Compliance Testing, LLC
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Test Report

Prepared for: Syntonics, LLC

Model: FORAX-DAS (AIU)

Description: Fiber Optic Remote Antenna eXtension

To

FCC Part 74H

And

IC RSS-123 Issue 2

Date of Issue: September 25, 2013

On the behalf of the applicant:	**Syntonics, LLC** **9160 Red Branch Rd** **Columbia, MD 21045-2002**
Attention of:	**Steve Gemeny, Director, Advanced Programs** **Ph: (410) 884-0500** **E-Mail: Steve.Gemeny@syntonicscorp.com**

Prepared by
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Project No: p1370013

Alex Macon

Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	September 25, 2013	Alex Macon	Original Document

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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer 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.

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Testing Certificate Number: **2152.01**

FCC OATS Reg, #933597

IC Reg. #2044A-1

Non-accredited tests contained in this report:

N/A

The Applicant has been cautioned as to the following

15.21: **Information to the User**

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance cold void the user's authority to operate the equipment.

15.27(a): **Special Accessories**

Equipment marketed to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer, without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Subpart 2.1033(c)(14)
Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II, Part 2, Subpart J, Sections 2.947, 2.1033(c), 2.1041, 2.1046, 2.1047, 2.1079, 2.1051, 2.1053, 2.1055, 2.1057, and the following individual Parts: 74.

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

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 specify 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		
Temperature (°C)	**Humidity (%)**	**Pressure (mbar)**
26.5 - 38.4	11.2 – 40.4	963.3 – 969.7

EUT Description
Model: FORAX-DAS (AIU)
Description: Fiber Optic Remote Antenna eXtension
Additional Information:
The EUT is an Antenna Interface Unit incorporating a fiber optic connection.

Accessories:

Qty	Desc	Mfg	Model	S/N
1	Optical Interface Unit	Syntonics	N/A	N/A

Cables:

Qty	Desc	Length (m)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
1	Fiber Optic Cable	>3m	N	N	N
2	AC Power Cable	<3m	N	N	N

Modifications: None

Test Result Summary

Specification	Test Name	Pass, Fail, N/A	Comments
2.1046(a) 74.861(e)(1)(ii) RSS-123 (4.2.1.1)	Carrier Output Power (Conducted)	Pass	
2.1051, 74.861(e)(6) RSS-123 (5.5.1)	Unwanted Emissions (Transmitter Conducted)	Pass	
2.1053 74.861(e)(6) RSS-123 (5.5.1)	Field Strength of Spurious Radiation	Pass	
74.861(e)(6) RSS-123 (5.5.1)	Emission Masks (Occupied Bandwidth)	Pass	
2.1047(a)	Audio Low Pass Filter (Voice Input)	N/A	EUT does not create modulated signals
2.1047(a)	Audio Frequency Response	N/A	EUT does not create modulated signals
2.1047(b)	Modulation Limiting	N/A	EUT does not create modulated signals
2.1055, 74.861(e)(4) RSS-123 (5.4)	Frequency Stability (Temperature Variation)	Pass	
2.1055 RSS-123 (5.4)	Frequency Stability (Voltage Variation)	Pass	
RSS-Gen	Receiver Spurious Emissions	Pass	

Carrier Output Power (Conducted)

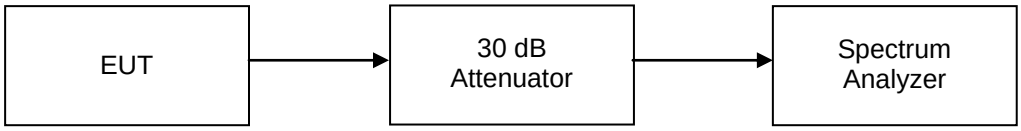
Name of Test:	Carrier Output Power (Conducted)	**Engineer:** Alex Macon
Test Equipment Utilized:	i00379	**Test Date:** 9/19/13

Measurement Procedure

The Equipment Under Test (EUT) was connected directly to a spectrum analyzer. The test cable and attenuator were entered into the spectrum analyzer as a reference level offset before recording the peak conducted output power for the FCC and the average conducted output power for Industry Canada.

RBW = 100 kHz
Video BW = 300 kHz

Test Setup



FCC Transmitter Peak Output Power

Tuned Frequency (MHz)	Recorded Measurement (dBm)	Limit (dBm)	Result
470.5	16.84	24	Pass
539.0	15.13	24	Pass
607.5	14.3	24	Pass
614.5	14.12	24	Pass
656.0	14.07	24	Pass
697.5	13.46	24	Pass

IC Transmitter Average Output Power

Tuned Frequency (MHz)	Recorded Measurement (dBm)	Limit (dBm)	Result
470.5	16.25	24	Pass
539.0	14.74	24	Pass
607.5	13.94	24	Pass
614.5	13.91	24	Pass
656.0	13.84	24	Pass
697.5	13.30	24	Pass

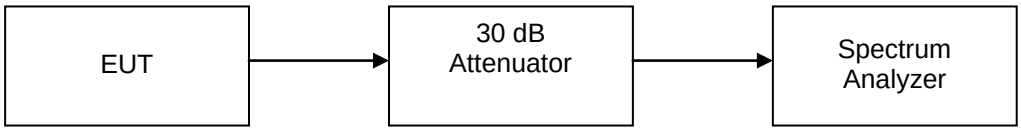
Conducted Spurious Emissions

Name of Test: Conducted Spurious Emissions **Engineer:** Alex Macon
Test Equipment Utilized: i00379 **Test Date:** 9/25/13

Test Procedure

The EUT was connected directly to a spectrum analyzer to verify that the UUT met the requirements for spurious emissions. For the FCC the RBW was set to 100 KHz for measurements up to 1 GHz and 1 MHz for measurements above 1 GHz using a peak detector.
For Industry Canada the RBW was set to 30 kHz for all measurements using an average detector.
The reference level was adjusted to ensure the system had sufficient dynamic range to measure spurious emissions. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed and plotted.
The limit line was set for -25 dBm for comparison to RSS-123 which is the more stringent limit.

Test Setup



FCC Conducted Spurious Emissions Summary Test Table

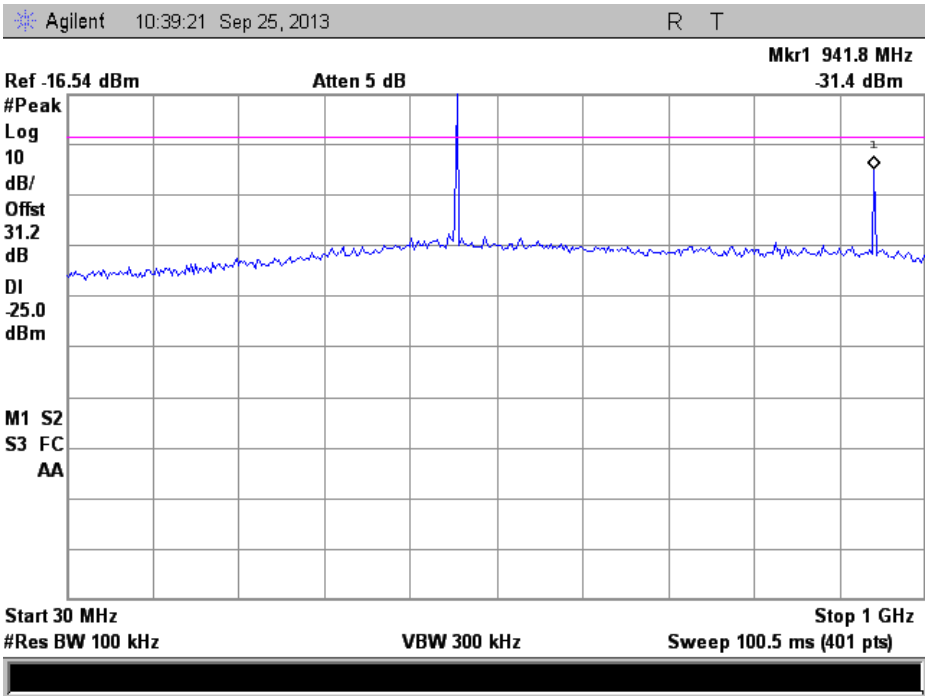
Tuned Frequency (MHz)	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
470.5	941.8	-31.4	-13	Pass
539.0	2980.0	-39.74	-13	Pass
607.5	2950.0	-39.2	-13	Pass
614.5	2980.0	-39.45	-13	Pass
656.0	2980.0	-39.8	-13	Pass
697.5	507.7	-37.91	-13	Pass

IC Conducted Spurious Emissions Summary Test Table

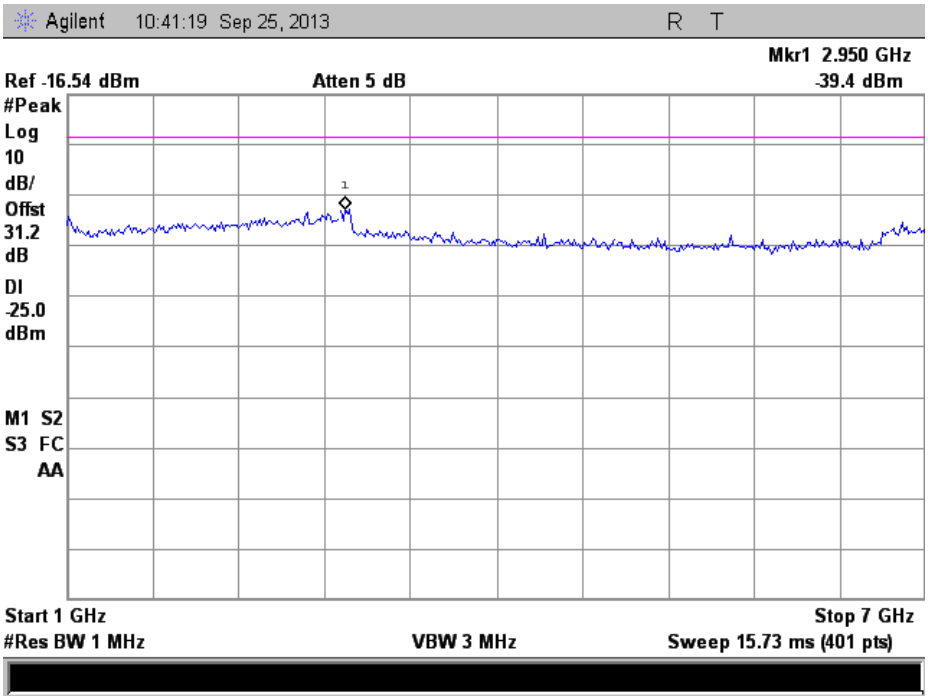
Tuned Frequency (MHz)	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
470.5	939.4	-50.38	-25	Pass
539.0	459.2	-61.18	-25	Pass
607.5	500.5	-61.17	-25	Pass
614.5	459.2	-60.59	-25	Pass
656.0	461.7	-61.55	-25	Pass
697.5	459.2	-60.44	-25	Pass

FCC Conducted Spurious Test Plots

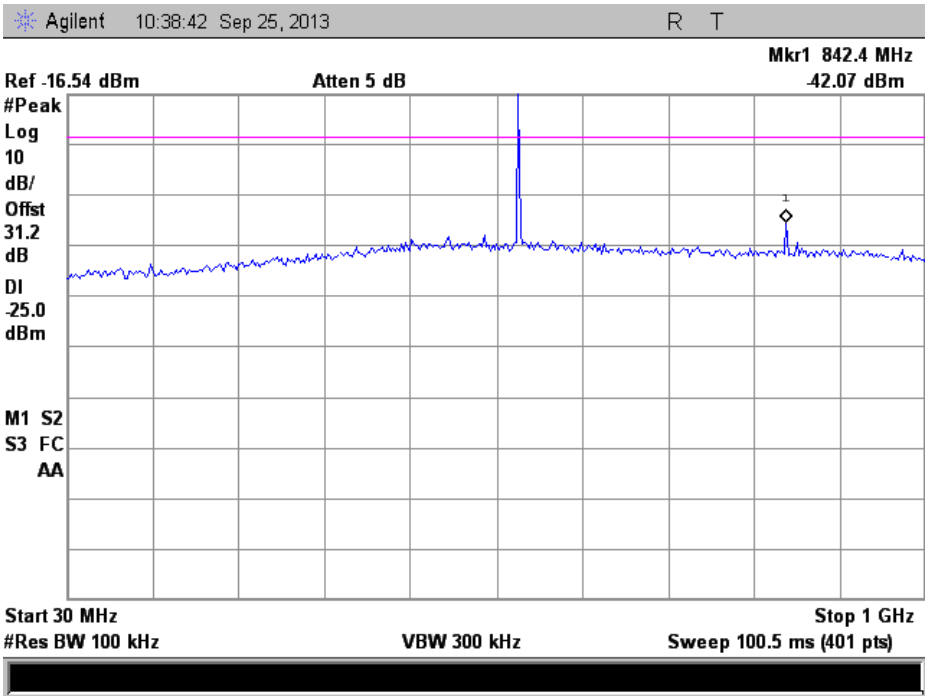
Tuned Frequency – 470.5 MHz
30 MHz to 1 GHz



