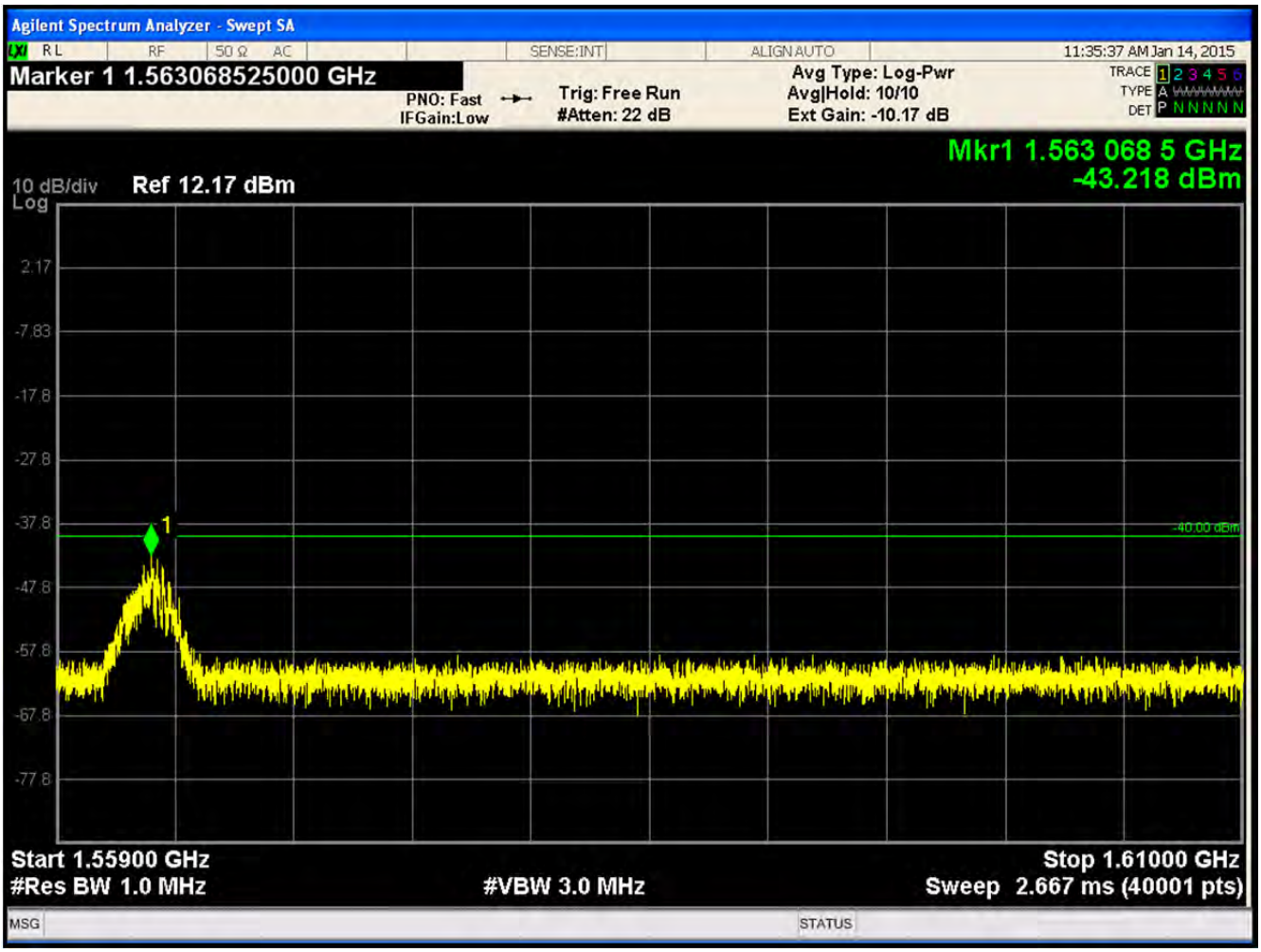
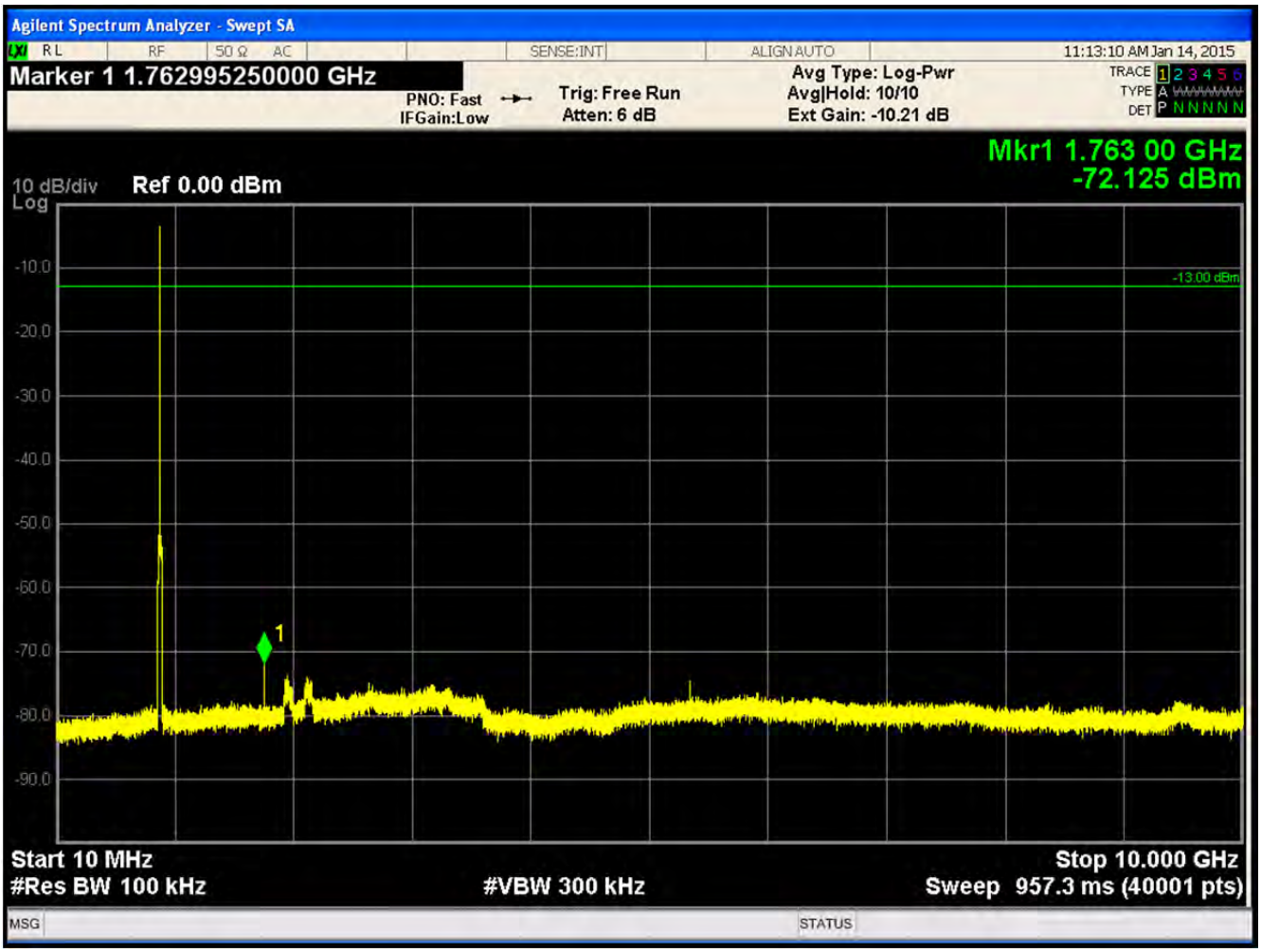
**• Band 13 / Uplink / 781.5 MHz / 1 559 MHz to 1 610 MHz**



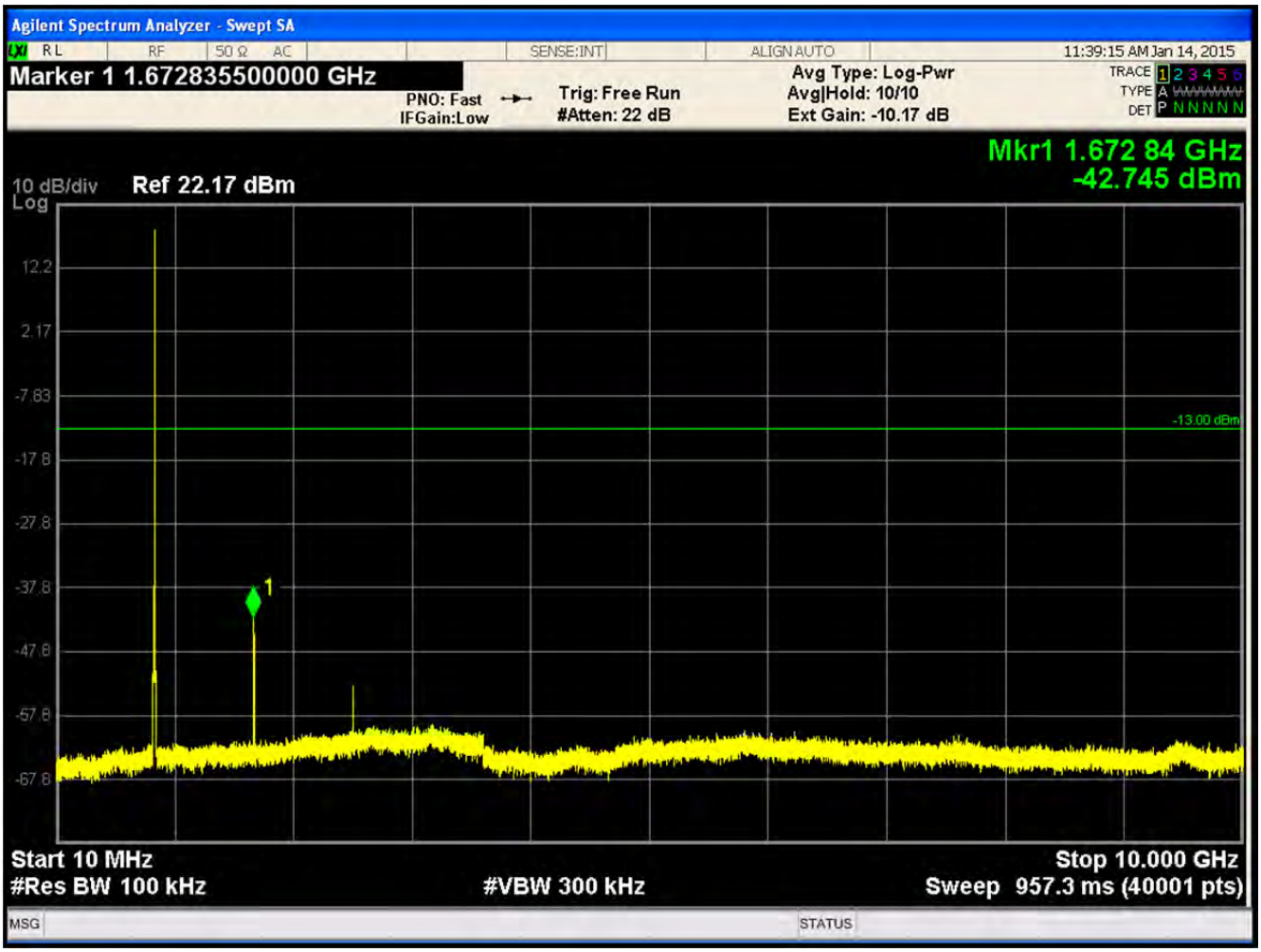

| | |
|---|---|
| Operating frequency : | 781.5 MHz |
| RBW : | 1 MHz |
| VBW : | 3 MHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 1 559 MHz to 1 610 MHz |
| Emission : | -43.21 dBm |

**• Band 5 / Downlink / 881.5 MHz / 10 MHz to 10 GHz**



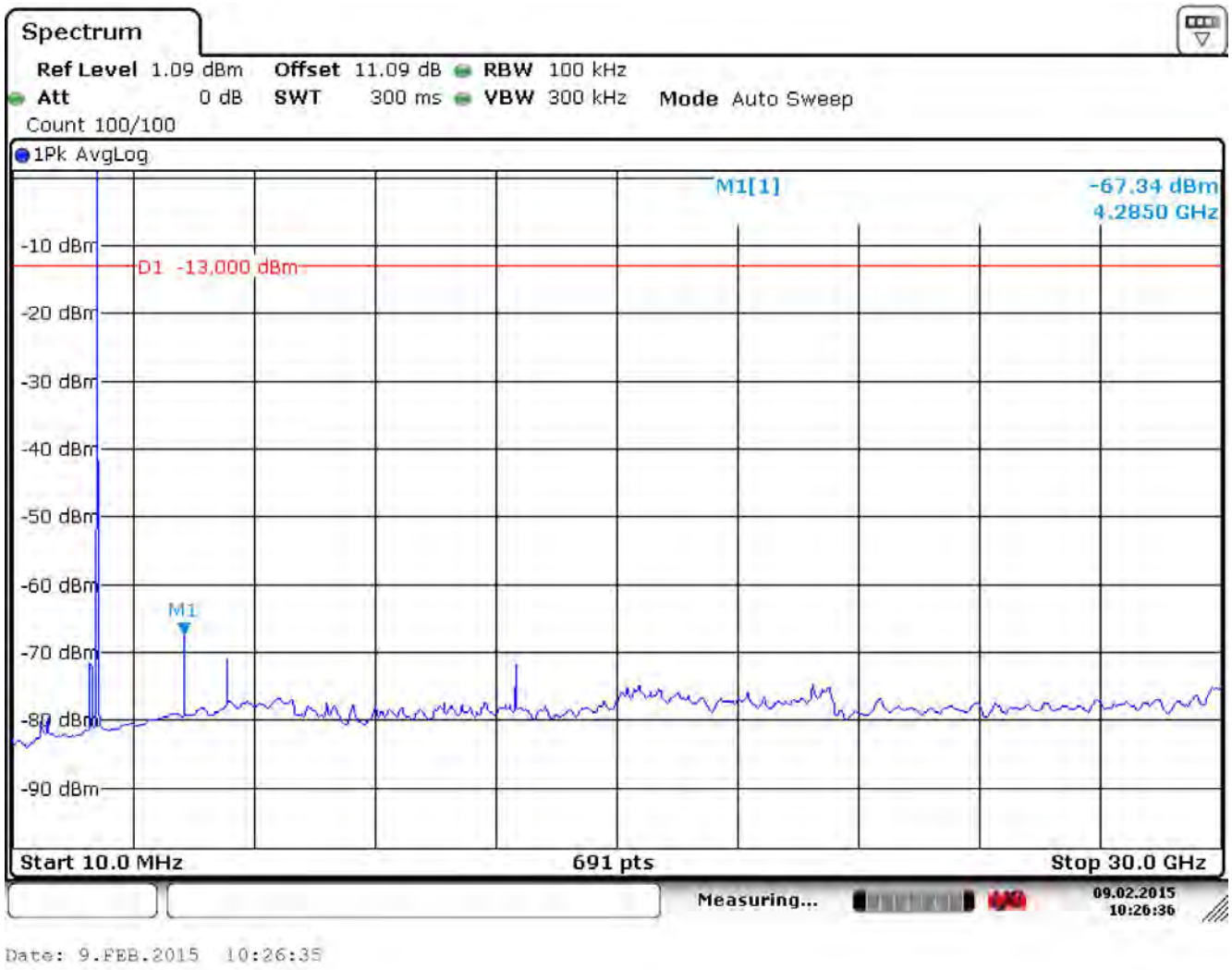

| | |
|---|---|
| Operating frequency : | 881.5 MHz |
| RBW : | 100 kHz |
| VBW : | 300 kHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 10 MHz to 10 GHz |
| Emission : | -72.12 dBm |

**• Band 5 / Uplink / 836.5 MHz / 10 MHz to 10 GHz**



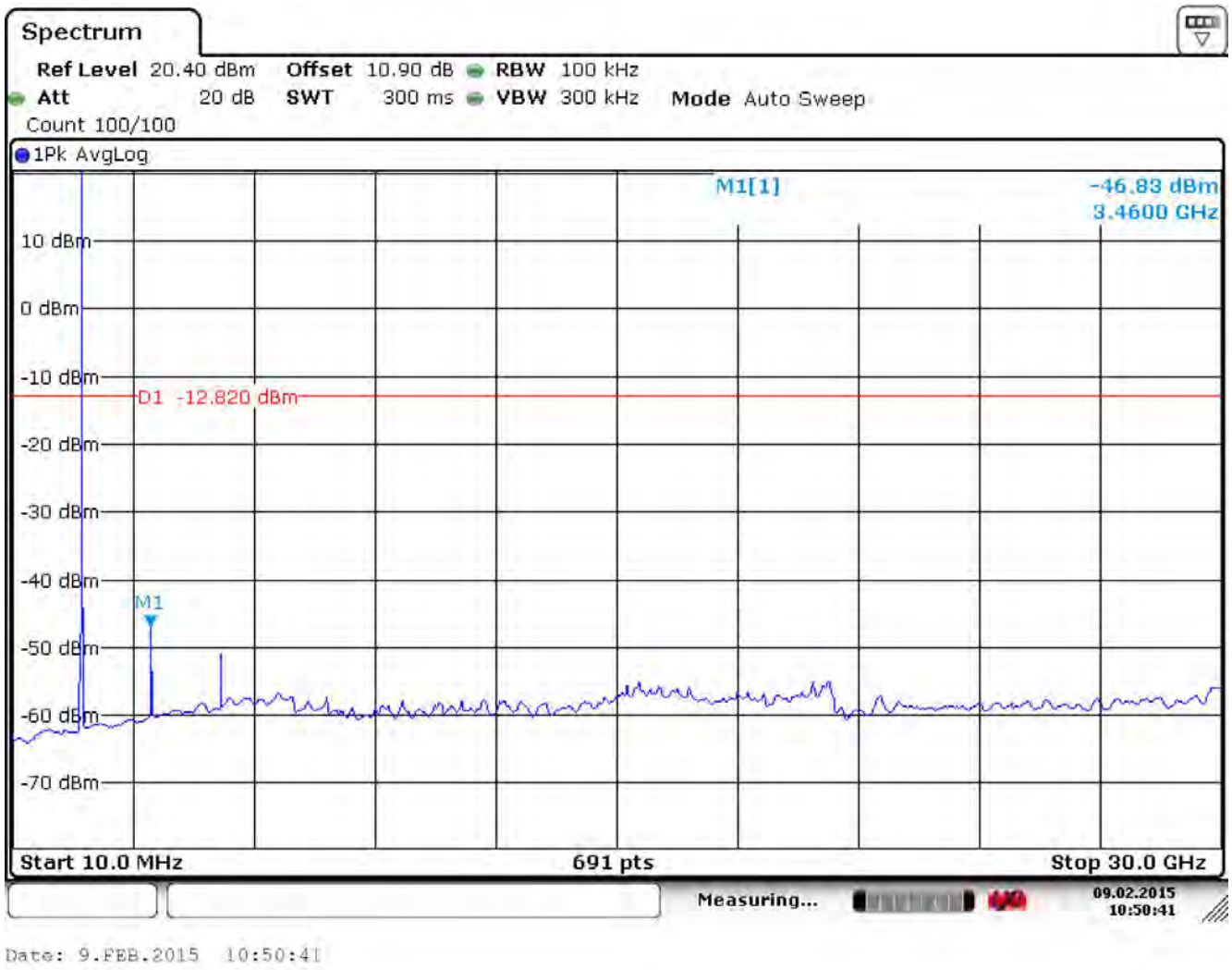

| | |
|---|---|
| Operating frequency : | 836.5 MHz |
| RBW : | 100 kHz |
| VBW : | 300 kHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 10 MHz to 10 GHz |
| Emission : | -42.74 dBm |

**• Band 4 / Downlink / 2132.5 MHz / 10 MHz to 30 GHz**



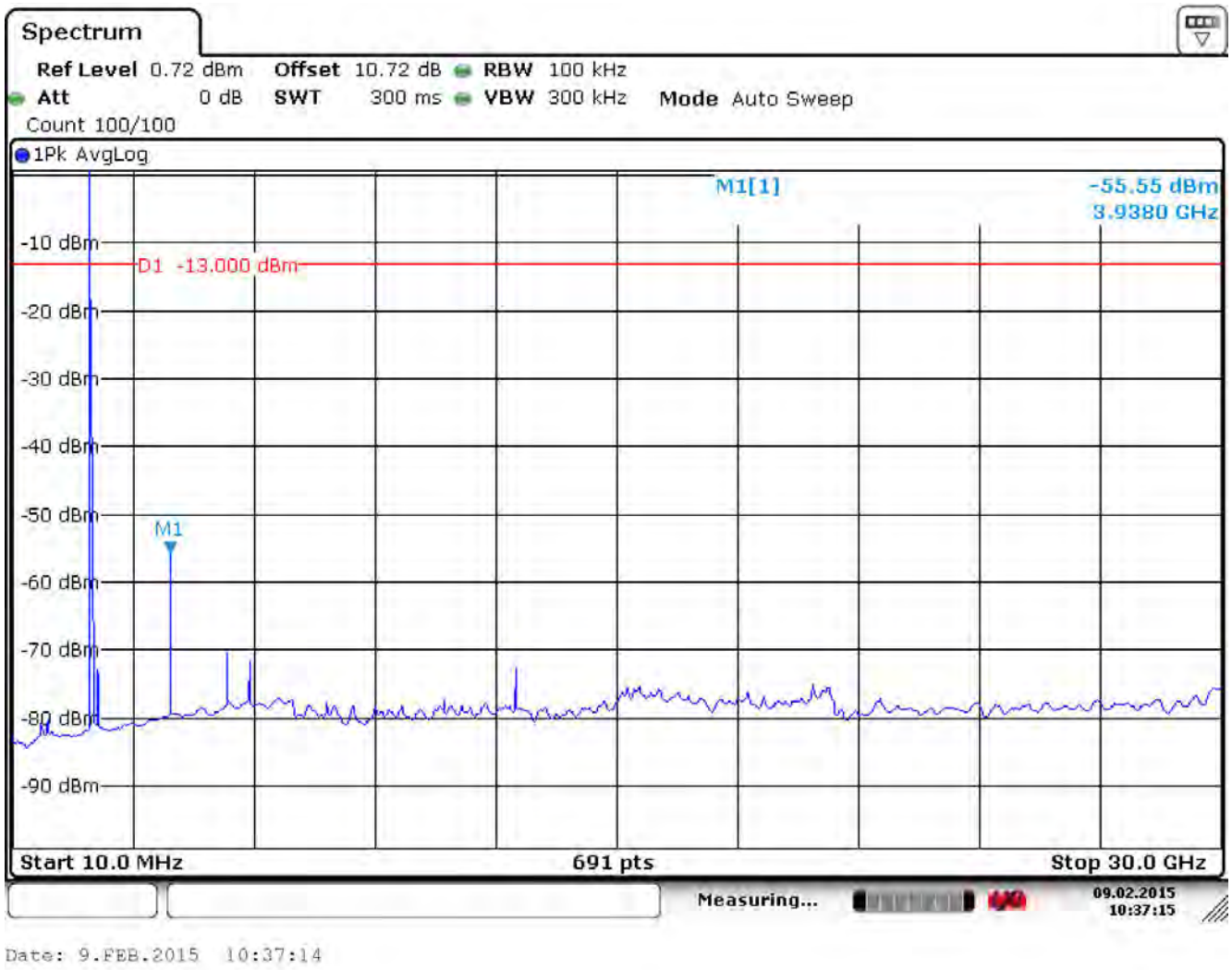

| | |
|---|---|
| Operating frequency : | 2132.5 MHz |
| RBW : | 100 kHz |
| VBW : | 300 kHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 10 MHz to 30 GHz |
| Emission : | -67.34 dBm |

**• Band 4 / Uplink / 1732.5 MHz / 10 MHz to 30 GHz**



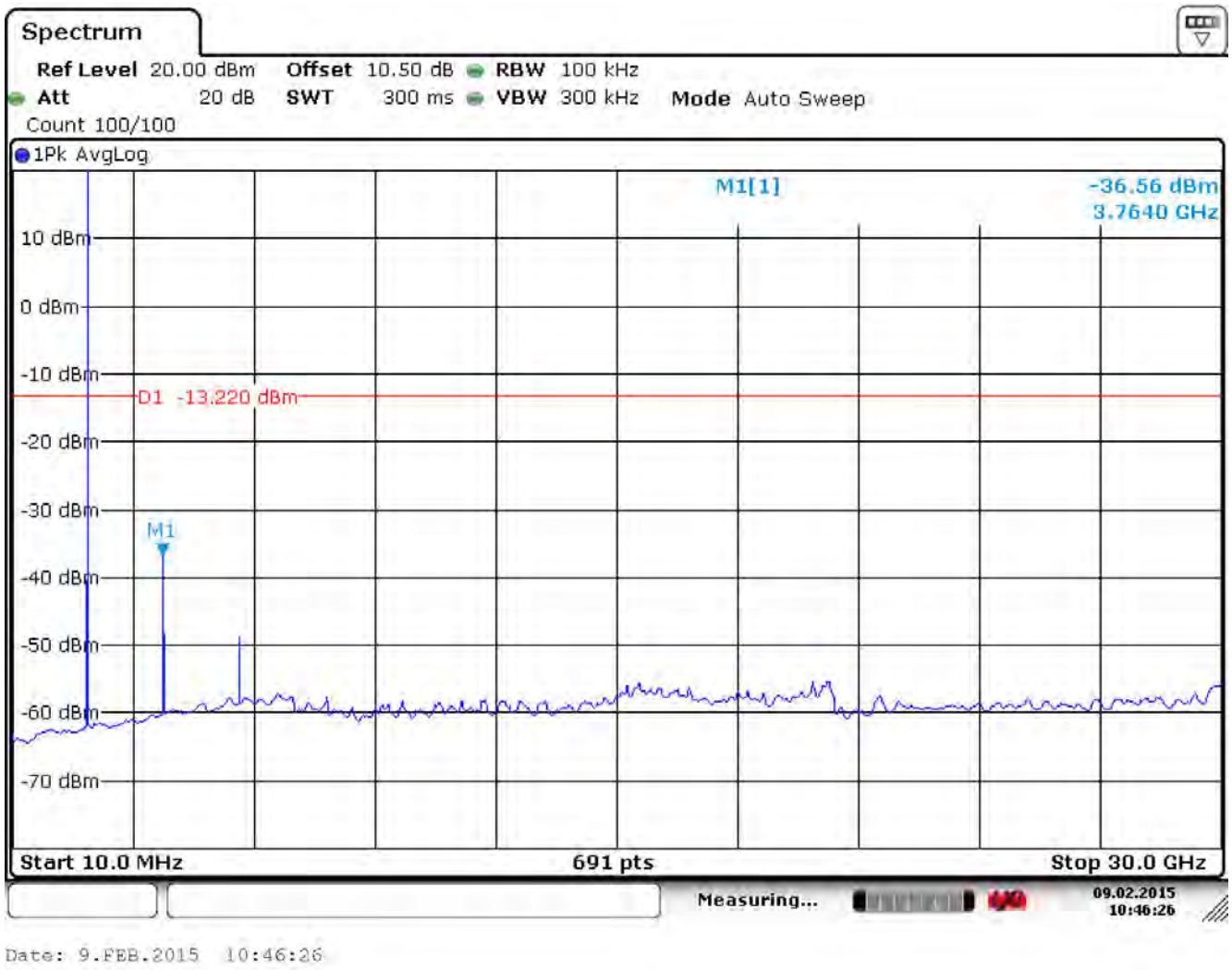

| | |
|---|---|
| Operating frequency : | 1732.5 MHz |
| RBW : | 100 kHz |
| VBW : | 300 kHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 10 MHz to 30 GHz |
| Emission : | -46.83 dBm |

**• Band 25/ Downlink / 1962.5 MHz / 10 MHz to 30 GHz**




| | |
|---|---|
| Operating frequency : | 1962.5 MHz |
| RBW : | 100 kHz |
| VBW : | 300 kHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 10 MHz to 30 GHz |
| Emission : | -55.55 dBm |

**• Band 25/ Uplink / 1882.5 MHz / 10 MHz to 30 GHz**




| | |
|---|---|
| Operating frequency : | 1882.5 MHz |
| RBW : | 100 kHz |
| VBW : | 300 kHz |
| Detector mode : | Peak |
| Trace mode : | Average |
| Emission range : | 10 MHz to 30 GHz |
| Emission : | -36.56 dBm |

## 3.7 Noise limit

### 3.7.1 Specification

• FCC Part 20.21 (e)(8)(i)(A)

### 3.7.2 Measurement method

• 935210 D03 Signal Booster Measurement v02r01

a) Connect the EUT to the test equipment as shown in Set-Up 1. Begin with the uplink output connected to the spectrum analyzer.

b) Set the spectrum analyzer RBW to 1 MHz with the VBW ≥ 3X 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 ≥ 2X 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 steps b) to f) for all operational uplink and downlink bands.

h) Connect the EUT to the test equipment as shown in Set-Up 2 for uplink and Set-Up 3 for downlink. Ensure the coupled path of the RF coupler is connected to the spectrum analyzer.

i) Configure the signal generator for 4.1 MHz AWGN operation for uplink test and 200 kHz 99% OBW AWGN for downlink test.

j) Set the spectrum analyzer RBW for 1 MHz with the VBW ≥3X the RBW with an RMS AVERAGE 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 ≥ 2X the CMRS band. This shall include all spectrum blocks in the particular CMRS band under test (see Annex A). 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. For downlink noise measurements, set the spectrum analyzer to the center of the downlink band and tune the signal generator to the upper or lower band-edge of the same band, ensuring that the maximum noise power is being measured.

l) Measure the maximum transmitter noise power level when varying the downlink signal generator level from −90 dBm to −20 dBm in 1 dB steps within the RSSI dependent region and 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.

m) Repeat g) through l) for all operational uplink and downlink bands.

n) Variable uplink noise timing is to be measured as follows.

o) Set the spectrum analyzer to the uplink frequency to be measured.

p) Set the span to 0 Hz with a sweep time of 10 seconds.

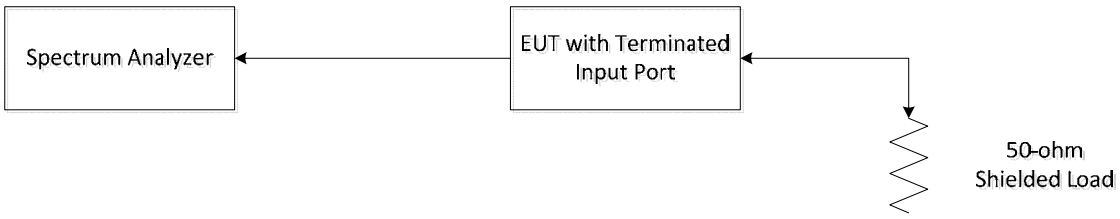
q) Set the power level of the signal generator to the lowest level of the RSSI dependent noise.

r) Select MAX HOLD and increase the power level of the signal generator by 10 dB for mobile boosters and 20 dB for fixed boosters.

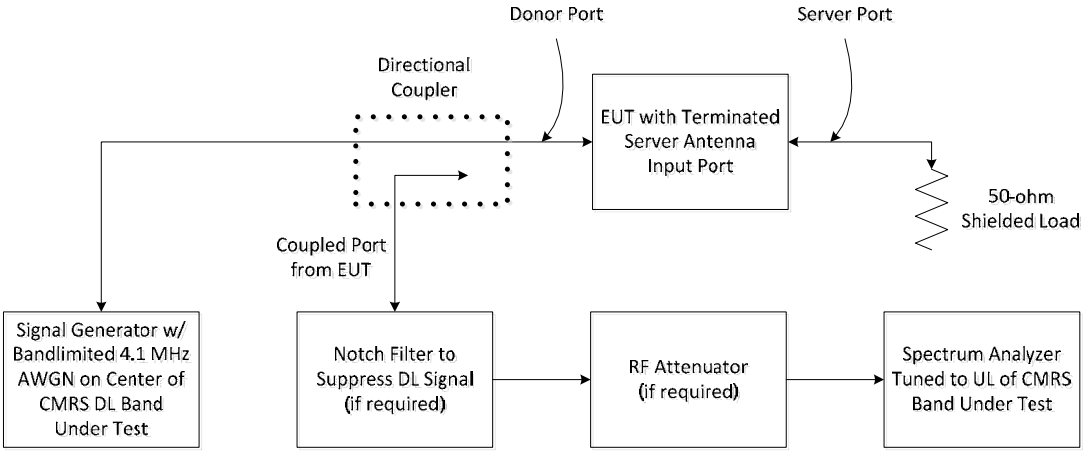
s) Ensure that the uplink noise decreases to the specified level within 1 second for mobile devices and 3 seconds for fixed devices.

t) Repeat n) to s) for all operational uplink and downlink bands

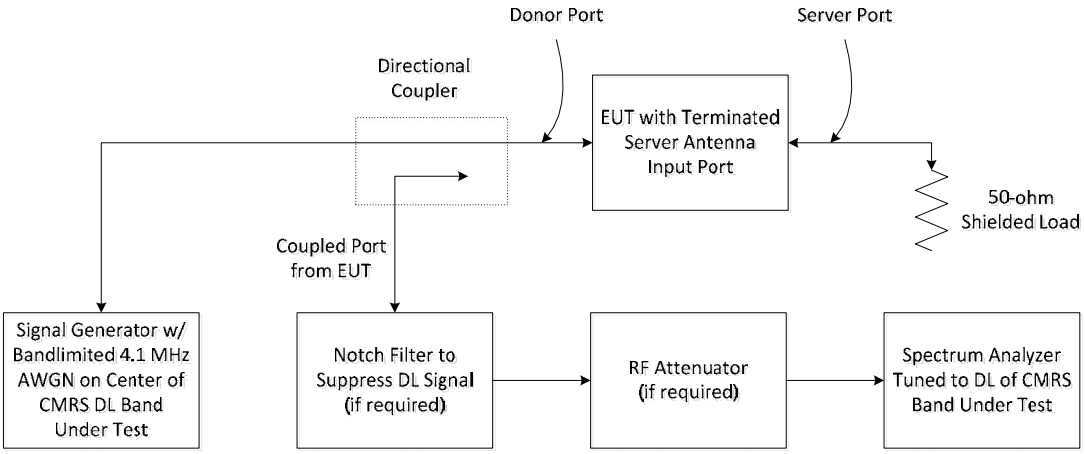
### 3.7.3 Set-up 1 (Noise limit instrumentation setup)




### 3.7.4 Set-up 2 (Test setup for uplink noise power measurement in the presence of a downlink signal)




### 3.7.5 Set-up 3 (Test setup for downlink noise power measurement in the presence of a downlink signal)




### 3.7.6 Limit

- §20.21(e)(8)(i)(A)(1), The transmitted noise power in dBm/MHz of consumer boosters at their uplink and downlink ports shall not exceed −103 dBm/MHz—RSSI.
- §20.21(e)(8)(i)(A)(2)(i), Fixed booster maximum noise power shall not exceed −102.5 dBm/MHz + 20 log (F), where Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz.

### 3.7.7 Test equipment list

| Equipment | Model Name | Manufacturer |
|---|---|---|
| EUT | USHR-781921-5B | OPISYS Incorporated |
| Signal Generator | N5182A | Agilent |
| Signal Generator | E4432B | Agilent |
| Spectrum Analyzer | N9020A | Agilent |
| Directional Coupler | 87300B | Agilent |
| Attenuator | AF115A-09-34 | Weinschel |

### 3.7.8 Test condition

• Test place: Shield Room
• Test environment: 23.0 °C, 44 % R.H.

