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Test Report

Prepared for: G-Wave Incorporated

Model: BDA-PS7W-37/37-90-R

Description: Bi-Directional amplifier (BDA), for the PS 700 MHz band

Serial Number: 15051002

FCC ID: Q8KPS7W3790R

To

FCC Part 90

Date of Issue: January 21, 2016

On the behalf of the applicant:	**G-Wave Incorporated** **38 Leuning St.** **South Hackensack, NJ 07606**
Attention of:	**Greg David, VP of Engineering** **Ph: (201)343-6388** **E-Mail: tech-support@gwaverf.com**

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Greg Corbin

Greg Corbin
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	December 1, 2015	Greg Corbin	Original Document
2.0	January 21, 2016	Greg Corbin	Updated the emission designator table

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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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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 D05 Booster, and 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)**
24.3 – 29.2	41.1 – 53.0	962.1 – 969.9

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

EUT Description
Model: BDA-PS7W-37/37-90-R
Description: Bi-Directional amplifier (BDA), for the PS 700 MHz band
Serial Number: 15051002

Additional Information:
The EUT is classified as a Part 90 PS **Class B** industrial signal booster

The EUT is a Bi-directional Amplifier that operates from 758 - 775 MHz (Base to Mobile) and 788 - 805 MHz (Mobile to Base).

System Power is 120 VAC @ 60 Hz.

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

Frequency	Emission Designators
758 - 775 MHz 788 - 805 MHz	F3E, G1D, G1E, G7W, W7D

EUT Operation during Tests

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

30 dB, 50 watt attenuators were installed on both RF ports for all tests.

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 10^{th}'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.

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

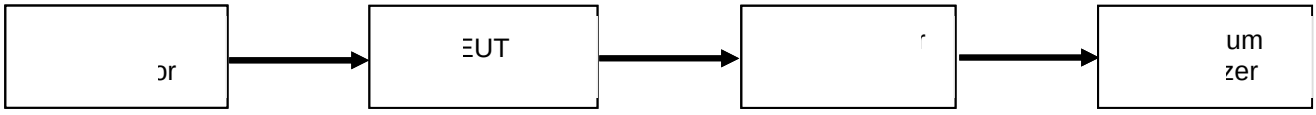
Specification	Test Name	Pass, Fail, N/A	Comments
KDB 935210-D05	Out of Band Rejection	Pass	
2.1046	Output Power (Conducted)	Pass	
90.219(e)(1)	Radiated Output Power	Pass	
90.210 2.1049	Occupied Bandwidth (Emission Masks)	Pass	
90.219(e)(3) 2.1051	Spurious Emissions (Transmitter Conducted)	Pass	
90.543(e) 90.543(f)	Spurious Emissions (Transmitter Conducted)	Pass	
2.1053	Radiated Spurious Emissions	Pass	
KDB 935210-D05	Intermodulation	Pass	
90.219(e)(2)	Noise Figure	Pass	
90.213	Frequency Stability (Temperature Variation)	N/A	
90.213	Frequency Stability (Voltage Variation)	N/A	

