

## Test Report

**Prepared for: Wilson Electronics, LLC (weBoost)**

**Model: Home Studio Lite**

**Description: dual Band Signal Booster**

**FCC ID: PWO460065**

**ISED ID: 4726A-460065**

**To**

**FCC: Part 20**

**ISED: RSS-131 (Issue 3)**

**Date of Issue: October 28, 2020**

**On the behalf of the applicant:**

**Wilson Electronics, LLC (weBoost)  
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**To the attention of:**

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**Greg Corbin  
Project Test Engineer**

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All results contained herein relate only to the sample tested.

### Test Report Revision History

| Revision | Date             | Revised By  | Reason for Revision |
|----------|------------------|-------------|---------------------|
| 1.0      | October 28, 2020 | Greg Corbin | Original Document   |
|          |                  |             |                     |
|          |                  |             |                     |

*Current revision of the test report replaces any prior versions. Only the current version of the test report is valid.*

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## ANAB

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.



**FCC Site Reg. #349717**

**IC Site Reg. #2044A-2**

**Non-accredited tests contained in this report:**

**N/A**

## Test and Measurement Data

Sub-part

2.1033(c)(14):

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Part 2, Subpart J and the following individual Parts: 20.21 in conjunction with latest version of KDB 935210, ANSI C63-26-2015. For ISSED, RSS-131 and RSS-GEN were used.

## Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI/C63.4-2014, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F), unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

| Environmental Conditions |              |                 |
|--------------------------|--------------|-----------------|
| Temp (°C)                | Humidity (%) | Pressure (mbar) |
| 27.3 – 28.8              | 113.5– 24.2  | 960.5 – 967.2   |

Measurement results, unless otherwise noted, are worst-case measurements.

## EUT Description

**Model:** Home Studio Lite\_460065

**Description:** Dual Band Signal Booster

**Firmware:** V4.04

**Serial Number:** 01

**PMN:** Home Studio Lite

**FVIN:** V4.04

**HVIN:** 460065

**HMN:** 460065

## Additional Information:

The EUT is an In-Building, bi-directional amplifier for the boosting of cellular phone signals and data communication devices.

The following frequency bands and emission types are utilized.

|                      | Frequency Band (MHz) |                              |
|----------------------|----------------------|------------------------------|
| Uplink               | 698 - 716            | 776 – 787<br>(IC, 777 – 787) |
| Downlink             | 728 - 746            | 746 – 757<br>(IC, 746 – 756) |
| Modulation Type      | LTE                  |                              |
| Emission Designators | G7D, W7D             |                              |

The modulation types and emission designators listed in the tables represent the modulations that the cell phone providers use for each frequency band. GSM, CDMA, and WCDMA represent all the modulation types (phase and amplitude or a combination thereof) utilized within the industry. EDGE, HSPA, LTE etc. are all protocols or multiplexing techniques using the base modulations.

### **EUT Operation during Tests**

The EUT was in a normal operating condition with all external attenuation set to 0 dB.

The EUT input supply voltage is 4.2 vdc.

The EUT donor port impedance is 75 ohms.

The EUT Server port is 50 ohms.

A 75 ohm to 50 ohm adapter was installed on the Donor port to match the impedance of the test equipment.

The transformer was installed for all tests.

### **Accessories:**

| <b>Qty</b> | <b>Description</b>           | <b>Manufacturer</b> | <b>Model</b>     | <b>S/N</b> |
|------------|------------------------------|---------------------|------------------|------------|
| 1          | AC to DC power supply        | Power Partners      | SAW20-050-2500UD | N/A        |
| 1          | 75 ohm to 50 ohm Transformer | Mini-Circuits       | SFMP-5075-3+     | N/A        |

**Cables: none**

**Modifications: none**

## Test Result Summary Table

| Specification                                                                |                                    | Test Name                    | Pass, Fail, N/A | Comments                                          |
|------------------------------------------------------------------------------|------------------------------------|------------------------------|-----------------|---------------------------------------------------|
| FCC                                                                          | ISED                               |                              |                 |                                                   |
| 20.21(e)(3)                                                                  | RSS-131_3.5(a)                     | Authorized Frequency Band    | Pass            |                                                   |
| 20.21(e)(8)(i)(B)<br>20.21(e)(8)(i)(C)<br>20.21(e)(8)(i)(D)                  | RSS-131_5.1.1.2<br>RSS-131_5.1.3.3 | Maximum Power and Gain       | Pass            |                                                   |
| 20.21(e)(8)(i)(F)                                                            | RSS-131_5.1.3.5                    | Intermodulation              | Pass            |                                                   |
| 20.21(e)(8)(i)(E)                                                            | RSS-131_5.1.3.4                    | Out-of-Band Emissions        | Pass            |                                                   |
| 2.1051<br>27.53(c)<br>27.53(f)<br>27.53(g)                                   | RSS-130_4.7.1<br>RSS-130_4.7.2     | Conducted Spurious Emissions | Pass            |                                                   |
| 20.21(e)(8)(i)(A)                                                            | RSS-131_5.1.3.1                    | Noise Limits                 | Pass            |                                                   |
| 20.21(e)(8)(i)(I)                                                            | RSS-131_5.1.3.7                    | Uplink Inactivity            | Pass            |                                                   |
| 20.21(e)(8)(i)(C)(1)<br>20.21(e)(8)(i)(H)<br>20.21(e)(8)(i)(C)(2)(i) (Fixed) | RSS-131_5.1.3.2                    | Variable Gain                | Pass            |                                                   |
| 2.1049                                                                       | RSS-GEN_6.7                        | Occupied Bandwidth           | Pass            |                                                   |
| 20.21(e)(8)(ii)(A)                                                           | RSS-131_5.1.1.1                    | Anti - Oscillation           | Pass            |                                                   |
| 2.1053                                                                       | RSS-GEN_6.13                       | Radiated Spurious            | Pass            |                                                   |
| 20.21(e)(8)(i)(B)                                                            |                                    | Spectrum Block Filtering     | N/A             | This device does not use spectrum block filtering |

## Statements of conformity

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

## Authorized Frequency Band

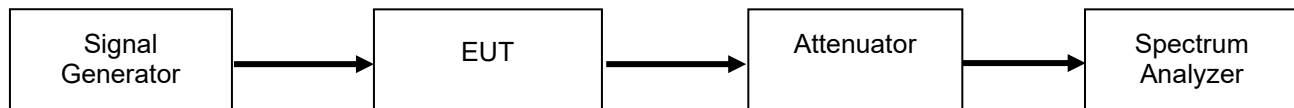
**Engineer:** Greg Corbin

**Test Date:** 10/26/2020

## Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings. A signal generator was utilized to produce a CW input signal tuned to the center channel of the operational band. The RF input level was increased to a point just prior to the AGC being in control of the power, then reduced 3 dB. The Signal generator was set to sweep across 2X the operational band of the EUT while the spectrum analyzer was set to MAX HOLD. Two markers were placed at the edges of the operational band and a third marker was placed at the highest point within the band no closer than 2.5 MHz from the band edge.

