

# 10.0-40.0 GHz GaAs MMIC Distributed Amplifier

December 2006 - Rev I9-Dec-06

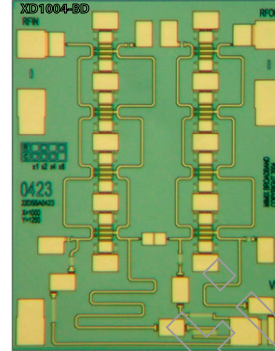
## Features

- ✕ Ultra Wide Band Driver Amplifier
- ✕ Self Biased Architecture
- ✕ 17.0 dB Small Signal Gain
- ✕ 5.0 dB Noise Figure
- ✕ 100% On-Wafer RF, DC and Output Power Testing
- ✕ 100% Visual Inspection to MIL-STD-883 Method 2010

## General Description

Mimix Broadband's 10.0-40.0 GHz GaAs MMIC distributed amplifier has a small signal gain of 17.0 dB with a noise figure of 5.0 dB. This MMIC uses Mimix Broadband's 0.15  $\mu\text{m}$  GaAs PHEMT device model technology, and is based upon electron beam lithography to ensure high repeatability and uniformity. The chip has surface passivation to protect and provide a rugged part with backside via holes and gold metallization to allow either a conductive epoxy or eutectic solder die attach process. This device is well suited for microwave, millimeter-wave, wideband military, and fiber optic applications.

## Chip Device Layout



## Absolute Maximum Ratings

Supply Voltage (Vd)	+6.0 VDC
Supply Current (Id)	175 mA
Input Power (Pin)	+17 dBm
Storage Temperature (Tstg)	-65 to +165 °C
Operating Temperature (Ta)	-55 to MTTF Table <sup>2</sup>
Channel Temperature (Tch)	MTTF Table <sup>2</sup>

(2) Channel temperature affects a device's MTTF. It is recommended to keep channel temperature as low as possible for maximum life.

