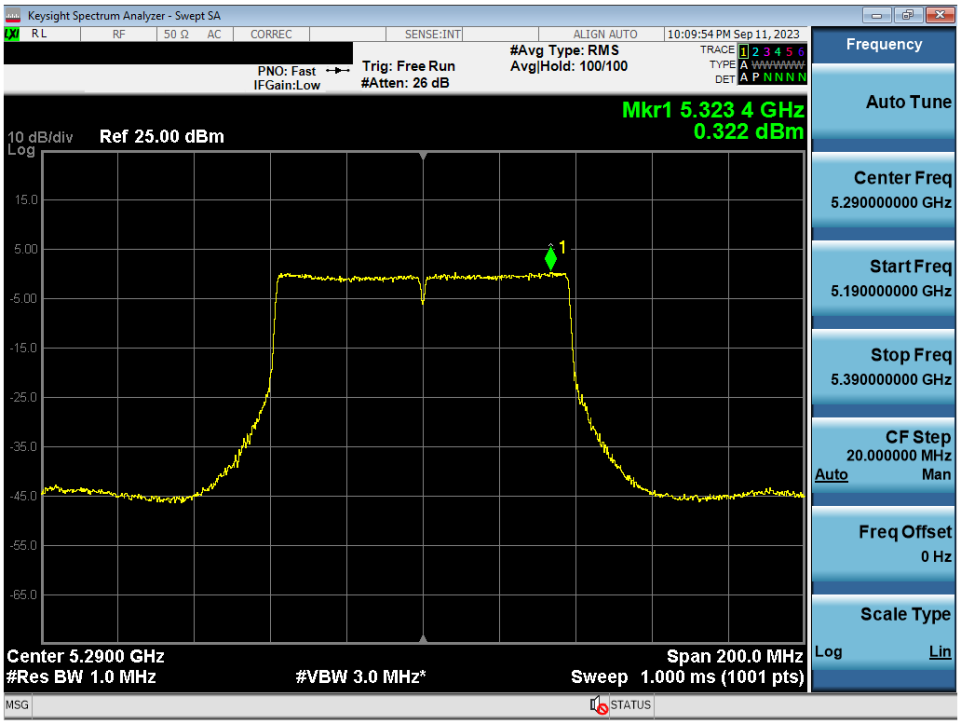


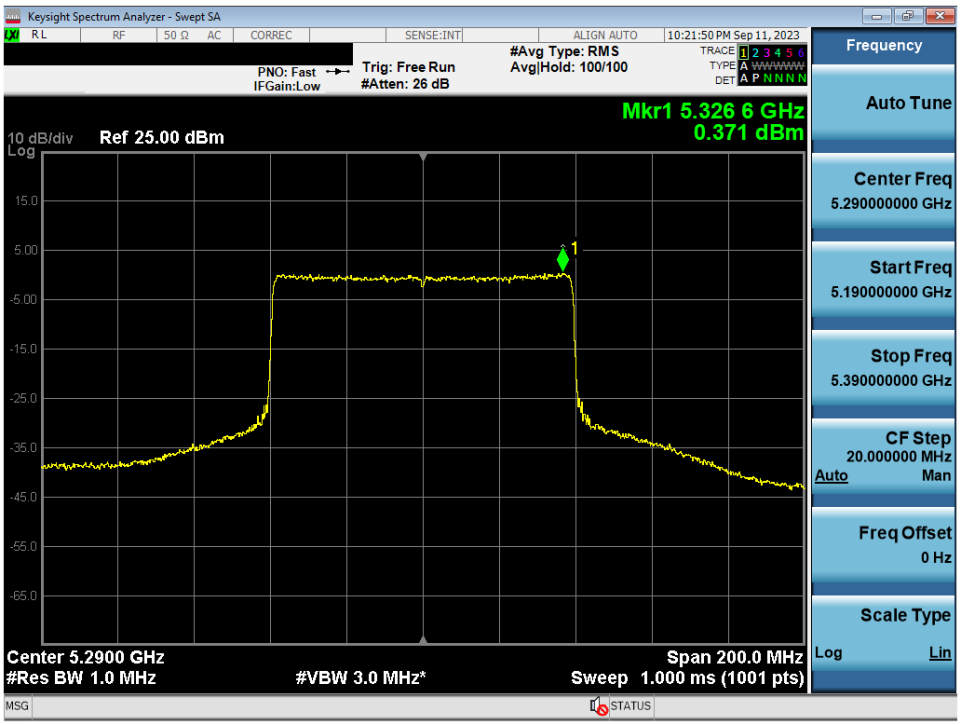
Plot 7-95. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11n (UNII Band 2A) – Ch. 62)



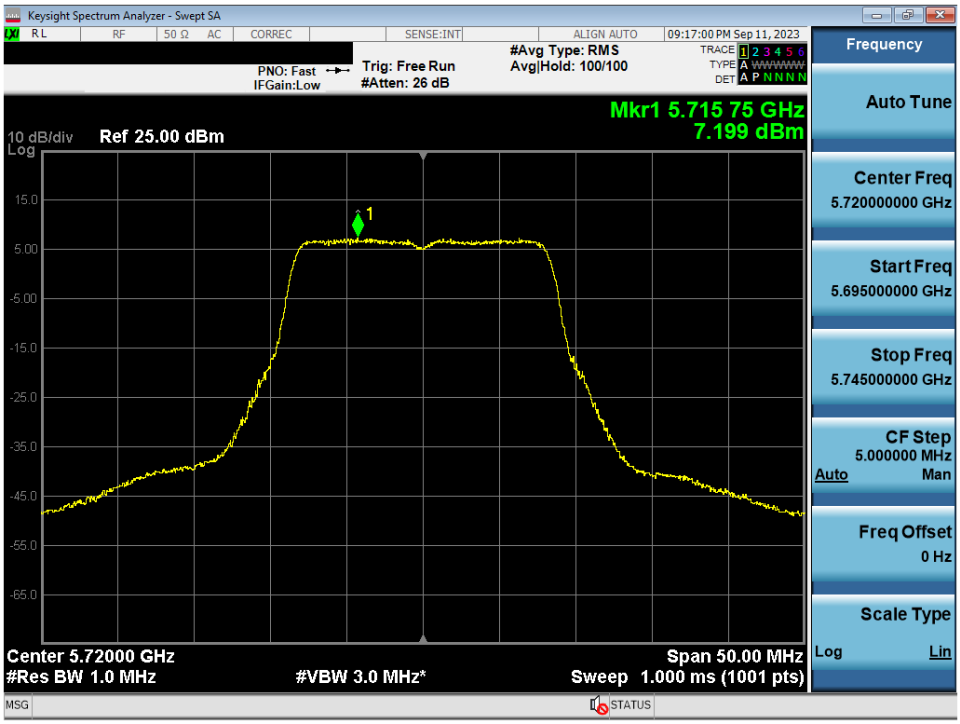
Plot 7-96. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11ax/be (UNII Band 2A) – Ch. 54)



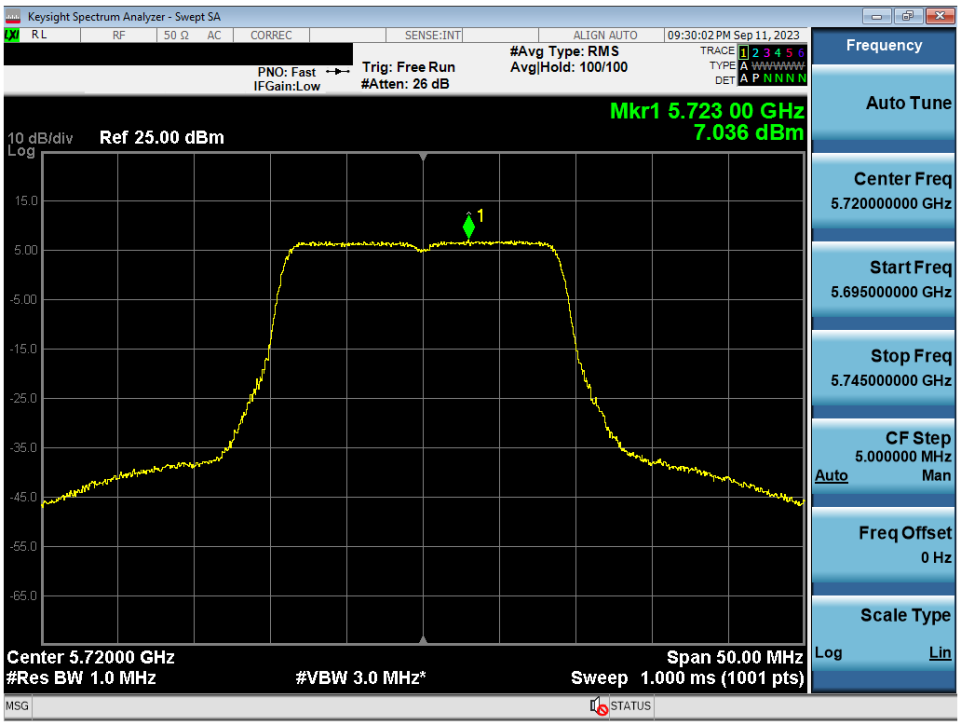
Plot 7-97. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ac (UNII Band 2A) – Ch. 58)



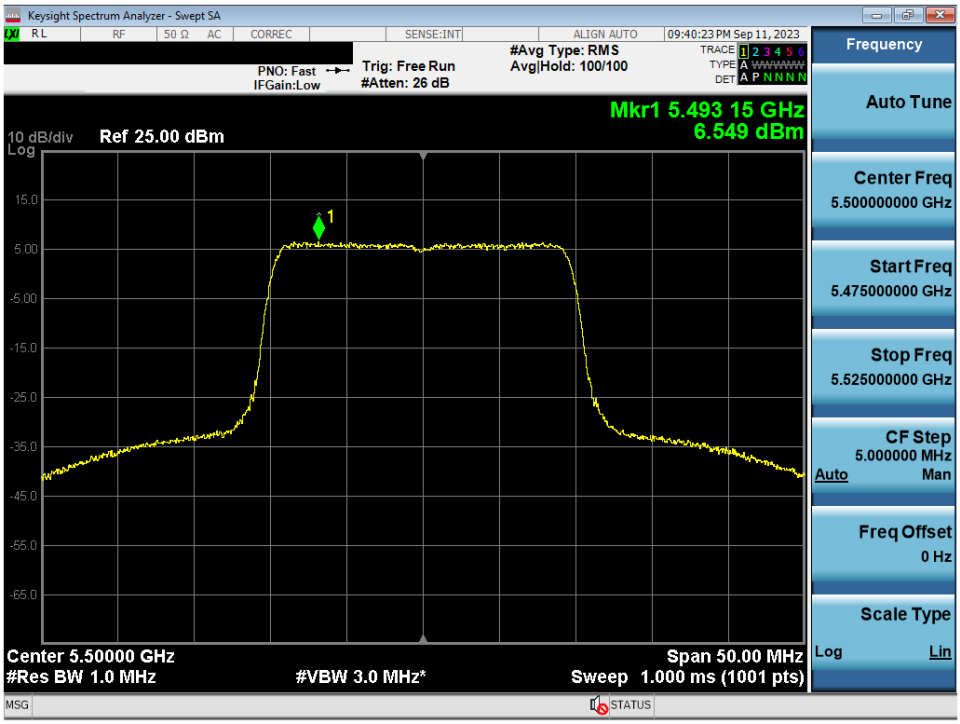
Plot 7-98. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ax/be (UNII Band 2A) – Ch. 58)



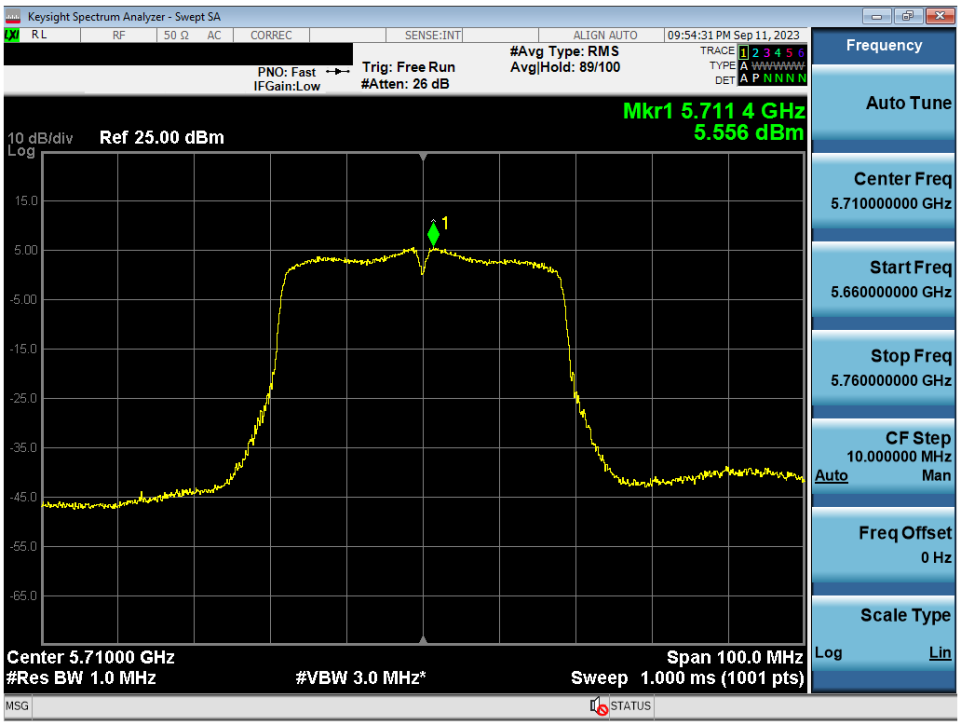
Plot 7-99. Power Spectral Density Plot MIMO ANT1 (802.11a (UNII Band 2C) – Ch. 144)



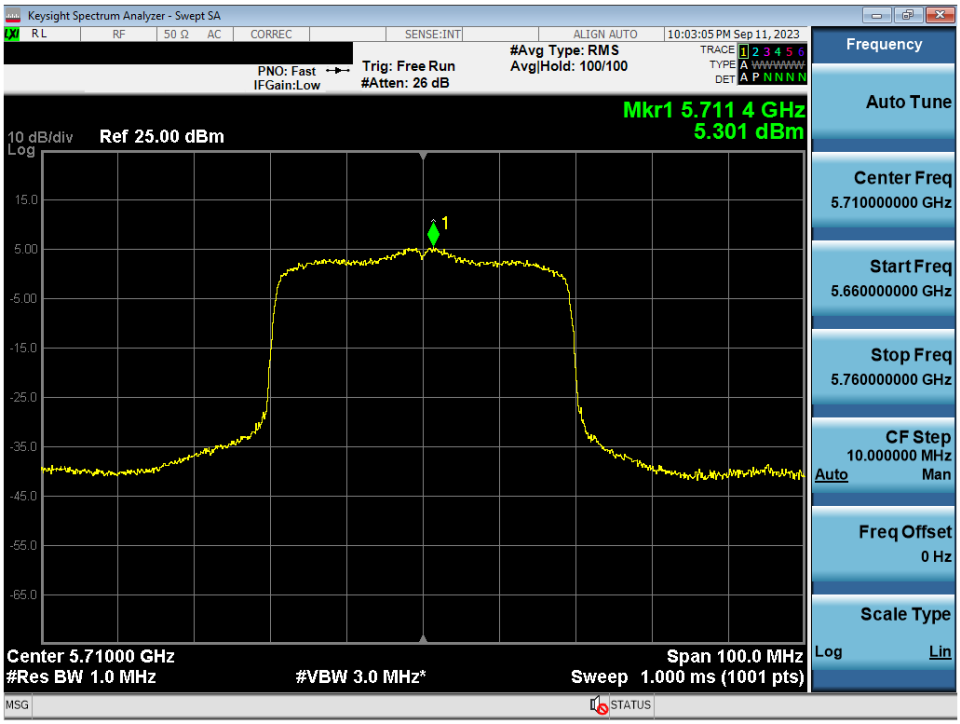
Plot 7-100. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11n (UNII Band 2C) – Ch. 144)



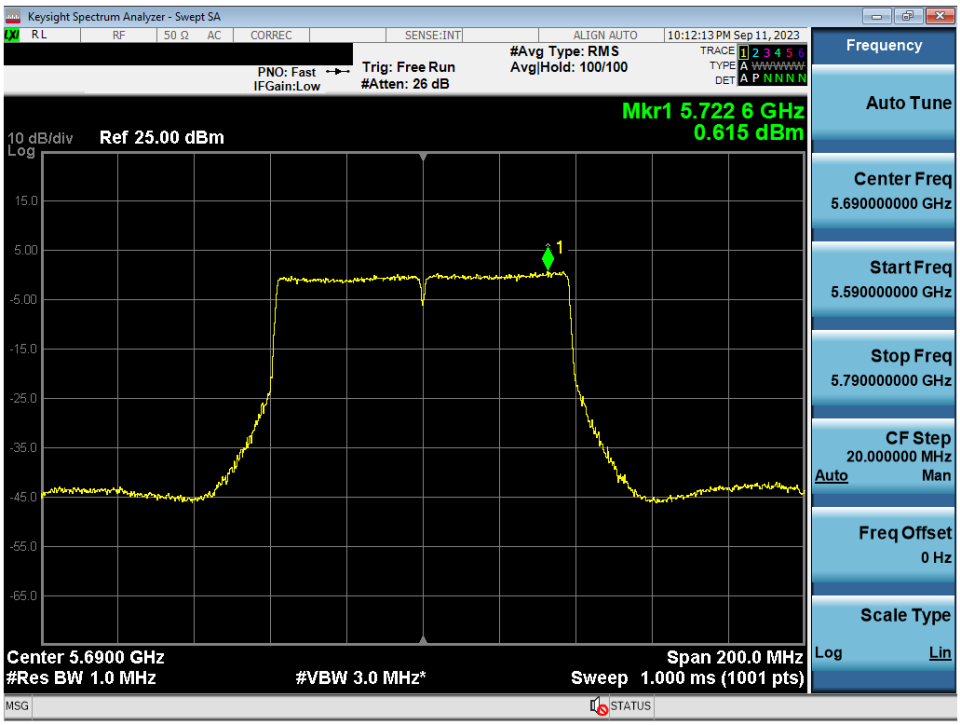
Plot 7-101. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11ax/be (UNII Band 2C) – Ch. 100)



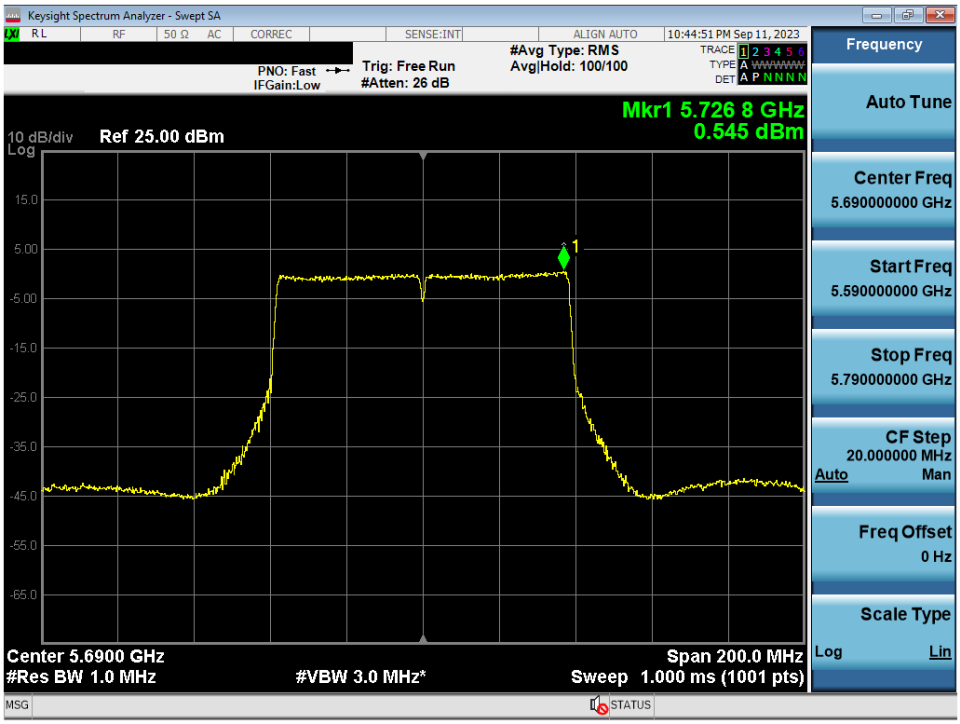
Plot 7-102. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11n (UNII Band 2C) – Ch. 142)



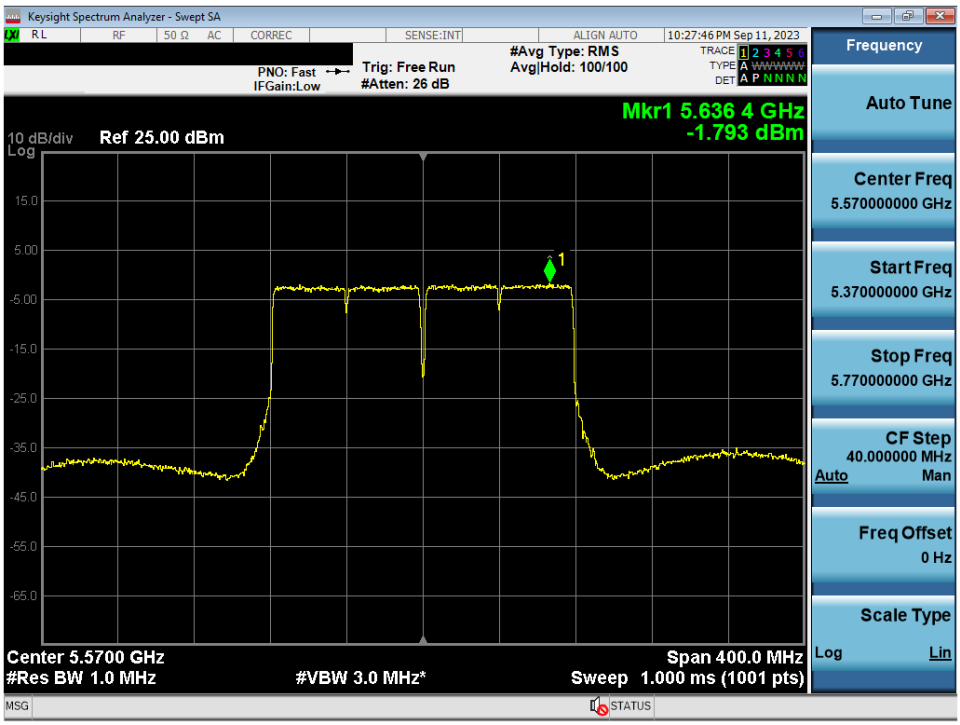
Plot 7-103. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11ax/be (UNII Band 2C) – Ch. 142)