## Test Setup



## Annex A Authorized Frequency Band

Refer to Annex A for Authorized Frequency Band plots.

## Maximum Power and Gain

**Engineer:** Greg Corbin

**Test Date:** 10/26/2020

### Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings. The spectrum analyzer and signal generator were tuned to the frequency with the highest power level in the band, as determined by the Authorized Frequency Band test. The RF input level was increased to a point just prior to the AGC being in control of the power for both pulsed single time slot GSM modulation and 4.1 MHz AWGN modulation. The maximum power was measured and verified to meet the minimum and maximum levels allowed, with the maximum gain being computed from these values. The uplink and downlink gain under each condition were verified to be within 9 dB of each other.

The input level was incremented in 2 dB steps up to the maximum input level for the EUT. The output power was recorded at the maximum input level. If the EUT shutdown before the maximum input level was reached, the input level was reduced to 1 dB before the EUT shutdown and the input and output levels were recorded.

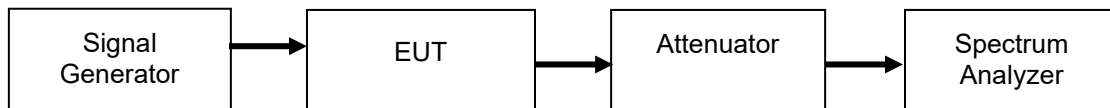
For Fixed installations, the following formula was used for calculating the gain limits.

$$\text{Gain Limit (dB)} = 6.5 \text{ dB} + 20\text{Log}(F_{\text{MHz}})$$

$F_{\text{MHz}}$  is the uplink mid-band frequency with the downlink gain limit being equivalent to the paired Uplink band gain limit.

Antenna Gain (dBi)=maximum antenna gain + the minimum cable loss

### Test Setup



### Uplink Power Test Results

| Frequency Band (MHz)     | Input Level (dBm) | Output Power (dBm) | Antenna Gain (dBi) | EIRP (dBm) | Lower Limit (dBm) | Upper Limit (dBm) | Result |
|--------------------------|-------------------|--------------------|--------------------|------------|-------------------|-------------------|--------|
| 698 - 716 MHz Pulsed GSM | -34.4             | 24.3               | 4.9                | 29.2       | 17                | 30                | Pass   |
| 698 - 716 MHz AWGN       | -35.7             | 22.0               | 4.9                | 26.9       | 17                | 30                | Pass   |
| 776 - 787 MHz Pulsed GSM | -33.7             | 23.0               | 4.9                | 27.9       | 17                | 30                | Pass   |
| 776 - 787 MHz AWGN       | -34.6             | 21.2               | 4.9                | 26.1       | 17                | 30                | Pass   |

### Downlink Power Test Results

| Frequency Band (MHz)     | Input Level (dBm) | Output Power (dBm) | Antenna Gain (dBi) | EIRP (dBm) | Upper Limit (dBm) | Result |
|--------------------------|-------------------|--------------------|--------------------|------------|-------------------|--------|
| 728 - 746 MHz Pulsed GSM | -48.4             | 11.4               | 2                  | 13.4       | 17                | Pass   |
| 728 - 746 MHz AWGN       | -46.6             | 11.7               | 2                  | 13.7       | 17                | Pass   |
| 746 - 757 MHz Pulsed GSM | -48.9             | 12.9               | 2.2                | 15.1       | 17                | Pass   |
| 746 - 757 MHz AWGN       | -48.6             | 10.9               | 2.2                | 13.1       | 17                | Pass   |

### Uplink and Downlink Gain Test Results

| Modulation | Uplink Frequency (MHz) | Downlink Frequency (MHz) | Uplink Gain (dB) | Uplink Limit (dB) | Downlink Gain (dB) | Downlink Limit (dB) | Delta (dB) | Limit (dB) | Margin (dB) |
|------------|------------------------|--------------------------|------------------|-------------------|--------------------|---------------------|------------|------------|-------------|
| Pulsed GSM | 702.95                 | 732.35                   | 58.7             | 63.5              | 59.8               | 63.5                | 1.1        | 9          | -7.9        |
| AWGN       | 702.95                 | 732.35                   | 57.7             | 63.5              | 58.3               | 63.5                | 0.6        | 9          | -8.4        |
| Pulsed GSM | 784.13                 | 750.375                  | 56.7             | 64.4              | 61.8               | 64.4                | 5.1        | 9          | -3.9        |
| AWGN       | 784.13                 | 750.375                  | 55.8             | 64.4              | 59.5               | 64.4                | 3.7        | 9          | -5.3        |

### Uplink Output Power at Maximum Input Power Test

| Frequency Band (MHz)     | Maximum Input Level (dBm) | Output Power at Maximum Input Power (dBm) | Antenna Gain (dBi) | EIRP (dBm) | Lower Limit (dBm) | Upper Limit (dBm) | Result |
|--------------------------|---------------------------|-------------------------------------------|--------------------|------------|-------------------|-------------------|--------|
| 698 - 716 MHz Pulsed GSM | 0.0                       | 24.2                                      | 4.9                | 29.1       | 17                | 30                | Pass   |
| 698 - 716 MHz AWGN       | 0.0                       | 22.0                                      | 4.9                | 26.9       | 17                | 30                | Pass   |
| 776 - 787 MHz Pulsed GSM | 0.0                       | 22.8                                      | 4.9                | 27.7       | 17                | 30                | Pass   |
| 776 - 787 MHz AWGN       | 0.0                       | 21.1                                      | 4.9                | 26         | 17                | 30                | Pass   |

### Downlink Output Power at Maximum Input Power Test

| Frequency Band (MHz)     | Maximum Input Level (dBm) | Output Power at Maximum Input Power (dBm) | Antenna Gain (dBi) | EIRP (dBm) | Upper Limit (dBm) | Result |
|--------------------------|---------------------------|-------------------------------------------|--------------------|------------|-------------------|--------|
| 728 - 746 MHz Pulsed GSM | -20                       | 11.4                                      | 2                  | 13.4       | 17                | Pass   |
| 728 - 746 MHz AWGN       | -20                       | -7.7                                      | 2                  | -5.7       | 17                | Pass   |
| 746 - 757 MHz Pulsed GSM | -20                       | 12.8                                      | 2.2                | 15         | 17                | Pass   |
| 746 - 757 MHz AWGN       | -20                       | -7.8                                      | 2.2                | -5.6       | 17                | Pass   |