Out of Band Rejection
Engineer: Greg Corbin
Test Date: 9/22/2015

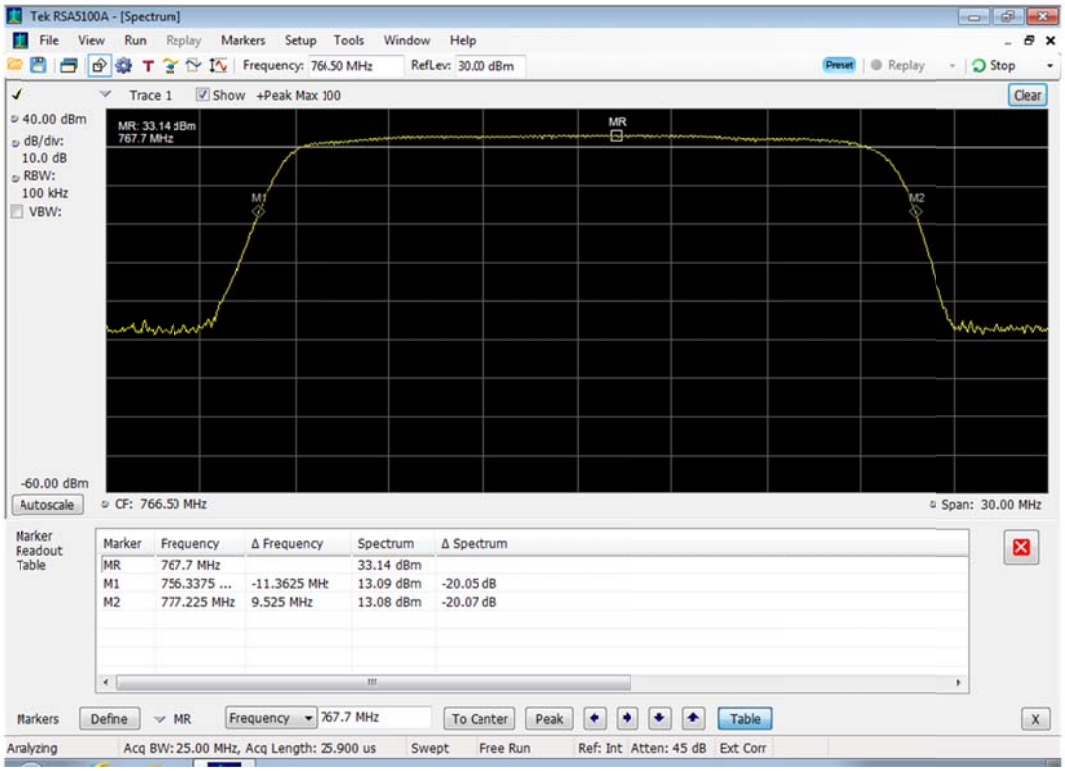
Test Procedure

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 to 3 dB below the AGC Threshold level. The Uplink and Downlink filter response and the -20 dB bandwidth were measured. 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

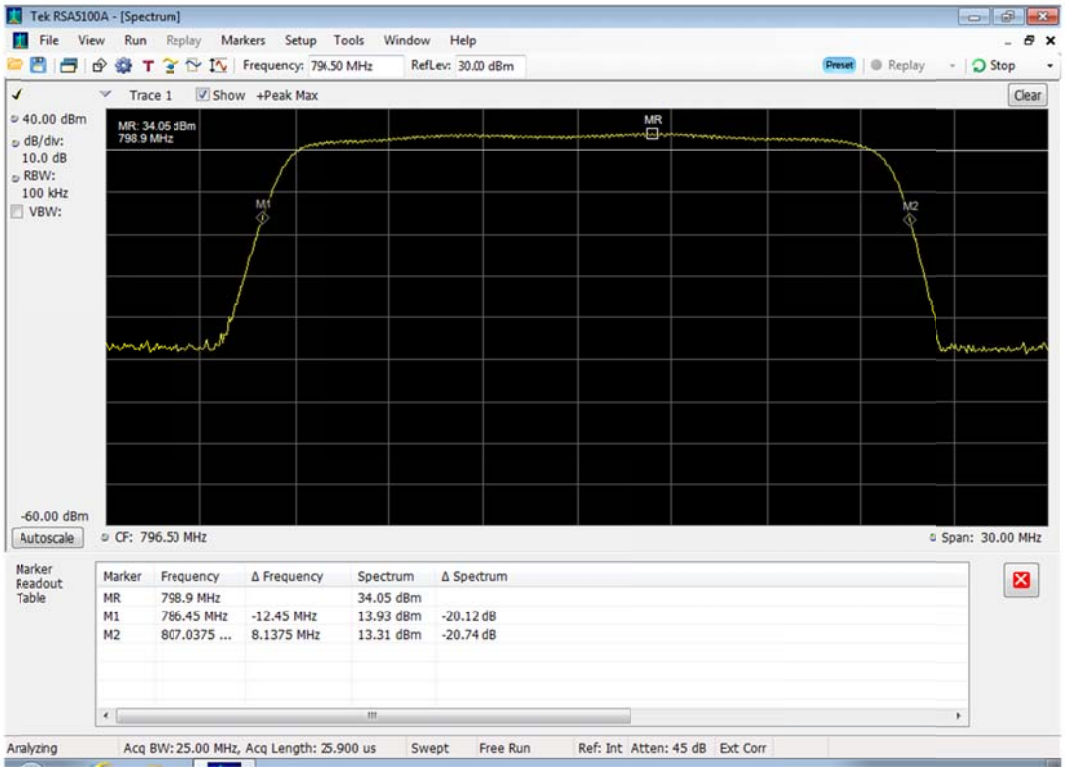
Test Setup



Out of Band Rejection Test Plots
758 – 775 MHz



788 – 805 MHz



Conducted Output Power and Amplifier Gain

Engineer: Greg Corbin

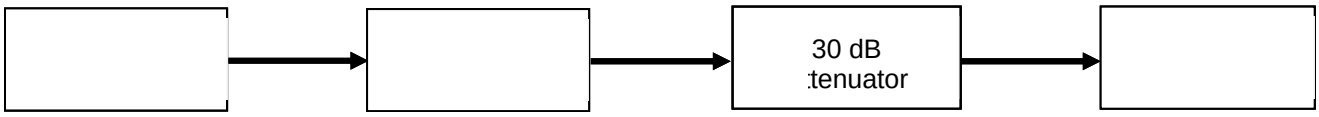
Test Date: 12/22/2015

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 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

Frequency Range (MHz)	Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
758 - 775	767.7	-49.0	36.0	85.0
788 - 805	798.9	-49.4	36.0	85.4

Radiated Output Power
Radiated Power (ERP) is dependent on the cable loss and antennas used when installed.
The electrical specifications provided by the manufacturer list the Composite Output Power as +37 dBm ± 1dB.

