Band 12

Band 13

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Band 25

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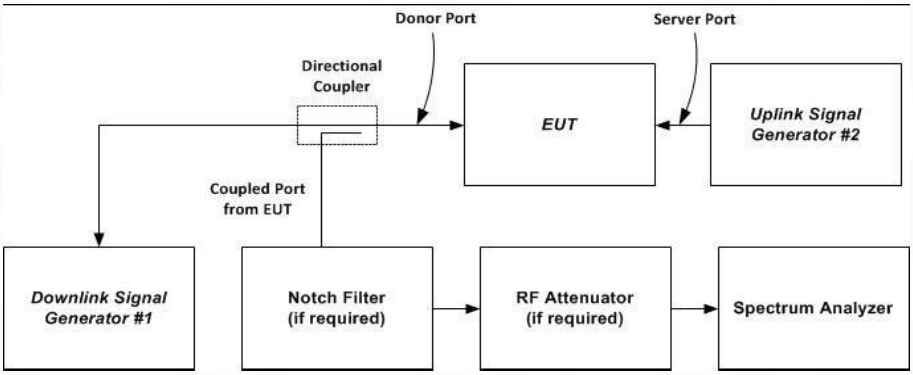
5.9 Variable Booster Gain

Test Requirement:	This procedure shall be used to demonstrate compliance to the Booster Gain Limits specified for Wideband Consumer Signal Boosters in §21(e)(8)(i)(C). The variable booster gain limits are expressed as a function of RSSI and MSCL. The RSSI is varied over a range of values as specified within the procedure. Refer to Annex B of this document for guidance with respect to determining the applicable MSCL value.
Limit:	-34 dB -RSSI + MSCL
Test Setup:	
Procedure:	a) Connect the EUT to the test equipment as shown in Figure 6 with the uplink output connected to signal generator 1. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer. b) Configure downlink signal generator #1 for AWGN operation with an 99% occupied bandwidth of 4.1 MHz tuned to the center of the operational band. c) Set the power level and frequency of signal generator # 2 to a value 5 dB below the AGC level from section 7.2. The signal type is AWGN with a 99% OBW of 4.1 MHz. d) Set RBW = 100 kHz. e) Set VBW ⩾ 300 kHz. f) Select the CHANNEL POWER measurement tool. g) Select the RMS (power averaging) detector. h) Ensure that the number of measurement points per sweep ⩾ (2 x span)/RBW. i) Sweep time = auto couple or as necessary. j) Trace average at least 10 traces in power averaging (i.e., RMS) mode. k) Measure the maximum channel power and compute maximum gain when varying the signal generator 1 to a level from -90 to -10 dBm in 1 dB steps inside the RSSI dependent region and 10 dB steps outside the RSSI dependent region and report the six values closest to the limit, including at least two points from within the RSSI dependent region of operation. l) Repeat 7.9.3 – 7.9.11 for all operational uplink bands. m) Variable Uplink gain timing is to be measured as follows. n) Set the spectrum analyzer to the uplink frequency to be measured. o) Set the span to 0 Hz with a sweep time of 10 seconds. p) Set the power level of signal generator 1 to the lowest level of the RSSI dependent gain. q) Select MAX HOLD and increase the power level of signal generator 1 by 10 dB for mobile booster and 20 dB for fixed indoor boosters. r) Ensure that the Uplink gain decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.

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	s) Repeat 7.9.13 – 7.9.18 for all operational uplink bands.

5.9.1 E.U.T. Operation:

Operating Environment:	
Temperature:	−30 °C and +50
Humidity:	46.3 %
Atmospheric Pressure:	1010 mbar

5.9.2 Test Data:

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MSCL Calculation							
Operation Bands	Frequency (MHz)	Distance (m)	Path loss (dB)	Indoor Antenna Gain(dBi)	Indoor Cable Loss(dB)	Polarity Loss(dB)	MSCL (dB)
Band 5	869	2	37.30	9	3	9.03	40.33
Band 4	2110	2	45.01	9	3	9.03	48.04
Band 12	729	2	35.78	9	3	9.03	38.81
Band 13	746	2	35.98	9	3	9.03	39.01
Band 25	1930	2	44.23	9	3	9.03	47.26

Note : Path loss = 20logf + 20logd – 27.5
Polarity loss = 20Log (2/Sin (45deg)) dB = 9.03dB

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Variable booster gain							
Operation Band	RSSI (dBm)	Input Power (dBm)	Output Power (dBm)	Measured Gain (dB)	MSCL	Limit	Results
Band 5	-52	-41	11.27	52.27	40.33	58.33	PASS
	-51	-41	10.38	51.38	40.33	57.33	PASS
	-48	-41	9.46	50.46	40.33	54.33	PASS
	-46	-41	5.94	46.94	40.33	52.33	PASS
	-43	-41	4.63	45.63	40.33	49.33	PASS
	-41	-41	3.62	44.62	40.33	47.33	PASS
Band 4	-52	-41	11.34	52.34	48.04	66.04	PASS
	-50	-41	10.51	51.51	48.04	64.04	PASS
	-47	-41	9.36	50.36	48.04	61.04	PASS
	-45	-41	5.81	46.81	48.04	59.04	PASS
	-43	-41	4.58	45.58	48.04	57.04	PASS
	-42	-41	3.51	44.51	48.04	56.04	PASS
Band 12	-53	-41	10.57	51.57	38.81	57.81	PASS
	-51	-41	9.63	50.63	38.81	55.81	PASS
	-50	-41	6.81	47.81	38.81	54.81	PASS
	-45	-41	3.72	44.72	38.81	49.81	PASS
	-40	-41	1.91	42.91	38.81	44.81	PASS
	-39	-41	0.21	41.21	38.81	43.81	PASS
Band 13	-52	-41	11.37	52.37	39.01	57.01	PASS
	-50	-41	8.21	49.21	39.01	55.01	PASS
	-49	-41	7.25	48.25	39.01	54.01	PASS
	-46	-41	4.01	45.01	39.01	51.01	PASS
	-40	-41	2.25	43.25	39.01	45.01	PASS
	-38	-41	1.98	42.98	39.01	43.01	PASS
	-40	-41	2.91	43.91	39.01	45.01	PASS
	-38	-41	1.83	42.83	39.01	43.01	PASS
Band 25	-52	-41	11.81	52.81	47.26	65.26	PASS
	-50	-41	8.83	49.83	47.26	63.26	PASS

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	-49	-41	7.00	48.00	47.26	62.26	PASS
	-46	-41	4.51	45.51	47.26	59.26	PASS
	-40	-41	2.31	43.31	47.26	53.26	PASS
	-38	-41	1.25	42.25	47.26	51.26	PASS

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Variable Uplink Gain Timing

Variable Uplink Gain Timing			
Operation Band	Measured Sec	Limit Sec	Result
Band 5	1.28	3.0	PASS
Band 4	1.19	3.0	PASS
Band 12	1.38	3.0	PASS
Band 13	1.52	3.0	PASS
Band 25	1.56	3.0	PASS

Band 5

Band 4

Band 12

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Band 13

Band 25

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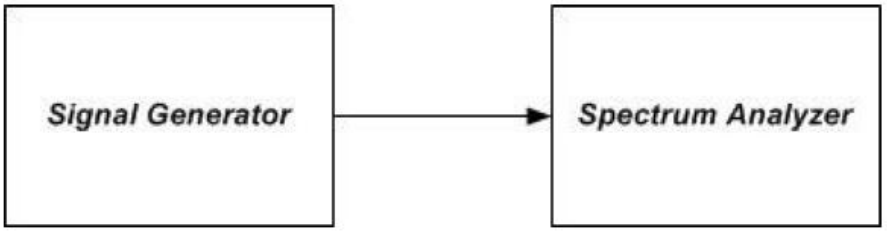
5.10 Occupied Bandwidth

