



## Test Report

Prepared for: Shenzhen Huaptec Co., LTD

Model: F15G-CPAL-AB-C

Description: Mobile Signal Booster

Serial Number: 21205000001

FCC ID: OWWF15G-CPAL-AB-C

To

FCC Part 20

Date of Issue: December 8, 2015

On the behalf of the applicant:

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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 12, 2015	Greg Corbin	Original Document
2.0	December 8, 2015	Greg Corbin	Updated Oscillation Mitigation data

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## ILAC / A2LA

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

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Testing Certificate Number: **2152.01**



**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.

## Standard Test Conditions and Engineering Practices

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

In accordance with ANSI/C63.4-2009, 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)
24.4 – 29.7	36.8 – 53.7	959.1 – 972.7

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

## EUT Description

**Model:** F15G-CPAL-AB-C

**Description:** Mobile Signal Booster

**Firmware:** AF20-5S-V01

**Software:** AF20-5S-V1.6

**Serial Number:** 21205000001

## 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	704 - 716	776 - 787	824 - 849	1850 - 1910	1710 – 1755
Downlink	734 - 746	746 - 757	869 - 894	1930 - 1990	2110 - 2155
Modulation Type	LTE			GSM, CDMA, EDGE, HSPA, EVDO, LTE	CDMA, HSPA, LTE, EDGE, EVDO

Emission Designators					
CDMA	HSPA	LTE	EVDO	EDGE	GSM
F9W	F9W	G7D	F9W	G7W	GXW

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.



## Test Result Summary

Specification	Test Name	Pass, Fail, N/A	Comments
20.21(e)(3)	Authorized Frequency Band	Pass	
20.21(e)(8)(i)(B) 20.21(e)(8)(i)(C) 20.21(e)(8)(i)(D)	Maximum Power and Gain	Pass	
20.21(e)(8)(i)(F)	Intermodulation	Pass	
20.21(e)(8)(i)(E)	Out-of-Band Emissions	Pass	
2.1051 22.917(a) 24.238((a) 27.53(c) 27.53(e) 27.53(f) 27.53(g)	Conducted Spurious Emissions	Pass	
20.21(e)(8)(i)(A)	Noise Limits	Pass	
20.21(e)(8)(i)(I)	Uplink Inactivity	Pass	
20.21(e)(8)(i)(C)(1) 20.21(e)(8)(i)(H) 20.21(e)(8)(i)(C)(2)(i) (Fixed)	Variable Gain	Pass	
2.1049	Occupied Bandwidth	Pass	
20.21(e)(8)(ii)(A)	Oscillation Detection	Pass	
2.1053	Radiated Spurious	Pass	
20.21(e)(8)(i)(B)	Spectrum Block Filtering	N/A	This only applies to devices utilizing spectrum block filtering

**Authorized Frequency Band**

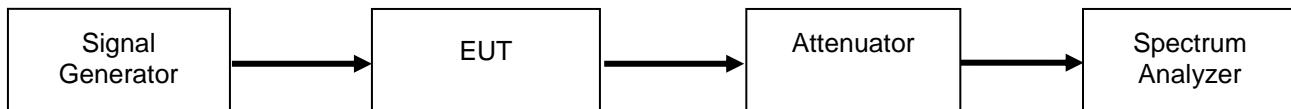
**Engineer:** Greg Corbin

**Test Date:** 7/27/2015

**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. 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**



**Refer to Annex A for Authorized Frequency Band plots.**

## Maximum Power and Gain

Engineer: Greg Corbin

Test Date: 7/28/2015

### Test Procedure

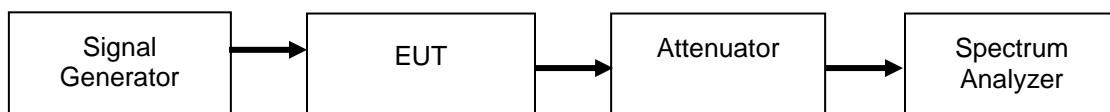
The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings. The spectrum analyzer and signal generator were tuned to the frequency with 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.

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.

### Test Setup



### Uplink Power Test Results

Frequency Band (MHz)	Input Level (dBm)	Output Power (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Result
704 - 716 MHz Pulsed GSM	-35.8	23.6	17	30	5.4	29.0	Pass
704 - 716 MHz AWGN	-42.3	18.1	17	30	5.4	23.5	Pass
776 - 787 MHz Pulsed GSM	-37.2	23.8	17	30	5.4	29.2	Pass
776 - 787 MHz AWGN	-42.0	19.4	17	30	5.4	24.9	Pass
824 - 849 MHz Pulsed GSM	-36.1	23.7	17	30	5.4	29.1	Pass
824 - 849 MHz AWGN	-41.0	19.5	17	30	5.4	24.9	Pass
1710 - 1755 MHz Pulsed GSM	-38.3	22.8	17	30	6.2	29.0	Pass
1710 - 1755 MHz AWGN	-45.3	19.1	17	30	6.2	25.3	Pass
1850 - 1910 MHz Pulsed GSM	-37.0	21.9	17	30	6.2	28.1	Pass
1850 - 1910 MHz AWGN	-45.7	18.6	17	30	6.2	24.8	Pass