## Intermodulation

**Engineer:** Greg Corbin

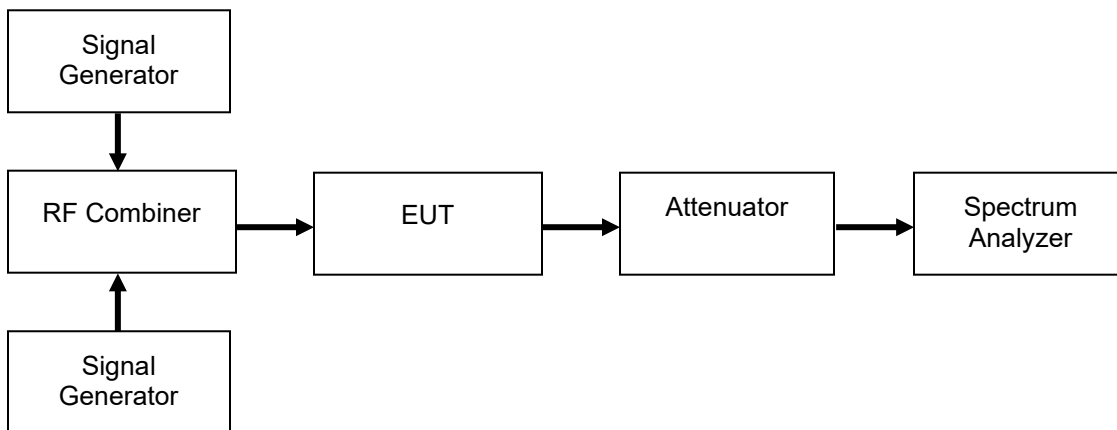
**Test Date:** 10/26/2020

### Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator. Two signal generators were utilized to produce two CW signals 600 kHz apart and centered at the peak of the operational band. Attenuator and cable insertion loss correction factors were input to either the signal generator or the spectrum analyzer as required to ensure that accurate measurements were recorded. The input power was set at the maximum allowable power and the RMS intermodulation products were measured to ensure they were less than -19 dBm in a 3 kHz RBW. The uplink and downlink intermodulation products were plotted, with the levels being listed in the summary tables.

The input power was increased in 2 dB increments to 10 dB above the AGC threshold and to verify the intermodulation products remain below the limit. During this test, the input power was not increased past the maximum allowed. The Intermodulation level was recorded

### Test Setup



### Intermodulation Test Results Uplink Test Results

| Frequency Band (MHz) | Intermodulation Level (dBm) | Limit (dBm) | Result | Intermod Level with Input Power @ AGC + 10 dB | Result (Pass / Fail) |
|----------------------|-----------------------------|-------------|--------|-----------------------------------------------|----------------------|
| 698 - 716 MHz        | -20.2                       | -19         | Pass   | -20.1                                         | Pass                 |
| 776 - 787 MHz        | -19.8                       | -19         | Pass   | -19                                           | Pass                 |

### Downlink Test Results

| Frequency Band (MHz) | Intermodulation Level (dBm) | Limit (dBm) | Result | Intermod Level with Input Power @ AGC + 10 dB | Result (Pass / Fail) |
|----------------------|-----------------------------|-------------|--------|-----------------------------------------------|----------------------|
| 728 - 746 MHz        | -20.1                       | -19         | Pass   | -27.6                                         | Pass                 |
| 746 - 757 MHz        | -19.1                       | -19         | Pass   | -26.6                                         | Pass                 |

## Annex B Intermodulation

Refer to Annex B for Intermodulation Test plots

## Out-of-Band Emissions

Engineer: Greg Corbin

Test Date: 10/26/2020

### Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor in order to ensure accurate readings. A signal generator was utilized to produce the following signals: GSM, CDMA, and WCDMA. The signal generator was tuned to the lowest allowable upper and lower channel within the EUT operational band for each respective modulation type. The RF input level was increased to a point just prior to the AGC being in control of the power. For each modulation type the Out of Band Emissions were measured to ensure they met the limits.

The following formula was used for calculating the limits:

$$\text{Limit} = P1 - 6 - (43 + 10\log(P2)) = -19\text{dBm}$$

P1 = power in dBm

P2 = power in Watts

**The Booster is compliant to the OOB Limits at 10 dB above the AGC Threshold.**

### Test Setup



### GSM Uplink Test Results

| Frequency Band (MHz) | Band Edge | Measured Level (dBm) | Limit (dBm) | Result | OOBE Below Limit at Max Input Power (Pass/Fail) |
|----------------------|-----------|----------------------|-------------|--------|-------------------------------------------------|
| 698 - 716            | Lower     | -30.9                | -19         | Pass   | Pass                                            |
| 776 - 787            | Lower     | -29.3                | -19         | Pass   | Pass                                            |
| 698 - 716            | Upper     | -28.9                | -19         | Pass   | Pass                                            |
| 776 - 787            | Upper     | -29.2                | -19         | Pass   | Pass                                            |

### CDMA Uplink Test Results

| Frequency Band (MHz) | Band Edge | Measured Level (dBm) | Limit (dBm) | Result | OOBE Below Limit at Max Input Power (Pass/Fail) |
|----------------------|-----------|----------------------|-------------|--------|-------------------------------------------------|
| 698 - 716            | Lower     | -47.9                | -19         | Pass   | Pass                                            |
| 776 - 787            | Lower     | -40.9                | -19         | Pass   | Pass                                            |
| 698 - 716            | Upper     | -41.8                | -19         | Pass   | Pass                                            |
| 776 - 787            | Upper     | -39.3                | -19         | Pass   | Pass                                            |

### WCDMA Uplink Test Results

| Frequency Band (MHz) | Band Edge | Measured Level (dBm) | Limit (dBm) | Result | Oobe Below Limit at Max Input Power (Pass/Fail) |
|----------------------|-----------|----------------------|-------------|--------|-------------------------------------------------|
| 698 - 716            | Lower     | -47.1                | -19         | Pass   | Pass                                            |
| 776 - 787            | Upper     | -43.2                | -19         | Pass   | Pass                                            |
| 698 - 716            | Upper     | -44.3                | -19         | Pass   | Pass                                            |
| 776 - 787            | Lower     | -43.8                | -19         | Pass   | Pass                                            |

### GSM Downlink Test Results

| Frequency Band (MHz) | Band Edge | Measured Level (dBm) | Limit (dBm) | Result | Oobe Below Limit at Max Input Power (Pass/Fail) |
|----------------------|-----------|----------------------|-------------|--------|-------------------------------------------------|
| 728 - 746 MHz        | Lower     | -38.4                | -19         | Pass   | Pass                                            |
| 746 - 757 MHz        | Lower     | -34.6                | -19         | Pass   | Pass                                            |
| 728 - 746 MHz        | Upper     | -35.1                | -19         | Pass   | Pass                                            |
| 746 - 757 MHz        | Upper     | -41.5                | -19         | Pass   | Pass                                            |

### CDMA Downlink Test Results

| Frequency Band (MHz) | Band Edge | Measured Level (dBm) | Limit (dBm) | Result | Oobe Below Limit at Max Input Power (Pass/Fail) |
|----------------------|-----------|----------------------|-------------|--------|-------------------------------------------------|
| 728 - 746 MHz        | Lower     | -56.1                | -19         | Pass   | Pass                                            |
| 746 - 757 MHz        | Lower     | -58.2                | -19         | Pass   | Pass                                            |
| 728 - 746 MHz        | Upper     | -50.7                | -19         | Pass   | Pass                                            |
| 746 - 757 MHz        | Upper     | -63.4                | -19         | Pass   | Pass                                            |

