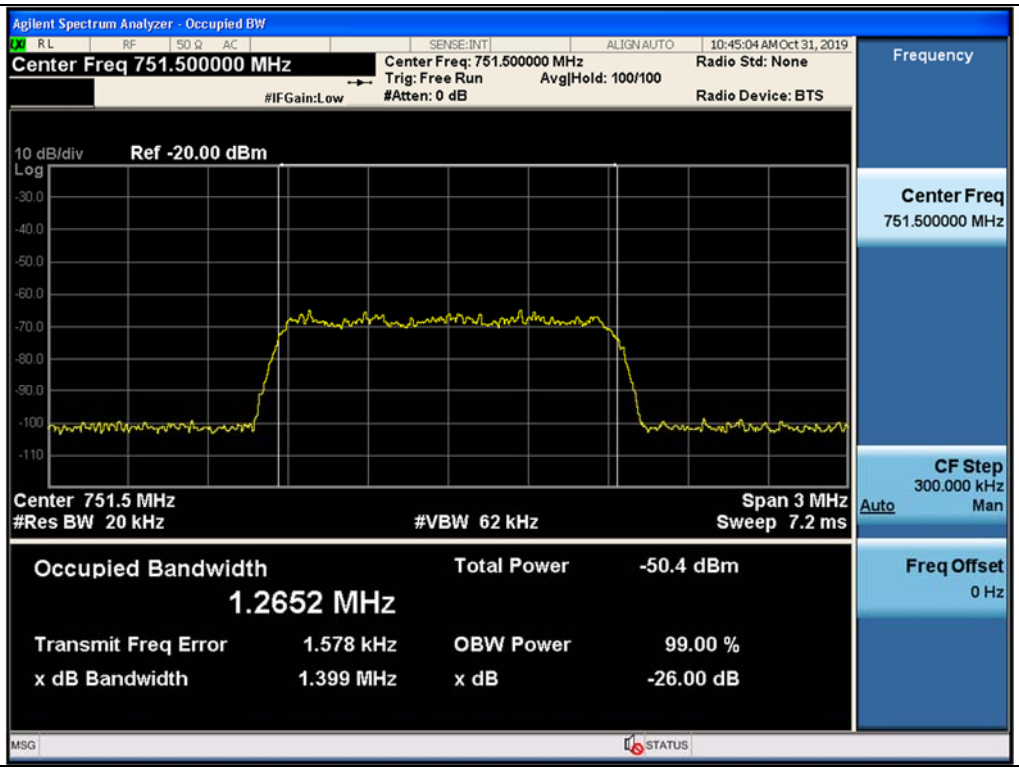
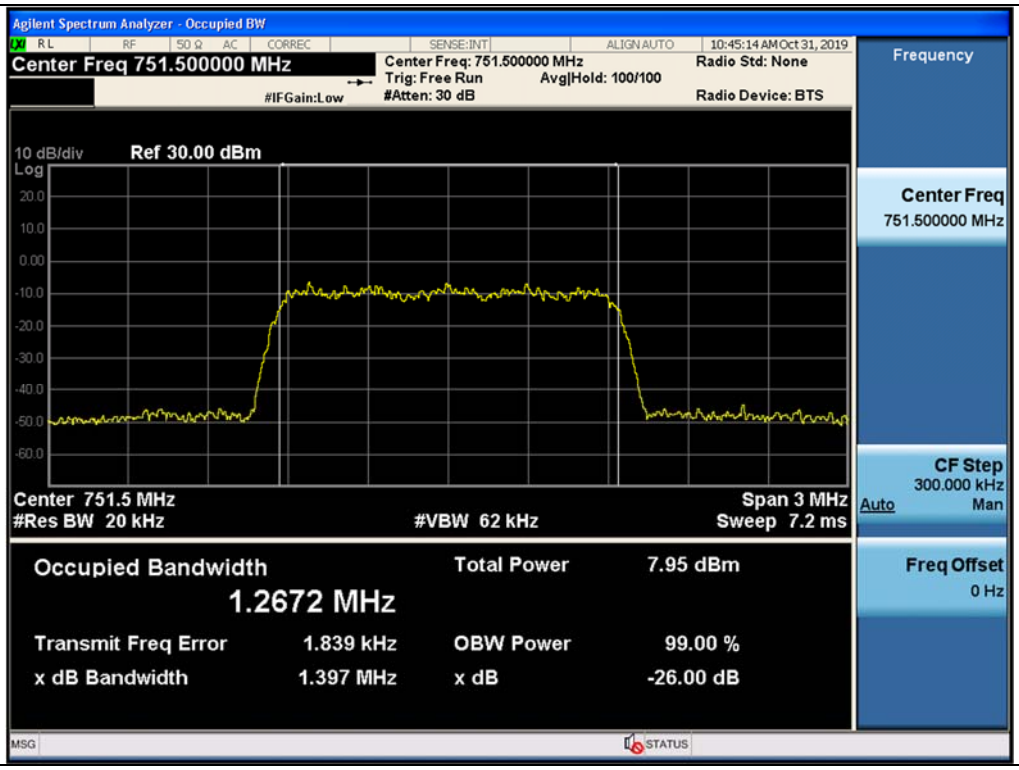
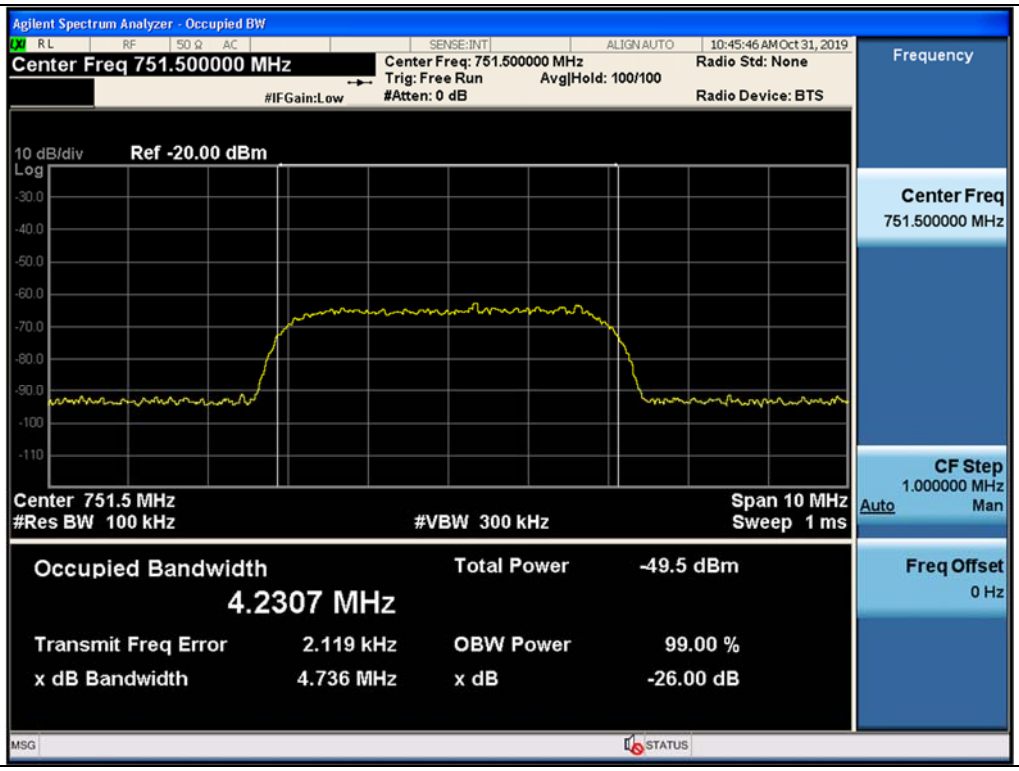
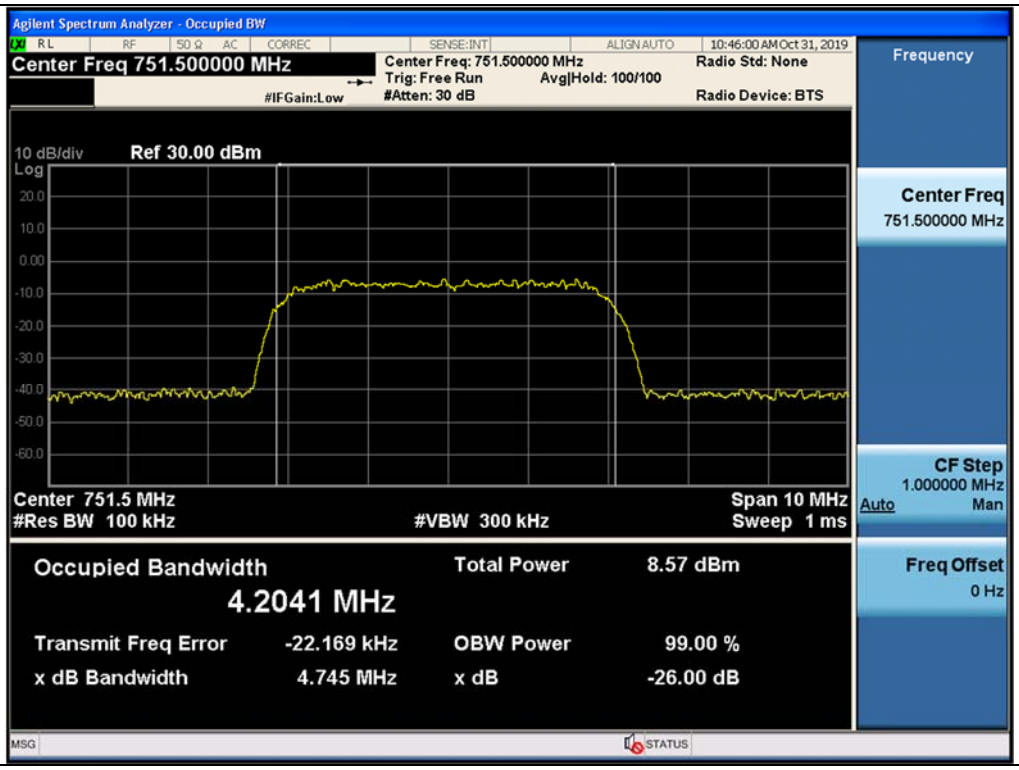
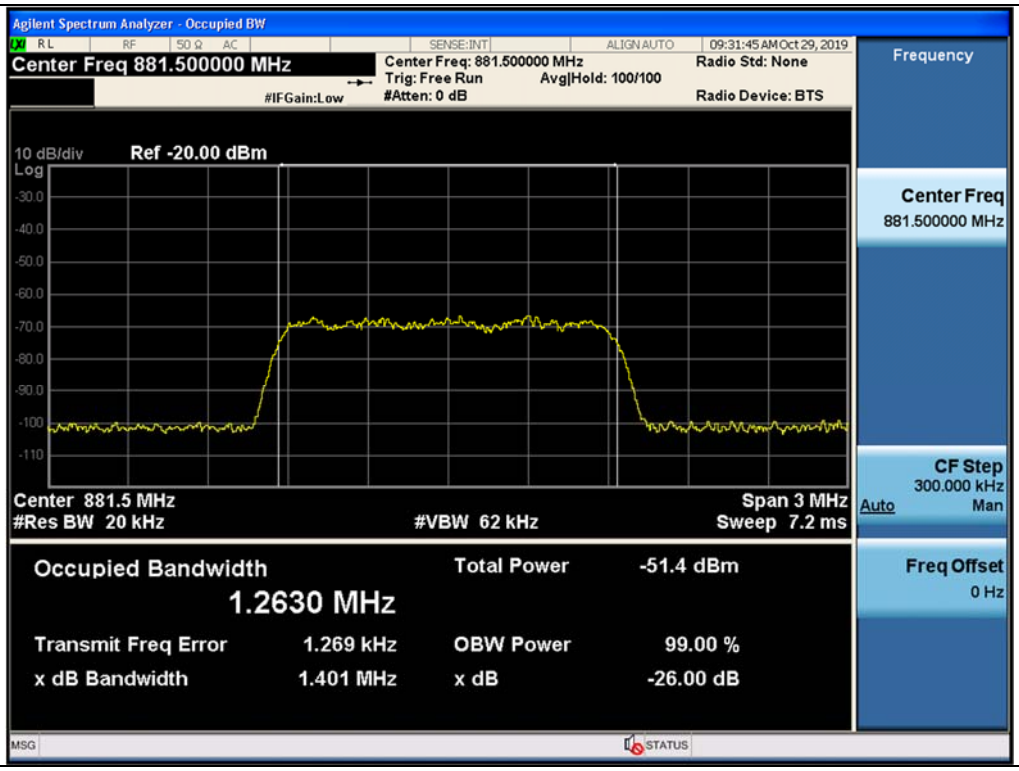
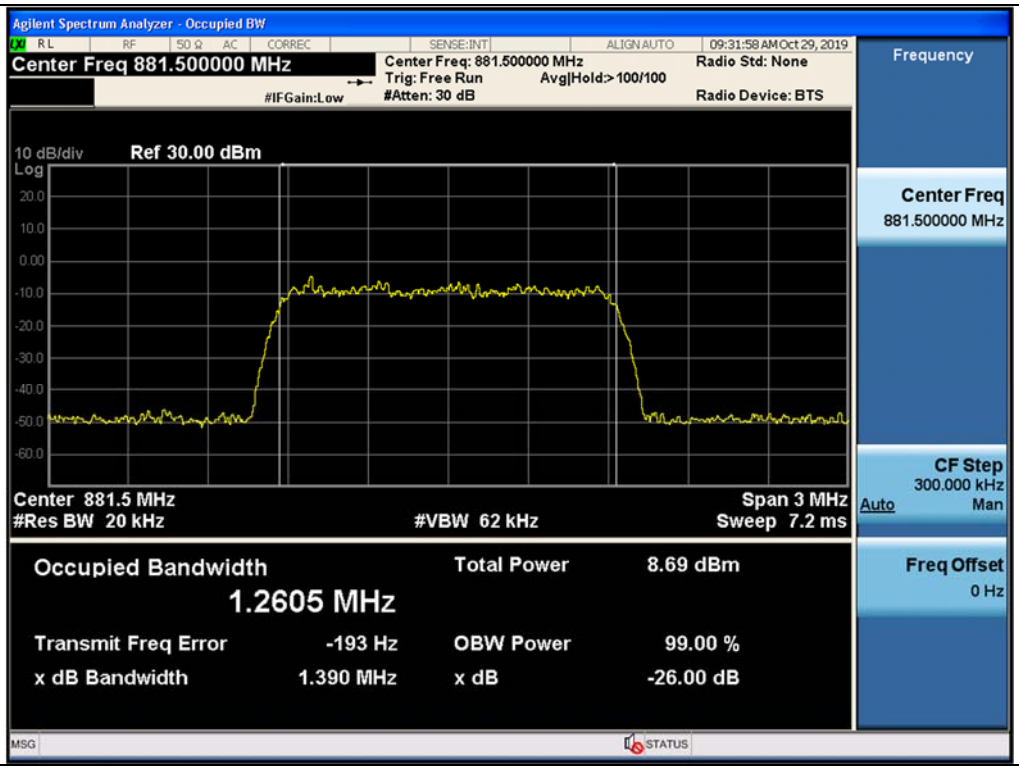
Occupied Bandwidth / Upper 700 MHz / Downlink / CDMA/ Input