### Downlink Power Test Results

Frequency Band (MHz)	Input Level (dBm)	Output Power (dBm)	Upper Limit (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Result
734 - 746 MHz Pulsed GSM	-53.6	5.4	17	0.2	5.6	Pass
734 - 746 MHz AWGN	-65.0	-4.4	17	0.2	-4.2	Pass
746 - 757 MHz Pulsed GSM	-53.2	4.9	17	0.2	5.1	Pass
746 - 757 MHz AWGN	-62.9	-4.1	17	0.2	-3.9	Pass
869 - 894 MHz Pulsed GSM	-53.1	5.3	17	0.2	5.5	Pass
869 - 894 MHz AWGN	-64.2	-4.3	17	0.2	-4.1	Pass
1930 - 1990 MHz Pulsed GSM	-57.6	3.3	17	0.9	4.2	Pass
1930 - 1990 MHz AWGN	-70.0	-7.8	17	0.9	-6.9	Pass
2110 - 2155 MHz Pulsed GSM	-59.3	4.9	17	0.9	5.8	Pass
2110 - 2155 MHz AWGN	-71.0	-5.5	17	0.9	-4.6	Pass

### Uplink and Downlink Gain Test Results

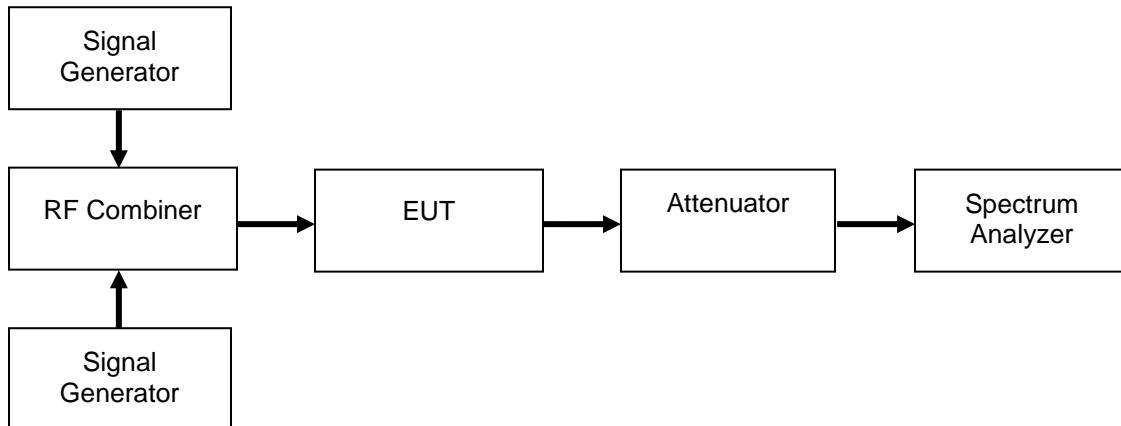
Modulation	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Uplink Gain (dB)	Uplink Limit (dB)	Downlink Gain (dB)	Downlink Limit (dB)	Delta (dB)	Limit (dB)	Margin (dB)
Pulsed GSM	710.8	740.688	59.4	63.5	59.0	63.5	0.4	710.8	-8.6
AWGN	710.8	740.688	60.4	63.5	60.6	63.5	0.2	710.8	-8.8
Pulsed GSM	785.3	750.75	61.0	64.4	58.1	64.4	2.9	785.3	-6.1
AWGN	785.3	750.75	61.4	64.4	58.8	64.4	2.6	785.3	-6.4
Pulsed GSM	844.6	881.725	59.8	64.9	58.4	64.9	1.4	844.6	-7.6
AWGN	844.6	881.725	60.5	64.9	59.9	64.9	0.6	844.6	-8.4
Pulsed GSM	1734	2123.5	61.1	71	64.2	71	3.1	1734	-5.9
AWGN	1734	2123.5	64.4	71	65.5	71	1.1	1734	-7.9
Pulsed GSM	1871.6	1987.5	58.9	72	60.9	72	2	1871.6	-7
AWGN	1871.6	1987.5	64.3	72	62.2	72	2.1	1871.6	-6.9

**Intermodulation**
**Engineer:** Greg Corbin

**Test Date:** 9/14/2015

**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 in 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.

**Test Setup**

**Uplink Test Results**

Frequency Band (MHz)	Intermodulation Level (dBm)	Limit (dBm)	Result
704 - 716 MHz	-38.6	-19	Pass
776 - 787 MHz	-33.4	-19	Pass
824 - 849 MHz	-32.2	-19	Pass
1710 - 1755 MHz	-20.5	-19	Pass
1850 - 1910 MHz	-29.9	-19	Pass

**Downlink Test Results**

Frequency Band (MHz)	Intermodulation Level (dBm)	Limit (dBm)	Result
734 - 746 MHz	-74.3	-19	Pass
746 - 757 MHz	-75.3	-19	Pass
869 - 894 MHz	-73	-19	Pass
1930 - 1990 MHz	-67.8	-19	Pass
2110 - 2155 MHz	-65.1	-19	Pass