### 3.7.9 Test results of noise limit

| Band | Link | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 12 | Downlink | -47.2 | -45.5 | 2.2 |
| | Uplink | -48.1 | -45.5 | 2.6 |
| Band 13 | Downlink | -47.4 | -44.6 | 2.8 |
| | Uplink | -46.5 | -44.6 | 1.9 |
| Band 5 | Downlink | -45.6 | -44.1 | 1.5 |
| | Uplink | -46.9 | -44.1 | 2.8 |
| Band 4 | Downlink | -38.5 | -37.0 | 1.5 |
| | Uplink | -42.6 | -37.7 | 4.9 |
| Band 25 | Downlink | -37.5 | -37.0 | 0.5 |
| | Uplink | -40.1 | -37.0 | 3.1 |

### 3.7.10 Test results of variable downlink noise limit

| Band | RSSI [dBm] | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 12 | -90.0 | -48.56 | -45.5 | 3.66 |
| | -70.0 | -48.36 | -45.5 | 3.46 |
| | -69.0 | -48.48 | -45.5 | 3.58 |
| | -68.0 | -48.59 | -45.5 | 3.69 |
| | -60.0 | -48.34 | -45.5 | 3.44 |
| | -58.0 | -46.50 | -45.5 | 1.00 |
| | -55.0 | -51.29 | -48.0 | 3.29 |
| | -50.0 | -56.40 | -53.0 | 3.40 |
| | -45.0 | -61.11 | -58.0 | 3.11 |
| | -42.0 | -63.56 | -61.0 | 2.56 |
| | -41.0 | -64.08 | -62.0 | 2.08 |
| | -40.0 | -73.20 | -63.0 | 10.20 |
| | -39.0 | -82.09 | -64.0 | 18.09 |
| | -38.0 | -82.55 | -65.0 | 17.55 |
| | -30.0 | -82.13 | -70.0 | 12.13 |
| Band 13 | -90.0 | -48.89 | -44.6 | 4.29 |
| | -70.0 | -48.49 | -44.6 | 3.89 |
| | -69.0 | -48.35 | -44.6 | 3.75 |
| | -68.0 | -48.15 | -44.6 | 3.45 |
| | -60.0 | -48.30 | -44.6 | 3.70 |
| | -58.0 | -46.74 | -44.6 | 2.14 |
| | -55.0 | -50.67 | -48.0 | 2.67 |
| | -50.0 | -55.46 | -53.0 | 2.46 |
| | -45.0 | -60.04 | -58.0 | 2.04 |
| | -42.0 | -62.63 | -61.0 | 1.63 |
| | -41.0 | -63.29 | -62.0 | 1.29 |
| | -40.0 | -63.99 | -63.0 | 0.99 |
| | -39.0 | -82.00 | -64.0 | 18.00 |
| | -38.0 | -82.33 | -65.0 | 17.33 |
| | -30.0 | -82.17 | -70.0 | 12.17 |

| Band | RSSI [dBm] | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 5 | -90.0 | -47.55 | -44.1 | 3.45 |
| | -70.0 | -47.11 | -44.1 | 3.01 |
| | -69.0 | -47.26 | -44.1 | 3.16 |
| | -68.0 | -47.32 | -44.1 | 3.22 |
| | -60.0 | -47.31 | -44.1 | 3.21 |
| | -59.0 | -46.80 | -44.1 | 2.70 |
| | -55.0 | -51.90 | -48.0 | 3.90 |
| | -50.0 | -57.14 | -53.0 | 4.14 |
| | -45.0 | -61.55 | -58.0 | 3.55 |
| | -42.0 | -63.87 | -61.0 | 2.87 |
| | -41.0 | -64.77 | -62.0 | 2.77 |
| | -40.0 | -82.05 | -63.0 | 19.05 |
| | -39.0 | -82.41 | -64.0 | 18.41 |
| | -38.0 | -82.25 | -65.0 | 17.25 |
| | -30.0 | -82.65 | -70.0 | 12.65 |
| Band 4 | -90.0 | -39.75 | -37.0 | 2.75 |
| | -70.0 | -39.55 | -37.0 | 2.55 |
| | -69.0 | -39.55 | -37.0 | 2.55 |
| | -68.0 | -39.85 | -37.0 | 2.85 |
| | -67.0 | -40.82 | -36.0 | 4.82 |
| | -60.0 | -47.69 | -43.0 | 4.69 |
| | -55.0 | -52.73 | -48.0 | 4.73 |
| | -50.0 | -57.59 | -53.0 | 4.59 |
| | -45.0 | -62.53 | -58.0 | 4.53 |
| | -42.0 | -64.47 | -61.0 | 3.47 |
| | -41.0 | -65.60 | -62.0 | 3.60 |
| | -40.0 | -71.18 | -63.0 | 8.18 |
| | -39.0 | -82.34 | -64.0 | 18.34 |
| | -38.0 | -82.33 | -65.0 | 17.33 |
| | -30.0 | -82.29 | -70.0 | 12.29 |

| Band | RSSI [dBm] | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 25 | -90.0 | -38.75 | -37.0 | 1.75 |
| | -70.0 | -38.64 | -37.0 | 1.64 |
| | -69.0 | -38.19 | -37.0 | 1.19 |
| | -68.0 | -38.66 | -37.0 | 1.66 |
| | -67.0 | -38.91 | -37.0 | 1.91 |
| | -60.0 | -45.25 | -43.0 | 2.25 |
| | -55.0 | -50.05 | -48.0 | 2.05 |
| | -50.0 | -54.82 | -53.0 | 1.82 |
| | -45.0 | -59.83 | -58.0 | 1.83 |
| | -42.0 | -62.20 | -61.0 | 1.20 |
| | -41.0 | -62.81 | -62.0 | 0.81 |
| | -40.0 | -63.47 | -63.0 | 0.47 |
| | -39.0 | -81.99 | -64.0 | 17.99 |
| | -38.0 | -81.78 | -65.0 | 16.78 |
| | -30.0 | -82.40 | -70.0 | 12.40 |

### 3.7.11 Test results of variable uplink noise limit

| Band | RSSI [dBm] | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 12 | -90.0 | -51.20 | -45.5 | 5.70 |
| | -70.0 | -50.60 | -45.5 | 5.10 |
| | -69.0 | -51.68 | -45.5 | 6.18 |
| | -68.0 | -52.49 | -45.5 | 6.99 |
| | -60.0 | -59.55 | -45.5 | 14.05 |
| | -58.0 | -58.80 | -45.5 | 13.30 |
| | -55.0 | -63.54 | -48.0 | 15.54 |
| | -50.0 | -67.92 | -53.0 | 14.92 |
| | -45.0 | -71.77 | -58.0 | 13.77 |
| | -42.0 | -73.80 | -61.0 | 12.80 |
| | -41.0 | -74.01 | -62.0 | 12.01 |
| | -40.0 | -82.33 | -63.0 | 19.33 |
| | -39.0 | -81.78 | -64.0 | 17.78 |
| | -38.0 | -82.30 | -65.0 | 17.30 |
| | -30.0 | -82.00 | -70.0 | 12.00 |
| Band 13 | -90.0 | -48.54 | -44.6 | 3.94 |
| | -70.0 | -48.26 | -44.6 | 3.66 |
| | -69.0 | -48.95 | -44.6 | 4.35 |
| | -68.0 | -49.00 | -44.6 | 4.40 |
| | -60.0 | -57.22 | -44.6 | 12.62 |
| | -58.0 | -56.82 | -44.6 | 12.22 |
| | -55.0 | -60.94 | -48.0 | 12.94 |
| | -50.0 | -66.15 | -53.0 | 13.15 |
| | -45.0 | -70.20 | -58.0 | 12.20 |
| | -42.0 | -72.63 | -61.0 | 11.63 |
| | -41.0 | -73.36 | -62.0 | 11.36 |
| | -40.0 | -81.95 | -63.0 | 18.95 |
| | -39.0 | -82.46 | -64.0 | 18.46 |
| | -38.0 | -82.38 | -65.0 | 17.38 |
| | -30.0 | -82.61 | -70.0 | 12.61 |

| Band | RSSI [dBm] | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 5 | -90.0 | -46.77 | -44.1 | 2.67 |
| | -70.0 | -46.54 | -44.1 | 2.44 |
| | -69.0 | -46.72 | -44.1 | 2.62 |
| | -68.0 | -46.69 | -44.1 | 2.59 |
| | -60.0 | -54.69 | -44.1 | 10.59 |
| | -59.0 | -54.01 | -44.1 | 9.91 |
| | -55.0 | -59.31 | -48.0 | 11.31 |
| | -50.0 | -64.28 | -53.0 | 11.28 |
| | -45.0 | -68.92 | -58.0 | 10.92 |
| | -42.0 | -71.54 | -61.0 | 10.54 |
| | -41.0 | -72.40 | -62.0 | 10.40 |
| | -40.0 | -73.06 | -63.0 | 10.06 |
| | -39.0 | -73.70 | -64.0 | 9.70 |
| | -38.0 | -82.41 | -65.0 | 17.41 |
| | -30.0 | -82.15 | -70.0 | 12.15 |
| Band 4 | -90.0 | -41.21 | -37.7 | 3.57 |
| | -70.0 | -40.93 | -37.7 | 3.23 |
| | -69.0 | -41.55 | -37.7 | 3.85 |
| | -68.0 | -42.60 | -37.7 | 4.90 |
| | -67.0 | -43.65 | -37.7 | 5.95 |
| | -60.0 | -51.61 | -43.0 | 8.61 |
| | -55.0 | -56.56 | -48.0 | 8.56 |
| | -50.0 | -61.66 | -53.0 | 8.66 |
| | -45.0 | -65.53 | -58.0 | 7.53 |
| | -42.0 | -68.10 | -61.0 | 7.10 |
| | -41.0 | -69.00 | -62.0 | 7.00 |
| | -40.0 | -82.55 | -63.0 | 19.55 |
| | -39.0 | -82.21 | -64.0 | 18.21 |
| | -38.0 | -82.42 | -65.0 | 17.42 |
| | -30.0 | -82.12 | -70.0 | 12.12 |

| Band | RSSI [dBm] | Noise Level [dBm] | Noise Level Limit [dBm] | Margin [dB] |
|---|---|---|---|---|
| Band 25 | -90.0 | -40.11 | -37.0 | 3.11 |
| | -70.0 | -39.61 | -37.0 | 2.61 |
| | -69.0 | -40.72 | -37.0 | 3.72 |
| | -68.0 | -41.71 | -37.0 | 4.71 |
| | -67.0 | -42.28 | -37.0 | 5.28 |
| | -60.0 | -50.48 | -43.0 | 7.48 |
| | -55.0 | -55.18 | -48.0 | 7.18 |
| | -50.0 | -60.72 | -53.0 | 7.72 |
| | -45.0 | -64.86 | -58.0 | 6.86 |
| | -42.0 | -68.05 | -61.0 | 7.05 |
| | -41.0 | -82.33 | -62.0 | 20.33 |
| | -40.0 | -82.42 | -63.0 | 19.42 |
| | -39.0 | -82.44 | -64.0 | 18.44 |
| | -38.0 | -82.08 | -65.0 | 17.08 |
| | -30.0 | -82.39 | -70.0 | 12.39 |

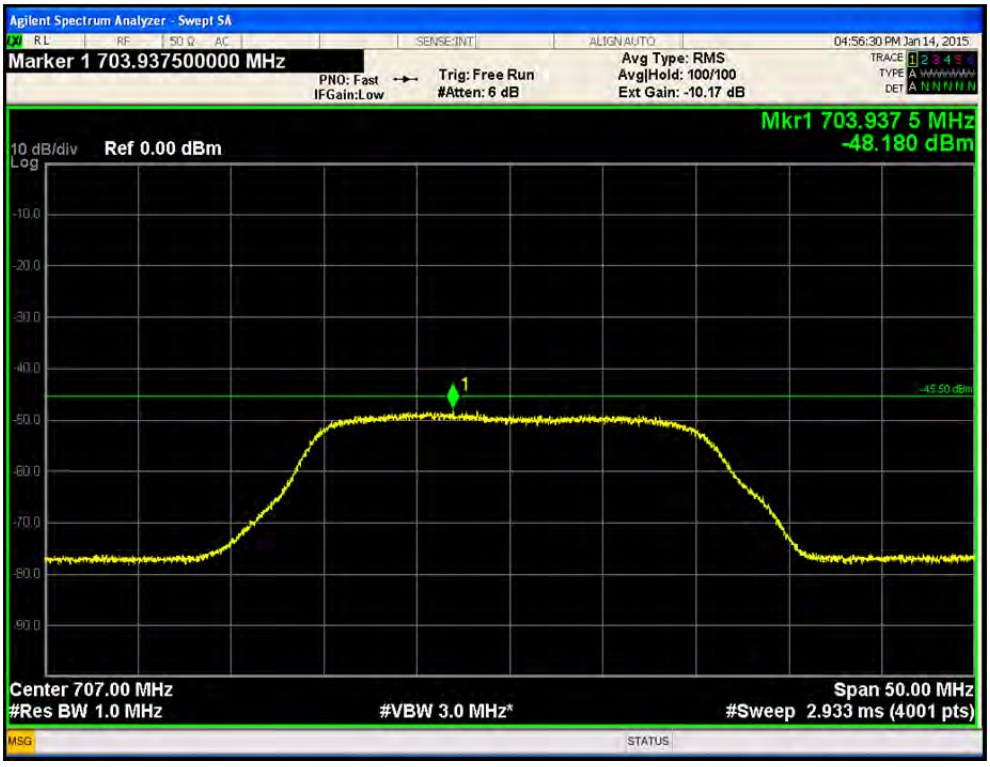
### 3.7.12 Test results of variable decrease noise timing

| Band | Link | Noise Timing [s] | Limit [s] | Result |
|---|---|---|---|---|
| Band 12 | Downlink | 0.170 | 3.0 | Pass |
| | Uplink | 0.100 | 3.0 | Pass |
| Band 13 | Downlink | 0.170 | 3.0 | Pass |
| | Uplink | 0.190 | 3.0 | Pass |
| Band 5 | Downlink | 0.200 | 3.0 | Pass |
| | Uplink | 0.100 | 3.0 | Pass |
| Band 4 | Downlink | 0.250 | 3.0 | Pass |
| | Uplink | 0.150 | 3.0 | Pass |
| Band 25 | Downlink | 0.220 | 3.0 | Pass |
| | Uplink | 0.140 | 3.0 | Pass |

### 3.7.13 Test plots

- **Band 12 / Downlink**

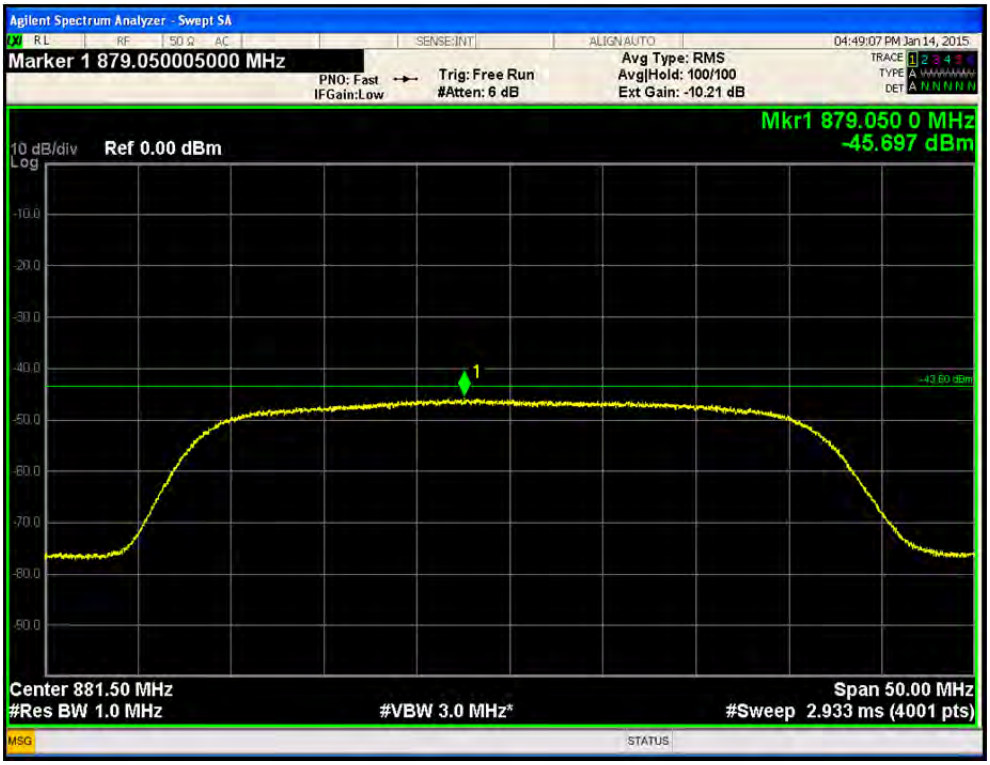

- **Band 12 / Uplink**



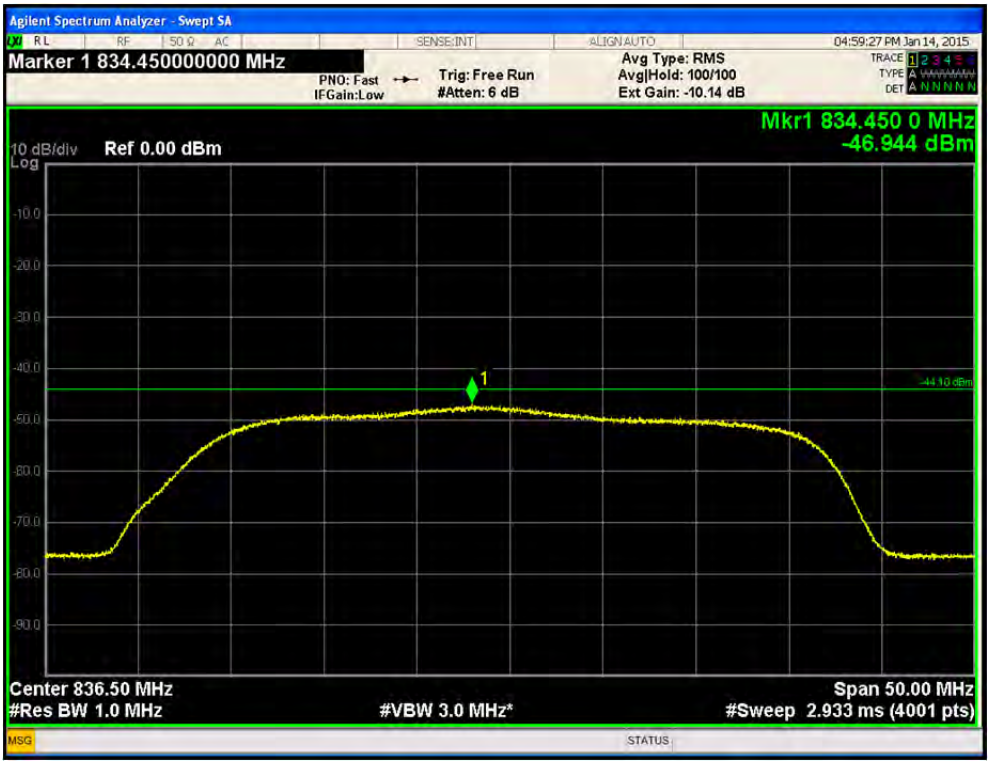
- **Band 13 / Downlink**


- **Band 13 / Uplink**

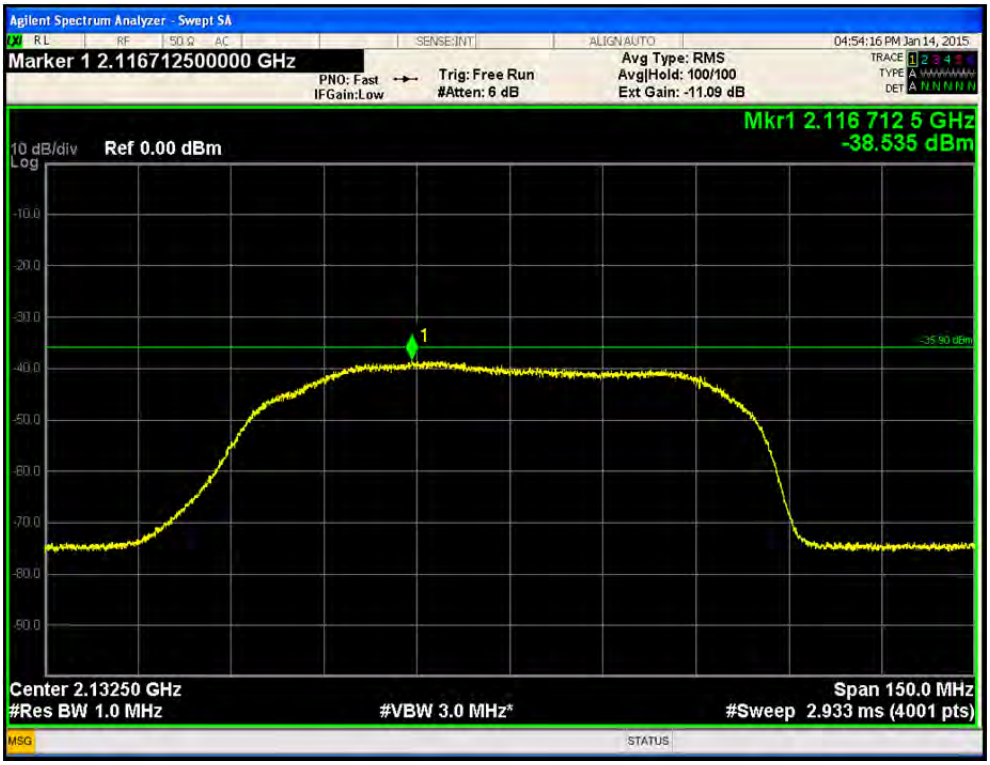
- **Band 5 / Downlink**



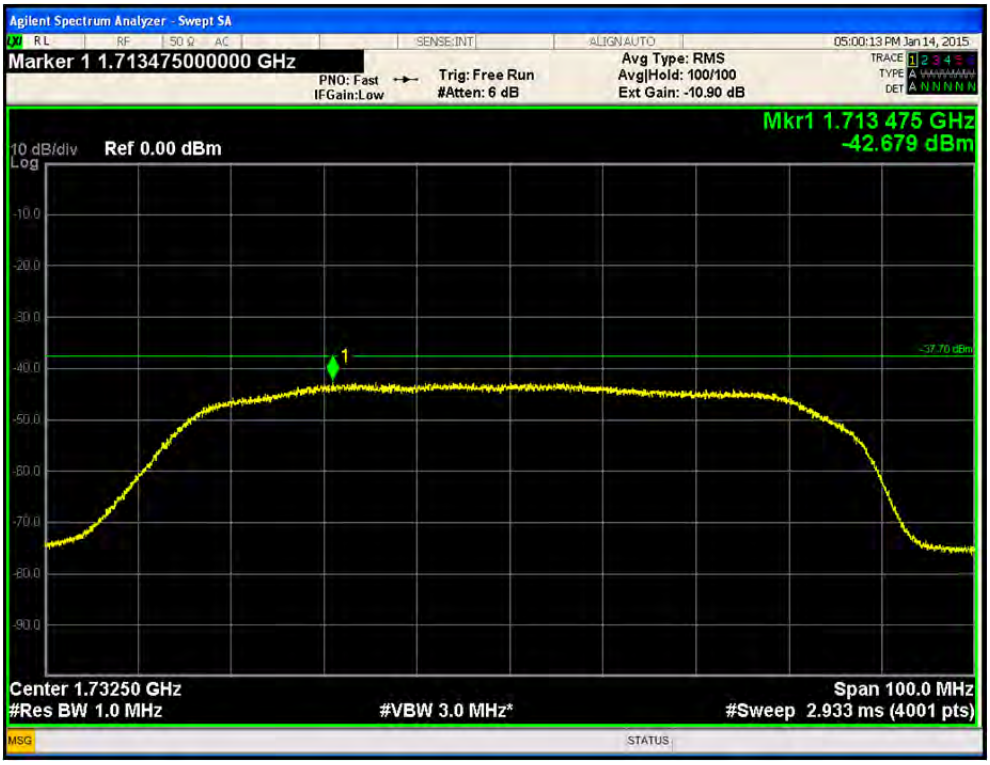

- **Band 5 / Uplink**



- **Band 4 / Downlink**

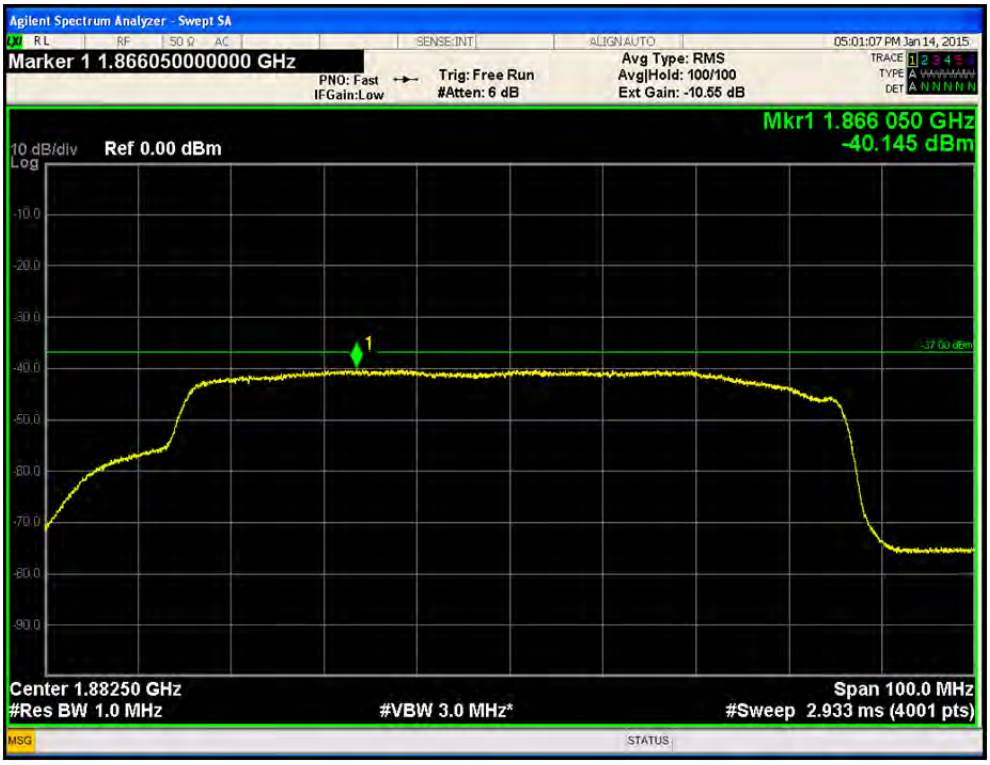



- **Band 4 / Uplink**



- **Band 25/ Downlink**


- **Band 25/ Uplink**



### 3.7.14 Test plots of decrease timing

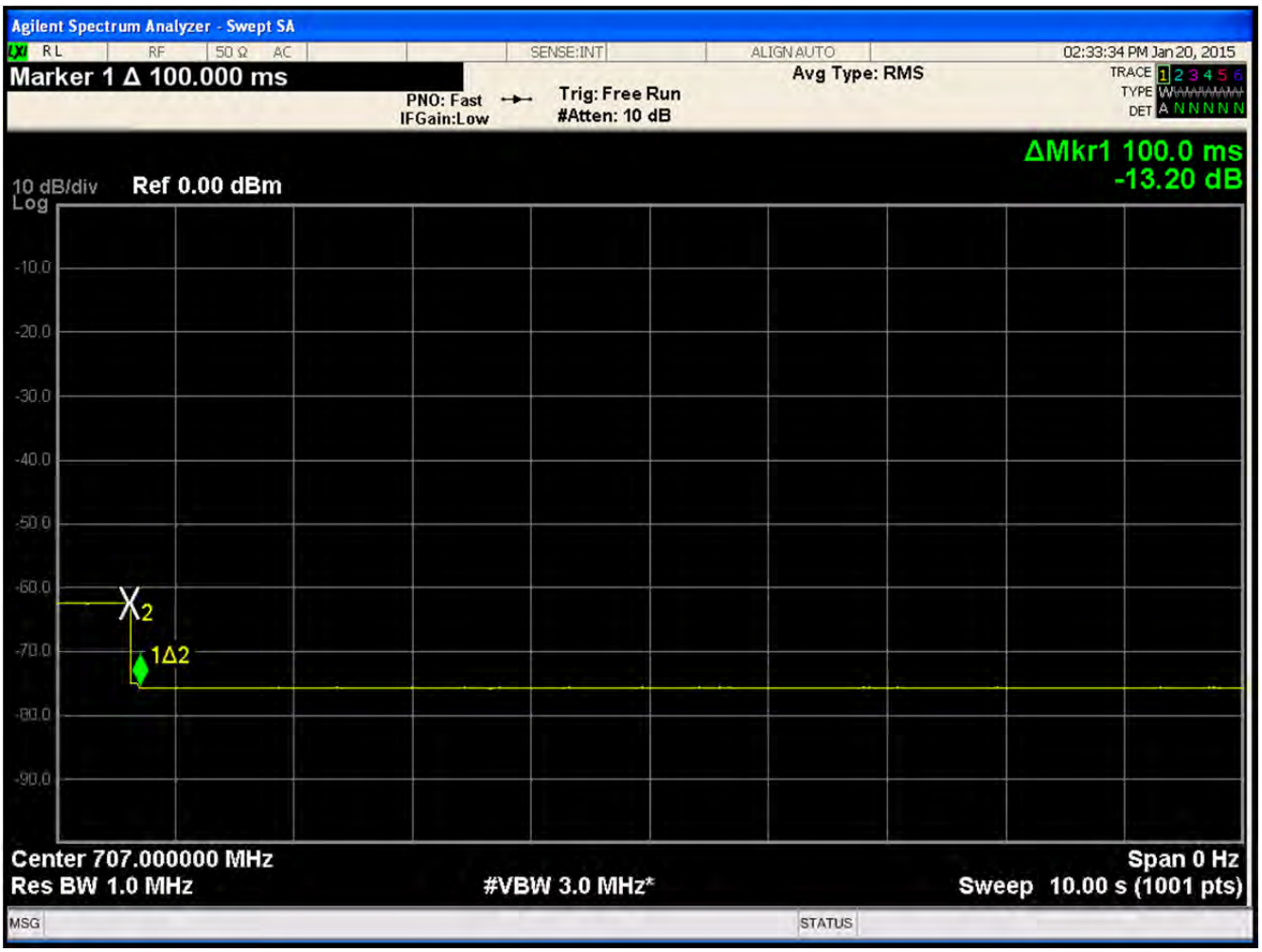
- **Band 12 / Downlink**


Frequency : 737.000 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.170 s

Limit of timing : 3 s (Fixed device)

- **Band 12 / Uplink**




Frequency : 707.000 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.100 s

Limit of timing : 3 s (Fixed device)

- **Band 13 / Downlink**


Frequency : 751.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.170 s

Limit of timing : 3 s (Fixed device)

- **Band 13 / Uplink**


Frequency : 781.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.190 s

Limit of timing : 3 s (Fixed device)

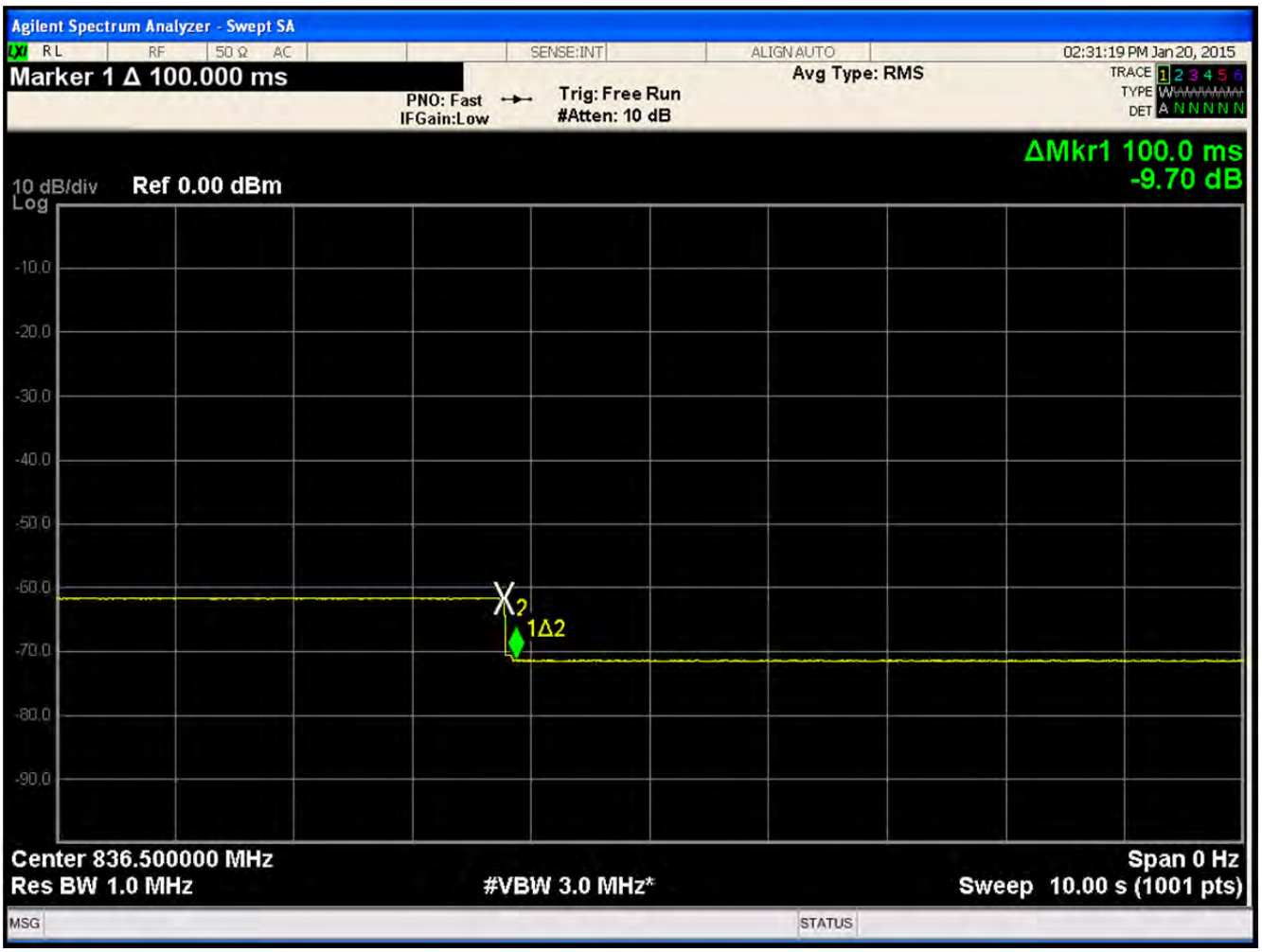
- **Band 5 / Downlink**


Frequency : 881.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.200 s

Limit of timing : 3 s (Fixed device)

- **Band 5 / Uplink**




Frequency : 836.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.100 s

Limit of timing : 3 s (Fixed device)

- **Band 4 / Downlink**


Frequency : 2132.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.250 s

Limit of timing : 3 s (Fixed device)

- **Band 4 / Uplink**


Frequency : 1732.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.150 s

Limit of timing : 3 s (Fixed device)

- **Band 25/ Downlink**


Frequency : 1962.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.220 s

Limit of timing : 3 s (Fixed device)

- **Band 25/ Uplink**


Frequency : 1882.500 MHz
Span : Zero
Sweep time : 10 s

Time of decrease gain : 0.140 s

Limit of timing : 3 s (Fixed device)

## 3.8 Uplink inactivity

### 3.8.1 Specification

- FCC Part 20.21 (e)(8)(i)(l)

### 3.8.2 Measurement method

- 935210 D03 Signal Booster Measurement v02r01

a) Connect the EUT to the test equipment as shown in Set-Up with the uplink output connected to the spectrum analyzer.

b) Select the RMS power averaging detector.

c) Set the spectrum analyzer RBW for 1 MHz with the VBW ≥ 3X 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) 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.

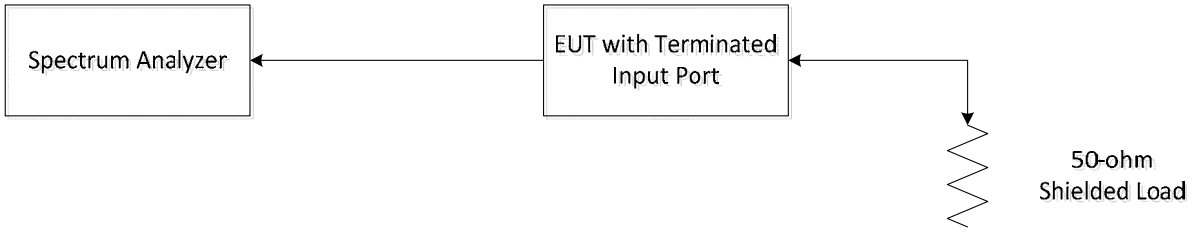
i) Ensure the noise level for the squelched signal is below the uplink inactivity noise power limit, as specified by the rules.

j) Capture the plot for inclusion in the test report.

k) Measure noise using procedures in a) to e).

l) Repeat steps c) to k) for all operational uplink bands.

### 3.8.3 Set-Up




### 3.8.4 Limit

- §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.

### 3.8.5 Test equipment list

| Equipment | Model Name | Manufacturer |
|---|---|---|
| EUT | USHR-781921-5B | OPISYS Incorporated |
| Spectrum Analyzer | N9020A | Agilent |

### 3.8.6 Test condition

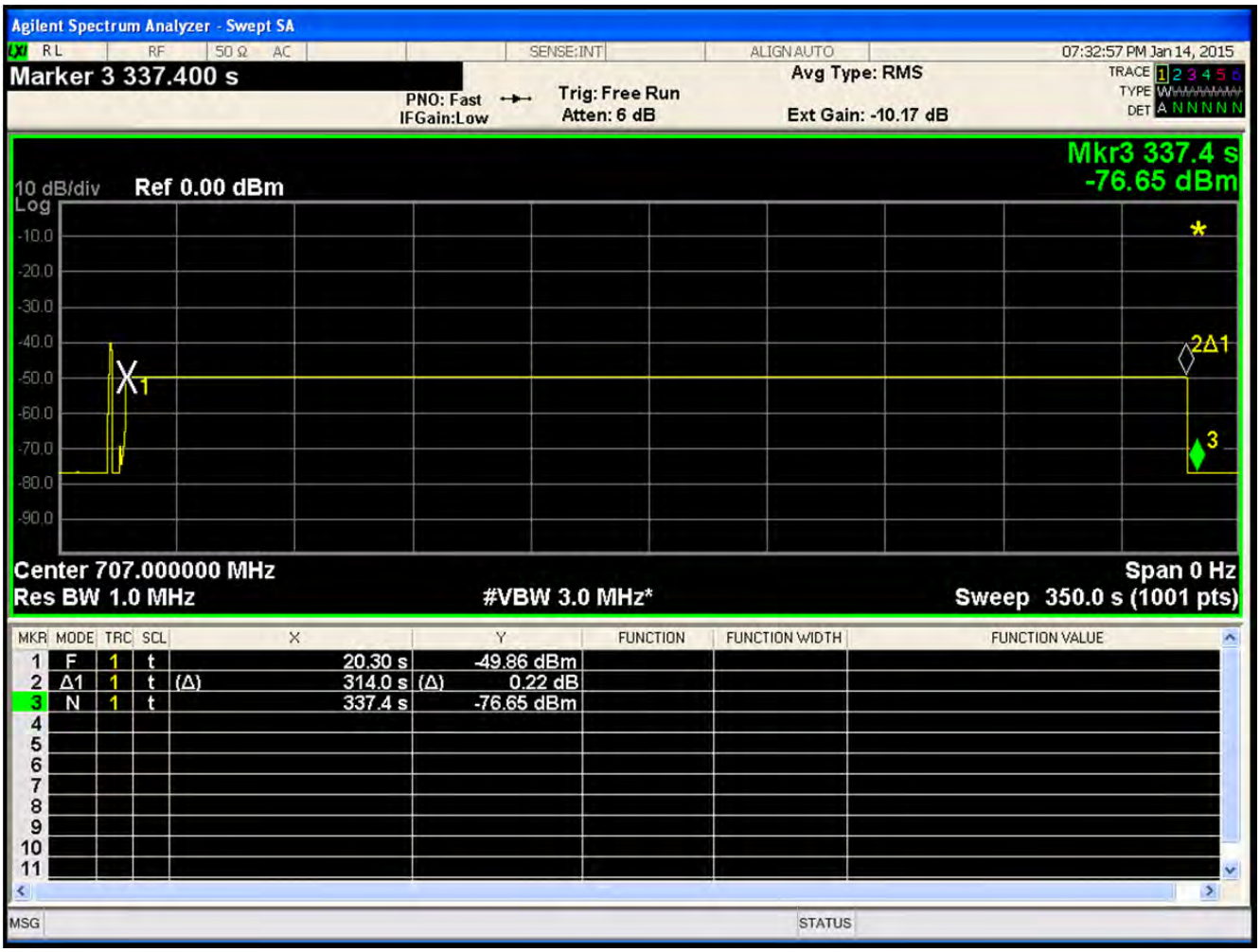
• Test place: Shield Room
• Test environment: 23.0 °C, 44 % R.H.