## Electrical Characteristics (Ambient Temperature T = 25 °C)

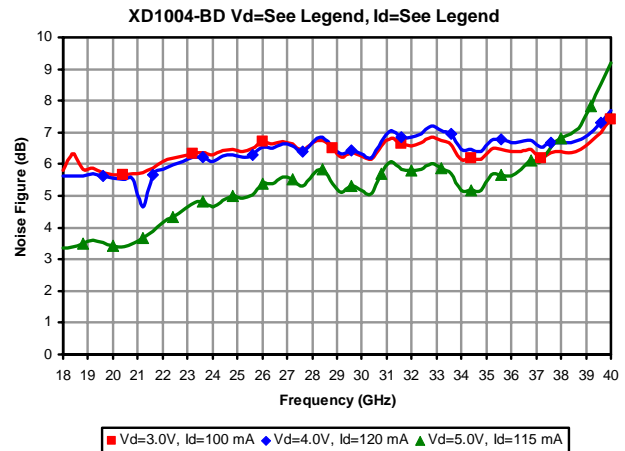
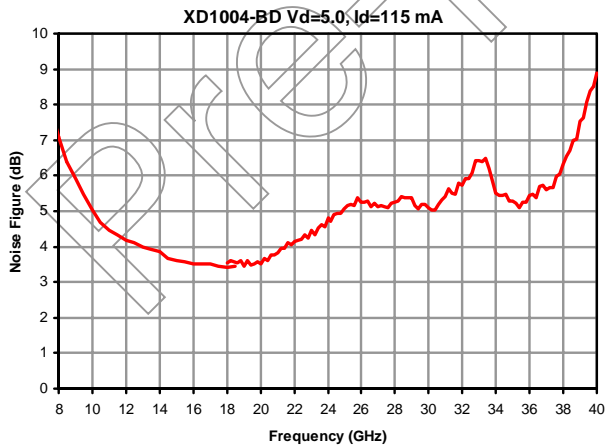
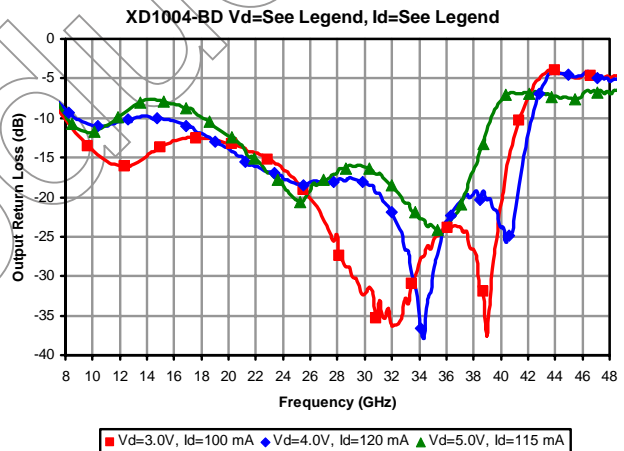
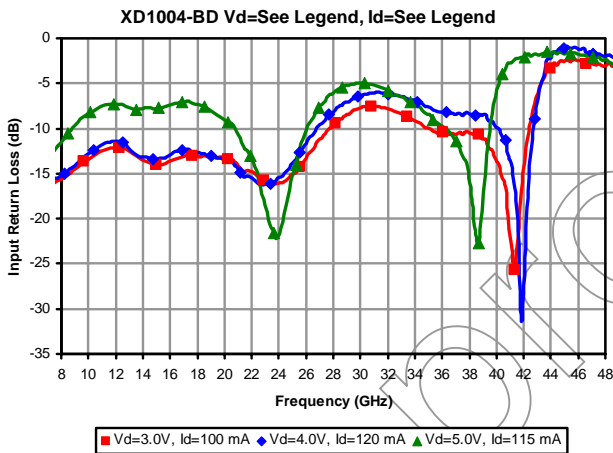
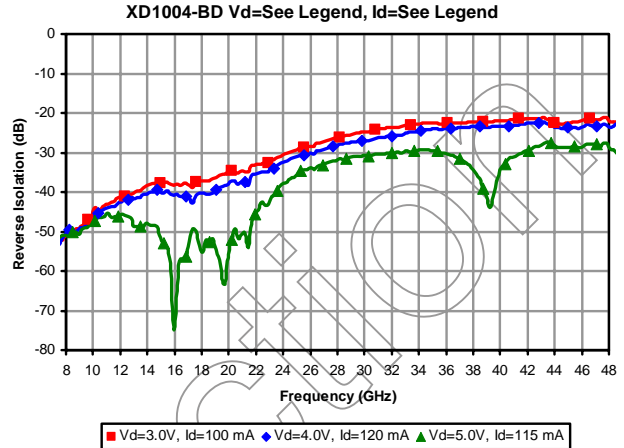
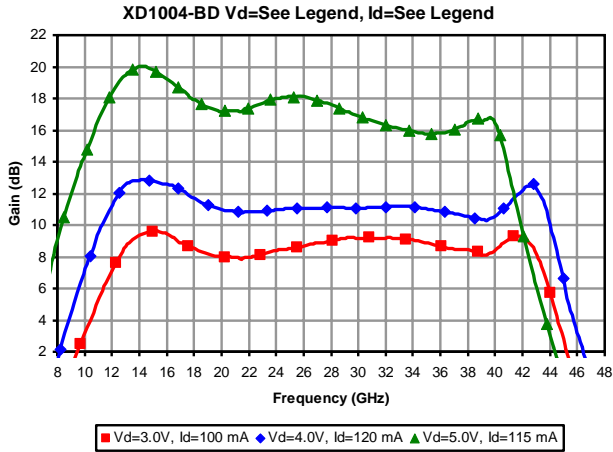
Parameter	Units	Min.	Typ.	Max.
Frequency Range (f)	GHz	10.0	-	40.0
Input Return Loss (S11)	dB	-	7.0	-
Output Return Loss (S22)	dB	-	12.0	-
Small Signal Gain (S21)	dB	-	17.0	-
Gain Flatness ( $\Delta S21$ )	dB	-	+/-2.5	-
Reverse Isolation (S12)	dB	-	30.0	-
Noise Figure (NF)	dB	-	5.0	-
Output Power for 1 dB Compression Point (P1dB) <sup>1</sup>	dBm	-	TBD	-
Drain Bias Voltage (Vd)	VDC	-	+5.0	+5.5
Supply Current (Id) (Vd=5.0V)	mA	-	115	145

(1) Measured using constant current.