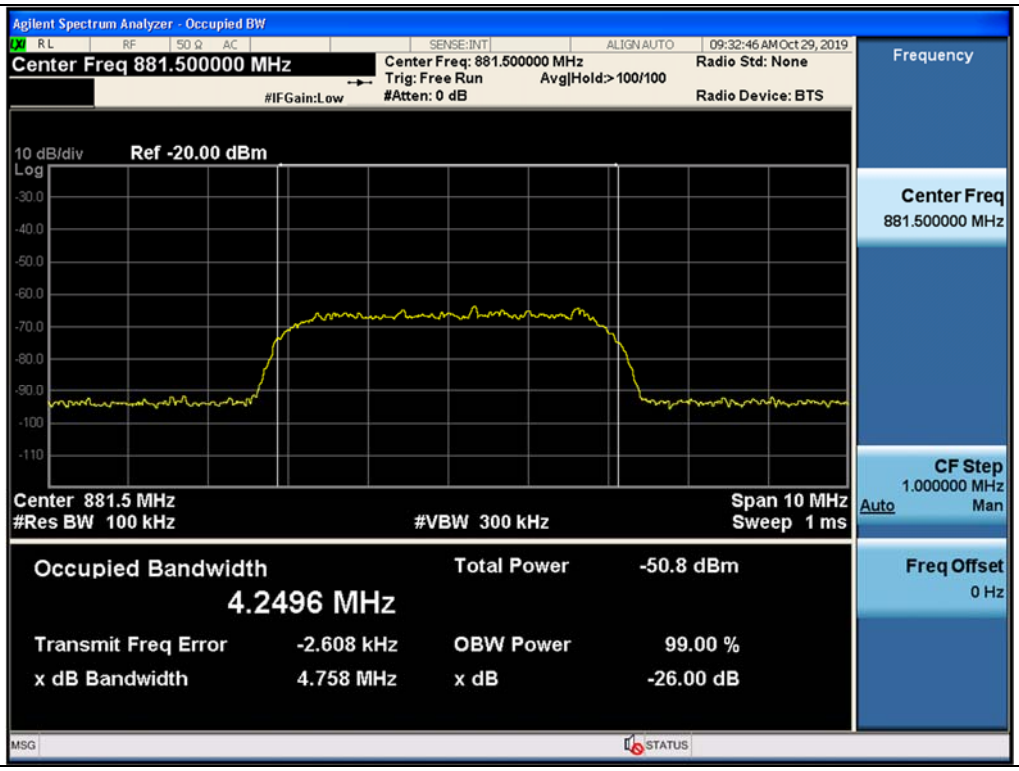
Occupied Bandwidth / Upper 700 MHz / Downlink / CDMA / Output


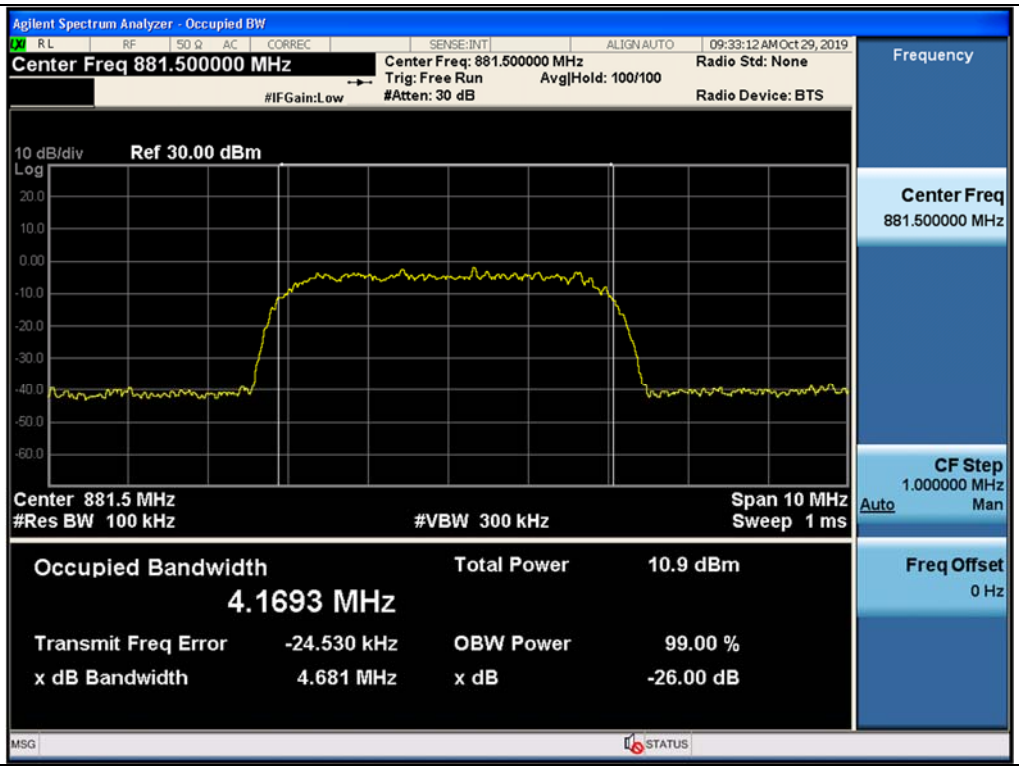
Occupied Bandwidth / Upper 700 MHz / Downlink / WCDMA/ Input


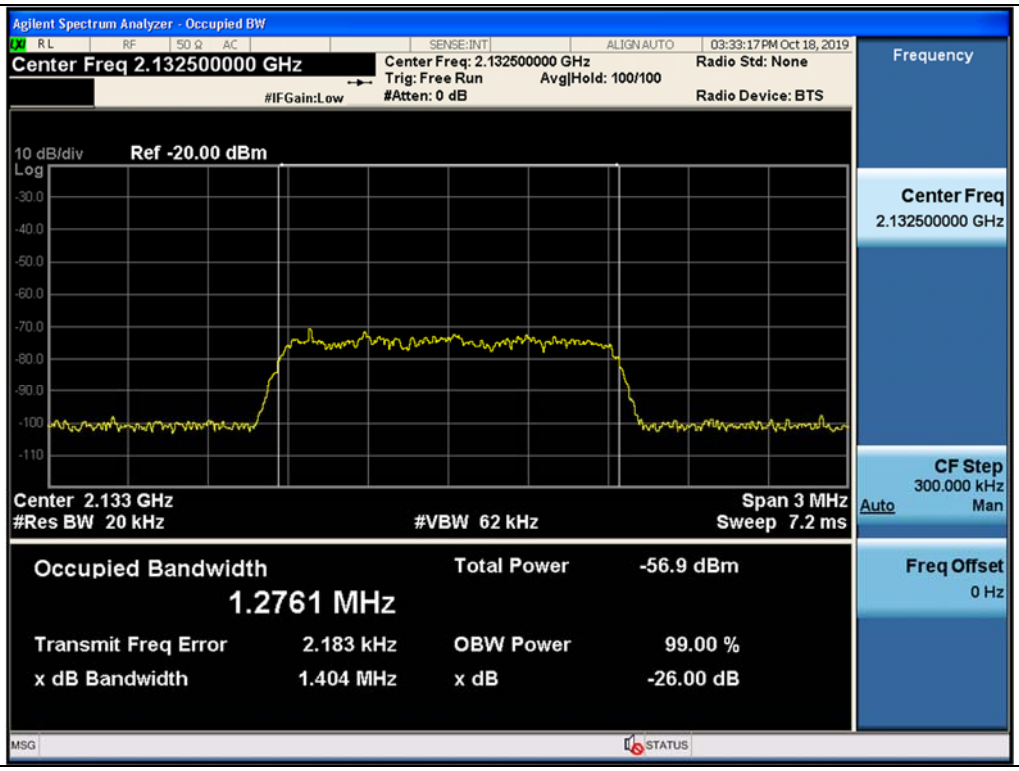
Occupied Bandwidth / Upper 700 MHz / Downlink / WCDMA / Output


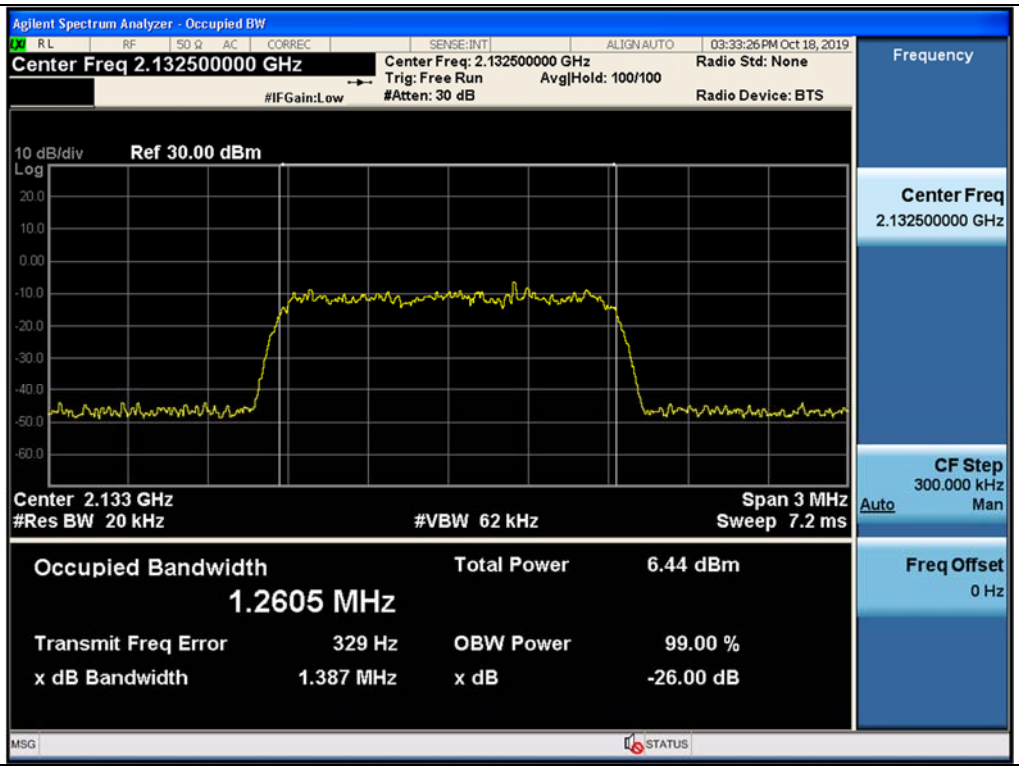
Occupied Bandwidth / Cellular / Downlink / CDMA/ Input


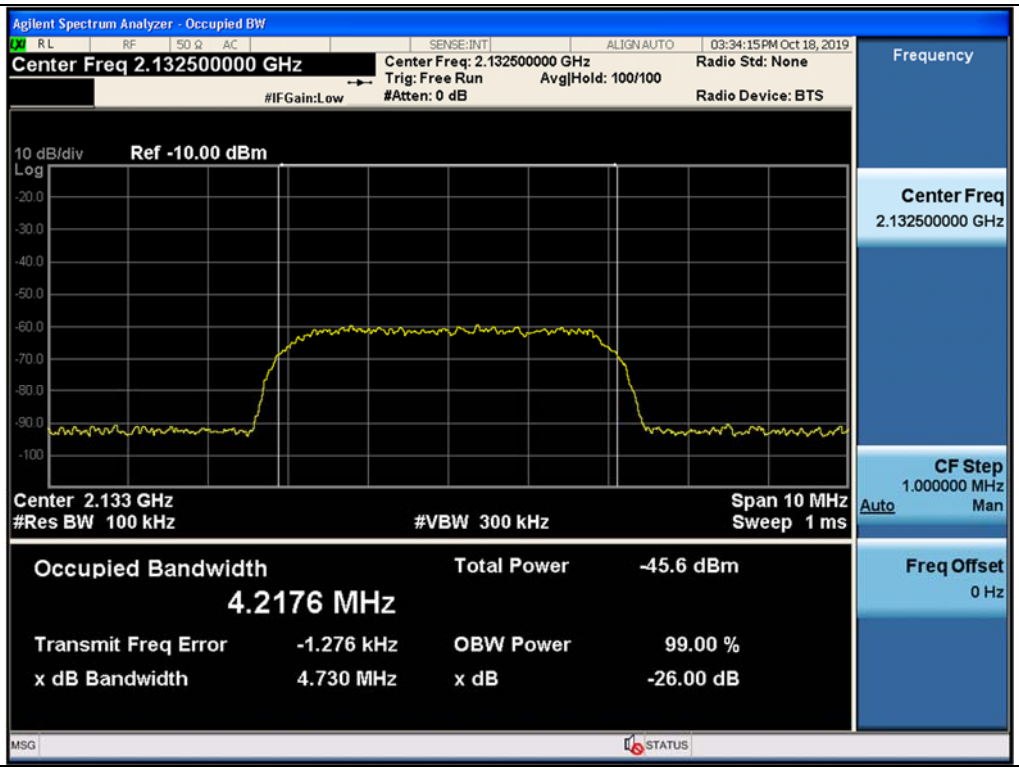
Occupied Bandwidth / Cellular / Downlink / CDMA / Output


