

## Upper700MHz GSM DL Left Side Pre AGC



## Upper700MHz GSM DL Left Side Pre AGC+10dB



## Upper700MHz GSM DL Right Side Pre AGC



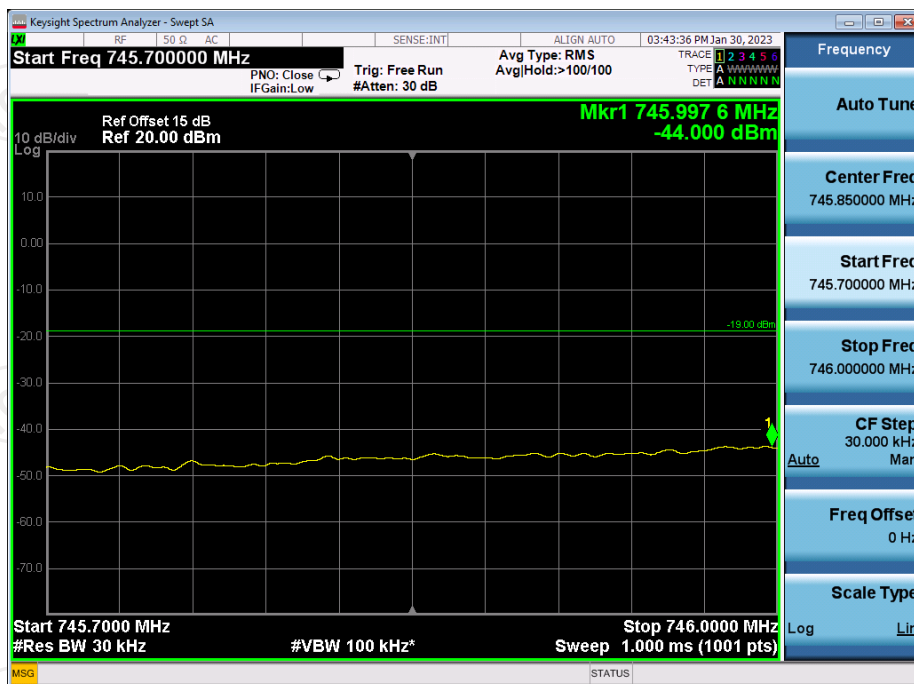
## Upper700MHz GSM DL Right Side Pre AGC+10dB



## Upper700MHz CDMA DL Left Side Pre AGC



## Upper700MHz CDMA DL Left Side Pre AGC+10dB



## Upper700MHz CDMA DL Right Side Pre AGC



## Upper700MHz CDMA DL Right Side Pre AGC+10dB



## Upper700MHz LTE DL Left Side Pre AGC



## Upper700MHz LTE DL Left Side Pre AGC+10dB



## Upper700MHz LTE DL Right Side Pre AGC

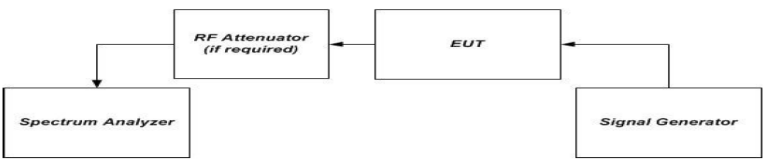


## Upper700MHz LTE DL Right Side Pre AGC+10dB



## 5.5. Conducted Spurious Emission

### 5.5.1. Test Specification

|                          |   |
|--------------------------|---|
| <b>Test Requirement:</b> | FCC Part2 Section 1051; FCC Rules Part 27 Subpart C, Section 27.53  |
| <b>Test Method:</b>      | KDB 935210 D03 Signal Booster Measurements v04r04   |
| <b>Limit:</b>            | <p>-13 dBm;</p> <p>For equipment operating in the frequency bands 746-756 MHz and 777-787 MHz, The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:</p> <p>(i) <math>76 + 10 \log_{10} p</math> (watts), dB, for base and fixed equipment, and</p> <p>(ii) <math>65 + 10 \log_{10} p</math> (watts), dB, for mobile and portable equipment.</p>   |
| <b>Test Setup:</b>       |  <pre> graph LR     SG[Signal Generator] --&gt; EUT[EUT]     EUT --&gt; RA[RF Attenuator (if required)]     RA --&gt; SA[Spectrum Analyzer] </pre>   |
| <b>Test Procedure:</b>   | <p>a) Connect the EUT to the test equipment as shown in Set-Up. Begin with the uplink output connected to the spectrum analyzer.</p> <p>b) Configure the signal generator for AWGN with a 99% occupied bandwidth of 4.1 MHz operation with a center frequency corresponding to the center of the CMRS band under test.</p> <p>c) Set the signal generator amplitude to the level determined in the power measurement procedure in Maximum power.</p> <p>d) Turn on the signal generator RF output and measure the spurious emission power levels with an appropriate measurement instrument as follows.</p> <p>e) Set RBW = measurement bandwidth specified in the applicable rule section for the operational frequency band under consideration (see Annex A for relevant cross-references). Note that many of the individual rule sections permit the use of a narrower RBW (typically <math>\geq 1\%</math> of the emission bandwidth) to enhance measurement accuracy, but the result must then be integrated over the specified measurement bandwidth.</p> <p>f) Set VBW = 3 X RBW.</p> <p>g) Select the power averaging (RMS) detector. (See above note regarding the use of a peak detector for preliminary measurements.)</p> <p>h) Sweep time = auto-couple.</p> <p>i) Set the analyzer start frequency to the lowest radio frequency signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part. Note that the number of measurement points in each sweep must be <math>\geq (2 \times \text{span}/\text{RBW})</math> which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer. Trace average at least 10 traces in power averaging (i.e., RMS) mode.</p> |



|                     |  |
|---------------------|--|
|                     | <p>j) Use the peak marker function to identify the highest amplitude level over each measured frequency range Record the frequency and amplitude and capture a Test Plots for inclusion in the test report.</p> <p>k) Reset the analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the analyzer stop frequency to 10 times the highest frequency of the fundamental emission. Note that the number of measurement points in each sweep must be <math>\geq (2 \times \text{span/RBW})</math> which may require that the measurement range defined by the start and stop frequencies above be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.</p> <p>l) Use the peak marker function to identify the highest amplitude level over each of the measured frequency ranges. Record the frequency and amplitude and capture a Test Plots for inclusion in the test report.</p> <p>m) Repeat steps b) through l) for each supported frequency band of operation.</p> |
| <b>Test Result:</b> | PASS   |

## 5.5.2. Test Instruments

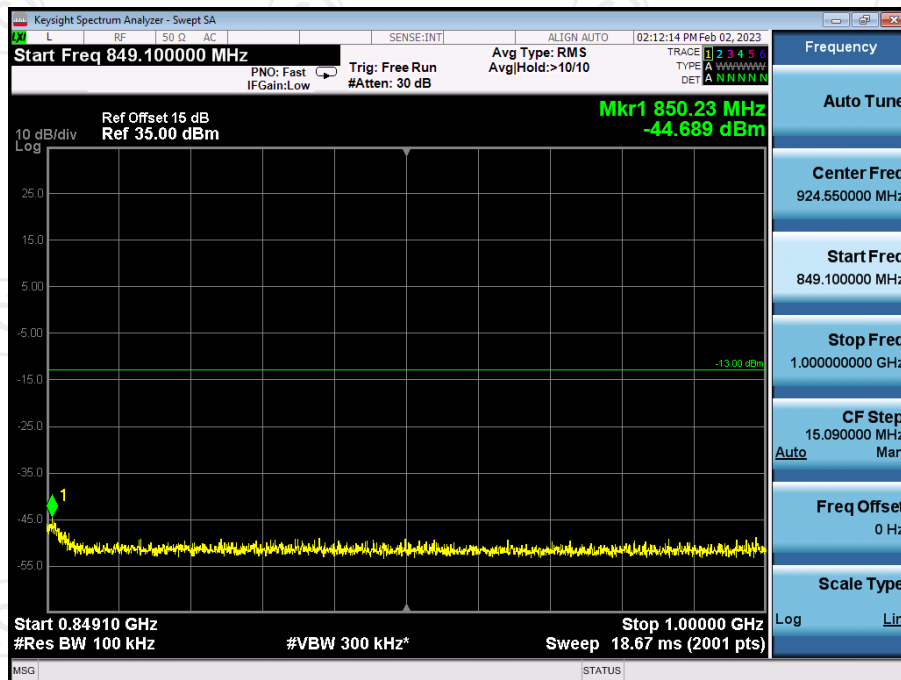
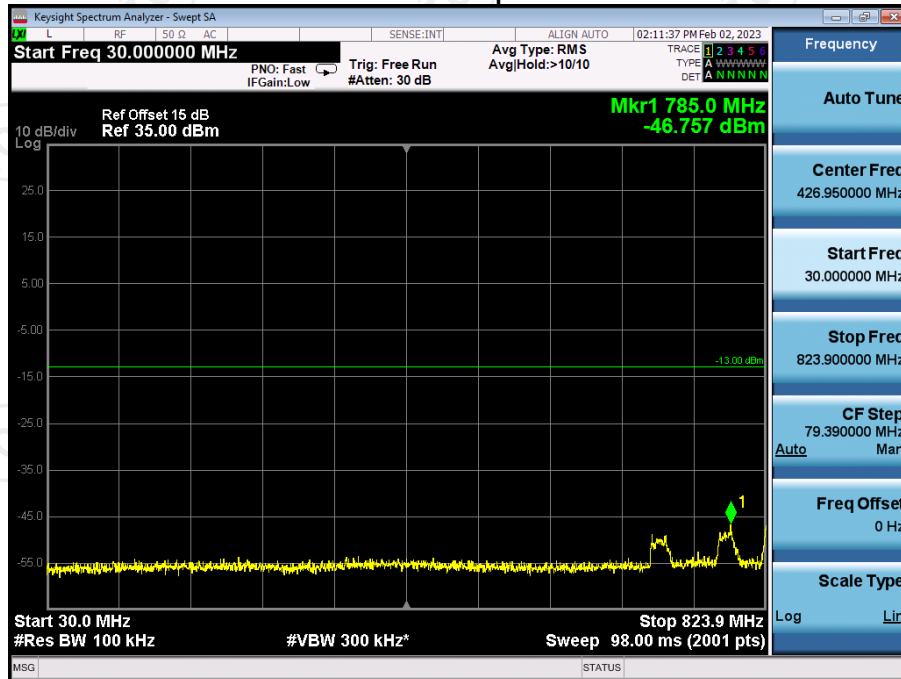
| Equipment         | Manufacturer | Model  | Serial Number | Calibration Date | Calibration Due |
|-------------------|--------------|--------|---------------|------------------|-----------------|
| Signal Generator  | Agilent      | N5182A | MY47070282    | Jul. 04, 2022    | Jul. 03, 2023   |
| Spectrum Analyzer | Agilent      | N9020A | MY49100619    | Jul. 05, 2022    | Jul. 04, 2023   |
| Attenuator        | 50FP-006-H3  | JFW    | 907763        | /                | /               |

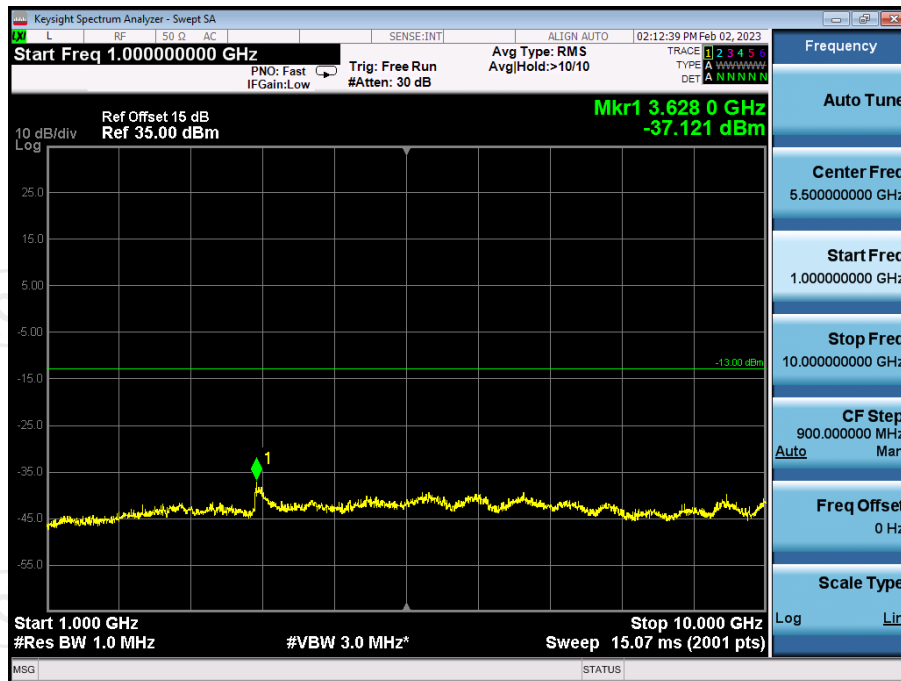


## 5.5.3. Test data

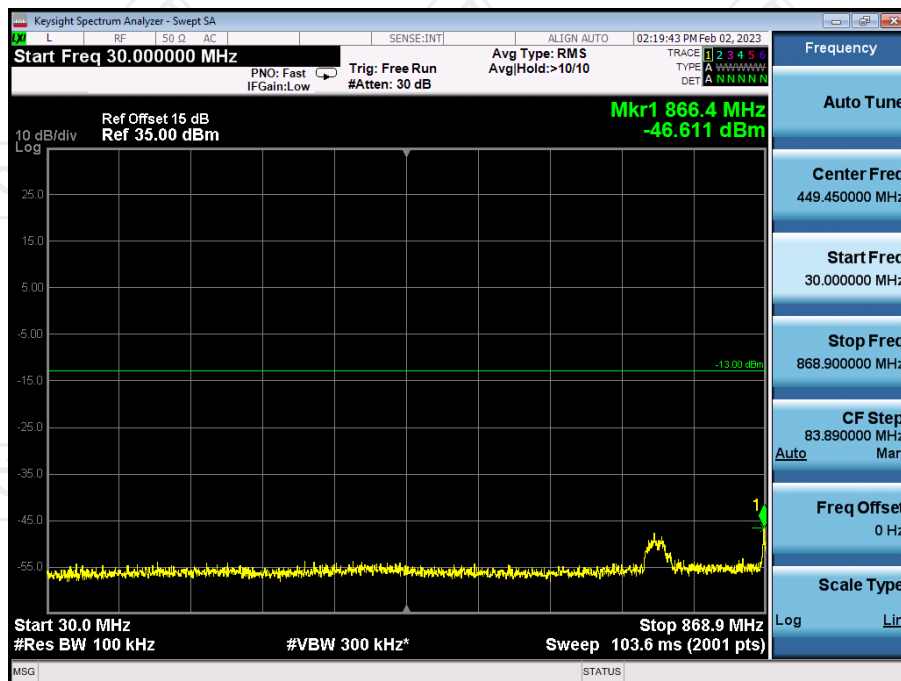
### Test Plots

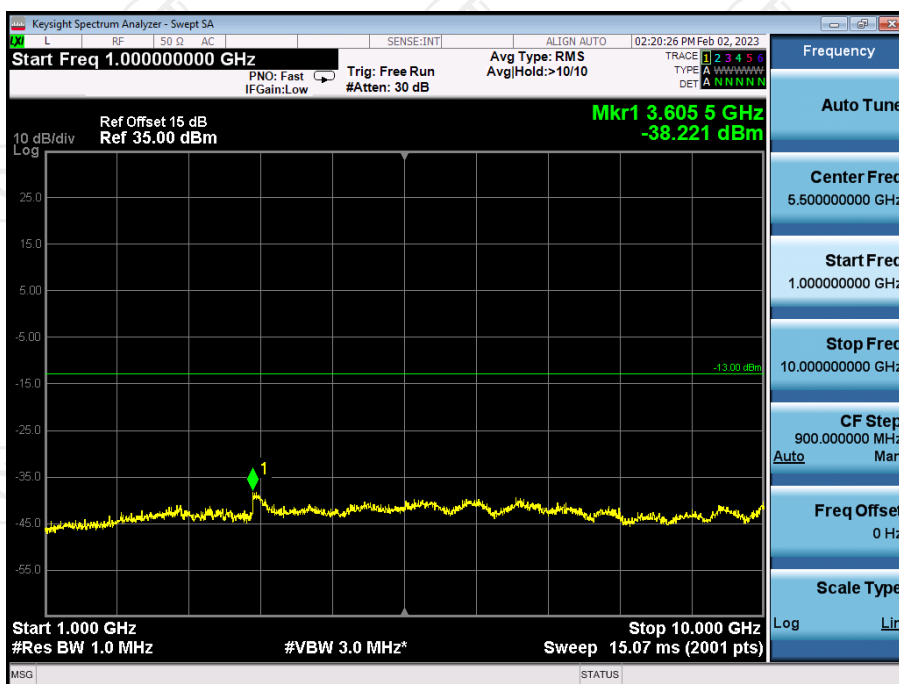
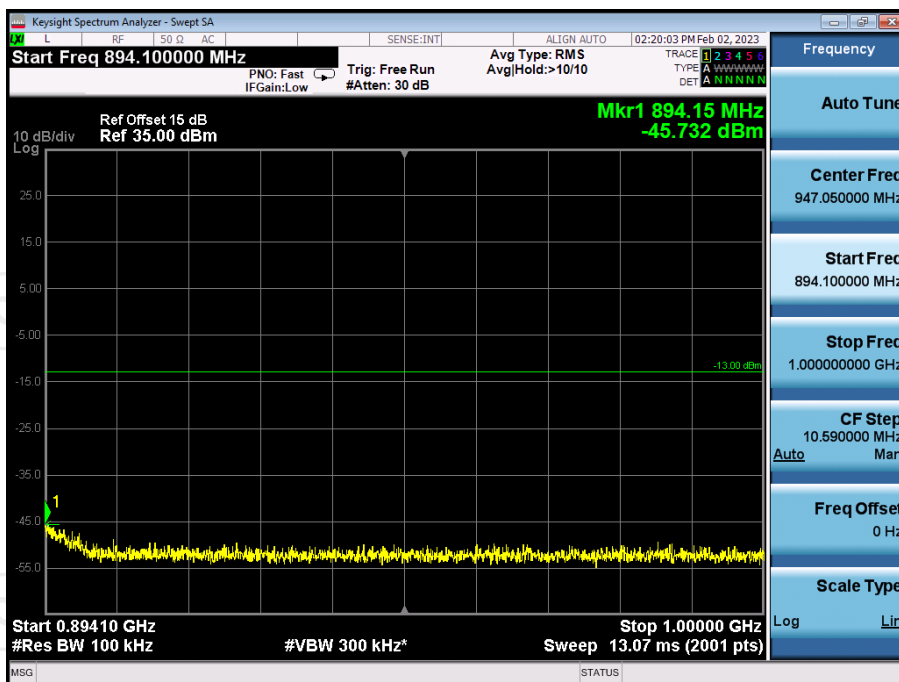
#### Cellular Uplink