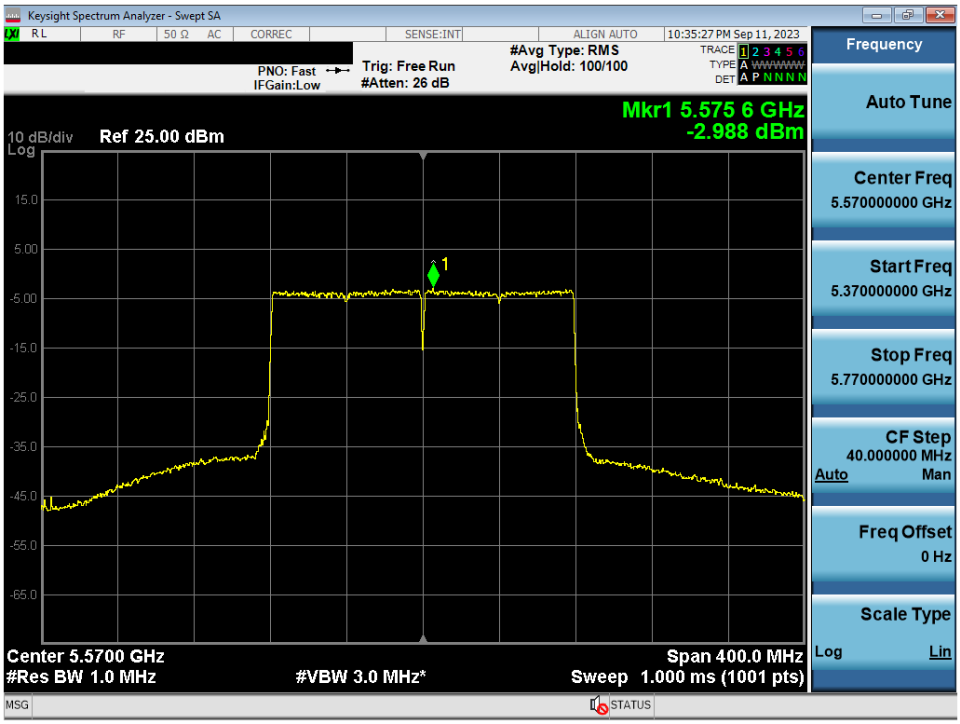
Plot 7-104. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ac (UNII Band 2C) – Ch. 138)



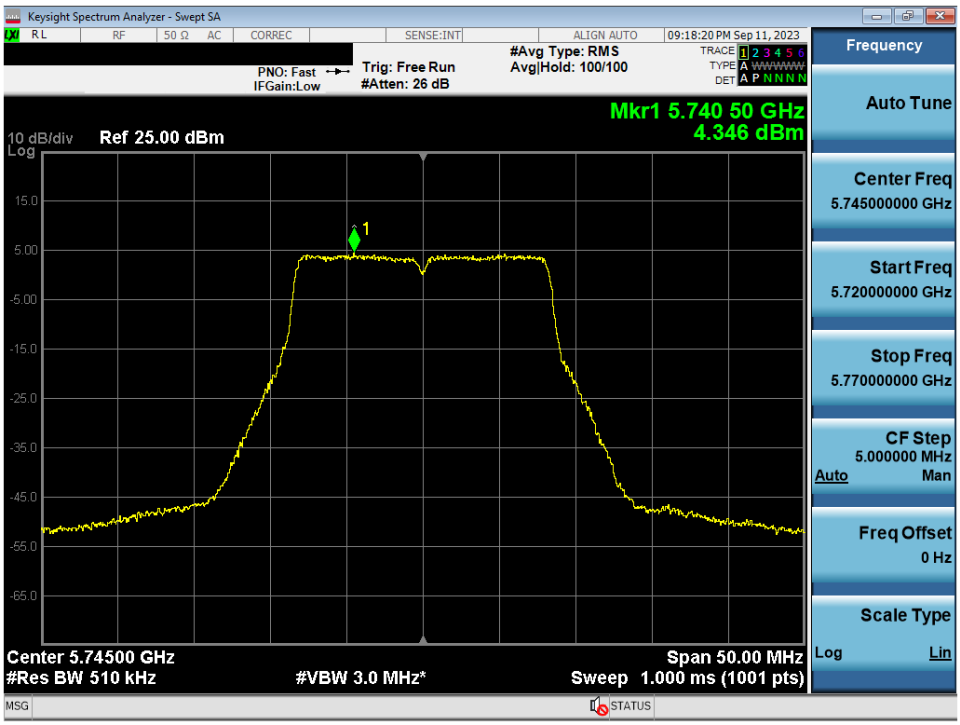
Plot 7-105. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ax/be (UNII Band 2C) – Ch. 138)



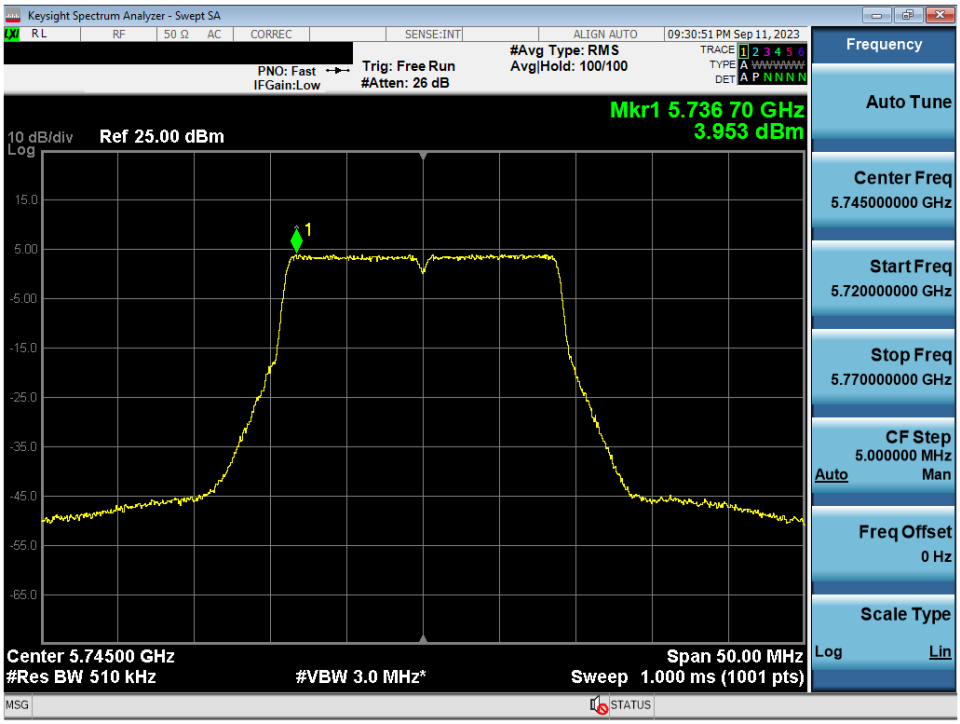
Plot 7-106. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11ac (UNII Band 2C) – Ch. 114)



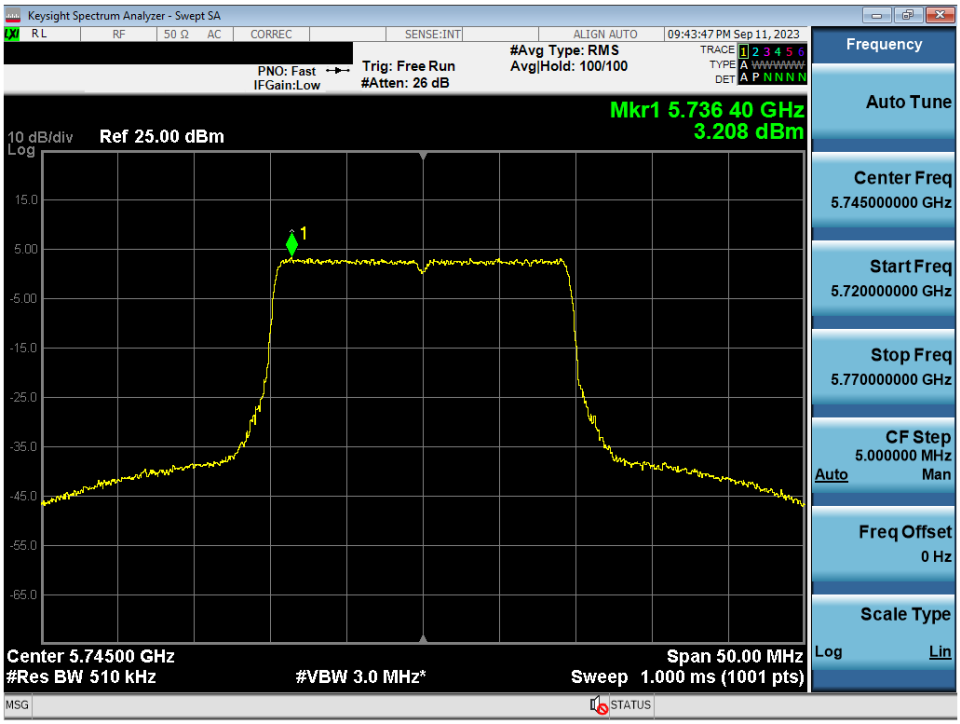
Plot 7-107. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11ax/be (UNII Band 2C) – Ch. 114)



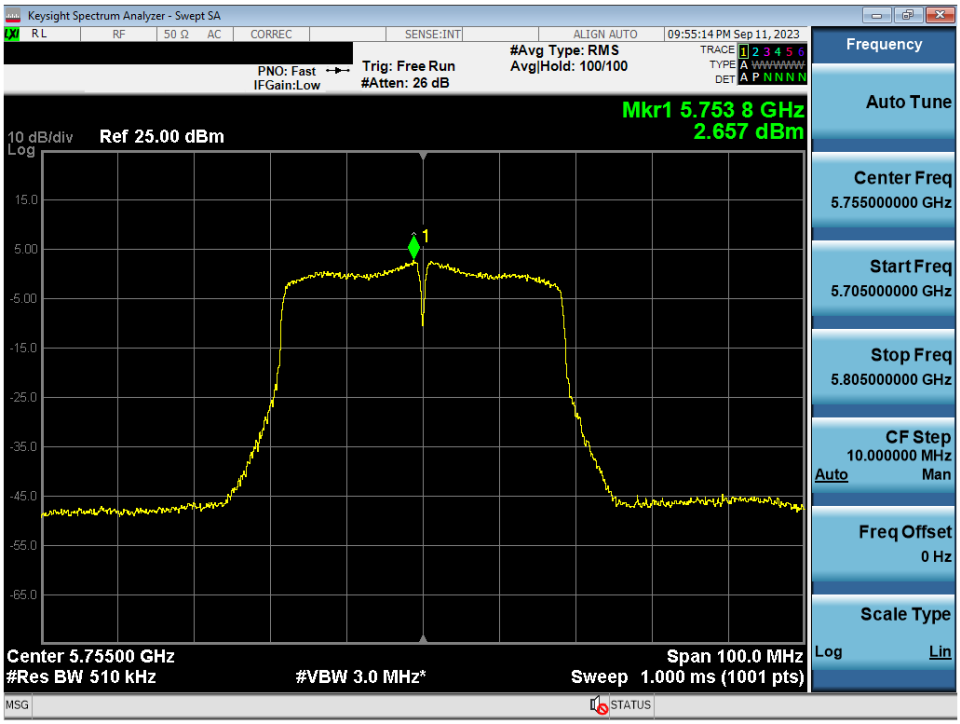
Plot 7-108. Power Spectral Density Plot MIMO ANT1 (802.11a (UNII Band 3) – Ch. 149)



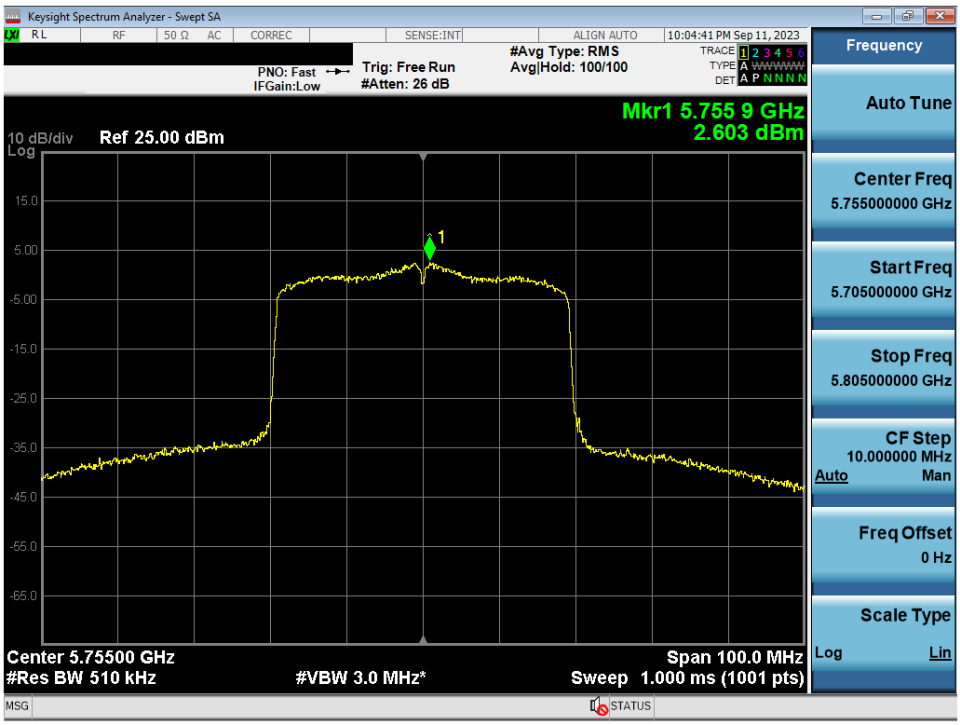
Plot 7-109. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11n (UNII Band 3) – Ch. 149)



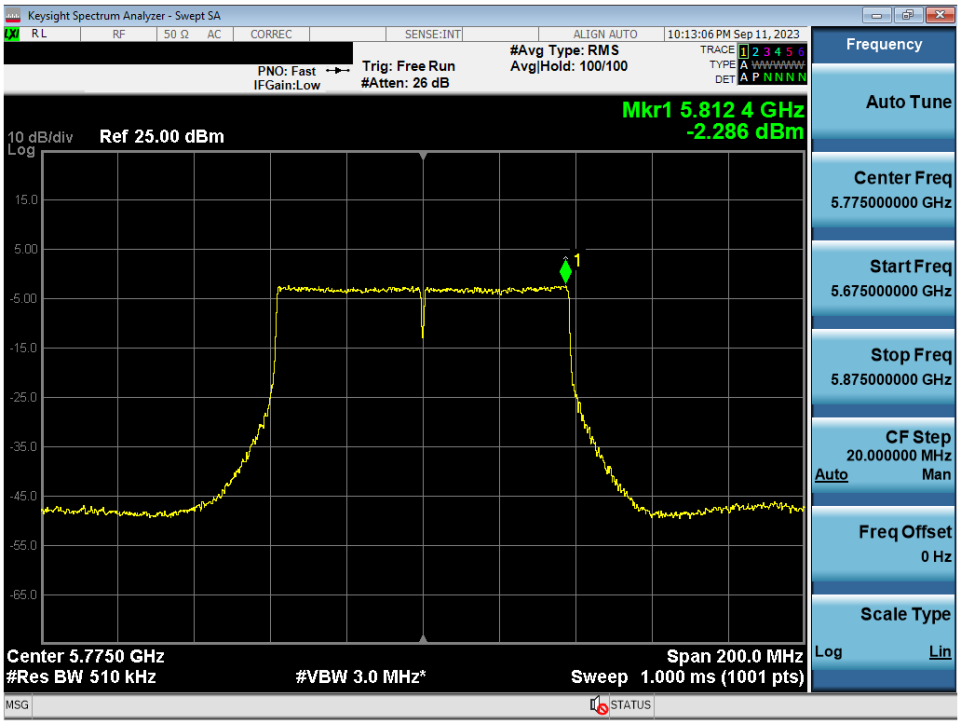
Plot 7-110. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11ax/be (UNII Band 3) – Ch. 149)



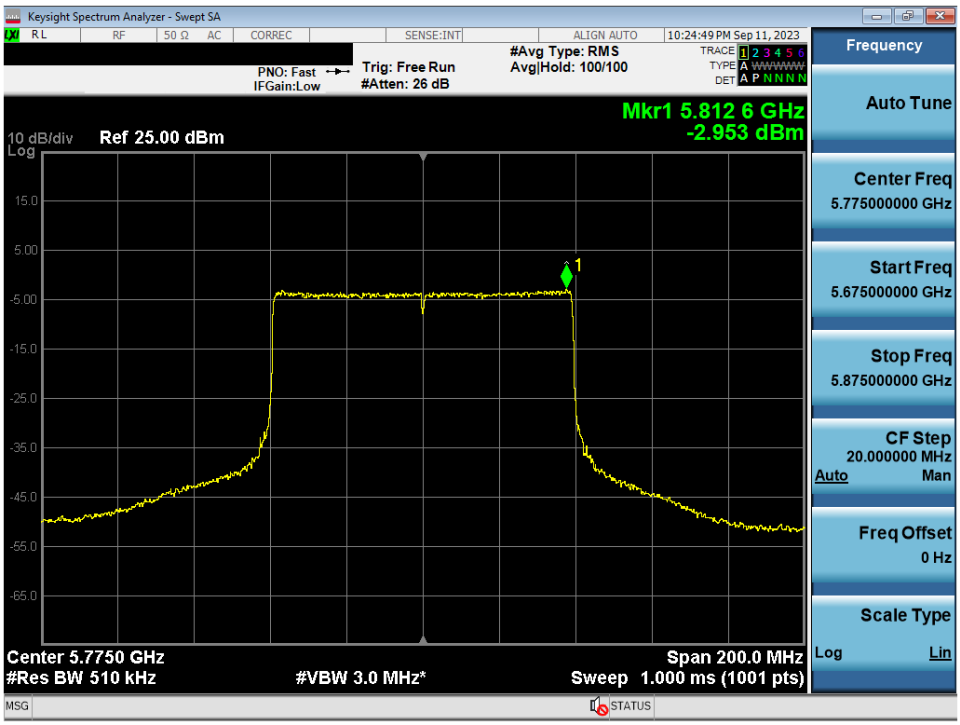
Plot 7-111. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11n (UNII Band 3) – Ch. 151)



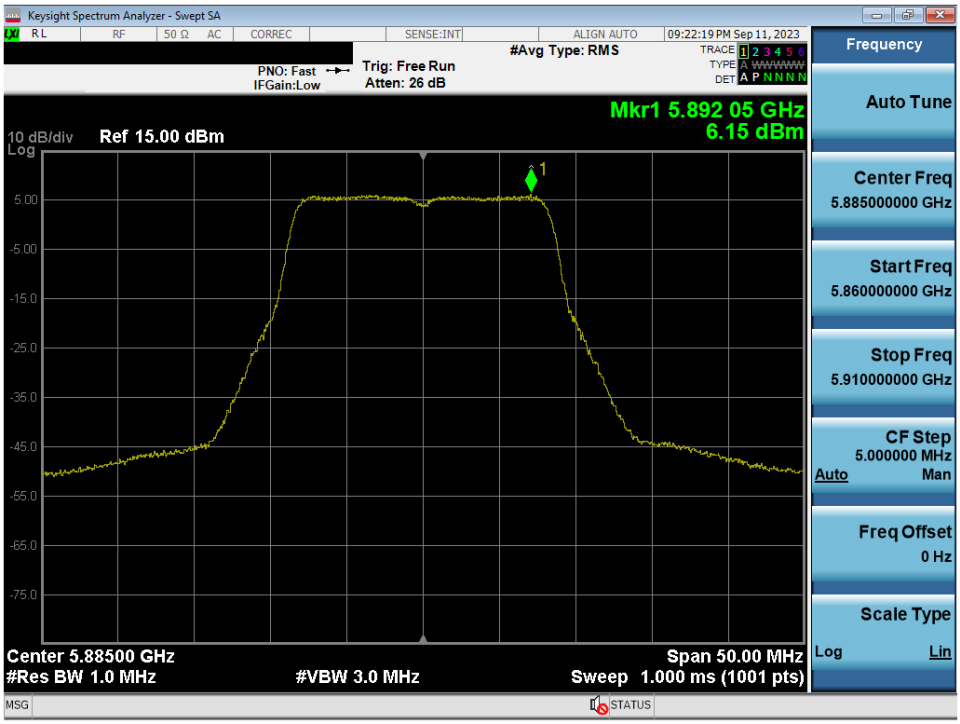
Plot 7-112. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11ax/be (UNII Band 3) – Ch. 151)



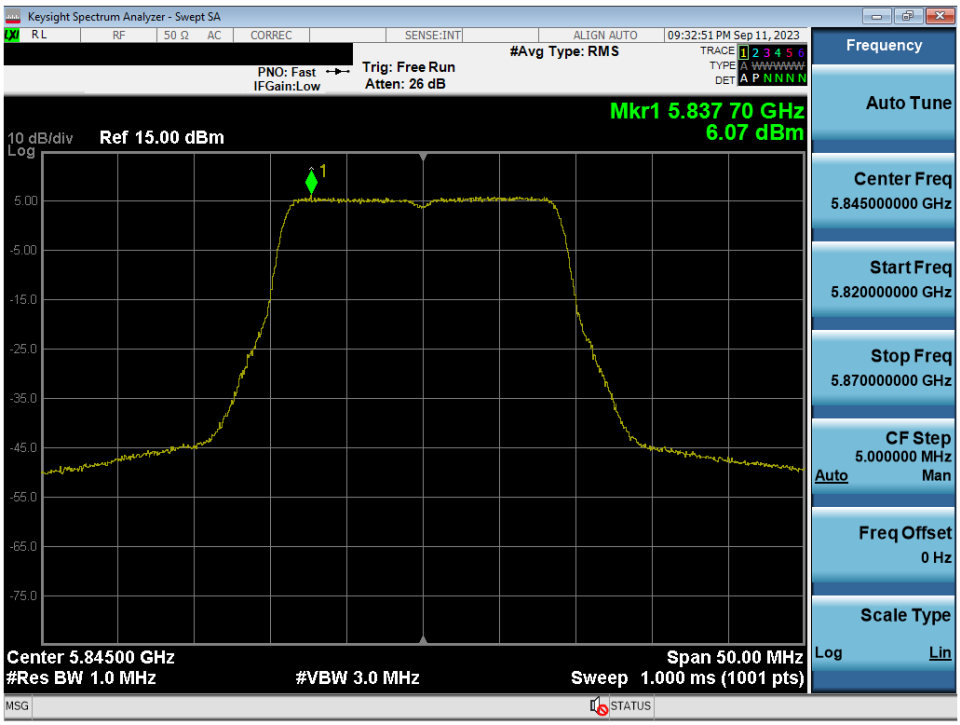
Plot 7-113. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ac (UNII Band 3) – Ch. 155)



