

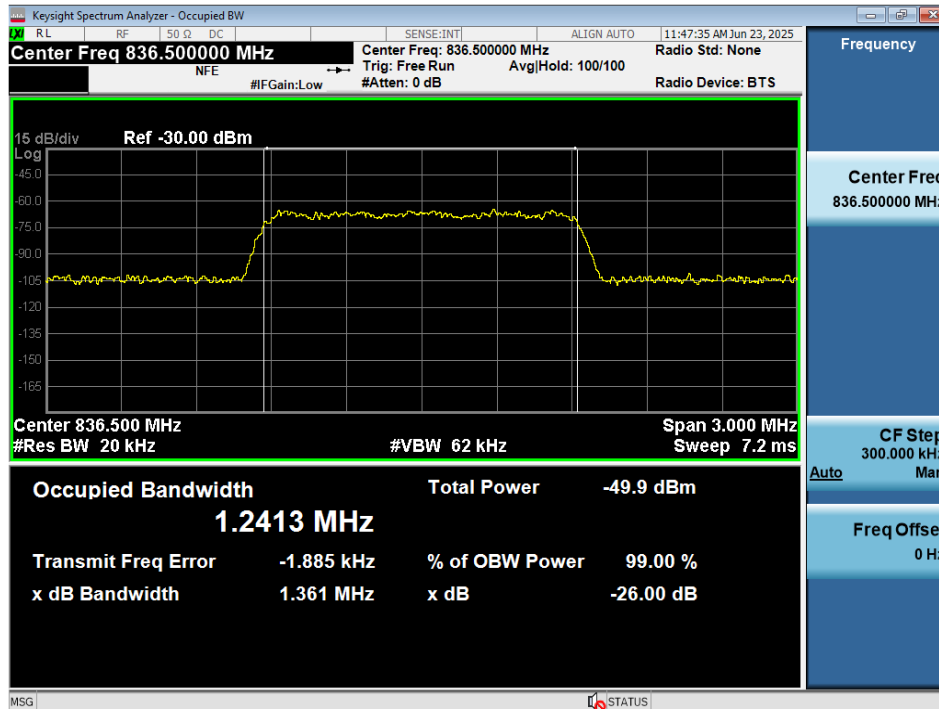
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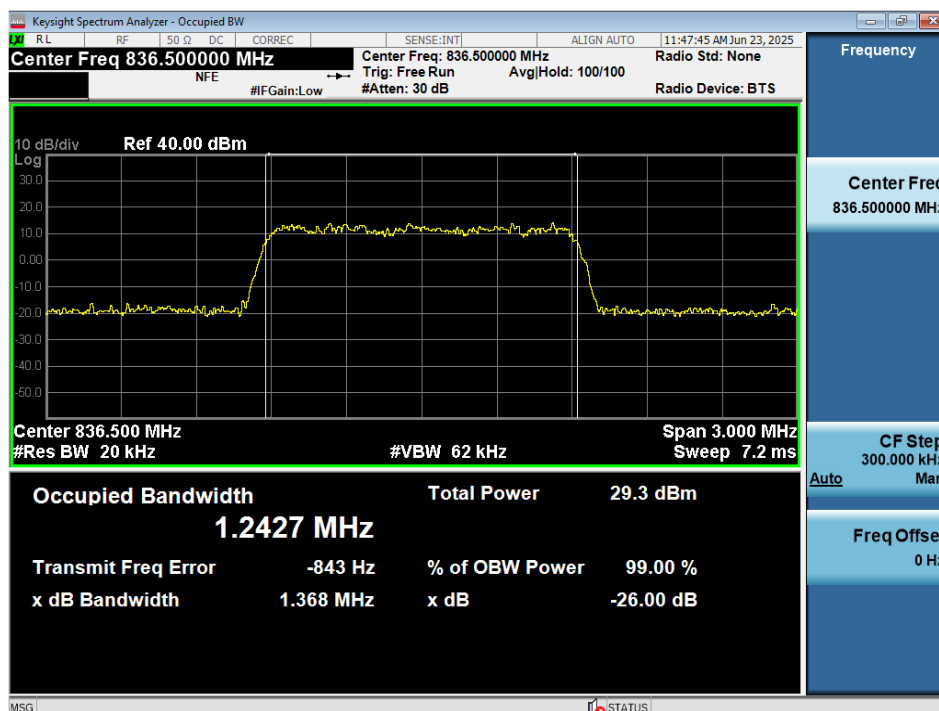
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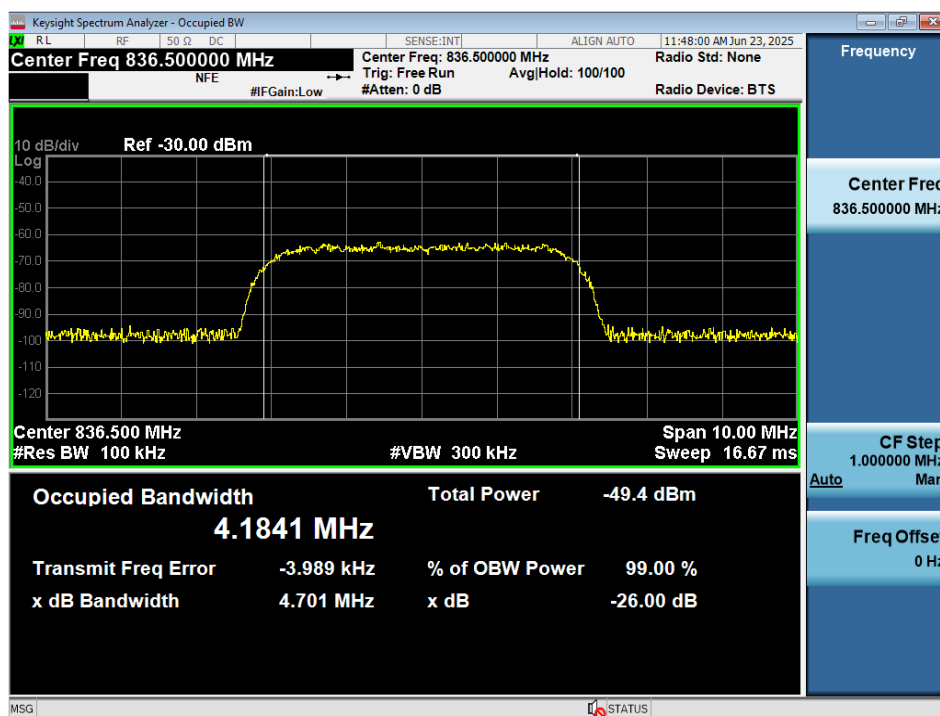
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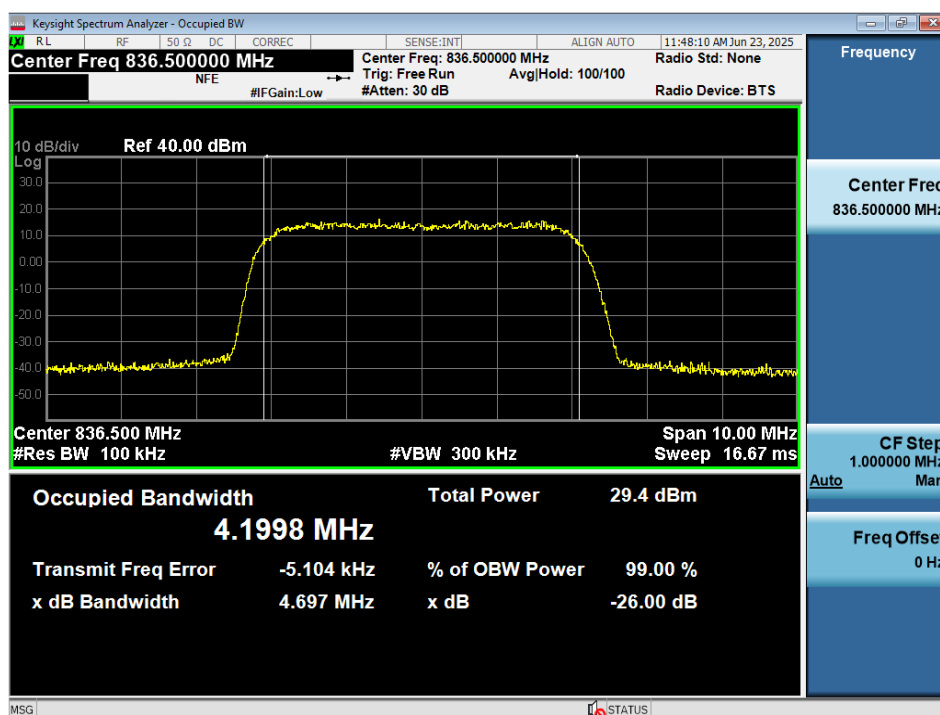
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Occupied Bandwidth / Cellular / Uplink / WCDMA/ Input / ANT 2



Occupied Bandwidth / Cellular / Uplink / WCDMA / Output / ANT 2



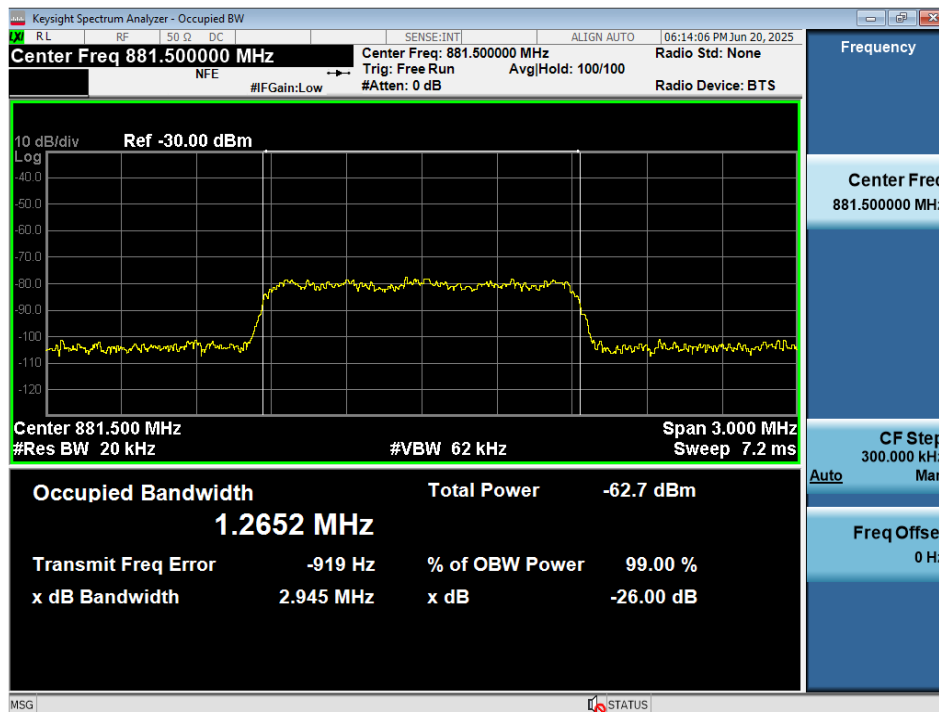
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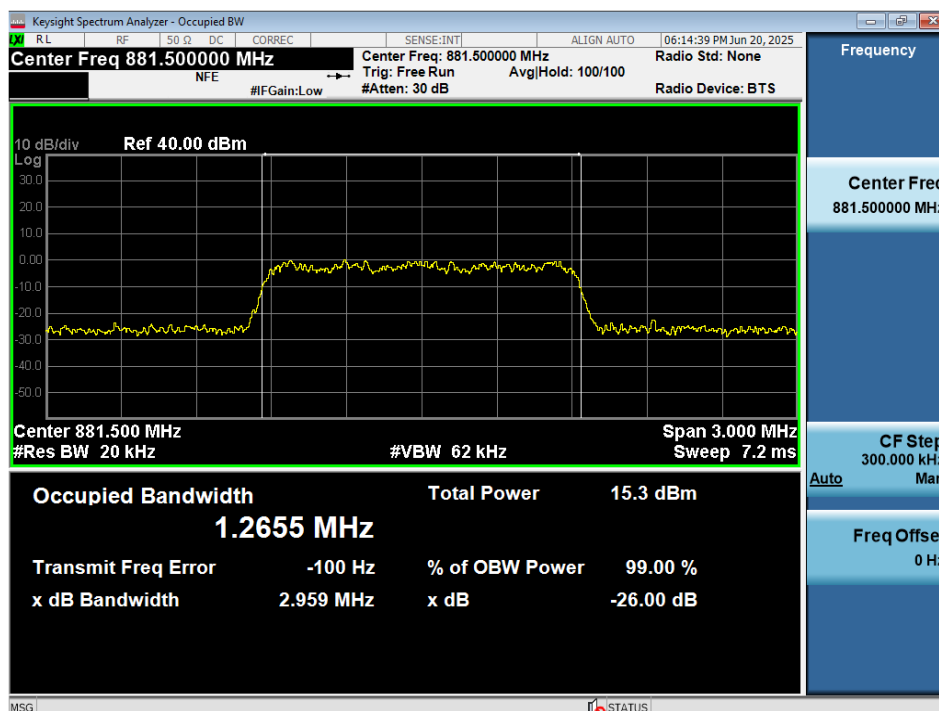
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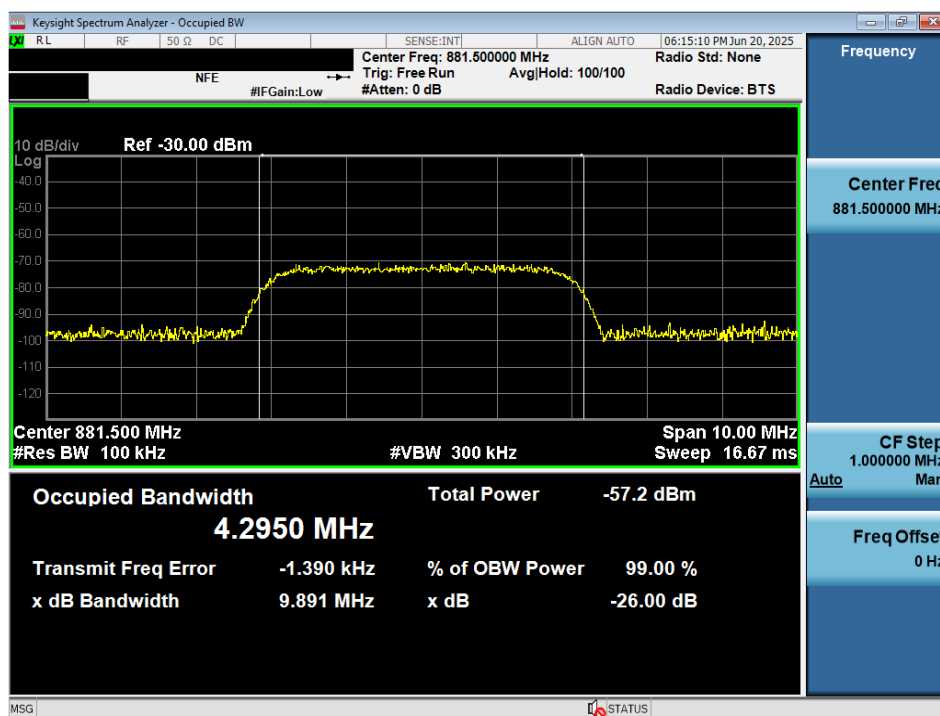
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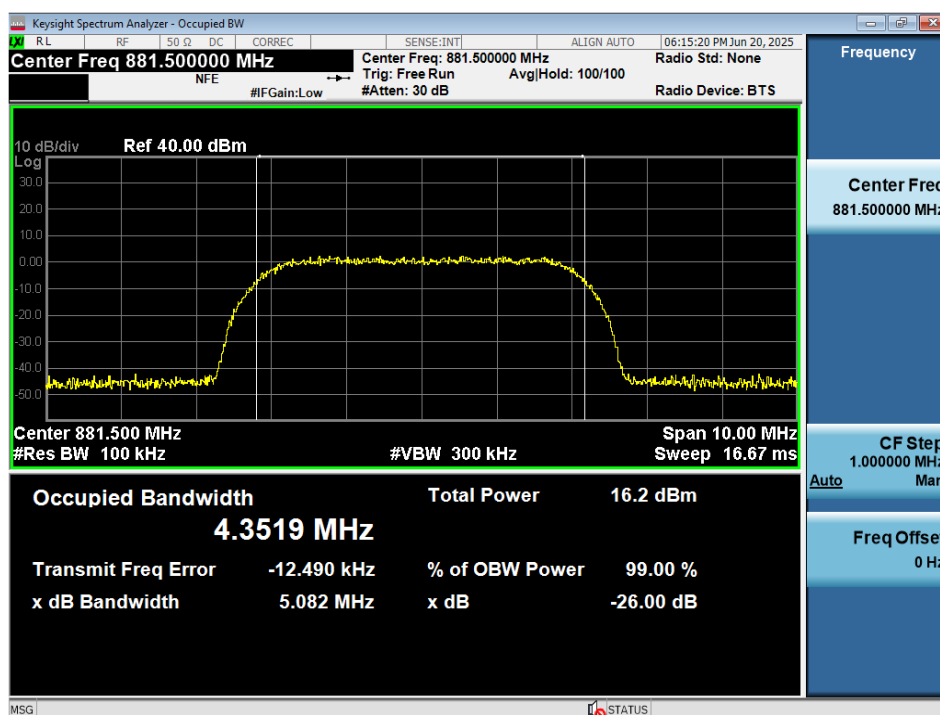
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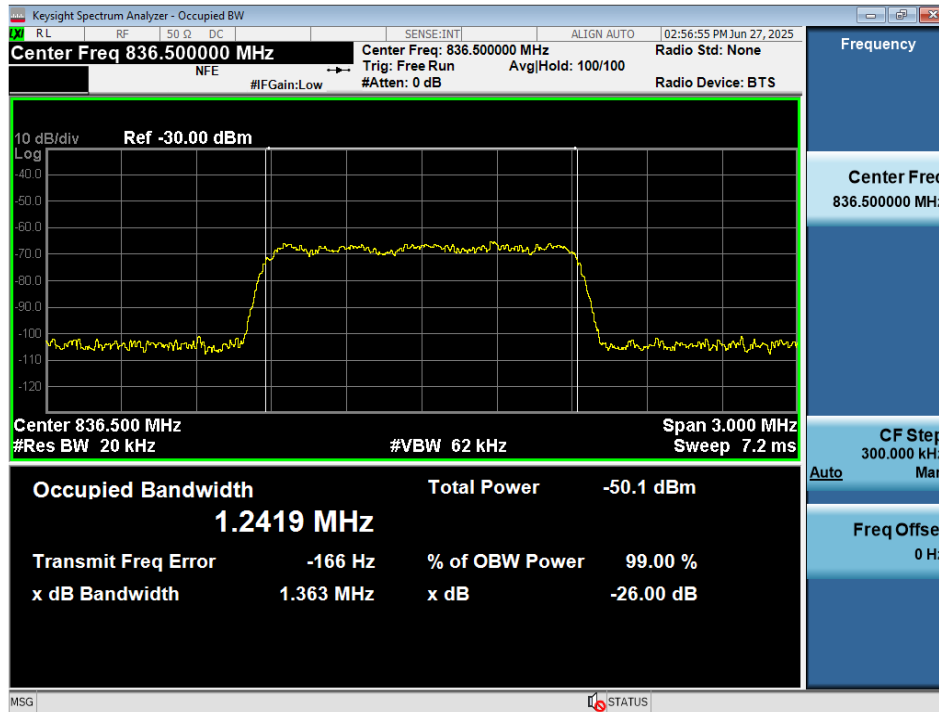
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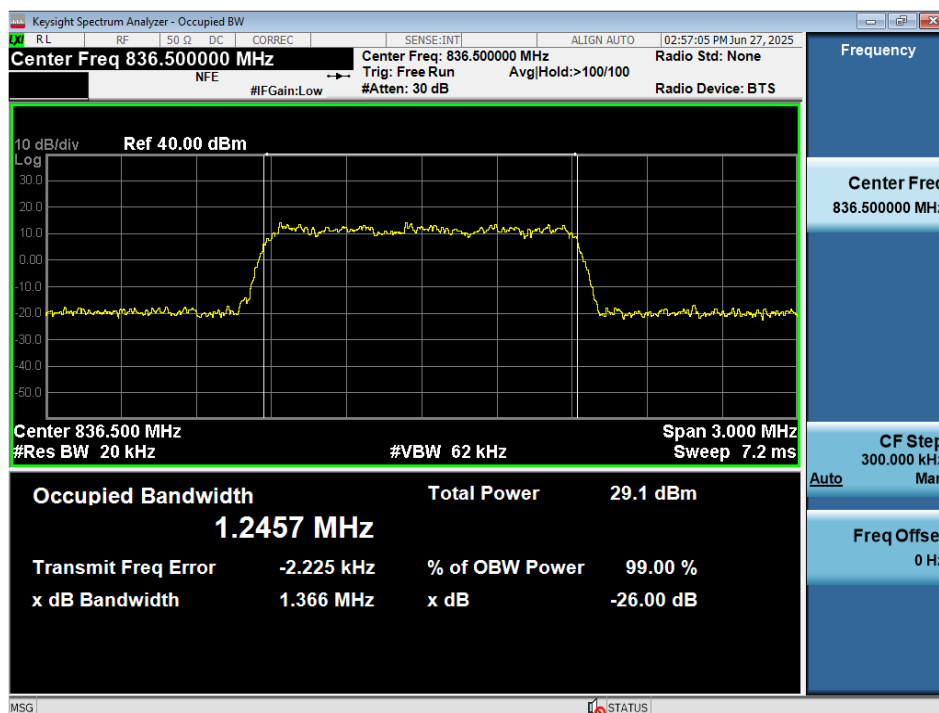
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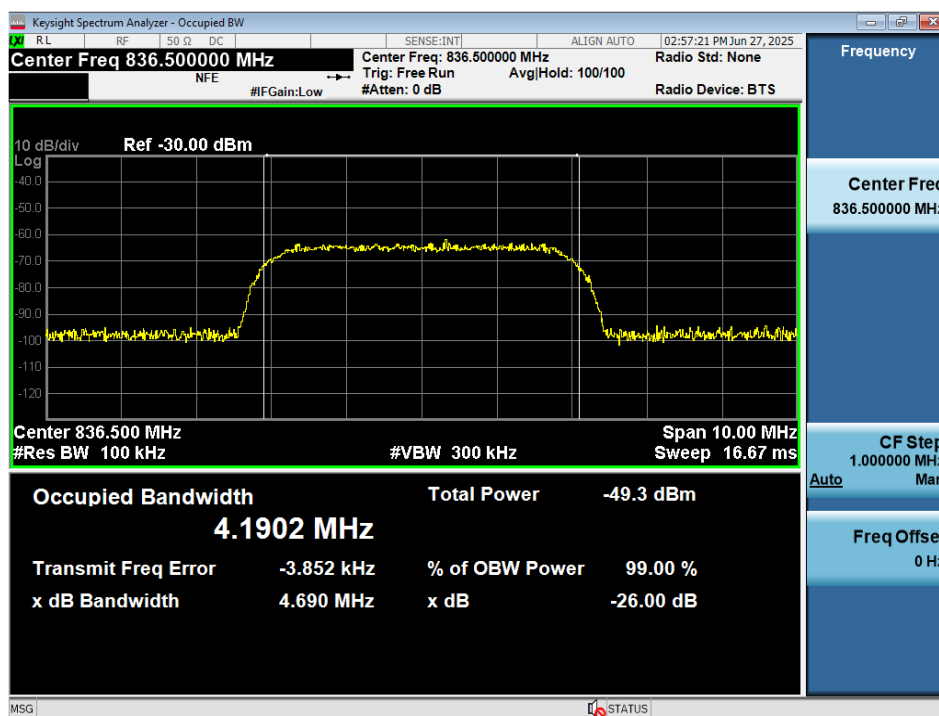
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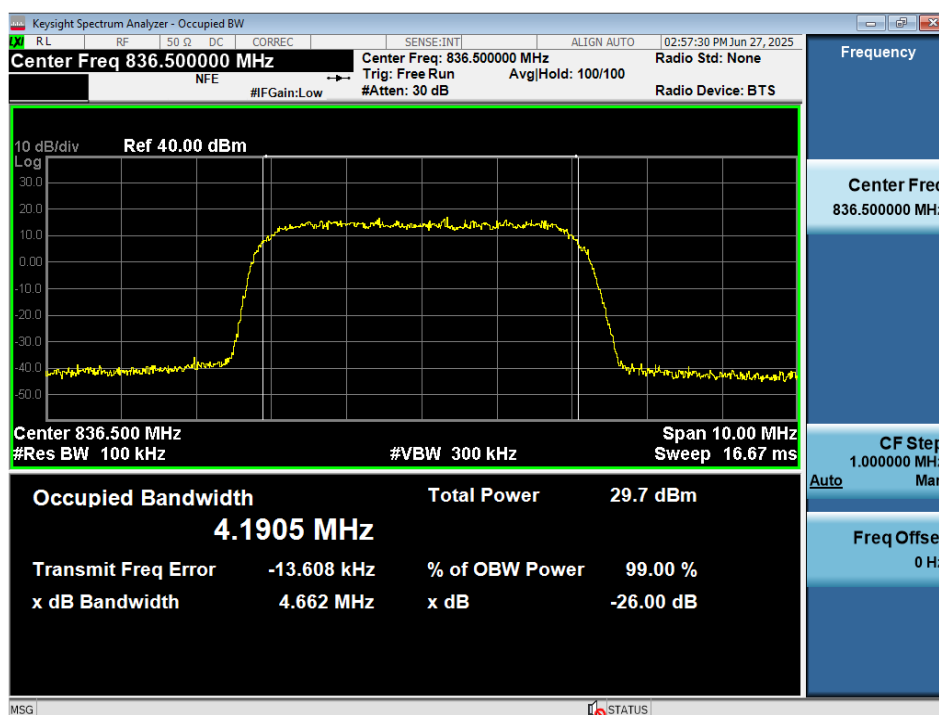
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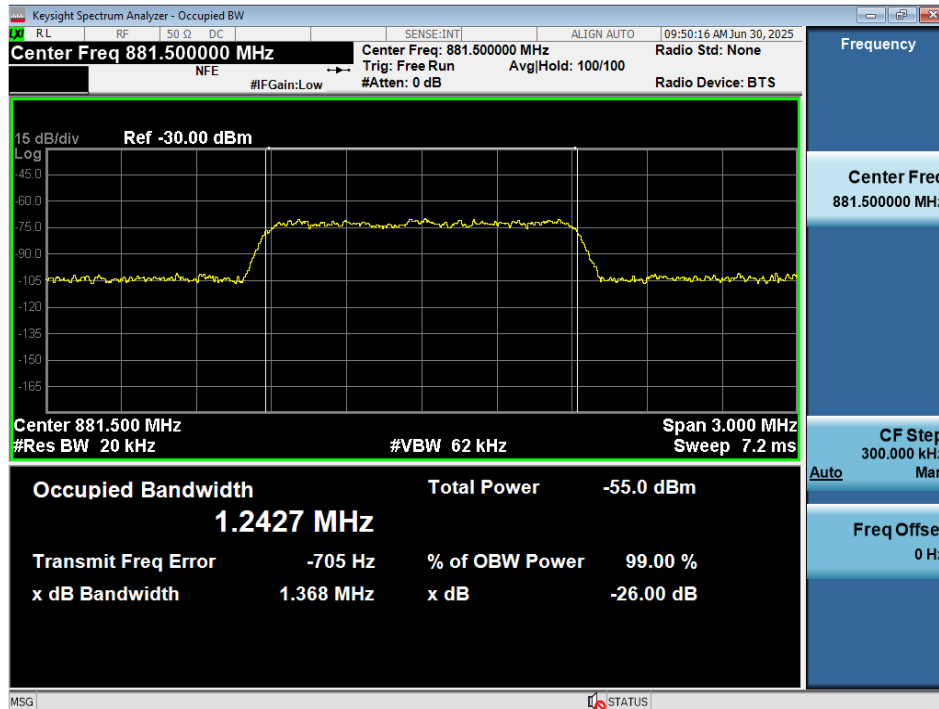
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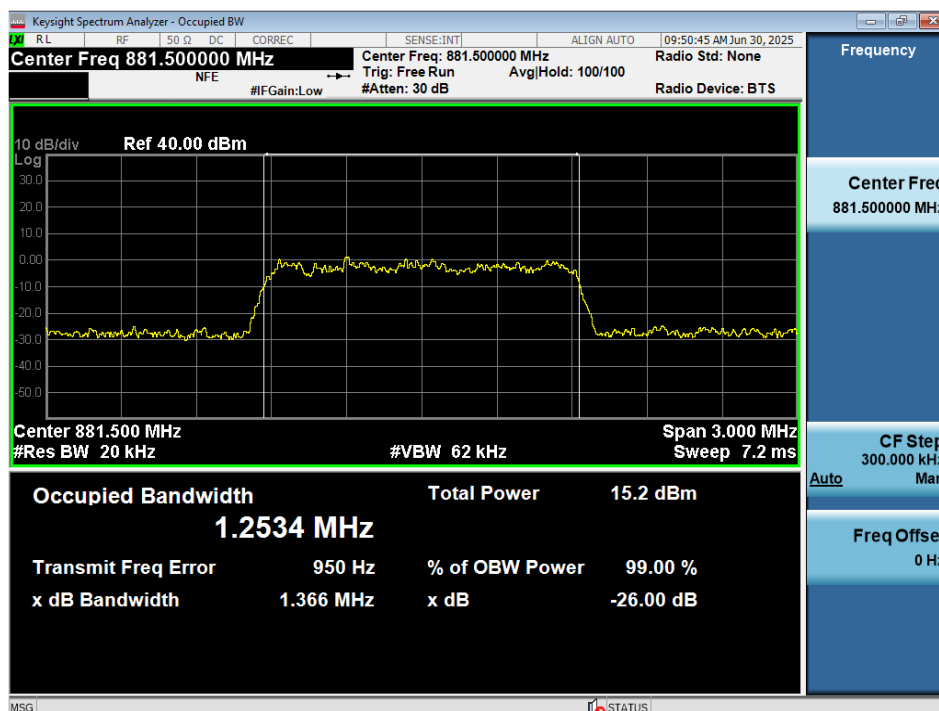
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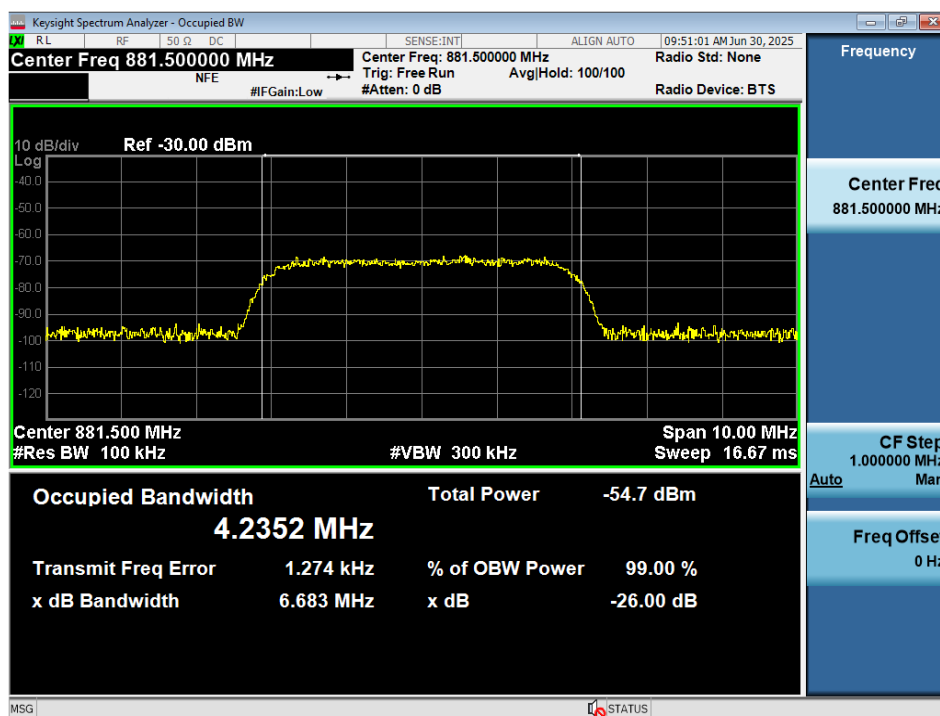
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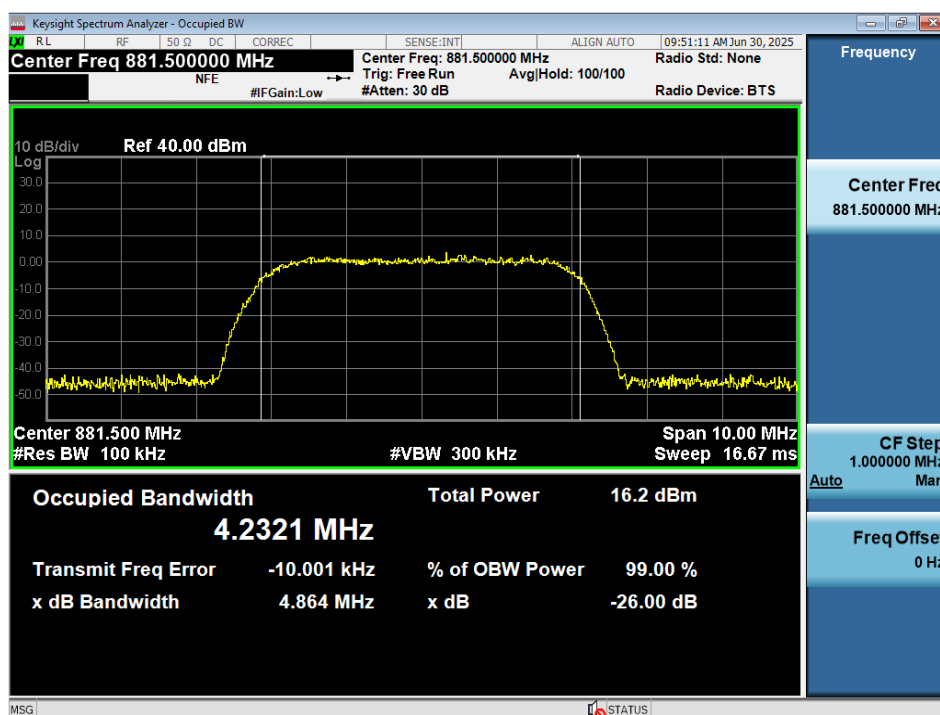
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Occupied Bandwidth / Cellular / Downlink / WCDMA/ Input / ANT 3