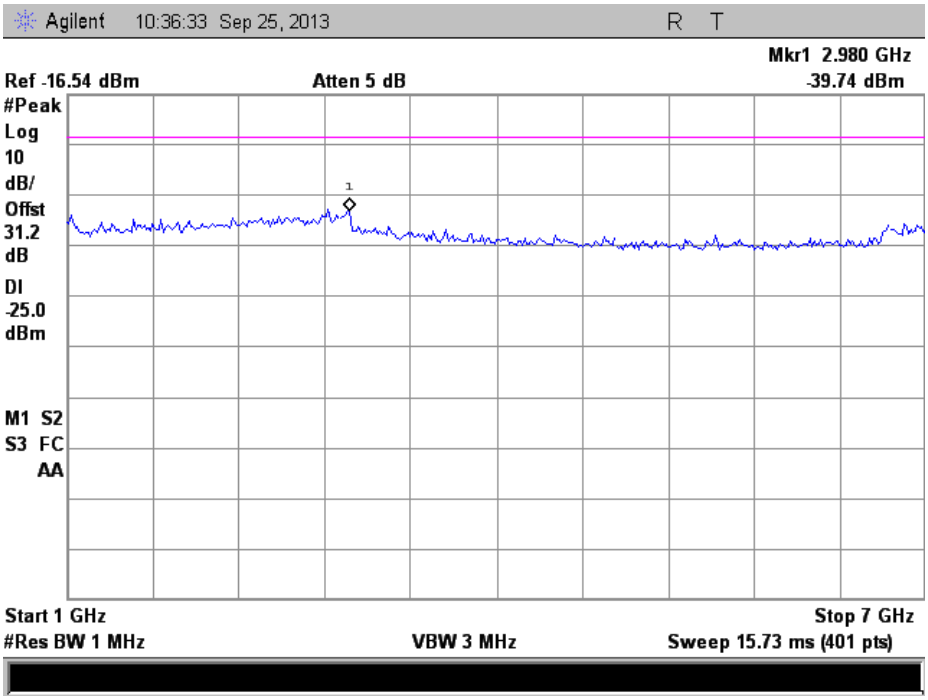
1 GHz to 7 GHz



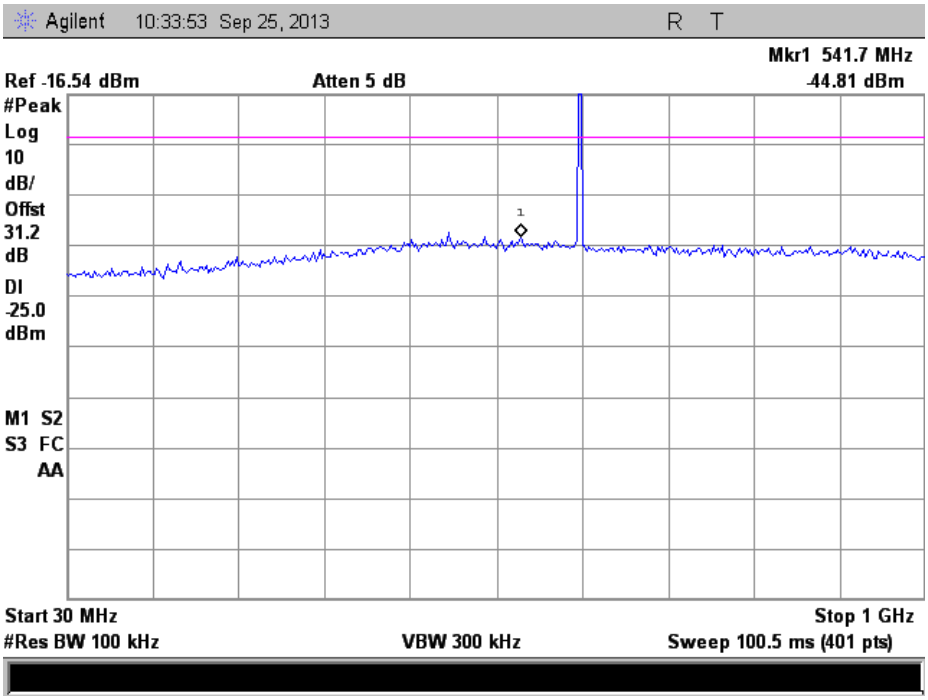
Tuned Frequency – 539 MHz
30 MHz to 1 GHz



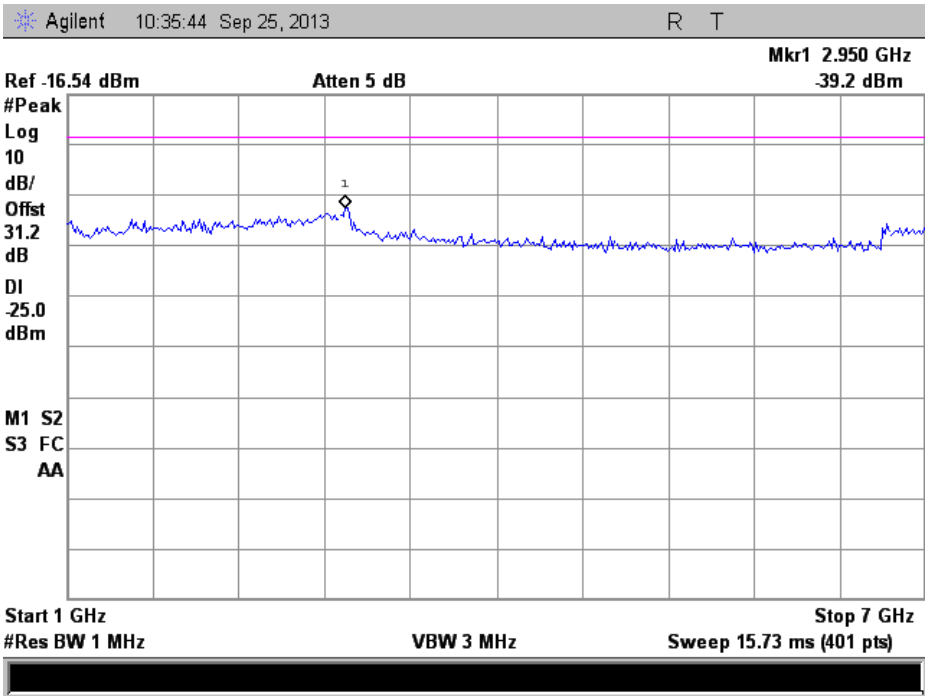
1 GHz to 7 GHz



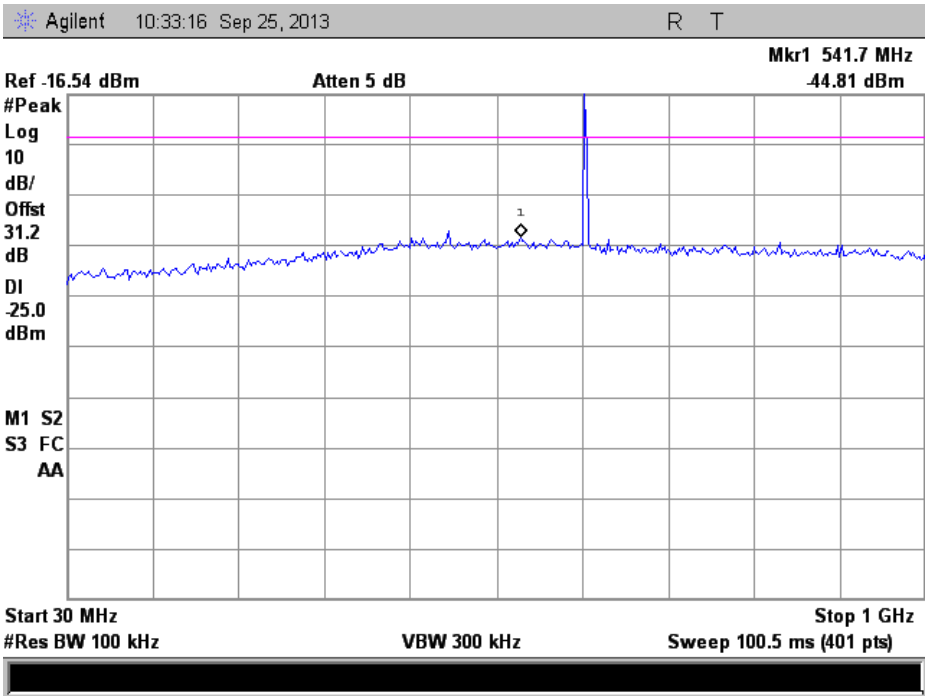
Tuned Frequency – 607.5 MHz
30 MHz to 1 GHz



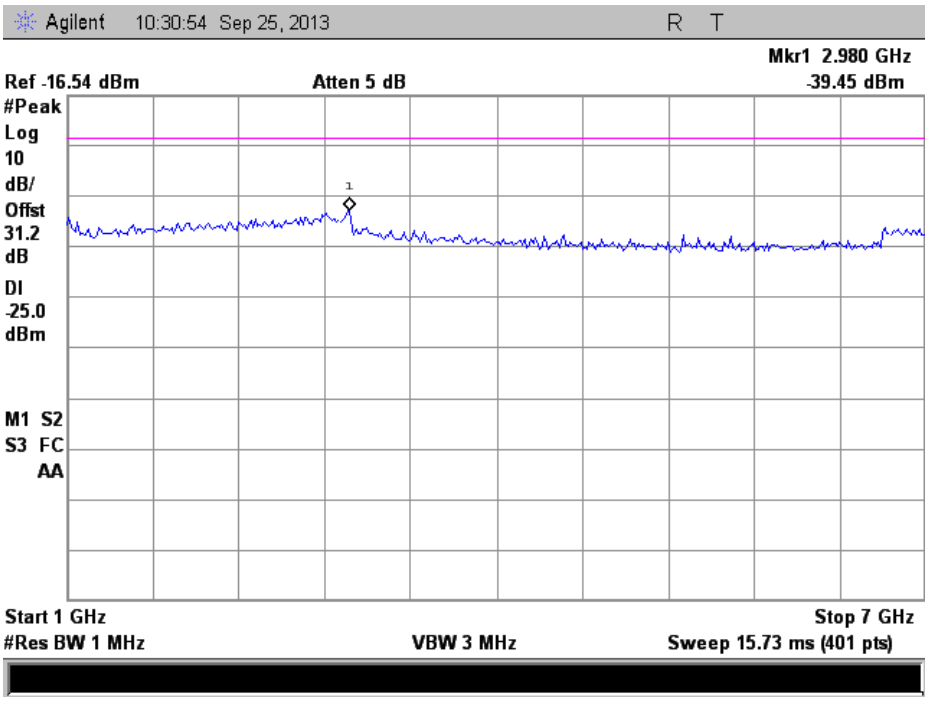
1 GHz to 7 GHz



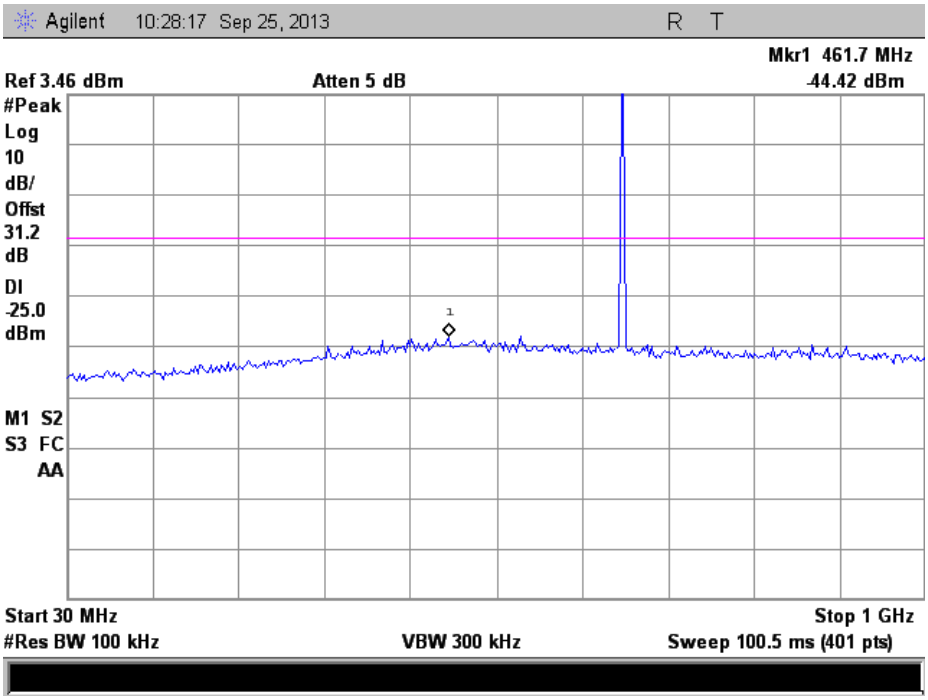
Tuned Frequency – 614.5 MHz
30 MHz to 1 GHz



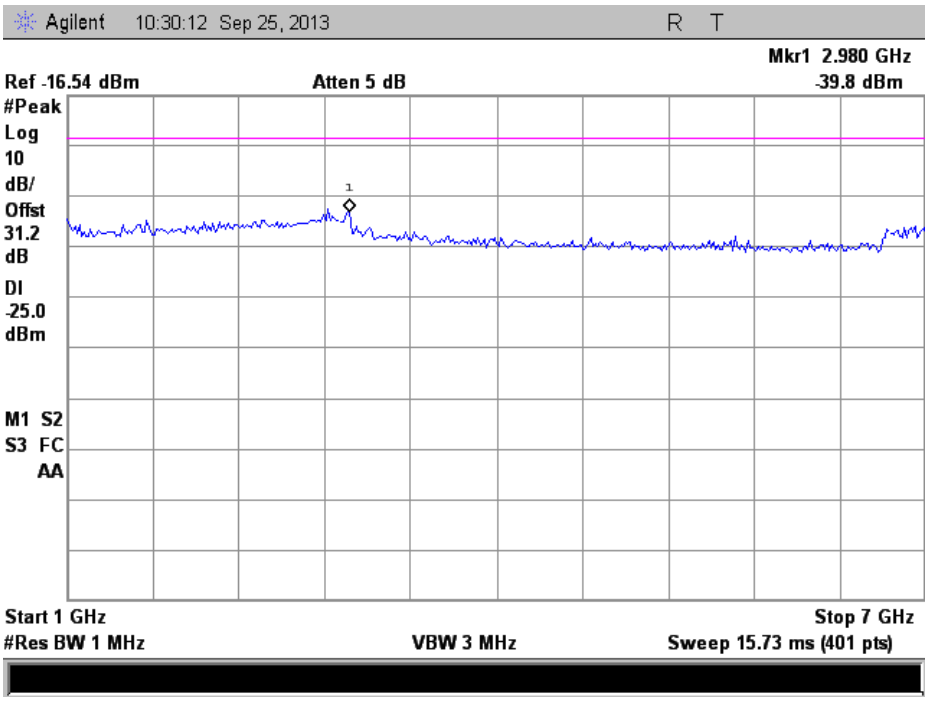
1 GHz to 7 GHz



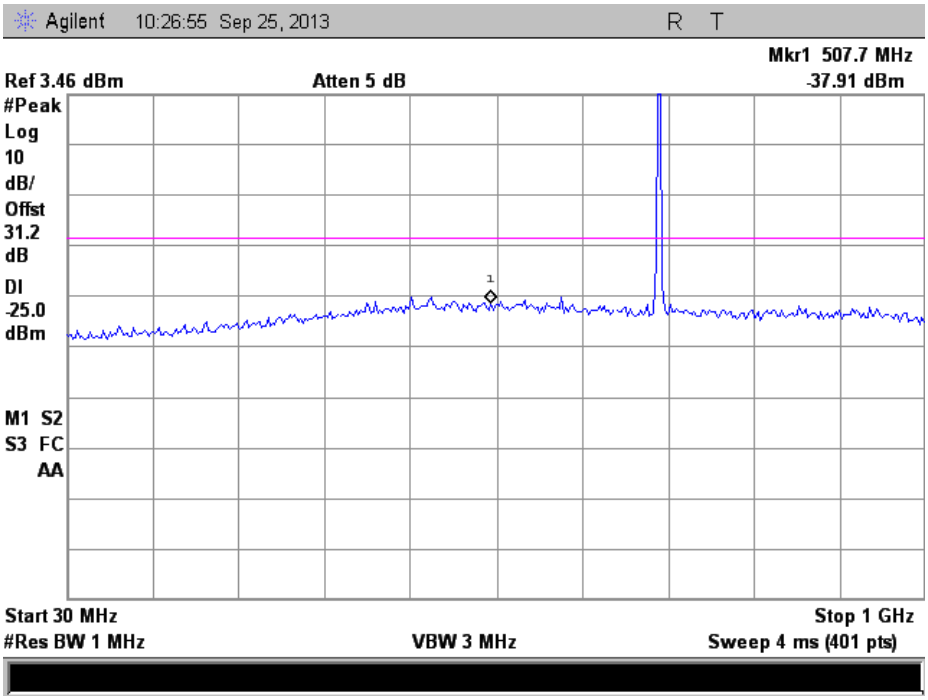
Tuned Frequency – 656 MHz
30 MHz to 1 GHz