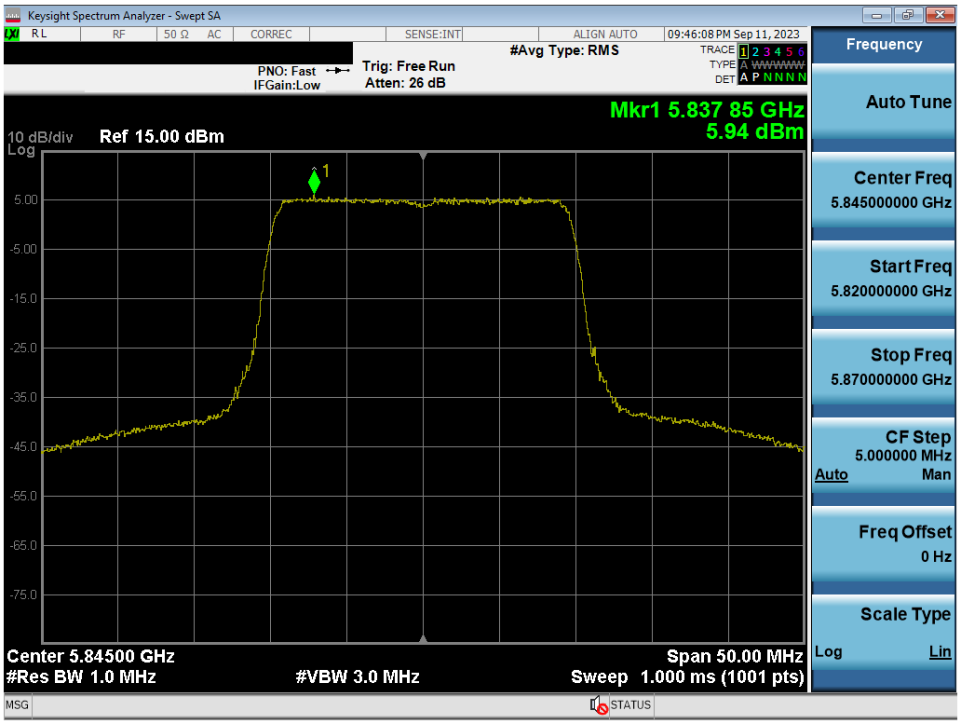
Plot 7-114. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ax/be (UNII Band 3) – Ch. 155)



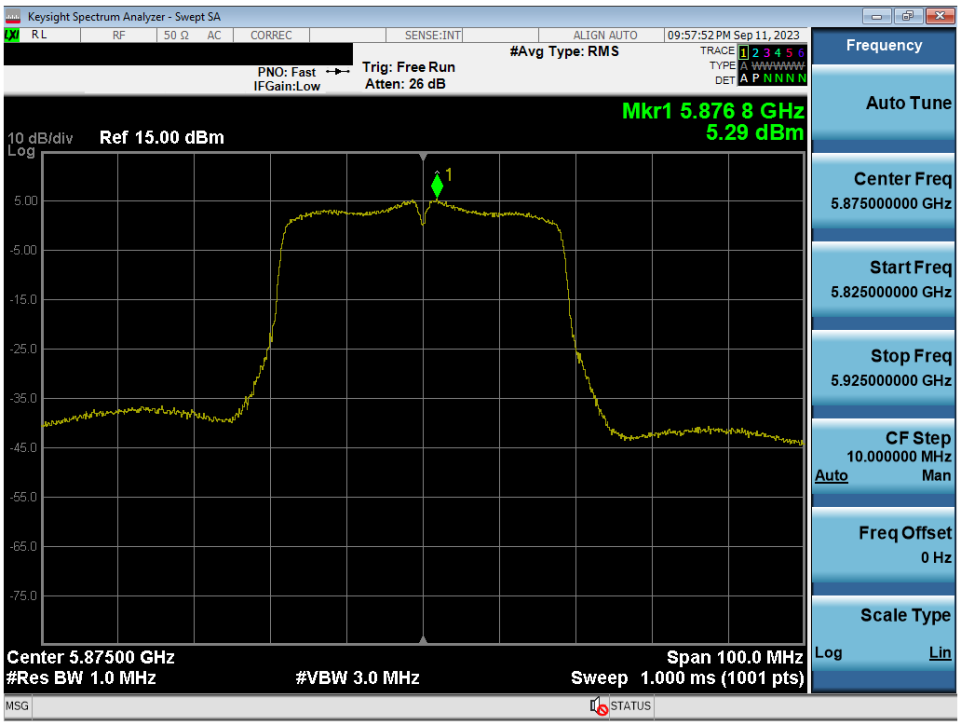
Plot 7-115. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11a (UNII Band 4) – Ch. 177)



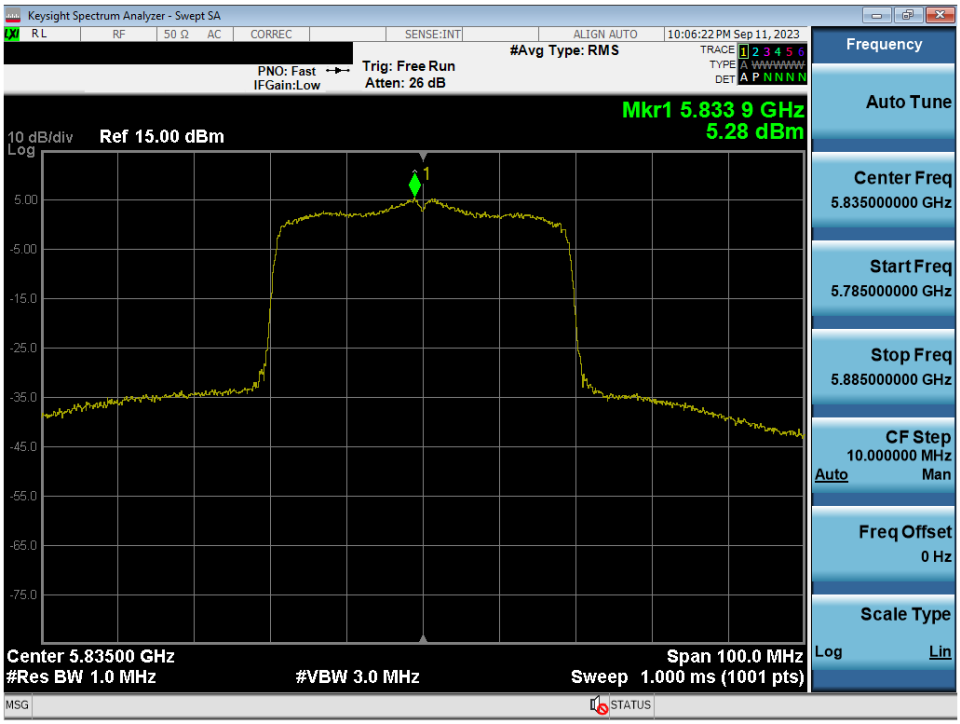
Plot 7-116. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11n (UNII Band 3/4) – Ch. 169)



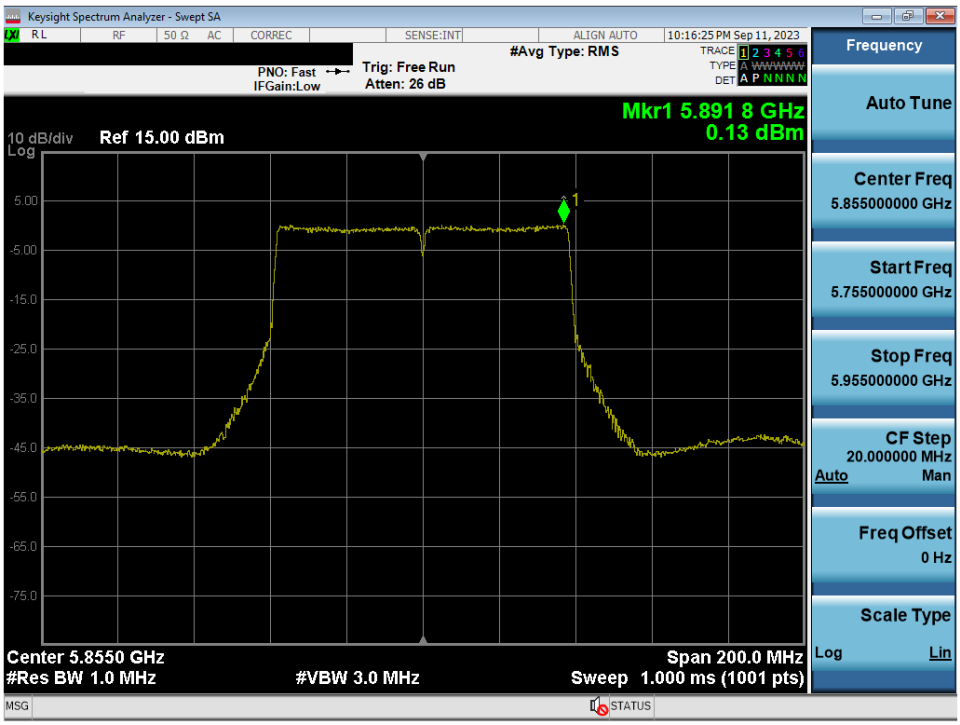
Plot 7-117. Power Spectral Density Plot MIMO ANT1 (20MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 169)



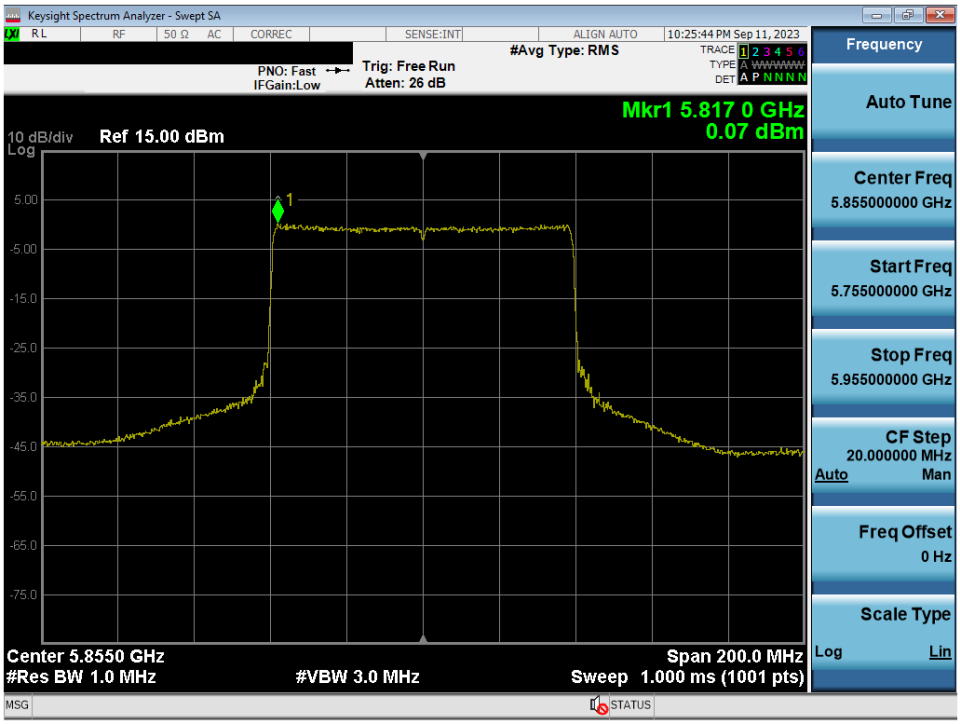
Plot 7-118. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11n (UNII Band 4) – Ch. 175)



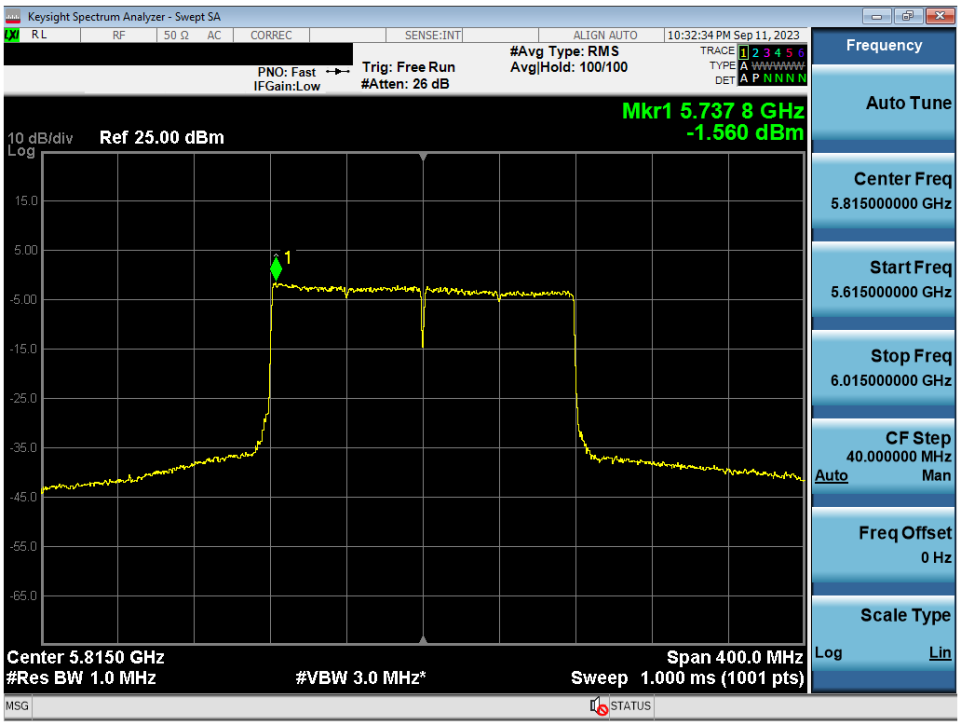
Plot 7-119. Power Spectral Density Plot MIMO ANT1 (40MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 167)



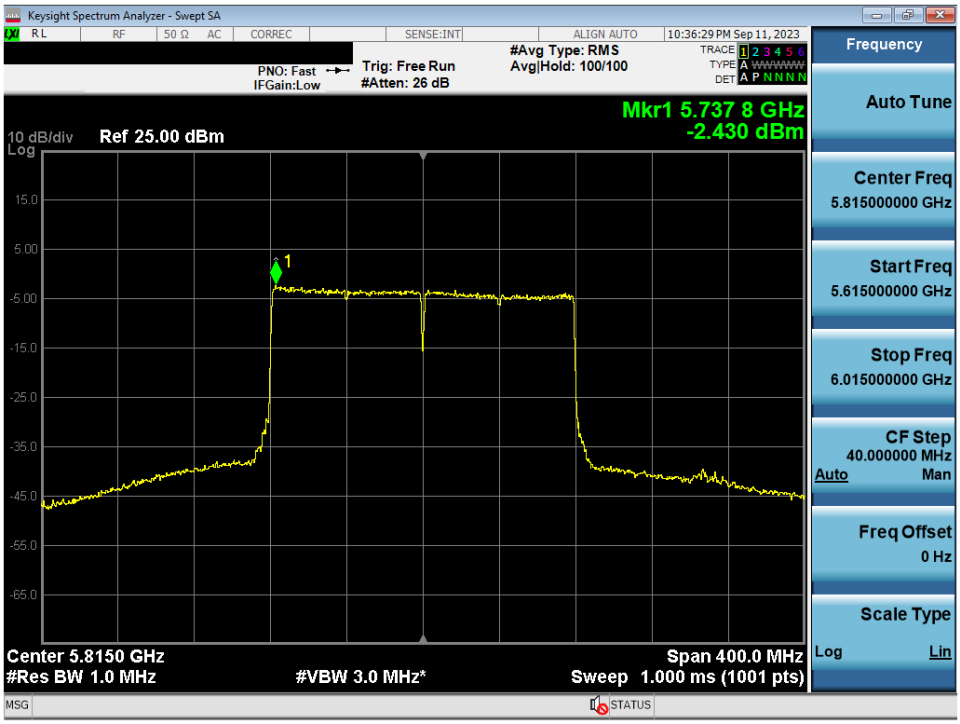
Plot 7-120. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ac (UNII Band 3/4) – Ch. 171)



Plot 7-121. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 171)

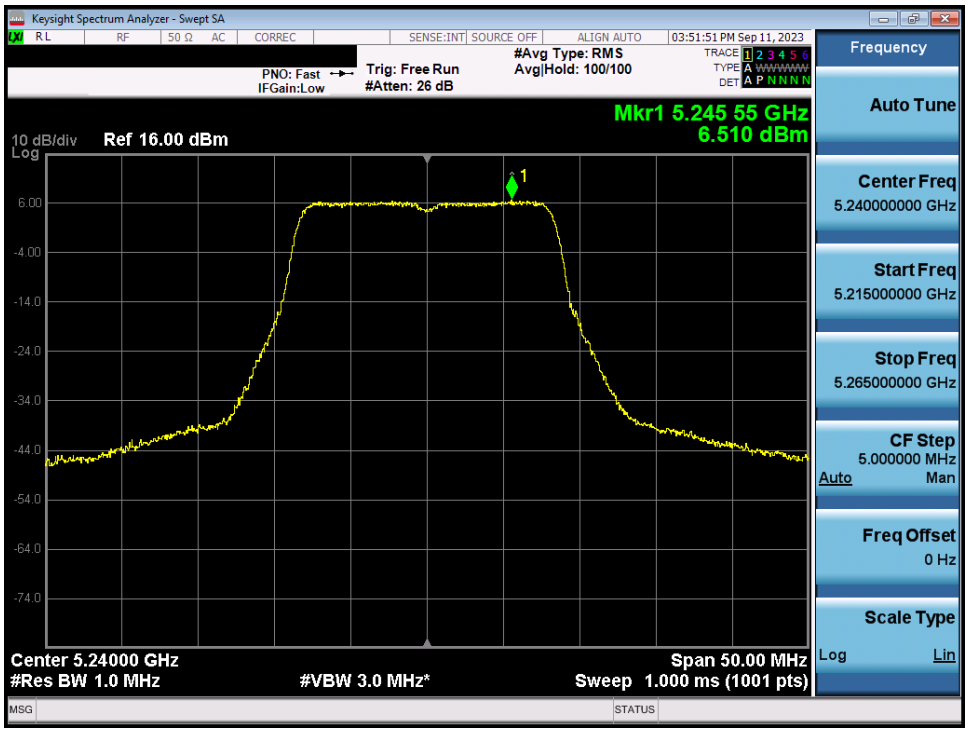


Plot 7-122. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11ac (UNII Band 3/4) – Ch. 163)

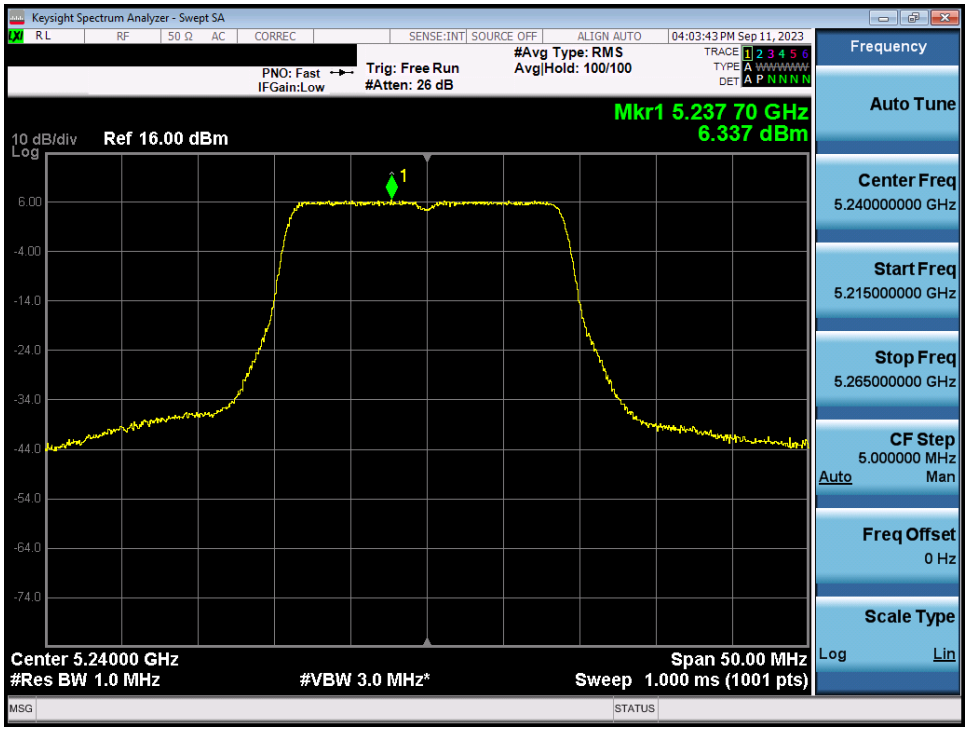


Plot 7-123. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 163)

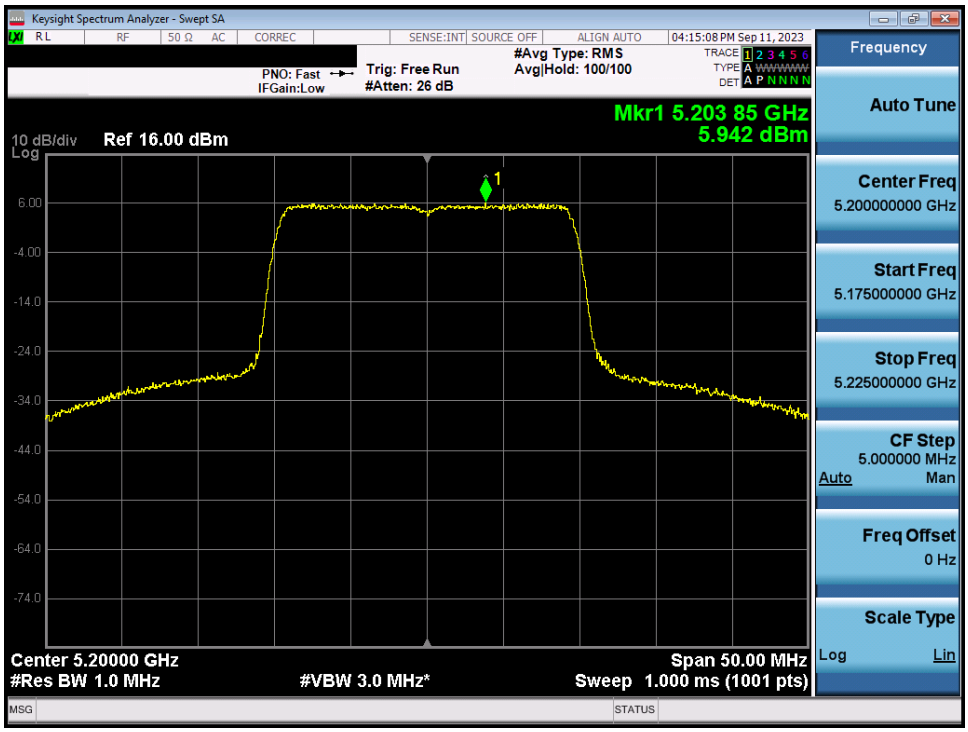
7.5.2 MIMO Antenna-2 Power Spectral Density Measurements



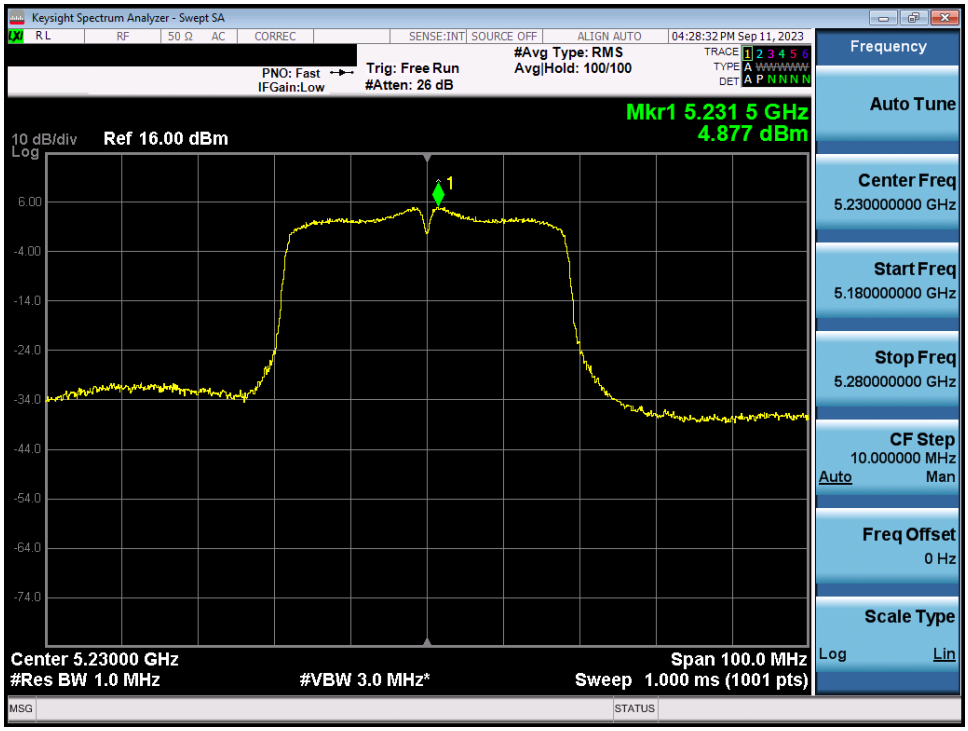
Plot 7-124. Power Spectral Density Plot MIMO ANT2 (802.11a (UNII Band 1) – Ch. 48)



