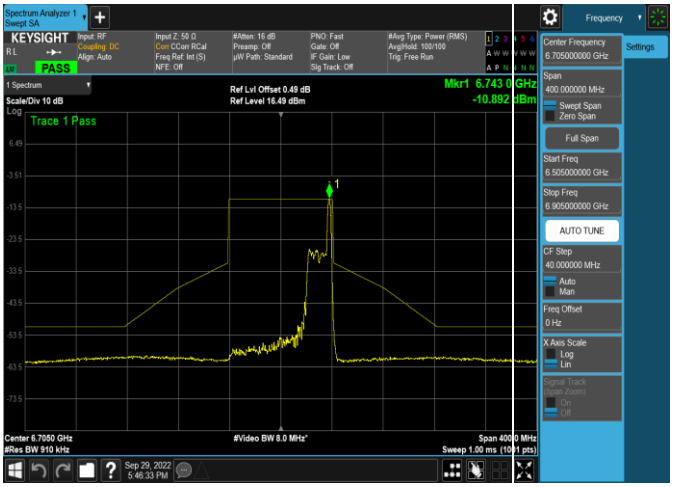
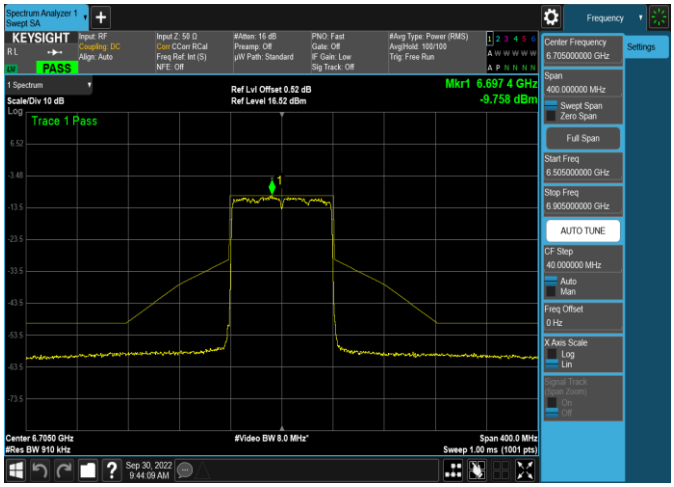
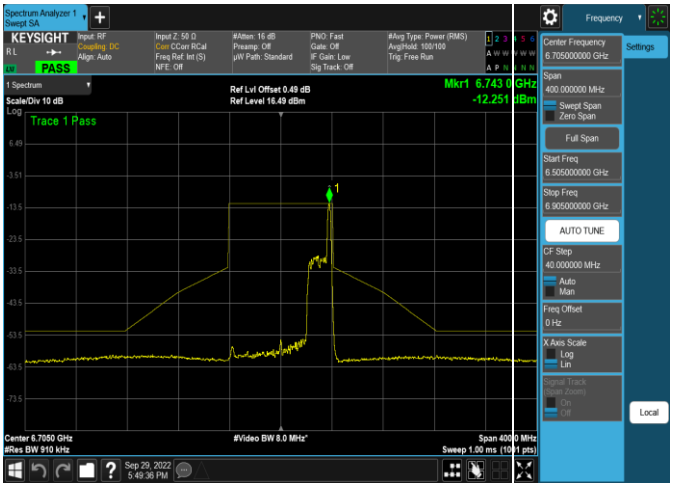


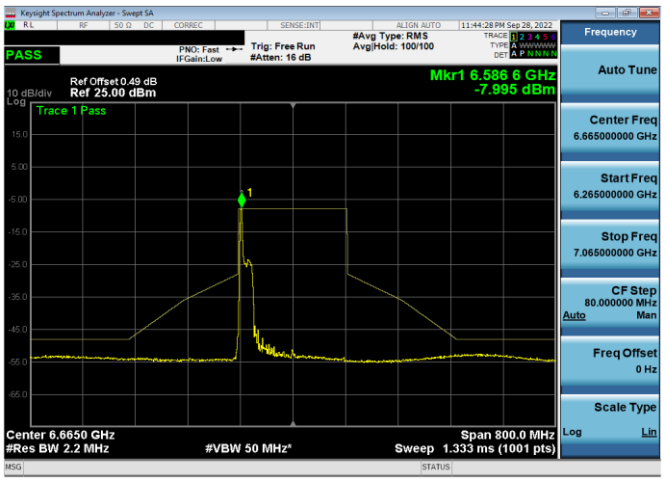
Plot 7-597. In-Band Emission Plot SDM Antenna 5b (80MHz 802.11ax RU26 (UNII Band 7) – Ch. 151)



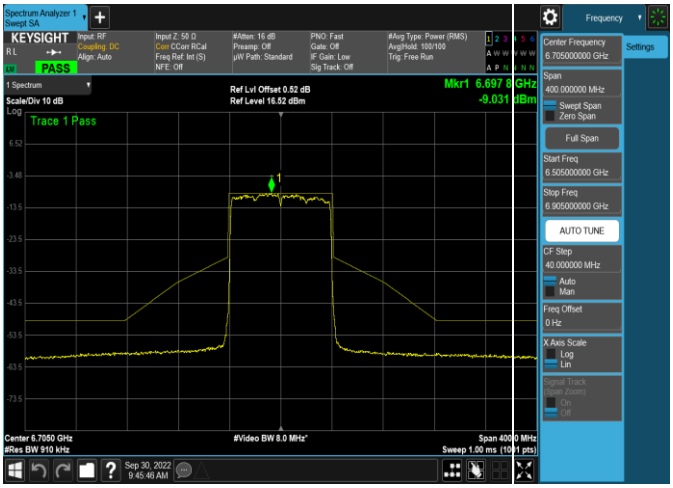
Plot 7-600. In-Band Emission Plot SDM Antenna 4a (80MHz 802.11ax RU996 (UNII Band 7) – Ch. 151)



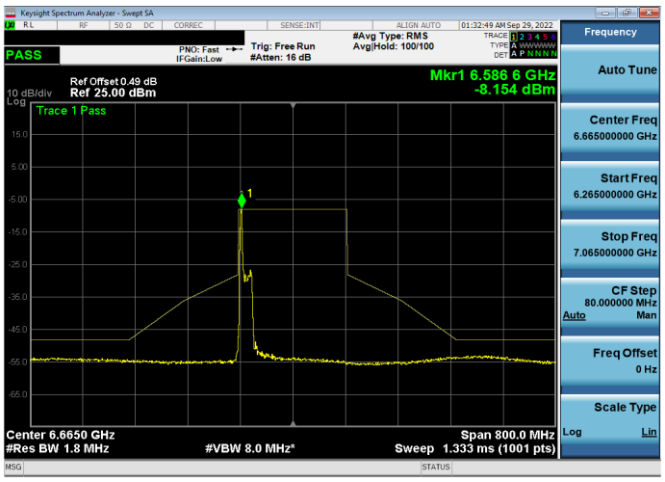
Plot 7-598. In-Band Emission Plot SDM Antenna 4a (80MHz 802.11ax RU26 (UNII Band 7) – Ch. 151)



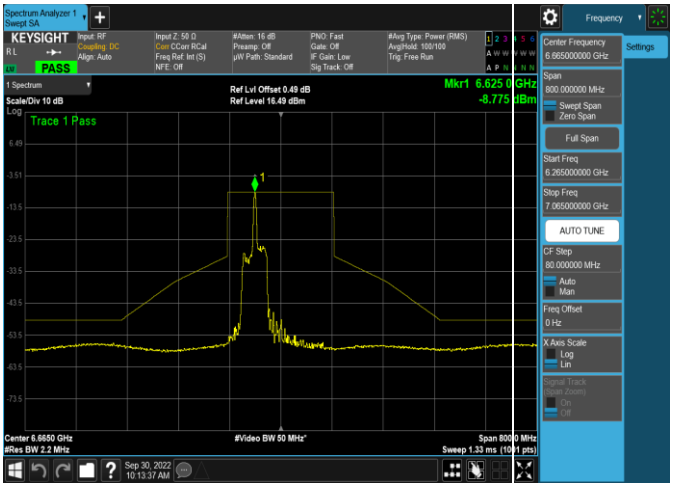
Plot 7-601. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU26 (UNII Band 7) – Ch. 143)



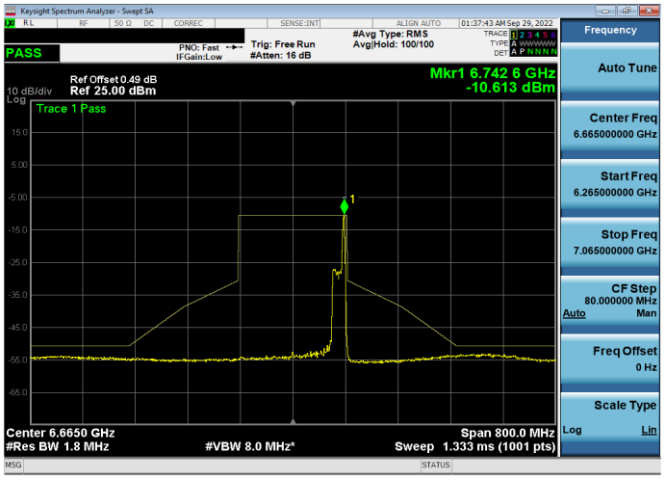
Plot 7-599. In-Band Emission Plot SDM Antenna 5b (80MHz 802.11ax RU996 (UNII Band 7) – Ch. 151)



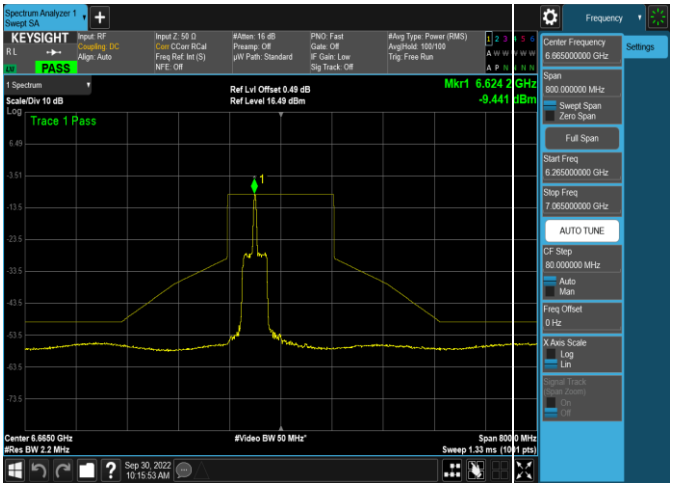
Plot 7-602. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU26 (UNII Band 7) – Ch. 143)



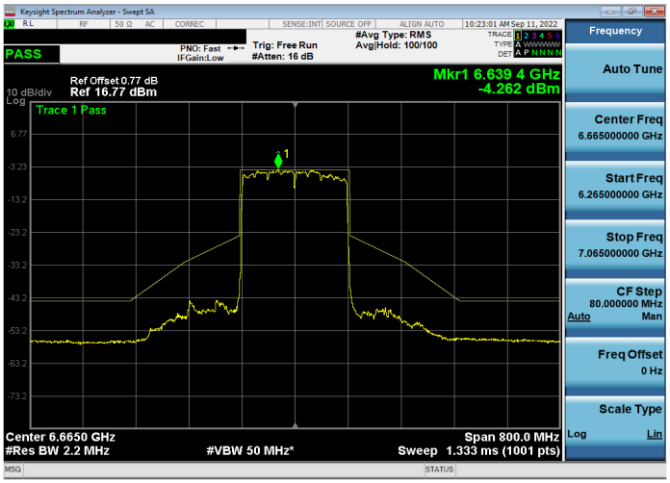
Plot 7-603. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU26 (UNII Band 7) – Ch. 143)



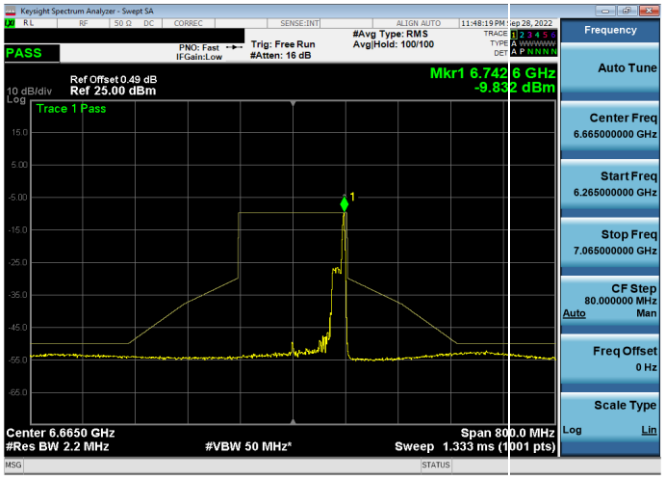
Plot 7-606. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU26 (UNII Band 7) – Ch. 143)



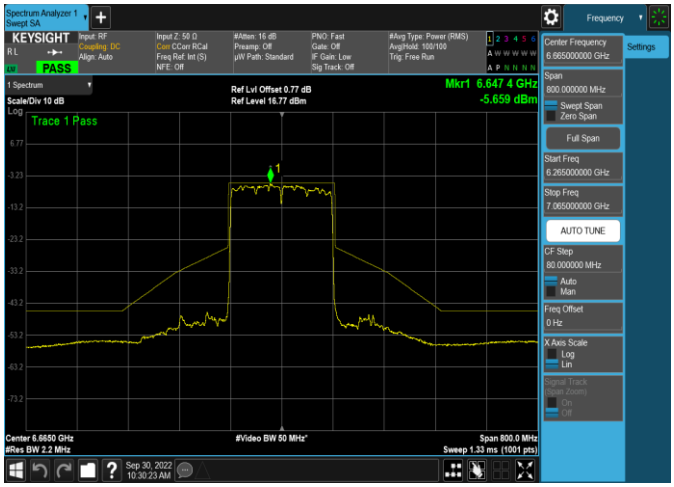
Plot 7-604. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU26 (UNII Band 7) – Ch. 143)



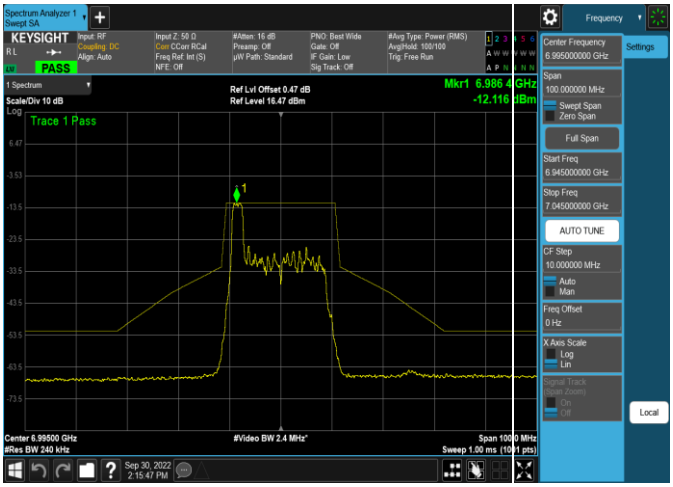
Plot 7-607. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU996x2 (UNII Band 7) – Ch. 143)



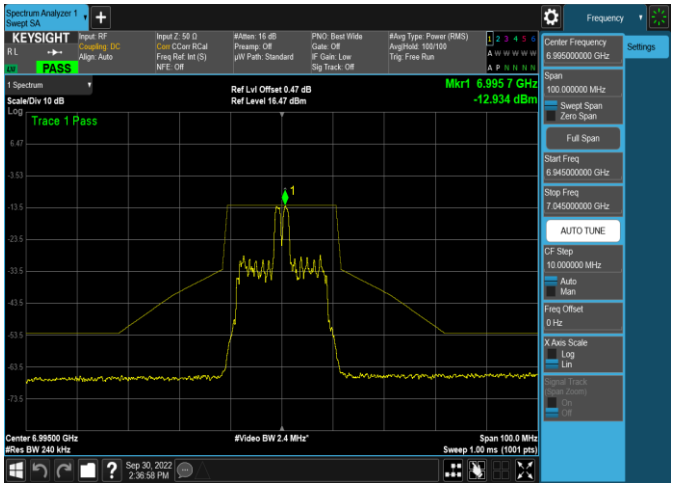
Plot 7-605. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU26 (UNII Band 7) – Ch. 143)



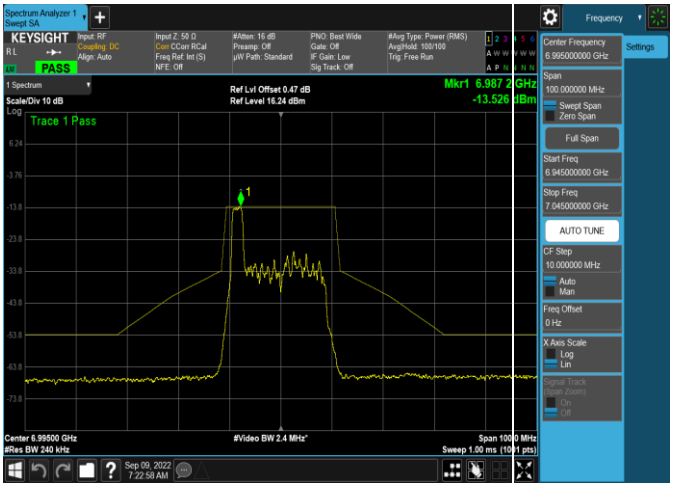
Plot 7-608. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU996x2 (UNII Band 7) – Ch. 143)