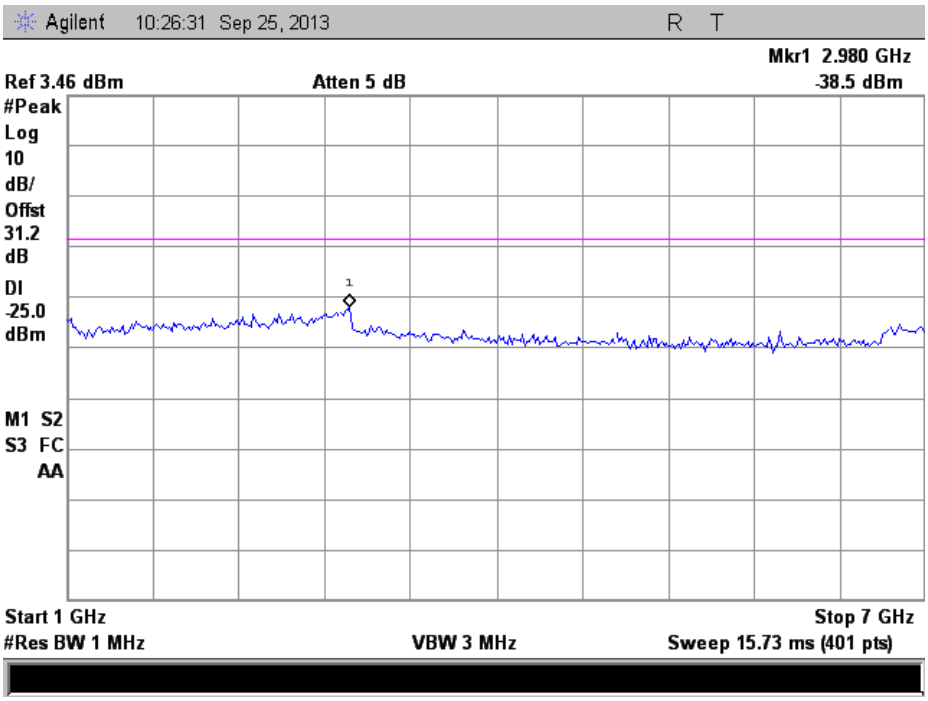
1 GHz to 7 GHz



Tuned Frequency – 697.5 MHz
30 MHz to 1 GHz

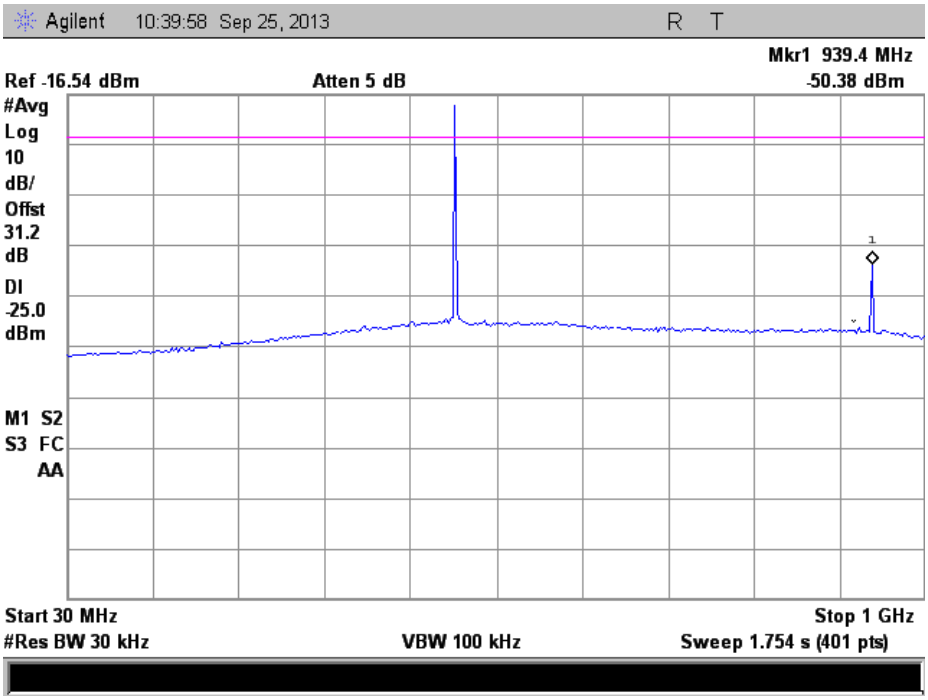


1 GHz to 7 GHz

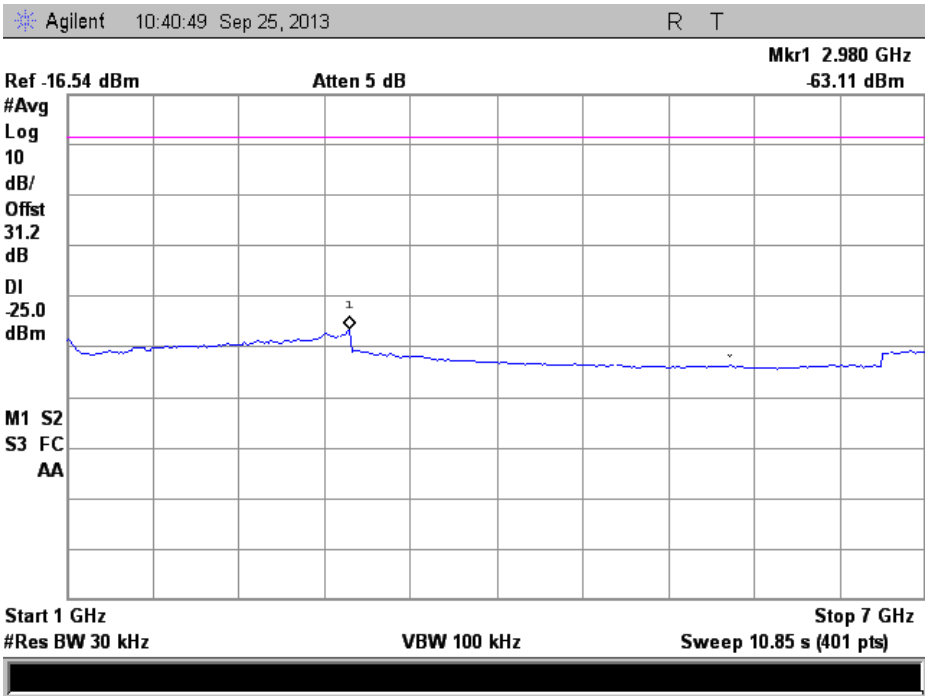


IC Conducted Spurious Test Plots

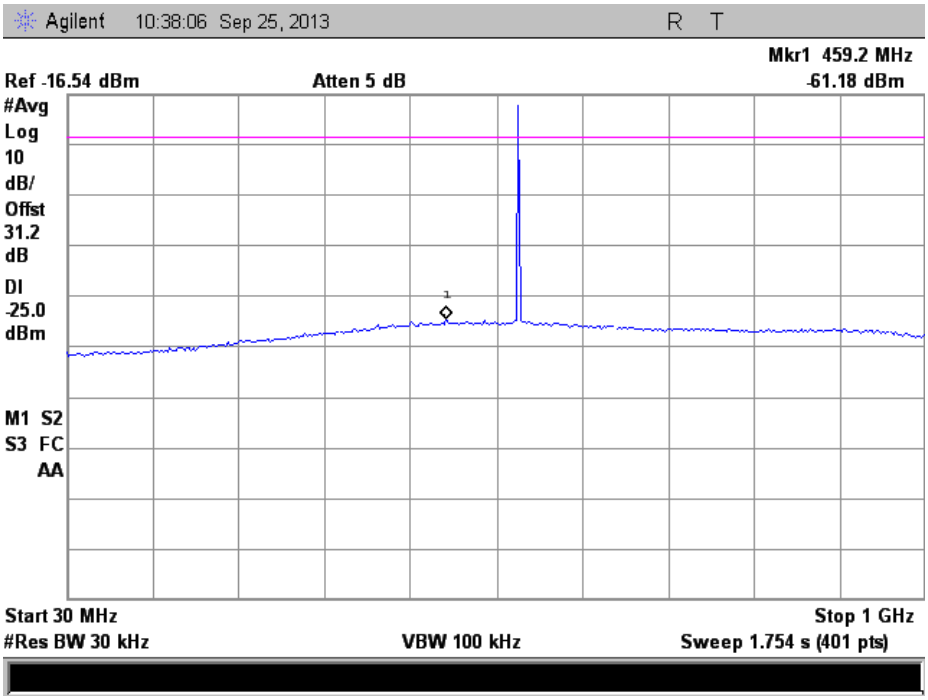
Tuned Frequency – 470 MHz
30 MHz to 1 GHz



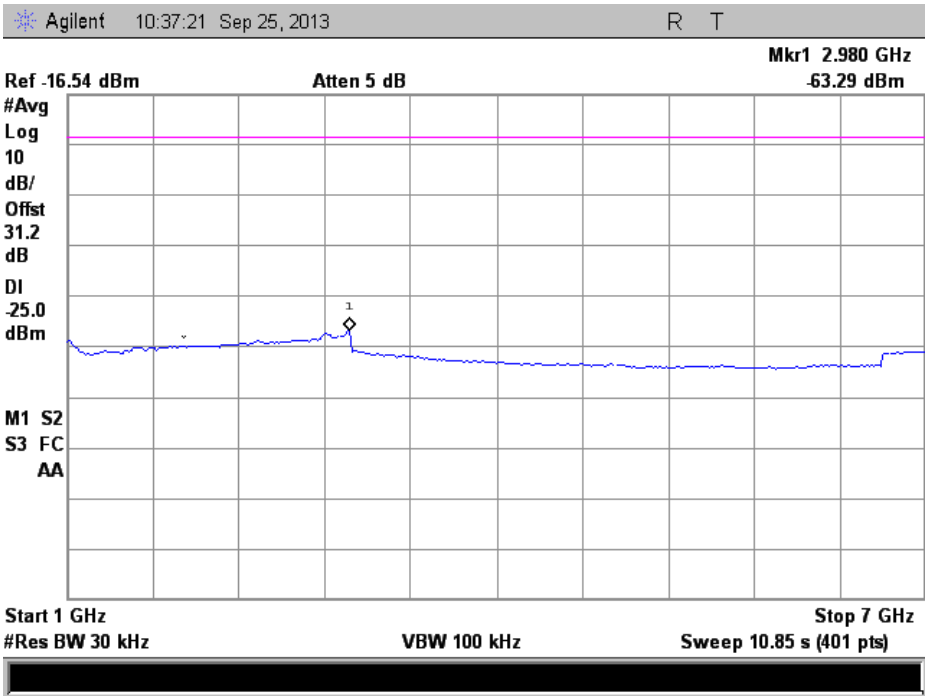
1 GHz to 7 GHz



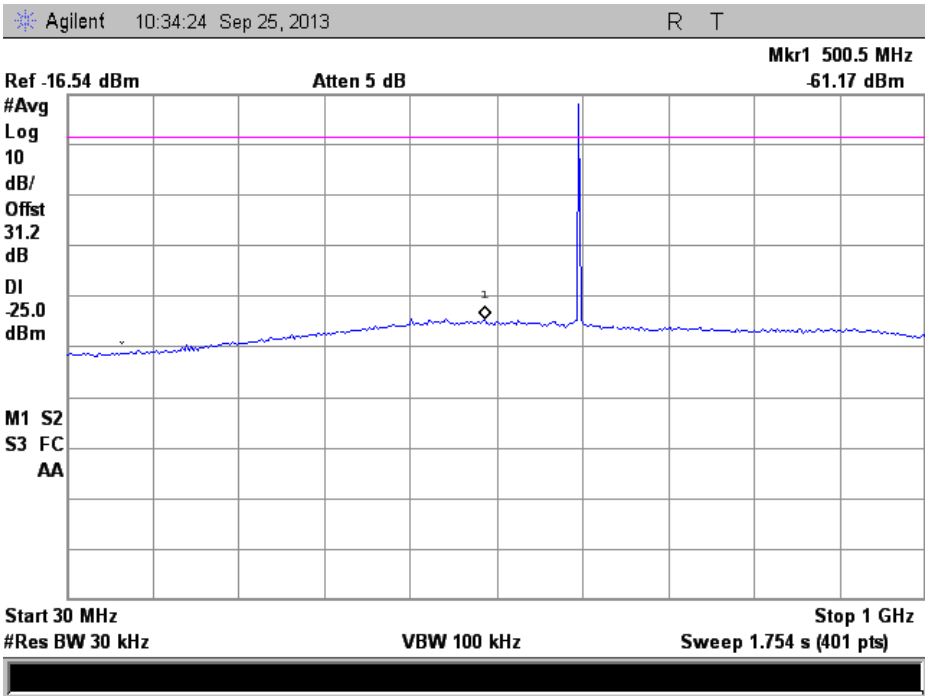
Tuned Frequency – 539 MHz
30 MHz to 1 GHz