Refer to Annex B for Intermodulation Test plots

## Out-of-Band Emissions

Engineer: Greg Corbin

Test Date: 9/15/2015

### 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

### Test Setup





### GSM Uplink Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)	Result
704 - 716	Lower	-65.2	-19	Pass
704 - 716	Upper	-33.2	-19	Pass
776 - 787	Lower	-33.9	-19	Pass
776 - 787	Upper	-33.5	-19	Pass
824 - 849	Lower	-37.9	-19	Pass
824 - 849	Upper	-41.3	-19	Pass
1710 - 1755	Lower	-45.2	-19	Pass
1710 - 1755	Upper	-43.5	-19	Pass
1850 - 1910	Lower	-39.6	-19	Pass
1850 - 1910	Upper	-80.4	-19	Pass

### CDMA Uplink Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)	Result
704 - 716	Lower	-70.8	-19	Pass
704 - 716	Upper	-48.3	-19	Pass
776 - 787	Lower	-39.1	-19	Pass
776 - 787	Upper	-43.8	-19	Pass
824 - 849	Lower	-32.1	-19	Pass
824 - 849	Upper	-38.7	-19	Pass
1710 - 1755	Lower	-41.6	-19	Pass
1710 - 1755	Upper	-42.0	-19	Pass
1850 - 1910	Lower	-31.9	-19	Pass
1850 - 1910	Upper	-69.9	-19	Pass

### WCDMA Uplink Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)	Result
704 - 716	Lower	-70.4	-19	Pass
704 - 716	Upper	-45.8	-19	Pass
776 - 787	Lower	-42.6	-19	Pass
776 - 787	Upper	-44.0	-19	Pass
824 - 849	Lower	-29.6	-19	Pass
824 - 849	Upper	-32.9	-19	Pass
1710 - 1755	Lower	-34.5	-19	Pass
1710 - 1755	Upper	-34.8	-19	Pass
1850 - 1910	Lower	-22	-19	Pass
1850 - 1910	Upper	-54	-19	Pass

### GSM Downlink Test Results

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)	Result
734 - 746	Lower	-60.7	-19	Pass
734 - 746	Upper	-49.7	-19	Pass
746 - 757	Lower	-49.9	-19	Pass
746 - 757	Upper	-52.2	-19	Pass
869 - 894	Lower	-57.8	-19	Pass
869 - 894	Upper	-60.4	-19	Pass
1930 - 1990	Lower	-64.8	-19	Pass
1930 - 1990	Upper	-72.7	-19	Pass
2110 - 2155	Lower	-64.3	-19	Pass
2110 - 2155	Upper	-66.6	-19	Pass

**CDMA Downlink Test Results**

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)	Result
734 - 746	Lower	-68.3	-19	Pass
734 - 746	Upper	-65.0	-19	Pass
746 - 757	Lower	-68.8	-19	Pass
746 - 757	Upper	-70.8	-19	Pass
869 - 894	Lower	-67.3	-19	Pass
869 - 894	Upper	-69.6	-19	Pass
1930 - 1990	Lower	-65.4	-19	Pass
1930 - 1990	Upper	-69.2	-19	Pass
2110 - 2155	Lower	-64.7	-19	Pass
2110 - 2155	Upper	-57.3	-19	Pass

**WCDMA Downlink Test Results**

Frequency Band (MHz)	Band Edge	Measured Level (dBm)	Limit (dBm)	Result
734 - 746	Lower	-69.6	-19	Pass
734 - 746	Upper	-65.8	-19	Pass
746 - 757	Lower	-67.2	-19	Pass
746 - 757	Upper	-70.4	-19	Pass
869 - 894	Lower	-58.8	-19	Pass
869 - 894	Upper	-62.3	-19	Pass
1930 - 1990	Lower	-60.4	-19	Pass
1930 - 1990	Upper	-57.3	-19	Pass
2110 - 2155	Lower	-52.5	-19	Pass
2110 - 2155	Upper	-53.4	-19	Pass

Refer to Annex C for Out of Band Emission plots

## Conducted Spurious Emissions

Engineer: Greg Corbin

Test Date: 9/29/2015

### 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.

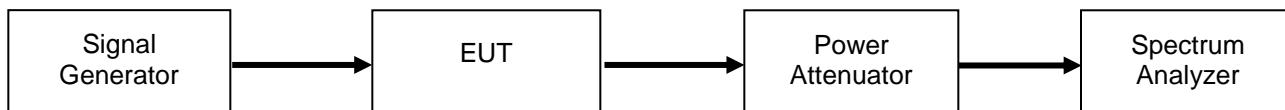
The following formulas are used for calculating the limits.

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

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
704 - 716	7418.1	-26.9	-13	Pass
776 - 787	7309.6	-26.1	-13	Pass
824 - 849	8339.7	-25.1	-13	Pass
1710 - 1755	15488.2	-23.7	-13	Pass
1850 - 1910	17978.5	-23.4	-13	Pass

### Downlink Test Results

Frequency Band (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	Limit (dBm)	Result
734 - 746	2114.7	-29.6	-13	Pass
746 - 757	2128.7	-26.6	-13	Pass
869 - 894	1943	-28.1	-13	Pass
1930 - 1990	2125.7	-28.6	-13	Pass
2110 - 2155	1945	-27.7	-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;*

*Segment, for mobile and portable stations*

RBW = 6.25 kHz

**776 – 787 MHz Uplink Band**

Spurious Frequency Range (MHz)	Measured Frequency (MHz)	Measured Value (dBm)	Final Value (dBm)	Limit (dBm)	Margin (dB)
763 – 775	774.94	-54.5	-54.50	-46	-8.50
793 – 805	793.33	-65.1	-65.10	-46	-19.10

**746 - 757 MHz Downlink Band**

Spurious Frequency Range (MHz)	Measured Frequency (MHz)	Measured Value (dBm)	Final Value (dBm)	Limit (dBm)	Margin (dB)
763 – 775	771.856	-86.1	-86.10	-46	-40.10
793 – 805	795.463	-86.4	-86.40	-46	-40.40



**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.

Since the limit is referenced to EIRP, the final data is computed using the Conducted Spurious Emission data plus the final gain/loss data from the antenna kitting information supplied by the manufacturer.