Conducted Spurious Emissions
Engineer: Greg Corbin
Test Date: 9/25/2015

Test Procedure

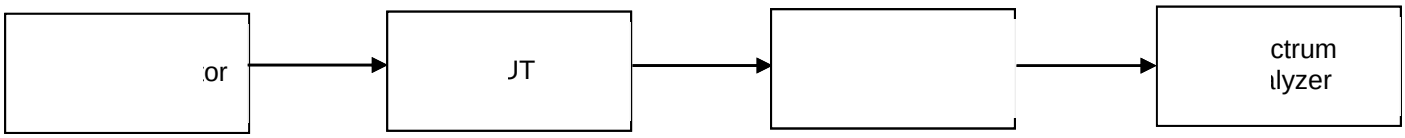
The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings were obtained.
A CW signal was utilized, set to the low, middle, high frequency within the passband.
The RF input signal level was set to 0.2 dB below the AGC Threshold.

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



Refer to Annex A for Conducted Spurious Emissions Plots

Conducted Spurious Emissions_Additional Tests for §90.543
Engineer: Greg Corbin
Test Date: 12-22-2015

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 highest frequency measured in the Out of Band Rejection test.
The RF input signal level was set to 0.2 dB below the AGC Threshold.

§90.543(e)
(e) For operations in the 758-768 MHz and the 788-798 MHz bands, 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:
(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.
(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.
(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

§90.543(f)
For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics 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.

The following formulas were used for calculating the limits.

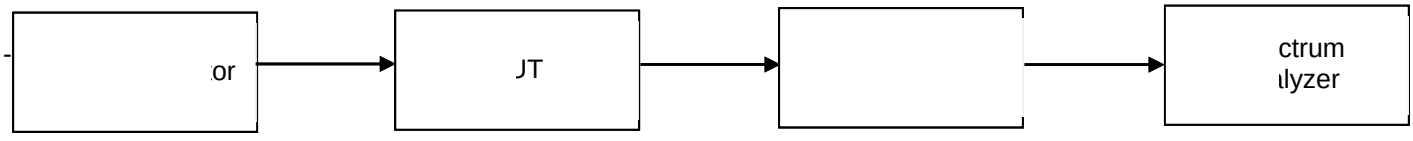
Conducted Spurious Emissions Limit = P1 – (76+ 10Log(P2)) = -46 dBm
Conducted Spurious Emissions Limit = P1 – (65+ 10Log(P2)) = -35 dBm
Conducted Spurious Emissions Limit = P1 – (43+ 10Log(P2)) = -13 dBm
P1 = power in dBm
P2 = power in Watts

The spurious emission limit is an EIRP limit, so the EIRP level of the spurious emission was calculated using the following formula.

EIRP (dBm) = Measured Spurious Level (dBm) + Antenna Gain (dBi)

Note: 2 antennas are specified f0r use with this system. The highest gain antenna was used in calculating the worst case spurious emission EIRP limit for *§90.543(f)*.
A directional antenna mdl: TDJ-700/2500YG with a maximum antenna gain of 8.5 dB.
A Wideband high Gain Ceiling mount antenna with a maximum gain of 2 dBi.

Test Setup



Refer to Annex B for Conducted Spurious_90.943e and 90.943f plots

Radiated Spurious Emissions
Engineer: Greg Corbin
Test Date: 9/30/2015

Test Procedure

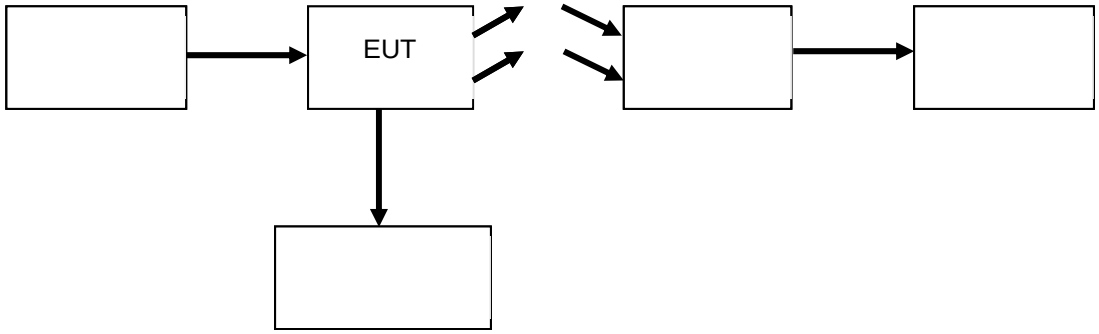
The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation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