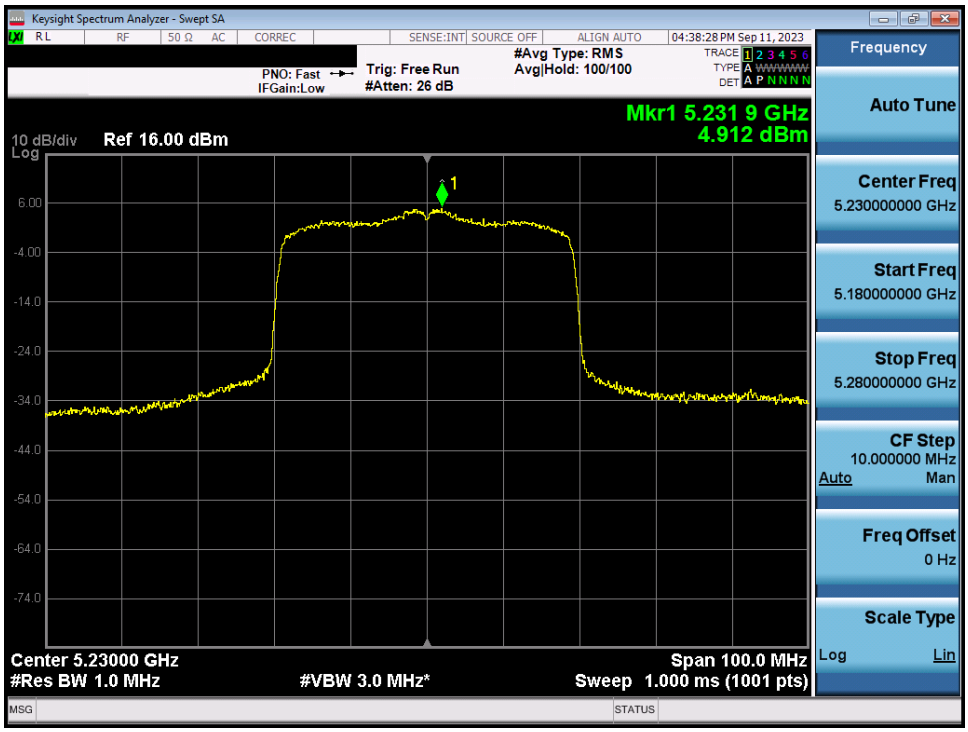
Plot 7-125. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11n (UNII Band 1) – Ch. 48)



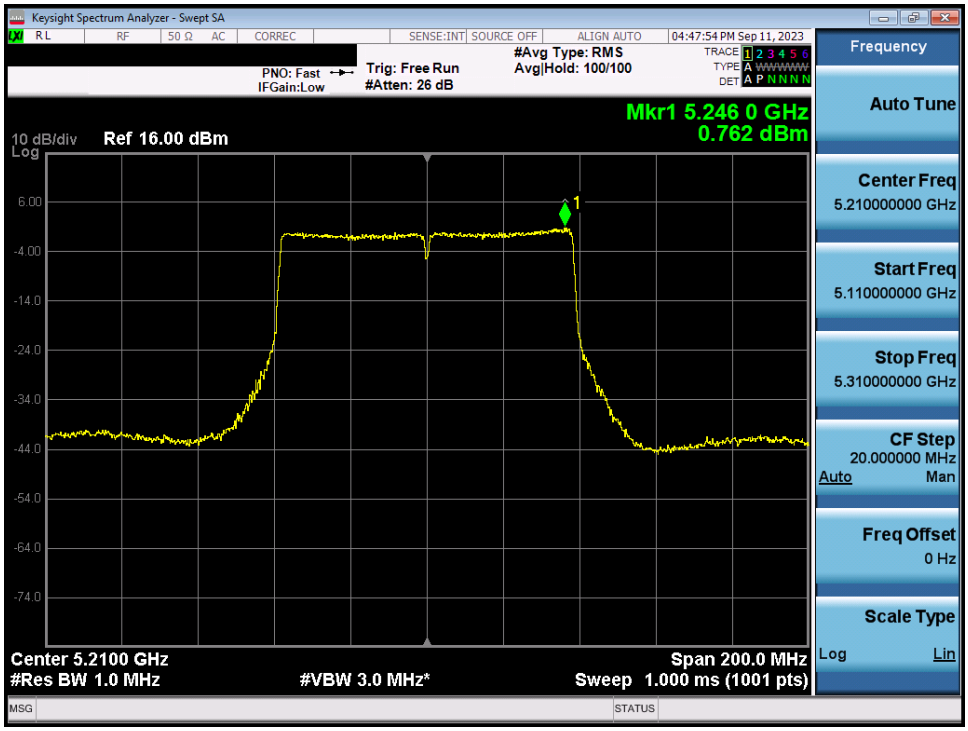
Plot 7-126. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802. 11ax/be (UNII Band 1) – Ch. 40)



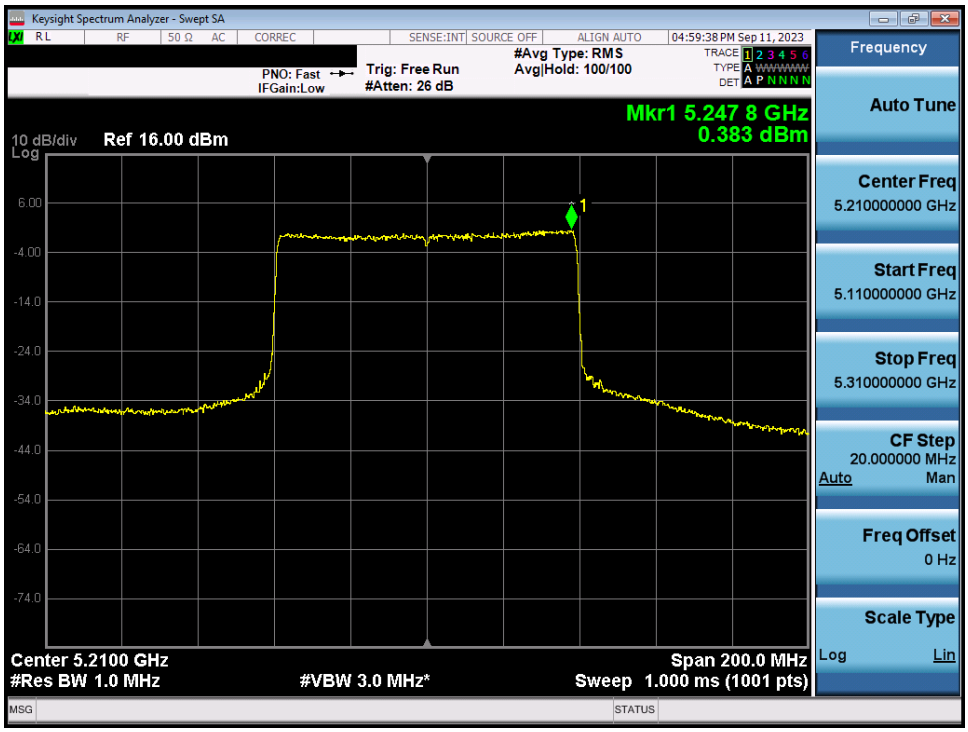
Plot 7-127. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11n (UNII Band 1) – Ch. 46)



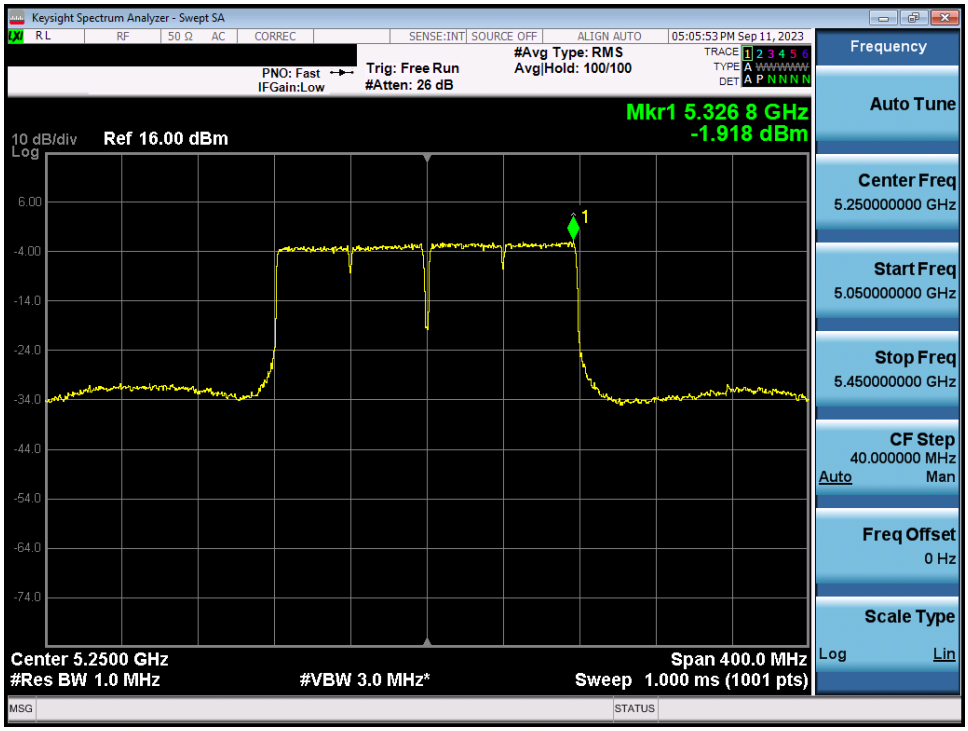
Plot 7-128. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802. 11ax/be (UNII Band 1) – Ch. 46)



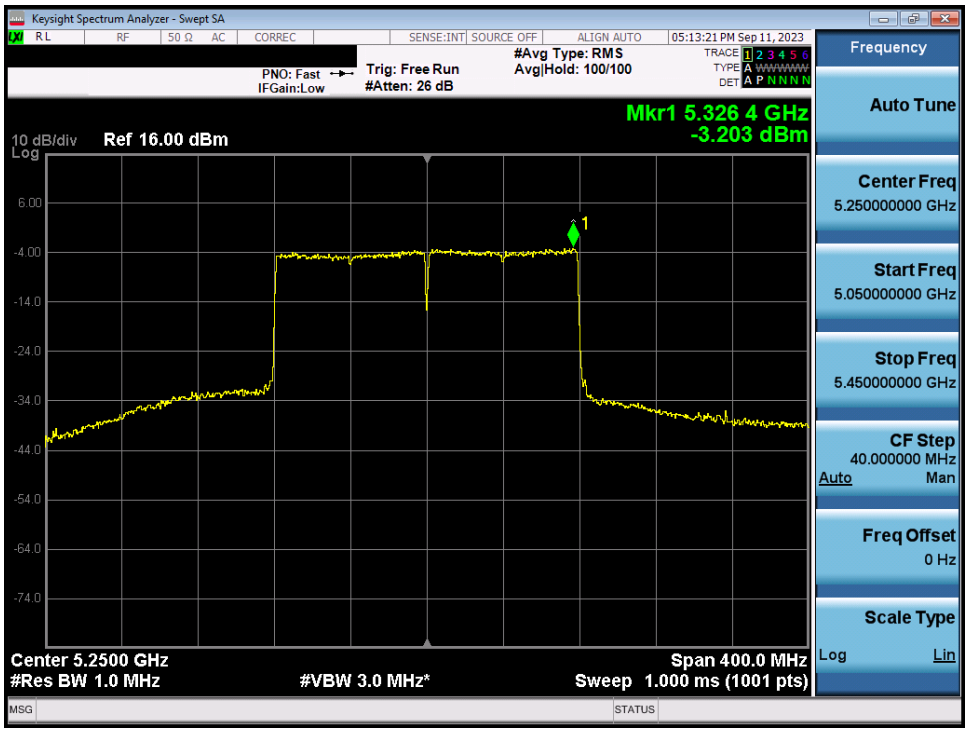
Plot 7-129. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)



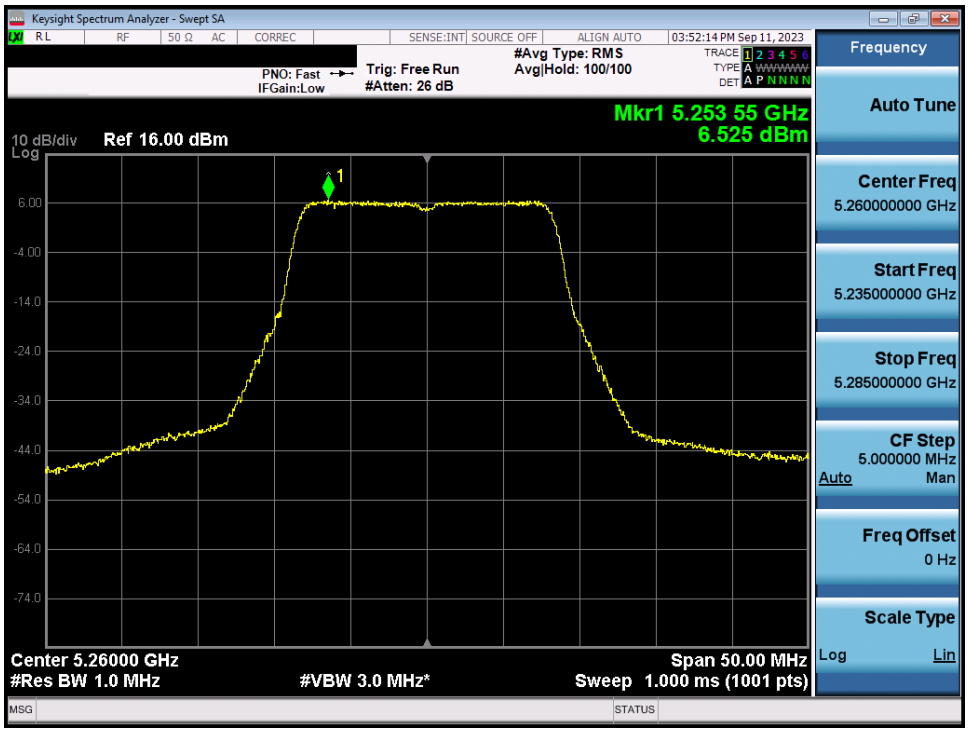
Plot 7-130. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802. 11ax/be (UNII Band 1) – Ch. 42)



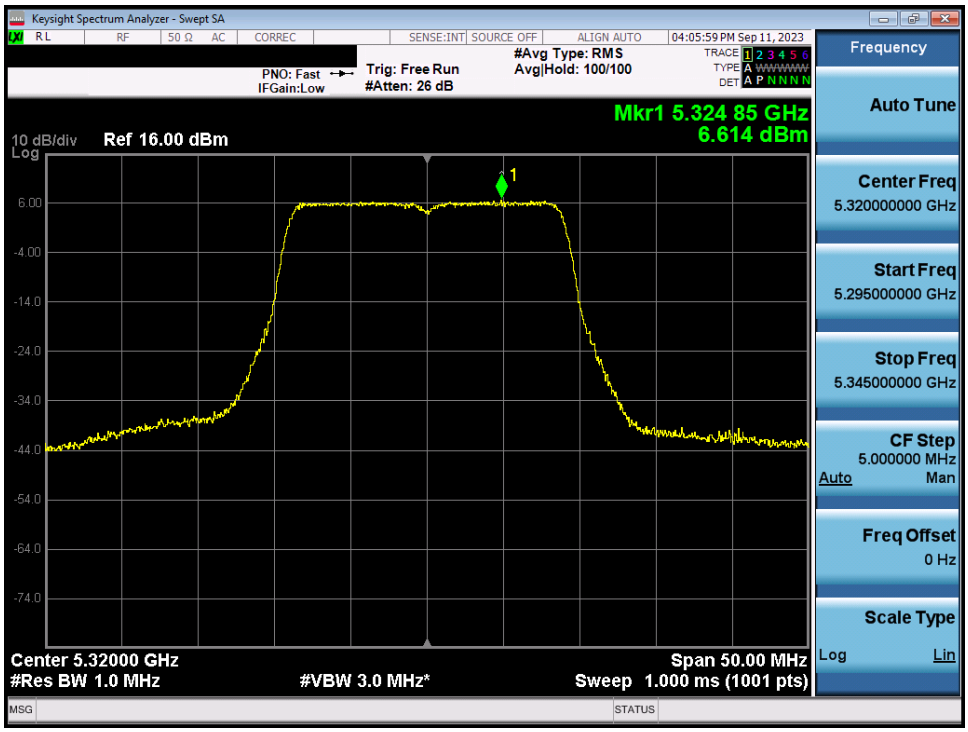
Plot 7-131. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11ac (UNII Band 1/2A) – Ch. 50)



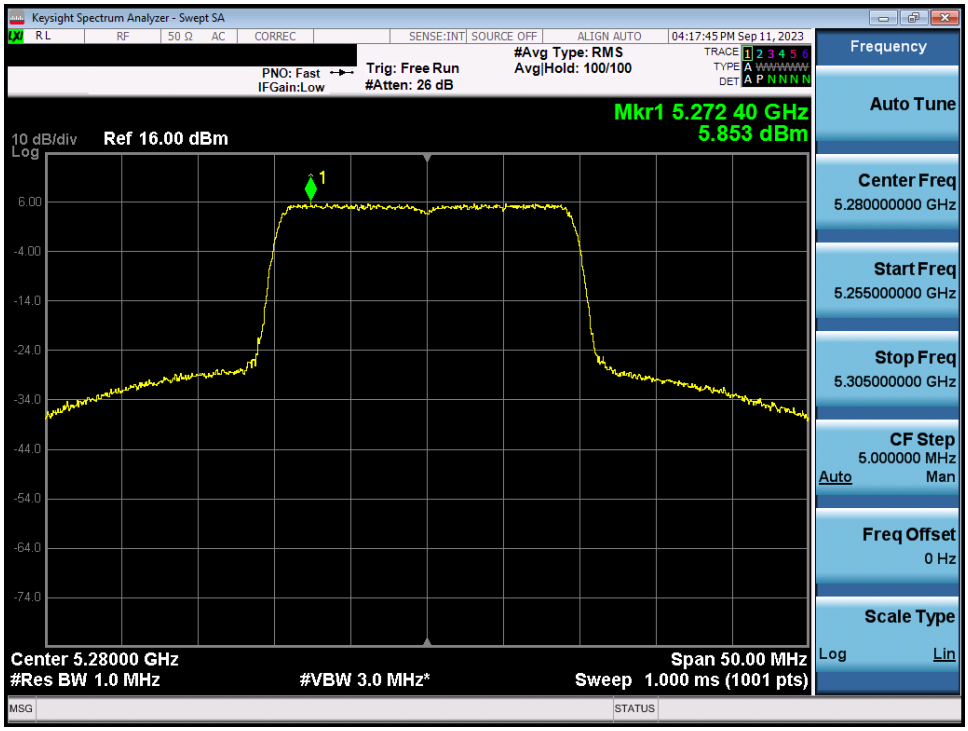
Plot 7-132. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802. 11ax/be (UNII Band 1/2A) – Ch. 50)



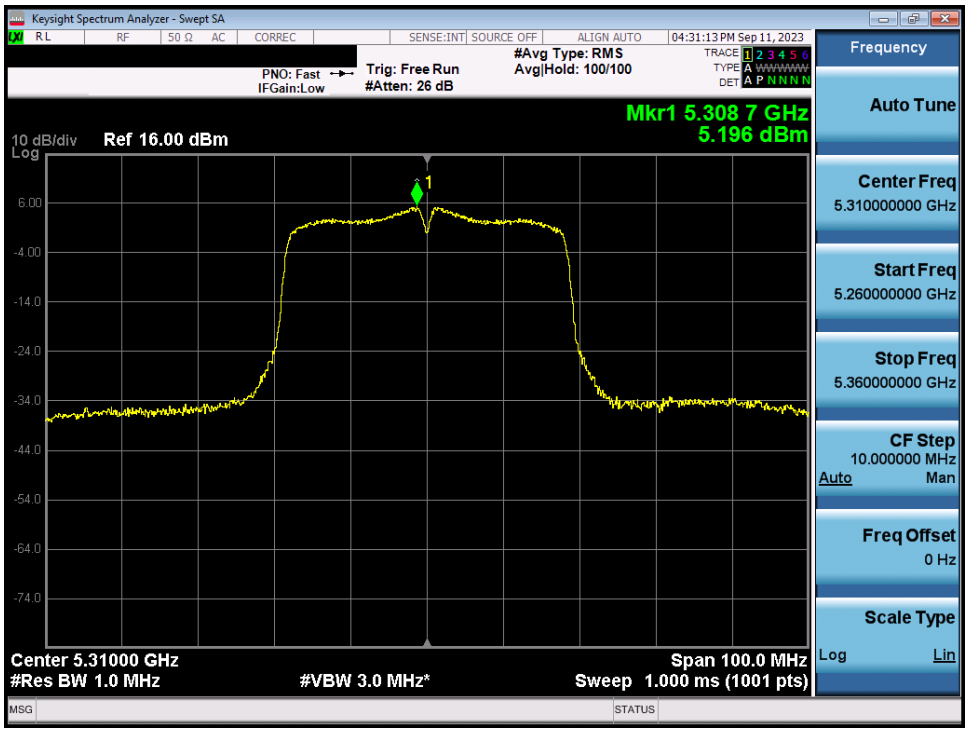
Plot 7-133. Power Spectral Density Plot MIMO ANT2 (802.11a (UNII Band 2A) – Ch. 52)



