Compliance Testing, LLC
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Test Report

Prepared for: G-Way Microwave

Models:
GA-V139/152/2/33/80-R6U15
GA-V162/173/2/33/80-R6U15

Description: VHF Bi-Directional Amplifier for land-mobile radio systems.
Used to amplify frequencies within RF shielded buildings.

Serial Numbers: 14081001, 14081002

FCC ID: Q8KVHF2W80

To

FCC Part 90

Date of Issue: December 10, 2014

On the behalf of the applicant:	**G-Wave Incorporated** **38 Leuning Street** **South Hackensack, NJ 07606**
Attention of:	**Gregory Tsvika Blekher, Project Engineer** **Ph: (201) 343-3140** **E-Mail: t_blekher@gwaymicrowave.com**

Prepared By
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Project No: p1480008

Greg Corbin
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	September 5, 2014	Greg Corbin	Original Document
2.0	October 23, 2014	Greg Corbin	Added Intermodulation Test Data on pages
3.0	November 3, 2014	Greg Corbin	Updated references on the Test Summary Table, Added Input plots for Occupied Bandwidth, Added section for Radiated Output Power, Added section for Noise Figure
4.0	December 4, 2014	Greg Corbin	Added the following note **"Not applicable for FCC certification"** to all the data recorded below 150 MHz.

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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.

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

Testing Certificate Number: **2152.01**

FCC Site Reg. #349717

IC Site Reg. #2044A-2

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 could 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.

Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations Part 90.219, KDB 935210 D03 Booster, or FCC Part 2 where appropriate.

Standard Test Conditions and Engineering Practices

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

In accordance with ANSI/TIA 603C, 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		
Temp (ºC)	**Humidity (%)**	**Pressure (mbar)**
24.6 – 28.7	38.9 – 45.9	963.8 – 972.4

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

EUT Description
Models: GA-V139/152/2/33/80-R6U15
GA-V162/173/2/33/80-R6U15
Description: VHF Bi-Directional Amplifier for land-mobile radio systems. Used to amplify frequencies within RF shielded buildings.
Firmware: N/A
Serial Number: 14081001, 14081002

Additional Information:
The EUT is classified as a **Class B** industrial signal booster

The EUT is a VHF Bi-directional Amplifier that operates from 138 – 174 MHz in both directions. It is used to amplify frequencies within RF shielded buildings for land mobile radio systems.
The system uses modules which have 2 MHz wide bandpass filters with the frequencies selected per the installation requirements.
The system uses the same modules and antennas for the uplink and downlink.
The modules are the same electrically for the uplink and downlink.
The manufacturer supplied 4 modules tuned to the low (139 MHz), mid-lo (151MHz), mid hi (162 MHz), and high (173 MHz) sections of the passband.
2 modules are installed in an enclosure. The 139 MHz and 151 MHz modules were installed in 1 enclosure. The 162 MHz and 173 MHz modules were installed in a 2nd enclosure.
Additional narrowband cavity filters tuned to specific channels or bands within the 2 MHz passband. These narrowband cavity filters were not installed during the tests.
System Power is 120 VAC @ 60 Hz.

The signal booster uses the following frequency bands.
The emission designators listed are representative emission designators used by transmitters whose signal is amplified by this booster.

	Frequency - MHz	Emission Designators
Downlink	138 ** - 174	F3E, F3D, F1E
Uplink	138 ** - 174	F3E, F3D, F1E

****Note: The operating frequencies below 150 MHz are "Not applicable for FCC certification".**

EUT Operation during Tests

The EUT was tested under normal operating conditions with the front panel attenuators set to 0 dB for all measurements.

AGC Threshold
Several tests reference the AGC Threshold level.
The AGC Threshold was measured as follows:

- Connect a signal generator to the input of the EUT.
- Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- Use a CW signal.
- While monitoring the output of the EUT, increase the input level until the output stops increasing or drops a few 10th's of a dB.
- This is the AGC threshold level of the EUT.
- When the procedure calls out to set the RF Input to just below the AGC Threshold, The AGC Threshold is measured using the procedure listed above, and then the RF Input is backed off 0.2 dB below this threshold level.

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Accessories: None

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Termination
1	AC power cable	2	N	N	N/A

Modifications: None

Test Result Summary

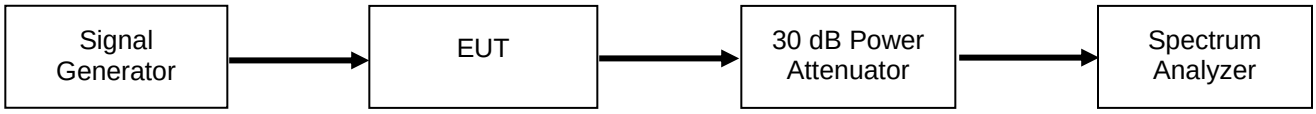
Specification	Test Name	Pass, Fail, N/A	Comments
KDB 935210-D03	Authorized Frequency Band	Pass	
2.1046	Output Power (Conducted)	Pass	
90.219(e)(1)	Radiated Output Power	Pass	
90.219(e)(4)(i)(ii)(iii) 90.210 2.1049	Occupied Bandwidth (Emission Masks)	Pass	
90.219(e)(3) 2.1051	Spurious Emissions (Transmitter Conducted)	Pass	
KDB 935210-D03	Intermodulation	Pass	
90.219(e)(2)	Noise Figure	Pass	
90.213	Frequency Stability (Temperature Variation)	N/A	The EUT does not perform frequency translation
90.213	Frequency Stability (Voltage Variation)	N/A	The EUT does not perform frequency translation

Authorized Frequency Band
Engineer: Greg Corbin
Test Date: 8/25/14

Test Procedure

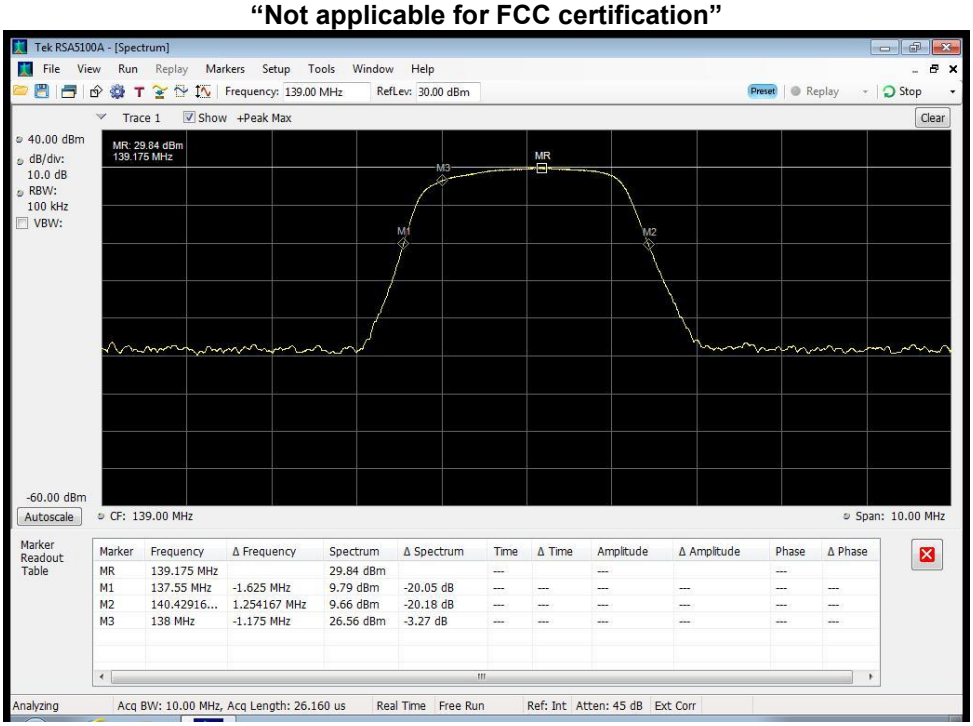
The EUT was connected to a spectrum analyzer through a 30 dB power attenuator. A signal generator was utilized to produce a swept CW signal with the RF input level set to3 dB below the AGC Threshold level. The Out of Band Rejection filter response and the -20 dB bandwidth were recorded. The marker table function of the spectrum analyzer was used to show the peak amplitude in the passband and the -20 dB bandwidth of the pass band filter.
RBW = 100 KHz
Video BW = 3x RBW

Test Setup

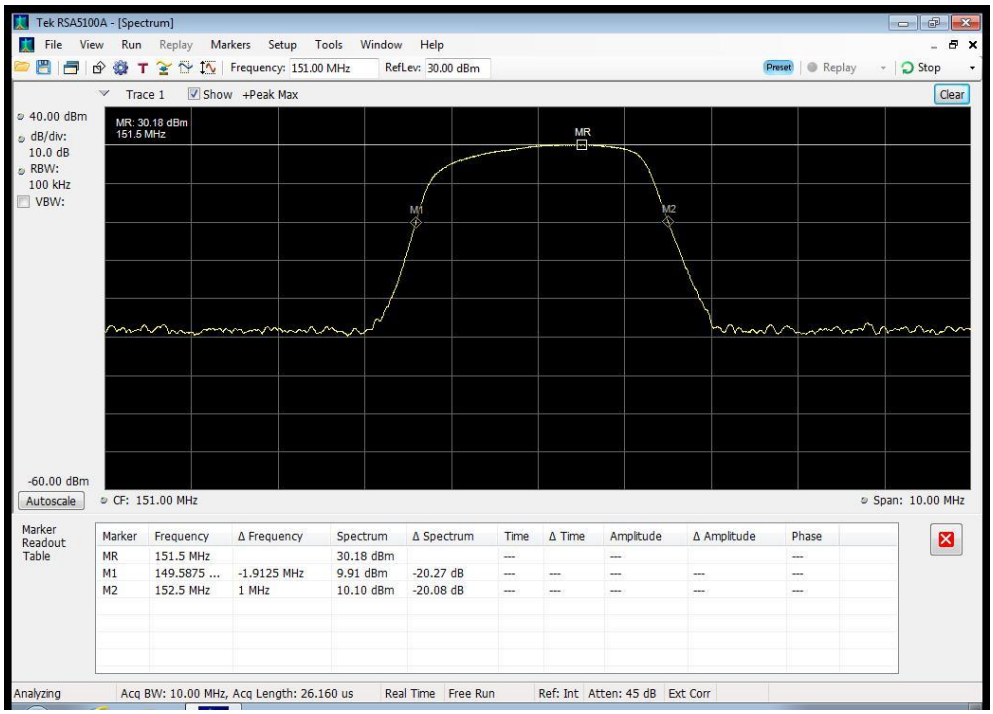


Out of Band Rejection Test Results

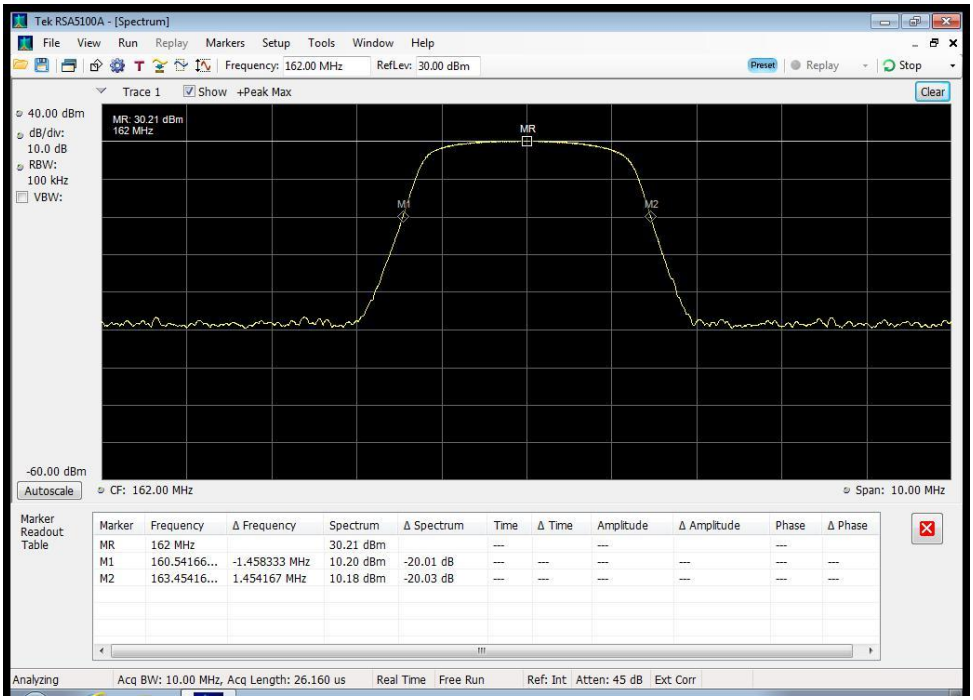
139 MHz
"Not applicable for FCC certification"



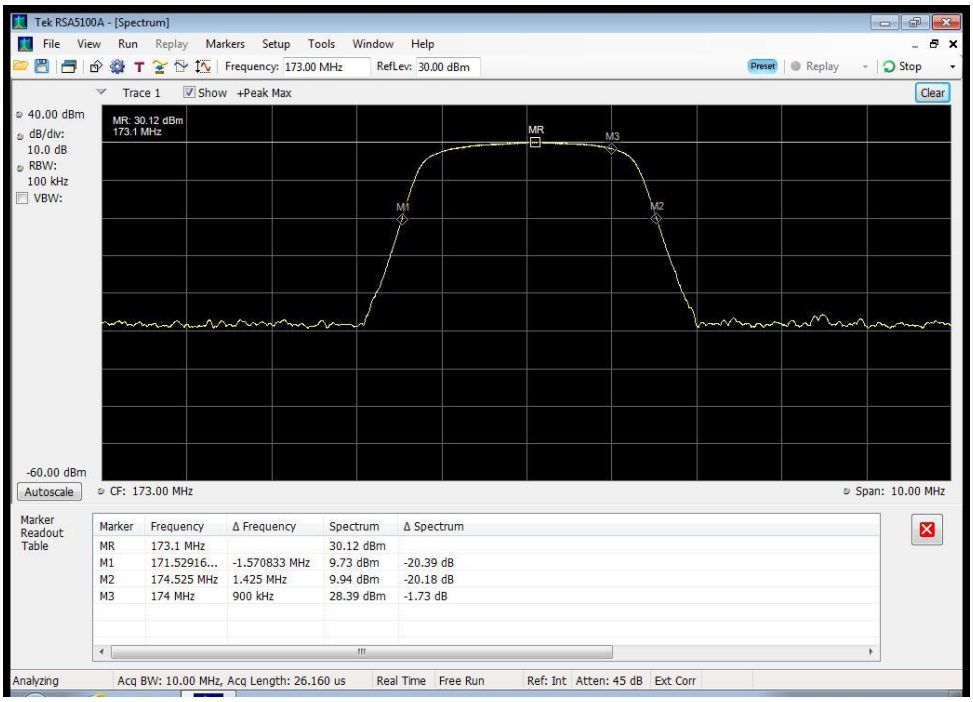
151 MHz



162 MHz



173 MHz



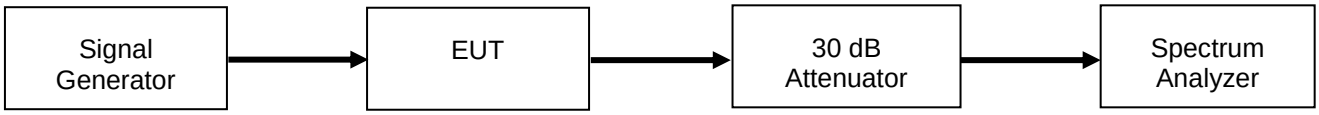
Conducted Output Power and Amplifier Gain
Engineer: Greg Corbin
Test Date: 8/27/14