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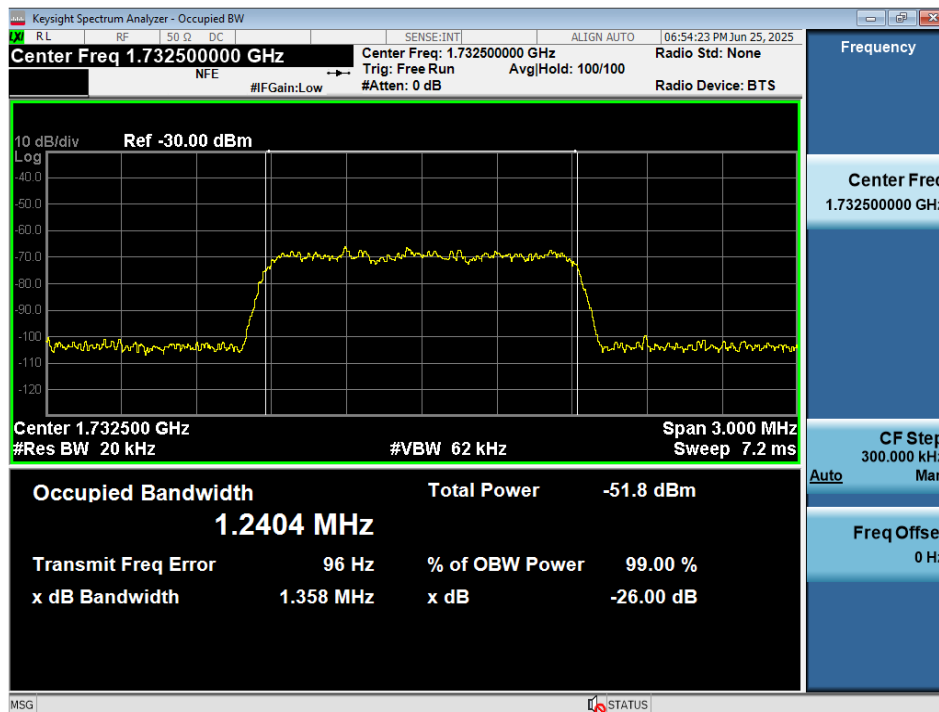
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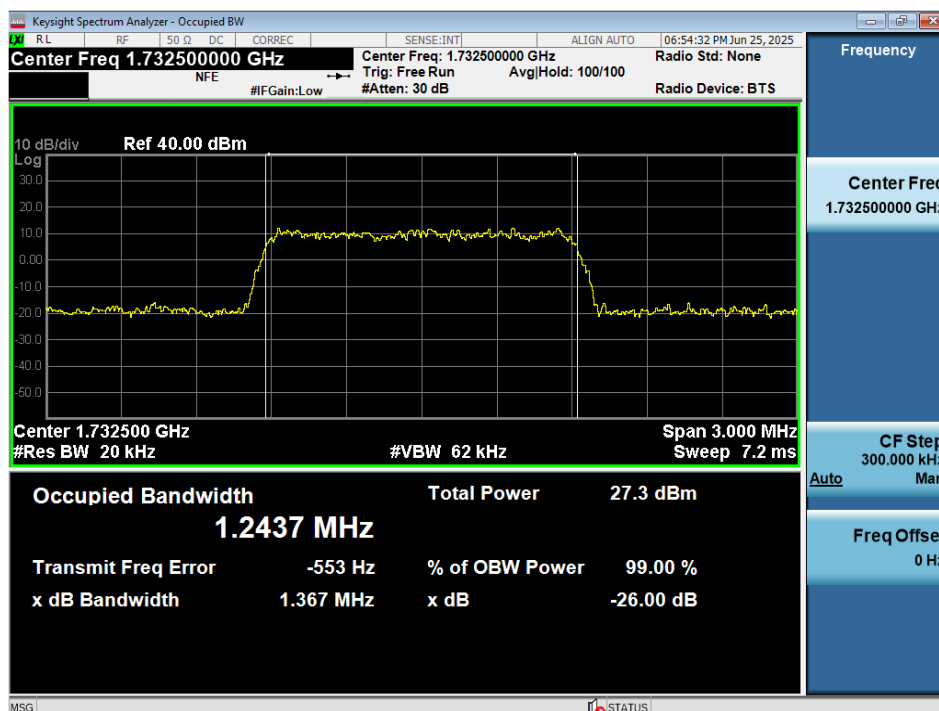
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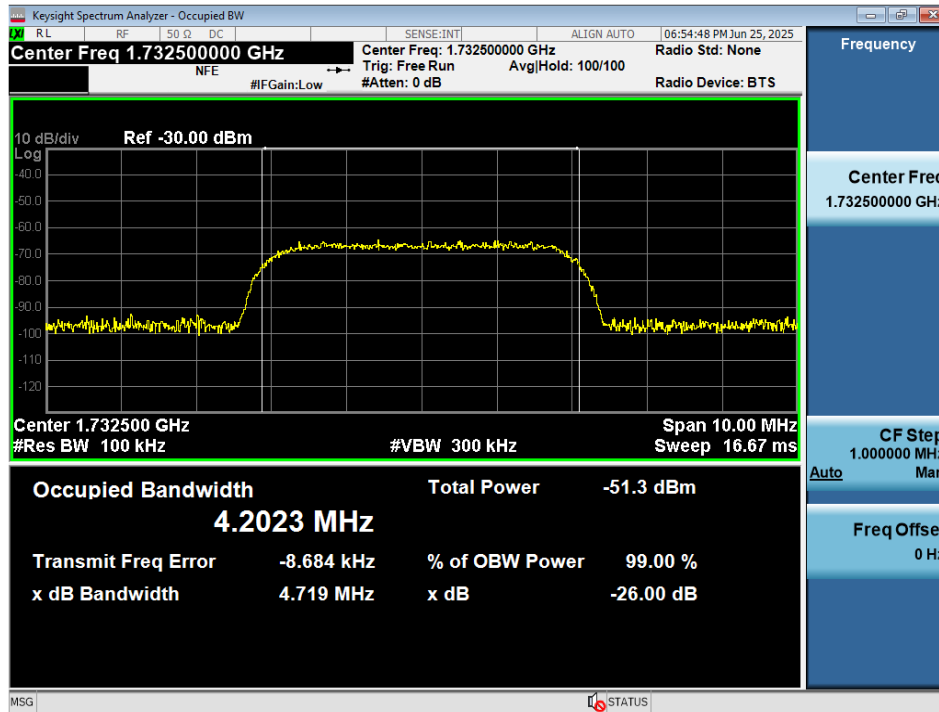
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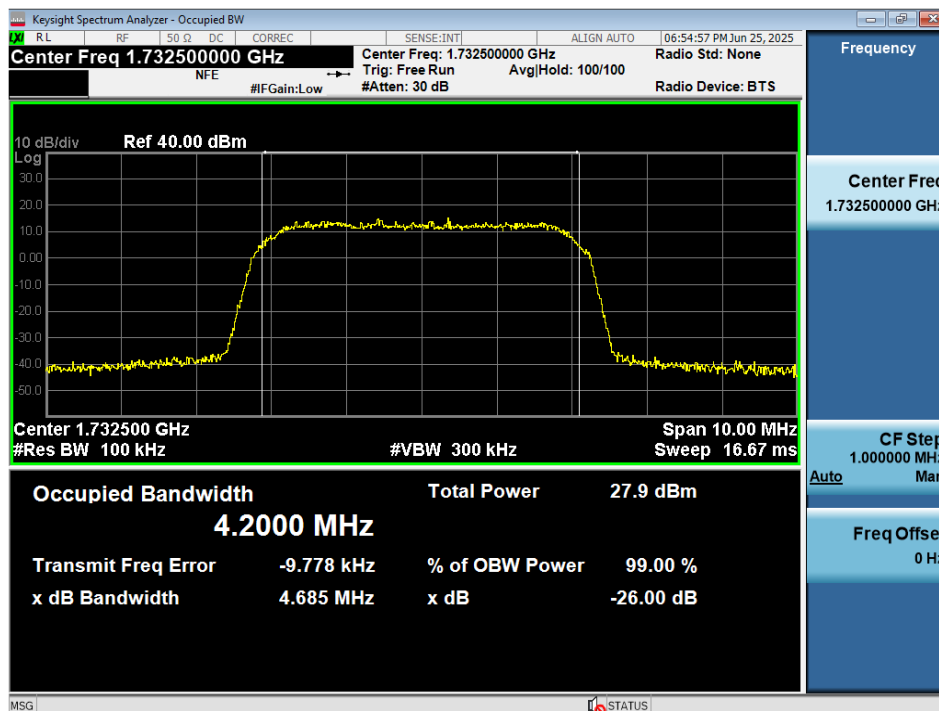
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Occupied Bandwidth / AWS-1 / Uplink / WCDMA/ Input / ANT 1



Occupied Bandwidth / AWS-1 / Uplink / WCDMA / Output / ANT 1



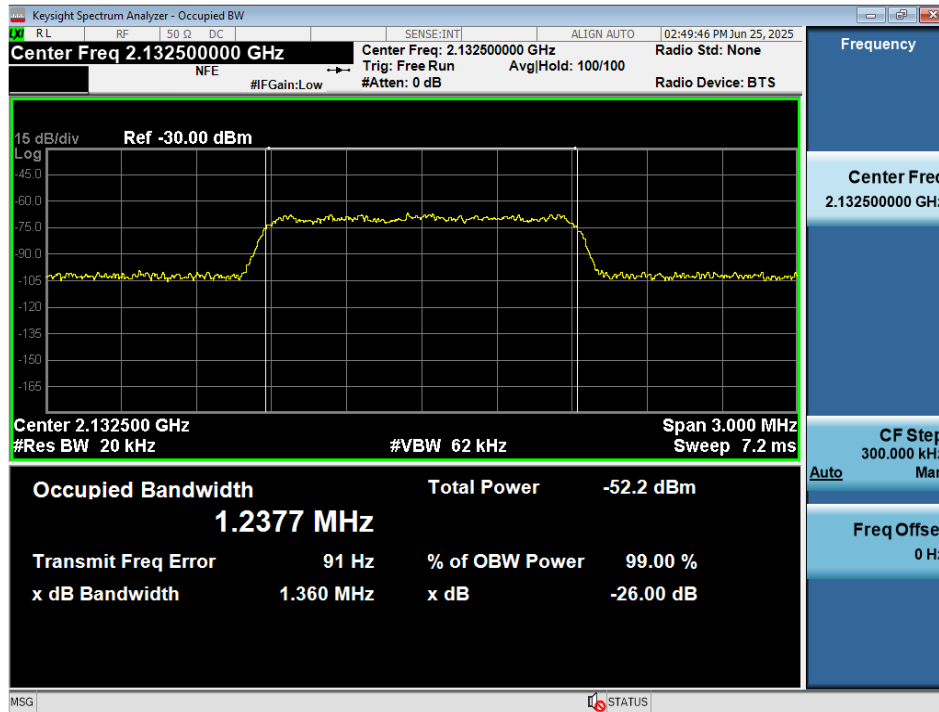
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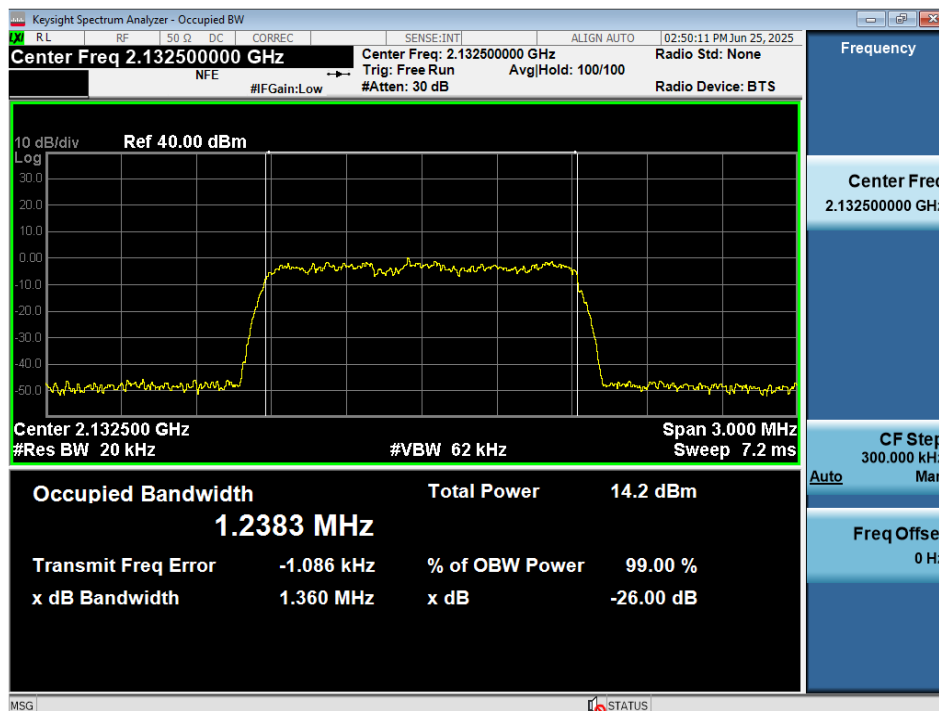
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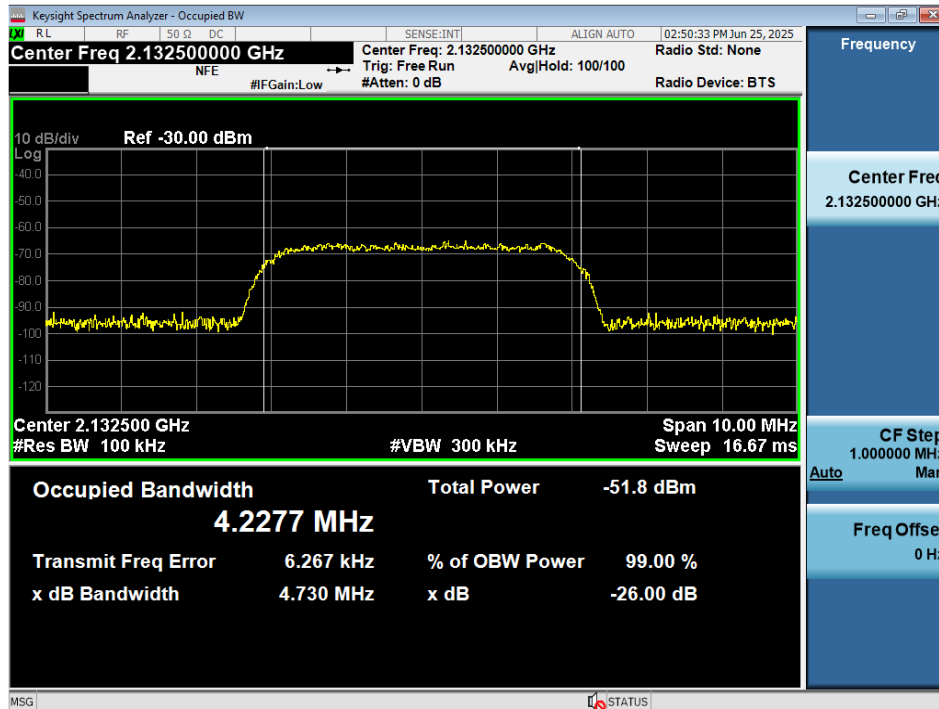
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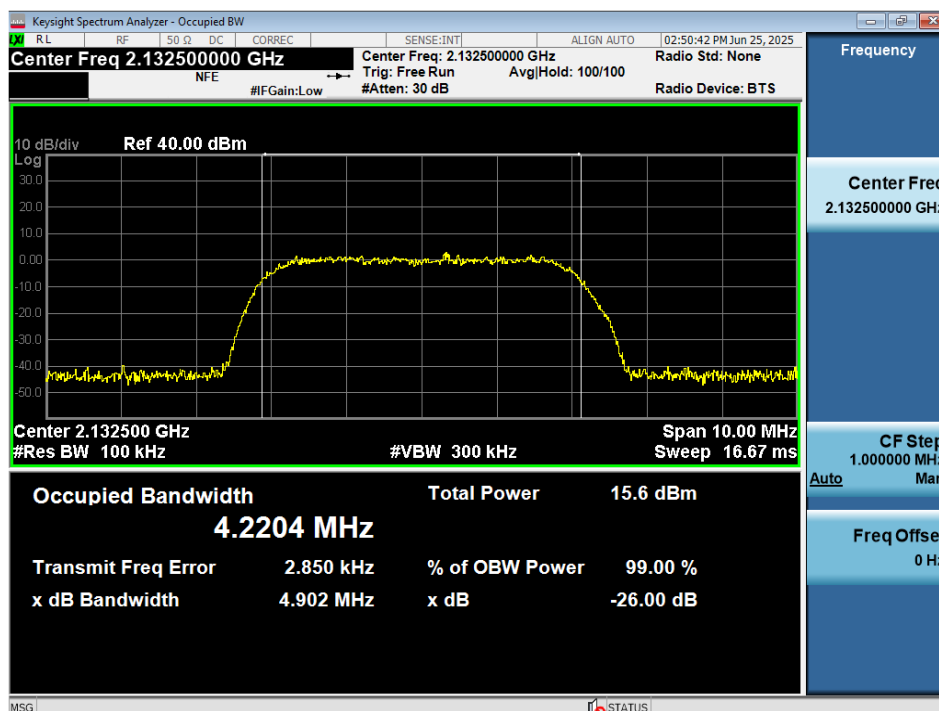
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Occupied Bandwidth / AWS-1 / Downlink / WCDMA/ Input / ANT 1



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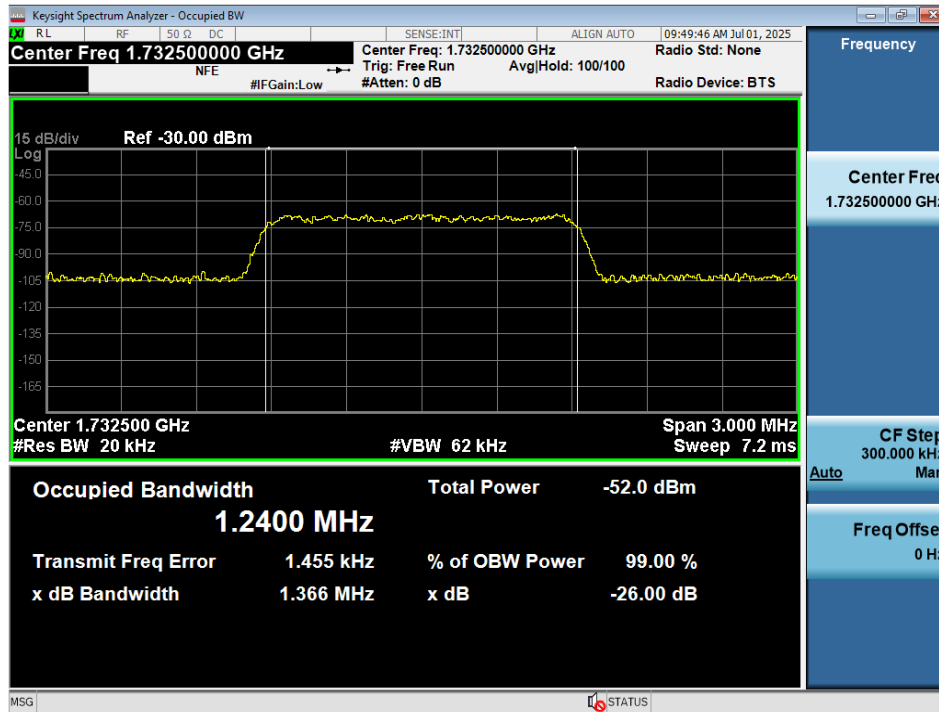
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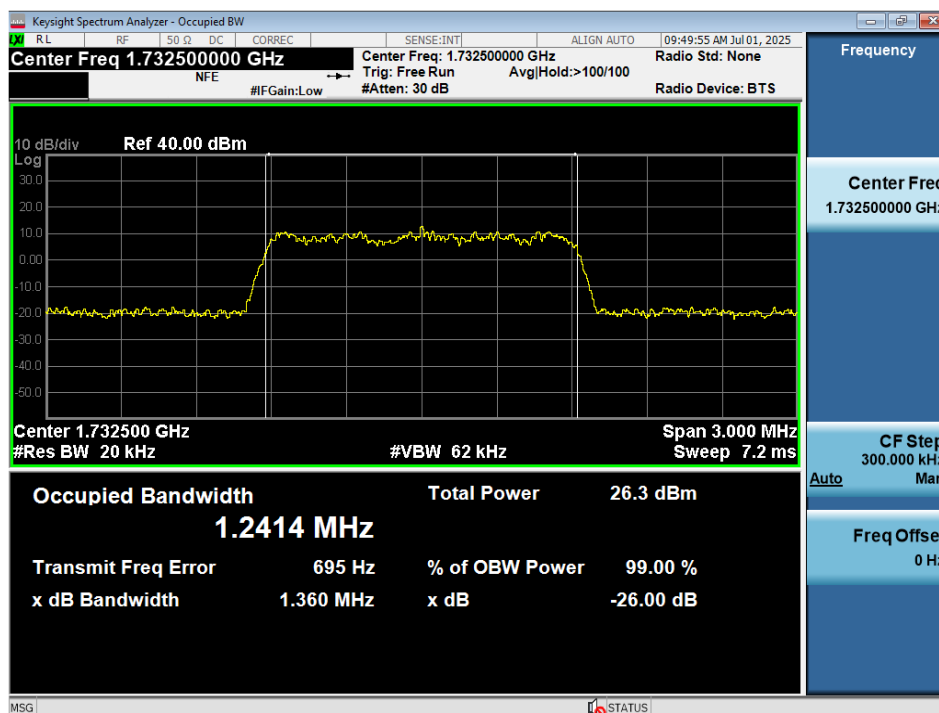
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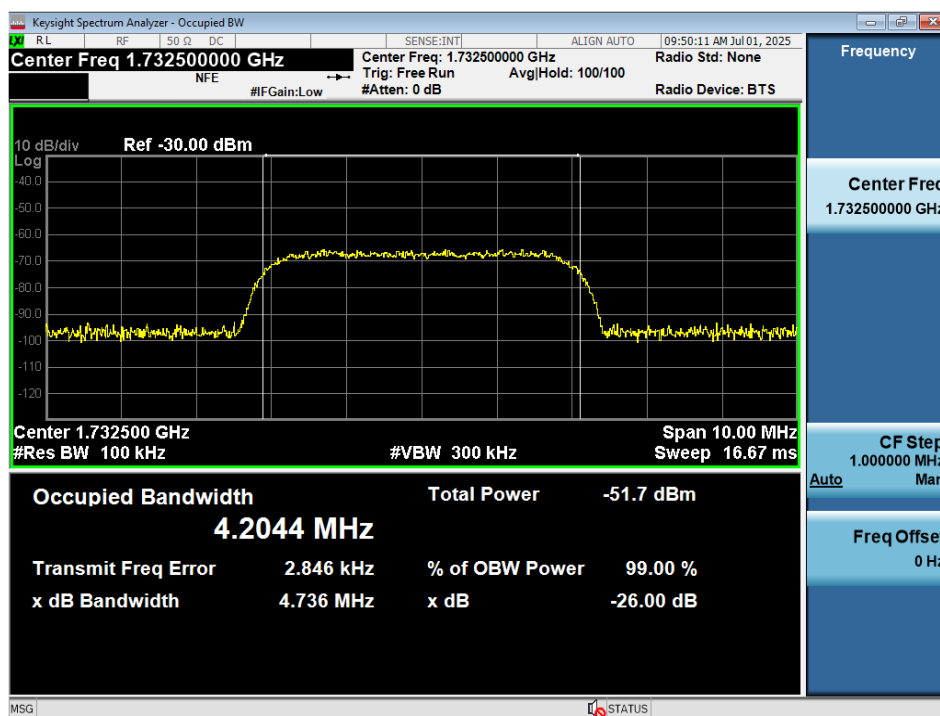
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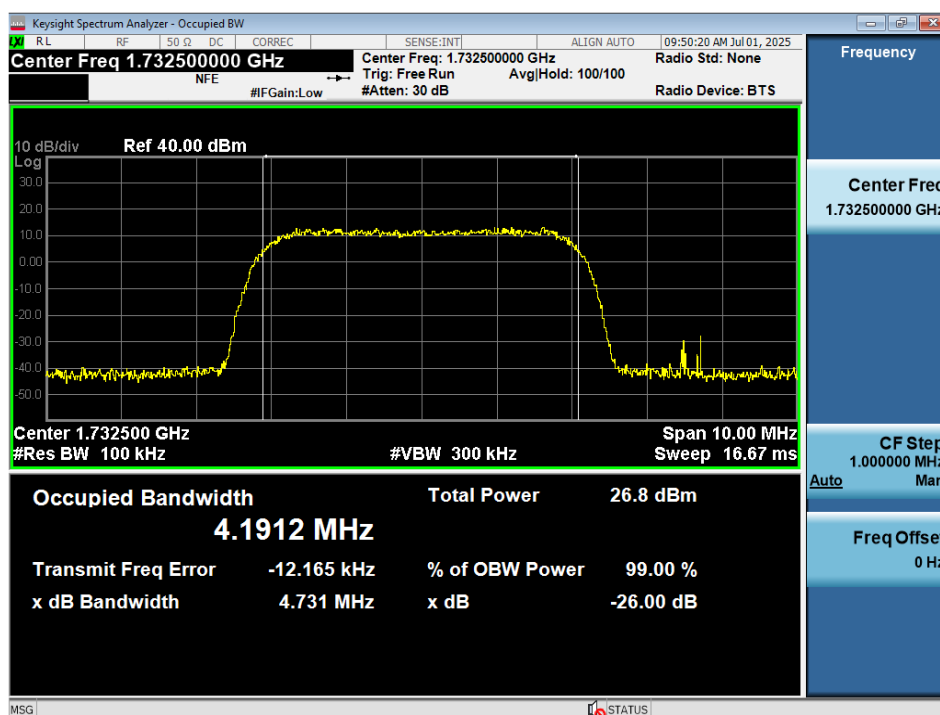
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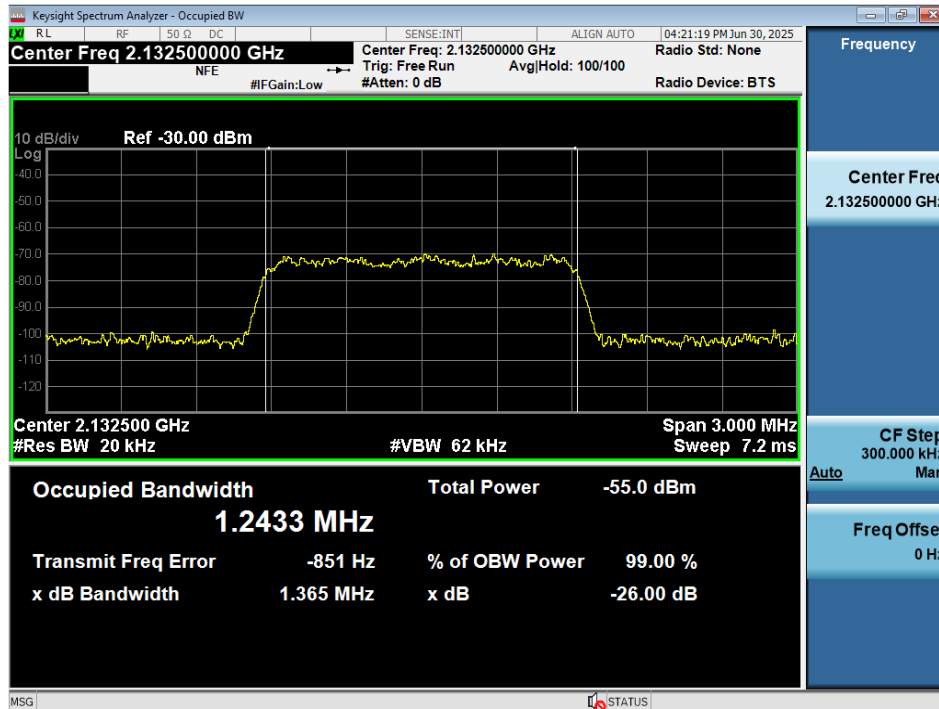
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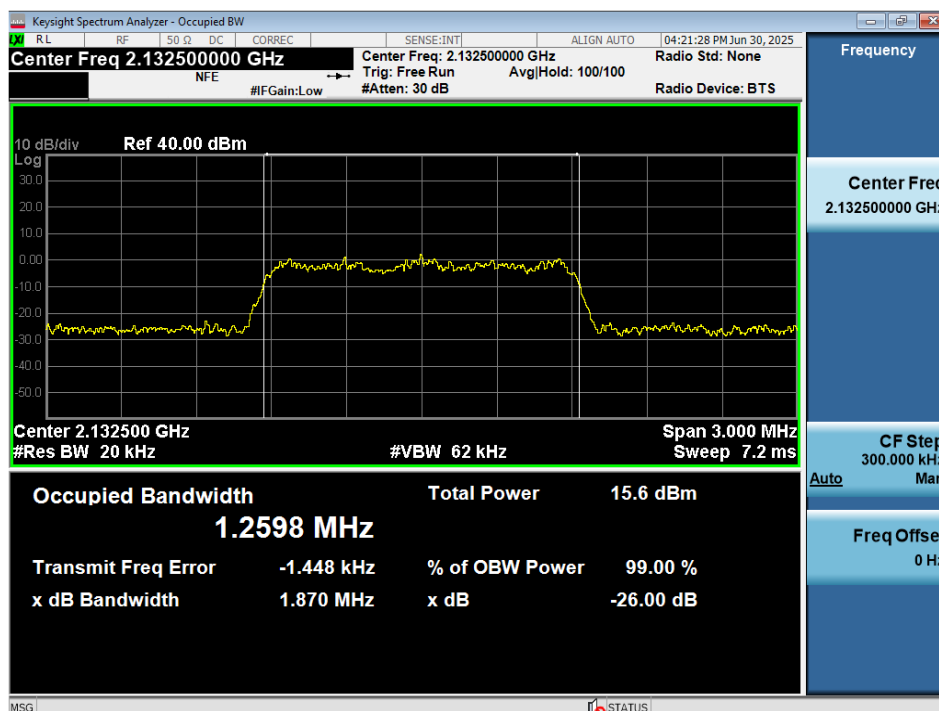
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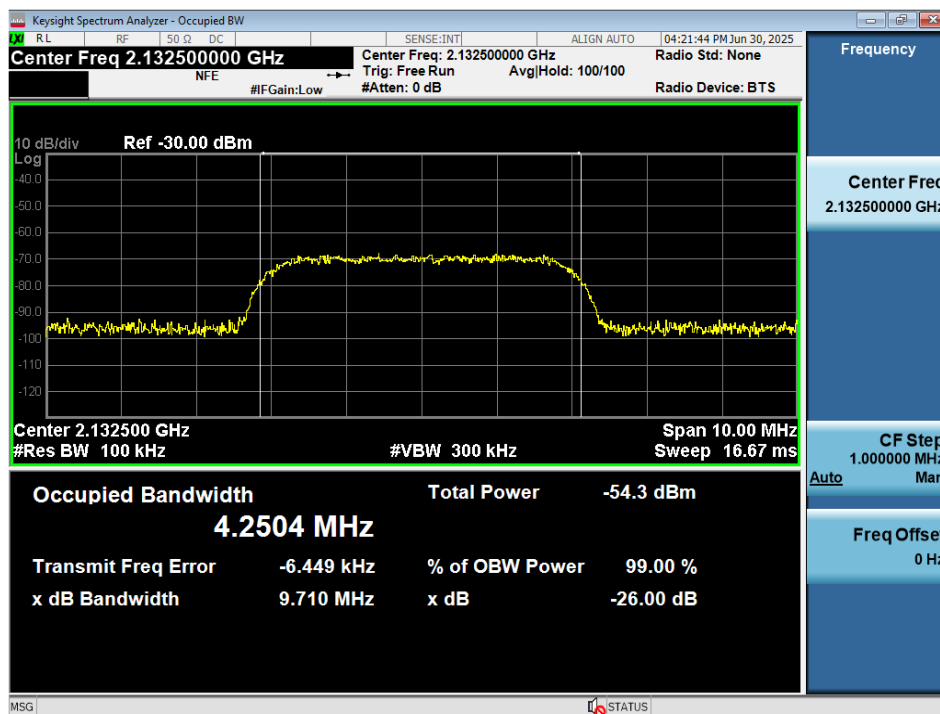
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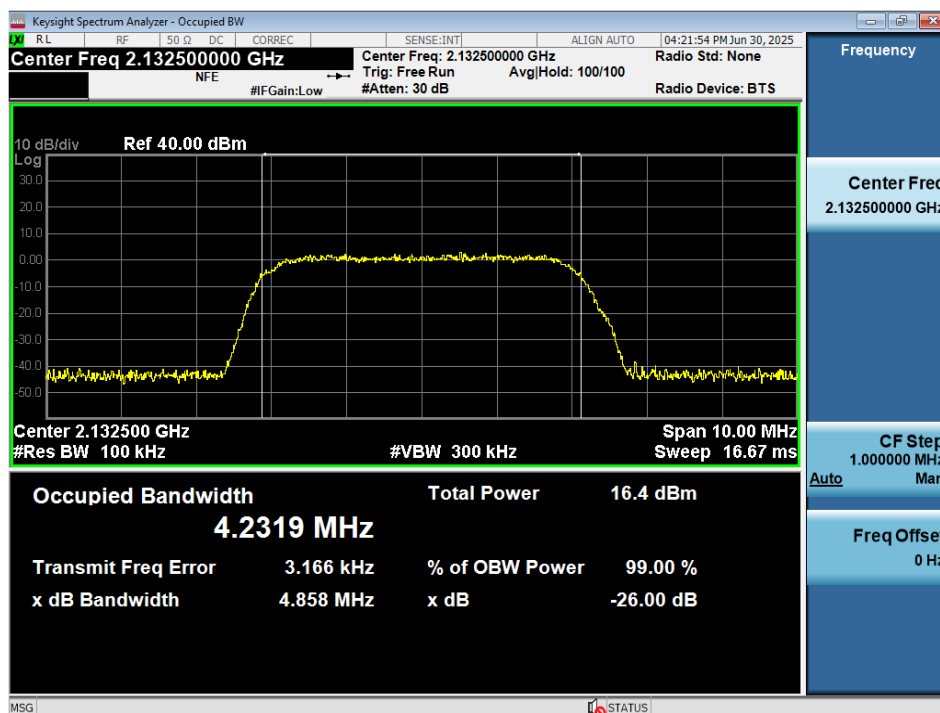
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Occupied Bandwidth / AWS-1 / Downlink / WCDMA/ Input / ANT 2