Test Requirement:	This measurement is required to compare the uniformity of the output signal relative to the input signal and to satisfy the requirements of §2.1049.
Test setup:	 Figure 6 – Test setup for measuring characteristics of test signals used for subsequent EUT occupied bandwidth testing
Procedure:	a) Connect the test equipment as shown in Figure 7 to measure the characteristics of the test signals produced by the signal generator. b) Set VBW to ⩾ 3X RBW c) Set the center frequency of the spectrum analyzer to the center of the operational band. The span will be adjusted for each modulation type and occupied bandwidth as necessary for accurately viewing the signals. d) Set the signal generator for power level to match the values obtained in section 7.2. e) Set the signal generator modulation type for GSM with a PBRS pattern and allow the trace on the signal generator to stabilize adjusting the span as necessary. f) Set the spectrum analyzer RBW for 1% to 5% of the emissions bandwidth. g) Capture the spectrum analyzer trace for inclusion in the test report. h) Repeat steps 7.10.3 – 7.10.7 for CDMA and WCDMA modulation adjusting the span as necessary for all uplink and downlink operational bands. [AWGN or LTE may be used in place of WCDMA, as an option] i) Connect the test equipment as shown in Figure 1. Begin with the uplink output connected to the spectrum analyzer j) Repeat steps 7.10.3 – 7.10.8 in this new configuration.

5.10.1 E.U.T. Operation:

Operating Environment:	
Temperature:	−30 °C and +50
Humidity:	46.3 %
Atmospheric Pressure:	1010 mbar

5.10.2 Test Data:

Operation Band		Signal	Input OBW [MHz]	Output OBW [MHz]	Results
Uplink	Band 5	AWGN	4.5429	4.5442	PASS
	Band 4	AWGN	4.5277	4.5191	PASS
	Band 12	AWGN	4.5397	4.5408	PASS
	Band 13	AWGN	4.5466	4.5333	PASS
	Band 25	AWGN	4.5298	4.5403	PASS
Downlink	Band 5	AWGN	4.5398	4.5389	PASS
	Band 4	AWGN	4.5218	4.5328	PASS
	Band 12	AWGN	4.5332	4.5268	PASS
	Band 13	AWGN	4.5297	4.5407	PASS
	Band 25	AWGN	4.5292	4.5503	PASS

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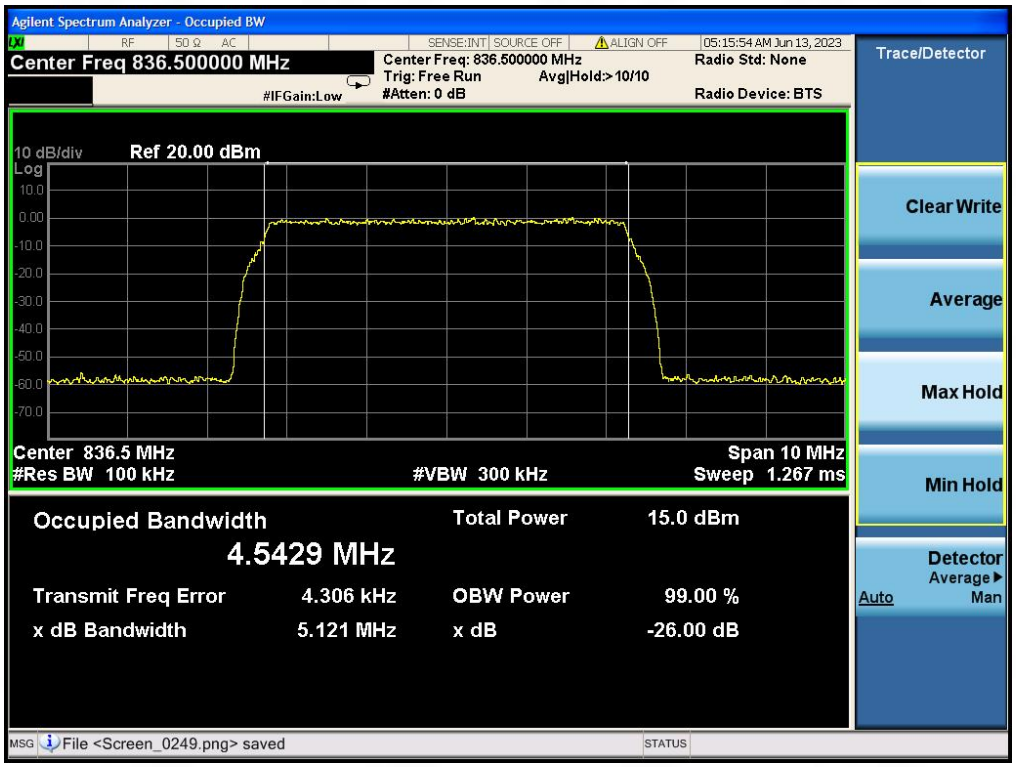
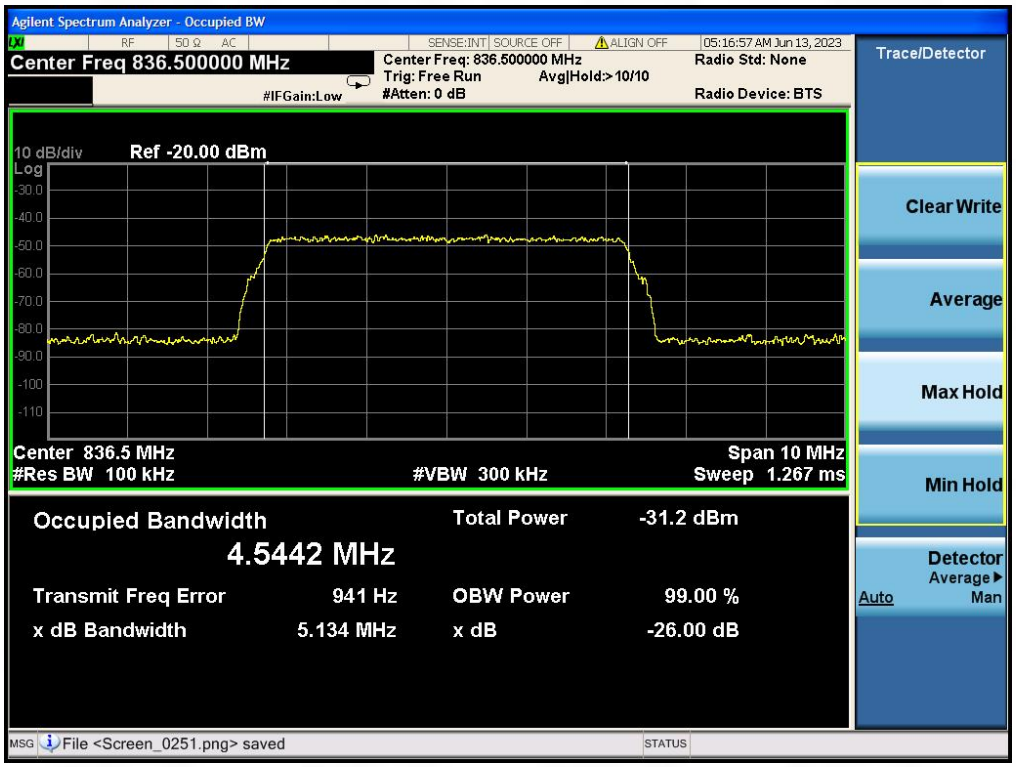
Band 5 AWGN UL Input