Measurement Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a reference level offset to ensure accurate readings were obtained.
A CW signal was utilized, set to the frequency of the peak amplitude measured in the Out of Band Rejection test.
The RF input signal level was set to 0.2 dB below the AGC Threshold.
RBW = 100 kHz
Video BW = 3x RBW
The Input and Output power levels were recorded and the gain was calculated using the following formula:

Gain (dB) = Output Power (dBm) – Input Power (dBm)

Test Setup



Output Power and Gain Test Results

Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
139 **	-49.7	32.9	82.6
151	-47.9	32.9	80.8
162	-48.8	33.2	82
173	-48.5	33	81.5

*** * Note: "Not applicable for FCC certification"**

Radiated Output Power
Radiated Power (ERP) is dependent on the cable loss and antennas used when installed.
The user's manual contains the following statement limiting the Output Power to 33 dBm.

ALC (Automatic Level Control)
To minimize intermodulation products, each amplifier in the BDA contains an ALC feedback loop. The ALC circuit senses the output power and limits it to the factory preset level of +33 dBm.

Conducted Spurious Emissions

Engineer: Greg Corbin
Test Date: 8/28/14

Test Procedure

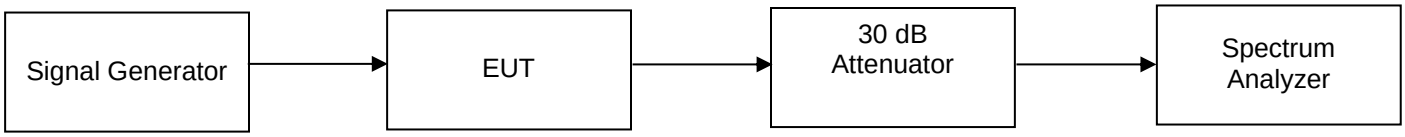
The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings were obtained.
A CW signal was utilized, set to the center frequency of the passband.
The RF input signal level was set to 0.2 dB below the AGC Threshold.
The RBW was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.
The VBW was set to 3 times the RBW.

The frequency range from 30 MHz to the 10th harmonic of the passband frequency was observed and plotted.

The following formula was used for calculating the limits.

Conducted Spurious Emissions Limit = P1 – (43+ 10Log(P2)) = -13 dBm
P1 = power in dBm
P2 = power in Watts

Test Setup



Conducted Spurious Emissions Summary Table

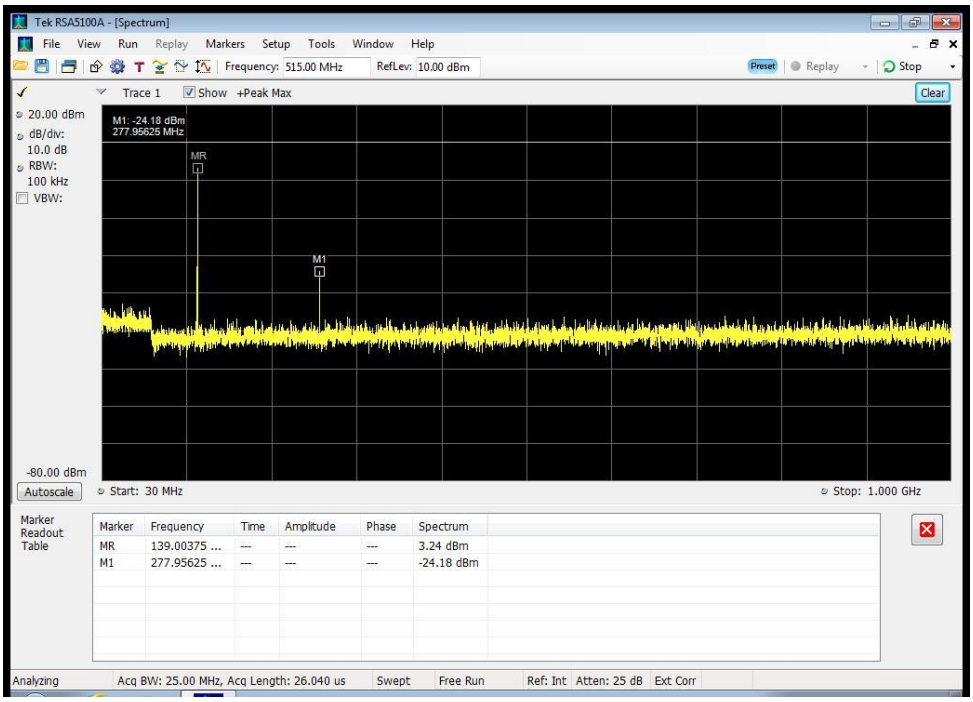
Tuned Frequency (MHz)	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
139 **	277.956	-26.7	-13	Pass
151	301.963	-24.2	-13	Pass
162	323.829	-13.4	-13	Pass
173	346.058	-18.2	-13	Pass

**** Note: "Not applicable for FCC certification"**

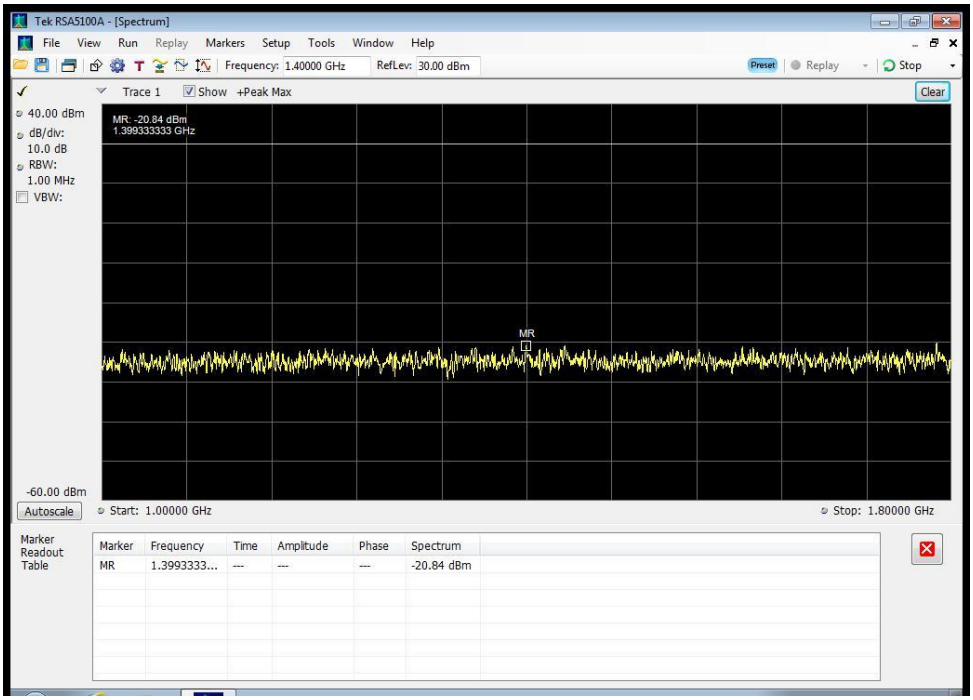
Conducted Spurious Emissions Test Plots

Input Frequency = 139 MHz
**** Note: "Not applicable for FCC certification"**

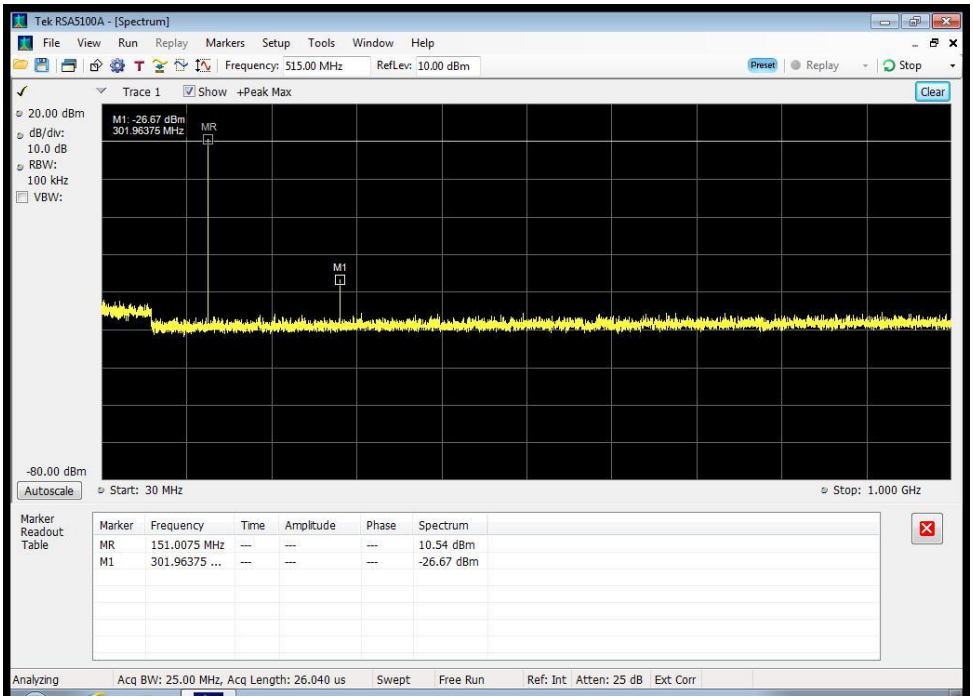
30 MHz – 1 GHz



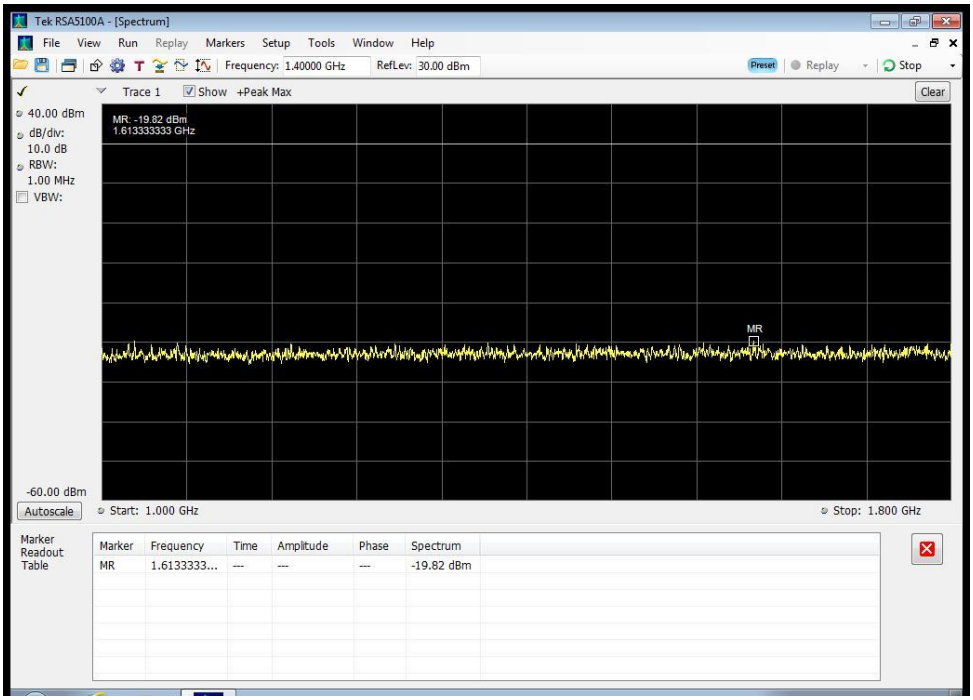
1 – 1.8 GHz



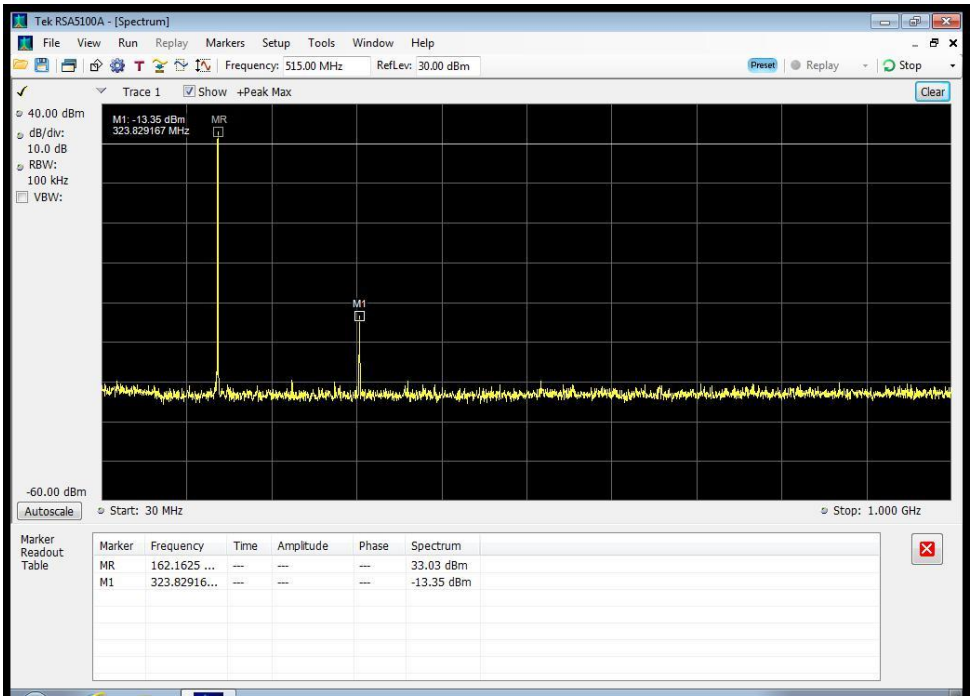
Input Frequency = 151 MHz
30 MHz – 1 GHz