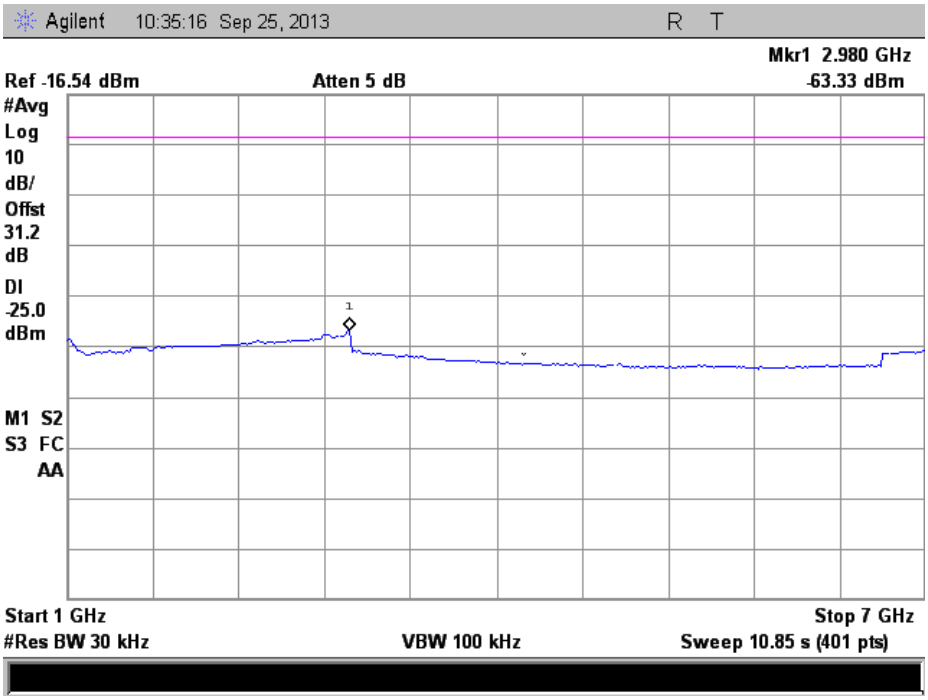
1 GHz to 6 GHz



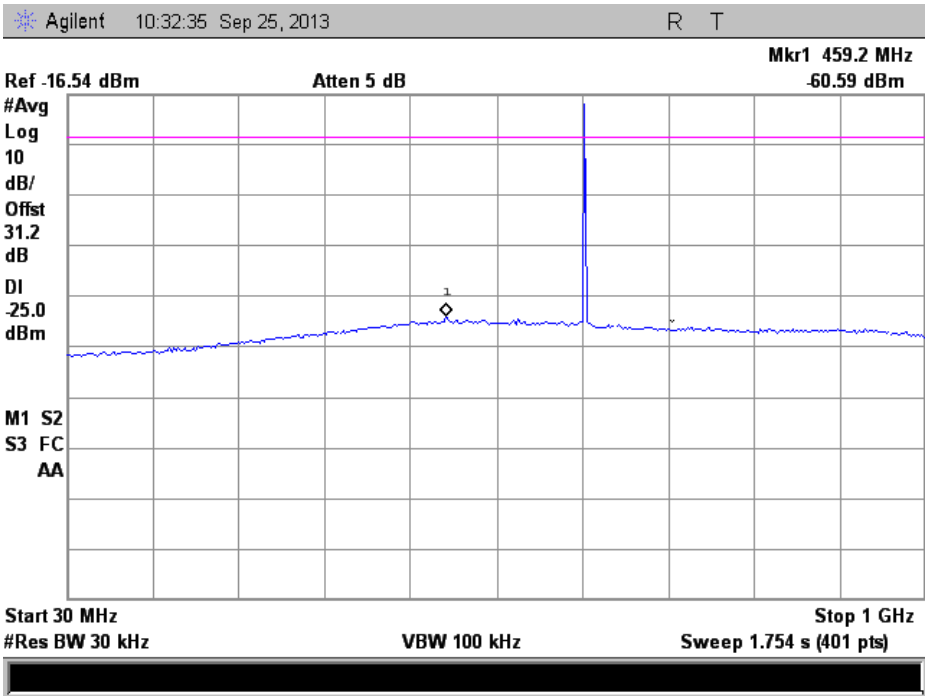
Tuned Frequency – 607.5 MHz
30 MHz to 1 GHz



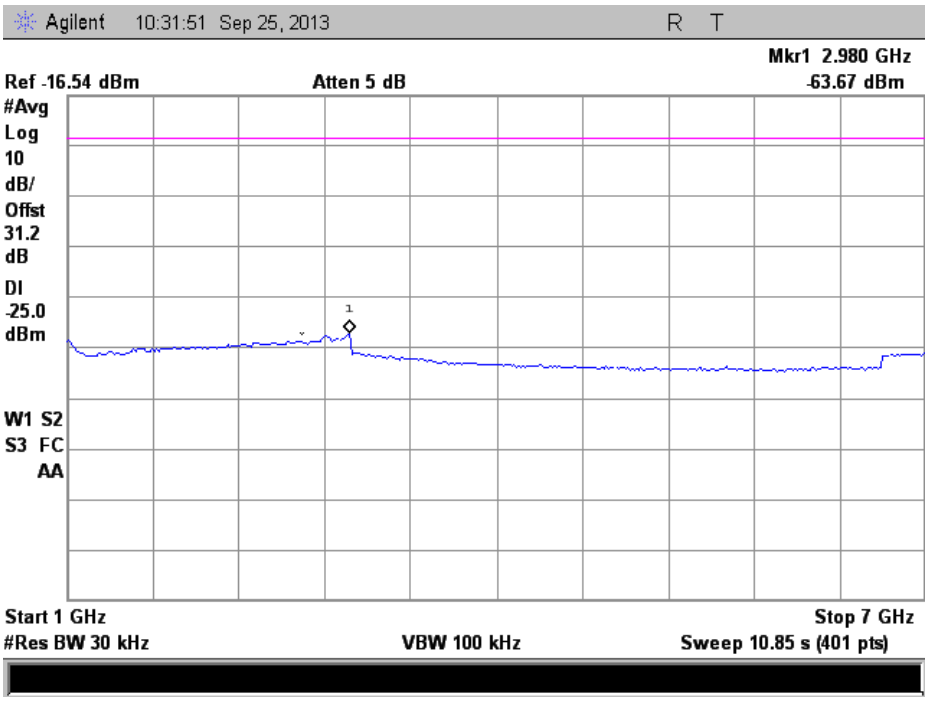
1 GHz to 6 GHz



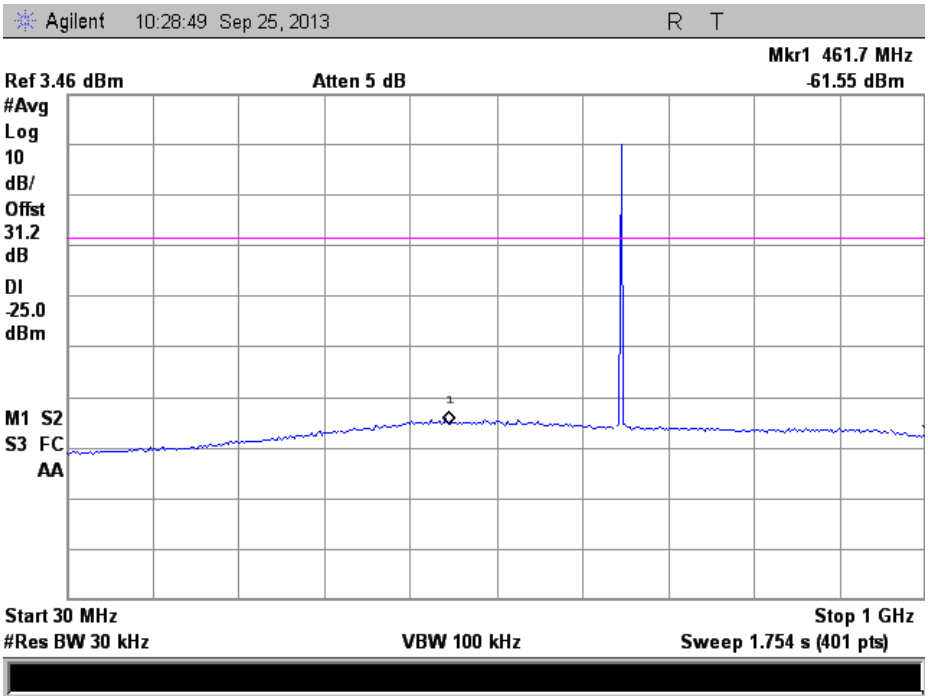
Tuned Frequency – 614.5 MHz
30 MHz to 1 GHz



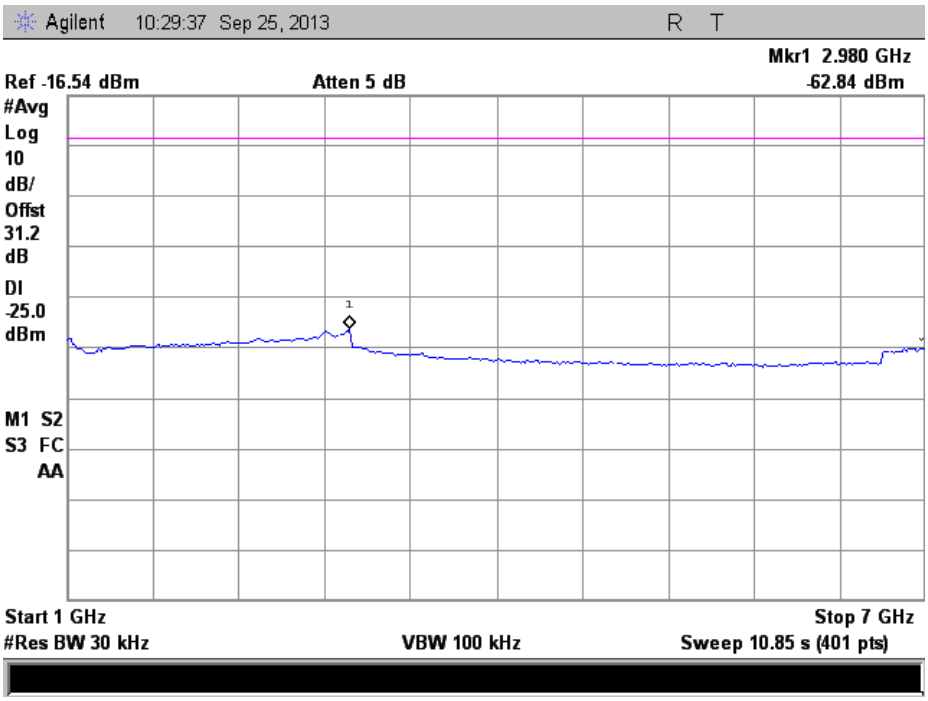
1 GHz to 7 GHz



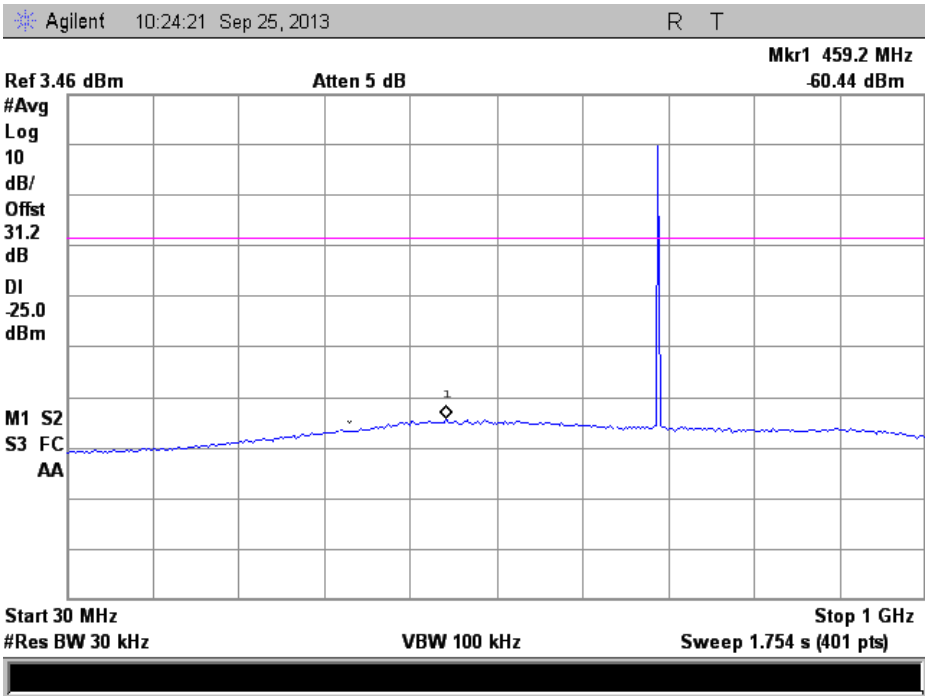
Tuned Frequency – 656 MHz
30 MHz to 1 GHz



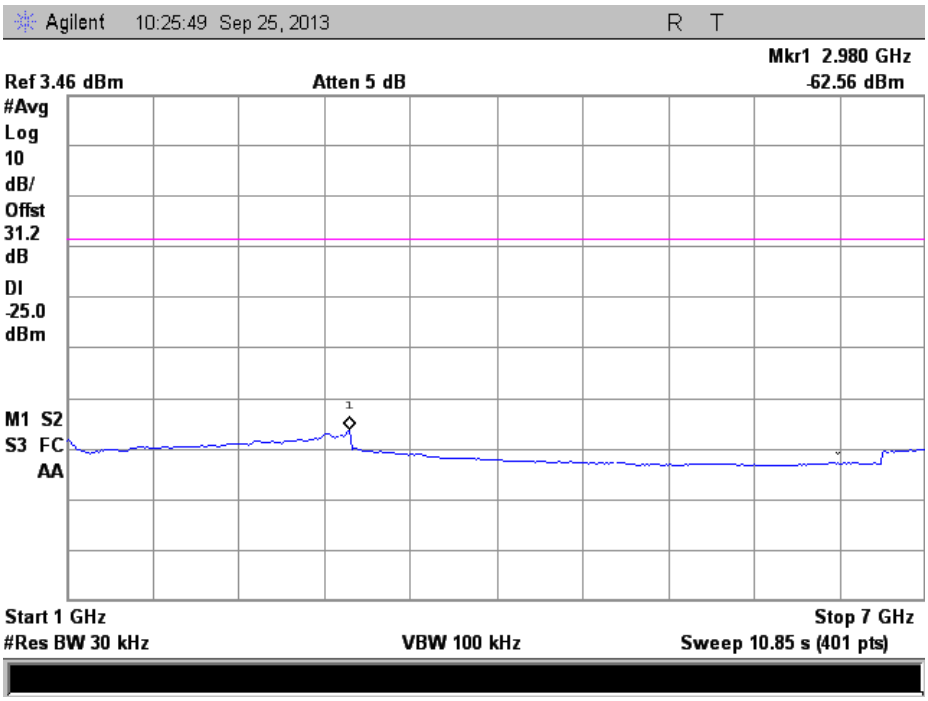
1 GHz to 7 GHz



Tuned Frequency – 697.5 MHz
30 MHz to 1 GHz



1 GHz to 7 GHz



Field Strength of Spurious Radiation

Name of Test:	Field Strength of Spurious Radiation	**Engineer:** Alex Macon
Test Equipment Utilized:	i00142, i00147, i00148, i00271, i00379, i00349, i00364	**Test Date:** 9/25/13