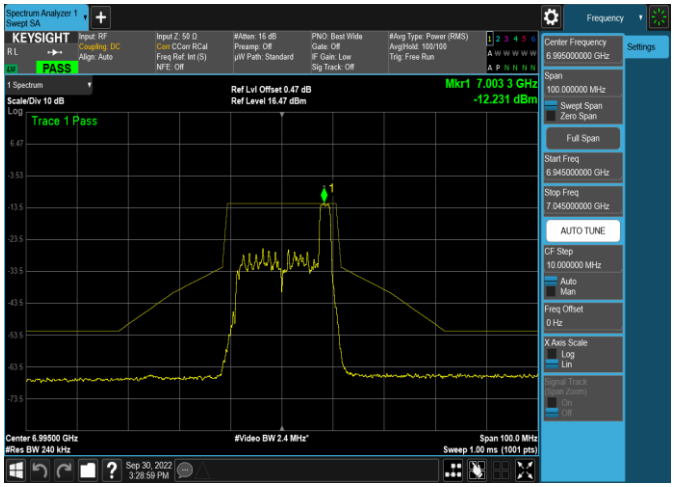
Plot 7-609. In-Band Emission Plot SDM Antenna 5b (20MHz 802.11ax RU26 (UNII Band 8) – Ch. 209)



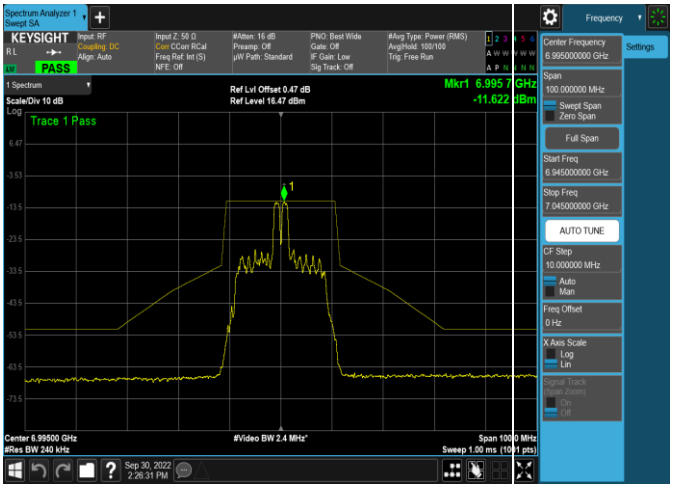
Plot 7-612. In-Band Emission Plot SDM Antenna 4a (20MHz 802.11ax RU26 (UNII Band 8) – Ch. 209)



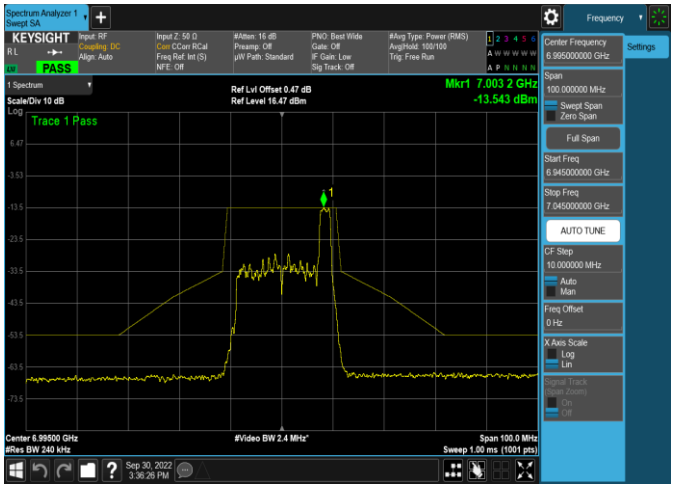
Plot 7-610. In-Band Emission Plot SDM Antenna 4a (20MHz 802.11ax RU26 (UNII Band 8) – Ch. 209)



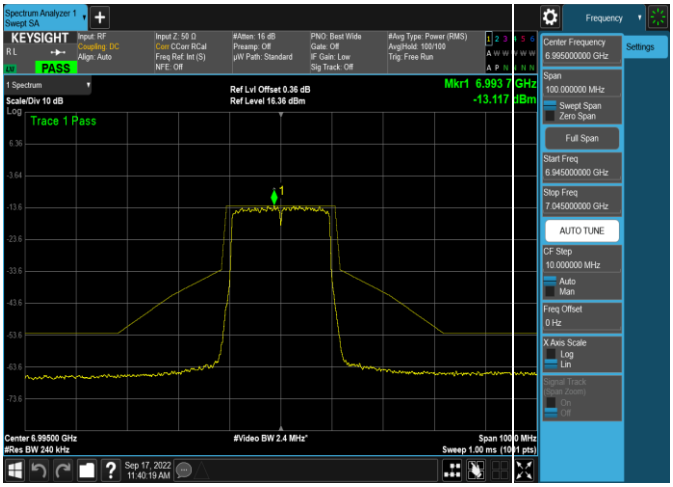
Plot 7-613. In-Band Emission Plot SDM Antenna 5b (20MHz 802.11ax RU26 (UNII Band 8) – Ch. 209)



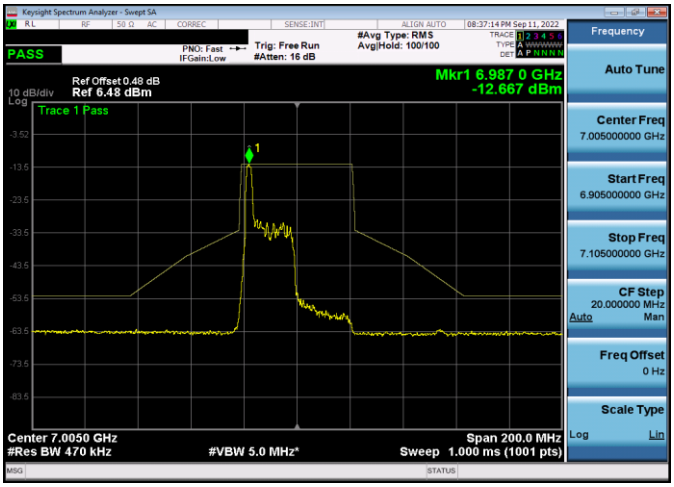
Plot 7-611. In-Band Emission Plot SDM Antenna 5b (20MHz 802.11ax RU26 (UNII Band 8) – Ch. 209)



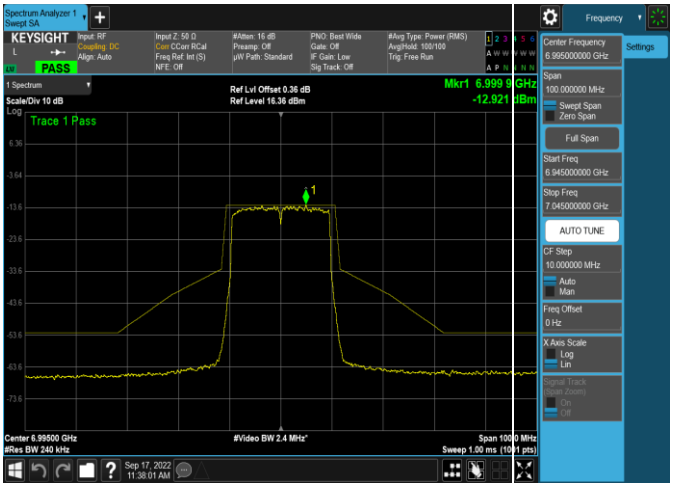
Plot 7-614. In-Band Emission Plot SDM Antenna 4a (20MHz 802.11ax RU26 (UNII Band 8) – Ch. 209)



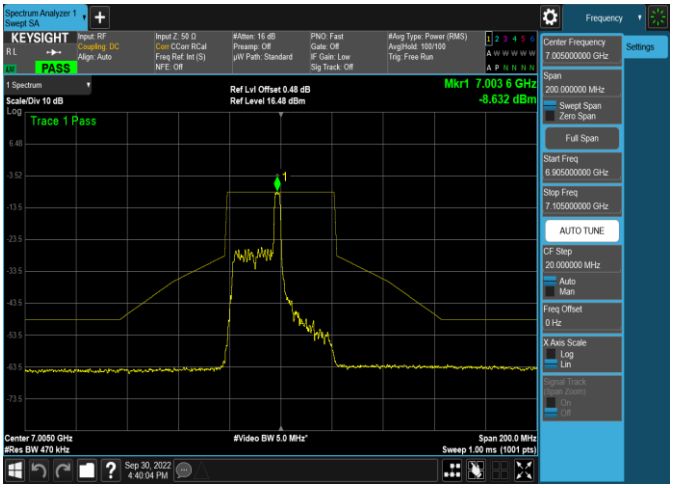
Plot 7-615. In-Band Emission Plot SDM Antenna 5b (20MHz 802.11ax RU242 (UNII Band 8) – Ch. 209)



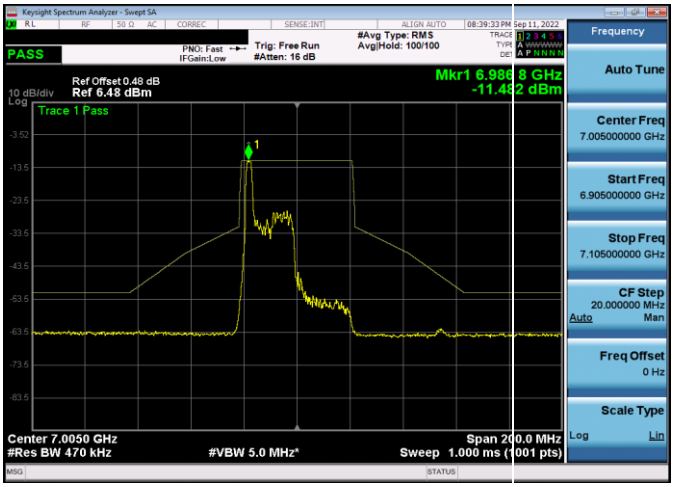
Plot 7-618. In-Band Emission Plot SDM Antenna 4a (40MHz 802.11ax RU26 (UNII Band 8) – Ch. 211)



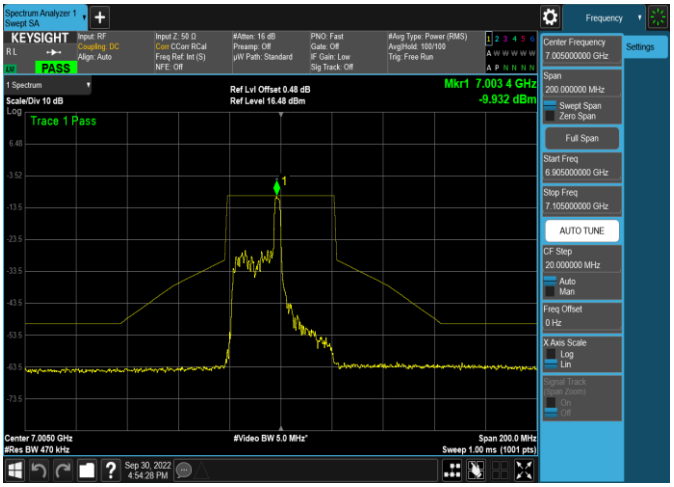
Plot 7-616. In-Band Emission Plot SDM Antenna 4a (20MHz 802.11ax RU242 (UNII Band 8) – Ch. 209)



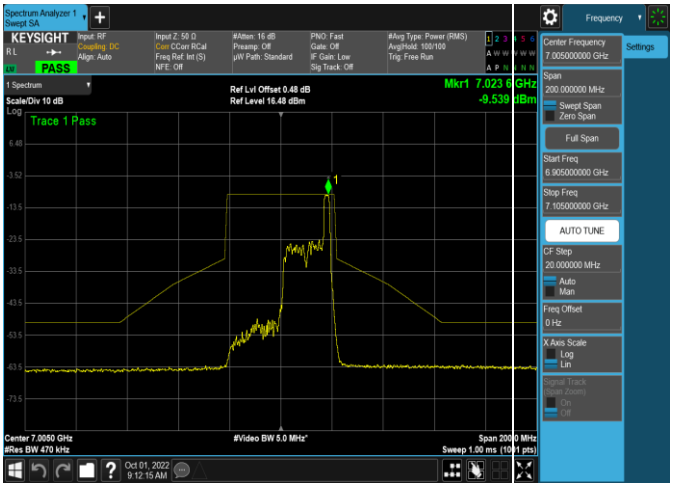
Plot 7-619. In-Band Emission Plot SDM Antenna 5b (40MHz 802.11ax RU26 (UNII Band 8) – Ch. 211)



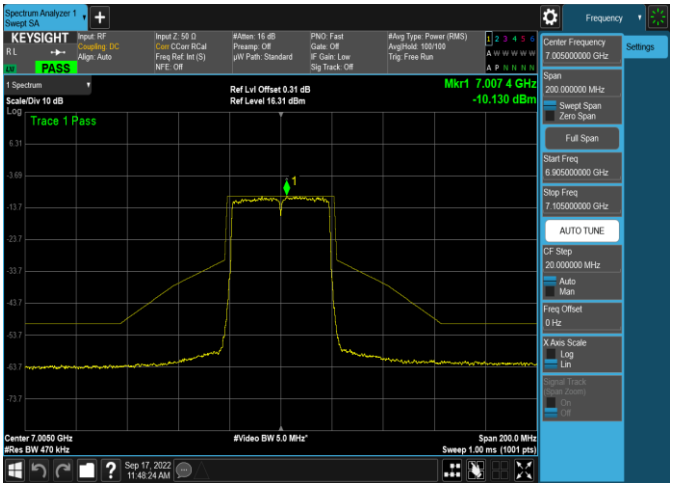
Plot 7-617. In-Band Emission Plot SDM Antenna 5b (40MHz 802.11ax RU26 (UNII Band 8) – Ch. 211)



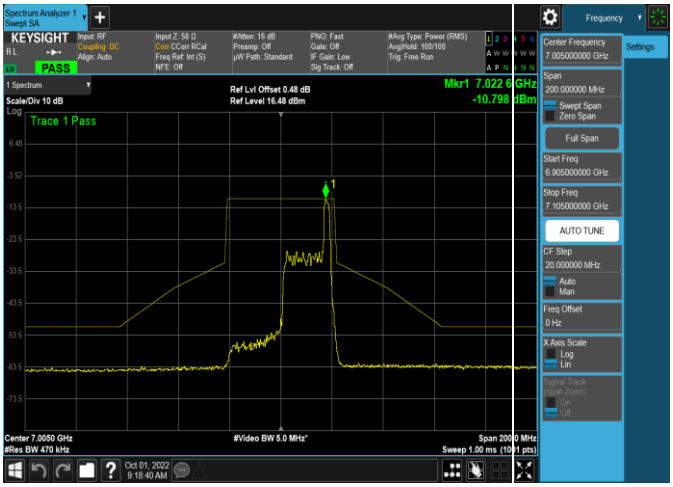
Plot 7-620. In-Band Emission Plot SDM Antenna 4a (40MHz 802.11ax RU26 (UNII Band 8) – Ch. 211)



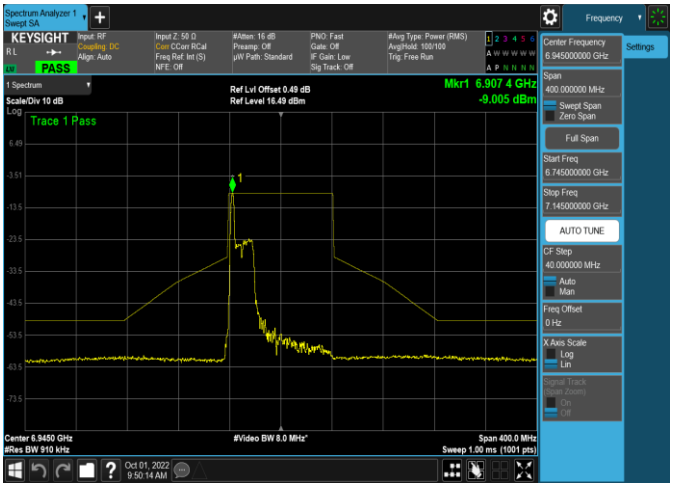
Plot 7-621. In-Band Emission Plot SDM Antenna 5b (40MHz 802.11ax RU26 (UNII Band 8) – Ch. 211)



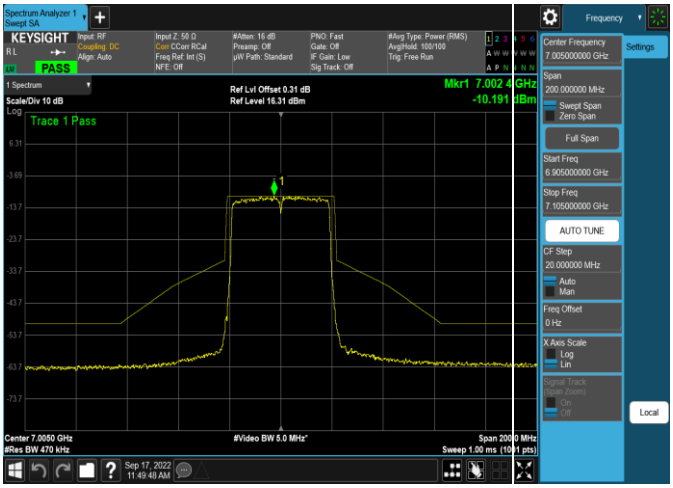
Plot 7-624. In-Band Emission Plot SDM Antenna 4a (40MHz 802.11ax RU484 (UNII Band 8) – Ch. 211)