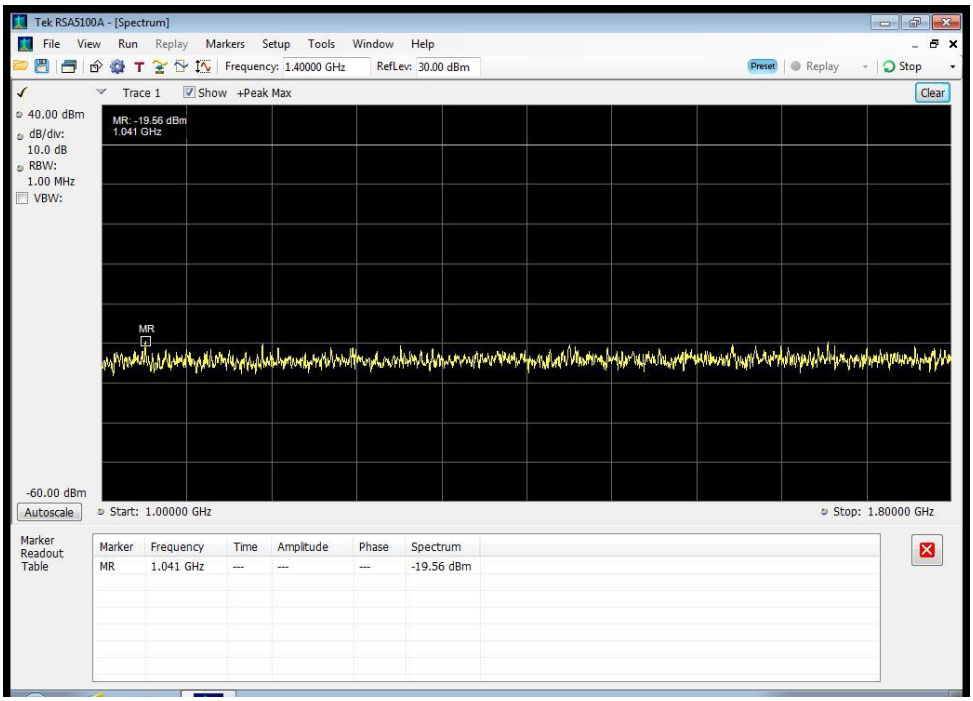
1 – 1.8 GHz



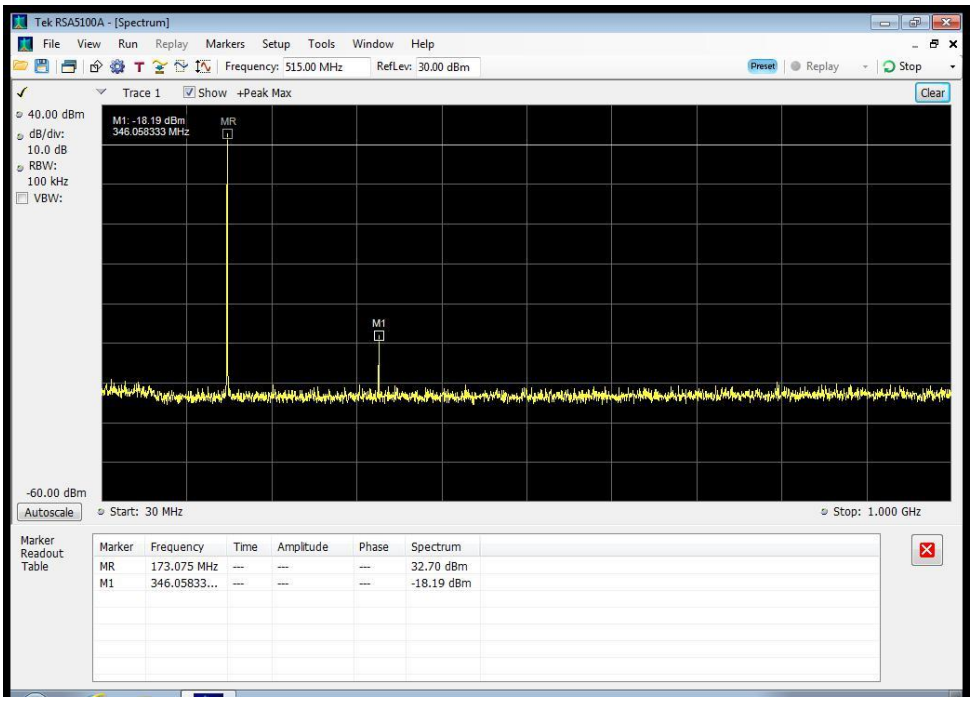
Input Frequency = 162 MHz
30 MHz – 1 GHz



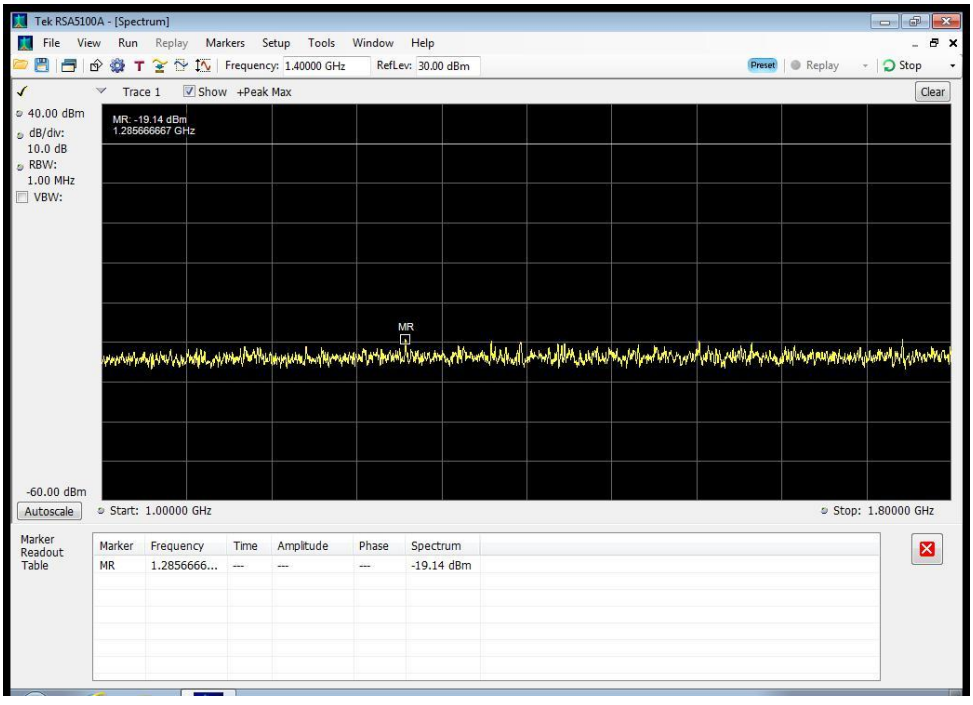
1 – 1.8 GHz



Input Frequency = 173 MHz
30 MHz – 1 GHz



1 – 1.8 GHz



Radiated Spurious Emissions
Engineer: Greg Corbin
Test Date: 8/29/14

Test Procedure

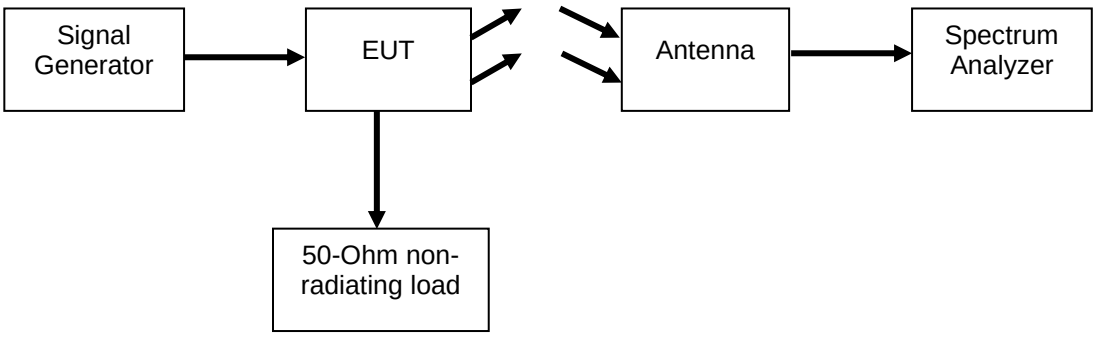
The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation 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. The EUT output was terminated into a 50 Ohm non-radiating load.

The RBW was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.
The VBW was set to 3 times the RBW.

The following formula was used for calculating the limits:

Radiated Spurious Emissions Limit = P1 – (43+ 10Log(P2)) = -13dBm
P1 = power in dBm
P2 = power in Watts

Test Setup



Test Results

Tuned Frequency (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	Limit (dBm)	Result
139 **	278	-85.7	-13	Pass
139 **	417	-84.1	-13	Pass
151	302	-81.9	-13	Pass
151	453	-81.8	-13	Pass
162	324	-82.9	-13	Pass
162	486	-79.4	-13	Pass
173	346	-82.7	-13	Pass
173	519	-81.0	-13	Pass

No other emissions were detected. All emissions were noise floor measurements.

**** Note: "Not applicable for FCC certification"**

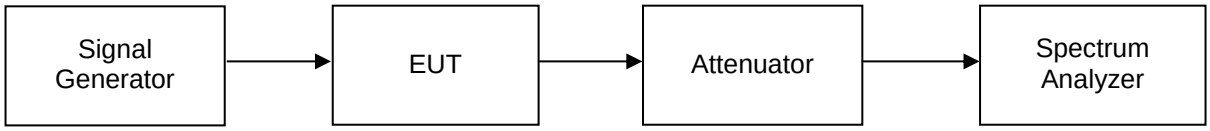
Emission Masks (Occupied Bandwidth)
Engineer: Greg Corbin
Test Date: 8/26/14

Measurement Procedure

The EUT was connected directly to a spectrum analyzer to verify that the EUT meets 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 is a booster amplifier that does not contain a transmitter, representative emission designators used in the industry were used for the emission masks and are listed in Table 1.

Emission Designator	Emission Mask	Type of Modulation	Occupied Bandwidth (kHz)	Channel Spacing (kHz)	Audio Frequency (kHz)	Deviation (kHz)	RBW (Hz)
16K0F3E	B	FM	16.0	25	2.5	5.0	300
11K3F3E	D	FM	11.3	12.5	1.0	2.5	100
4K00F1E	E	FM	4	6.25	1.0	1.0	100