RBW = 700 Hz (Narrowband)

RBW = 1 MHz (Wideband)

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

The Limit for discreet (narrowband) emissions is  $-80$  dBW ( $-50$  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)	1606.863	-72.5	5.40	-67.10	-40	-27.10
1559 – 1610 (Narrowband)	1609.215	-102	5.40	-96.60	-50	-46.60

**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)	1568.645	-72.3	0.20	-72.10	-40	-32.10
1559 – 1610 (Narrowband)	1607.609	-102.6	0.20	-102.40	-50	-52.40

Refer to Annex D for Conducted Spurious Emission plots.

**Noise Limits**
**Engineer:** Greg Corbin

**Test Date:** 7/28/2015

**Test Procedure**

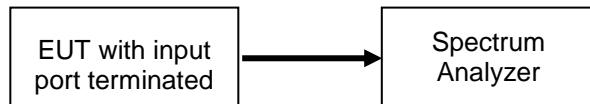
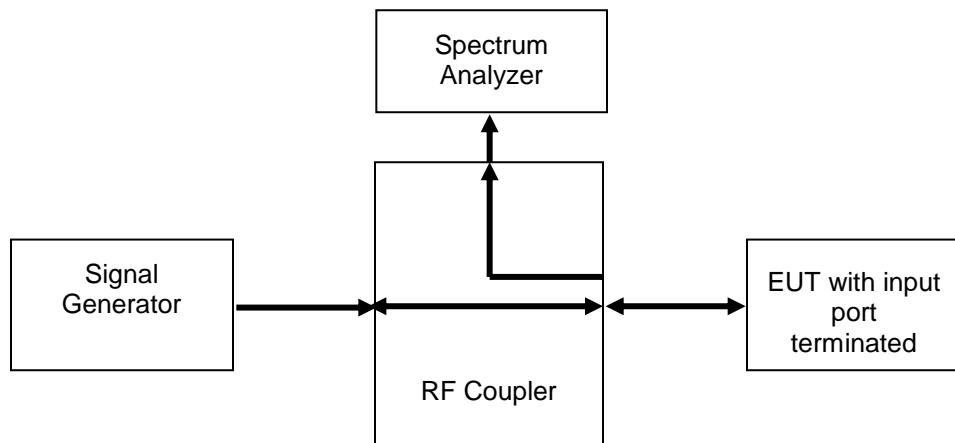
The EUT was connected to a spectrum analyzer through an attenuator with the losses being input into the spectrum analyzer as a combination of reference level offset and correction factor as necessary to ensure that accurate readings were obtained. A series of three tests were performed: the maximum uplink 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 KDB 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516c 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+LOG10(Band Center Frequency)\*20

Variable Noise =-103 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
704 - 716	-50.8	-45.5	-5.3	Pass
776 - 787	-49.5	-44.6	-4.9	Pass
824 - 849	-48.2	-44.1	-4.1	Pass
1710 - 1755	-42.2	-37.7	-4.5	Pass
1850 - 1910	-40.1	-37.0	-3.1	Pass

### Maximum Downlink Noise Test Results

Frequency Band (MHz)	Measured Noise (dBm)	Limit (dBm)	Margin (dB)	Result
734 - 746	-49.7	-45.5	-4.2	Pass
746 - 757	-50.8	-44.6	-6.2	Pass
869 - 894	-48	-44.1	-3.9	Pass
1930 - 1990	-41.6	-37.0	-4.6	Pass
2110 - 2155	-41.1	-37.7	-3.4	Pass

### Uplink Noise Timing Test Results

Frequency Band (MHz)	Measured Timing (Seconds)	Limit (Seconds)	Result
704 - 716	0.250	3.0	Pass
776 - 787	0.225	3.0	Pass
824 - 849	0.275	3.0	Pass
1710 - 1755	0.275	3.0	Pass
1850 - 1910	0.250	3.0	Pass

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



### Variable Uplink Noise Limit Test Results

#### 704 - 716 MHz

RSSI (dBm)	Noise Limit (dBm)	Measured Noise (dBm)	Margin (dB)
-70.0	-45.5	-49.5	-4.0
-69.0	-45.5	-49.5	-4.0
-65.0	-45.5	-49.7	-4.2
-64.0	-45.5	-49.2	-3.7
-54.0	-49.0	-57.3	-8.3
-51.0	-52.0	-60	-8.0

#### 776 - 787 MHz

RSSI (dBm)	Noise Limit (dBm)	Measured Noise (dBm)	Margin (dB)
-72.0	-44.6	-49.2	-4.6
-71.0	-44.6	-49.2	-4.6
-65.0	-44.6	-49.1	-4.5
-64.0	-44.6	-49	-4.4
-55.0	-48.0	-55.7	-7.7
-53.0	-50.0	-57.9	-7.9