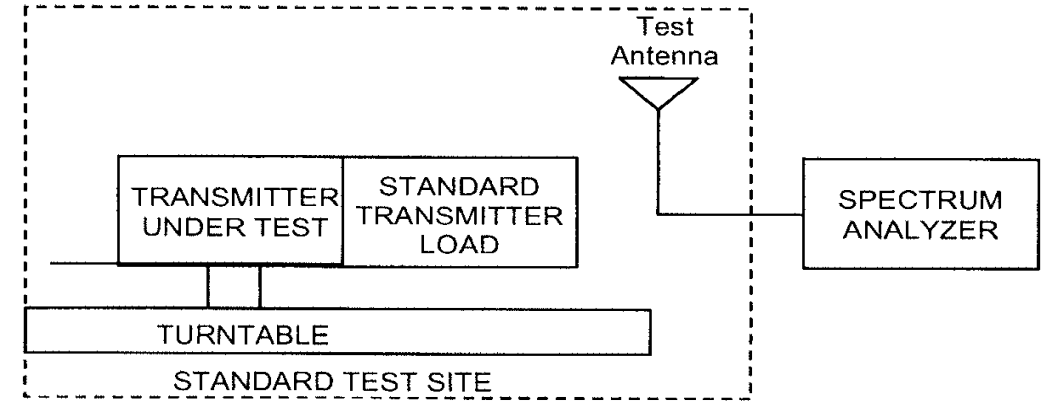
Test Procedure

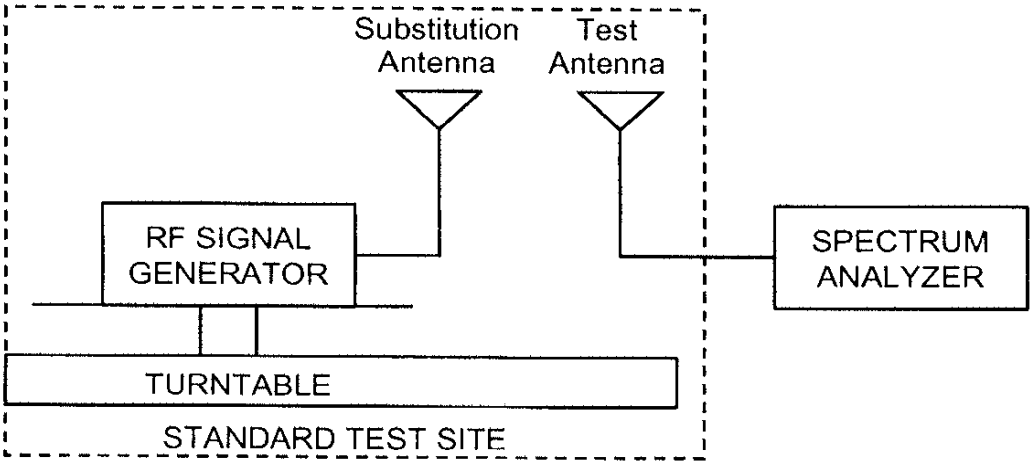
A) Connect the equipment as illustrated
B) Adjust the spectrum analyzer for the following settings:
   1) Resolution Bandwidth 100 kHz (< 1 GHZ), 1 MHZ (> 1GHz) unless otherwise specified.
   2) Video Bandwidth ≥ 3 times Resolution Bandwidth
   3) Sweep Speed ≤2000 Hz/second
   4) Detector Mode = Average
C) Place the transmitter to be tested on the turntable in the standard test site. Transmitters without antennas were transmitting into a non-radiated load. The RF cable to this load should be of minimum length. Transmitters with antennas were transmitting into the manufacturer's supplied antenna.
D) For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth (see section 1.3.4.4).
E) For each spurious frequency, raise and lower the test antenna from 1 m to 4 m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Repeat this procedure to obtain the highest possible reading. Record this maximum reading.
F) Repeat step E) for each spurious frequency with the test antenna polarized vertically.
G) Reconnect the equipment as illustrated.
H) Keep the spectrum analyzer adjusted as in step B).
I) Remove the transmitter and replace it with a substitution antenna (the antenna should be half wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter. At lower frequencies, where the substitution antenna is very long, this will be impossible to achieve when the antenna is polarized vertically. In such case the lower end of the antenna should be 0.3 m above the ground.
J) Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a non-radiating cable. With the antennas at both ends horizontally polarized and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained. This should be done carefully repeating the adjustment of the test antenna and generator output.
K) Repeat step J) with both antennas vertically polarized for each spurious frequency.
L) Calculate power in dBm into a reference ideal half-wave dipole antenna by reducing the readings obtained in steps J) and K) by the power loss in the cable between the generator and the antenna and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna.
M) The levels recorded in step L) are absolute levels of radiated spurious emissions in dBm. The radiated spurious emissions in dB can be calculated by the following:

Radiated spurious emissions dB = $10\log_{10}$ (TX power in watts/0.001) – the levels in step I)

NOTE: It is permissible that the other antennas provided can be referenced to a dipole.

Test Setup


Test
Antenna
TRANSMITTER
UNDER TEST
STANDARD
TRANSMITTER
LOAD
SPECTRUM
ANALYZER
TURNTABLE
STANDARD TEST SITE


Substitution
Antenna
Test
Antenna
RF SIGNAL
GENERATOR
SPECTRUM
ANALYZER
TURNTABLE
STANDARD TEST SITE

Test Results

RBW = 1 MHz (FCC)

Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Level (dBm)	Limit (dBm) EIRP	Result
470.5	1410.36	-78.87	-25	Pass
539.0	1617.99	-73.32	-25	Pass
607.5	1214.3	-75.32	-25	Pass
614.5	1227.28	-71.91	-25	Pass
656.0	1312.03	-72.25	-25	Pass
697.5	2091.56	-74.43	-25	Pass

RBW = 30 KHz (RSS-123)

Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Level (dBm)	Limit (dBm) EIRP	Result
470.5	940.77	-79.21	-25	Pass
539.0	1618.0	-90.14	-25	Pass
607.5	1215.35	-90.76	-25	Pass
614.5	1226.95	-85.61	-25	Pass
656.0	1312.0	-75.8	-25	Pass
697.5	2093.05	-88.01	-25	Pass

RBW was set to 30 kHz for RSS-123 test requirements.
The limit was set for -25 dBm for comparison to RSS-123 which is the more stringent limit.
No other emissions were detected. All emissions were lower than –25 dBm.

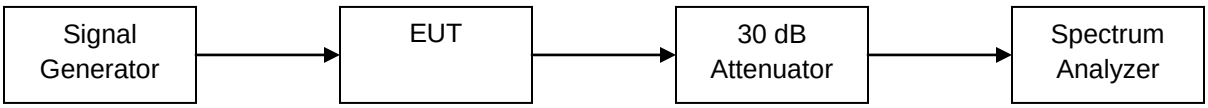
Emission Masks (Occupied Bandwidth)

Name of Test:	Emission Masks (Occupied Bandwidth)	**Engineer:** Alex Macon
Test Equipment Utilized:	i00363, 00379	**Test Date:** 9/25/13

Test Procedure

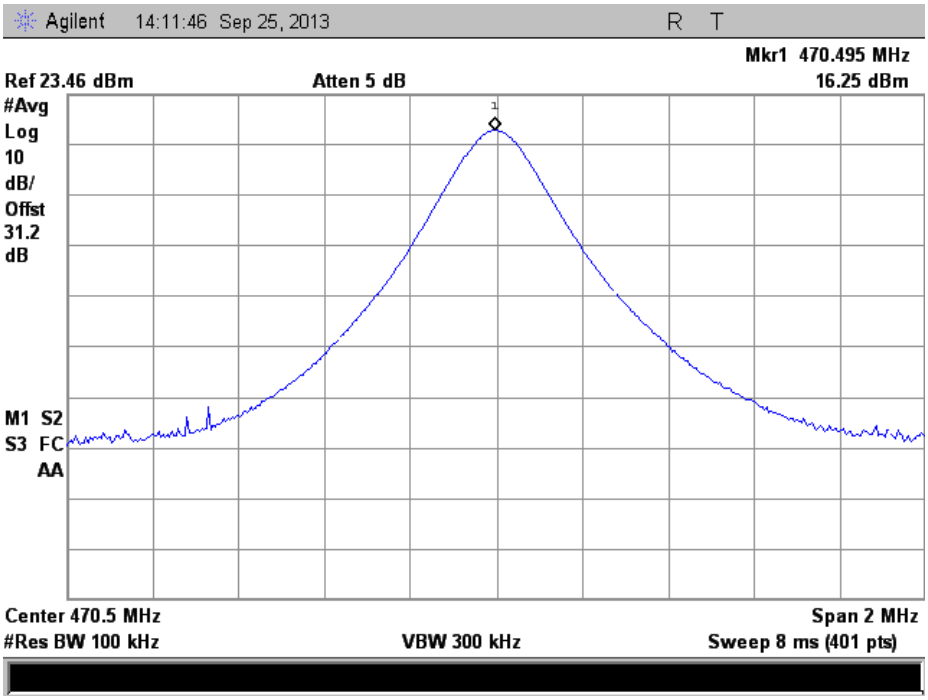
The EUT was connected directly to a spectrum analyzer to verify that the EUT met the required emissions mask. A reference level plot is provided to verify that the peak power was established prior to testing the mask.
The EUT Audio Input control circuit was set to -10 dB per the manufacturer's instructions.
A modulating frequency of 2.5 KHz was input to the EUT audio circuit.

Test Setup

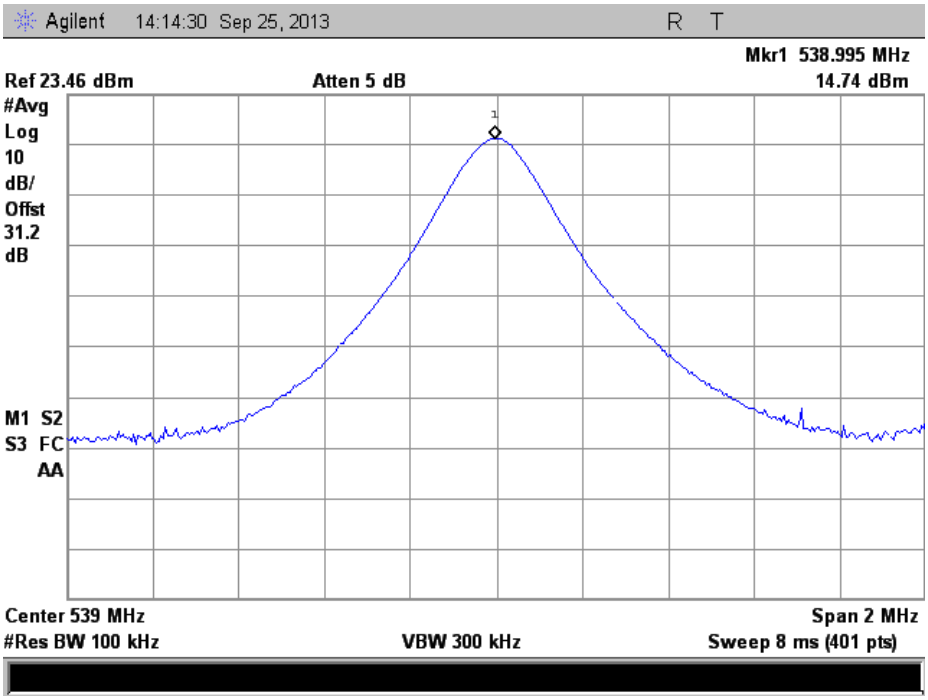


Emission Mask Test Data

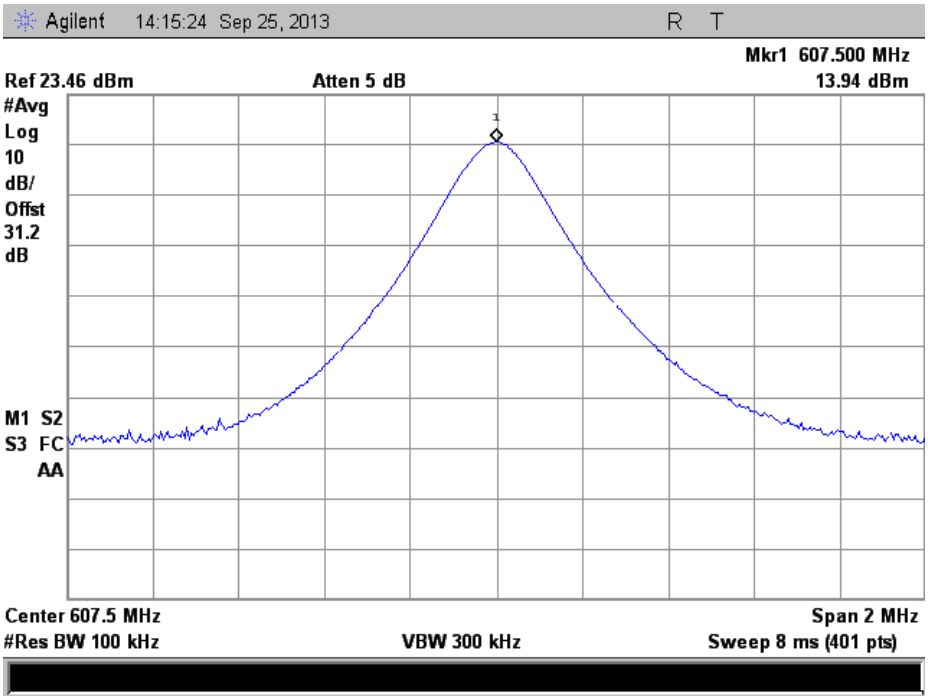
Reference Plots
Tuned Frequency = 470.5 MHz



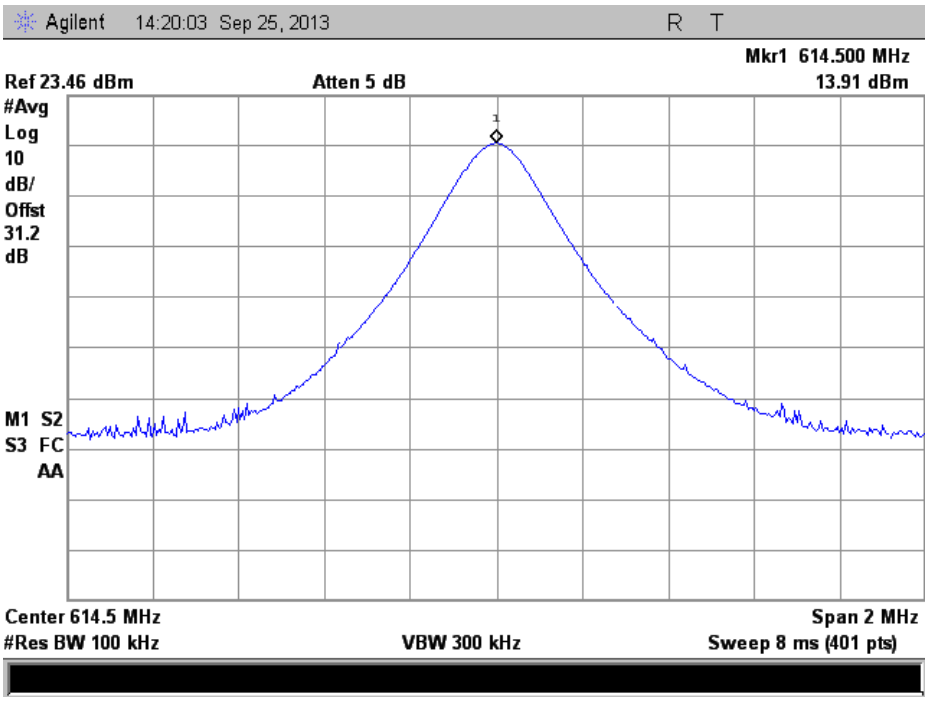
Tuned Frequency = 539 MHz



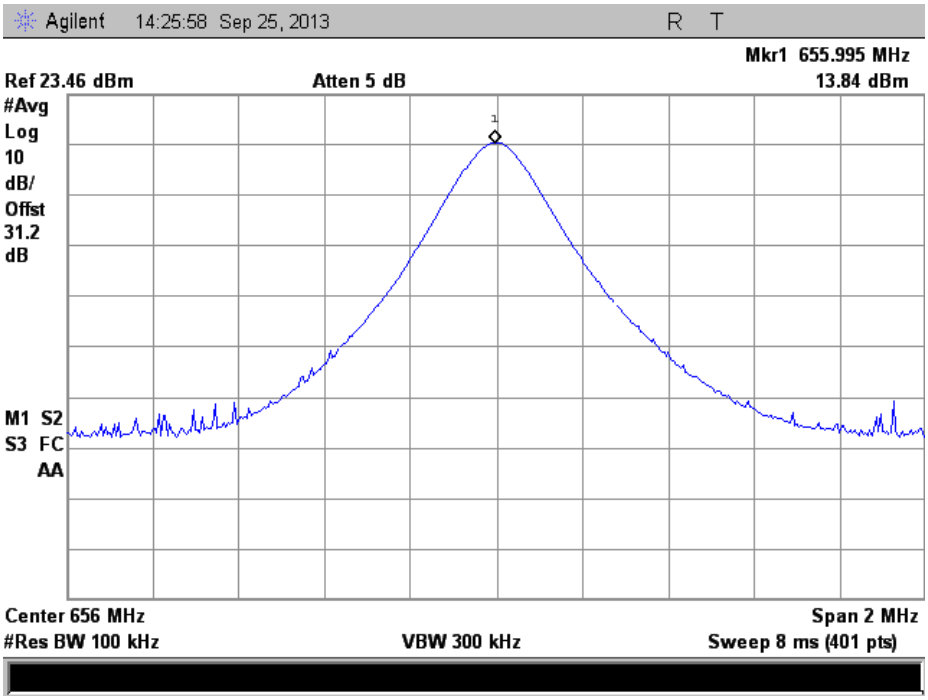
Tuned Frequency = 607.5 MHz



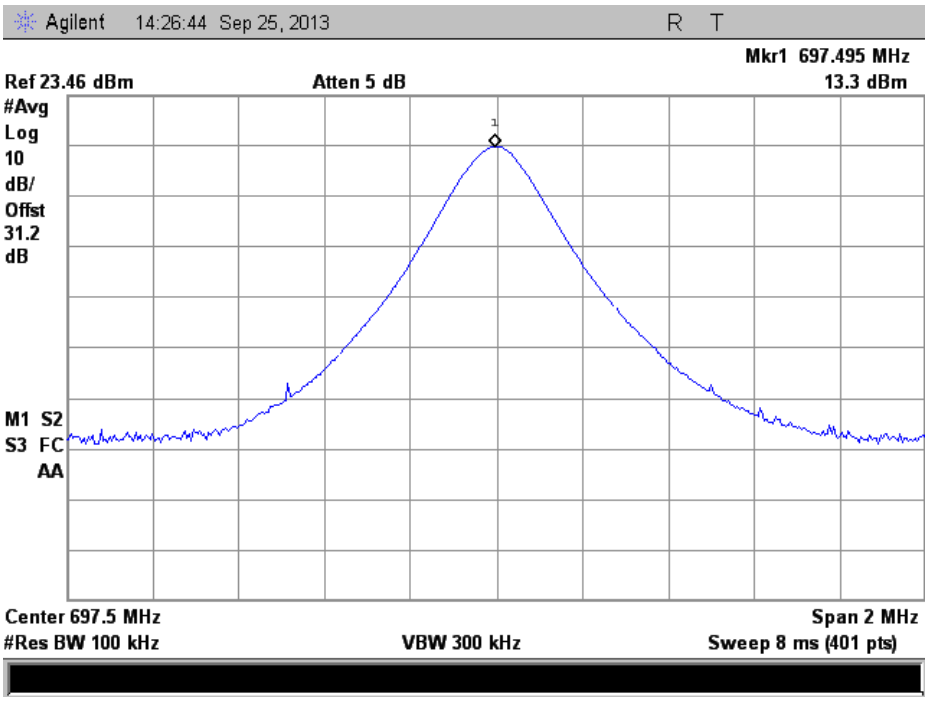
Tuned Frequency = 614.5 MHz



Tuned Frequency = 656 MHz

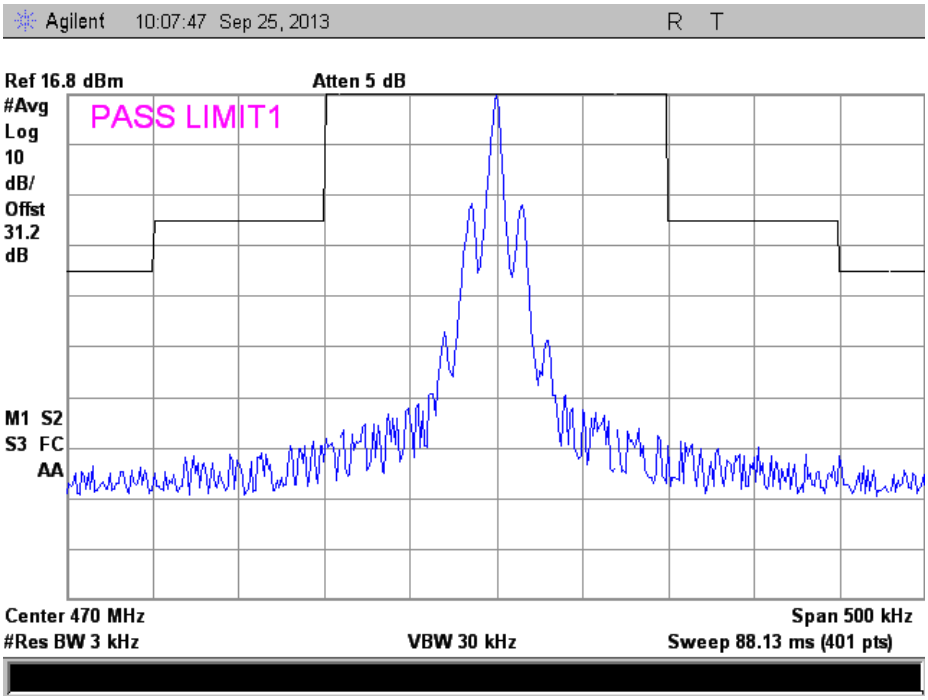


Tuned Frequency = 697.5 MHz

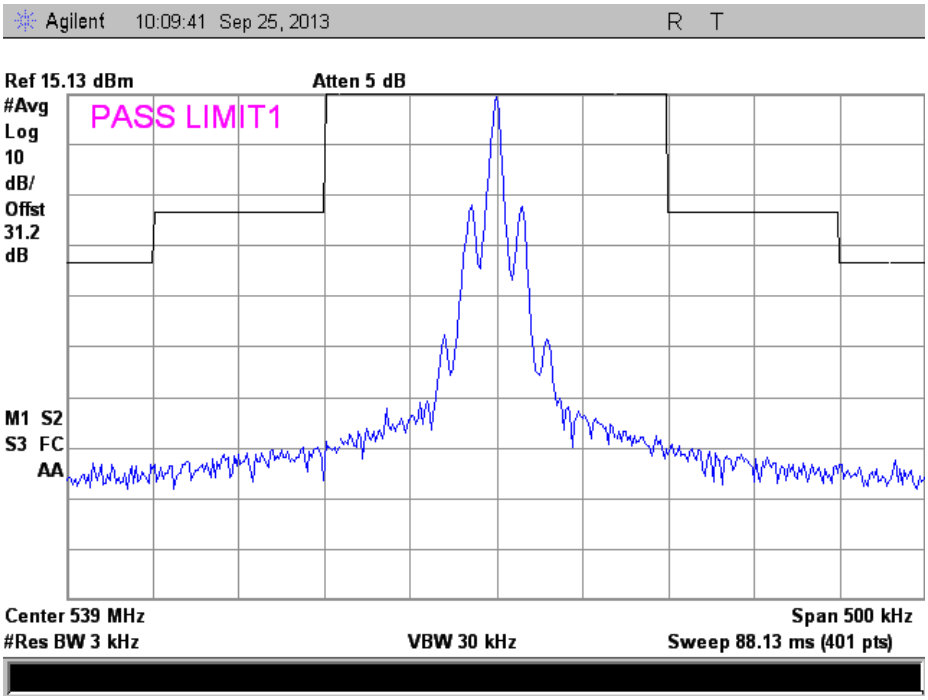


Emission Mask Plots

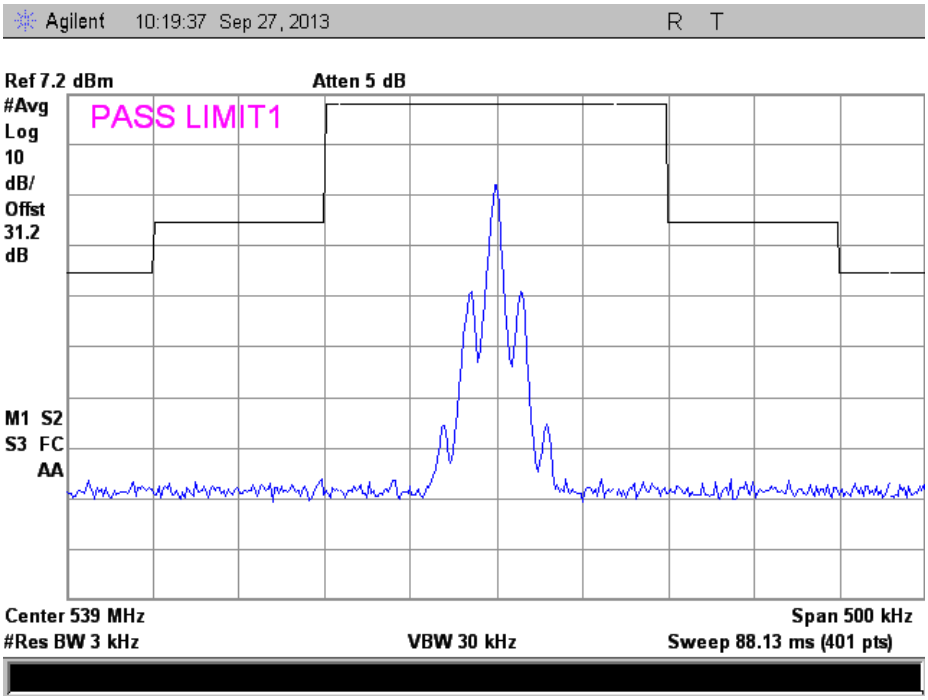
Tuned Frequency = 470 MHz



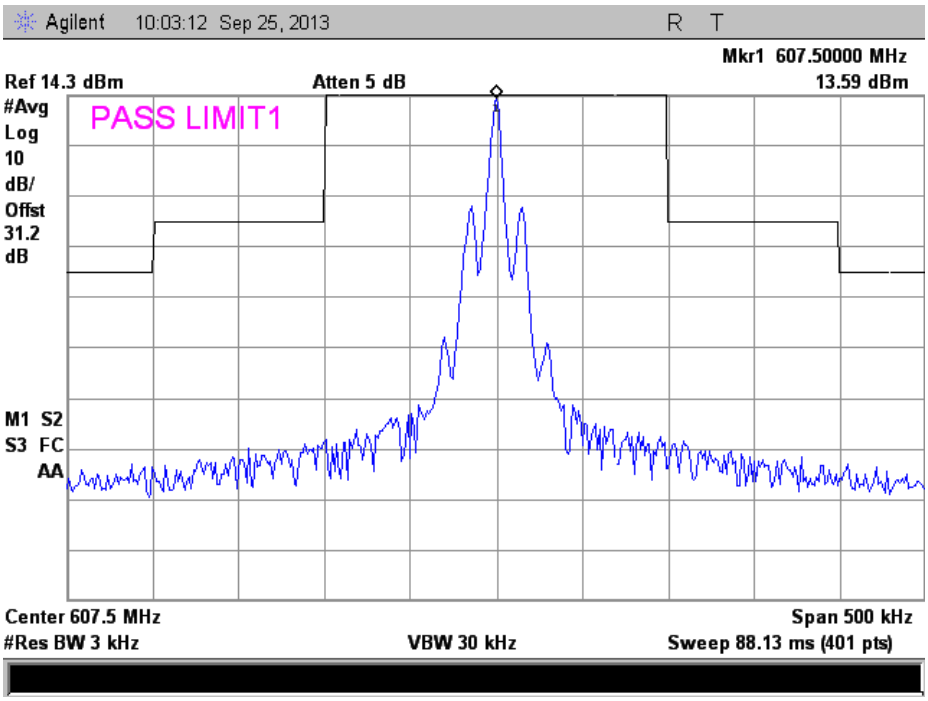
Tuned Frequency = 539 MHz



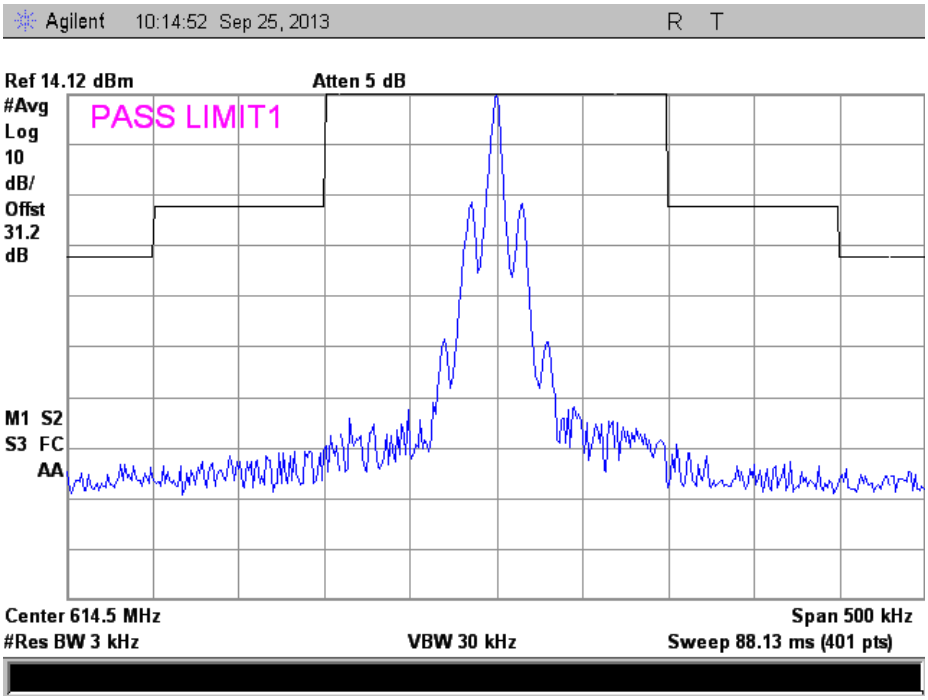
539 MHz Input Signal for Comparison



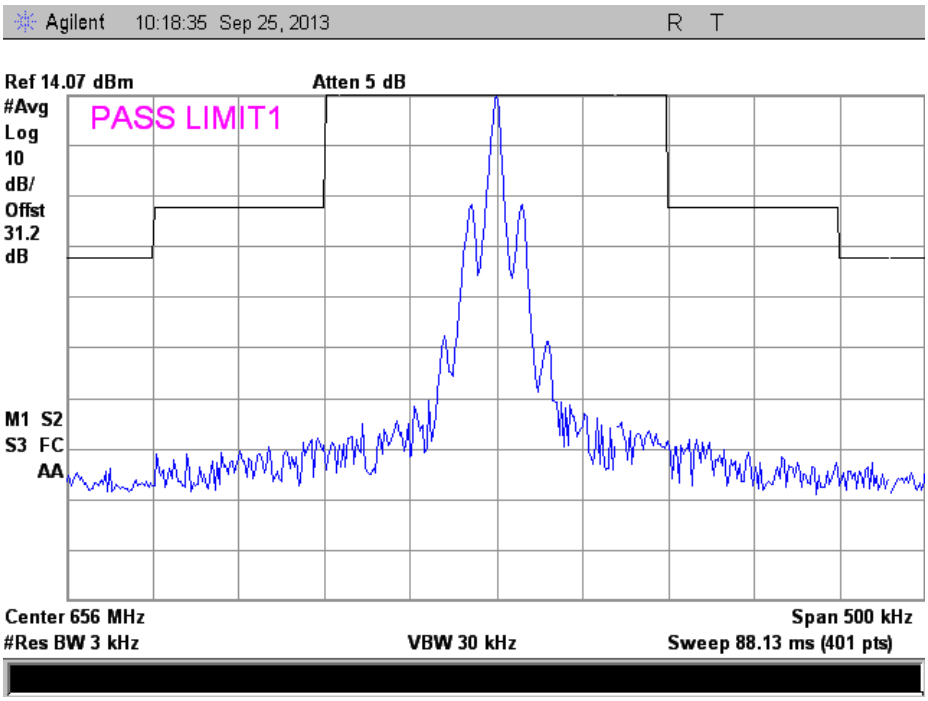
Tuned Frequency = 607.5 MHz



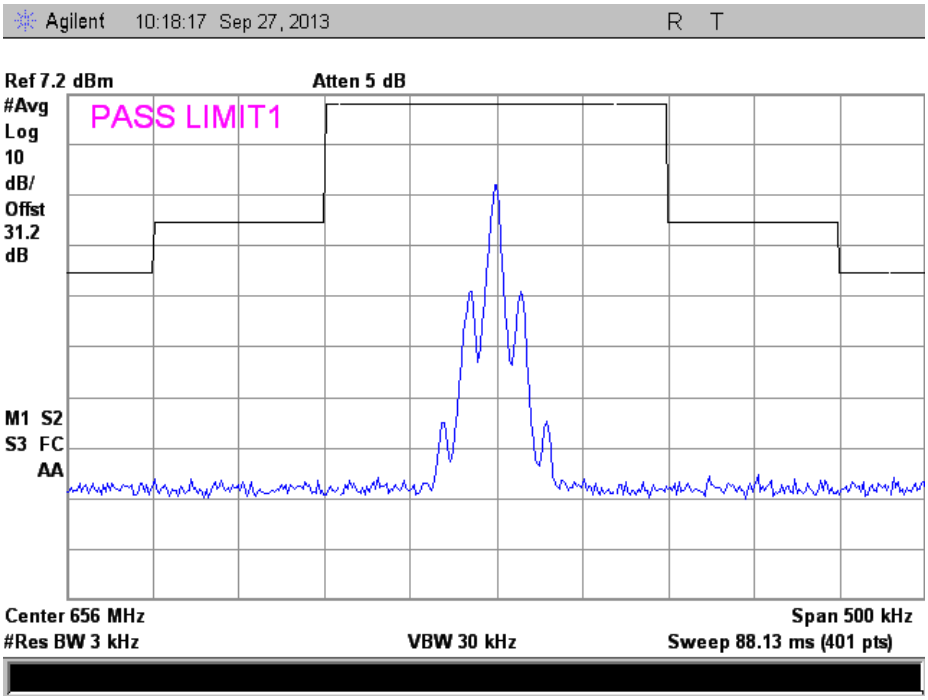
Tuned Frequency = 614.5 MHz



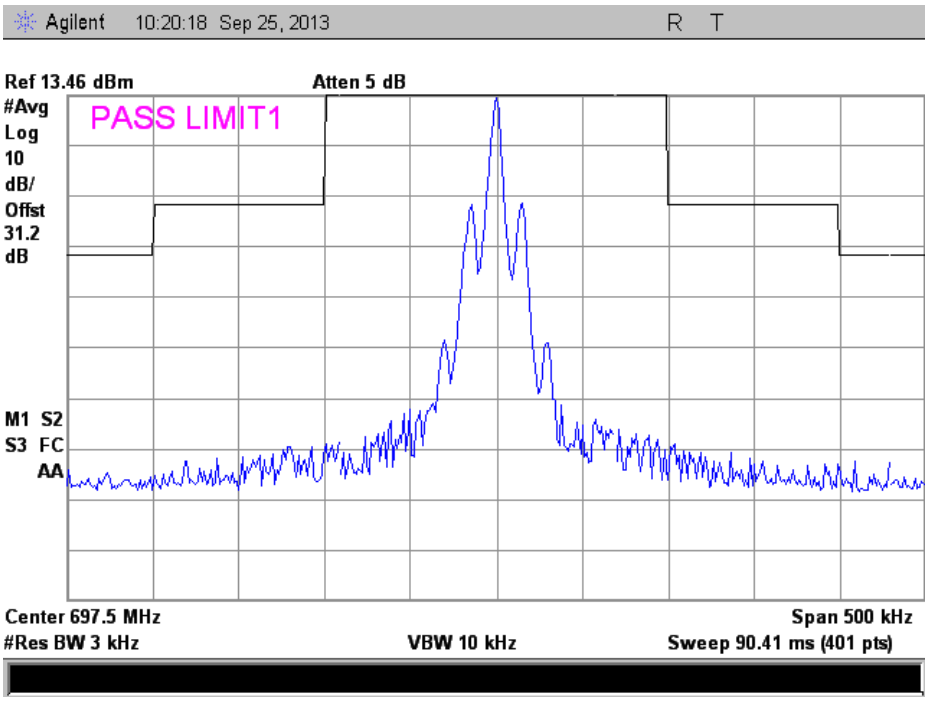
Tuned Frequency = 656 MHz



656 MHz Input Signal for Comparison

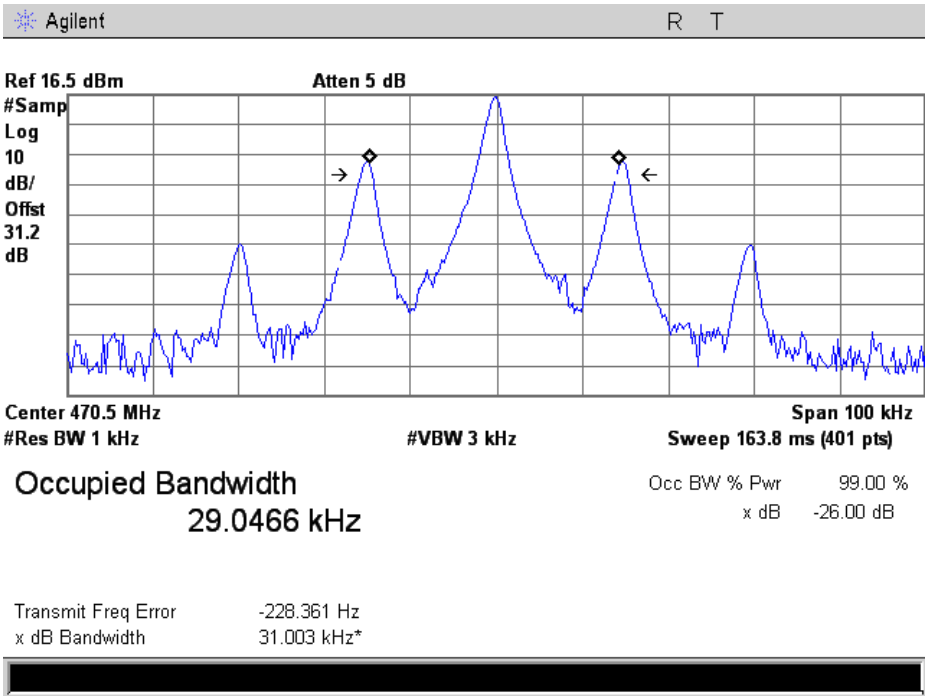


Tuned Frequency = 697.5 MHz

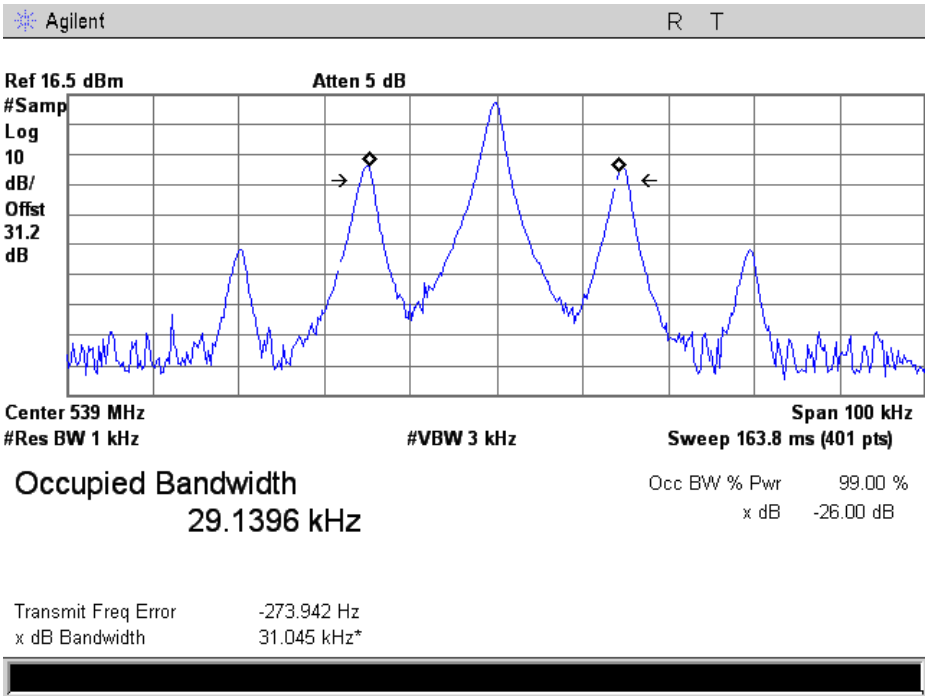


99% Occupied Bandwidth Test Data

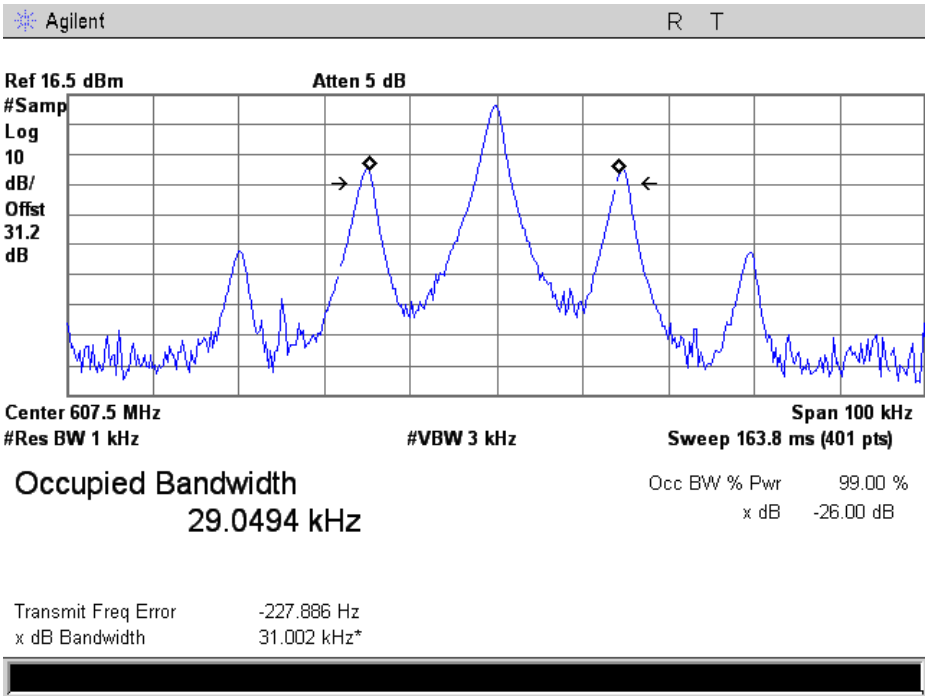
Tuned Frequency = 470.5 MHz



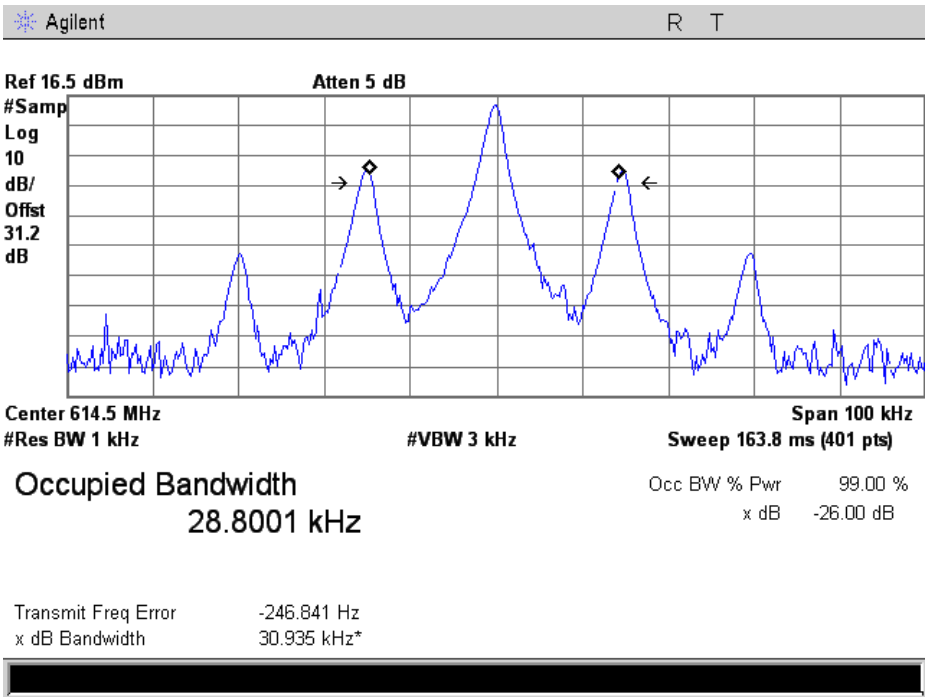
Tuned Frequency = 539MHz



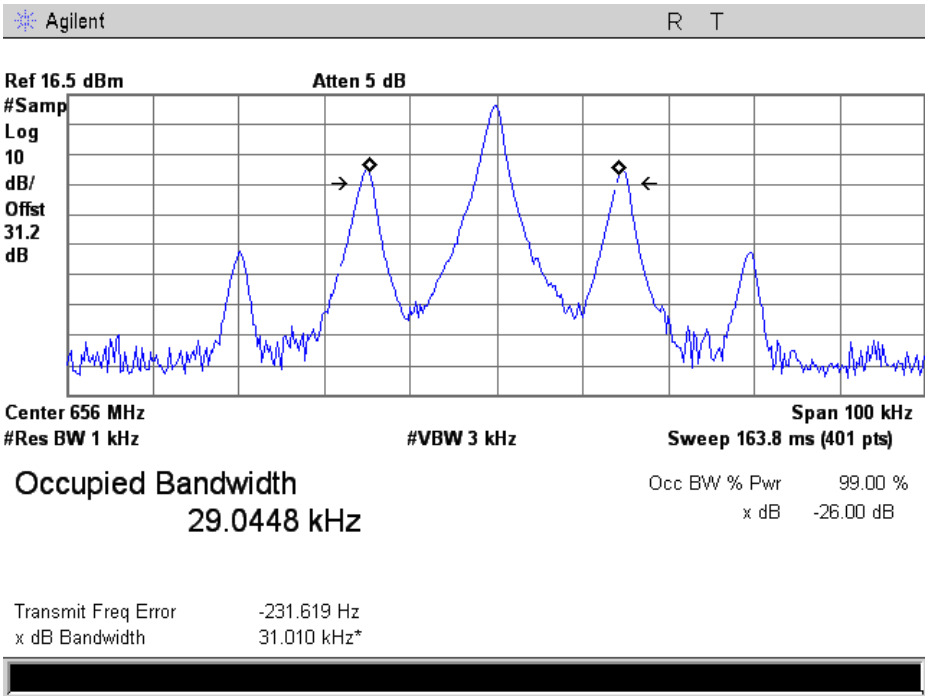
Tuned Frequency = 607.5 MHz



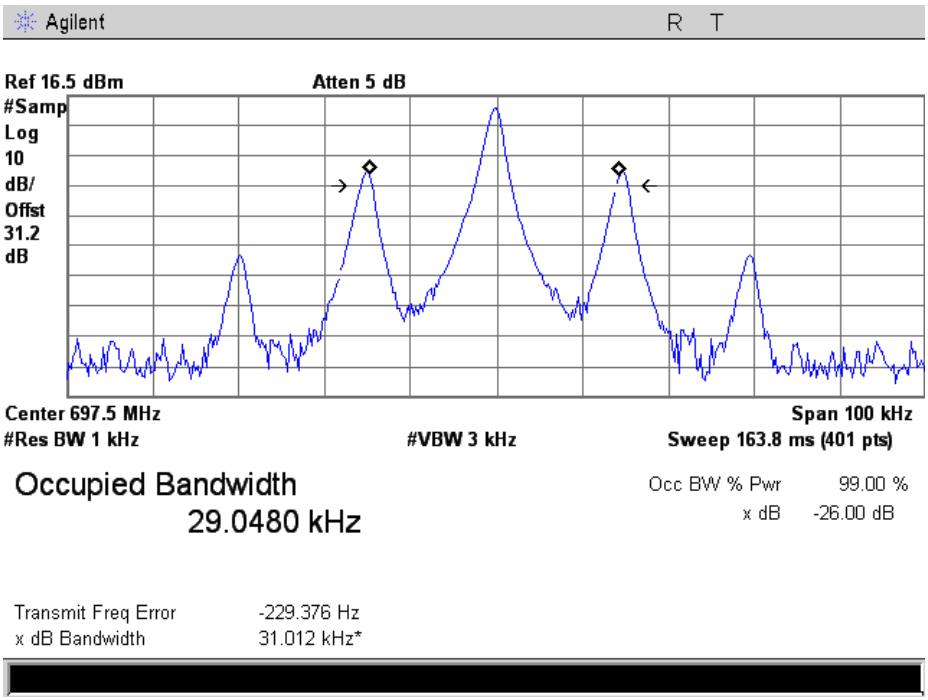
Tuned Frequency = 614.5 MHz



Tuned Frequency = 656 MHz



Tuned Frequency = 697.5 MHz



Frequency Stability (Temperature Variation)

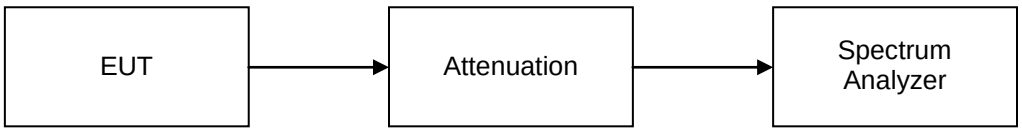
Name of Test: Frequency Stability (Temperature Variation) **Engineer:** Alex Macon
Test Equipment Utilized: i00287, i00320, i00343, i00345 **Test Date:** 9/24/13

Measurement Procedure

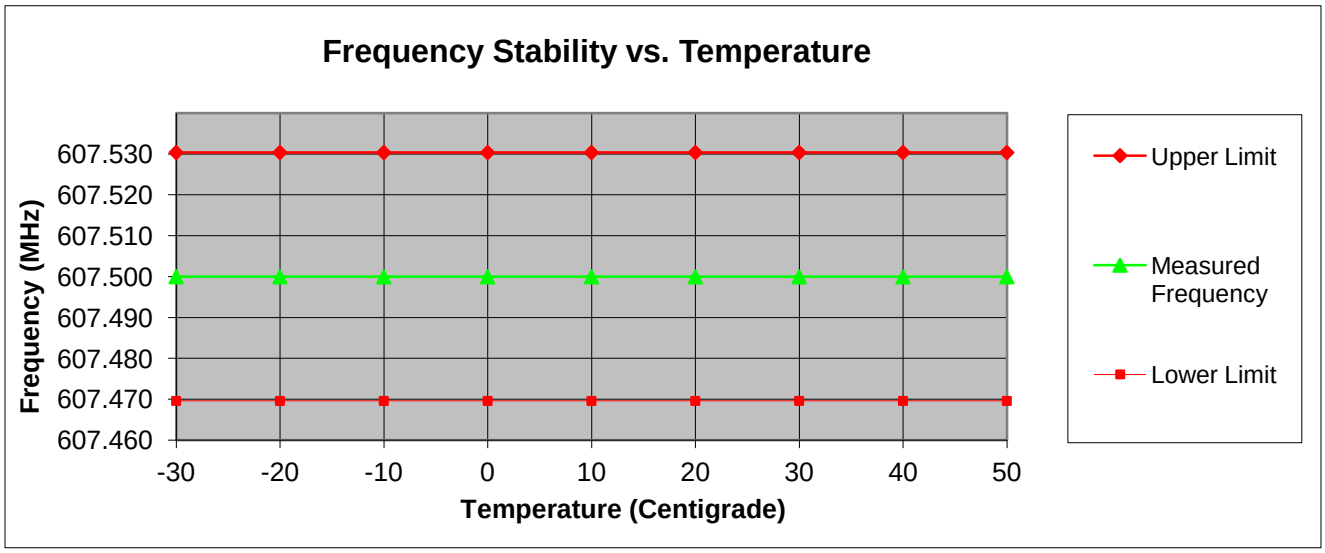
The EUT was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer. The temperature was varied from -30°C to 50°C in 10°C increments. After a sufficient time for temperature stabilization the RF output frequency was measured.

The limit for the FCC and IC are the same. FCC = .005% and IC = +/- 50 PPM.
The Limits on the graph are:
Lower limit = 607.469625 MHz
Upper Limit = 607.530375 MHz

Measurement Setup



Measurement Results



Frequency Stability (Voltage Variation)

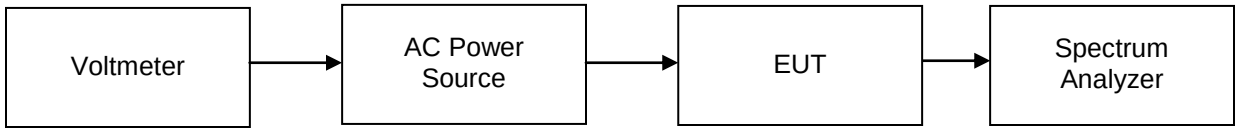
Name of Test:	Frequency Stability (Voltage Variation)	**Engineer:** Alex Macon
Test Equipment Utilized:	i00287, i00320, i00343, i00345	**Test Date:** 9/24/13

Measurement Procedure

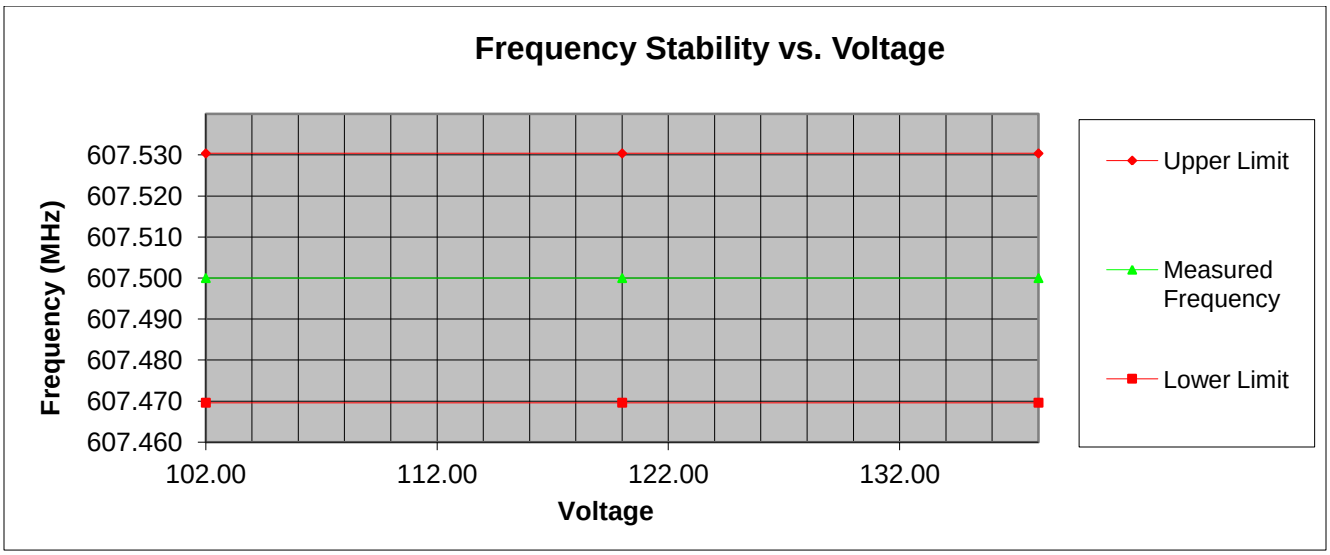
The EUT was placed in a temperature chamber at 25±5°C and connected directly to a Spectrum Analyzer and variable power supply. The power supply voltage to the EUT was varied from 85% to 115% of the nominal value and the RF output was measured.

The limit for the FCC and IC are the same. FCC = .005% and IC = +/- 50 PPM.
The Limits on the graph are:
Lower limit = 607.469625 MHz
Upper Limit = 607.530375 MHz

Measurement Setup



Measurement Results



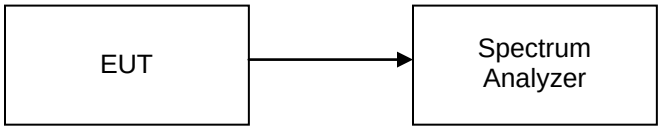
Receiver Spurious Emissions

Name of Test:	Receiver Spurious Emissions	**Engineer:** Alex Macon
Test Equipment Utilized:	i00379	**Test Date:**9/25/13

Test Procedure