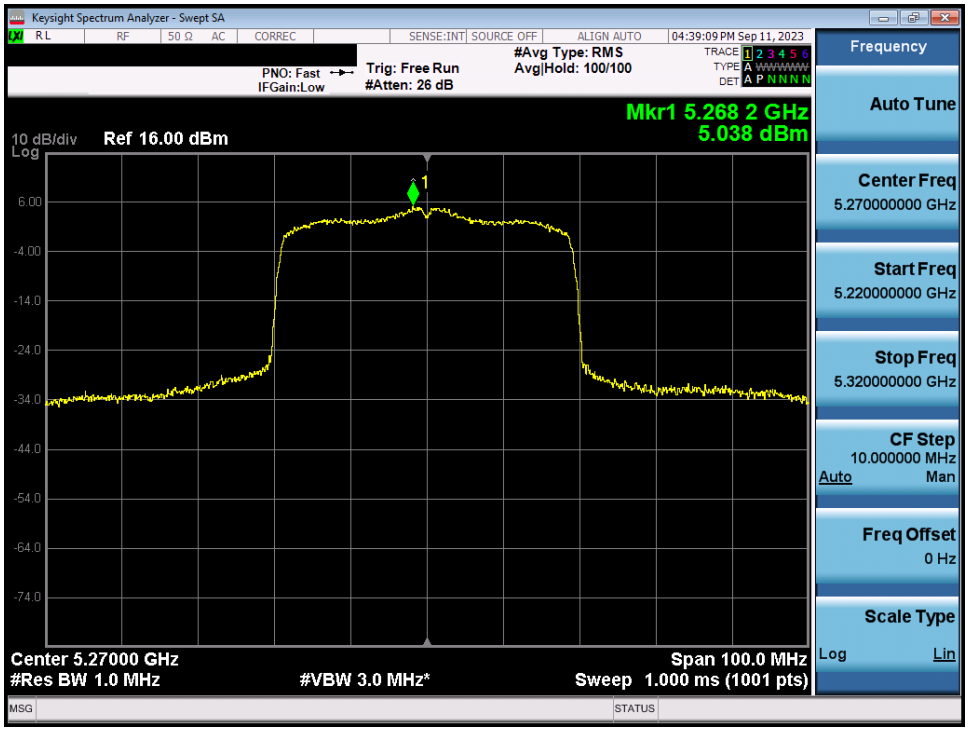
Plot 7-134. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11n (UNII Band 2A) – Ch. 64)



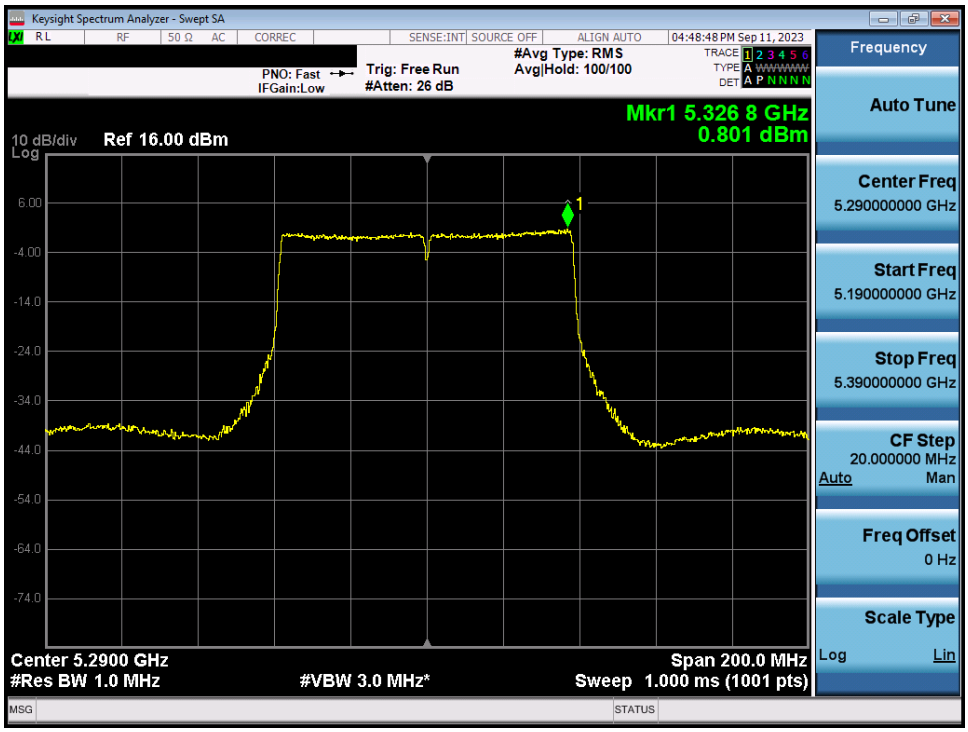
Plot 7-135. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11ax/be (UNII Band 2A) – Ch. 56)



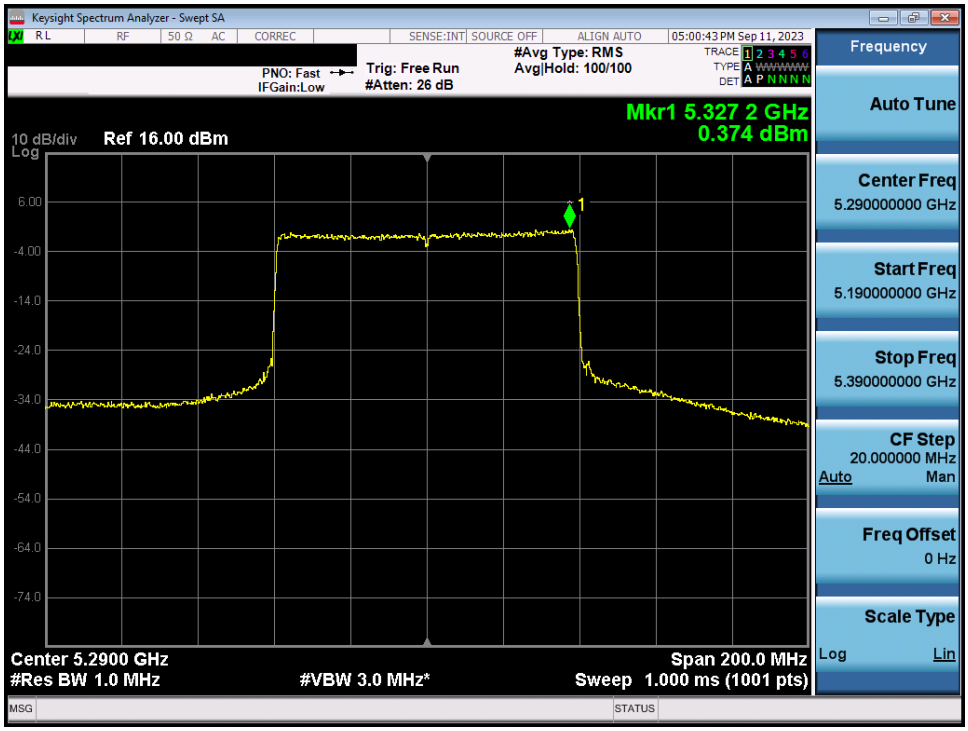
Plot 7-136. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11n (UNII Band 2A) – Ch. 62)



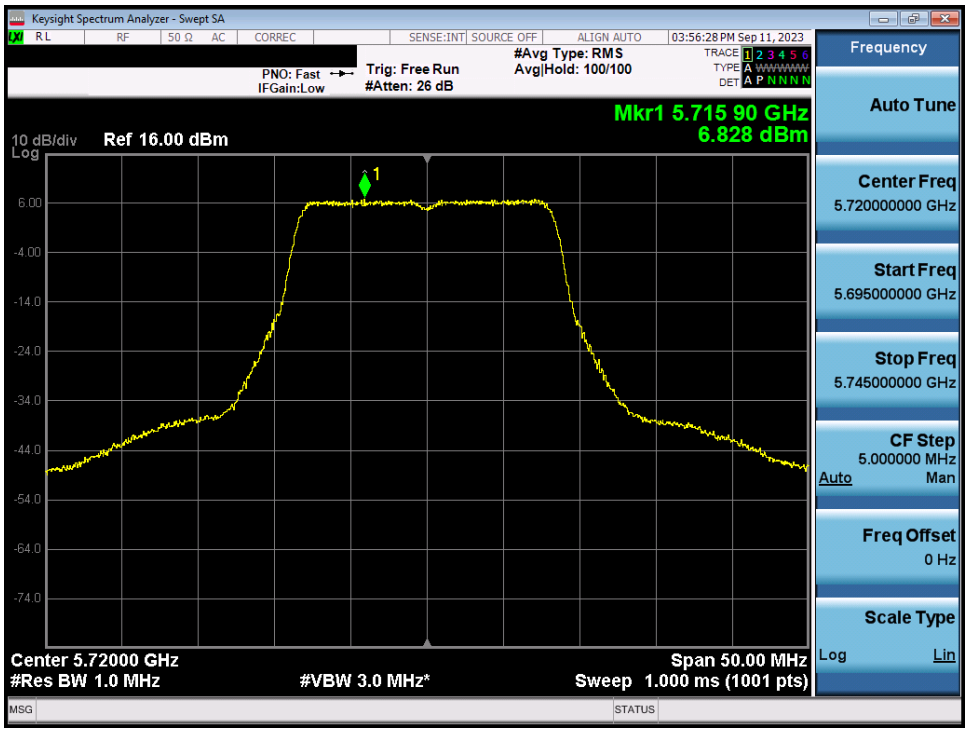
Plot 7-137. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11ax/be (UNII Band 2A) – Ch. 54)



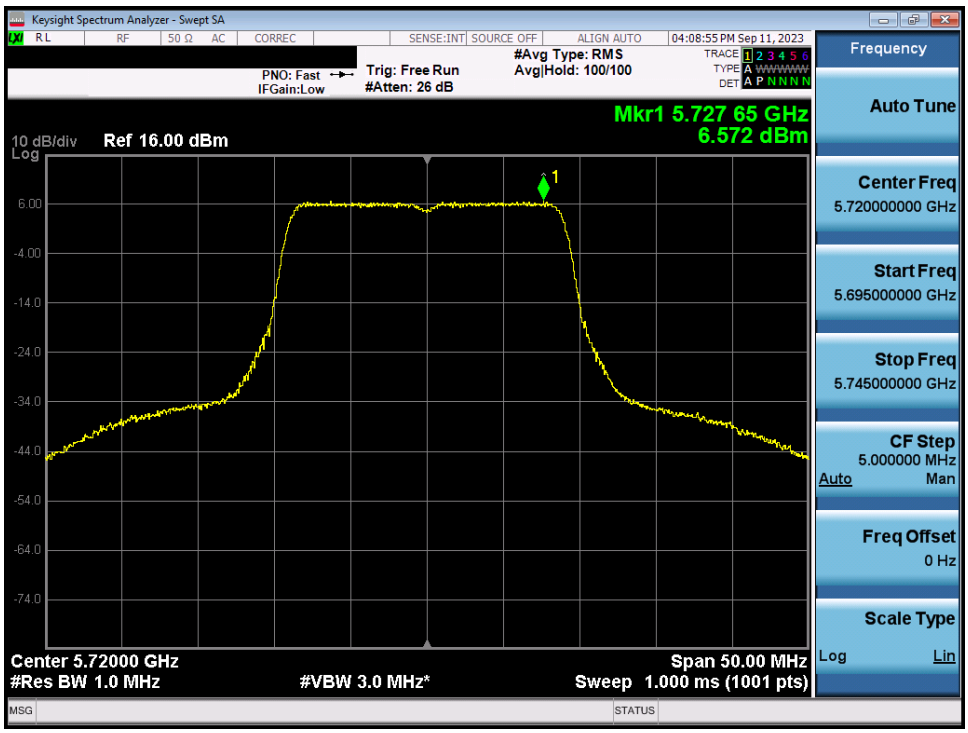
Plot 7-138. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ac (UNII Band 2A) – Ch. 58)



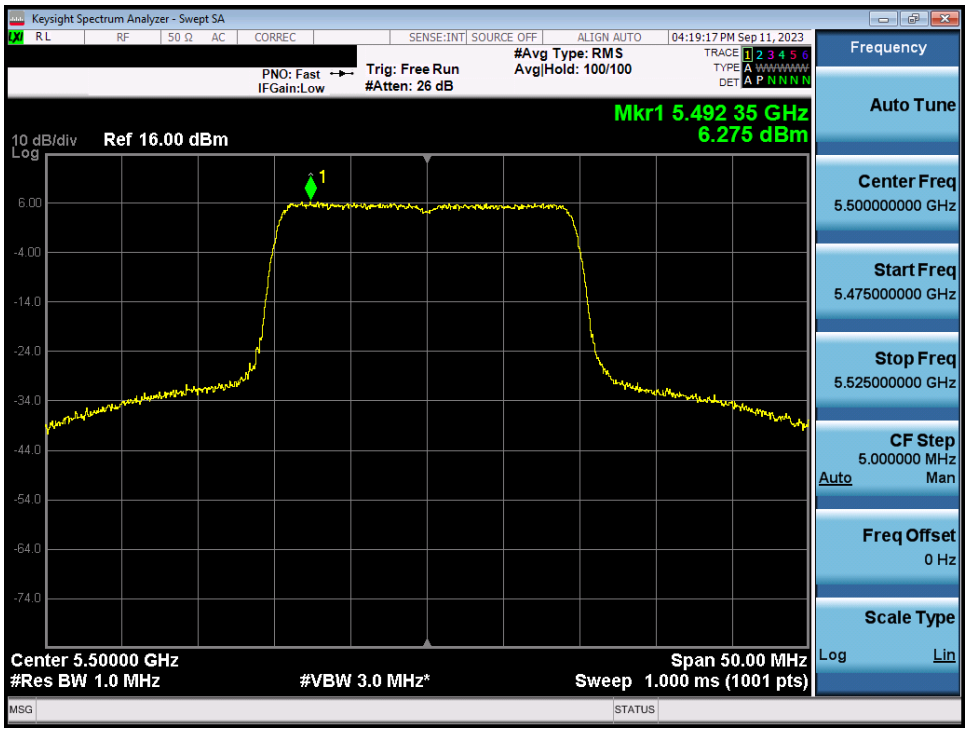
Plot 7-139. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ax/be (UNII Band 2A) – Ch. 58)



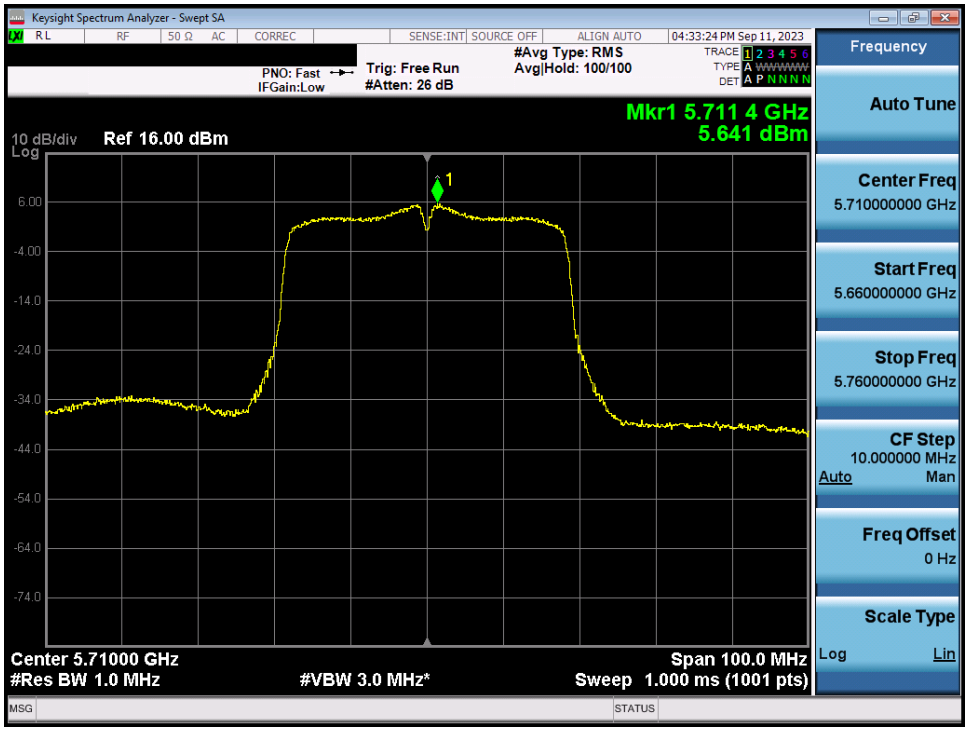
Plot 7-140. Power Spectral Density Plot MIMO ANT2 (802.11a (UNII Band 2C) – Ch. 144)



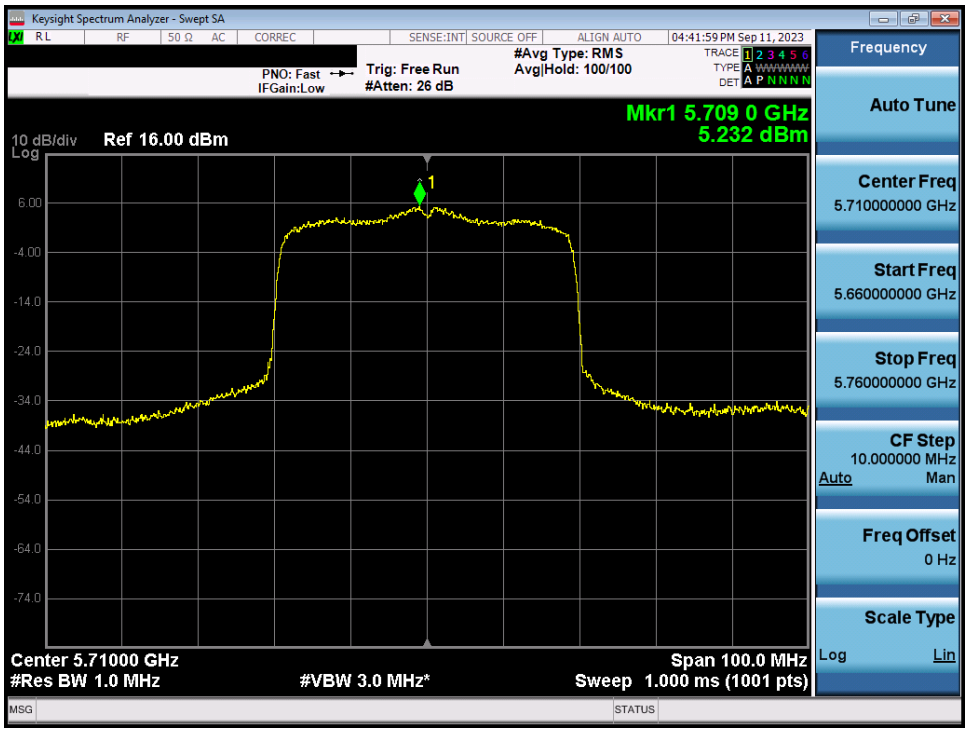
Plot 7-141. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11n (UNII Band 2C) – Ch. 144)



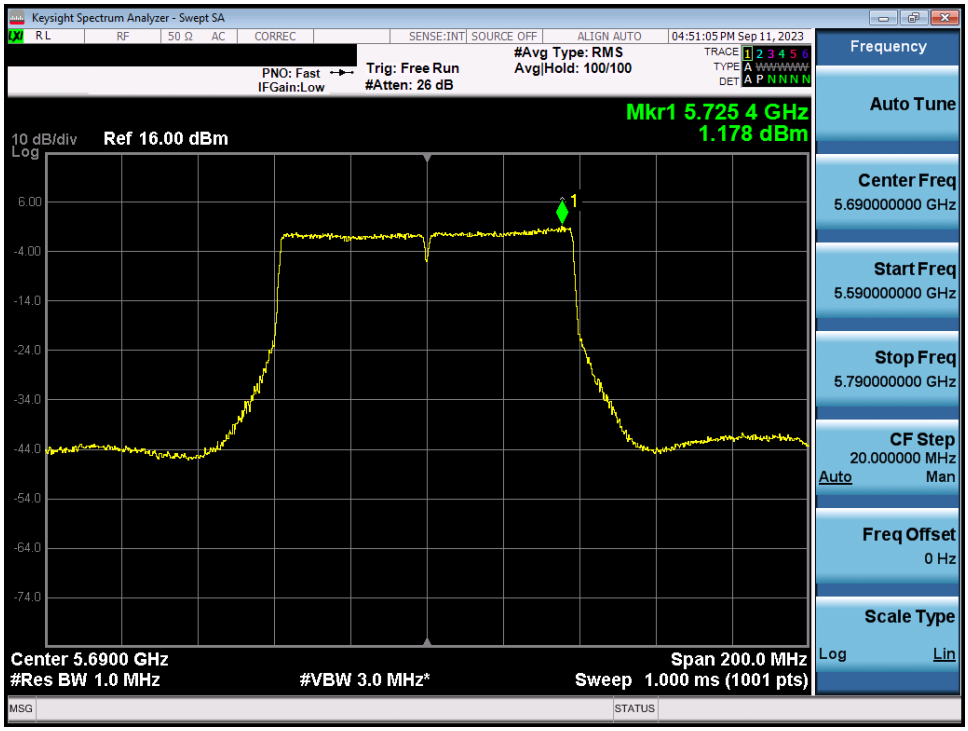
Plot 7-142. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11ax/be (UNII Band 2C) – Ch. 100)



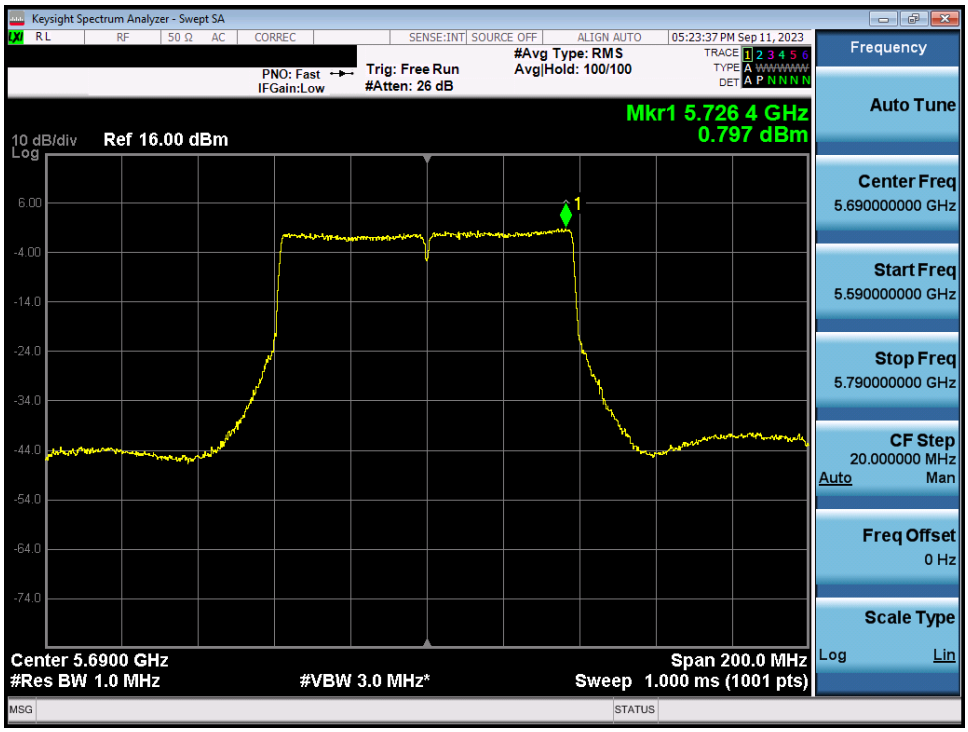
Plot 7-143. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11n (UNII Band 2C) – Ch. 142)