### WCDMA Downlink Test Results

| Frequency Band (MHz) | Band Edge | Measured Level (dBm) | Limit (dBm) | Result | Oobe Below Limit at Max Input Power (Pass/Fail) |
|----------------------|-----------|----------------------|-------------|--------|-------------------------------------------------|
| 728 - 746 MHz        | Lower     | -53.5                | -19         | Pass   | Pass                                            |
| 746 - 757 MHz        | Lower     | -52.8                | -19         | Pass   | Pass                                            |
| 728 - 746 MHz        | Upper     | -54.1                | -19         | Pass   | Pass                                            |
| 746 - 757 MHz        | Upper     | -54.6                | -19         | Pass   | Pass                                            |

## Annex C Out of Band Emission

Refer to Annex C for Out of Band Emission plots

## Conducted Spurious Emissions

**Engineer:** Greg Corbin

**Test Date:** 10/26/2020

### Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator, with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings. A signal generator was utilized to produce a 4.1 MHz AWGN signal operating at the maximum allowable power. The conducted spurious emissions from 9 kHz to 10 times the highest tunable frequency for each operational band were measured (excluding the band defined by the Out of band emissions test). The emissions were plotted and the highest level was recorded in the summary table.

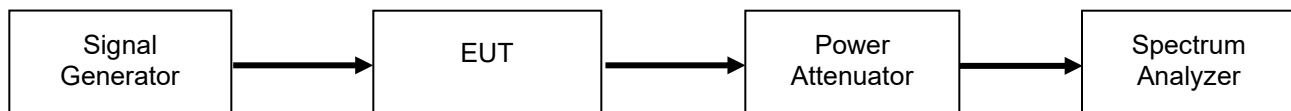
The following formulas are used for calculating the limits.

Conducted Spurious Emissions Limit =  $P1 - (43 + 10\log(P2)) = -13 \text{ dBm}$

P1 = power in dBm

P2 = power in Watts

### Test Setup



### Uplink Test Results

| Frequency Band (MHz) | Measured Frequency (MHz) | Measured Level (dBm) | Limit (dBm) | Result |
|----------------------|--------------------------|----------------------|-------------|--------|
| 698 - 716            | 7378.7                   | -30.5                | -13         | Pass   |
| 776 - 787            | 7384.5                   | -30.7                | -13         | Pass   |

### Downlink Test Results

| Frequency Band (MHz) | Measured Frequency (MHz) | Measured Level (dBm) | Limit (dBm) | Result |
|----------------------|--------------------------|----------------------|-------------|--------|
| 728 - 746            | 7472.1                   | -30.4                | -13         | Pass   |
| 746 - 757            | 7361.2                   | -29.2                | -13         | Pass   |

For the 746 – 758 downlink and 776 – 788 Uplink bands of operation, the following additional spurious emissions requirements apply.

**FCC 27.53(c)**

*For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:*

- (3) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than  $76 + 10 \log (P)$  dB in a 6.25 kHz band segment, for base and fixed stations;

**776 – 787 MHz Uplink Band**

| Spurious Frequency Range (MHz) | Measured Frequency (MHz) | Measured Value (dBm) | Limit (dBm) | Margin (dB) |
|--------------------------------|--------------------------|----------------------|-------------|-------------|
| 763 – 775                      | 774.721                  | -52.1                | -46         | -6.10       |
| 793 – 805                      | 793.129                  | -59.7                | -46         | -13.70      |

**746 - 757 MHz Downlink Band**

| Spurious Frequency Range (MHz) | Measured Frequency (MHz) | Measured Value (dBm) | Limit (dBm) | Margin (dB) |
|--------------------------------|--------------------------|----------------------|-------------|-------------|
| 763 – 775                      | 770.548                  | -69.8                | -46         | -23.80      |
| 793 – 805                      | 802.972                  | -68.7                | -46         | -22.70      |

#### FCC 27.53(e)

For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Final Value (dBm) = conducted measurement + final gain/loss from Antenna Kitting document

The Limit for discreet (narrowband) emissions is -80dBW (-50 dBm) in 700 MHz BW.

The Limit for (wideband Emissions) is -70 dBW (-40 dBm) in a 1 MHz BW.

#### 776 – 787 MHz Uplink Band

| Spurious Frequency Range (MHz) | Measured Frequency (MHz) | Measured Value (dBm) | Gain/Loss from Antenna Kitting Information (dB) | Final Value (dBm) | Limit (dBm) | Margin (dB) |
|--------------------------------|--------------------------|----------------------|-------------------------------------------------|-------------------|-------------|-------------|
| 1559 – 1610 (Wideband)         | 1565.2                   | -51.1                | 4.90                                            | -46.20            | -40         | -6.20       |
| 1559 – 1610 (Narrowband)       | 1572.6                   | -80.6                | 4.90                                            | -75.70            | -50         | -25.70      |

#### 746 - 757 MHz Downlink Band

| Spurious Frequency Range (MHz) | Measured Frequency (MHz) | Measured Value (dBm) | Gain/Loss from Antenna Kitting Information (dB) | Final Value (dBm) | Limit (dBm) | Margin (dB) |
|--------------------------------|--------------------------|----------------------|-------------------------------------------------|-------------------|-------------|-------------|
| 1559 – 1610 (Wideband)         | 1566                     | -49.6                | 2.20                                            | -47.40            | -40         | -7.40       |
| 1559 – 1610 (Narrowband)       | 1588.8                   | -78.9                | 2.20                                            | -76.70            | -50         | -26.70      |

#### Annex D Conducted Spurious Emission

Refer to Annex D for Conducted Spurious Emission plots.

## Noise Limits

**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

## Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as necessary to ensure that accurate readings were obtained. A series of three tests were performed: the maximum uplink and downlink noise, the variable noise for the uplink and downlink in the presence of a downlink signal, and the variable uplink noise timing. The detailed procedures from the latest version of KDB 935210 D03 were followed.

For all other installations, the Noise Limit is calculated using the following formula.

The following formulas are used for calculating the limits. Note – Downlink noise power limit is calculated with the center frequency of the associated uplink band.