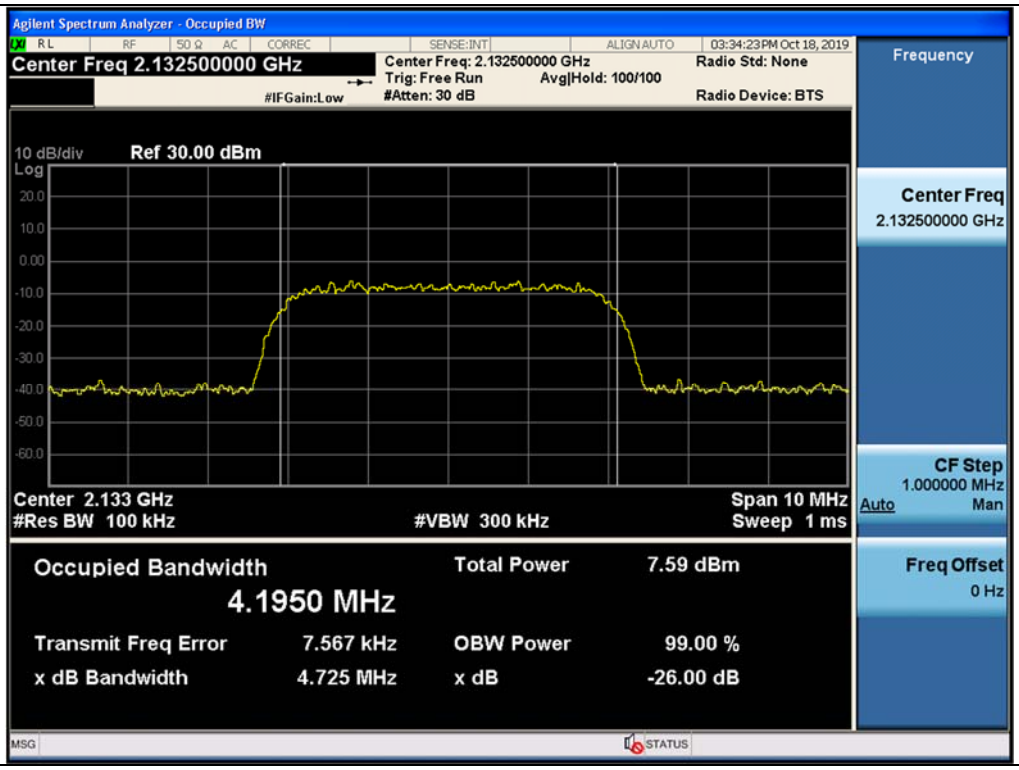
Occupied Bandwidth / Cellular / Downlink / WCDMA/ Input


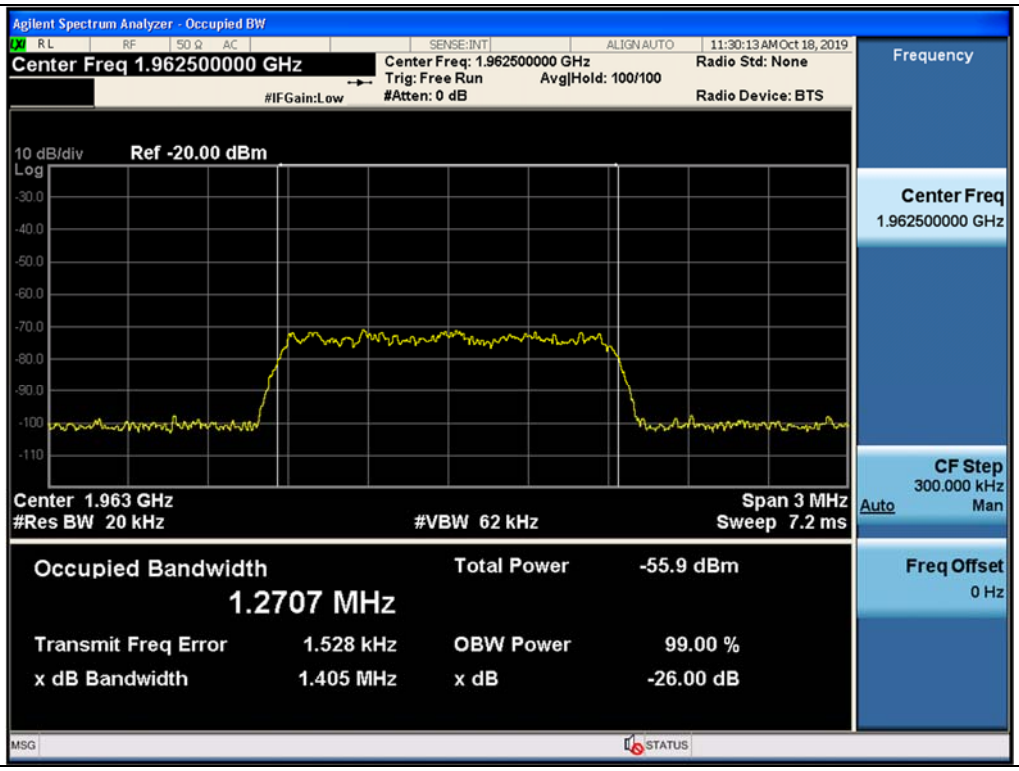
Occupied Bandwidth / Cellular / Downlink / WCDMA / Output


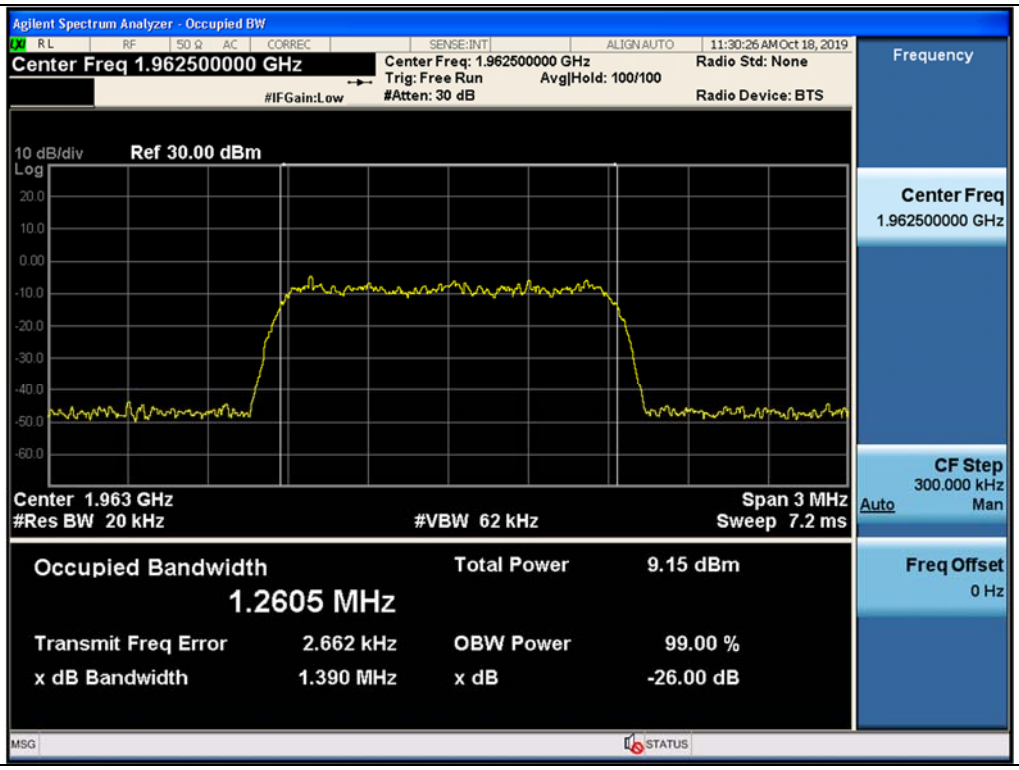
Occupied Bandwidth / AWS-1 / Downlink / CDMA/ Input


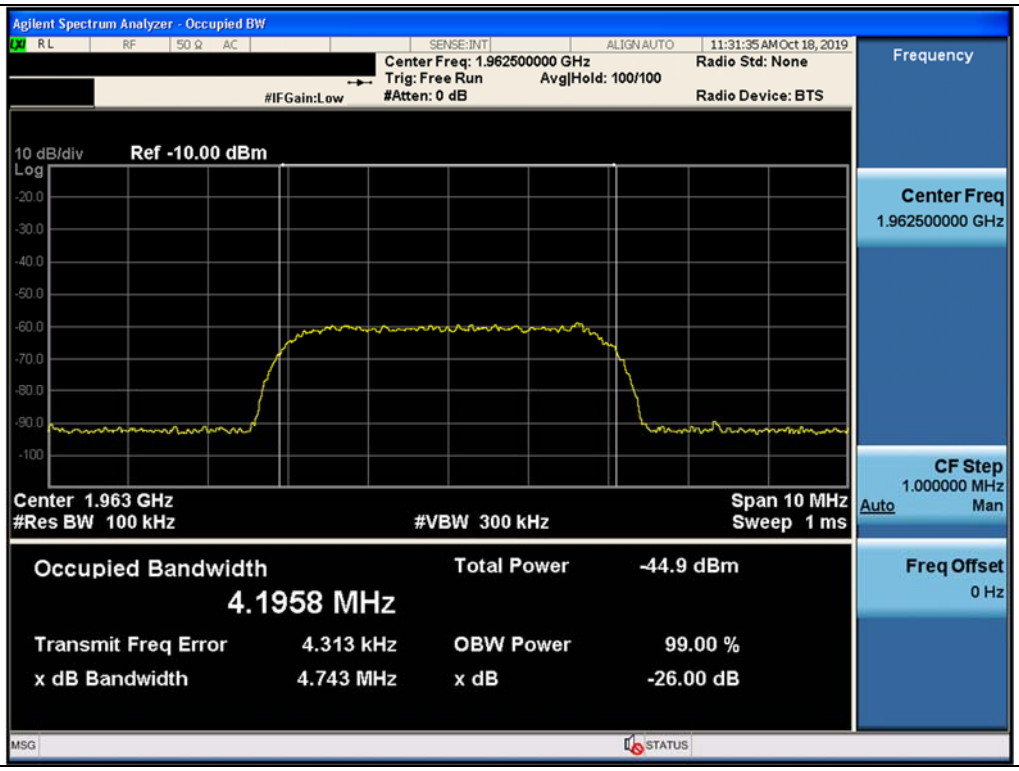
Occupied Bandwidth / AWS-1 / Downlink / CDMA / Output


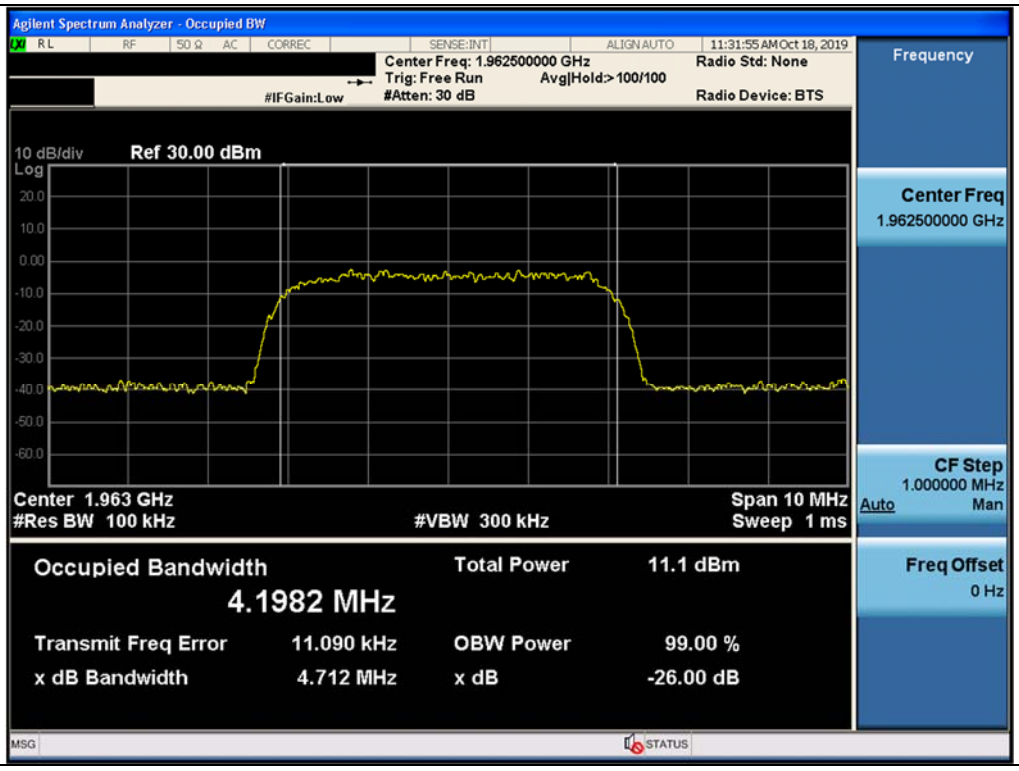
Occupied Bandwidth / AWS-1 / Downlink / WCDMA/ Input


Occupied Bandwidth / AWS-1 / Downlink / WCDMA / Output


Occupied Bandwidth / Broadband PCS / Downlink / CDMA/ Input


Occupied Bandwidth / Broadband PCS / Downlink / CDMA / Output


Occupied Bandwidth / Broadband PCS / Downlink / WCDMA/ Input


Occupied Bandwidth / Broadband PCS / Downlink / WCDMA / Output


5.11. OSCILLATION

Test Requirements:

§ 20.21(e)(8)(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 D03 v04r03.

7.11.2 Oscillation restart tests

a) Beginning with the spectrum analyzer on the uplink output (donor) port. Confirm that the RF coupled path is connected to the spectrum analyzer.

b) Spectrum analyzer settings:

1) Center frequency at the center of the band under test

2) Span equal or slightly exceeding the width of the band under test

3) Continuous sweep, max-hold

4) RBW x 1 MHz, VBW > 3 x RBW

c) Decrease the variable attenuator until the spectrum analyzer displays a signal within the band under test. Using a marker, identify the approximate center frequency of this signal on the max-hold display, increase the attenuation by 10 dB, then reset the EUT (e.g., cycle ac/dc power).

d) Repeat c) twice to ensure that the center of the signal created by the booster remains within 250 kHz of the spectrum analyzer display center frequency. If the frequency of the signal is unstable, confirm that the spectrum analyzer display is centered between the frequency extremes observed. If the signal is wider than 1 MHz, ensure that the spectrum analyzer display is centered on the signal by increasing the RBW. Reset the EUT (e.g., cycle ac/dc power) after each oscillation event, if necessary. Set the spectrum analyzer sweep trigger level to just below the peak amplitude of the displayed EUT oscillation signal.

e) Set the spectrum analyzer to zero-span, with a sweep time of 5 seconds, and single-sweep with max-hold. The spectrum analyzer sweep trigger level in this and the subsequent steps shall be the level identified in d).

f) Decrease the variable attenuator until the spectrum analyzer sweep is triggered, increase the attenuation by 10 dB, then reset the EUT (e.g., cycle ac/dc power).

g) Reset the zero-span trigger of the spectrum analyzer, then repeat f) twice to ensure that the spectrum analyzer is reliably triggered, resetting the EUT (e.g., cycle ac/dc power) after each oscillation event if necessary.

h) Reset the zero-span sweep trigger of the spectrum analyzer, and reset the EUT (e.g., cycle ac/dc power).

i) Force the EUT into oscillation by reducing the attenuation.

j) Use the marker function of the spectrum analyzer to measure the time from the onset of oscillation until the EUT

turns off, by setting Marker 1 on the leading edge of the oscillation signal and Marker 2 on the trailing edge. The spectrum analyzer sweep time may be adjusted to improve the time resolution of these cursors.

k) Capture the spectrum analyzer zero-span trace for inclusion in the test report. Report the power level associated with the oscillation separately if it can't be displayed on the trace.

l) Repeat b) to k) for all operational uplink and downlink bands.

m) Set the spectrum analyzer zero-span sweep time for longer than 60 seconds, then measure the restart time for each operational uplink and downlink band.

n) Replace the normal-operating mode EUT with the EUT that supports an anti-oscillation test mode.

o) Set the spectrum analyzer zero-span time for a minimum of 120 seconds, and a single sweep.

p) Manually trigger the spectrum analyzer zero-span sweep, and manually force the booster into oscillation as described in i).

q) When the sweep is complete, place cursors between the first two oscillation detections, and save the plot for inclusion in the test report. The time between restarts must match the manufacturer's timing for the test mode, and there shall be no more than 5 restarts.

r) Repeat m) to q) for all operational uplink and downlink bands.