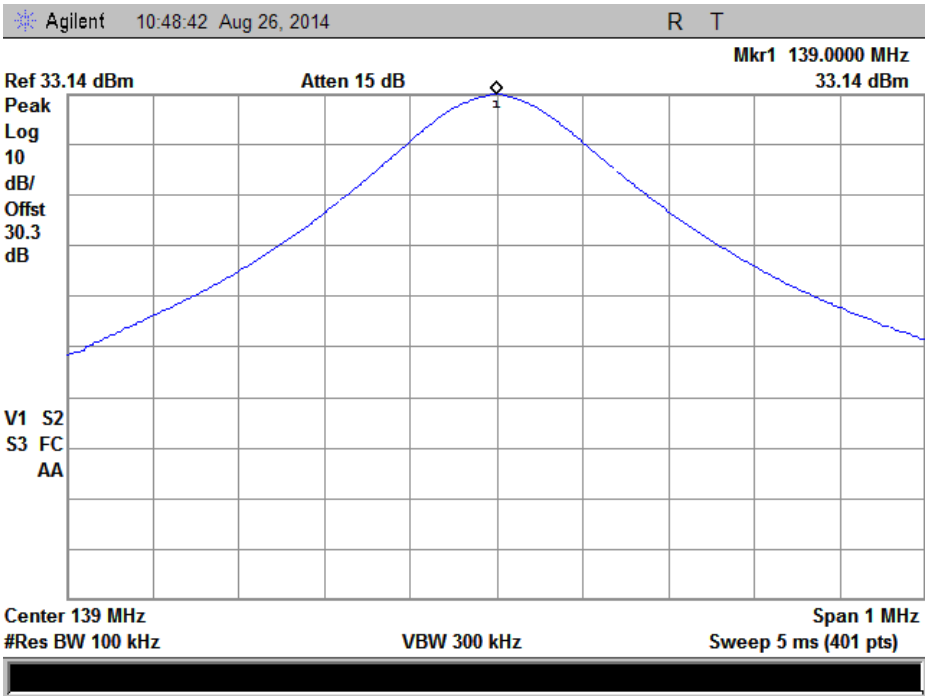
Test Setup



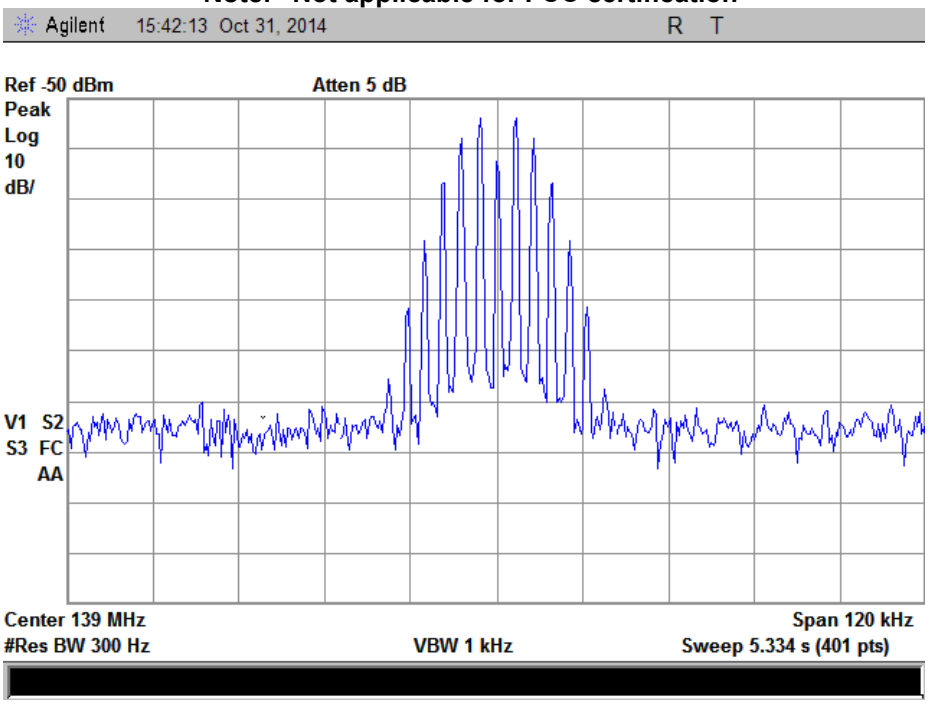
Emission Mask Plots

Tuned Frequency = 139 MHz
**** Note: "Not applicable for FCC certification"**

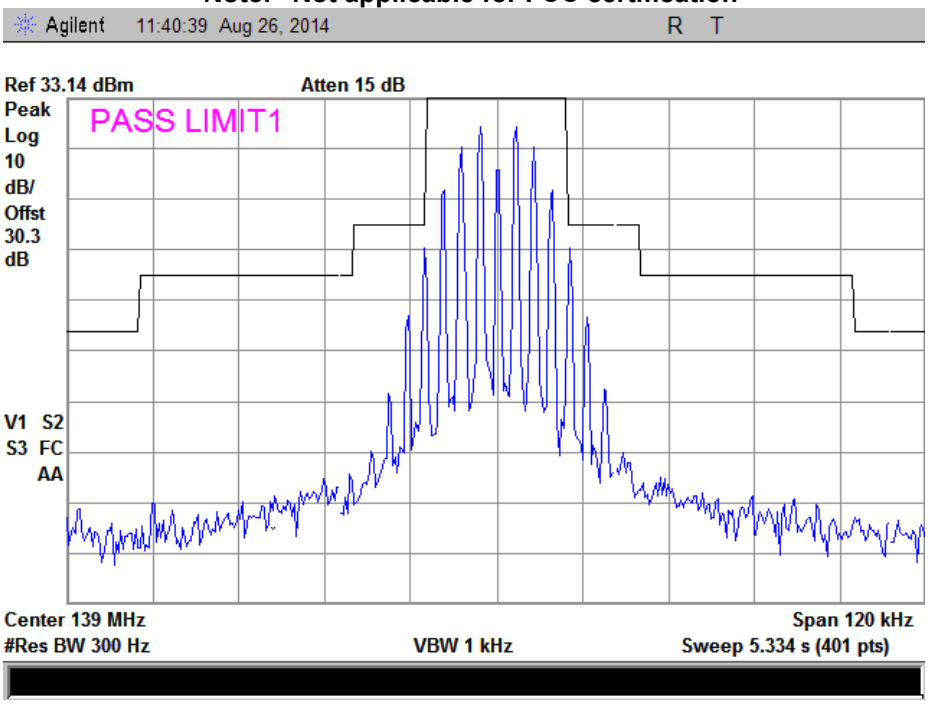
Reference Plot



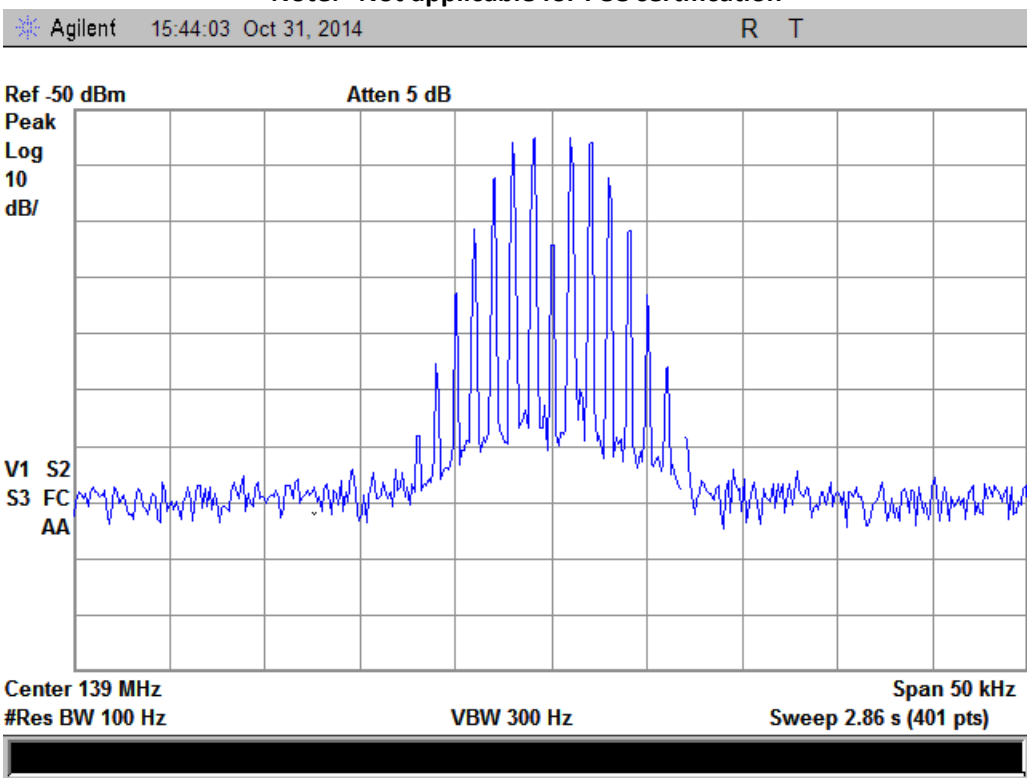
Input Signal for Mask B
**** Note: "Not applicable for FCC certification"**



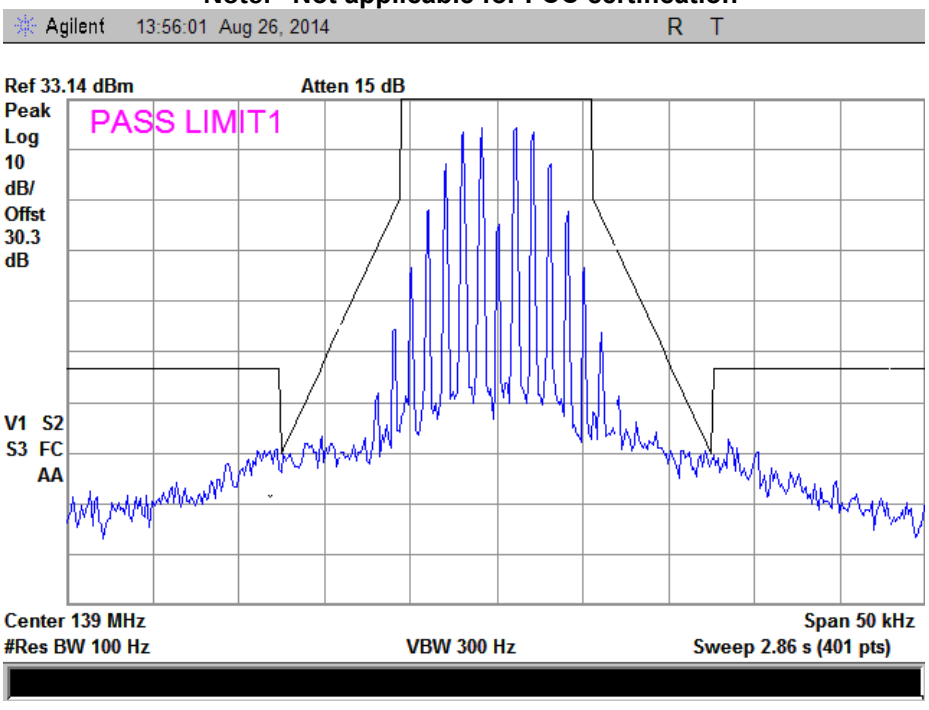
Mask B Output Signal
**** Note: "Not applicable for FCC certification"**



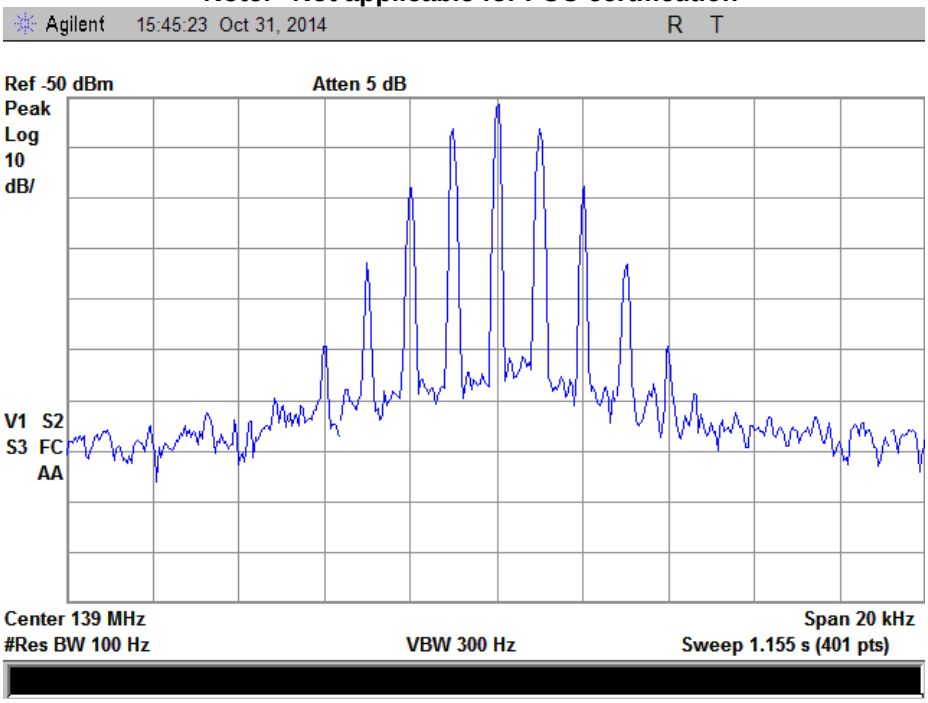
Input Signal for Mask D
**** Note: "Not applicable for FCC certification"**



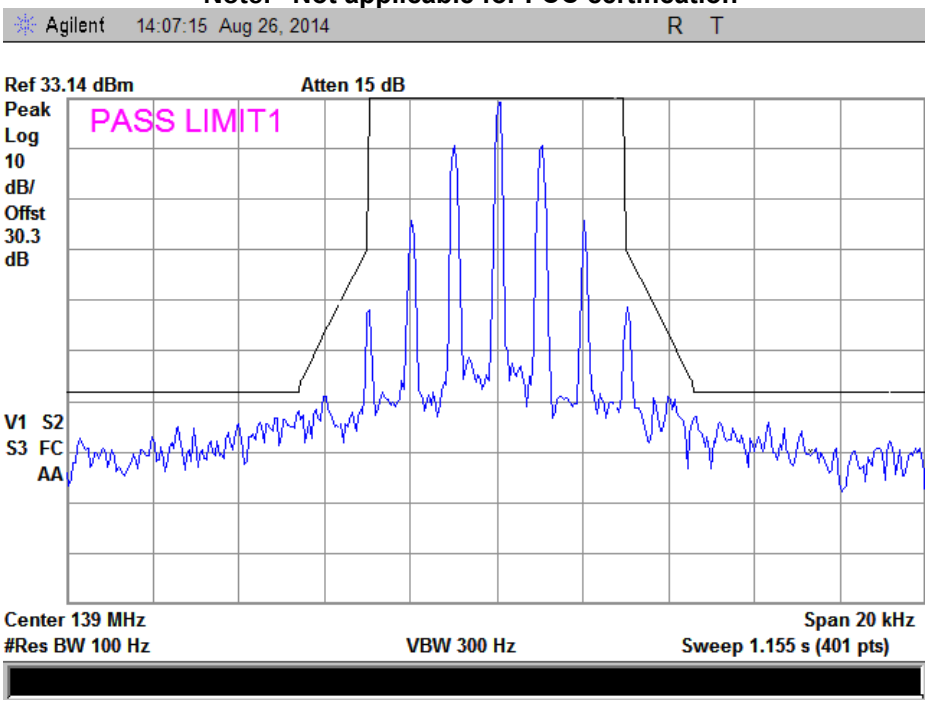
Mask D Output Signal
**** Note: "Not applicable for FCC certification"**