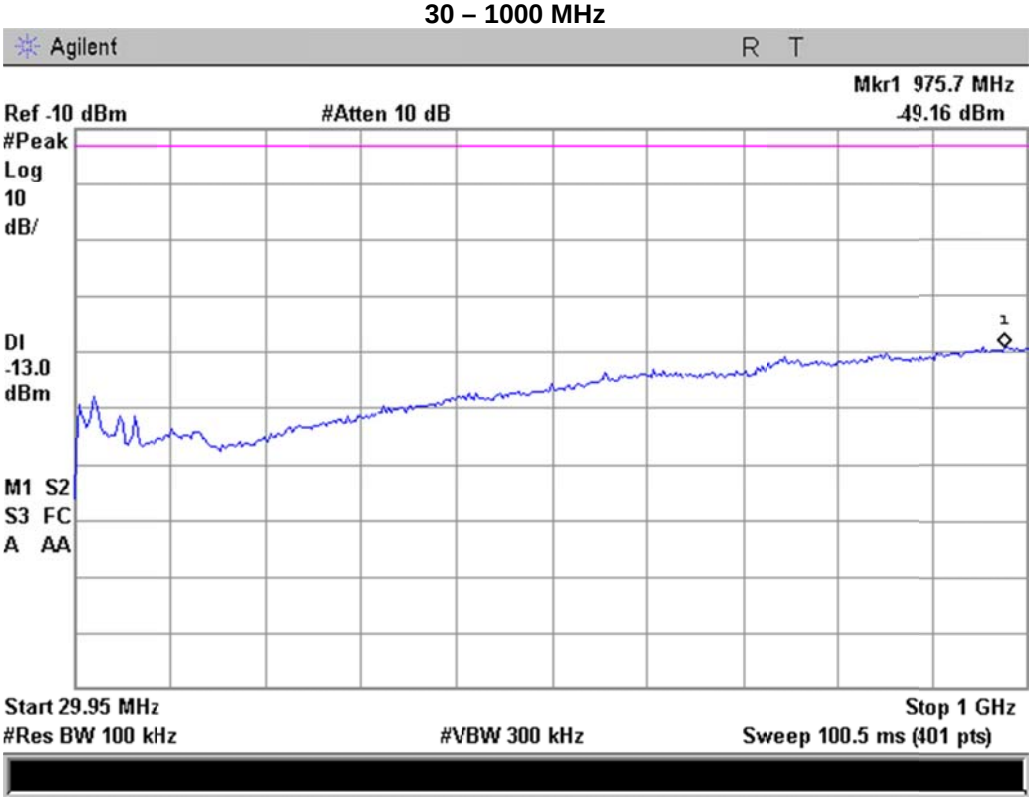
Radiated Spurious Emissions Limit = P1 – (43+ 10Log(P2)) = -13dBm
P1 = power in dBm
P2 = power in Watts

Test Setup

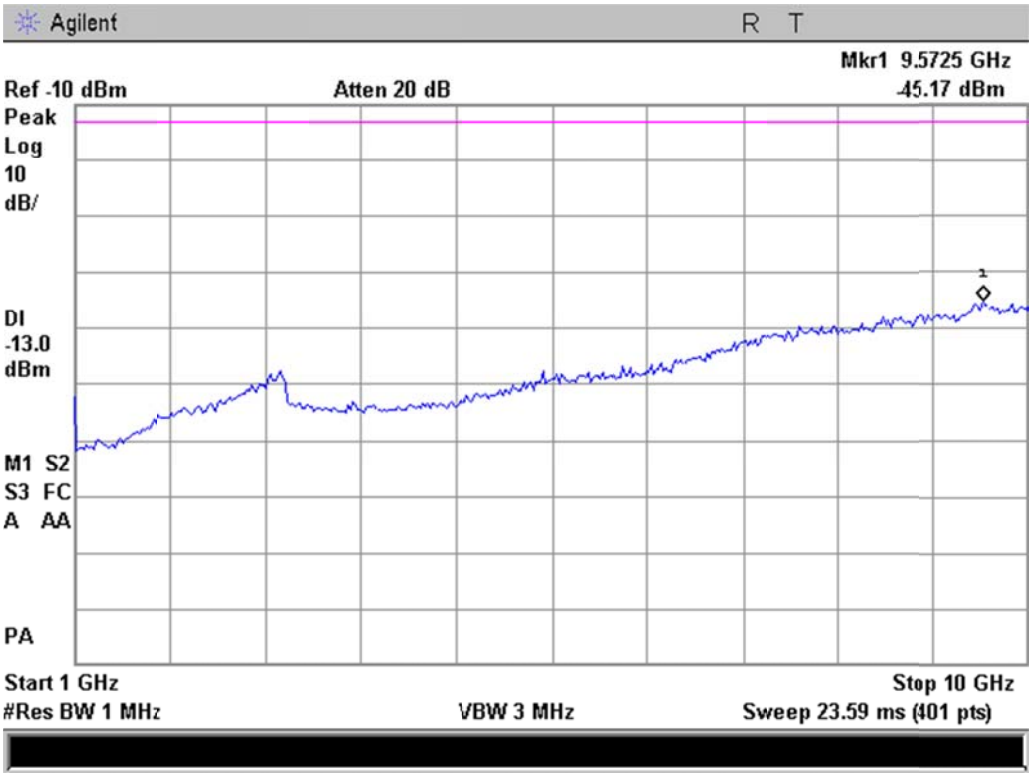


All emissions were below –13 dBm.

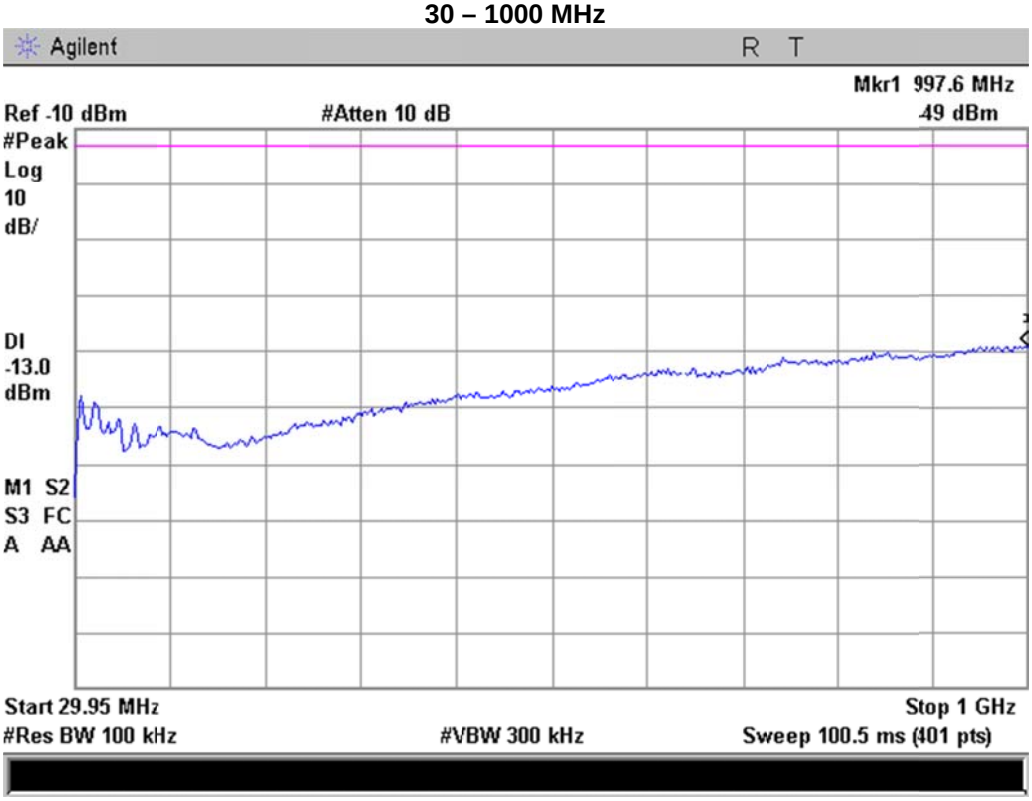
Radiated Spurious Emissions Plots
Tuned Frequency = 767.7 MHz
30 – 1000 MHz



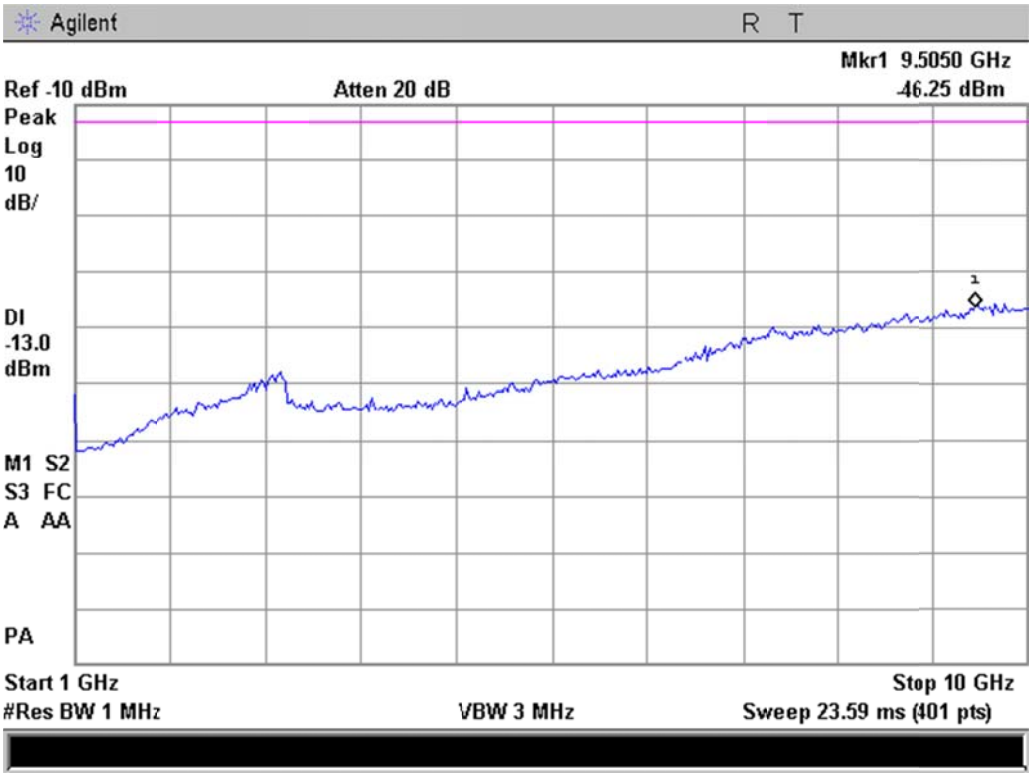
Tuned Frequency = 767.7 MHz
1 – 10 GHz



Tuned Frequency = 798.9 MHz
30 – 1000 MHz



Tuned Frequency = 798.9 MHz
1 – 10 GHz



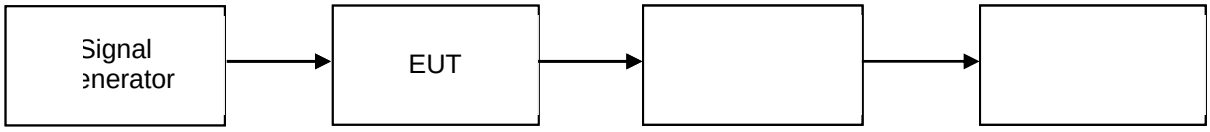
Emission Masks (Occupied Bandwidth)
Engineer: Greg Corbin
Test Date: 9/22/2015

Test 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 below.
Emission Masks were measured with the input power set to 0.2 dB below the AGC threshold level and at + 3dB above the AGC Threshold.
Input plots were recorded to for the input vs output comparison.

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
4K00F1E	C	FM	4	6.25	1.0	1.0	100
C4FM	C	Digital	4	6.25	N/A	N/A	100

Test Setup



Refer to Annex C for Emission Mask plots

Intermodulation
Engineer: Greg Corbin
Test Date: 12/1/2015

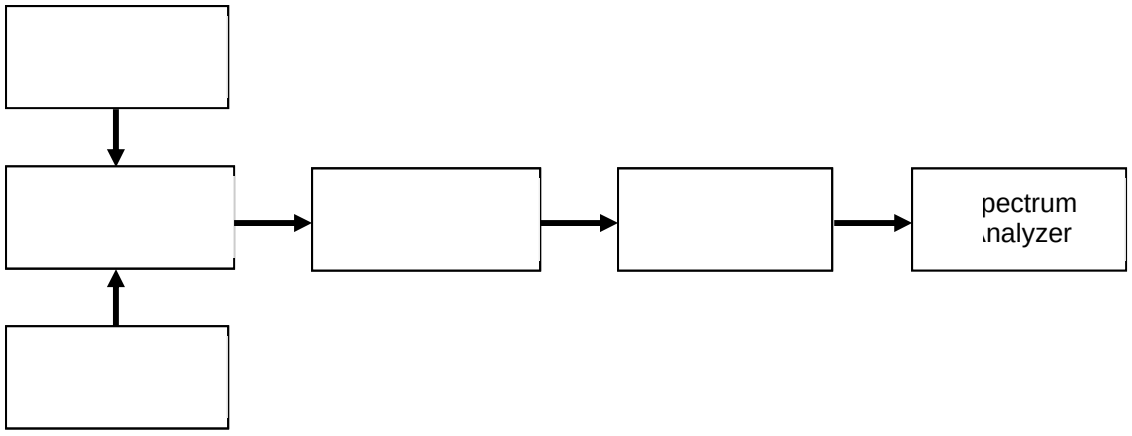
Test Procedure

The EUT was connected to a spectrum analyzer through a 30 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.

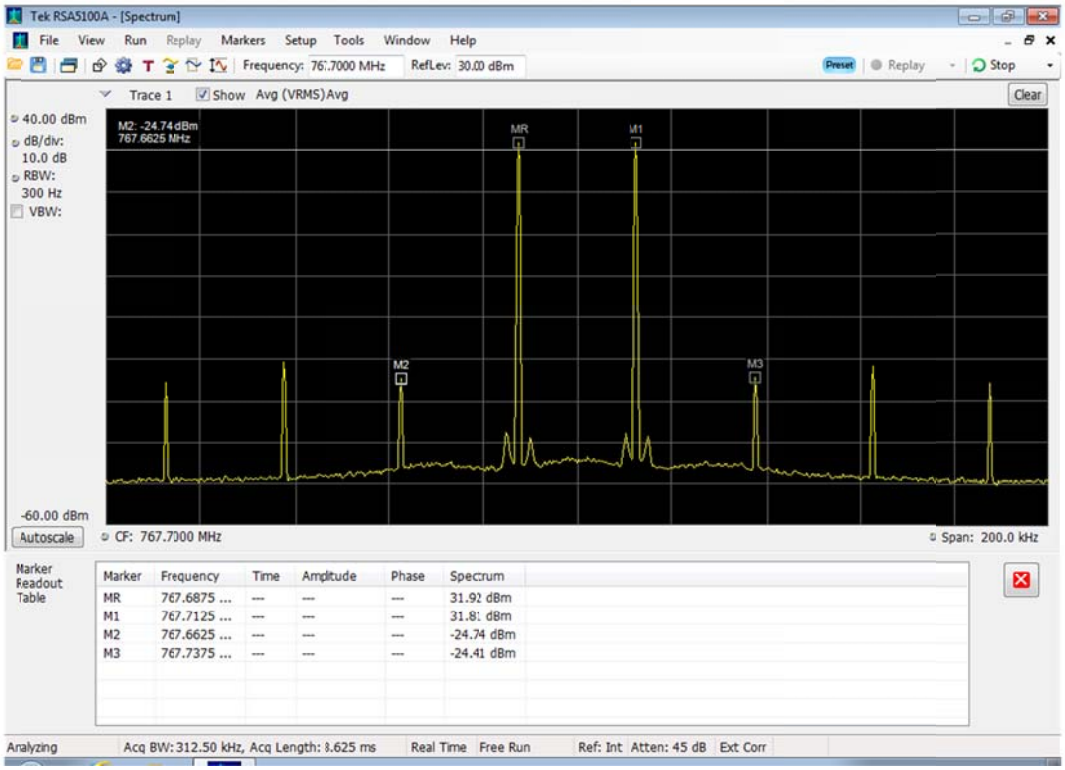
The RF input signal level was set to 0.2 dB below the AGC Threshold.
RBW = 200 Hz
Video BW = 3x RBW

Both directions (Base to Mobile) and (Mobile to Base) were tested. The results were captured in a spectrum analyzer plot and included in this test report.

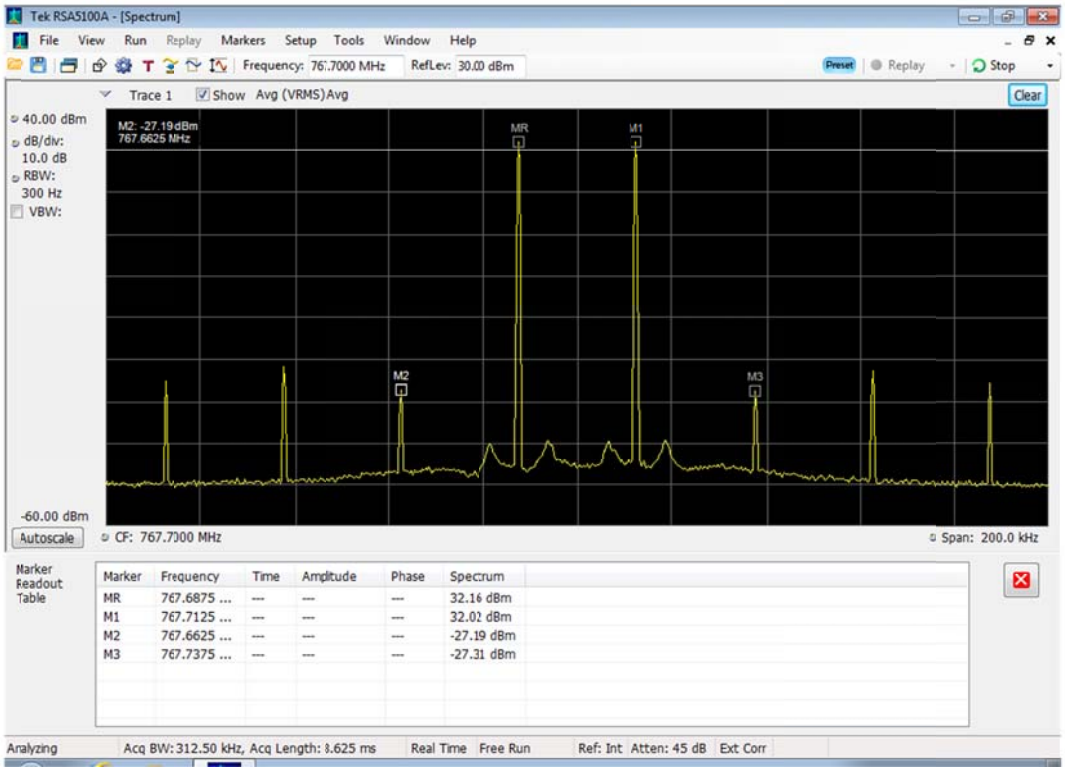
Test Setup



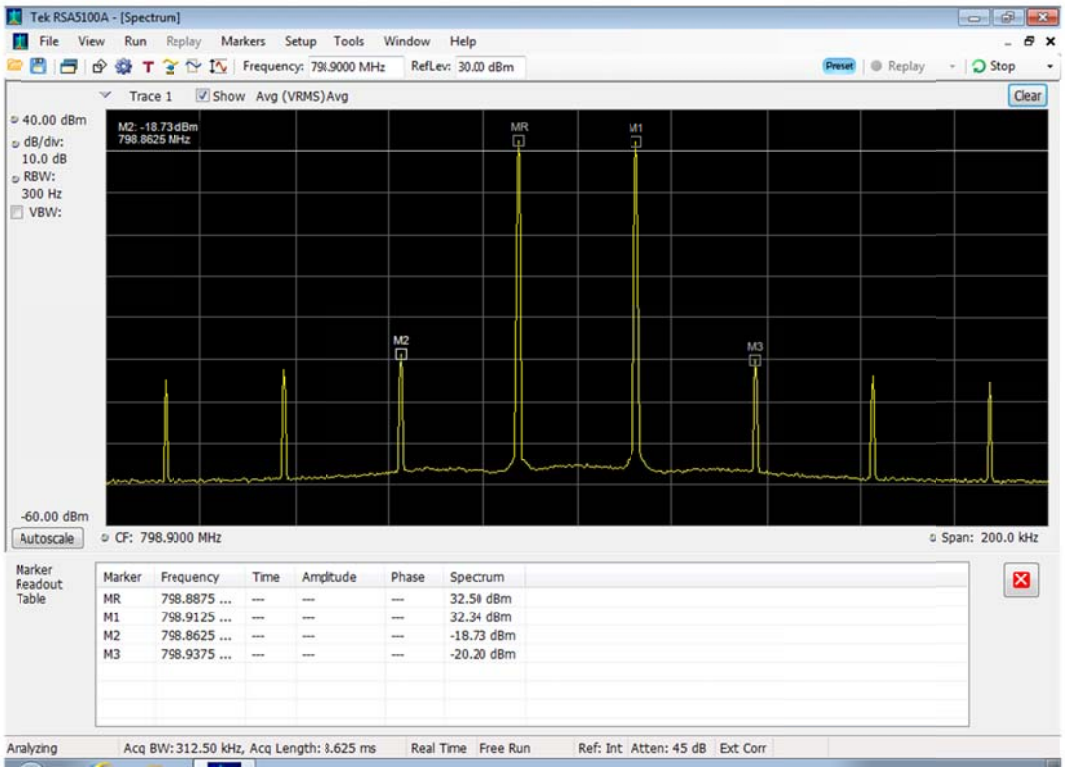
Intermodulation Test Data
758 – 775 MHz



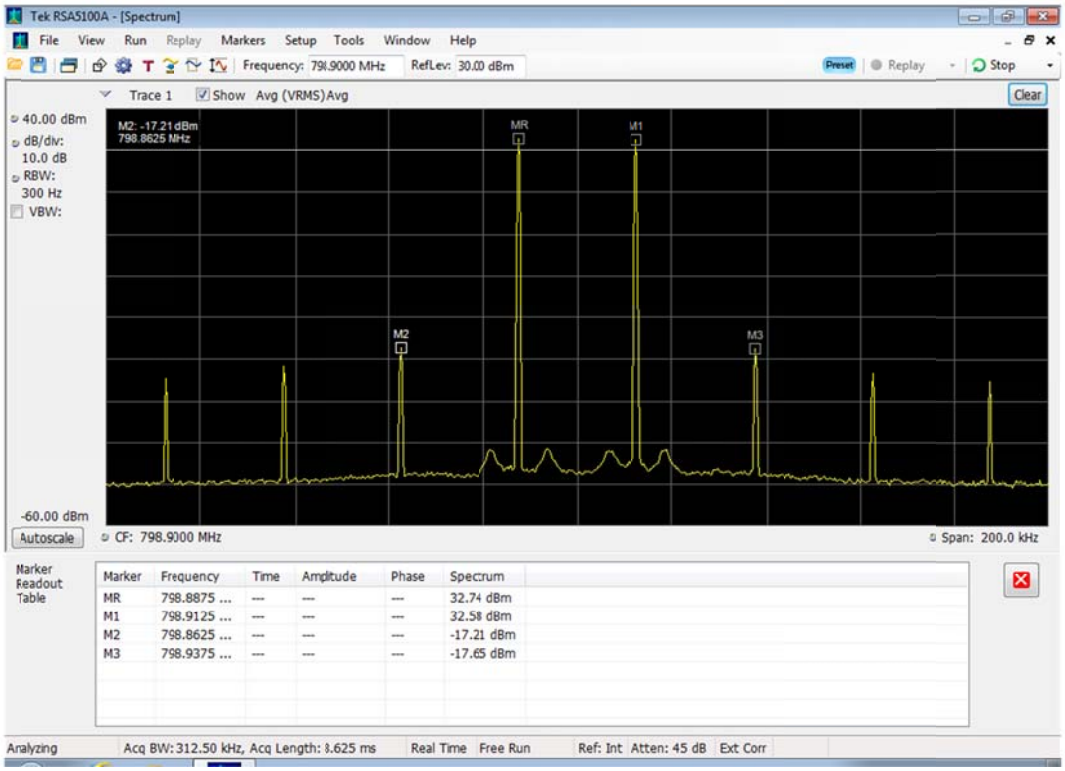
758 – 775 MHz_Pin + 3 dB



Intermodulation Test Data
788 - 805 MHz



788 - 805 MHz_Pin + 3 dB

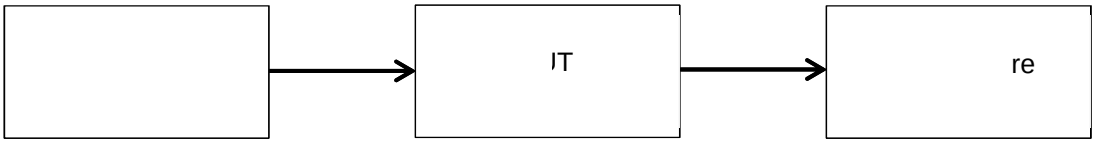


Noise Figure Test
Engineer: Greg Corbin
Test Date: 9/24/2015

Test Procedure

The test equipment was connected as shown in the test setup.

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
767.7	3.2	9	5.8
798.9	3.2	9	5.8

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	4/1/15	4/1/16
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	10/19/15	10/19/17
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	3/12/16
Noise Figure Meter	HP	8970B	i00444	8/13/15	8/13/16
Noise Source	HP	346A	i00445	8/13/15	8/13/16

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