Noise Power =  $-102.5 + \text{LOG}_{10}(\text{Band Center Frequency}) * 20$

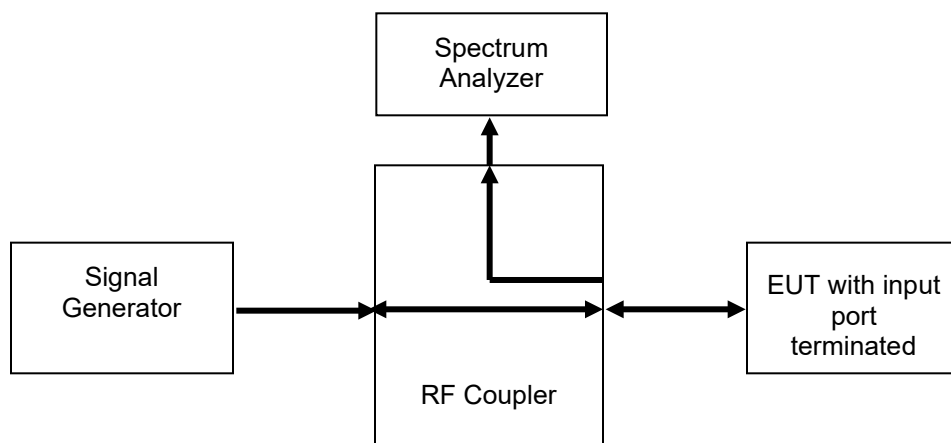
Variable Noise =  $-103 \text{ dBm/MHz-RSSI}$

## Test Setup

### Maximum Noise Power



### Variable Uplink Noise Power and Timing



### Maximum Uplink Noise Test Results

| Frequency Band (MHz) | Measured Noise (dBm) | Limit (dBm) | Margin (dB) | Result |
|----------------------|----------------------|-------------|-------------|--------|
| 698 - 716            | -49.7                | -45.5       | -4.2        | Pass   |
| 776 - 787            | -53                  | -44.6       | -8.4        | Pass   |

### Maximum Downlink Noise Test Results

| Frequency Band (MHz) | Measured Noise (dBm) | Limit (dBm) | Margin (dB) | Result |
|----------------------|----------------------|-------------|-------------|--------|
| 728 - 746            | -49.8                | -45.5       | -4.3        | Pass   |
| 746 - 757            | -50.1                | -44.6       | -5.5        | Pass   |

### Uplink Noise Timing Test Results

| Frequency Band (MHz) | Measured Timing (Seconds) | Limit (Seconds) | Result |
|----------------------|---------------------------|-----------------|--------|
| 698 - 716            | 0.50                      | 3.0             | Pass   |
| 776 - 787            | 0.34                      | 3.0             | Pass   |

### Variable Uplink Noise Limit Test Results

#### 698 - 716 MHz

| RSSI (dBm) | Noise Limit (dBm) | Measured Noise (dBm) | Margin (dB) |
|------------|-------------------|----------------------|-------------|
| -63.0      | -45.5             | -49.2                | -3.7        |
| -62.0      | -45.5             | -49.2                | -3.7        |
| -61.0      | -45.5             | -49.2                | -3.7        |
| -60.0      | -45.5             | -49.8                | -4.3        |
| -49.0      | -54.0             | -58.5                | -4.5        |
| -41.0      | -62.0             | -65.7                | -3.7        |

#### 776 - 787 MHz

| RSSI (dBm) | Noise Limit (dBm) | Measured Noise (dBm) | Margin (dB) |
|------------|-------------------|----------------------|-------------|
| -66.0      | -44.6             | -52.2                | -7.6        |
| -65.0      | -44.6             | -52.1                | -7.5        |
| -51.0      | -52.0             | -59.1                | -7.1        |
| -47.0      | -56.0             | -63                  | -7.0        |
| -46.0      | -57.0             | -64                  | -7.0        |
| -45.0      | -58.0             | -64.3                | -6.3        |

## Annex E Noise Limits and Uplink Noise Timing

Refer to Annex E for Noise Limits and Uplink Noise Timing Plots

## Uplink Inactivity

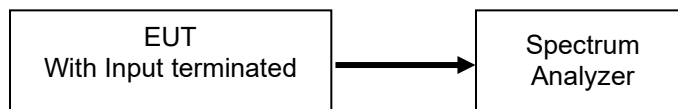
**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

### Test Procedure

The EUT was connected directly to a spectrum analyzer set to operate in the center of the EUT operational uplink and downlink bands. The span was set to 0 Hz with a sweep time of 330 seconds and MAX HOLD operation. The EUT was powered on and the time for the uplink to return to an inactive state was measured using the DELTA MARKER method to ensure that it was less than 300 seconds. The noise level after the return to an inactive state was less than -70 dBm/MHz.

### Test Setup



### Uplink Test Results

| Frequency Band (MHz) | Measured Time (Seconds) | Limit (Seconds) | Result |
|----------------------|-------------------------|-----------------|--------|
| 698 - 716            | 285.8                   | 300             | Pass   |
| 776 - 787            | 286.2                   | 300             | Pass   |

## Annex F Uplink Inactivity

Refer to Annex F for Uplink Inactivity Plots

## Variable Gain

**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

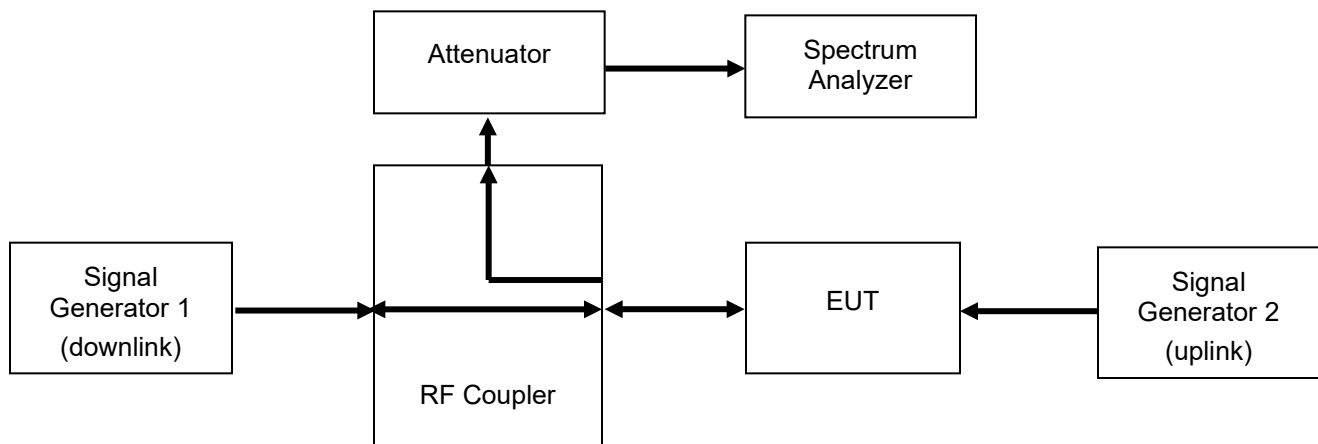
## Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor in order to ensure accurate readings were obtained. The uplink gain in the presence of a downlink signal was measured for each operational uplink band using the detailed procedures from the latest version of KDB 935210 D03.