7.11.3 Test procedure for measuring oscillation mitigation or shutdown

a) Connect the normal-operating mode EUT to the test equipment.

b) Set the spectrum analyzer center frequency to the center of band under test, and use the following settings:

1) RBW=30 kHz, VBW $\geq$ 3 × RBW,

2) power averaging (rms) detector,

3) trace averages $\geq$ 100,

4) span $\geq$ 120% of operational band under test,

5) number of sweep points $\geq$ 2 × Span/RBW.

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. 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. Affirm that the input signal is not obstructing the measurement of the strongest oscillation peak in the band, and is not included within the span in the measurement.

1) Boosters with operating spectrum passbands of 10 MHz or less may use a CW signal source at the band edge rather than AWGN.

2) 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.

d) Set the variable attenuator to a high attenuation setting such that the booster will operate at maximum gain when powered on. Reset the 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.

e) 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, for the band under test.

f) 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) Affirm that the peak oscillation level measured in 2), does not exceed by 12.0 dB the minimal output level measured in 4). Record the measurement results of 2) and 4) in tabular format for inclusion in the test report.

6) The procedure of 1) to 5) allows the spectrum analyzer trace to stabilize, and verification of shutdown or oscillation level measurement must occur within 300 seconds.

g) Decrease the variable attenuator in 1 dB steps, and repeat step f) 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.

h) Repeat a) to g) for all operational uplink and downlink bands.

Note1. According to § 20.21(e)(8)(ii)(A), limits of oscillation test are as follows.

- Detect and miation time: Uplink 0.3 second, Downlink 1 second.
- Mitigation duration: 1 minute.
- Number of restart: 5 times.
- Oscillation Mitigation limit '12 dB' refers to section 7.11.3 of KDB 935210 D03

Note2. We adjusted the sweep time of test in KDB procedure to show the data.

Note3. 4.1 MHz AWGN Signal is used for mitigation test.

Test Result:

Tabulated Result of Uplink Oscillation Detection

Band	Frequency (MHz)	Limit (ms)	Measured Time (ms)
Lower 700 MHz	706.028	300	3.00
Upper 700 MHz	781.632		2.00
Cellular	829.275		2.00
AWS-1	1 725.750		4.00
Broadband PCS	1 898.750		4.00

Tabulated Result of Downlink Oscillation Detection

Band	Frequency (MHz)	Limit (ms)	Measured Time (ms)
Lower 700 MHz	734.096	1 000	1.00
Upper 700 MHz	749.014		4.00
Cellular	878.150		6.00
AWS-1	2 139.475		3.00
Broadband PCS	1 971.535		4.00

Tabulated Result of Uplink Oscillation Restart

Band	Frequency (MHz)	Time Limit (s)	Restart Limit	Restart Time (s)	Number of Restart
Lower 700 MHz	706.028	60	5	60.02	5
Upper 700 MHz	781.632			60.02	5
Cellular	829.275			60.00	5
AWS-1	1 725.750			60.00	5
Broadband PCS	1 898.750			60.00	5

Tabulated Result of Downlink Oscillation Restart

Band	Frequency (MHz)	Time Limit (s)	Restart Limit	Restart Time (s)	Number of Restart
Lower 700 MHz	734.096	60	5	60.02	5
Upper 700 MHz	749.014			60.00	5
Cellular	878.150			60.00	5
AWS-1	2 139.475			60.00	5
Broadband PCS	1 971.535			60.02	5

Tabulated Result of Uplink Oscillation Mitigation

Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Lower 700 MHz	Shut down						

Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Upper 700 MHz	Shut down						

Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Cellular	Shut down						

Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
AWS-1	+5	1 710.811	-37.335	1 712.33	-40.37	12	3.04
	+4	1 714.271	-37.298	1 711.64	-40.10		2.80
	+3	1 714.129	-37.024	1 712.50	-40.96		3.94
	+2	1 714.500	-37.166	1 712.29	-40.64		3.47
	+1	1 714.483	-36.909	1 711.11	-40.81		3.91
	0	1 714.467	-36.941	1 712.49	-41.13		4.19
	-1	1 714.421	-37.304	1 711.99	-41.47		4.17
	-2	1 714.261	-37.939	1 712.13	-41.38		3.44
	-3	1 714.430	-37.577	1 712.89	-42.05		4.47
	-4	1 714.407	-37.585	1 712.04	-42.20		4.62
	-5	1 714.397	-38.157	1 713.25	-42.63		4.47

Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Broadband PCS	+5	1 852.203	-38.697	1 850.55	-41.64	12	2.94
	+4	1 852.310	-38.866	1 850.52	-42.31		3.45
	+3	1 852.067	-38.526	1 850.55	-42.42		3.89
	+2	1 852.028	-38.386	1 854.07	-42.25		3.87
	+1	1 851.960	-38.165	1 853.92	-42.47		4.31
	0	1 851.834	-37.853	1 853.40	-42.38		4.52
	-1	1 851.433	-37.561	1 854.27	-42.64		5.08
	-2	1 851.485	-37.340	1 854.31	-42.94		5.60
	-3	1 851.626	-36.669	1 854.31	-43.19		6.52
	-4	1 851.313	-36.531	1 854.39	-43.77		7.24
	-5	1 851.806	-35.435	1 854.46	-43.97		8.53

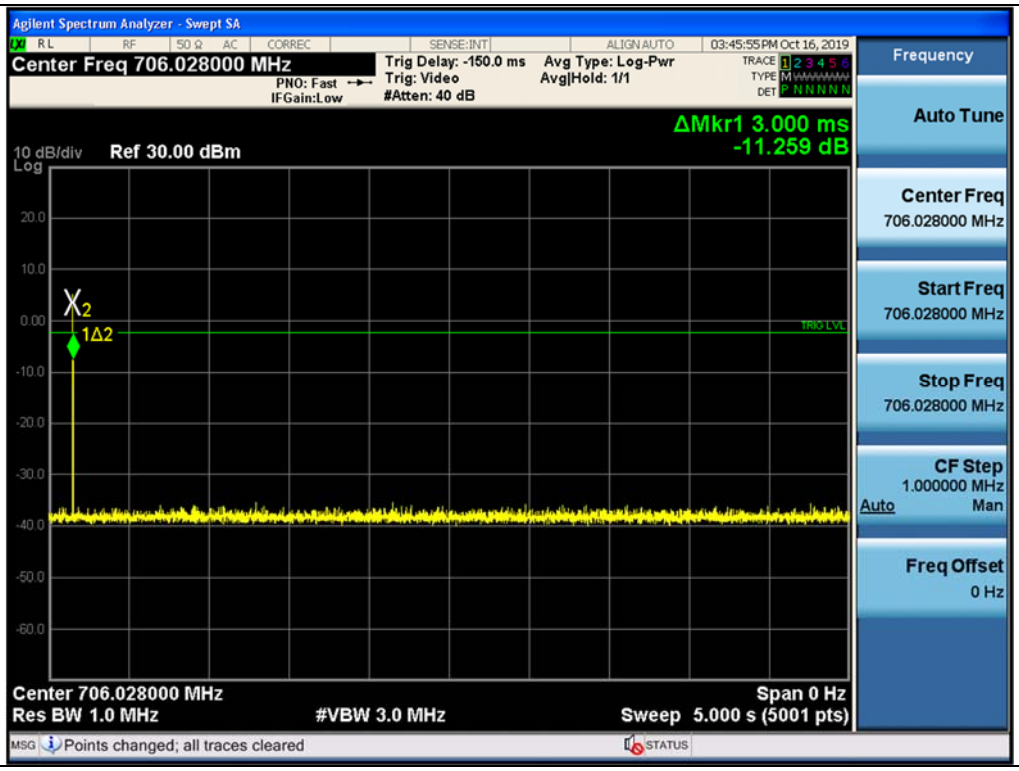
Tabulated Result of Downlink Oscillation Mitigation

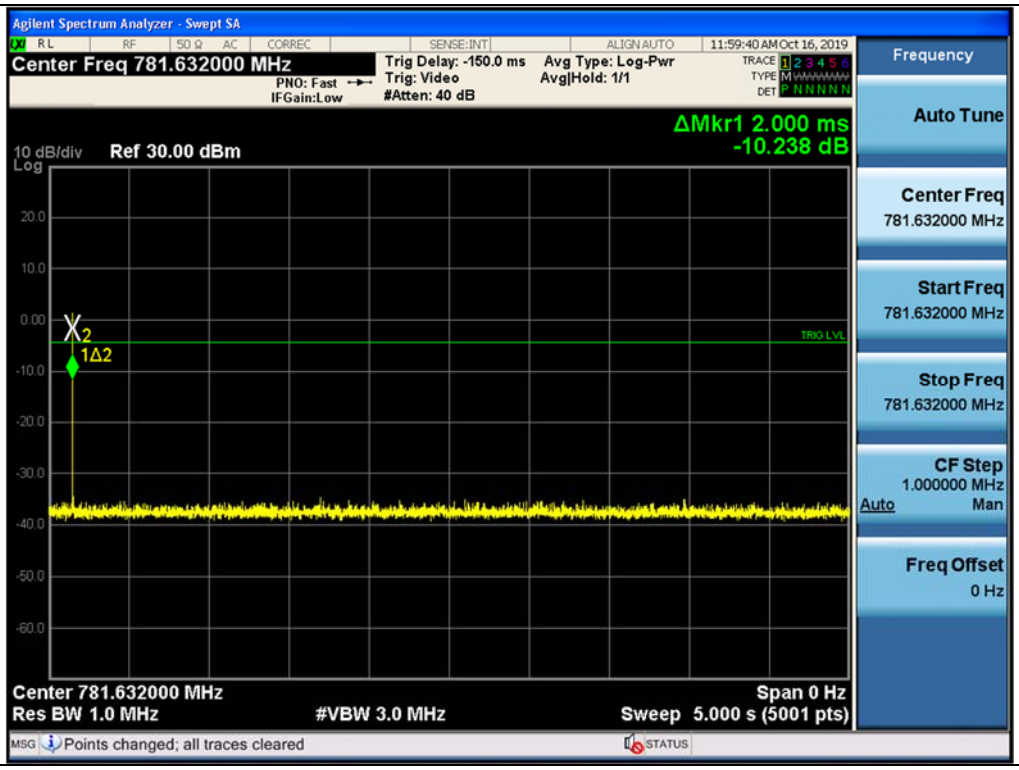
Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Lower 700 MHz	+5	737.783	-47.518	735.55	-52.50	12	4.98
	+4	737.429	-47.910	735.50	-52.68		4.77
	+3	737.597	-47.634	735.88	-52.63		4.99
	+2	737.278	-47.361	735.64	-52.82		5.46
	+1	737.391	-47.384	735.44	-53.25		5.86
	0	737.355	-46.686	735.53	-53.91		7.23
	-1	737.464	-46.710	735.88	-53.64		6.93
	-2	737.415	-46.006	735.98	-53.62		7.61
	-3	737.276	-46.236	735.43	-53.93		7.70
	-4	737.255	-45.378	735.50	-54.17		8.79
	-5	737.183	-44.686	735.41	-54.28		9.59
Upper 700 MHz	+5	749.259	-46.598	746.97	-51.75		5.15
	+4	749.084	-46.557	750.47	-52.06		5.51
	+3	748.796	-46.708	750.50	-52.46		5.75
	+2	749.189	-46.089	747.36	-52.18		6.09
	+1	749.068	-45.969	747.35	-52.39		6.43
	0	749.100	-45.269	747.02	-52.50		7.23
	-1	748.909	-44.637	750.50	-52.67		8.04
	-2	749.103	-44.503	747.43	-52.96		8.46
	-3	749.083	-43.581	747.25	-53.02		9.44
	-4	749.148	-42.916	747.32	-53.40		10.48
	-5	749.222	-41.774	746.68	-53.75		11.98