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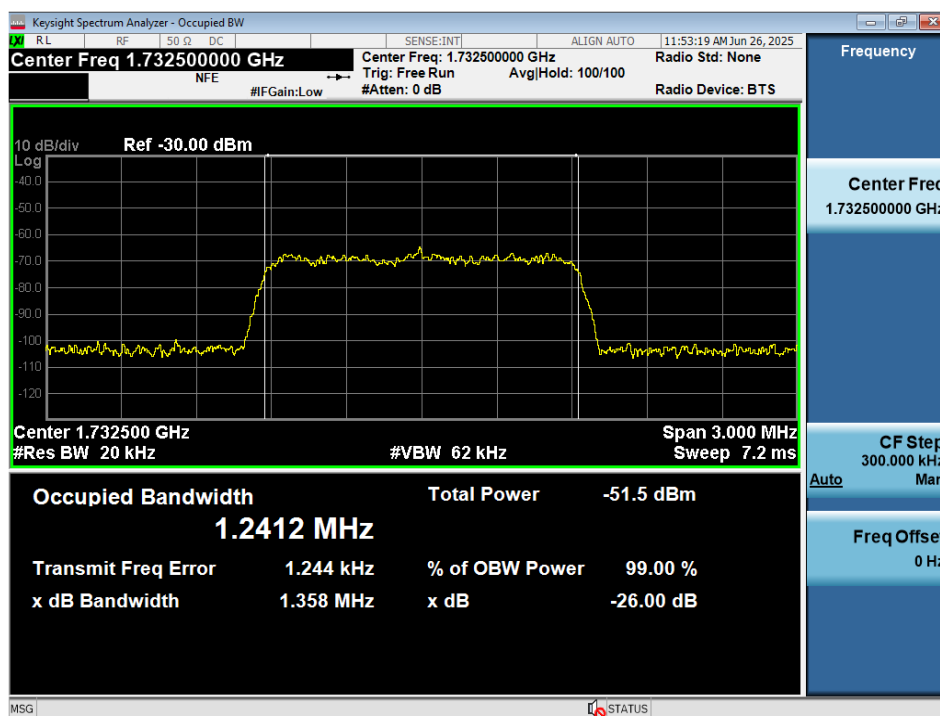
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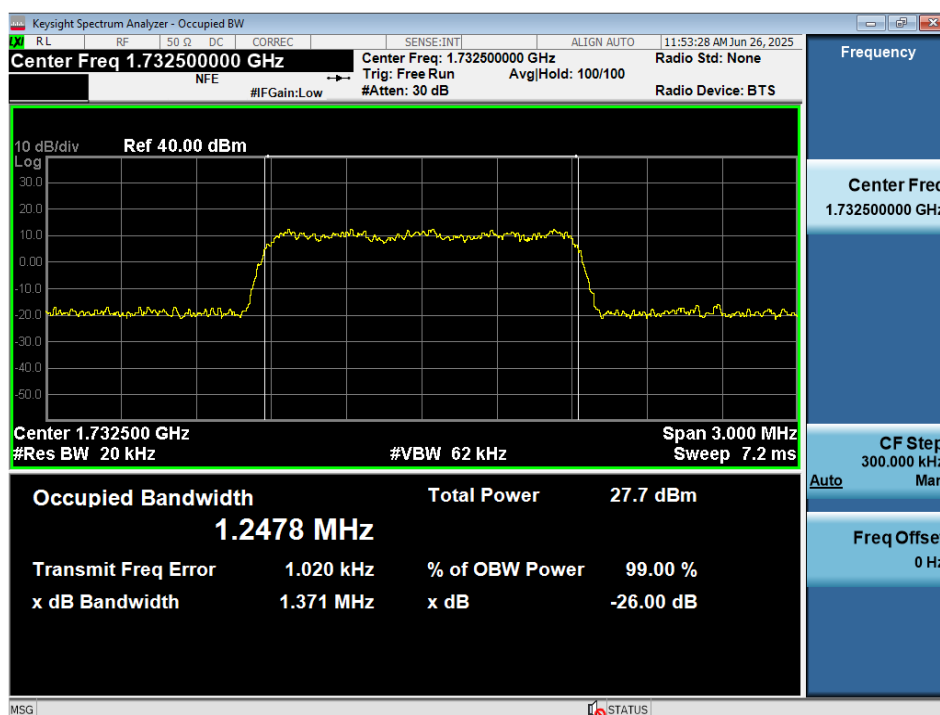
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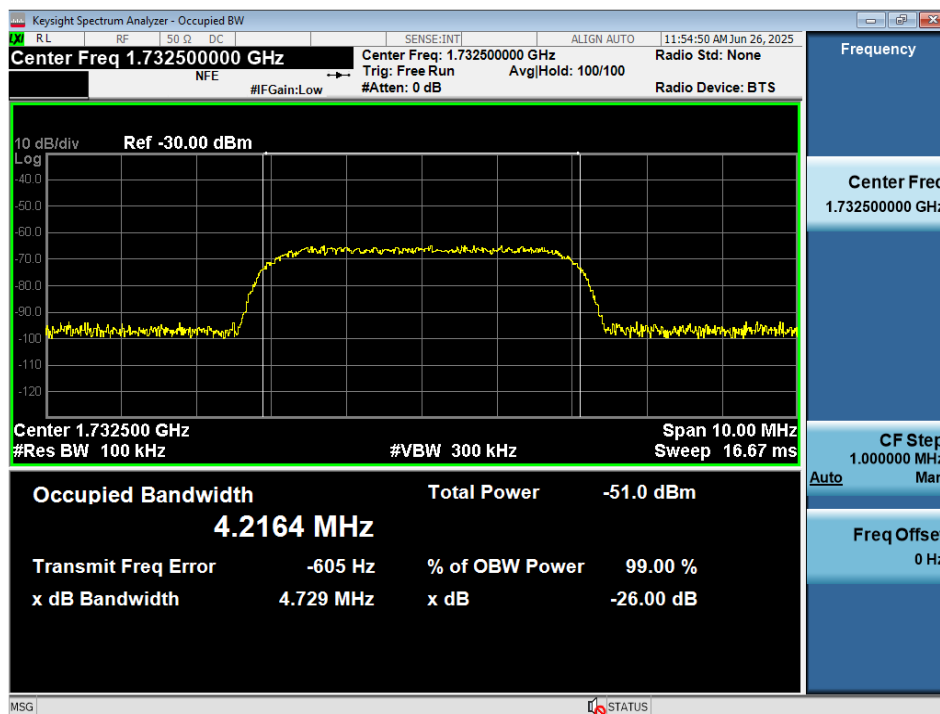
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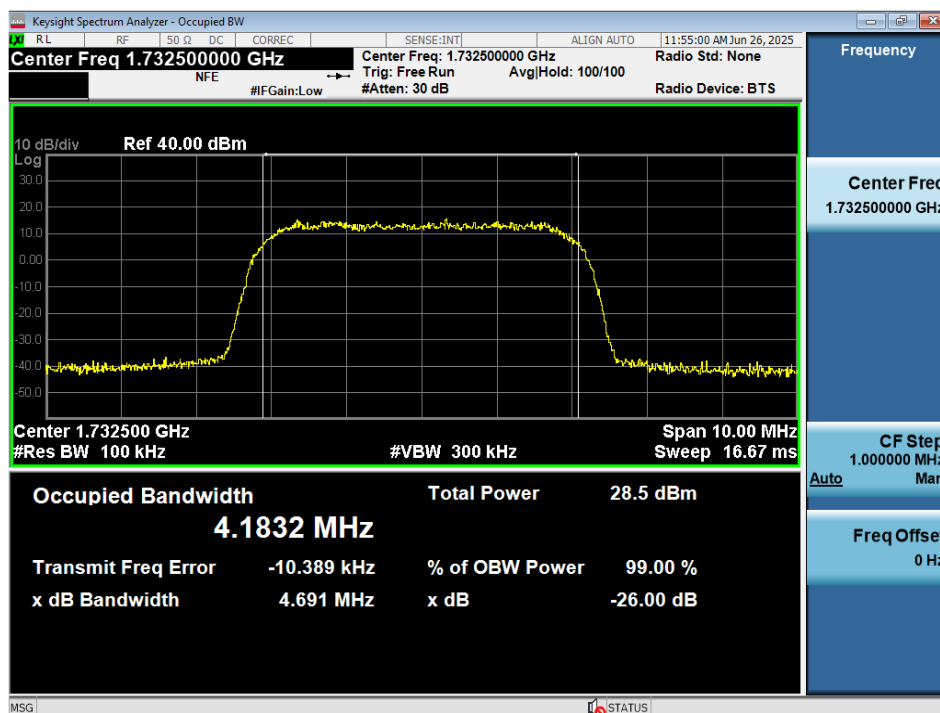
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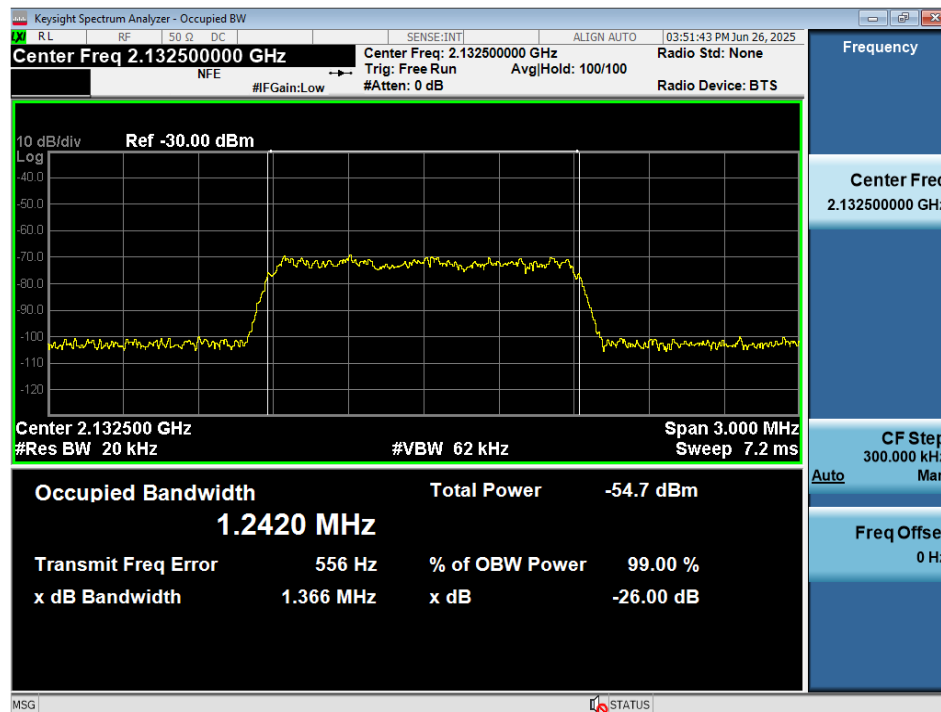
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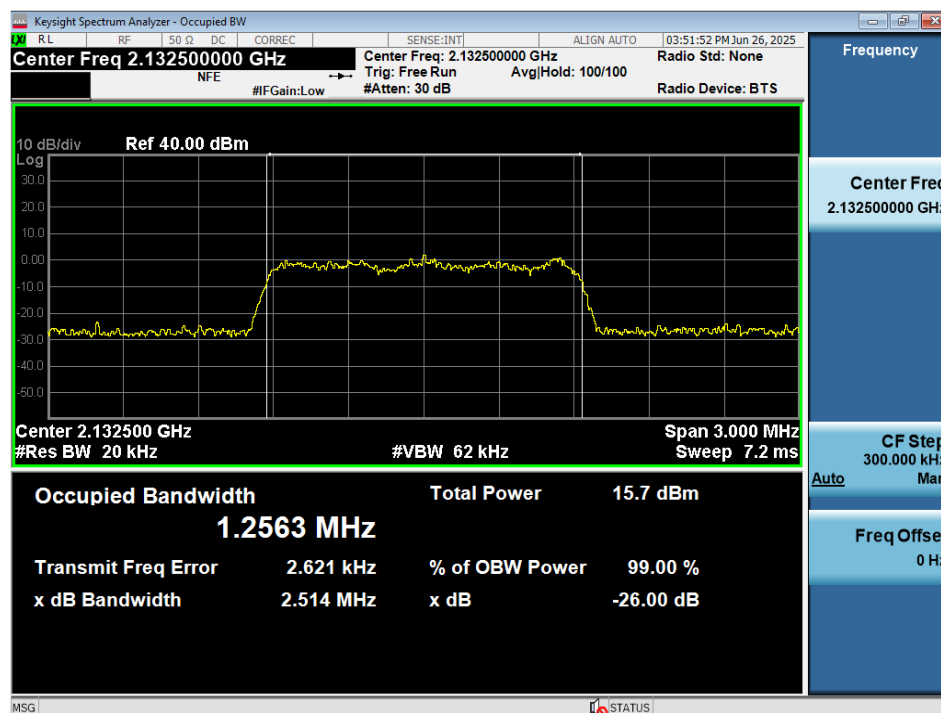
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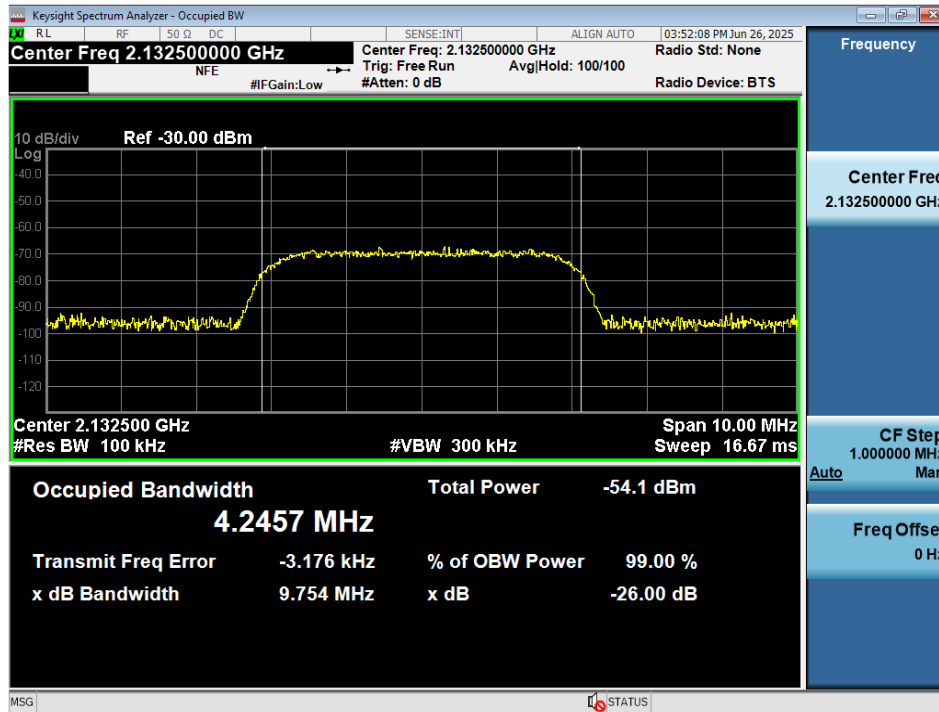
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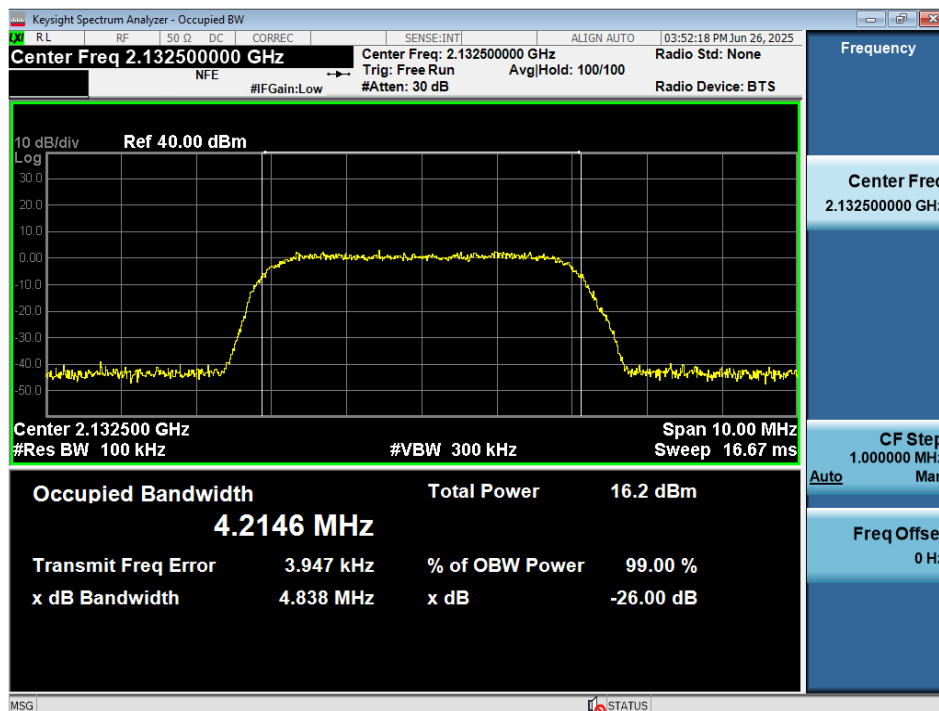
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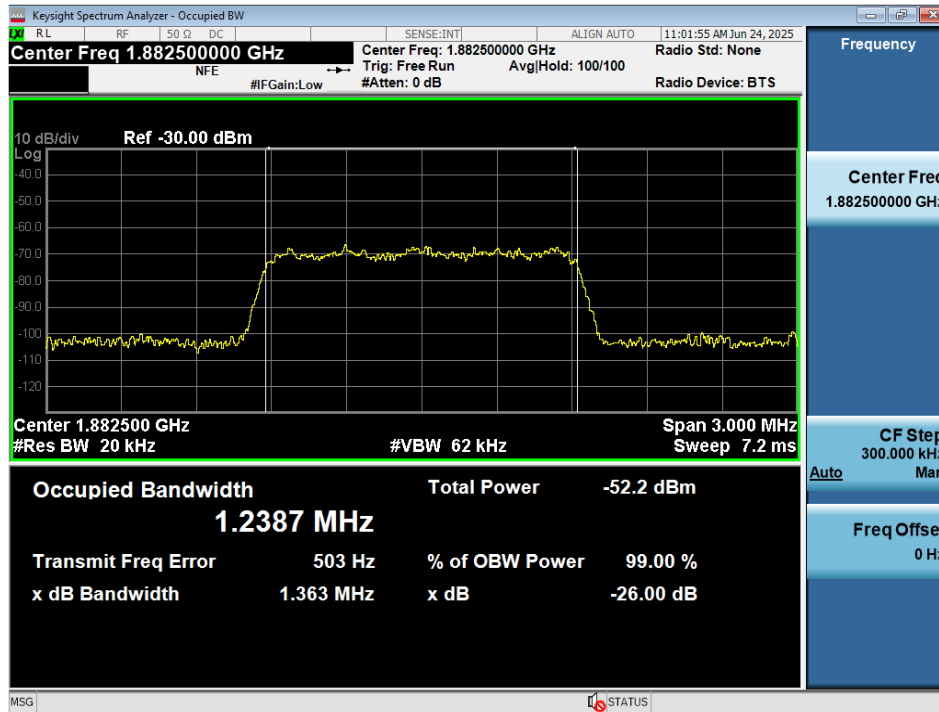
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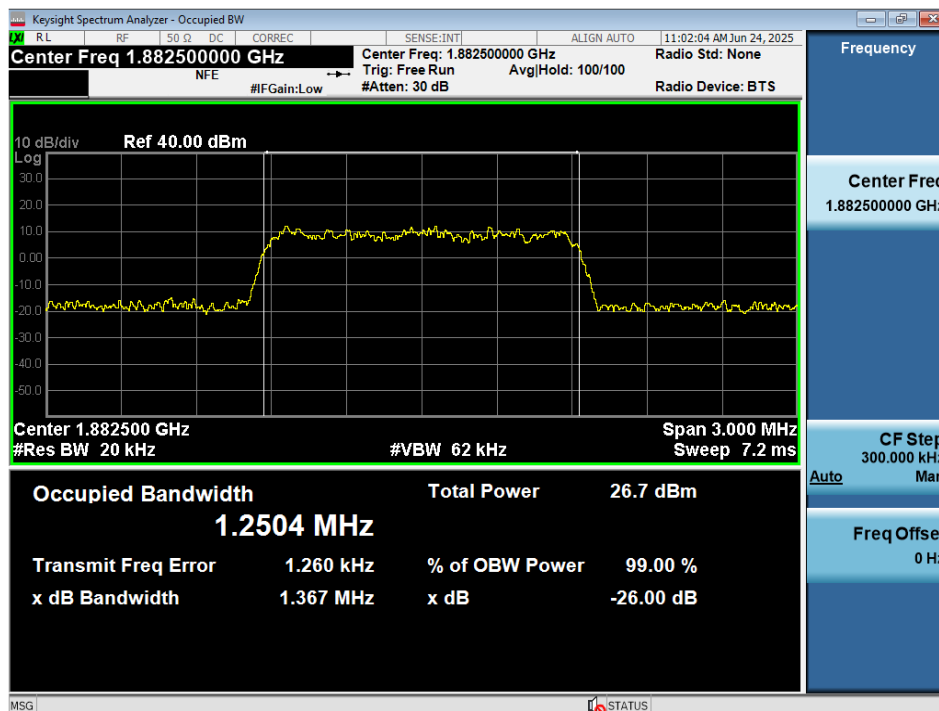
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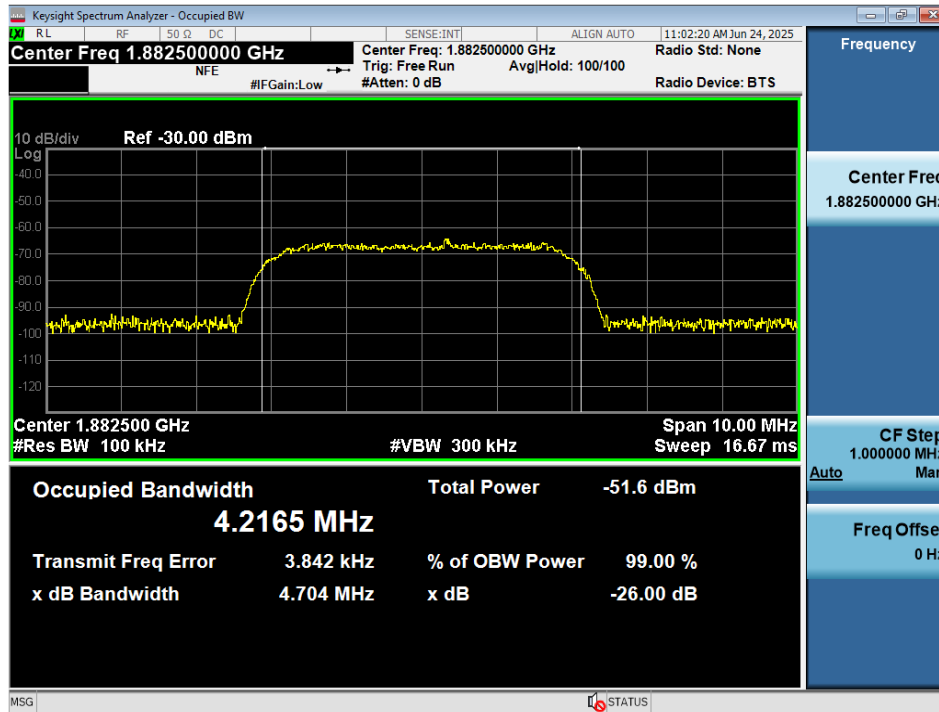
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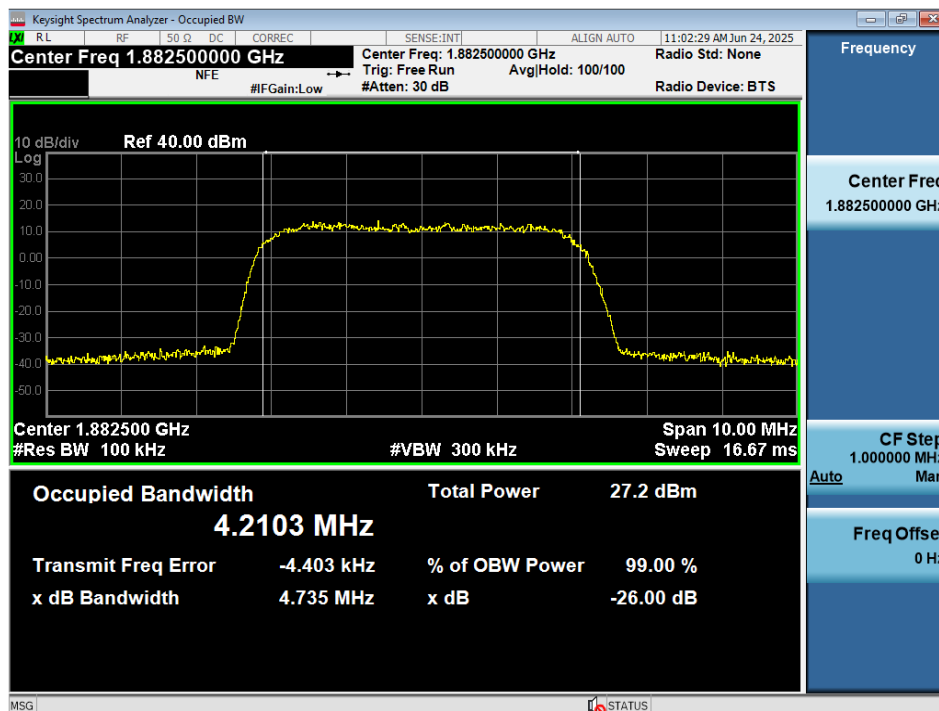
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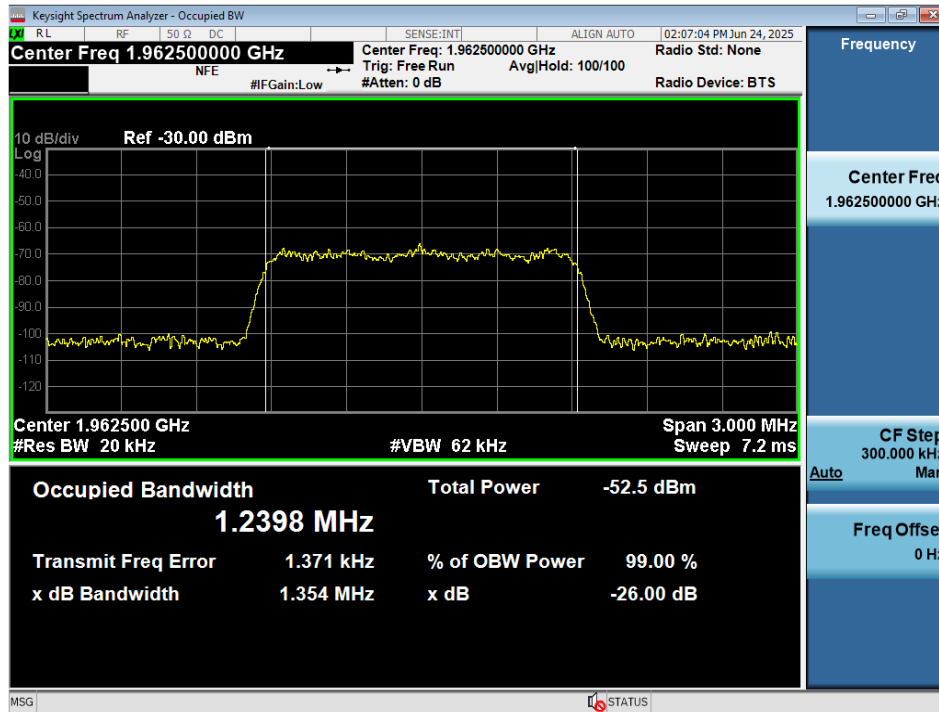
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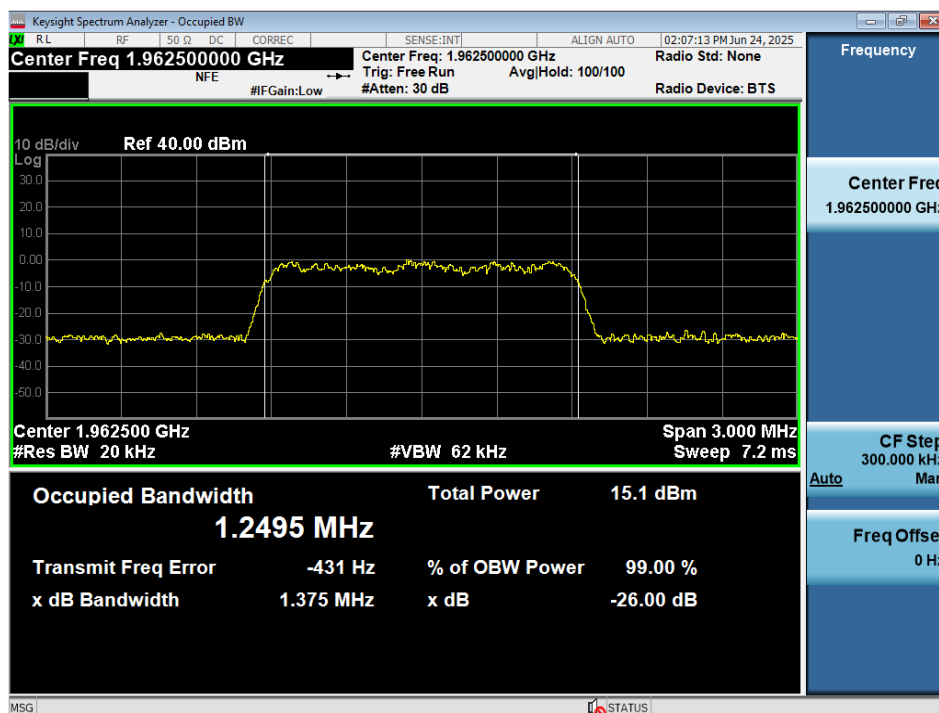
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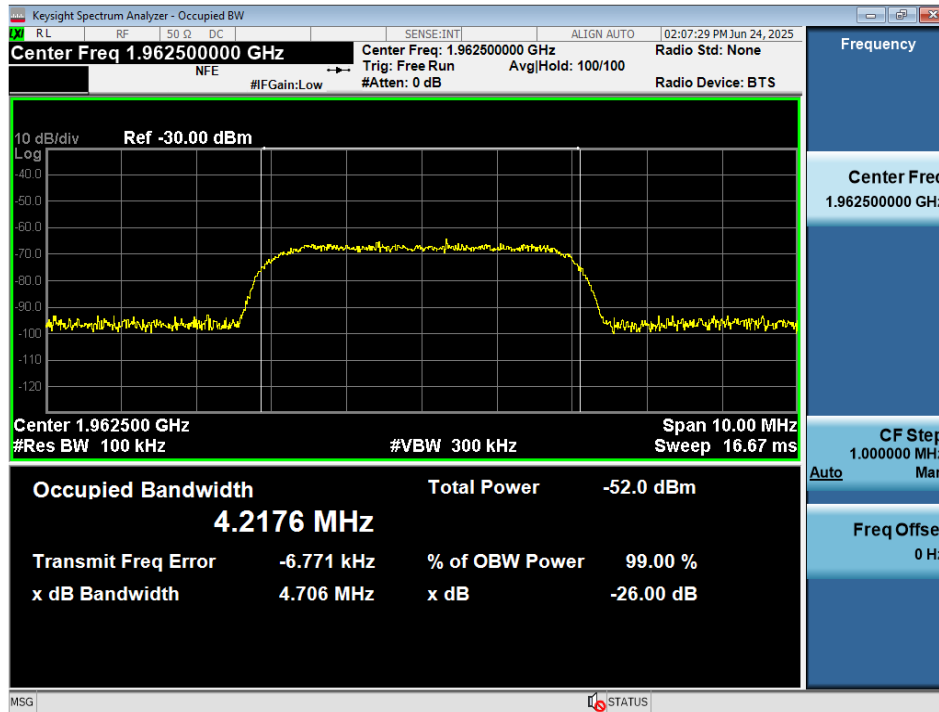
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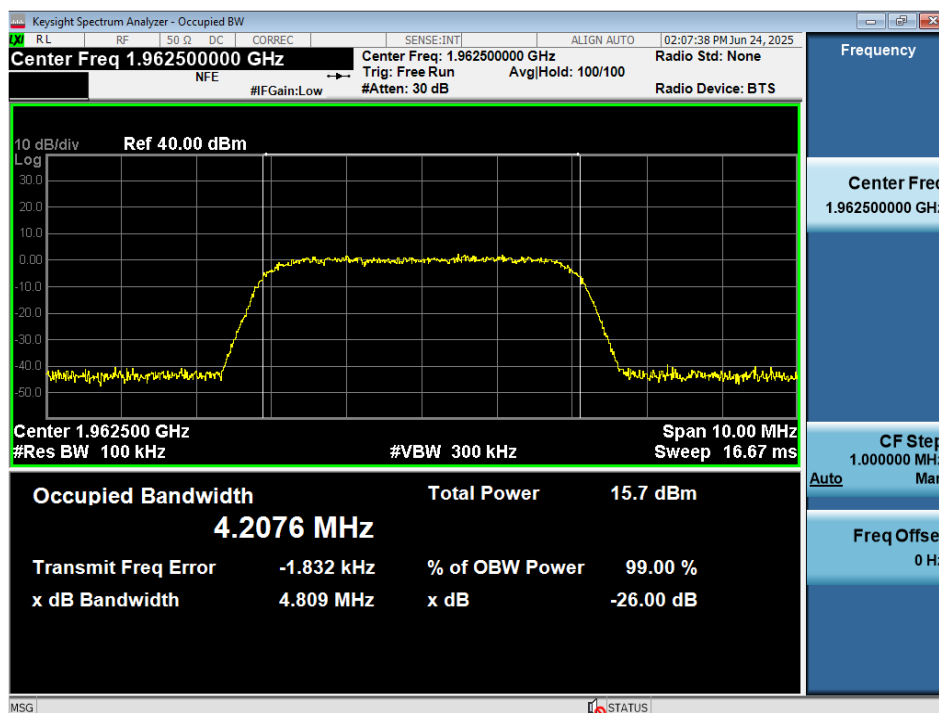
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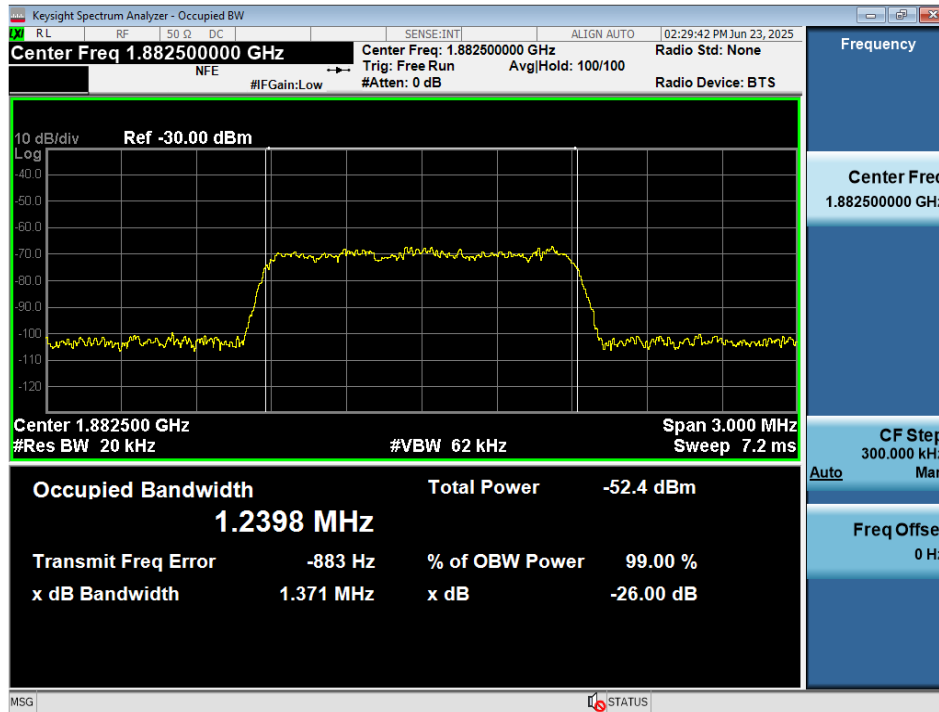
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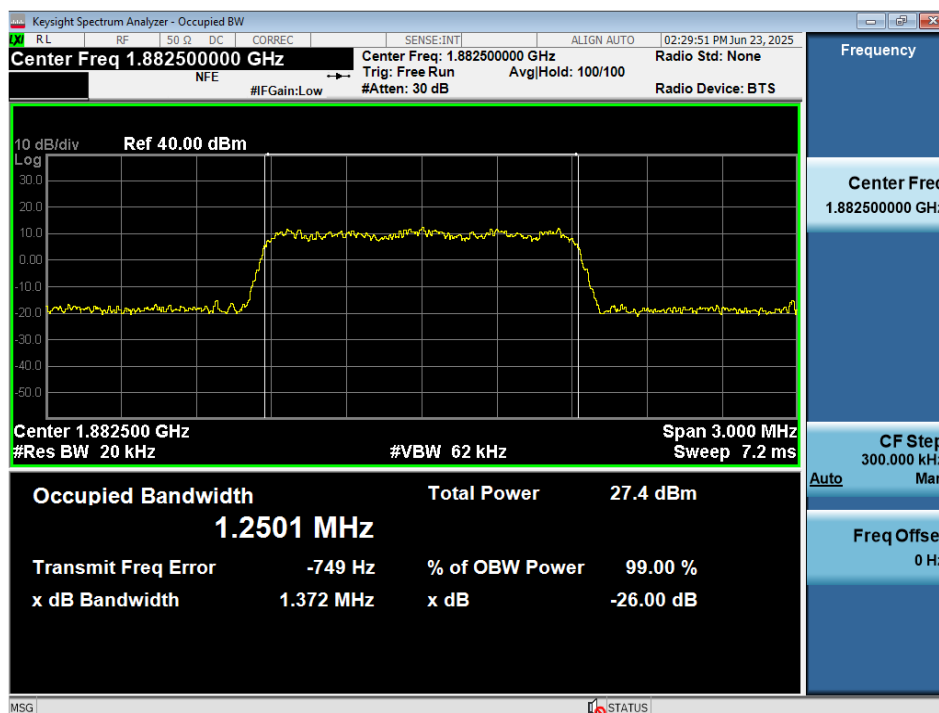
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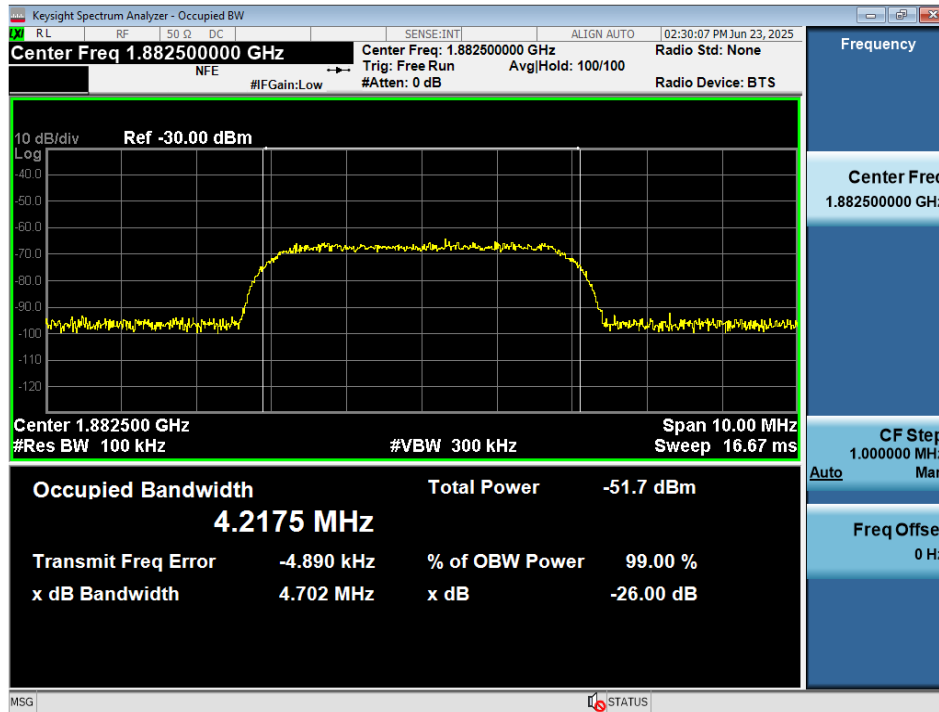
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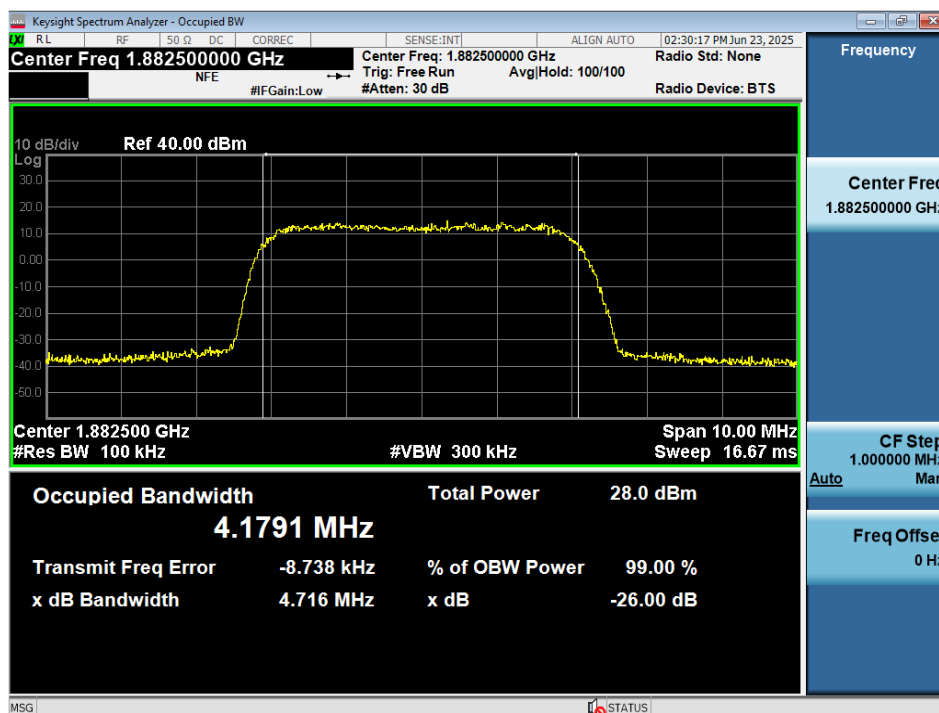
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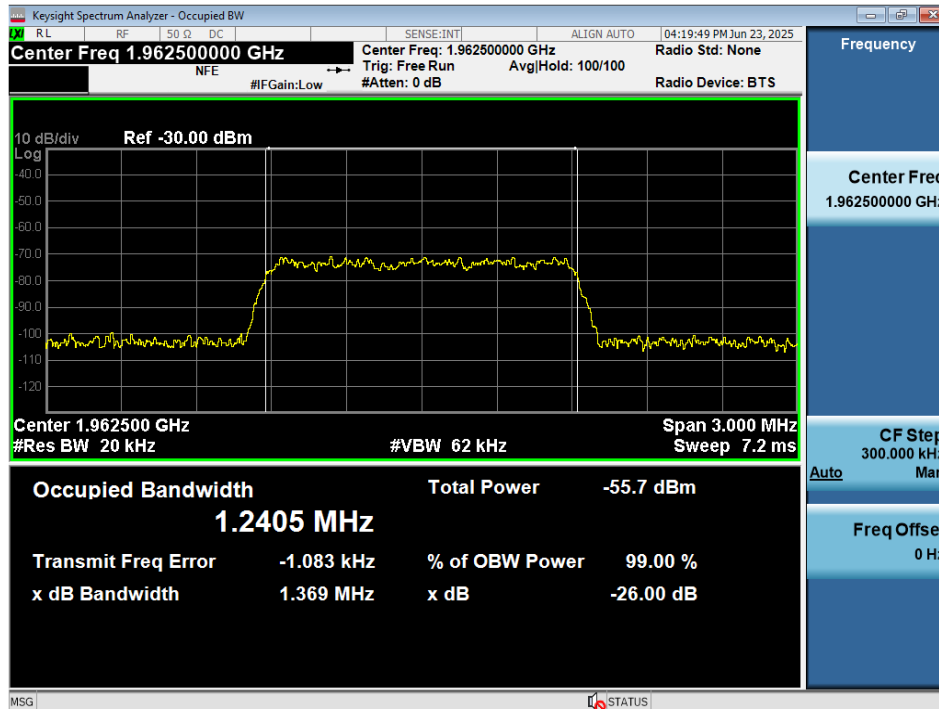
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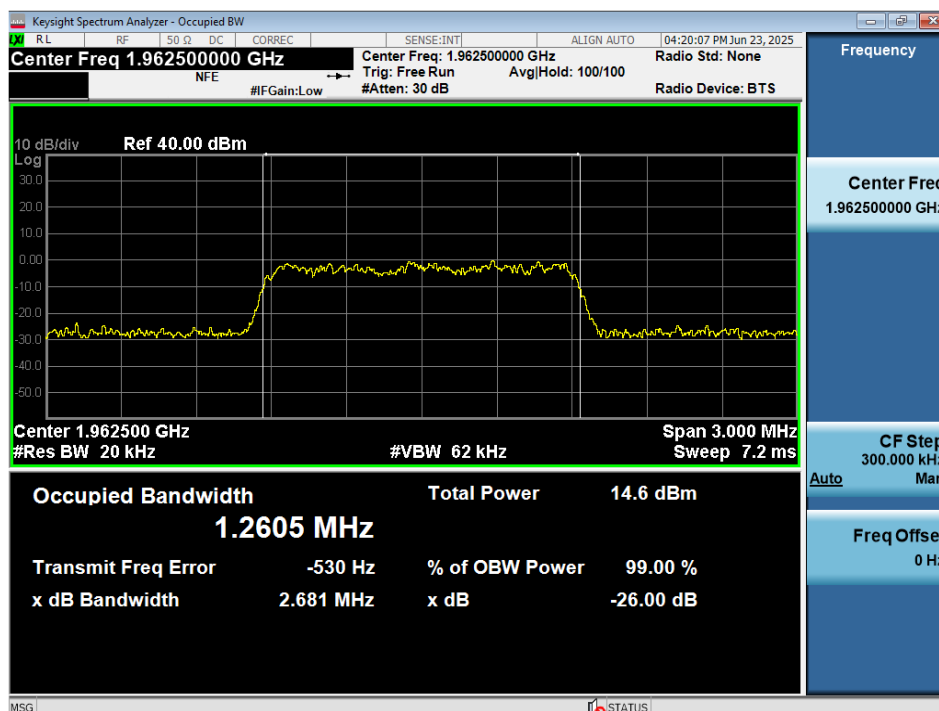
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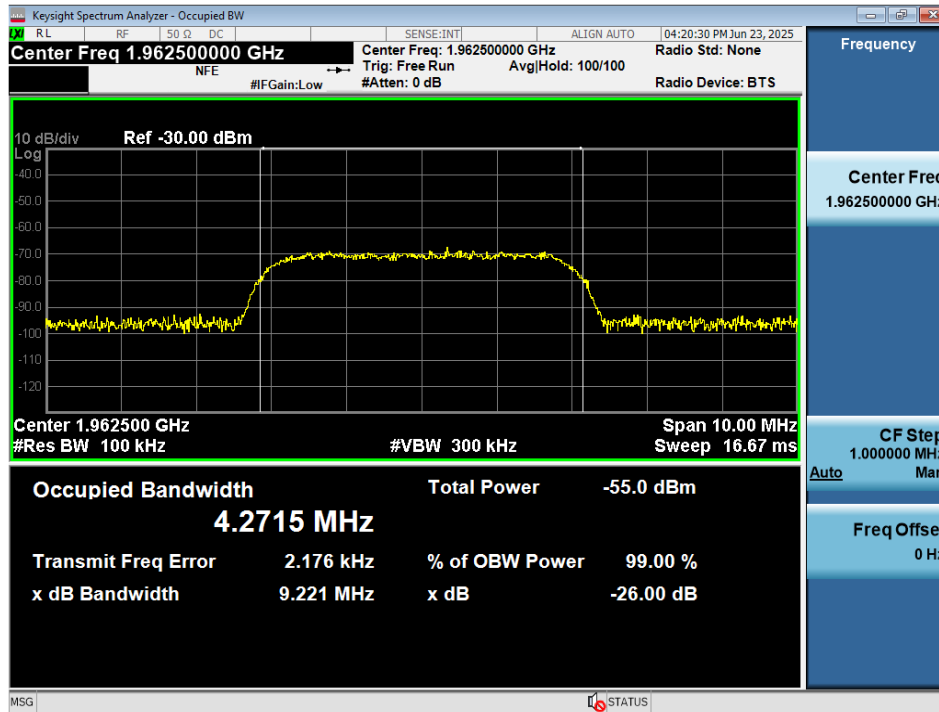
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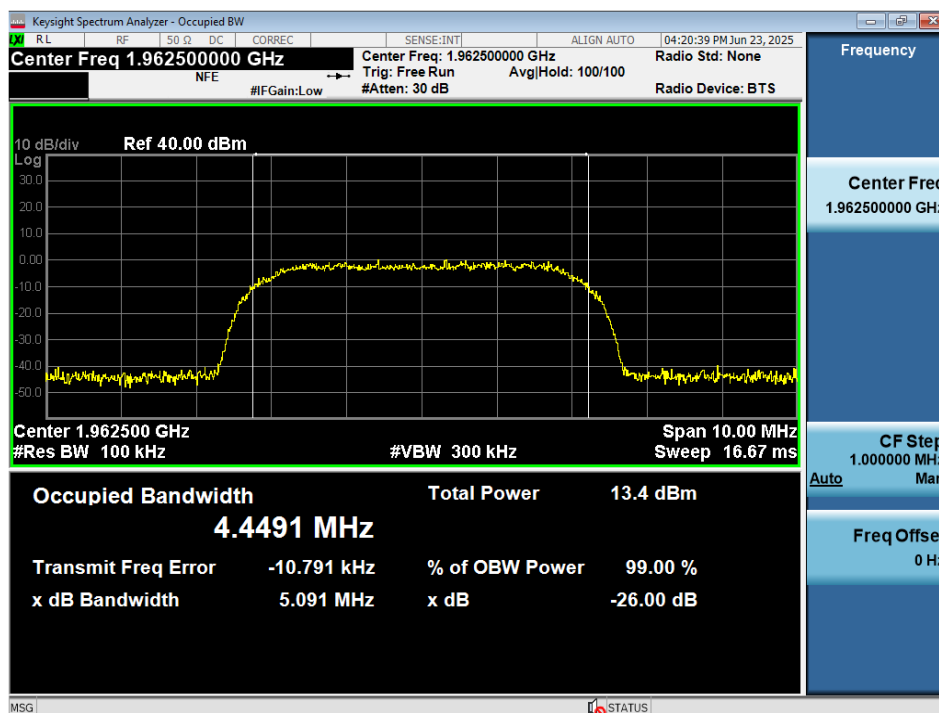
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Occupied Bandwidth / Broadband PCS / Downlink / WCDMA/ Input / ANT 2