Input Signal for Mask E
**** Note: "Not applicable for FCC certification"**

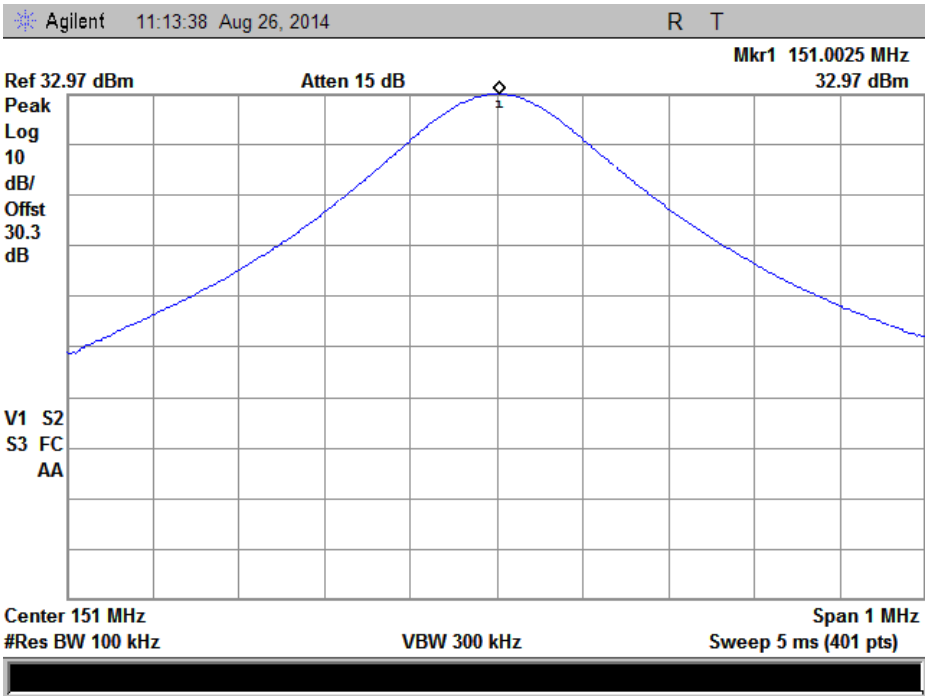


Mask E Output Signal
**** Note: "Not applicable for FCC certification"**

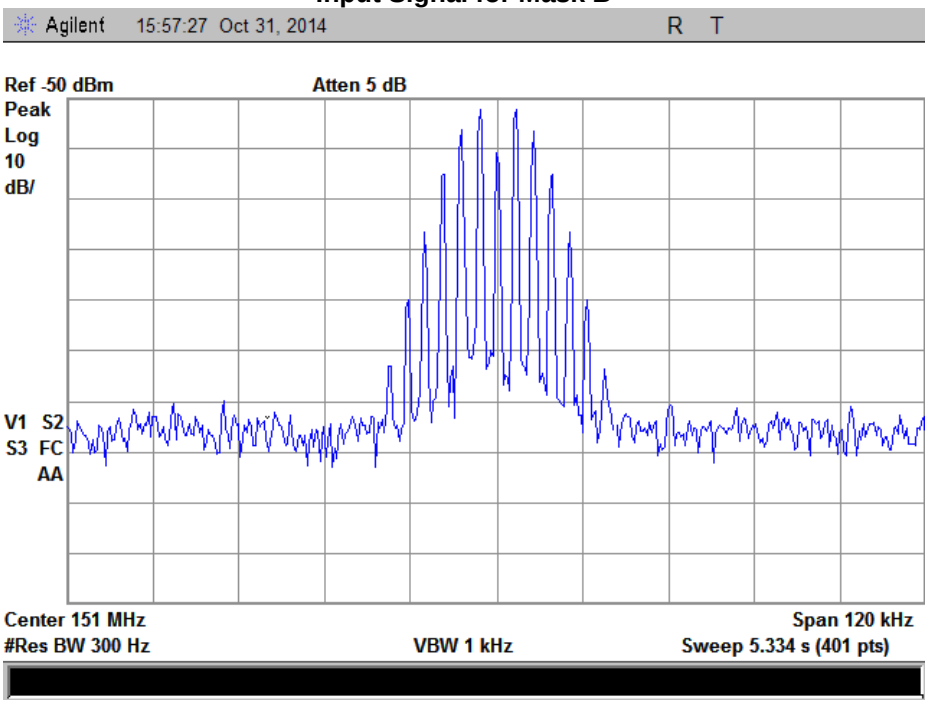


Tuned Frequency = 151 MHz

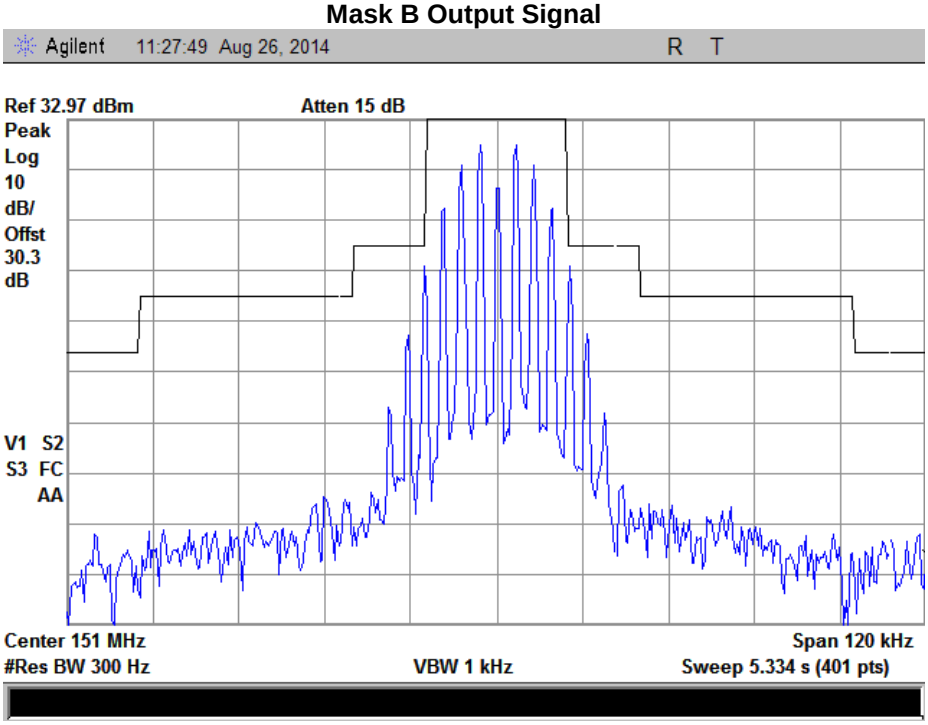
Reference Plot



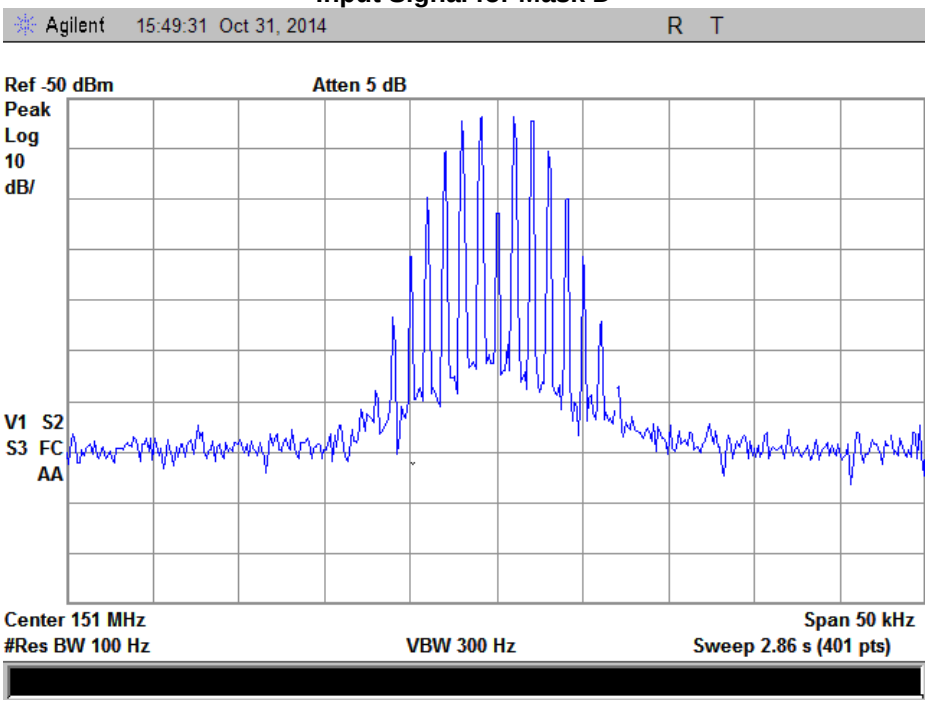
Input Signal for Mask B



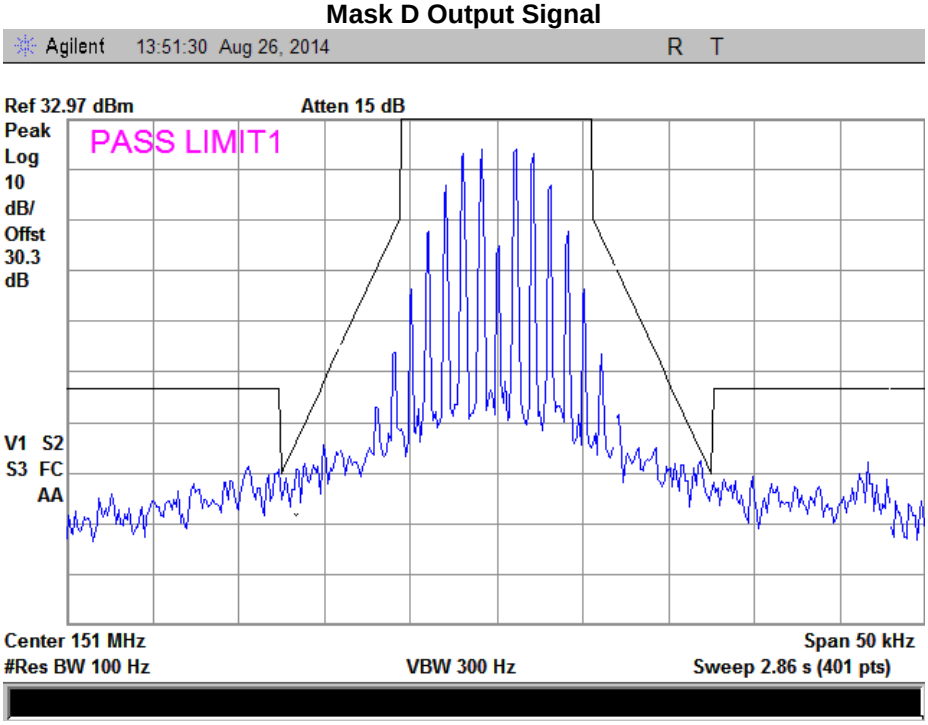
Mask B Output Signal



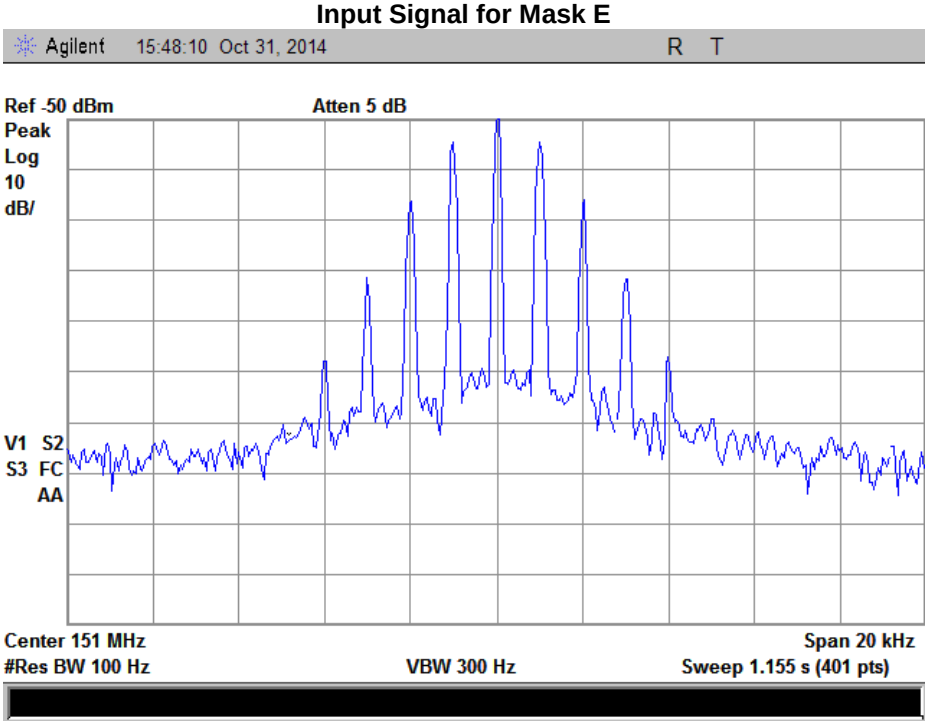
Input Signal for Mask D



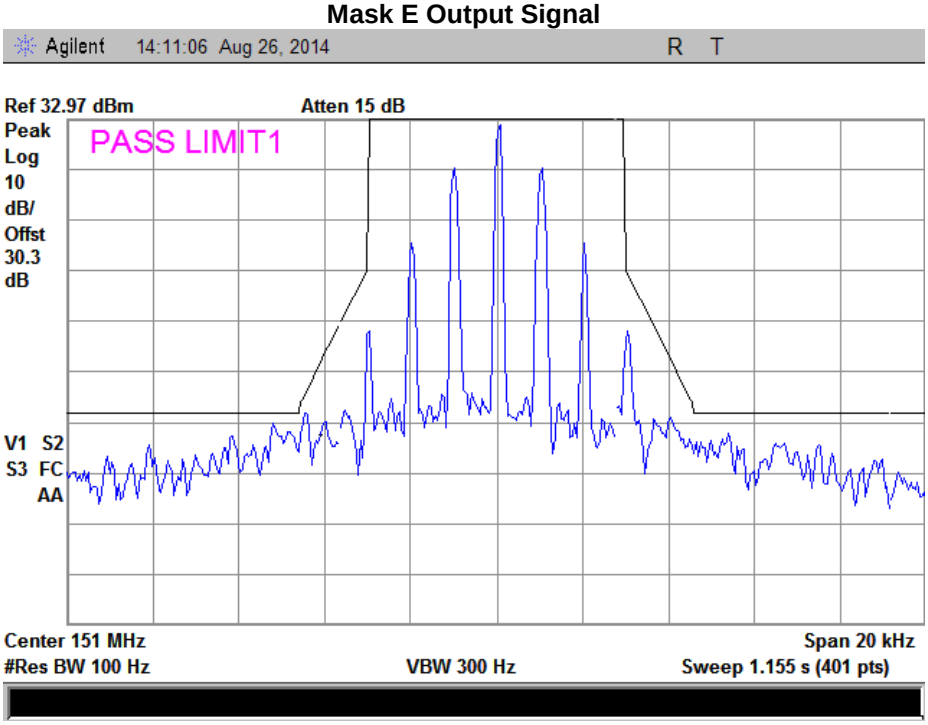
Mask D Output Signal



Input Signal for Mask E

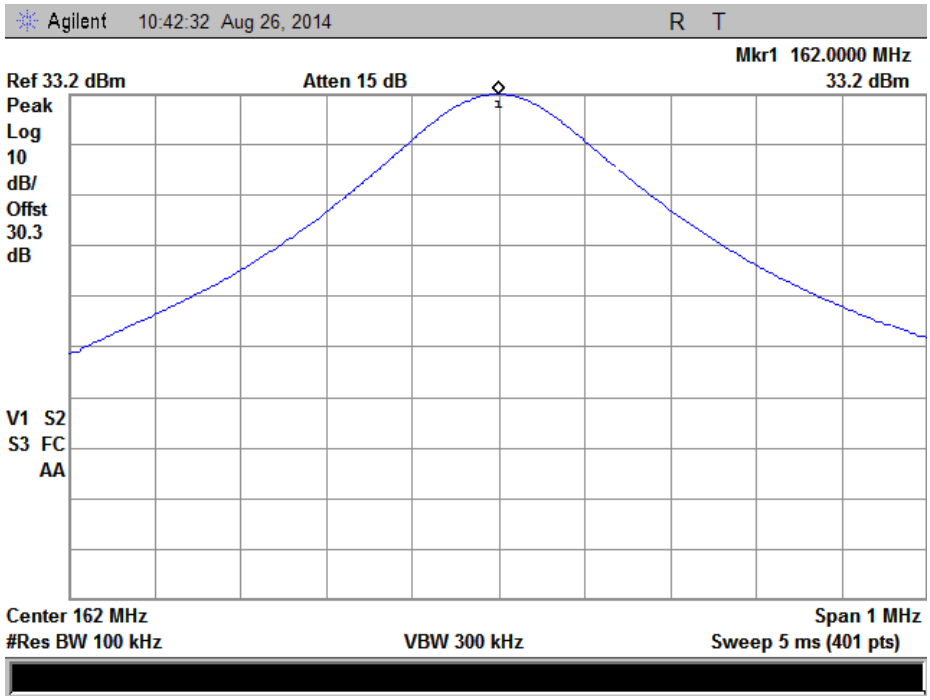


Mask E Output Signal

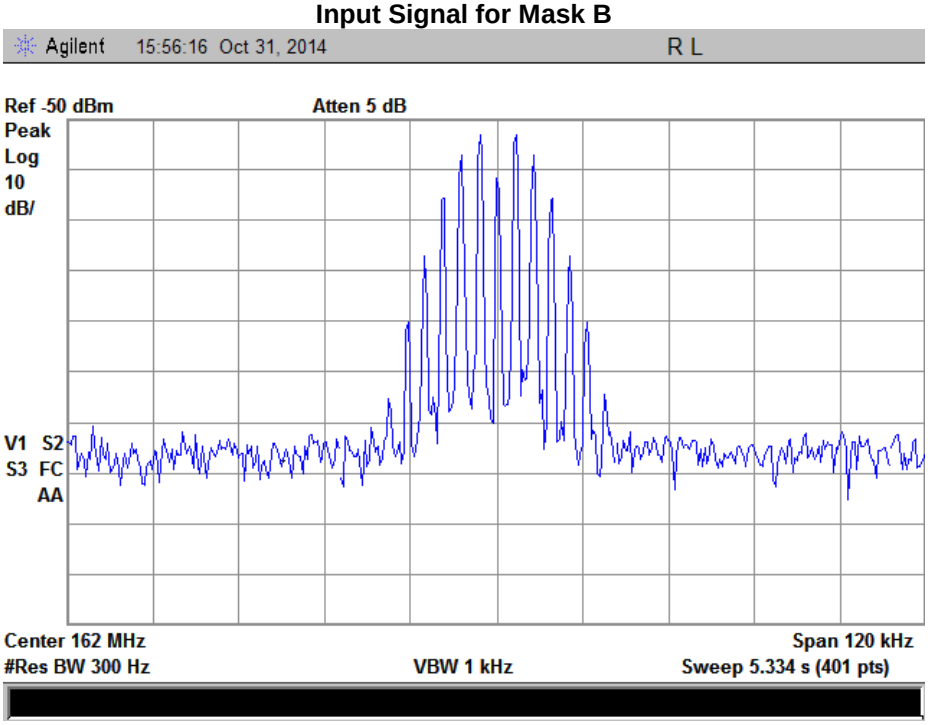


Tuned Frequency = 162 MHz

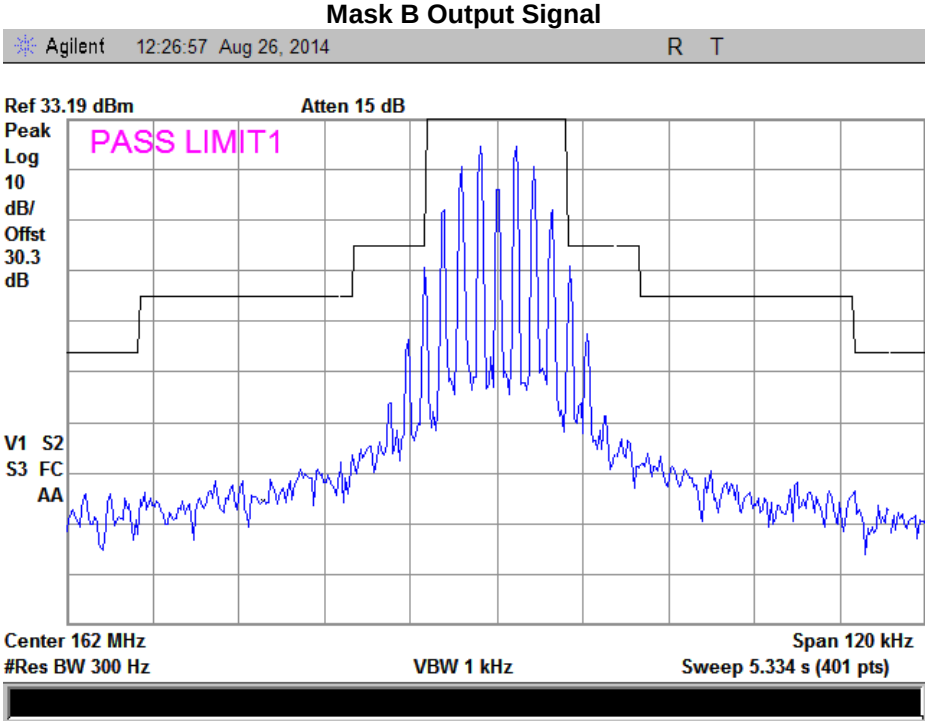
Reference Plot



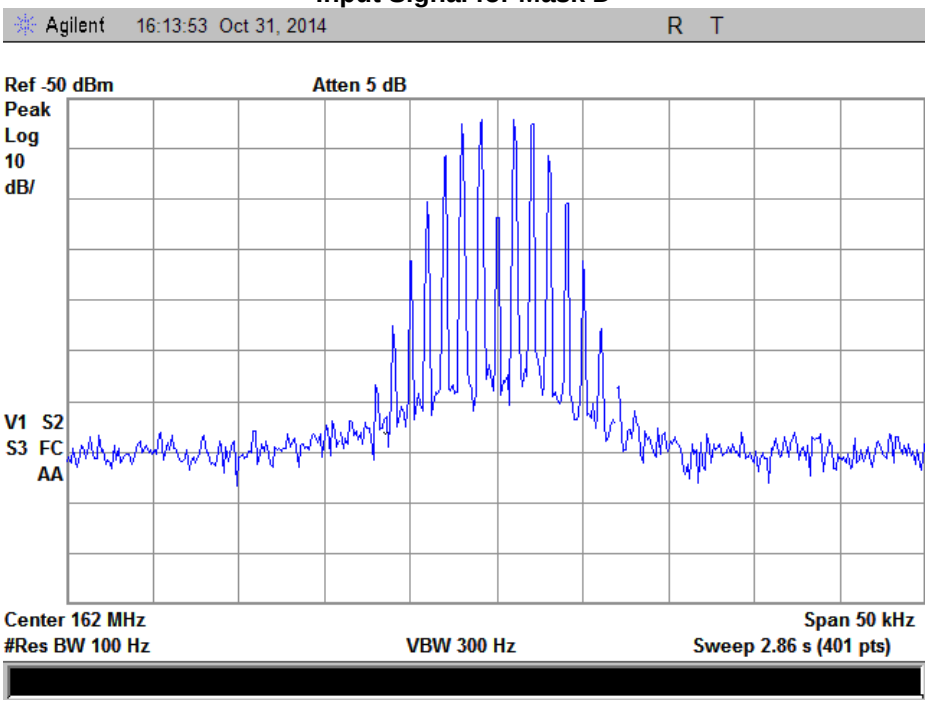
Input Signal for Mask B



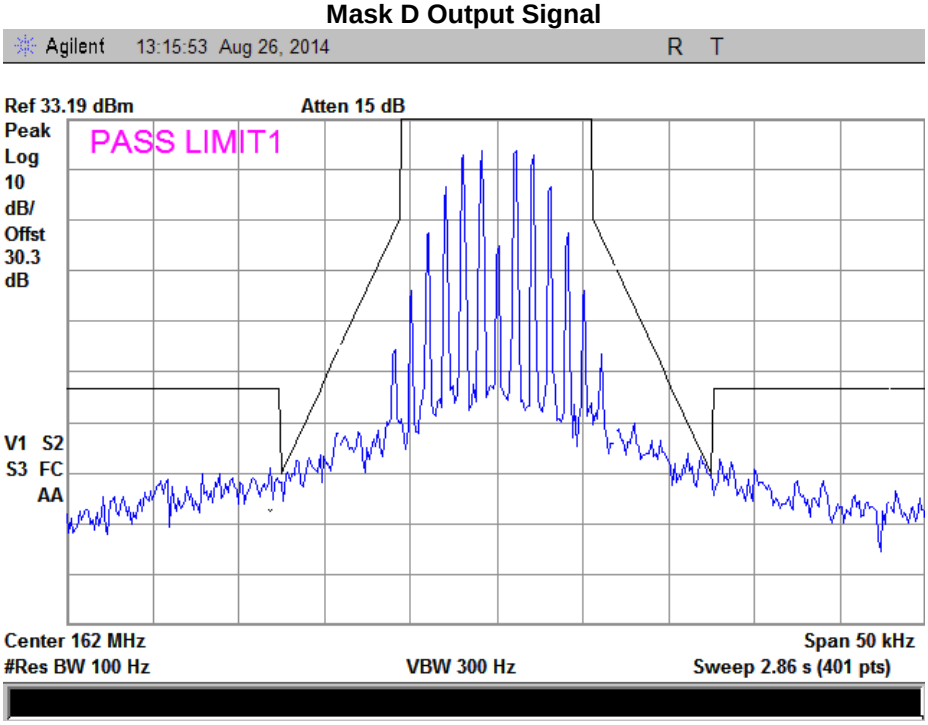
Mask B Output Signal



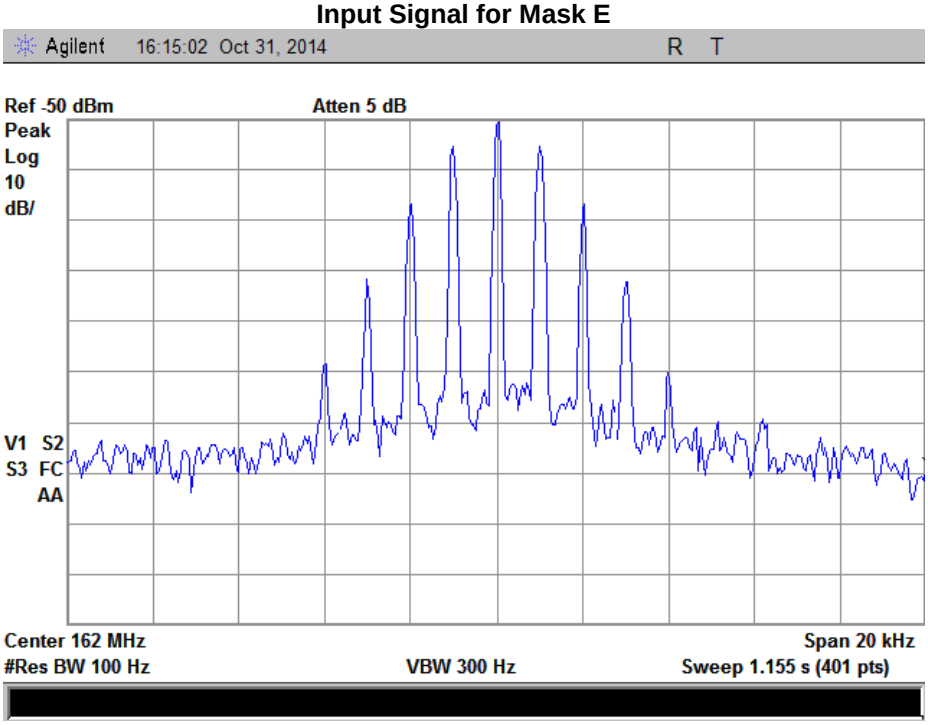
Input Signal for Mask D