The following formula is used for calculating the limits:

Variable Gain = -34 dB - RSSI + MSCL

## Test Setup



## Uplink Test Results

### 698 - 716 MHz

| RSSI (dBm) | MSCL (dB) | Gain Limit (dBm) | P(in) (dBm) | P(out) (dBm) | Gain (dB) | Margin (dB) |
|------------|-----------|------------------|-------------|--------------|-----------|-------------|
| -60.0      | 36.4      | 62.4             | -40.7       | 13.6         | 54.3      | -8.1        |
| -59.0      | 36.4      | 61.4             | -40.7       | 13.1         | 53.8      | -7.6        |
| -58.0      | 36.4      | 60.4             | -40.7       | 11.6         | 52.3      | -8.1        |
| -57.0      | 36.4      | 59.4             | -40.7       | 10.6         | 51.3      | -8.1        |
| -56.0      | 36.4      | 58.4             | -40.7       | 9.7          | 50.4      | -8.0        |
| -55.0      | 36.4      | 57.4             | -40.7       | 8.2          | 48.9      | -8.5        |

### 776 - 787 MHz

| RSSI (dBm) | MSCL (dB) | Gain Limit (dBm) | P(in) (dBm) | P(out) (dBm) | Gain (dB) | Margin (dB) |
|------------|-----------|------------------|-------------|--------------|-----------|-------------|
| -59.0      | 37.1      | 62.1             | -39.6       | 15.3         | 54.9      | -7.2        |
| -58.0      | 37.1      | 61.1             | -39.6       | 14.3         | 53.9      | -7.2        |
| -57.0      | 37.1      | 60.1             | -39.6       | 12.9         | 52.5      | -7.6        |
| -56.0      | 37.1      | 59.1             | -39.6       | 11.9         | 51.5      | -7.6        |
| -55.0      | 37.1      | 58.1             | -39.6       | 10.4         | 50.0      | -8.1        |
| -54.0      | 37.1      | 57.1             | -39.6       | 9.5          | 49.1      | -8.0        |

### Uplink Gain Timing Test Results

| Frequency Band (MHz) | Measured Timing (Seconds) | Limit (Seconds) | Result |
|----------------------|---------------------------|-----------------|--------|
| 698 - 716 MHz        | 0.35                      | 3.0             | Pass   |
| 776 - 787 MHz        | 0.38                      | 3.0             | Pass   |

#### Annex G Uplink Gain Timing

Refer to Annex G for Uplink Gain Timing Plots

## Occupied Bandwidth

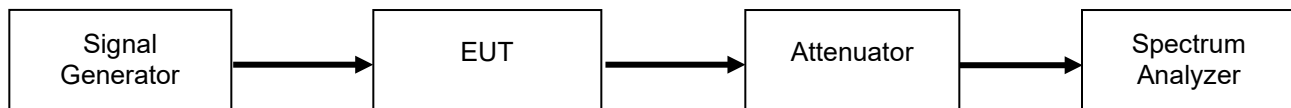
**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

### Test Procedure

The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as required to ensure that accurate readings were obtained. A signal generator was utilized to produce the following signals: GSM, CDMA, and WCDMA. The signal generator was tuned to the center channel of each of the EUT operational uplink and downlink bands with the RF level set at a point just prior to the AGC being in control of the power. For each modulation type, the input and output signal was measured and plotted to ensure that the signals were similar.

### Test Setup



## Annex H Occupied Bandwidth

Refer to Annex H for Occupied Bandwidth plots

## Anti-Oscillation

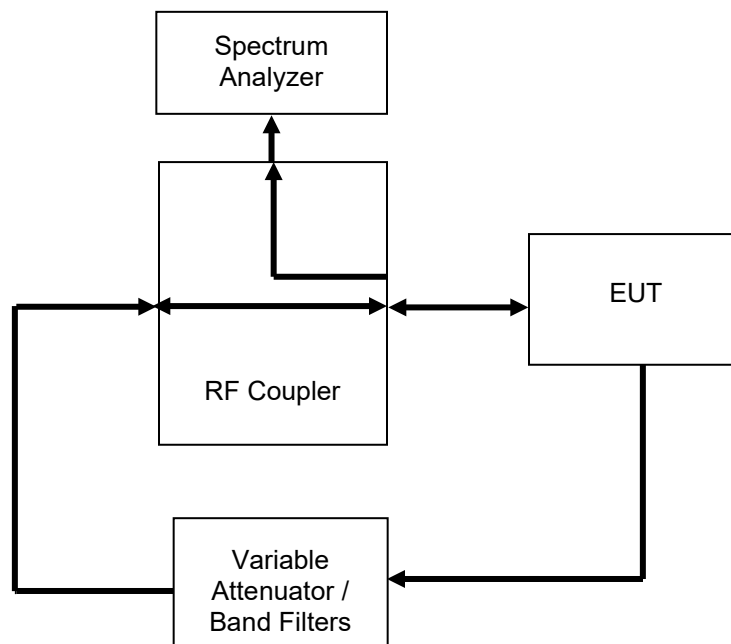
**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

### Test Procedure

The EUT was connected to a spectrum analyzer set for zero span mode. The EUT uplink and downlink were loop backed to each other through a selectable band pass filter and variable attenuator. The EUT uplink and downlink were tested to ensure that the presence of oscillation was detected and that the EUT output turned off within 300 mS for the Uplink and 1 second for the Downlink and remained off for 1 minute. The time was extended to capture how many times the unit attempted to restart.

### Test Setup



### Uplink Detection Time Test Results

| Frequency Band (MHz) | Measured Time (mS) | Limit (mS) | Result |
|----------------------|--------------------|------------|--------|
| 698 - 716            | 112.5              | 300        | Pass   |
| 776 - 787            | 75                 | 300        | Pass   |

### Downlink Detection Time Test Results

| Frequency Band (MHz) | Measured Time (mS) | Limit (mS) | Result |
|----------------------|--------------------|------------|--------|
| 728 - 746            | 137.5              | 1000       | Pass   |
| 746 - 757            | 150                | 1000       | Pass   |

#### Uplink Restart Time Test Results

| Frequency Band (MHz) | Measured Time (S) | Limit (S) | Result |
|----------------------|-------------------|-----------|--------|
| 698 - 716            | >90               | ≥60       | Pass   |
| 776 - 787            | >90               | ≥60       | Pass   |

#### Downlink Restart Time Test Results

| Frequency Band (MHz) | Measured Time (S) | Limit (S) | Result |
|----------------------|-------------------|-----------|--------|
| 728 - 746            | >90               | ≥60       | Pass   |
| 746 - 757            | >90               | ≥60       | Pass   |

#### Uplink Restart Count Test Results

| Frequency Band (MHz) | Restarts | Limit | Result |
|----------------------|----------|-------|--------|
| 698 - 716            | 0        | ≤5    | Pass   |
| 776 - 787            | 0        | ≤5    | Pass   |

#### Downlink Restart Count Test Results

| Frequency Band (MHz) | Restarts | Limit | Result |
|----------------------|----------|-------|--------|
| 728 - 746            | 0        | ≤5    | Pass   |
| 746 - 757            | 0        | ≤5    | Pass   |

## Annex I Anti-Oscillation

Refer to Annex I for Anti-Oscillation Plots

## Oscillation Mitigation

**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

### Test Procedure

The EUT was connected as shown per KDB 935210 D03. The EUT was verified to shut down in the presence of an oscillation.