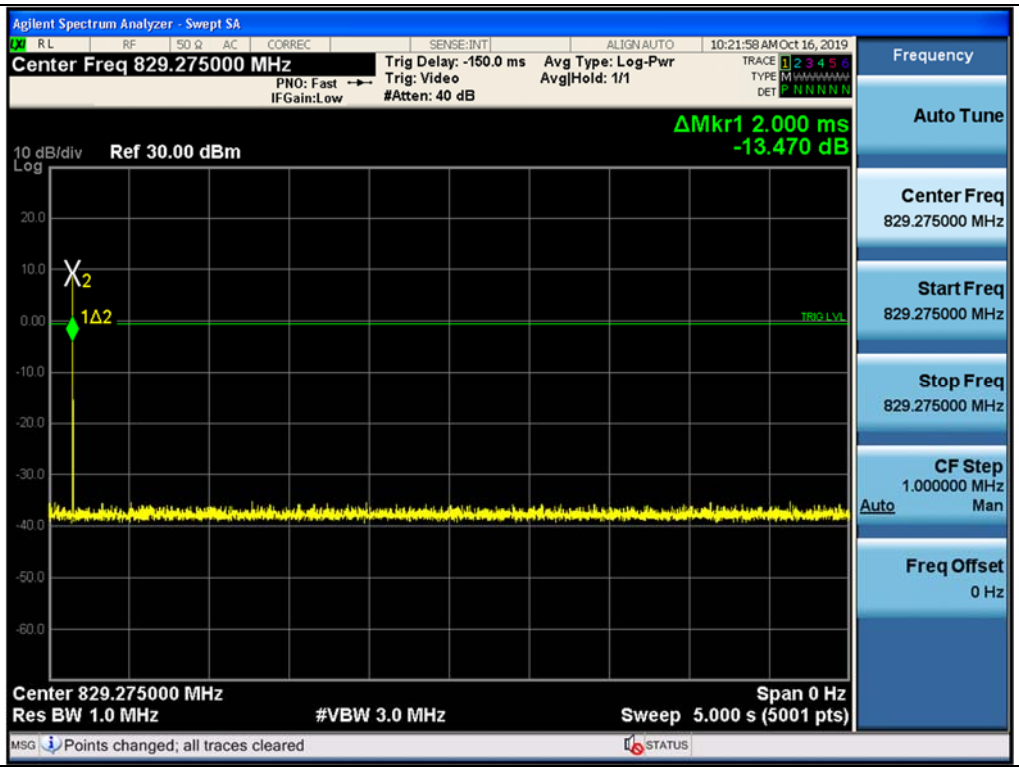
Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Cellular	+5	871.005	-52.560	869.52	-58.73	12	6.17
	+4	871.167	-52.433	869.60	-58.46		6.03
	+3	871.132	-52.509	869.52	-59.05		6.54
	+2	870.943	-51.879	869.67	-59.42		7.54
	+1	871.229	-51.695	869.66	-59.43		7.73
	0	870.924	-51.431	869.51	-60.34		8.90
	-1	871.088	-50.707	869.66	-59.51		8.80
	-2	871.005	-50.273	869.63	-59.58		9.30
	-3	871.104	-49.908	869.59	-60.13		10.22
	-4	871.087	-49.016	869.51	-60.46		11.44
	-5	871.083	-48.664	869.66	-60.26		11.60
AWS-1	+5	2 110.649	-56.963	2 112.01	-60.01		3.04
	+4	2 114.469	-56.651	2 112.57	-59.78		3.13
	+3	2 114.201	-56.940	2 112.86	-59.88		2.94
	+2	2 114.426	-56.505	2 112.02	-60.20		3.69
	+1	2 114.441	-56.498	2 112.22	-60.13		3.63
	0	2 114.318	-56.383	2 112.52	-60.76		4.38
	-1	2 114.111	-57.258	2 112.00	-60.75		3.49
	-2	2 114.299	-57.018	2 111.36	-60.87		3.85
	-3	2 114.394	-57.321	2 112.52	-61.08		3.76
	-4	2 114.453	-57.659	2 112.56	-61.48		3.82
	-5	2 114.373	-58.178	2 112.30	-62.02		3.84

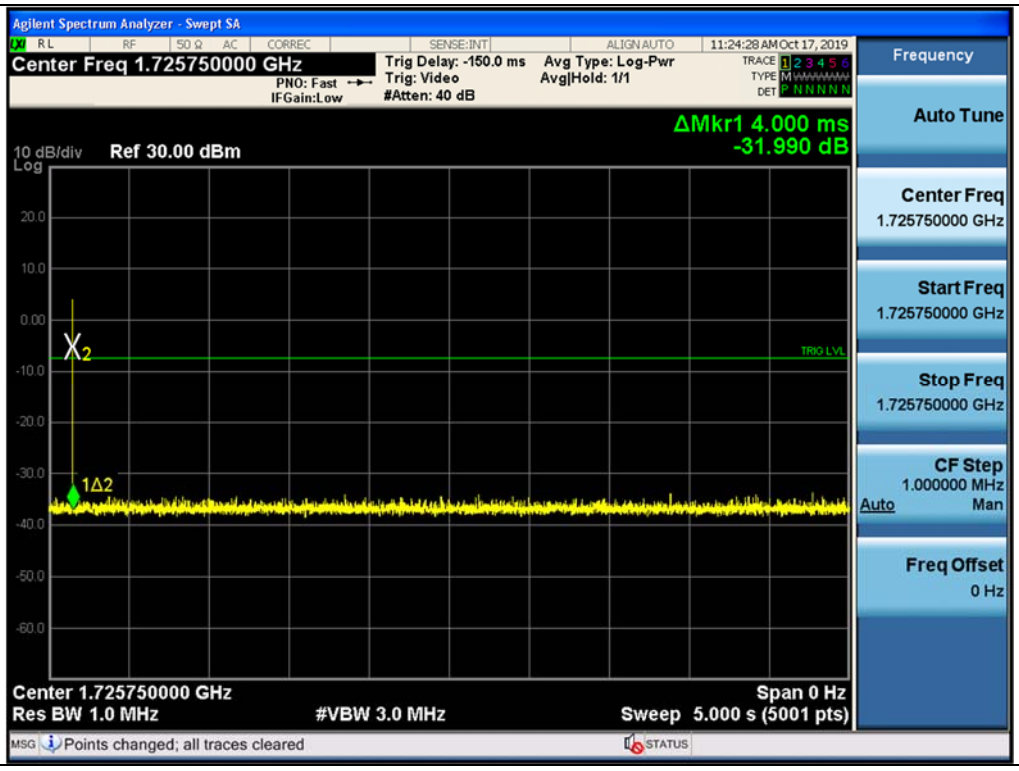
Band	Variable Att. (dB)	Max Freq. (MHz)	Max Level (dBm)	Min Freq. (MHz)	Min Level (dBm)	Limit (dB)	Difference (dB)
Broadband PCS	+5	1 933.241	-57.174	1 930.87	-61.30	12	4.12
	+4	1 933.091	-57.068	1 931.07	-61.01		3.94
	+3	1 933.455	-56.888	1 930.76	-61.36		4.47
	+2	1 933.271	-56.823	1 931.02	-61.13		4.31
	+1	1 932.473	-56.953	1 930.58	-61.57		4.61
	0	1 932.965	-56.562	1 930.58	-62.15		5.58
	-1	1 932.611	-56.935	1 930.53	-61.56		4.62
	-2	1 933.183	-56.704	1 931.16	-61.58		4.87
	-3	1 933.057	-56.315	1 930.51	-61.65		5.33
	-4	1 932.938	-55.888	1 930.52	-62.05		6.17
	-5	1 932.900	-55.728	1 930.87	-62.40		6.68

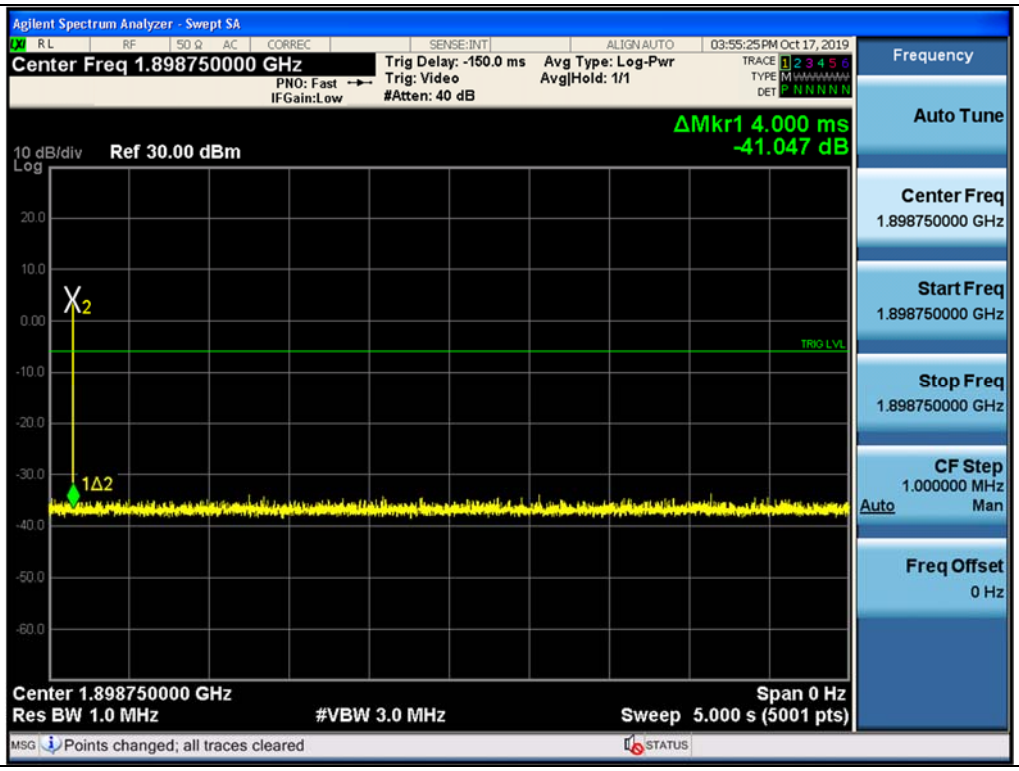
Plot data of Oscillation Detect

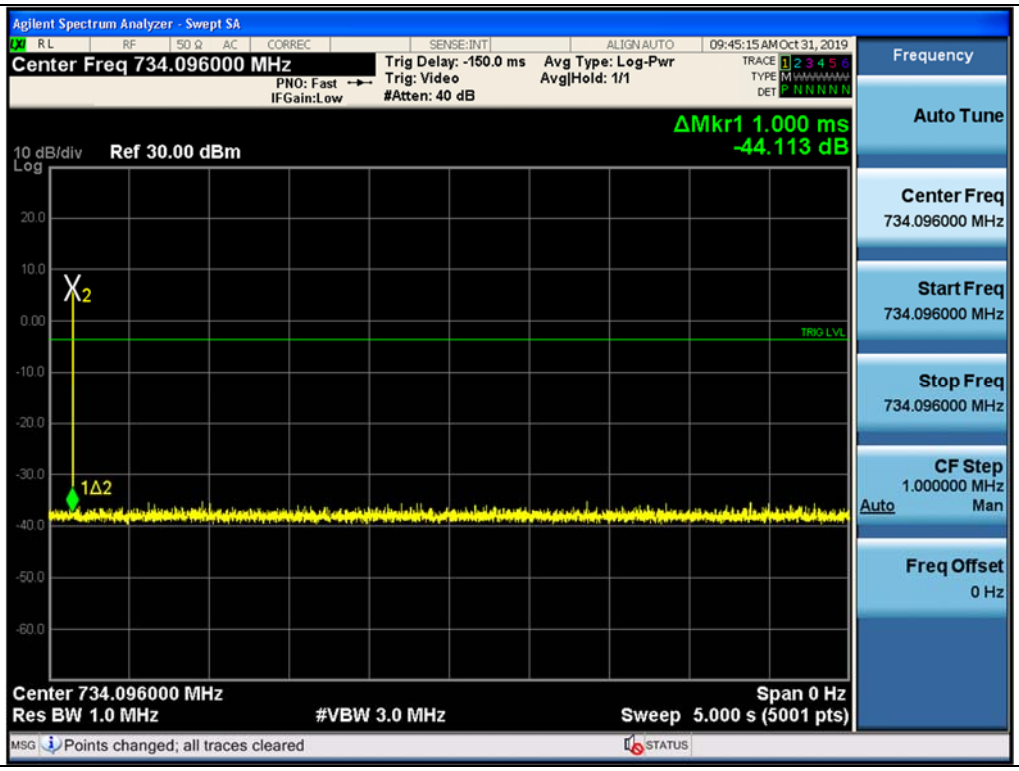
Oscillation Detect / Lower 700 MHz / Uplink


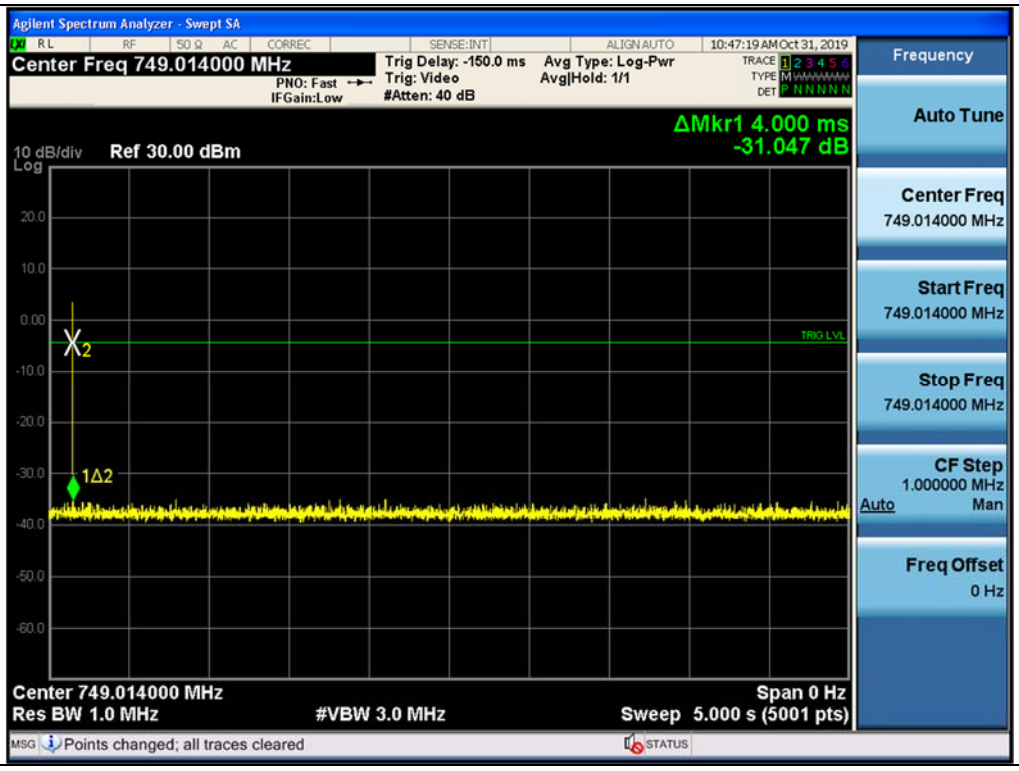
Oscillation Detect / Upper 700 MHz / Uplink