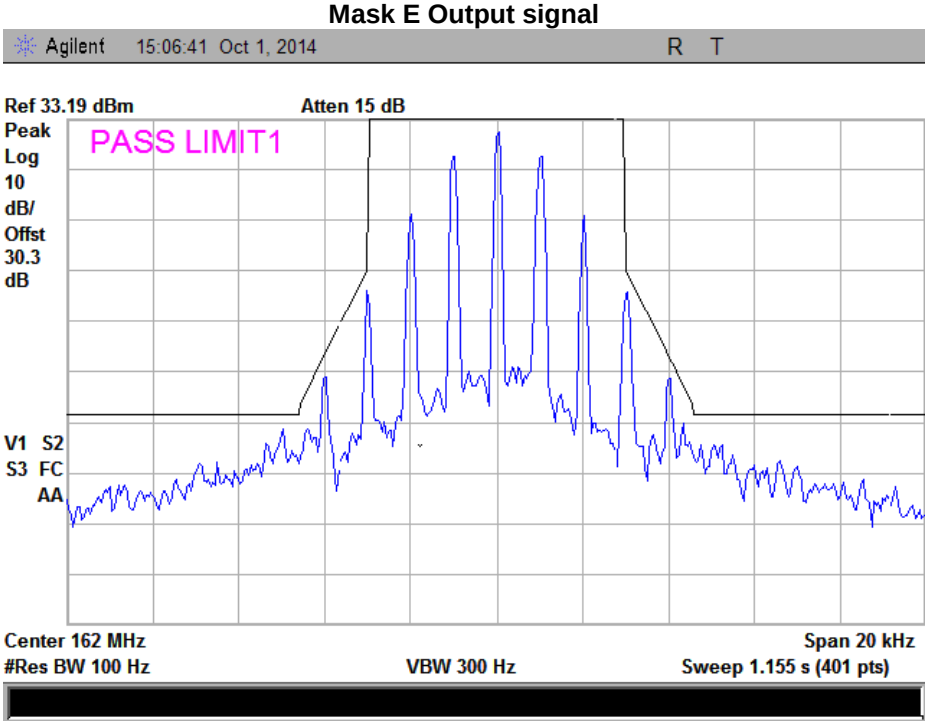
Mask D Output Signal



Input Signal for Mask E

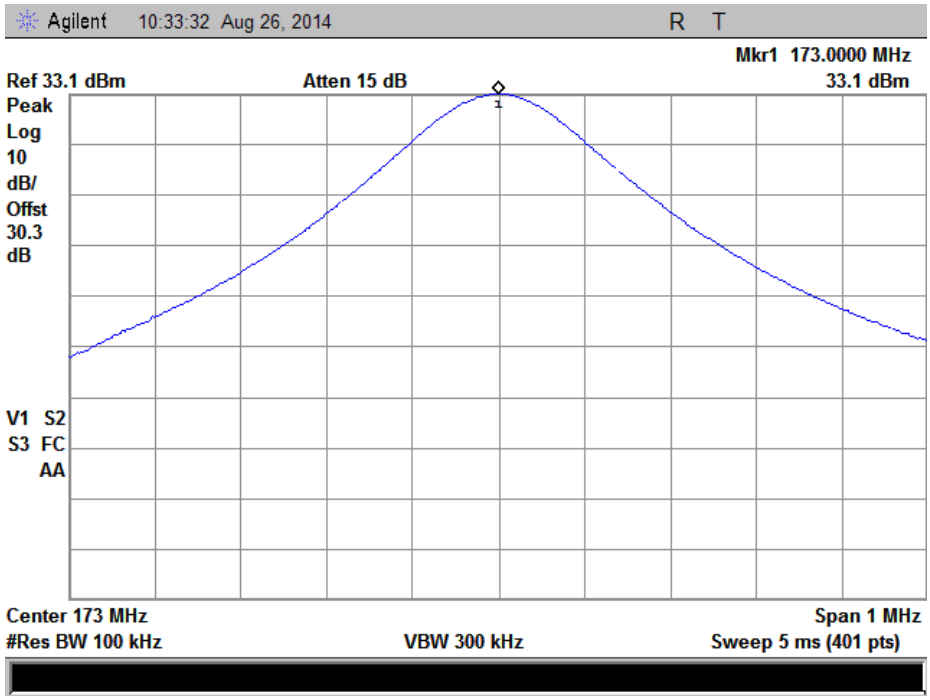


Mask E Output signal

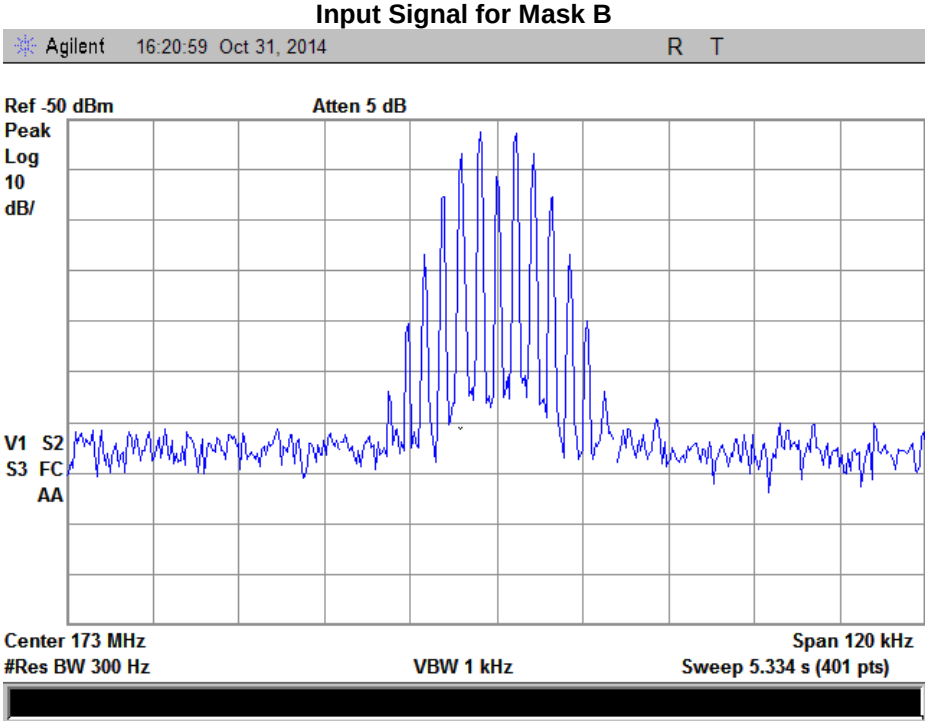


Tuned Frequency = 173 MHz

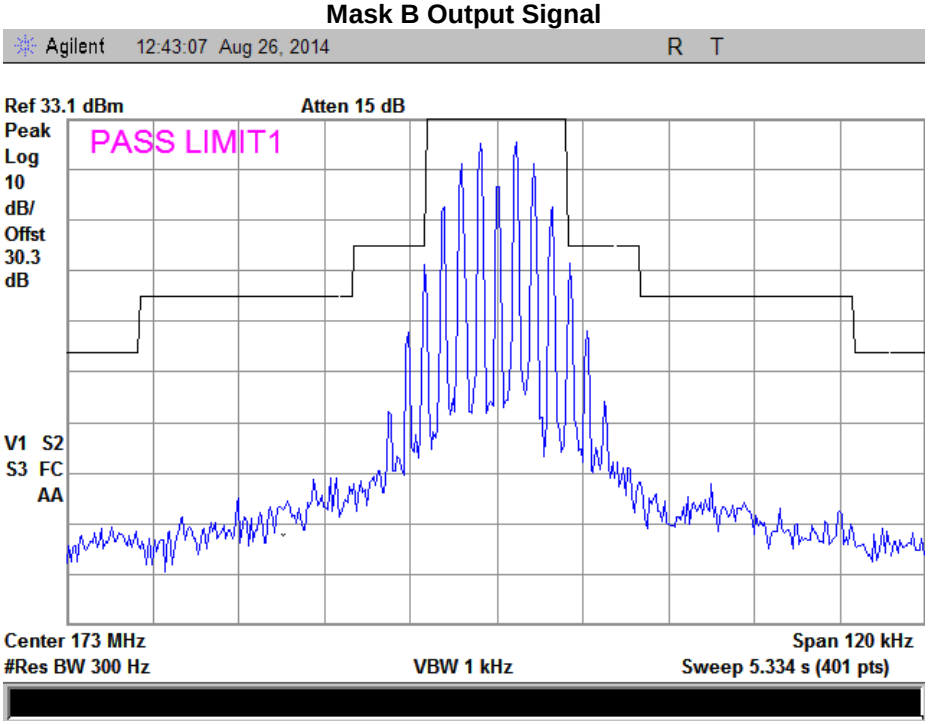
Reference Plot



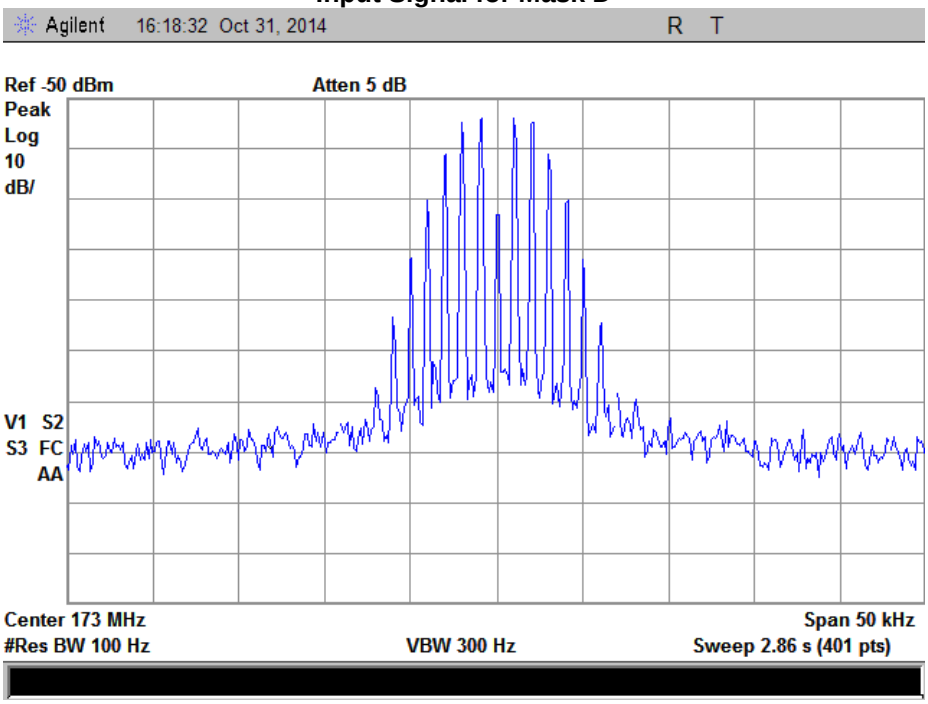
Input Signal for Mask B



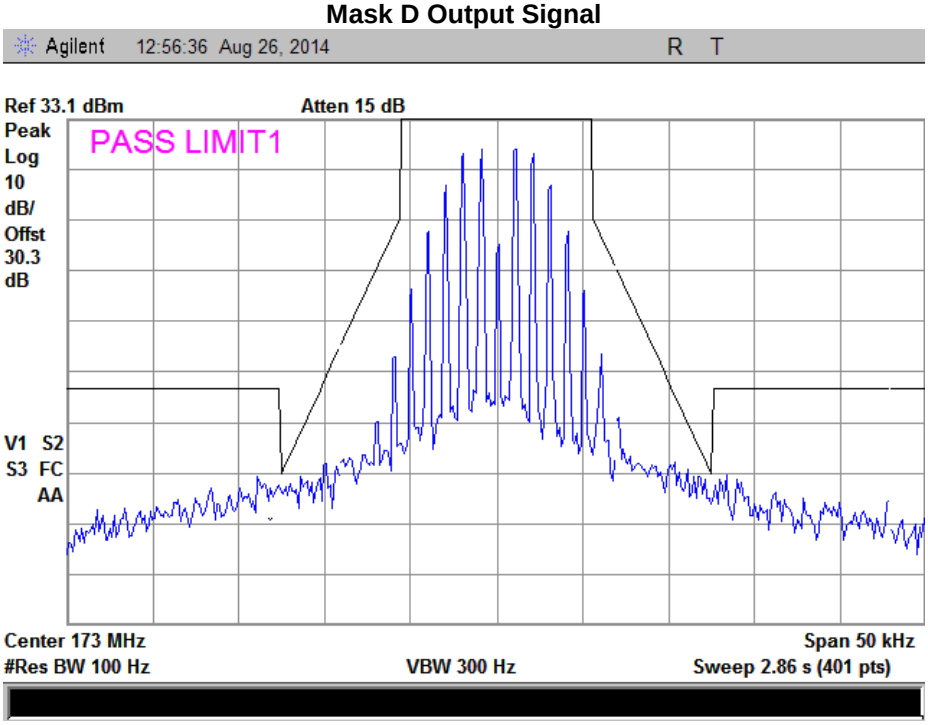
Mask B Output Signal



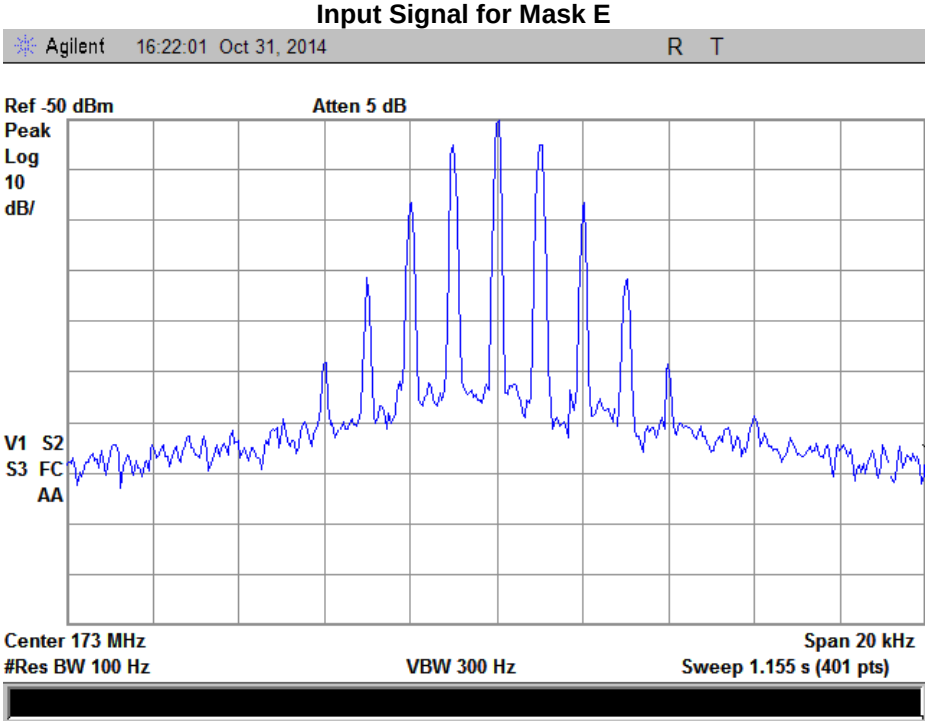
Input Signal for Mask D



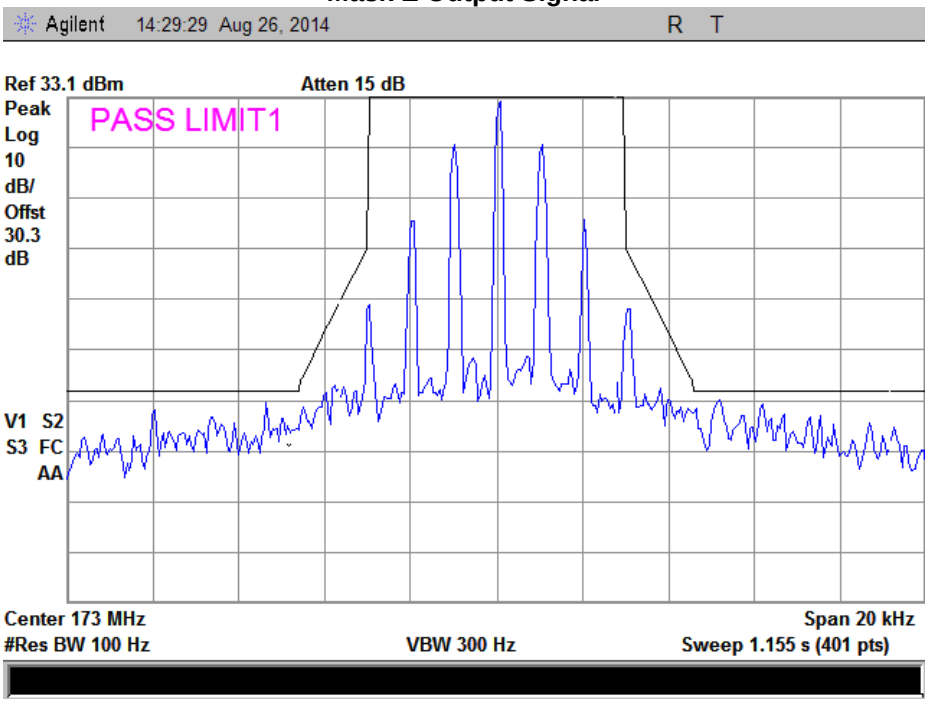
Mask D Output Signal



Input Signal for Mask E



Mask E Output Signal



Intermodulation
Engineer: Greg Corbin
Test Date: 8/28/14

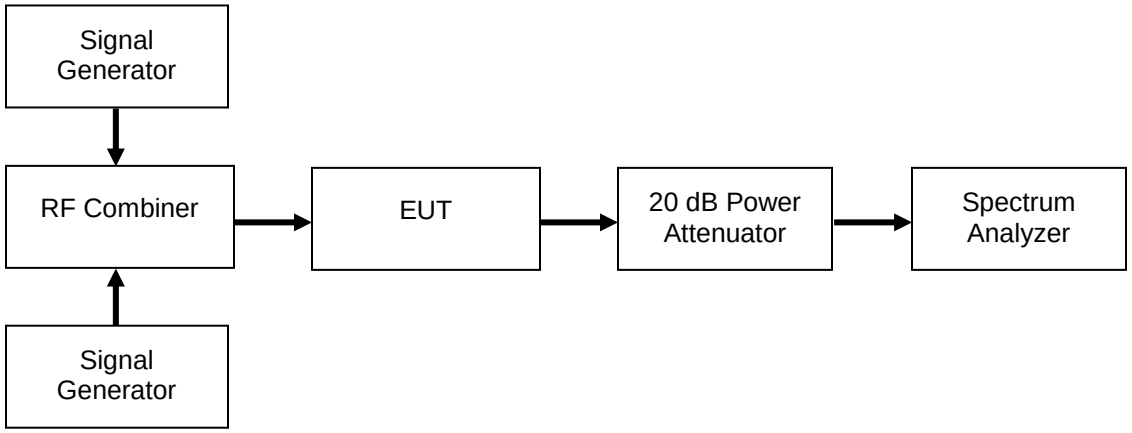
Test Procedure

The EUT was connected to a spectrum analyzer through a 20 dB power attenuator. Two signal generators were utilized to produce a two tone signal with the 12.5 KHz channel spacing set so the intermodulation products fell within the operational band. Frequency at the maximum power from out of band rejection was utilized.