#### 824 - 849 MHz

RSSI (dBm)	Noise Limit (dBm)	Measured Noise (dBm)	Margin (dB)
-68.0	-44.0	-48.1	-4.1
-67.0	-44.0	-48.1	-4.1
-66.0	-44.0	-48.1	-4.1
-64.0	-44.0	-47.8	-3.8
-57.0	-46.0	-53.3	-7.3
-54.0	-49.0	-56.1	-7.1

#### 1710 - 1755 MHz

RSSI (dBm)	Noise Limit (dBm)	Measured Noise (dBm)	Margin (dB)
-83.0	-37.7	-41.2	-3.5
-82.0	-37.7	-41.2	-3.5
-81.0	-37.7	-41.2	-3.5
-70.0	-37.7	-41.4	-3.7
-58.0	-45.0	-50.1	-5.1
-57.0	-46.0	-50.8	-4.8

#### 1850 - 1910 MHz

RSSI (dBm)	Noise Limit (dBm)	Measured Noise (dBm)	Margin (dB)
-82.0	-37.0	-40	-3.0
-81.0	-37.0	-40	-3.0
-68.0	-37.0	-38.8	-1.8
-67.0	-37.0	-39.9	-2.9
-58.0	-45.0	-47.9	-2.9
-55.0	-48.0	-50.4	-2.4

## Uplink Inactivity

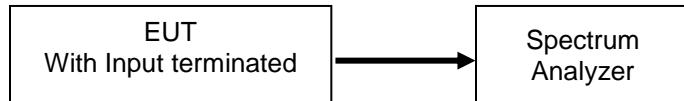
Engineer: Greg Corbin

Test Date: 5/4/2015

### 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
704 - 716	297	300	Pass
776 - 787	297.9	300	Pass
824 - 849	297.9	300	Pass
1710 - 1755	297.9	300	Pass
1850 - 1910	297	300	Pass

Refer to Annex F for Uplink Inactivity Plots

**Variable Gain**
**Engineer:** Greg Corbin

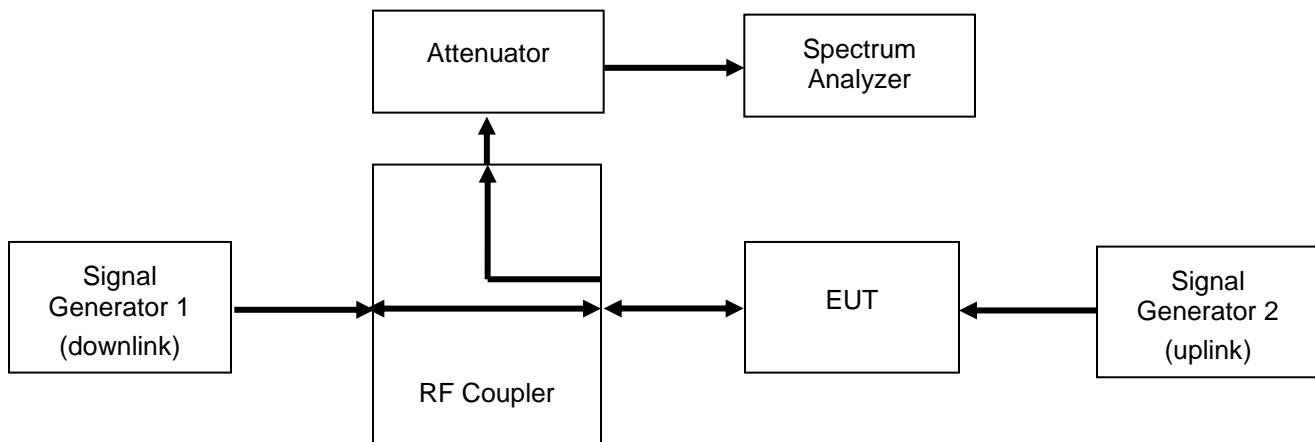
**Test Date:** 9/29/2015

**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 KDB 935210 D03 Wideband Consumer Signal Booster Measurement Guidance DR04-41516.

The following formula is used for calculating the limits:

$$\text{Variable Gain} = -34 \text{ dB} - \text{RSSI} + \text{MSCL}$$

**Test Setup**

**Uplink Test Results**
**704 - 716 MHz**

RSSI (dBm)	MSCL (dB)	Gain Limit (dBm)	P(in) (dBm)	P(out) (dBm)	Gain (dB)	Margin (dB)
-67.0	34.7	63.5	-47.3	10.8	58.1	-5.4
-66.0	34.7	63.5	-47.3	10.8	58.1	-5.4
-65.0	34.7	63.5	-47.3	10.8	58.1	-5.4
-64.0	34.7	63.5	-47.3	10.8	58.1	-5.4
-54.0	34.7	54.7	-47.3	2.0	49.3	-5.4
-53.0	34.7	53.7	-47.3	1.1	48.4	-5.3

**776 - 787 MHz**

RSSI (dBm)	MSCL (dB)	Gain Limit (dBm)	P(in) (dBm)	P(out) (dBm)	Gain (dB)	Margin (dB)
-62.0	35.6	63.6	-47.0	11.5	58.5	-5.1
-61.0	35.6	62.6	-47.0	10.5	57.5	-5.1
-60.0	35.6	61.6	-47.0	9.5	56.5	-5.1
-59.0	35.6	60.6	-47.0	8.4	55.4	-5.2
-57.0	35.6	58.6	-47.0	6.4	53.4	-5.2
-55.0	35.6	56.6	-47.0	4.4	51.4	-5.2