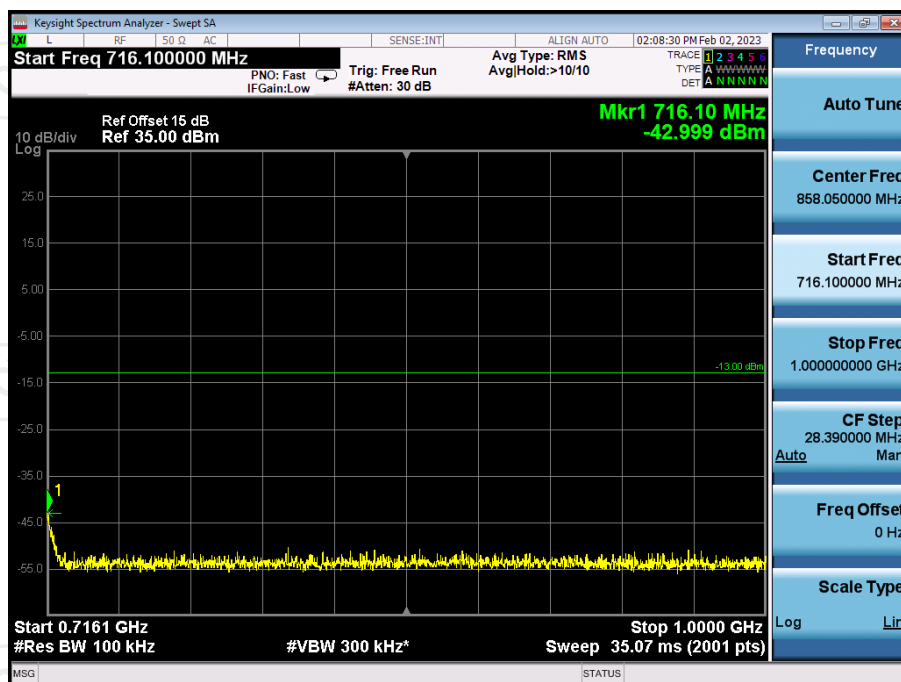
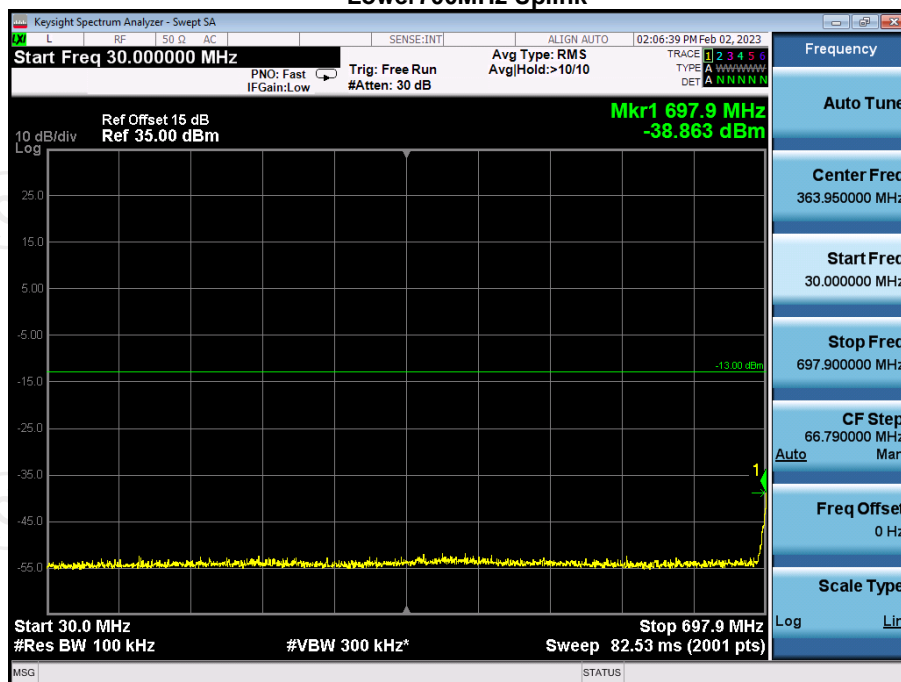
## Cellular Downlink





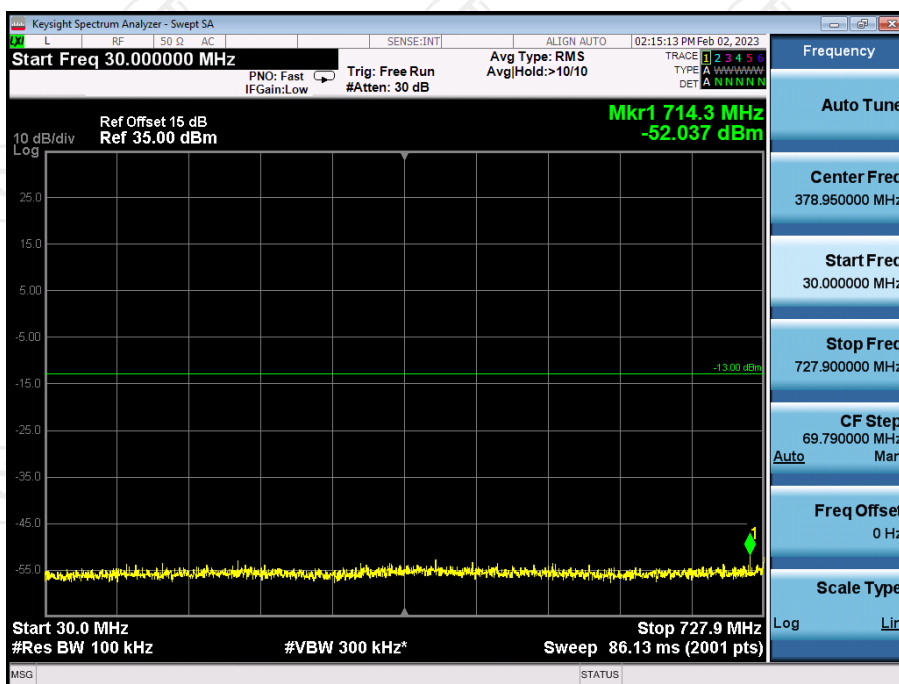
## Test Plots

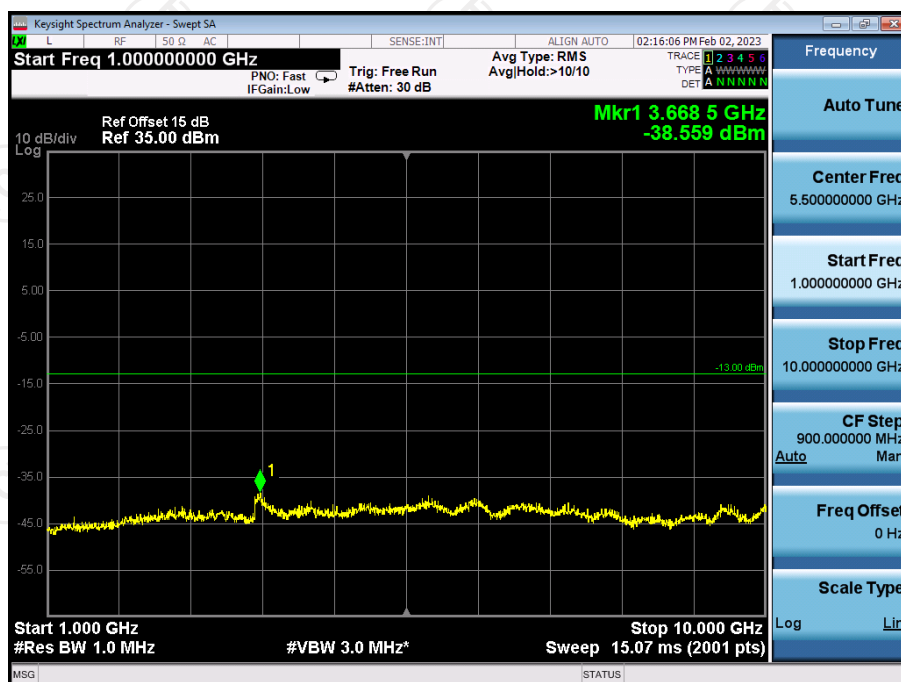
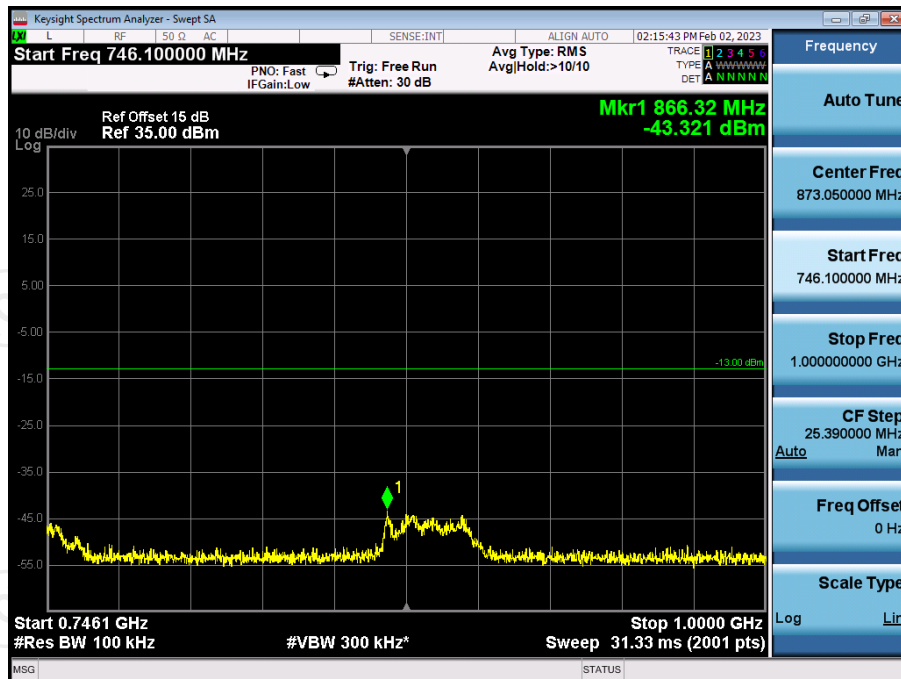
### Lower700MHz Uplink





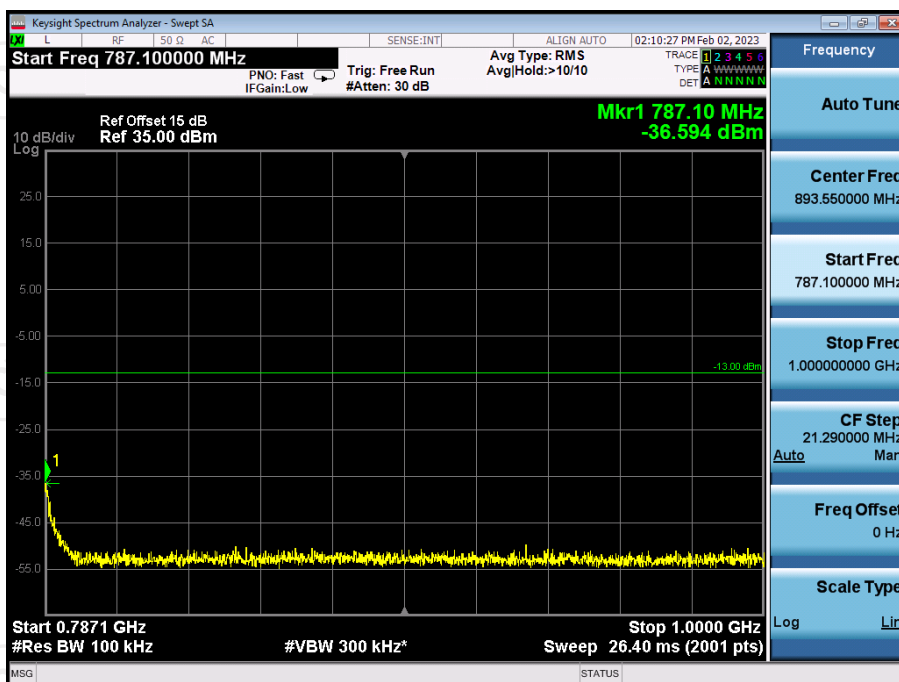
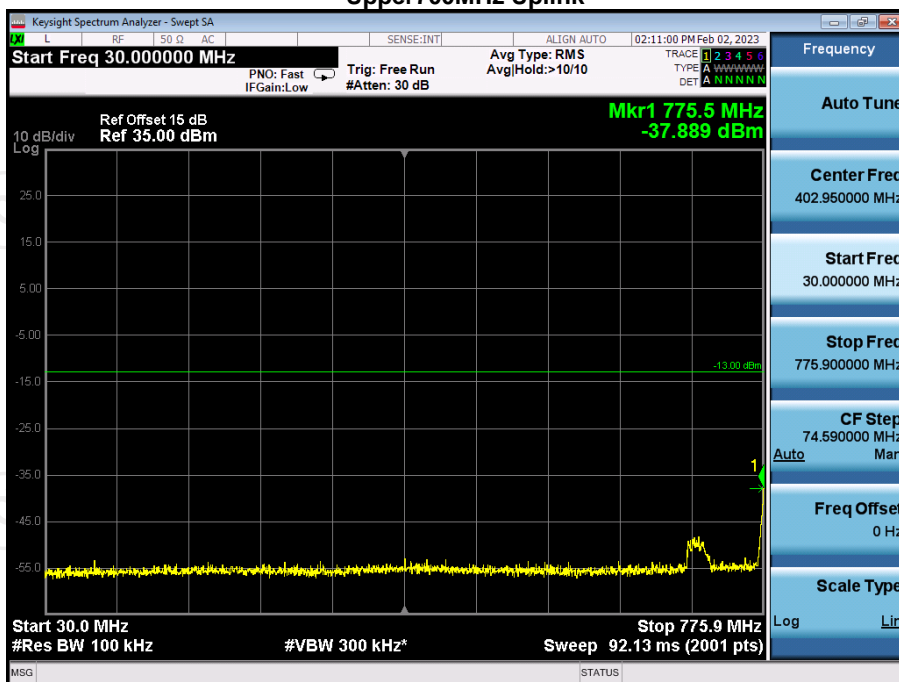
Lower700MHz Downlink