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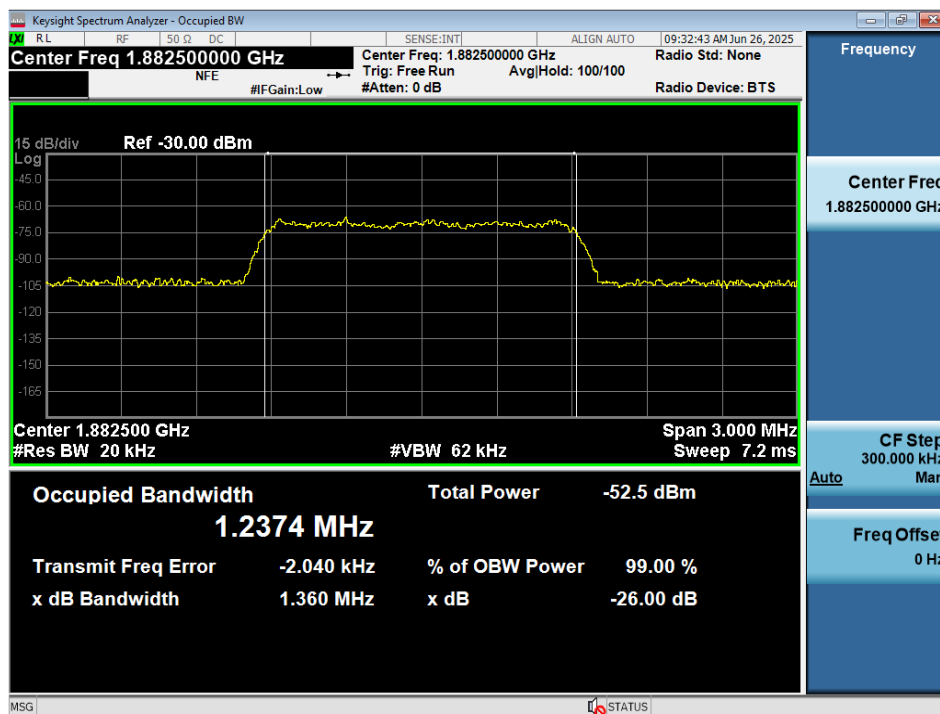
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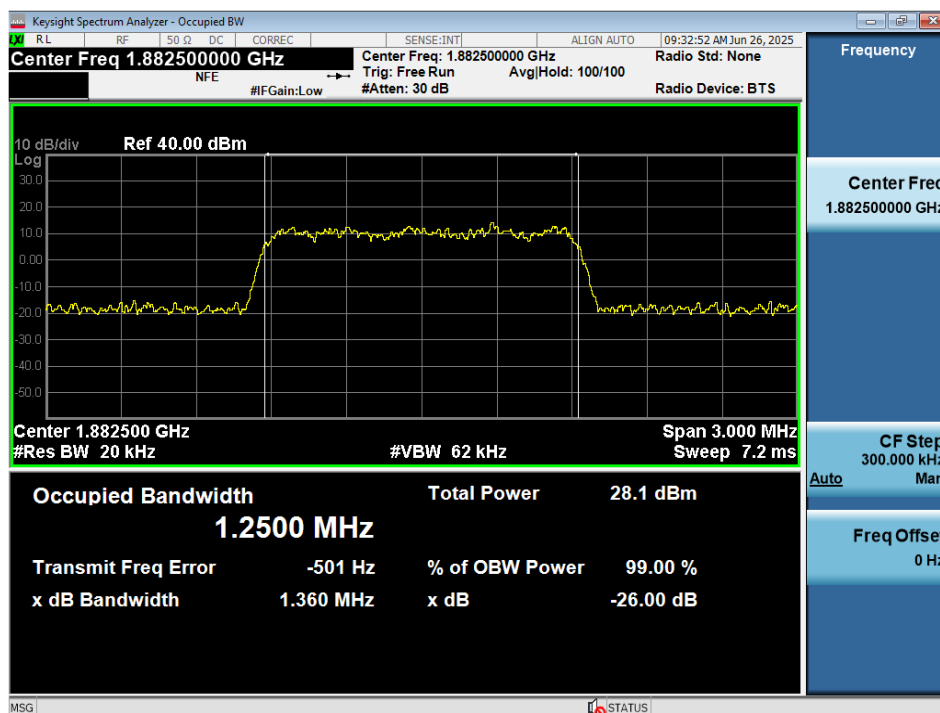
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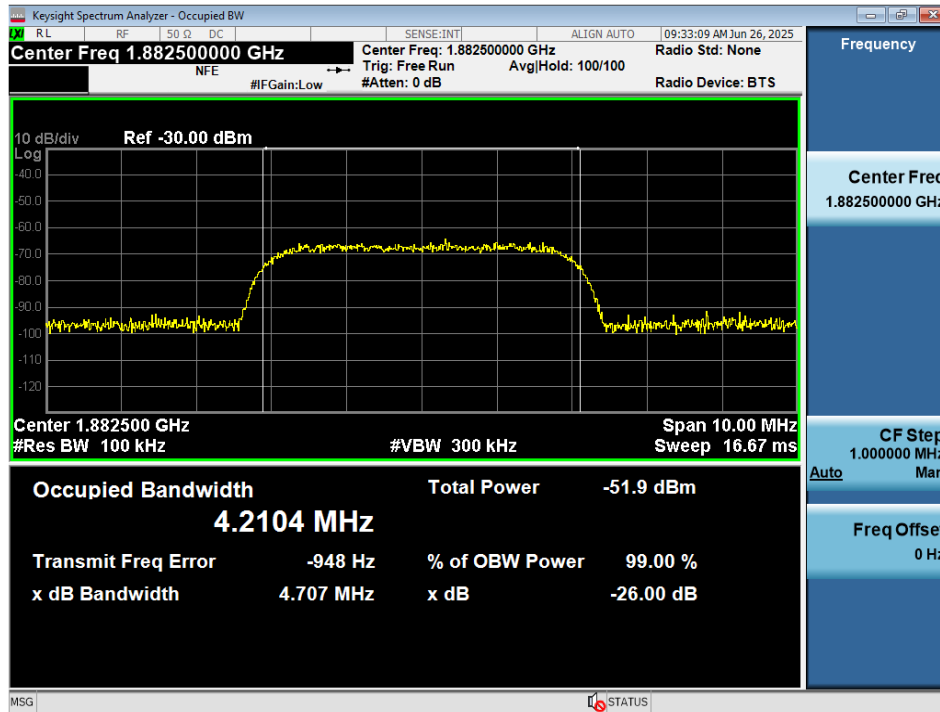
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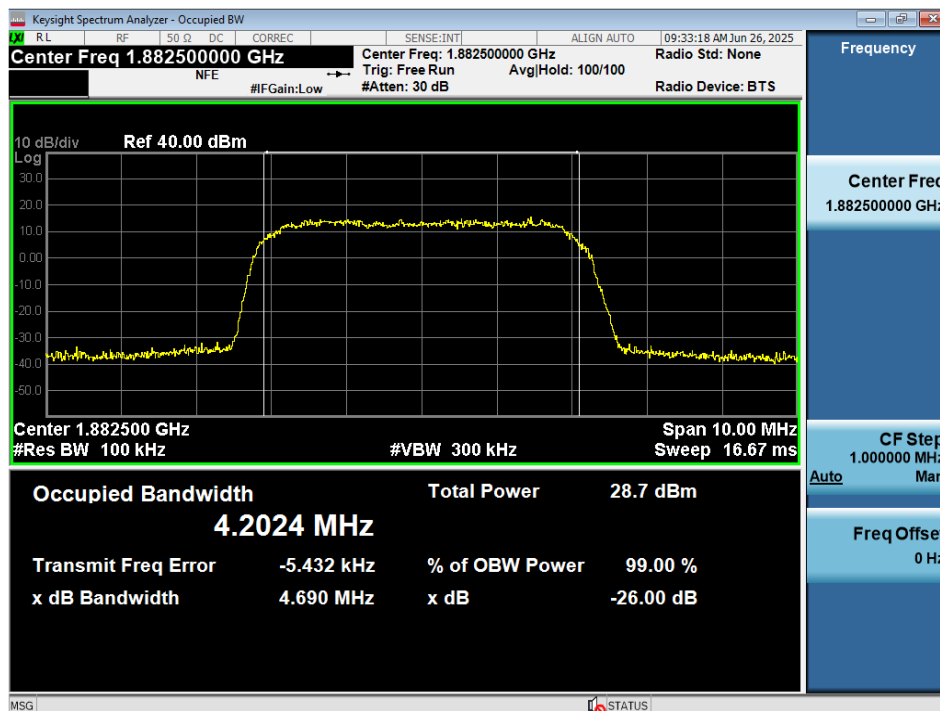
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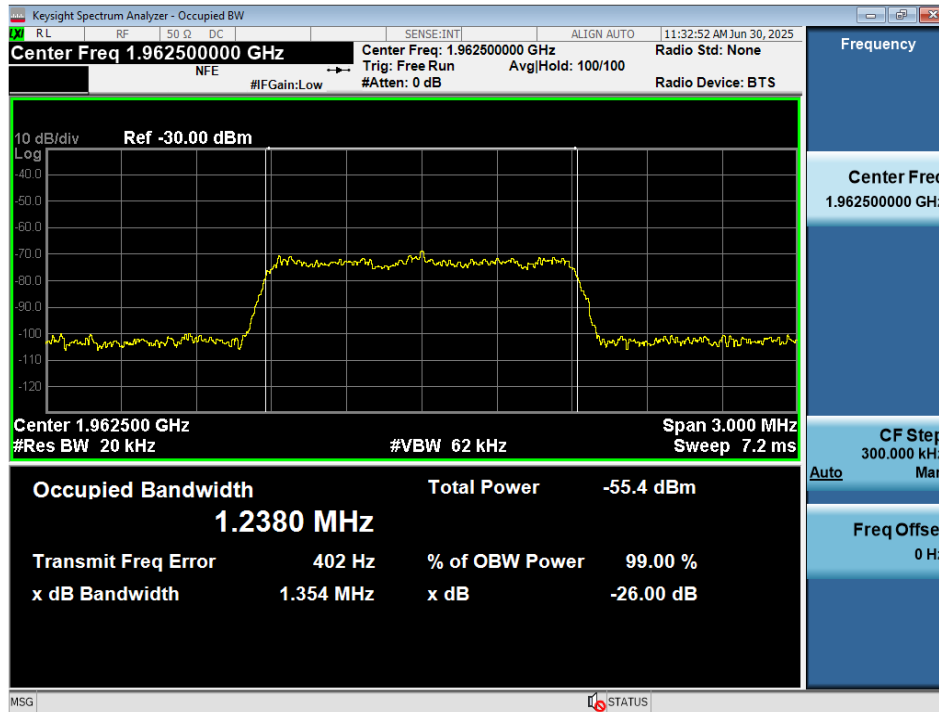
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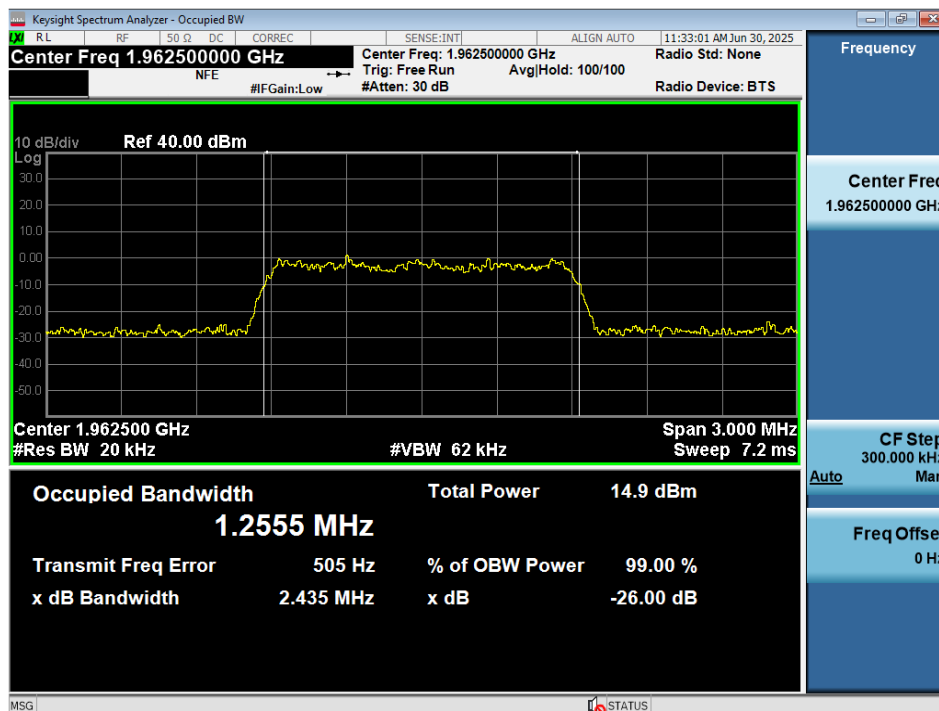
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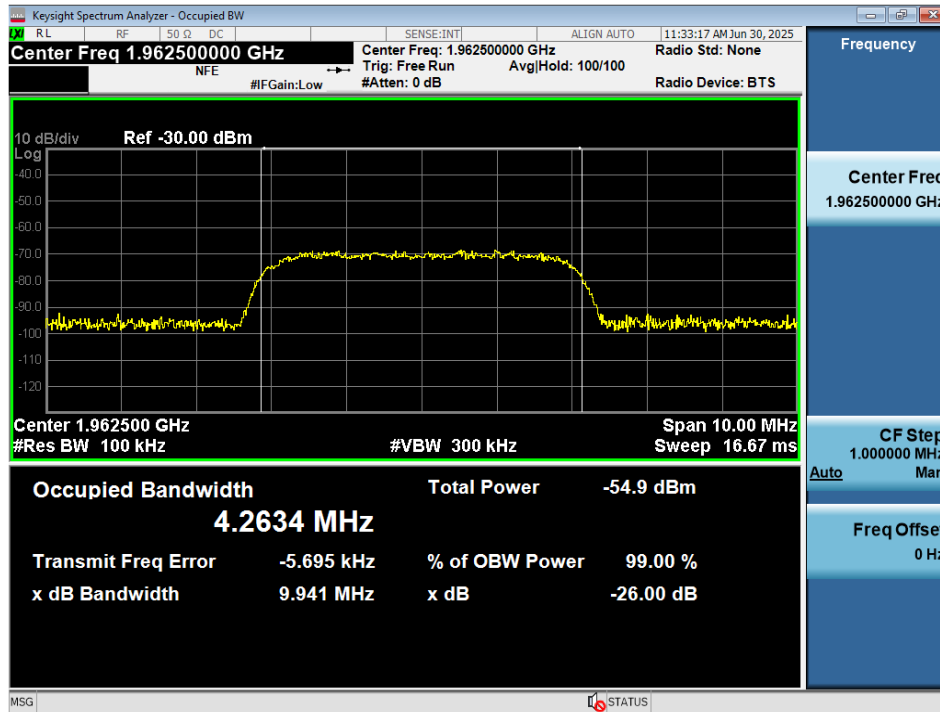
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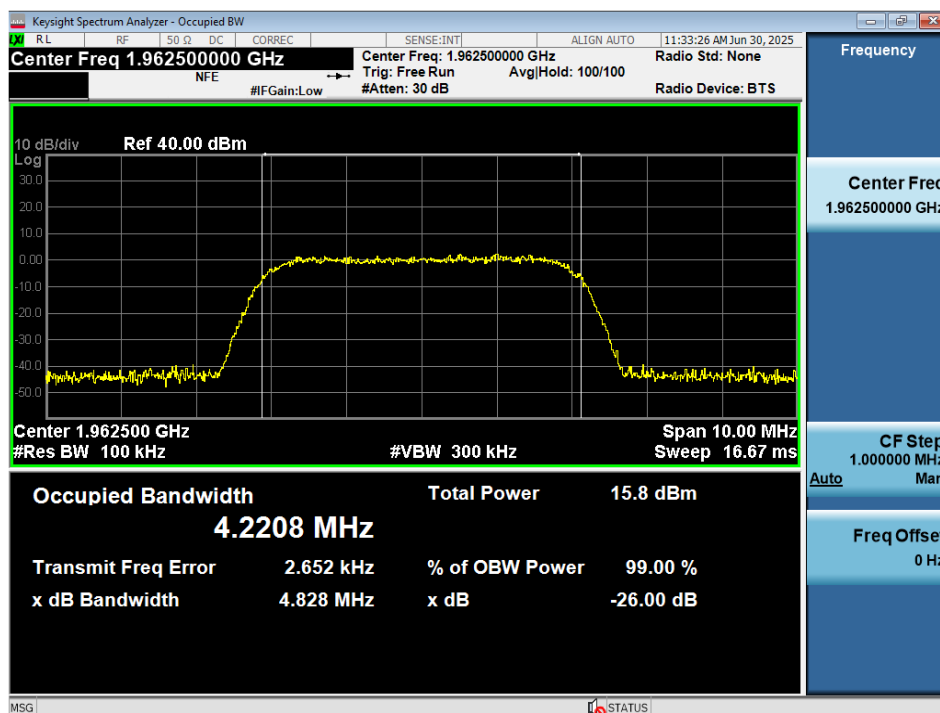
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Occupied Bandwidth / Broadband PCS / Downlink / WCDMA/ Input / ANT 3