**824 - 849 MHz**

RSSI (dBm)	MSCL (dB)	Gain Limit (dBm)	P(in) (dBm)	P(out) (dBm)	Gain (dB)	Margin (dB)
-62.0	36.2	64.2	-46.0	11.4	57.4	-6.8
-59.0	36.2	61.2	-46.0	8.6	54.6	-6.6
-56.0	36.2	58.2	-46.0	5.4	51.4	-6.8
-54.0	36.2	56.2	-46.0	3.4	49.4	-6.8
-51.0	36.2	53.2	-46.0	0.3	46.3	-6.9
-50.0	36.2	52.2	-46.0	-0.7	45.3	-6.9

**1710 - 1755 MHz**

RSSI (dBm)	MSCL (dB)	Gain Limit (dBm)	P(in) (dBm)	P(out) (dBm)	Gain (dB)	Margin (dB)
-73.0	42.5	71.0	-50.3	14.1	64.4	-6.6
-72.0	42.5	71.0	-50.3	14.1	64.4	-6.6
-71.0	42.5	71.0	-50.3	14.1	64.4	-6.6
-70.0	42.5	71.0	-50.3	14.1	64.4	-6.6
-57.0	42.5	65.5	-50.3	2.2	52.5	-13.0
-56.0	42.5	64.5	-50.3	1.2	51.5	-13.0

**1850 - 1910 MHz**

RSSI (dBm)	MSCL (dB)	Gain Limit (dBm)	P(in) (dBm)	P(out) (dBm)	Gain (dB)	Margin (dB)
-70.0	43.2	72.0	-50.7	12.0	62.7	-9.3
-69.0	43.2	72.0	-50.7	12.0	62.7	-9.3
-68.0	43.2	72.0	-50.7	12.0	62.7	-9.3
-67.0	43.2	72.0	-50.7	12.0	62.7	-9.3
-56.0	43.2	65.2	-50.7	1.5	52.2	-13.0
-55.0	43.2	64.2	-50.7	0.4	51.1	-13.1

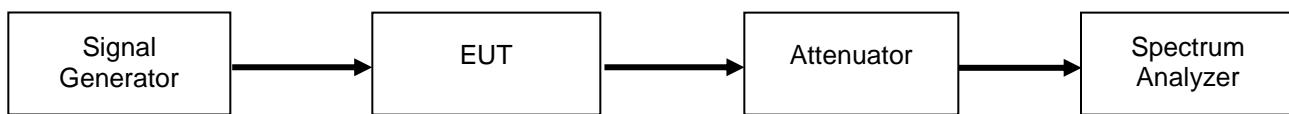
**Uplink Gain Timing Test Results**

Frequency Band (MHz)	Measured Timing (Seconds)	Limit (Seconds)	Result
704 - 716	0.750	3.0	Pass
776 - 787	0.750	3.0	Pass
824 - 849	0.325	3.0	Pass
1710 - 1755	0.325	3.0	Pass
1850 - 1910	0.250	3.0	Pass

Refer to Annex G for Uplink Gain Timing Plots

**Occupied Bandwidth****Engineer:** Greg Corbin**Test Date:** 9/15/2015**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.

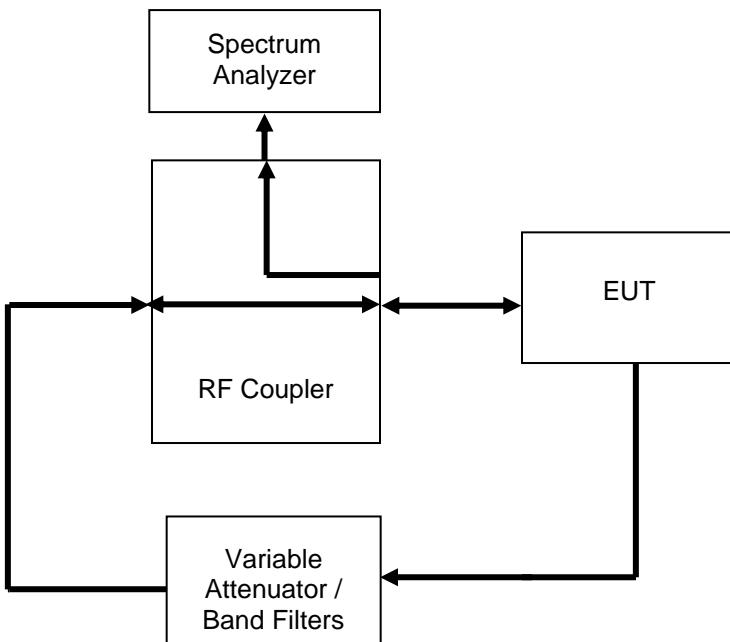
**Test Setup****Refer to Annex H for Occupied Bandwidth plots**

**Oscillation Detection**
**Engineer:** Greg Corbin

**Test Date:** 7/29/2015

**Test Procedure**

The EUT was connected to a spectrum analyzer set for 0 Hz operation. The EUT uplink and downlink were fed back upon 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. A EUT with test software was utilized to ensure that the EUT only had a maximum of 5 attempts at restart from oscillation before permanently shutting off.