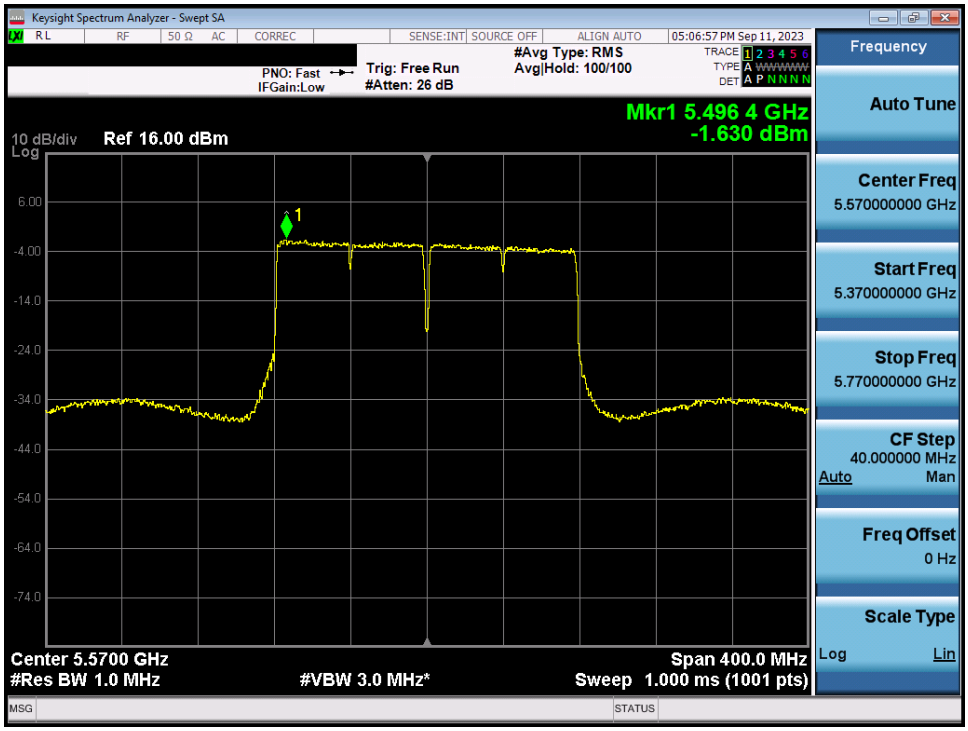
Plot 7-144. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11ax/be (UNII Band 2C) – Ch. 142)



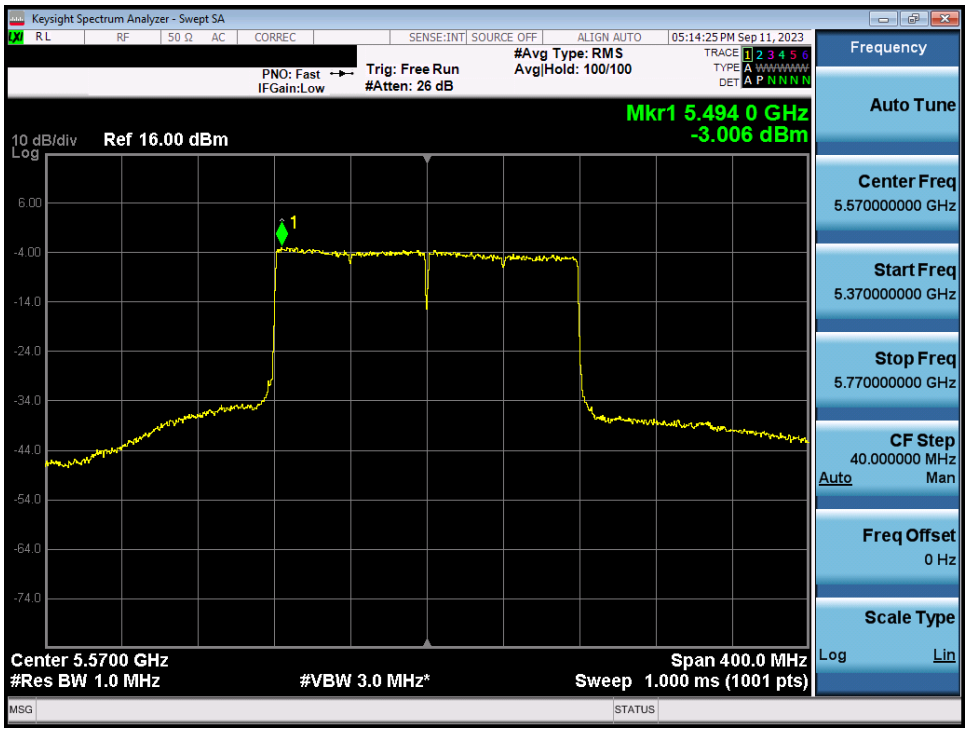
Plot 7-145. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ac (UNII Band 2C) – Ch. 138)



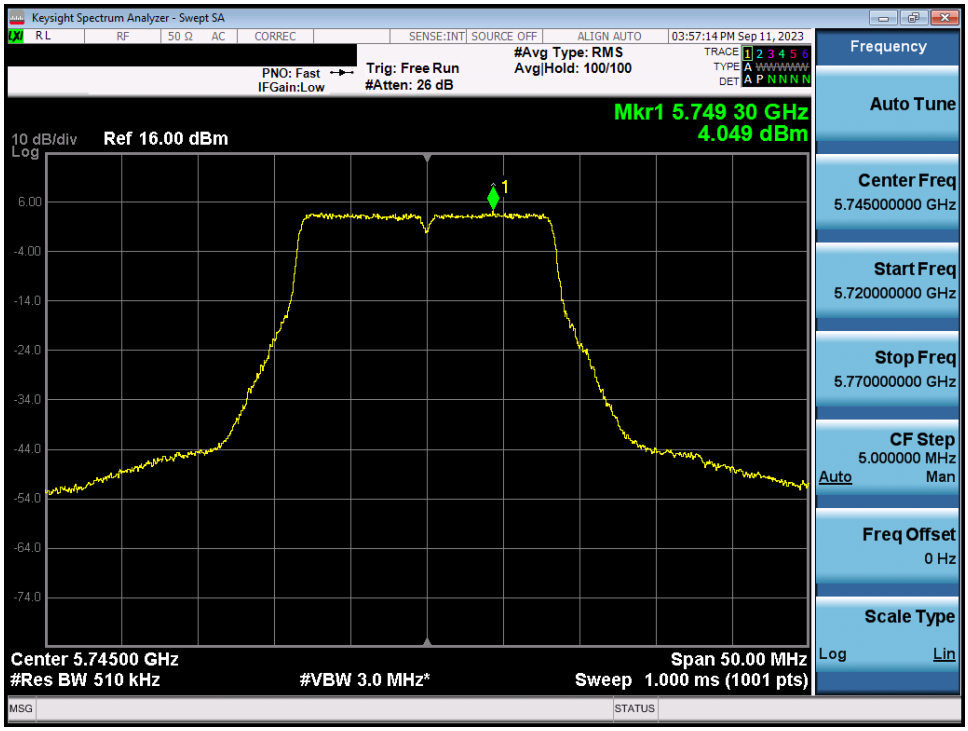
Plot 7-146. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ax/be (UNII Band 2C) – Ch. 138)



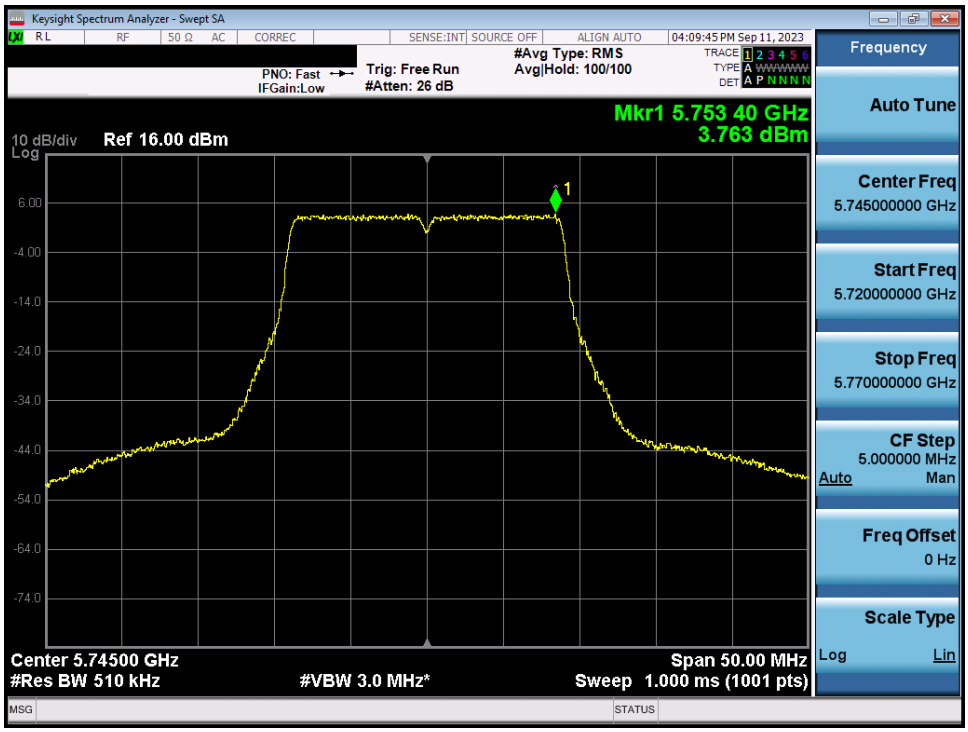
Plot 7-147. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11ac (UNII Band 2C) – Ch. 114)



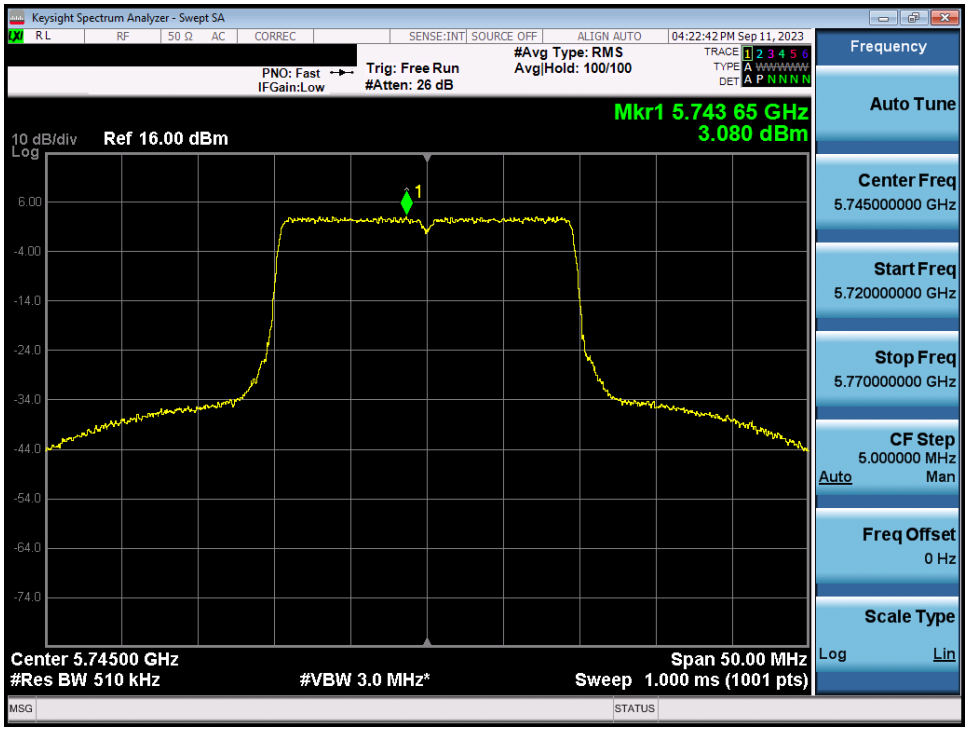
Plot 7-148. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11ax/be (UNII Band 2C) – Ch. 114)



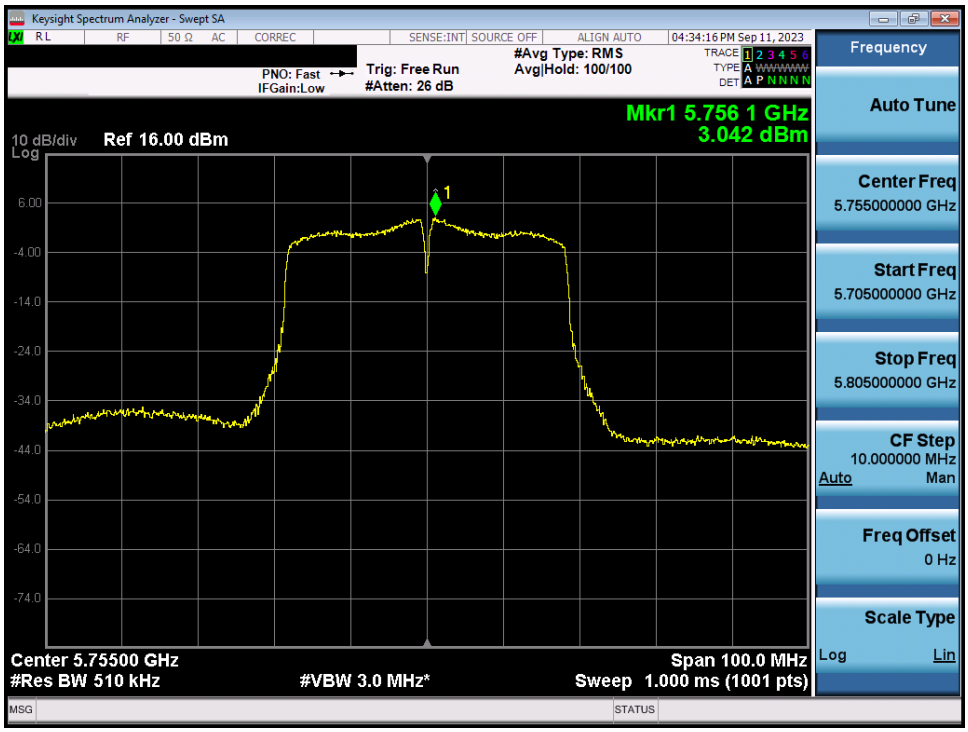
Plot 7-149. Power Spectral Density Plot MIMO ANT2 (802.11a (UNII Band 3) – Ch. 149)



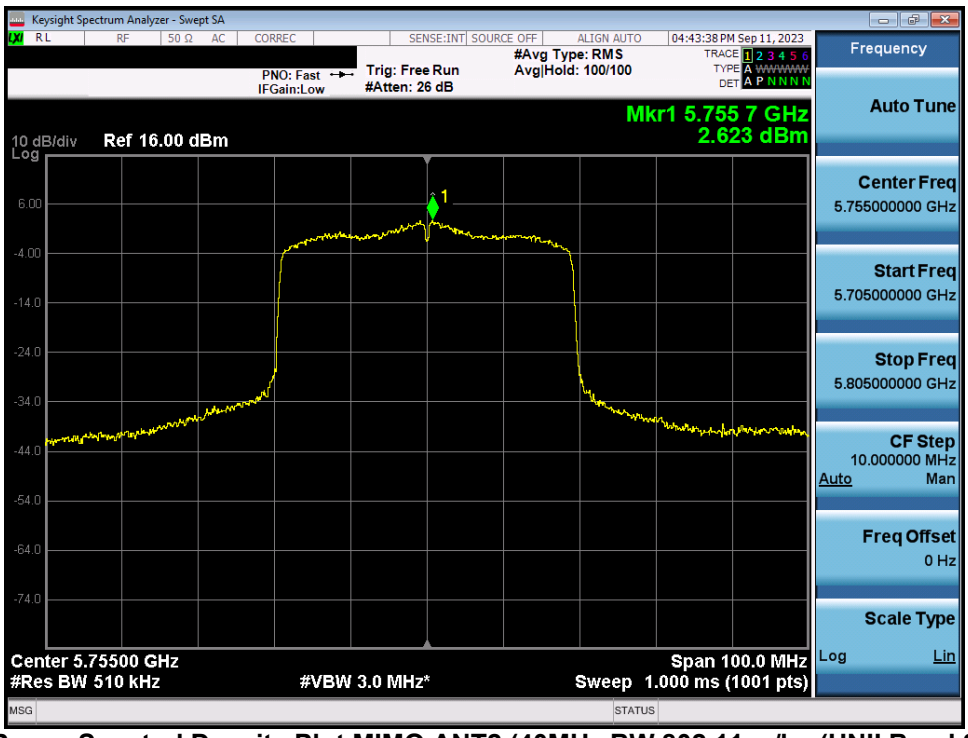
Plot 7-150. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11n (UNII Band 3) – Ch. 149)



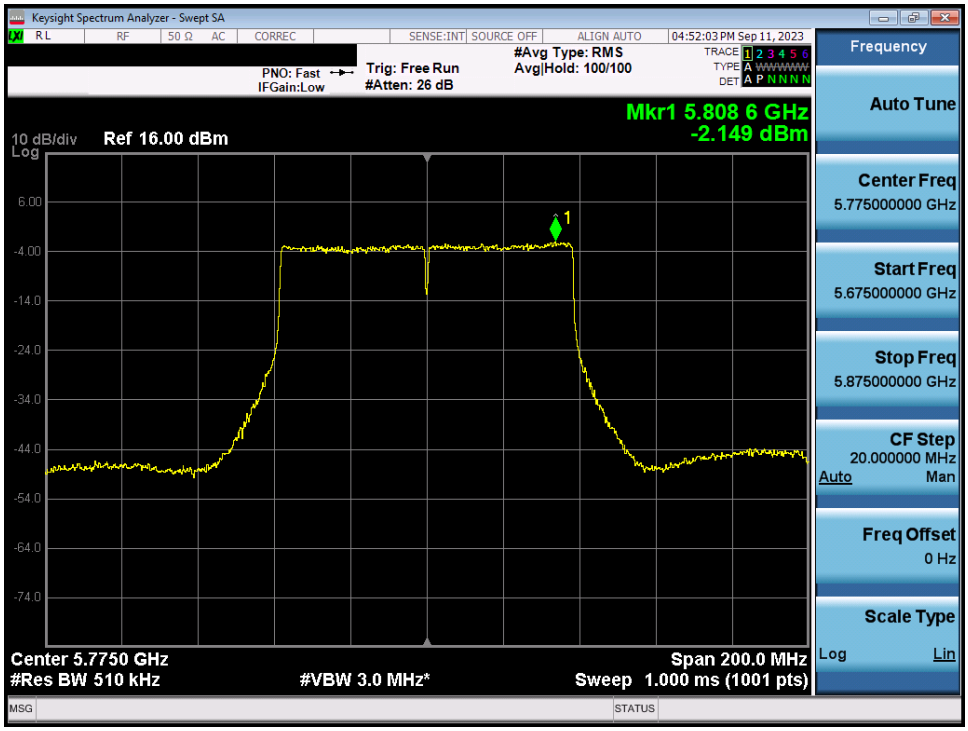
Plot 7-151. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11ax/be (UNII Band 3) – Ch. 149)



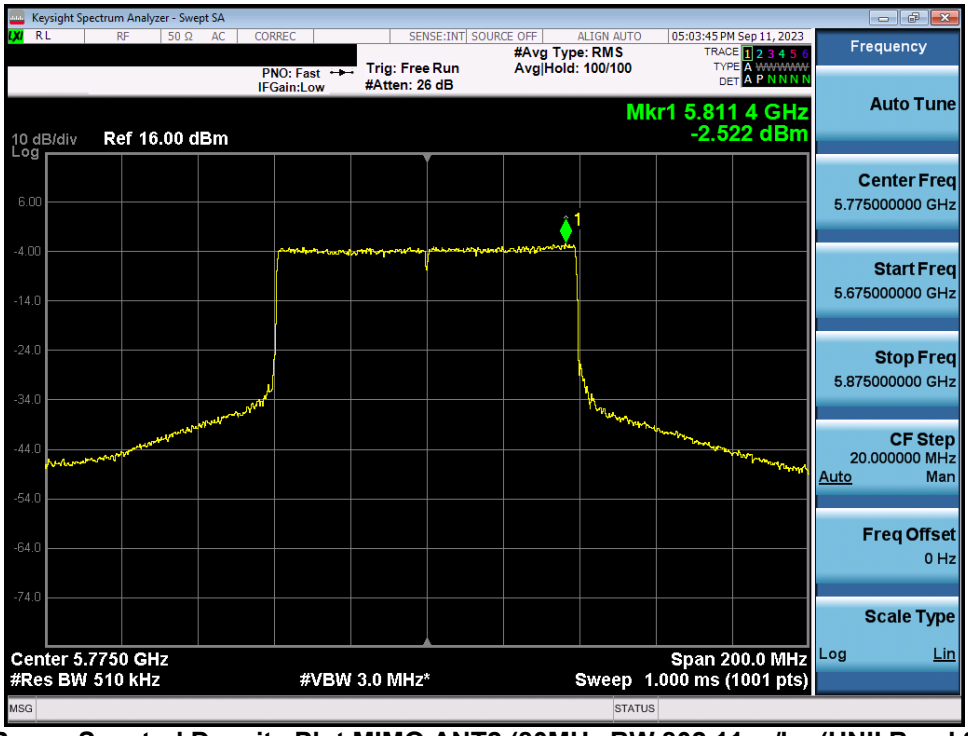
Plot 7-152. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11n (UNII Band 3) – Ch. 151)



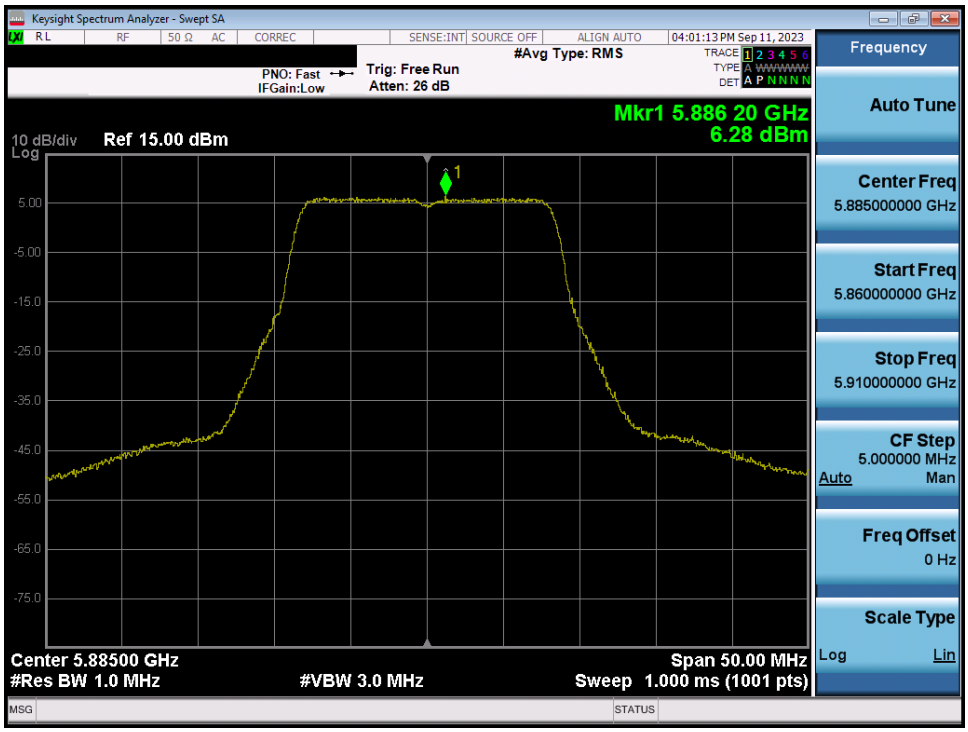
Plot 7-153. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11ax/be (UNII Band 3) – Ch. 151)