### 3.8.7 Test results

| Band | Link | Inactivity Time [s] | Inactivity Level [dBm] | Inactivity Level Limit [dBm] |
|---|---|---|---|---|
| Band 12 | Uplink | 314.0 | -76.65 | -70 |
| Band 13 | Uplink | 313.6 | -76.49 | |
| Band 5 | Uplink | 313.6 | -76.54 | |
| Band 4 | Uplink | 312.9 | -75.52 | |
| Band 25 | Uplink | 312.9 | -75.61 | |

### 3.8.8 Test plots

- **Band 12 / Uplink**

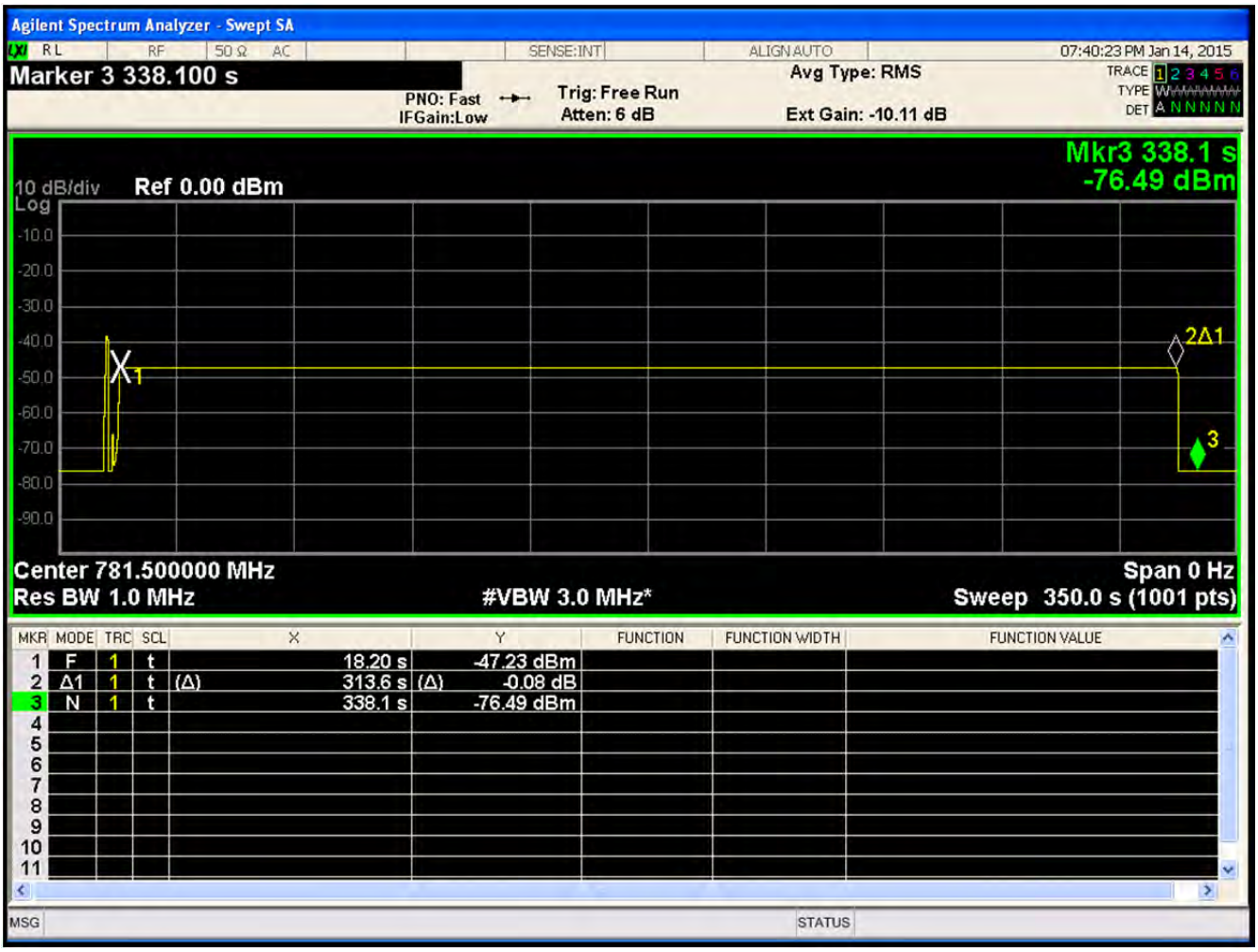



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : Normal

Inactivity timing : 314.0 s
Noise level at inactivity : -76.6 dBm/MHz

Limit of noise level at inactivity : -70.0 dBm/MHz

- **Band 13 / Uplink**

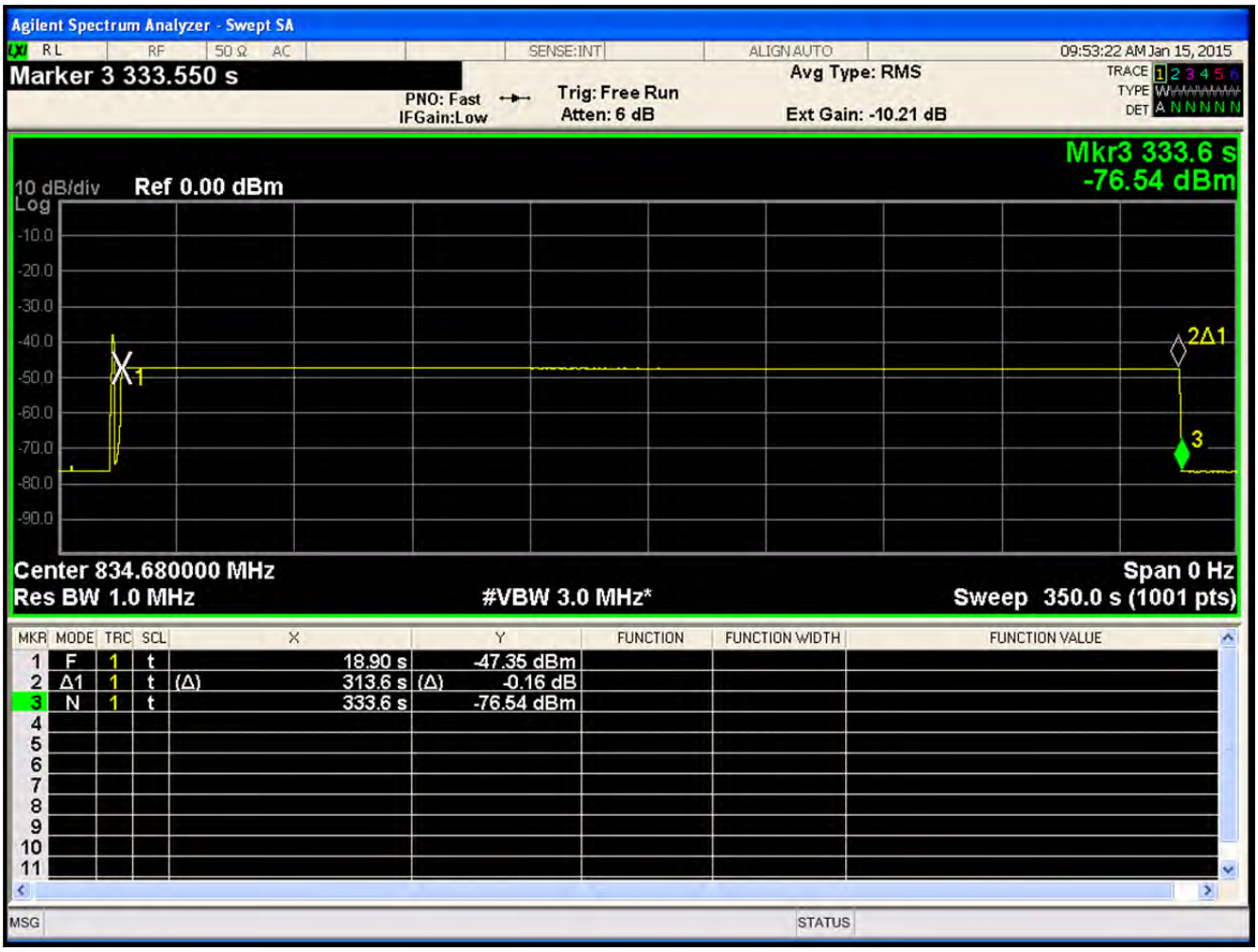



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : Normal

Inactivity timing : 313.6 s
Noise level at inactivity : -76.49 dBm/MHz

Limit of noise level at inactivity : -70.0 dBm/MHz

- **Band 5 / Uplink**

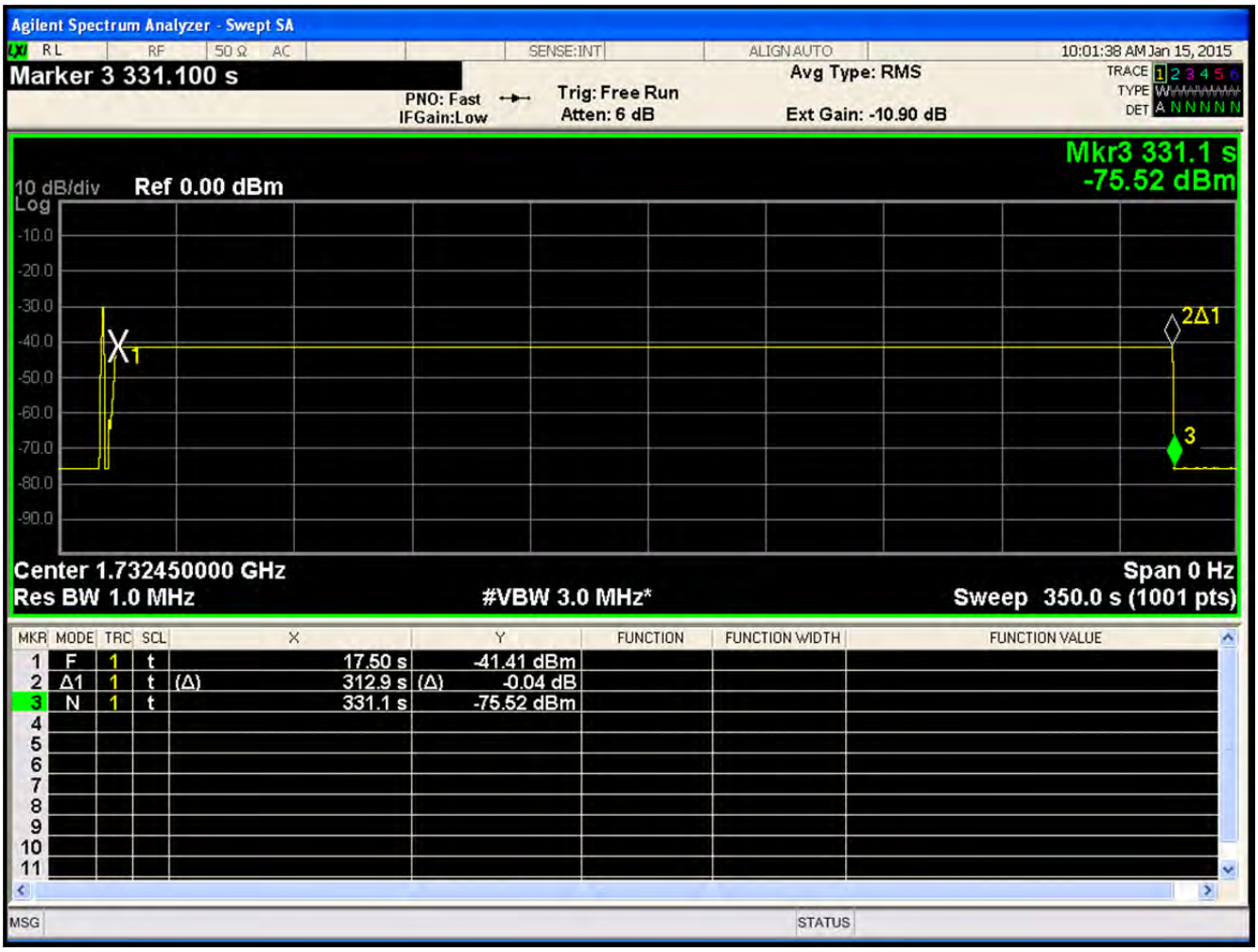



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : Normal

Inactivity timing : 313.6 s
Noise level at inactivity : -76.54 dBm/MHz

Limit of noise level at inactivity : -70.0 dBm/MHz

- **Band 4 / Uplink**

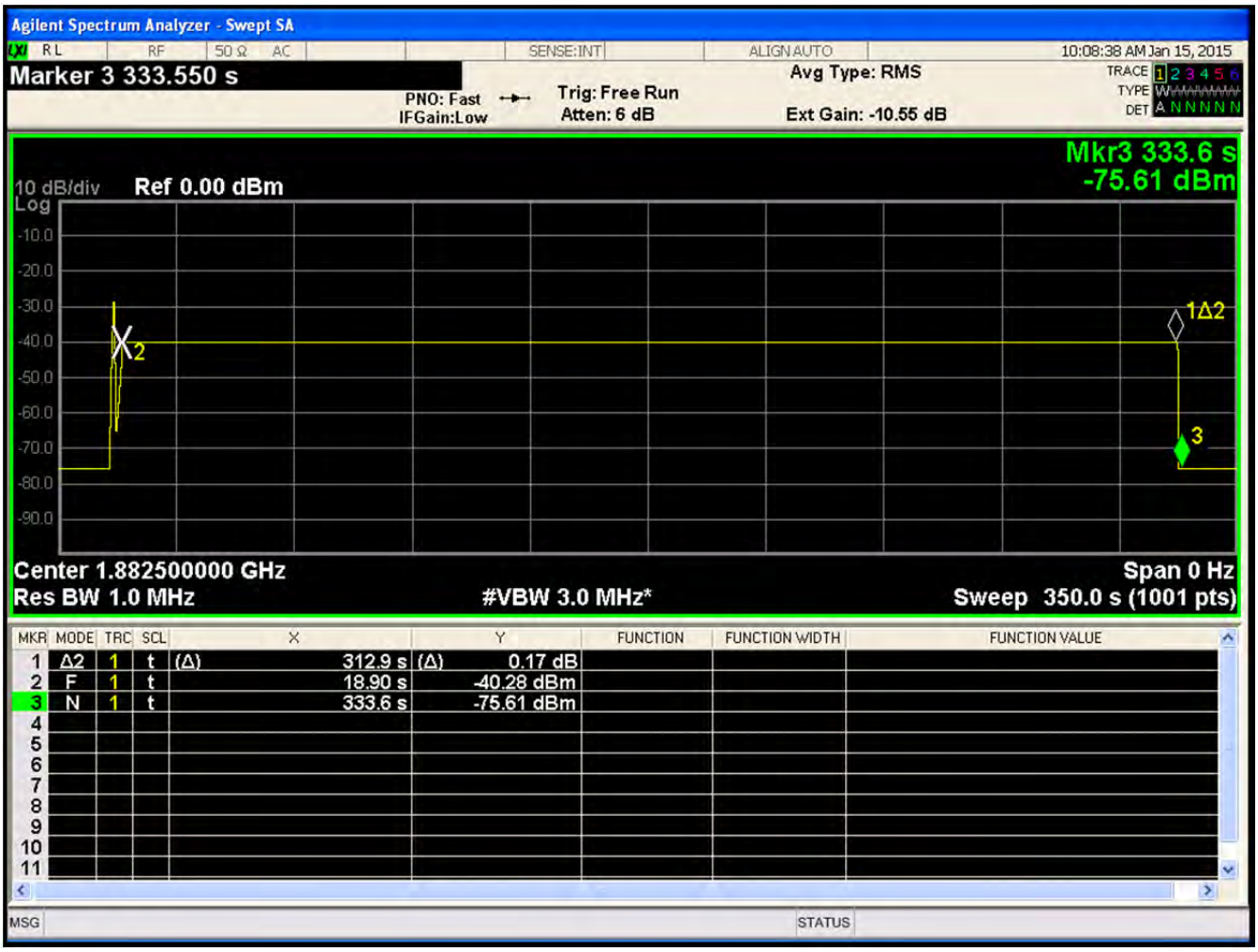



RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : Normal

Inactivity timing : 312.9 s
Noise level at inactivity : -75.52 dBm/MHz

Limit of noise level at inactivity : -70.0 dBm/MHz

- **Band 25/ Uplink**




RBW : 1 MHz
VBW : 3 MHz
Detector mode : RMS
Trace mode : Normal

Inactivity timing : 312.9 s
Noise level at inactivity : -75.61 dBm/MHz

Limit of noise level at inactivity : -70.0 dBm/MHz

## 3.9 Variable booster gain

### 3.9.1 Specification

• FCC Part 20.21 (e)(8)(i)(C)

### 3.9.2 Measurement method

• 935210 D03 Signal Booster Measurement v02r01

a) Connect the EUT to the test equipment as shown in Set-Up 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 determined from Maximum power. 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 (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 to a level from −90 dBm to −20 dBm in 1 dB steps within 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. See gain limit charts in Annex D.

l) Repeat c) to k) 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.

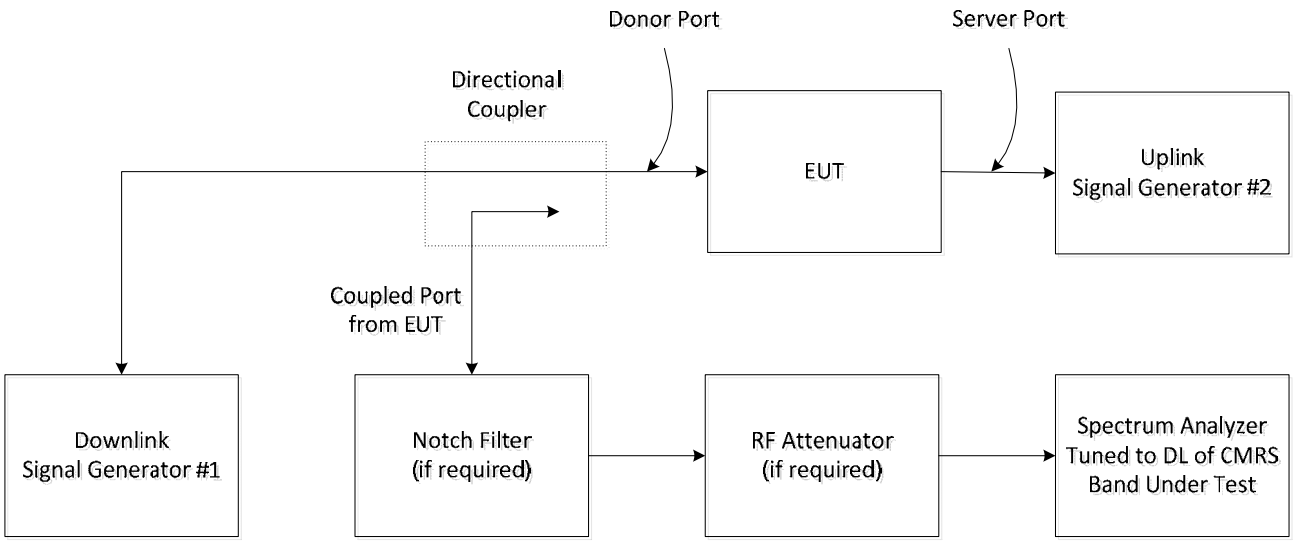
p) Set the power level of signal generator 1 to the lowest level of the RSSI dependent gain.

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. Signal generator 2 remains same, as described in c).

r) Ensure that the uplink gain decrease to the specified levels within 1 second for mobile devices and 3 seconds for fixed devices.

s) Repeat m) to r) for all operational uplink bands.

### 3.9.3 Set-Up




### 3.9.4 Limit

• §20.21(e), The uplink gain in dB of a consumer booster referenced to its input and output ports shall not exceed -34 dB - RSSI + MSCL.

### 3.9.5 Test equipment list

| Equipment | Model Name | Manufacturer |
|---|---|---|
| EUT | USHR-781921-5B | OPISYS Incorporated |
| Signal Generator | E4432B | Agilent |
| Signal Generator | N5182A | Agilent |
| Spectrum Analyzer | N9020A | Agilent |
| Directional Coupler | 87300B | Agilent |
| Attenuator | AF115A-09-34 | Weinschel |

### 3.9.6 Test condition

• Test place: Shield Room
• Test environment: 23.0 °C, 44 % R.H.

### 3.9.7 Test results of variable gain

• Uplink max gain = -34 dB - RSSI + MSCL
• RSSI = Downlink output power - Downlink gain
• MSCL (distance of between uplink input port and mobile station is 1 meter)

Lfs = 32.45 + 20 log (d km) + 20 log (f MHz) [free space path loss model : CCIR]
= 32.45 + 20 log (0.001) + 20 log (698) [29.28 dB : Band 12]
= 32.45 + 20 log (0.001) + 20 log (776) [30.20 dB : Band 13]
= 32.45 + 20 log (0.001) + 20 log (824) [30.72 dB : Band 5]
= 32.45 + 20 log (0.001) + 20 log (1710) [33.74 dB : Band 4]
= 32.45 + 20 log (0.001) + 20 log (1850) [37.89 dB : Band 25]

| Band | RSSI [dBm] | MSCL [dB] | Gain Limit [dB] | Uplink Input Power [dBm] | Uplink Output Power [dBm] | Uplink Gain [dB] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| Band 12 | -70.0 | 29.28 | 65.28 | -37.0 | 21.09 | 58.09 | 7.19 |
| | -69.0 | | 64.28 | -37.0 | 20.07 | 57.07 | 7.21 |
| | -68.0 | | 63.28 | -37.0 | 19.04 | 56.04 | 7.24 |
| | -67.0 | | 62.28 | -37.0 | 19.08 | 56.08 | 6.20 |
| | -60.0 | | 55.28 | -37.0 | 12.02 | 49.02 | 6.26 |
| | -55.0 | | 50.28 | -37.0 | 8.02 | 45.02 | 5.26 |
| | -50.0 | | 45.28 | -37.0 | 3.14 | 40.14 | 5.14 |
| | -45.0 | | 40.28 | -37.0 | -1.79 | 35.21 | 5.07 |
| | -42.0 | | 37.28 | -37.0 | -4.69 | 32.31 | 4.97 |
| | -41.0 | | 36.28 | -37.0 | -5.89 | 31.11 | 5.17 |
| | -40.0 | | 35.28 | -37.0 | Shutdown | Shutdown | - |
| | -39.0 | | 34.28 | -37.0 | Shutdown | Shutdown | - |
| | -38.0 | | 33.28 | -37.0 | Shutdown | Shutdown | - |
| | -37.0 | | 32.28 | -37.0 | Shutdown | Shutdown | - |
| | -30.0 | | 25.28 | -37.0 | Shutdown | Shutdown | - |
| Band 13 | -70.0 | 30.20 | 66.20 | -38.0 | 20.15 | 58.15 | 8.05 |
| | -69.0 | | 65.20 | -38.0 | 20.35 | 58.35 | 6.85 |
| | -68.0 | | 64.20 | -38.0 | 19.33 | 57.33 | 6.87 |
| | -67.0 | | 63.20 | -38.0 | 18.20 | 56.20 | 7.00 |
| | -60.0 | | 56.20 | -38.0 | 12.13 | 50.13 | 6.07 |
| | -55.0 | | 51.20 | -38.0 | 8.12 | 46.12 | 5.08 |
| | -50.0 | | 46.20 | -38.0 | 3.10 | 41.10 | 5.10 |
| | -45.0 | | 41.20 | -38.0 | -1.63 | 36.37 | 4.83 |

| Band | RSSI [dBm] | MSCL [dB] | Gain Limit [dB] | Uplink Input Power [dBm] | Uplink Output Power [dBm] | Uplink Gain [dB] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| Band 13 | -42.0 | 30.20 | 38.20 | -38.0 | -4.86 | 33.14 | 5.06 |
| | -41.0 | | 37.20 | -38.0 | -5.68 | 32.32 | 4.88 |
| | -40.0 | | 36.20 | -38.0 | -6.74 | 31.26 | 4.94 |
| | -39.0 | | 35.20 | -38.0 | Shutdown | Shutdown | - |
| | -38.0 | | 34.20 | -38.0 | Shutdown | Shutdown | - |
| | -37.0 | | 33.20 | -38.0 | Shutdown | Shutdown | - |
| | -30.0 | | 26.20 | -38.0 | Shutdown | Shutdown | - |
| Band 5 | -70.0 | 30.72 | 66.72 | -38.0 | 22.86 | 60.86 | 5.86 |
| | -69.0 | | 65.72 | -38.0 | 22.93 | 60.93 | 4.79 |
| | -68.0 | | 64.72 | -38.0 | 22.84 | 60.84 | 3.88 |
| | -67.0 | | 63.72 | -38.0 | 21.82 | 59.82 | 3.90 |
| | -60.0 | | 56.72 | -38.0 | 14.84 | 52.84 | 3.88 |
| | -55.0 | | 51.72 | -38.0 | 9.80 | 47.80 | 3.92 |
| | -50.0 | | 46.72 | -38.0 | 4.78 | 42.78 | 3.94 |
| | -45.0 | | 41.72 | -38.0 | -0.23 | 37.77 | 3.95 |
| | -42.0 | | 38.72 | -38.0 | -3.19 | 34.81 | 3.91 |
| | -41.0 | | 37.72 | -38.0 | -4.15 | 33.85 | 3.87 |
| | -40.0 | | 36.72 | -38.0 | -5.08 | 32.92 | 3.80 |
| | -39.0 | | 35.72 | -38.0 | -6.13 | 31.87 | 3.85 |
| | -38.0 | | 34.72 | -38.0 | Shutdown | Shutdown | - |
| | -37.0 | | 33.72 | -38.0 | Shutdown | Shutdown | - |
| | -30.0 | | 26.72 | -38.0 | Shutdown | Shutdown | - |
| Band 4 | -70.0 | 33.74 | 73.74 | -45.0 | 22.39 | 67.39 | 6.35 |
| | -69.0 | | 72.74 | -45.0 | 21.28 | 66.28 | 6.46 |
| | -68.0 | | 71.74 | -45.0 | 20.26 | 65.26 | 6.48 |
| | -67.0 | | 70.74 | -45.0 | 19.27 | 64.27 | 6.47 |
| | -60.0 | | 63.74 | -45.0 | 12.08 | 57.08 | 6.66 |
| | -55.0 | | 58.74 | -45.0 | 6.95 | 51.95 | 6.79 |
| | -50.0 | | 53.74 | -45.0 | 1.86 | 46.86 | 6.88 |

| Band | RSSI [dBm] | MSCL [dB] | Gain Limit [dB] | Uplink Input Power [dBm] | Uplink Output Power [dBm] | Uplink Gain [dB] | Margin [dB] |
|---|---|---|---|---|---|---|---|
| Band 4 | -45.0 | 33.74 | 48.74 | -45.0 | -2.21 | 42.79 | 5.95 |
| | -42.0 | | 45.74 | -45.0 | -5.37 | 39.63 | 6.11 |
| | -41.0 | | 44.74 | -45.0 | -6.55 | 38.45 | 6.29 |
| | -40.0 | | 43.74 | -45.0 | Shutdown | Shutdown | - |
| | -39.0 | | 42.74 | -45.0 | Shutdown | Shutdown | - |
| | -38.0 | | 41.74 | -45.0 | Shutdown | Shutdown | - |
| | -37.0 | | 40.74 | -45.0 | Shutdown | Shutdown | - |
| | -30.0 | | 33.74 | -45.0 | Shutdown | Shutdown | - |
| Band 25 | -70.0 | 37.89 | 73.89 | -45.0 | 23.67 | 68.67 | 5.22 |
| | -69.0 | | 72.89 | -45.0 | 22.21 | 67.21 | 5.68 |
| | -68.0 | | 71.89 | -45.0 | 21.84 | 66.84 | 5.05 |
| | -67.0 | | 70.89 | -45.0 | 19.69 | 64.69 | 6.20 |
| | -60.0 | | 63.89 | -45.0 | 12.36 | 57.36 | 6.53 |
| | -55.0 | | 58.89 | -45.0 | 7.41 | 52.41 | 6.48 |
| | -50.0 | | 53.89 | -45.0 | 2.26 | 47.26 | 6.63 |
| | -45.0 | | 48.89 | -45.0 | -3.08 | 41.92 | 6.97 |
| | -42.0 | | 45.89 | -45.0 | -6.30 | 38.70 | 7.19 |
| | -41.0 | | 44.89 | -45.0 | -7.49 | 37.51 | 7.38 |
| | -40.0 | | 43.89 | -45.0 | Shutdown | Shutdown | - |
| | -39.0 | | 42.89 | -45.0 | Shutdown | Shutdown | - |
| | -38.0 | | 41.89 | -45.0 | Shutdown | Shutdown | - |
| | -37.0 | | 40.89 | -45.0 | Shutdown | Shutdown | - |
| | -30.0 | | 33.89 | -45.0 | Shutdown | Shutdown | - |

## 3.10 Occupied bandwidth

### 3.10.1 Specification

- FCC Rules Part 2 Section 2.1049

### 3.10.2 Measurement method

- 935210 D03 Signal Booster Measurement v02r01

a) Connect the test equipment as shown in Set-Up 1 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 Maximum power.

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 emissions bandwidth.

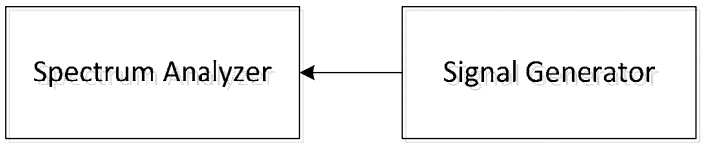
g) Capture the spectrum analyzer trace for inclusion in the test report.

h) Repeat steps c) to g) for CDMA and W-CDMA modulation adjusting the span as necessary for all uplink and downlink operational bands. (AWGN or LTE may be used in place of W-CDMA, as an option.)

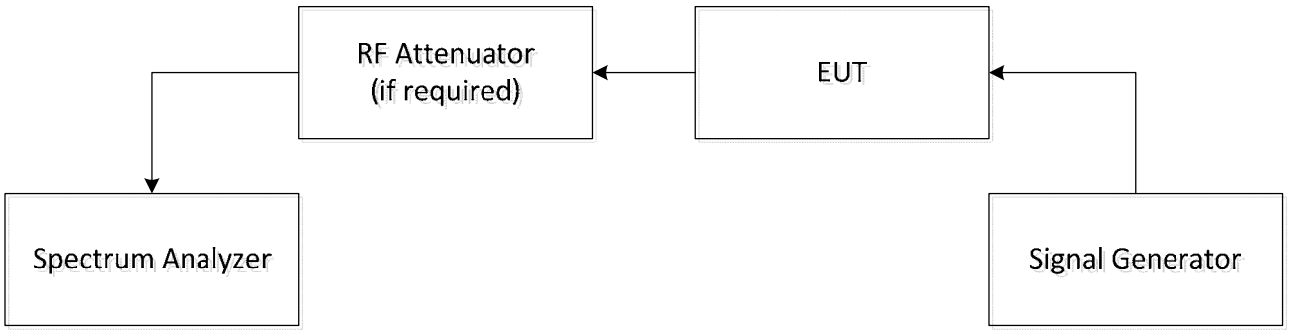
i) Connect the test equipment as shown in Set-Up 2. Begin with the uplink output connected to the spectrum analyzer

j) Repeat steps c) to h) in this new configuration.

### 3.10.3 Set-up 1 (Instrumentation)




### 3.10.4 Set-up 2 (Occupied bandwidth)



### 3.10.5 Test equipment list

| Equipment | Model Name | Manufacturer |
|---|---|---|
| EUT | USHR-781921-5B | OPISYS Incorporated |
| Signal Generator | N5182A | Agilent |
| Signal Generator | E4432B | Agilent |
| Spectrum Analyzer | N9020A | Agilent |
| Attenuator | AF115A-09-34 | Weinschel |

### 3.10.6 Test condition

- Test place: Shield Room
- Test environment: 24.2 ℃, 51 % R.H.

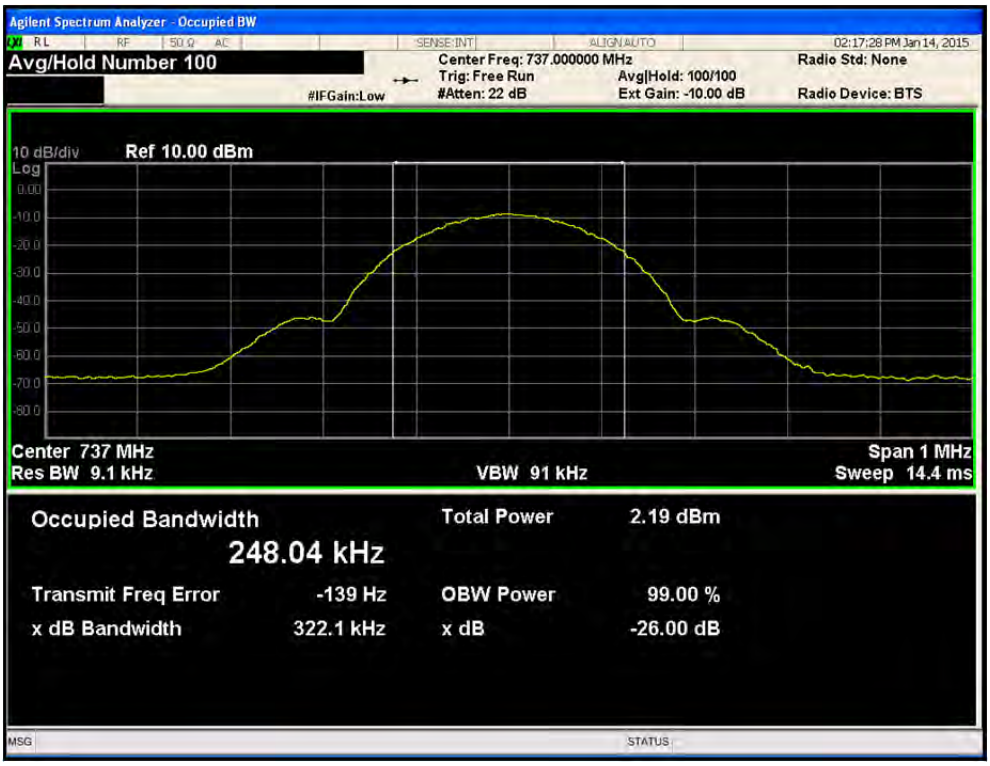
### 3.10.7 Test results

| Band | Link | Signal Type | Frequency [MHz] | Input OBW [MHz] | Output OBW [MHz] | 26 dB Bandwidth [MHz] |
|---|---|---|---|---|---|---|
| Band 12 | Downlink | GSM | 737.0 | 0.248 | 0.248 | 0.322 |
| | | CDMA | 737.0 | 1.270 | 1.271 | 1.426 |
| | | AWGN | 737.0 | 4.101 | 4.103 | 4.688 |
| | | LTE | 737.0 | 4.495 | 4.498 | 4.831 |
| | Uplink | GSM | 707.0 | 0.248 | 0.248 | 0.320 |
| | | CDMA | 707.0 | 1.269 | 1.267 | 1.428 |
| | | AWGN | 707.0 | 4.099 | 4.117 | 4.701 |
| | | LTE | 707.0 | 4.493 | 4.500 | 4.891 |
| Band 13 | Downlink | GSM | 751.5 | 0.249 | 0.249 | 0.322 |
| | | CDMA | 751.5 | 1.272 | 1.271 | 1.426 |
| | | AWGN | 751.5 | 4.101 | 4.097 | 4.690 |
| | | LTE | 751.5 | 4.495 | 4.497 | 4.835 |
| | Uplink | GSM | 781.5 | 0.249 | 0.249 | 0.321 |
| | | CDMA | 781.5 | 1.271 | 1.271 | 1.430 |
| | | AWGN | 781.5 | 4.102 | 4.089 | 4.691 |
| | | LTE | 781.5 | 4.495 | 4.495 | 4.806 |
| Band 5 | Downlink | GSM | 881.5 | 0.247 | 0.247 | 0.323 |
| | | CDMA | 881.5 | 1.271 | 1.271 | 1.429 |
| | | AWGN | 881.5 | 4.101 | 4.100 | 4.686 |
| | | LTE | 881.5 | 4.495 | 4.499 | 4.909 |

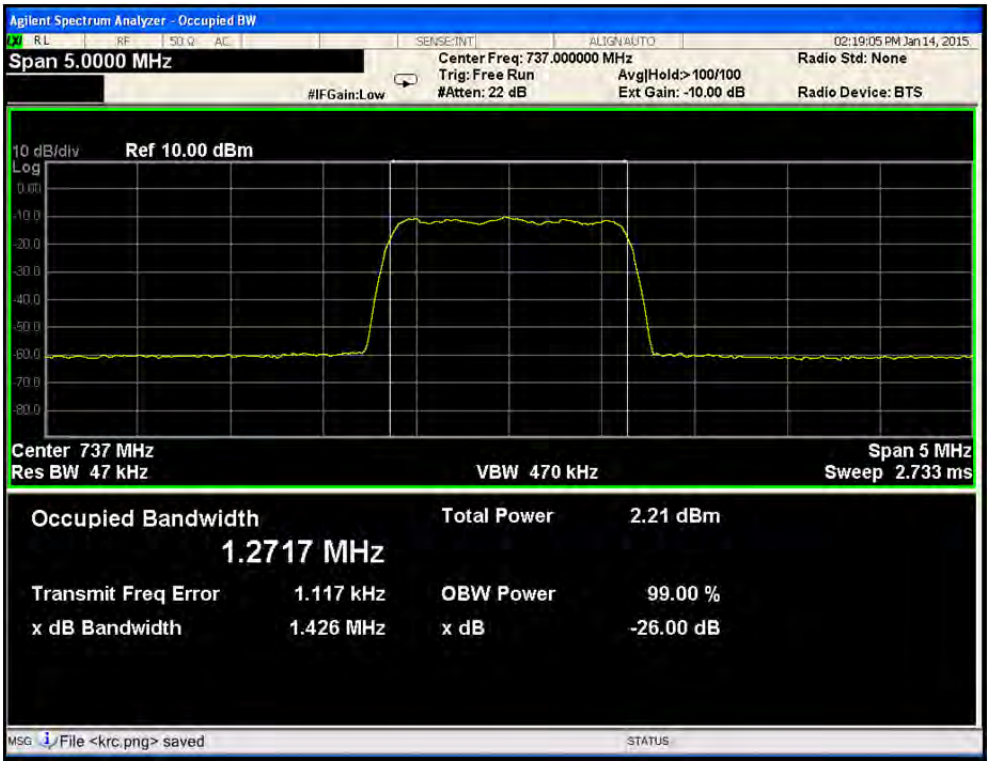
| Band | Link | Signal Type | Frequency [MHz] | Input OBW [MHz] | Output OBW [MHz] | 26 dB Bandwidth [MHz] |
|---|---|---|---|---|---|---|
| Band 5 | Uplink | GSM | 836.5 | 0.247 | 0.249 | 0.322 |
| | | CDMA | 836.5 | 1.268 | 1.267 | 1.428 |
| | | AWGN | 836.5 | 4.101 | 4.085 | 4.693 |
| | | LTE | 836.5 | 4.495 | 4.492 | 4.790 |
| Band 4 | Downlink | GSM | 2132.5 | 0.247 | 0.249 | 0.321 |
| | | CDMA | 2132.5 | 1.270 | 1.271 | 1.430 |
| | | AWGN | 2132.5 | 4.097 | 4.110 | 4.695 |
| | | LTE | 2132.5 | 4.495 | 4.498 | 4.877 |
| | Uplink | GSM | 1732.5 | 0.248 | 0.249 | 0.322 |
| | | CDMA | 1732.5 | 1.267 | 1.271 | 1.428 |
| | | AWGN | 1732.5 | 4.102 | 4.098 | 4.699 |
| | | LTE | 1732.5 | 4.494 | 4.502 | 4.818 |
| BAND 25 | Downlink | GSM | 1962.5 | 0.249 | 0.249 | 0.324 |
| | | CDMA | 1962.5 | 1.270 | 1.271 | 1.428 |
| | | AWGN | 1962.5 | 4.098 | 4.105 | 4.715 |
| | | LTE | 1962.5 | 4.494 | 4.504 | 4.812 |
| | Uplink | GSM | 1882.5 | 0.250 | 0.250 | 0.324 |
| | | CDMA | 1882.5 | 1.272 | 1.272 | 1.428 |
| | | AWGN | 1882.5 | 4.099 | 4.098 | 4.696 |
| | | LTE | 1882.5 | 4.493 | 4.508 | 4.835 |