Band 5 AWGN UL output



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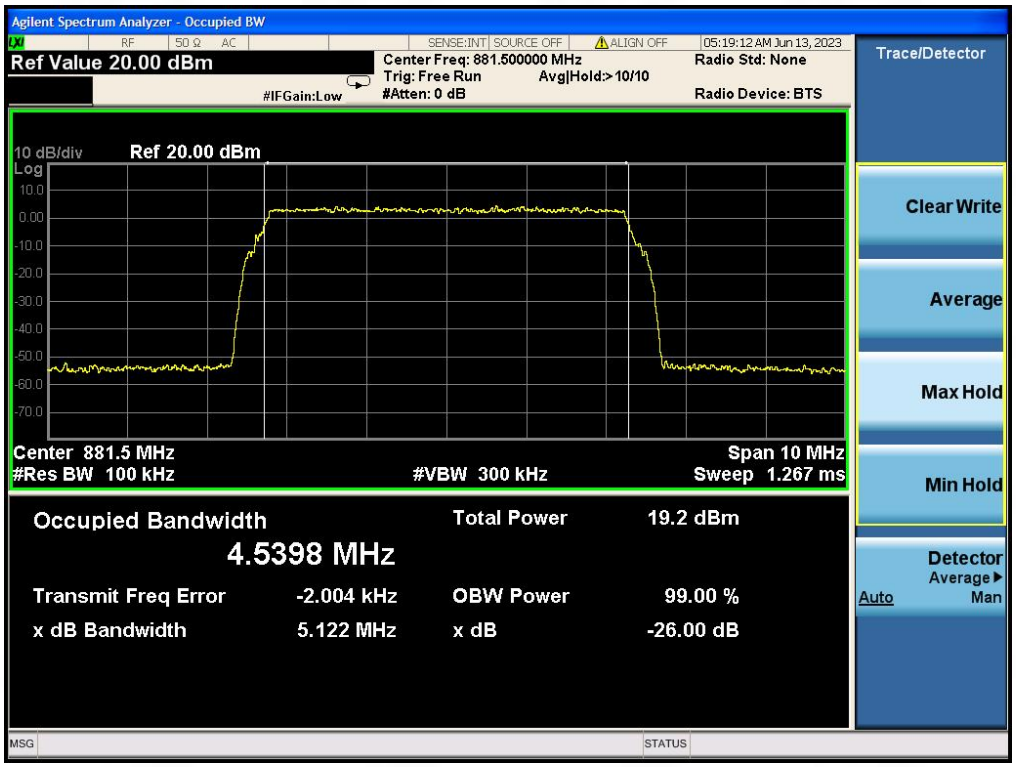
Band 5 AWGN DL Input



Band 5 AWGN DL output

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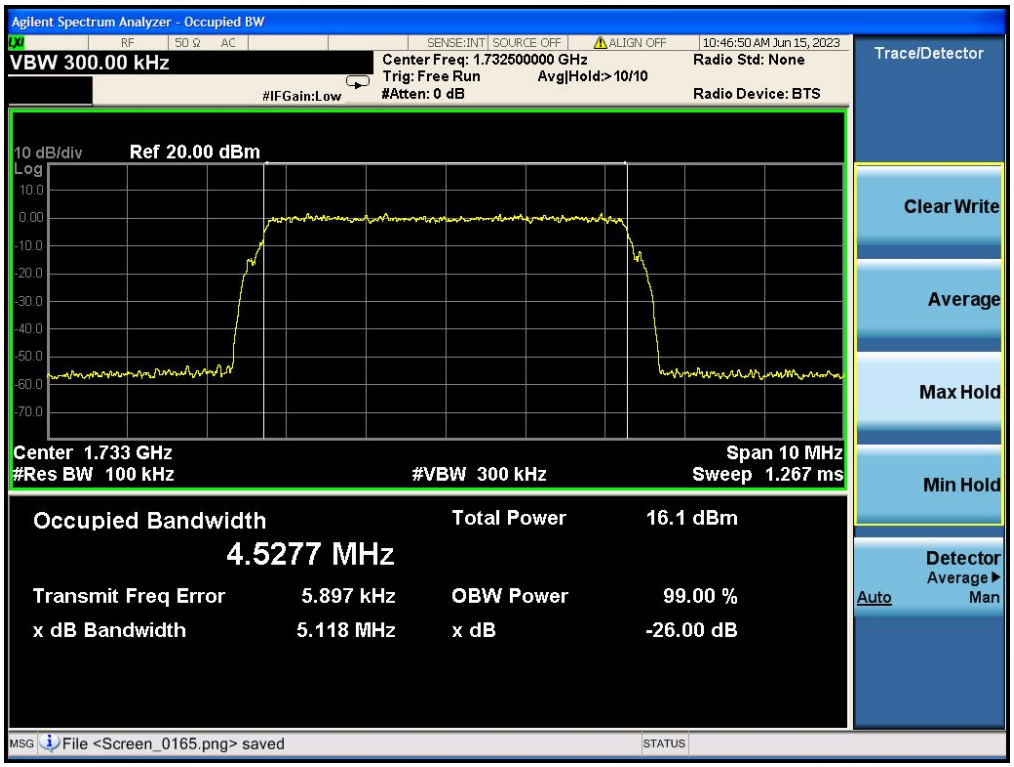
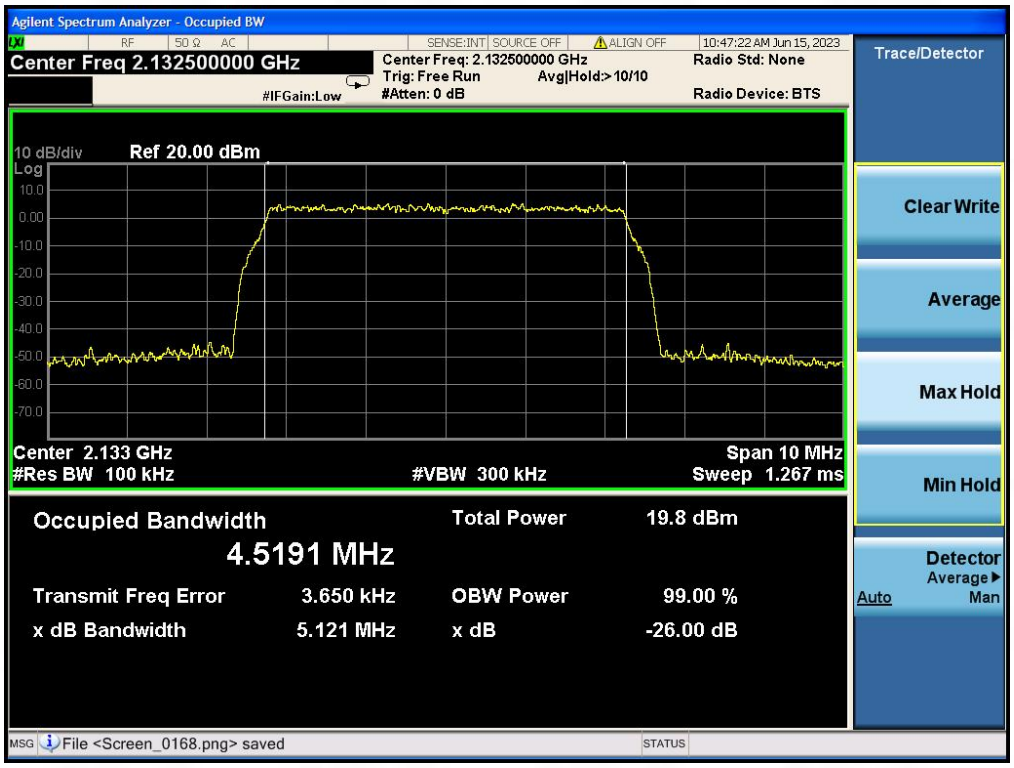
Band 4 AWGN DL Input