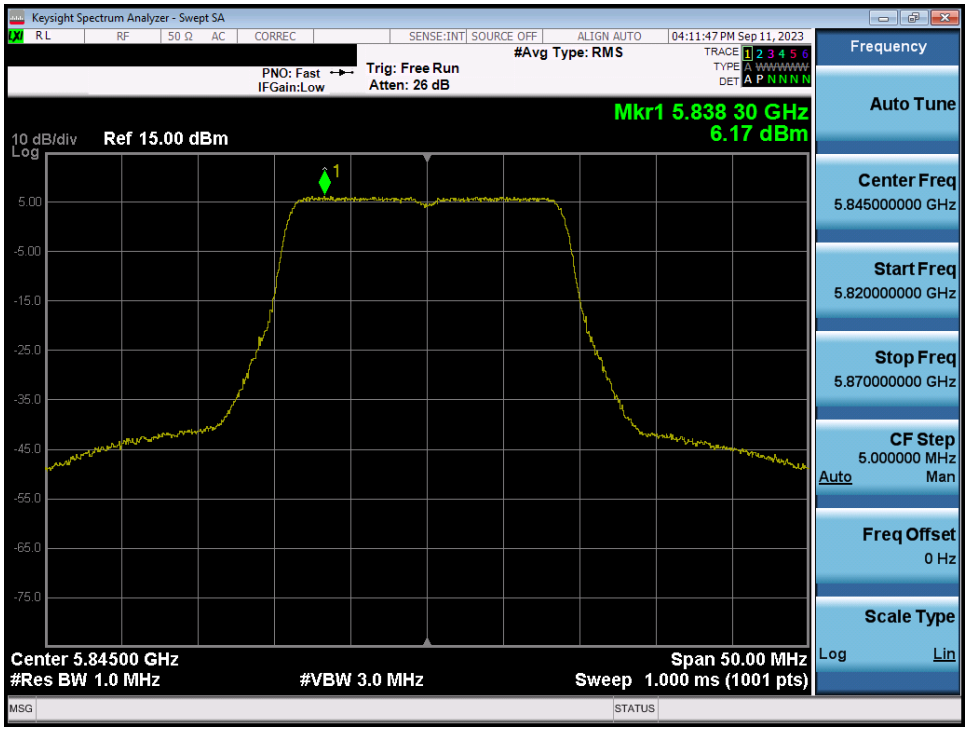
Plot 7-154. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ac (UNII Band 3) – Ch. 155)



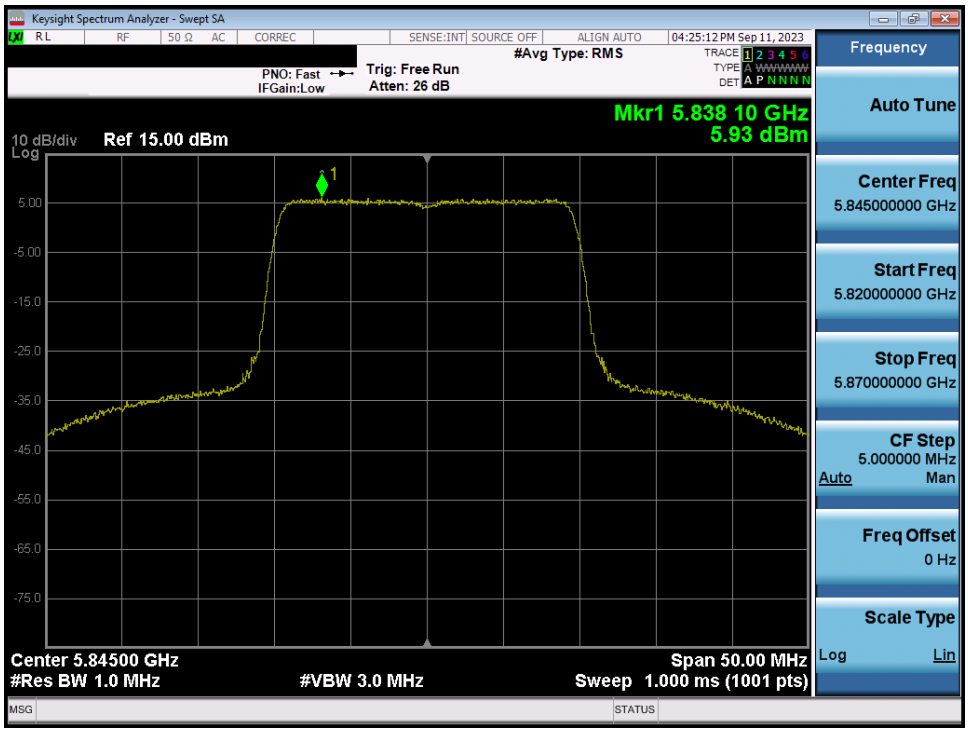
Plot 7-155. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ax/be (UNII Band 3) – Ch. 155)



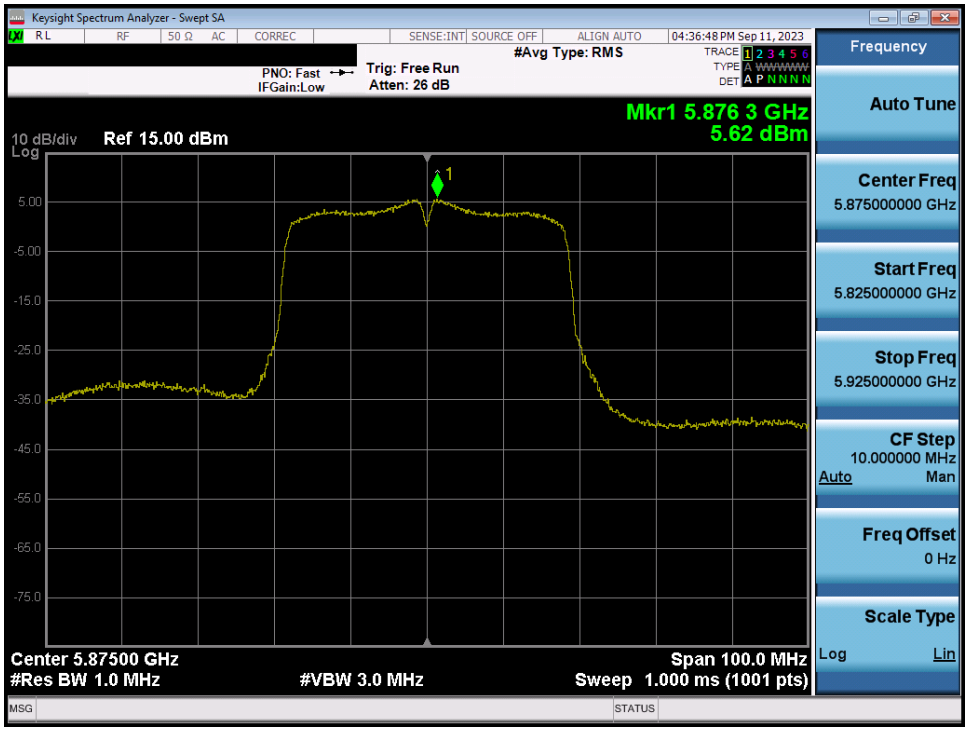
Plot 7-156. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11a (UNII Band 4) – Ch. 177)



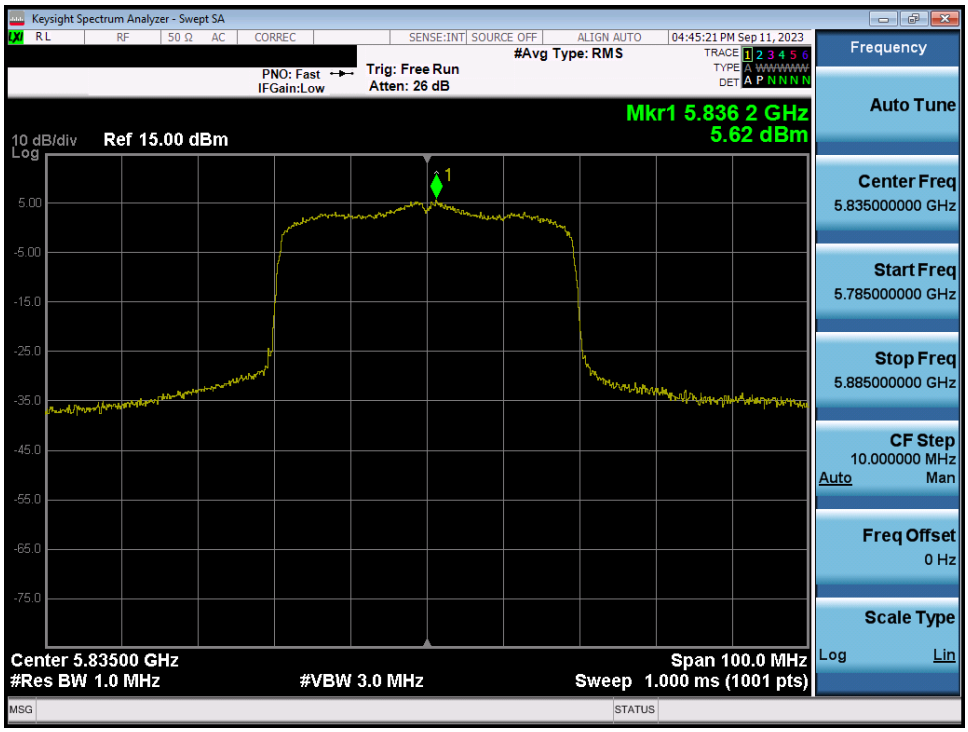
Plot 7-157. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11n (UNII Band 3/4) – Ch. 169)



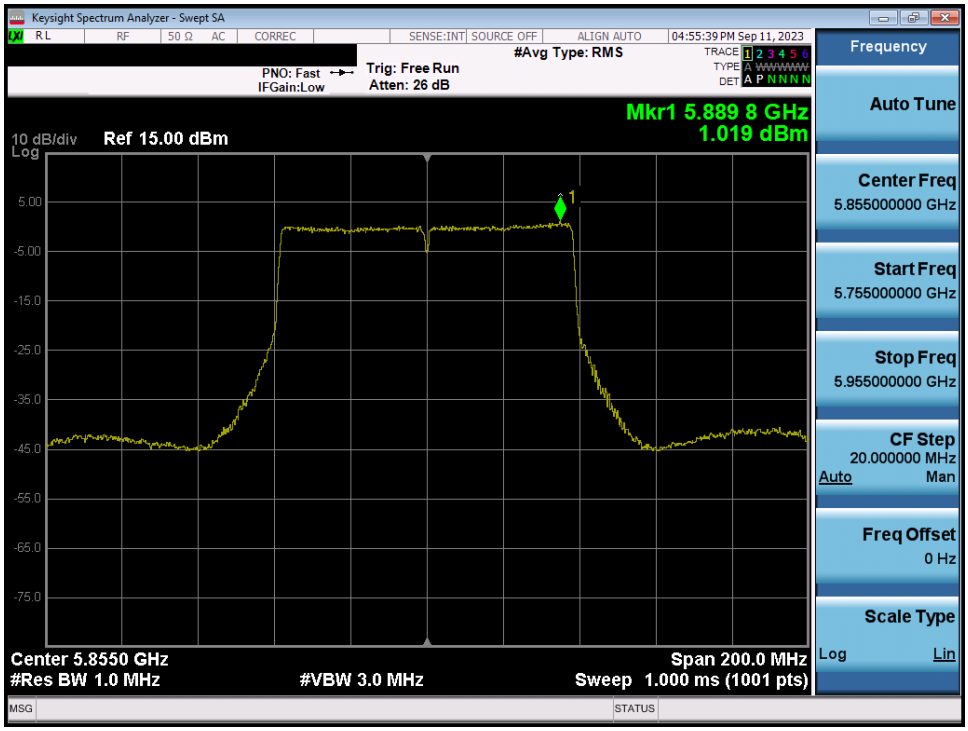
Plot 7-158. Power Spectral Density Plot MIMO ANT2 (20MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 169)



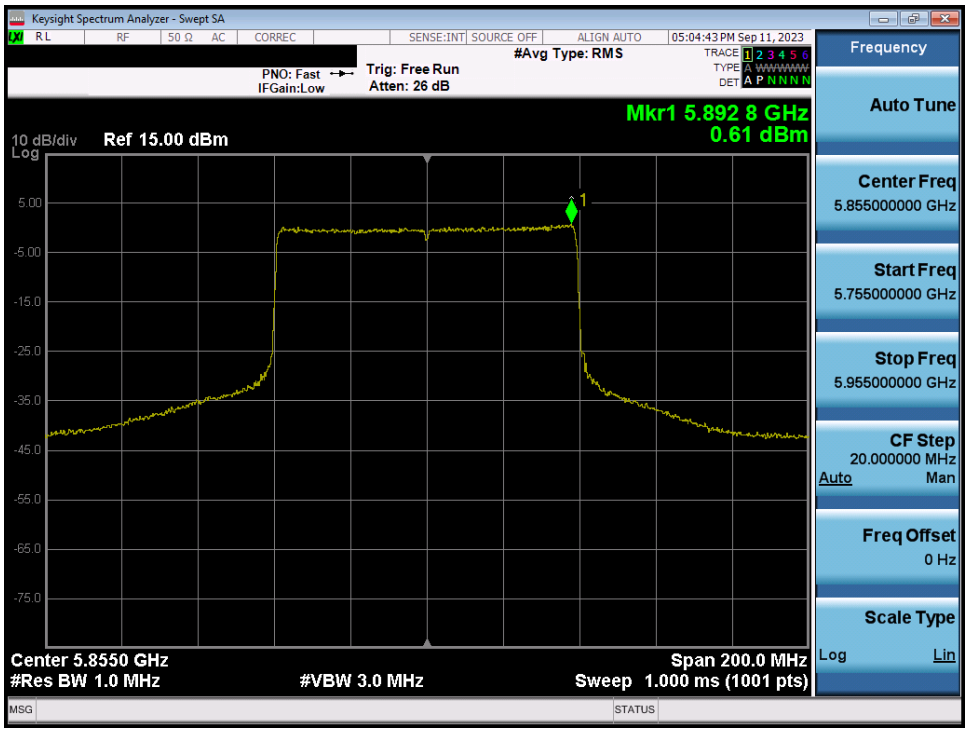
Plot 7-159. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11n (UNII Band 4) – Ch. 175)



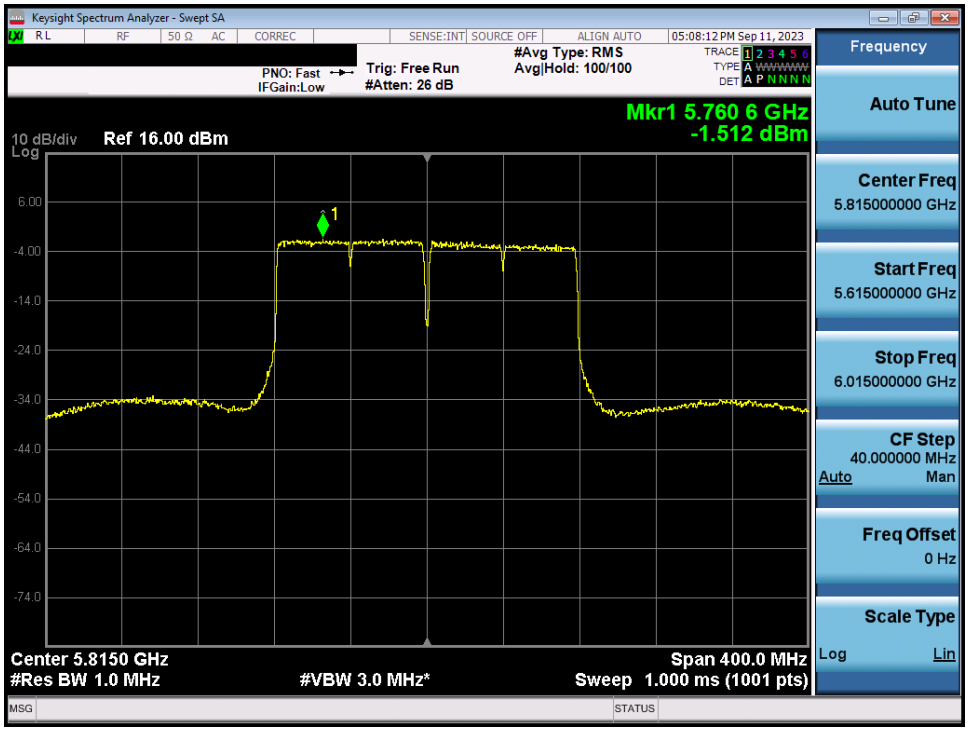
Plot 7-160. Power Spectral Density Plot MIMO ANT2 (40MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 167)



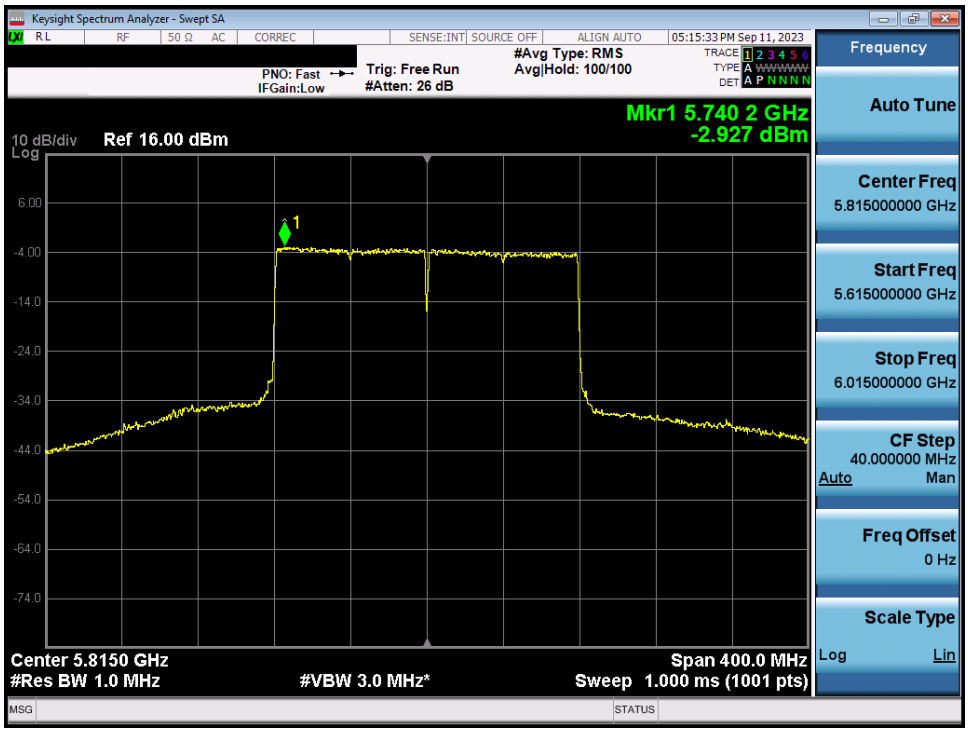
Plot 7-161. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ac (UNII Band 3/4) – Ch. 171)



Plot 7-162. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 171)



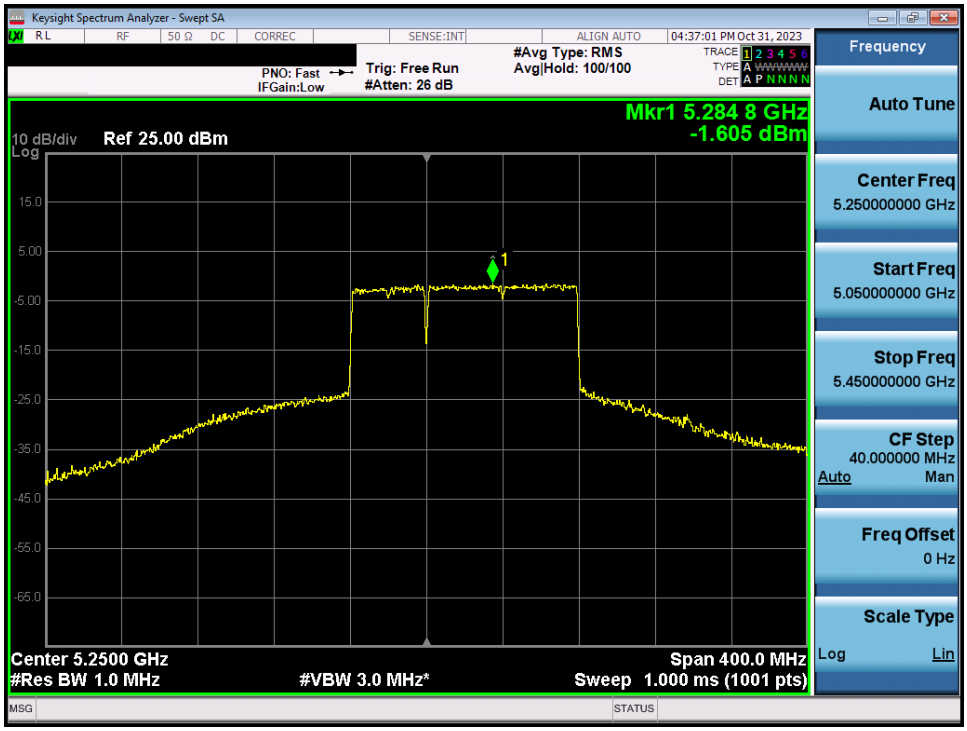
Plot 7-163. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11ac (UNII Band 3/4) – Ch. 163)



Plot 7-164. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11ax/be (UNII Band 3/4) – Ch. 163)

7.5.3 MIMO Antenna-1 Power Spectral Density Measurements - Punctured

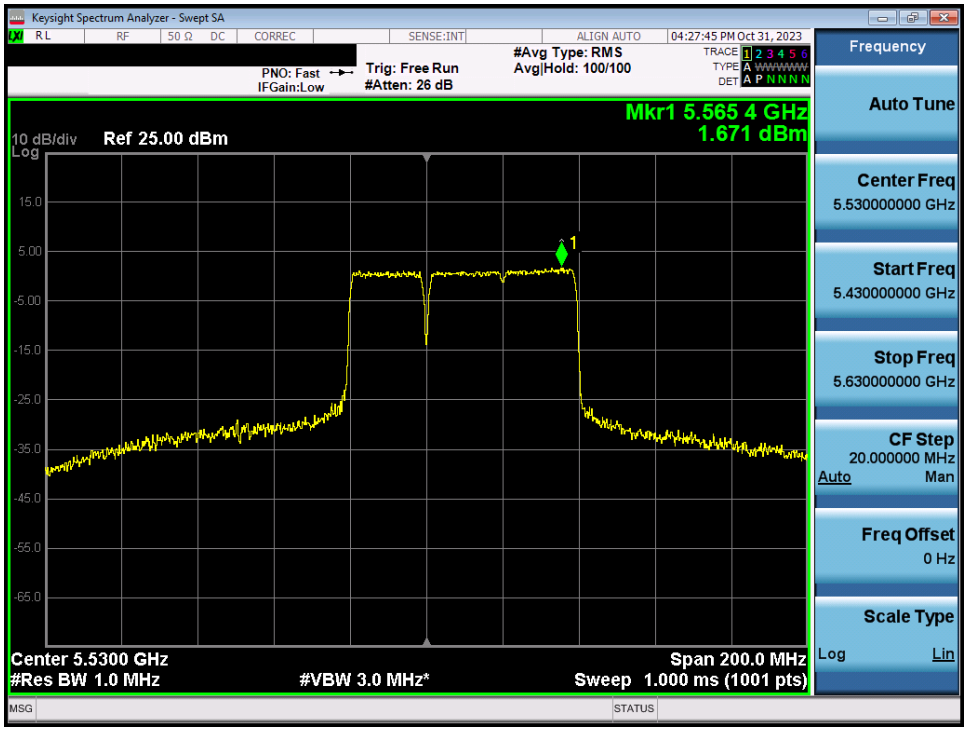
Plot 7-165. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11be (UNII Band 1) – Ch. 42)