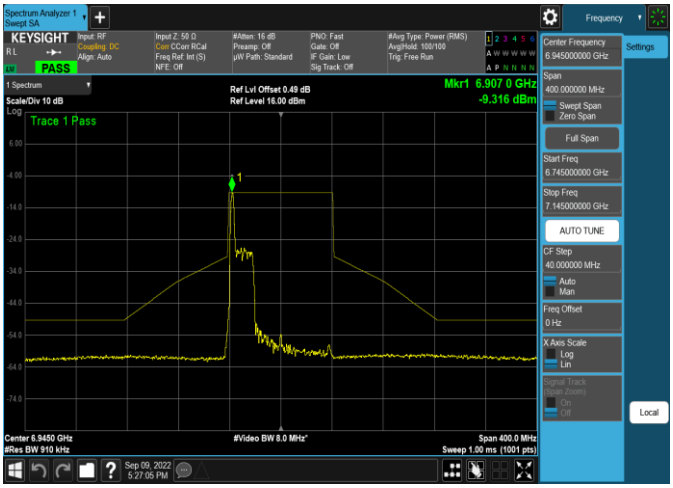
Plot 7-622. In-Band Emission Plot SDM Antenna 4a (40MHz 802.11ax RU26 (UNII Band 8) – Ch. 211)



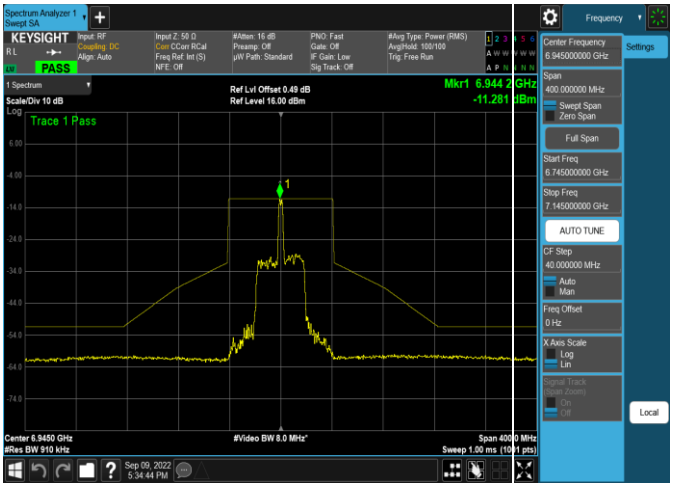
Plot 7-625. In-Band Emission Plot SDM Antenna 5b (80MHz 802.11ax RU26 (UNII Band 8) – Ch. 199)



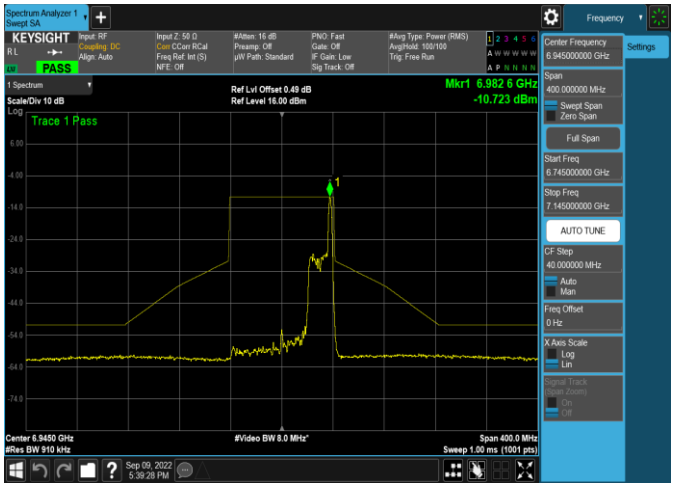
Plot 7-623. In-Band Emission Plot SDM Antenna 5b (40MHz 802.11ax RU484 (UNII Band 8) – Ch. 211)



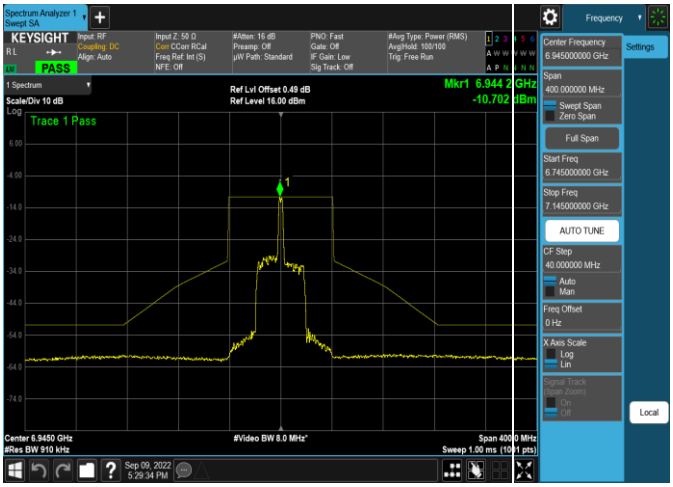
Plot 7-626. In-Band Emission Plot SDM Antenna 4a (80MHz 802.11ax RU26 (UNII Band 8) – Ch. 199)



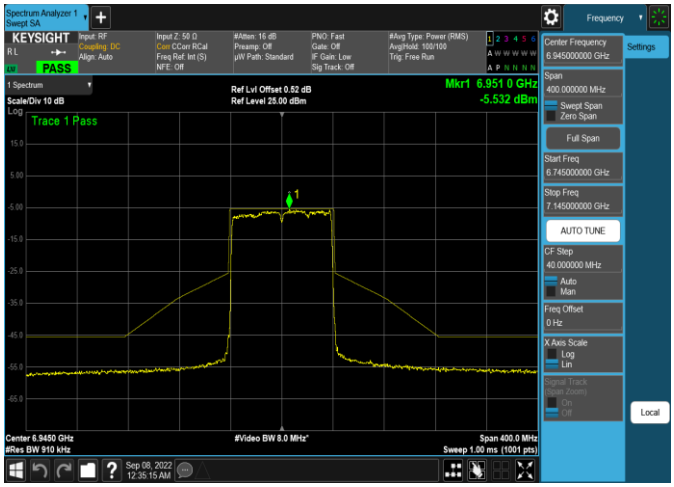
Plot 7-627. In-Band Emission Plot SDM Antenna 5b (80MHz 802.11ax RU26 (UNII Band 8) – Ch. 199)



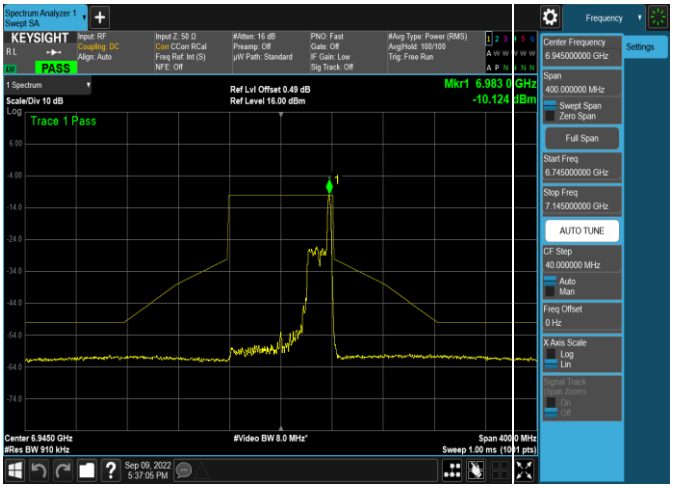
Plot 7-630. In-Band Emission Plot SDM Antenna 4a (80MHz 802.11ax RU26 (UNII Band 8) – Ch. 199)



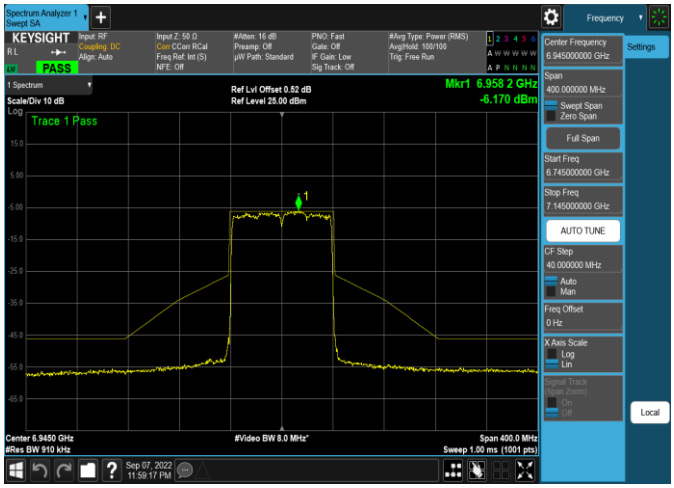
Plot 7-628. In-Band Emission Plot SDM Antenna 4a (80MHz 802.11ax RU26 (UNII Band 8) – Ch. 199)



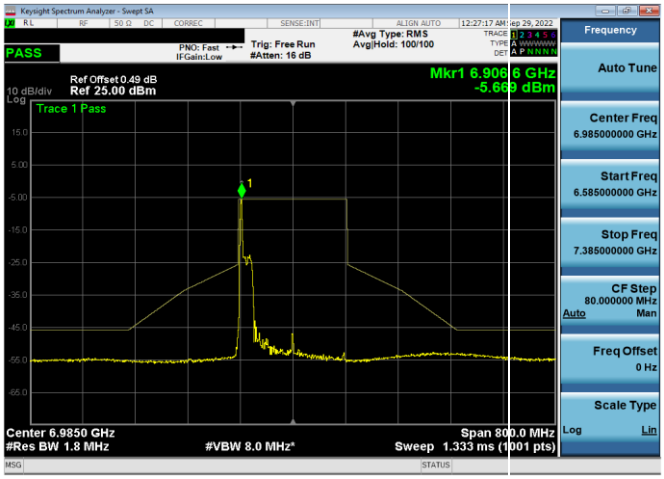
Plot 7-631. In-Band Emission Plot SDM Antenna 5b (80MHz 802.11ax RU996 (UNII Band 8) – Ch. 199)



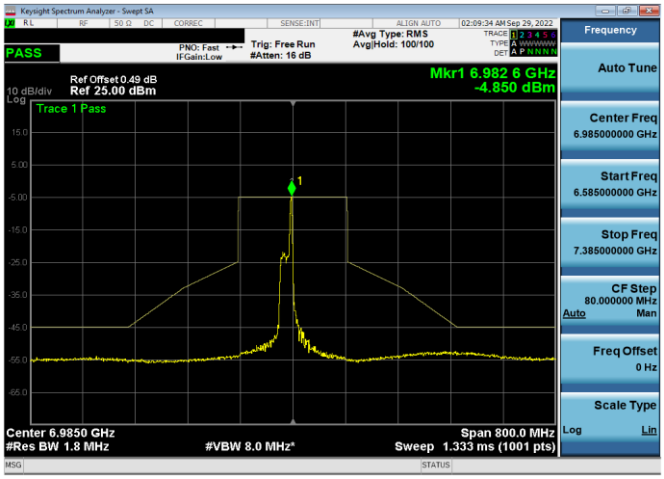
Plot 7-629. In-Band Emission Plot SDM Antenna 5b (80MHz 802.11ax RU26 (UNII Band 8) – Ch. 199)



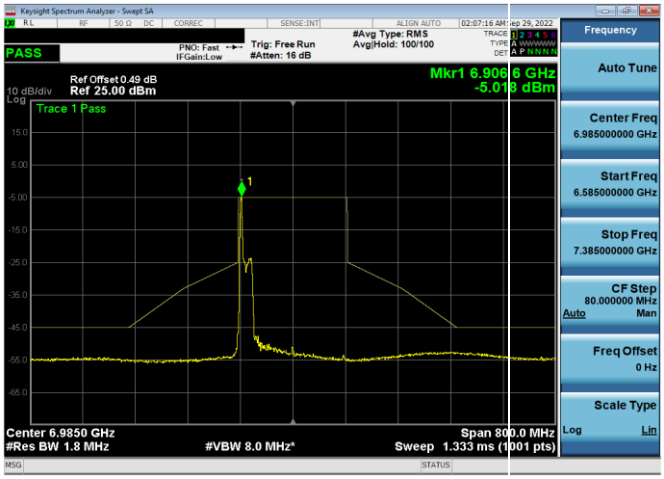
Plot 7-632. In-Band Emission Plot SDM Antenna 4a (80MHz 802.11ax RU996 (UNII Band 8) – Ch. 199)



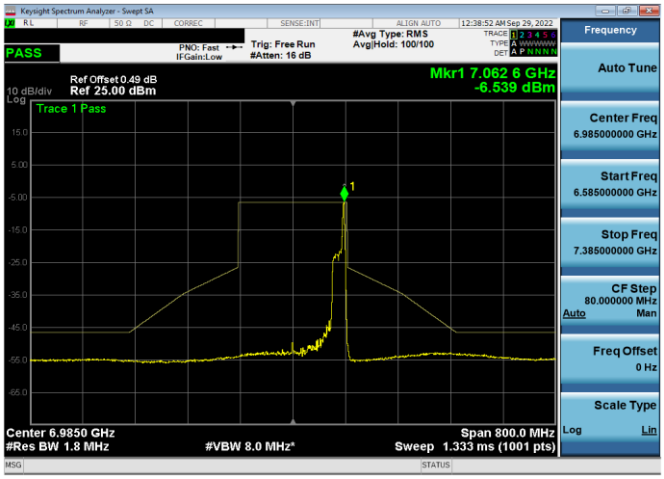
Plot 7-633. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU26 (UNII Band 8) – Ch. 207)



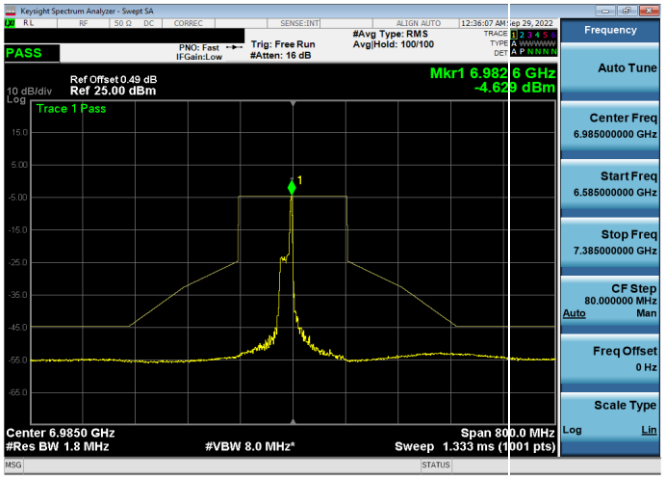
Plot 7-636. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU26 (UNII Band 8) – Ch. 207)



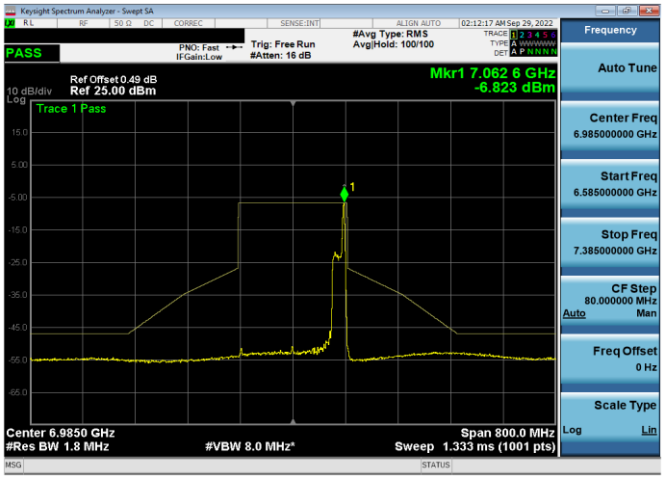
Plot 7-634. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU26 (UNII Band 8) – Ch. 207)



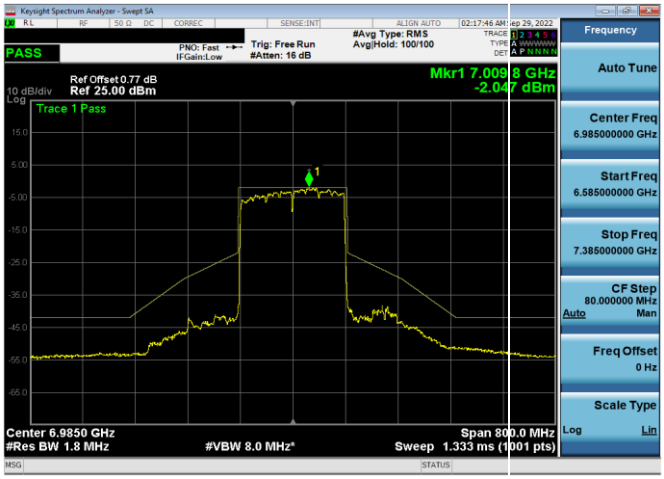
Plot 7-637. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU26 (UNII Band 8) – Ch. 207)



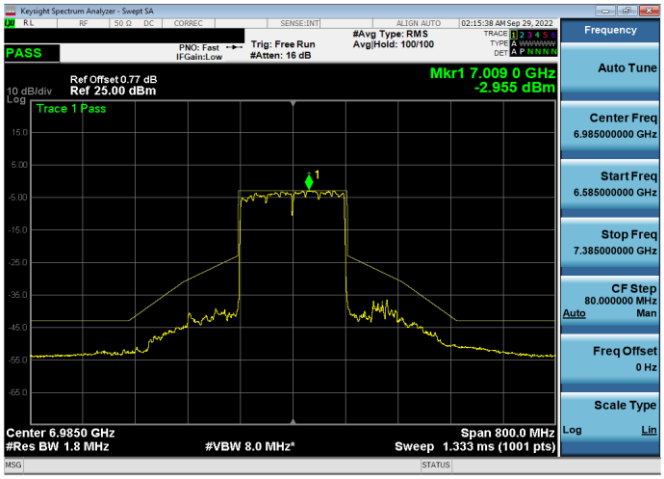
Plot 7-635. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU26 (UNII Band 8) – Ch. 207)