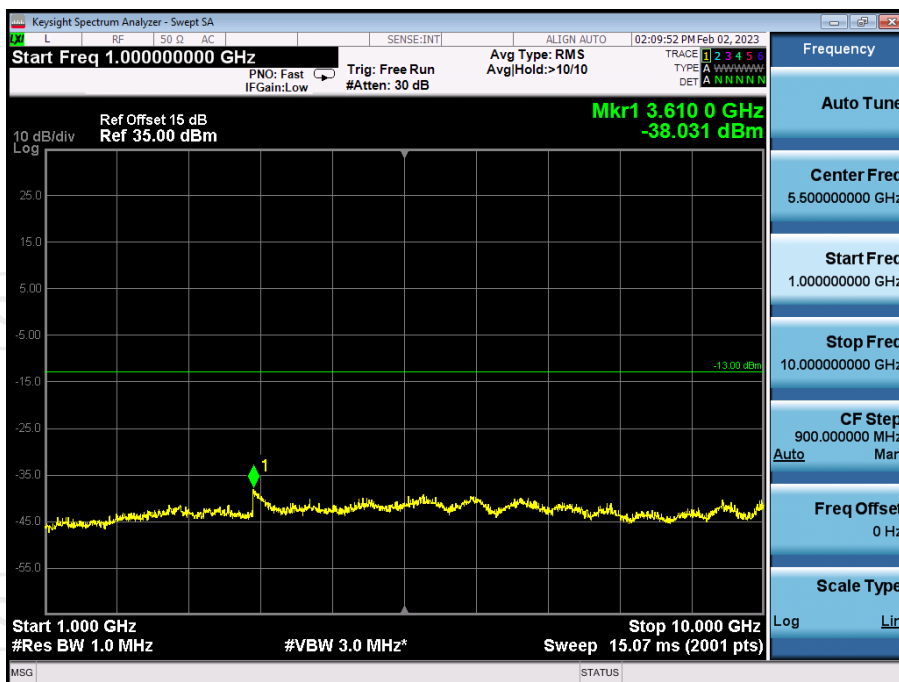


## Test Plots

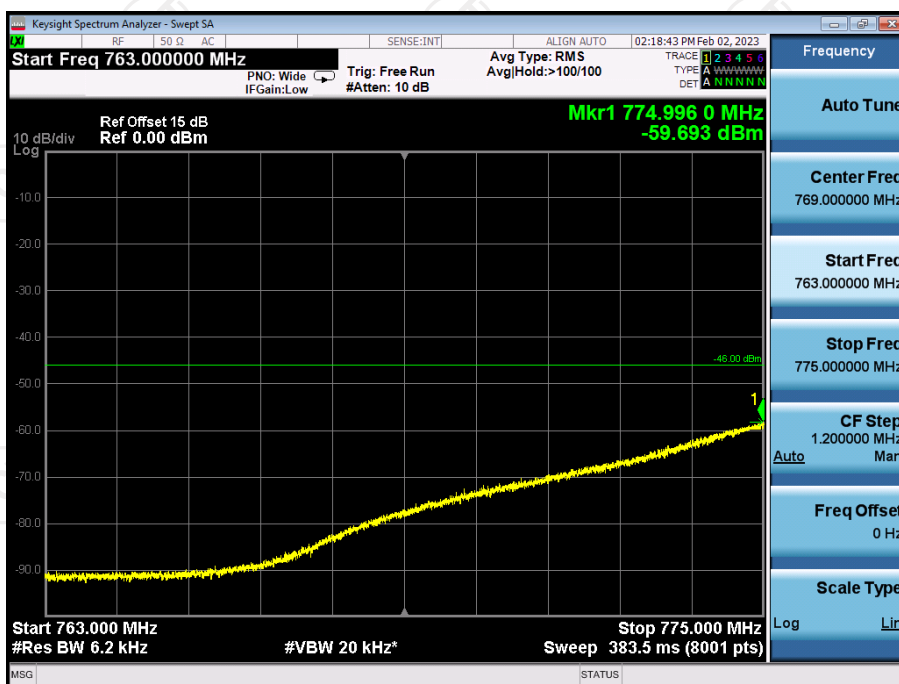
### Upper700MHz Uplink



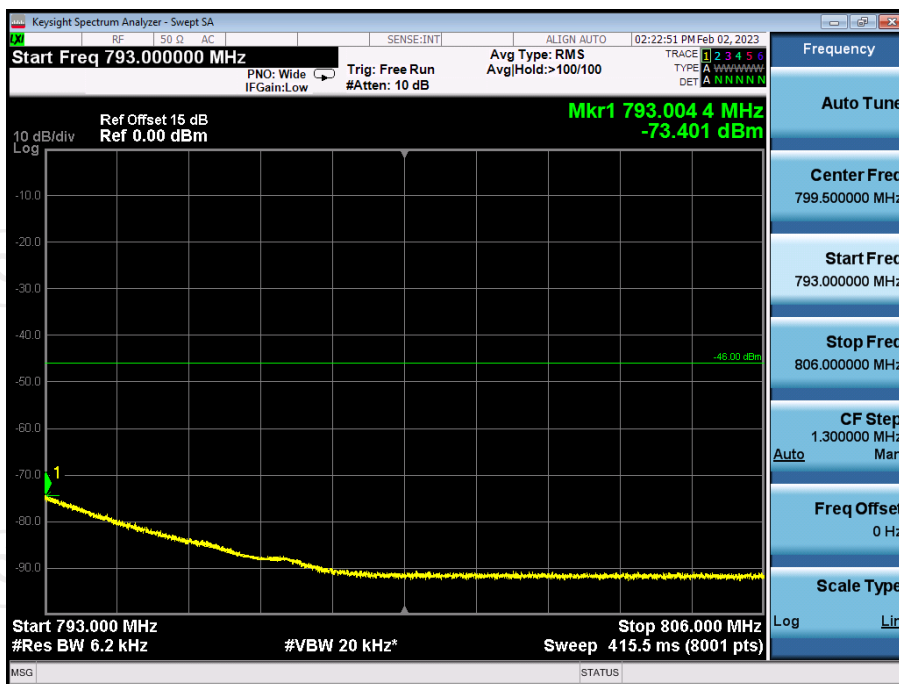




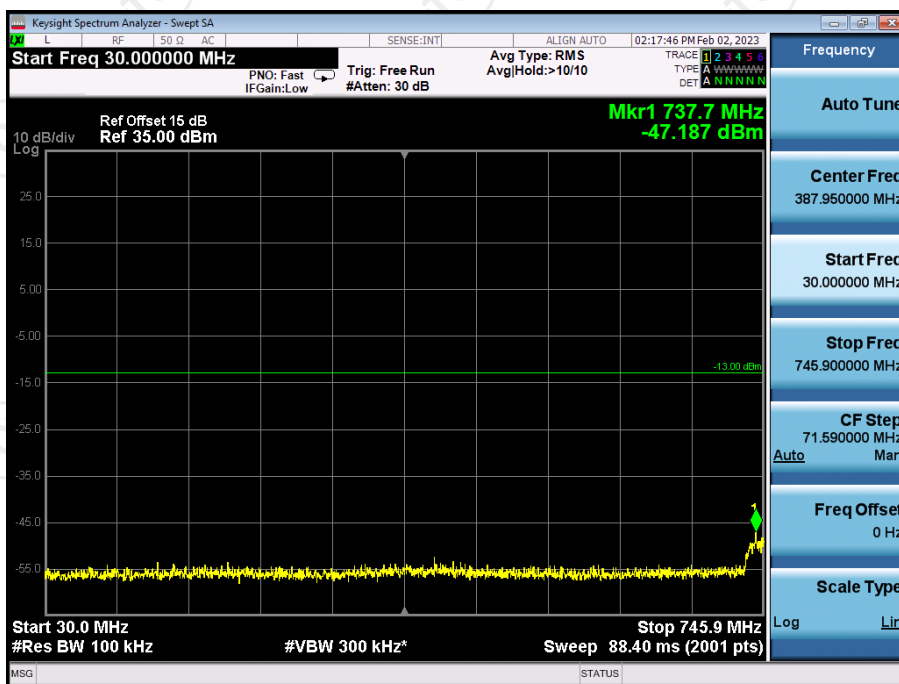
763MHz-775MHz

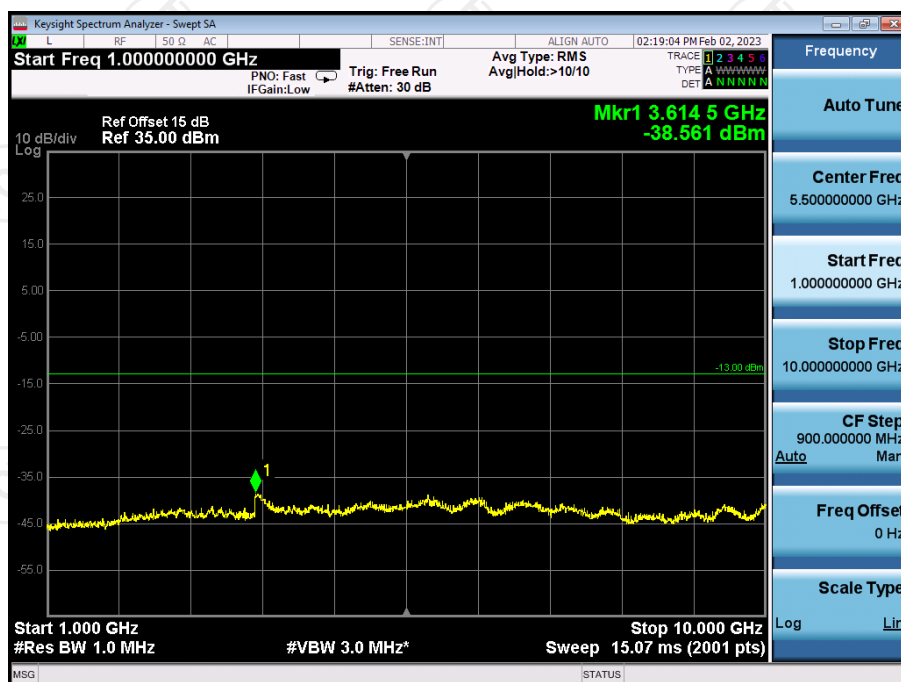
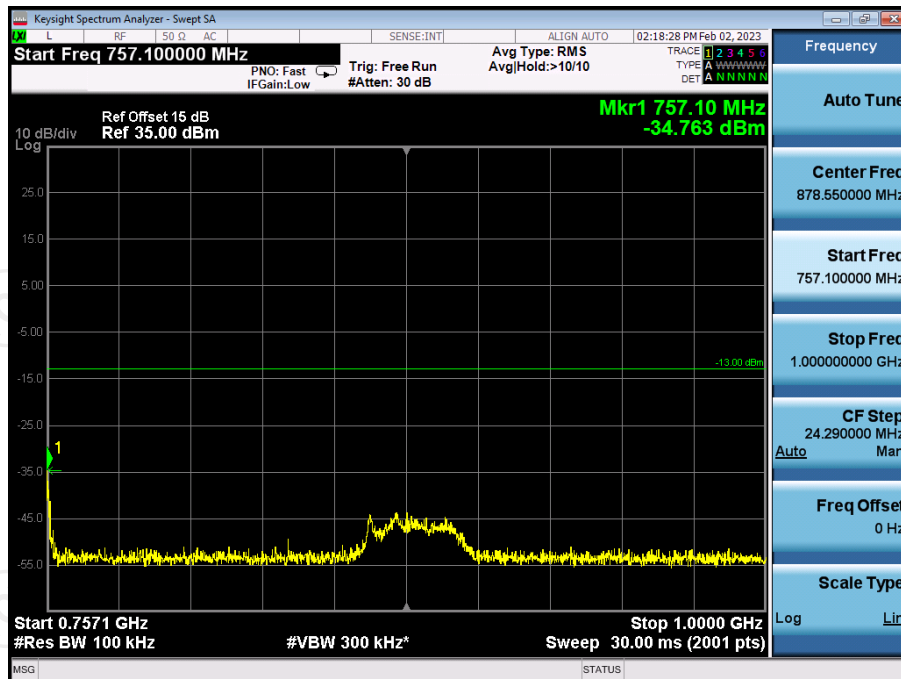


## 793MHz-806MHz

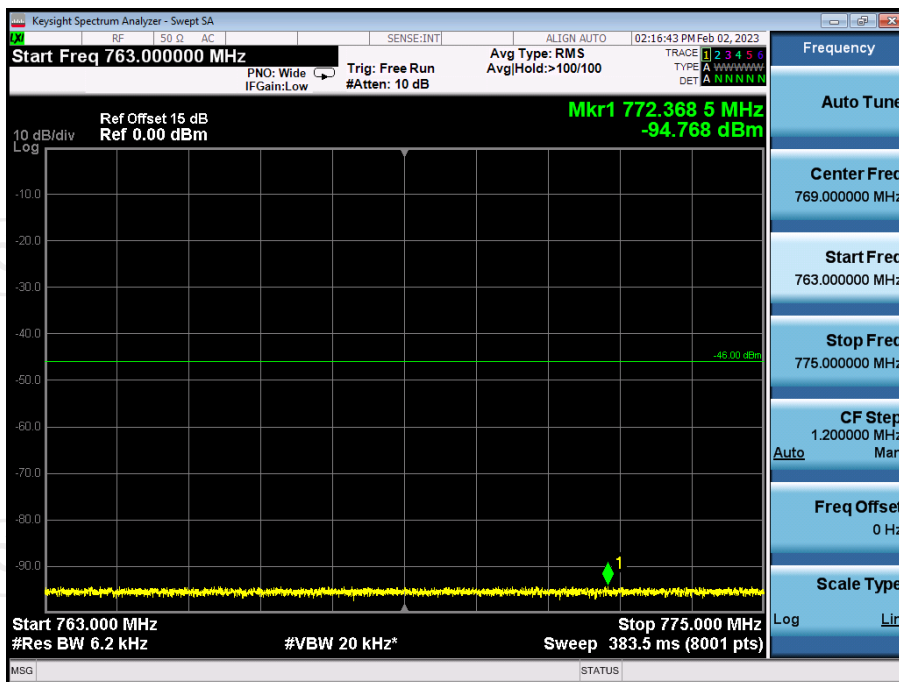


## Upper700MHz Downlink

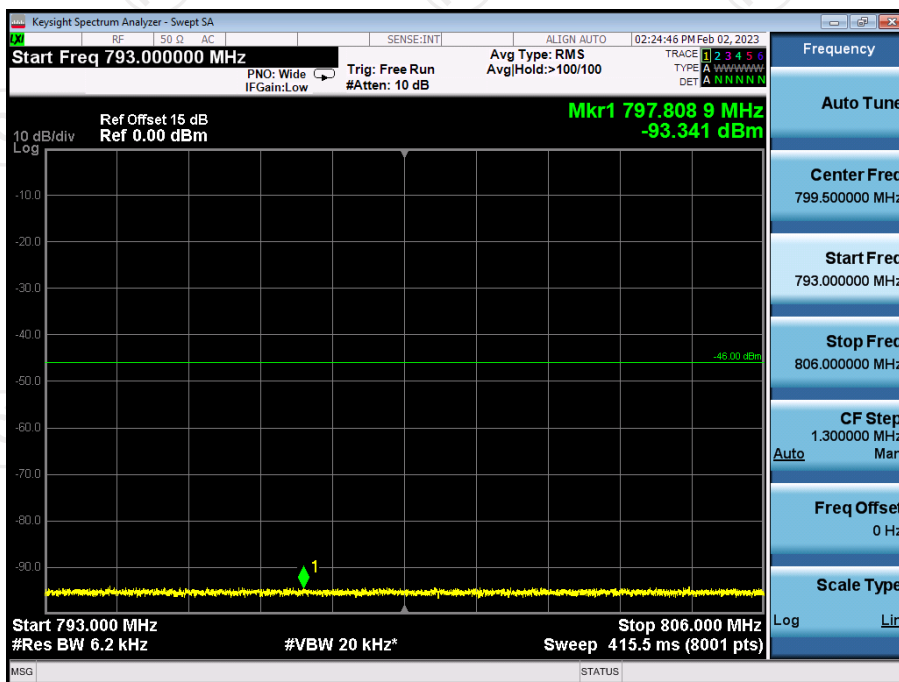




## 763MHz-775MHz

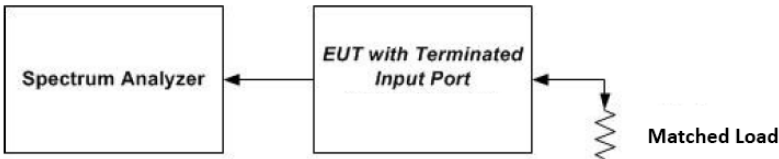
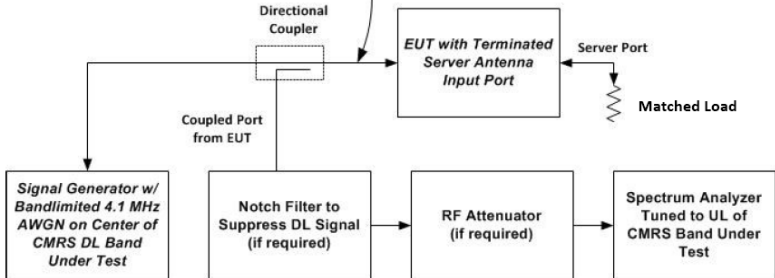


## 793MHz-806MHz



## 5.6. Noise Limits

### 5.6.1. Test Specification

|                          |   |
|--------------------------|---|
| <b>Test Requirement:</b> | FCC Part20 Section 20.21(e)(8)(i)(A); 20.21(e)(8)(i)(H)   |
| <b>Test Method:</b>      | KDB935210 D03 Signal Booster Measurements v04r04  |
| <b>Limit:</b>            | not exceed $-103 \text{ dBm/MHz}$ —RSSI.<br>not exceed $-102.5 \text{ dBm/MHz} + 20 \log (F)$ , where Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz.  |
| <b>Test Setup:</b>       |  <p>Figure 3 – Noise limit test setup (also used for 7.8)</p>  <p>Figure 4 – Test setup for uplink noise power measurement in the presence of a downlink signal</p>  |
| <b>Test Procedure:</b>   | <ol style="list-style-type: none"> <li>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.</li> <li>Set the spectrum analyzer RBW to 1 MHz with the VBW <math>\geq 3 \cdot</math> RBW.</li> <li>Select the power averaging (rms) detector and trace average over at least 100 traces.</li> <li>Set the center frequency of the spectrum analyzer to the center of the CMRS band under test with the span <math>\geq 2 \cdot</math> the CMRS band.</li> <li>Measure the maximum transmitter noise power level.</li> <li>Save the spectrum analyzer Test Plots as necessary for inclusion in the final test report.</li> <li>Repeat 7.7b) to 7.7f) for all operational uplink and downlink bands.</li> <li>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.</li> <li>Configure the signal generator for AWGN operation with a 99% OBW of 4.1 MHz.</li> <li>Set the spectrum analyzer RBW for 1 MHz, VBW <math>\geq 3 \cdot</math> RBW, with a power averaging (rms) detector with at least 100 trace averages.</li> <li>Set the center frequency of the spectrum analyzer to the center of</li> </ol> |

|                     |   |
|---------------------|---|
|                     | <p>the CMRS band under test, with the span <math>\geq 2</math> the CMRS band. This shall include all spectrum blocks in the particular CMRS band under test (see Appendix A).</p> <p>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.</p> <p>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.</p> <p>n) Repeat 7.7.1h) through 7.7.1m) for all operational uplink bands.</p> <p><b>Variable uplink noise timing</b></p> <p>Variable uplink noise timing is to be measured as follows, using the test setup shown in Figure 4.</p> <p>a) Set the spectrum analyzer to the uplink frequency to be measured.</p> <p>b) Set the span to 0 Hz, with a sweep time of 10 seconds.</p> <p>c) Set the power level of signal generator to the lowest level of the RSSI-dependent noise [see 7.7.1m)].</p> <p>d) Select MAX HOLD and increase the power level of signal generator by 10 dB for mobile boosters, and 20 dB for fixed boosters.</p> <p>e) Confirm that the uplink noise decreases to the specified level within 1 second for mobile devices, and within 3 seconds for fixed devices.<sup>12</sup></p> <p>f) Repeat 7.7.2a) to 7.7.2e) for all operational uplink bands.</p> <p>g) Include Test Plotss and summary table in test report.</p> |
| <b>Test Result:</b> | PASS  |

## 5.6.2. Test Instruments

| Equipment         | Manufacturer | Model       | Serial Number | Calibration Date | Calibration Due |
|-------------------|--------------|-------------|---------------|------------------|-----------------|
| Signal Generator  | Agilent      | N5182A      | MY47070282    | Jul. 04, 2022    | Jul. 03, 2023   |
| Spectrum Analyzer | Agilent      | N9020A      | MY49100619    | Jul. 05, 2022    | Jul. 04, 2023   |
| RF Combiner       | SUNVNDN      | SUD-CS 0800 | 16230009      | /                | /               |
| Attenuator        | 50FP-006-H3  | JFW         | 907763        | /                | /               |

### 5.6.3. Test Data

| Max Noise Power      |                  |               |             |
|----------------------|------------------|---------------|-------------|
| Frequency Band (MHz) | Measured dBm/MHz | Limit dBm/MHz | Result (dB) |
| Cellular Uplink      | -44.42           | -44.05        | PASS        |
| Lower700MHz Uplink   | -48.71           | -45.51        | PASS        |
| Upper700MHz Uplink   | -46.57           | -44.64        | PASS        |
| Cellular Downlink    | -45.34           | -44.05        | PASS        |
| Lower700MHz Downlink | -46.30           | -45.51        | PASS        |
| Upper700MHz Downlink | -47.96           | -44.64        | PASS        |

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

| Variable Uplink Noise |          |                  |               |         |
|-----------------------|----------|------------------|---------------|---------|
| Operation Bands       | RSSI dBm | Measured dBm/MHz | Limit dBm/MHz | Results |
| Cellular              | -60      | -46.46           | -43           | PASS    |
|                       | -58      | -48.25           | -45           | PASS    |
|                       | -56      | -50.18           | -47           | PASS    |
|                       | -55      | -51.47           | -48           | PASS    |
|                       | -54      | -53.40           | -49           | PASS    |
|                       | -52      | -54.57           | -51           | PASS    |
| Lower700MHz           | -61      | -49.71           | -42           | PASS    |
|                       | -58      | -51.32           | -45           | PASS    |
|                       | -55      | -53.80           | -48           | PASS    |
|                       | -53      | -58.32           | -50           | PASS    |
|                       | -51      | -60.30           | -52           | PASS    |
|                       | -48      | -61.79           | -55           | PASS    |
| Upper700MHz           | -60      | -46.62           | -43           | PASS    |
|                       | -59      | -47.03           | -44           | PASS    |
|                       | -57      | -48.45           | -46           | PASS    |
|                       | -56      | -49.79           | -47           | PASS    |
|                       | -54      | -51.39           | -49           | PASS    |
|                       | -52      | -53.54           | -51           | PASS    |



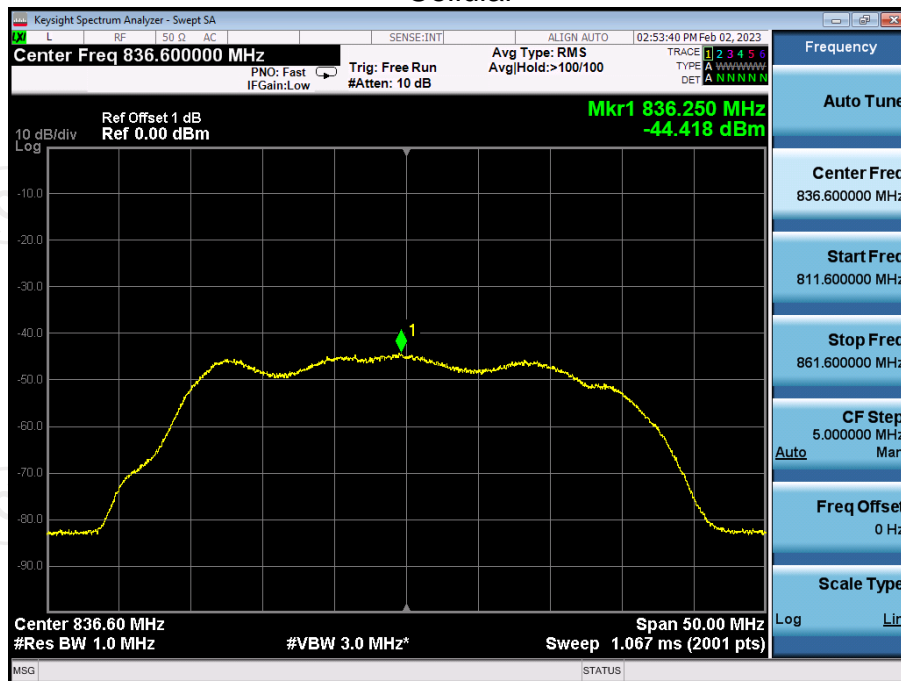
**Note:** According to the KDB 935210 D03 Signal Booster Measurements v04r04 APPENDIX D, when outside of RSSI Dependent limit (20.21.e.8.1.A.1),fixed booster maximum noise power shall not exceed  $-102.5 \text{ dBm/MHz} + 20 \log (F)$ .RSSI limit not exceed  $-103 \text{ dBm/MHz-RSSI}$ .