The Equipment Under Test (EUT) was connected directly to a Spectrum Analyzer. The cable loss was input into the analyzer as a reference level offset to ensure accurate readings.

Test Setup



Emission Frequency (MHz)	Recorded Measurement (pW)	Limit (nW)	Result
752.7	60.55	2	Pass
2375.5	136.3	5	Pass

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Temperature Chamber	Tenney	Tenney II Benchmaster	i00287	Verified on: 9/24/13	
EMI Receiver	HP	8546A	i00033	12/27/12	12/27/13
Monopole Antenna Set	Ailtech	DM-105A-T1,T2,T3	i00142, 147,148	Verified on:9/25/13	
High Pass Filter	Trilithic	4HX3400-3-XX	i00177	Verified on:9/13/13	
Bi-Log Antenna	Schaffner	CBL611C	i00267	12/19/11	12/19/13
LISN	FCC	FCC-LISN-50-32-2-01	i00270	10/5/12	10/5/14
Horn Antenna, Amplified	ARA	DRG-118/A	i00271	4/19/12	4/19/14
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	12/4/12	12/4/13
Voltmeter	Fluke	75III	i00320	2/1/13	2/1/14
Spectrum Analyzer	Agilent	E4407B	i00331	4/23/13	4/23/14
Data Logger	Fluke	Hydra Data Bucket	i00343	12/19/12	12/19/13
Spectrum Analyzer	Tektronix	RSA3308A	i00345	10/16/12	10/16/13
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	5/25/11	5/25/13
AC Power Source	Behlman	BL 6000	i00362	Verified on:9/13/13	
Signal Generator	Rohde & Schwarz	SME02	i00363	12/19/12	12/19/13
Tunable Notch Filter	Eagle	TNF-240MFMF	i00364	Verified on:9/25/13	
EMI Analyzer	Agilent	E7405A	i00379	11/21/12	11/21/13
Labview Software	National Instruments	FCC_PART15AB_R2	i00395	Compiled on: 06/11	
Thermo Hygrometer	Omega	RH81	i00408	4/15/13	4/15/15

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