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toll-free: (866) 311-3268
fax: (480) 926-3598
<http://www.ComplianceTesting.com>
info@ComplianceTesting.com

Test Report

Prepared for: G-Way Incorporated

Model: BDA-PS7W/PS8NEPS-37/37-90-C

Description: Public Safety 700/800 MHz Band Bi-Directional Amplifier

Serial Number: 16061001

FCC ID: Q8KPS7W83790

To

FCC Part 90

Date of Issue: July 13, 2016

On the behalf of the applicant:

G-Way Incorporated
38 Leuning St.
South Hackensack, NJ 07606

Attention of:

Gregory Tsvika Blekher, Project Engineer
Ph: (201)343-6388
E-Mail: tech-support@gwaverf.com

Prepared By
Compliance Testing, LLC
1724 S. Nevada Way
Mesa, AZ 85204
(480) 926-3100 phone / (480) 926-3598 fax
www.compliancetesting.com
Project No: p1660016

Greg Corbin
Project Test Engineer

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Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	June 29, 2016	Greg Corbin	Original Document
2.0	July 13, 2016	Greg Corbin	Updated Output power table on page 11. Updated radiated emission plots in Annex C



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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 (°C)	Humidity (%)	Pressure (mbar)
27.6 – 35	19.4 – 24.7	961.1 – 970.5

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

EUT Description

Model: BDA-PS7W/PS8NEPS-37/37-90-C

Description: The industrial booster is a Bi-Directional amplifier (BDA), used to amplify DL an UL frequencies in the PS 700/800 MHz band.

Firmware: N/A

Serial Number: 16061001

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 in the Frequency ranges listed in Table 1.

System Power is 120 VAC @ 60 Hz.

The emission designators listed in Table 1 are representative emission designators used by transmitters whose signal is amplified by this booster.

Table 1

Frequency		Emission Designators
Base to Mobile	Mobile to Base	
758 - 775	788 - 805	F3E, G1D, G1E, W7W, F2D
851 - 862	806 - 817	F3E, G1D, G1E, W7W, F2D

EUT Operation during Tests

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

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



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	Out of Band Rejection	Pass	
2.1046	Output Power (Conducted)	Pass	
90.210 2.1049	Occupied Bandwidth (Emission Masks)	Pass	
2.1051	Spurious Emissions (Transmitter Conducted)	Pass	
2.1053	Radiated Spurious Emissions	Pass	
KDB 935210-D03	Intermodulation	Pass	
90.219(e)(2)	Noise Figure	Pass	
90.213	Frequency Stability (Temperature Variation)	N/A	No frequency translation
90.213	Frequency Stability (Voltage Variation)	N/A	No frequency translation



AGC Threshold

Engineer: Greg Corbin

Test Date: 6/21/2016

Test Procedure

A signal generator producing a CW signal was connected to the input of the EUT. A spectrum analyzer was connected to the EUT in order to monitor the output power levels. The input power level was increase in 1 dB increments until the power no longer increased. The input levels were recorded in the table below.

Spectrum Analyzer settings

Power Channel integration

RBW = 1-5% of EBW

Video BW = 3x RBW

Test Setup



Mobile to Base

Tuned Frequency (MHz)	AGC Threshold (dBm)
796.5	-51.3
811.5	-51.6

Base to Mobile

Tuned Frequency (MHz)	AGC Threshold (dBm)
766.5	-51.7
856.5	-47.3



Out of Band Rejection

Engineer: Greg Corbin

Test Date: 6/21/2016

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



Refer to Annex A for Out of Band Rejection plots.



Conducted Output Power and Amplifier Gain

Engineer: Greg Corbin

Test Date: 6/22/2016

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.

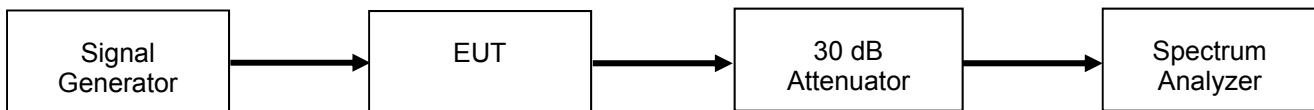
RBW = 100 kHz

Video BW = 3x RBW

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

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

Test Setup



Output Power and Gain Test Results

Mobile to Base

Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
796.5	-51.4	36.4	87.8
811.5	-51.6	35.2	86.8

Base to Mobile

Tuned Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
766.5	-52.0	35.6	87.6
856.5	-47.9	35.5	83.4

Radiated Output Power

Radiated Power (ERP) is dependent on the cable loss and antennas used when installed.