## Variable Uplink Noise Timing

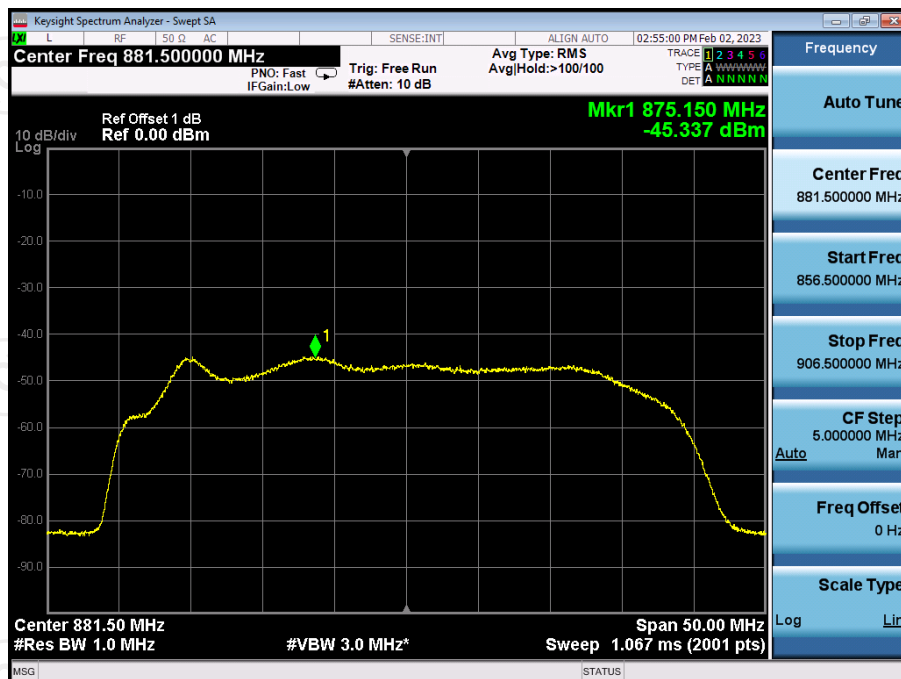
| Operation Bands | Measured Sec | Limit Sec | Results |
|-----------------|--------------|-----------|---------|
| Cellular        | 0.050        | 3         | PASS    |
| Lower700MHz     | 1.480        | 3         | PASS    |
| Upper700MHz     | 0.555        | 3         | PASS    |

## Test Plots

### Cellular

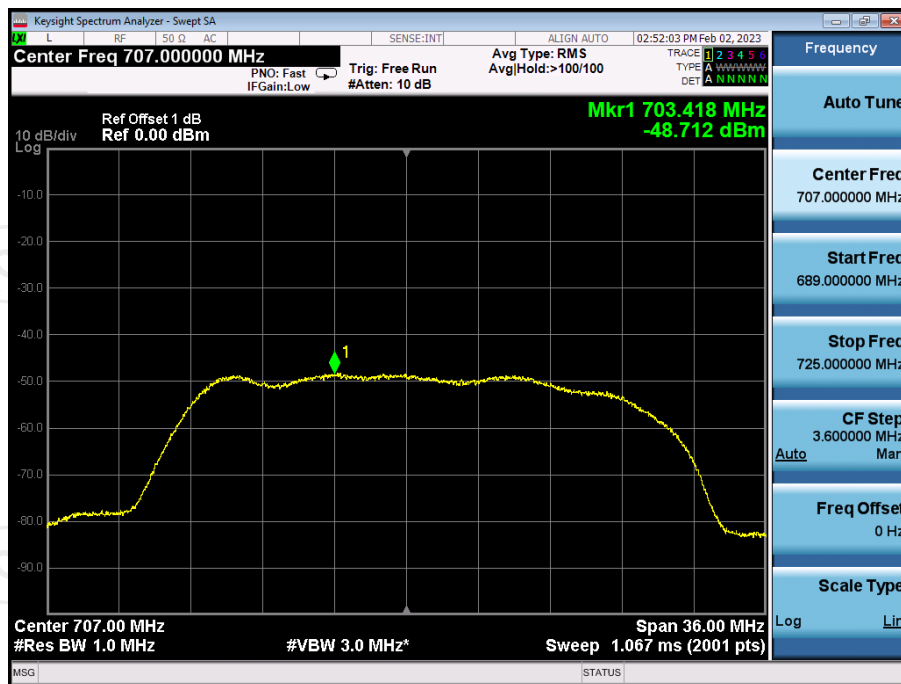


### Uplink Noise

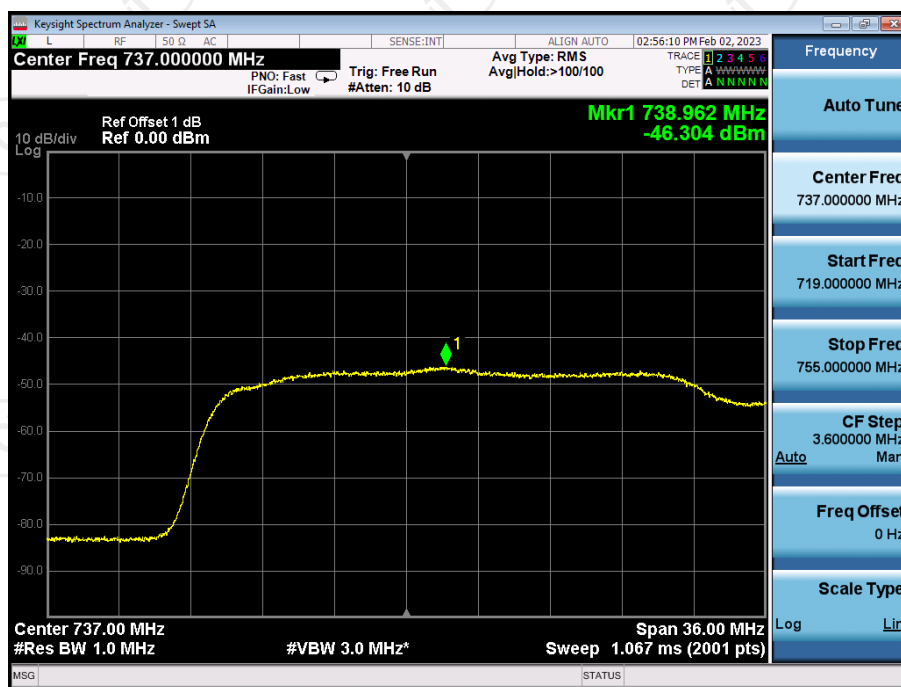


### Downlink Noise

### Lower700MHz

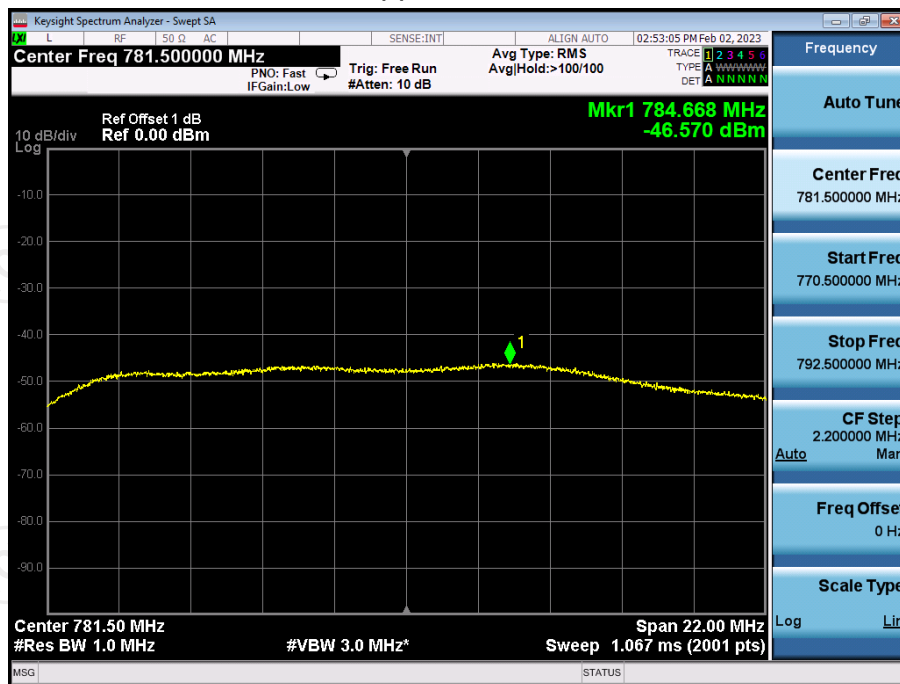


### Uplink Noise

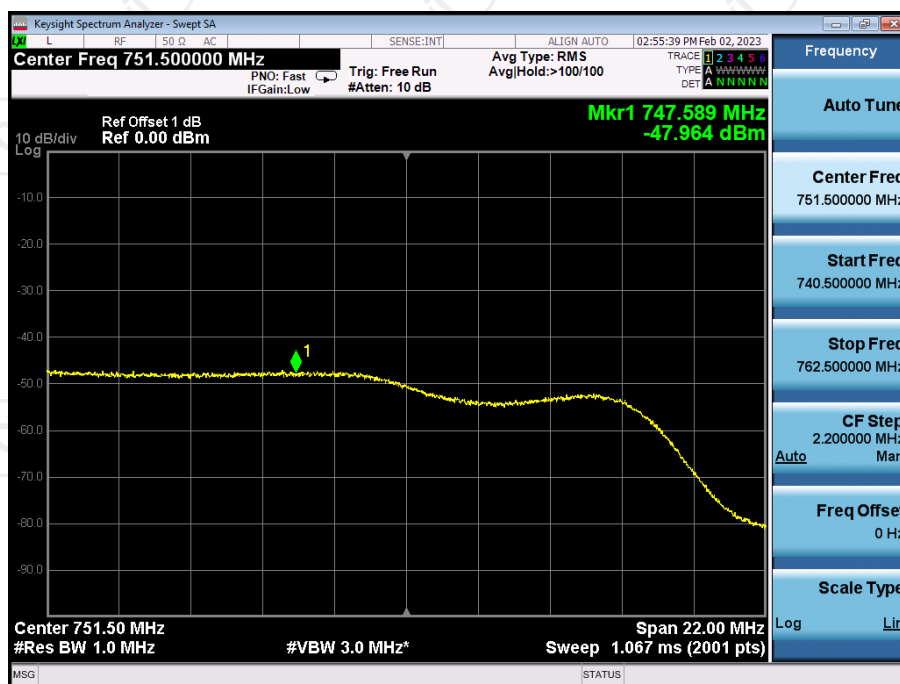


### Downlink Noise

## Upper700MHz



## Uplink Noise



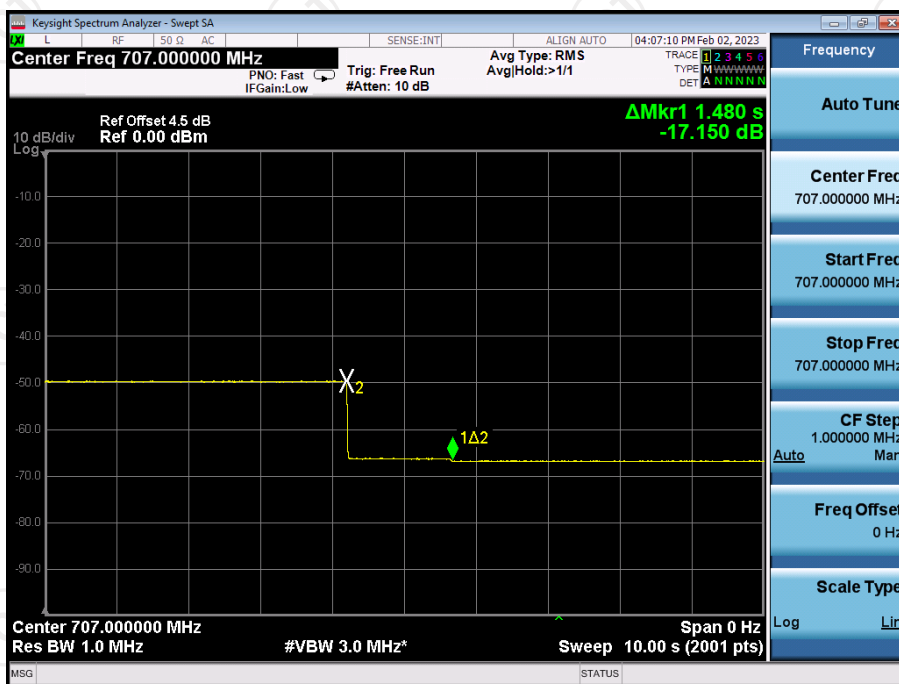
## Downlink Noise

## Variable Noise Timing Test Plots

### Cellular



### Lower700MHz

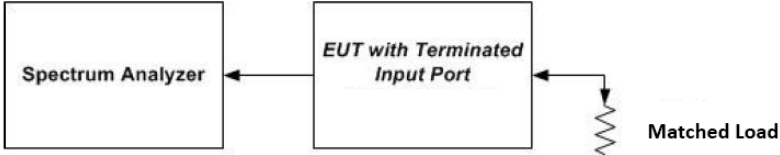


## Upper700MHz



## 5.7. Uplink Inactivity

### 5.7.1. Test Specification

|                          |  |
|--------------------------|--|
| <b>Test Requirement:</b> | FCC Part20 Section 20.21(e)(8)(i)(I)   |
| <b>Test Method:</b>      | KDB935210 D03 Signal Booster Measurements v04r04   |
| <b>Limit:</b>            | 20.21(e), When a consumer booster is not serving an active device connection after 5 minutes the uplink noise power shall not exceed -70 dBm/MHz.  |
| <b>Test Setup:</b>       |  <p>Figure 3 – Noise limit test setup (also used for 7.8)</p>  |
| <b>Test Procedure:</b>   | <ol style="list-style-type: none"> <li>Connect the EUT to the test equipment as shown in Set-Up with the uplink output connected to the spectrum analyzer.</li> <li>Select the RMS power averaging detector.</li> <li>Set the spectrum analyzer RBW for 1 MHz with the VBW <math>\geq 3X</math> RBW.</li> <li>Set the center frequency of the spectrum analyzer to the center of the uplink operational band.</li> <li>Set the span for 0 Hz with a single sweep time for a minimum of 330 seconds.</li> <li>Start to capture a new trace using MAX HOLD.</li> <li>After approximately 15 seconds turn on the EUT power.</li> <li>Once the full spectrum analyzer trace is complete place a MARKER on the leading edge of the pulse and use the DELTA MARKER METHOD to measure the time until the uplink was squelched.</li> <li>Ensure the noise level for the squelched signal is below the uplink inactivity noise power limit, as specified by the rules.</li> <li>Capture the Test Plots for inclusion in the test report.</li> <li>Measure noise using procedures in a) to e).</li> <li>Repeat steps c) to k) for all operational uplink bands.</li> </ol> |
| <b>Test Result:</b>      | PASS   |

### 5.7.2. Test Instruments

| Equipment         | Manufacturer | Model  | Serial Number | Calibration Date | Calibration Due |
|-------------------|--------------|--------|---------------|------------------|-----------------|
| Spectrum Analyzer | Agilent      | N9020A | MY49100619    | Jul. 05, 2022    | Jul. 04, 2023   |



### 5.7.3. Test Data

| Uplink Inactivity |              |           |        |
|-------------------|--------------|-----------|--------|
| Operation Bands   | Measured (s) | Limit (s) | Result |
| Cellular          | 270.9        | 300.0     | PASS   |
| Lower700MHz       | 270.3        | 300.0     | PASS   |
| Upper700MHz       | 270.6        | 300.0     | PASS   |

## Test Plots

### Cellular



### Lower700MHz

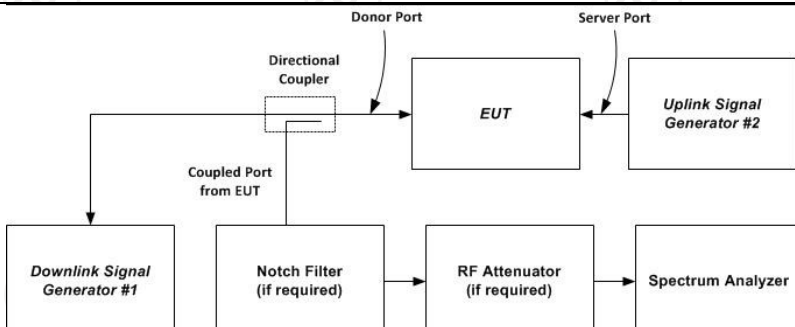


## Upper700MHz



## 5.8. Variable Booster Gain

### 5.8.1. Test Specification

|                          |   |
|--------------------------|---|
| <b>Test Requirement:</b> | FCC Part20 Section 120.21(e)(8)(i)(C)(1)<br>FCC Part20 Section 120.21(e)(8)(i)(H)   |
| <b>Test Method:</b>      | KDB935210 D03 Signal booster Measurements v04r04  |
| <b>Limit:</b>            | -34 dB - RSSI + MSCL  |
| <b>Test Setup:</b>       |  <p>Figure 5 – Variable gain instrumentation test setup</p>   |
| <b>Test Procedure:</b>   | <p><b>Variable gain:</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>Configure downlink signal generator #1 for AWGN operation with a 99% OBW of 4.1 MHz, tuned to the center of the operational band.</li> <li>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.</li> <li>Set RBW = 100 kHz.</li> <li>Set VBW ≥ 300 kHz.</li> <li>Select the CHANNEL POWER measurement mode.</li> <li>Select the power averaging (rms) detector.</li> <li>Affirm that the number of measurement points per sweep ≥ (2 . span)/RBW.</li> <li>Sweep time = auto couple or as necessary (but no less than auto couple value).</li> <li>Trace average at least 10 traces in power averaging (i.e., rms) mode.</li> <li>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.</li> <li>Repeat 7.9.1b) to 7.9.1k) for all operational uplink bands.</li> </ol> <p><b>Variable uplink gain timing:</b><br/>Variable uplink gain timing is to be measured as follows, using the test setup shown in Figure 5.</p> |

|                     |   |
|---------------------|---|
|                     | <p>a) Set the spectrum analyzer to the uplink frequency to be measured.</p> <p>b) Set the span to 0 Hz with a sweep time of 10 seconds.</p> <p>c) Set the power level of signal generator #1 to the lowest level of the RSSI-dependent gain [see 7.9.1k)].</p> <p>d) 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).</p> <p>e) Confirm that the uplink gain decreases to the specified levels, within 1 second for mobile devices, and within 3 seconds for fixed devices.13</p> <p>f) Repeat 7.9.2a) to 7.9.2e) for all operational uplink bands.</p> |
| <b>Test Result:</b> | PASS  |

### 5.8.2. Test Instruments

| Equipment         | Manufacturer | Model       | Serial Number | Calibration Date | Calibration Due |
|-------------------|--------------|-------------|---------------|------------------|-----------------|
| Signal Generator  | Agilent      | E4421B      | GB39340839    | Jul. 05, 2022    | Jul. 04, 2023   |
| Signal Generator  | Agilent      | N5182A      | MY47070282    | Jul. 04, 2022    | Jul. 03, 2023   |
| Spectrum Analyzer | Agilent      | N9020A      | MY49100619    | Jul. 05, 2022    | Jul. 04, 2023   |
| RF Combiner       | SUNVNDN      | SUD-CS 0800 | 16230009      | /                | /               |
| Attenuator        | 50FP-006-H3  | JFW         | 907763        | /                | /               |

### 5.8.3. Test Data

**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.

| MSCL Calculation |                 |              |                |                          |                       |                   |              |
|------------------|-----------------|--------------|----------------|--------------------------|-----------------------|-------------------|--------------|
| Operation Bands  | Frequency (MHz) | Distance (m) | Path loss (dB) | Indoor Antenna Gain(dBi) | Indoor Cable Loss(dB) | Polarity Loss(dB) | MSCL (dB)    |
| Cellular         | 824             | 2            | 36.84          | 7                        | 2.29                  | 3.01              | <b>35.14</b> |
| Lower700 MHz     | 698             | 2            | 35.40          | 7                        | 2.19                  | 3.01              | <b>33.60</b> |
| Upper700 MHz     | 776             | 2            | 36.32          | 7                        | 2.19                  | 3.01              | <b>34.52</b> |

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

Polarity loss =  $20\log (1/\sin (45\deg))$  dB = 3.01dB

| Variable booster gain |            |                   |                    |                    |       |       |         |
|-----------------------|------------|-------------------|--------------------|--------------------|-------|-------|---------|
| Operation Band        | RSSI (dBm) | Input Power (dBm) | Output Power (dBm) | Measured Gain (dB) | MSCL  | Limit | Results |
| Cellular              | -60        | -46.0             | 8.77               | 54.77              | 35.14 | 61.14 | PASS    |
|                       | -58        | -46.0             | 7.03               | 53.03              | 35.14 | 59.14 | PASS    |
|                       | -56        | -46.0             | 5.66               | 51.66              | 35.14 | 57.14 | PASS    |
|                       | -54        | -46.0             | 2.83               | 48.83              | 35.14 | 55.14 | PASS    |
|                       | -52        | -46.0             | 1.70               | 47.70              | 35.14 | 53.14 | PASS    |
|                       | -50        | -46.0             | -0.26              | 45.74              | 35.14 | 51.14 | PASS    |
| Lower700M Hz          | -61        | -46.0             | 10.27              | 56.27              | 33.60 | 60.60 | PASS    |
|                       | -59        | -46.0             | 9.38               | 55.38              | 33.60 | 58.60 | PASS    |
|                       | -57        | -46.0             | 7.59               | 53.59              | 33.60 | 56.60 | PASS    |
|                       | -54        | -46.0             | 4.80               | 50.80              | 33.60 | 53.60 | PASS    |
|                       | -53        | -46.0             | 1.98               | 47.98              | 33.60 | 52.60 | PASS    |
|                       | -51        | -46.0             | 0.99               | 46.99              | 33.60 | 50.60 | PASS    |
| Upper700M Hz          | -58        | -44.0             | 9.04               | 53.04              | 34.52 | 58.52 | PASS    |
|                       | -56        | -44.0             | 6.98               | 50.98              | 34.52 | 56.52 | PASS    |
|                       | -53        | -44.0             | 4.09               | 48.09              | 34.52 | 53.52 | PASS    |
|                       | -51        | -44.0             | 1.31               | 45.31              | 34.52 | 51.52 | PASS    |
|                       | -49        | -44.0             | 0.42               | 44.42              | 34.52 | 49.52 | PASS    |
|                       | -48        | -44.0             | -0.50              | 43.50              | 34.52 | 48.52 | PASS    |

**Variable Uplink Gain Timing**

| Operation Band | Measured Sec | Limit Sec | Result |
|----------------|--------------|-----------|--------|
| Cellular       | 0.840        | 3.0       | PASS   |
| Lower700MHz    | 1.900        | 3.0       | PASS   |
| Upper700MHz    | 1.230        | 3.0       | PASS   |