Occupied Bandwidth / Broadband PCS / Downlink / WCDMA / Output / ANT 3



5.12. OSCILLATION

Test Requirements:

§ 20.21(e)(5) Anti-Oscillation.

Consumer Signal Boosters must be able to detect and mitigate any unintended oscillations in uplink and downlink bands (such as may result from insufficient isolation between the antennas).

§ 20.21(e)(9)(ii)(A) Anti-Oscillation.

Consumer boosters must be able to detect and mitigate (*i.e.*, by automatic gain reduction or shut down), any oscillations in uplink and downlink bands. Oscillation detection and mitigation must occur automatically within 0.3 seconds in the uplink band and within 1 second in the downlink band. In cases where oscillation is detected, the booster must continue mitigation for at least one minute before restarting. After five such restarts, the booster must not resume operation until manually reset.

Test Procedures:

Measurements were in accordance with the test methods section 7.11 of KDB 935210 D04 v02r04.

7.11.2 Oscillation detection tests

- a) Connect the normal-operating mode EUT to the test equipment as shown in Figure 10 (uplink) or Figure 11 (downlink).
- b) Set the feedback step attenuator to 110 dB, and set the BSCL step attenuator such that the booster is operating at maximum gain and the minimum input level required for normal operation.
- c) Spectrum analyzer settings:
 - 1) Set the spectrum analyzer center frequency to the center of the passband of the booster.
 - 2) Set the spectrum analyzer RBW to at least 1 MHz and the VBW $\geq$ 3 MHz.
 - 3) Set the spectrum analyzer to zero-span, with a sweep time of 5 seconds, single-sweep, max-hold.
- d) Set the spectrum analyzer sweep trigger level in this and the subsequent steps to 3 dB above the output power level of the booster that was found in 7.11.2b).
- e) Reduce the feedback step attenuator setting from 110 dB until the sweep is triggered at oscillation onset, which may require an iterative process to find the precise setting where oscillation occurs, or up to a level equal to the booster maximum gain – 20 dB.
- f) Use the CURSOR function of the spectrum analyzer to measure the time from the onset of oscillation until the EUT turns off, by setting CURSOR 1 on the leading edge of the oscillation signal, and CURSOR 2 on the trailing edge. The spectrum analyzer sweep time may be adjusted to improve the time resolution of these cursors.
- g) Capture the spectrum analyzer trace for inclusion in the test report, and with the oscillation power level being discernible.
- h) Repeat 7.11.2b) to 7.11.2g) for all operational uplink and downlink bands.
- i) Replace the normal-operating mode EUT with the EUT that supports a test mode.
- j) Set the spectrum analyzer time base (zero-span time) for a minimum 120 seconds, with the same trigger as in the preceding steps, and a single sweep.
- k) Start the spectrum analyzer sweep, and manually force the booster into oscillation by changing the feedback step attenuator, as described in 7.11.2e).

- l) When the sweep is complete, place cursors between the first two oscillation detections, and save the plot for inclusion in the test report; report the power level associated with the oscillation separately if it can't be displayed on the trace. The time between restarts must match the manufacturer's timing for the test mode, and there shall be no more than five restarts.
- m) Repeat 7.11.2j) through 7.11.2l) for all operational uplink and downlink bands.
- n) If no oscillations are detected with the preceding procedure, a pre-test shall be performed with a wider spectrum span to ensure that the frequency of oscillation is within the RBW of the spectrum analyzer.

7.11.3 Test procedure for measuring oscillation mitigation or shutdown

- a) Connect the normal-operating mode EUT to the test equipment as shown in Figure 12. Alternatively, the test mode EUT as described in 6.3.3 may be used.

- b) Spectrum analyzer settings:

- 1) Set the spectrum analyzer's center frequency to the center of band under test,
- 2) $RBW = 30 \text{ kHz}$, $VBW \geq 3 \times RBW$,
- 3) power averaging (rms) detector,
- 4) trace averages ≥ 100 ,
- 5) span $\geq 120 \%$ of operational band under test,
- 6) number of sweep points $\geq 2 \times \text{span}/RBW$.

NOTE—To measure 120 % of the band under test in one span with spectrum analyzers having less than the required number of sweep points: i) Perform pre-tests with span equal to smaller band segments, such that 120 % of the operational band is captured in multiple tests, using the setup parameters specified; ii) record the center frequency of the strongest oscillation level occurring, and iii) confirm this frequency is within the span and band segment used in this test.

- c) Configure the signal generator for AWGN operation with a 99 % OBW of 4.1 MHz, tuned to the frequency of 2.5 MHz above the lower edge or below the upper edge of the operating band under test.
- d) Adjust the RF output level of the signal generator such that the measured power level of the AWGN signal at the output port of the booster is 30 dB less than the maximum power of the booster for the band under test. The input signal shall not obstruct the measurement of the strongest oscillation peak in the band, and shall not be included within the span of the measurement.

NOTE—Boosters with operating spectrum passbands of 10 MHz or less may use a CW signal source at band edge rather than AWGN. For device passbands greater than 10 MHz, standard CMRS signal sources (i.e., CDMA, W-CDMA, LTE) may be used instead of AWGN at the band edge.

- e) Set the variable attenuator to a high attenuation setting such that the booster will operate at maximum gain when powered on. Reset the EUT (e.g., cycle ac/dc power). Allow the EUT to complete its boot-up process, to reach full operational gain, and to stabilize its operation.
- f) Set the variable attenuator such that the insertion loss for the center of the band under test (isolation) between the booster donor port and server port is 5 dB greater than the maximum gain, as recorded in the maximum gain test procedure (see 7.3), for the band under test.
- g) Verify the EUT shuts down, i.e., to mitigate the oscillations. If the booster does not shut down, measure and verify the peak oscillation level as follows.

- 1) Allow the spectrum analyzer trace to stabilize.
- 2) Place the marker at the highest oscillation level occurring within the span, and record its output level and frequency.
- 3) Set the spectrum analyzer center frequency to the frequency with the highest oscillation signal level, and reduce the span such that the upper and lower adjacent oscillation peaks are within the span.
- 4) Use the minimum search marker function to find the lowest output level that is within the span, and within the operational band under test, and record its output level and frequency.
- 5) The peak oscillation level, as measured in 7.11.3g2), shall not exceed by 12.0 dB the minimal output level measured in 7.11.3g4). Record the measurement results of 7.11.3g2) and 7.11.3g4) in tabular format for inclusion in the report.
- 6) The procedure of 7.11.3g1) to 7.11.3g5) allows the spectrum analyzer trace to stabilize, and verification of shutdown or oscillation level measurement shall occur within 300 seconds.
- h) Decrease the variable attenuator in 1 dB steps, and repeat 7.11.3g) for each 1 dB step. Continue testing to the level when the insertion loss for the center of band under test (isolation) between the booster donor port and server port is 5 dB lower than the maximum gain (see 7.3).

NOTE—Provider-specific boosters with gain greater than 75 dB and 85 dB must continue testing to the levels 15 dB and 25 dB lower than maximum gain, respectively.
- i) Repeat 7.11.3b) to 7.11.3h) for all operational uplink and downlink bands.

Notes:

1. For the oscillation detection test, the EUT operated in normal mode and was configured according to Figures 10 and 11 of KDB935210 D04.
2. For the restart test, the EUT was configured to operate in test mode.
3. Since the booster automatically shuts down in the event of oscillation, the oscillation mitigation test cases are not required.
4. According to §20.21(e)(9)(ii)(A), the limits for oscillation test are as follows:
 - Detection and mitigation time: 0.3 seconds for uplink, 1 second for downlink.
 - Migration duration: at least 1 minute.
 - Number of restart: 5 times.
5. In the Number of Oscillation Restart plot, Marker 1 indicates the initial oscillation signal, and Markers 2 to 5 indicate the restart signals.

Test Result:
Tabulated Result of Uplink Oscillation Detection

ANT	Band	Frequency (MHz)	Limit (ms)	Detect Time (ms)
1	Upper 700 MHz	780.050	300	33.00
	Cellular	835.425		54.00
	AWS-1	1730.340		73.00
	Broadband PCS	1884.255		47.00
2	Lower 700 MHz	707.585	300	86.00
	Cellular	834.875		79.00
	AWS-1	1731.510		34.00
	Broadband PCS	1881.525		85.00
3	Lower 700 MHz	707.364	300	20.00
	Cellular	836.100		86.00
	AWS-1	1730.430		96.00
	Broadband PCS	1880.745		77.00

Tabulated Result of Uplink Oscillation Restart

ANT	Band	Frequency (MHz)	Time Limit (s)	Restart Limit	Restart Time (s)	Number of Restart
1	Upper 700 MHz	780.050	60 ≤	5	60.50	4
	Cellular	835.425			60.58	4
	AWS-1	1730.340			60.58	4
	Broadband PCS	1884.255			60.48	4
2	Lower 700 MHz	707.585	60 ≤	5	60.50	4
	Cellular	834.875			60.55	4
	AWS-1	1731.510			60.53	4
	Broadband PCS	1881.525			60.53	4
3	Lower 700 MHz	707.364	60 ≤	5	60.58	4
	Cellular	836.100			60.48	4
	AWS-1	1730.430			60.55	4
	Broadband PCS	1880.745			60.58	4

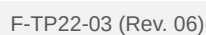
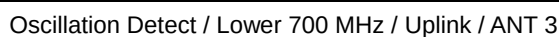
Tabulated Result of Downlink Oscillation Detection

ANT	Band	Frequency (MHz)	Limit (ms)	Detect Time (ms)
1	Upper 700 MHz	752.820	1,000	116.00
	Cellular	883.575		113.00
	AWS-1	2130.430		28.00
	Broadband PCS	1964.255		25.00
2	Lower 700 MHz	737.432	1,000	76.00
	Cellular	883.775		63.00
	AWS-1	2131.915		73.00
	Broadband PCS	1964.775		62.00
3	Lower 700 MHz	739.336	1,000	35.00
	Cellular	883.575		62.00
	AWS-1	2134.525		58.00
	Broadband PCS	1963.865		103.00

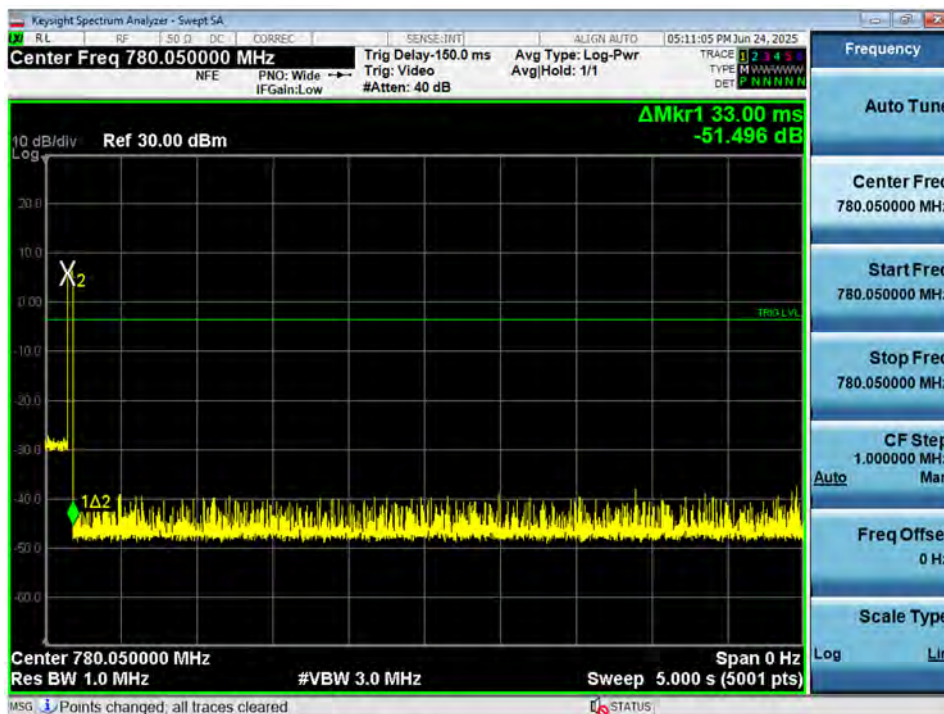
Tabulated Result of Downlink Oscillation Restart

ANT	Band	Frequency (MHz)	Time Limit (s)	Restart Limit	Restart Time (s)	Number of Restart
1	Upper 700 MHz	752.820	60 ≤	5	60.53	4
	Cellular	883.575			60.58	4
	AWS-1	2130.430			60.55	4
	Broadband PCS	1964.255			60.53	4
2	Lower 700 MHz	737.432	60 ≤	5	60.58	4
	Cellular	883.775			60.62	4
	AWS-1	2131.915			60.60	4
	Broadband PCS	1964.775			60.50	4
3	Lower 700 MHz	739.336	60 ≤	5	60.58	4
	Cellular	883.575			60.53	4
	AWS-1	2134.525			60.62	4
	Broadband PCS	1963.865			60.53	4