Band 4 AWGN DL output



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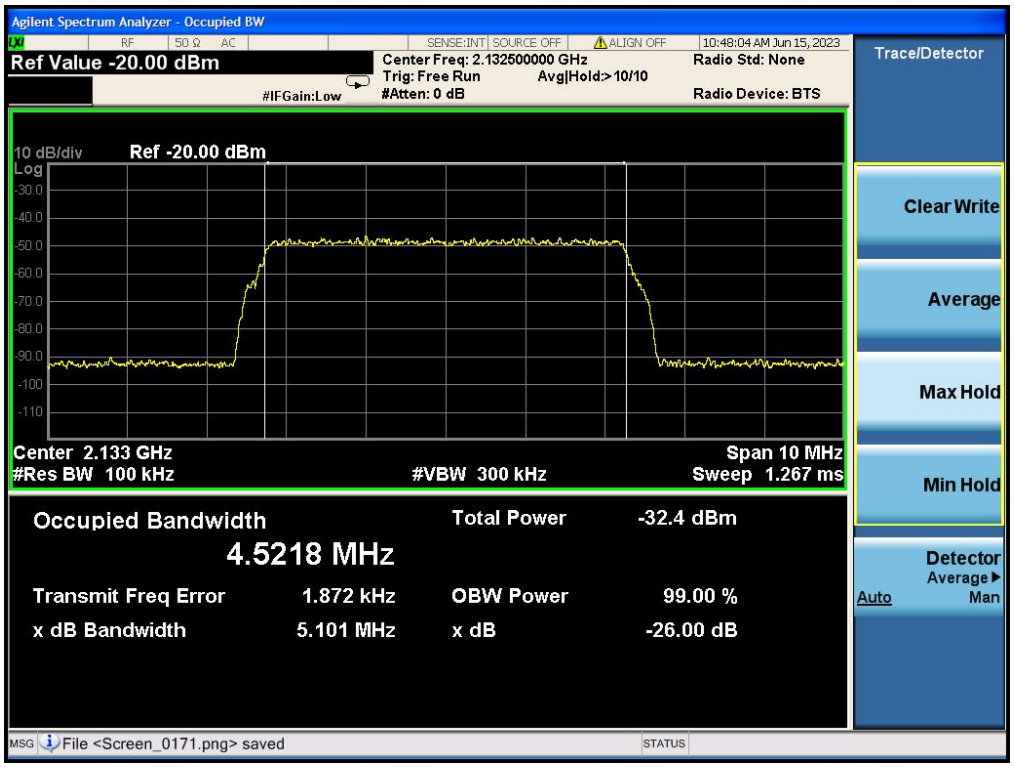
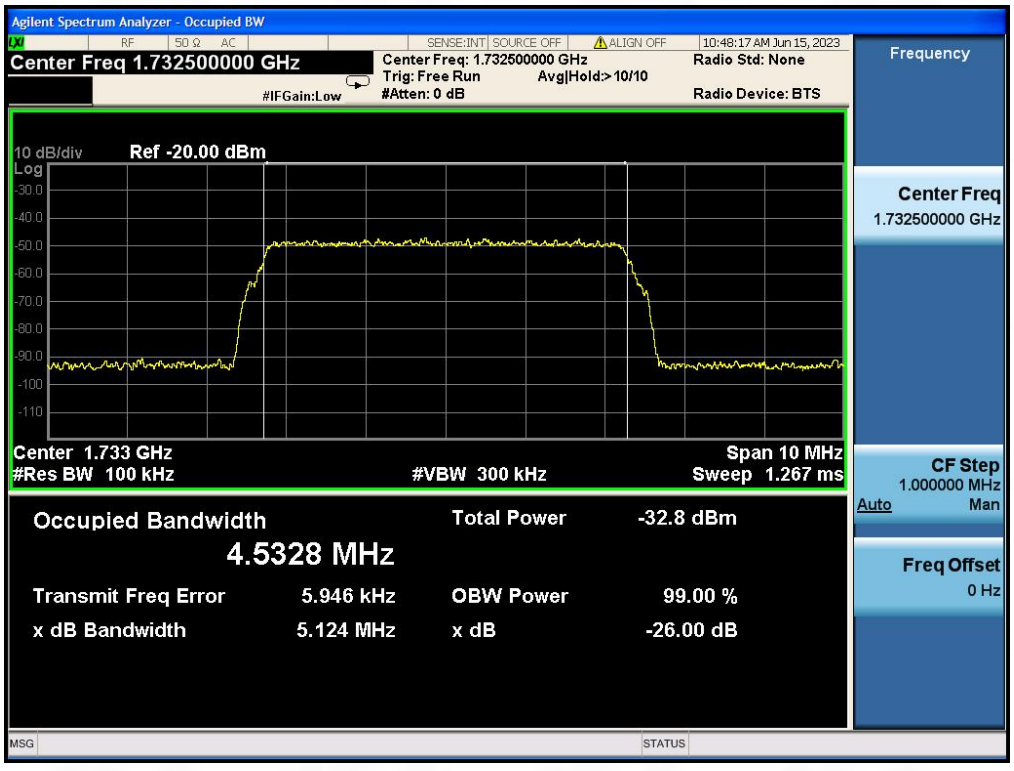
Band 4 AWGN UL Input



Band 4 AWGN UL output



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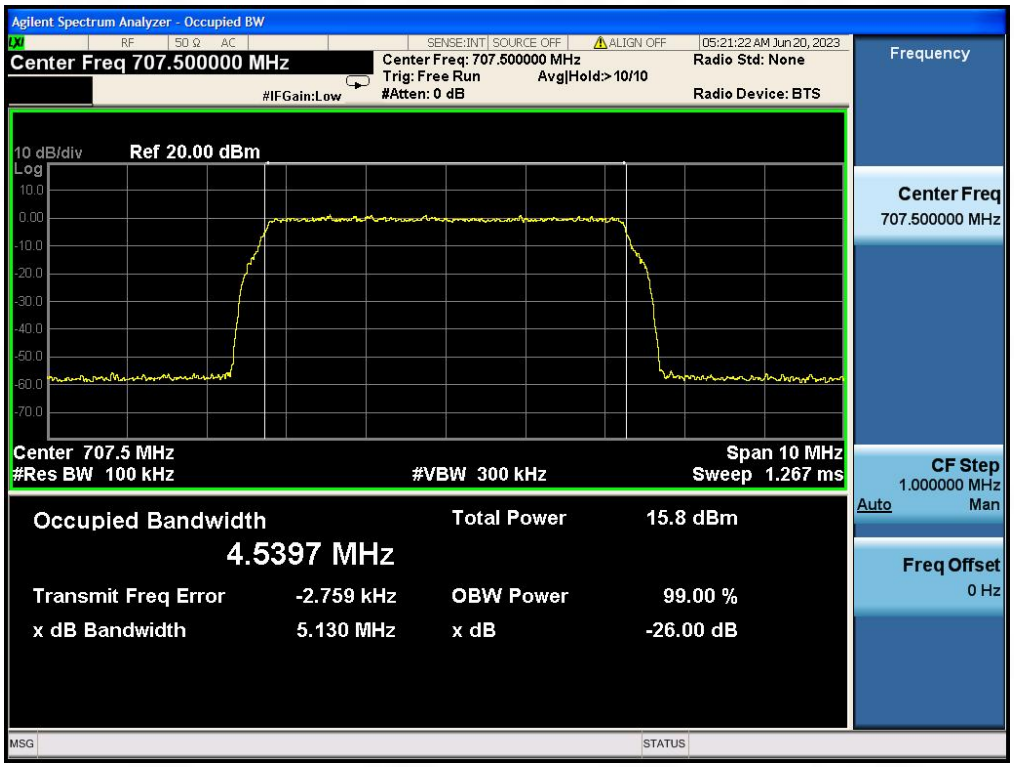
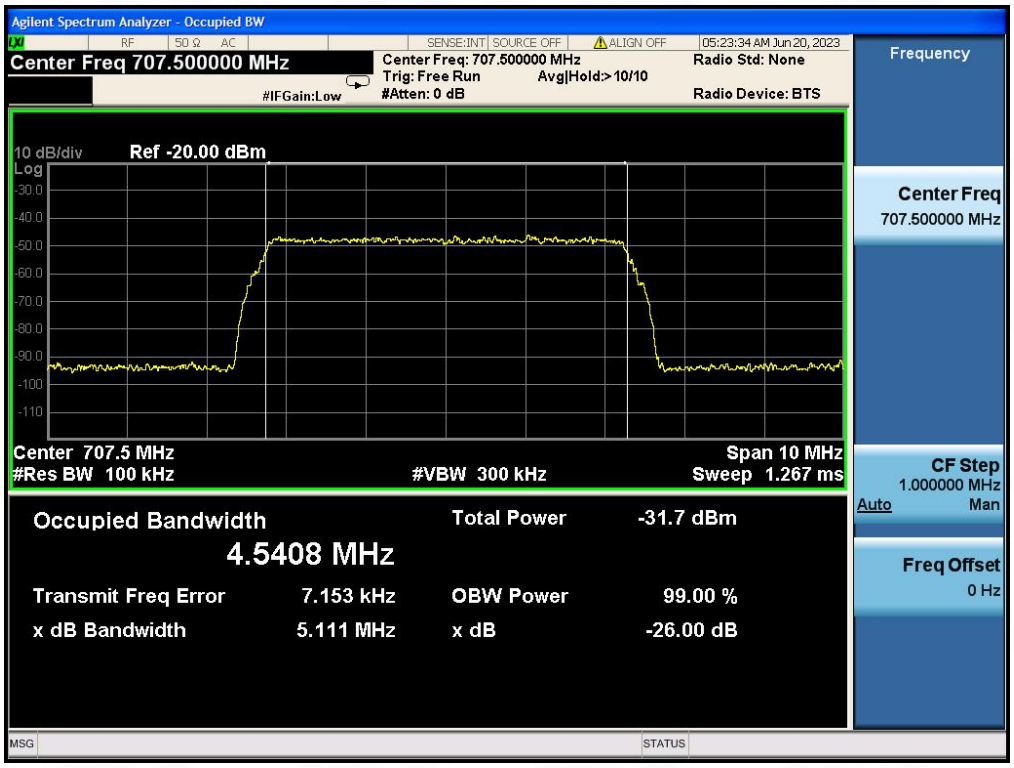
Band 12 UL Input