### 3.10.8 Plots of Occupied bandwidth

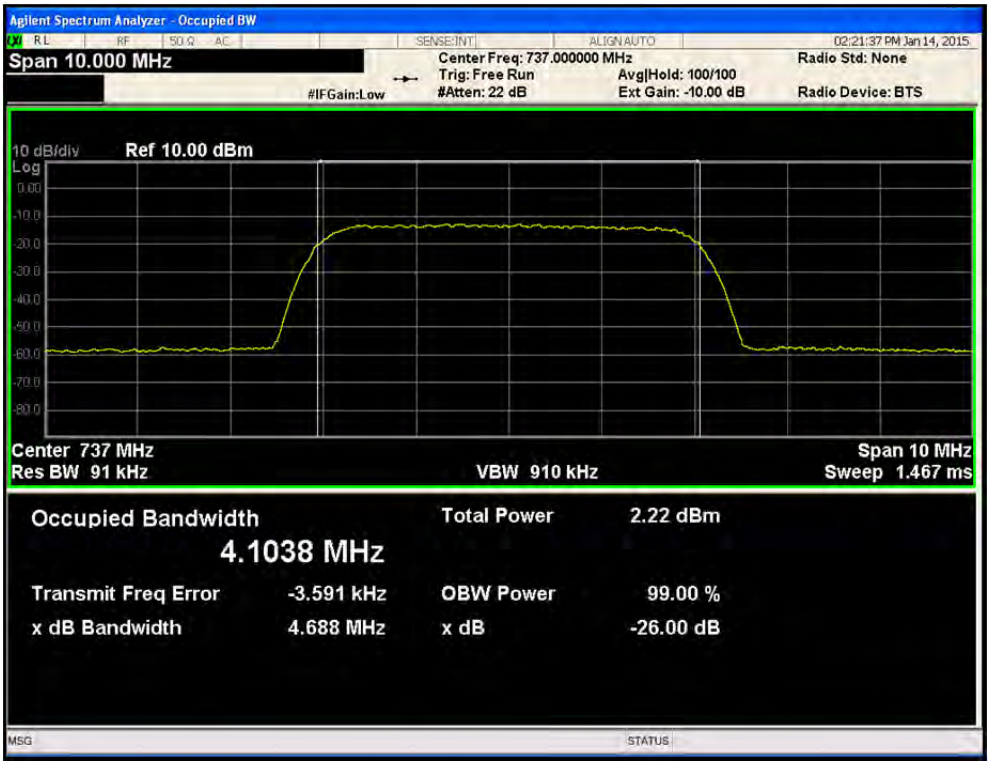
- **Band 12 / Downlink / GSM**



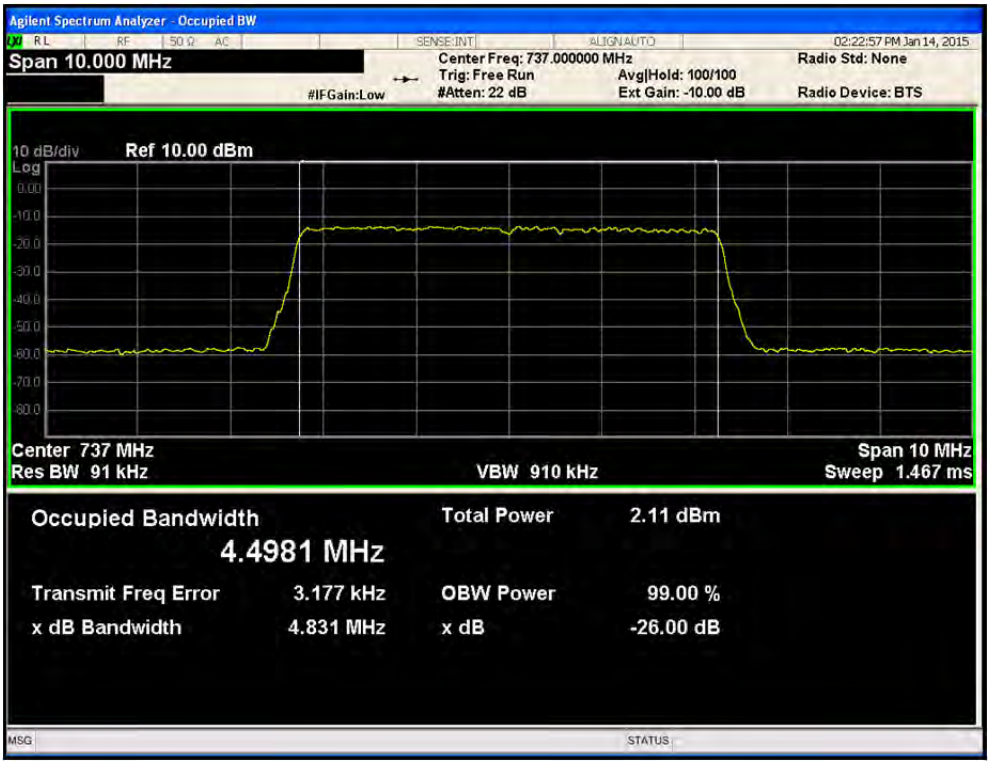

- **Band 12 / Downlink / CDMA**



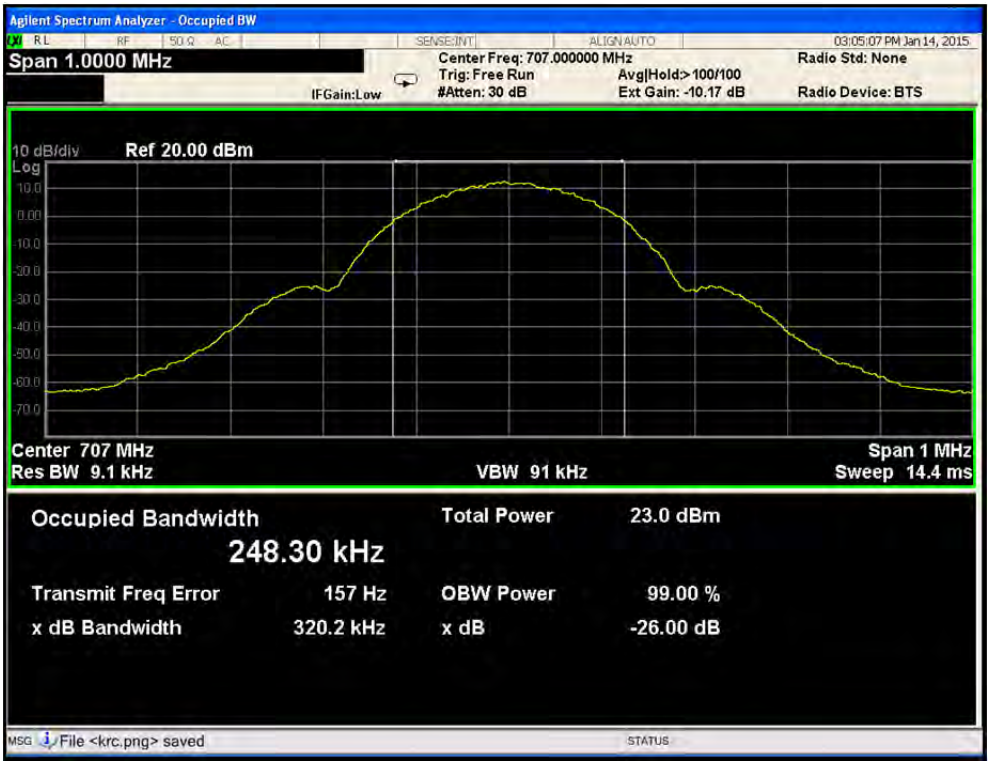
- **Band 12 / Downlink / AWGN**



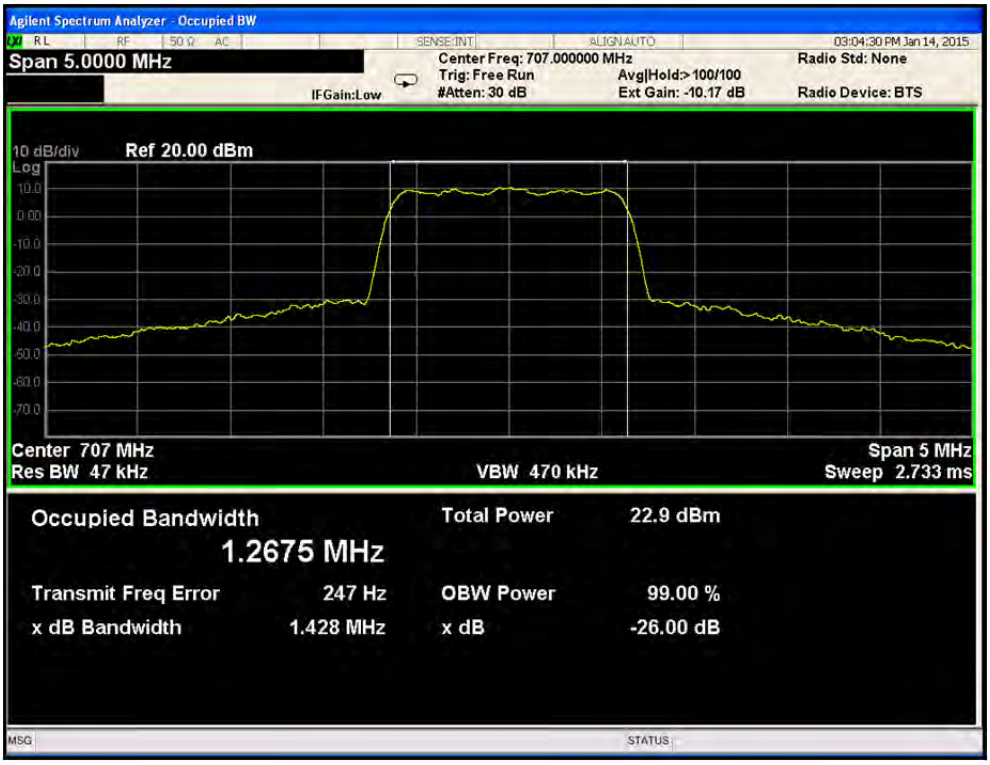

- **Band 12 / Downlink / LTE**



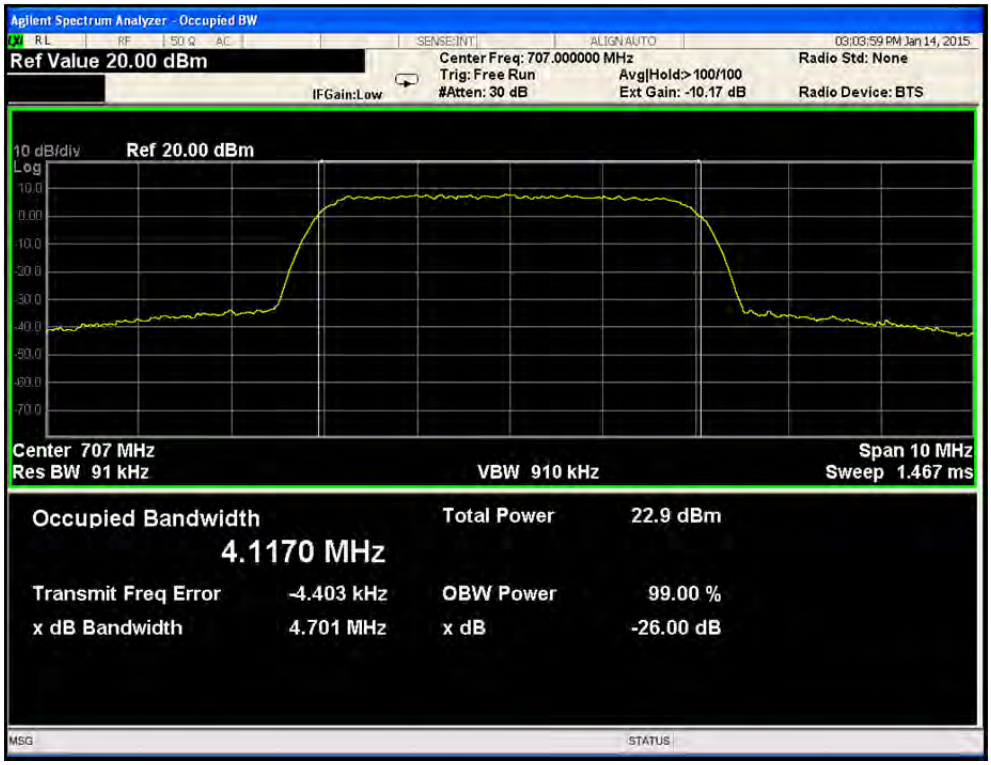
- **Band 12 / Uplink / GSM**



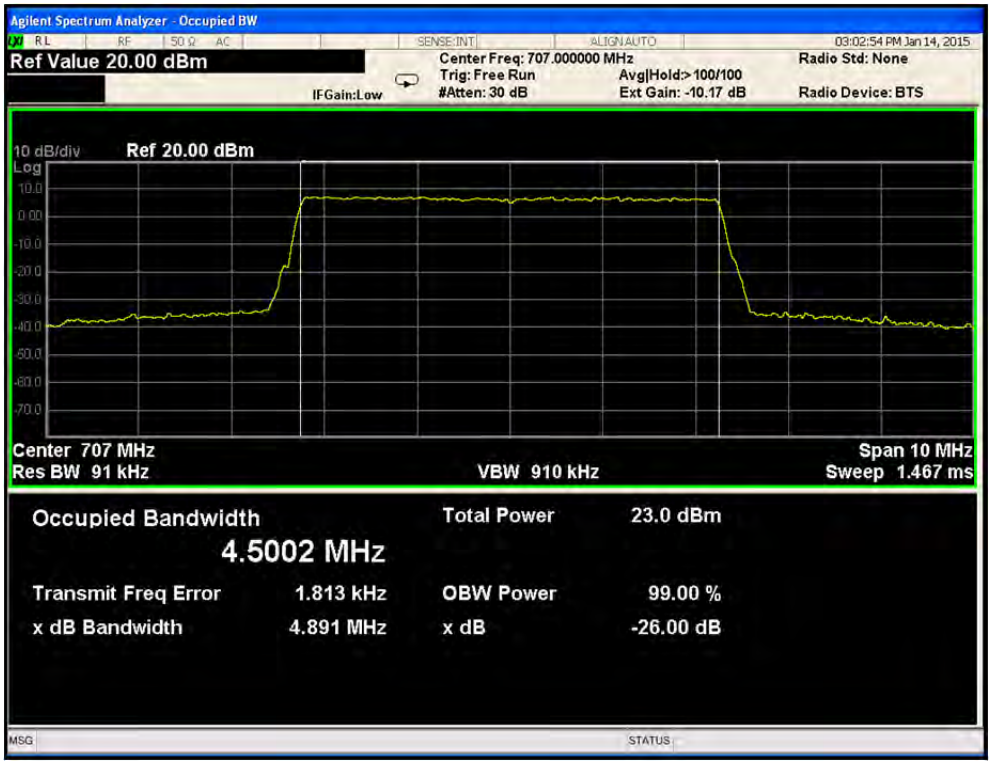

- **Band 12 / Uplink / CDMA**



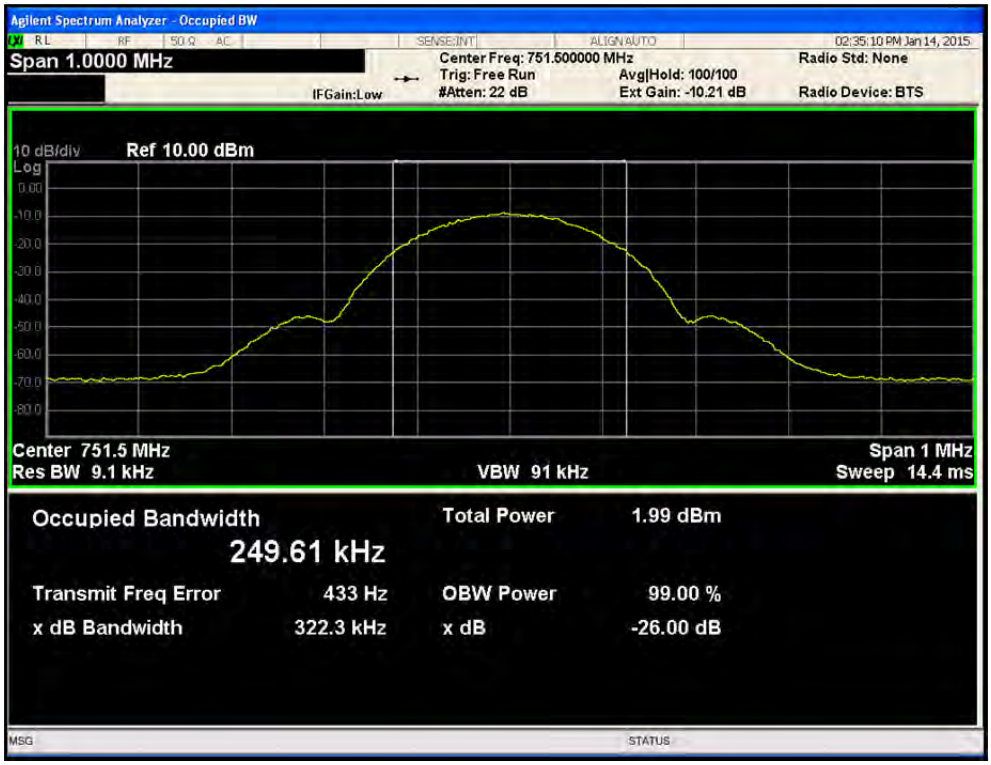
- **Band 12 / Uplink / AWGN**



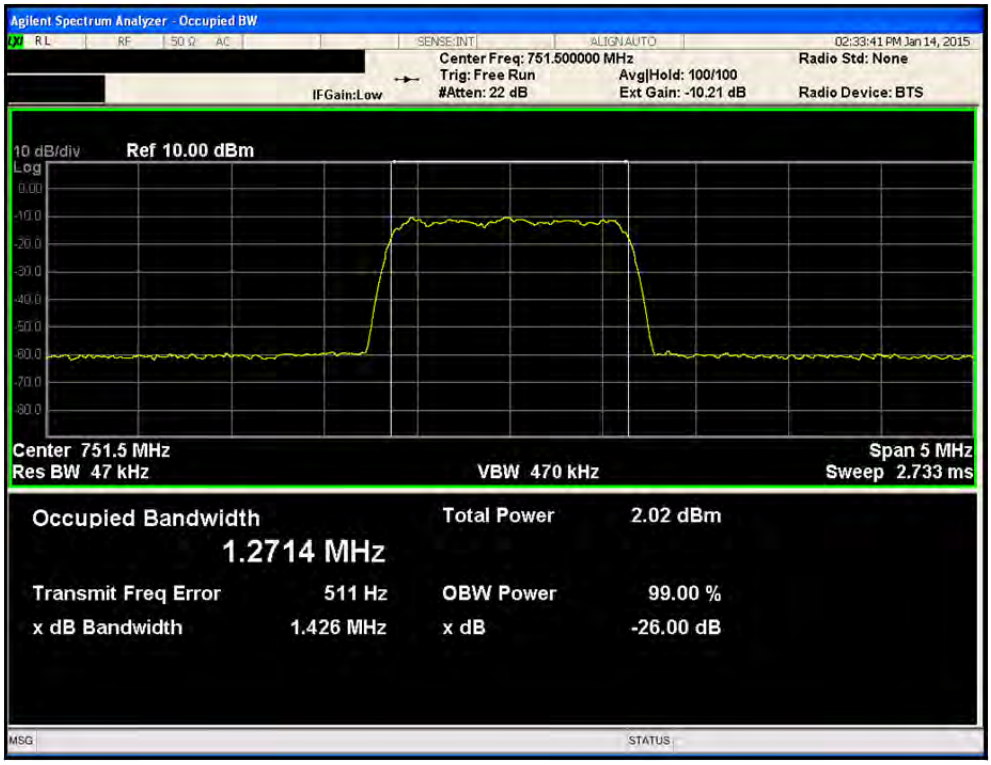

- **Band 12 / Uplink / LTE**



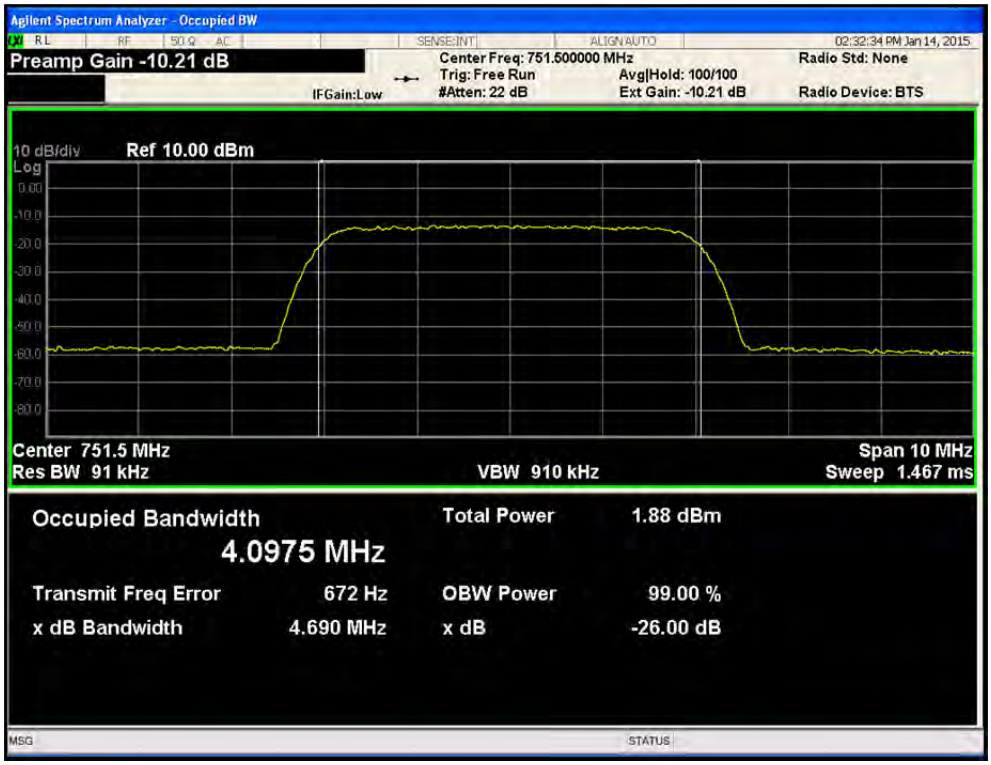
- **Band 13 / Downlink / GSM**



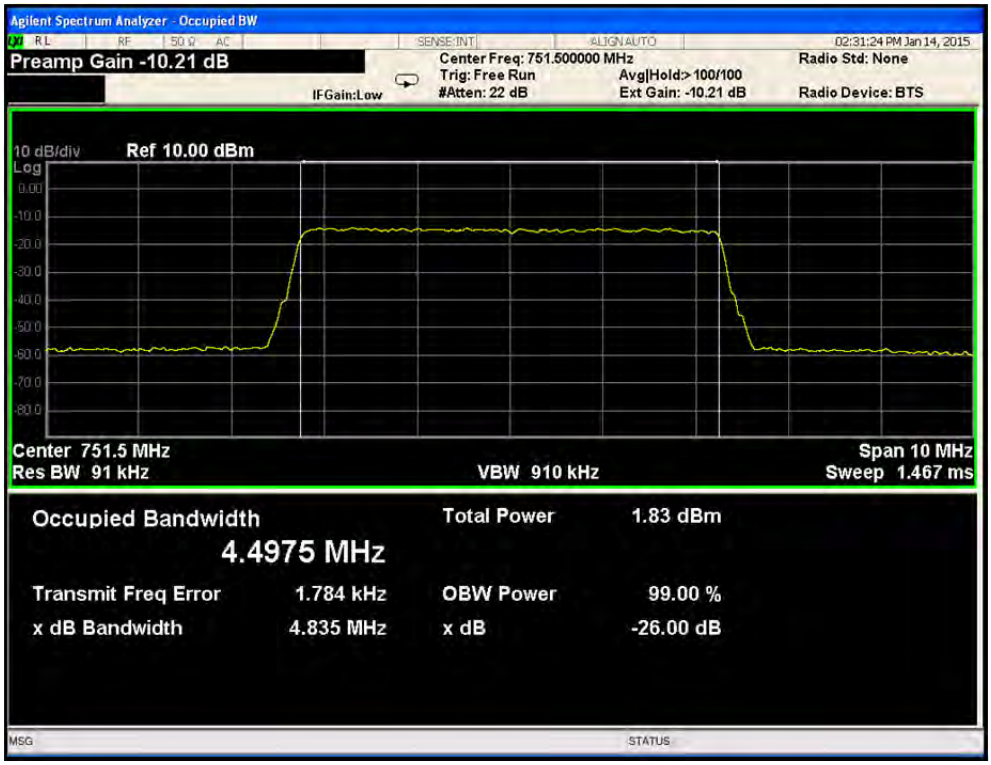

- **Band 13 / Downlink / CDMA**



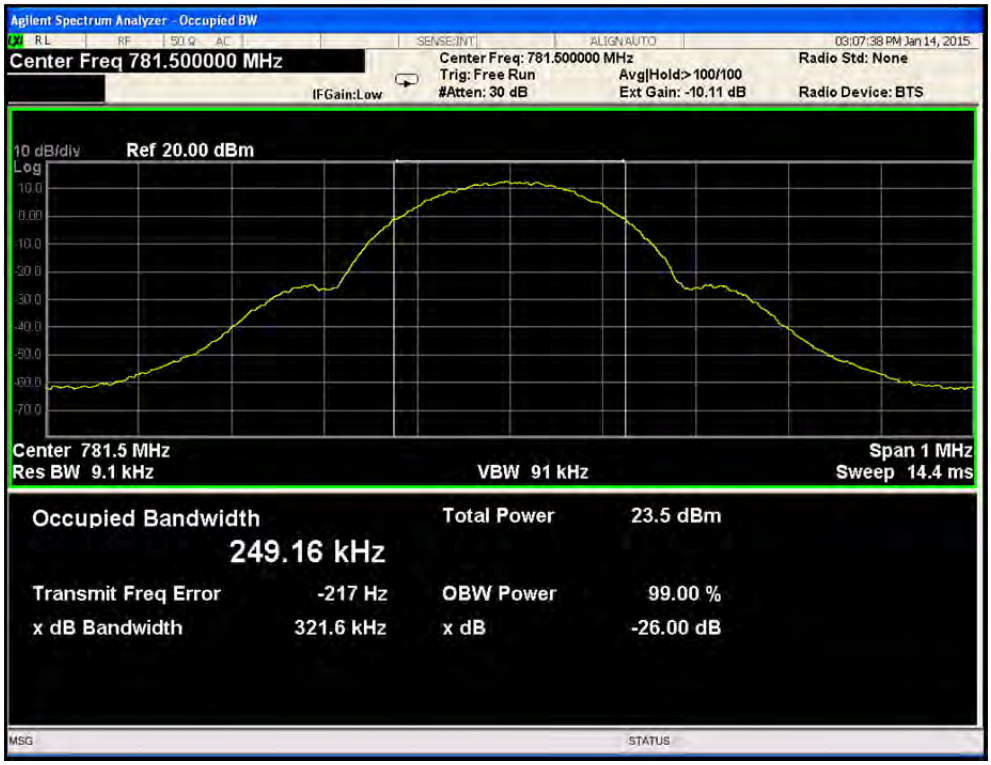
- **Band 13 / Downlink / AWGN**



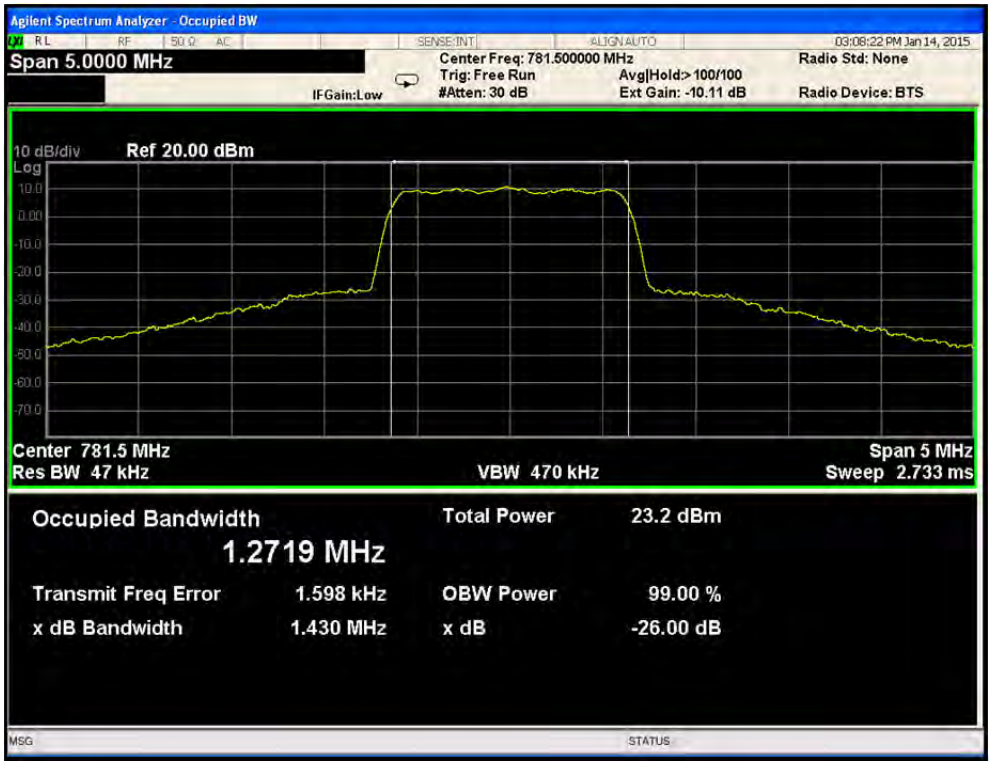

- **Band 13 / Down link / LTE**



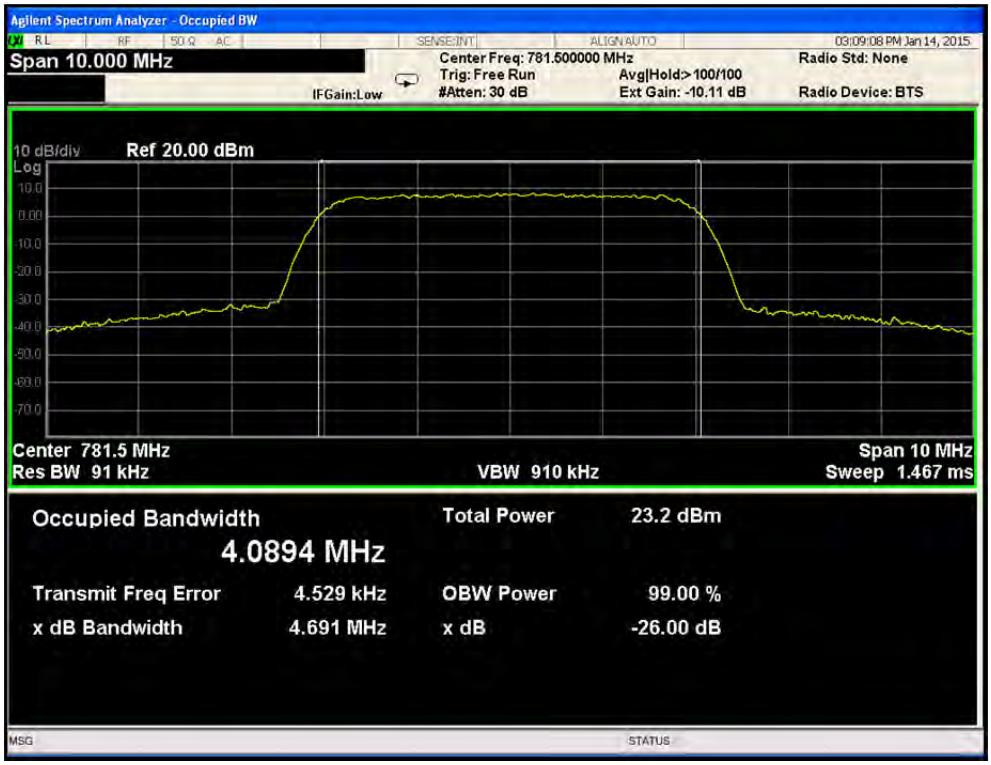
- **Band 13 / Uplink / GSM**



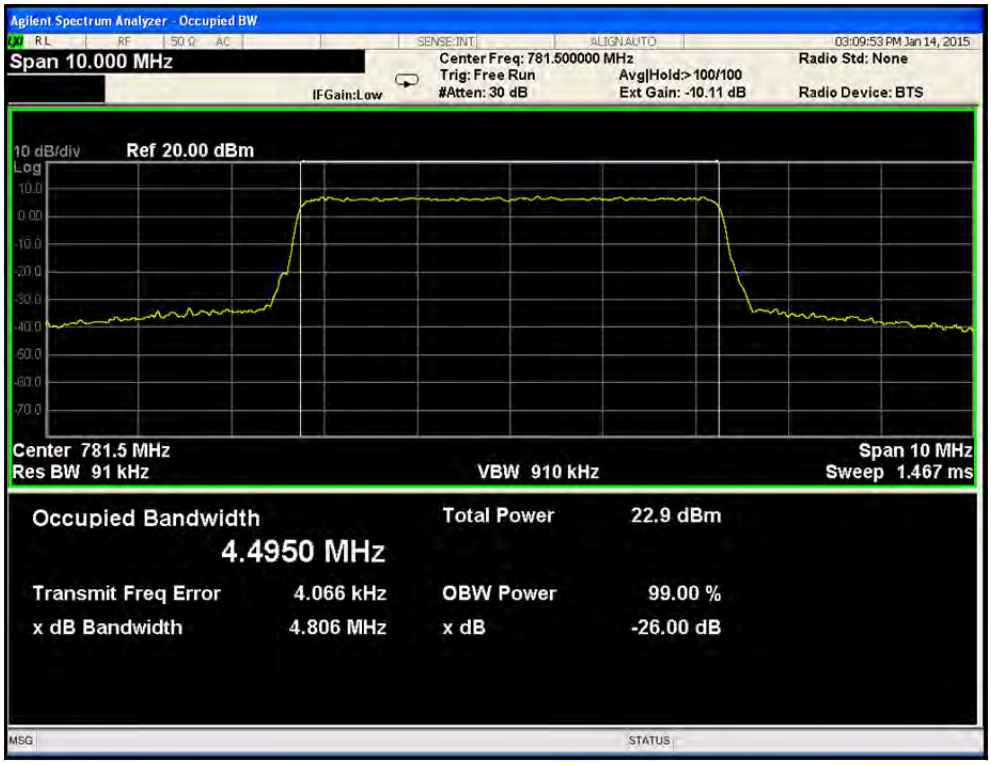

- **Band 13 / Uplink / CDMA**



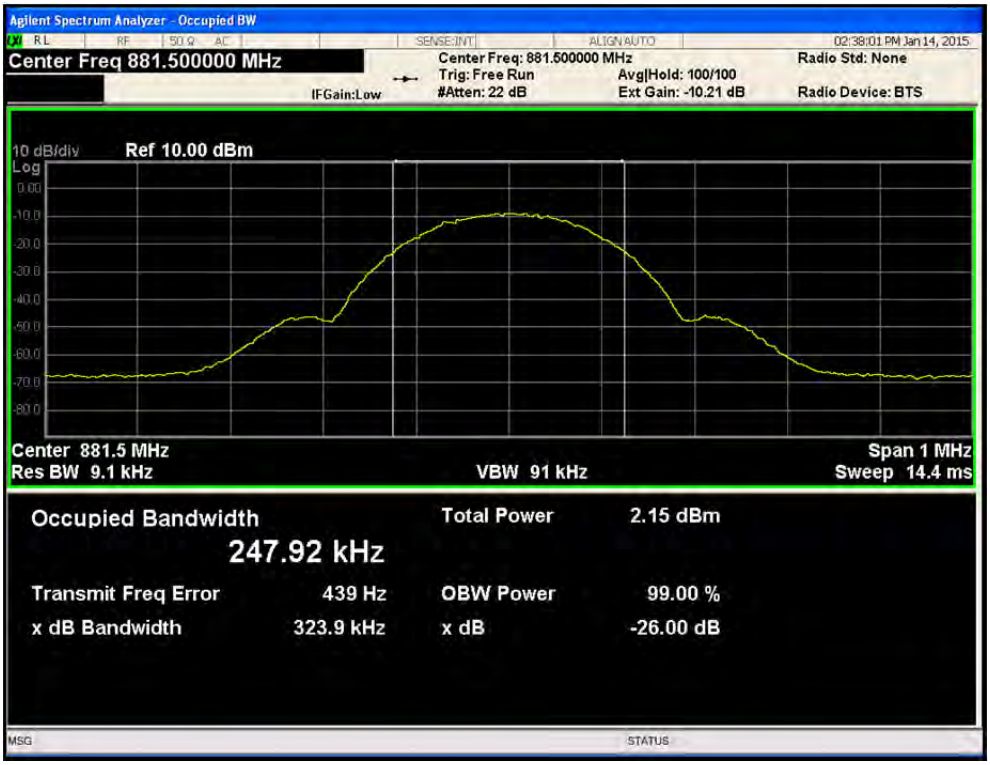
- **Band 13 / Uplink / AWGN**



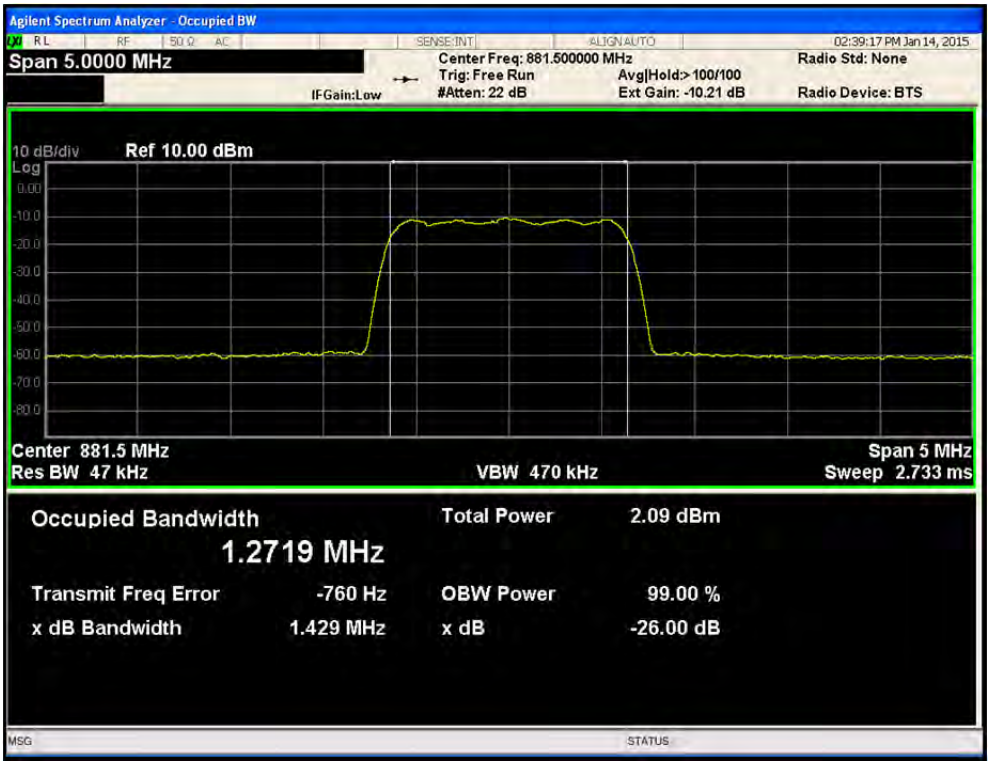

- **Band 13 / Uplink / LTE**



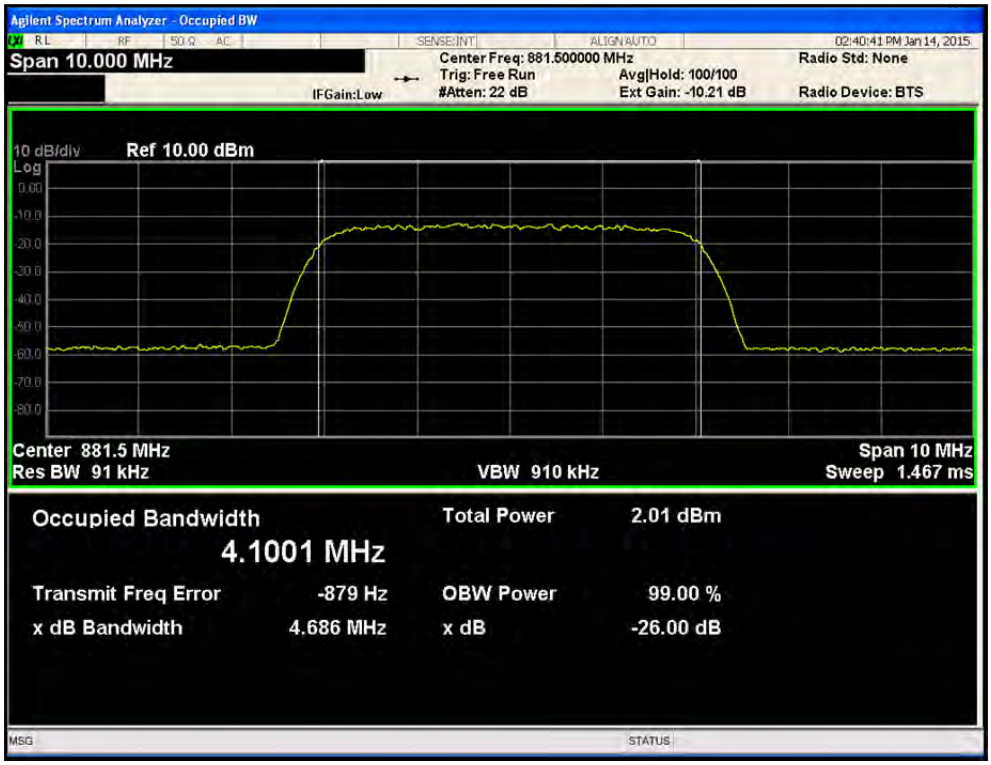
- **Band 5 / Downlink / GSM**



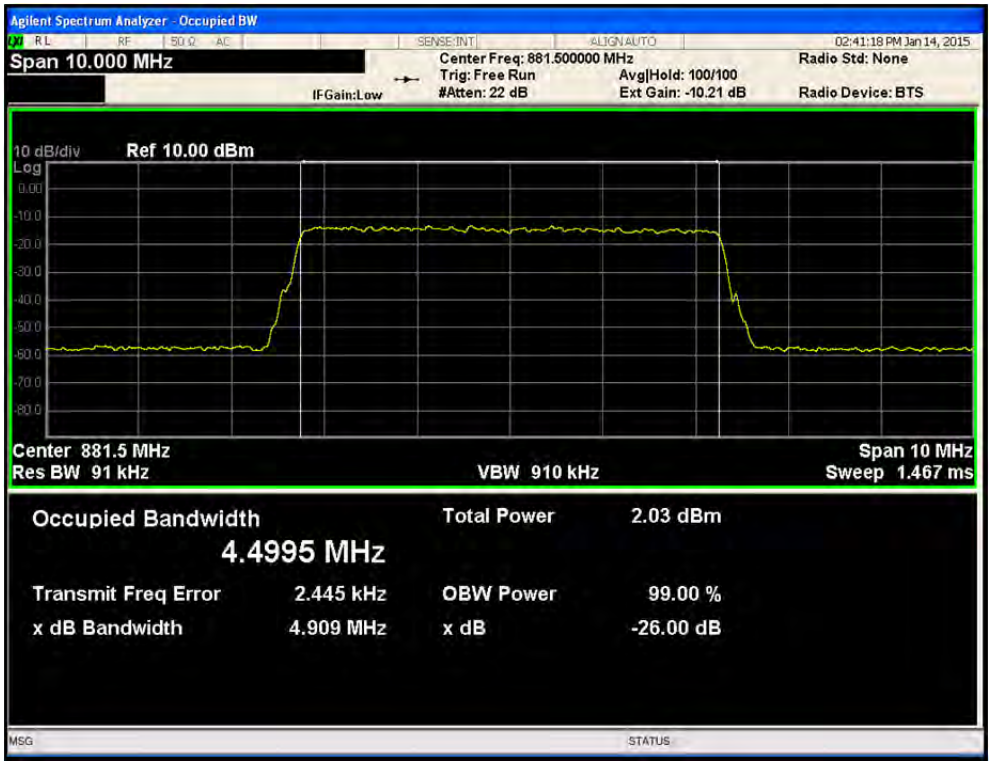

- **Band 5 / Downlink / CDMA**



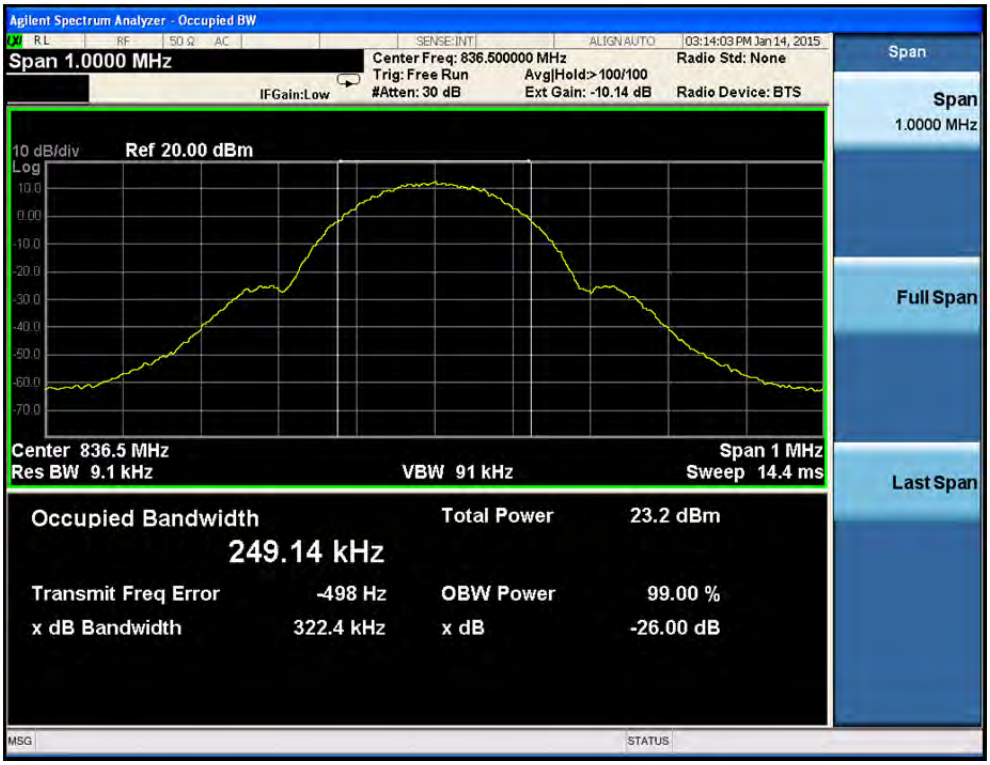
- **Band 5 / Downlink / AWGN**



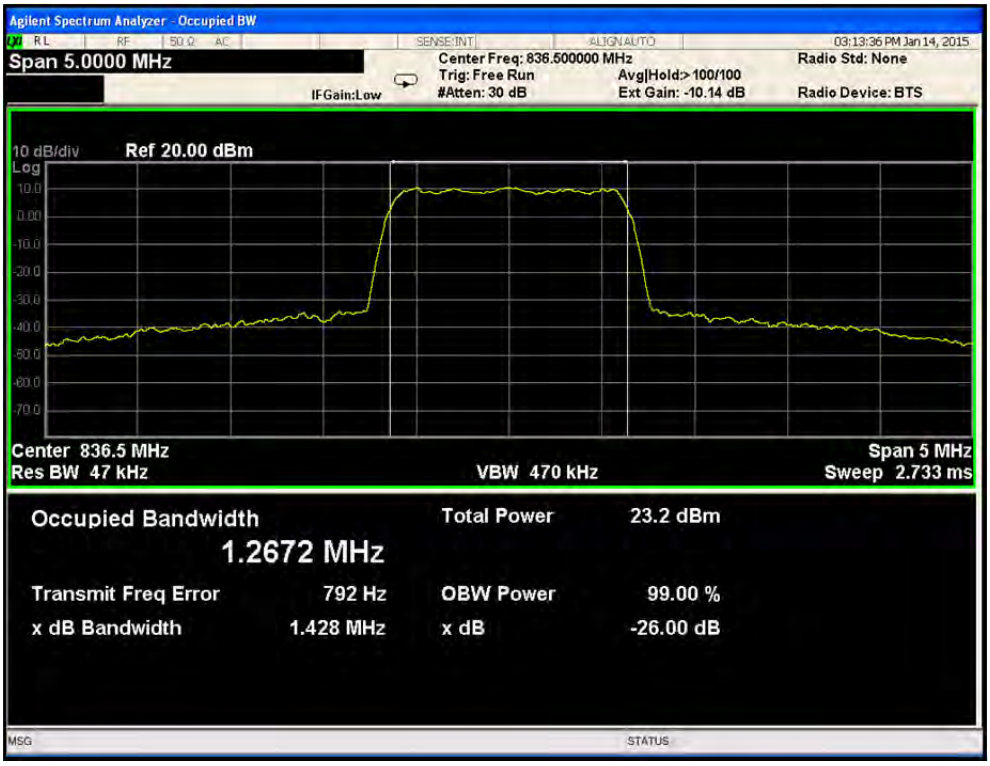

- **Band 5 / Down link / LTE**



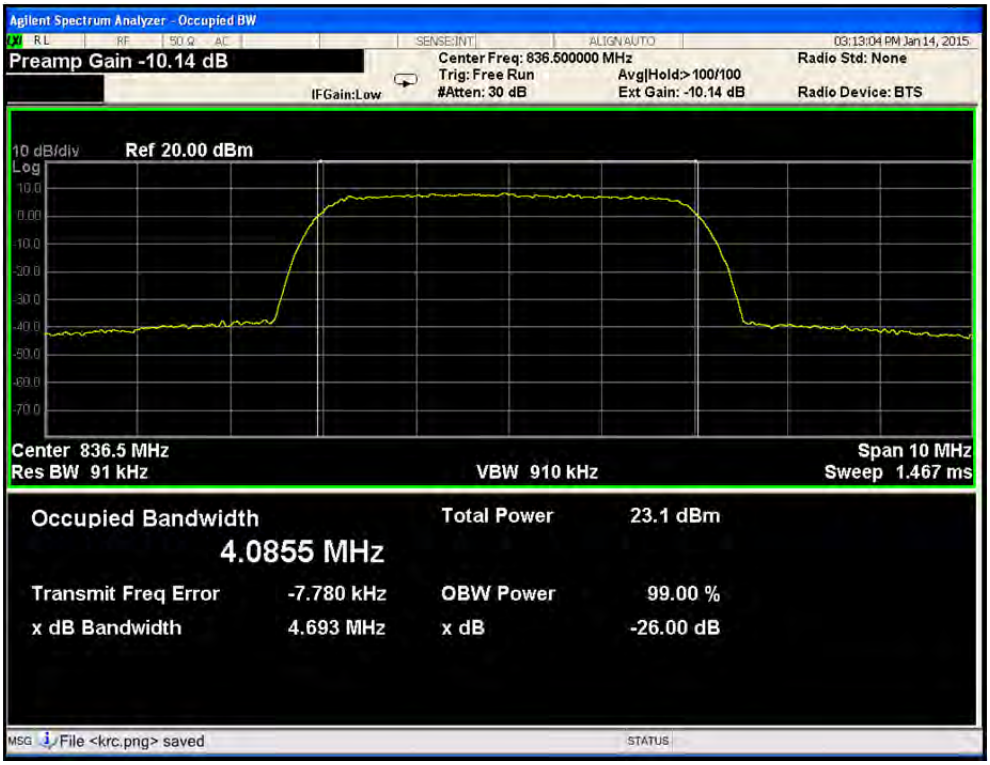
- **Band 5 / Uplink / GSM**