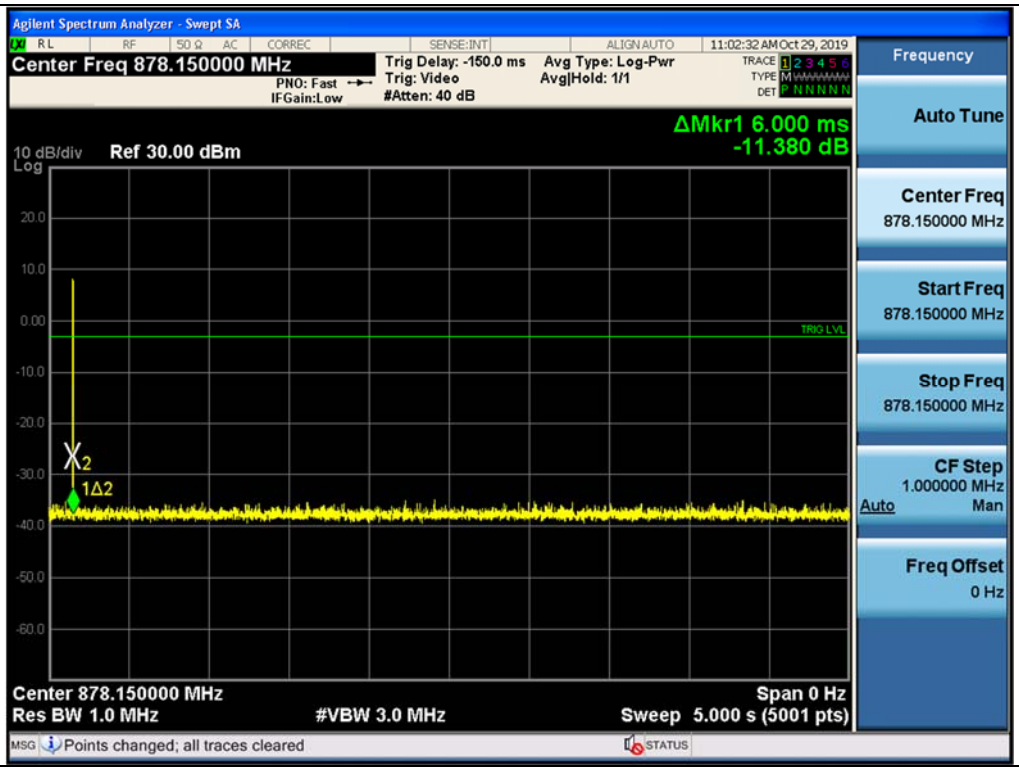
Oscillation Detect / Cellular / Uplink


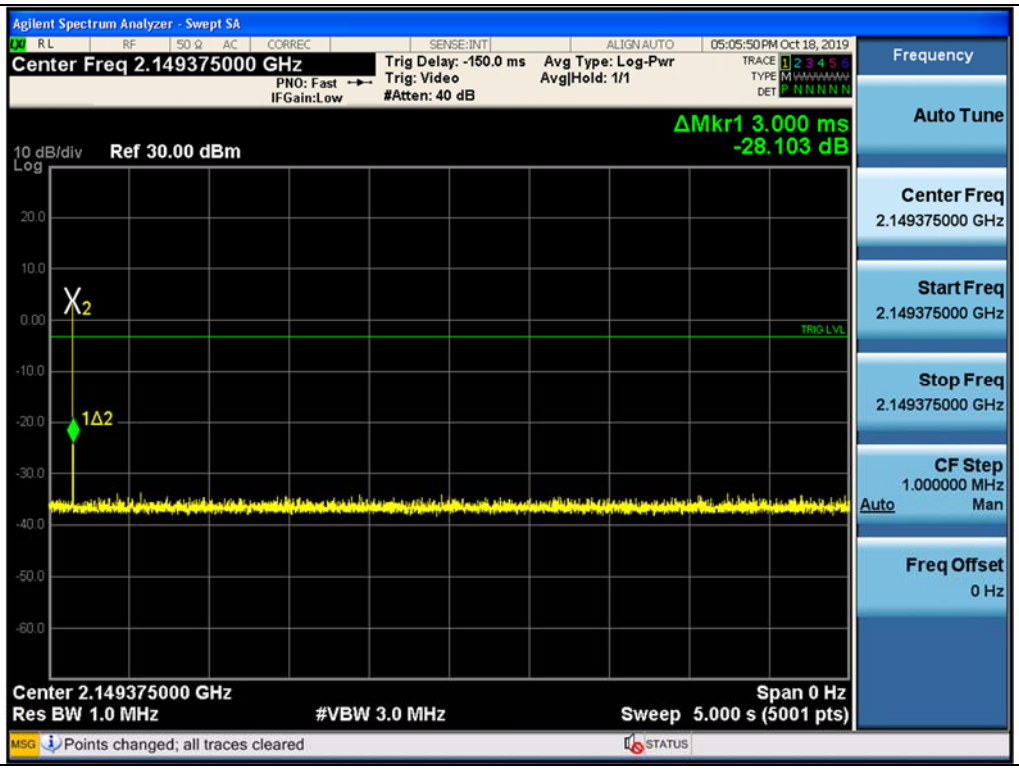
Oscillation Detect / AWS-1 / Uplink


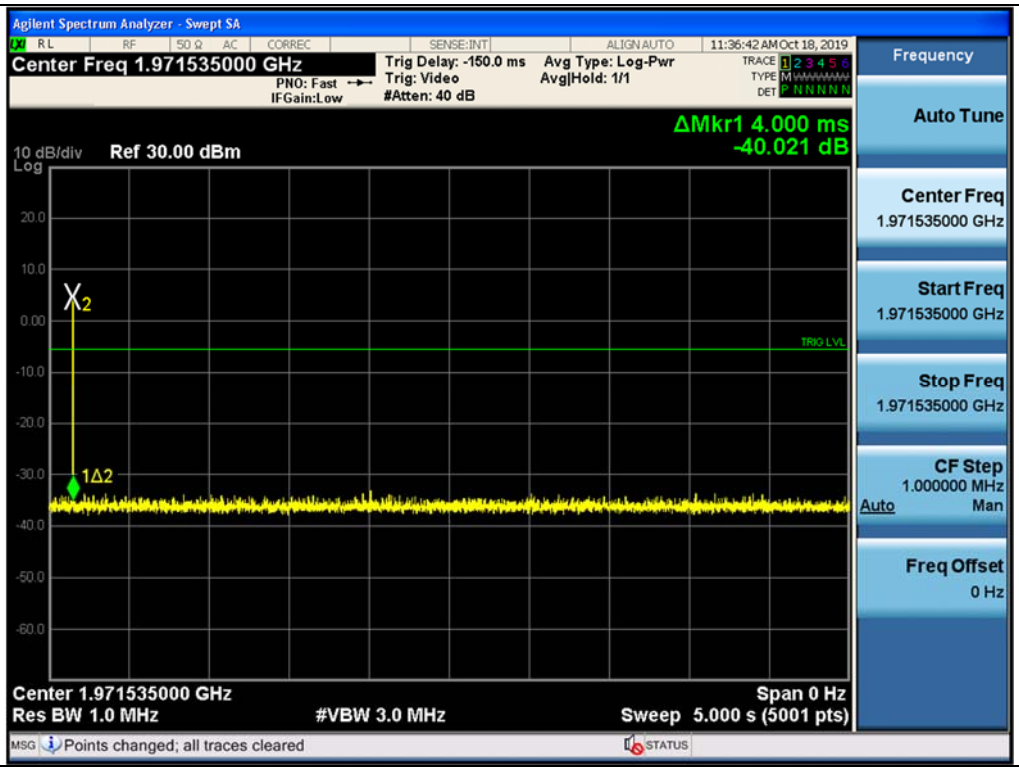
Oscillation Detect / Broadband PCS / Uplink


Oscillation Detect / Lower 700 MHz / Downlink


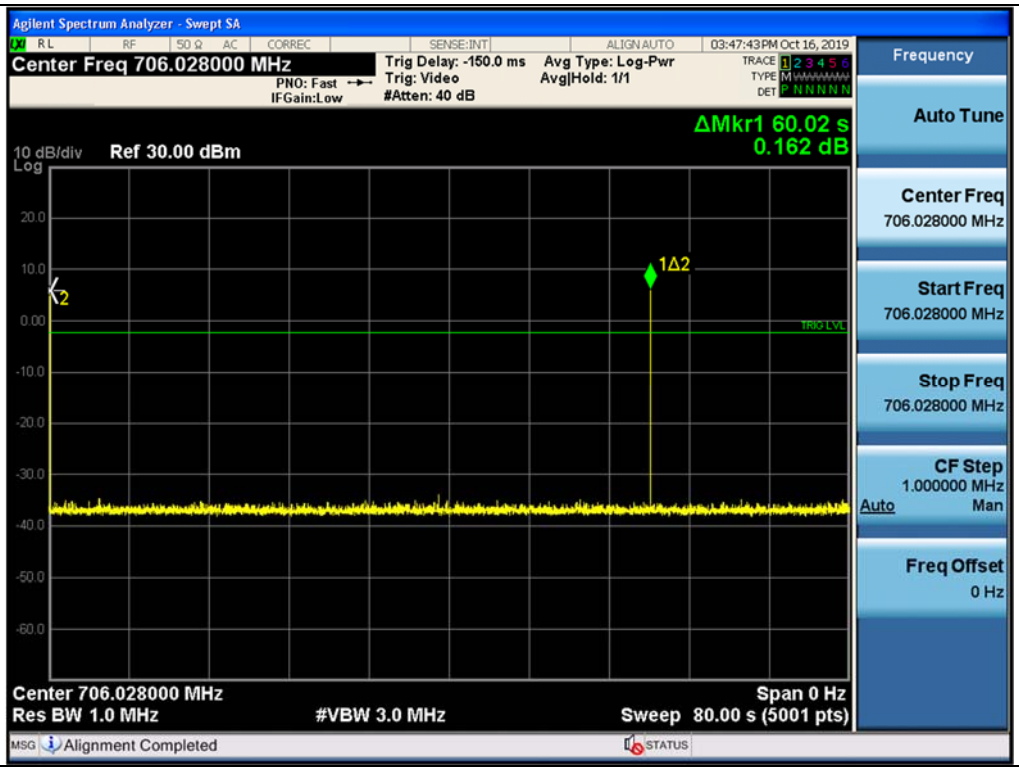
Oscillation Detect / Upper 700 MHz / Downlink


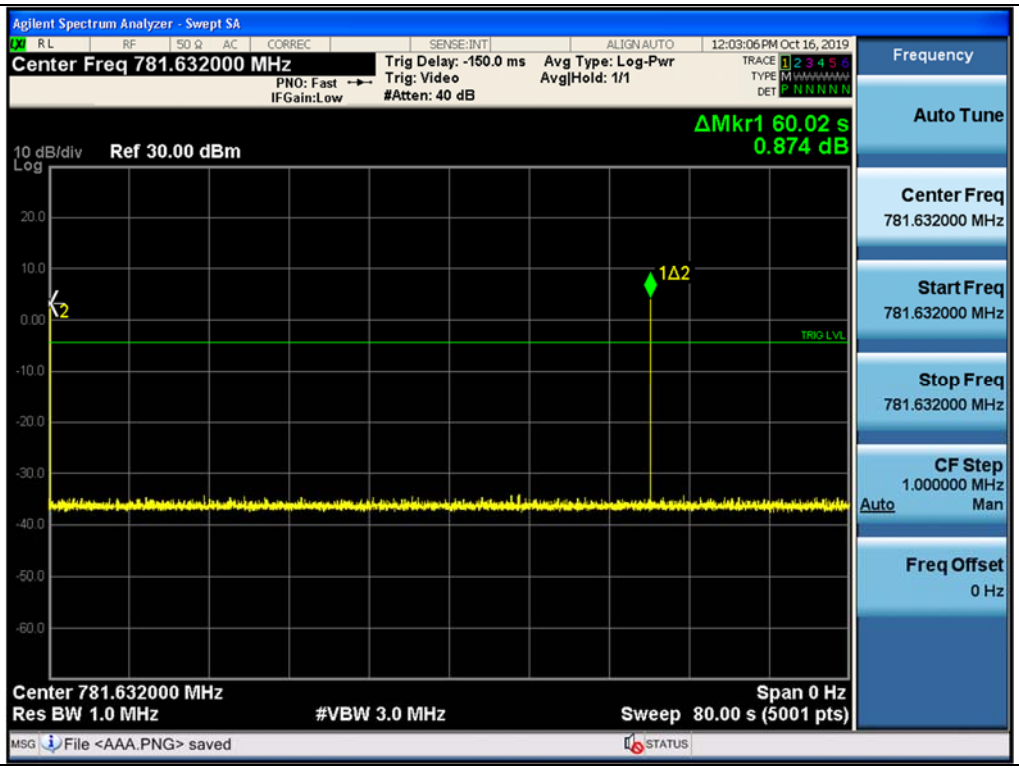
Oscillation Detect / Cellular / Downlink