The total attenuation from output to input was set +5 dB higher than the gain for the band being tested.

For EUT's that do not shutdown, the peak oscillation was measured and the variable attenuator was reduced in 1 dB increments until the booster shuts off.

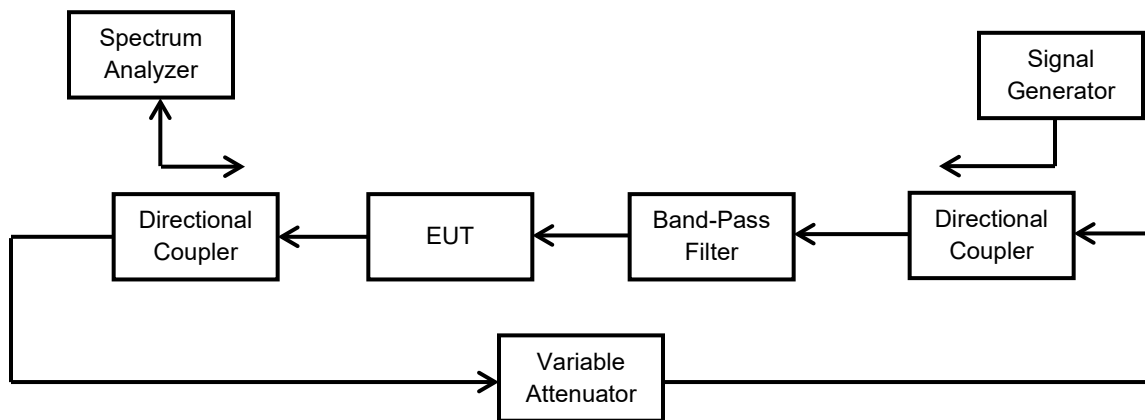
The frequency and amplitude of the highest oscillation and the lowest level in the valley next to the oscillation was recorded for each 1 dB step as required per the KDB.

For oscillations that exceeded the 12 dB limit, the time required for the booster to mitigate the oscillation to less than 12 dB was recorded.

If the booster mitigated the oscillation within the 300 second time limit, the time required to mitigate the oscillation was recorded along with the final level of the oscillation after mitigation.

**Note:** In all cases the booster mitigated the oscillation to less than 12 dB before the 300 second limit.

### Test Setup



### Uplink Oscillation Mitigation Test Data

| Oscillation Mitigation - Uplink |                               |       |       |       |        |       |                              |                       |             |
|---------------------------------|-------------------------------|-------|-------|-------|--------|-------|------------------------------|-----------------------|-------------|
| Band                            | 698 – 716 MHz                 |       |       |       |        |       |                              |                       |             |
| Test Signal Type                | CDMA                          |       |       |       |        |       |                              |                       |             |
| Variable Attenuator Setting     | Oscillations and Power Levels |       |       |       | Margin | Limit | Time to Mitigate Oscillation | Mitigation Time Limit | Pass / Fail |
|                                 | Freq.                         | Level | Freq. | Level |        |       |                              |                       |             |
| dB                              | MHz                           | dBm   | MHz   | dBm   | dB     | dB    | sec                          | sec                   |             |
| +5                              | 703.9                         | -62.1 | 706.4 | -70.7 | 8.6    | <12   | N/A                          | < 300                 | Pass        |
| +4                              | 703.9                         | -61.3 | 706.4 | -70.8 | 9.5    | <12   | N/A                          | < 300                 | Pass        |
| +3                              | 703.9                         | -61.1 | 706.4 | -71.7 | 10.6   | <12   | N/A                          | < 300                 | Pass        |
| +2                              | 703.9                         | -59.1 | 706.4 | -71.9 | 12.8   | <12   | 51                           | < 300                 | Pass        |
| +1                              | 703.9                         | -57.9 | 706.4 | -71.1 | 13.2   | <12   | 52                           | < 300                 | Pass        |
| +0                              | 703.9                         | -56.2 | 706.4 | -72.4 | 16.2   | <12   | 45                           | < 300                 | Pass        |
| -1                              | 703.9                         | -54.9 | 706.4 | -72.3 | 17.4   | <12   | 48                           | < 300                 | Pass        |
| -2                              | 703.9                         | -45.4 | 706.4 | -72.8 | 27.4   | <12   | 57                           | < 300                 | Pass        |
| -3                              | EUT shutdown                  |       |       |       |        |       |                              |                       | Pass        |

| Oscillation Mitigation - Uplink |                               |       |       |       |        |       |                              |                       |             |
|---------------------------------|-------------------------------|-------|-------|-------|--------|-------|------------------------------|-----------------------|-------------|
| Band                            | 776 – 787 MHz                 |       |       |       |        |       |                              |                       |             |
| Test Signal Type                | CDMA                          |       |       |       |        |       |                              |                       |             |
| Variable Attenuator Setting     | Oscillations and Power Levels |       |       |       | Margin | Limit | Time to Mitigate Oscillation | Mitigation Time Limit | Pass / Fail |
|                                 | Freq.                         | Level | Freq. | Level |        |       |                              |                       |             |
| dB                              | MHz                           | dBm   | MHz   | dBm   | dB     | dB    | sec                          | sec                   |             |
| +5                              | 783.5                         | -60.6 | 785.1 | -72.3 | 11.7   | <12   | N/A                          | < 300                 | Pass        |
| +4                              | 783.5                         | -58.9 | 785.1 | -72.6 | 13.7   | <12   | 50                           | < 300                 | Pass        |
| +3                              | 783.5                         | -57   | 785.1 | -73.3 | 16.3   | <12   | 45                           | < 300                 | Pass        |
| +2                              | 783.5                         | -53.9 | 785.1 | -73.1 | 19.2   | <12   | 56                           | < 300                 | Pass        |
| +1                              | 783.5                         | -50.3 | 785.1 | -73.3 | 23     | <12   | 54                           | < 300                 | Pass        |
| +0                              | 783.5                         | -45.1 | 785.1 | -73.3 | 28.2   | <12   | 49                           | < 300                 | Pass        |
| -1                              | EUT shutdown                  |       |       |       |        |       |                              |                       | Pass        |