**Test Setup**

**Uplink Detection Time Test Results**

Frequency Band (MHz)	Measured Time (mS)	Limit (mS)	Result
704 - 716	75.2	300	Pass
776 - 787	43.75	300	Pass
824 - 849	180	300	Pass
1710 - 1755	32.5	300	Pass
1850 - 1910	235	300	Pass

**Downlink Detection Time Test Results**

Frequency Band (MHz)	Measured Time (mS)	Limit (mS)	Result
734 - 746	31.25	1000	Pass
746 - 757	62.5	1000	Pass
869 - 894	85	1000	Pass
1930 - 1990	36.25	1000	Pass
2110 - 2155	191.25	1000	Pass



#### Uplink Restart Time Test Results

Frequency Band (MHz)	Measured Time (S)	Limit (S)	Result
704 - 716	62	≥60	Pass
776 - 787	62	≥60	Pass
824 - 849	62.25	≥60	Pass
1710 - 1755	62.125	≥60	Pass
1850 - 1910	62.125	≥60	Pass

#### Downlink Restart Time Test Results

Frequency Band (MHz)	Measured Time (S)	Limit (S)	Result
734 - 746	62.125	≥60	Pass
746 - 757	62.125	≥60	Pass
869 - 894	62	≥60	Pass
1930 - 1990	62.125	≥60	Pass
2110 - 2155	62.125	≥60	Pass

#### Uplink Restart Count Test Results

Frequency Band (MHz)	Restarts	Limit	Result
704 - 716	5	≤5	Pass
776 - 787	5	≤5	Pass
824 - 849	5	≤5	Pass
1710 - 1755	5	≤5	Pass
1850 - 1910	5	≤5	Pass

#### Downlink Restart Count Test Results

Frequency Band (MHz)	Restarts	Limit	Result
734 - 746	5	≤5	Pass
746 - 757	5	≤5	Pass
869 - 894	5	≤5	Pass
1930 - 1990	5	≤5	Pass
2110 - 2155	5	≤5	Pass

Refer to Annex I for Oscillation Detection Plots

## Oscillation Mitigation

**Engineer:** Greg Corbin

**Test Date:** 12/7/2015

### Test Procedure

The EUT was connected as shown per KDB 935210 D03 v03. 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.

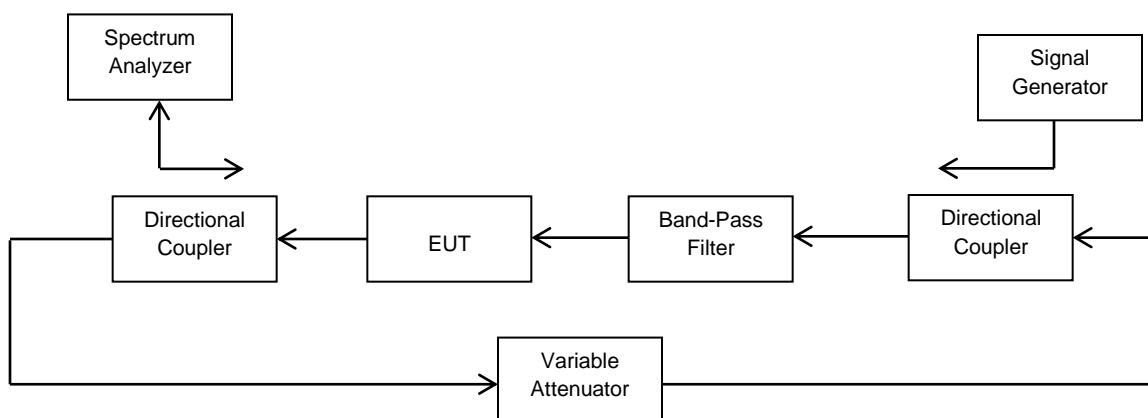
The frequency and amplitude of the highest oscillation and the lowest level in the valley next to the oscillation was recorded for each 1 dB step as required per the KDB.

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 either shut down or 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		Lowest Output Power Level		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	711.7	-65.7	713.15	-73.6	7.9	<12	N/A	< 300	Pass
+4	711.7	-65	713.15	-74	9	<12	N/A	< 300	Pass
+3	711.7	-62.5	713.15	-73.7	11.2	<12	N/A	< 300	Pass
+2	711.7	-61.4	713.15	-74.5	13.1	<12	77	< 300	Pass
+1	EUT shutdown in 77 seconds								

Oscillation Mitigation - Uplink									
Band	776 – 787 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	785.68	-65.6	783.76	-74.1	8.5	<12	N/A	< 300	Pass
+4	785.68	-64.2	783.76	-74	9.8	<12	N/A	< 300	Pass
+3	785.68	-63	783.76	-73.6	10.6	<12	N/A	< 300	Pass
2	785.68	-61.1	783.76	-74.1	13	<12	32	< 300	Pass
+1	EUT shutdown in 32 seconds								

Oscillation Mitigation - Uplink									
Band	824 - 849 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	840.725	-59.2	842.57	-71.6	12.4	<12	45	< 300	Pass
+4	EUT shutdown in 45 seconds								