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## Distributed Amplifier Measurements



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## S-Parameters

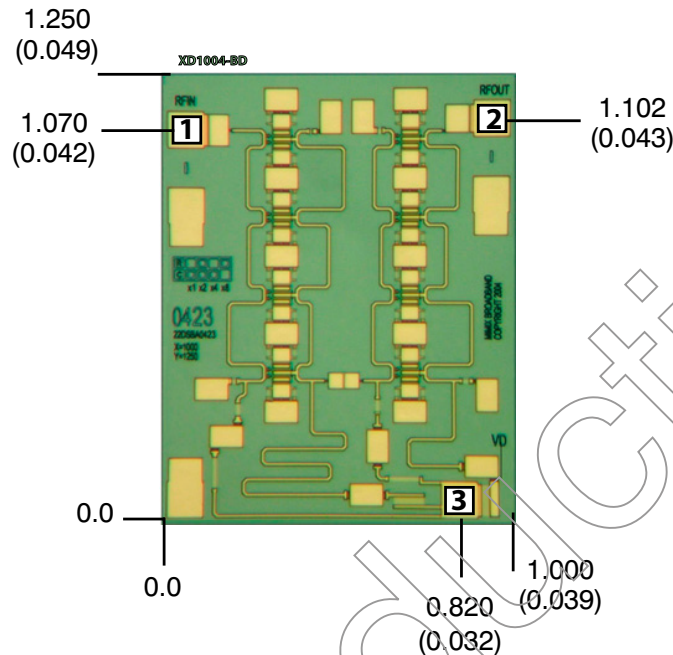
Typical S-Parameter Data for XD1004-BD  
Vd=5.0 V Id=115 mA