Band 12 UL output



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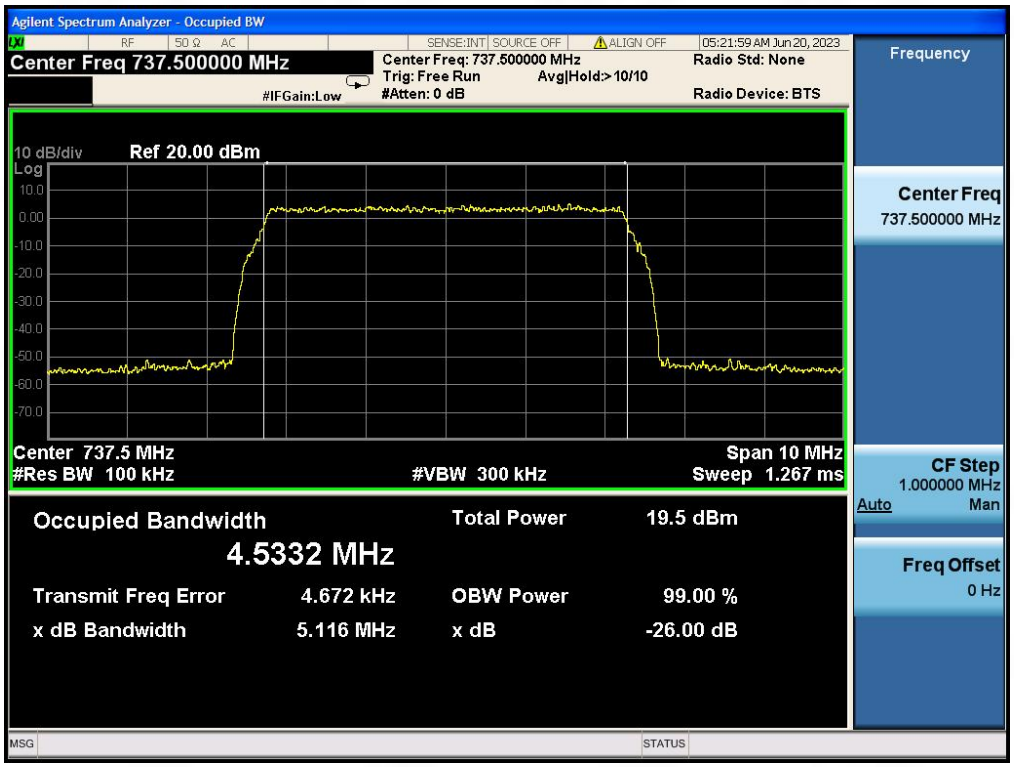
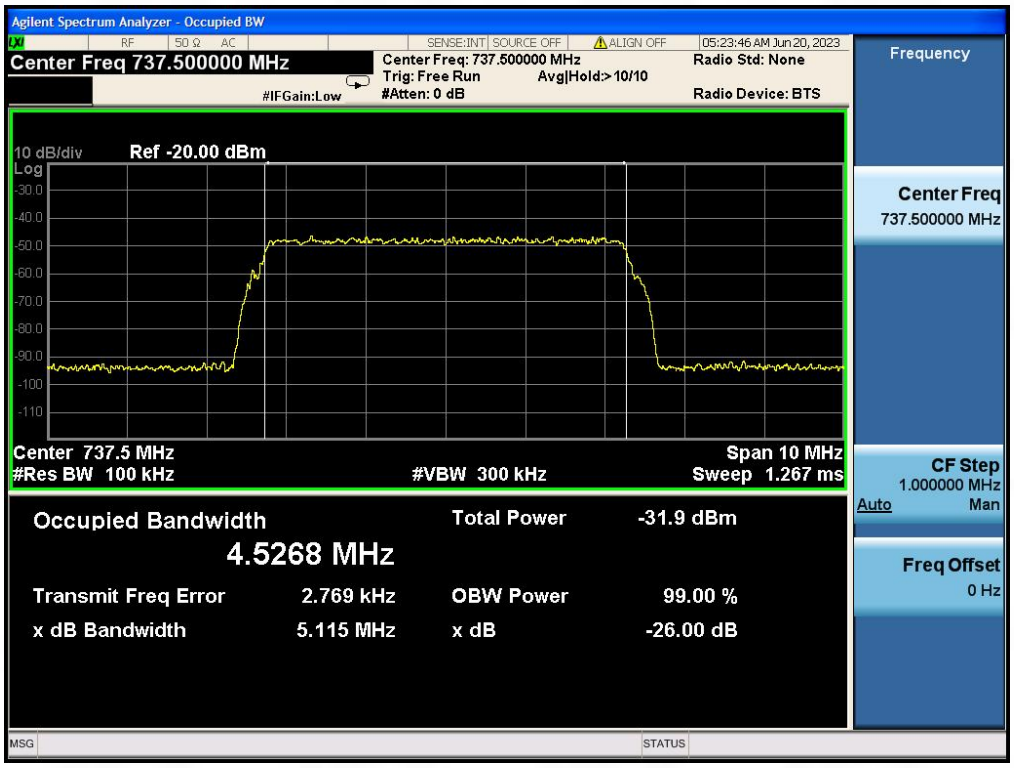
Band 12 DL Input