## Variable Uplink Gain Timing Test Plots

### Cellular



### Lower700MHz

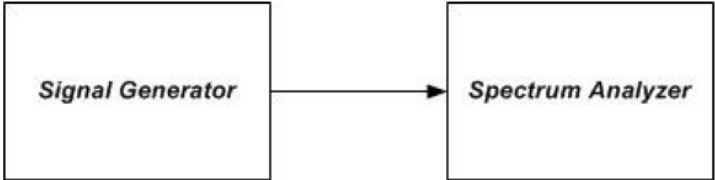


## Upper700MHz



## 5.9. Occupied Bandwidth

### 5.9.1. Test Specification

|                          |   |
|--------------------------|---|
| <b>Test Requirement:</b> | FCC Part2 Section 2.1049  |
| <b>Test Method:</b>      | KDB935210 D03 Signal booster Measurements v04r04  |
| <b>Limit:</b>            | N/A   |
| <b>Test setup:</b>       |  <p>Figure 6 – Test setup for measuring characteristics of test signals used for subsequent EUT occupied bandwidth testing</p>  |
| <b>Test Procedure:</b>   | <ol style="list-style-type: none"> <li>Connect the test equipment as shown in Figure 6 to firstly measure the characteristics of the test signals produced by the signal generator.</li> <li>Set VBW <math>\geq 3</math> RBW.</li> <li>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.</li> <li>Set the signal generator for power level to match the values obtained from the tests of 7.2.</li> <li>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.</li> <li>Set the spectrum analyzer RBW for 1% to 5% of the EBW.</li> <li>Capture the spectrum analyzer trace for inclusion in the test report.</li> <li>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.</li> <li>Repeat 7.10c) to 7.10h) for all uplink and downlink operational bands.</li> <li>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.</li> <li>Repeat 7.10c) to 7.10i) with this EUT uplink path test setup.</li> <li>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.</li> <li>Repeat 7.10c) to 7.10j) with this EUT downlink path test setup.</li> </ol> |
| <b>Test results:</b>     | PASS  |

## 5.9.2. Test Instruments

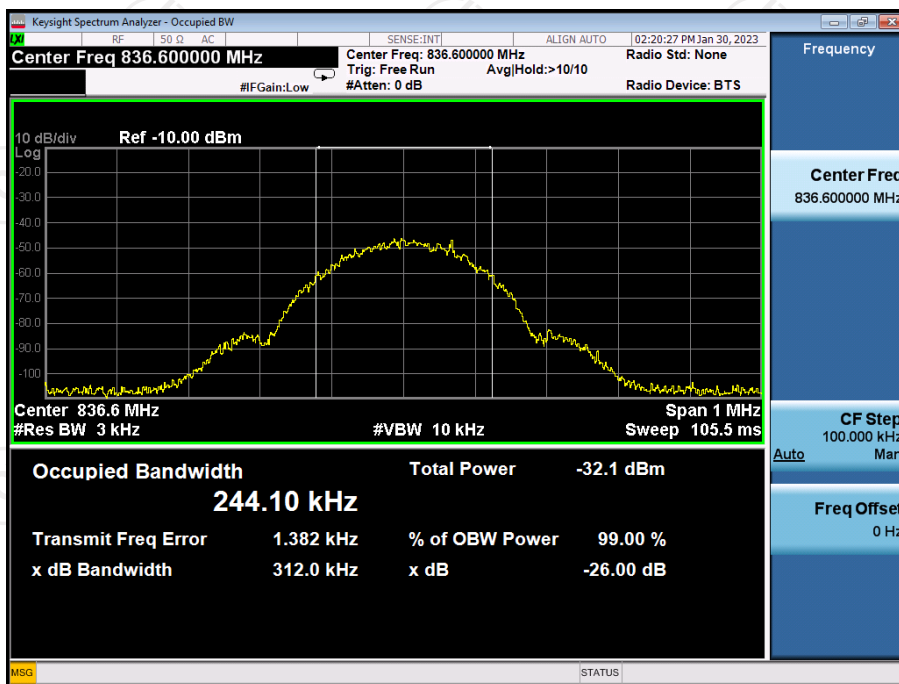
| Equipment         | Manufacturer | Model  | Serial Number | Calibration Date | Calibration Due |
|-------------------|--------------|--------|---------------|------------------|-----------------|
| Signal Generator  | Agilent      | N5182A | MY47070282    | Jul. 04, 2022    | Jul. 03, 2023   |
| Spectrum Analyzer | Agilent      | N9020A | MY49100619    | Jul. 05, 2022    | Jul. 04, 2023   |

### 5.9.3. Test Data

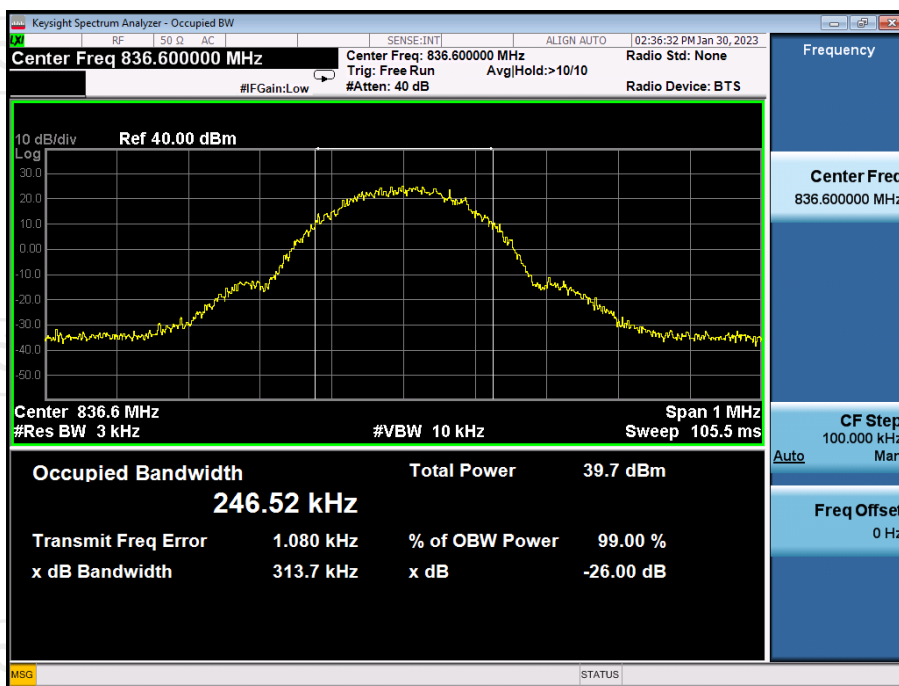
| Operation Band |              | Signal Type | Input OBW [MHz] | Output OBW [MHz] | Results |
|----------------|--------------|-------------|-----------------|------------------|---------|
| Uplink         | Cellular     | GSM         | 0.244           | 0.247            | PASS    |
|                |              | CDMA        | 1.244           | 1.248            | PASS    |
|                |              | LTE         | 4.520           | 4.496            | PASS    |
|                | Lower700M Hz | GSM         | 0.247           | 0.243            | PASS    |
|                |              | CDMA        | 1.246           | 1.247            | PASS    |
|                |              | LTE         | 4.508           | 4.498            | PASS    |
|                | Upper700M Hz | GSM         | 0.243           | 0.243            | PASS    |
|                |              | CDMA        | 1.243           | 1.243            | PASS    |
|                |              | LTE         | 4.517           | 4.508            | PASS    |
| Downlink       | Cellular     | GSM         | 0.246           | 0.244            | PASS    |
|                |              | CDMA        | 1.245           | 1.242            | PASS    |
|                |              | LTE         | 4.514           | 4.498            | PASS    |
|                | Lower700M Hz | GSM         | 0.245           | 0.245            | PASS    |
|                |              | CDMA        | 1.245           | 1.245            | PASS    |
|                |              | LTE         | 4.515           | 4.513            | PASS    |
|                | Upper700M Hz | GSM         | 0.244           | 0.242            | PASS    |
|                |              | CDMA        | 1.244           | 1.246            | PASS    |
|                |              | LTE         | 4.520           | 4.484            | PASS    |