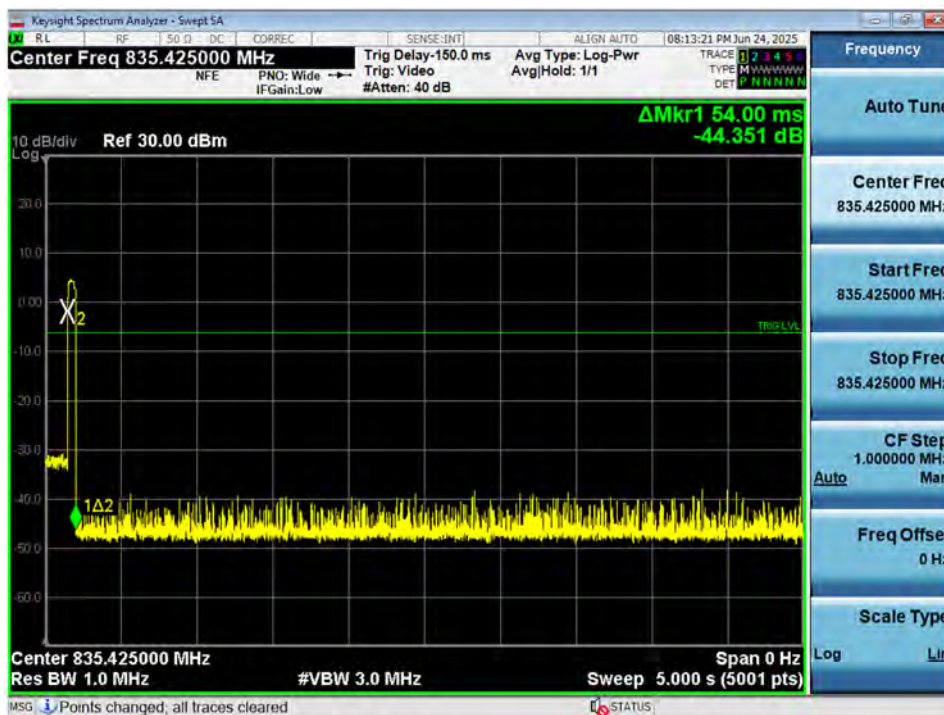
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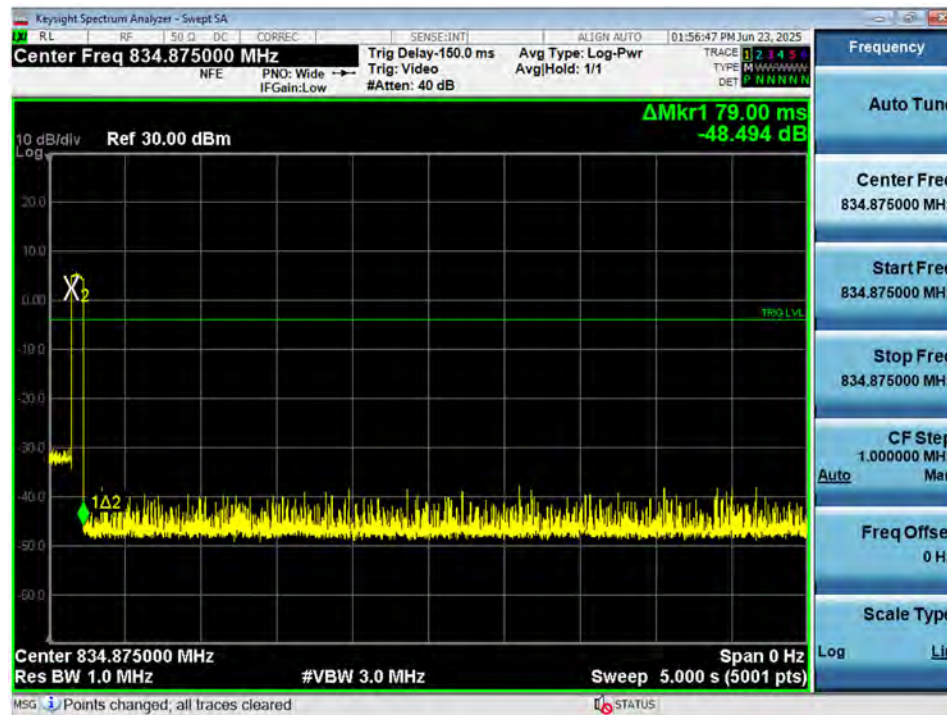
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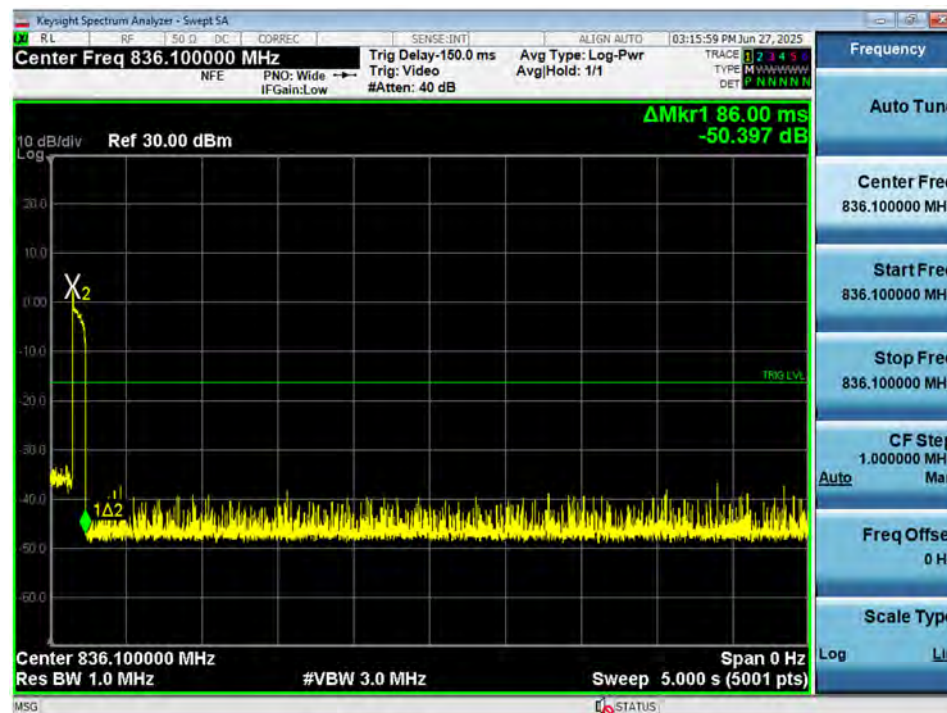
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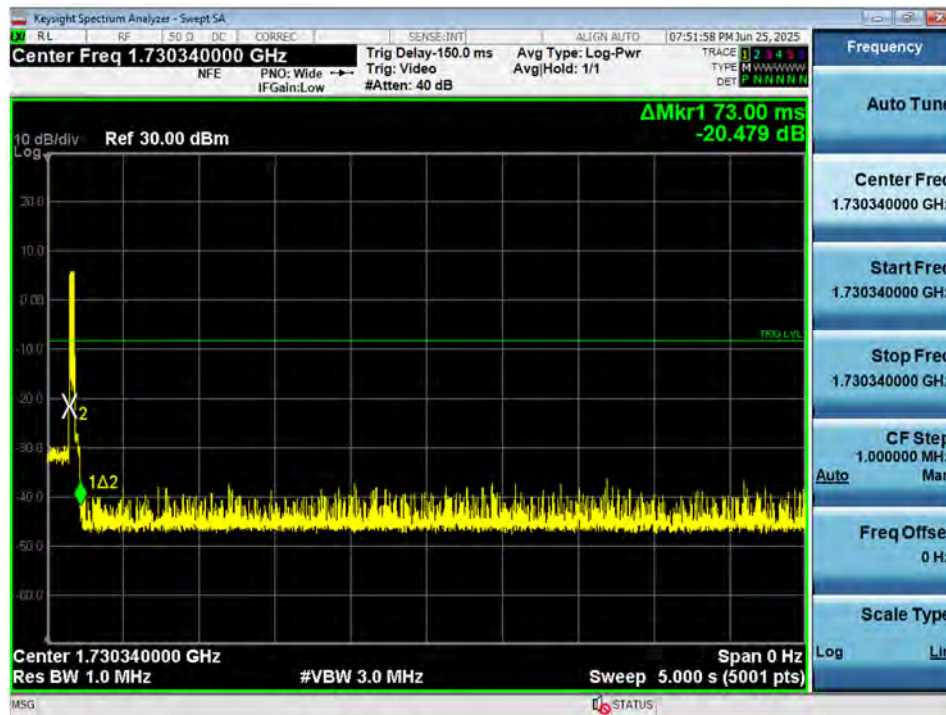
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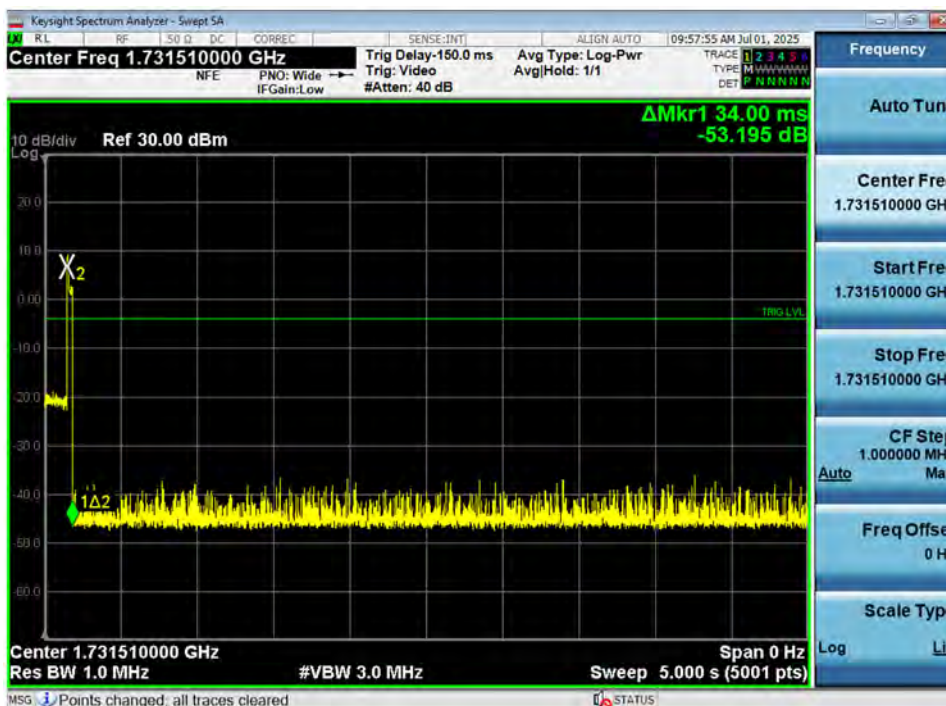
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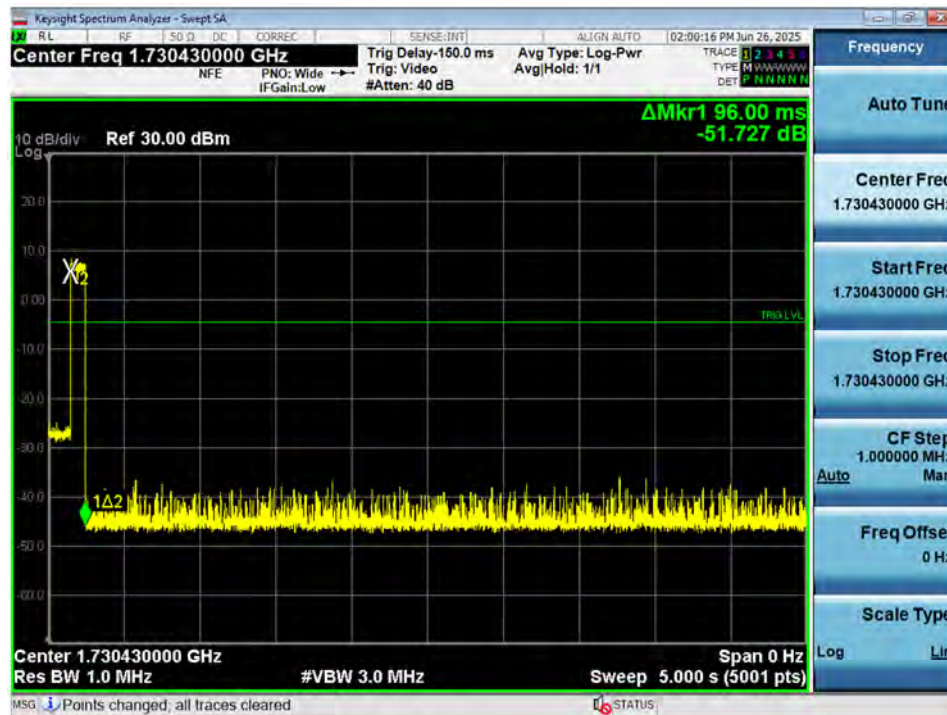
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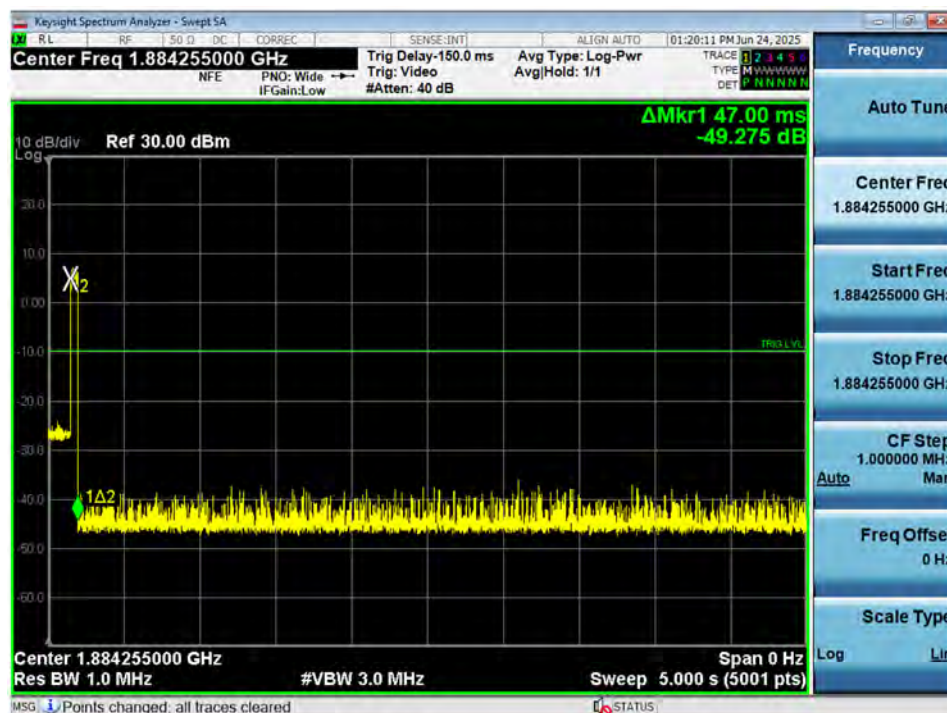
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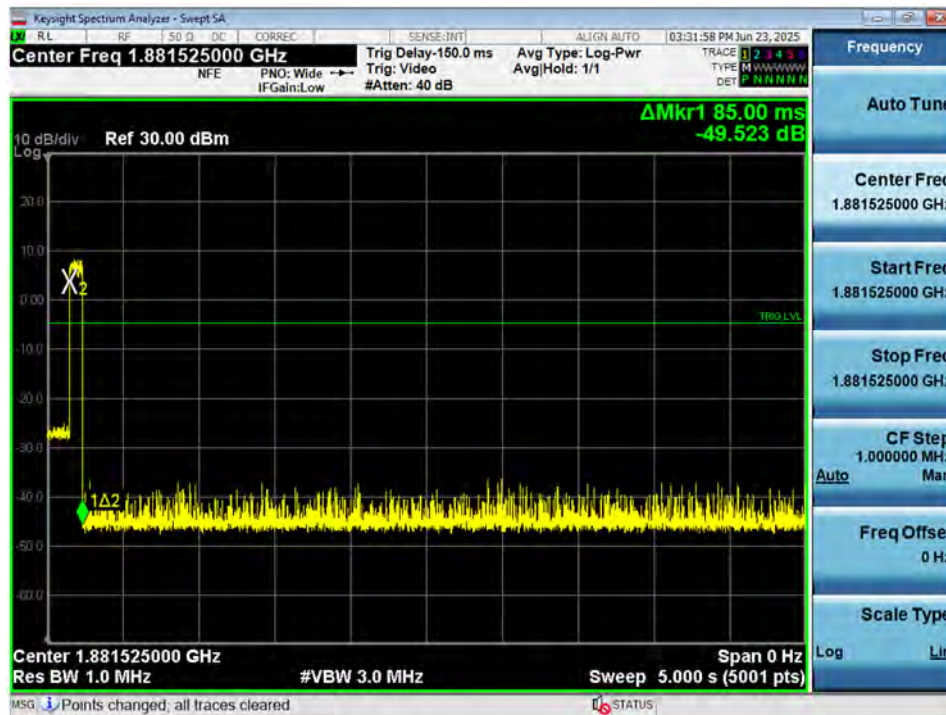
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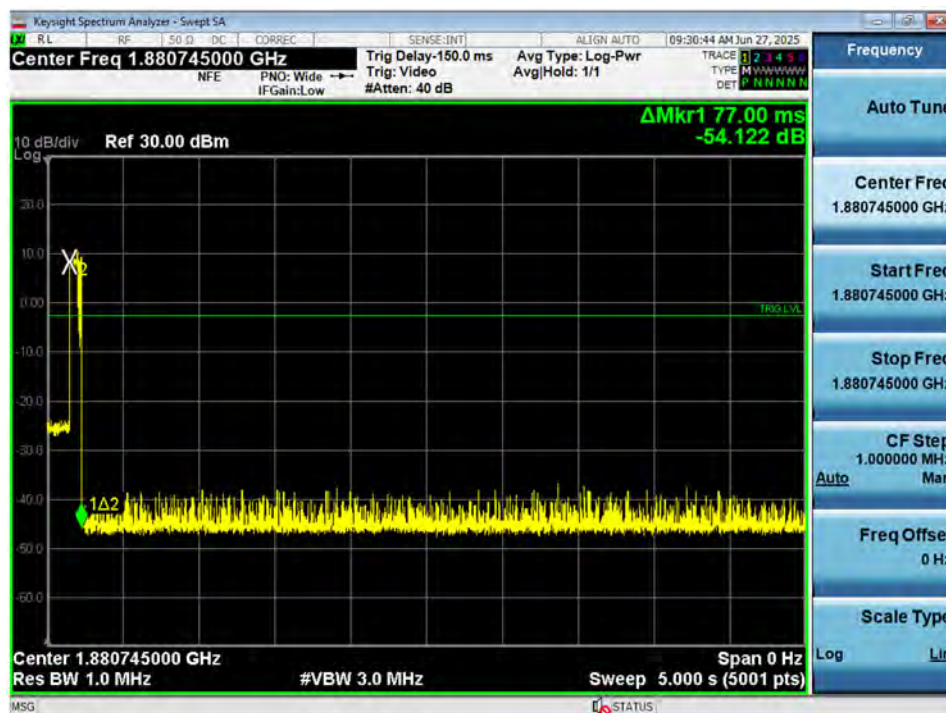
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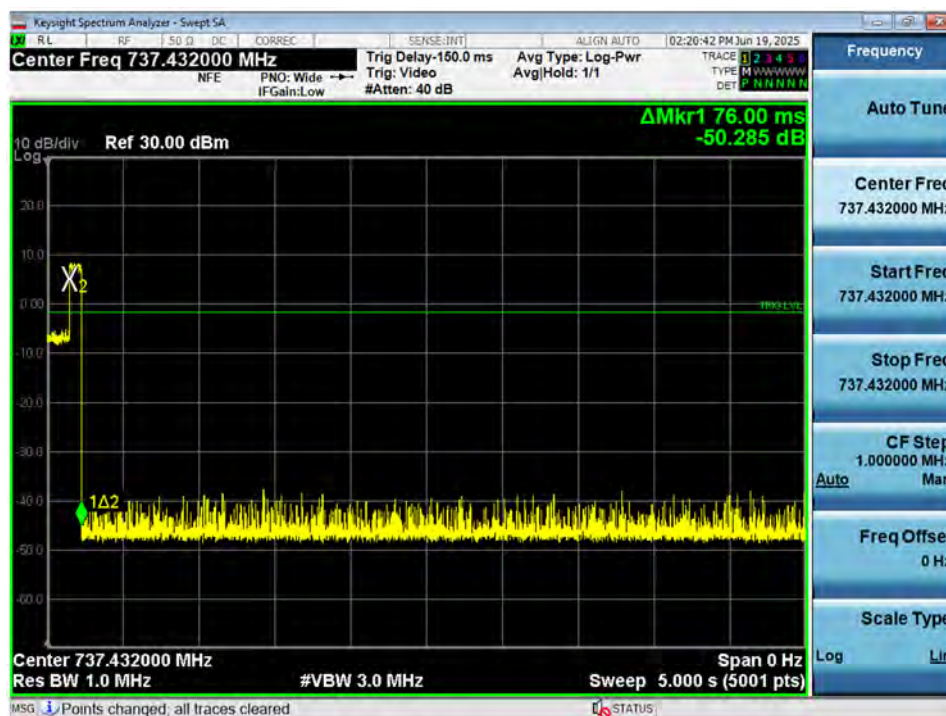
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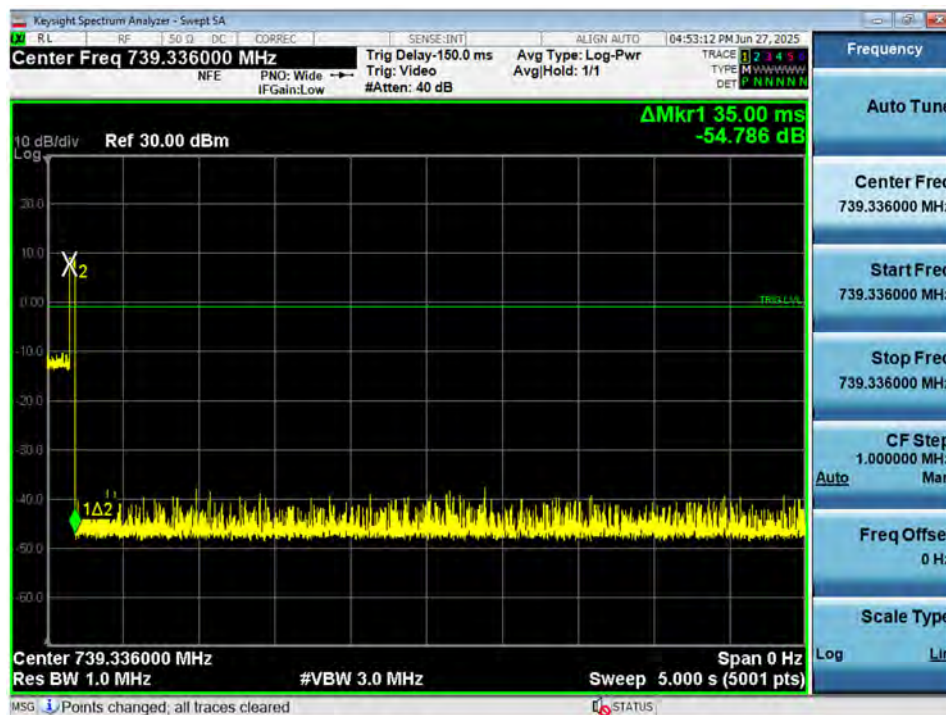
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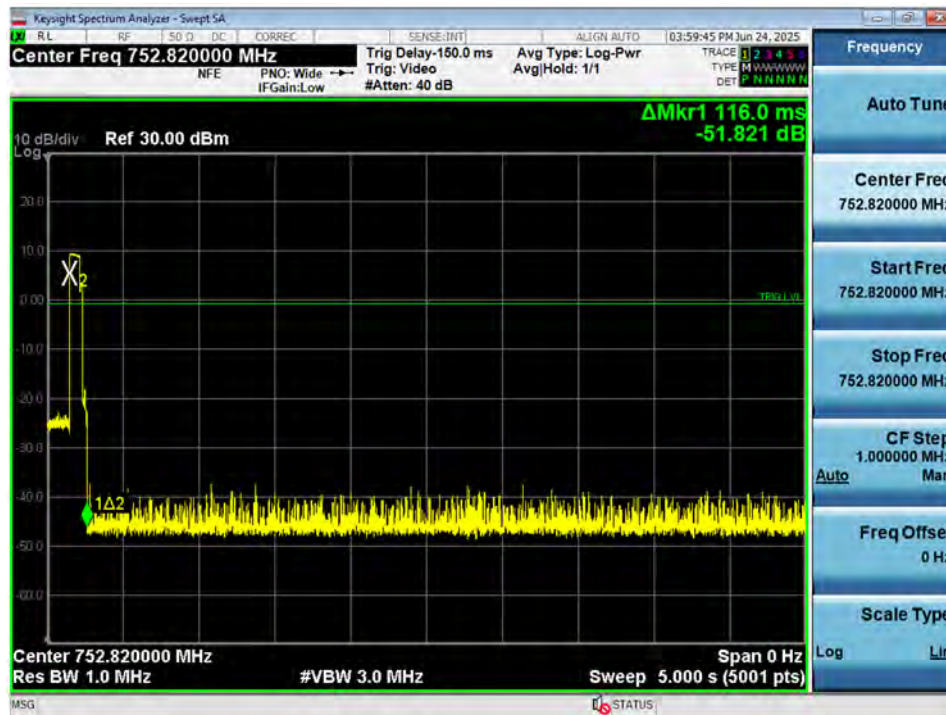
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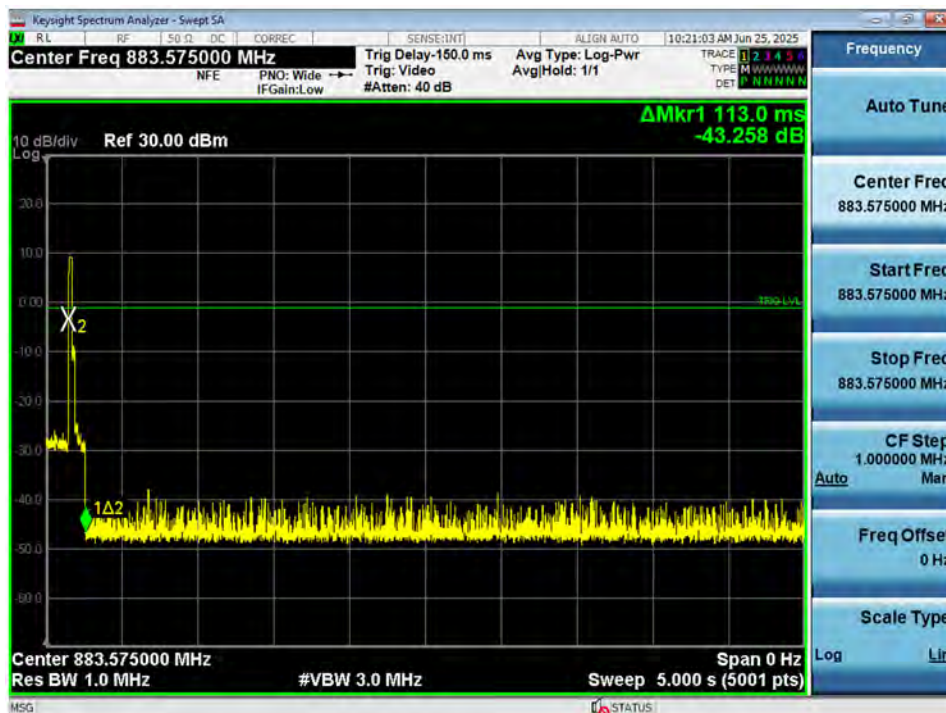
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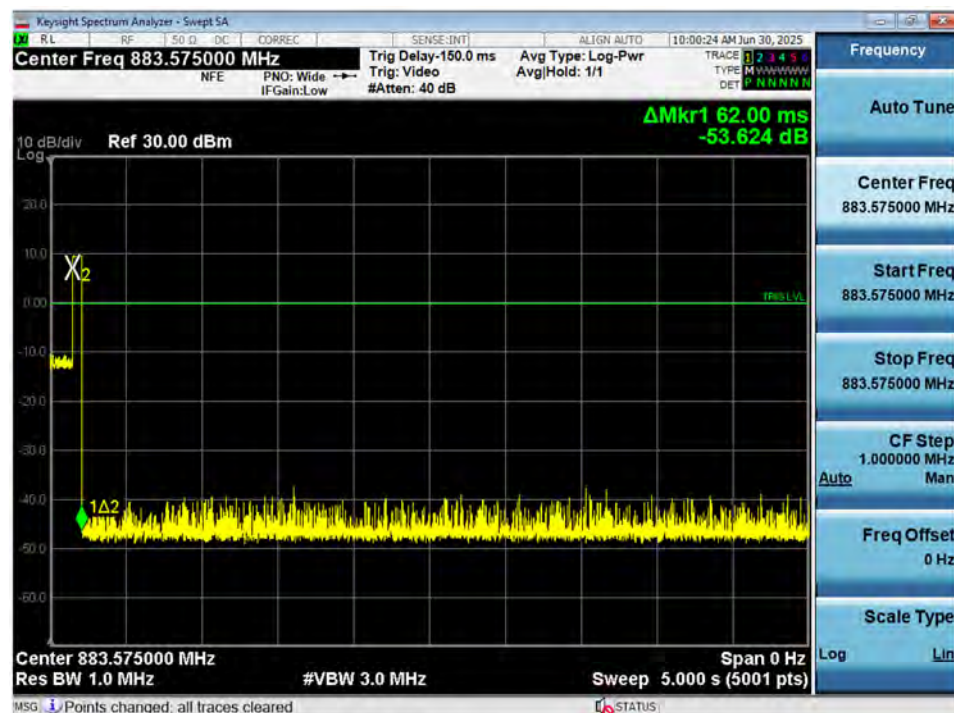
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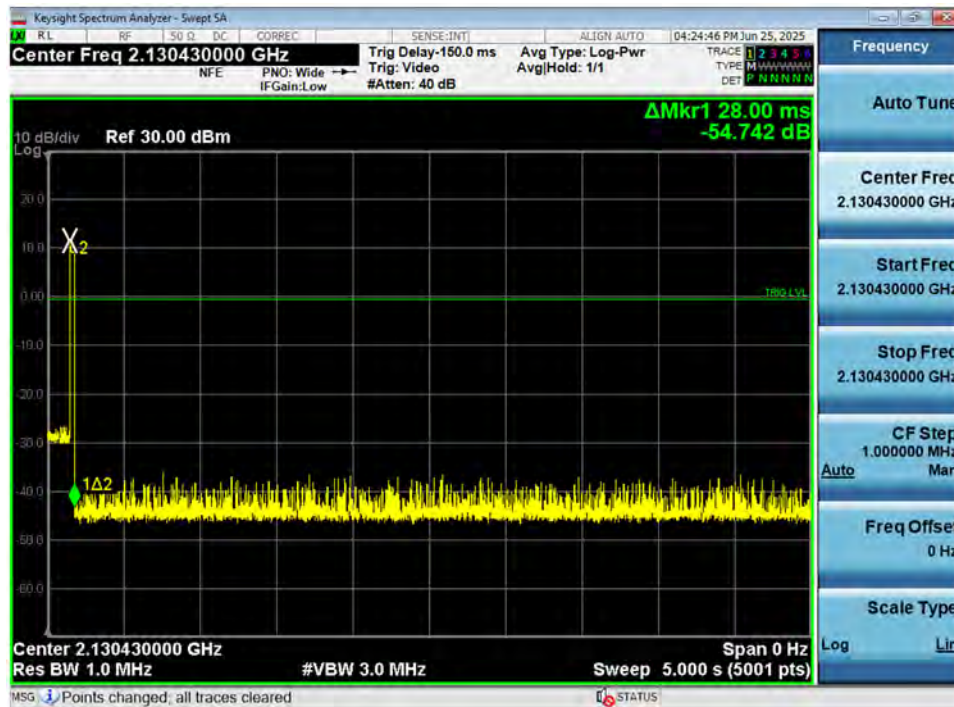
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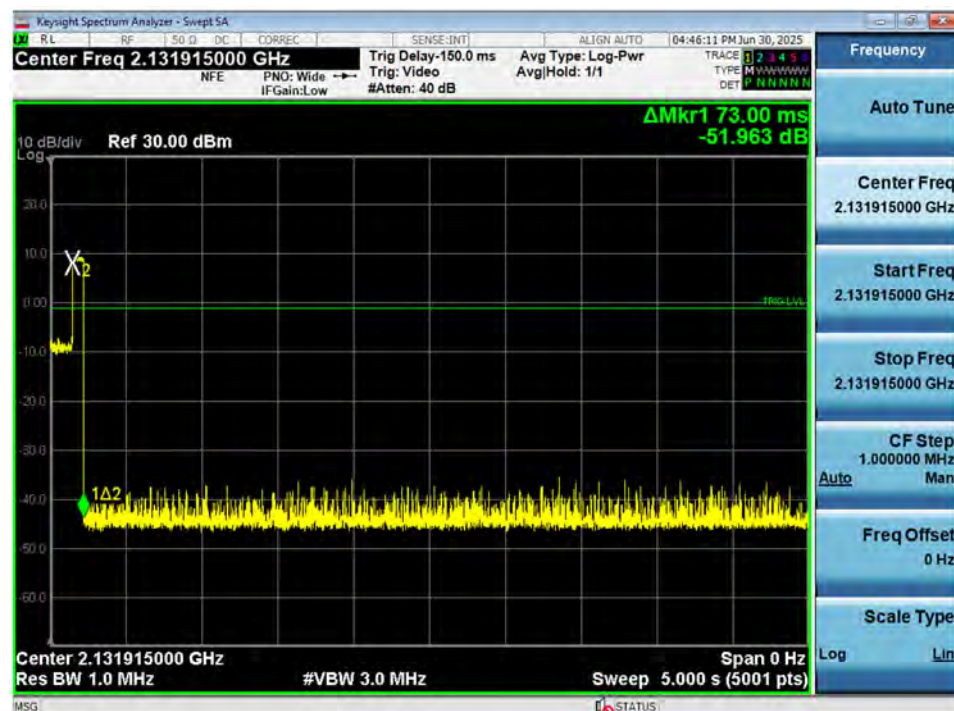