Oscillation Mitigation - Uplink									
Band	1710 - 1755 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	1731.5	-56.4	1725.5	-67.3	10.9	<12	N/A	< 300	Pass
+4	1731.5	-54.9	1725.5	-67.6	12.7	<12	22	< 300	Pass
+3	EUT shutdown in 22 seconds								

Oscillation Mitigation - Uplink									
Band	1850 - 1915 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	1871.4	-56.7	1865.2	-67.6	10.9	<12	N/A	< 300	Pass
+4	1871.4	-55.1	1865.2	-68.5	13.4	<12	58	< 300	Pass
+3	EUT shutdown in 58 seconds								

### Downlink Oscillation Mitigation Test Data

Oscillation Mitigation - Downlink									
Band	728 - 746 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	733.3	-70.2	731.9	-75.4	5.2	<12	N/A	< 300	Pass
+4	733.3	-71.5	731.9	-75.1	3.6	<12	N/A	< 300	Pass
+3	733.3	-69.8	731.9	-75.5	5.7	<12	N/A	< 300	Pass
2	733.3	-69.3	731.9	-75.6	6.3	<12	N/A	< 300	Pass
+1	733.3	-68.2	731.9	-75.6	7.4	<12	N/A	< 300	Pass
+0	733.3	-67.2	731.9	-76.2	9	<12	N/A	< 300	Pass
-1	733.3	-66	731.9	-75.9	9.9	<12	N/A	< 300	Pass
-2	733.3	-64.2	731.9	-76.3	12.1	<12	47	< 300	Pass
-3	EUT shutdown in 47 seconds								



Oscillation Mitigation - Downlink									
Band	746 - 757 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	746.1	-66.8	747.7	-74.2	7.4	<12	N/A	< 300	Pass
+4	746.1	-66.1	747.7	-74.7	8.6	<12	N/A	< 300	Pass
+3	746.1	-62.8	747.7	-75.6	12.8	<12	88	< 300	Pass
2	EUT shutdown in 88 seconds								

Oscillation Mitigation – Downlink									
Band	869 - 894 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	883.5	-61.5	881.1	-71.9	10.4	<12	N/A	< 300	Pass
+4	883.5	-58.3	881.1	-72.8	14.5	<12	80	< 300	Pass
+3	EUT shutdown in 80 seconds								

Oscillation Mitigation - Downlink									
Band	1930 - 1995 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	1944.4	-53.1	1948.1	-64.3	11.2	<12	N/A	< 300	Pass
+4	1944.4	-50	1948.1	-64.4	14.4	<12	45	< 300	Pass
+3	EUT shutdown in 45 seconds								



Oscillation Mitigation - Uplink									
Band	2110 - 2155 MHz								
Test Signal Type	CDMA								
Variable Attenuator Setting	Oscillations		Lowest Output Power Level		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	2121.7	-57	2128.4	-65.1	8.1	<12	N/A	< 300	Pass
+4	2121.7	-56.5	2128.4	-64.7	8.2	<12	N/A	< 300	Pass
+3	2121.7	-56.7	2128.4	-65.5	8.8	<12	N/A	< 300	Pass
2	2121.7	-55.3	2128.4	-66.2	10.9	<12	N/A	< 300	Pass
+1	2121.7	-52.4	2128.4	-66	13.6	<12	44	< 300	Pass
+0	EUT shutdown in 44 seconds								

**Radiated Spurious**
**Engineer:** Greg Corbin

**Test Date:** 9/30/2015

**Test Procedure**

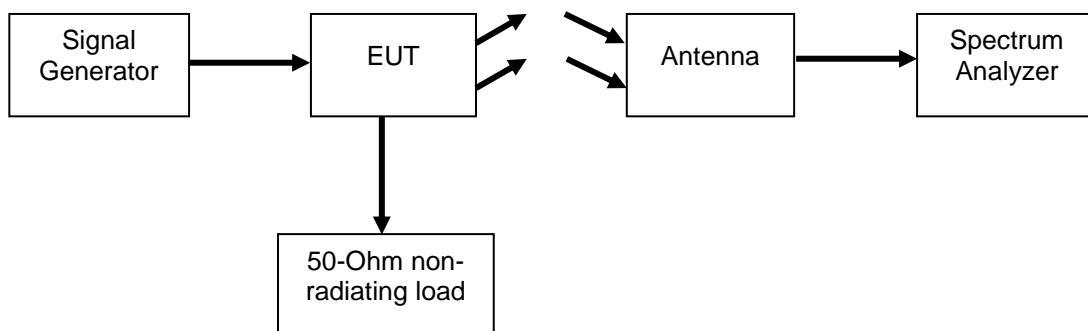
The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation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

**Refer to Annex J for Radiated Spurious Emission plots**

No spurious emissions above the system noise floor were observed.

All emissions were lower than -13 dBm.

**Test Equipment Utilized**

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	EMCO	3115	i00103	1/20/15	1/20/17
Horn Antenna, Amplified	ARA	DRG-118/A	i00271	5/8/14	5/8/16
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	4/1/15	4/1/16
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	10/8/13	10/8/15
EMI Analyzer	Agilent	E7405A	i00379	2/5/15	2/5/16
Signal Generator	Rohde & Schwarz	SMU200A	i00405	1/19/15	1/19/16
Spectrum Analyzer	Textronix	RSA5126A	i00424	3/12/15	3/12/16
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	11/26/13	11/26/15

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**