## Test Plots

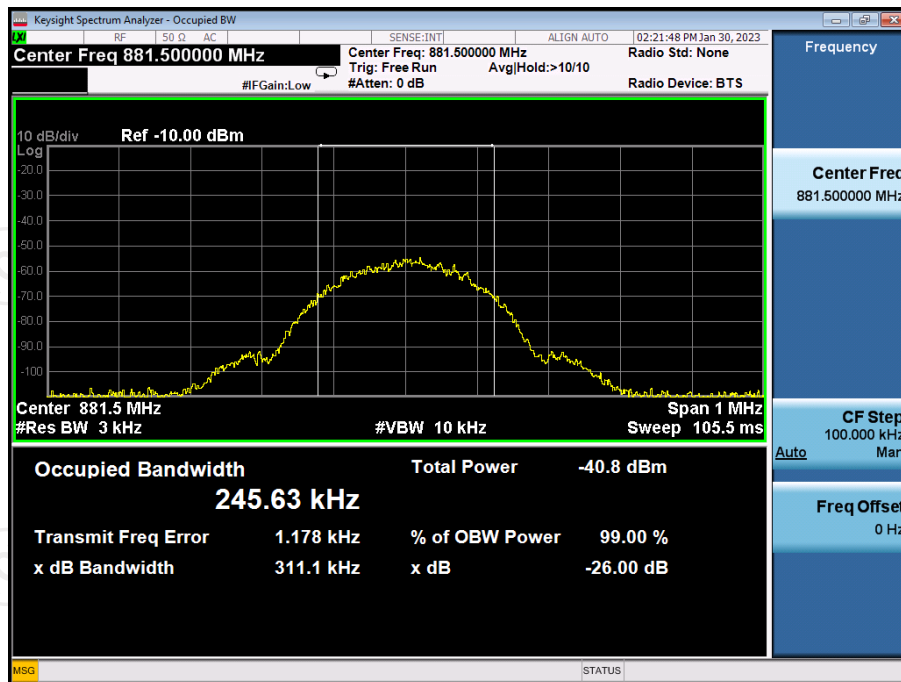
### Cellular GSM UL Input



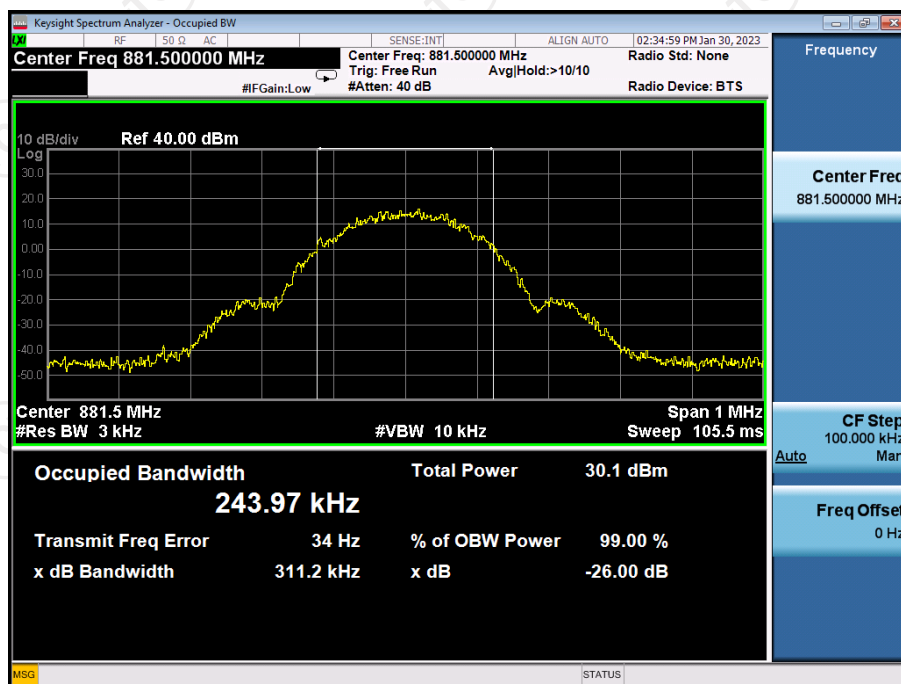
### Cellular GSM UL output



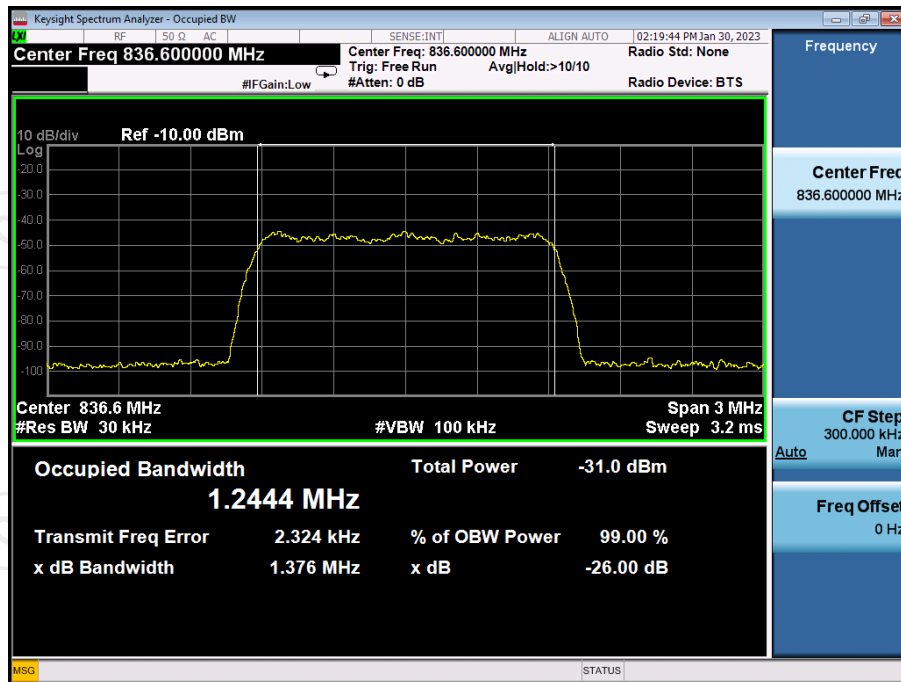
## Cellular GSM DL Input



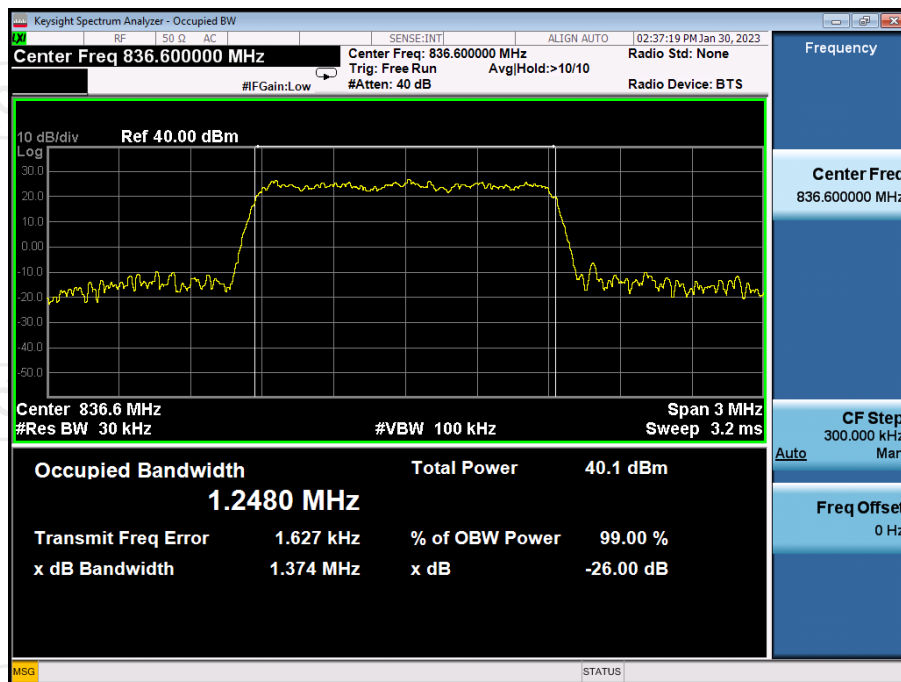
## Cellular GSM DL Output



## Cellular CDMA UL Input

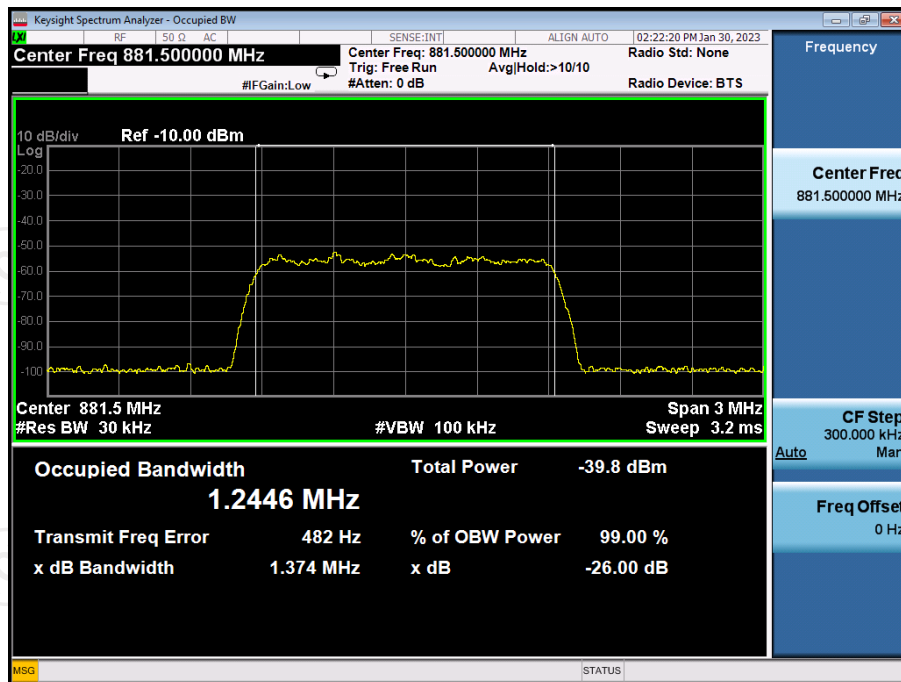


## Cellular CDMA UL output

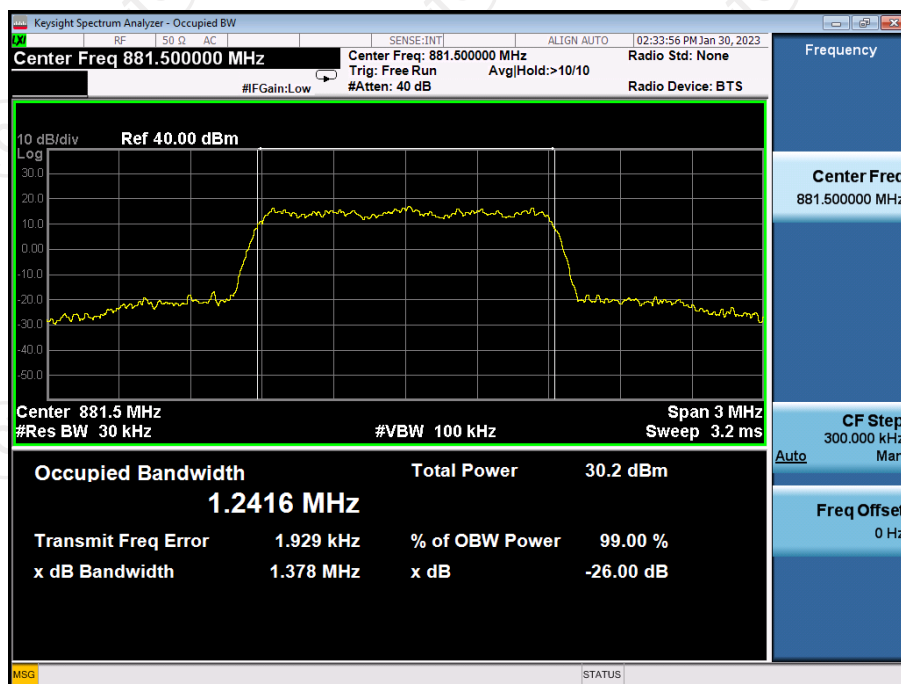




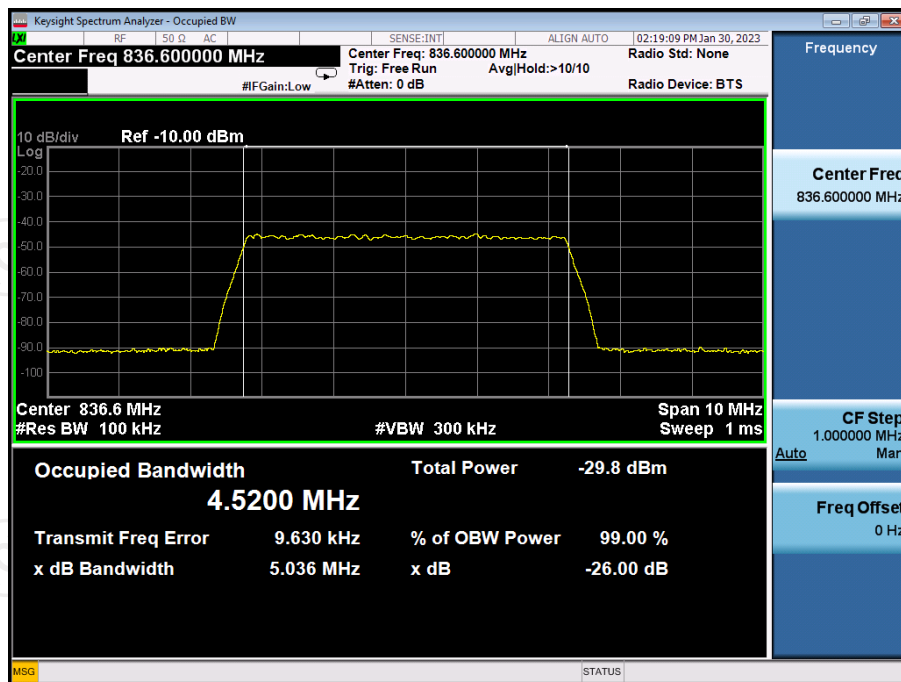
## Cellular CDMA DL Input



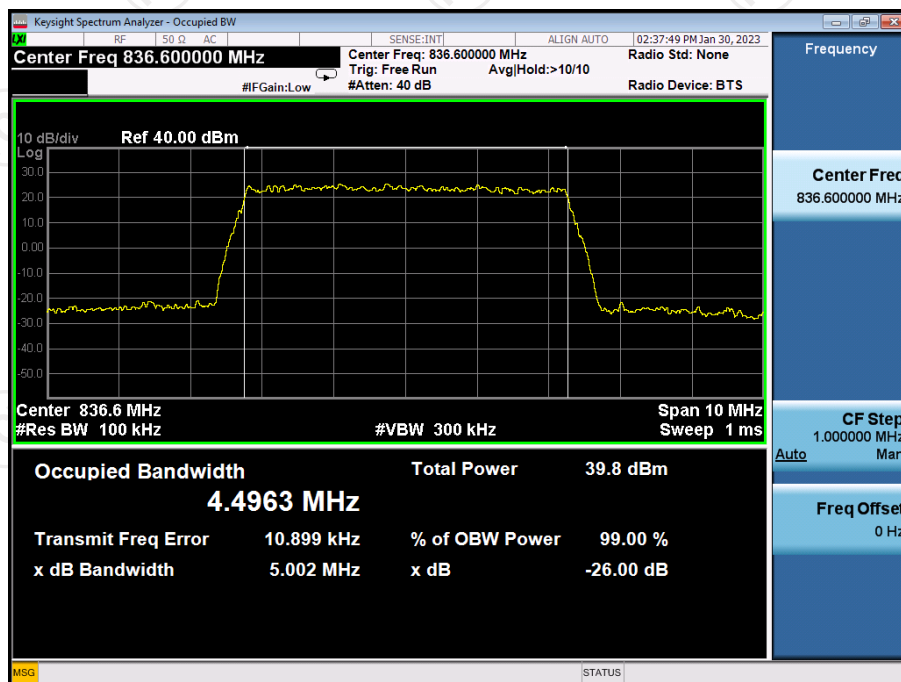
## Cellular CDMA DL Output



## Cellular LTE UL Input



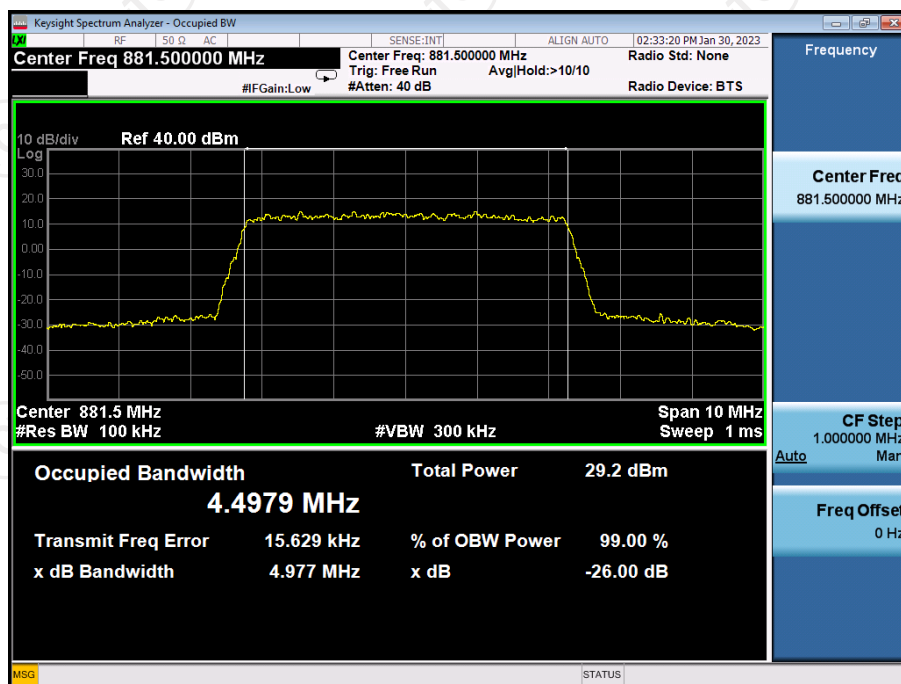
## Cellular LTE UL output



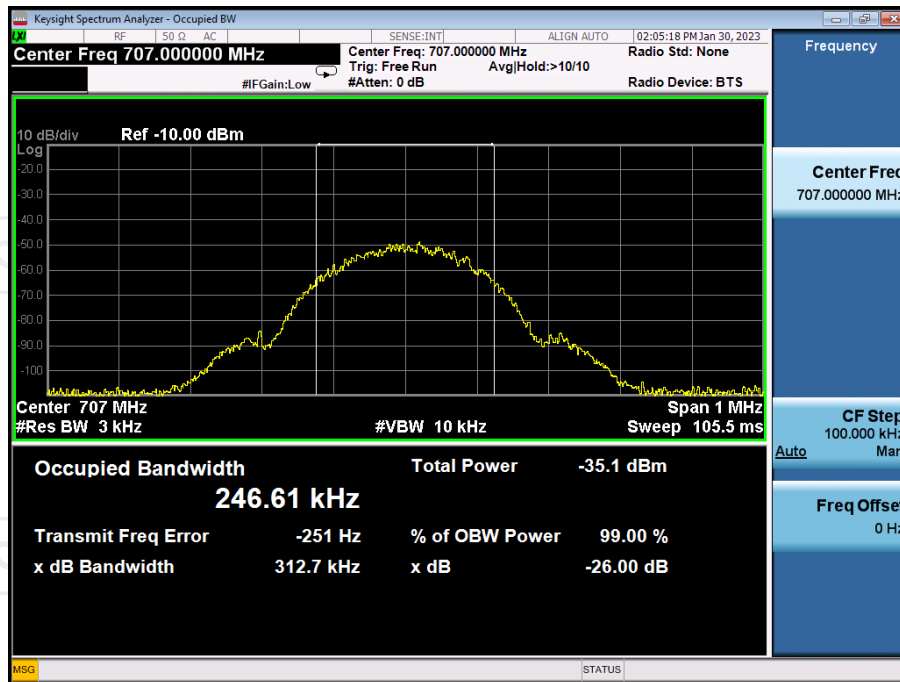
## Cellular LTE DL Input



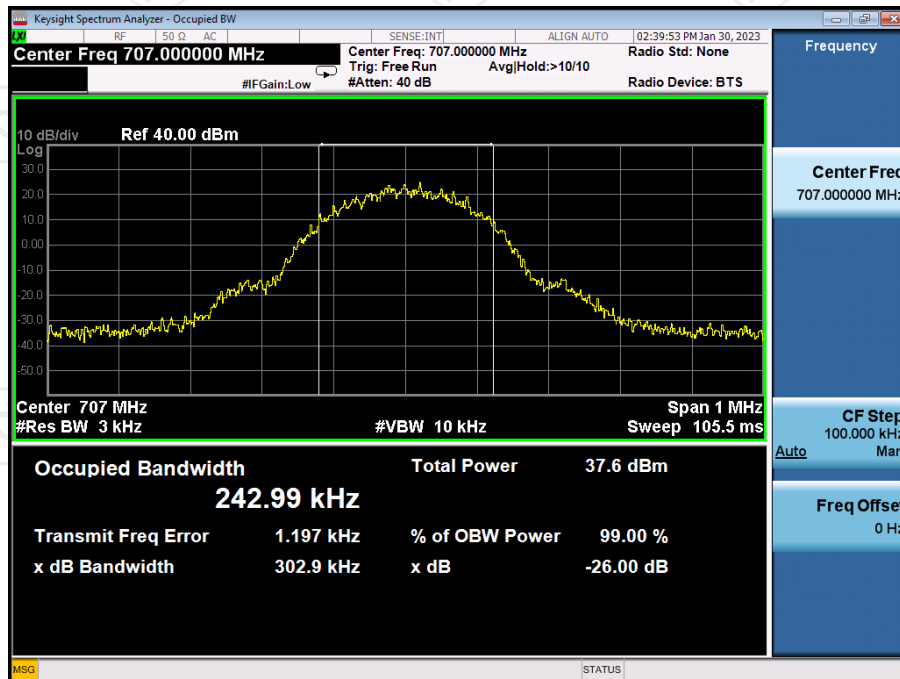
## Cellular LTE DL Output



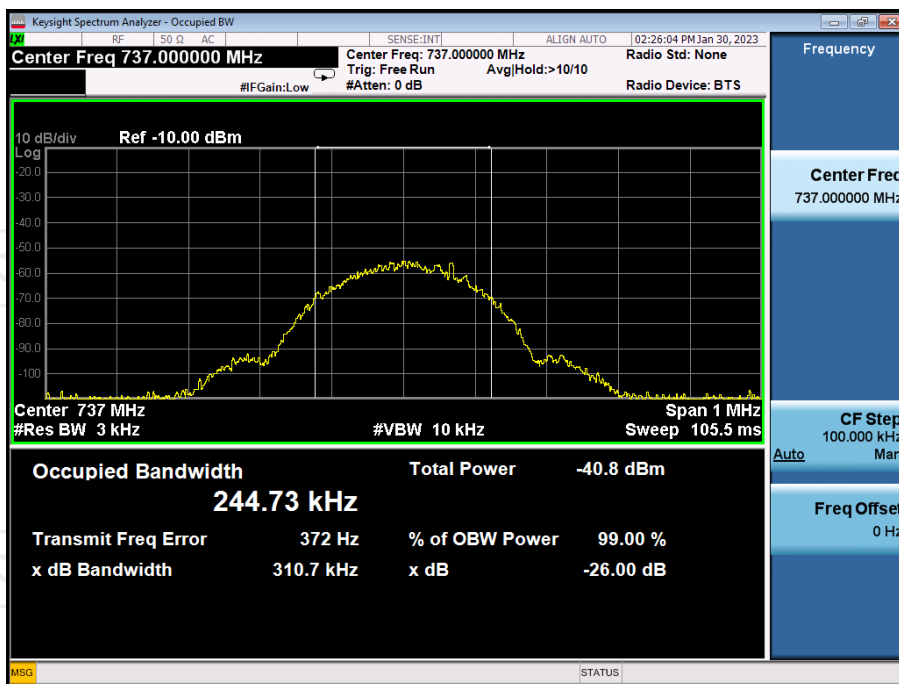
## Lower700MHz GSM UL Input



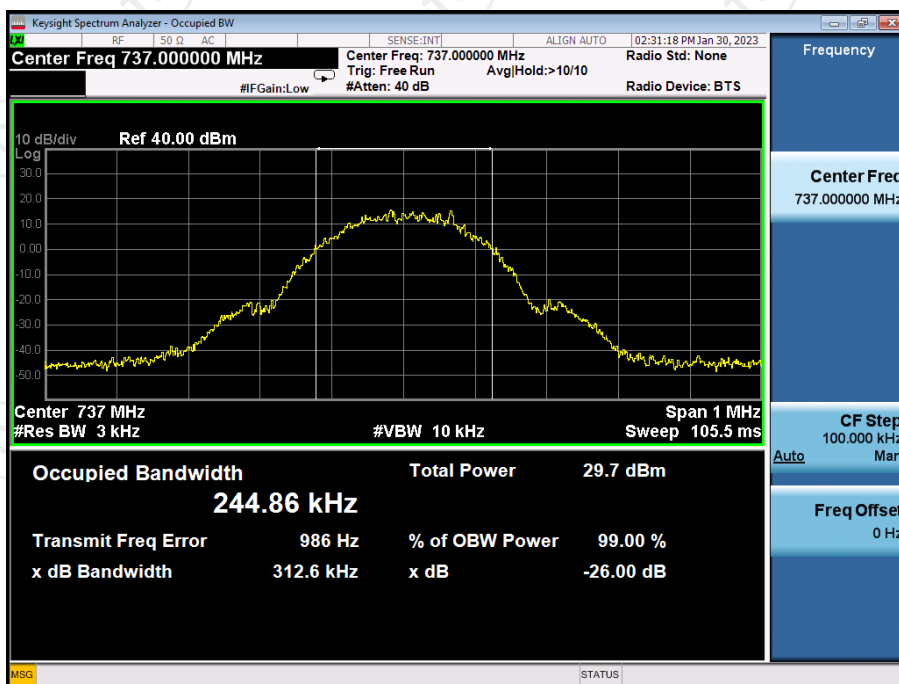
## Lower700MHz GSM UL output



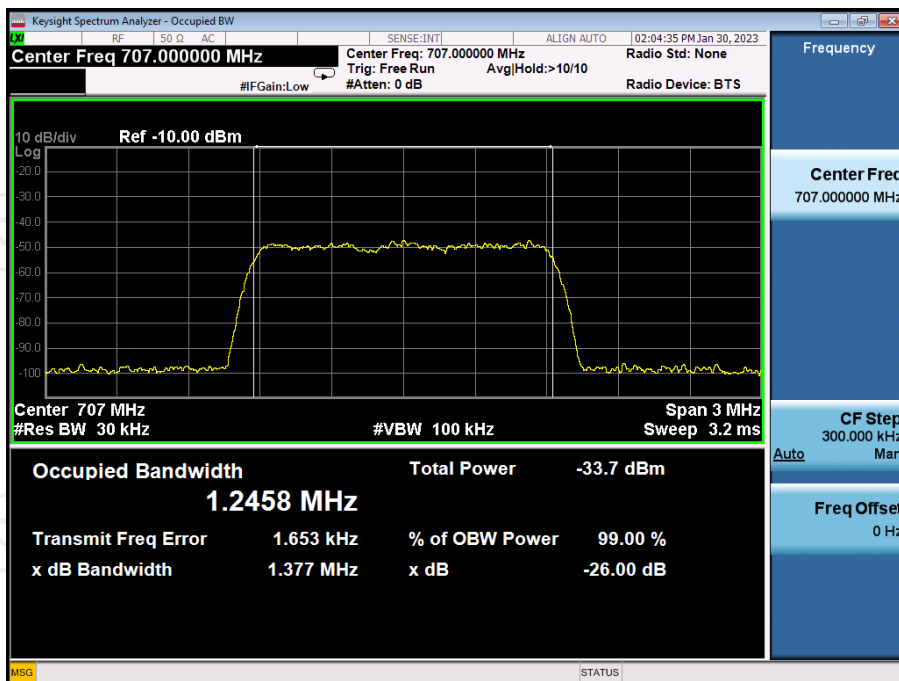
## Lower700MHz GSM DL Input



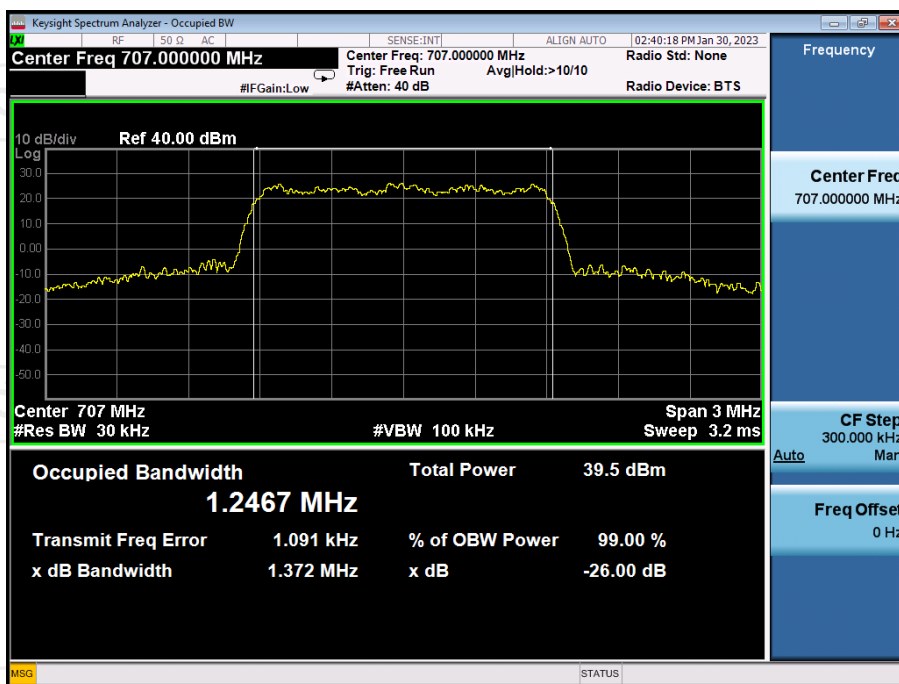
## Lower700MHz GSM DL Output



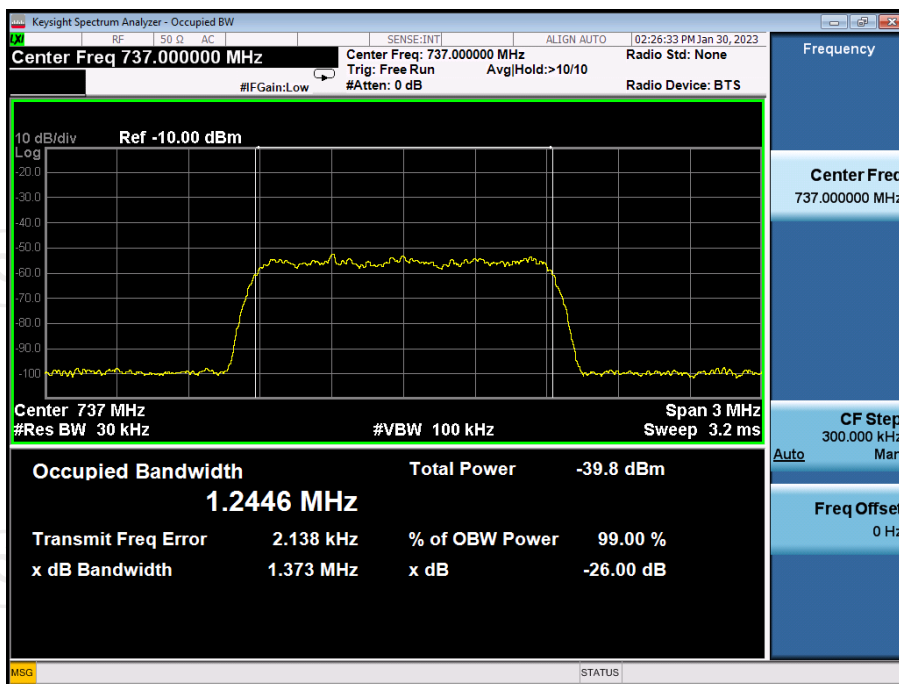
## Lower700MHz CDMA UL Input



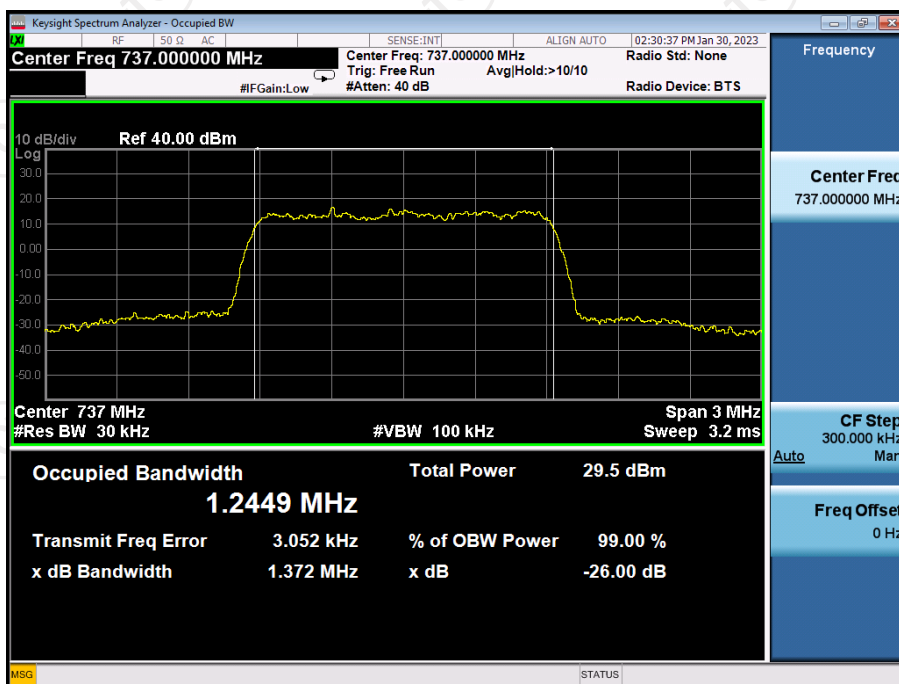
## Lower700MHz CDMA UL output



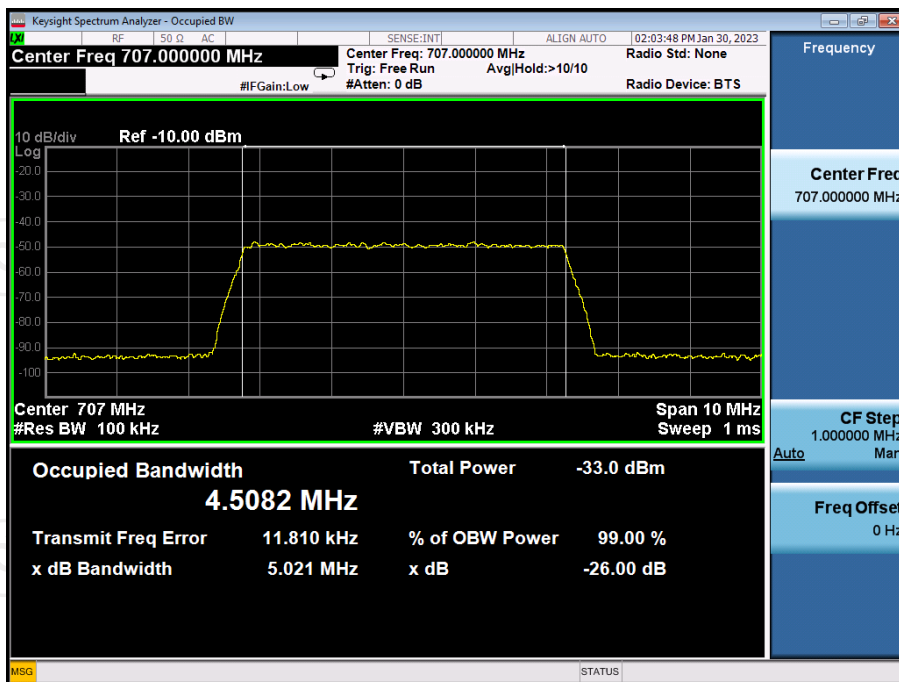
## Lower700MHz CDMA DL Input



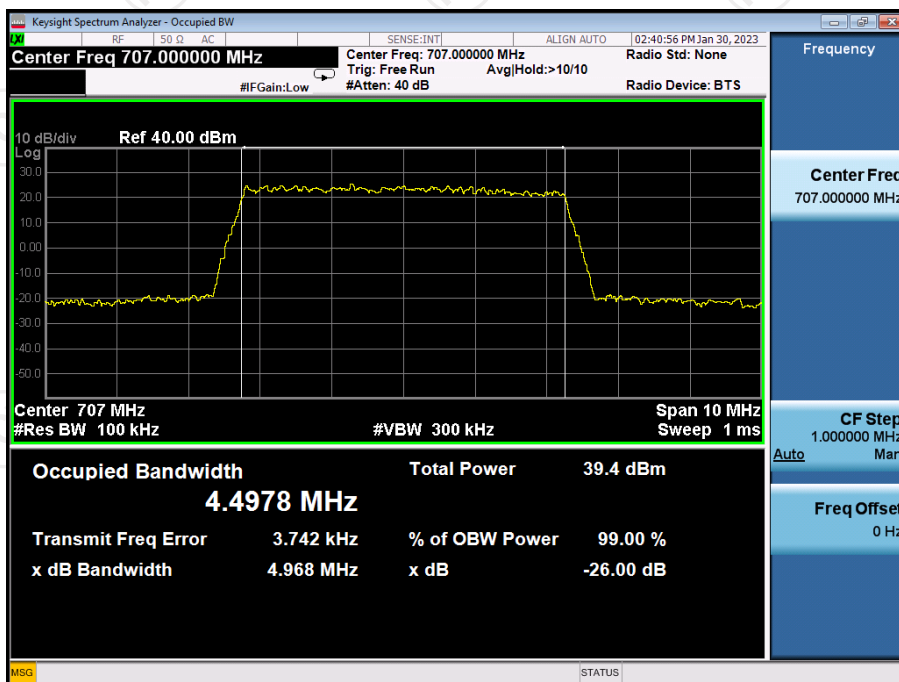
## Lower700MHz CDMA DL Output



## Lower700MHz LTE UL Input

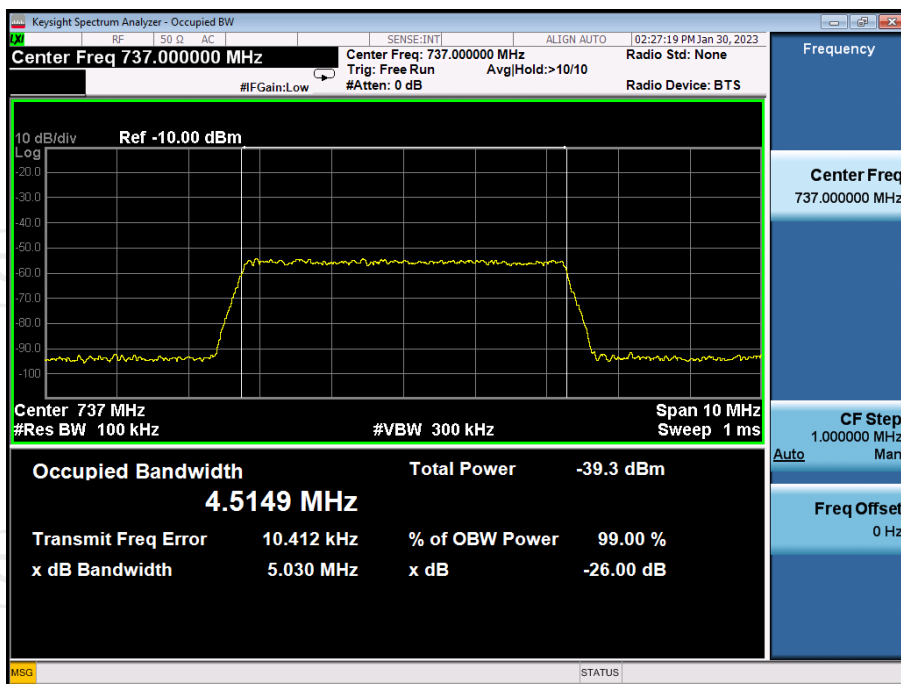


## Lower700MHz LTE UL output

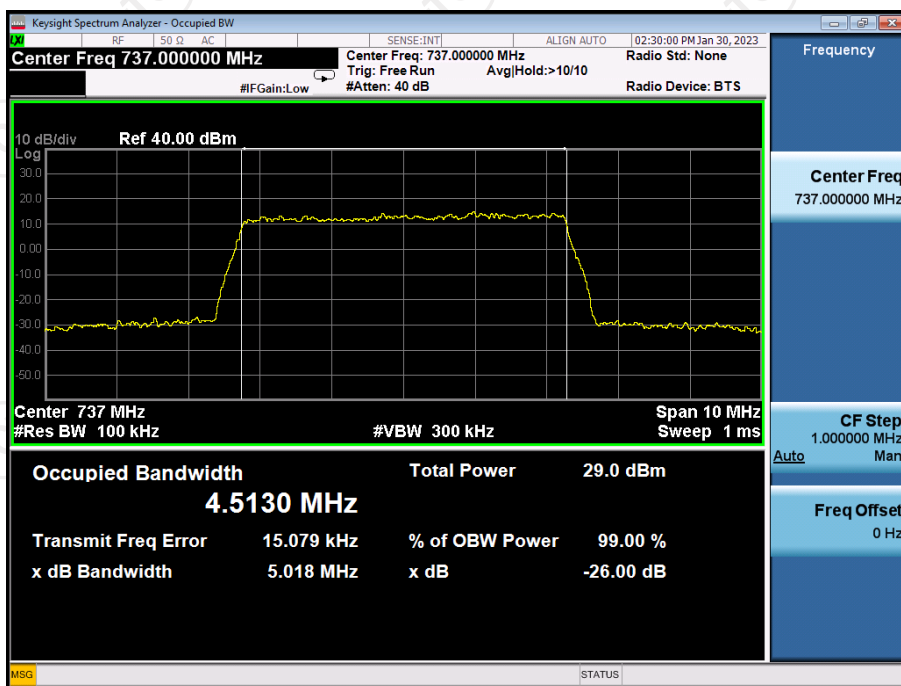




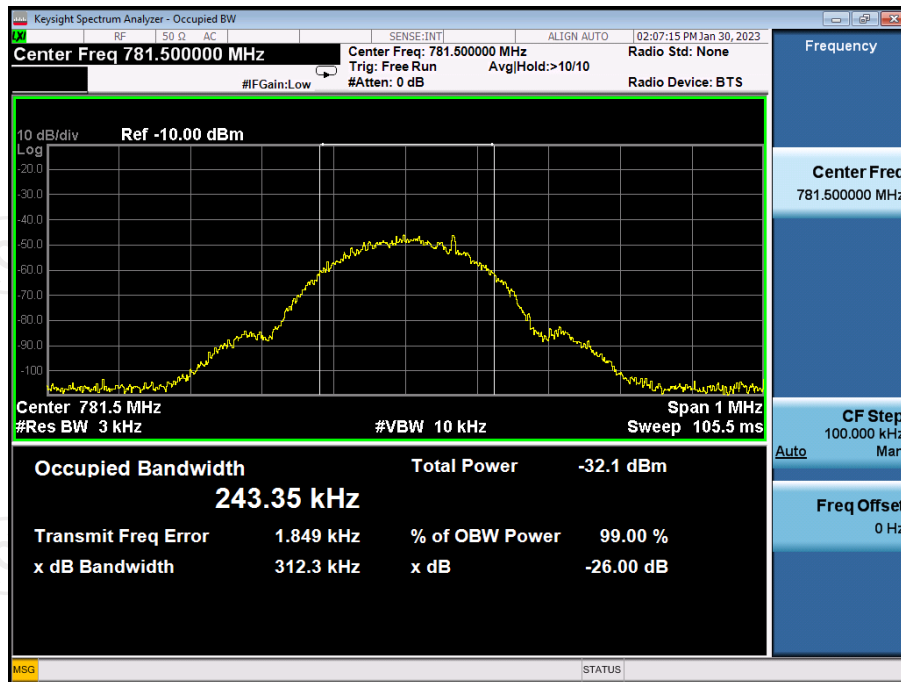
## Lower700MHz LTE DL Input



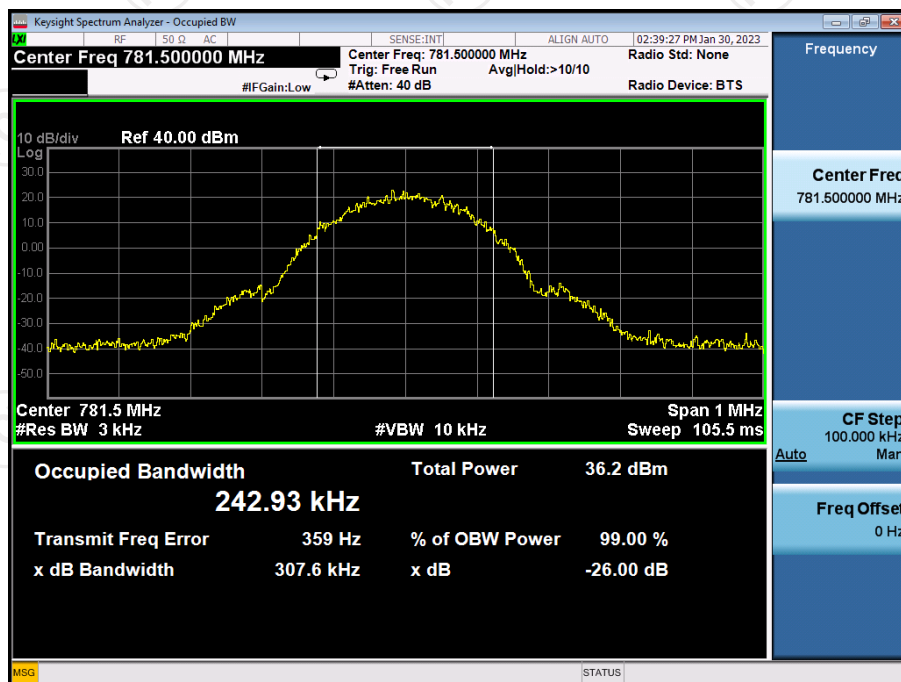
## Lower700MHz LTE DL Output



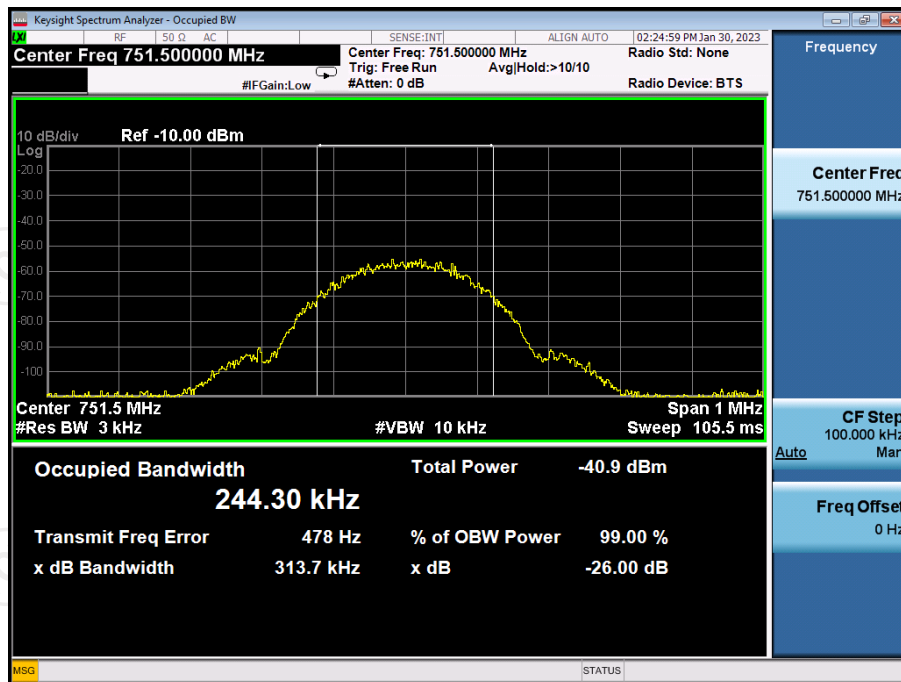
## Upper700MHz GSM UL Input



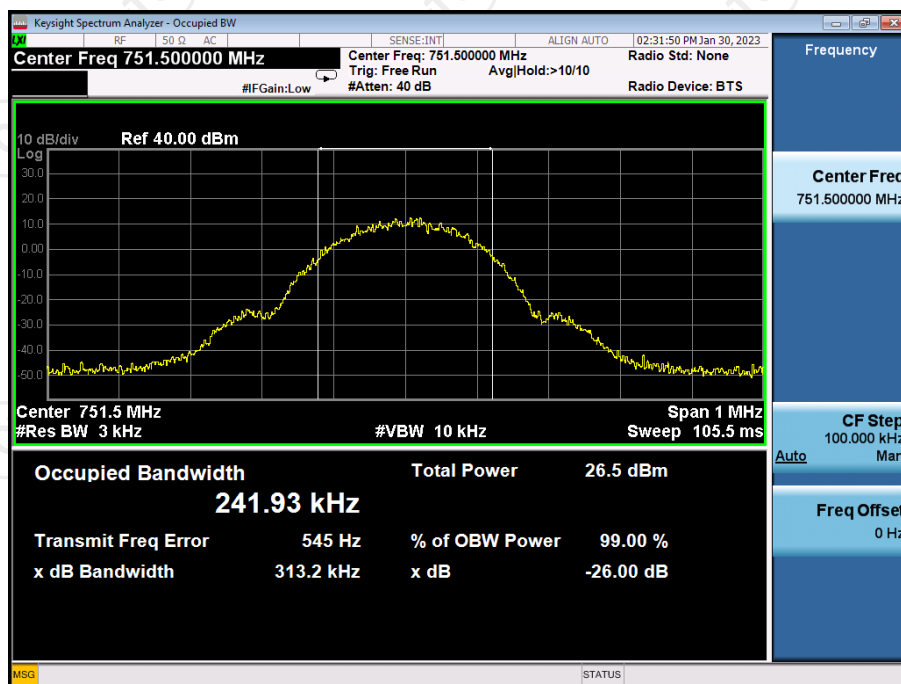
## Upper700MHz GSM UL output



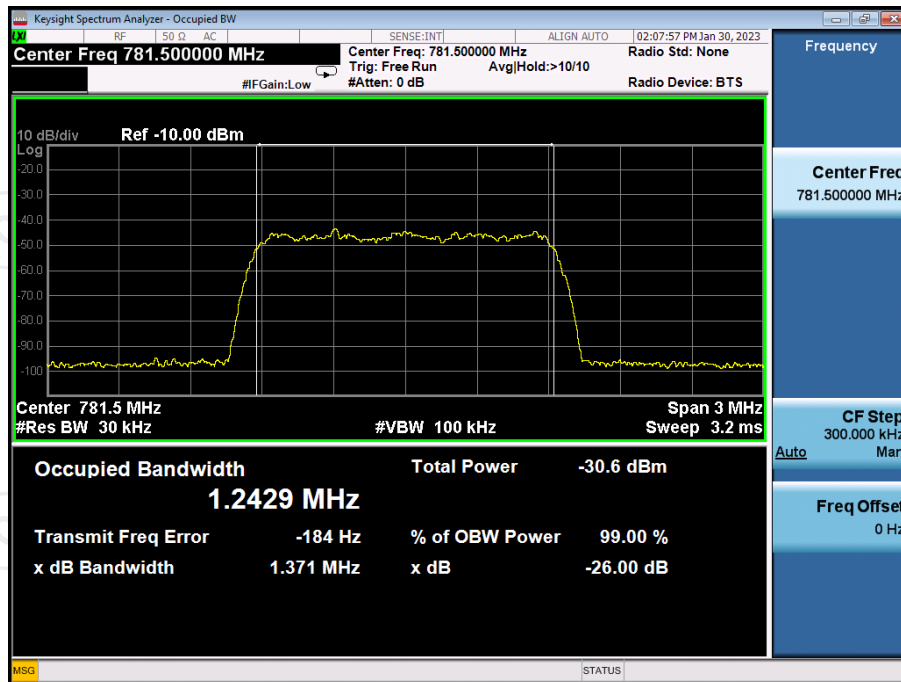
## Upper700MHz GSM DL Input



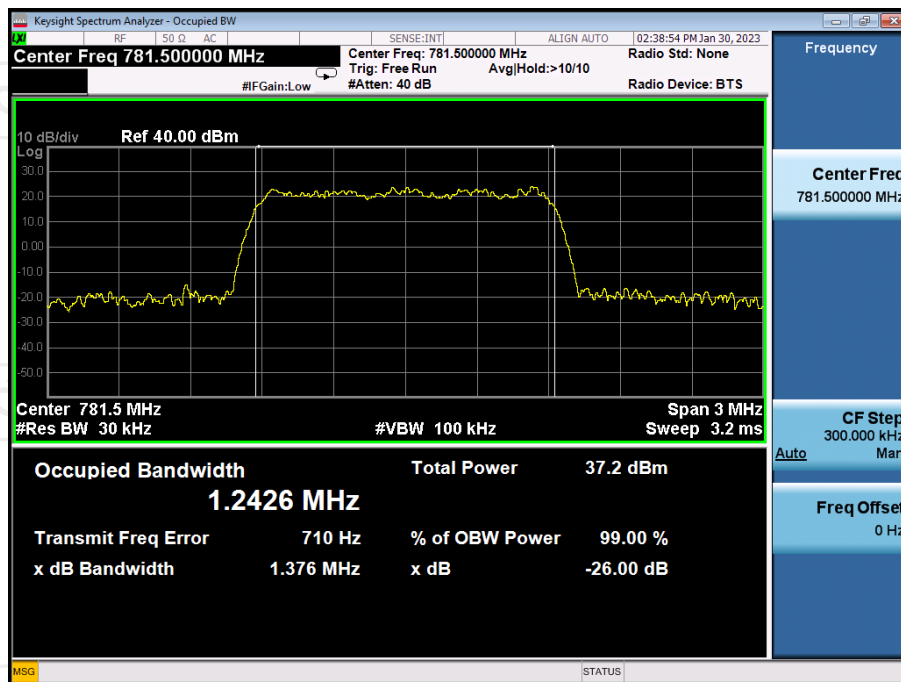
## Upper700MHz GSM DL Output



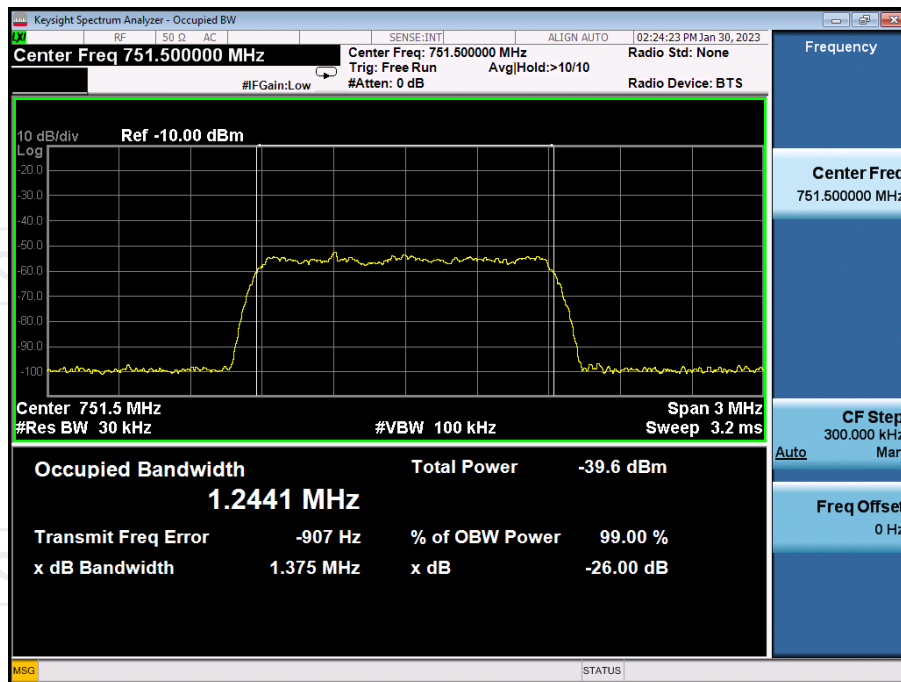
## Upper700MHz CDMA UL Input



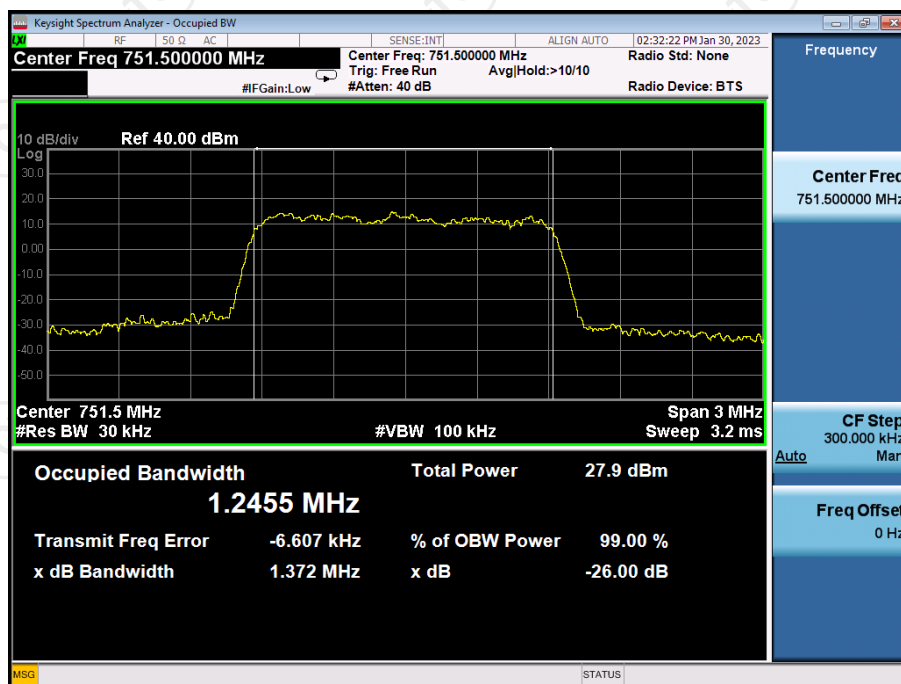
## Upper700MHz CDMA UL output



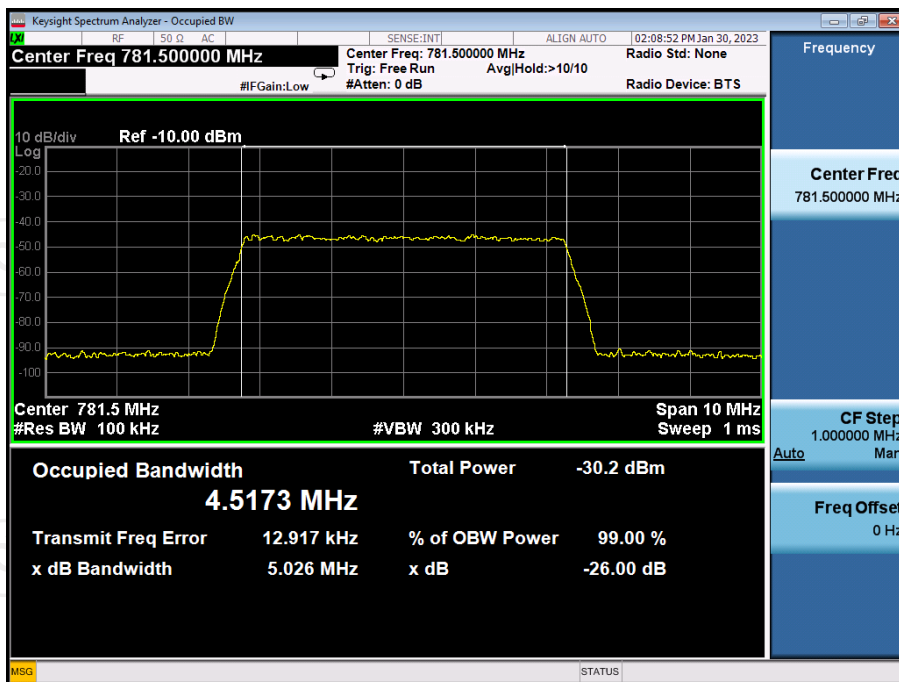
## Upper700MHz CDMA DL Input



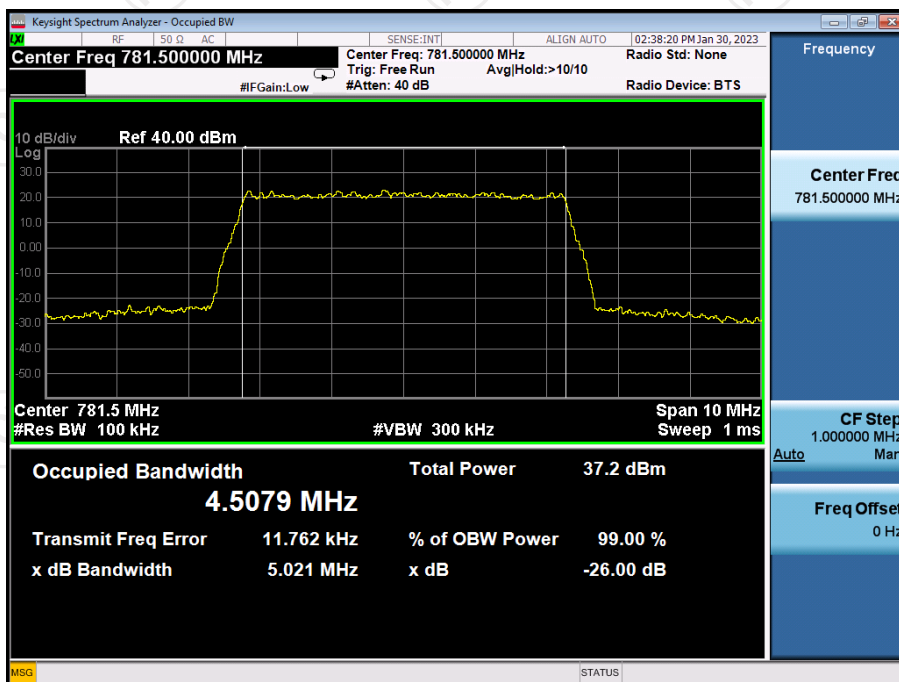
## Upper700MHz CDMA DL Output



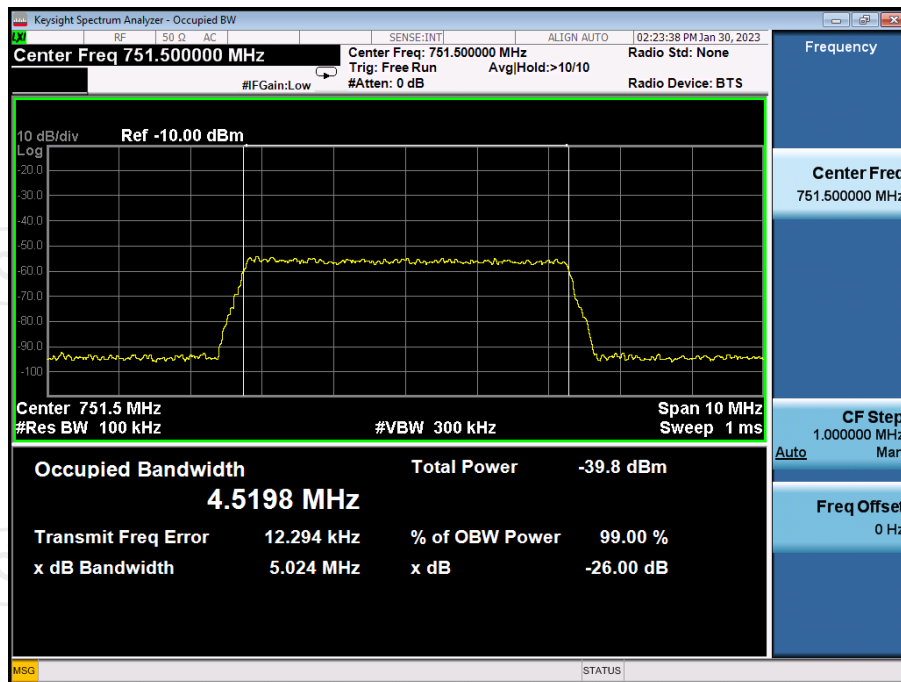
## Upper700MHz LTE UL Input



## Upper700MHz LTE UL output



## Upper700MHz LTE DL Input

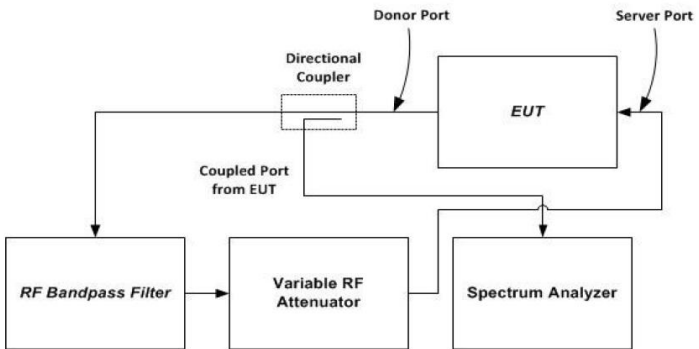
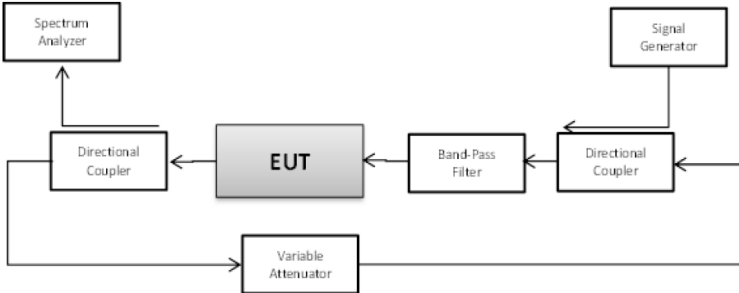


## Upper700MHz LTE DL Output



## 5.10. Oscillation Detection and Mitigation

### 5.10.1. Test Specification

|                          |   |
|--------------------------|---|
| <b>Test Requirement:</b> | FCC Part20 Section 20.21(e)(8)(ii)(A)   |
| <b>Test Method:</b>      | KDB935210 D03 Signal booster Measurements v04r04  |
| <b>Limit:</b>            | Reference to test data bellow   |
| <b>Test setup:</b>       |  <p>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.</p> <p><b>Figure 7 – Oscillation detection (7.11.2) test setup</b></p>  <p><b>Figure 8 – Oscillation mitigation/shutdown test setup</b></p>   |