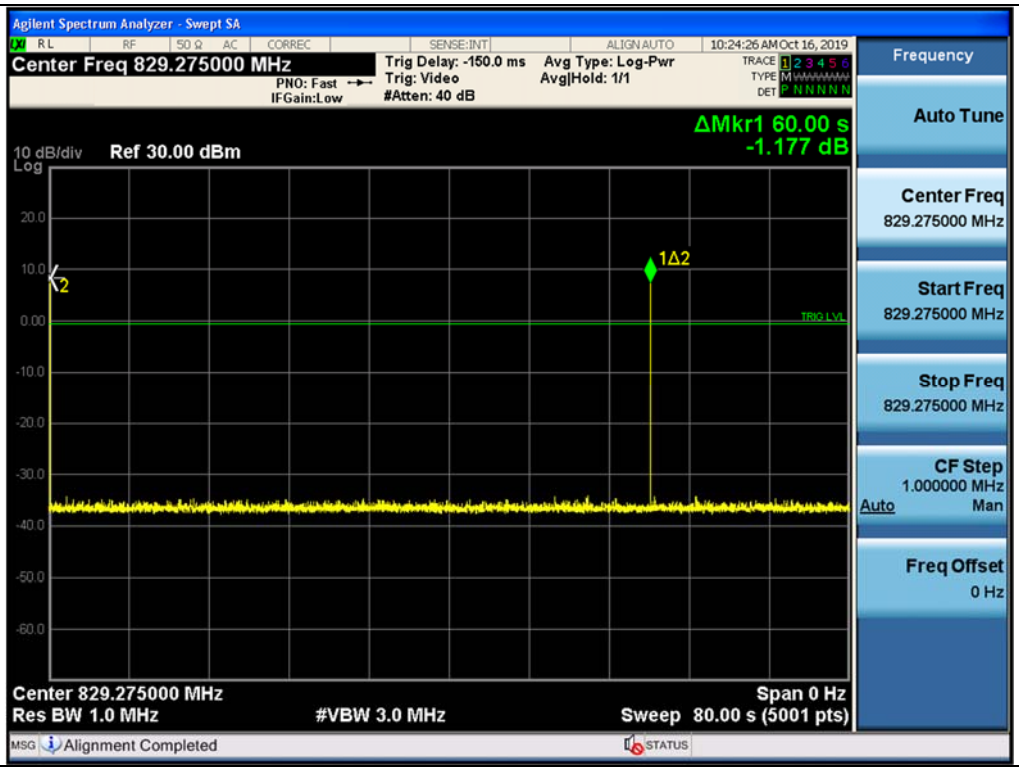
Oscillation Detect / AWS-1 / Downlink


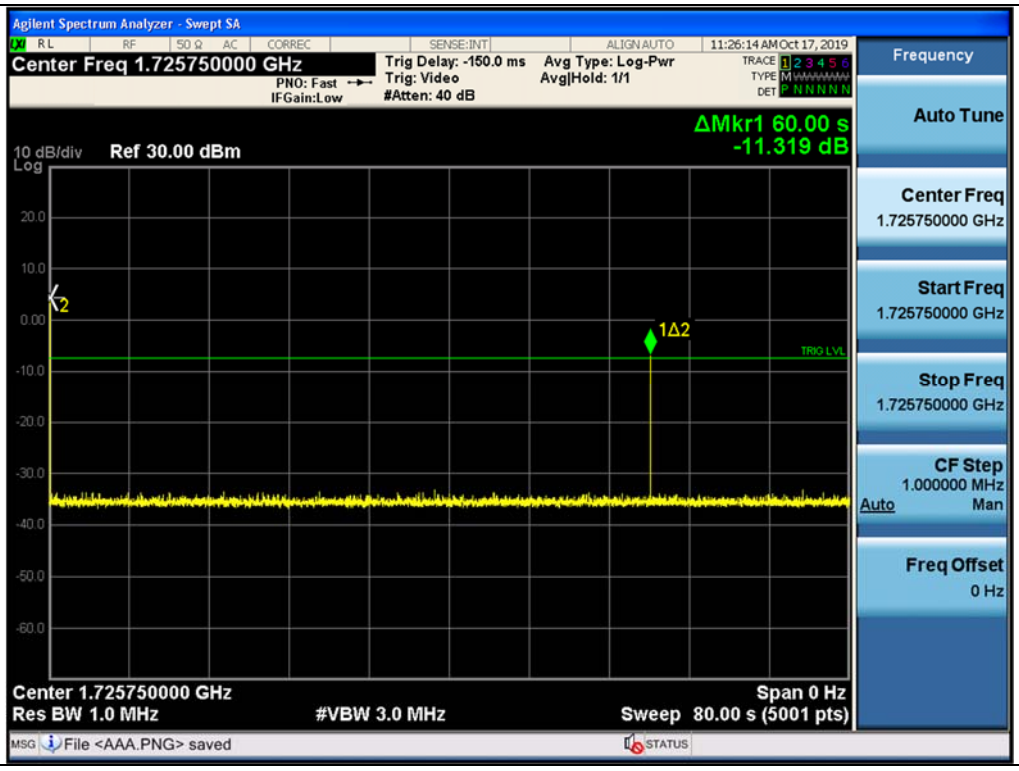
Oscillation Detect / Broadband PCS / Downlink


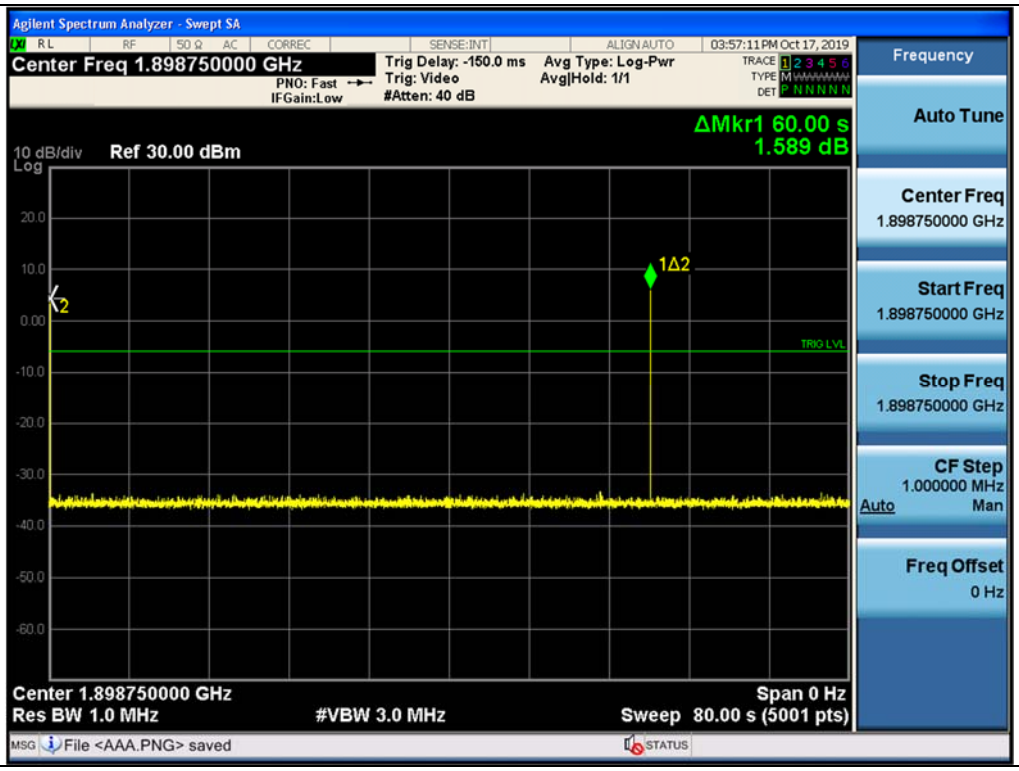
Plot data of Oscillation Restart Time

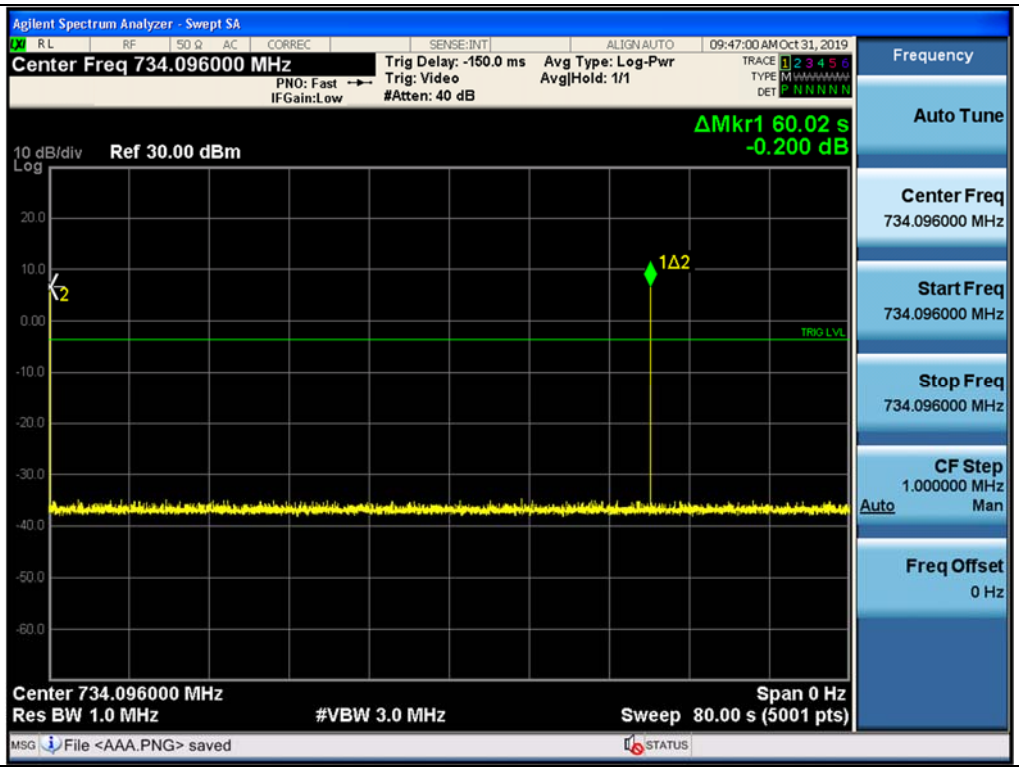
Oscillation Restart Time / Lower 700 MHz / Uplink


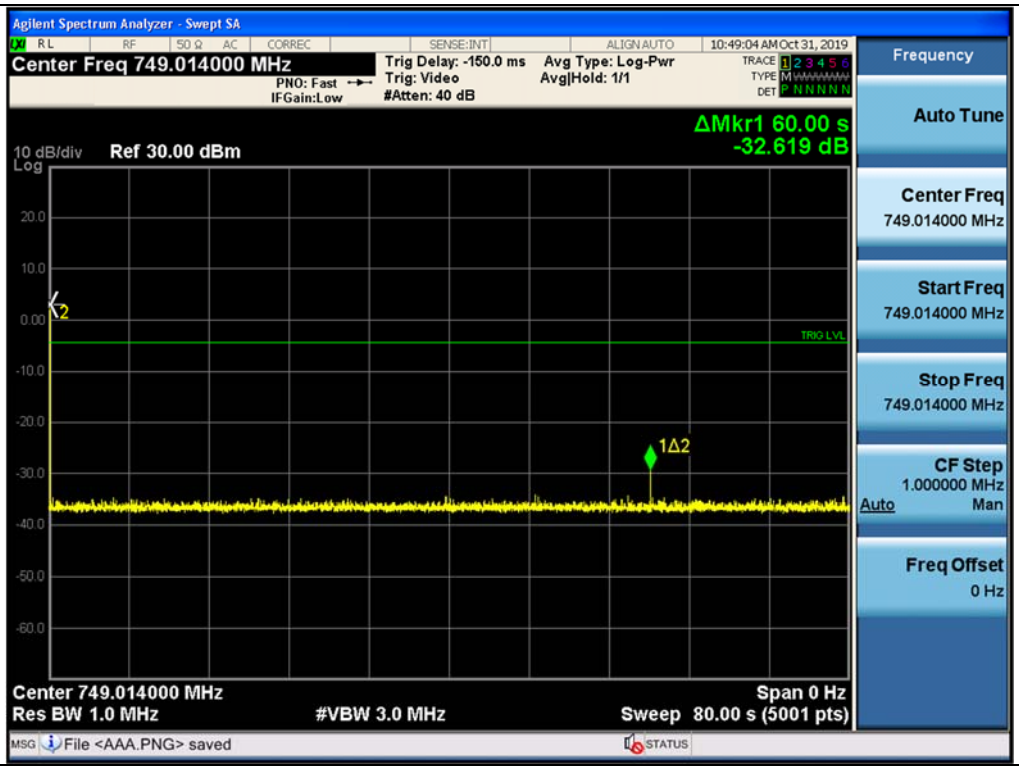
Oscillation Restart Time / Upper 700 MHz / Uplink


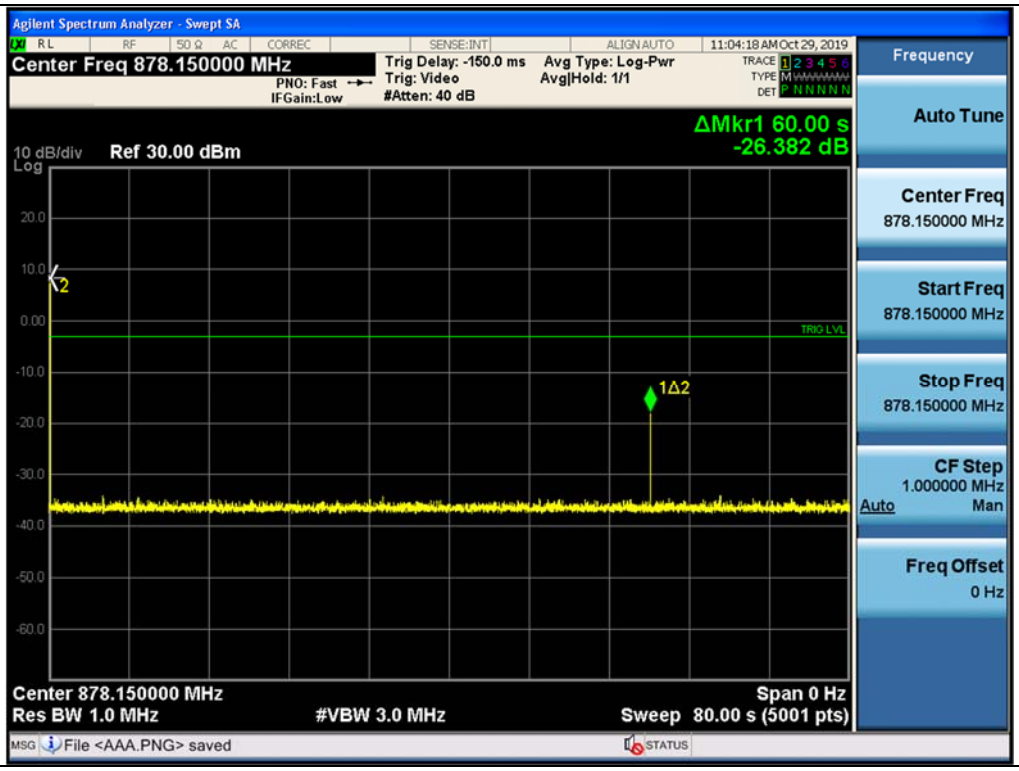
Oscillation Restart Time / Cellular / Uplink


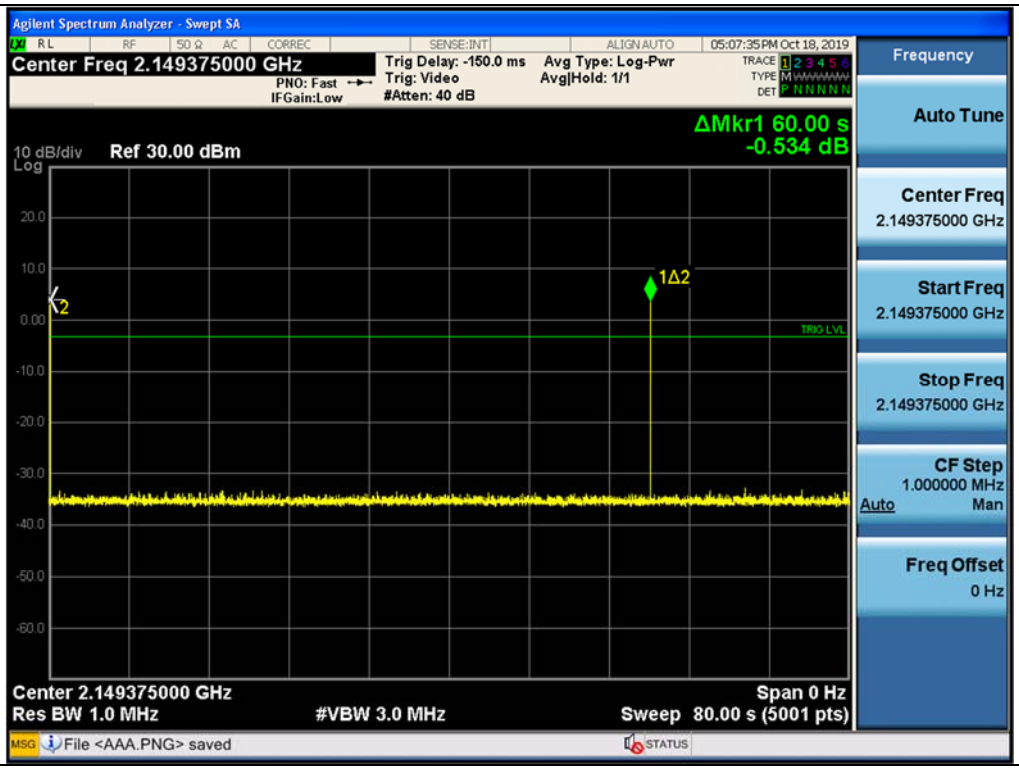
Oscillation Restart Time / AWS-1 / Uplink


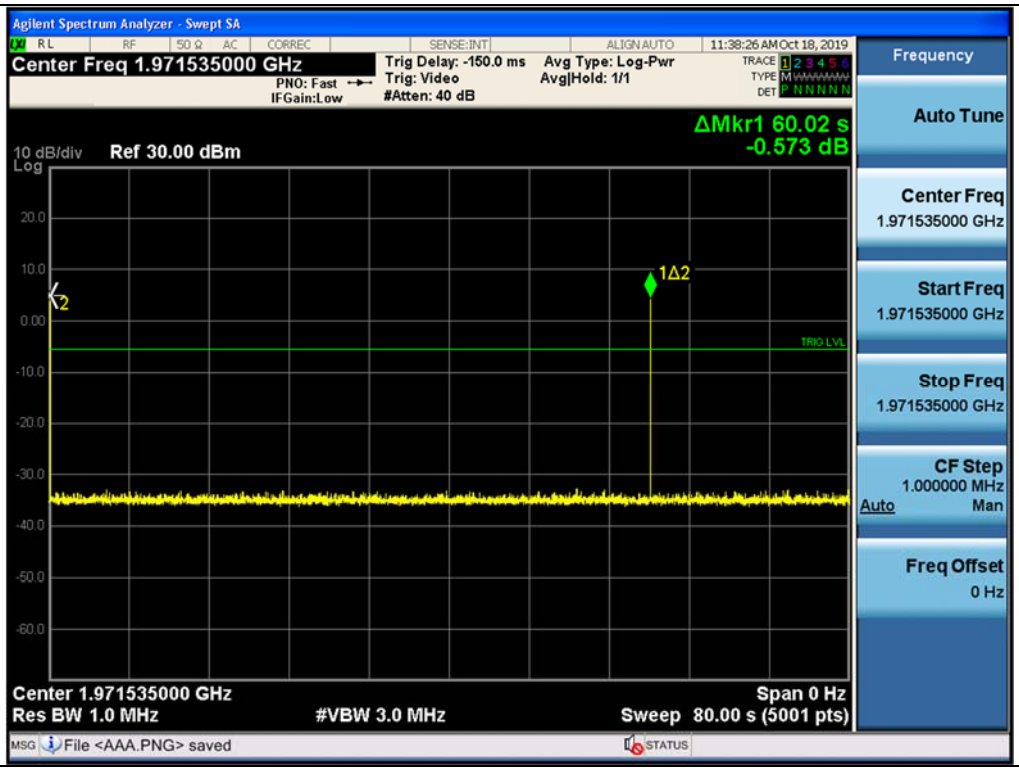
Oscillation Restart Time / Broadband PCS / Uplink


Oscillation Restart Time / Lower 700 MHz / Downlink


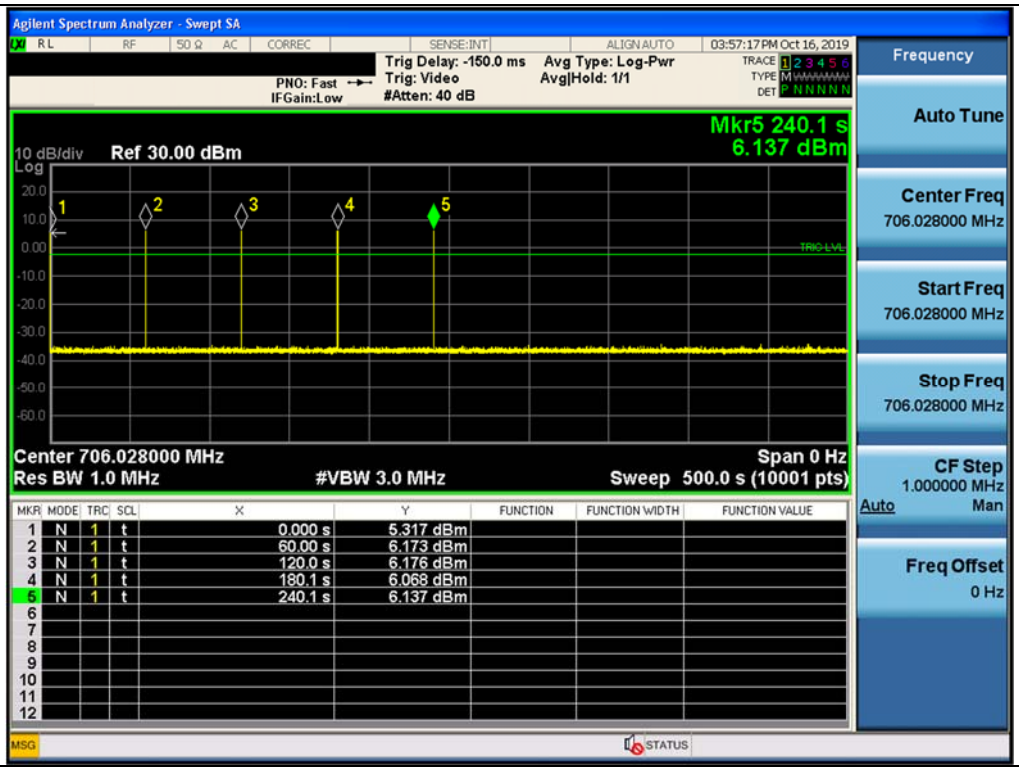
Oscillation Restart Time / Upper 700 MHz / Downlink


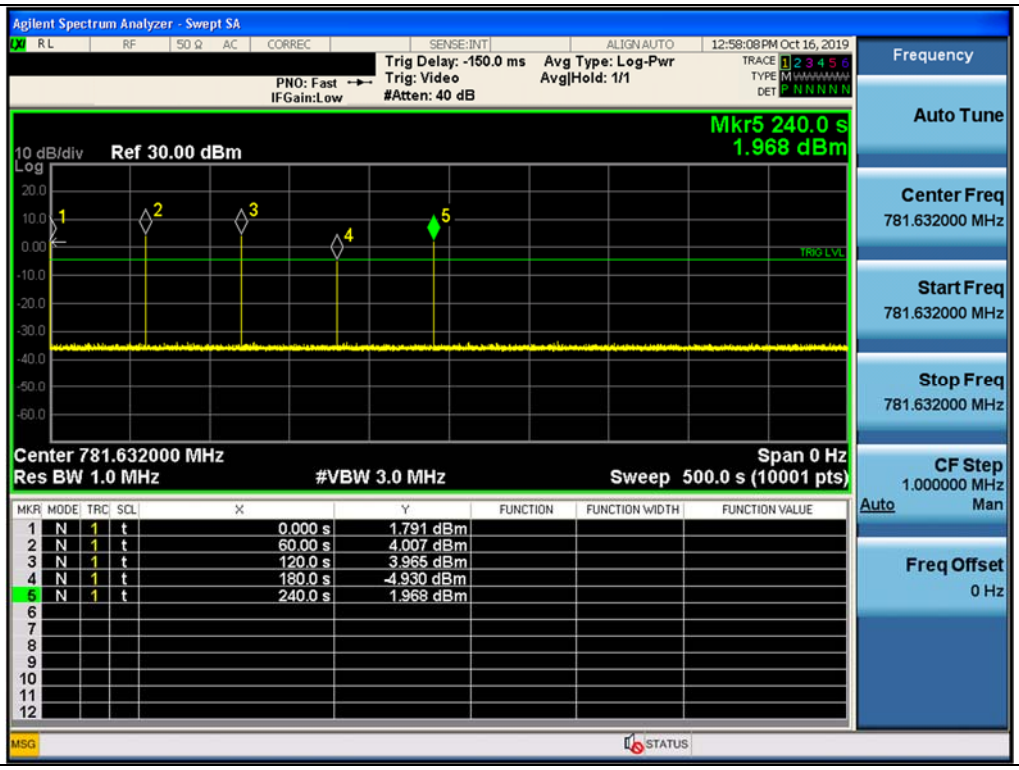
Oscillation Restart Time / Cellular / Downlink


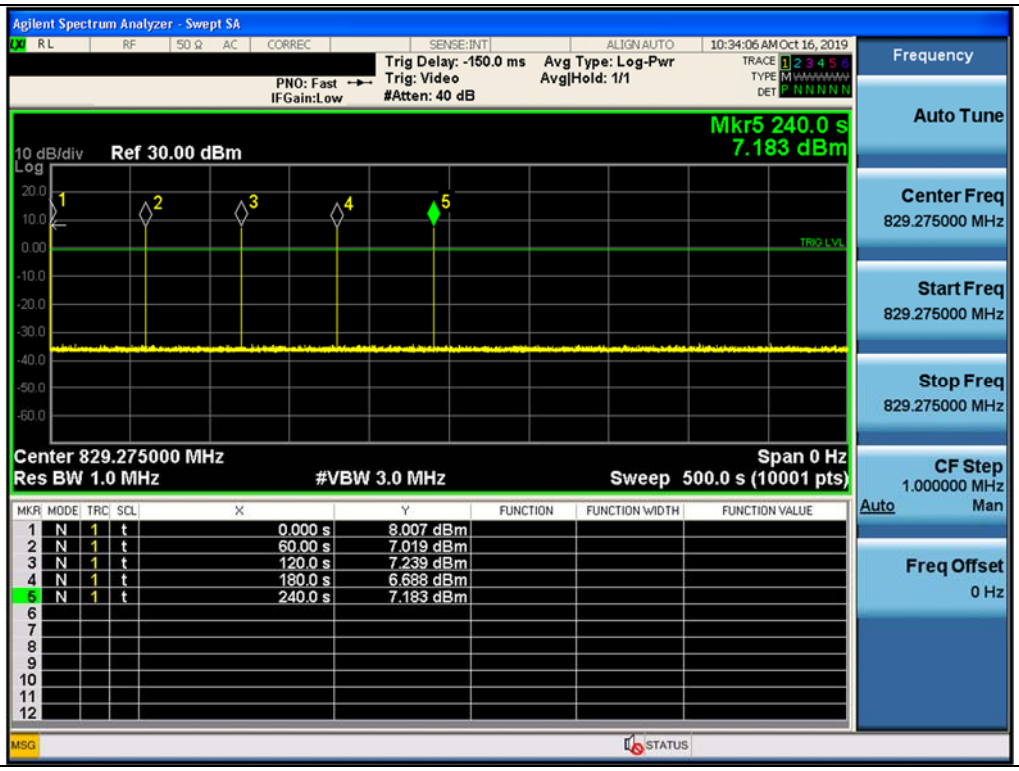
Oscillation Restart Time / AWS-1 / Downlink


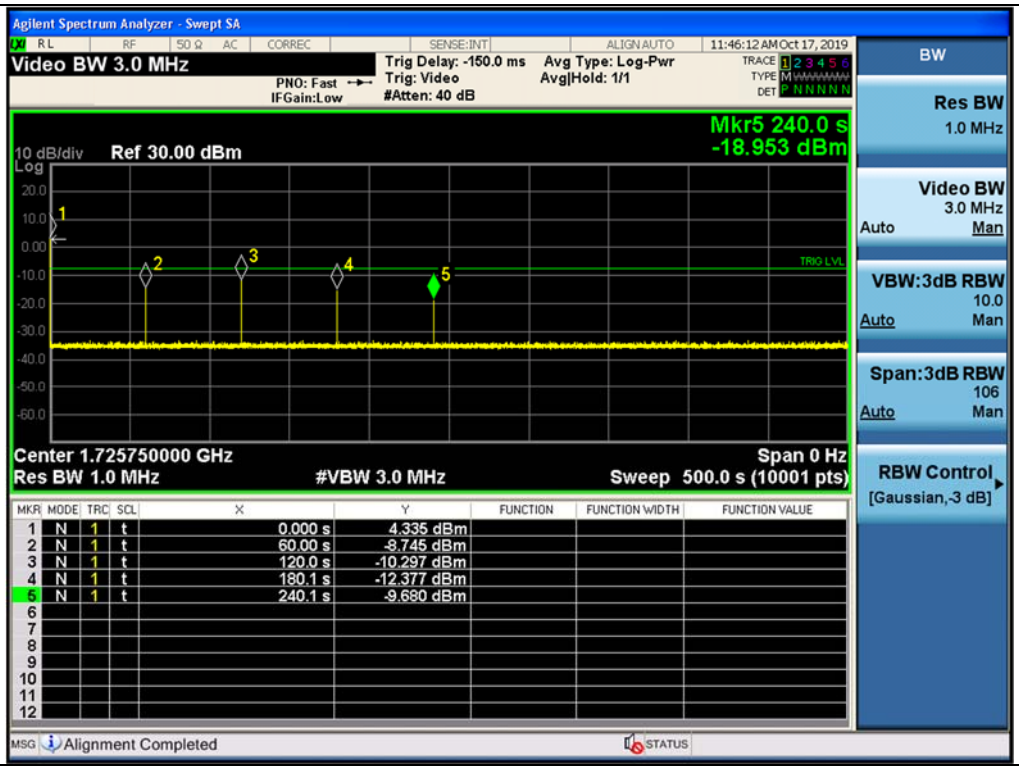
Oscillation Restart Time / Broadband PCS / Downlink


Plot data of Number of Oscillation Restart

Number of Oscillation Restart / Lower 700 MHz / Uplink


Number of Oscillation Restart / Upper 700 MHz / Uplink


Number of Oscillation Restart / Cellular / Uplink


Number of Oscillation Restart / AWS-1 / Uplink


Number of Oscillation Restart / Broadband PCS / Uplink