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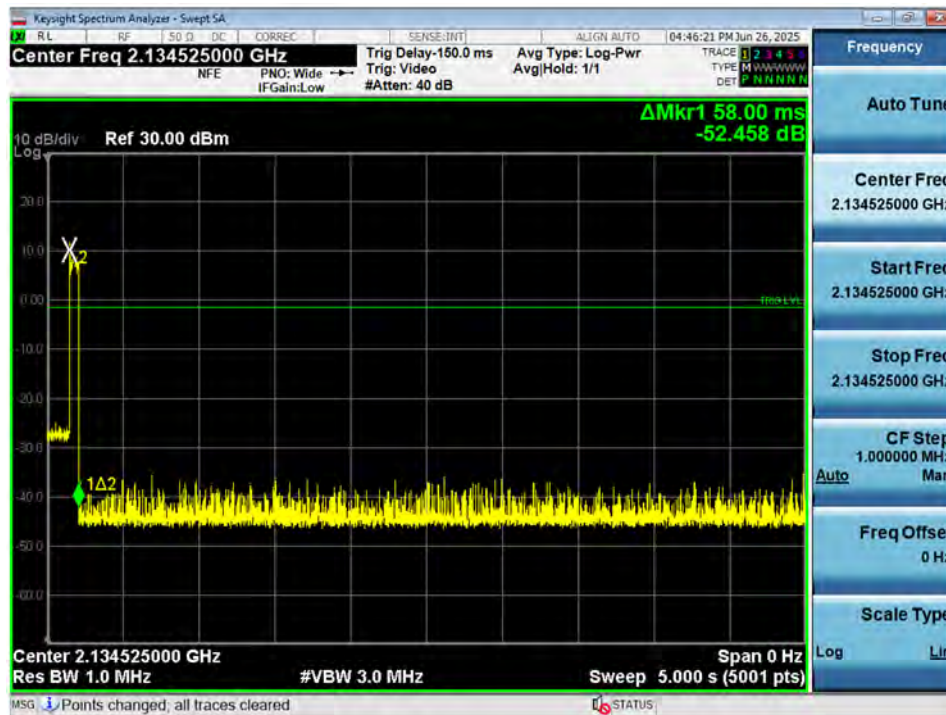
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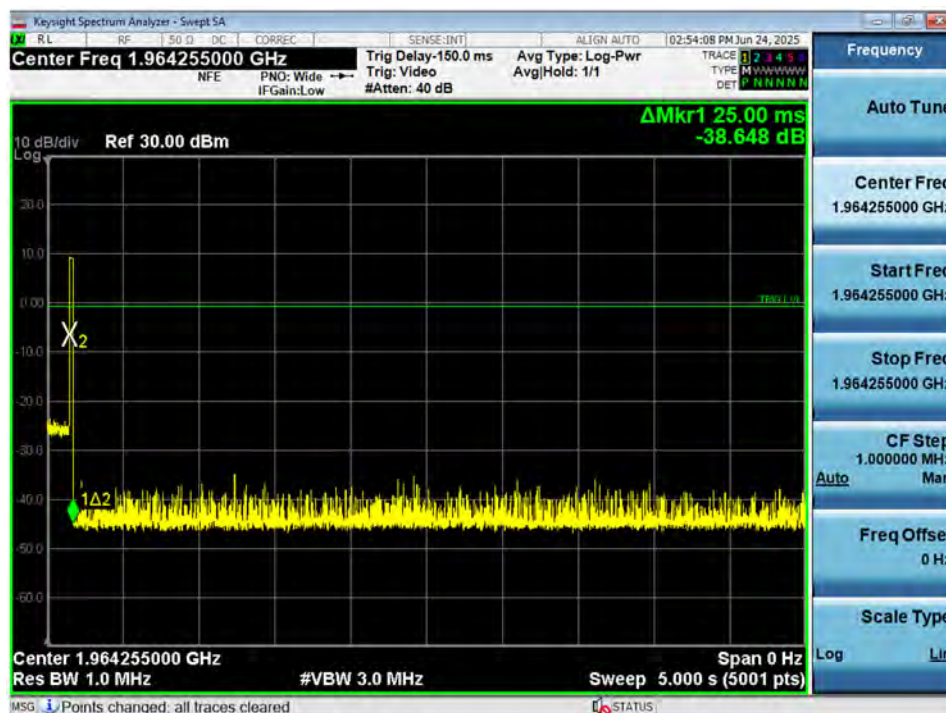
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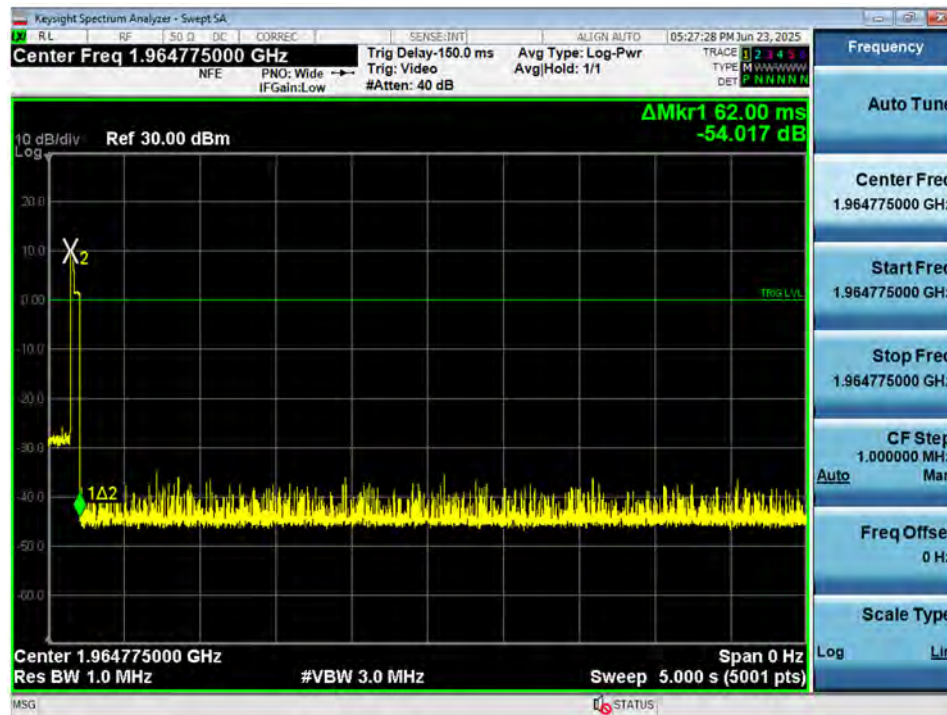
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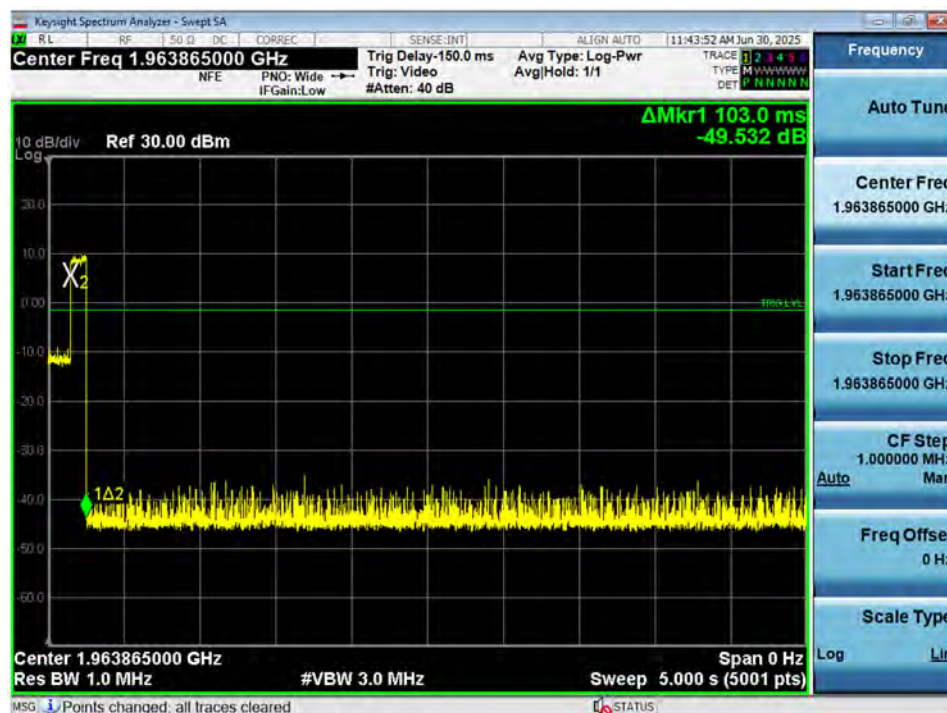
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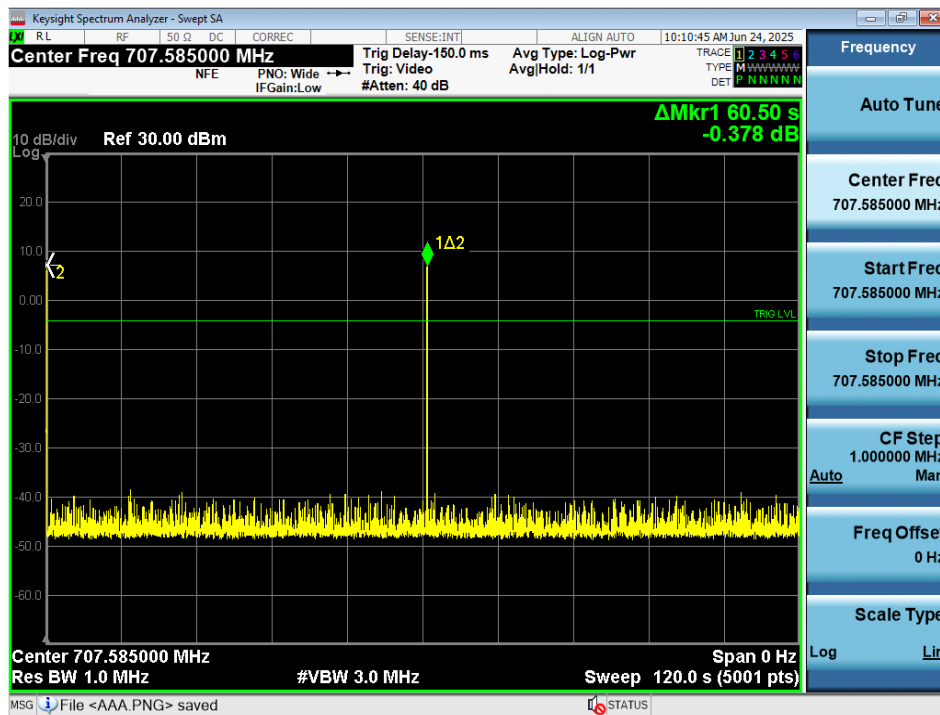
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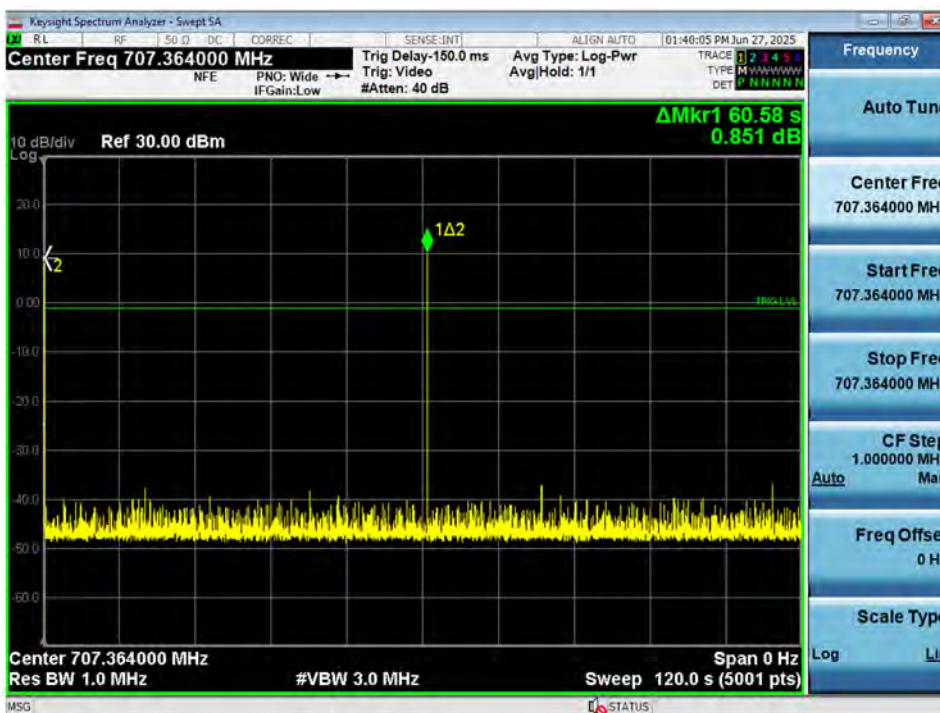
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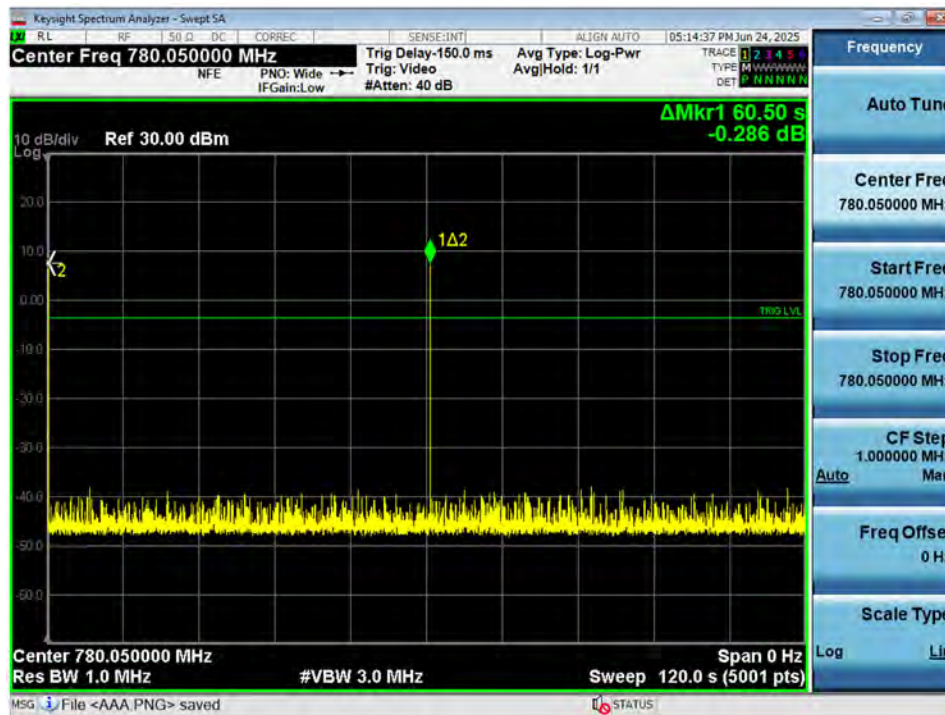
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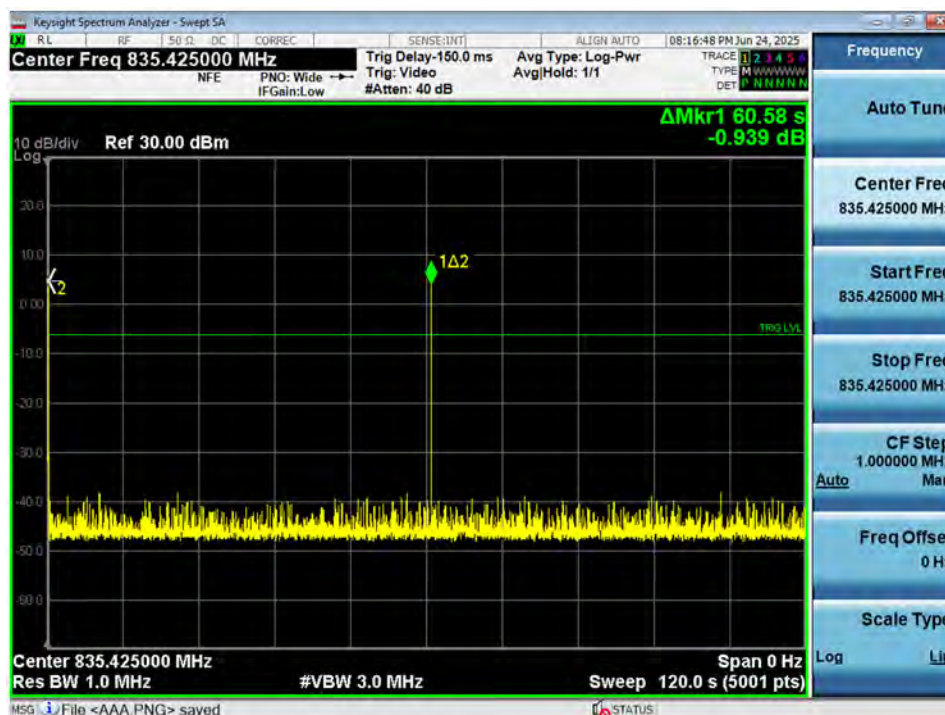
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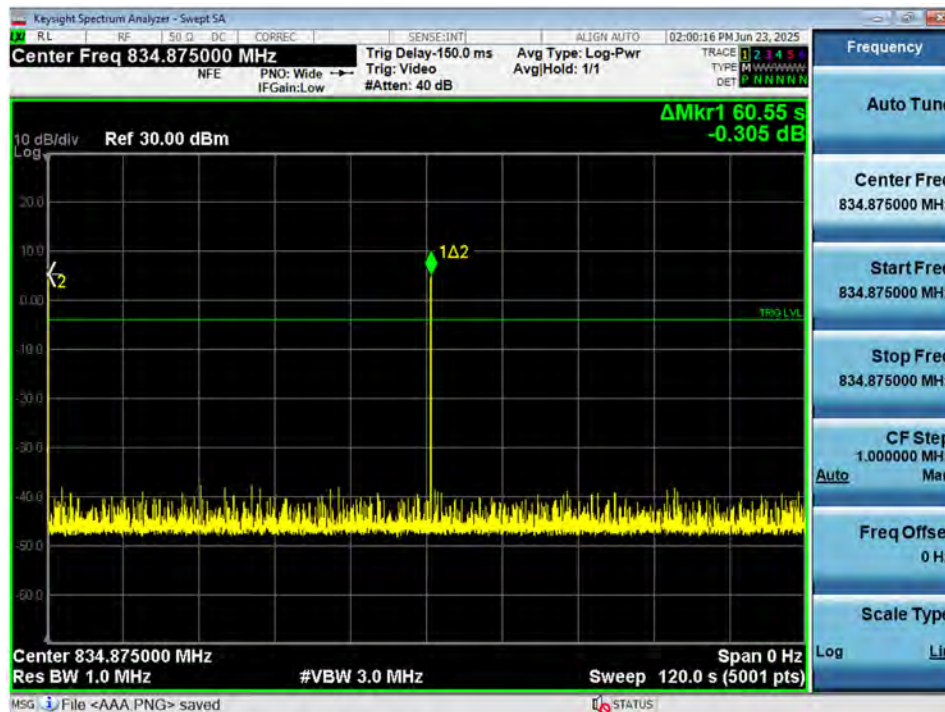
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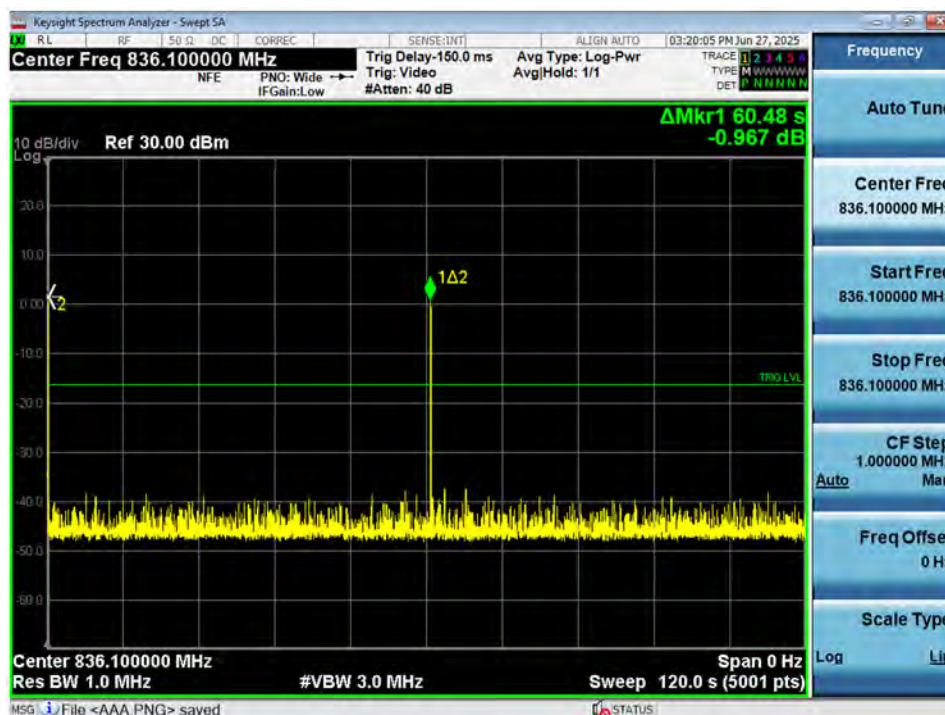
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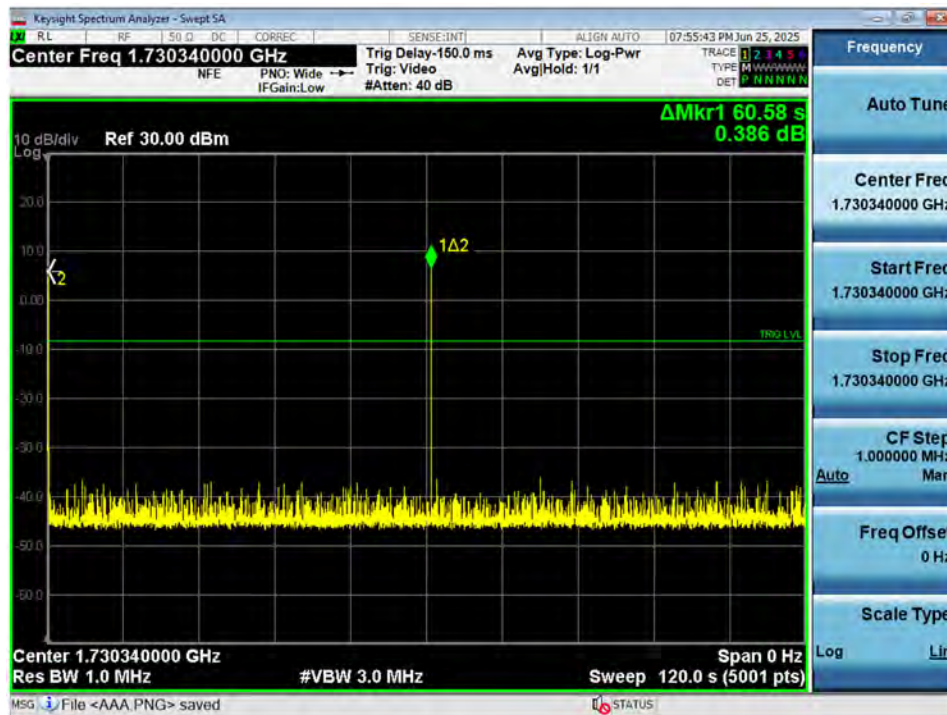
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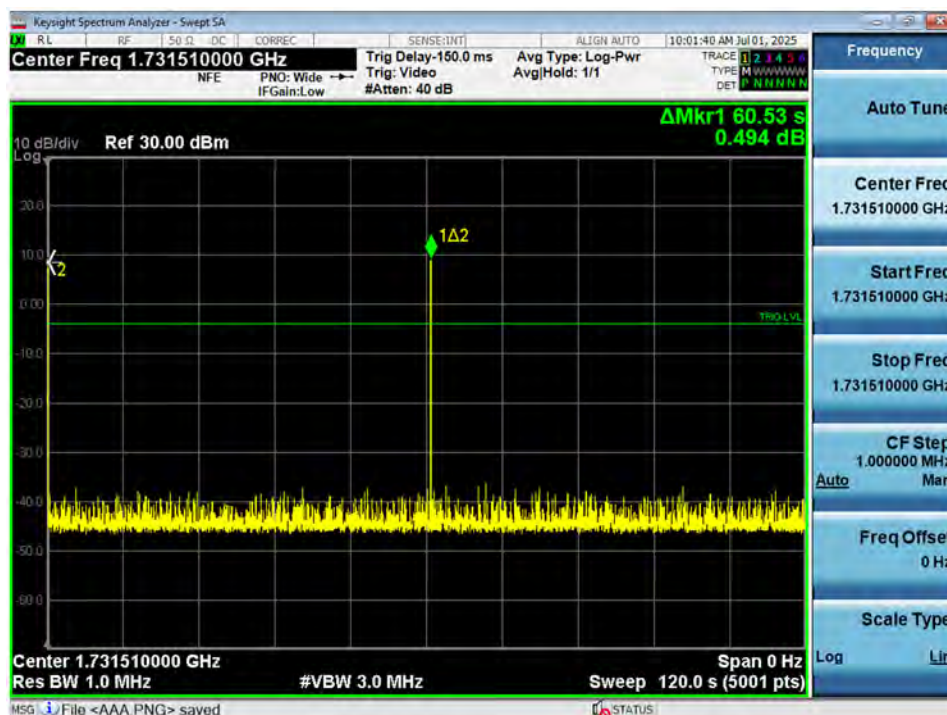
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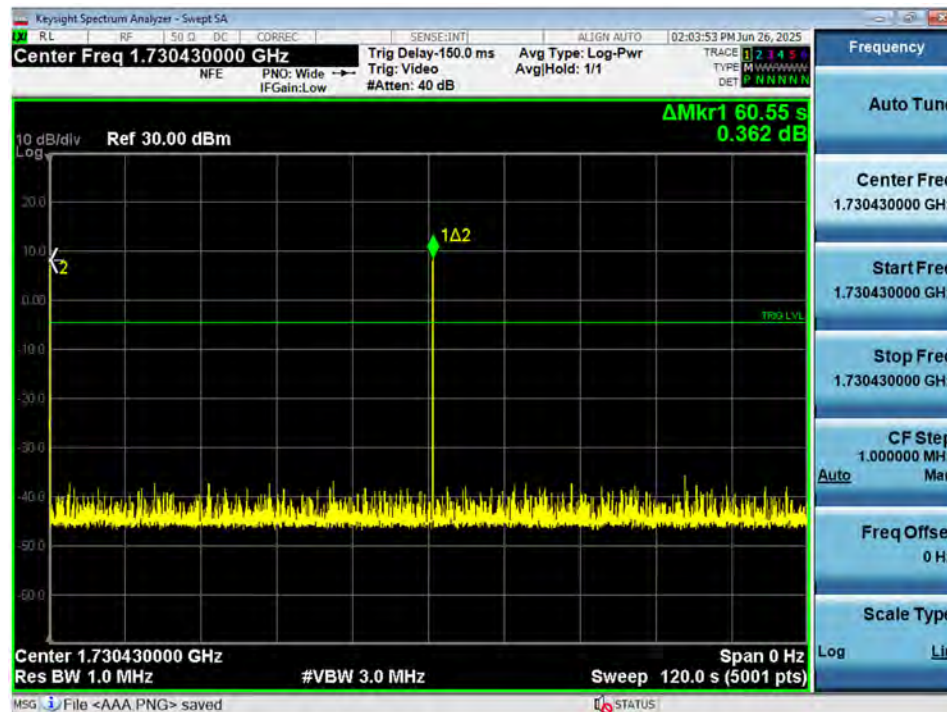
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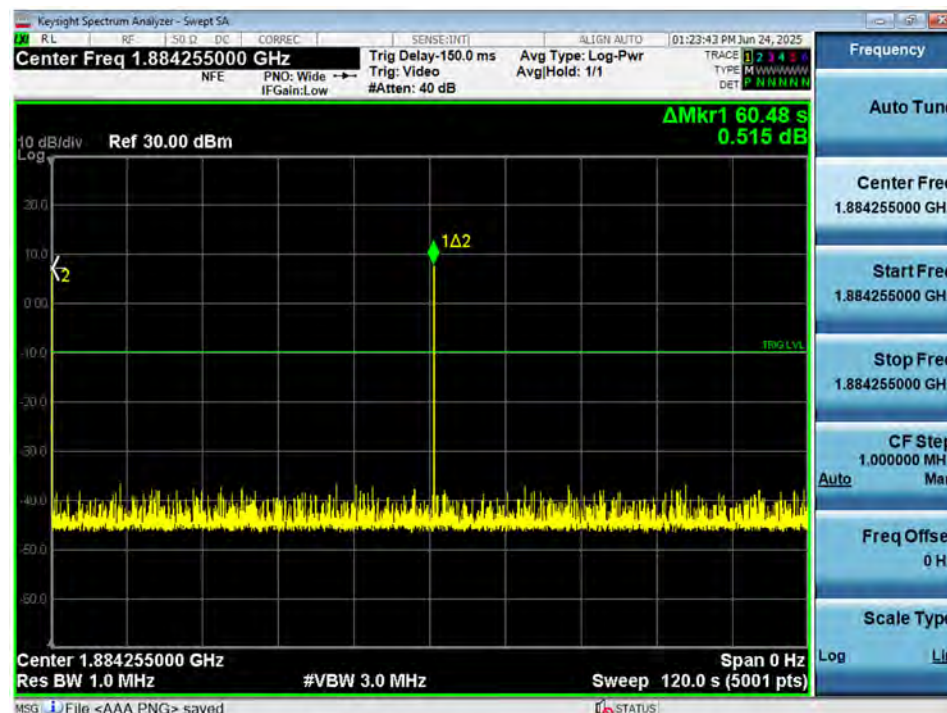
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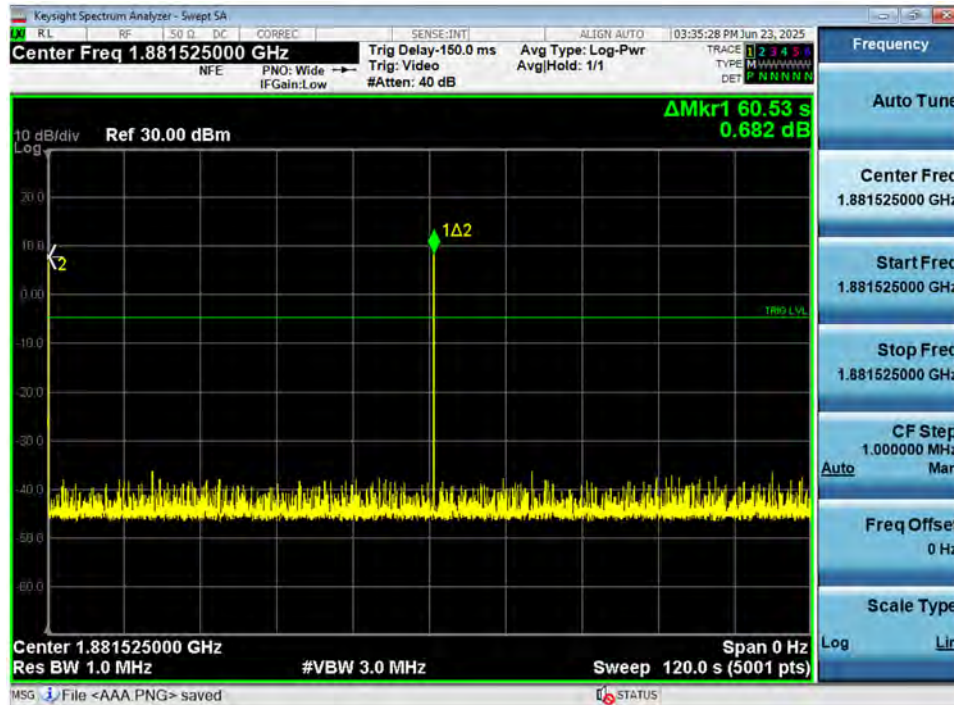
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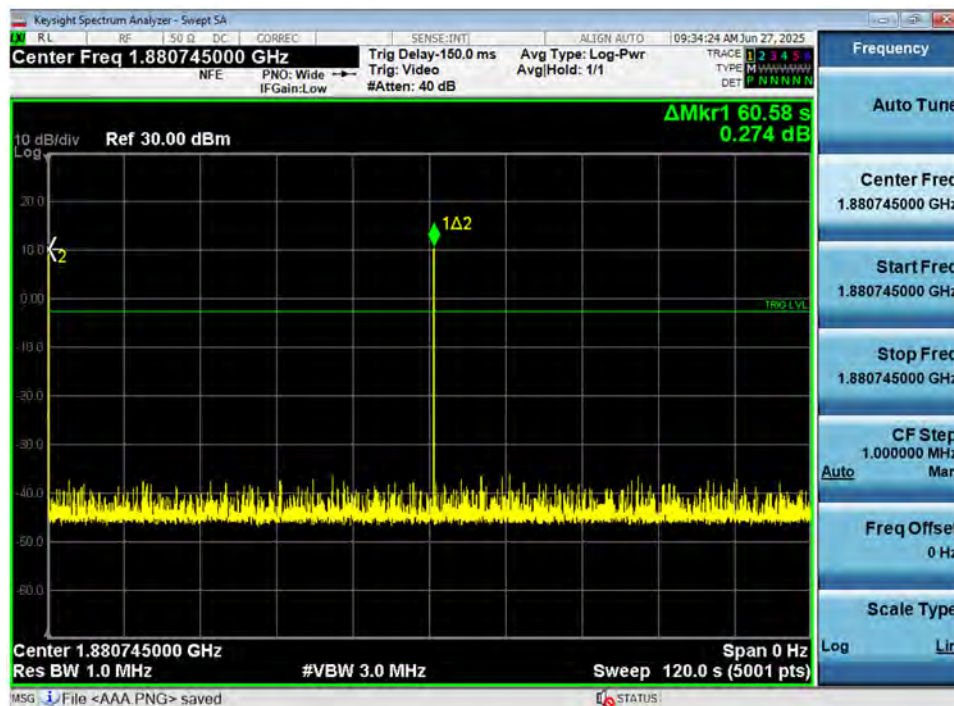