Band 12 DL output



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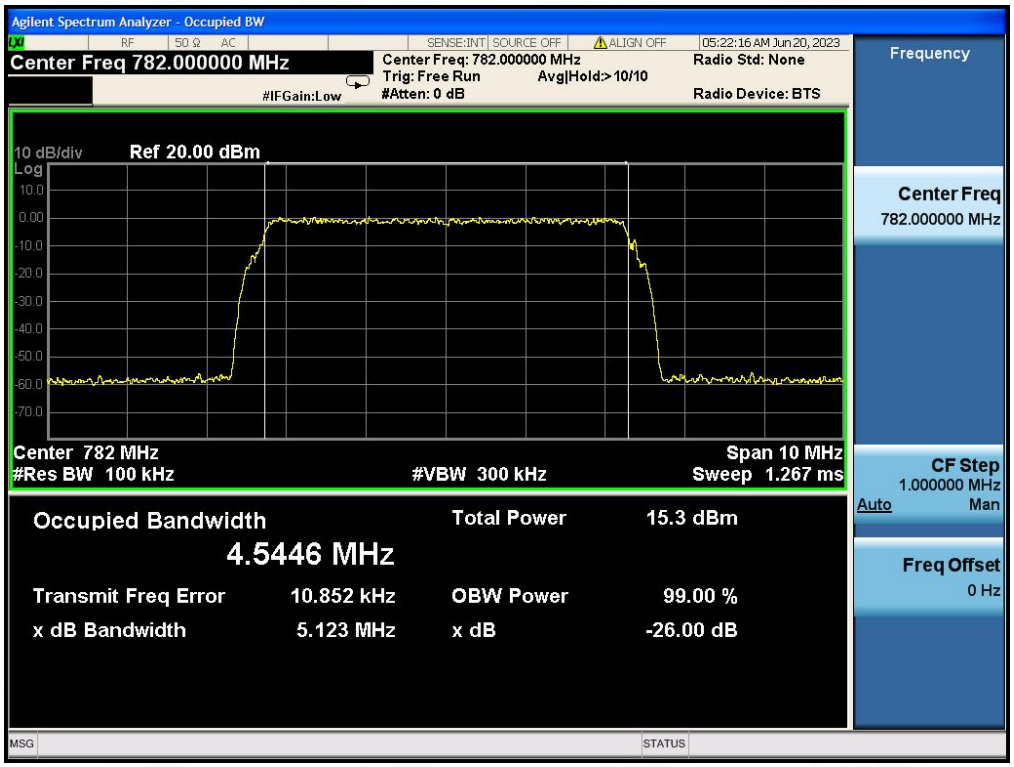
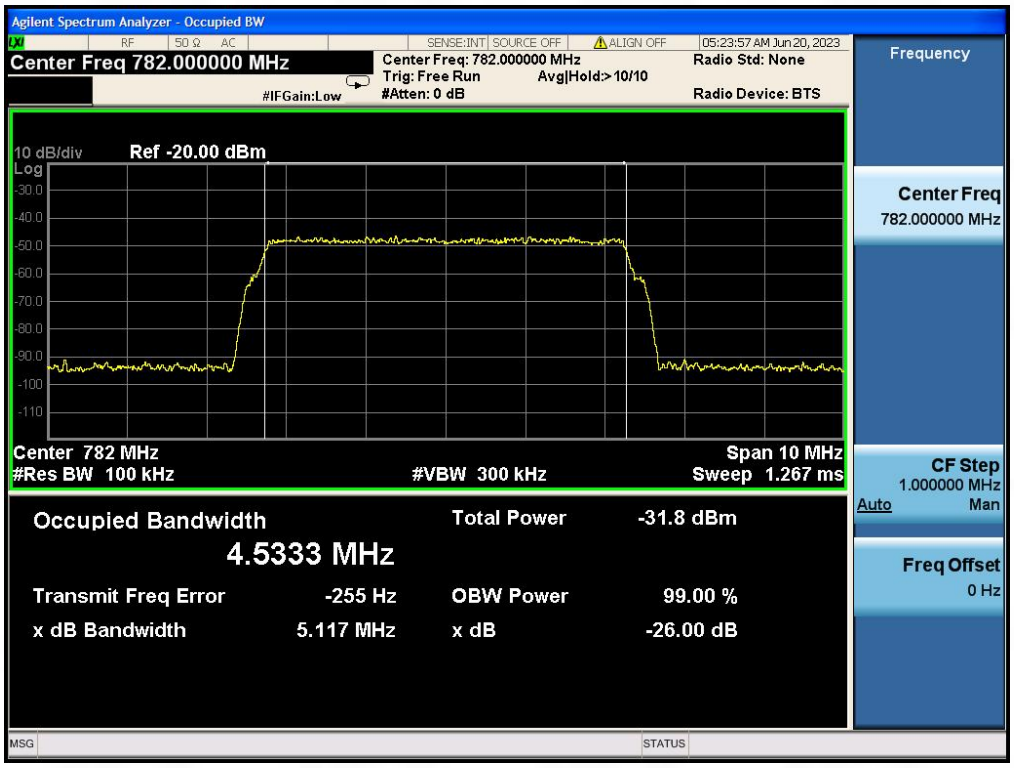
Band 13 UL Input



Band 13 UL output



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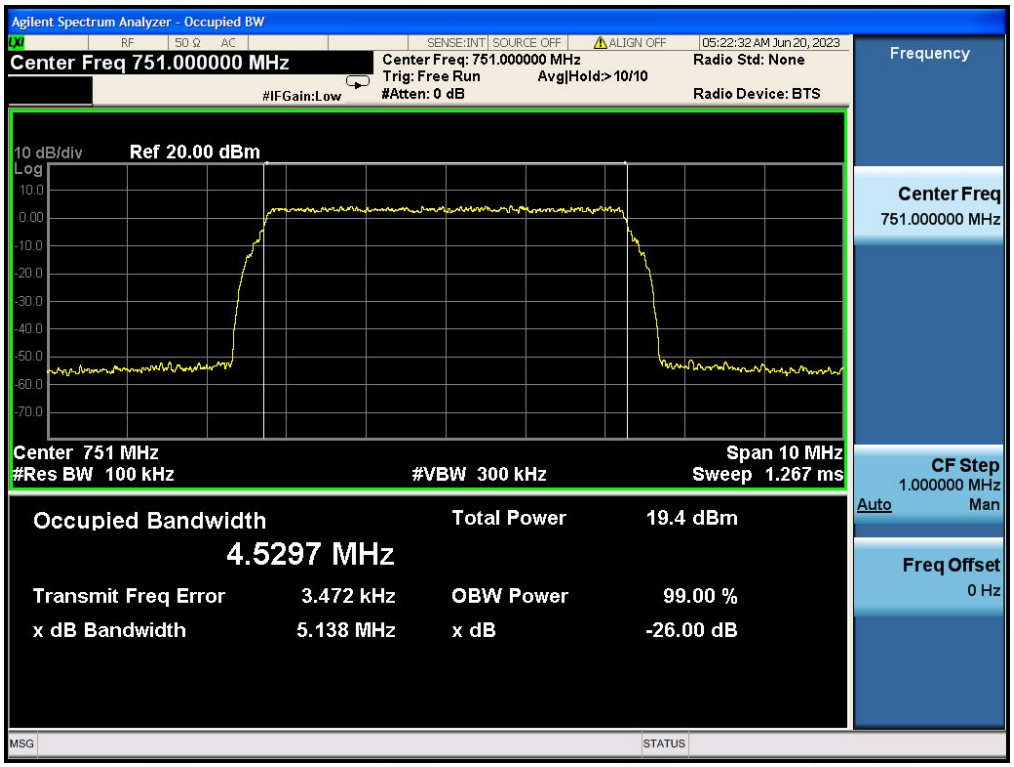
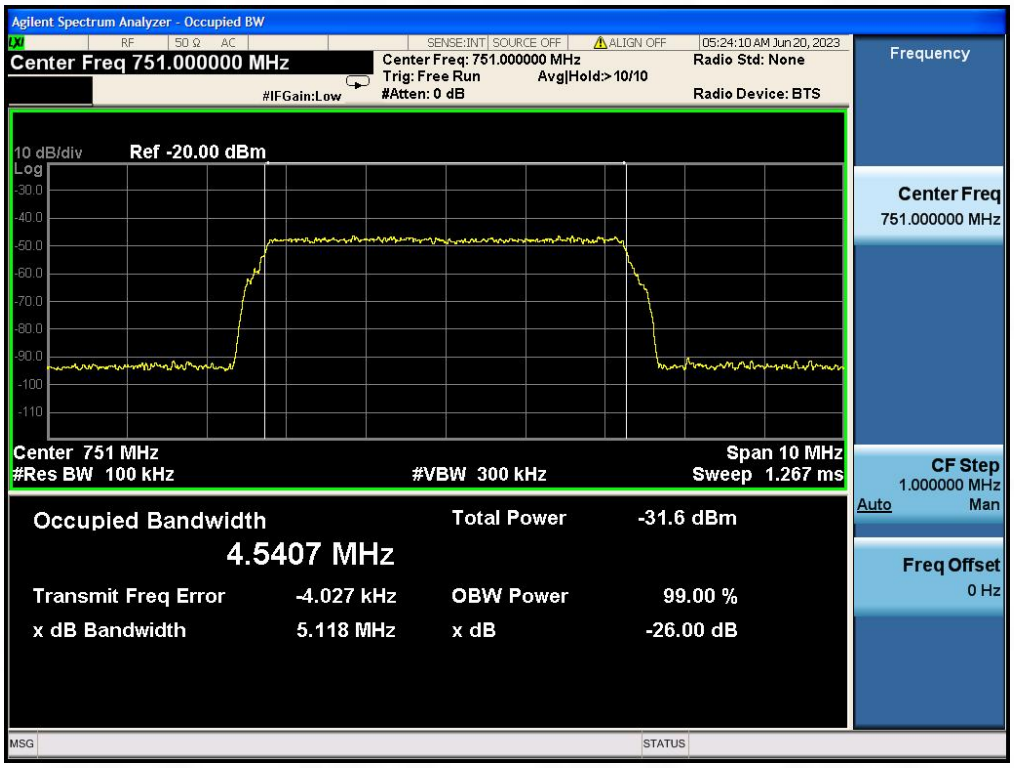
Band 13 DL Input