The manufacturers Electrical Specification for Composite Output Power is $37.0 \text{ dBm} \pm 1 \text{ dB}$.

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: 6/28/2016

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.

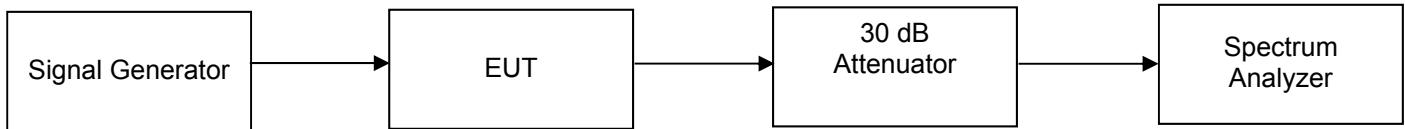
The following formula was used for calculating the limits.

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

P1 = power in dBm

P2 = power in Watts

Test Setup



Refer to Annex B for the Conducted Spurious Emissions Plots



For the 758-768 MHz and the 788-798 MHz bands of operation, the following additional spurious emissions requirements apply.

90.543 Emission Limitations

90.543(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.
- (4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.
- (5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

Refer to Annex B for the additional Conducted Spurious Emissions Plots for 90.543(e) emission limitations



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.

Since the limit is referenced to EIRP, the final data is computed using the Conducted Spurious Emission data and adding the BW correction factor (if required) plus the final gain/loss data from the antenna kitting information supplied by the manufacturer.

Note: the spectrum analyzer used for this test was able to set the RBW to the correct RBW so no RBW correction factor was applied

For the Narrowband measurement, the test can be performed using a 10 kHz RBW. Since the limit is referenced to a 700 Hz BW, the following correction factor is applied to the measured data.

BW correction Factor = $10\log B1/B2$

BW correction Factor = $10\log 700 / 10000 = -11.55 \text{ dB}$

Final Value (dBm) = conducted measurement +BW correction factor + final gain/loss from Antenna Kitting document

The Limit for discreet (narrowband) emissions is -80dBW (-50 dBm) in 700 MHz BW.

The Limit for (wideband Emissions) is -70 dBW (-40 dBm) in a 1 MHz BW.

758 - 775 MHz Band

Spurious Frequency Range (MHz)	Measured Frequency (MHz)	Measured Value (dBm)	Bandwidth Correction Factor (dB)	Gain/Loss from Antenna Kitting Information (dB)	Final Value (dBm)	Limit (dBm)	Margin (dB)
1559 – 1610 (Wideband)	1605.8	-51.7	0	8.5	-43.2	-40	-3.2
1559 – 1610 (Narrowband)	1607.35	-81	0	8.5	-72.5	-50	-22.5

788 - 805 MHz Band

Spurious Frequency Range (MHz)	Measured Frequency (MHz)	Measured Value (dBm)	Bandwidth Correction Factor (dB)	Gain/Loss from Antenna Kitting information (dB)	Final Value (dBm)	Limit (dBm)	Margin (dB)
1559 – 1610 (Wideband)	1569.6	-51.4	0	8.5	-42.9	-40	-2.9
1559 – 1610 (Narrowband)	1576	-76.9	0	8.5	-68.4	-50	-18.4

Refer to Annex B for the additional Conducted Spurious Emissions Plots for 90.543(f) emission limitations



Radiated Spurious Emissions

Engineer: Greg Corbin

Test Date: 6/28/2016

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.

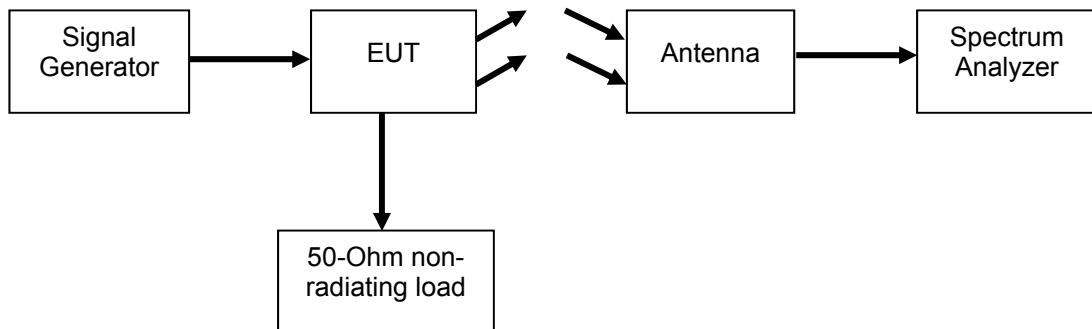
The following formula was used for calculating the limits:

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

P1 = power in dBm

P2 = power in Watts

Test Setup



Test Results

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

Refer to Annex C for the Radiated Spurious Emissions Plots



Emission Masks (Occupied Bandwidth)

Engineer: Greg Corbin

Test Date: 6/22/2016

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 in Table 1.