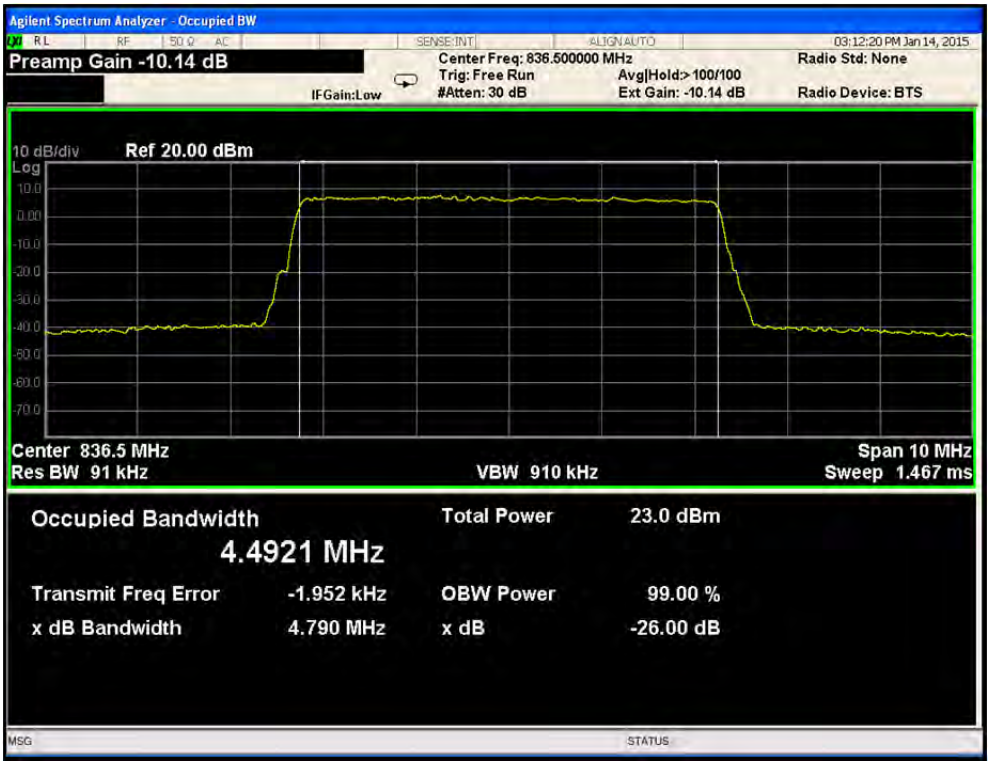

- **Band 5 / Uplink / CDMA**



- **Band 5 / Uplink / AWGN**

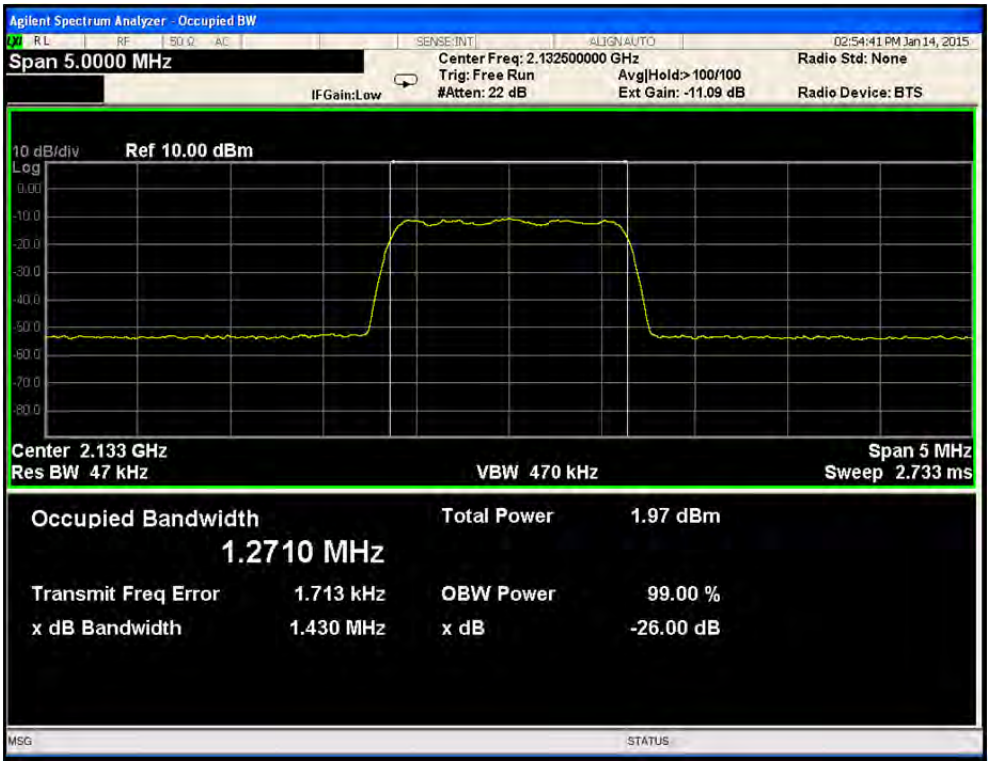



- **Band 5 / Uplink / LTE**

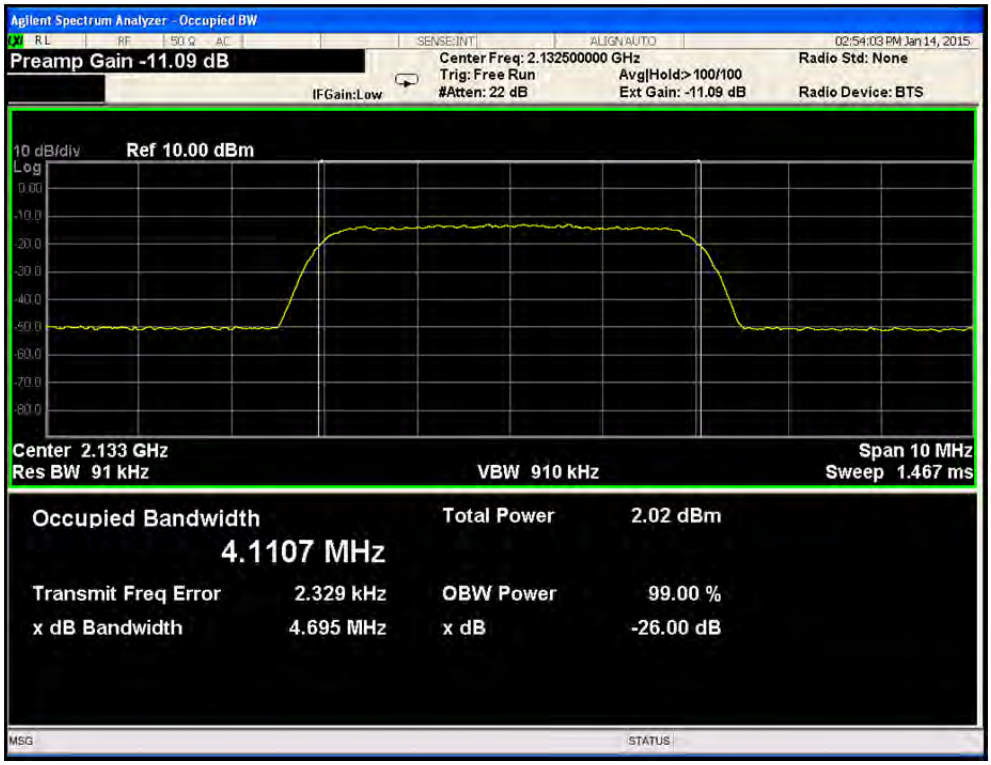


- **Band 4 / Downlink / GSM**

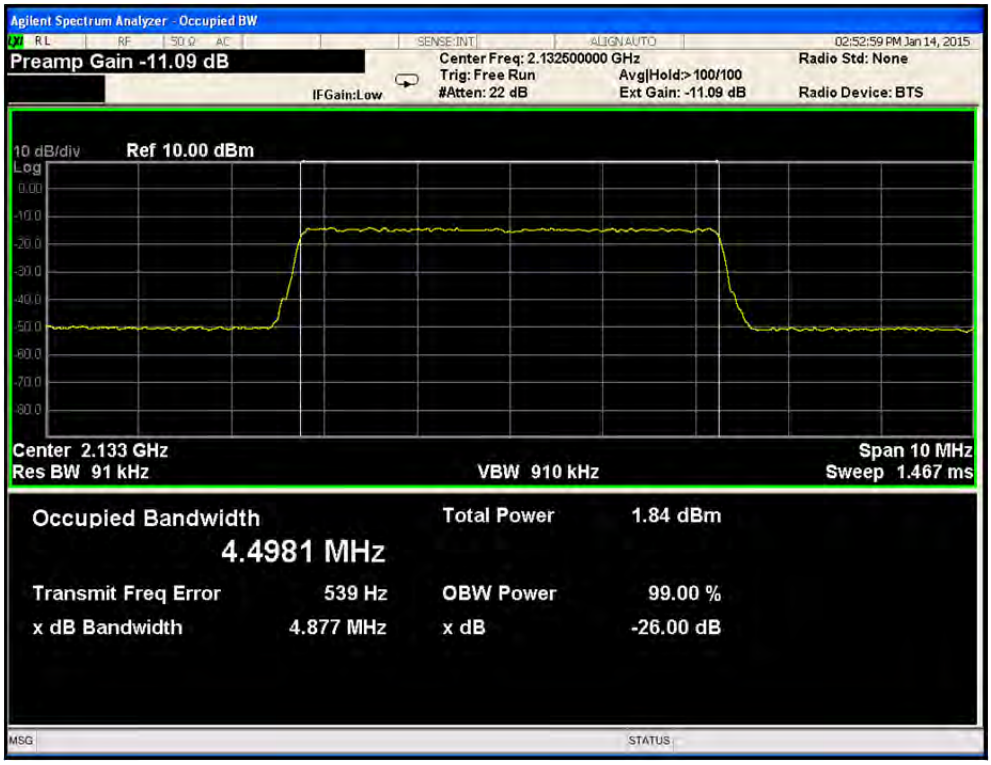

- **Band 4 / Downlink / CDMA**



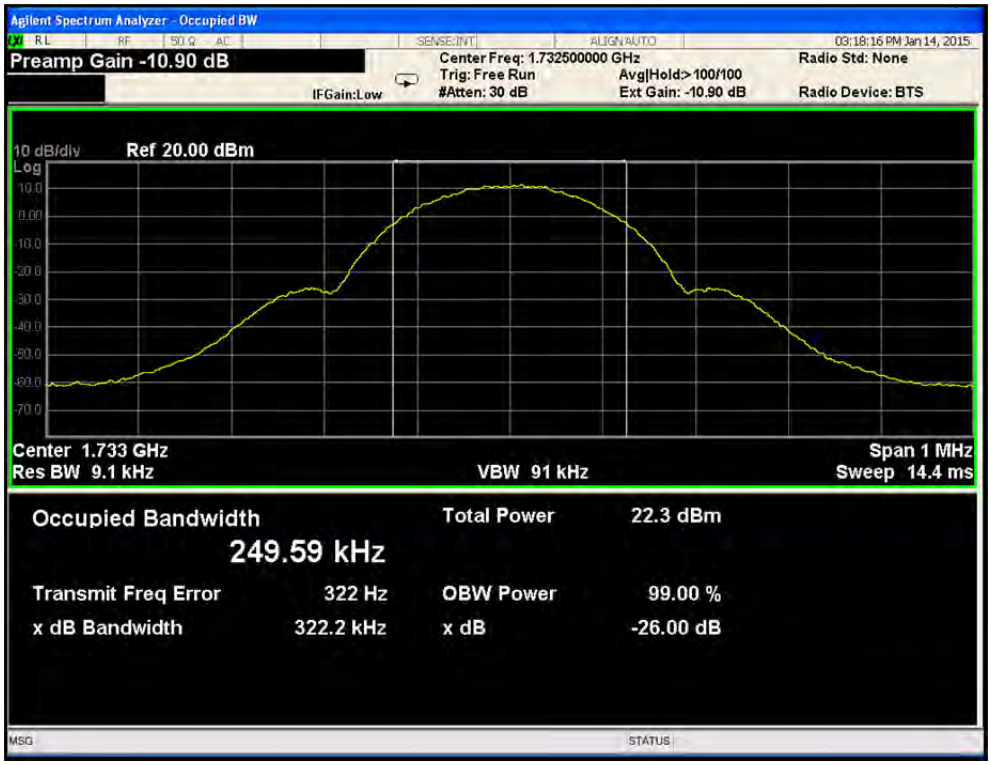
- **Band 4 / Downlink / AWGN**



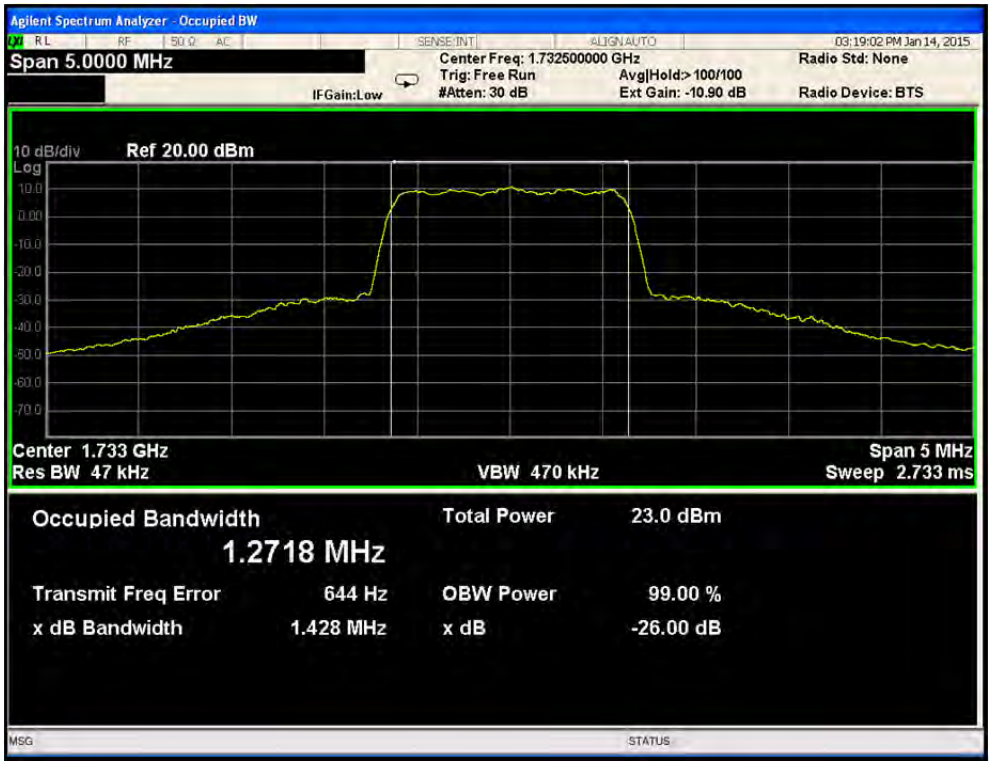

- **Band 4 / Down link / LTE**



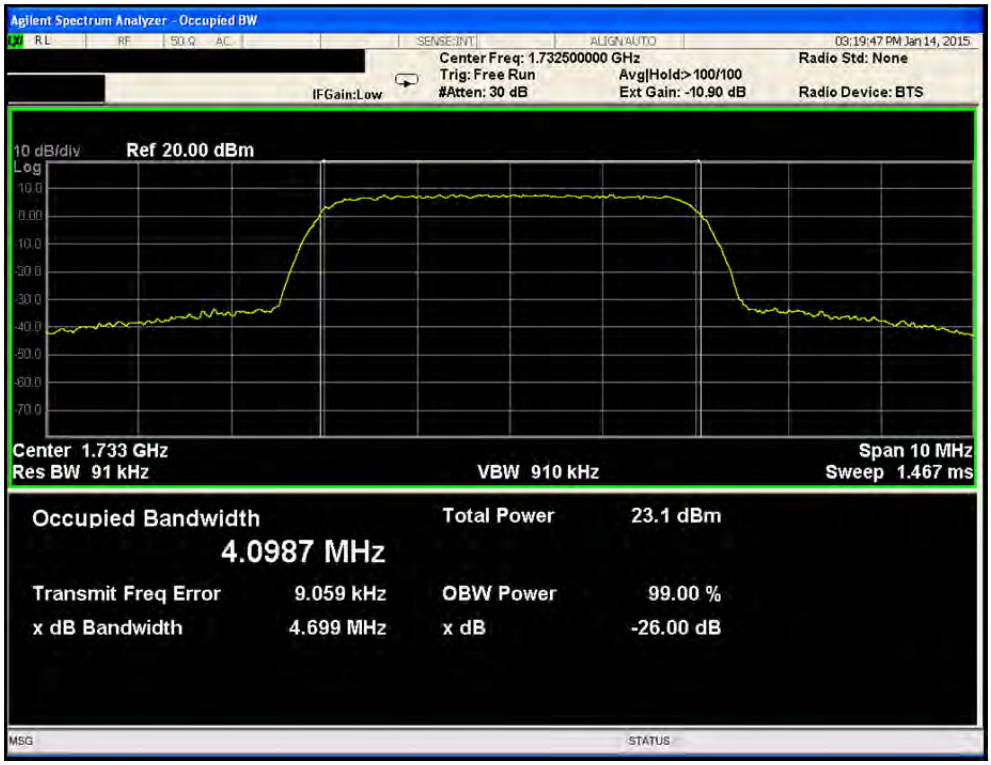
- **Band 4 / Uplink / GSM**



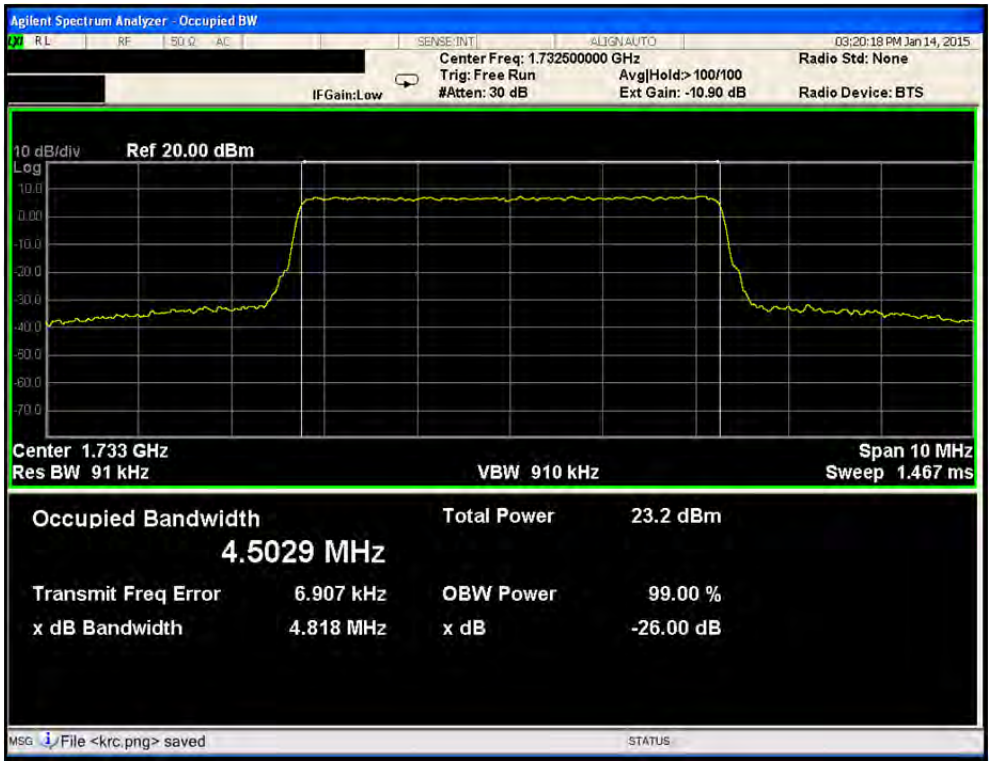

- **Band 4 / Uplink / CDMA**



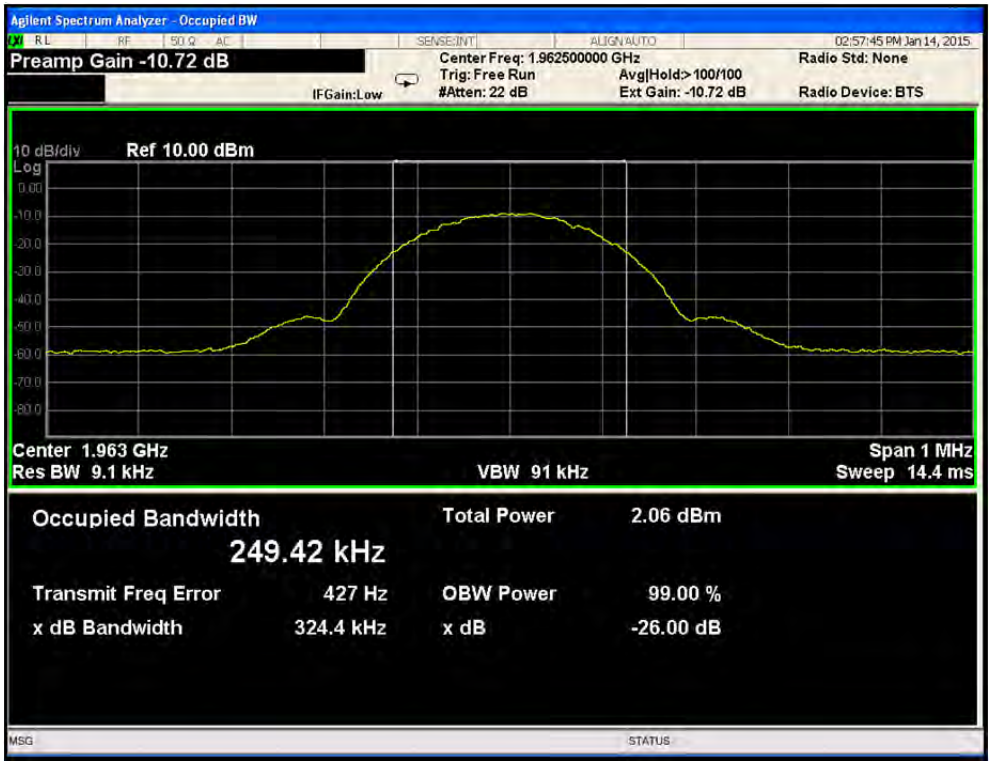
- **Band 4 / Uplink / AWGN**



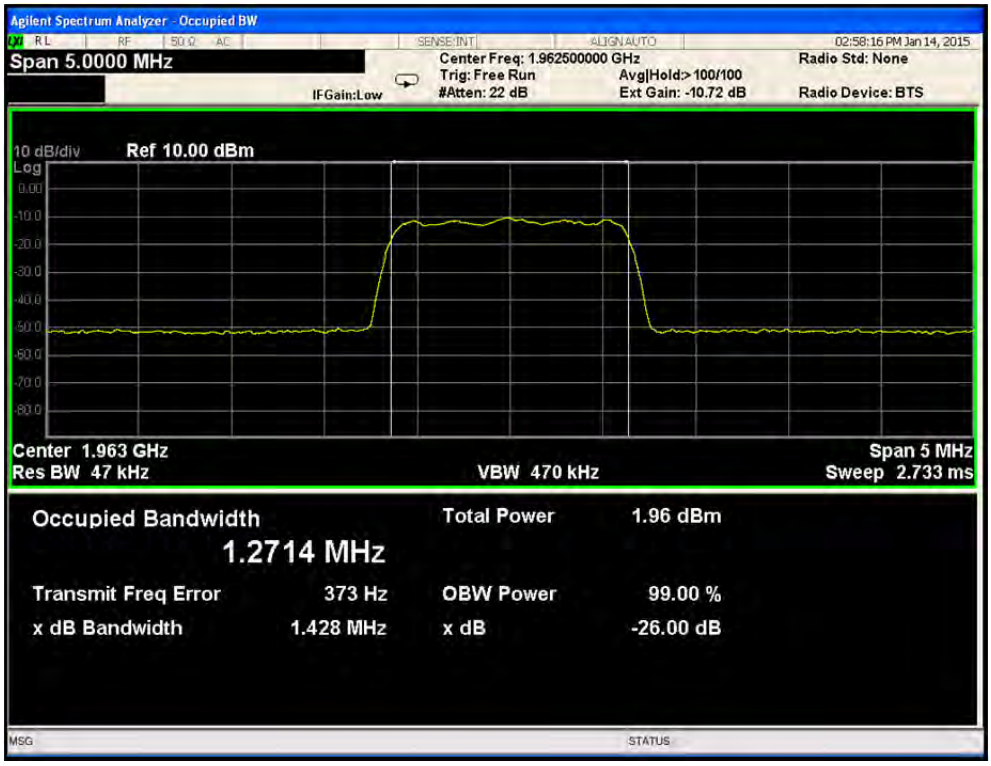

- **Band 4 / Uplink / LTE**



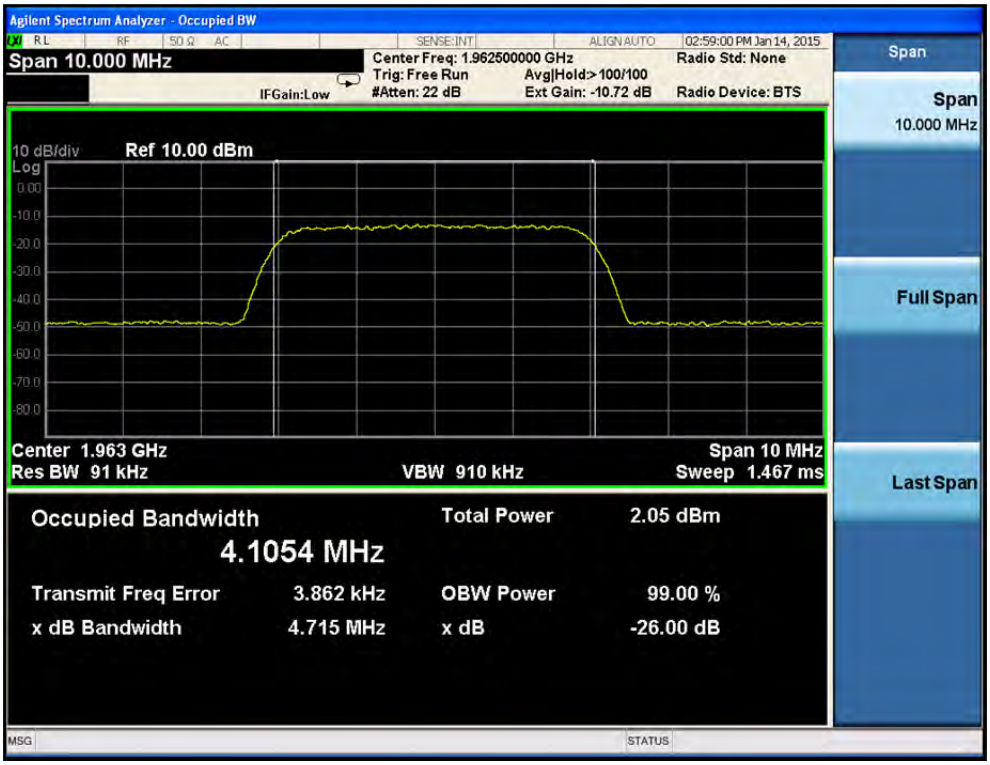
- **Band 25/ Downlink / GSM**



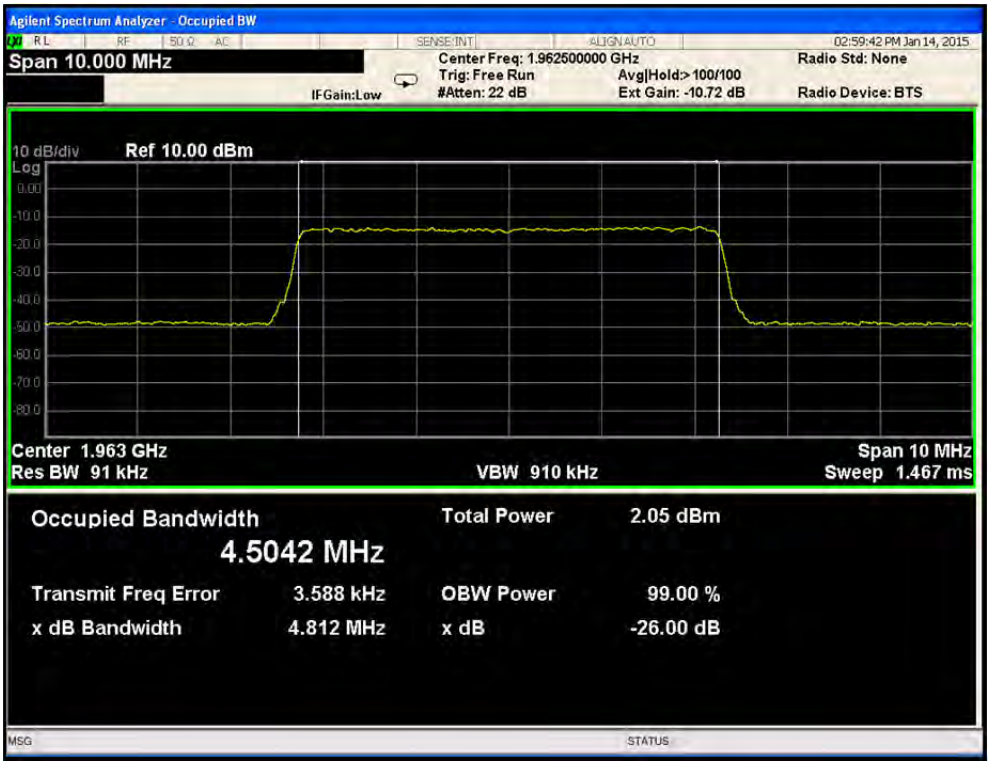

- **Band 25/ Downlink / CDMA**



- **Band 25/ Downlink / AWGN**

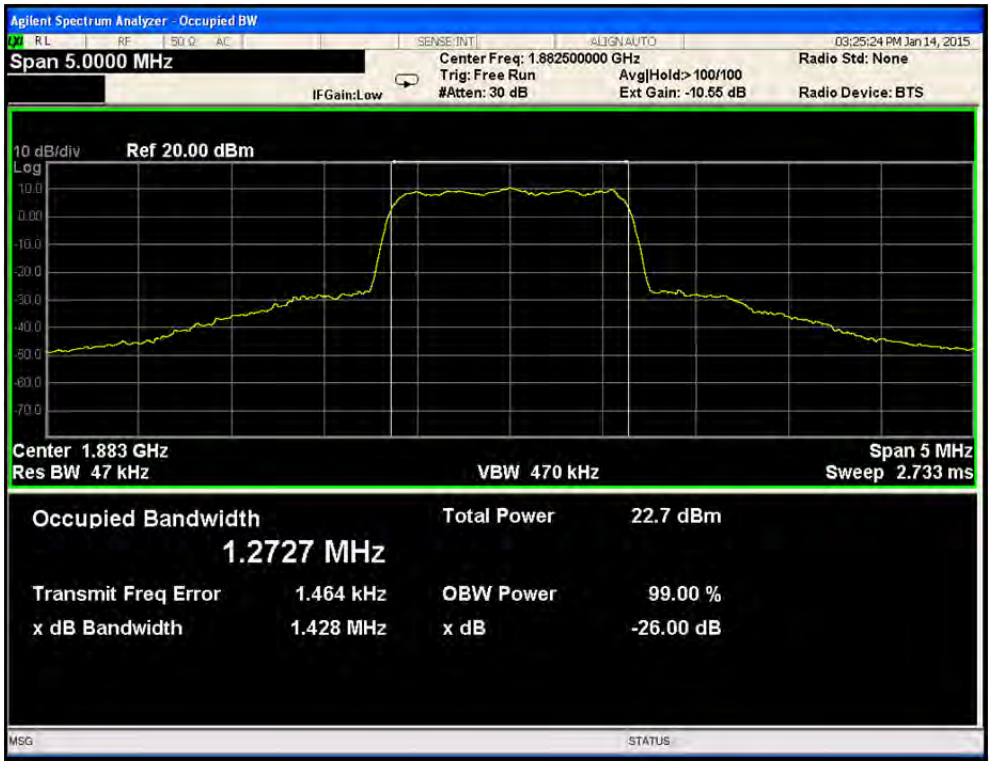



- **Band 25/ Down link / LTE**

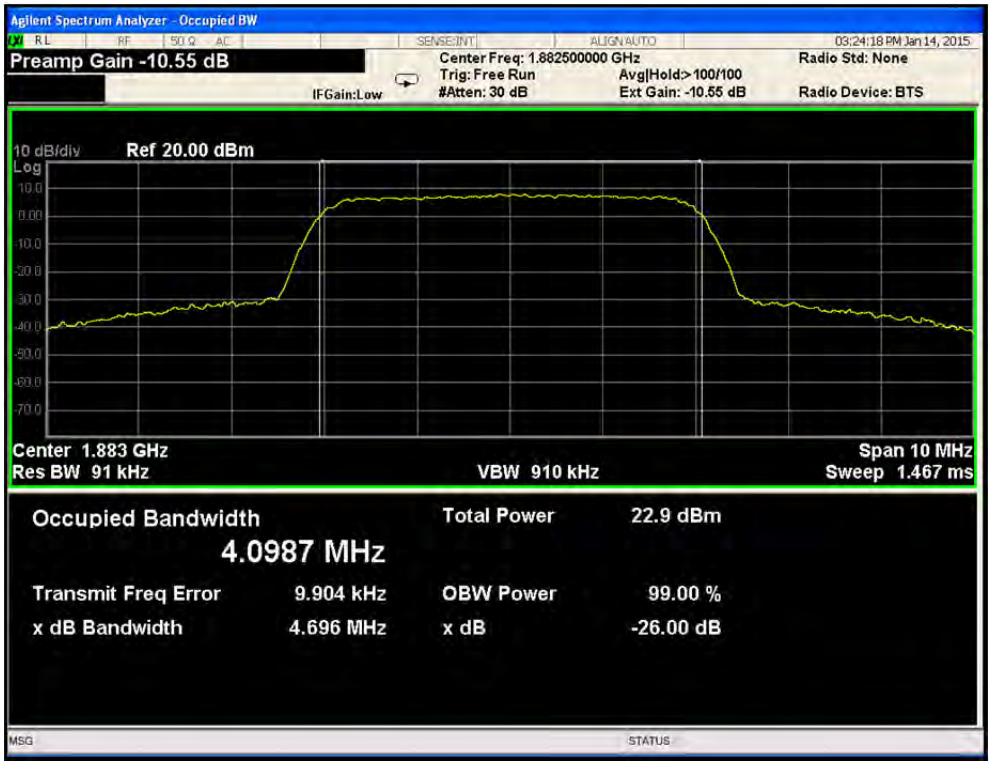


- **Band 25/ Uplink / GSM**

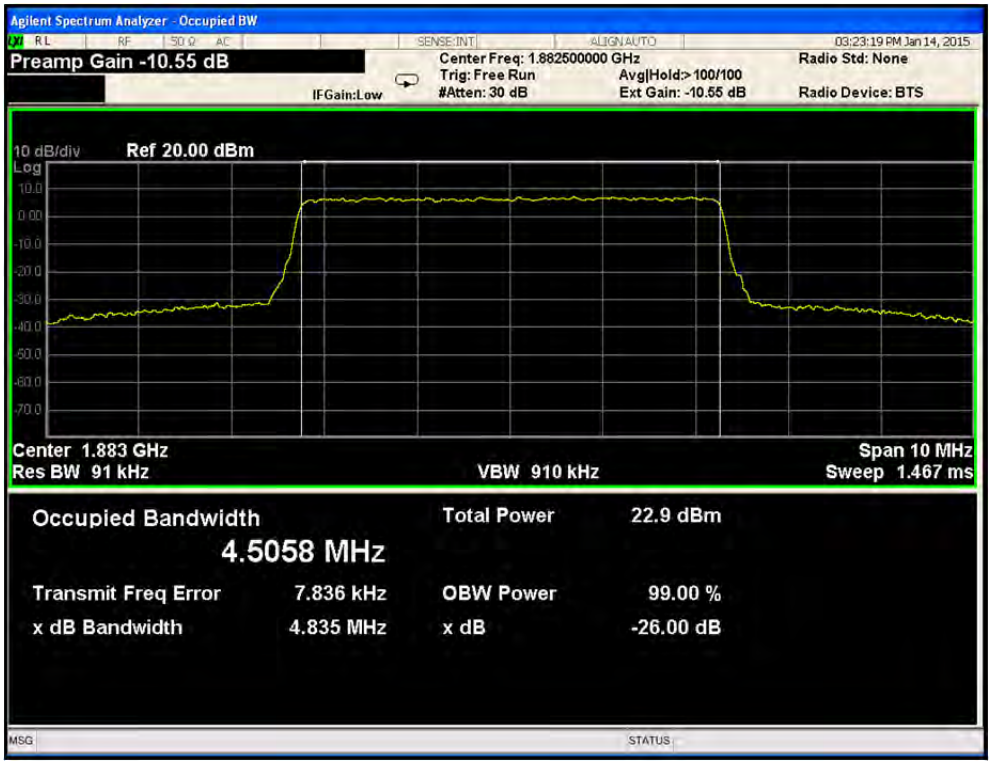

- **Band 25/ Uplink / CDMA**



- **Band 25/ Uplink / AWGN**




- **Band 25/ Uplink / LTE**



## 3.11 Oscillation detection

### 3.11.1 Specification

- FCC Part 20.21 (e)(8)(ii)(A)

### 3.11.2 Measurement method

- 935210 D03 Signal Booster Measurement v02r01

a) Connect the EUT set for normal operation to the test equipment as shown in Set-Up beginning with the spectrum analyzer on the uplink output side of the RF path. Ensure that the RF coupled path is connected to the spectrum analyzer.