Band 13 DL output



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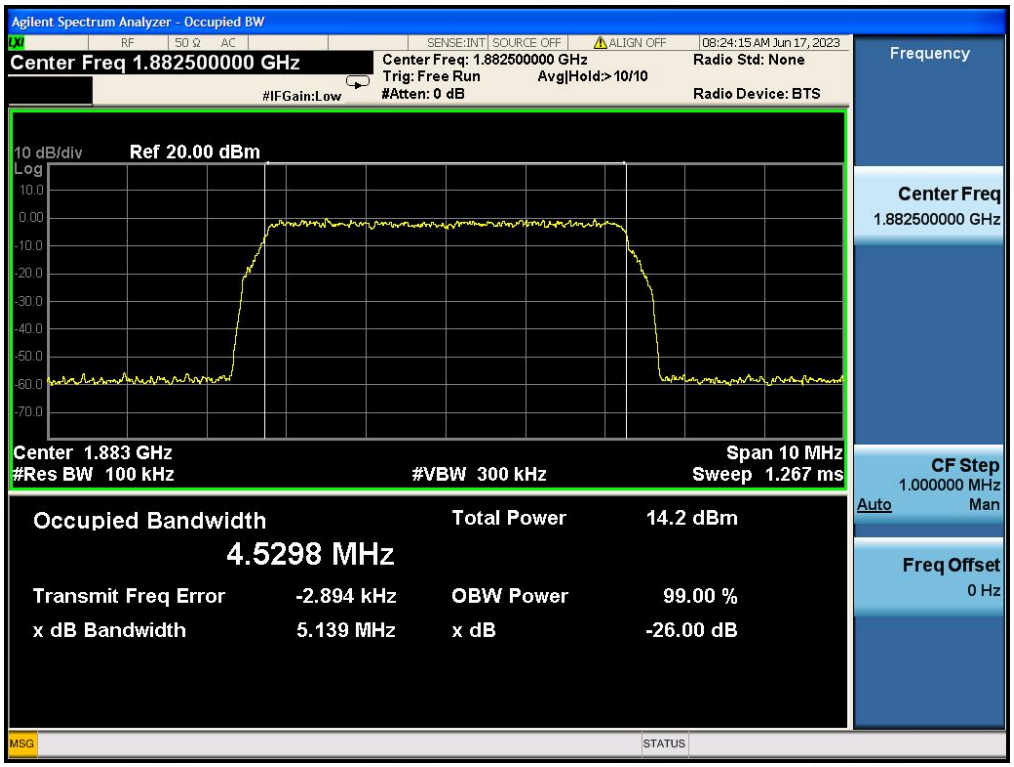
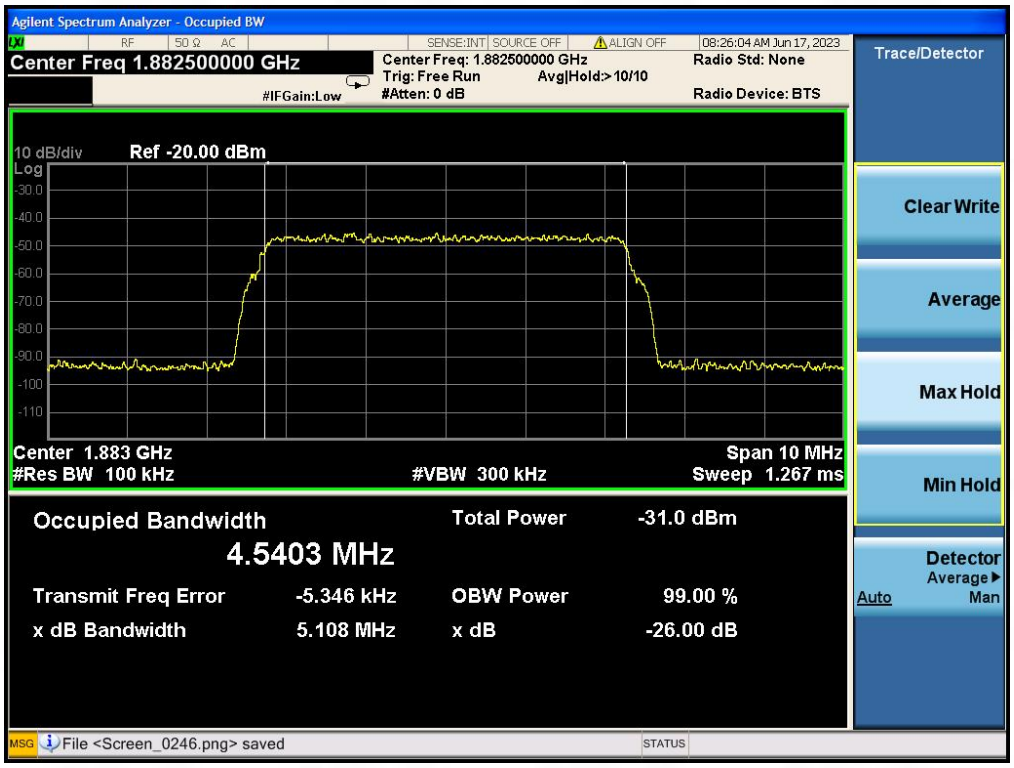
Band 25 UL Input