Plot 7-638. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU26 (UNII Band 8) – Ch. 207)



Plot 7-639. In-Band Emission Plot SDM Antenna 5b (160MHz 802.11ax RU996x2 (UNII Band 8) – Ch. 207)



Plot 7-640. In-Band Emission Plot SDM Antenna 4a (160MHz 802.11ax RU996x2 (UNII Band 8) – Ch. 207)

7.6 Contention Based Protocol – 802.11ax OFDMA

§15.407(d)(6), RSS-248 [4.8]

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 as long as 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

ANSI C63.10-2013 – Section 12.3.2.2
KDB 987594 D02 v01r01

Test Settings

1. Configure the EUT to transmit with a constant duty cycle.
2. Set the operating parameters of the EUT including power level, operating frequency, modulation and bandwidth
3. Set the signal analyzer center frequency to the nominal EUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT.
4. Connect the output port of the EUT to the signal analyzer 2, as shown in Figure 2. Ensure that the attenuator 2 provides enough attenuation to not overload the signal analyzer 2 receiver.
5. Monitoring the signal analyzer 2, verify the EUT is operating and transmitting with the parameters set at step two.
6. 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.
7. 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.
8. Transmit the AWGN signal (RF ON) and verify its characteristics on the signal analyzer 1.
9. 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.
10. 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.
11. Refer to Table 1 to determine 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

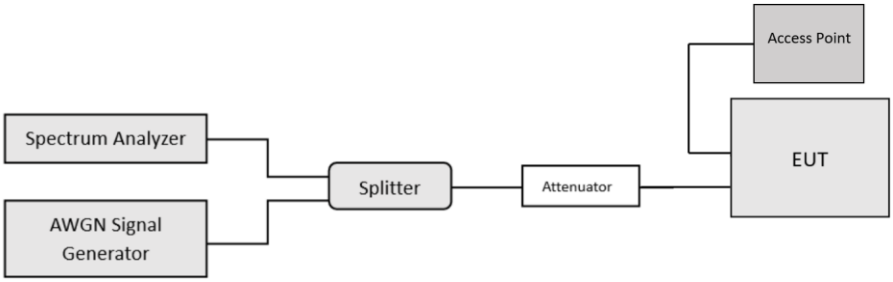


Figure 2. Contention-based protocol test setup, conducted method Step-by-Step Procedure, Conducted Setup

Test Notes

1. Per guidance from KDB 987594 D02 v01r01, contention based protocol was tested using an AWGN signal with a bandwidth of 10MHz. The amplitude of the signal was increased until detected by the EUT, signaled by the ceasing of transmission, marker indicates the point at which the AWGN signal is introduced.
2. 15 trials were ran in order 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.

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

Equation 7-1. Incumbent Detection Level Calculation

Band	Channel	Channel Frquency [MHz]	Channel BW [MHz]	Incumbent Frequency [MHz]	Injected (AWGN) [dBm]	Antenna Gain [dBi]	Adjusted Power Level [dBm]	Detection Limit [dBm]	Margin [dB]
UNII Band 5	53	6215	20	6215	-70.33	-1.50	-68.83	-62.0	-6.83
	47	6185	160	6110	-67.68	-1.50	-66.18	-62.0	-4.18
				6185	-68.83	-1.50	-67.33	-62.0	-5.33
				6260	-65.98	-1.50	-64.48	-62.0	-2.48
UNII Band 6	101	6455	20	6455	-71.71	-0.20	-71.51	-62.0	-9.51
	111	6505	160	6430	-70.32	-0.30	-70.02	-62.0	-8.02
				6505	-70.12	-0.20	-69.92	-62.0	-7.92
				6580	-66.52	-0.20	-66.32	-62.0	-4.32
UNII Band 7	149	6695	20	6695	-70.29	-0.80	-69.49	-62.0	-7.49
	143	6665	160	6590	-67.69	-0.20	-67.49	-62.0	-5.49
				6665	-67.99	-0.20	-67.79	-62.0	-5.79
				6740	-65.69	-2.90	-62.79	-62.0	-0.79
UNII Band 8	197	6935	20	6935	-70.72	-4.50	-66.22	-62.0	-4.22
	207	6985	160	6910	-69.52	-4.50	-65.02	-62.0	-3.02
				6985	-70.42	-4.90	-65.52	-62.0	-3.52
				7060	-68.02	-5.10	-62.92	-62.0	-0.92

Table 7-48. Contention Based Protocol – Incumbent Detection Results

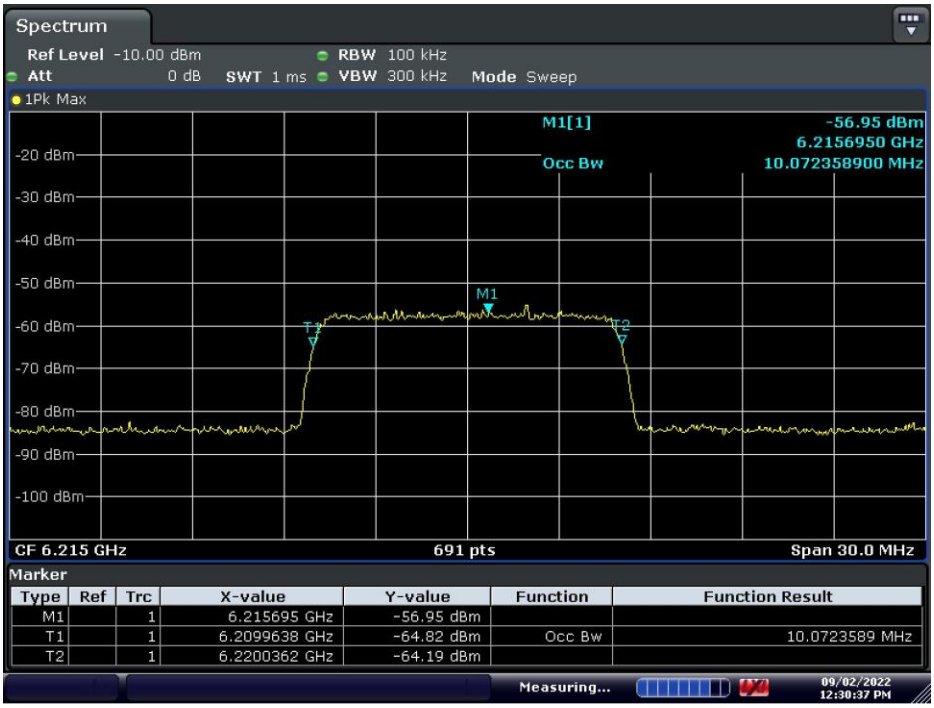
Band	Channel	Channel Frquency [MHz]	Channel BW [MHz]	Incumbent Frequency [MHz]	EUT Transmission Status		
					Adjusted AWGN Power (dBm)		
					Normal	Minimal	Ceased
UNII Band 5	53	6215	20	6215	-80.83	-71.33	-68.83
	47	6185	160	6110	-78.18	-68.68	-66.18
				6185	-79.33	-69.83	-67.33
				6260	-76.48	-66.98	-64.48
UNII Band 6	101	6455	20	6455	-83.51	-74.01	-71.51
	111	6505	160	6430	-82.02	-72.52	-70.02
				6505	-81.92	-72.42	-69.92
				6580	-78.32	-68.82	-66.32
UNII Band 7	149	6695	20	6695	-81.49	-71.99	-69.49
	175	6825	160	6750	-79.49	-69.99	-67.49
				6825	-79.79	-70.29	-67.79
				6900	-74.79	-65.29	-62.79
UNII Band 8	197	6935	20	6935	-78.22	-68.72	-66.22
	207	6985	160	6910	-77.02	-67.52	-65.02
				6985	-77.52	-68.02	-65.52
				7060	-74.92	-65.42	-62.92

Table 7-49. Contention Based Protocol – Detection Results – All Tx Cases

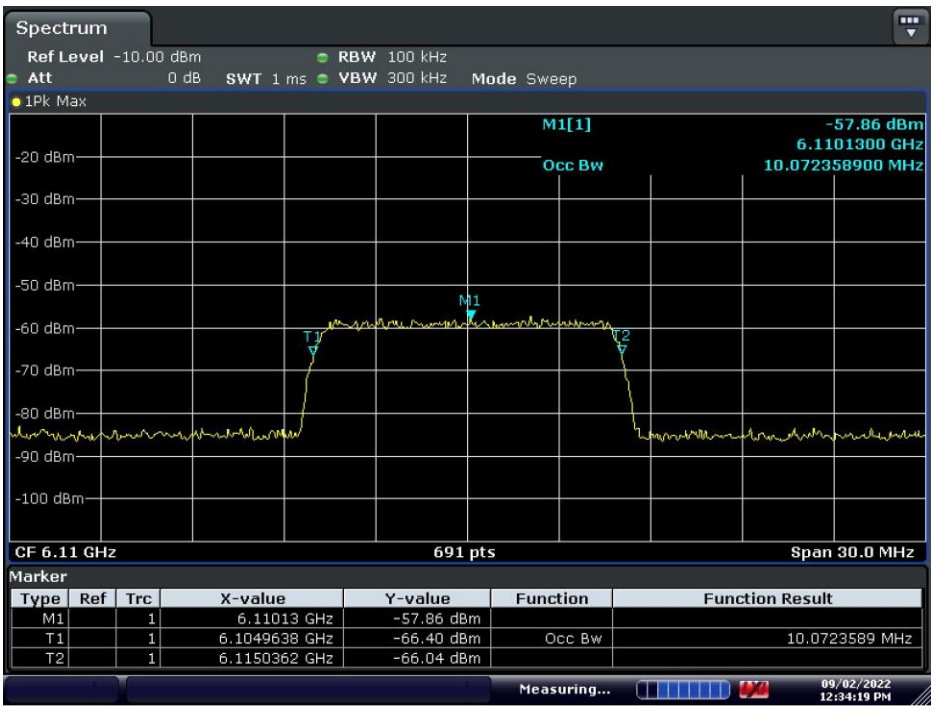
CBP Detection (1 = Detection, Blank = No Detection)																					
Band	Channel	Channel Frquency [MHz]	Channel BW [MHz]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Detection Rate [%]	Limit [%]	Pass/Fail
UNII Band 5	53	6215	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
	47	6185	160	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
UNII Band 6	101	6455	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
	111	6505	160	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
UNII Band 7	149	6695	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
	175	6665	160	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
UNII Band 8	197	6935	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
	207	6985	160	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.0	90	Pass

Table 7-50. Contention Based Protocol – Incumbent Detection Trial Results

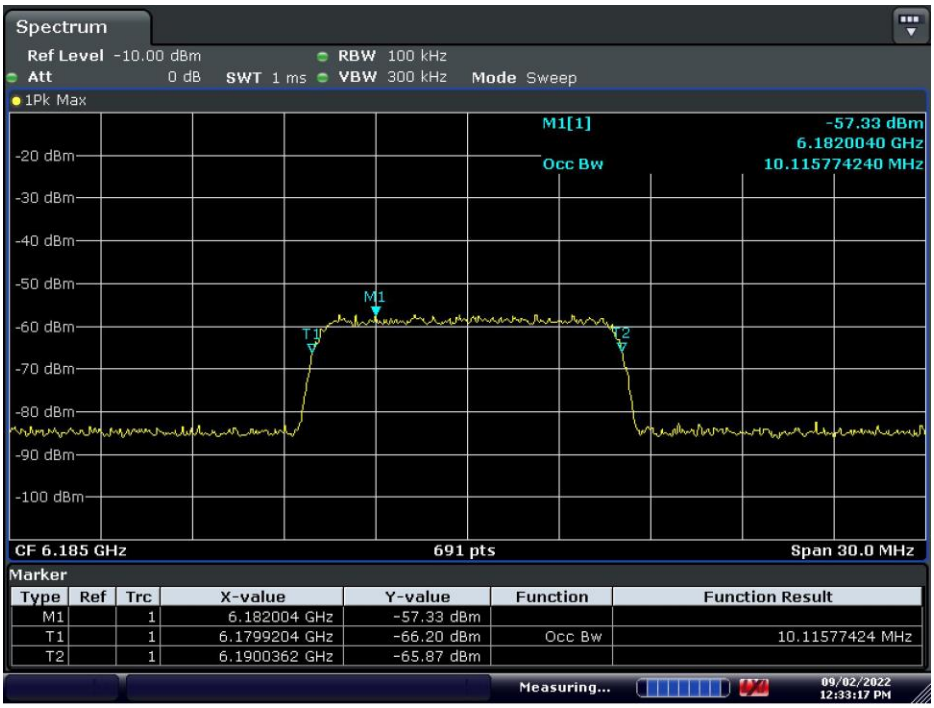
AWGN Plots



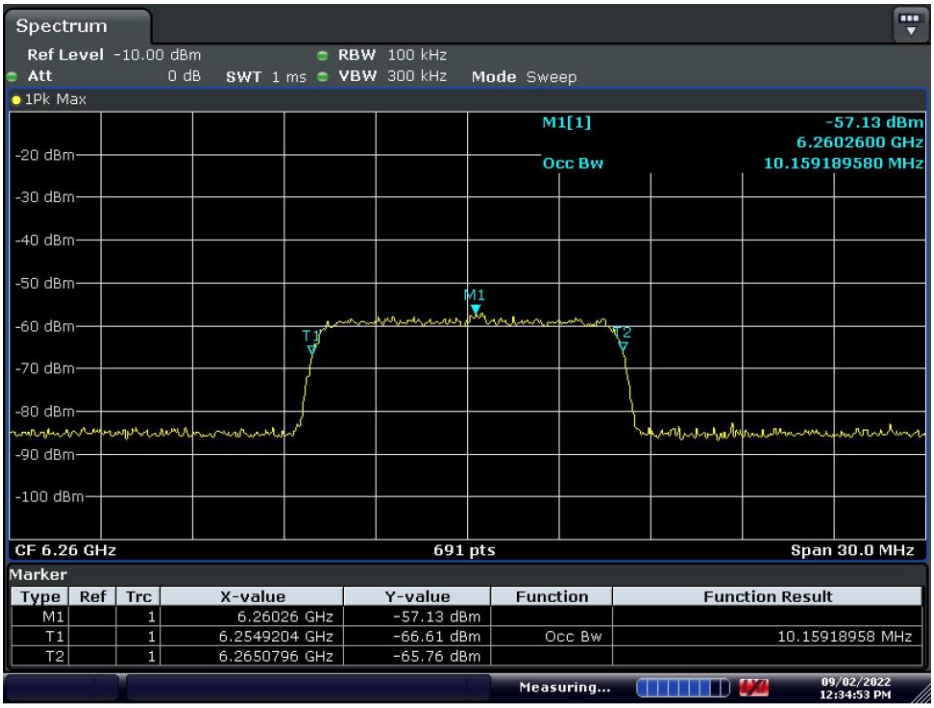
Plot 7-641. AWGN Signal – UNII 5 – 20MHz



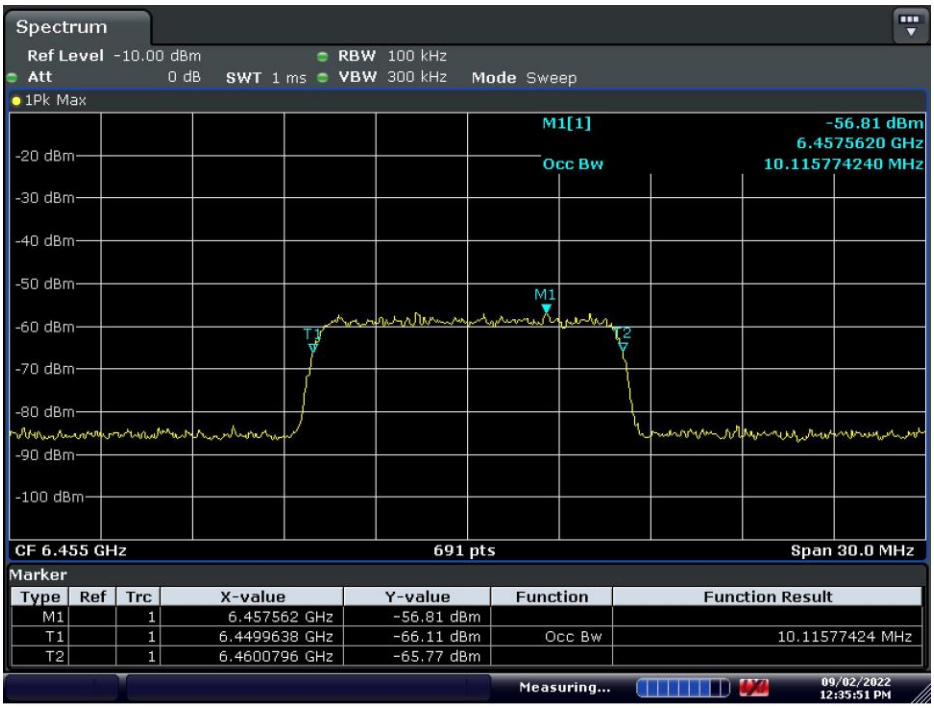
Plot 7-642. AWGN Signal – UNII 5 – 160MHz - Low