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 spectrum analyzer's center frequency to the center of the band under test. Set the spectrum analyzer's span to equal or slightly exceed the width of the band under test. Set the spectrum analyzer for a continuous sweep, max-hold. Set the spectrum analyzer's RBW to at least 1 MHz and the VBW to > 3 times RBW.

c) Decrease the variable attenuator until the spectrum analyzer displays a signal within the band under test. Using a marker, identify the approximate center frequency of this signal on the max-hold display, then increase the attenuation by 10 dB. Reset the EUT.

d) Repeat step c) twice to ensure that the center of the signal created by the booster remains within 250 kHz of the spectrum analyzer's center frequency. If the frequency of the signal is unstable, ensure that the spectrum analyzer is centered between the frequency extremes observed. If the signal is wider than 1 MHz, ensure that the spectrum analyzer is centered on the signal by increasing the resolution bandwidth. Reset the EUT after each oscillation event if necessary. Set the spectrum analyzer's sweep trigger level such that it's just below the peak amplitude of the displayed oscillation signal from the EUT.

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

f) Decrease the variable attenuator until the spectrum analyzer's sweep is triggered, then increase the attenuation 10 dB. Reset the EUT.

g) Reset the zero-span trigger of the spectrum analyzer and repeat step f) twice to ensure that the spectrum analyzer is reliably triggered, resetting the EUT after each oscillation event if necessary.

h) Reset the zero-span sweep trigger of the spectrum analyzer and reset the EUT with a power cycle.

i) Force the EUT to oscillate by reducing the attenuation.

j) Use the Marker function of the spectrum analyzer to measure the time from the on-set 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's sweep time may be altered to improve the time resolution of these cursors.

k) Capture the spectrum analyzer's zero-span trace for inclusion in the test report.

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

m) Set the spectrum analyzer's zero-span sweep time for longer than 1 minute and measure the restart time for each operational uplink and downlink band.

n) Replace the normal operating EUT for the EUT set-up to support an anti-oscillation test mode.

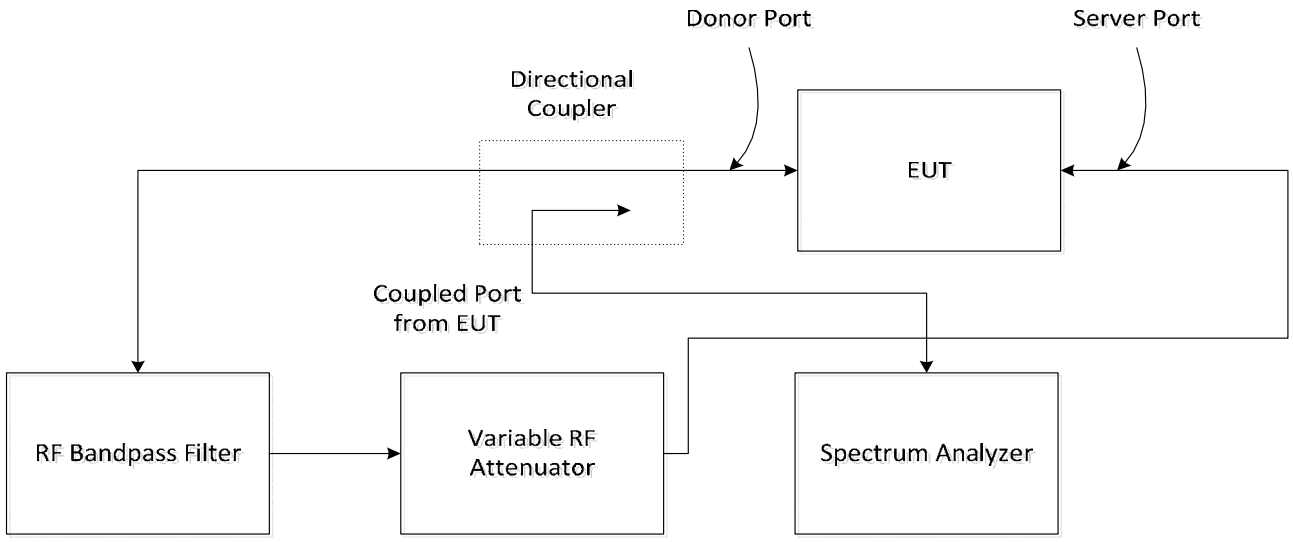
o) Set the spectrum analyzer's zero-span time for a minimum of 120 seconds and a single sweep.

p) Manually trigger the spectrum analyzer's zero-span sweep and a manually force the booster into oscillation as in step i).

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

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

### 3.11.3 Set-Up




### 3.11.4 Test equipment list

| Equipment | Model Name | Manufacturer |
|---|---|---|
| EUT | USHR-781921-5B | OPISYS Incorporated |
| Directional Coupler | 11667A | Agilent |
| Spectrum Analyzer | N9020A | Agilent |
| Attenuator | AF115A-09-34 | Weinschel |

### 3.11.5 Test condition

• Test place: Shield Room
• Test environment: 23.0 °C, 44 % R.H.

### 3.11.6 Test results of detection time

| Band | Link | Detection Time [s] | Limit [s] | Result |
|---|---|---|---|---|
| Band 12 | Down Link | 0.078 | 1.000 | Pass |
| | Up Link | 0.102 | 0.300 | Pass |
| Band 13 | Down Link | 0.104 | 1.000 | Pass |
| | Up Link | 0.104 | 0.300 | Pass |
| Band 5 | Down Link | 0.138 | 1.000 | Pass |
| | Up Link | 0.120 | 0.300 | Pass |
| Band 4 | Down Link | 0.020 | 1.000 | Pass |
| | Up Link | 0.132 | 0.300 | Pass |
| Band 25 | Down Link | 0.056 | 1.000 | Pass |
| | Up Link | 0.224 | 0.300 | Pass |

### 3.11.7 Test results of restarting time

| Band | Link | Restarting Time [s] | Limit [s] | Result |
|---|---|---|---|---|
| Band 12 | Down Link | 63.0 | ≥ 60.0 | Pass |
| | Up Link | 62.2 | ≥ 60.0 | Pass |
| Band 13 | Down Link | 62.0 | ≥ 60.0 | Pass |
| | Up Link | 62.7 | ≥ 60.0 | Pass |
| Band 5 | Down Link | 62.0 | ≥ 60.0 | Pass |
| | Up Link | 62.2 | ≥ 60.0 | Pass |
| Band 4 | Down Link | 63.0 | ≥ 60.0 | Pass |
| | Up Link | 63.0 | ≥ 60.0 | Pass |
| Band 25 | Down Link | 63.0 | ≥ 60.0 | Pass |
| | Up Link | 62.0 | ≥ 60.0 | Pass |

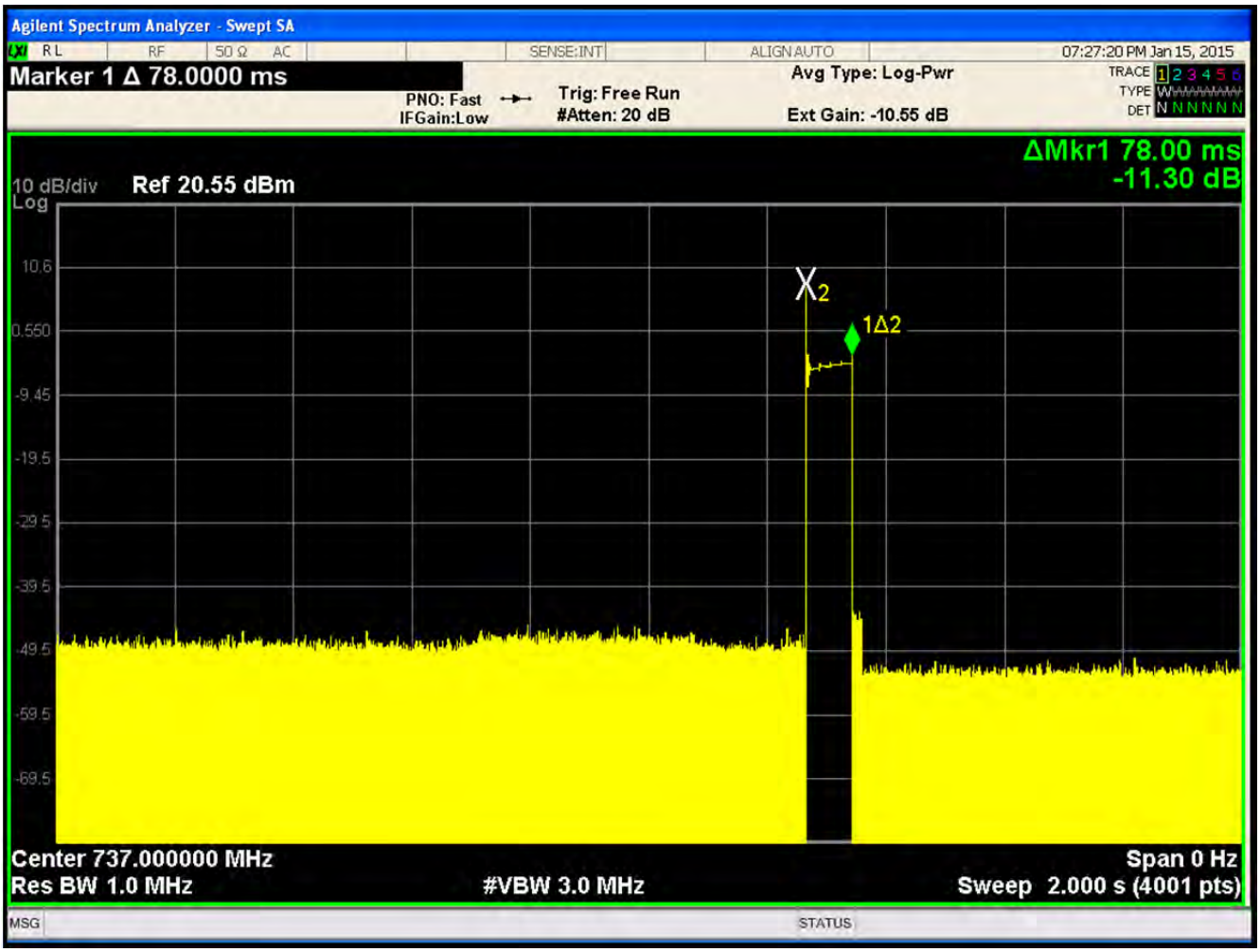
### 3.11.8 Test results of restarting count

| Band | Link | Restarting Counts | Limit | Result |
|---|---|---|---|---|
| Band 12 | Down Link | 4 | ≤ 5 | Pass |
| | Up Link | 4 | ≤ 5 | Pass |
| Band 13 | Down Link | 4 | ≤ 5 | Pass |
| | Up Link | 4 | ≤ 5 | Pass |
| Band 5 | Down Link | 4 | ≤ 5 | Pass |
| | Up Link | 4 | ≤ 5 | Pass |
| Band 4 | Down Link | 4 | ≤ 5 | Pass |
| | Up Link | 4 | ≤ 5 | Pass |
| Band 25 | Down Link | 4 | ≤ 5 | Pass |
| | Up Link | 4 | ≤ 5 | Pass |