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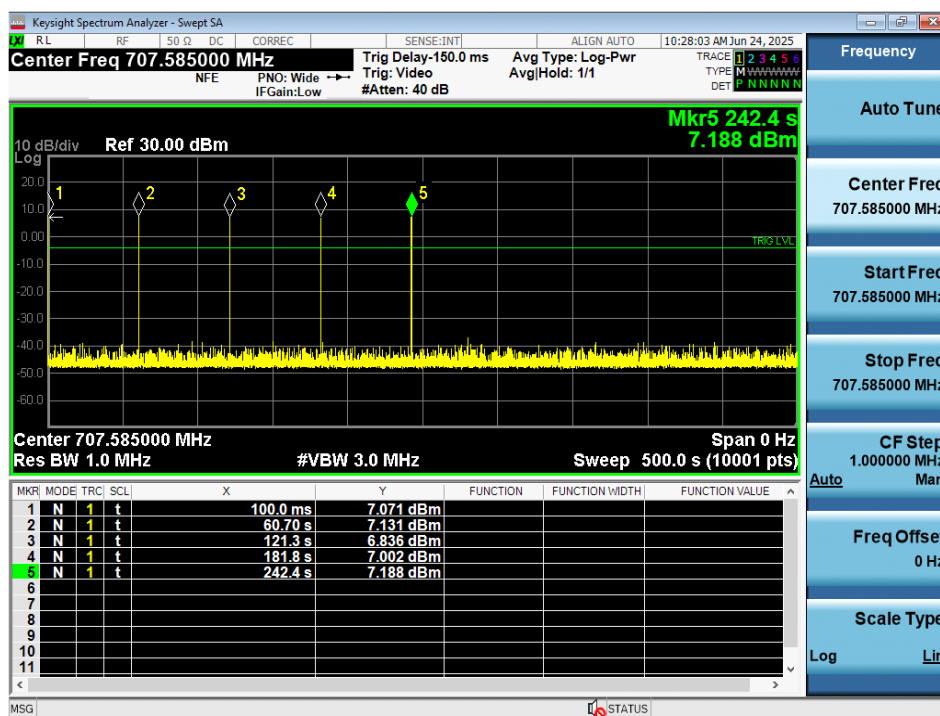
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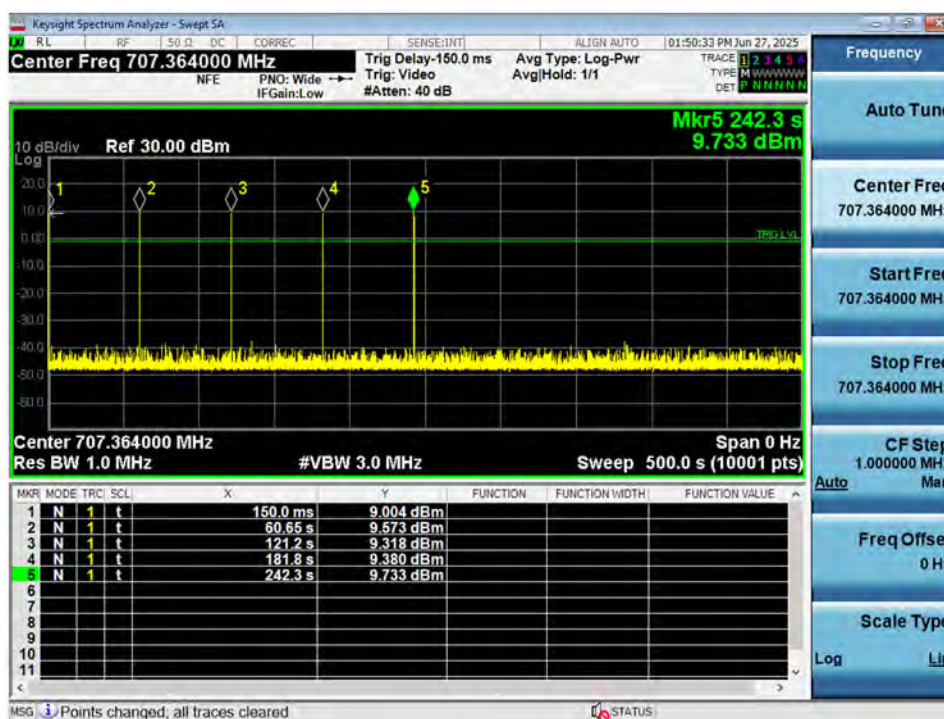
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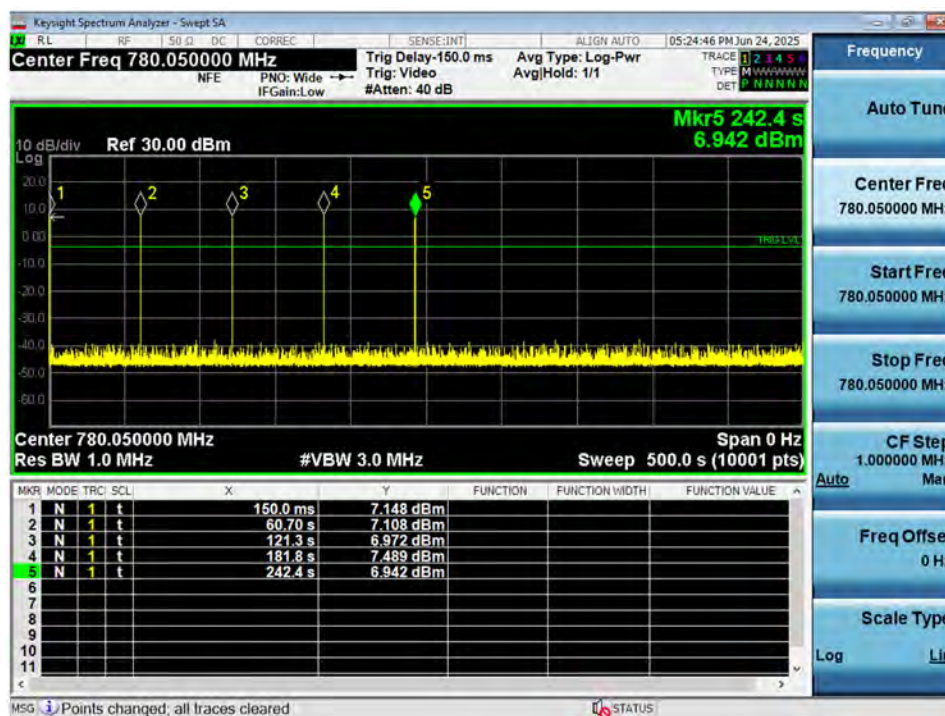
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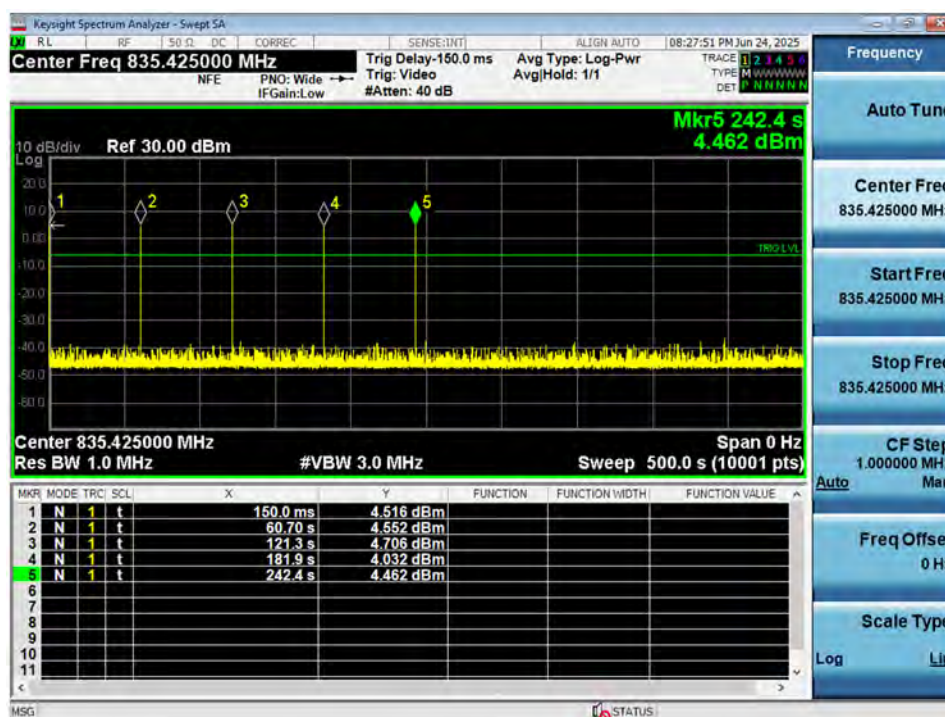
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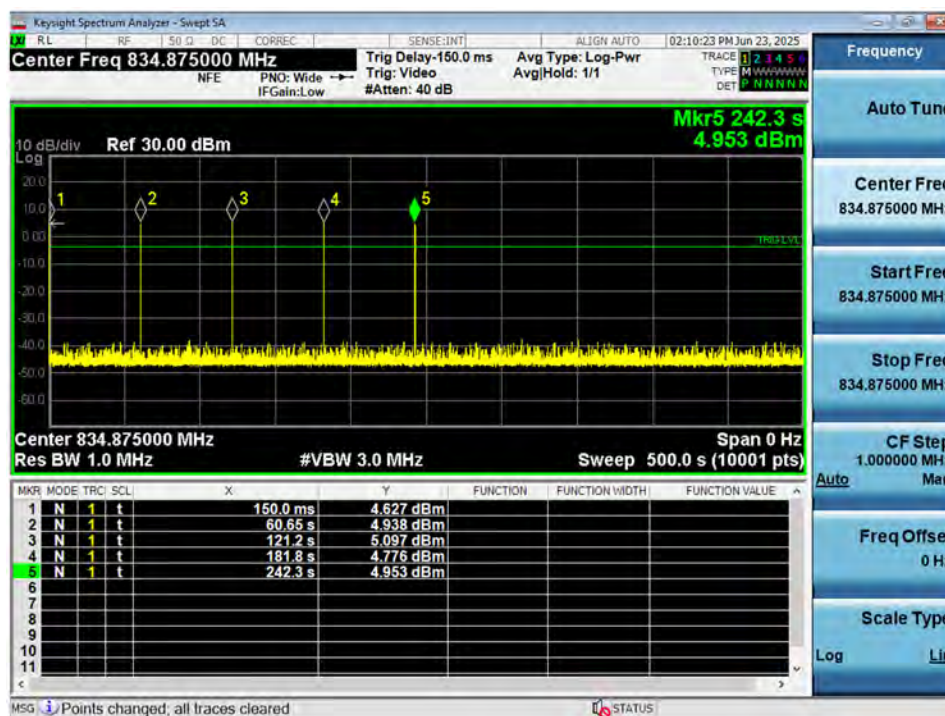
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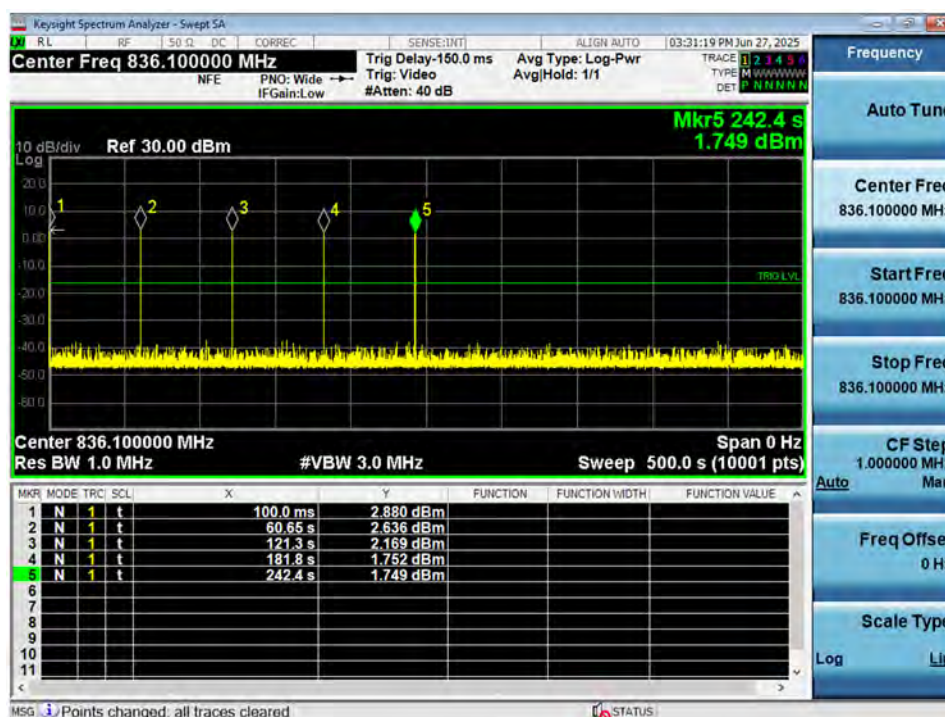
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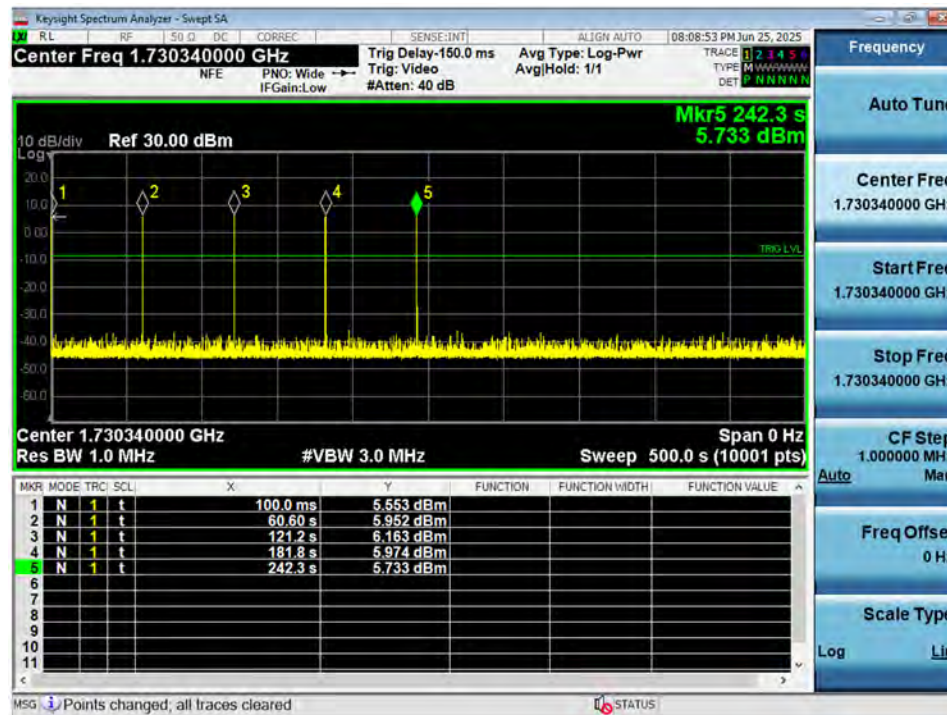
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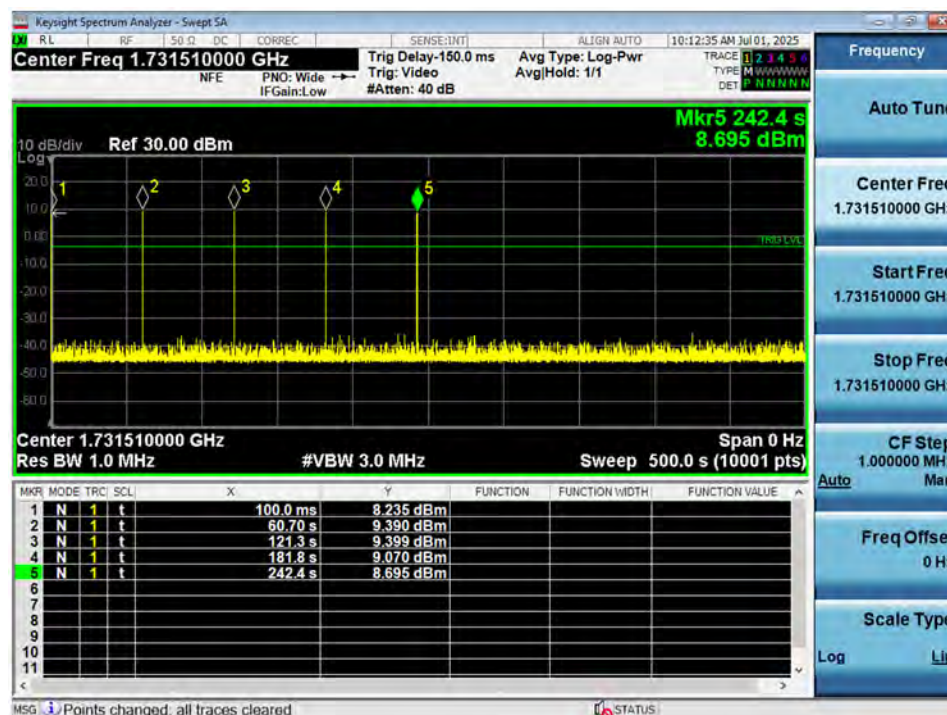
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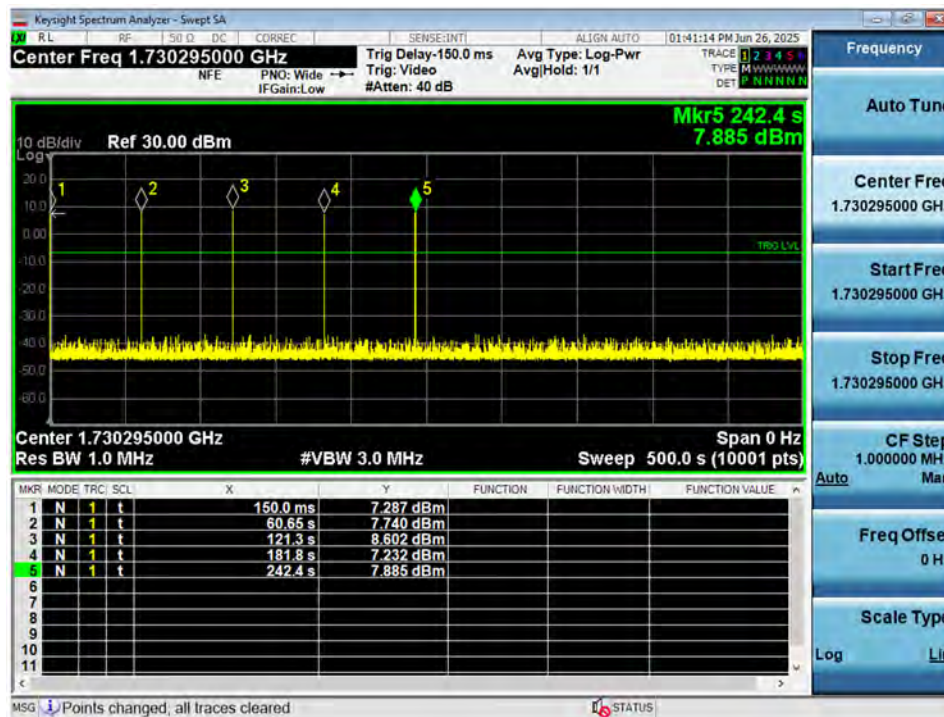
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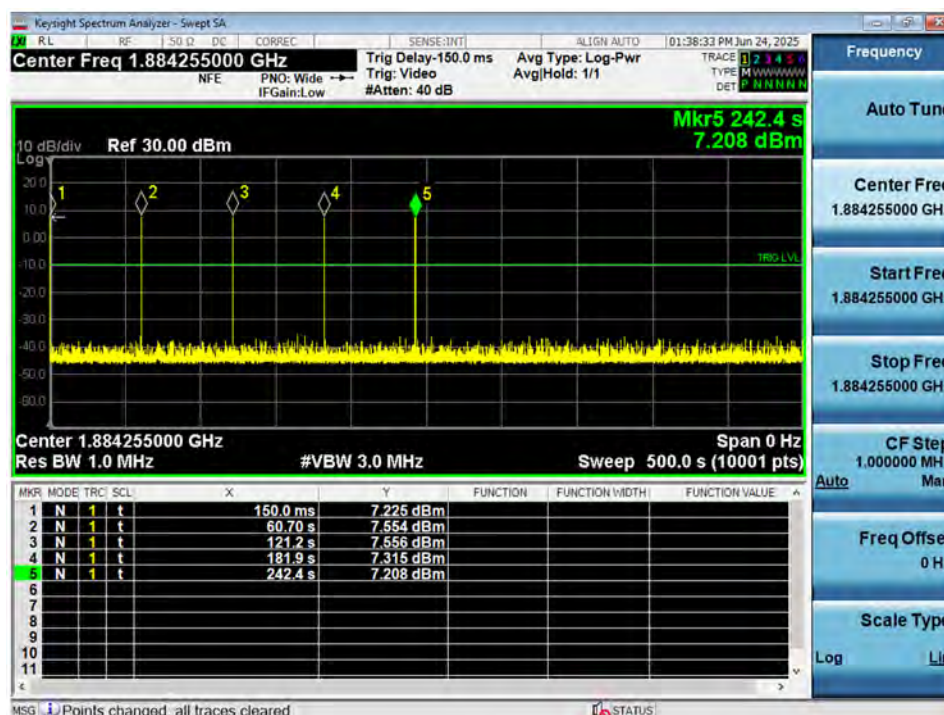
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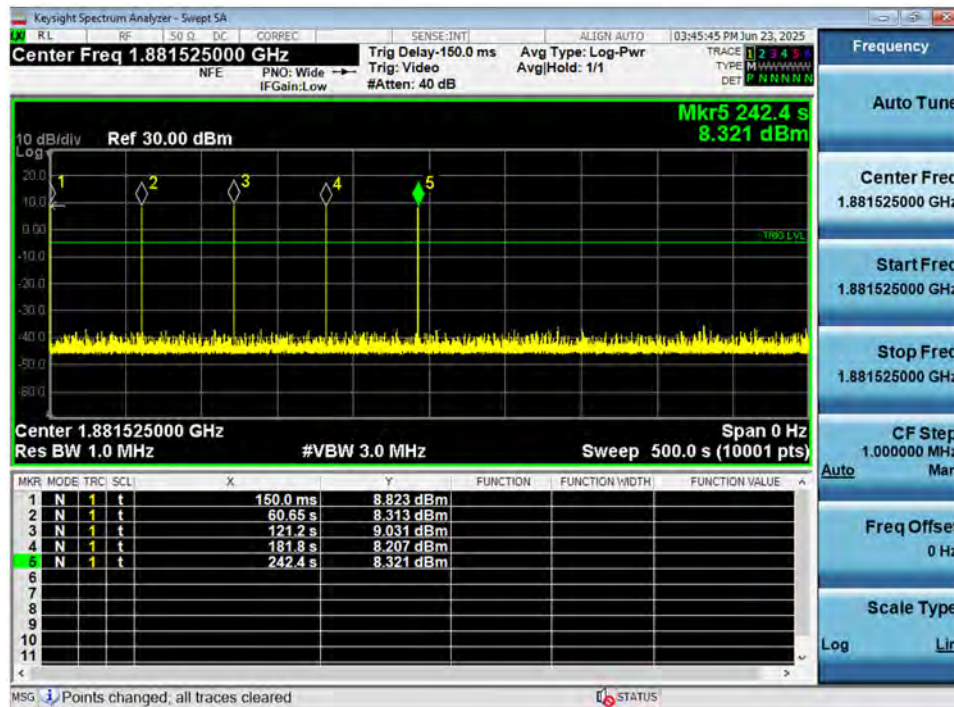
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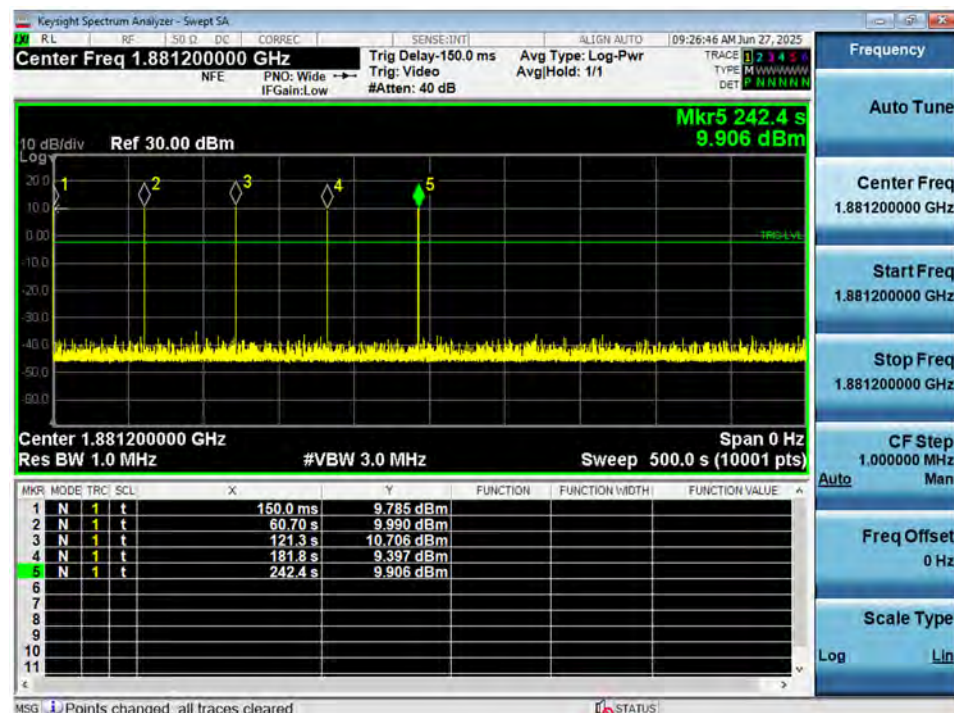
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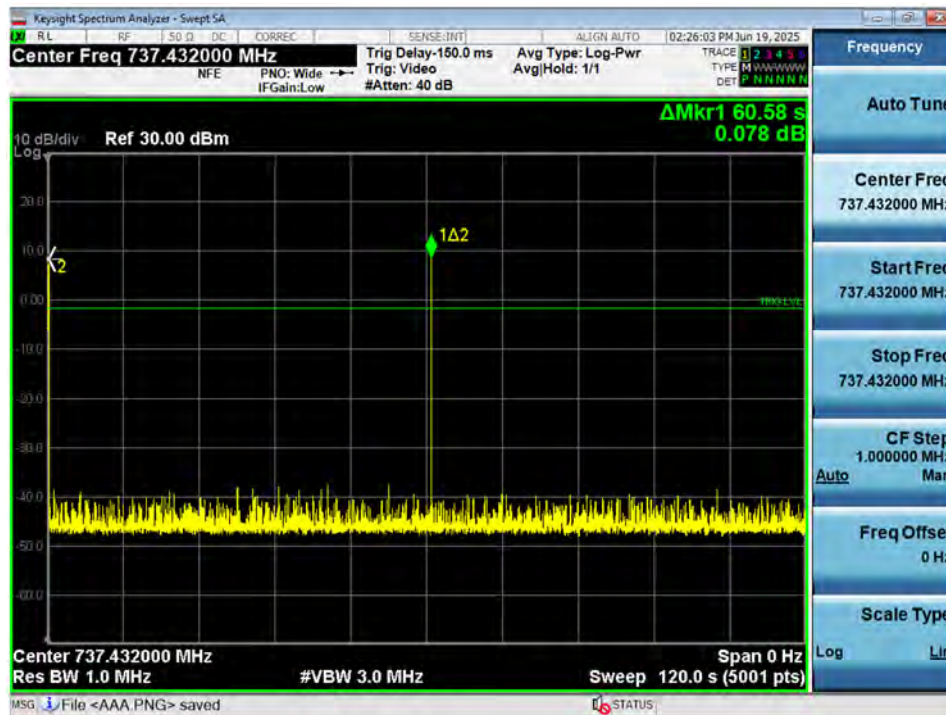
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Number of Oscillation Restart / Broadband PCS / Uplink / ANT 3



Oscillation Restart Time / Lower 700 MHz / Downlink / ANT 2



Oscillation Restart Time / Lower 700 MHz / Downlink / ANT 3