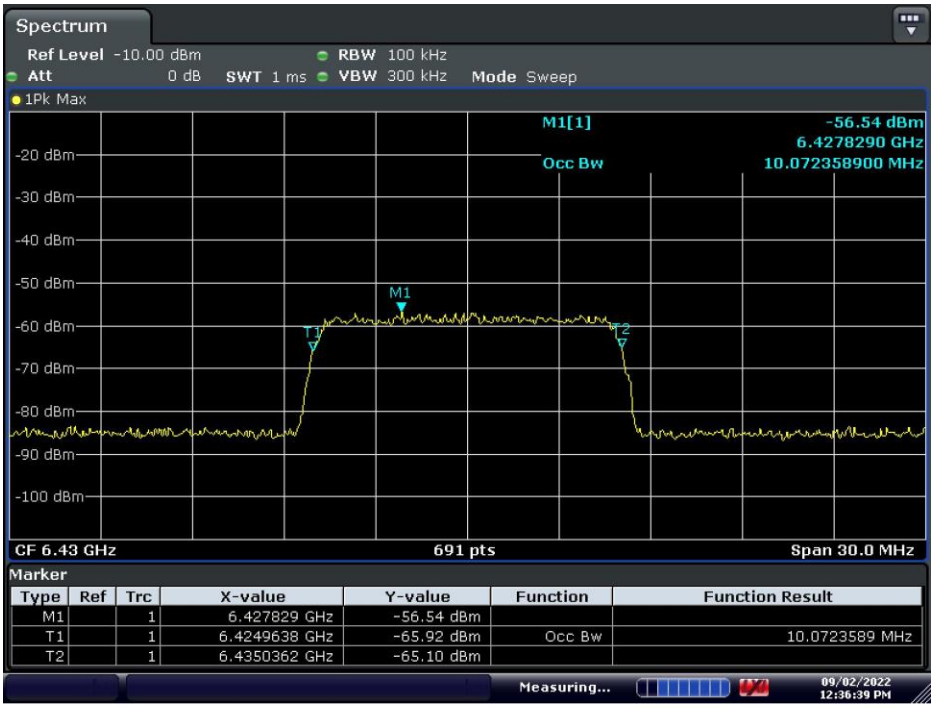
Plot 7-643. AWGN Signal – UNII 5 – 160MHz – Mid



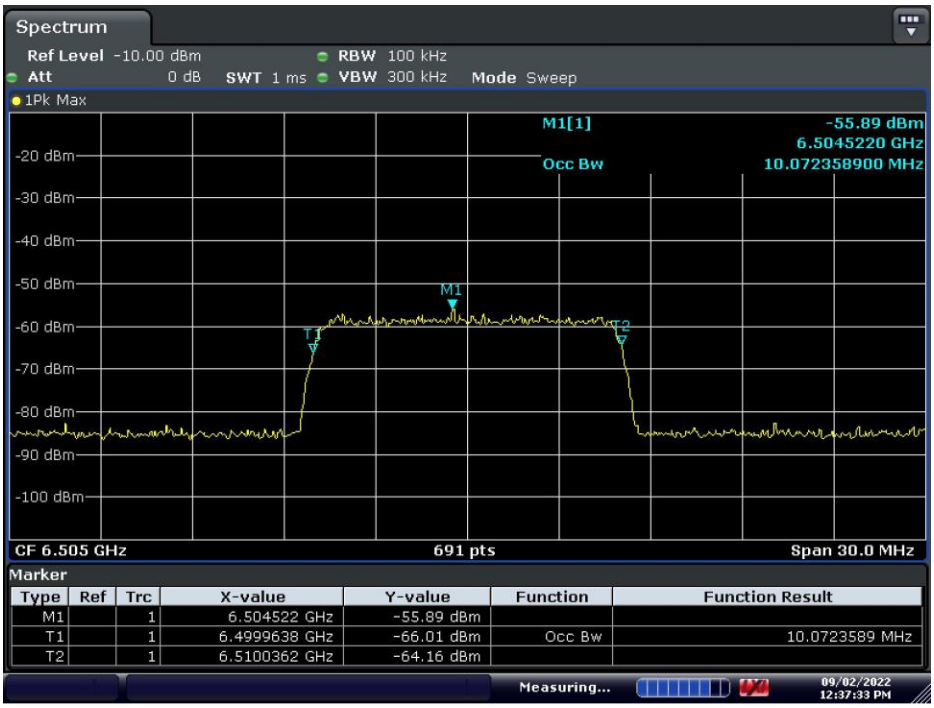
Plot 7-644. AWGN Signal – UNII 5 – 160MHz - High



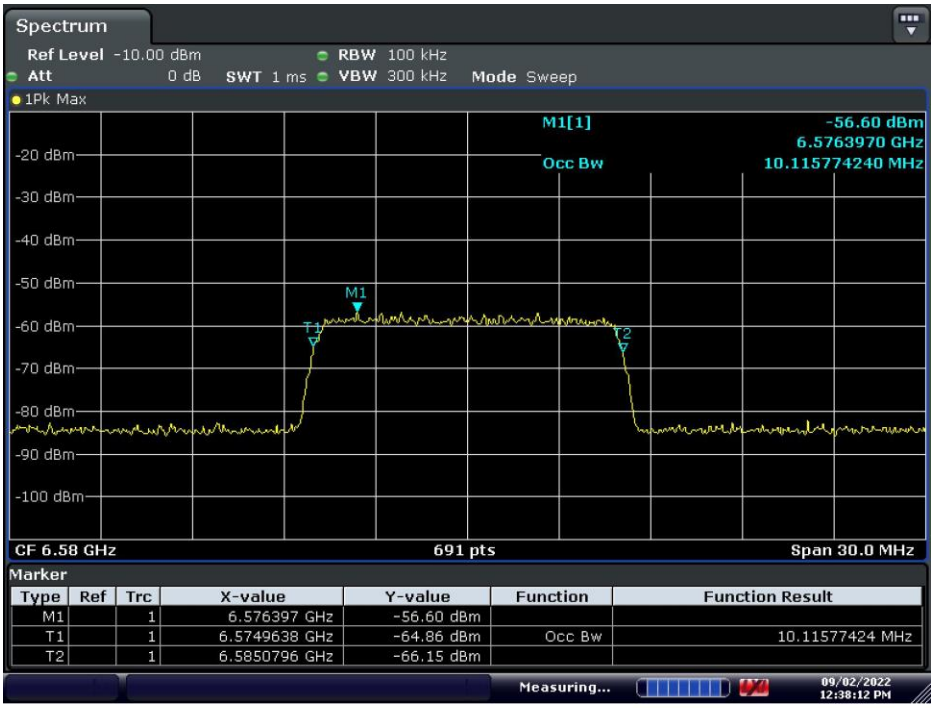
Plot 7-645. AWGN Signal – UNII 6 – 20MHz



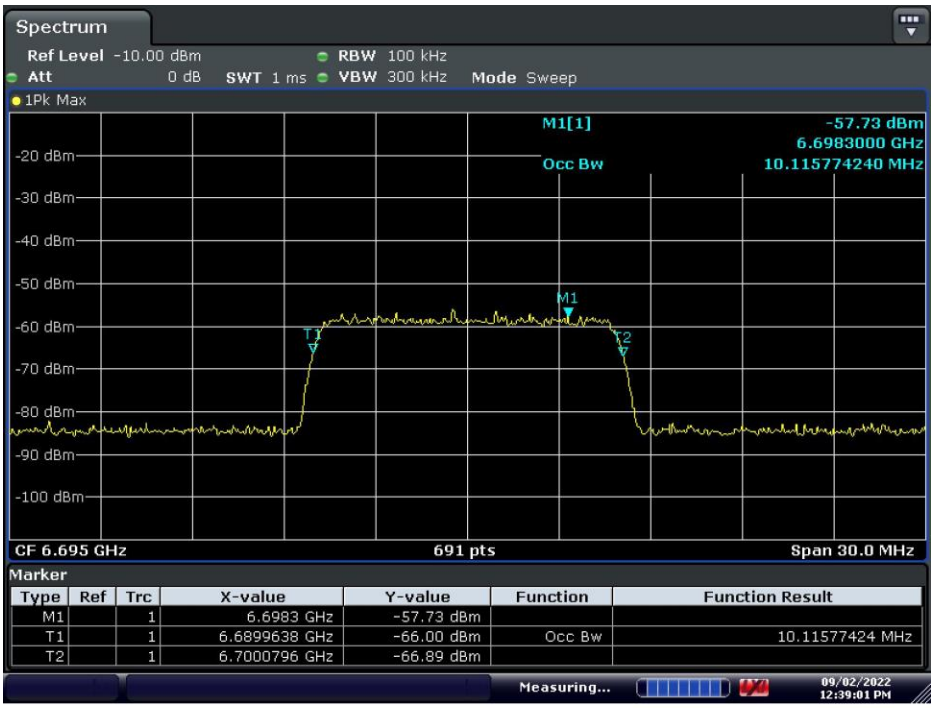
Plot 7-646. AWGN Signal – UNII 6 – 160MHz - Low



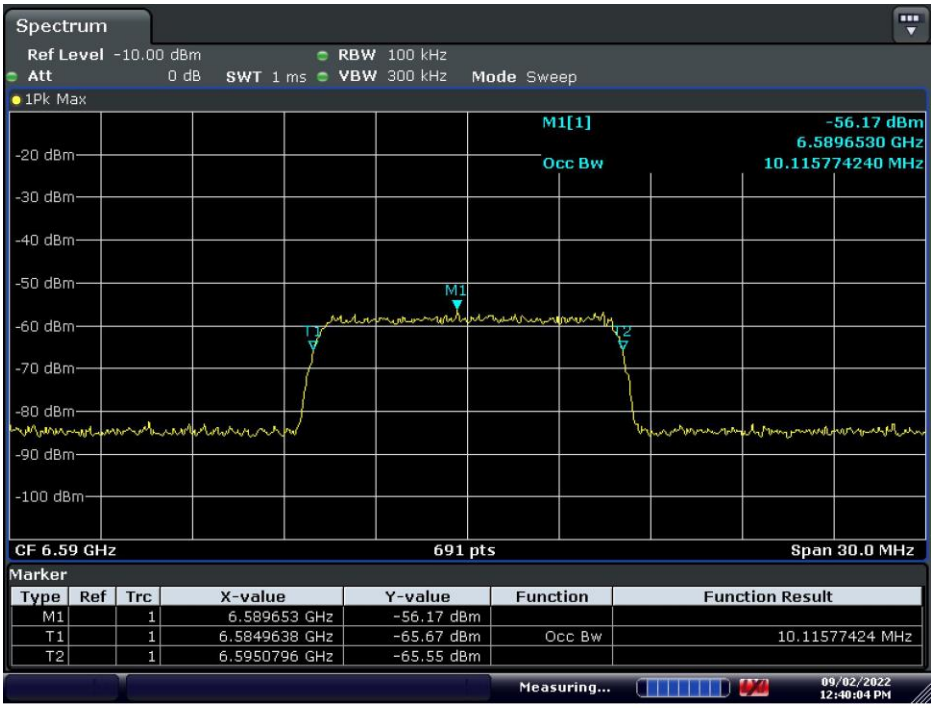
Plot 7-647. AWGN Signal – UNII 6 – 160MHz – Mid



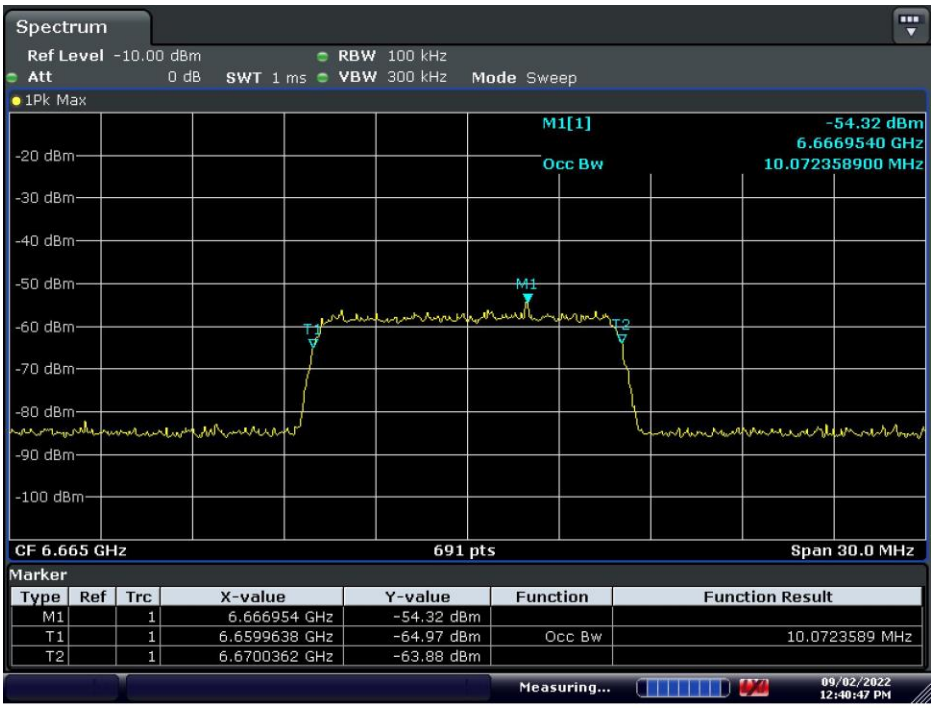
Plot 7-648. AWGN Signal – UNII 6 – 160MHz - High



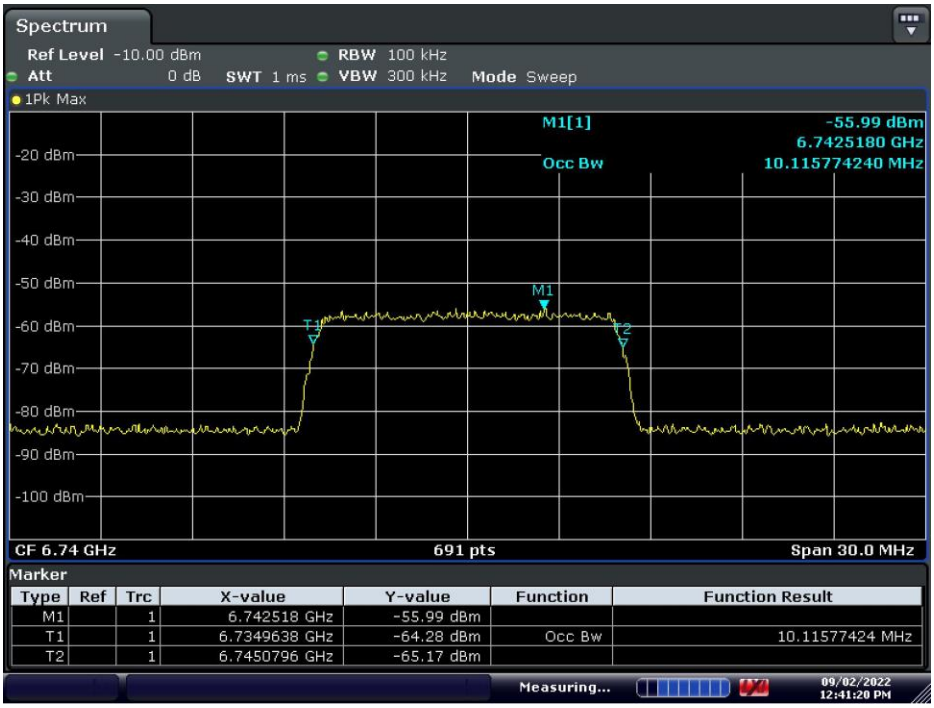
Plot 7-649. AWGN Signal – UNII 7 – 20MHz



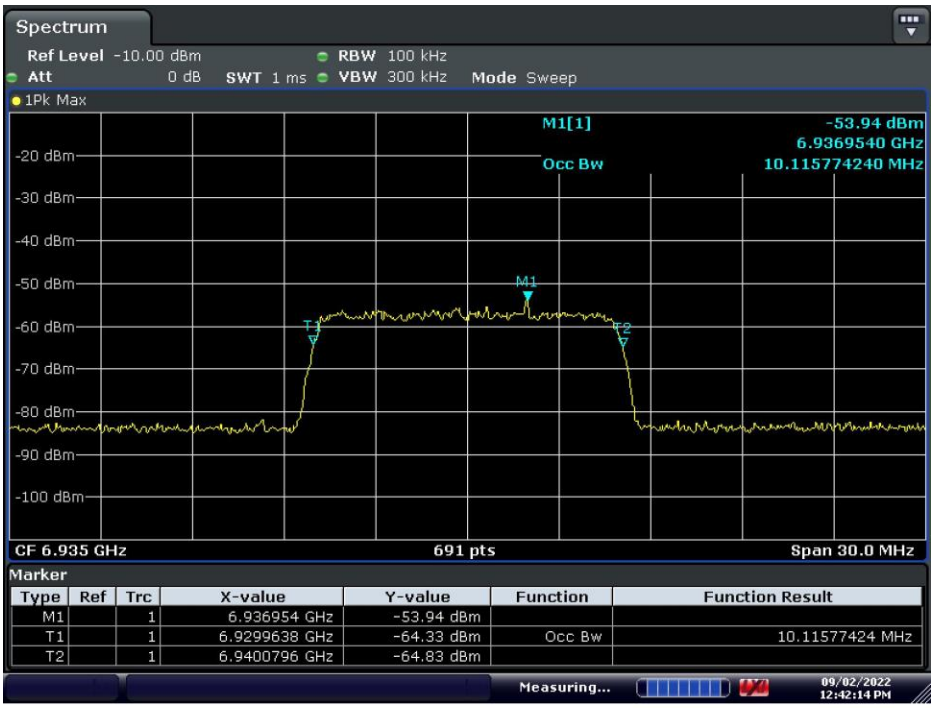
Plot 7-650. AWGN Signal – UNII 7 – 160MHz - Low



