

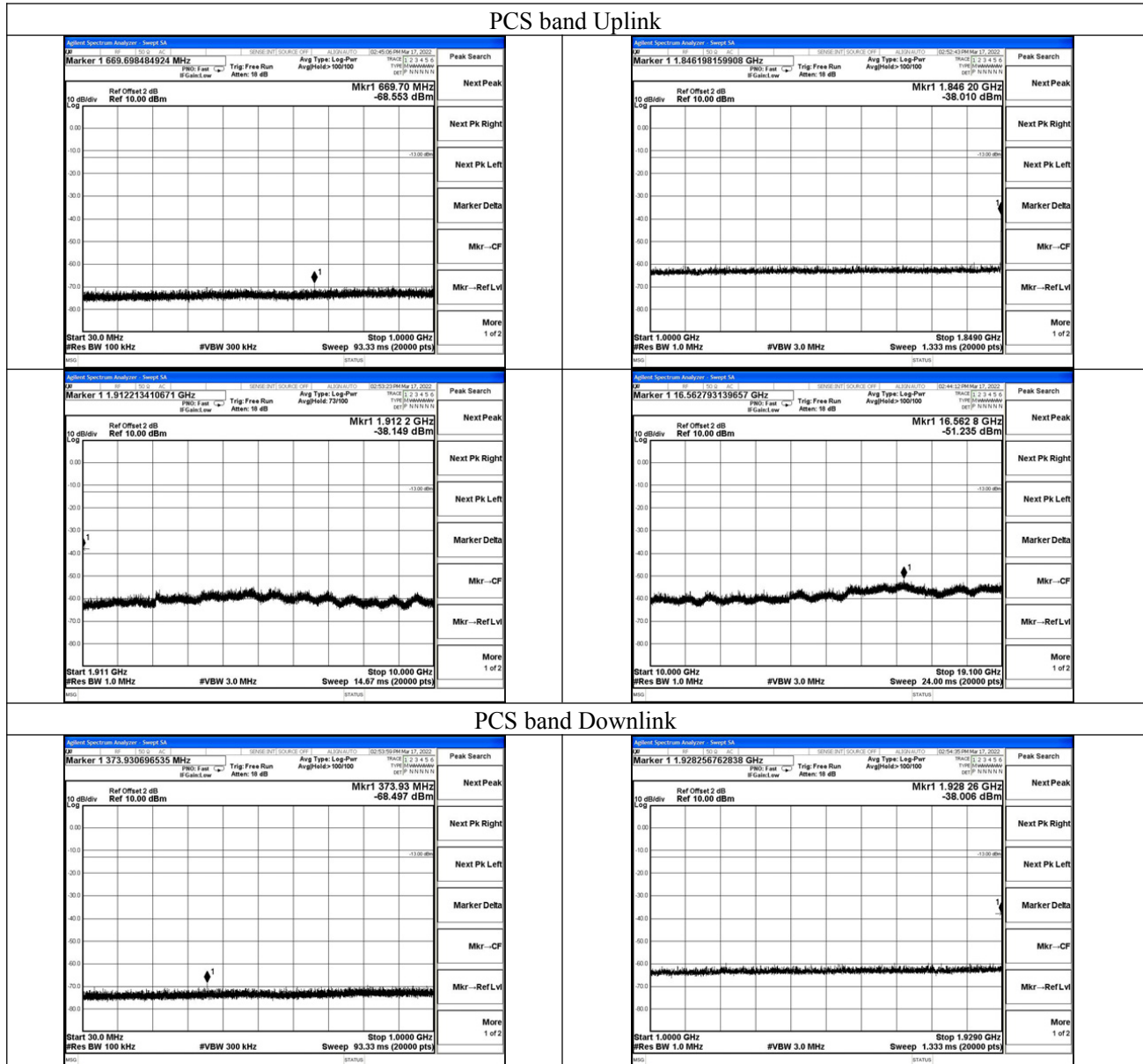


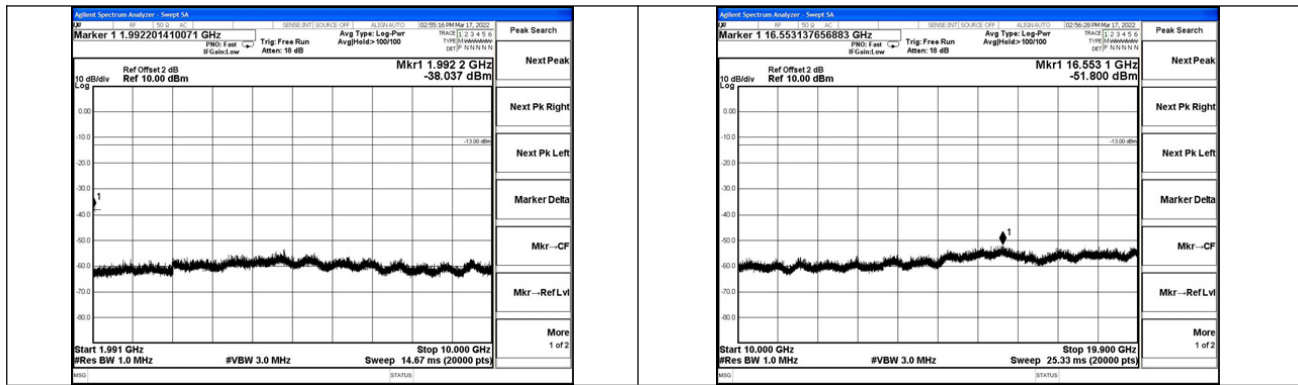
frequency ranges. Record the frequency and amplitude and capture a plot for inclusion in the test report.
e) Repeat 7.6b) through 7.6d) for each supported frequency band of operation.

Test data

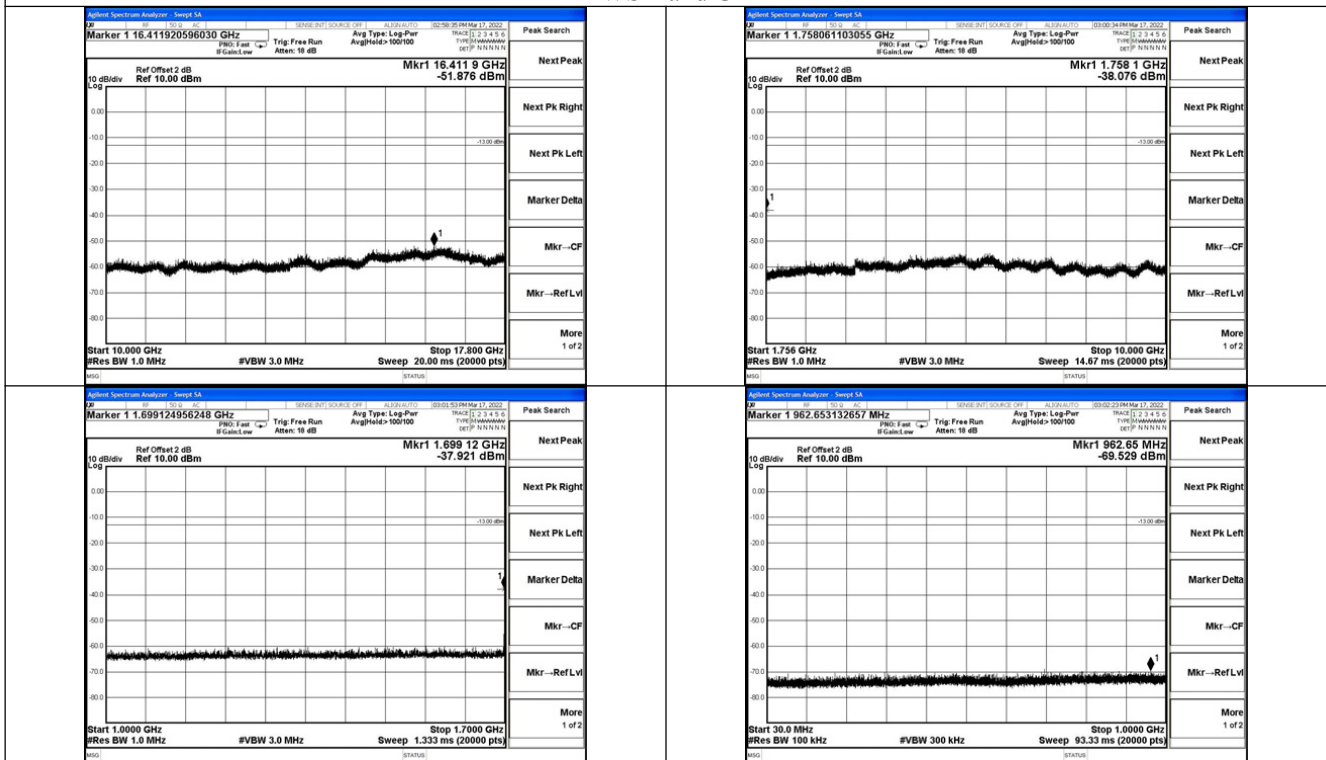
Temperature	23.1°C	Humidity	54.2%
Test Engineer	Ling Zhu	Test Mode	Transmitting

Test Graphs

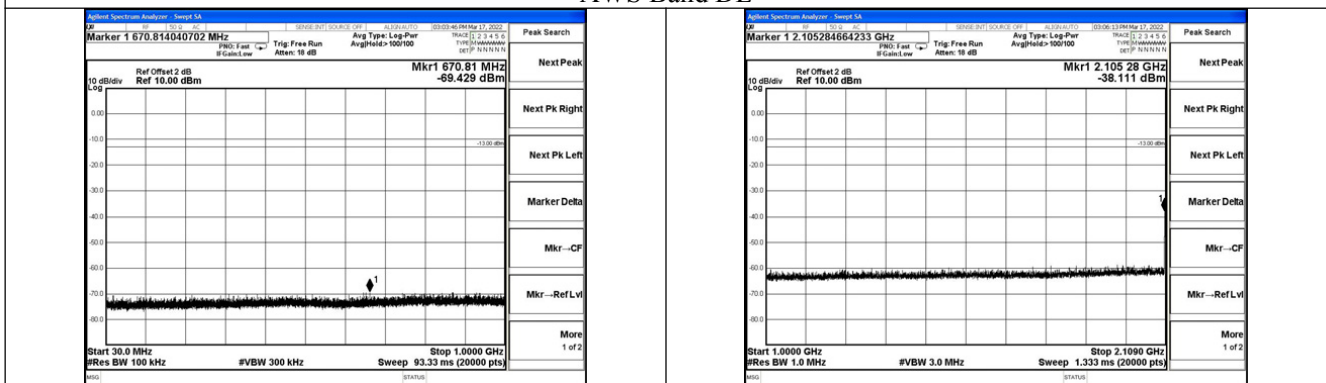


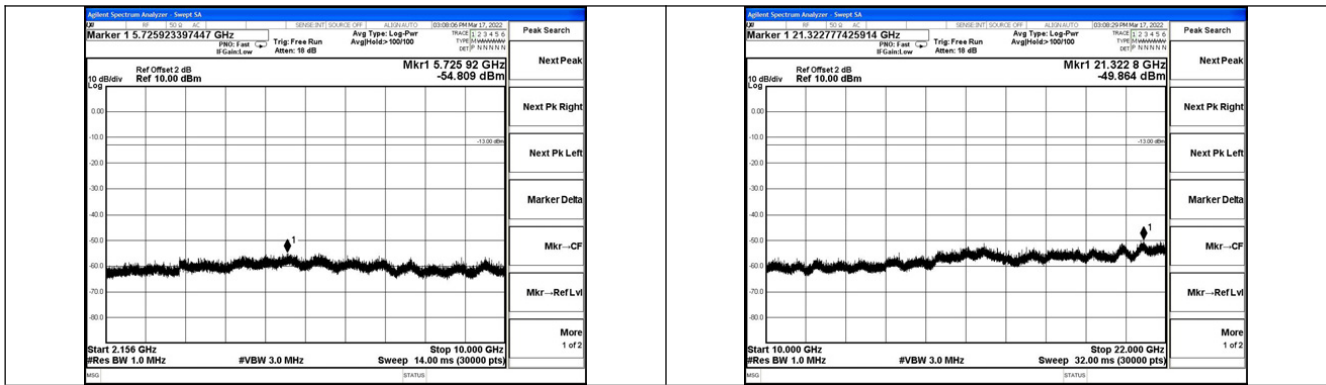


AWS Band UL

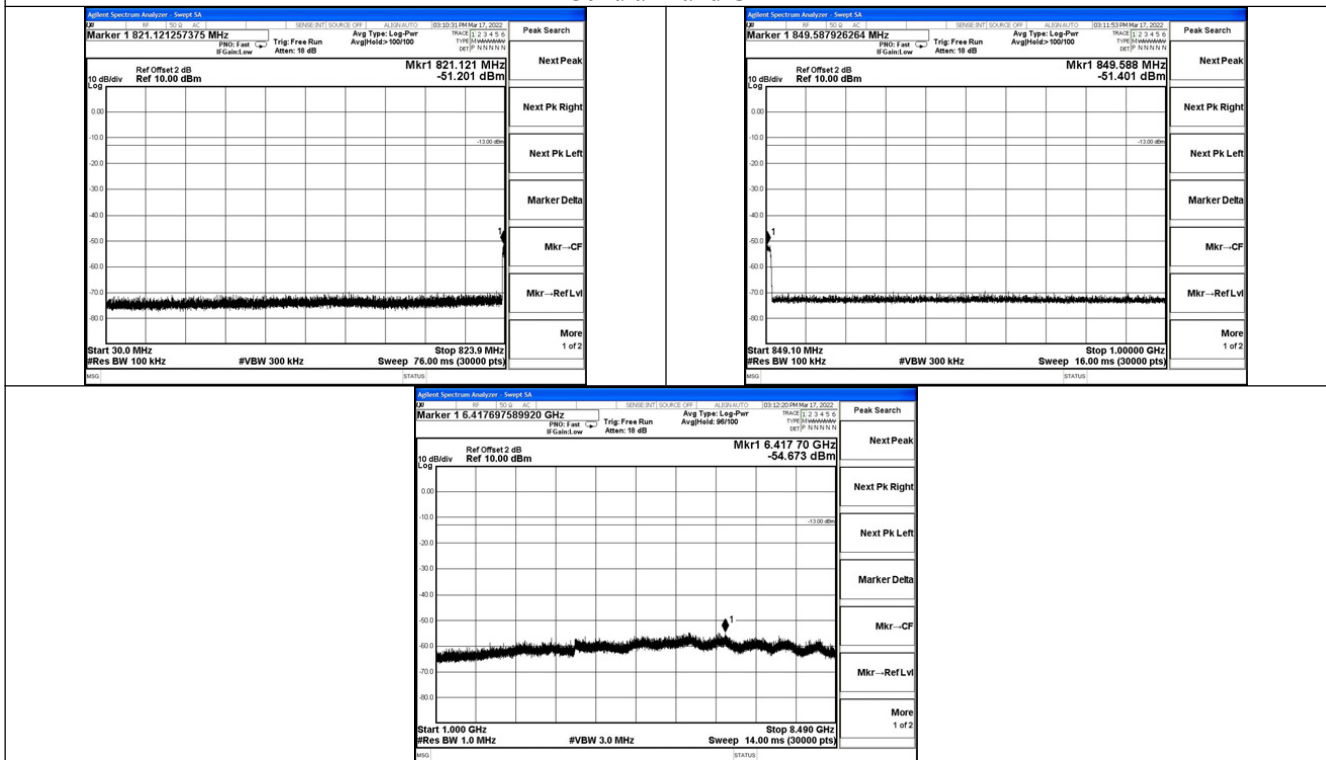


AWS Band DL

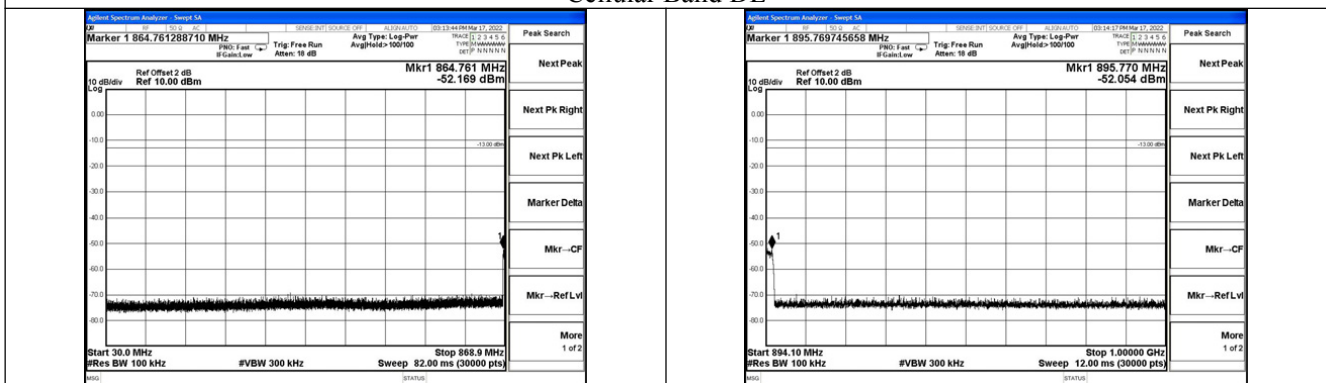


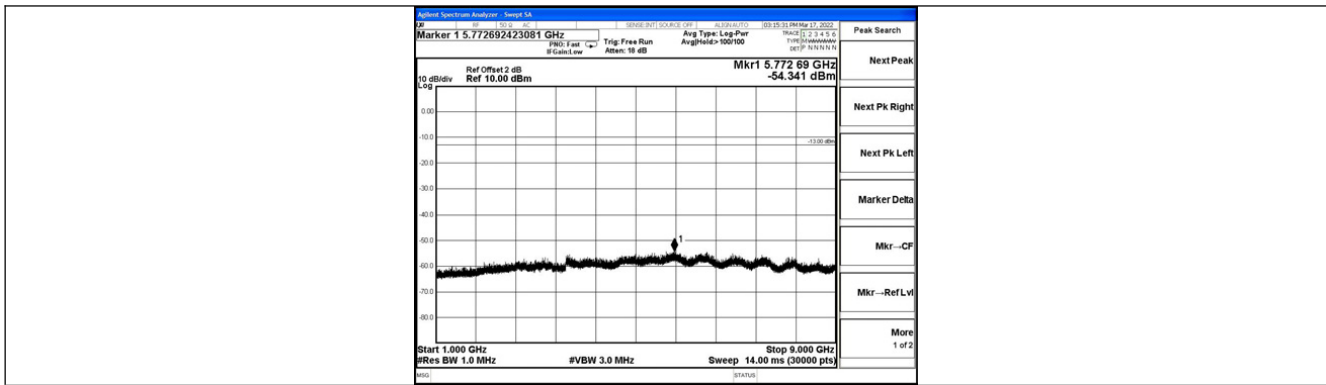


Cellular Band UL

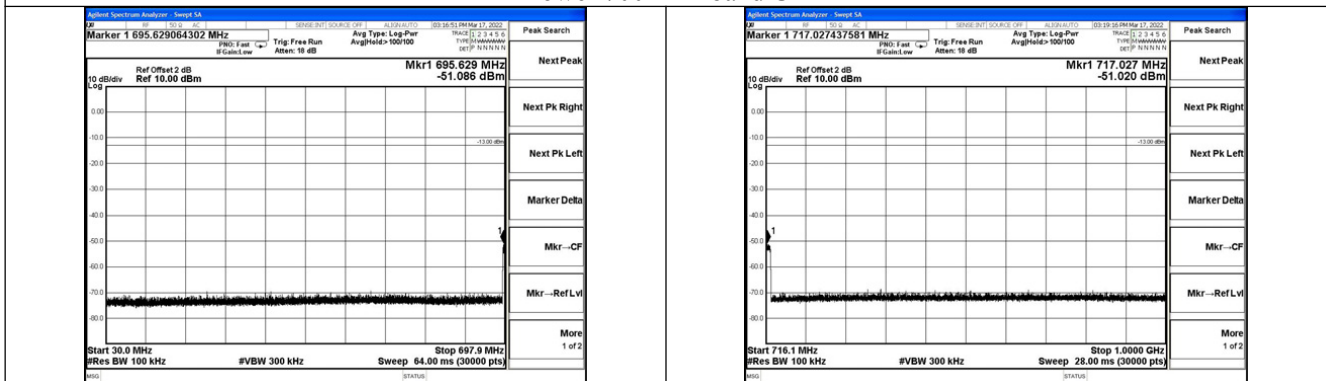


Cellular Band DL

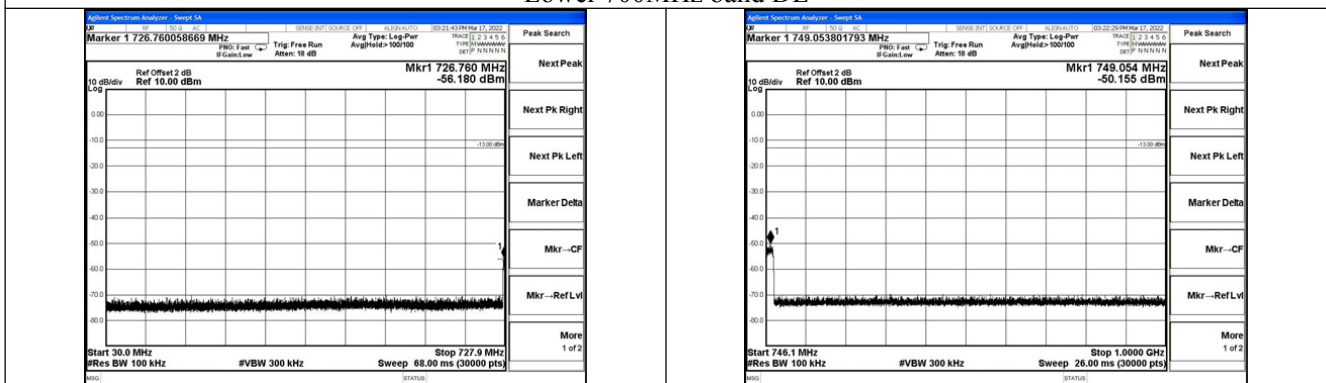


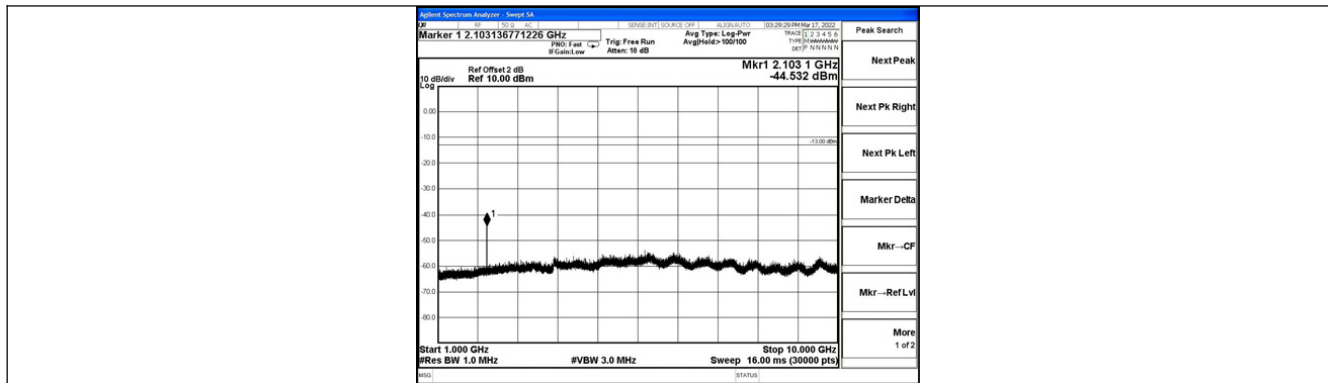


Lower 700MHz band UL

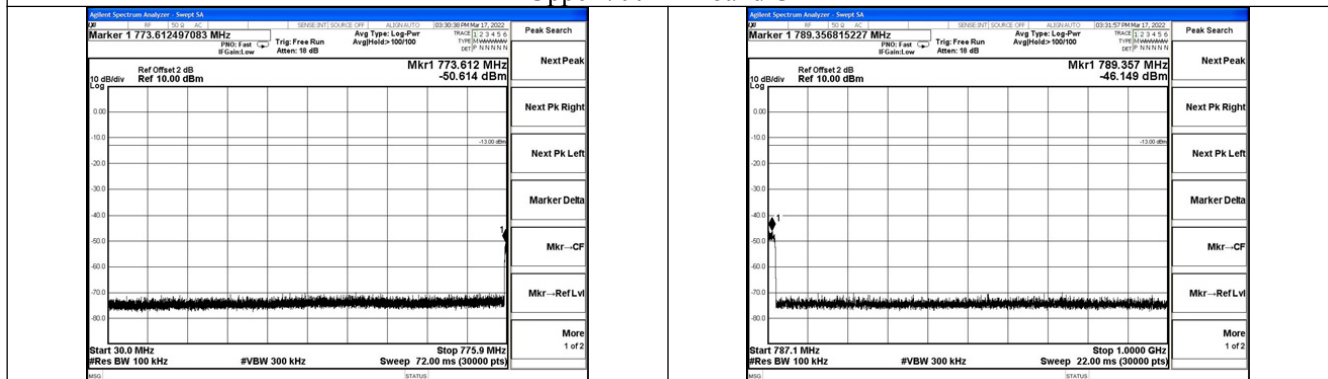


Lower 700MHz band DL

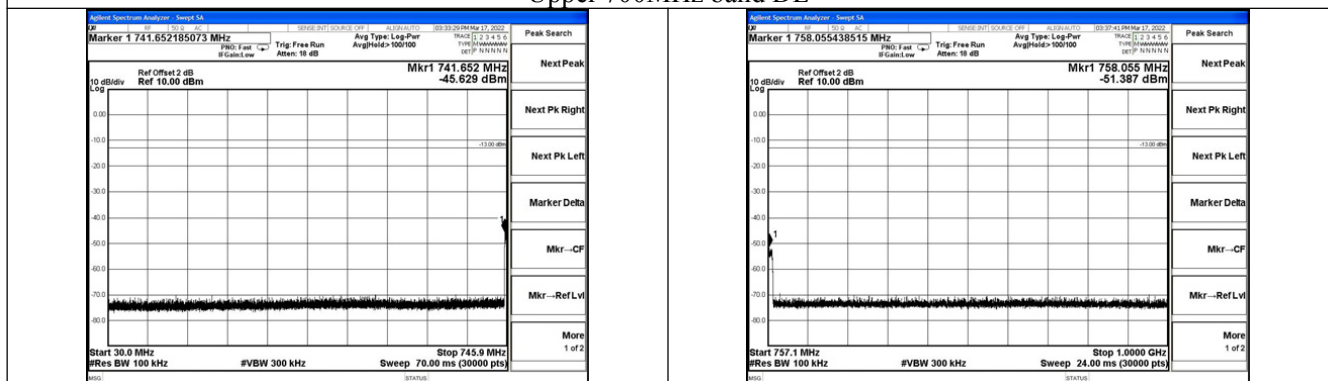


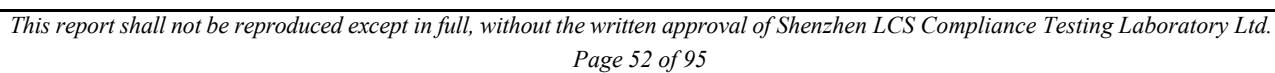
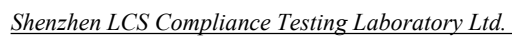


Upper 700MHz band UL



Upper 700MHz band DL







6.7 Noise Limits

Applicable Standard

According to §20.21(e)(8)(i)(A) Noise Limits (uplink); §20.21(e)(8)(i)(H) Transmit Power Off Mode (uplink and downlink noise power):

1. The transmitted maximum noise power in dBm/MHz of consumer boosters at their uplink and downlink ports shall not exceed the following limits:

Fixed booster maximum noise power shall not exceed $-102.5 \text{ dBm/MHz} + 20 \text{ Log}_{10}(\text{Frequency})$, where Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz.

2. The transmitted noise power in dBm/MHz of consumer boosters at their uplink port shall not exceed $-103 \text{ dBm/MHz} - \text{RSSI}$.

Test Procedure

Maximum transmitter noise power level

According to section 7.7.1 of KDB 935210 D03 Signal Booster Measurement v04r04:

- a) Connect the EUT to the test equipment as shown in Figure 3. Begin with the uplink output (donor) port connected to the spectrum analyzer. When measuring downlink noise, connect the downlink output (server) port to the spectrum analyzer.
- b) Set the spectrum analyzer RBW to 1 MHz with the VBW ≥ 3 RBW.
- c) Select the power averaging (rms) detector and trace average over at least 100 traces.
- d) Set the center frequency of the spectrum analyzer to the center of the CMRS band under test with the span ≥ 2 the CMRS band.
- e) Measure the maximum transmitter noise power level.
- f) Save the spectrum analyzer plot as necessary for inclusion in the final test report.
- g) Repeat 7.7b) to 7.7f) for all operational uplink and downlink bands.
- h) Connect the EUT to the test equipment as shown in Figure 4 for uplink noise power measurement in the presence a downlink signal. Affirm the coupled path of the RF coupler is connected to the spectrum analyzer.
 - i) Configure the signal generator for AWGN operation with a 99% OBW of 4.1 MHz.
 - j) Set the spectrum analyzer RBW for 1 MHz, VBW ≥ 3 RBW, with a power averaging (rms) detector with at least 100 trace averages.
 - k) Set the center frequency of the spectrum analyzer to the center of the CMRS band under test, with the span ≥ 2 the CMRS band. This shall include all spectrum blocks in the particular CMRS band under test (see Appendix A).
 - l) For uplink noise measurements, set the spectrum analyzer center frequency for the uplink band under test, and tune the signal generator to the center of the paired downlink band.
 - m) Measure the maximum transmitter noise power level while varying the downlink signal generator output level from -90 dBm to -20 dBm , as measured at the input port (i.e., downlink signal level at the booster donor port node of Figure 4), in 1 dB steps inside the RSSI-dependent region, and in 10 dB steps outside the RSSI-dependent region. Report the six values closest to the limit, with at least two points within the RSSI-dependent region of the limit. See Appendix D for noise limits graphs.
 - n) Repeat 7.7.1h) through 7.7.1m) for all operational uplink bands.

NOTE—Some signal boosters will require a signal generator input because they will not operate unless a signal is received at the input terminals. If this is the case, for the setups shown in Figure 3 and Figure 4 connect a second signal generator at the server port, then cycle the RF output of the second signal generator to simulate this function.

NOTE—Some signal boosters have a maximum transmitter noise power level that is less than the Transmit Power Off Mode of -70 dBm. For these boosters it is still necessary to confirm that the uplink noise power limits are met in the presence of a downlink signal. Test reports should show measurement data demonstrating compliance. Alternatively the applicant may provide attestation with detailed design information and explanation justifying the omission of the variable uplink testing.

Variable uplink noise timing

According to section 7.7.2 of KDB 935210 D03 Signal Booster Measurement v04r04:

Variable uplink noise timing is to be measured as follows, using the test setup shown in Figure 4.

- Set the spectrum analyzer to the uplink frequency to be measured.
- Set the span to 0 Hz, with a sweep time of 10 seconds.
- Set the power level of signal generator to the lowest level of the RSSI-dependent noise [see 7.7.1m)].
- Select MAX HOLD and increase the power level of signal generator by 10 dB for mobile boosters, and 20 dB for fixed boosters.
- Confirm that the uplink noise decreases to the specified level within 1 second for mobile devices, and within 3 seconds for fixed devices.¹⁸
- Repeat 7.7.2a) to 7.7.2e) for all operational uplink bands.
- Include plots and summary table in test report.

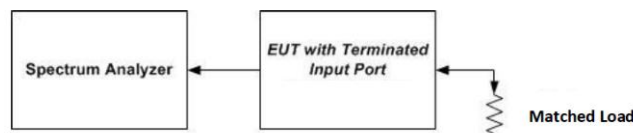


Figure 3 – Noise limit test setup

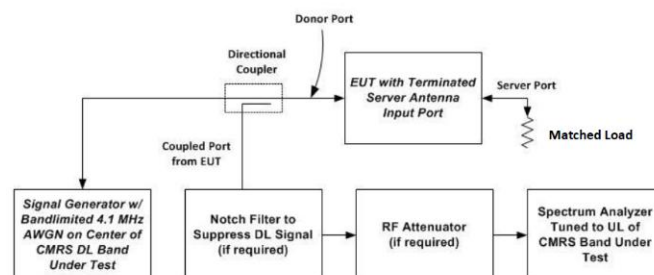


Figure 4 – Test setup for uplink noise power measurement in the presence of a downlink signal

**Test Data**

Temperature	23.1℃	Humidity	54.2%
Test Engineer	Ling Zhu	Test Mode	Transmitting

Max Noise Power			
Frequency Band (MHz)	Measured dBm/MHz	Limit dBm/MHz	Result (dB)
PCS Band Uplink	-47.51	-37.02	PASS
AWS Band Uplink	-42.86	-37.73	PASS
Cellular Band Uplink	-54.07	-44.05	PASS
Lower 700MHz band Uplink	-54.65	-45.51	PASS
Band13 Uplink	-69.70	-44.64	PASS
PCS Band Downlink	-58.04	-37.02	PASS
AWS Band Downlink	-54.18	-37.73	PASS
Cellular Band Downlink	-57.47	-44.05	PASS
Lower 700MHz band Downlink	-55.88	-45.51	PASS
Lower 700MHz band Downlink	-58.78	-44.64	PASS

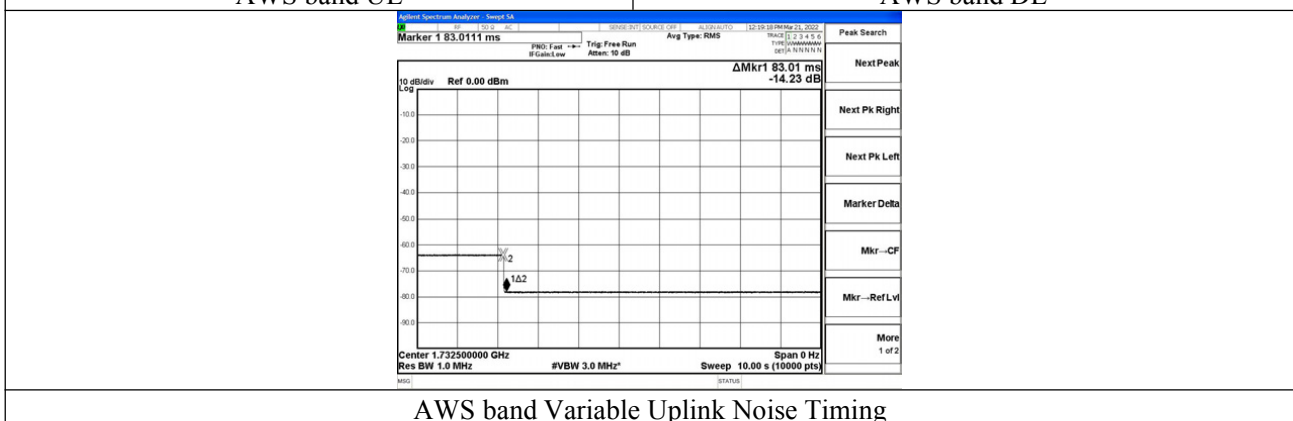
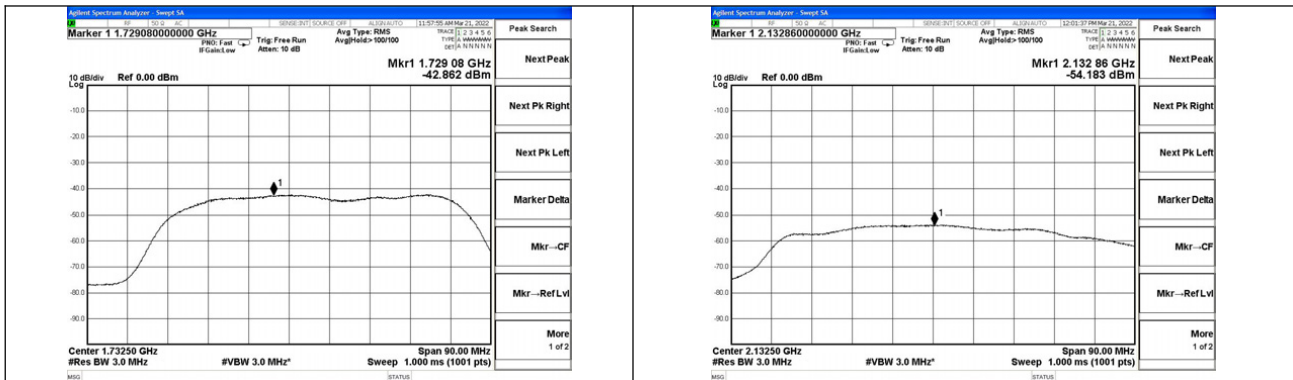
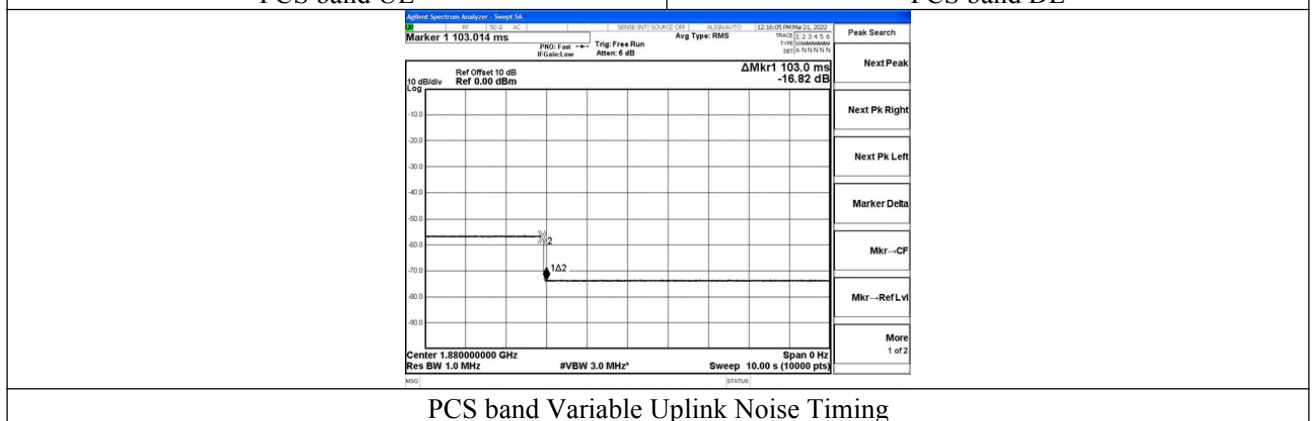
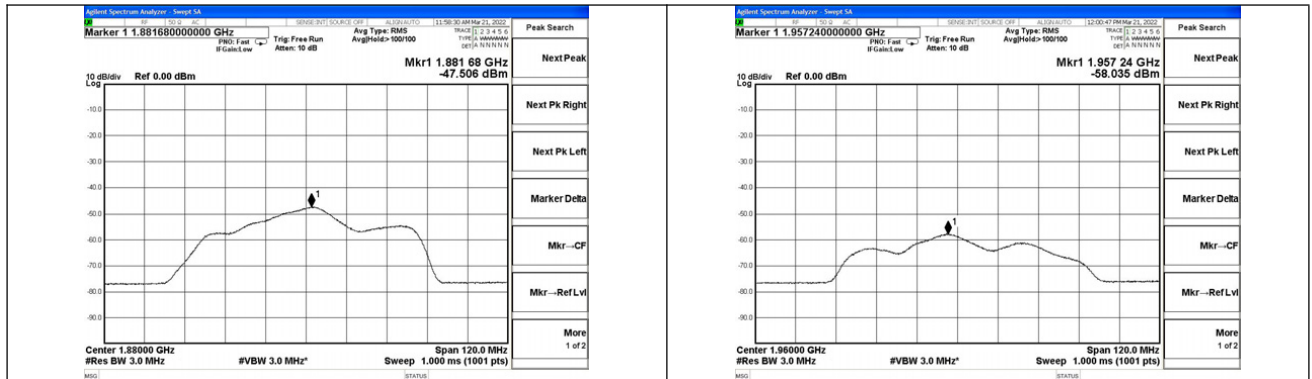


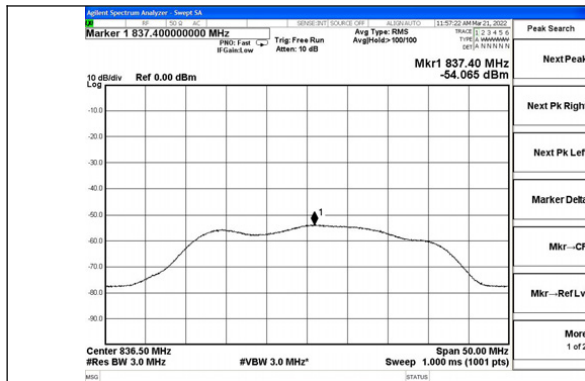
Variable Uplink Noise				
Operation Bands	RSSI dBm	Measured dBm/MHz	Limit dBm/MHz	Results
PCS	-65	-45.31	-38	PASS
	-63	-40.29	-40	PASS
	-53	-55.24	-50	PASS
	-44	-63.25	-59	PASS
	-43	-62.05	-60	PASS
	-42	-66.28	-61	PASS
AWS	-60	-52.00	-43	PASS
	-57	-50.21	-46	PASS
	-48	-51.03	-55	PASS
	-39	-67.14	-64	PASS
	-38	-68.29	-65	PASS
	-36	-70.32	-67	PASS
Cellular	-64	-44.91	-39	PASS
	-60	-45.26	-43	PASS
	-62	-44.26	-41	PASS
	-53	-54.39	-50	PASS
	-51	-55.14	-52	PASS
	-43	-56.32	-60	PASS
Lower 700 MHz	-65	-44.29	-38	PASS
	-55	-50.76	-48	PASS
	-51	-58.46	-52	PASS
	-50	-55.24	-53	PASS
	-44	-63.00	-59	PASS
	-41	-65.81	-62	PASS
Upper 700 MHz	-67	-40.11	-36	PASS
	-55	-52.37	-48	PASS
	-46	-60.25	-57	PASS
	-38	-66.34	-65	PASS
	-37	-67.49	-66	PASS
	-36	-69.64	-67	PASS

Variable Uplink Noise Timing			
Operation Bands	Measured Sec	Limit Sec	Results
PCS	0.103	3	PASS
AWS	0.083	3	PASS
Cellular	0.078	3	PASS
Lower 700	0.101	3	PASS
Upper 700	1.788	3	PASS

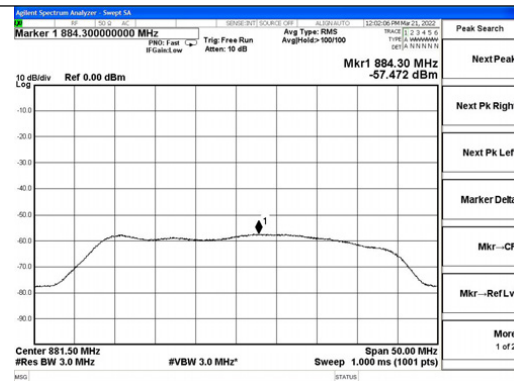


Test Graphs

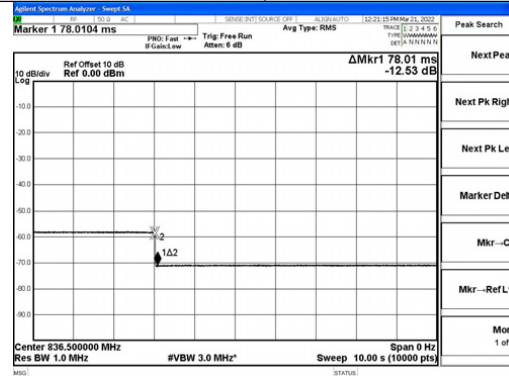




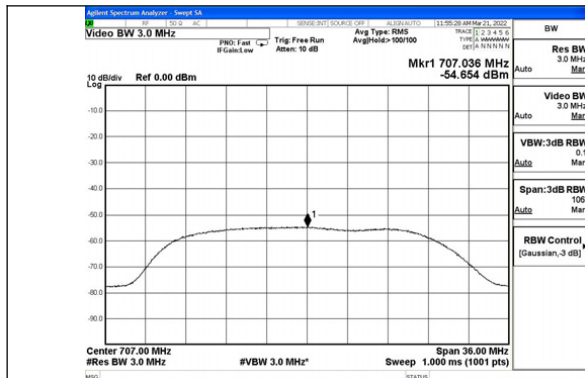
Cellular band UL



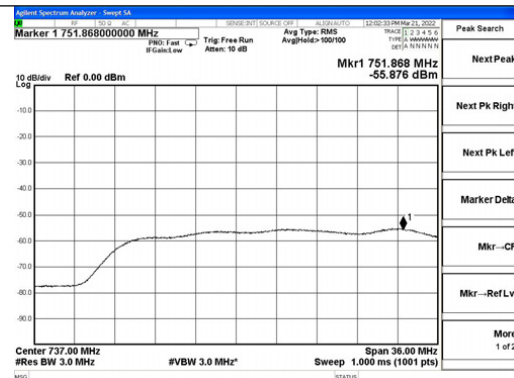
Cellular band DL



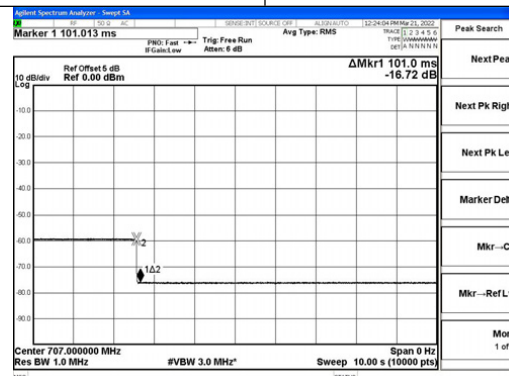
Cellular band Variable Uplink Noise Timing



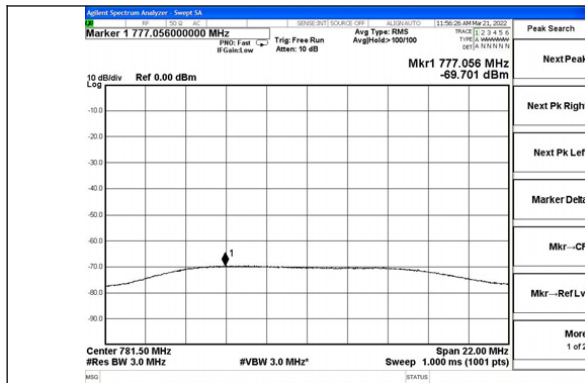
Lower 700MHz band UL



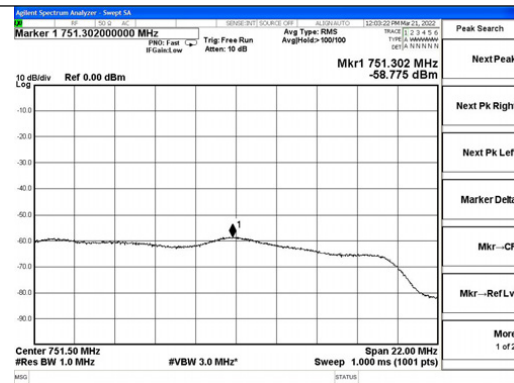
Lower 700MHz band DL



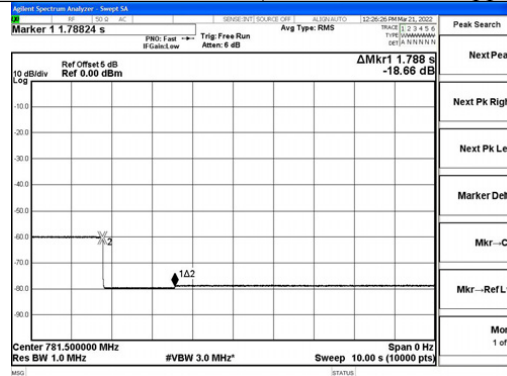
Lower 700MHz band Variable Uplink Noise Timing



Upper 700MHz band UL



Upper 700MHz band DL



Upper 700MHz band Variable Uplink Noise Timing



6.8 Uplink Inactivity

Applicable Standard

According to §20.21(e)(8)(i)(I) Uplink Inactivity:

When a consumer booster is not serving an active device connection after 5 minutes the uplink noise power shall not exceed -70 dBm/MHz.

Test Procedure

According to section 7.8 of KDB 935210 D03 Signal Booster Measurement v04r04:

- a. Connect the EUT to the test equipment as shown in Figure 3 with the uplink output (donor) port connected to the spectrum analyzer.
 - b. Select the power averaging (rms) detector.
 - c. Set the spectrum analyzer RBW for 1 MHz with the $VBW \geq 3$ RBW.
 - d. Set the center frequency of the spectrum analyzer to the center of the uplink operational band.
 - e. Set the span for 0 Hz with a single sweep time for a minimum of 330 seconds.
 - f. Start to capture a new trace using MAX HOLD.
 - g. After approximately 15 seconds, turn on the EUT power.
 - h. After the full spectrum analyzer trace is complete, place a MARKER on the leading edge of the pulse, then use the DELTA MARKER METHOD to measure the time until the uplink becomes inactive.
 - i. Affirm that the noise level is below the uplink inactivity noise power limit, as specified by the rules.
 - j. Capture the plot for inclusion in the test report.
 - k. Measure noise using procedures in 7.7.1a) to 7.7.1f).
- Repeat 7.8d) through 7.8k) for all operational uplink bands.

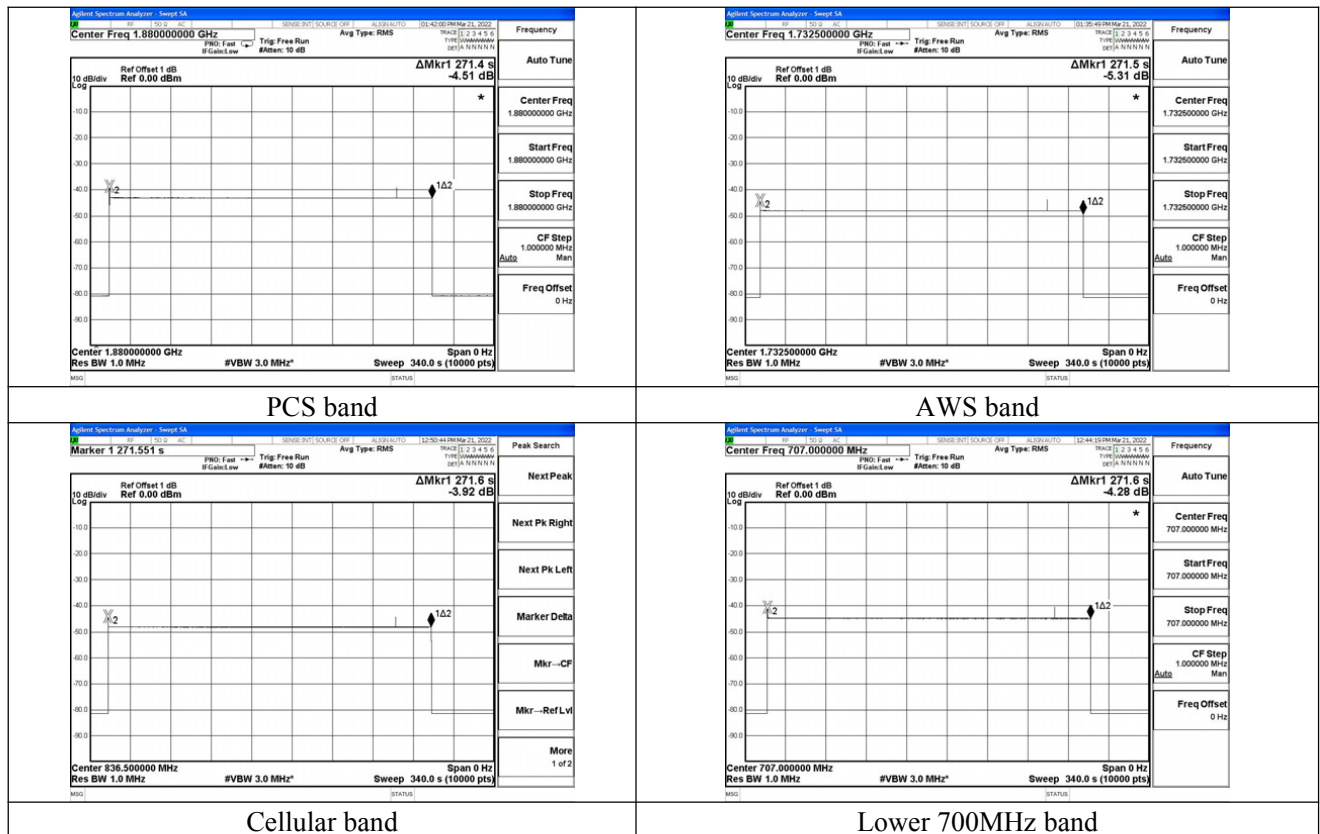


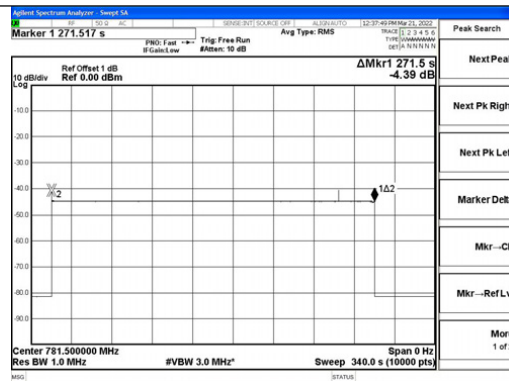
Test Data

Temperature	23.1℃	Humidity	54.2%
Test Engineer	Ling Zhu	Test Mode	Transmitting

Uplink Inactivity			
Operation Bands	Measured (s)	Limit (s)	Result
PCS Band	271.4	300.0	PASS
AWS Band	271.5	300.0	PASS
Cellular Band	271.6	300.0	PASS
Lower 700MHz Band	271.6	300.0	PASS
Upper 700 Mhz Band	271.5	300.0	PASS

Test Graphs





Upper 700MHz band



6.9 Variable Booster Gain

Applicable Standard

According to §20.21(e)(8)(i)(C)(1) Booster Gain Limits (variable gain); §20.21(e)(8)(i)(H) Transmit Power Off Mode (uplink gain):

The uplink gain in dB of a consumer booster referenced to its input and output ports shall not exceed $-34 \text{ dB} - \text{RSSI} + \text{MSCL}$.

(i) Where RSSI is the downlink composite received signal power in dBm at the booster donor port for all base stations in the band of operation. RSSI is expressed in negative dB units relative to 1 mW.

(ii) Where MSCL (Mobile Station Coupling Loss) is the minimum coupling loss in dB between the wireless device and input port of the consumer booster. MSCL must be calculated or measured for each band of operation and provided in compliance test reports.

Test Procedure

Variable gain

According to section 7.9.1 of KDB 935210 D03 Signal Booster Measurement v04r04:

- a) Connect the EUT to the test equipment as shown in Figure 5 with the uplink output (donor) port connected to signal generator #1. Affirm that the coupled path of the RF coupler is connected to the spectrum analyzer.
- b) Configure downlink signal generator #1 for AWGN operation with a 99% OBW 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 that is 5 dB below the AGC level determined from 7.2. The signal type is AWGN with a 99% OBW of 4.1 MHz.
- d) Set RBW = 100 kHz.
- e) Set VBW $\geq$ 300 kHz.
- f) Select the CHANNEL POWER measurement mode.
- g) Select the power averaging (rms) detector.
- h) Affirm that the number of measurement points per sweep $\geq (2 \text{ span})/\text{RBW}$.
- i) Sweep time = auto couple or as necessary (but no less than auto couple value).
- 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 output to a level from -90 dBm to -20 dBm , as measured at the input port (i.e., downlink signal level at the booster donor port node of Figure 5), in 1 dB steps inside the RSSI-dependent region, and 10 dB steps outside the RSSI-dependent region. Report the six values closest to the limit, including at least two points from within the RSSI-dependent region of operation. See gain limit in charts in Appendix D for uplink gain requirements. Additionally, document that the EUT provides equivalent uplink and downlink gain, and when operating in shutoff mode that the uplink and downlink gain is within the transmit power off mode gain limits.
- l) Repeat 7.9.1b) to 7.9.1k) for all operational uplink bands.

Variable uplink gain timing

According to section 7.9.2 of KDB 935210 D03 Signal Booster Measurement v04r04:

Variable uplink gain timing is to be measured as follows, using the test setup shown in Figure 5.

- Set the spectrum analyzer to the uplink frequency to be measured.
- Set the span to 0 Hz with a sweep time of 10 seconds.
- Set the power level of signal generator #1 to the lowest level of the RSSI-dependent gain [see 7.9.1k)].
- Select MAX HOLD and increase the power level of signal generator #1 by 10 dB for mobile boosters, and by 20 dB for fixed indoor boosters. Signal generator #2 remains same, as described in 7.9.1c).
- Confirm that the uplink gain decreases to the specified levels, within 1 second for mobile devices, and within 3 seconds for fixed devices.19
- Repeat 7.9.2a) to 7.9.2e) for all operational uplink bands.

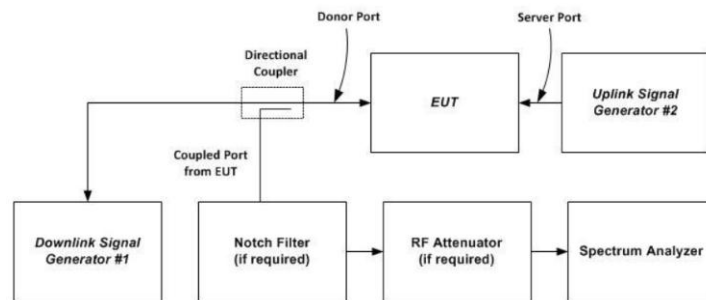


Figure 5—Variable gain instrumentation test setup

Mobile station coupling loss (MSCL): the minimum coupling loss (in dB) between the wireless device and the input (server) port of the consumer booster. MSCL must be calculated or measured for each band of operation and provided in compliance test reports. MSCL includes the path loss from the wireless device, and the booster's server antenna gain and cable loss. The wireless device is assumed to be an isotropic (0 dBi) antenna reference. Minimum standoff distances from inside wireless devices to the booster's server antenna must be reasonable and specified by the manufacturer in customer provided installation manuals.

**Test data**

Temperature	23.1℃	Humidity	54.2%
Test Engineer	Ling Zhu	Test Mode	Transmitting

MSCL Calculation							
Operation Frequency (MHz)	Frequency (MHz)	Distance (m)	Path loss (dB)	Indoor Antenna Gain(dBi)	Indoor Cable Loss(dB)	Polarity Loss(dB)	MSCL(dB)
PCS band	1850	2	43.8	8.5	2.55	3	40.85
Cellular band	824	2	36.8	7	2.29	3	35.09
Lower 700MHz band	698	2	35.3	7	2.19	3	33.49
Upper 700MHz band	776	2	36.3	7	2.19	3	34.49
AWS band	1710	2	43.1	8.5	2.42	3	40.02

Note :Path loss = $20\log f + 20\log d - 27.5$

Polarity loss = $20\log (1/\sin (45\deg))$ dB = 3.0dB



Variable booster gain							
Operation Band	RSSI (dBm)	Input Power (dBm)	Output Power (dBm)	Measured Gain (dB)	MSCL	Limit	Results
PCS band	-60	-49.2	2.16	51.36	40.85		PASS
	-50	-49.3	0.96	50.26	40.85		PASS
	-46	-49.3	0.01	49.31	40.85		PASS
	-43	-49.3	-0.69	48.61	40.85		PASS
	-42	-49.3	-2.05	47.25	40.85		PASS
	-40	-49.3	-4.92	44.38	40.85		PASS
	-70	-45.1	5.02	50.12	35.09		PASS
	-65	-45.1	12.51	57.61	35.09		PASS
Cellular band	-57	-45.1	10.29	55.39	35.09		PASS
	-40	-45.1	-6.89	38.21	35.09		PASS



	-44	-45.1	-4.74	40.36	35.09		PASS
	-41	-45.1	-4.08	41.02	35.09		PASS
Lower 700MHz band	-50	-44.3	2.05	46.35	33.49		PASS
	-49	-44.3	3.95	48.25	33.49		PASS
	-46	-44.3	-1.04	43.26	33.49		PASS
	-44	-44.3	-4.15	40.15	33.49		PASS
	-43	-44.3	-2.22	42.08	33.49		PASS
	-41	-44.3	-6.86	37.44	33.49		PASS
	-49	-44.6	1.08	45.68	34.49		PASS
	-47	-44.6	-1.69	42.91	34.49		PASS
Upper 700MHz band	-46	-44.6	1.98	46.58	34.49		PASS

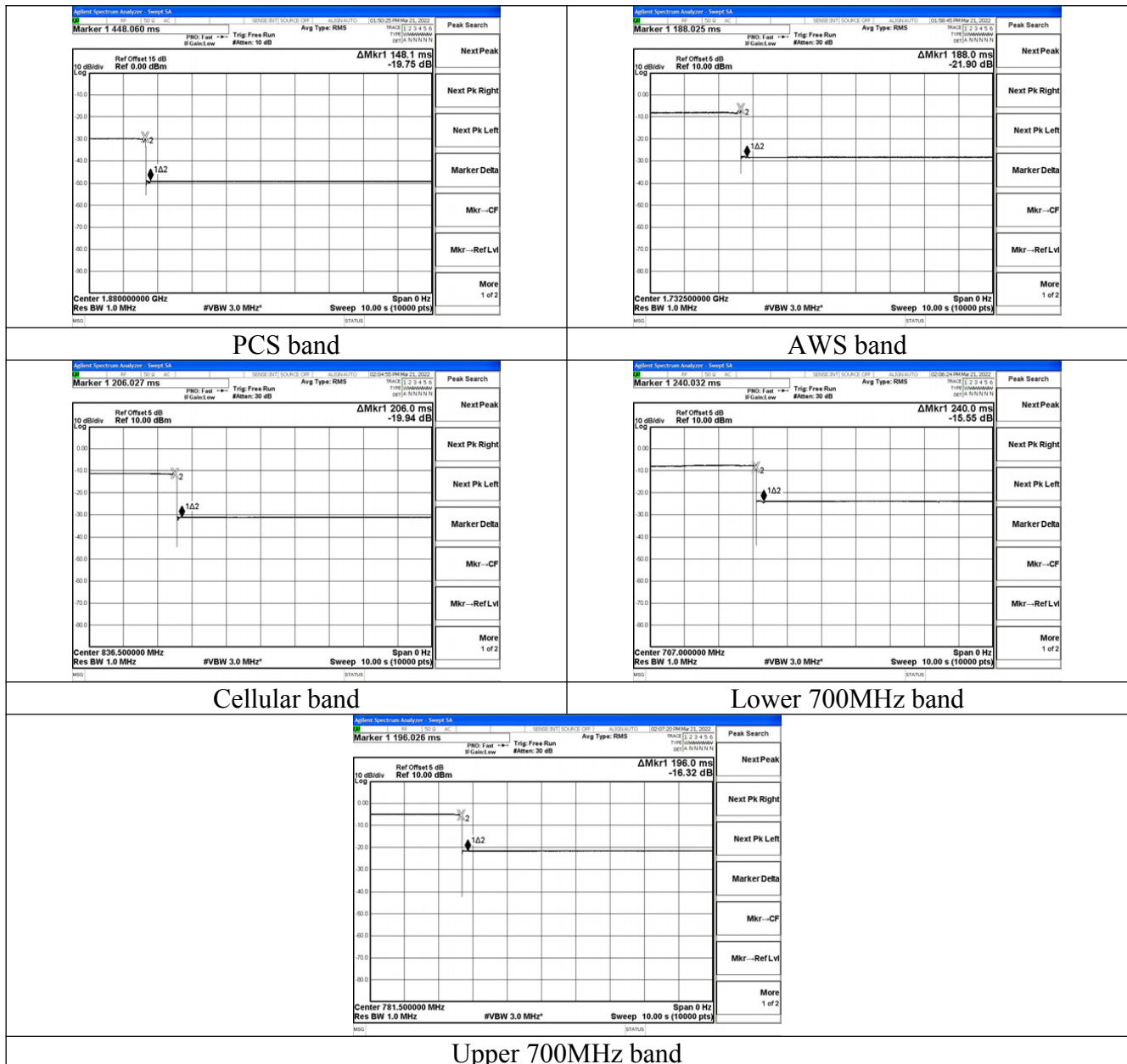


	-44	-44.6	-3.34	41.26	34.49		PASS
	-43	-44.6	-1.59	43.01	34.49		PASS
	-40	-44.6	-4.39	40.21	34.49		PASS
AWS band	-60	-47.3	2.05	49.35	40.02		PASS
	-50	-47.3	0.02	47.32	40.02		PASS
	-47	-47.3	-0.31	46.99	40.02		PASS
	-45	-47.3	-2.09	45.21	40.02		PASS
	-43	-47.3	-4.12	43.18	40.02		PASS
	-42	-47.3	-3.28	44.02	40.02		PASS



Variable Uplink Gain Timing			
Operation Band	Measured Sec	Limit Sec	Result
PCS band	0.148	3.0	PASS
AWS band	0.188	3.0	PASS
Cellular band	0.206	3.0	PASS
Lower 700MHz band	0.240	3.0	PASS
Upper 700MHz band	0.196	3.0	PASS

Test Graphs



6.10 Occupied Bandwidth

Applicable Standard

According to §2.1049 Measurements required: Occupied bandwidth.

This measurement is required to compare the consistency of the output signal relative to the input signal, and to satisfy the requirements of Section 2.1049.

Test Procedure

According to section 7.10 of KDB 935210 D03 Signal Booster Measurement v04r04:

- a) Connect the test equipment as shown in Figure 6 to firstly measure the characteristics of the test signals produced by the signal generator.
- b) Set $VBW \geq 3$ 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 OBW as necessary for accurately viewing the signals.
- d) Set the signal generator for power level to match the values obtained from the tests of 7.2.
- e) Set the signal generator modulation type for GSM with a PRBS 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 EBW.
- g) Capture the spectrum analyzer trace for inclusion in the test report.
- h) Repeat 7.10c) to 7.10g) for CDMA and W-CDMA modulation, adjusting the span as necessary. AWGN or LTE may be used in place of W-CDMA, as an option.
- i) Repeat 7.10c) to 7.10h) for all uplink and downlink operational bands.
- j) Connect the test equipment as shown in Figure 1, with the uplink output (donor) port connected to the spectrum analyzer, and the server port connected to the signal generator.
- k) Repeat 7.10c) to 7.10i) with this EUT uplink path test setup.
- l) Connect the test equipment as shown in Figure 1, with the downlink output (server) port connected to the spectrum analyzer, and the donor port connected to the signal generator.
- m) Repeat 7.10c) to 7.10i) with this EUT downlink path test setup.

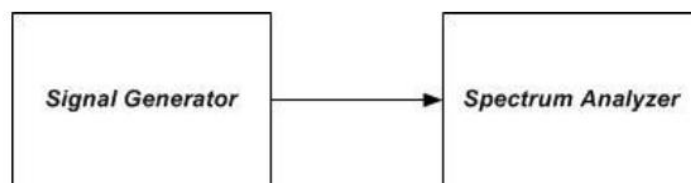


Figure 6 – Test setup for measuring characteristics of test signals used for subsequent EUT occupied bandwidth testing

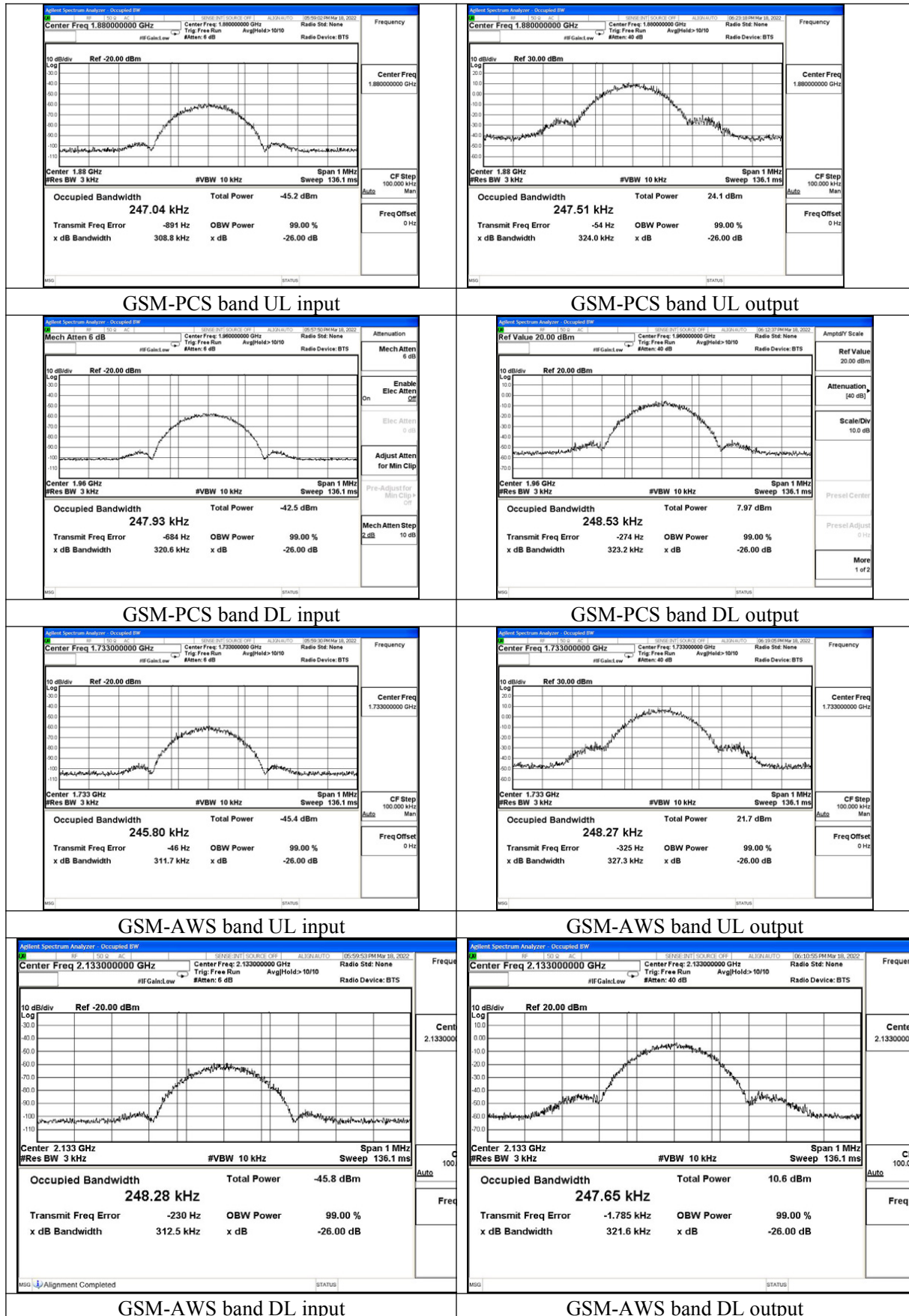
**Test data**

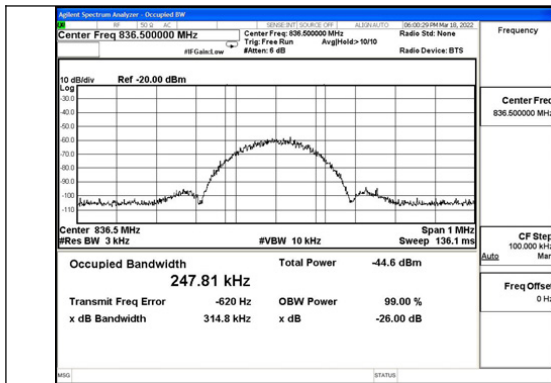
Temperature	23.1℃	Humidity	54.2%
Test Engineer	Ling Zhu	Test Mode	Transmitting

Operation Band		Signal Type	Input OBW [MHz]	Output OBW [MHz]
Uplink	PCS	GSM	0.247	0.248
		CDMA	1.252	1.252
		AWGN	4.558	4.543
	AWS	GSM	0.246	0.248
		CDMA	1.252	1.257
		AWGN	4.566	4.583
	Cellular	GSM	0.248	0.245
		CDMA	1.258	1.248
		AWGN	4.537	4.550
	Lower 700	GSM	0.249	0.248
		CDMA	1.251	1.253
		AWGN	4.535	4.569
	Upper 700	GSM	0.237	0.246
		CDMA	1.254	1.250
		AWGN	4.560	4.580
Downlink	PCS	GSM	0.248	0.249
		CDMA	1.264	1.250
		AWGN	4.565	4.501
	AWS	GSM	0.248	0.248
		CDMA	1.260	1.260
		AWGN	4.580	4.501
	Cellular	GSM	0.247	0.246
		CDMA	1.250	1.260
		AWGN	4.532	4.513
	Lower 700	GSM	0.249	0.248
		CDMA	1.258	1.257
		AWGN	4.532	4.544
	Upper 700	GSM	0.246	0.246
		CDMA	1.253	1.254
		AWGN	4.507	4.531

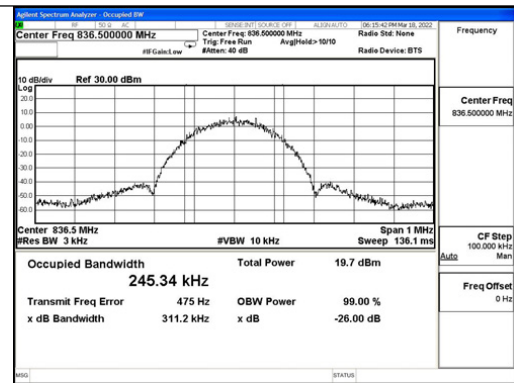


Test Graphs

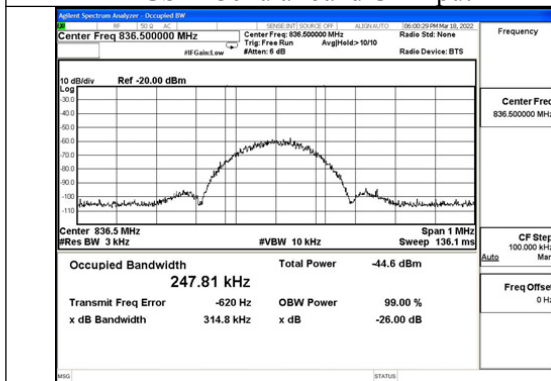




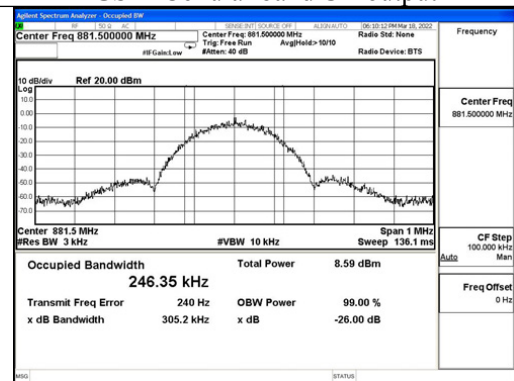
GSM-Cellular band UL input



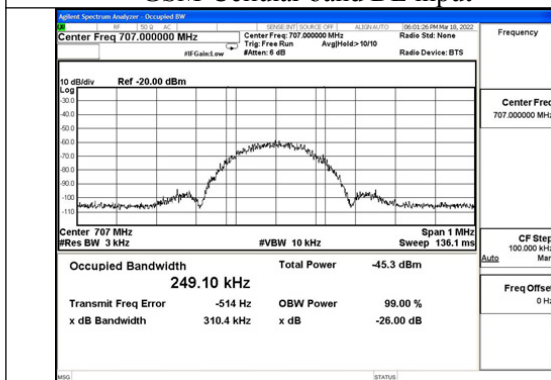
GSM-Cellular band UL output



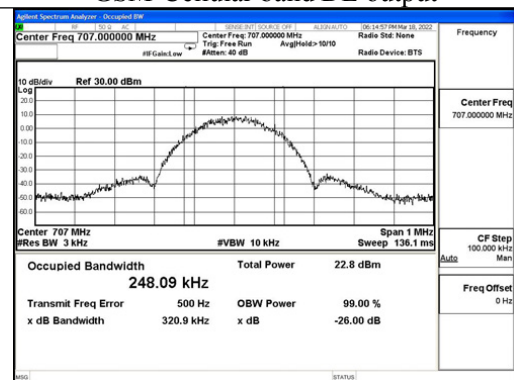
GSM-Cellular band DL input



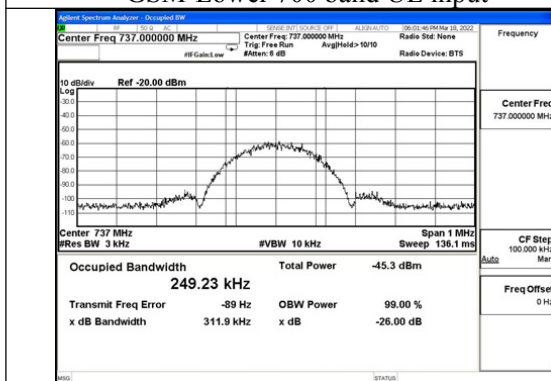
GSM-Cellular band DL output



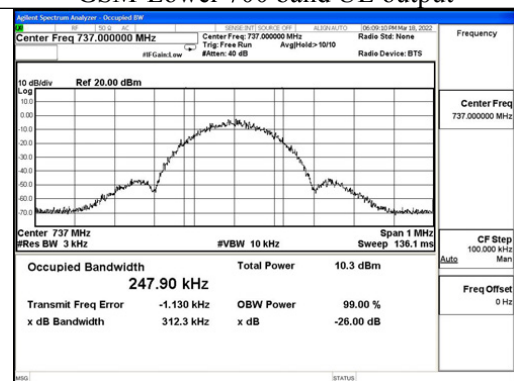
GSM-Lower 700 band UL input



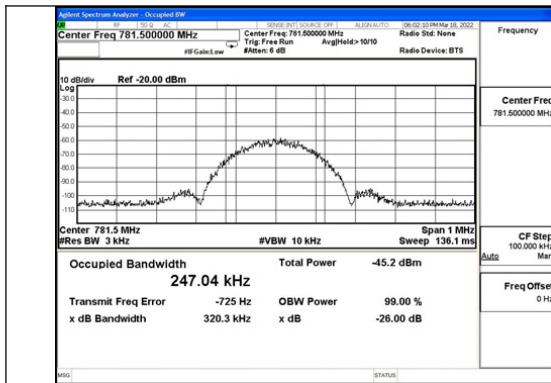
GSM-Lower 700 band UL output



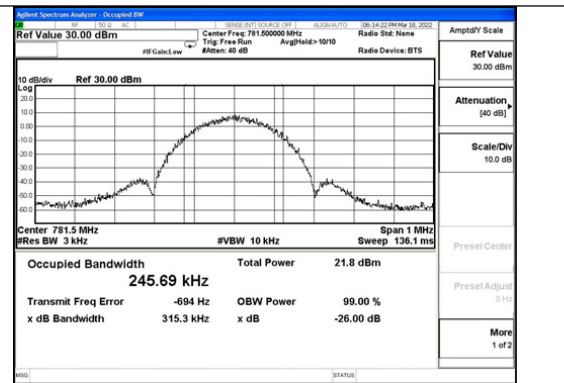
GSM-Lower 700 band DL input



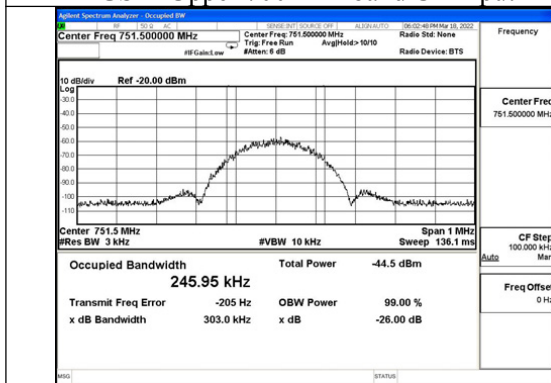
GSM-Lower 700 band DL output



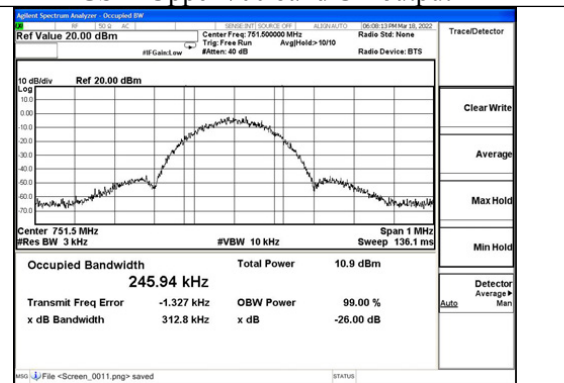
GSM-Upper 700MHz band UL input



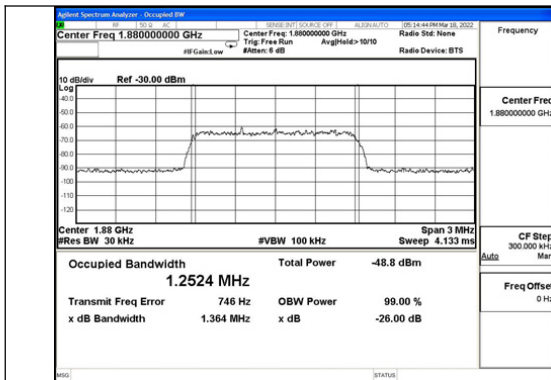
GSM-Upper 700 band UL output



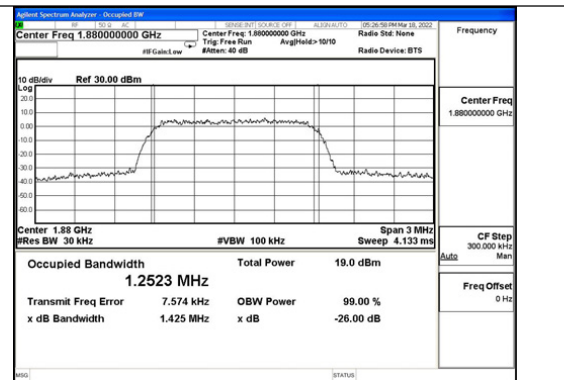
GSM-Upper 700 band DL input



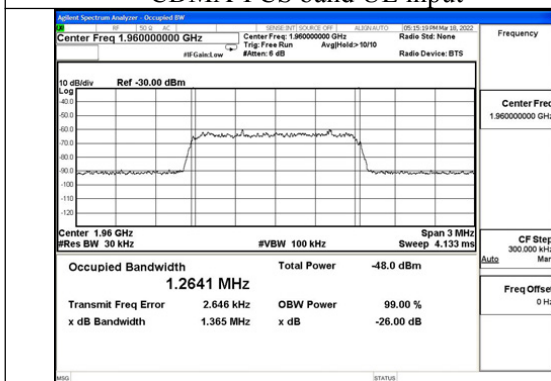
GSM-Upper 700 band DL output



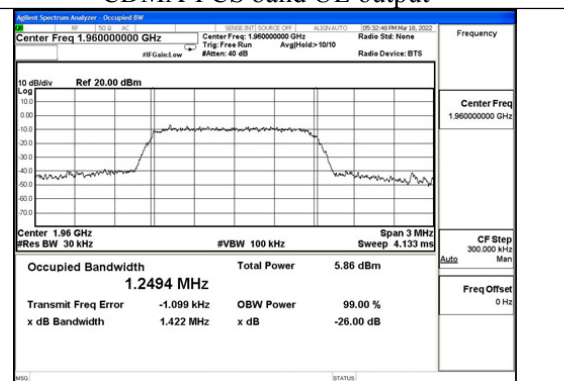
CDMA-PCS band UL input



CDMA-PCS band UL output



CDMA-PCS band DL input



CDMA-PCS band DL output