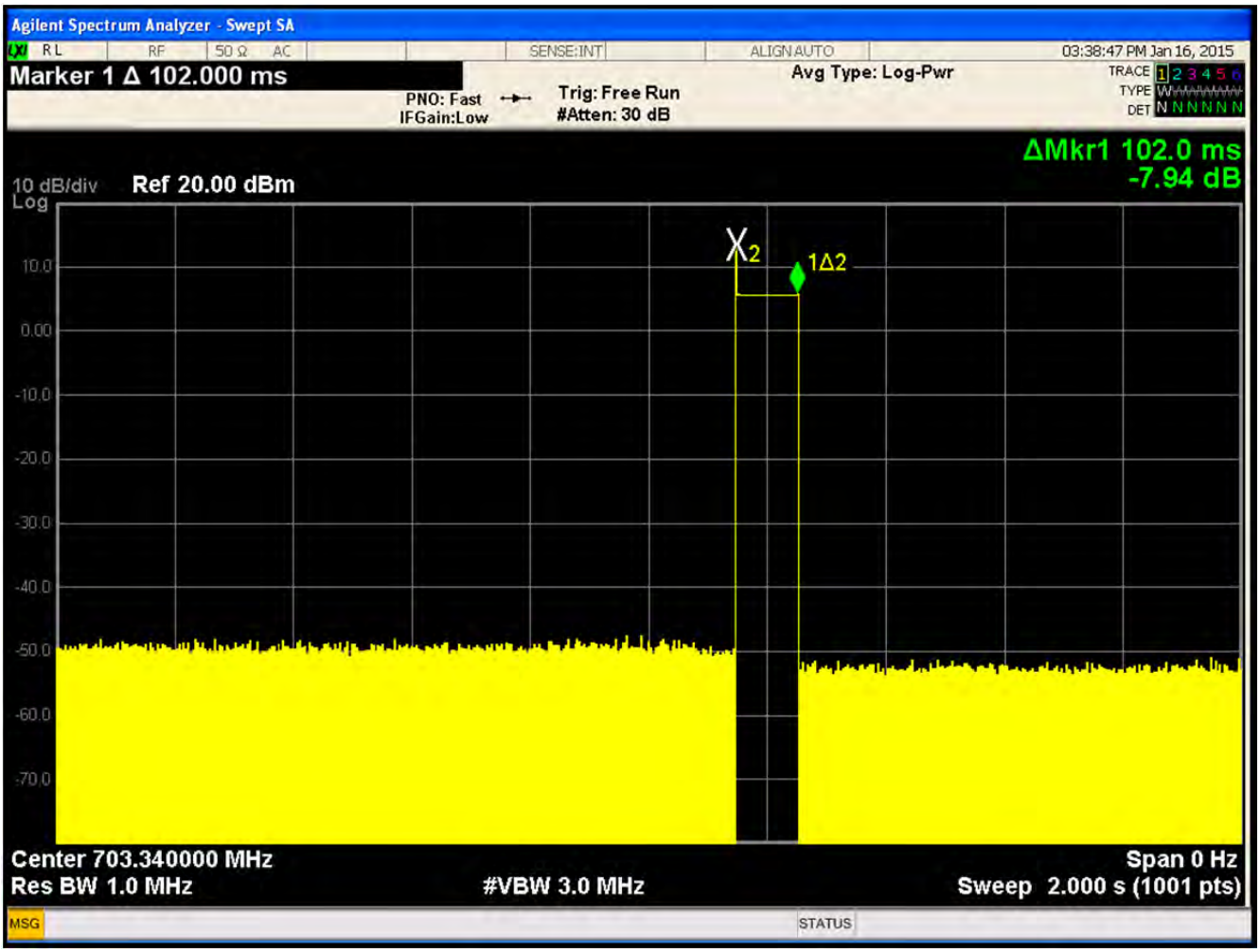
### 3.11.9 Test plots of detection time

- **Band 12 / Downlink**



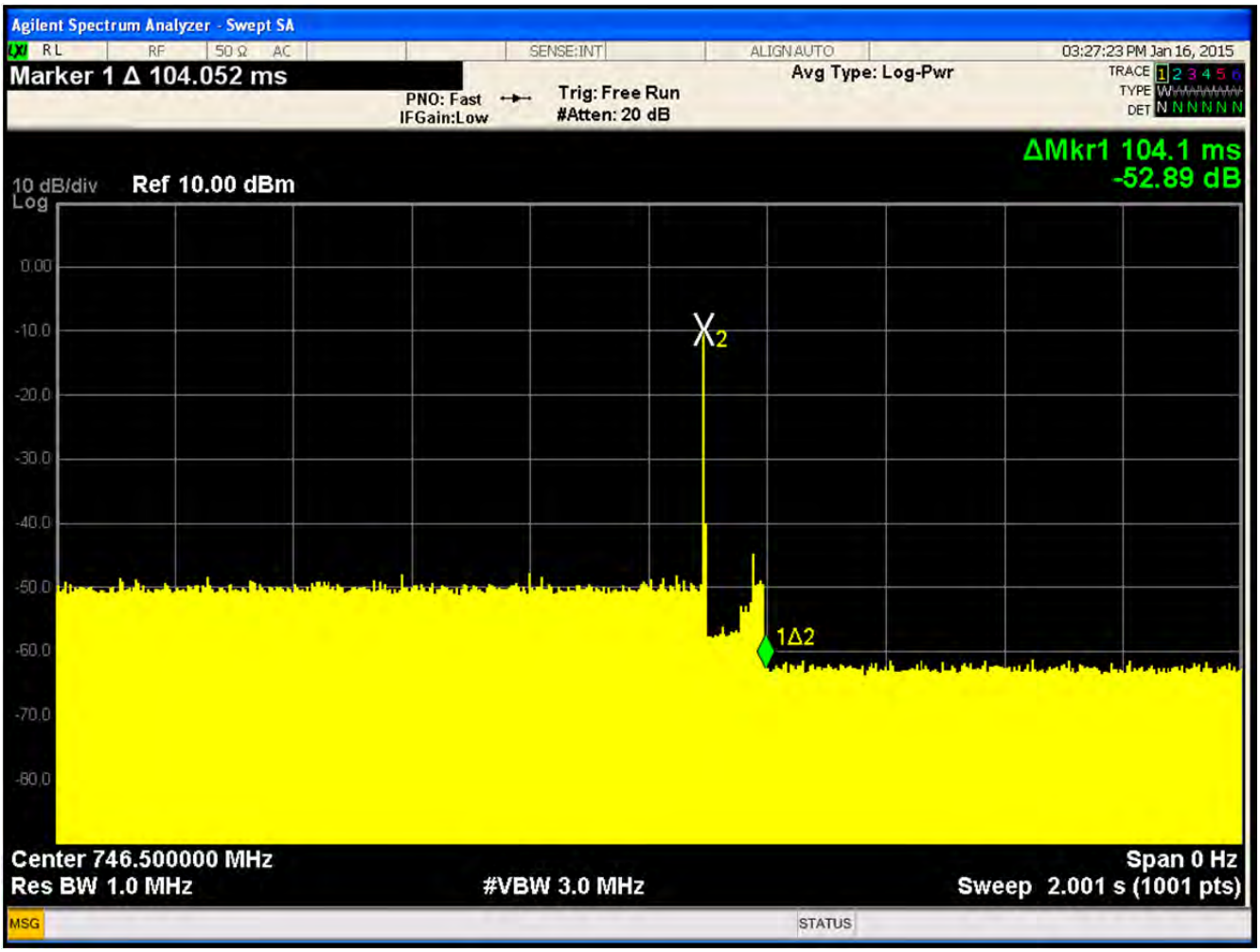

Time of oscillation detection and mitigation : 0.078 s
Limit : 1.000 s

- **Band 12 / Uplink**



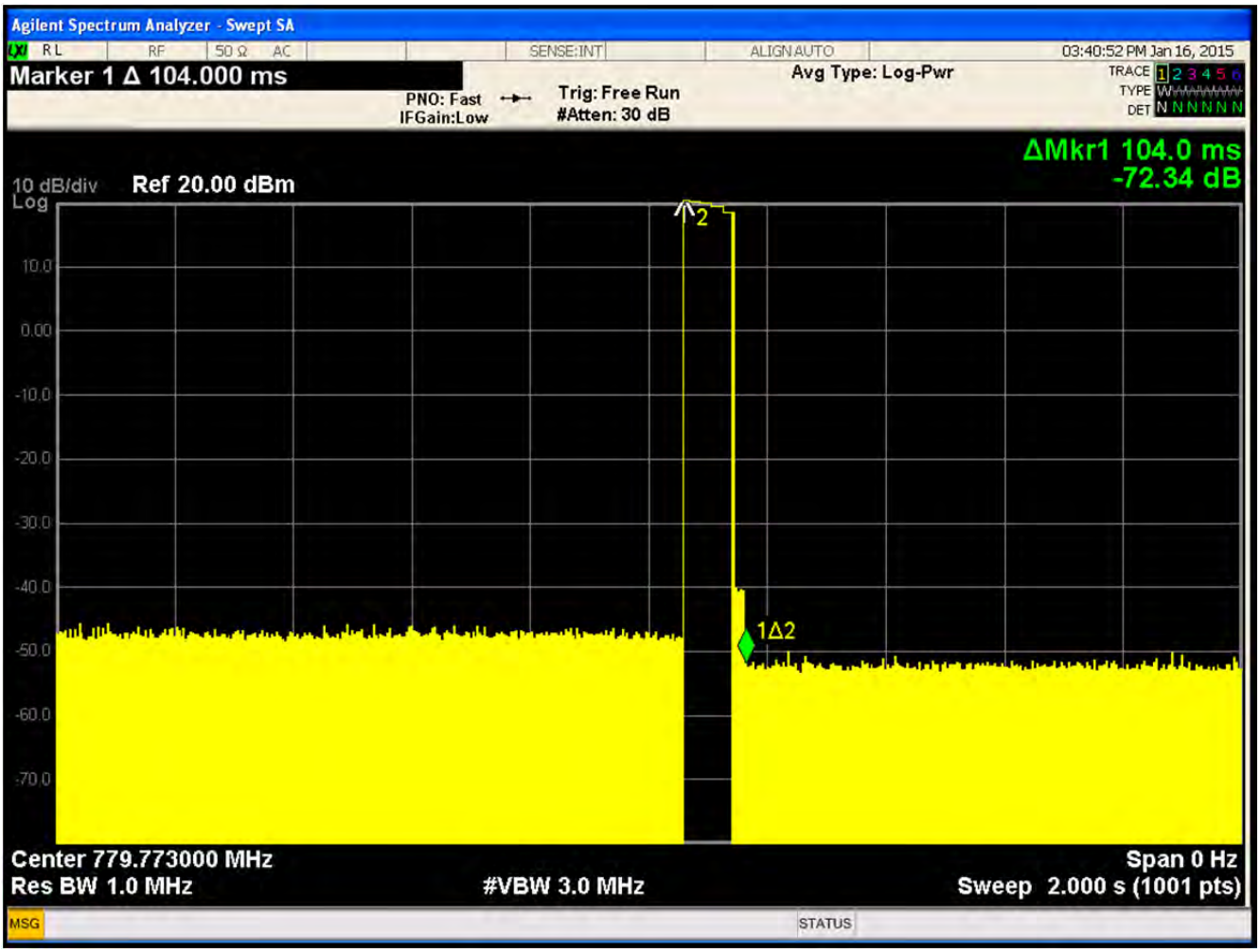

Time of oscillation detection and mitigation : 0.102 s
Limit : 0.300 s

- **Band 13 / Downlink**



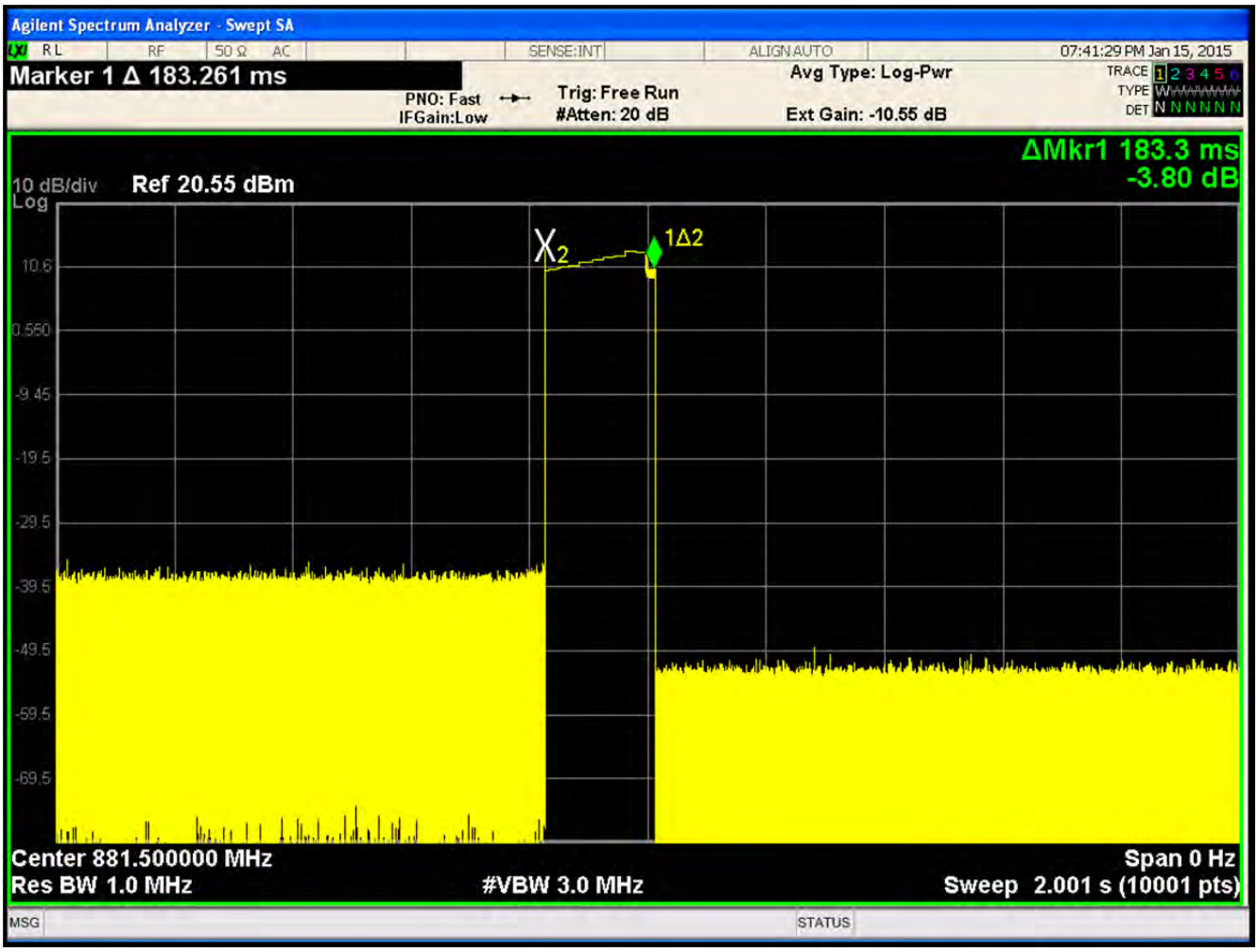

Time of oscillation detection and mitigation : 0.104 s
Limit : 1.000 s

- **Band 13 / Uplink**



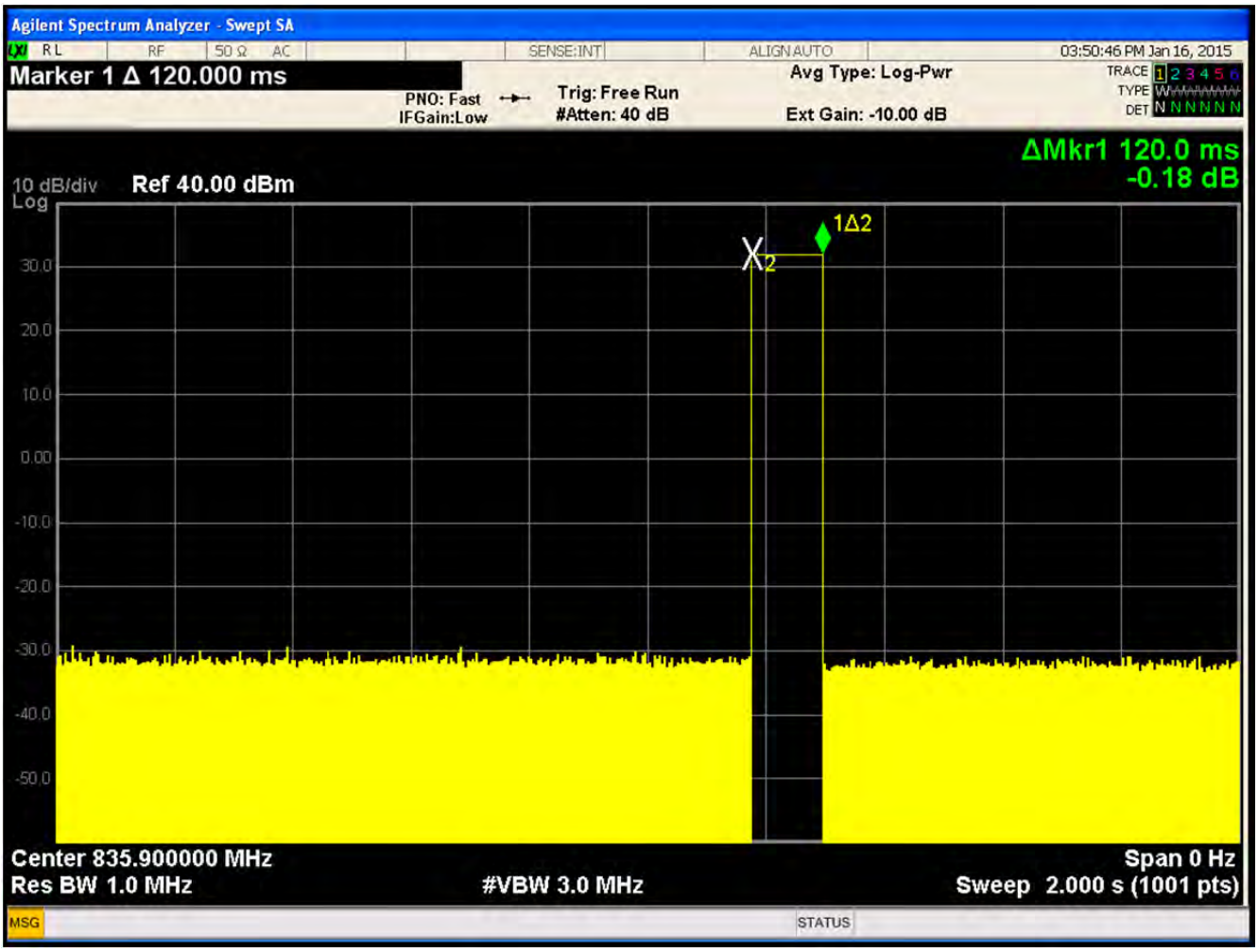

Time of oscillation detection and mitigation : 0.104 s
Limit : 0.300 s

- **Band 5 / Downlink**



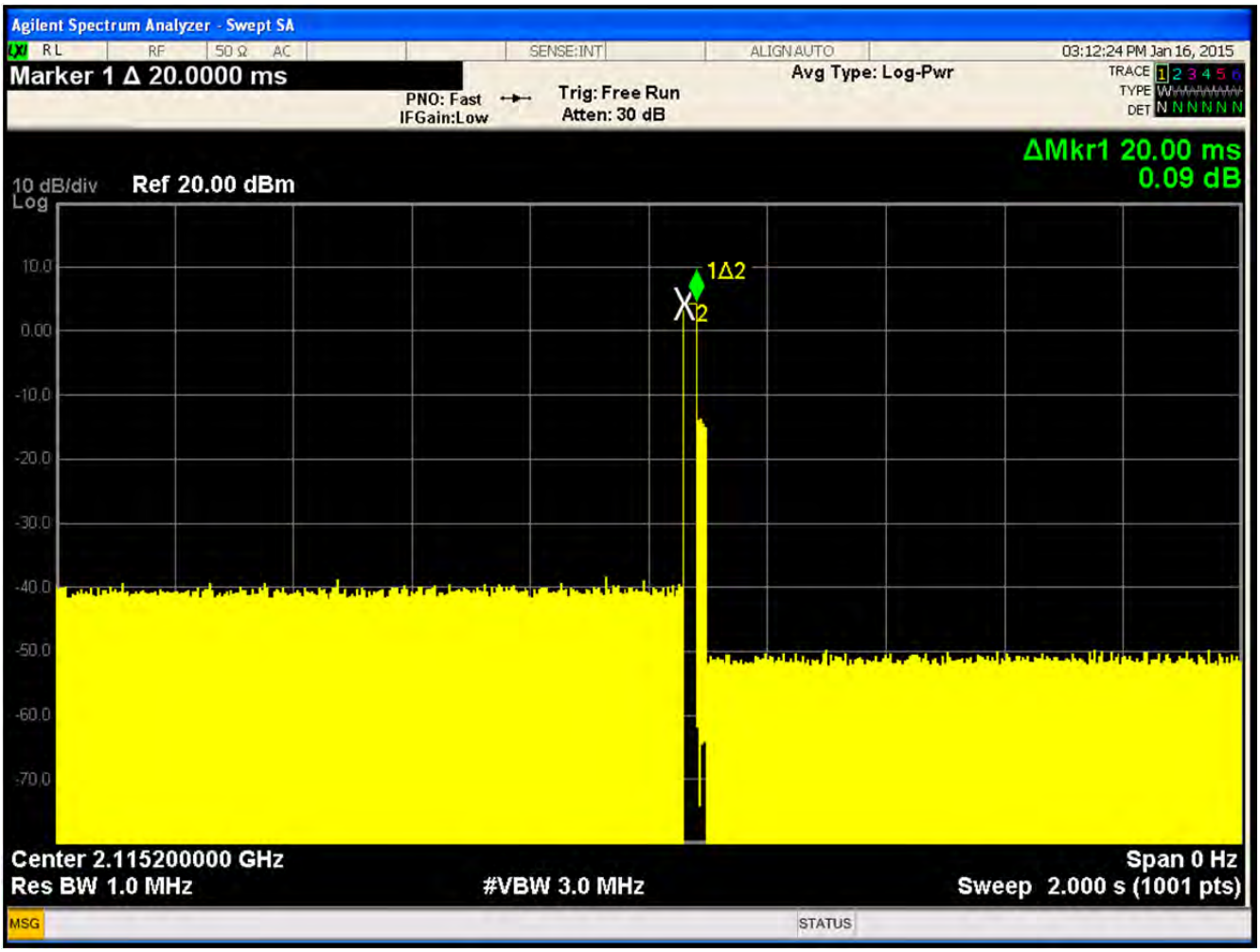

Time of oscillation detection and mitigation : 0.138 s
Limit : 1.000 s

- **Band 5 / Uplink**



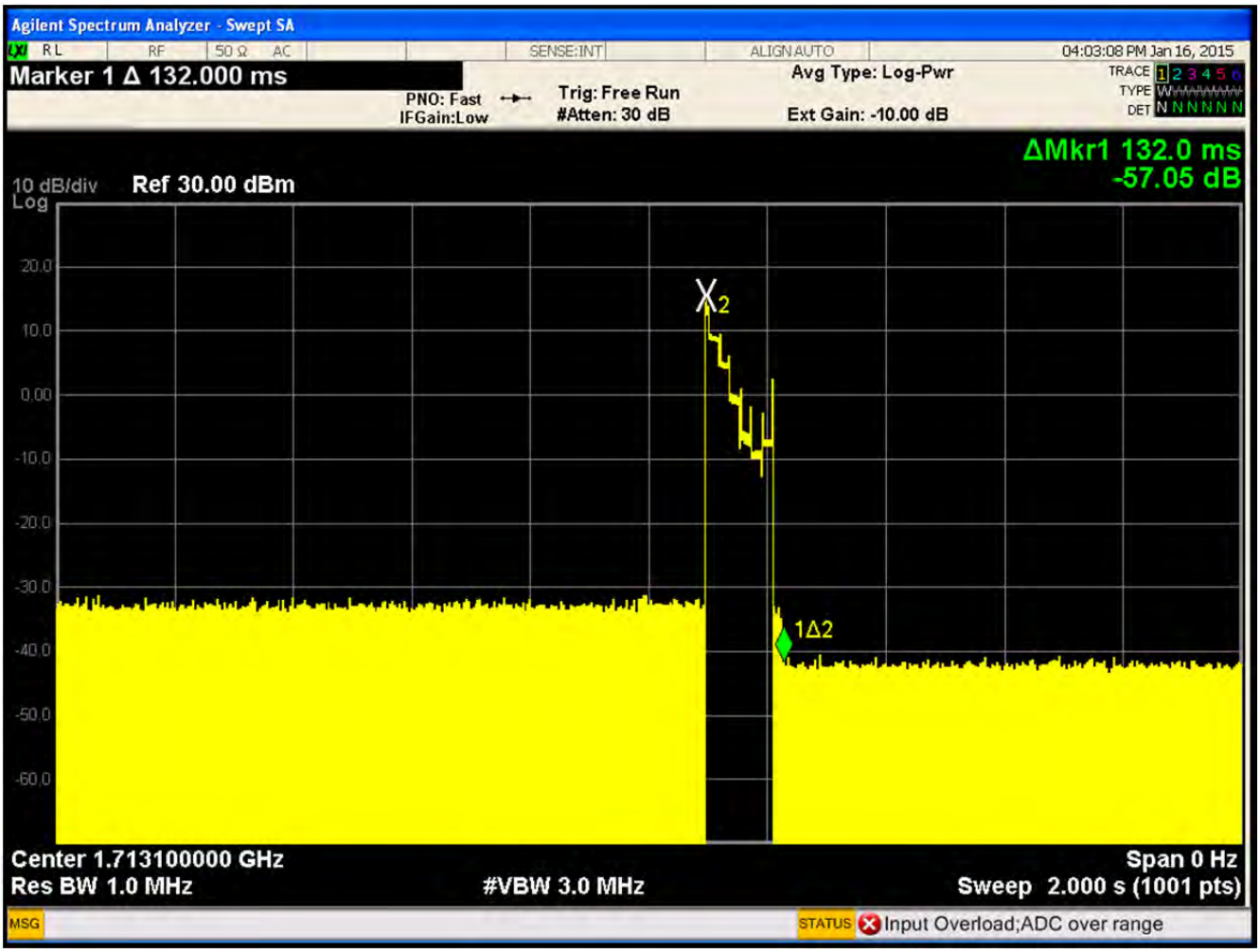

Time of oscillation detection and mitigation : 0.120 s
Limit : 0.300 s

- **Band 4 / Downlink**



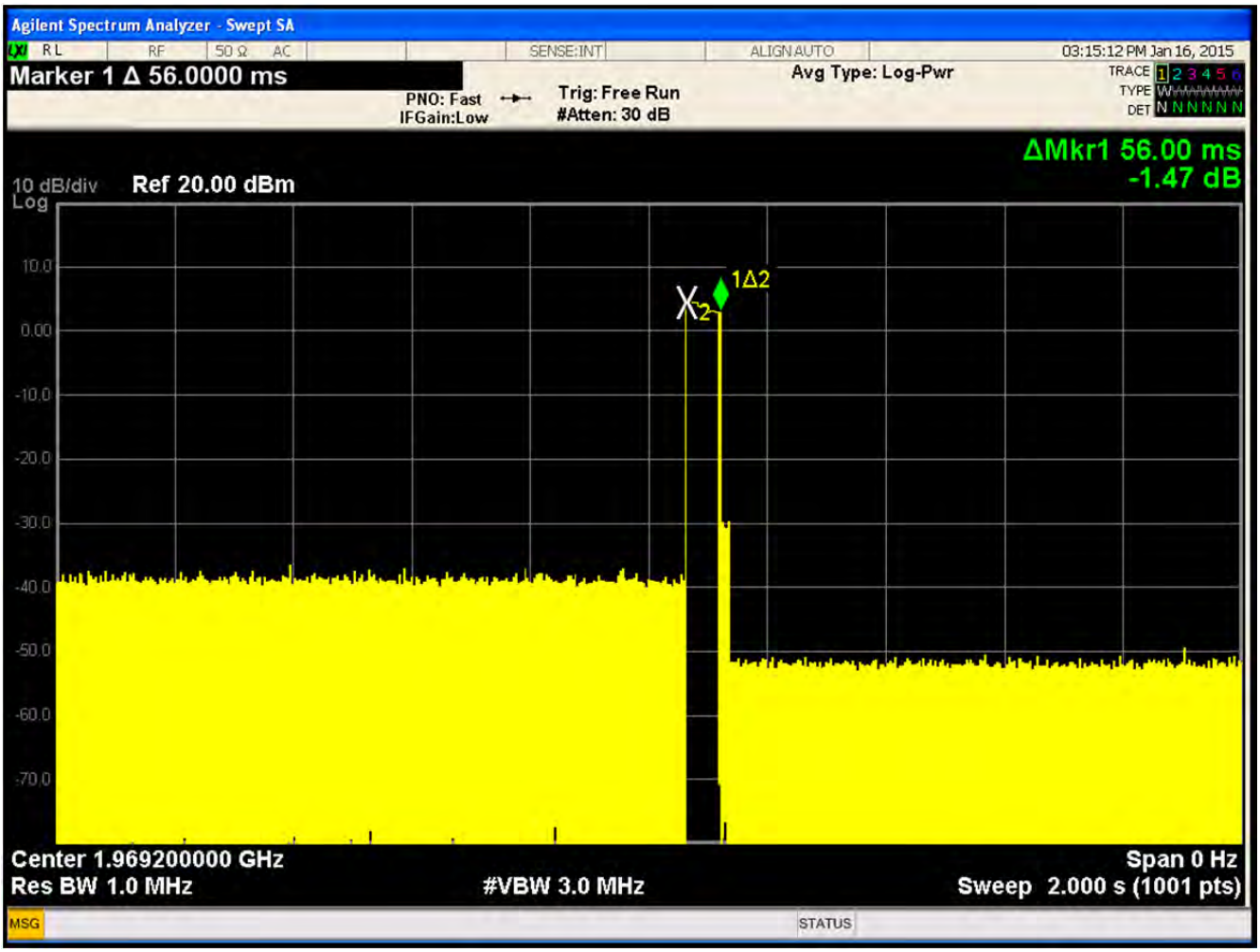

Time of oscillation detection and mitigation : 0.020 s
Limit : 1.000 s

- **Band 4 / Uplink**



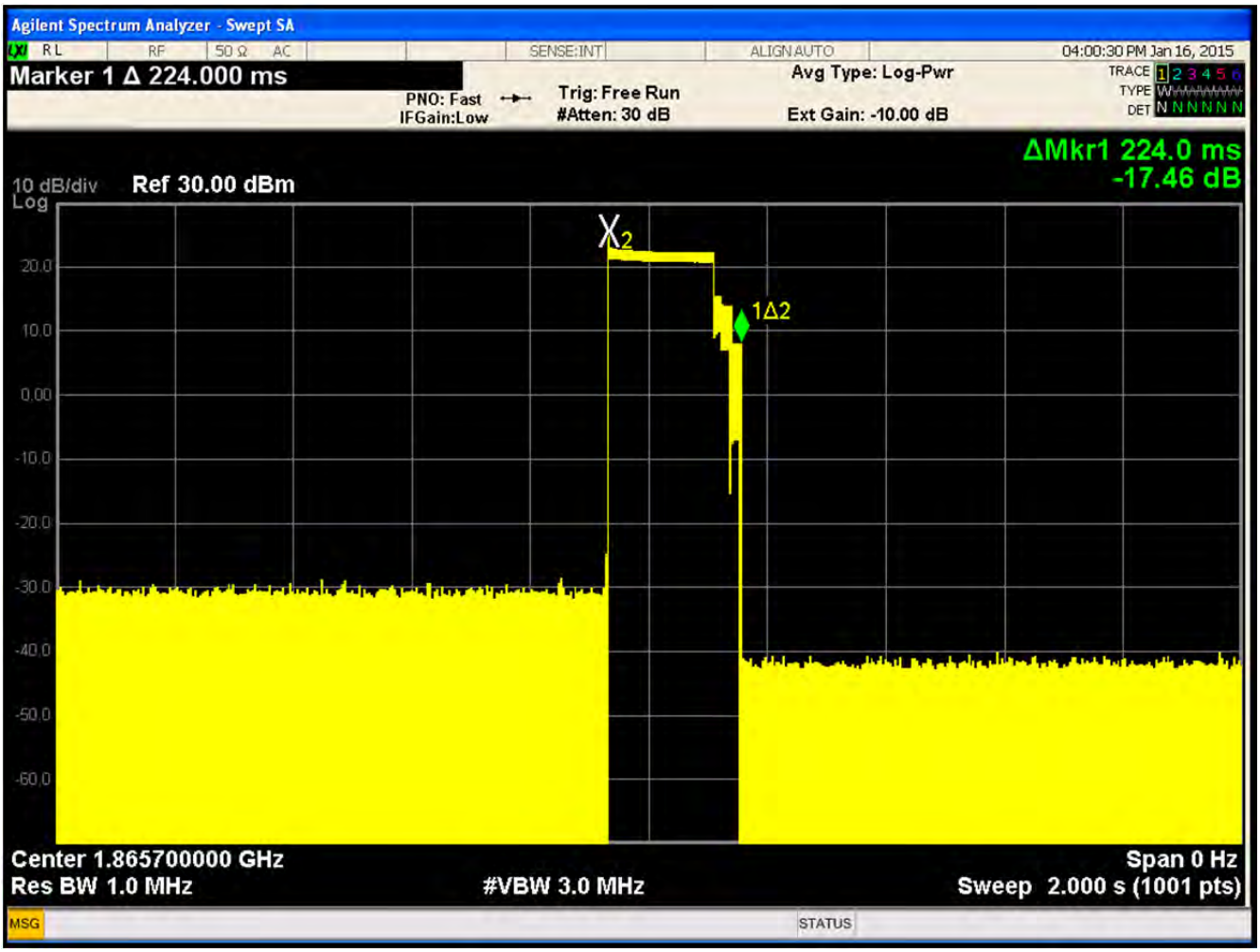

Time of oscillation detection and mitigation : 0.132 s
Limit : 0.300 s

- **Band 25/ Downlink**




Time of oscillation detection and mitigation : 0.056 s
Limit : 1.000 s

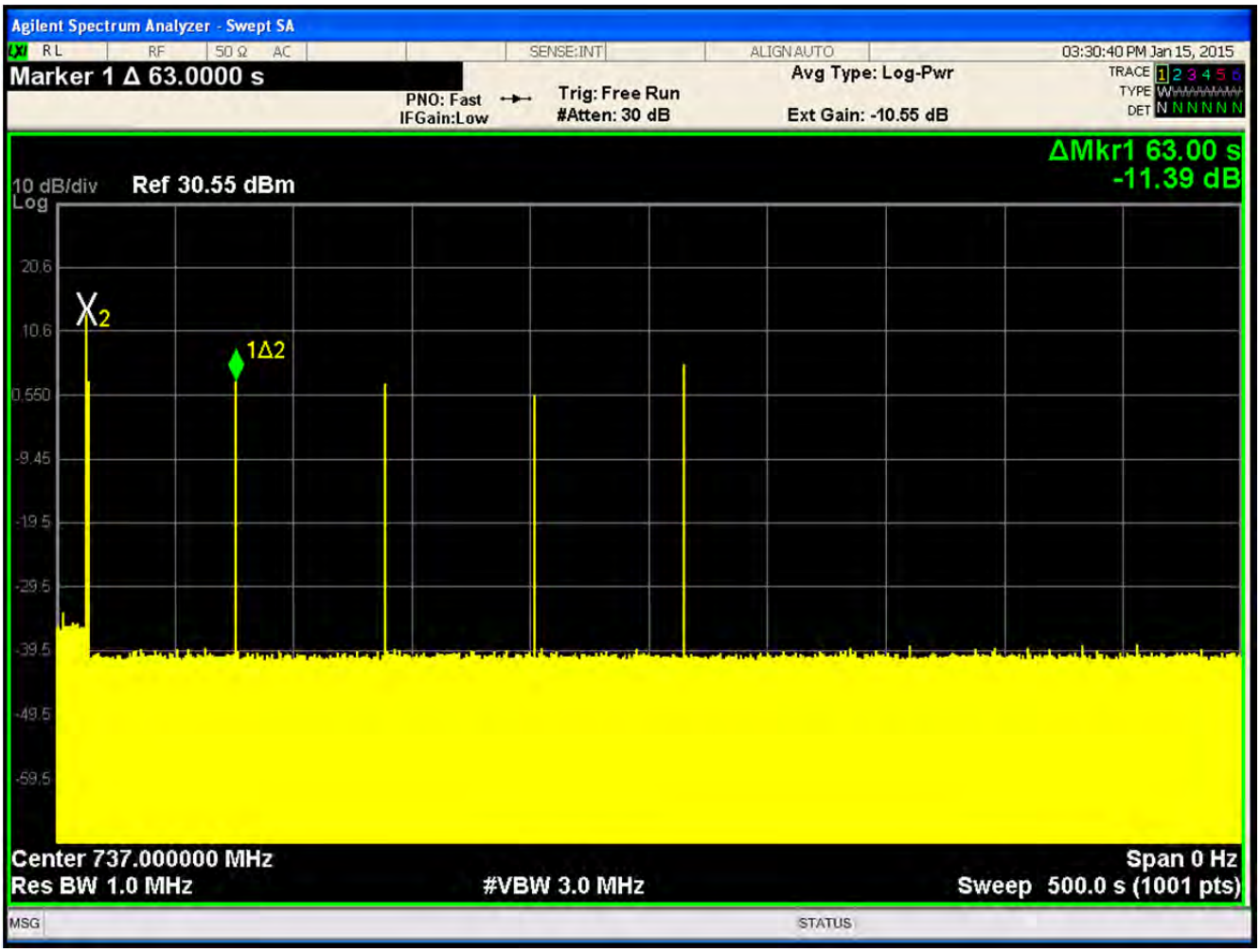
- **Band 25/ Uplink**




Time of oscillation detection and mitigation : 0.224 s
Limit : 0.300 s

### 3.11.10 Test plots of restarting time

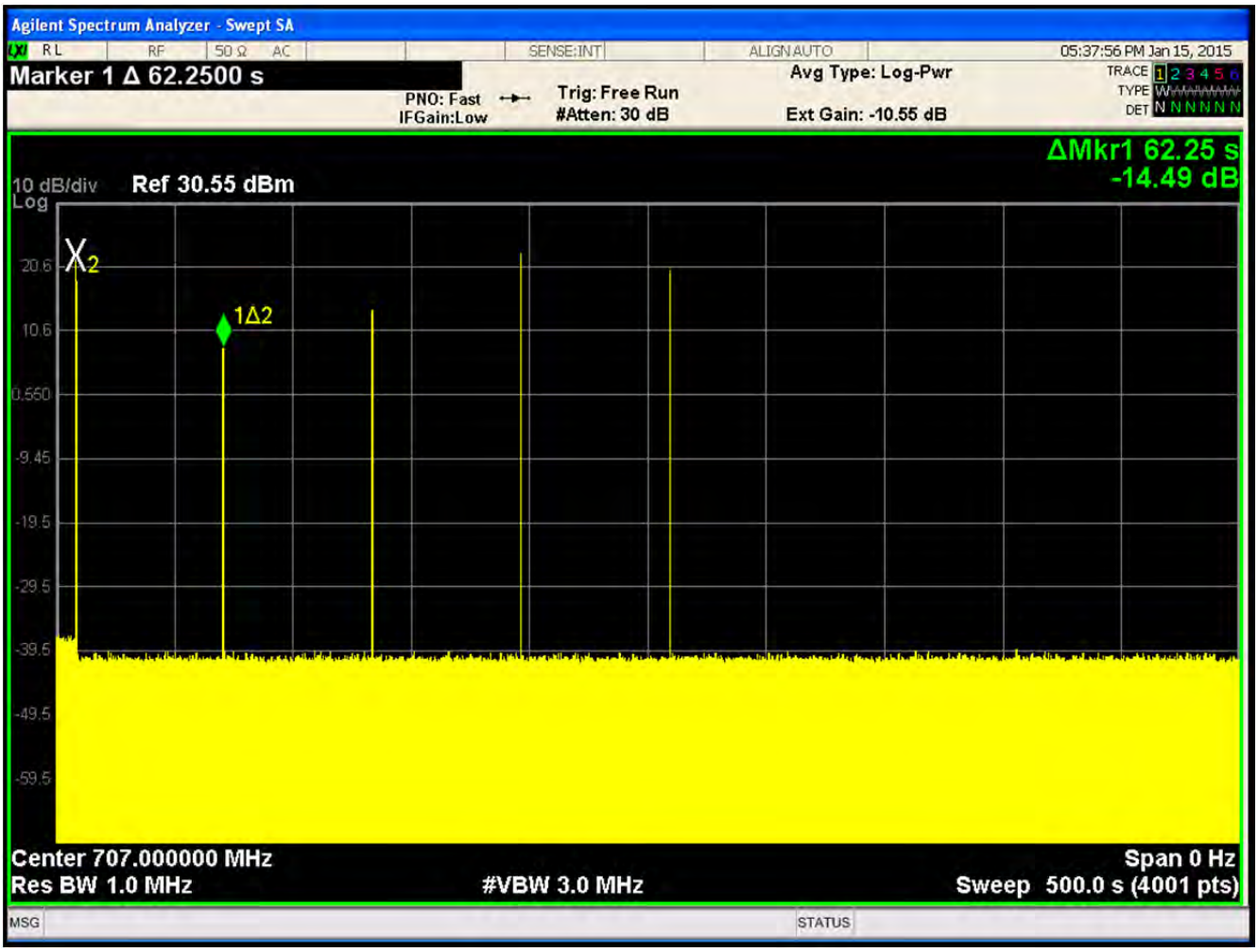
- **Band 12 / Downlink**




Restarting time : 63.0 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

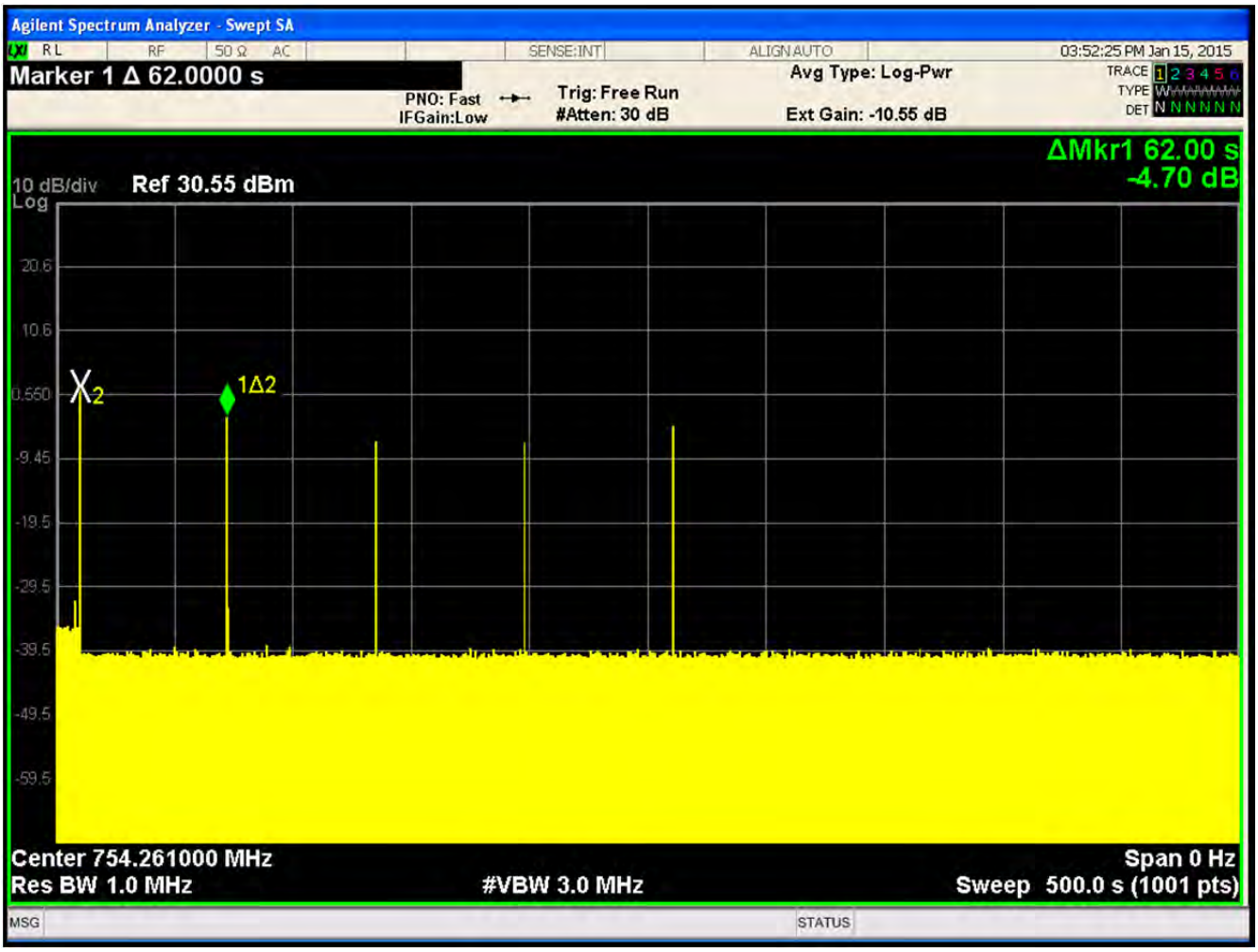
- **Band 12 / Uplink**




Restarting time : 62.2 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

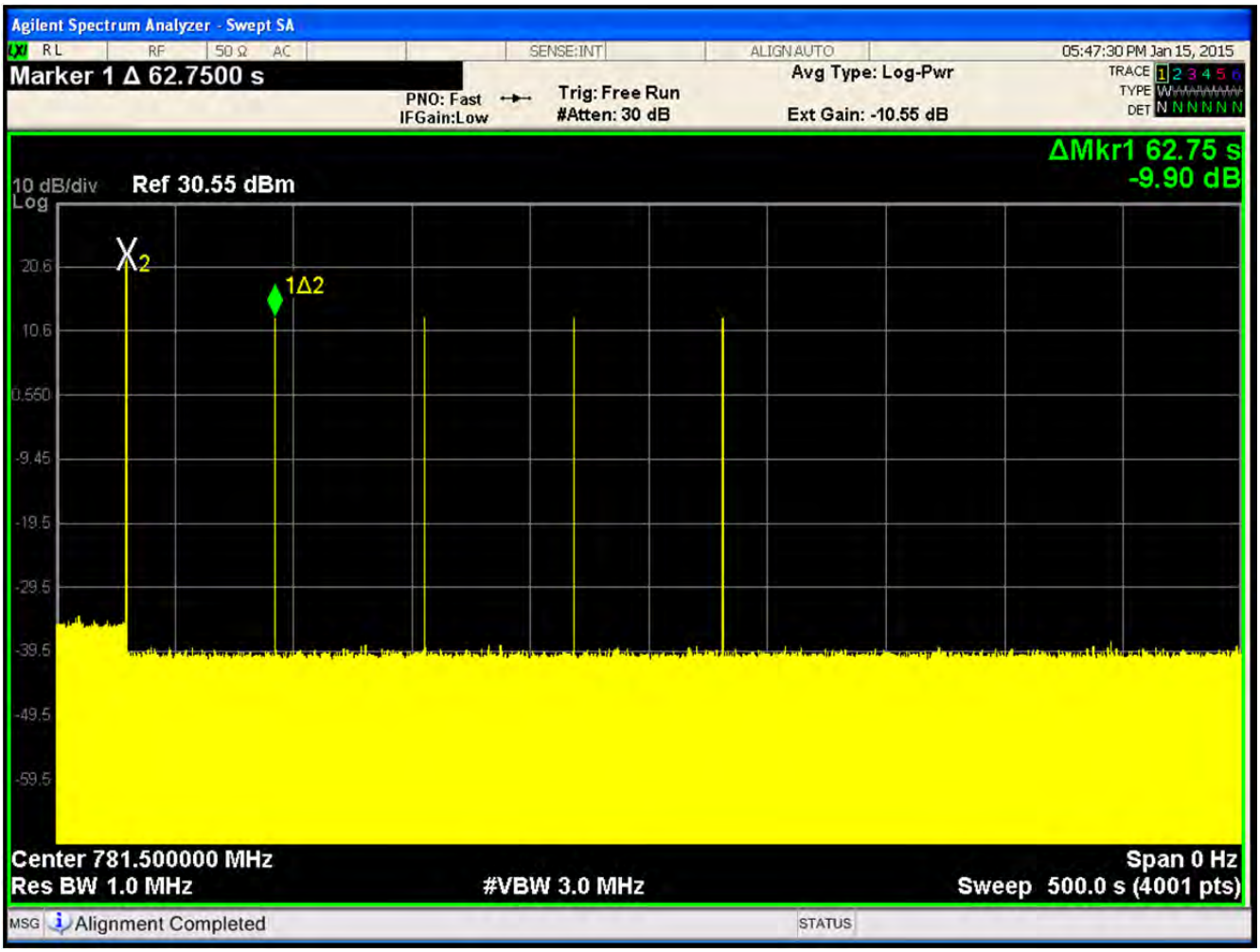
- **Band 13 / Downlink**




Restarting time : 62.0 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

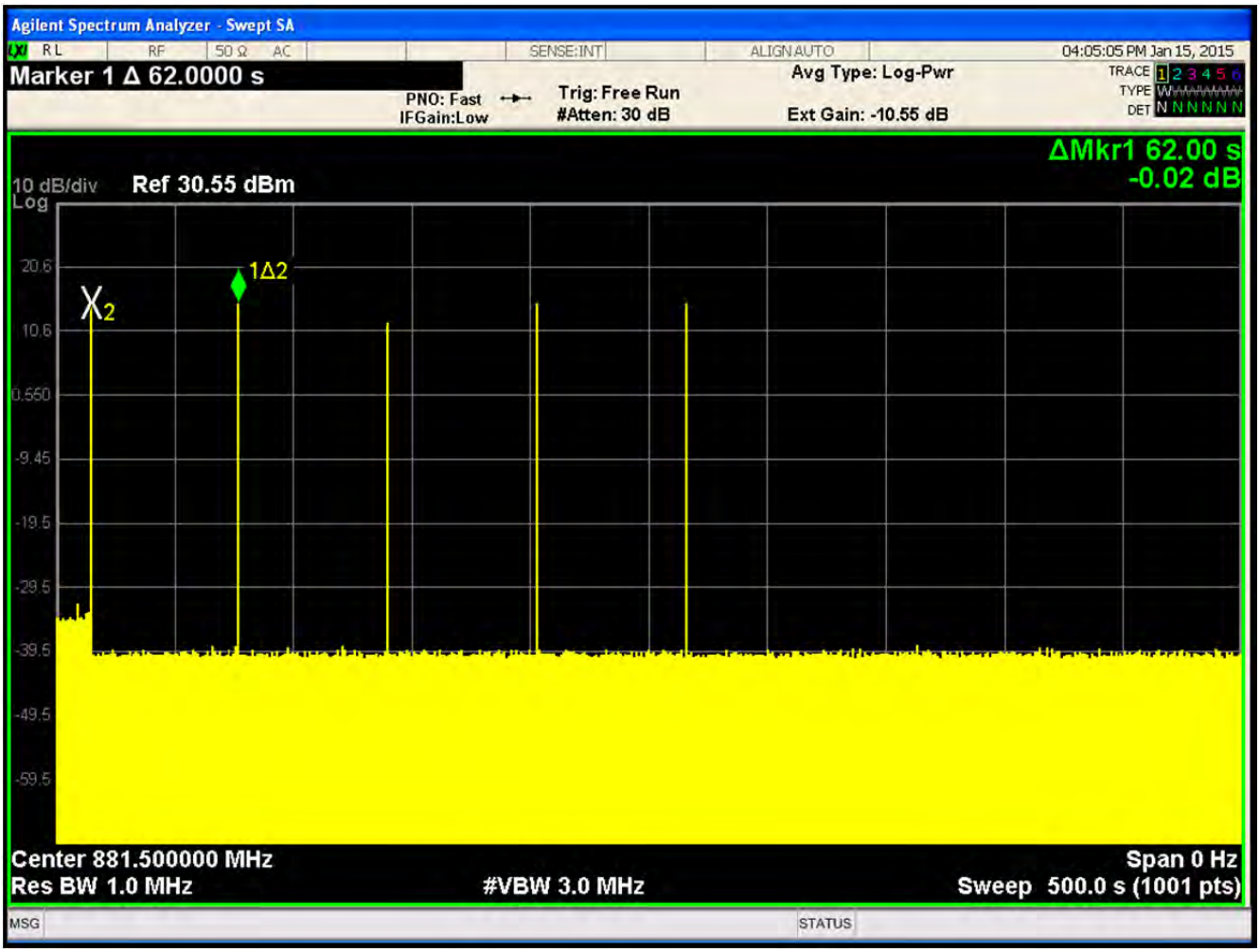
- **Band 13 / Uplink**




Restarting time : 62.7 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

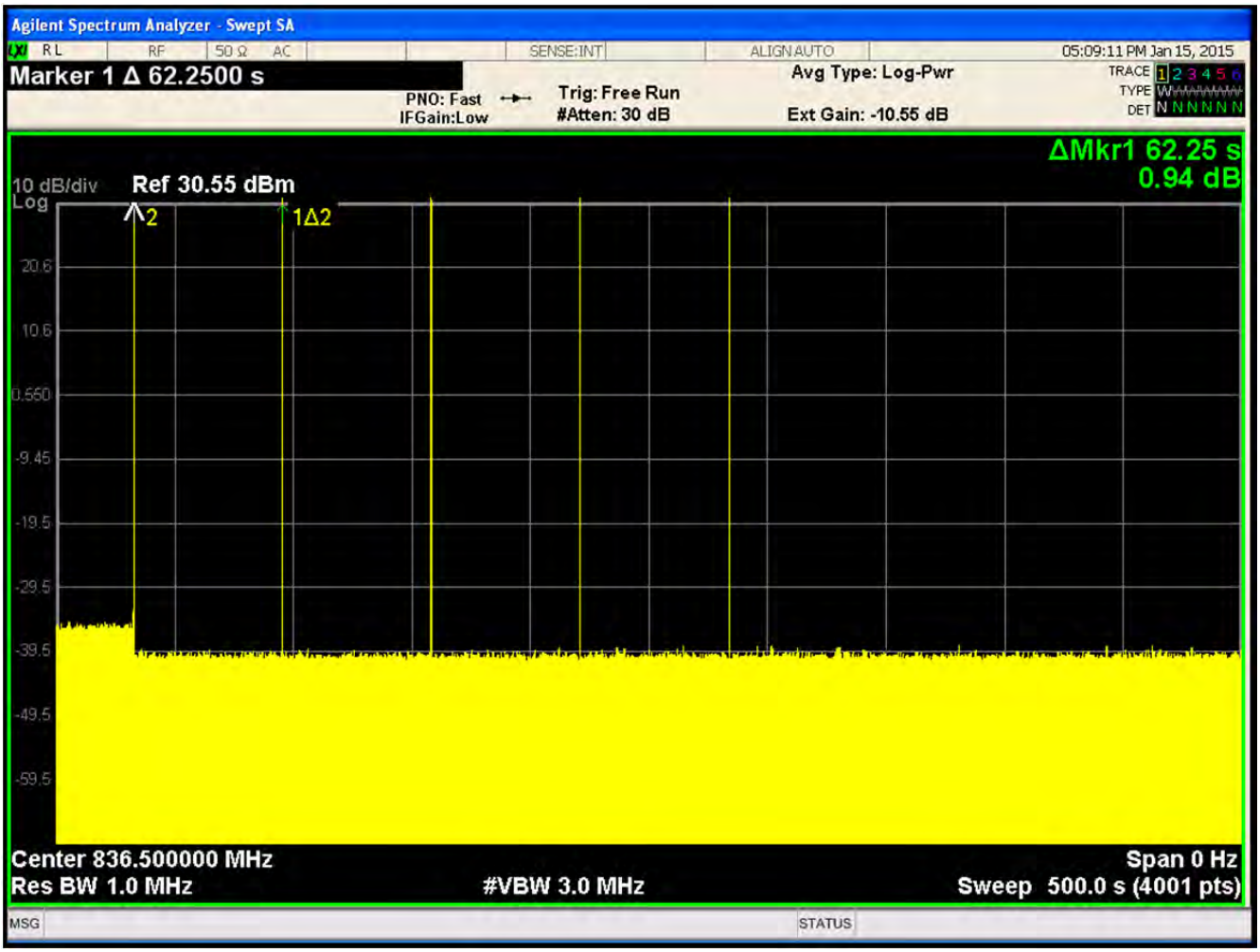
- **Band 5 / Downlink**




Restarting time : 62.0 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

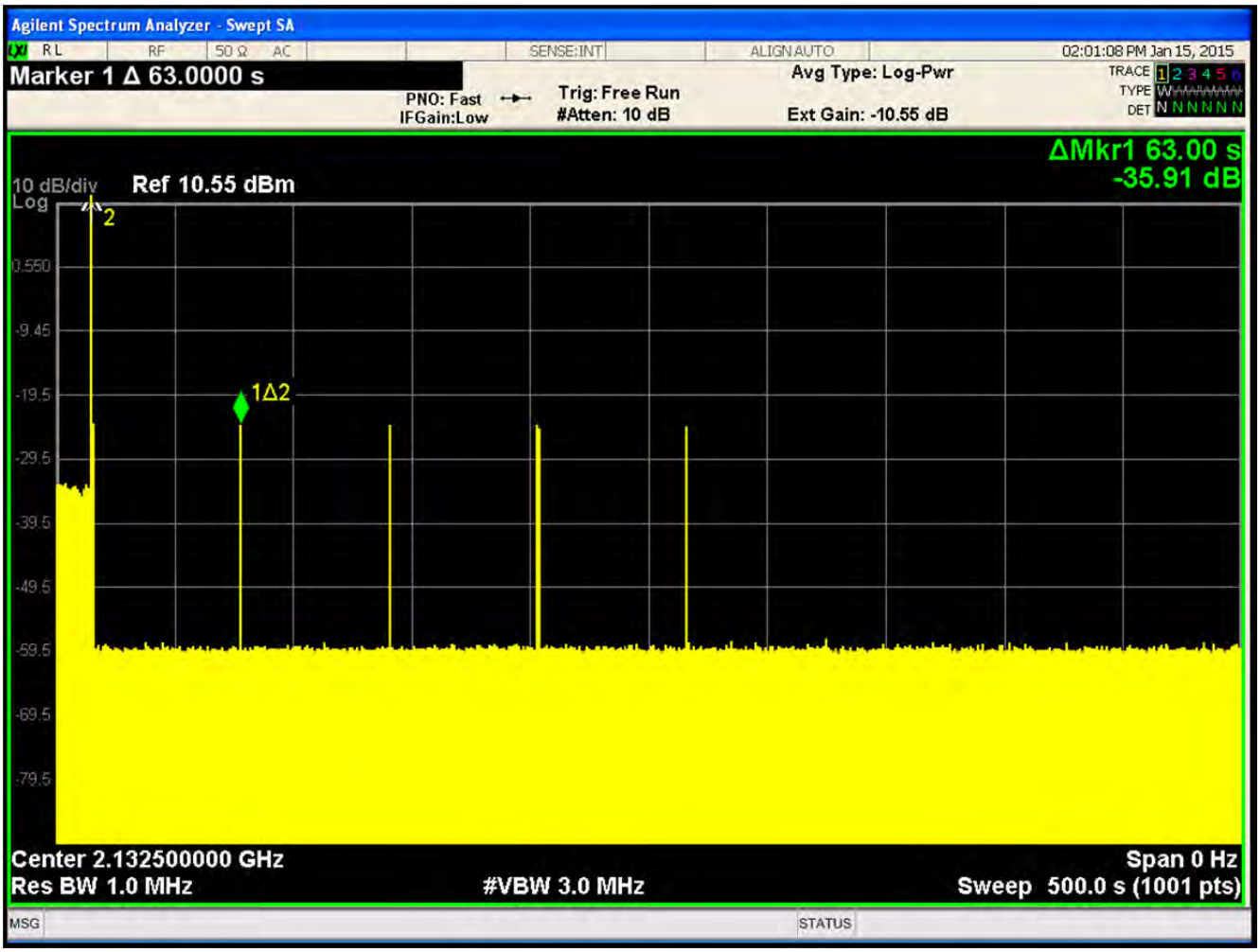
- **Band 5 / Uplink**




Restarting time : 62.2 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

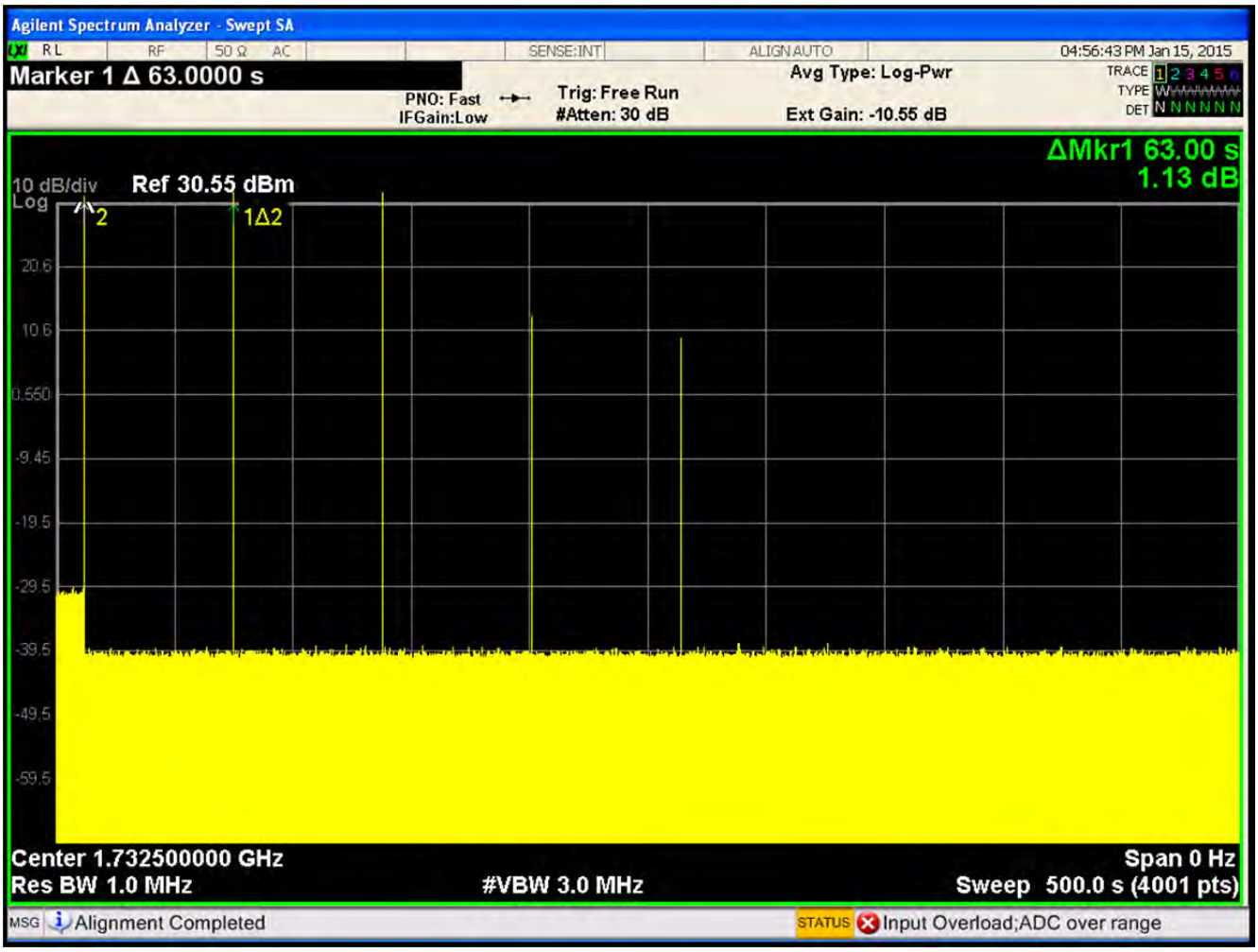
- **Band 4 / Downlink**




Restarting time : 63.0 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

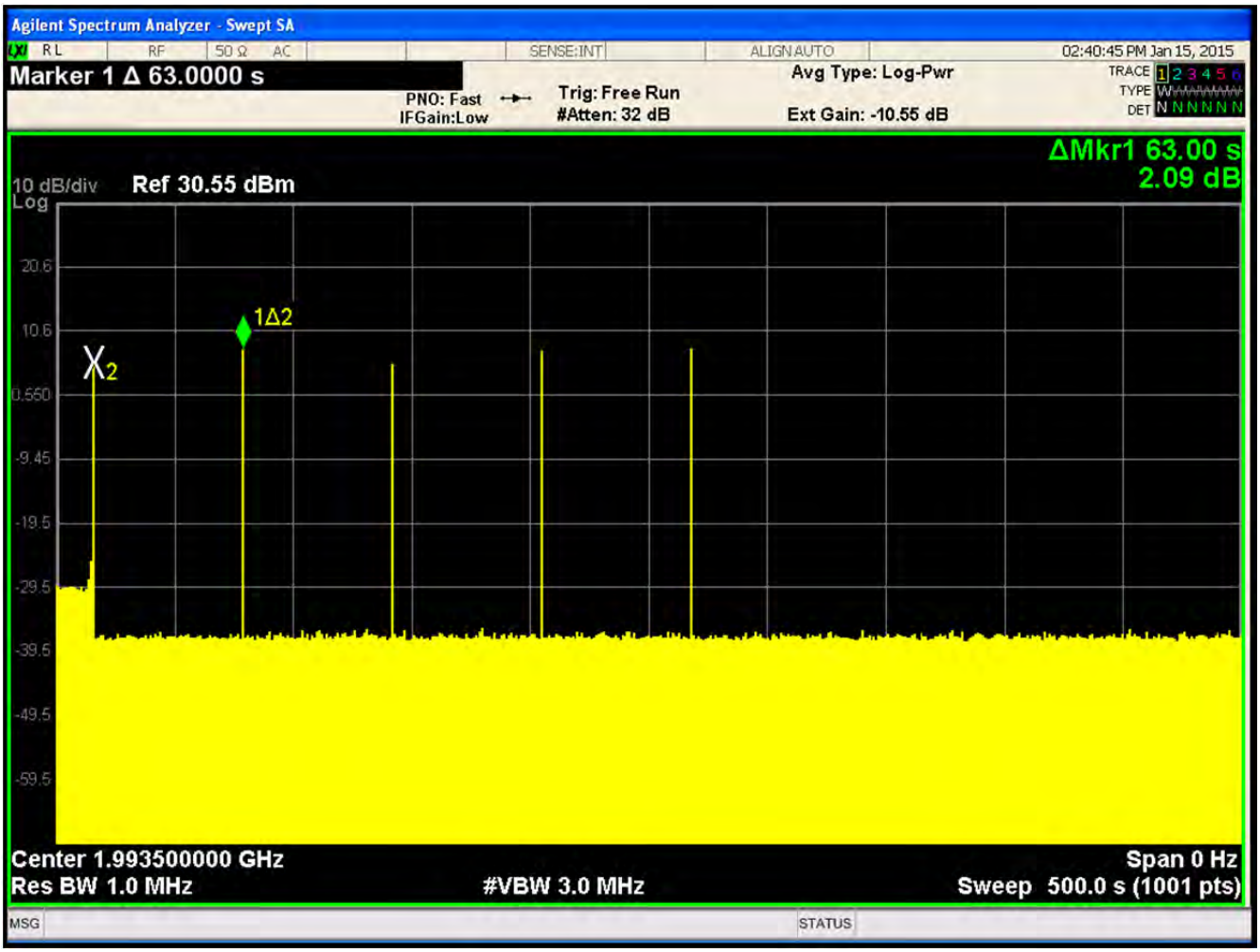
- **Band 4 / Uplink**




Restarting time : 63.0 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

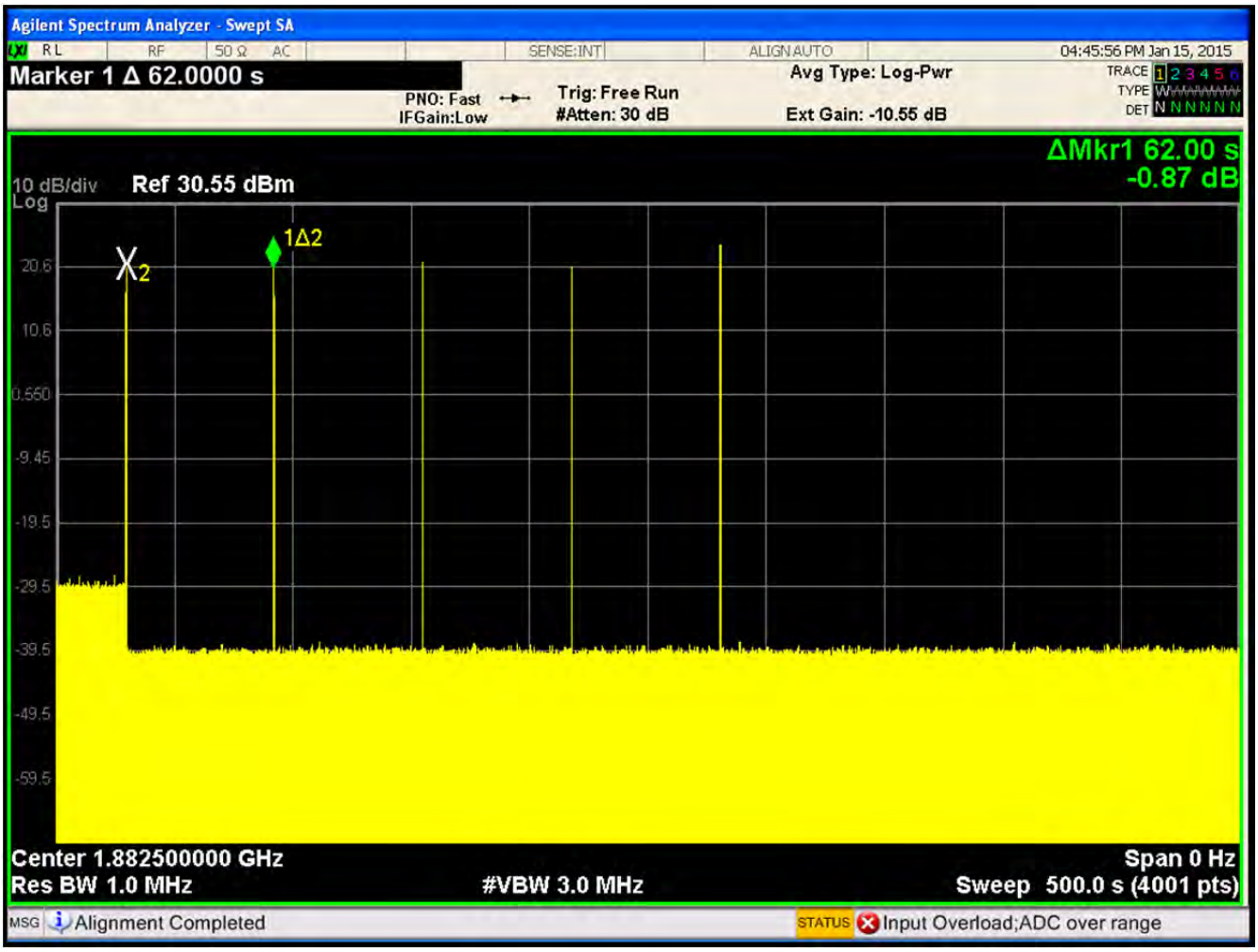
- **Band 25/ Downlink**




Restarting time : 63.0 s
Limit : More than 60.0 s

Restarting count : 4 times
Limit : Less than 5 times

- **Band 25/ Uplink**




Restarting time : 62.0 s
Limit : More than 60.0 s

Restarting count : 4 time
Limit : Less than 5 time

## 3.12 Radiated spurious emission

### 3.12.1 Specification

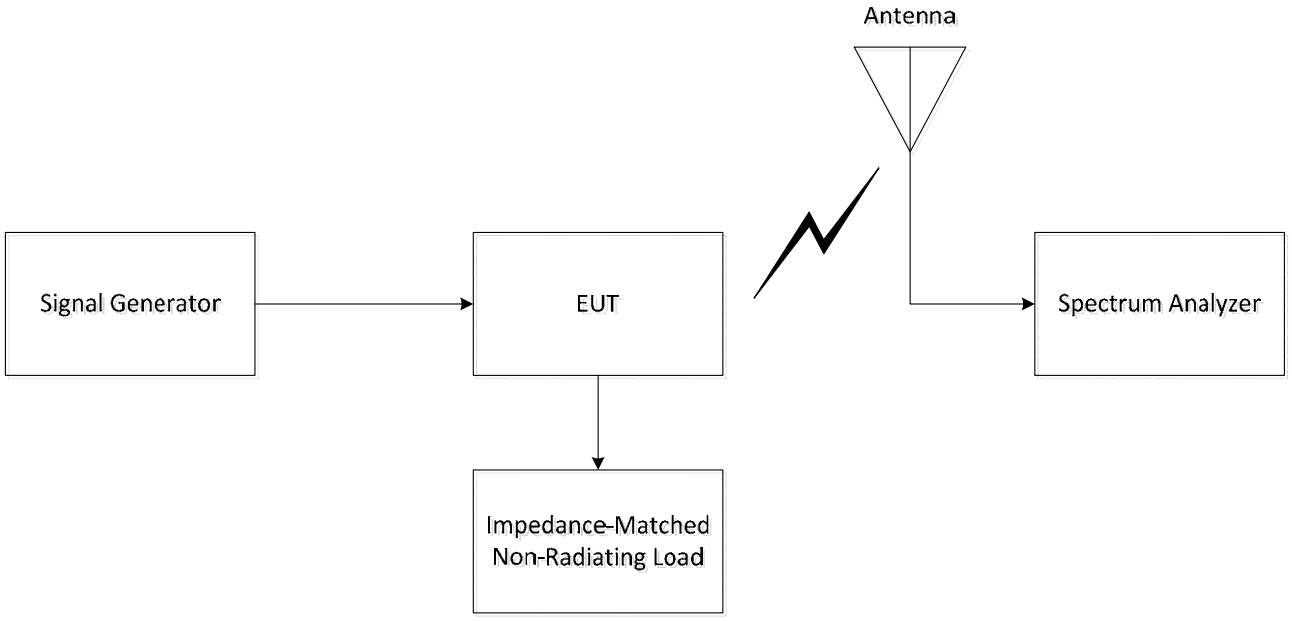
• FCC Rules Part 2 Section 2.1053

### 3.12.2 Measurement method

• 935210 D03 Signal Booster Measurement v02r01

a) Place the EUT on an OATS or semi-anechoic chamber turntable 3 m from the receiving antenna.
b) Connect the EUT to the test equipment as shown in Set-Up beginning with the uplink output
c) Set the signal generator for the center frequency of the operational band under test with the power level set at $P_{IN}$ from Maximum power with CW signal.
d) Measure the radiated spurious emissions from the EUT from lowest to the highest frequencies as specified in § 2.1057. Maximize the radiated emissions by utilizing the procedures described in Clause 8 of ANSI C63.4-2009.
e) Capture the peak emissions plots using a peak detector with Max-Hold for inclusion in the test report. Tabular data is acceptable in lieu of spectrum analyzer plots.
f) Repeat steps c) to e) for all operational bands.

### 3.12.3 Set-Up



### 3.12.4 Test equipment list

| Equipment | Model Name | Manufacturer |
|---|---|---|
| EUT | USHR-781921-5B | OPISYS Incorporated |
| Signal Generator | N5182A | Agilent |
| Spectrum Analyzer | N9020A | Agilent |
| EMI Test Receiver | ESS | R&S |
| Bi-conical Antenna | VHA9103 | R&S |
| Log Periodic Antenna | VULP9118A | R&S |
| Turn table | DS 1500 S-1t-O | Innco GmbH |
| Antenna mast | MA4000-O | Innco GmbH |
| Controller | CO 2000 | Innco GmbH |

### 3.12.5 Test condition

• Test place: Shield Room
• Test environment: 27 °C, 51 % R.H.

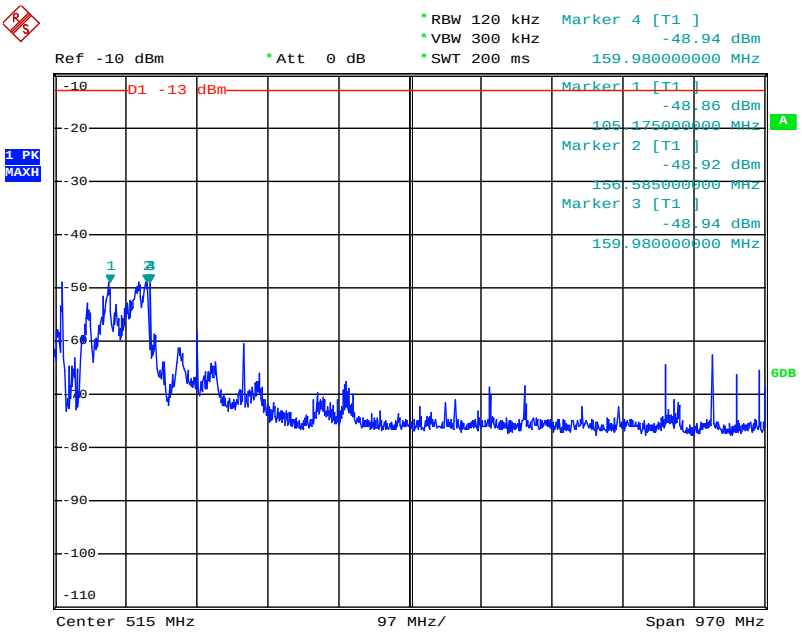
### 3.12.6 Test results

| Frequency [MHz] | Reading [dBuV] | Generator Level [dBm] | Antenna polarity [H/V] | Antenna gain [dBi] | Cable loss [dB] | Level [dBm] | Limit [dBm] | Margin [dB] |
|---|---|---|---|---|---|---|---|---|
| **Band 12 / Downlink / 737 MHz** | | | | | | | | |
| 105.17 | 45.83 | -58.0 | H | 10.84 | 1.45 | -48.86 | -13.00 | 35.86 |
| 156.58 | 41.07 | -58.0 | V | 15.29 | 1.70 | -48.92 | | 35.92 |
| 159.98 | 40.88 | -58.0 | H | 15.46 | 1.70 | -48.94 | | 35.94 |
| **Band 12 / Uplink / 707 MHz** | | | | | | | | |
| 75.15 | 45.68 | -37.0 | V | 6.44 | 1.30 | -53.56 | -13.00 | 40.56 |
| 103.23 | 43.24 | -37.0 | H | 10.55 | 1.43 | -51.76 | | 38.76 |
| 129.91 | 40.69 | -37.0 | H | 13.74 | 1.50 | -51.05 | | 38.05 |
| 142.02 | 42.10 | -37.0 | H | 14.58 | 1.70 | -48.60 | | 35.60 |
| **Band 13 / Downlink / 751.5 MHz** | | | | | | | | |
| 39.70 | 41.01 | -58.0 | V | 14.87 | 1.10 | -50.00 | -13.00 | 37.00 |
| 47.94 | 51.10 | -58.0 | H | 11.73 | 1.10 | -42.99 | | 29.99 |
| 105.66 | 43.95 | -58.0 | H | 10.91 | 1.46 | -50.66 | | 37.66 |
| 142.03 | 41.72 | -58.0 | H | 14.58 | 1.70 | -48.98 | | 35.98 |
| **Band 13 / Uplink / 781.5 MHz** | | | | | | | | |
| 39.70 | 34.09 | -38.0 | V | 14.87 | 1.10 | -56.92 | -13.00 | 43.92 |
| 73.16 | 43.70 | -38.0 | V | 6.34 | 1.30 | -55.64 | | 42.64 |
| 104.20 | 41.58 | -38.0 | H | 10.69 | 1.44 | -53.27 | | 40.27 |
| 141.55 | 56.05 | -38.0 | H | 14.56 | 1.70 | -50.93 | | 37.93 |
| **Band 5 / Downlink / 881.5 MHz** | | | | | | | | |
| 40.18 | 39.47 | -60.0 | H | 14.69 | 1.10 | -51.72 | -13.00 | 38.72 |
| 106.14 | 56.46 | -60.0 | H | 10.98 | 1.46 | -50.52 | | 37.52 |
| 134.27 | 41.44 | -60.0 | H | 14.06 | 1.59 | -49.89 | | 36.89 |
| 159.98 | 43.20 | -60.0 | H | 15.46 | 1.70 | -46.62 | | 33.62 |
| **Band 5 / Uplink / 836.5 MHz** | | | | | | | | |
| 75.59 | 47.98 | -38.0 | V | 6.46 | 1.31 | -51.23 | -13.00 | 38.23 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 95.96 | 50.81 | -38.0 | H | 9.38 | 1.40 | -56.17 | | 43.17 |
| 105.66 | 40.45 | -38.0 | V | 10.91 | 1.46 | -54.16 | | 41.16 |
| 142.02 | 43.22 | -38.0 | H | 14.58 | 1.70 | -47.48 | | 34.48 |
| **Band 4 / Downlink / 2131.5 MHz** | | | | | | | | |
| 39.70 | 39.69 | -68.0 | H | 14.87 | 1.10 | -51.32 | -13.00 | 38.32 |
| 105.17 | 46.57 | -68.0 | H | 10.84 | 1.45 | -48.12 | | 35.12 |
| 128.94 | 41.00 | -68.0 | H | 13.67 | 1.50 | -50.81 | | 37.81 |
| 154.64 | 40.46 | -68.0 | H | 15.20 | 1.70 | -49.62 | | 36.62 |
| **Band 4 / Uplink / 1732.5 MHz** | | | | | | | | |
| 40.18 | 38.18 | -45.0 | V | 14.69 | 1.10 | -53.01 | -13.00 | 40.01 |
| 75.59 | 47.34 | -45.0 | V | 6.46 | 1.31 | -51.87 | | 38.87 |
| 104.69 | 44.01 | -45.0 | H | 10.76 | 1.45 | -50.76 | | 37.76 |
| 142.02 | 41.34 | -45.0 | H | 14.58 | 1.70 | -49.36 | | 36.36 |