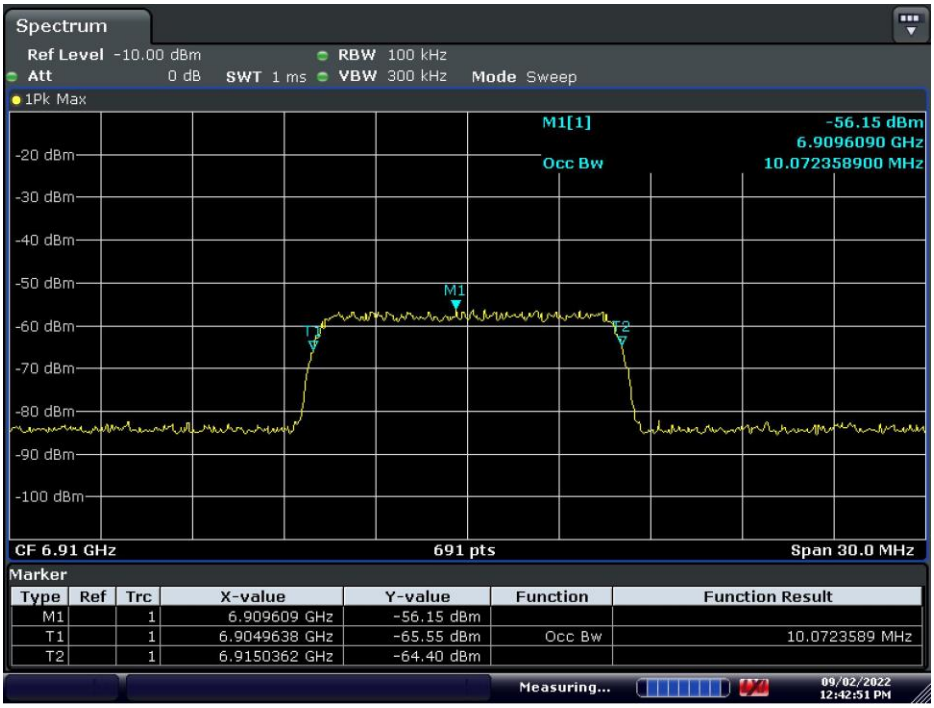
Plot 7-651. AWGN Signal – UNII 7 – 160MHz – Mid



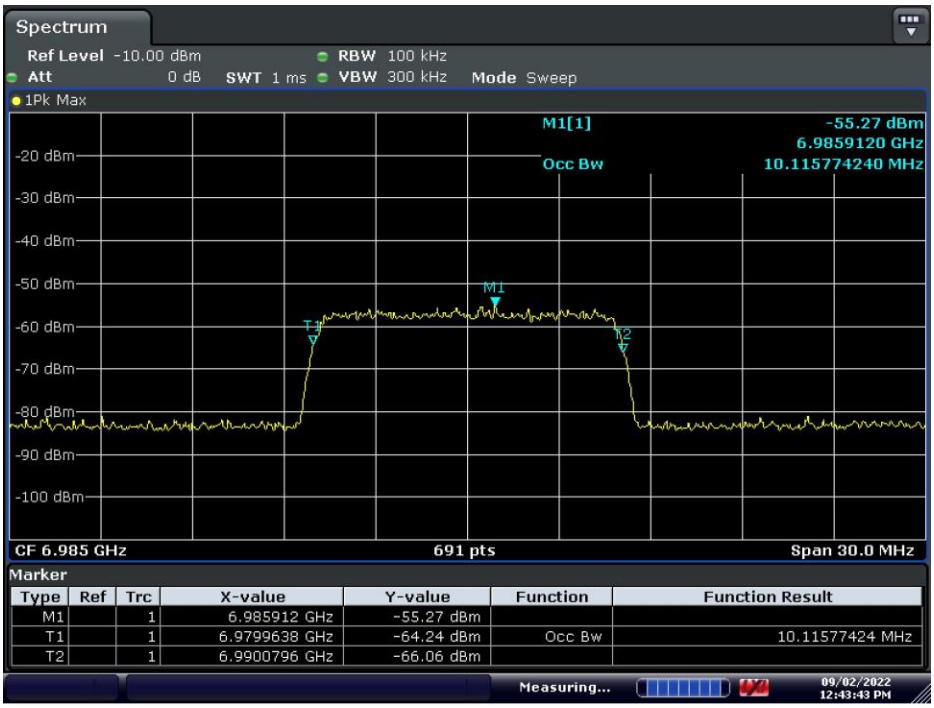
Plot 7-652. AWGN Signal – UNII 7 – 160MHz - High



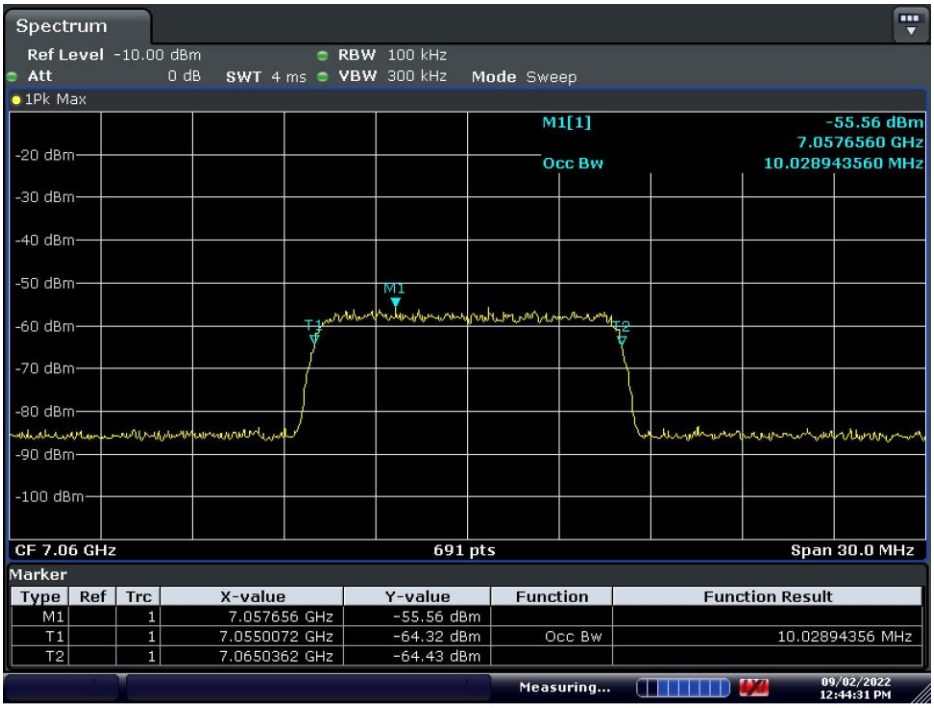
Plot 7-653. AWGN Signal – UNII 8 – 20MHz



Plot 7-654. AWGN Signal – UNII 8 – 160MHz - Low

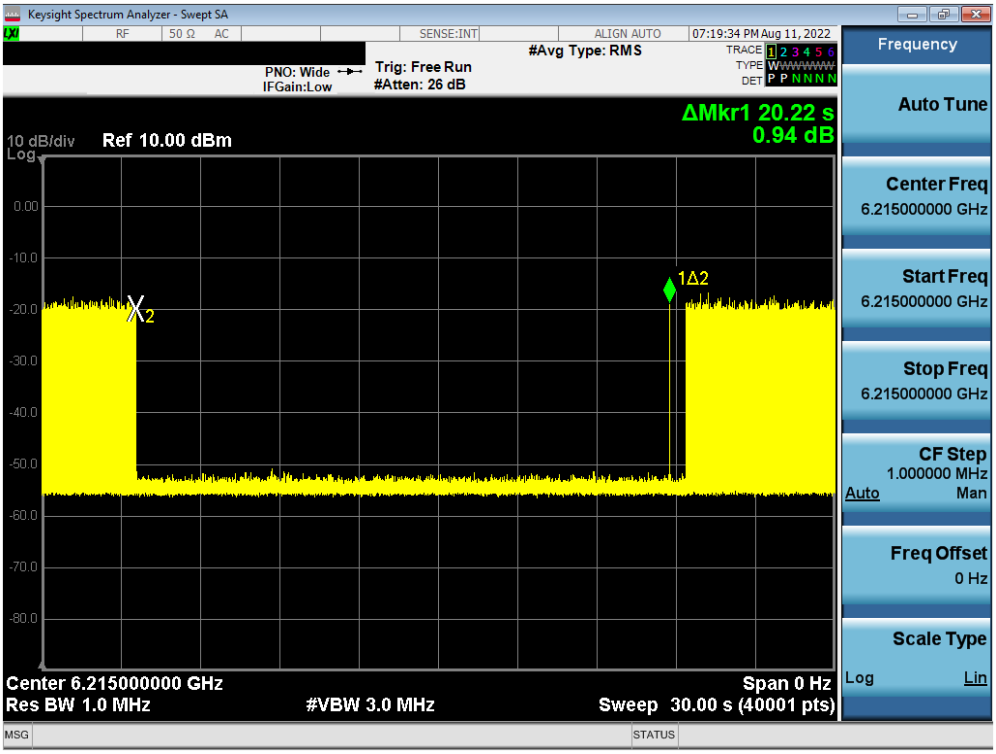


Plot 7-655. AWGN Signal – UNII 8 – 160MHz – Mid

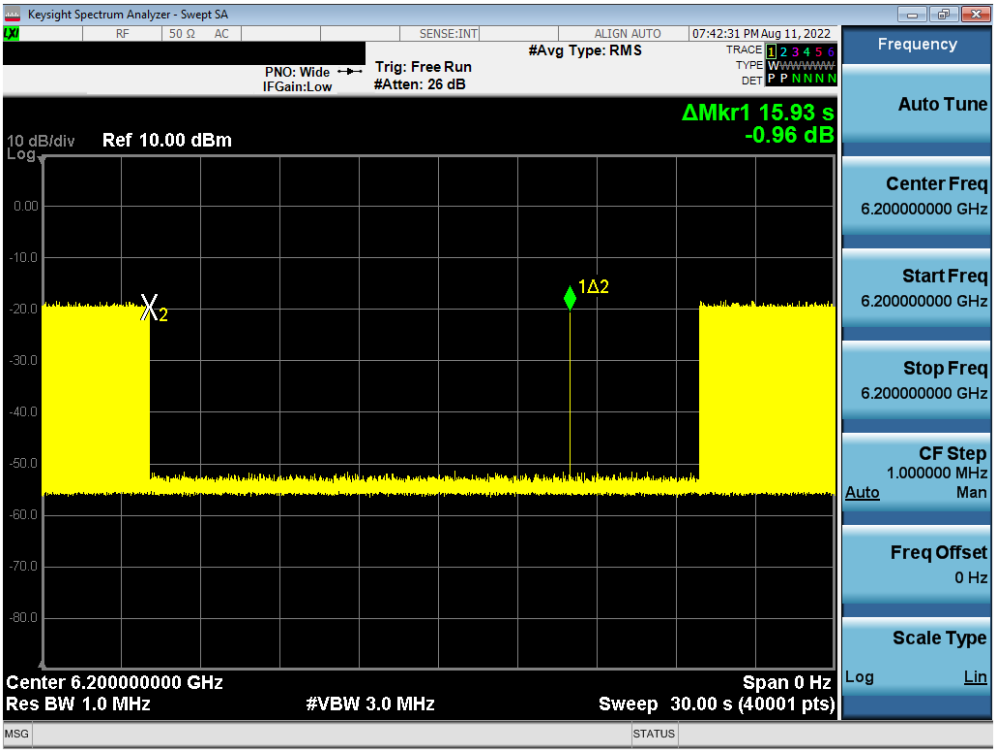


Plot 7-656. AWGN Signal – UNII 8 – 160MHz - High

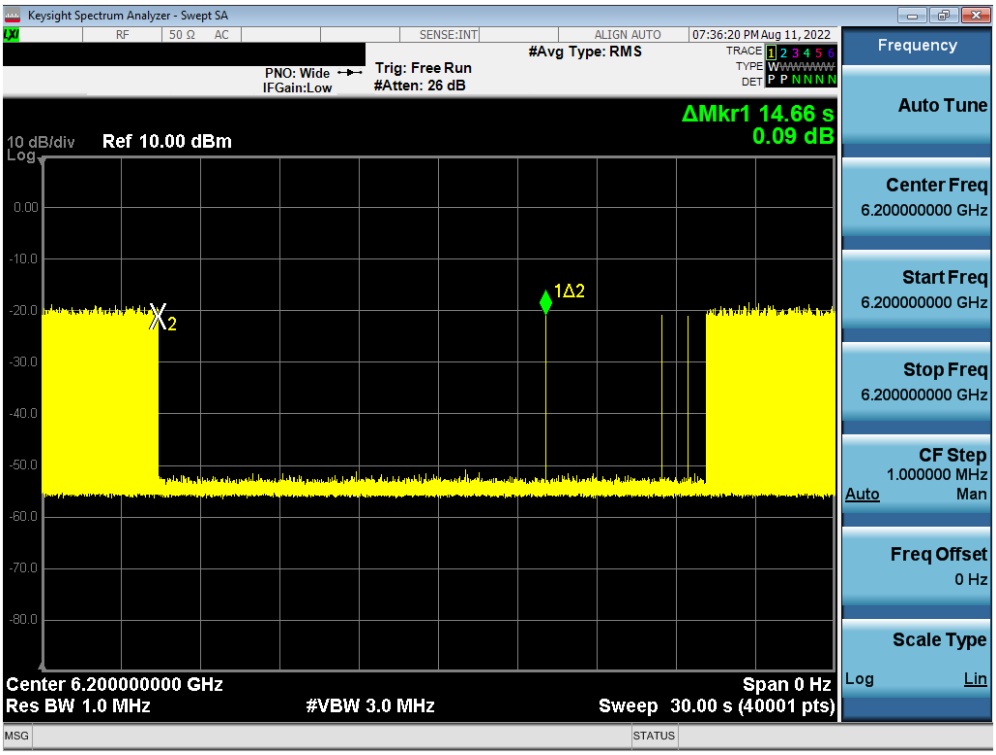
Contention-Based Protocol Timing Plots



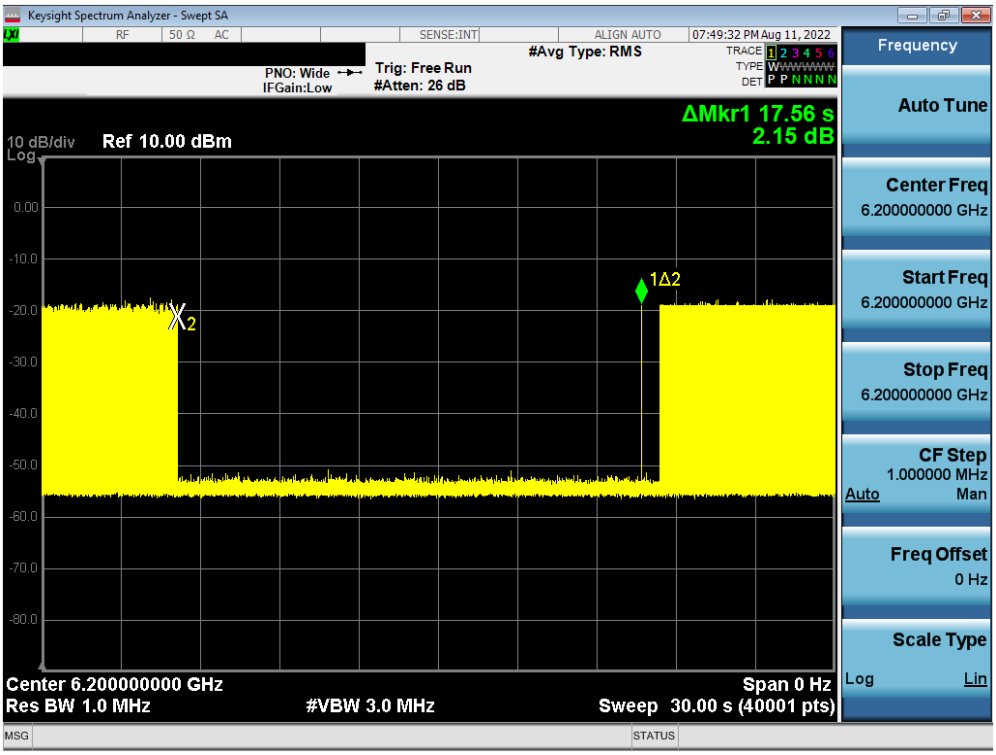
Plot 7-657. Contention Based Protocol Timing Plot – UNII 5 – 20MHz Channel 53



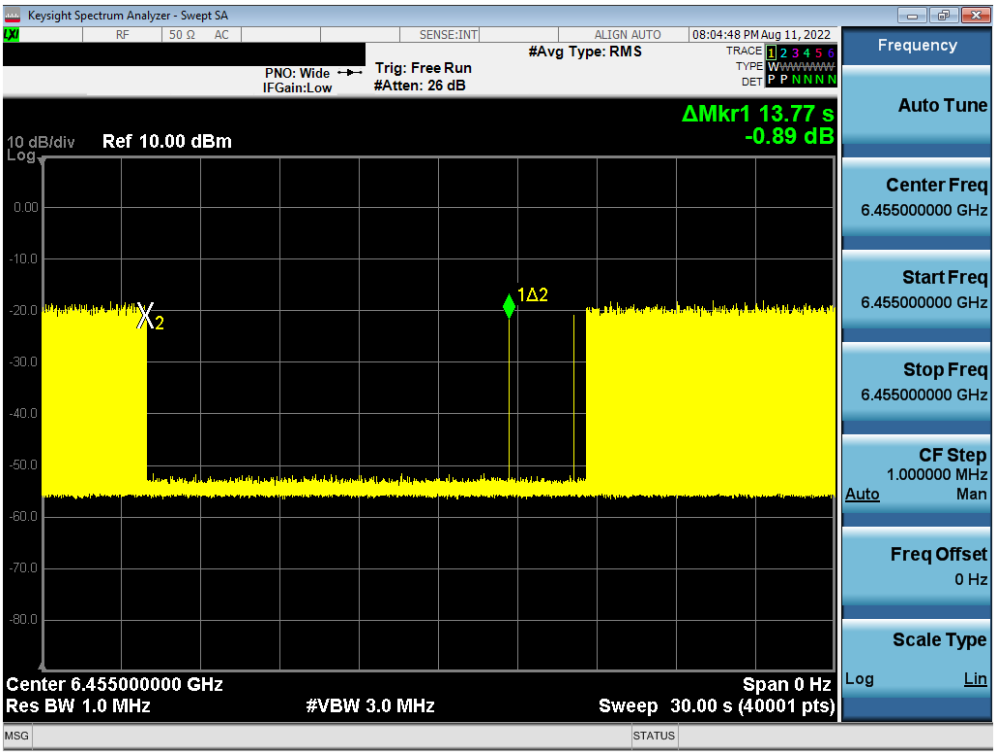
Plot 7-658. Contention Based Protocol Timing Plot – UNII 5 – 160MHz Channel 47 – Low