| <b>Test Procedure:</b>   | <p><b>Oscillation restart tests</b></p> <ol style="list-style-type: none"> <li>Connect the normal-operating mode EUT to the test equipment as shown in Figure 7 beginning with the spectrum analyzer on the uplink output (donor) port. Confirm that the RF coupled path is connected to the spectrum analyzer.</li> </ol> <p>NOTE—The band-pass filter shall provide sufficient out-of-band rejection to prevent oscillations from occurring in bands not under test.</p> <ol style="list-style-type: none"> <li>Spectrum analyzer settings: <ol style="list-style-type: none"> <li>Center frequency at the center of the band under test</li> <li>Span equal or slightly exceeding the width of the band under test</li> <li>Continuous sweep, max-hold</li> <li>RBW<math>\geq</math>1 MHz, VBW &gt; 3xRBW</li> </ol> </li> <li>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).</li> <li>Repeat 7.11.2c) twice to ensure that the center of the signal</li> </ol> |



- 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 7.11.2d).
  - 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 7.11.2f) 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 7.11.2b) to 7.11.2k) 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 7.11.2i).
  - q) When the sweep is complete, place cursors between the first two oscillation detections, and save the Test Plots 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 7.11.2m) to 7.11.2q) for all operational uplink and downlink bands.

**Test procedure for measuring oscillation mitigation or shutdown**

- a) Connect the normal-operating mode EUT to the test equipment as shown in Figure 8.
- b) Set the spectrum analyzer center frequency to the center of band under test, and use the following settings:
  - 1) RBW=30 kHz, VBW  $\geq 3 \times$  RBW,
  - 2) power averaging (rms) detector,
  - 3) trace averages  $\geq 100$ ,
  - 4) span  $\geq 120\%$  of operational band under test

|               |  |
|---------------|--|
|               | <p>5) number of sweep points <math>\geq 2 \times \text{Span/RBW}</math>.</p> <p>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.</p> <p>1) Boosters with operating spectrum passbands of 10 MHz or less may use a CW signal source at the band edge rather than AWGN.</p> <p>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.</p> <p>d) 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.</p> <p>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 (see 7.3), for the band under test.</p> <p>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.</p> <p>1) Allow the spectrum analyzer trace to stabilize.</p> <p>2) Place the marker at the highest oscillation level occurring within the span, and record its output level and frequency.</p> <p>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.</p> <p>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.</p> <p>5) Affirm that the peak oscillation level measured in 7.11.3f2), does not exceed by 12.0 dB the minimal output level measured in 7.11.3f4). Record the measurement results of 7.11.3f2) and 7.11.3f4) in tabular format for inclusion in the test report.</p> <p>6) The procedure of 7.11.3f1) to 7.11.3f5) allows the spectrum analyzer trace to stabilize, and verification of shutdown or oscillation level measurement must occur within 300 seconds.</p> <p>g) Decrease the variable attenuator in 1 dB steps, and repeat step 7.11.3f) 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).</p> <p>h) Repeat 7.11.3a) to 7.11.3g) for all operational uplink and downlink bands.</p> |
