



Test Report

Prepared for: G-Way Microwave

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

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 AB enclosure

FCC ID: Q8KUHF3680AB

To

FCC Part 90

Date of Issue: July 9, 2015

On the behalf of the applicant:

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Test Report Revision History

| Revision | Date | Revised By | Reason for Revision |
|-----------------|---------------|-------------------|--|
| 1.0 | June 3, 2015 | 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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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 (°C) | 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-AB

Description:

Bi-Directional amplifier (BDA), it is used to amplify DL and 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 AB enclosure.

Firmware: N/A

Serial Number: 15021002, 15031004

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

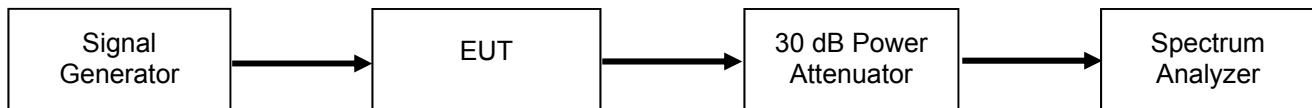
Test Procedure

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 to 3 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.

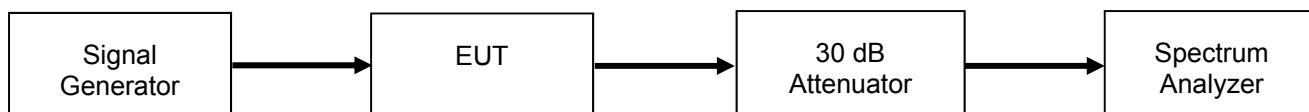
RBW = 100 kHz

Video BW = 3x RBW

The Input and Output power levels were recorded and the gain was calculated using the following formula:

$$\text{Gain (dB)} = \text{Output Power (dBm)} - \text{Input Power (dBm)}$$

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 \pm 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: 4/24/2015

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 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.

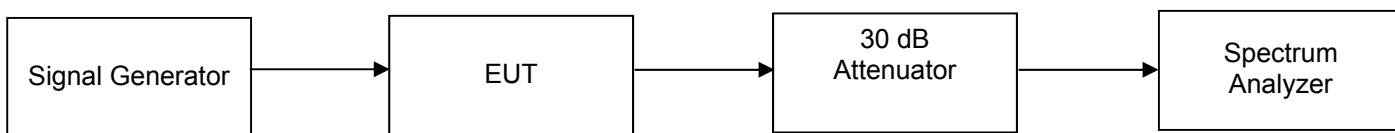
The following formula was used for calculating the limits.

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

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.

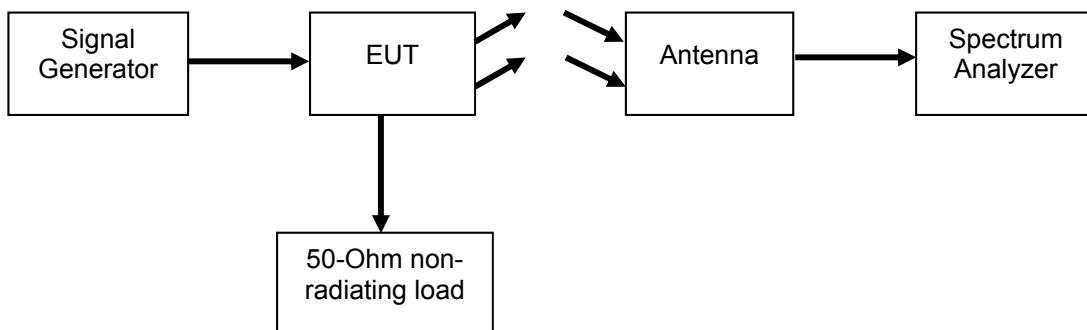
The following formula was used for calculating the limits:

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

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 |
|----------------|-----------------------|--------------------------|----------------------|-------------|--------|
| AB | 420 | 840 | -81.2 | -13 | Pass |
| AB | 420 | 1260 | -48.1 | -13 | Pass |
| AB | 420 | 1680 | -46.7 | -13 | Pass |
| AB | 429 | 858 | -81 | -13 | Pass |
| AB | 429 | 1287 | -48.2 | -13 | Pass |
| AB | 429 | 1716 | -45.5 | -13 | Pass |
| AB | 502 | 1004 | -50.2 | -13 | Pass |
| AB | 502 | 1506 | -45.4 | -13 | Pass |
| AB | 502 | 2008 | -43.9 | -13 | Pass |
| AB | 511 | 1022 | -50.1 | -13 | Pass |
| AB | 511 | 1533 | -47.1 | -13 | Pass |
| AB | 511 | 2044 | -44.0 | -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

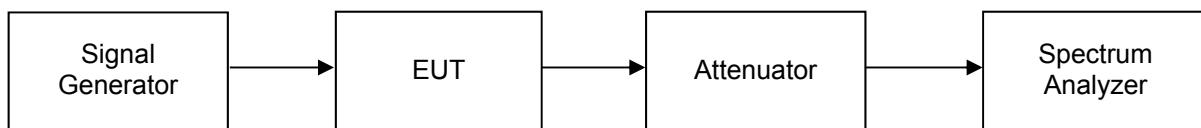
Measurement Procedure

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.

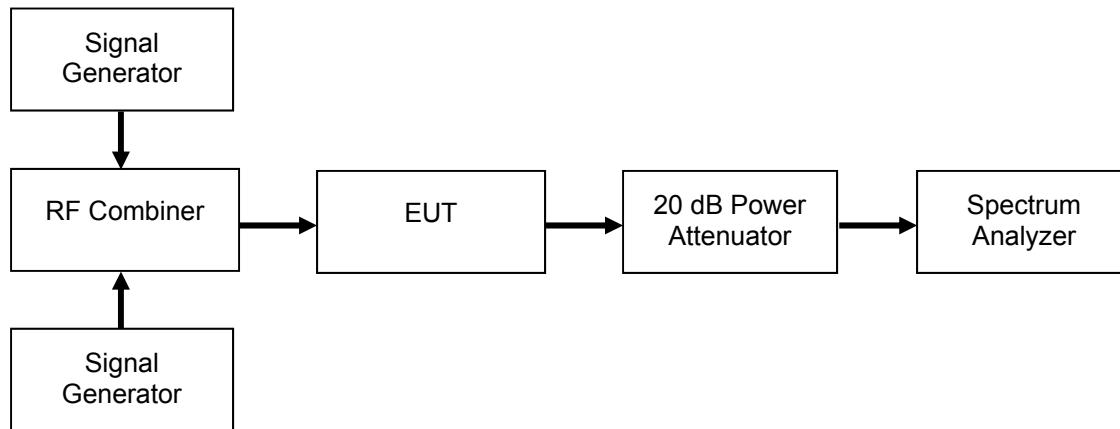
The RF input signal level was set to 0.2 dB below the AGC Threshold.

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 |

*90-day cal extension with lab manager's approval

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