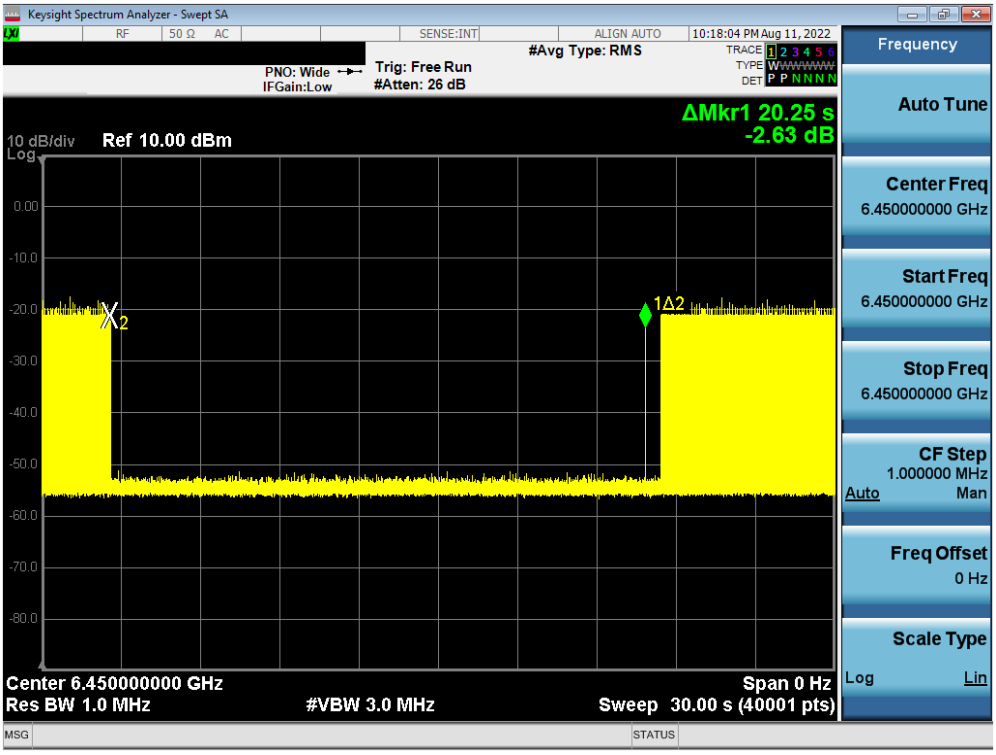
Plot 7-659. Contention Based Protocol Timing Plot – UNII 5 – 160MHz Channel 47 – Mid



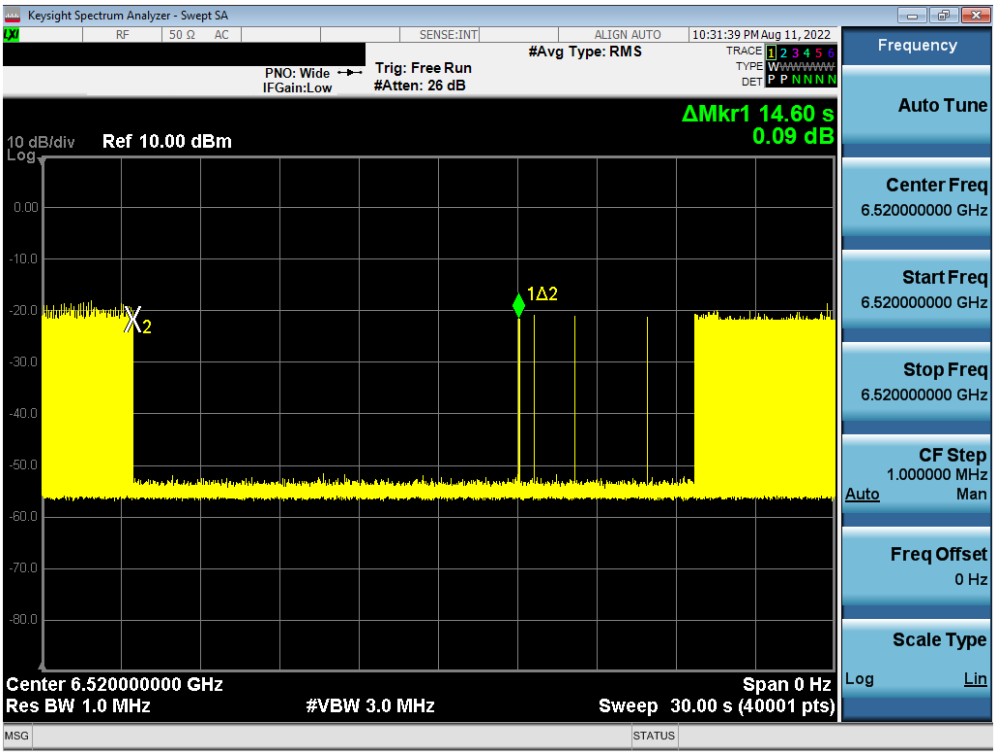
Plot 7-660. Contention Based Protocol Timing Plot – UNII 5 – 160MHz Channel 47 – High



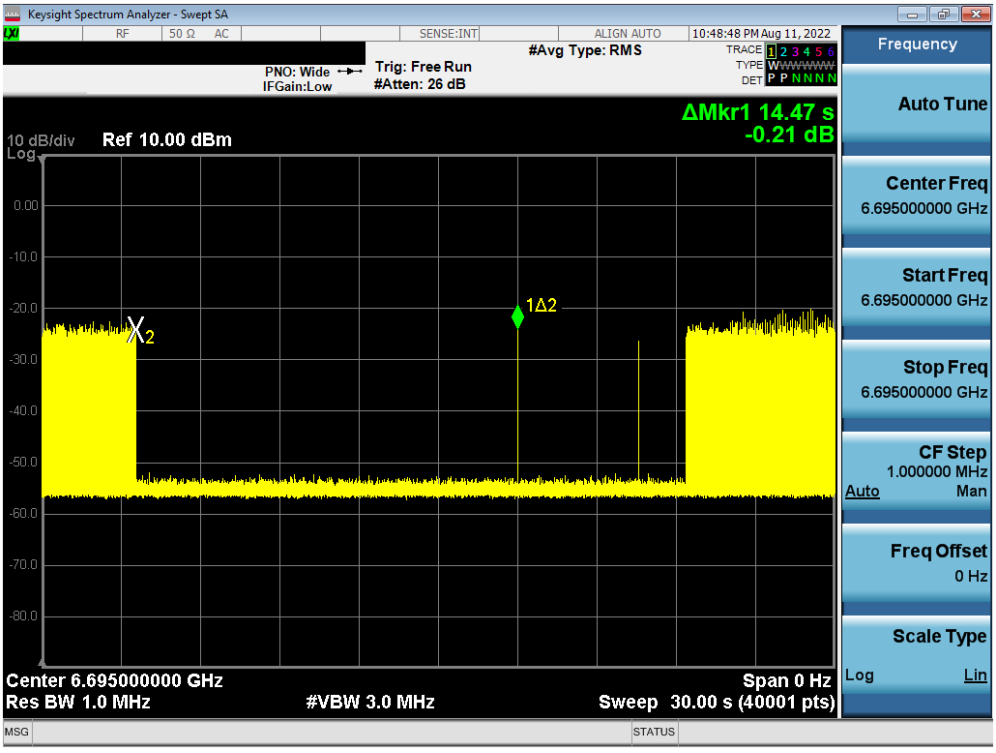
Plot 7-661. Contention Based Protocol Timing Plot – UNII 6 – 20MHz Channel 101



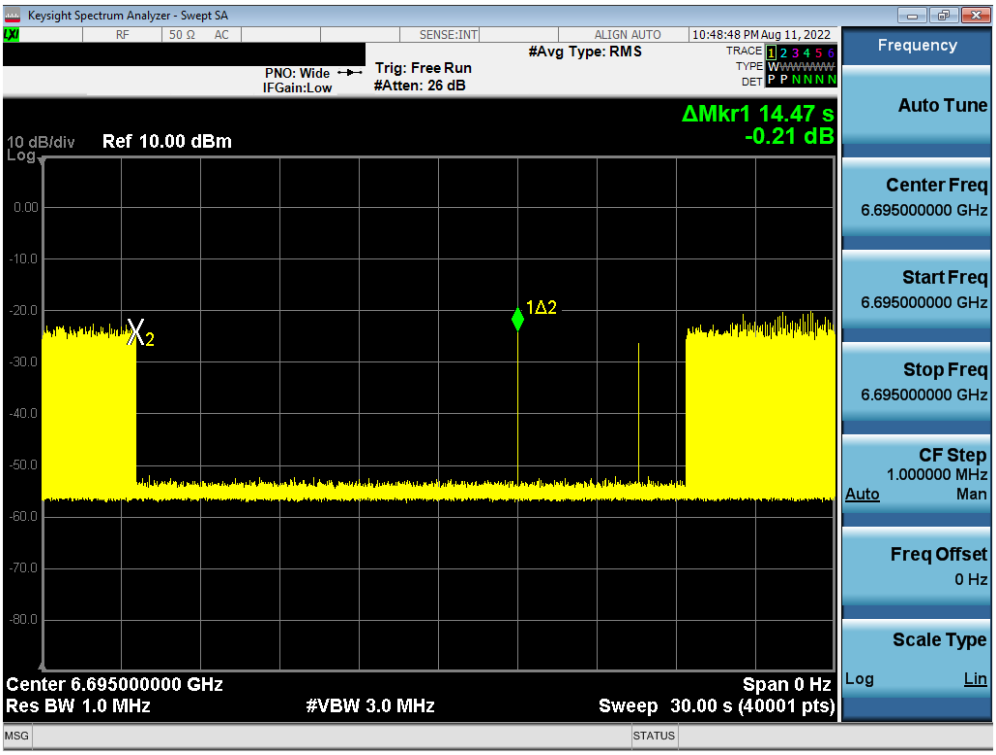
Plot 7-662. Contention Based Protocol Timing Plot – UNII 6 – 160MHz Channel 111 – Low



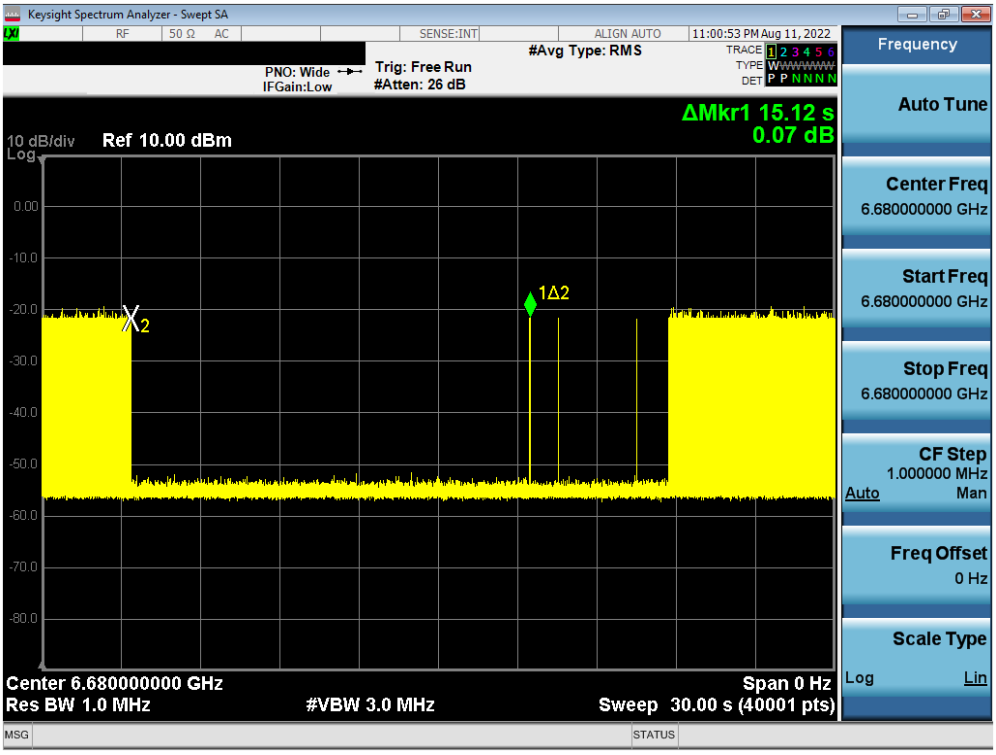
Plot 7-663. Contention Based Protocol Timing Plot – UNII 6 – 160MHz Channel 111 – Mid



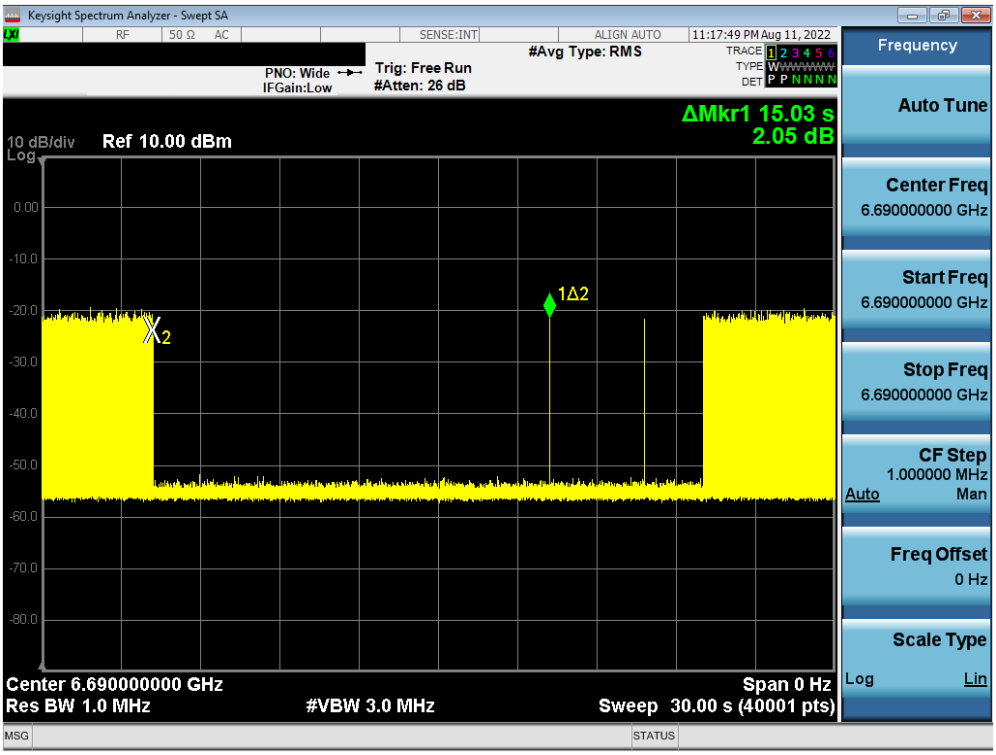
Plot 7-664. Contention Based Protocol Timing Plot – UNII 6 – 160MHz Channel 111 – High



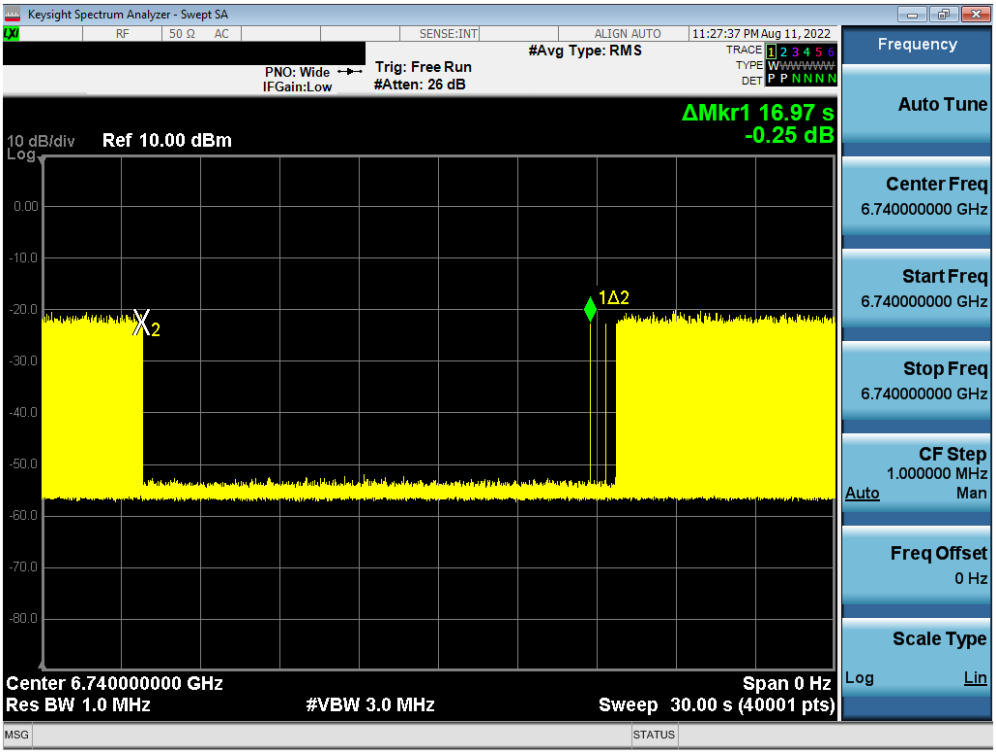
Plot 7-665. Contention Based Protocol Timing Plot – UNII 7 – 20MHz Channel 149