| **Band 25/ Downlink / 1962.5 MHz** | | | | | | | | |
| 40.67 | 38.06 | -67.0 | V | 14.50 | 1.10 | -52.52 | -13.00 | 39.52 |
| 75.10 | 46.30 | -67.0 | V | 6.43 | 1.30 | -52.95 | | 39.95 |
| 104.69 | 45.39 | -67.0 | H | 45.39 | 1.45 | -49.38 | | 36.38 |
| 128.94 | 41.94 | -67.0 | H | 13.97 | 1.50 | -49.87 | | 36.87 |
| **Band 25/ Uplink / 1882.5 MHz** | | | | | | | | |
| 40.18 | 38.56 | -45.0 | V | 14.69 | 1.10 | -52.63 | -13.00 | 39.63 |
| 75.59 | 48.20 | -45.0 | V | 6.46 | 1.31 | -51.01 | | 38.01 |
| 104.69 | 45.00 | -45.0 | H | 10.76 | 1.45 | -49.77 | | 36.77 |
| 130.88 | 41.80 | -45.0 | H | 13.81 | 1.52 | -49.85 | | 36.85 |

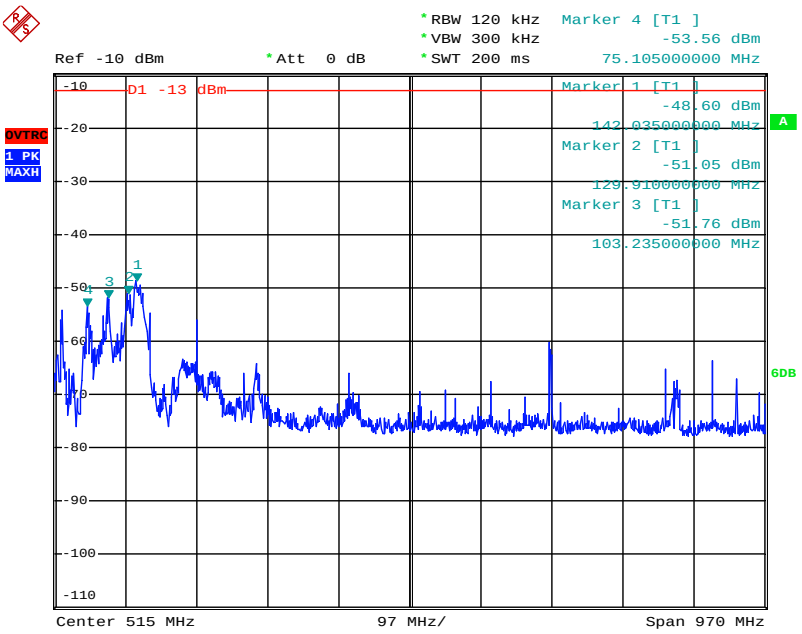
## 3.12.6 Plots of Radiated spurious emission

- **Band 12 / Downlink**



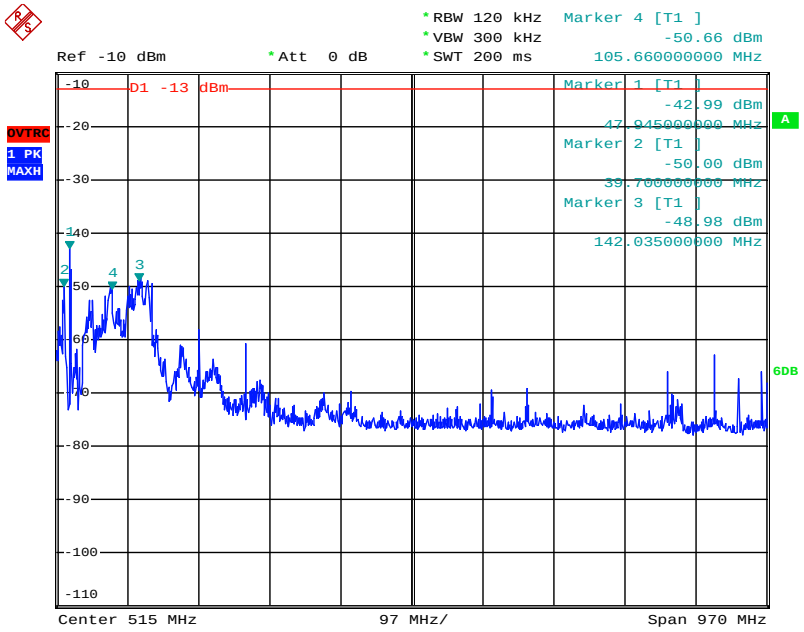

Date: 23.JAN.2015 10:39:46

- **Band 12 / Uplink**



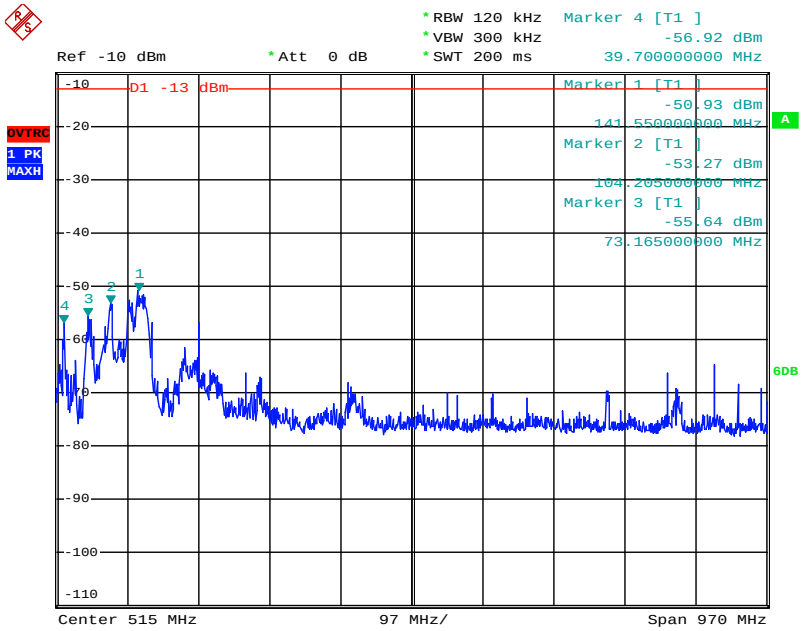

Date: 23.JAN.2015 11:03:08

- **Band 13 / Downlink**



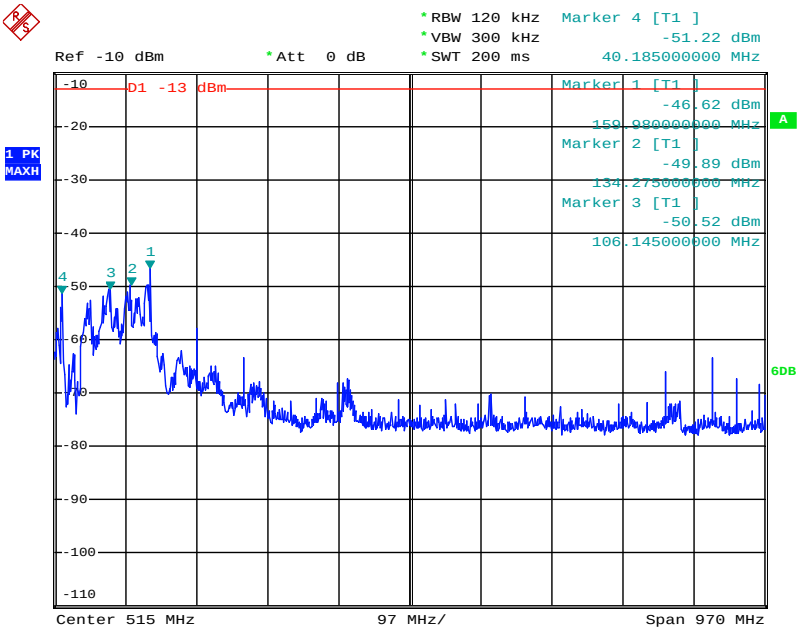

Date: 23.JAN.2015 10:45:08

- **Band 13 / Uplink**



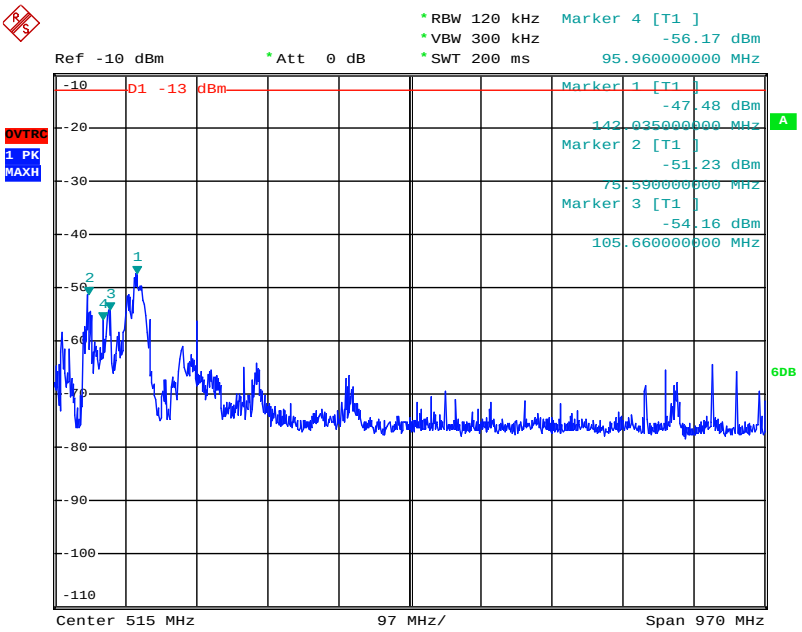

Date: 23.JAN.2015 11:09:25

- **Band 5 / Downlink**



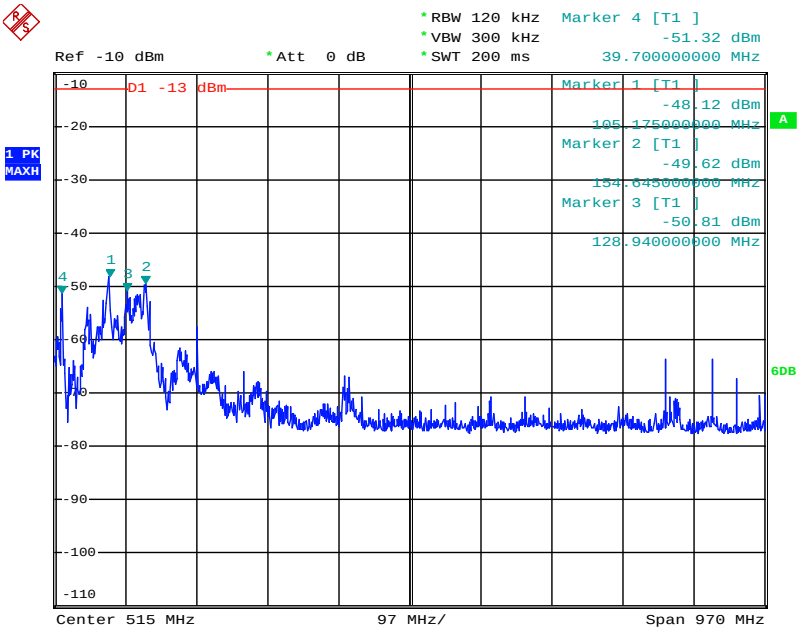

Date: 23.JAN.2015 10:48:55

- **Band 5 / Uplink**



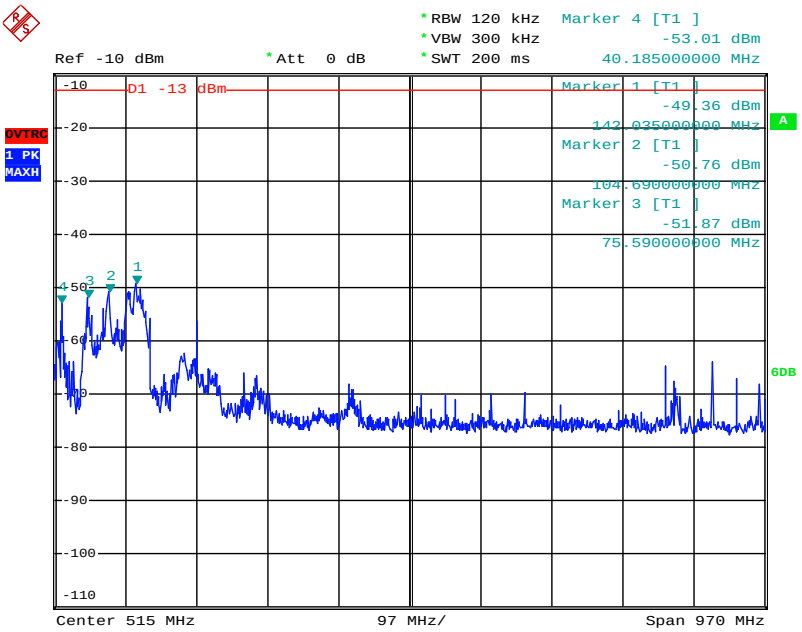

Date: 23.JAN.2015 11:12:38

- **Band 4 / Downlink**



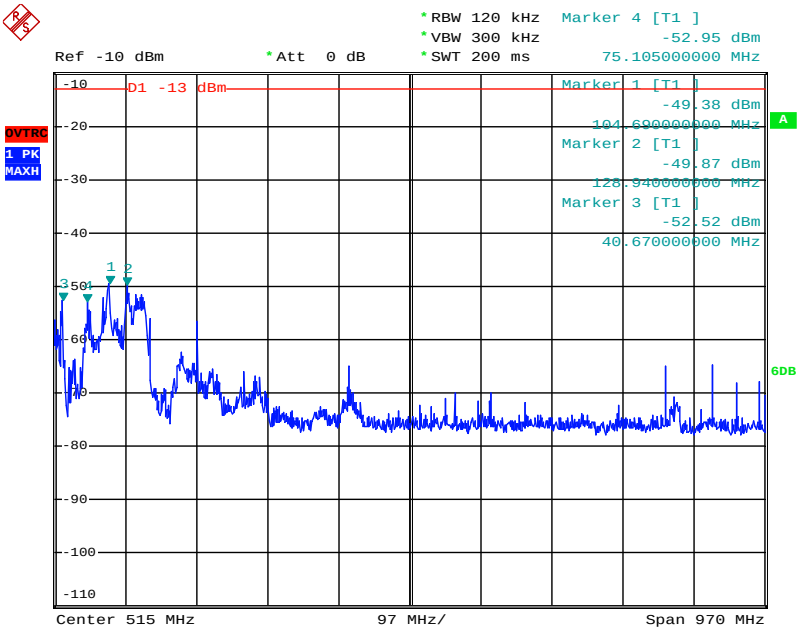

Date: 23.JAN.2015 10:53:44

- **Band 4 / Uplink**



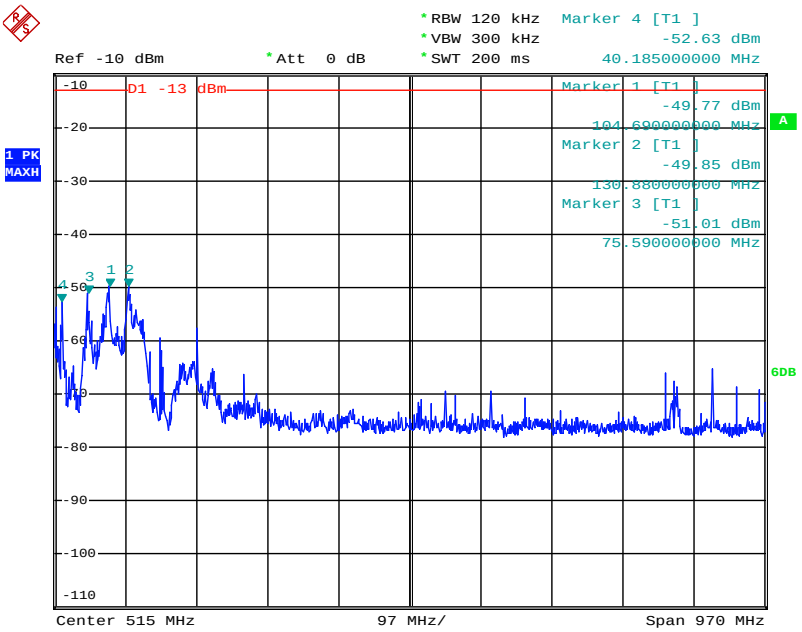

Date: 23.JAN.2015 11:17:59

- **Band 25/ Downlink**




Date: 23.JAN.2015 10:58:12

- **Band 25/ Uplink**




Date: 23.JAN.2015 11:21:07

## 4. RF exposure statement

According to FCC Part1 Section 1.1307, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to FCC Part1 Section 1.1310 and 2.1091 RF exposure is calculated by Friis transmission formula.

| Frequency Range [MHz] | Electric Field Strength [V/m] | Magnetic Field Strength [A/m] | Power Density [mW/cm$^2$] | Averaging Time [minute] |
|---|---|---|---|---|
| **Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3 – 1.34 | 614 | 1.63 | 100 | 30 |
| 1.34 – 30 | 824/f | 2.19/f | 180/f$^2$ | 30 |
| 30 – 300 | 27.5 | 0.073 | 0.2 | 30 |
| 300 – 1500 | - | - | f/1500 | 30 |
| 1500 – 100 000 | - | - | 1.0 | 30 |

**Limits for General Population/Uncontrolled Exposure**

Here, f = frequency in MHz

### 4.1 Friis transmission formula

$$P_d = (P_{out} \times G) / (4\pi r^2)$$

$P_d$ = Power density
$P_{out}$ = power input to antenna
G = power gain
r = distance to the center of radiation of the antenna

### 4.2 Information of Antenna

The Coaxial Cable is used for RF distribution to the Service Antenna (8 dBi gain) from USHR-781921-5B and to the Donnor Antenna (9 dBi gain) from USHR-781921-5B.

**• Model Name : TS260771(Service antenna)**

**Max Antenna Gain: 8 dBi**

**• Model Name : TS250374 (Service antenna)**

**Max Antenna Gain: 5 dBi**

• **Model Name : TQI-700/2700-SJ-01 (Service antenna)**

**Max Antenna Gain : 5 dBi**

• **Model Name : TS210471 (Donor antenna)**

**Max Antenna Gain : 4.5 dBi**

**• Model Name : TS220971 (Donor antenna)**

**Max Antenna Gain : 9 dBi**

**• Model Name : TS220971 (Donor antenna)**

**Max Antenna Gain : 8 dBi**

### 4.3 Calculation of MPE at 20 cm

| Band | Link | Frequency [MHz] | Output power [dBm] | Antenna gain [dBi] | Cable loss [dB] | EIRP | | Power density [mW/cm$^2$] | Limit [mW/cm$^2$] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | [dBm] | [mW] | | |
| Band 12 | Down | 735.848 | 2.86 | +8.0 | -0.9 | 9.96 | 9.90 | 0.001 972 2 | 0.490 565 |
| | Up | 700.700 | 23.08 | +9.0 | -2.1 | 29.98 | 995.40 | 0.198 130 1 | 0.467 133 |
| Band 13 | Down | 749.556 | 2.05 | +8.0 | -0.9 | 9.15 | 8.22 | 0.001 636 6 | 0.499 704 |
| | Up | 777.300 | 23.08 | +9.0 | -2.1 | 29.98 | 995.40 | 0.198 130 1 | 0.518 200 |
| Band 5 | Down | 875.900 | 2.59 | +8.0 | -0.9 | 9.69 | 9.31 | 0.001 853 3 | 0.583 933 |
| | Up | 834.680 | 23.06 | +9.0 | -2.1 | 29.96 | 990.83 | 0.197 219 7 | 0.556 453 |
| Band 4 | Down | 2121.70 | 2.44 | +8.0 | -0.9 | 9.54 | 8.99 | 0.001 790 4 | 1.414 467 |
| | Up | 1714.50 | 23.39 | +9.0 | -2.4 | 29.99 | 997.70 | 0.198 586 8 | 1.143 000 |
| Band 25 | Down | 1969.85 | 2.45 | +8.0 | -0.9 | 9.55 | 9.01 | 0.001 794 5 | 1.313 233 |
| | Up | 1865.30 | 23.37 | +9.0 | -2.4 | 29.97 | 993.11 | 0.196 674 4 | 1.243 533 |

- **Band 12**

The maximum conducted power is 23.08 dBm; antenna is fix-mounted with a maximum gain and cable loss of 6.9 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.
The maximum Peak EIRP calculated is 29.98 dBm.
The Power Density can be calculated using the formula

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.
At 0.2 m, S = 0.198 mW/cm$^2$, which is below the MPE Limit of 0.467 mW/cm$^2$

- **Band 13**

The maximum conducted power is 23.08 dBm; antenna is fix-mounted with a maximum gain and cable loss of 6.9 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.
The maximum Peak EIRP calculated is 29.98 dBm.

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.
At 0.2 m, S = 0.198 mW/cm$^2$, which is below the MPE Limit of 0.518 mW/cm$^2$

- **Band 5**

The maximum conducted power is 23.06 dBm; antenna is fix-mounted with a maximum gain and cable loss of 6.9 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.
The maximum Peak EIRP calculated is 29.96 dBm.

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.
At 0.2 m, S = 0.197 mW/cm$^2$, which is below the MPE Limit of 0.556 mW/cm$^2$

- **Band 4**

The maximum conducted power is 23.39 dBm; antenna is fix-mounted with a maximum gain and cable loss of 6.6 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.
The maximum Peak EIRP calculated is 29.99 dBm.

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.
At 0.2 m, S = 0.198 mW/cm$^2$, which is below the MPE Limit of 1.143 mW/cm$^2$

- **Band 25**

The maximum conducted power is 23.37 dBm; antenna is fix-mounted with a maximum gain and cable loss of 6.6 dBi gain.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.
The maximum Peak EIRP calculated is 29.97 dBm.

It is considered that 20 cm is the minimum distance that a user can go closer to the EUT.
At 0.2 m, S = 0.196 mW/cm$^2$, which is below the MPE Limit of 1.243 mW/cm$^2$

- **Band 12 + Band 13 + Band 5 + Band 4 + Band 25**

Power density on up link side for Band 12 to Band 25are 9.98 % and 10.38 % of the limit, so combined they are still well below 100 % of the limit.

## 5. Test equipment list

The listing below denotes the test equipment for the test(s).

| No. | Equipment | Model | Manufacturer | Serial Number | Calibration Due date |
|---|---|---|---|---|---|
| 1 | Spectrum analyzer | N9020A | Agilent | MY48010456 | 2016.01.20 |
| 2 | Spectrum analyzer | FSV | R&S | 101673 | 2016.01.21 |
| 2 | Signal generator | N5182A | Agilent | MY49060695 | 2016.01.19 |
| 3 | Signal generator | E4432B | Agilent | GB38450504 | 2016.01.20 |
| 4 | Attenuator | AF115A-09-34 | Weinschel | 18405 | 2016.01.20 |
| 5 | RF combiner | 1506A | Weinschel | NP154 | 2016.01.20 |
| 6 | Biconical antenna | VHA9103 | R&S | 2217 | 2015.11.15 |
| 7 | Log-Periodic antenna | VULP9118A | R&S | 382 | 2015.11.15 |
| 8 | EMI Test Receiver | ESS | R&S | 833776/011 | 2015.09.02 |
| 9 | Turn table | DS 1500 S-1t-O | Innco GmbH | N/A | N/A |
| 10 | Antenna mast | MA4000-O | Innco GmbH | N/A | N/A |
| 11 | Controller | CO 2000 | Innco GmbH | N/A | N/A |