The input and output was recorded per KDB 935210 D05 v01r01.

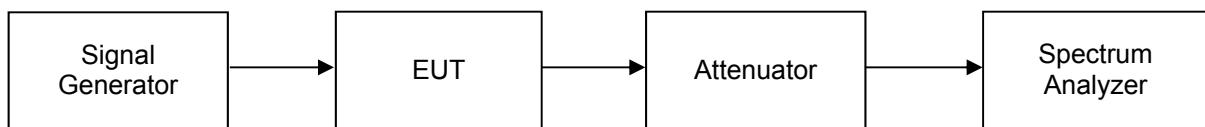
Emission Masks were measured with the RF Input set to 0.2 dB below AGC and 3.0 dB above the AGC Threshold per the latest edition of KDB 935210 D05.

The test was performed at the center frequency of the band of operation.

Occupied Bandwidth plots using a 4.1 MHz AWGN signal were recorded for the 758 – 768 MHz PS Broadband (FirstNet) passband.

Emission Mask	Type of Modulation	Audio Frequency (kHz)	Deviation (kHz)	RBW (Hz)
B	FM	1.0	5.0	300
C	FM, C4FM	1.0	2.5	100
G, H, §90.691	FM	1.0	2.5	100

Test Setup



Refer to Annex D for Emission Mask plots



OOBE / Intermodulation

Engineer: Greg Corbin

Test Date: 6/23/2016

Test Procedure

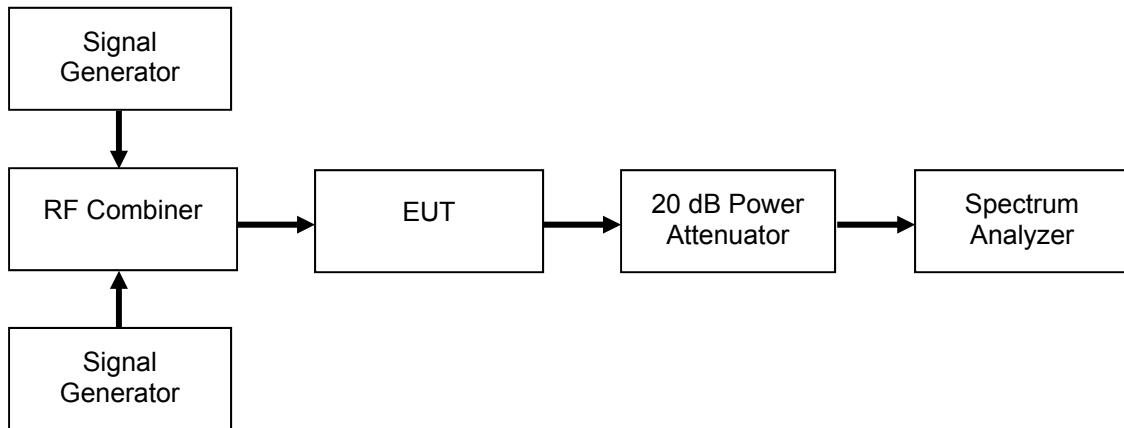
The EUT was connected to a spectrum analyzer through a 20 dB power attenuator. Two signal generators were utilized to produce a two tone signal with the 12.5 KHz channel spacing set so the intermodulation products fell within the operational band. Frequency at the maximum power from out of band rejection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

The test was performed with the RF input set to 0.2 dB below the AGC Threshold and 3 dB above the AGC Threshold.

RBW = 300 Hz

Video BW = 3x RBW

Test Setup



Refer to Annex E for OOBE / Intermodulation plots



Noise Figure Test

Engineer: Greg Corbin

Test Date: 6/23/2016

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 (dB)	Margin (dB)
766.5	2.6	9	6.4
796.5	2.2	9	6.8
811.5	2.1	9	6.9
856.5	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	5/26/16	5/26/17
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	10/19/15	10/19/17
EMI Analyzer	Agilent	E7405A	i00379	2/11/16	2/11/17
Signal Generator	Rohde & Schwarz	SMU200A	i00405	1/22/16	1/22/17
Spectrum Analyzer	Textronix	RSA5126A	i00424	3/28/16	3/28/17
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/27/14	7/27/16
Noise Figure Meter	Agilent	N8970B	i00444	8/13/15	8/13/16
Noise Source	Agilent	346A	i00445	8/28/15	8/28/16

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