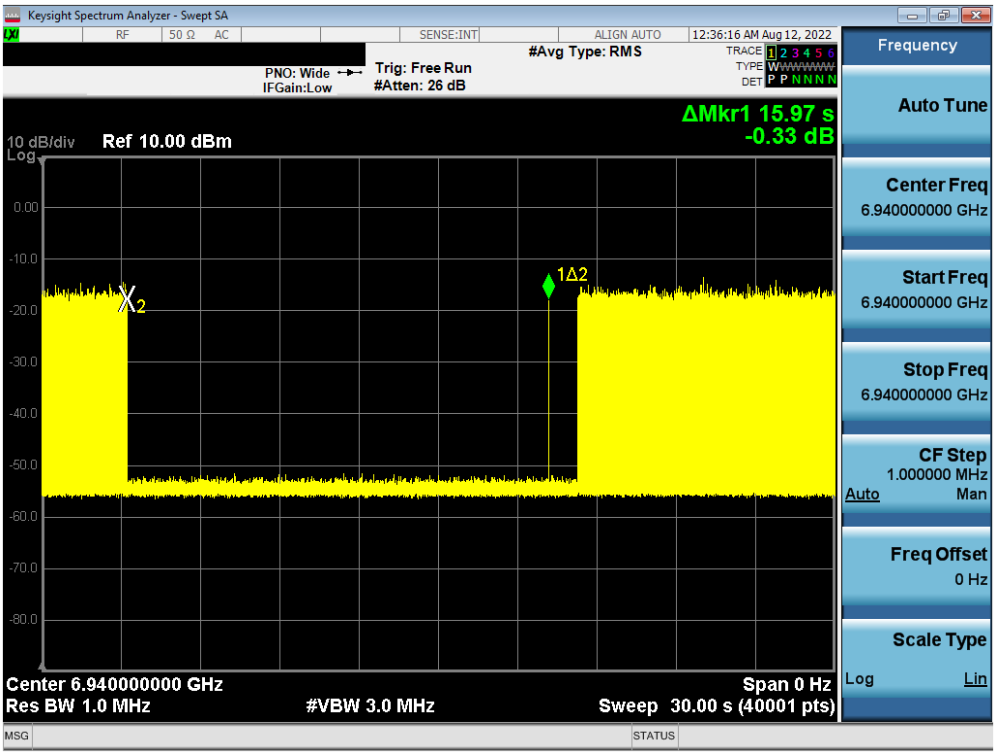
Plot 7-666. Contention Based Protocol Timing Plot – UNII 7 – 160MHz Channel 143 – Low



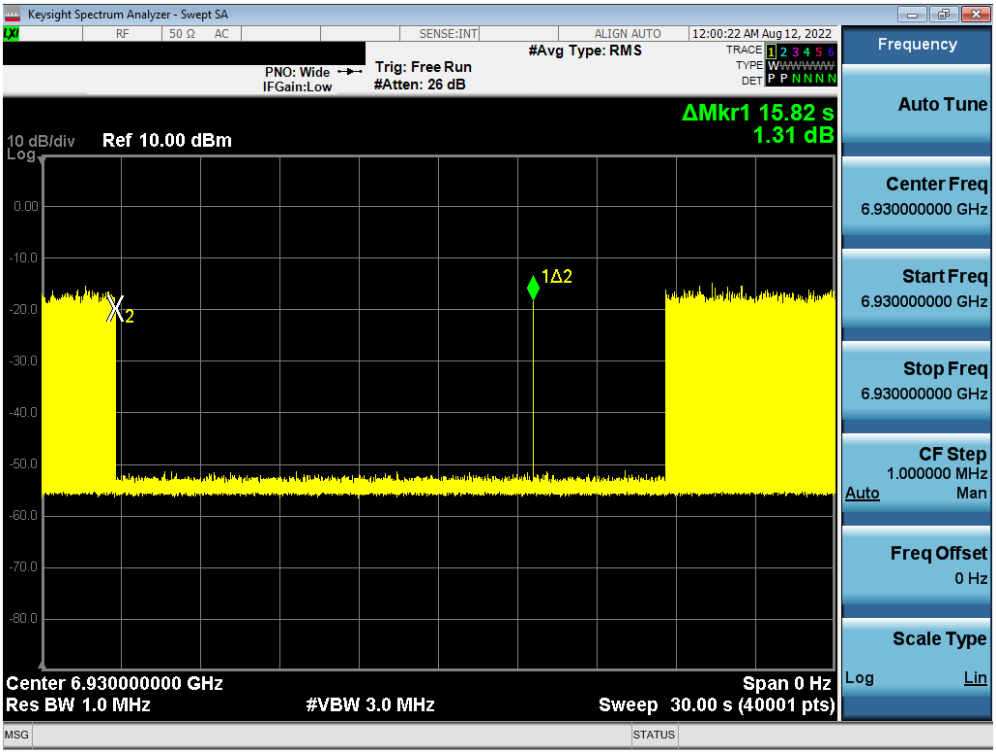
Plot 7-667. Contention Based Protocol Timing Plot – UNII 7 – 160MHz Channel 143 – Mid



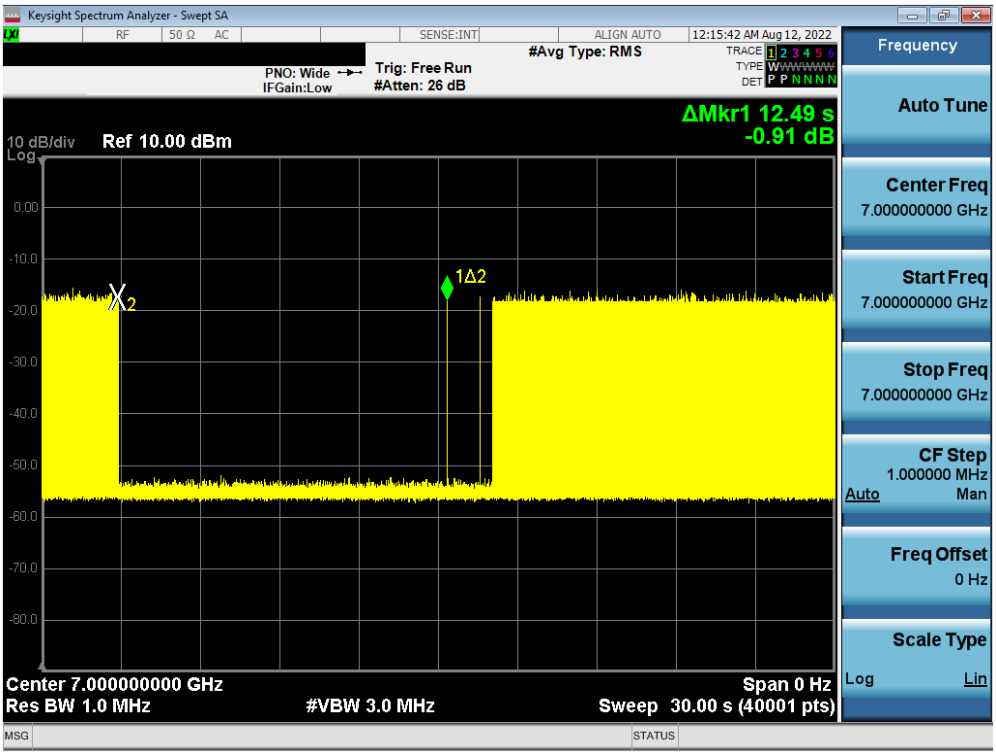
Plot 7-668. Contention Based Protocol Timing Plot – UNII 7 – 160MHz Channel 143 – High



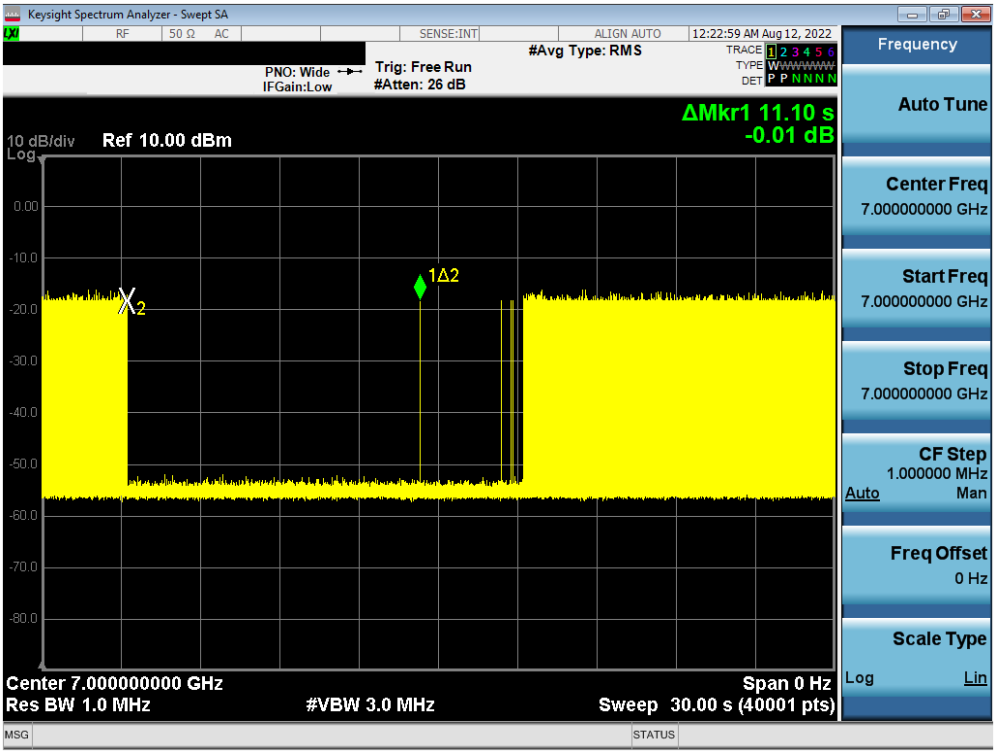
Plot 7-669. Contention Based Protocol Timing Plot – UNII 8 – 20MHz Channel 197



Plot 7-670. Contention Based Protocol Timing Plot – UNII 8 – 160MHz Channel 207 – Low



Plot 7-671. Contention Based Protocol Timing Plot – UNII 8 – 160MHz Channel 207 – Mid



Plot 7-672. Contention Based Protocol Timing Plot – UNII 8 – 160MHz Channel 207 – High

7.7 Radiated Spurious Emissions – Above 1GHz

§15.407(b) §15.205 §15.209; RSS-Gen [8.9]

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 KDB 789033 D02 v02r01, and at the appropriate frequencies. All channels, modes (e.g. 802.11a, 802.11n, 802.11ax(SU) (20MHz BW), 802.11n, 802.11ax(SU) (40MHz BW), and 802.11ac, 802.11ax(SU) (80MHz), 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.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 7 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-51 per Section 15.209 and RSS-Gen (8.9).

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

Table 7-51. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Sections 12.7.7.2, 12.7.6, 12.7.5
KDB 789033 D02 v02r01 – Section G

Test Settings

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points = 1001 (Number of points must be ≥ 2 x span/RBW)
6. Averaging type = power (RMS)
7. Sweep time = auto couple
8. Trace was averaged over 100 sweeps

Peak Field Strength Measurements

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

Test Setup

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

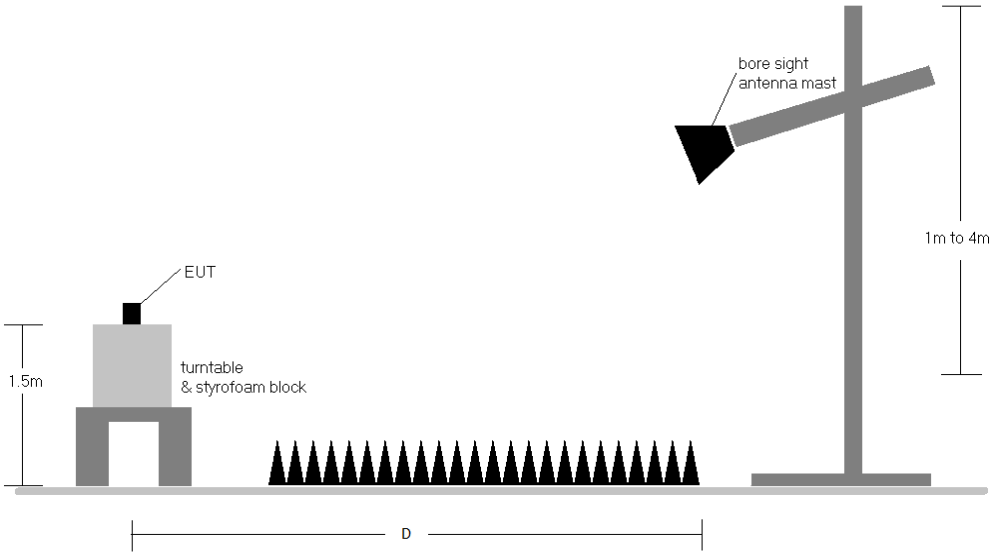


Figure 7-5. Test Instrument & Measurement Setup

Test Notes

1. All emissions that lie in the restricted bands (denoted by a * next to the frequency) specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-51.
2. All spurious emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-51. All spurious emissions that do not lie in a restricted band are subject to a peak limit of -27dBm/MHz. At a distance of 3 meters, the field strength limit in dBμV/m can be determined by adding a "conversion" factor of 95.2dB to the EIRP limit of -27dBm/MHz to obtain the limit for out of band spurious emissions of 68.2dBμV/m.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. This unit was tested with its standard battery.
5. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas.
6. D is the measurement test distance and emissions 1-18GHz were measured at a 3 meters test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The 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. All data rates were investigated and only the worse case is reported
9. The unit was tested with all possible modes and only the highest emission is reported.
10. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

Determining Spurious Emissions Levels

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

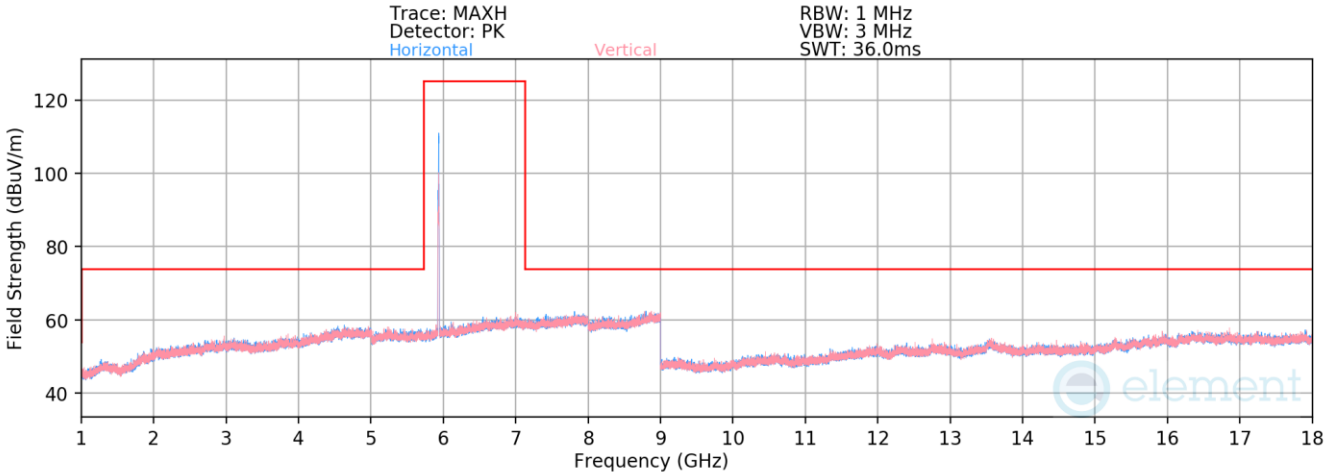
Radiated Band Edge Measurement Offset

- The amplitude offset shown in the radiated restricted band edge plots in Section 7.5 was calculated using the formula:

  Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain

7.7.1 Antenna 5b Primary Radiated Spurious Emission

RU26



Plot 7-673. Radiated Spurious Emissions above 1GHz Antenna 5b (802.11ax – Ch. 1 – RU26)

Mode:	802.11ax
Data Rate:	MCS0
Distance of Measurements:	3 Meters
Operating Frequency:	5955MHz
Channel:	1

	Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
*	11870.00	Peak	H	-	-	-72.51	16.96	51.45	73.98	-22.53
*	11870.00	Average	H	-	-	-83.45	16.96	40.51	53.98	-13.47
*	17805.00	Peak	H	-	-	-72.53	21.89	56.36	73.98	-17.62
*	17805.00	Average	H	-	-	-84.19	21.89	44.70	53.98	-9.28

Table 7-52. Radiated Spurious Emission Measurements Antenna 5b – RU26