### Downlink Oscillation Mitigation Test Data

| Oscillation Mitigation - Downlink |                               |       |       |       |        |       |                              |                       |             |
|-----------------------------------|-------------------------------|-------|-------|-------|--------|-------|------------------------------|-----------------------|-------------|
| Band                              | 728 - 746 MHz                 |       |       |       |        |       |                              |                       |             |
| Test Signal Type                  | CDMA                          |       |       |       |        |       |                              |                       |             |
| Variable Attenuator Setting       | Oscillations and Power Levels |       |       |       | Margin | Limit | Time to Mitigate Oscillation | Mitigation Time Limit | Pass / Fail |
|                                   | Freq.                         | Level | Freq. | Level |        |       |                              |                       |             |
| dB                                | MHz                           | dBm   | MHz   | dBm   | dB     | dB    | sec                          | sec                   |             |
| +5                                | 738.3                         | -64.1 | 736.9 | -72.6 | 8.5    | <12   | N/A                          | < 300                 | Pass        |
| +4                                | 738.3                         | -63.6 | 736.9 | -72.4 | 8.8    | <12   | N/A                          | < 300                 | Pass        |
| +3                                | 738.3                         | -62.4 | 736.9 | -73.1 | 10.7   | <12   | N/A                          | < 300                 | Pass        |
| +2                                | 738.3                         | -62   | 736.9 | -74.3 | 12.3   | <12   | 43                           | < 300                 | Pass        |
| +1                                | EUT shutdown                  |       |       |       |        |       |                              |                       | Pass        |

| Oscillation Mitigation - Downlink |                               |       |       |       |        |       |                              |                       |             |
|-----------------------------------|-------------------------------|-------|-------|-------|--------|-------|------------------------------|-----------------------|-------------|
| Band                              | 746 - 757 MHz                 |       |       |       |        |       |                              |                       |             |
| Test Signal Type                  | CDMA                          |       |       |       |        |       |                              |                       |             |
| Variable Attenuator Setting       | Oscillations and Power Levels |       |       |       | Margin | Limit | Time to Mitigate Oscillation | Mitigation Time Limit | Pass / Fail |
|                                   | Freq.                         | Level | Freq. | Level |        |       |                              |                       |             |
| dB                                | MHz                           | dBm   | MHz   | dBm   | dB     | dB    | sec                          | sec                   |             |
| +5                                | 749.8                         | -57.5 | 748.2 | -70.4 | 12.9   | <12   | 55                           | < 300                 | Pass        |
| +4                                | 749.8                         | -55.4 | 748.2 | -69.7 | 14.3   | <12   | 47                           | < 300                 | Pass        |
| +3                                | 749.8                         | -53.8 | 748.2 | -70.3 | 16.5   | <12   | 56                           | < 300                 | Pass        |
| +2                                | 749.8                         | -52.3 | 748.2 | -70.3 | 18     | <12   | 54                           | < 300                 | Pass        |
| +1                                | EUT shutdown                  |       |       |       |        |       |                              |                       | Pass        |

## Radiated Spurious

**Engineer:** Greg Corbin

**Test Date:** 10/27/2020

### Test Procedure

The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure that the signal levels were maximized.

The radiated spurious emissions were measured from 30 MHz to the 10th harmonic of the highest frequency used by the EUT.

All cable and antenna correction factors were input into the spectrum analyzer ensuring an accurate measurement in ERP/EIRP with the resultant power in dBm. A signal generator was used to provide a CW signal centered in each operational uplink and downlink band. The EUT output was terminated into a 50 Ohm non-radiating load.

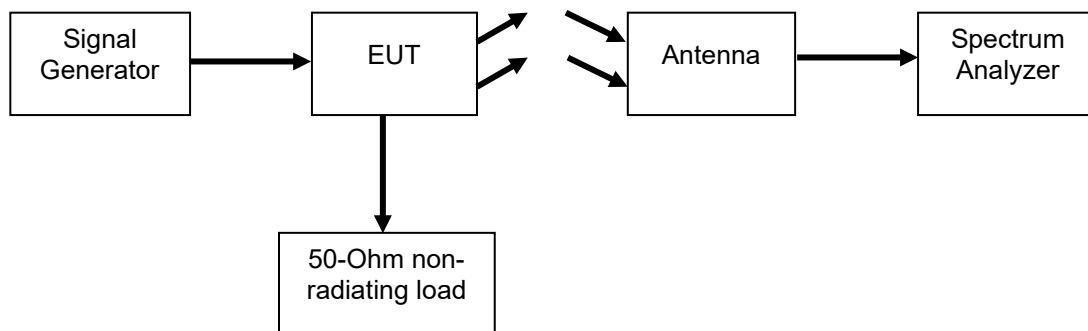
The following formula was used for calculating the limits:

$$\text{Radiated Spurious Emissions Limit} = P1 - (43 + 10\log(P2)) = -13\text{dBm}$$

P1 = power in dBm

P2 = power in Watts

### Test Setup



All emissions were lower than -13 dBm.

## Annex J Radiated Spurious Emission

Refer to Annex J for Radiated Spurious Emission plots

## Measurement Uncertainty

Measurement Uncertainty for Compliance Testing is listed in the table below.

The reported expanded uncertainty has been estimated at a 95% confidence level (k=2)

| Measurement Type                  | Expanded Uncertainty |
|-----------------------------------|----------------------|
| Conducted Emissions, AC Powerline | $\pm 3.28$ dB        |
| Radiated Emissions_30 – 1000 MHz  | $\pm 4.82$ dB        |
| Radiated Emissions_1 – 18 GHz     | $\pm 5.73$ dB        |
| Frequency Error                   | $\pm 22$ Hz          |
| Conducted RF Power                | $\pm 0.98$ dB        |
| Conducted Spurious Emission       | $\pm 2.49$ dB        |
| AC Voltage                        | $\pm 2.3$ %          |
| DC Voltage                        | $\pm 0.12$ %         |
| Temperature                       | $\pm 1.0$ deg C      |
| Humidity                          | $\pm 4.32$ %         |

## Test Equipment Utilized

| Description           | Manufacturer       | Model #                   | CT Asset #          | Last Cal Date | Cal Due Date |
|-----------------------|--------------------|---------------------------|---------------------|---------------|--------------|
| Horn Antenna          | EMCO               | 3116                      | i00085              | 2/28/19       | 2/28/21      |
| Horn Antenna          | ARA                | DRG-118/A                 | i00271              | 8/3/20        | 8/3/21       |
| Humidity / Temp Meter | Newport            | IBTHX-W-5                 | i00282              | 8/28/20       | 8/28/21      |
| Bi-Log Antenna        | Schaffner          | CBL 6111D                 | i00267              | 8/28/20       | 8/28/22      |
| EMI Analyzer          | Agilent            | E7405A                    | i00379              | 1/21/20       | 1/21/21      |
| Signal Generator      | Rohde & Schwarz    | SMU200A                   | i00405              | 8/6/20        | 8/6/21       |
| Filter Test Box       | Compliance Testing | N/A                       | i00411              | N/A           | N/A          |
| Spectrum Analyzer     | Textronix          | RSA5126A                  | i00424              | 8/3/20        | 8/3/21       |
| Variable Attenuator   | JFW                | 940-60-33-1               | i00433              | N/A           | N/A          |
| Signal Generator      | Agilent            | E4438C                    | i00457              | 1/3/2020      | 1/3/2021     |
| Preamplifier          | Miteq              | AMF-6F-18004000-29-8P     | i00461              | N/A           | N/A          |
| Voltmeter             | Fluke              | 179                       | i00488              | 5/18/20       | 5/18/21      |
| Preamplifier          | Miteq              | AFS44 00101 400 23-10P-44 | i00509              | N/A           | N/A          |
| Step Attenuator       | JFW Industries     | 50DR-061                  | S/N: 293459<br>0015 | N/A           | N/A          |

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT