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Test Report

Prepared for: G-Way Microwave

Model: BDA-UHF-36/36-80-R

**Description: Bi-Directional amplifier (BDA), amplify DL an UL frequencies in the UHF band.
The max composite power of this BDA is 36 dbm and has up to 80db gain, come within a rack enclosure**

Serial Number: 15031003

FCC ID: Q8KUHF3680R

To

FCC Part 90

Date of Issue: July 9, 2015

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) 343-6388** **E-Mail: t_blekher@gwaymicrowave.com**

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Project No: p1540002R

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	June 15, 2015	Greg Corbin	Removed radiated emission test data that does not apply to this enclosure from the table on page 13
3.0	June 17, 2015	Greg Corbin	Removed references to other enclosures on page 6.
4.0	July 9, 2015	Greg Corbin	Removed statement referring to “additional cavity filters” from the description on page 6. Added a table to the bottom of page 6 describing which test frequency was applied to each port. Removed extra radiated test photos that do not apply to this enclosure.

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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.

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

Testing Certificate Number: **2152.01**

FCC Site Reg. #349717

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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 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)**
24.2 – 27.9	23.6 – 33.4	960.4 – 968.2

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

EUT Description
Model: BDA-UHF-36/36-80-R
Description:
Bi-Directional amplifier (BDA), it is used to amplify DL an UL frequencies in the UHF band.
The max composite power of this BDA is 36 dBm, it has up to 80dB gain, and comes in an rack enclosure
Firmware: N/A
Serial Number: 15031003

Additional Information:
The EUT is classified as a **Class B** industrial signal booster
The EUT is a UHF Bi-directional Amplifier that operates from 406.1 – 430, and 450 – 512 MHz in both directions.
The system uses modules which have 2 MHz wide bandpass filters with the frequencies selected per the installation requirements.
The modules are the same electrically for the uplink and downlink.
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 - MHz	Emission Designators
406.1 – 430 MHz 450 – 512 MHz	F3E, F3D, F1E

Refer to the table below for which test frequencies were applied to each port and the direction of the signal path.

Signal path (Base to Mobile)	Signal Path (Mobile to Base)
Frequency (MHz)	Frequency (MHz)
407	416
420	429
451	460
502	511

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.

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

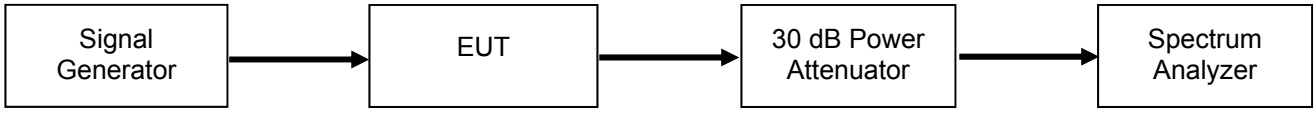
Specification	Test Name	Pass, Fail, N/A	Comments
KDB 935210-D03	Authorized Frequency Band	Pass	
2.1046	Output Power (Conducted)	Pass	
90.219(e)(1)	Radiated Output Power	Pass	
90.219(e)(4)(i)(ii)(iii) 90.210 2.1049	Occupied Bandwidth (Emission Masks)	Pass	
90.219(e)(3) 2.1051	Spurious Emissions (Transmitter 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: 5/20/2015

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 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



Refer to Annex A for Authorized Frequency Band plots.

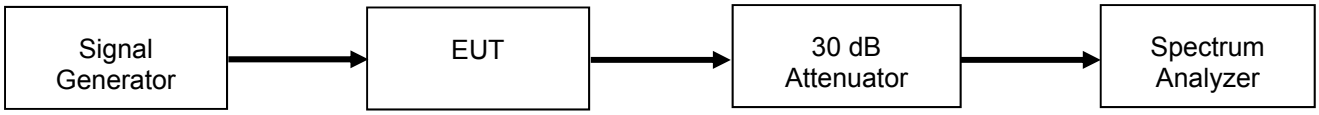
Conducted Output Power and Amplifier Gain
Engineer: Greg Corbin
Test Date: 4/23/2015

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)
406.25	-46.3	34.5	80.8
416.225	-47.0	35.2	82.2
419.725	-47.5	35.1	82.6
429.125	-46.2	35.1	81.3
450.475	-47.8	35.3	83.1
459.525	-48.1	35.2	83.3
501.425	-48.3	35.4	83.7
511.175	-48.8	35.2	84

Radiated Output Power
Radiated Power (ERP) is dependent on the cable loss and antennas used when installed.
The user manual specification for Composite Output Power is 36 dBm ± 1dB.

ALC (Automatic Level Control)
The user manual contains the following statement:
“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, as indicated in the specification.”

Conducted Spurious Emissions
Engineer: Greg Corbin
Test Date: 4/24/15

Test Procedure

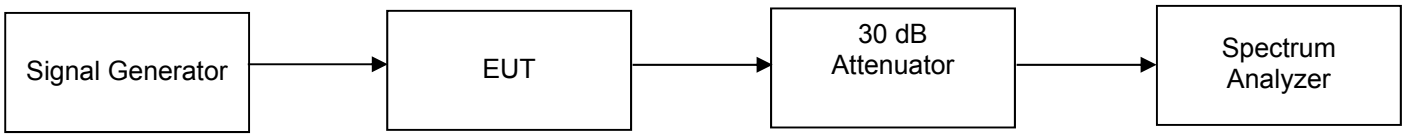
The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a combination of reference level offset and correction factor as needed to ensure accurate readings were obtained.
A CW signal 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 10^{th} 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
407	3462.5	-22.2	-13	Pass
416	3537.5	-27.5	-13	Pass
420	3625	-21.7	-13	Pass
429	3400	-21.6	-13	Pass
451	3475	-21.4	-13	Pass
460	4000	-21.5	-13	Pass
502	3475	-21.5	-13	Pass
511	3062.5	-21	-13	Pass

Refer to Annex B for Conducted Spurious Emissions Plots

Radiated Spurious Emissions
Engineer: Greg Corbin
Test Date: 6/1/2015

Test Procedure

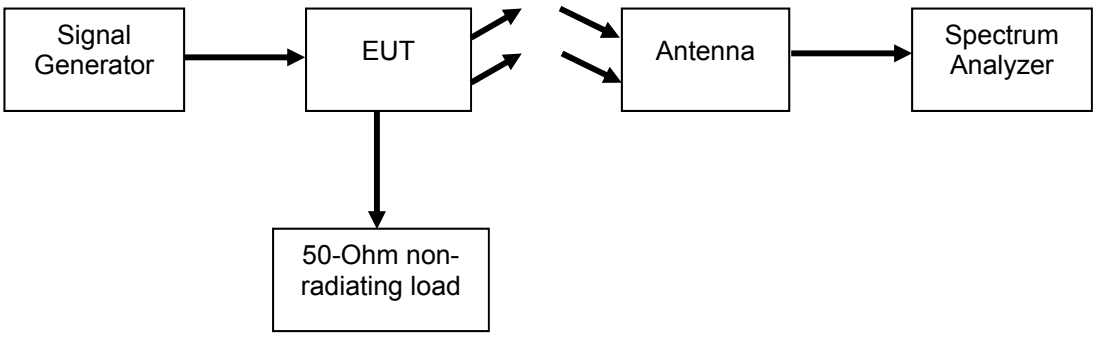
The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation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



Radiated Spurious Emissions Test Results

Enclosure Type	Tuned Frequency (MHz)	Measured Frequency (MHz)	Measured Level (dBm)	Limit (dBm)	Result
Rack	451	902	-80.3	-13	Pass
Rack	451	1353	-48.4	-13	Pass
Rack	451	1804	-44.5	-13	Pass
Rack	460	920	-80.9	-13	Pass
Rack	460	1380	-49.0	-13	Pass
Rack	460	1840	-45.9	-13	Pass

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

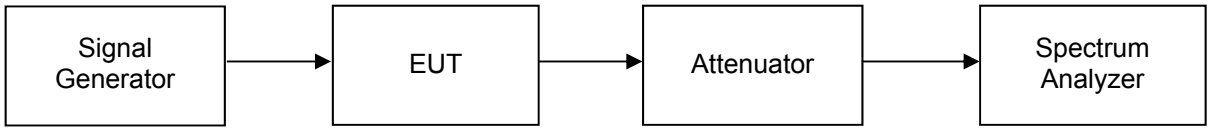
Emission Masks (Occupied Bandwidth)
Engineer: Greg Corbin
Test Date: 4/22/2015

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



Refer to Annex C for Emission Mask plots

Intermodulation
Engineer: Greg Corbin
Test Date: 4/23/2015

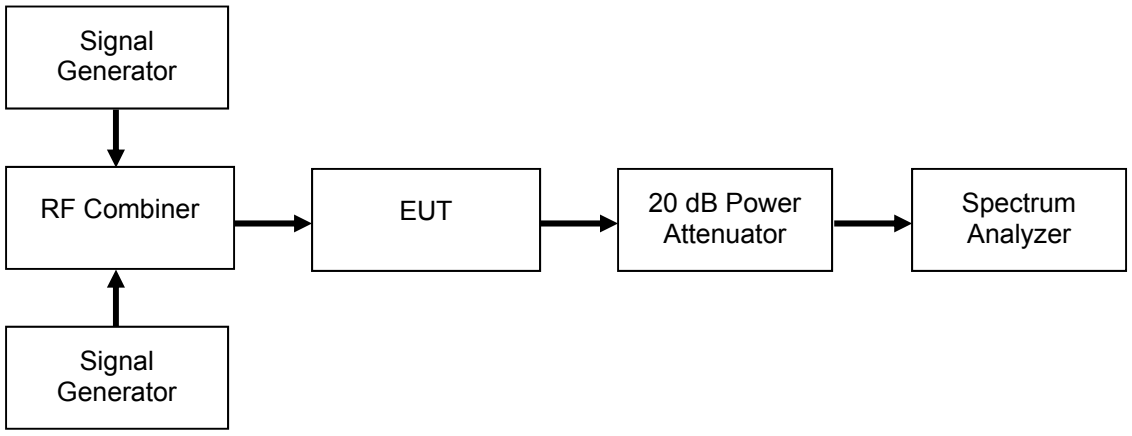
Test Procedure

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 (MHz)		Maximum Intermodulation Level (dBm)	Limit (dBm)	Margin (dB)
406.2375	406.6275	-19.0	-13	-6.0
416.2125	416.2375	-26.5	-13	-13.5
419.7125	419.7375	-21.2	-13	-8.2
429.1125	429.1375	-16.1	-13	-3.1
450.4625	450.4875	-18.1	-13	-5.1
459.5125	459.5375	-26	-13	-13.0
501.4125	501.4375	-22.9	-13	-9.9
511.1625	511.1875	-21.5	-13	-8.5

Refer to Annex D for Intermodulation plots

Noise Figure Test
Engineer: Greg Corbin
Test Date: 4/24/2015

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
407	4.5	9	-4.5
416	3.0	9	-6.0
420	7.4	9	-1.6
429	3.1	9	-5.9
451	7.2	9	-1.8
460	3.1	9	-5.9
501	6.8	9	-2.2
511	2.9	9	-6.1

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
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	4/1/15	4/1/16
Spectrum Analyzer	Agilent	E4407B	i00331	6/13/14	6/13/15
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
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