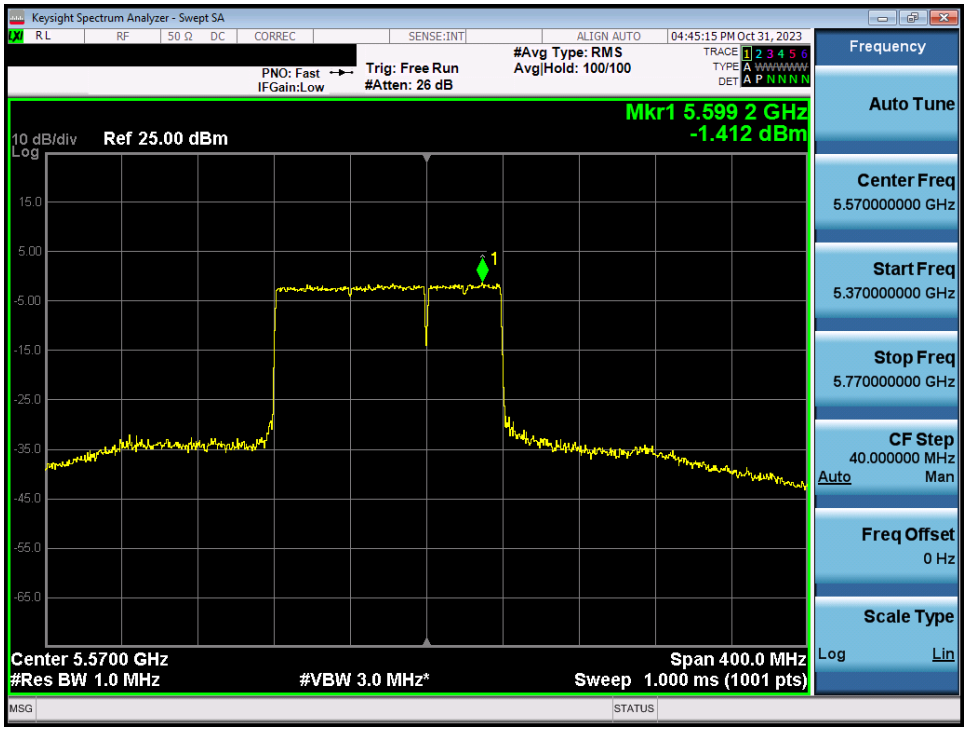
Plot 7-166. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11be (UNII Band 1/2A) – Ch. 50)

Plot 7-167. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11be (UNII Band 1/2A) – Ch. 50)

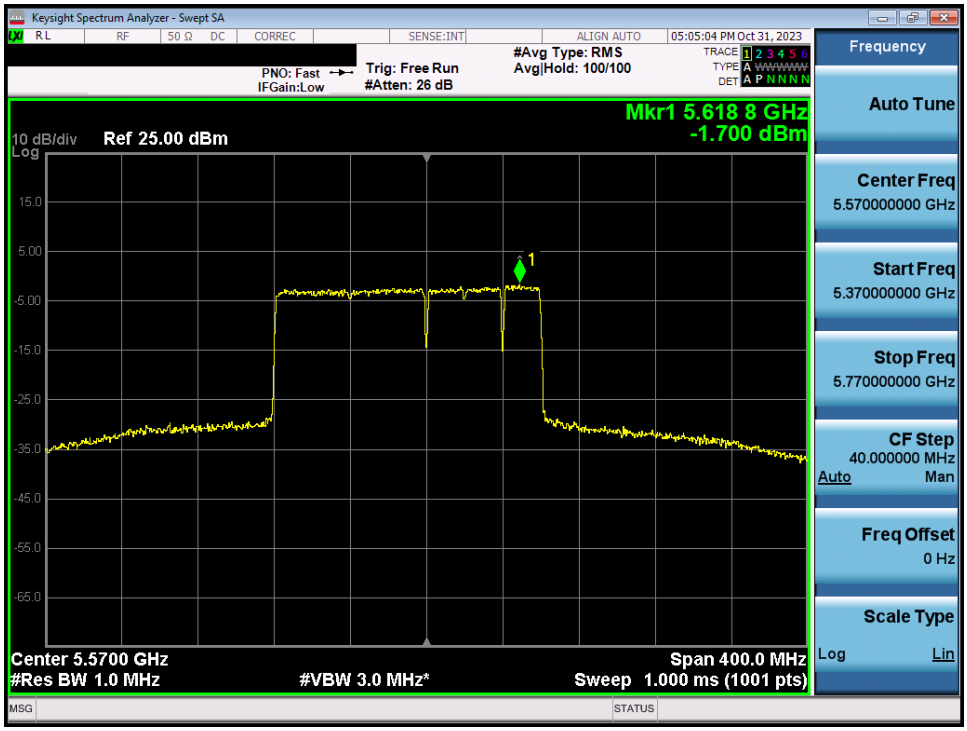
Plot 7-168. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11be (UNII Band 2A) – Ch. 58)



Plot 7-169. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11be (UNII Band 2C) – Ch. 106)

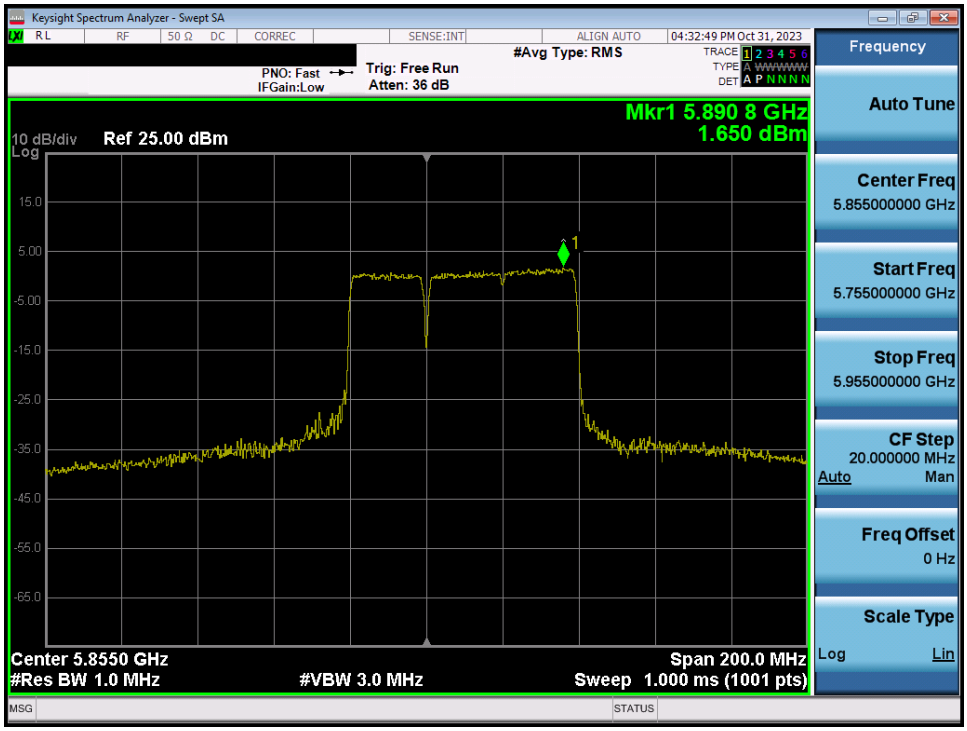


Plot 7-170. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11be (UNII Band 2C) – Ch. 114)



Plot 7-171. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11be (UNII Band 2C) – Ch. 114)

Plot 7-172. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11be (UNII Band 3) – Ch. 155)



Plot 7-173. Power Spectral Density Plot MIMO ANT1 (80MHz BW 802.11be (UNII Band 3/4) – Ch. 171)

Plot 7-174. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11be (UNII Band 3/4) – Ch. 163)

Plot 7-175. Power Spectral Density Plot MIMO ANT1 (160MHz BW 802.11be (UNII Band 3/4) – Ch. 163)

7.5.4 MIMO Antenna-2 Power Spectral Density Measurements - Punctured

Plot 7-176. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11be (UNII Band 1) – Ch. 42)

Plot 7-177. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11be (UNII Band 1/2A) – Ch. 50)

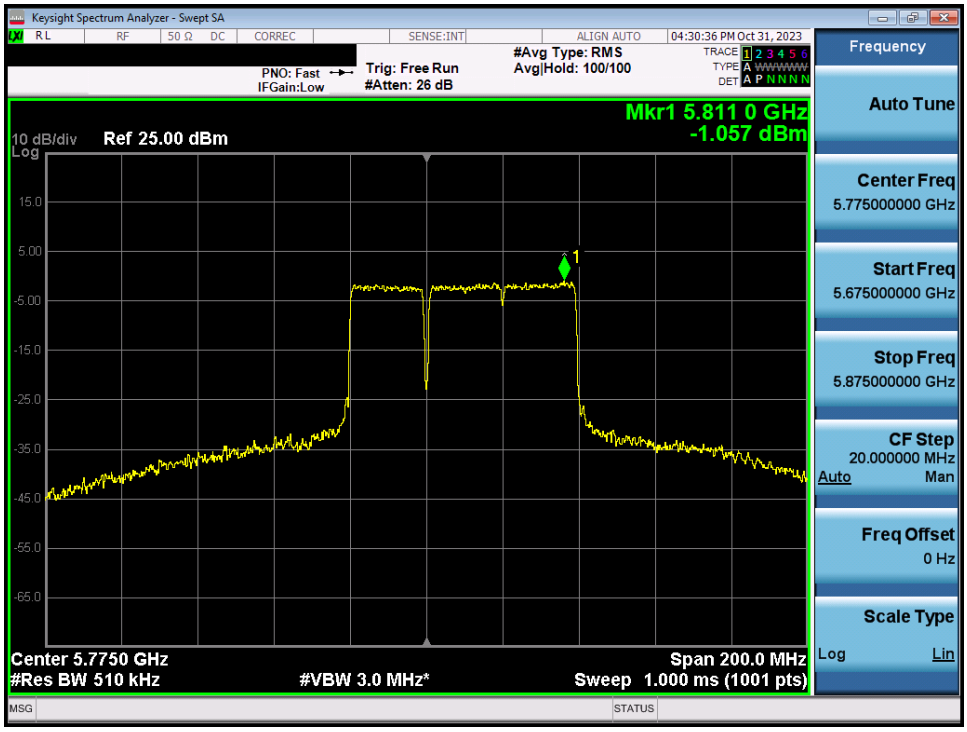
Plot 7-178. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11be (UNII Band 1/2A) – Ch. 50)

Plot 7-179. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11be (UNII Band 2A) – Ch. 58)

Plot 7-180. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11be (UNII Band 2C) – Ch. 106)

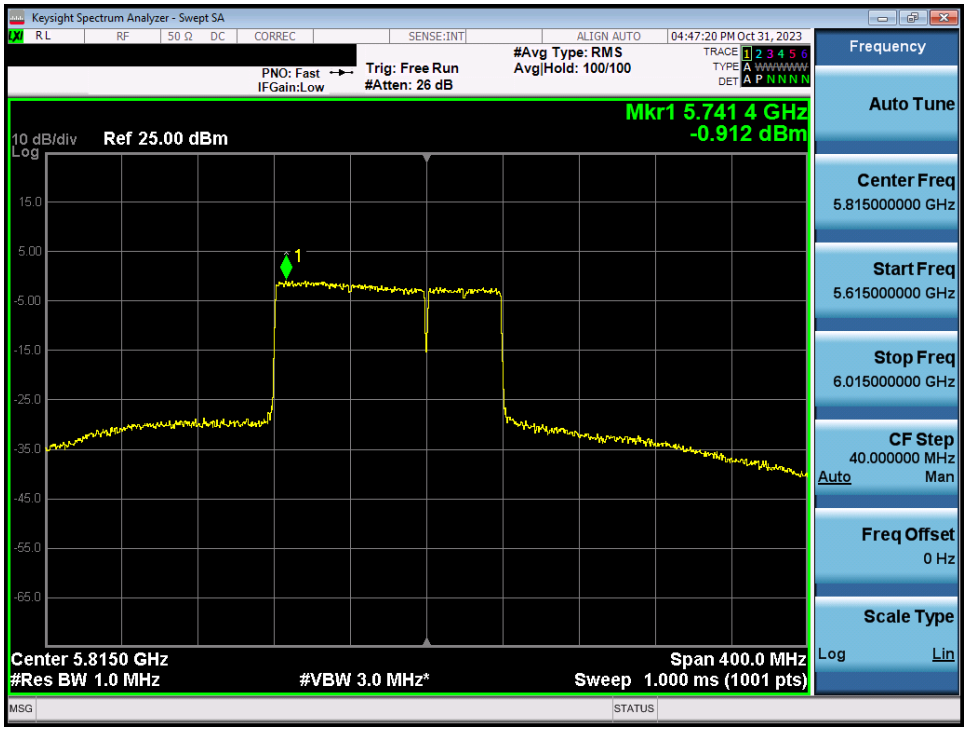
Plot 7-181. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11be (UNII Band 2C) – Ch. 114)

Plot 7-182. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11be (UNII Band 2C) – Ch. 114)

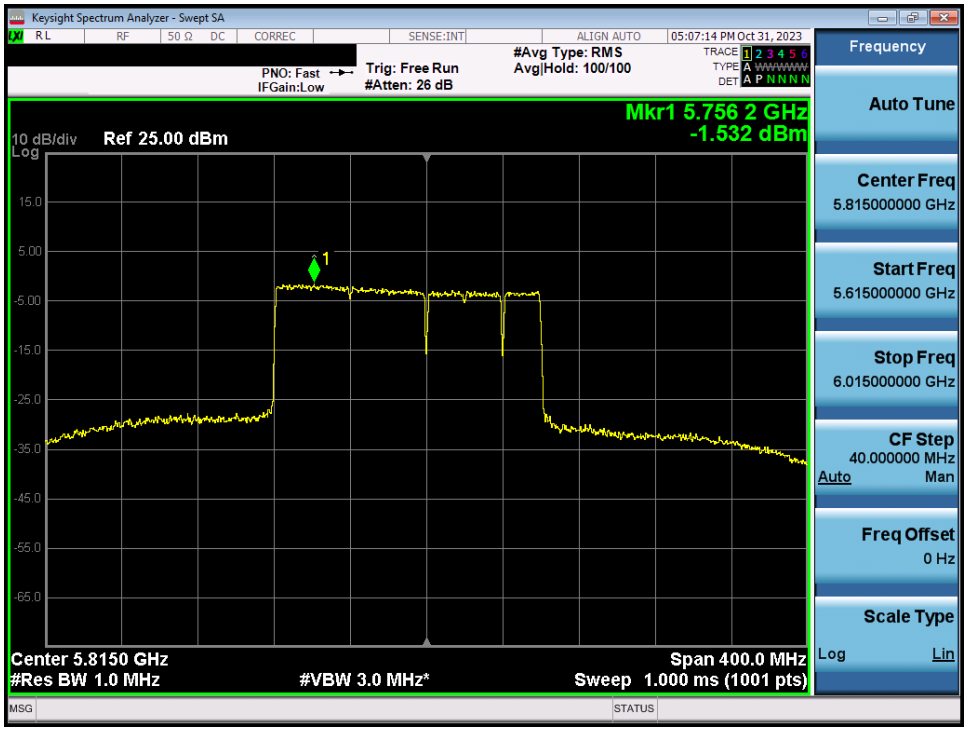


Plot 7-183. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11be (UNII Band 3) – Ch. 155)

Plot 7-184. Power Spectral Density Plot MIMO ANT2 (80MHz BW 802.11be (UNII Band 3/4) – Ch. 171)



Plot 7-185. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11be (UNII Band 3/4) – Ch. 163)



Plot 7-186. Power Spectral Density Plot MIMO ANT2 (160MHz BW 802.11be (UNII Band 3/4) – Ch. 163)

Note:

Per ANSI C63.10-2013 Section 14.3.2.2 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.

Sample MIMO Calculation:

At 5845MHz in 802.11n (20MHz BW) mode, the average conducted power spectral density was measured to be 6.07dBm for Antenna 1 and 6.17dBm for Antenna 2.

Antenna 1 + Antenna 2 = MIMO

(6.07 dBm + 6.17dBm) = (4.050mW + 4.136 mW) = 8.186mW = 9.13 dBm

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

At 5845MHz in 802.11n (20MHz BW) mode, the average MIMO power density was calculated to be 9.13 dBm with directional gain of 0.57 dBi.

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

9.13 dBm + 0.57 dBi = 9.70 dBm

7.6 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, 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 5.15-5.25 GHz and 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of −27 dBm/MHz.

For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an EIRP of −27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

For transmitters operating in the 5.850 – 5.895 GHz band: all emissions at or above 5.895GHz shall not exceed an e.i.r.p. of -5dBm/MHz and shall decrease linearly up to an e.i.r.p. of -27dBm/MHz at or above 5.925GHz, and all emissions below 5.725 GHz shall not exceed an e.i.r.p. of -27dBm/MHz at 5.65 GHz increasing linearly to 10dBm/MHz at 5.7GHz and from 5.7GHz increasing linearly to a level of 15.6dMb/MHz at 5.72GHz, and from 5.72GHz increasing linearly to a level of 27dBm/MHz at 5.725GHz.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown in the table below per FCC §15.209 and RSS-Gen (8.9).

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

Table 7-31. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Sections 12.7.7.2, 12.7.6, 12.7.5 (Radiated Spurious Emissions)
ANSI C63.10-2013 – Section 12.7.4.4 (Band Edge Measurements)

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.

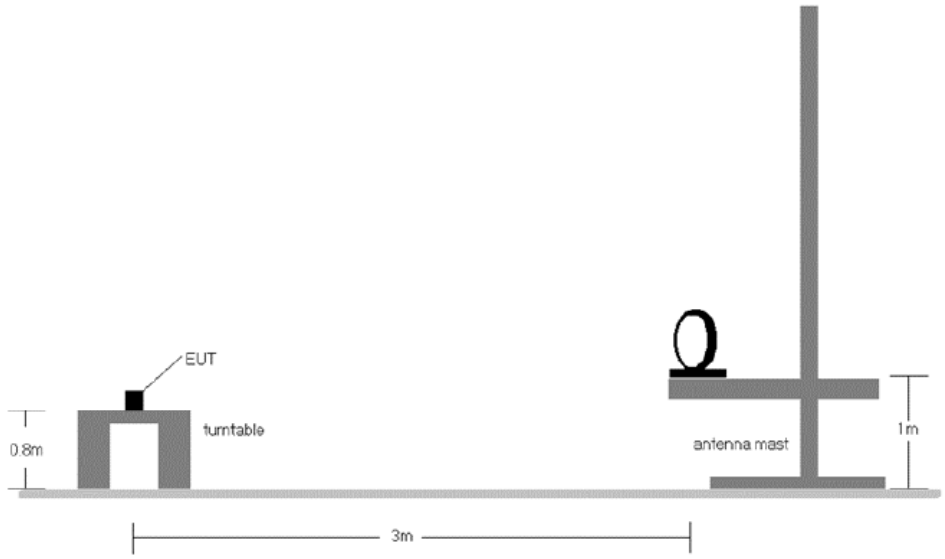


Figure 7-5. Radiated Test Setup < 30MHz

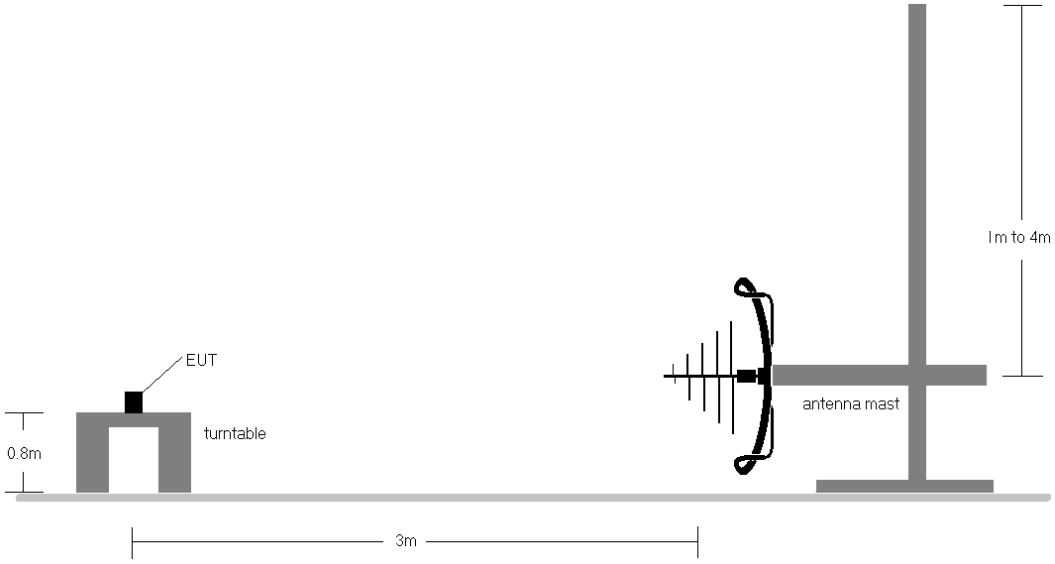


Figure 7-6. Radiated Test Setup < 1GHz

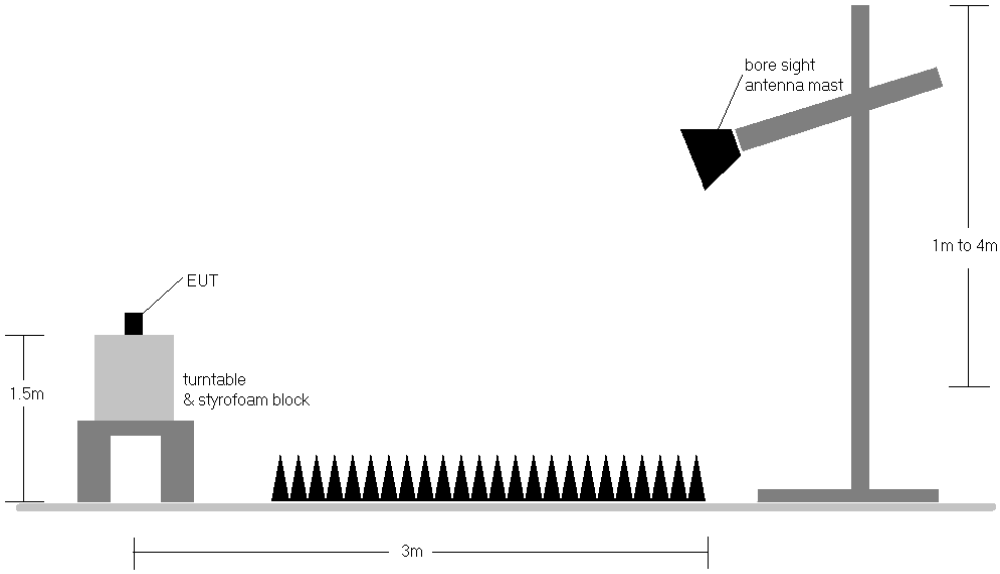


Figure 7-7. Radiated Test Setup > 1GHz

Test Notes

1. All spurious emissions lying in restricted bands specified in §15.205 are below the limits shown 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.
8. The "-" shown in the following RSE tables are used to denote a noise floor measurement.
9. In the case where a peak-detector measurement passed the given RMS limit it was determined sufficient to demonstrate compliance.
10. 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 Gai