Band 25 UL output



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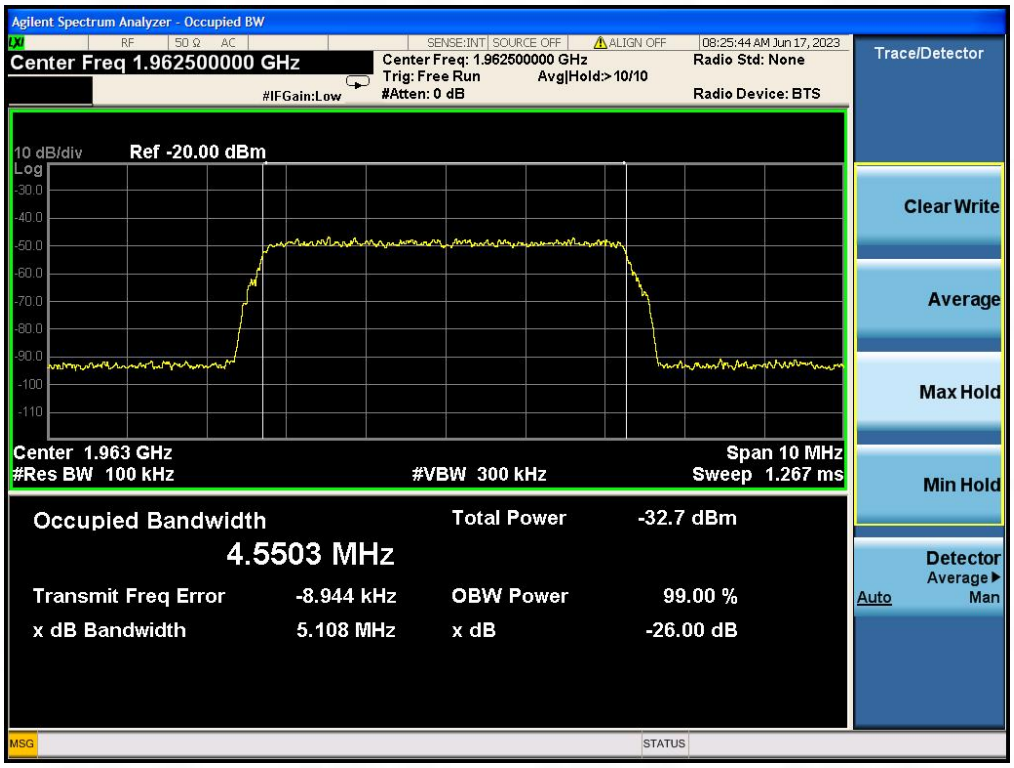
Band 25 DL Input

Band 25 DL output



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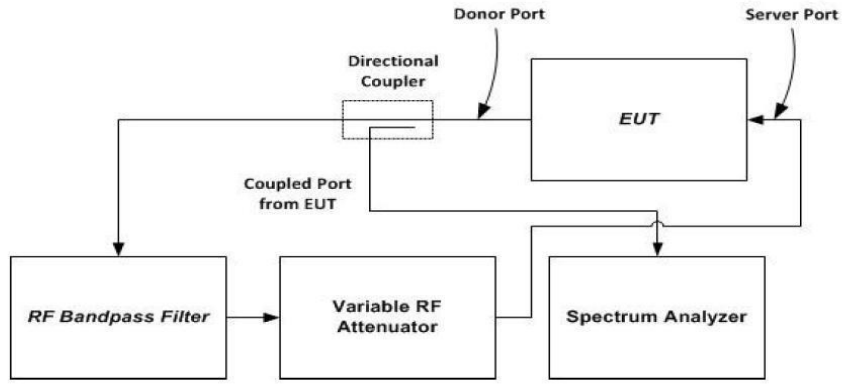
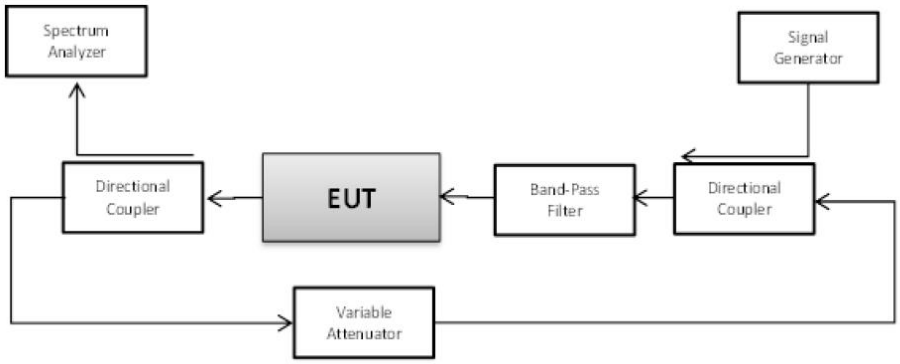
5.11 Oscillation Detection

Test Requirement:	This measurement is required to demonstrate compliance to the Anti-Oscillation specification for Wideband Consumer Signal Boosters provided in §20.21(e)(8)(ii)(A) For this measurement two EUTs will be permitted, one operating in a normal mode and the second operating in a test mode that is capable of disabling the uplink inactivity squelching and or a reduction of the time between restarts to 5 seconds. This will greatly decrease the test time required.
Test setup:	 NOTE—This figure shows the test setup for uplink bands transmission path tests; i.e., signal flow is out from the donor port into the directional coupler. For downlink bands transmission path tests, the feedback signal flow path direction and equipment connections shall be reversed, i.e., signal flow is out from the server port into the directional coupler, and signal flow is into the donor port from the variable RF attenuator. **Figure 7 – Oscillation detection (7.11.2) test setup**  **Figure 8 – Oscillation mitigation/shutdown test setup**
Procedure:	a) Connect the EUT set for normal operation to the test equipment as shown in Figure 8 beginning with the RF detector on the uplink output side of the RF path. Ensure that the RF coupled path is connected to the RF detector. Note: The band pass filter shall provide sufficient out-of-band rejection to prevent oscillations from occurring in bands not under test. b) Set the oscilloscope for a positive edge trigger and single trigger operation. c) Set the attenuation as necessary until the oscilloscope triggers and increase the attenuation level to a point 10 dB above that point. d) Reset the trigger of the oscilloscope and reset the EUT with a power cycle. e) Force the EUT to oscillate this will trigger the oscilloscope. f) Use the CURSOR function of the oscilloscope to measure the time from the detection of oscillation until the EUT turns off by setting CURSOR 1 on the leading edge of the signal and CURSOR 2 on the trailing edge. g) Capture the oscilloscope trace for inclusion in the test report. h) Repeat steps 7.11.2 to 7.11.7 for all operational uplink and downlink bands.

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	i) Set the oscilloscope time base for longer than 1 minute and measure the restart time for each operational uplink and downlink band. j) Replace the normal operating EUT for the EUT with the test mode. k) Set the oscilloscope time base for a minimum 120 seconds with an AUTO Trigger and a single sweep. l) Start the Oscilloscope and a manually force the booster into oscillation. m) 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 can be no more than 5 restarts. n) Repeat steps 7.11.12 to 7.11.13 for all operational uplink and downlink bands. Note: In lieu of an oscilloscope and RF detector, a spectrum analyzer set for 0 span, can be used to enhance sensitivity, with a center frequency set equal to the center of the operational band for broadband oscillation or a discrete frequency of oscillation. RBW shall be at least 1 MHz with VBW ⩾ 3 times RBW using a peak detector.

5.11.1 E.U.T. Operation:

Operating Environment:	
Temperature:	−30 °C and +50
Humidity:	46.3 %
Atmospheric Pressure:	1010 mbar

5.11.2 Test Data:

Test results of detection time				
Operation Bands		Detection Time(s)	Limit(s)	Result
Uplink	Band 5	0.015	0.300	PASS
	Band 4	0.030	0.300	PASS
	Band 12	0.030	0.300	PASS
	Band 13	0.035	0.300	PASS
	Band 25	0.040	0.300	PASS
Downlink	Band 5	0.030	0.300	PASS
	Band 4	0.035	0.300	PASS
	Band 12	0.040	0.300	PASS
	Band 13	0.035	0.300	PASS
	Band 25	0.030	0.300	PASS

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