| Test results: | PASS   |

### 5.10.2. Test Instruments

| Equipment         | Manufacturer         | Model                 | S/N        | Calibration Date | Calibration Due |
|-------------------|----------------------|-----------------------|------------|------------------|-----------------|
| Spectrum Analyzer | Agilent              | N9020A                | MY49100619 | Jul. 05, 2022    | Jul. 04, 2023   |
| Attenuation       | AF115A-09-34         | JFW                   | 907763     | /                | /               |
| RF Combiner       | SUNVNDN              | SUD-CS0800            | 16230009   | /                | /               |
| AN03468           | Band Pass Filter     | 4CS10-781.5/E12.2-O/O | /          | /                | /               |
| AN03469           | Band Pass Filter     | 4CS10-751.5/E12-O/O   | /          | /                | /               |
| AN02475           | 1 dB step Attenuator | 8494B                 | /          | /                | /               |
| AN03429           | 10dB step Attenuator | 8496B                 | /          | /                | /               |
| ANC00082          | RF Coupler           | 722-10-1.500V         | /          | /                | /               |

**5.10.3. Test Data**

| Test results of detection time |             |                    |           |        |
|--------------------------------|-------------|--------------------|-----------|--------|
| Operation Bands                |             | Detection Time (s) | Limit (s) | Result |
| Uplink                         | Cellular    | 0.270              | 0.300     | PASS   |
|                                | Lower700MHz | 0.250              | 0.300     | PASS   |
|                                | Upper700MHz | 0.045              | 0.300     | PASS   |
| Downlink                       | Cellular    | 0.600              | 1.000     | PASS   |
|                                | Lower700MHz | 0.585              | 1.000     | PASS   |
|                                | Upper700MHz | 0.585              | 1.000     | PASS   |

| Test results of restarting time |             |                    |           |                   |       |        |
|---------------------------------|-------------|--------------------|-----------|-------------------|-------|--------|
| Operation Bands                 |             | Restarting Time(s) | Limit (s) | Restarting Counts | Limit | Result |
| Uplink                          | Cellular    | 66.60              | 60        | 3                 | 5     | PASS   |
|                                 | Lower700MHz | 70.80              | 60        | 4                 | 5     | PASS   |
|                                 | Upper700MHz | 70.80              | 60        | 2                 | 5     | PASS   |
| Downlink                        | Cellular    | 65.40              | 60        | 3                 | 5     | PASS   |
|                                 | Lower700MHz | 70.20              | 60        | 3                 | 5     | PASS   |
|                                 | Upper700MHz | /                  | 60        | 0                 | 5     | PASS   |