Frequency (GHz)	S11 (Mag)	S11 (Ang)	S21 (Mag)	S21 (Ang)	S12 (Mag)	S12 (Ang)	S22 (Mag)	S22 (Ang)
8.0	0.266	-84.45	2.817	79.53	0.0028	-71.28	0.329	75.78
9.0	0.327	-91.33	3.905	52.25	0.0029	-91.04	0.270	55.13
10.0	0.377	-101.79	5.149	25.97	0.0041	-105.02	0.255	34.10
11.0	0.424	-115.11	6.898	-6.89	0.0054	-143.98	0.287	3.96
12.0	0.433	-126.57	8.344	-34.99	0.0052	-164.64	0.332	-21.03
13.0	0.412	-135.70	9.429	-64.24	0.0036	167.86	0.374	-46.40
14.0	0.409	-139.41	10.013	-92.80	0.0040	162.52	0.415	-71.95
15.0	0.408	-144.24	9.785	-120.19	0.0027	128.36	0.406	-94.54
16.0	0.425	-148.34	9.206	-143.62	0.0002	108.13	0.392	-112.14
17.0	0.443	-158.58	8.446	-169.45	0.0024	-117.53	0.362	-132.18
18.0	0.429	-168.79	7.880	172.65	0.0017	-170.59	0.317	-145.22
19.0	0.393	-178.03	7.447	156.62	0.0019	131.67	0.275	-156.40
20.0	0.351	174.97	7.231	141.98	0.0016	-20.62	0.242	-163.29
21.0	0.302	165.61	7.260	126.80	0.0029	-73.56	0.212	-171.23
22.0	0.223	159.38	7.405	111.79	0.0053	-69.71	0.176	-174.25
23.0	0.109	167.48	7.721	91.59	0.0082	-83.98	0.141	-174.45
24.0	0.082	-136.03	7.961	73.39	0.0129	-96.11	0.114	-172.92
25.0	0.177	-104.33	8.048	54.71	0.0169	-112.12	0.095	-163.22
26.0	0.308	-108.68	8.049	35.90	0.0204	-129.34	0.109	-145.40
27.0	0.414	-122.58	7.843	16.71	0.0216	-137.60	0.128	-147.14
28.0	0.488	-134.12	7.618	-2.03	0.0250	-148.72	0.141	-150.12
29.0	0.545	-149.53	7.229	-24.45	0.0282	-160.89	0.156	-159.55
30.0	0.563	-160.84	6.955	-41.89	0.0289	-170.71	0.155	-170.40
31.0	0.551	-170.23	6.762	-59.40	0.0302	-176.93	0.141	179.45
32.0	0.514	-179.06	6.558	-76.39	0.0314	175.02	0.118	170.74
33.0	0.473	175.85	6.405	-93.81	0.0327	168.19	0.092	165.96
34.0	0.430	171.06	6.263	-111.51	0.0332	159.36	0.073	160.02
35.0	0.371	163.46	6.137	-134.09	0.0336	145.03	0.064	158.77
36.0	0.324	159.72	6.172	-152.84	0.0297	132.80	0.064	152.46
37.0	0.268	149.53	6.316	-172.87	0.0267	118.95	0.090	132.61
38.0	0.156	127.96	6.684	163.95	0.0194	98.26	0.146	98.18
39.0	0.111	-1.01	6.681	134.93	0.0087	27.65	0.263	58.18
40.0	0.478	-67.43	6.830	98.74	0.0160	-109.83	0.405	14.95
41.0	0.733	-116.92	4.453	49.92	0.0280	-154.33	0.449	-29.19
42.0	0.784	-134.69	2.919	24.62	0.0329	-165.52	0.450	-49.46
43.0	0.807	-147.18	1.993	4.19	0.0385	-178.14	0.454	-64.80
44.0	0.819	-158.53	1.406	-13.99	0.0396	163.90	0.437	-76.65
45.0	0.818	-165.72	1.022	-29.20	0.0364	161.74	0.419	-83.59
46.0	0.814	-173.65	0.808	-42.51	0.0368	160.26	0.430	-83.85
47.0	0.786	175.95	0.657	-60.82	0.0399	150.91	0.455	-95.96
48.0	0.760	165.30	0.665	-75.14	0.0353	138.11	0.451	-98.88

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## Mechanical Drawing



(Note: Engineering designator is 22DSBA0423)

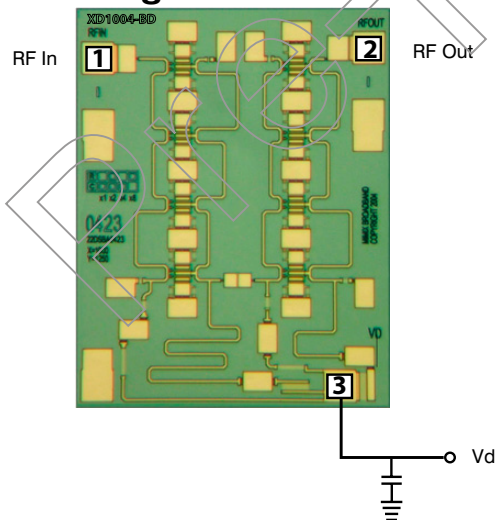
Units: millimeters (inches) Bond pad dimensions are shown to center of bond pad.  
Thickness: 0.110 +/- 0.010 (0.0043 +/- 0.0004), Backside is ground, Bond Pad/Backside Metallization: Gold  
All Bond Pads are 0.100 x 0.100 (0.004 x 0.004).

Bond pad centers are approximately 0.109 (0.004) from the edge of the chip.

Dicing tolerance: +/- 0.005 (+/- 0.0002). Approximate weight: 0.775 mg.

Bond Pad #1 (RF In)      Bond Pad #2 (RF Out)      Bond Pad #3 (Vd)

## Bias Arrangement



**Bypass Capacitors** - See App Note [2]

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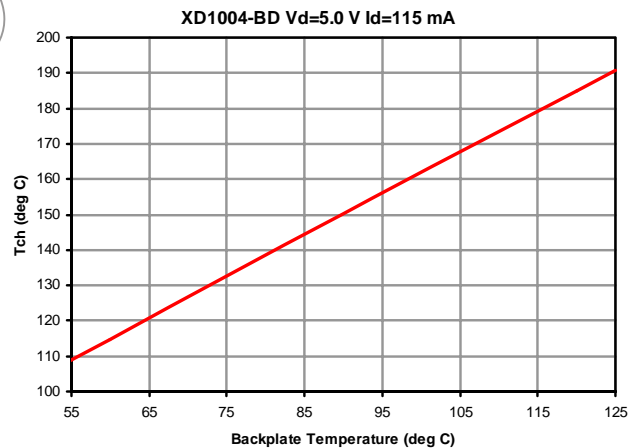
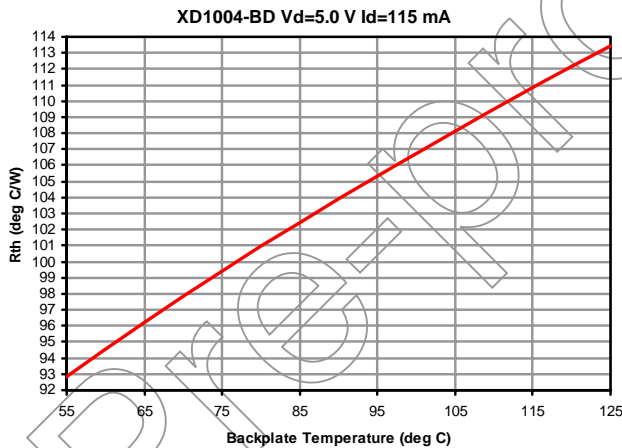
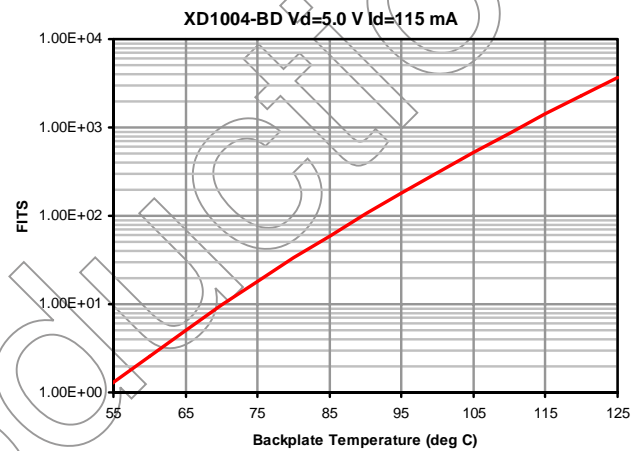
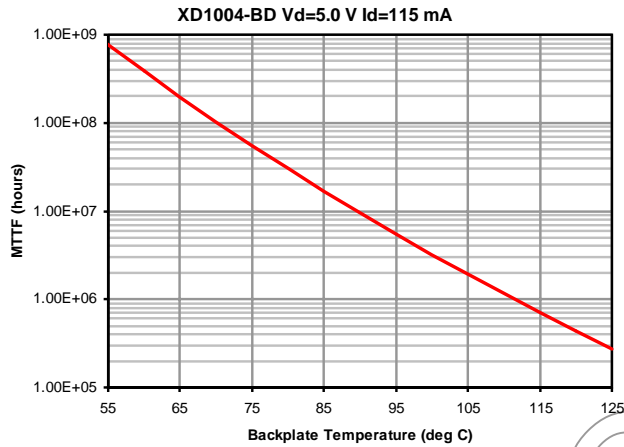
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**App Note [1] Biasing** - As shown in the bonding diagram, this device operates using a self-biased architecture and only requires one drain bias. Bias is nominally  $V_d=5V, I_d=115\text{ mA}$ .

**App Note [2] Bias Arrangement** - Each DC pad ( $V_d$ ) needs to have DC bypass capacitance ( $\sim 100\text{-}200\text{ pF}$ ) as close to the device as possible. Additional DC bypass capacitance ( $\sim 0.01\text{ }\mu\text{F}$ ) is also recommended.

## MTTF Graphs

These numbers were calculated based on accelerated life test information and thermal model analysis received from the fabricating foundry.



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## Handling and Assembly Information

**CAUTION!** - Mimix Broadband MMIC Products contain gallium arsenide (GaAs) which can be hazardous to the human body and the environment. For safety, observe the following procedures:

- Do not ingest.
- Do not alter the form of this product into a gas, powder, or liquid through burning, crushing, or chemical processing as these by-products are dangerous to the human body if inhaled, ingested, or swallowed.
- Observe government laws and company regulations when discarding this product. This product must be discarded in accordance with methods specified by applicable hazardous waste procedures.

**Life Support Policy** - Mimix Broadband's products are not authorized for use as critical components in life support devices or systems without the express written approval of the President and General Counsel of Mimix Broadband. As used herein: (1) Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user. (2) A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

**ESD** - Gallium Arsenide (GaAs) devices are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic containers, which should be opened in cleanroom conditions at an appropriately grounded antistatic workstation. Devices need careful handling using correctly designed collets, vacuum pickups or, with care, sharp tweezers.

**Die Attachment** - GaAs Products from Mimix Broadband are 0.100 mm (0.004") thick and have vias through to the backside to enable grounding to the circuit. Microstrip substrates should be brought as close to the die as possible. The mounting surface should be clean and flat. If using conductive epoxy, recommended epoxies are Tanaka TS3332LD, Die Mat DM6030HK or DM6030HK-Pt cured in a nitrogen atmosphere per manufacturer's cure schedule. Apply epoxy sparingly to avoid getting any on to the top surface of the die. An epoxy fillet should be visible around the total die periphery. For additional information please see the Mimix "Epoxy Specifications for Bare Die" application note. If eutectic mounting is preferred, then a fluxless gold-tin (AuSn) preform, approximately 0.001<sup>2</sup> thick, placed between the die and the attachment surface should be used. A die bonder that utilizes a heated collet and provides scrubbing action to ensure total wetting to prevent void formation in a nitrogen atmosphere is recommended. The gold-tin eutectic (80% Au 20% Sn) has a melting point of approximately 280 °C (Note: Gold Germanium should be avoided). The work station temperature should be 310 °C +/- 10 °C. Exposure to these extreme temperatures should be kept to minimum. The collet should be heated, and the die pre-heated to avoid excessive thermal shock. Avoidance of air bridges and force impact are critical during placement.

**Wire Bonding** - Windows in the surface passivation above the bond pads are provided to allow wire bonding to the die's gold bond pads. The recommended wire bonding procedure uses 0.076 mm x 0.013 mm (0.003" x 0.0005") 99.99% pure gold ribbon with 0.5-2% elongation to minimize RF port bond inductance. Gold 0.025 mm (0.001") diameter wedge or ball bonds are acceptable for DC Bias connections. Aluminum wire should be avoided. Thermo-compression bonding is recommended though thermosonic bonding may be used providing the ultrasonic content of the bond is minimized. Bond force, time and ultrasonics are all critical parameters. Bonds should be made from the bond pads on the die to the package or substrate. All bonds should be as short as possible.

## Part Number for Ordering

XD1004-BD-000V  
XD1004-BD-EV1

## Description

RoHS compliant die packed in vacuum release gel packs  
XD1004-BD evaluation module