The RF input signal level was set to 0.2 dB below the AGC Threshold.
RBW = 300 Hz
Video BW = 3x RBW

The downlink intermodulation products within the operational band were examined and the maximum amplitude from the intermodulation signals was recorded in tabular form.

Test Setup

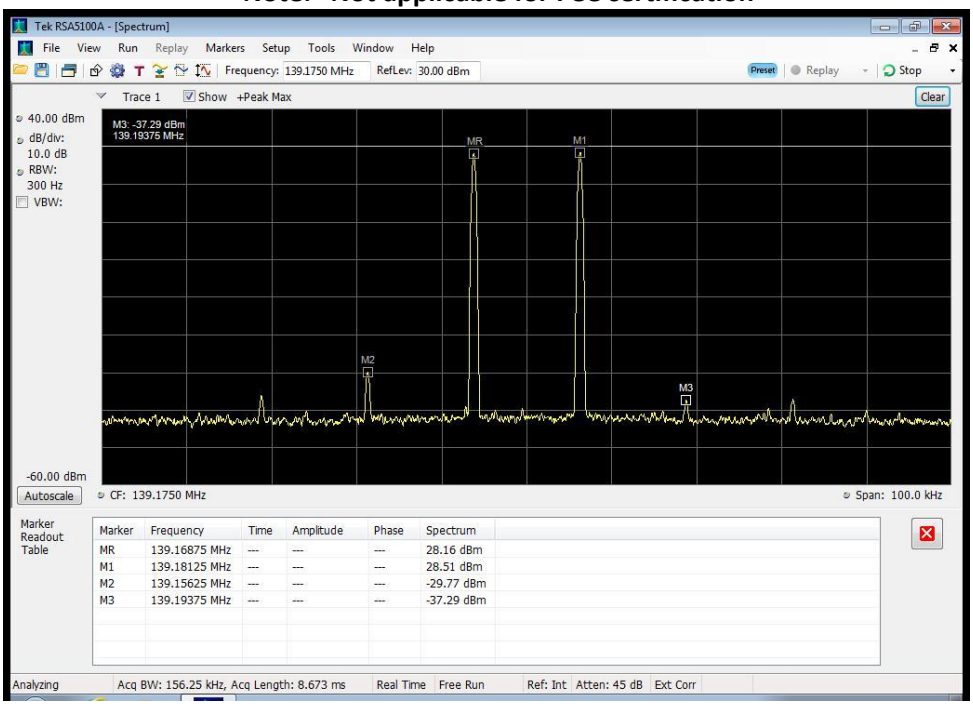


Input Frequency		Maximum Intermodulation Level	Limit	Margin
MHz	MHz	dBm	dBm	dB
139.16875 **	139.18125 **	-29.8	-13	-16.8
151.49375	151.50625	-23.1	-13	-10.1
161.99375	162.00625	-13.1	-13	-0.1
173.09375	173.10625	-28.8	-13	-15.8

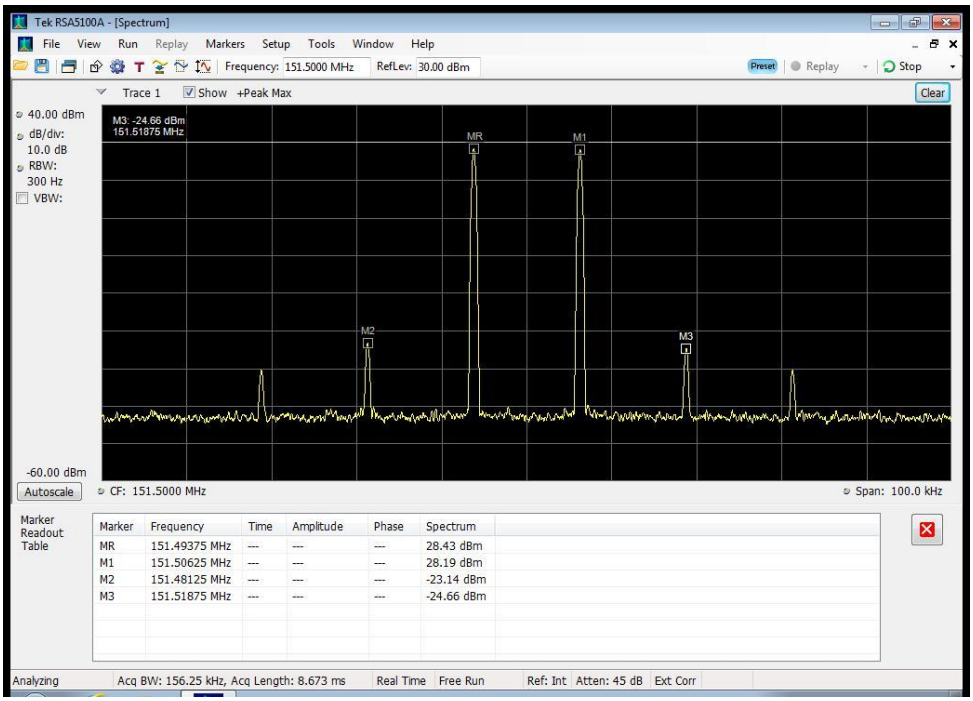
**** Note: "Not applicable for FCC certification"**

Intermodulation Test Plots

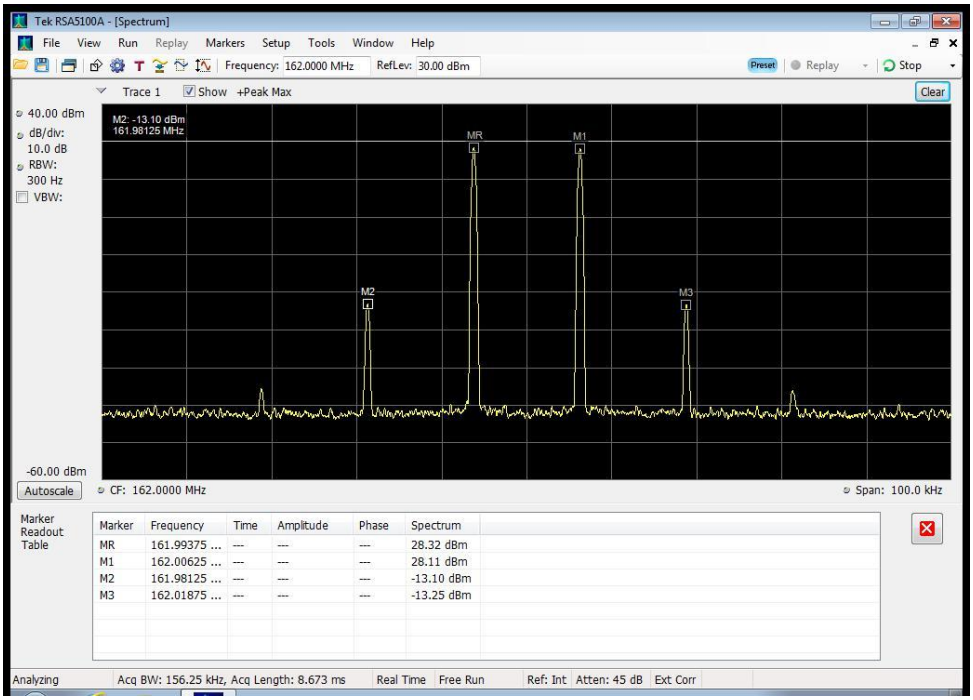
Tuned Frequency
139 MHz
** Note: “Not applicable for FCC certification”



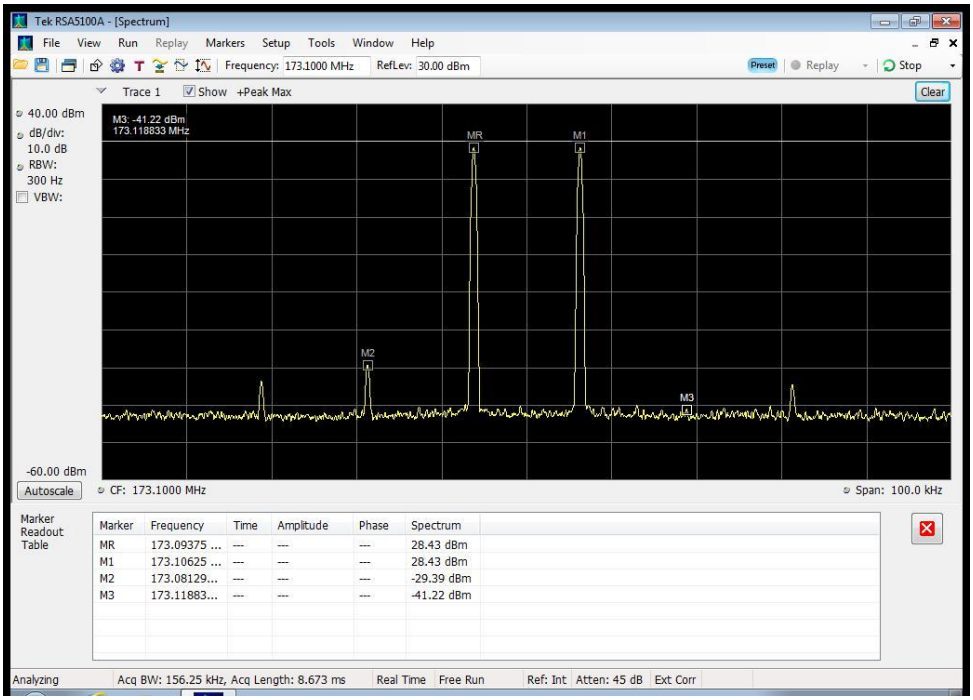
Tuned Frequency
151 MHz



Tuned Frequency
162 MHz



Tuned Frequency
173 MHz



Noise Figure Test
Engineer: Greg Corbin
Test Date: 9/12014

Test Procedure

The test equipment was connected as shown in the test set-up.

The noise figure was measured at the passband center frequency.
Noise figure was measured using the high power output.

Frequency (MHz)	Noise Figure (dB)	Limit	Margin
139 **	4.6	9	4.4
151	4.8	9	4.2
162	4.6	9	4.4
173	4.6	9	4.4

**** Note: "Not applicable for FCC certification"**

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	EMCO	3115	i00103	12/11/12	12/11/14
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	3/24/14	3/24/15
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	10/8/13	10/8/15
Signal Generator	HP	83650A	i00353	Verified on: 9/1/14	
EMI Analyzer	Agilent	E7405A	i00379	1/14/14	1/14/15
Signal Generator	Rohde & Schwarz	SMU200A	i00405	12/11/13	12/11/14
Spectrum Analyzer	Textronix	RSA5126A	i00424	9/22/13	9/22/14
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	11/26/13	11/26/15
Noise Figure Meter	HP	8970B	i00444	8/14/14	8/14/15
Noise Source	HP	346A	i00445	8/11/14	8/11/15
Downconverter for Noise Figure Meter	HP	8971C	i00450	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