20.0-36.0 GHz GaAs MMIC Low Noise Amplifier

Mimix BROADBAND™

January 2010 - Rev 09-Jan-10

XL1002-BD

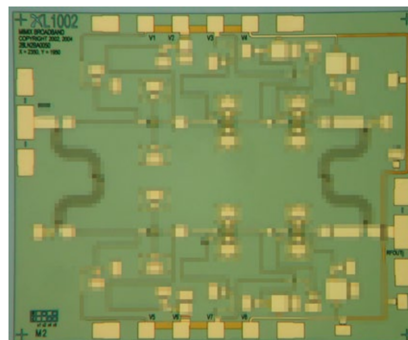
Features

- Balanced Design
- Excellent Input/Output Match
- Self-biased Architecture
- 23.0 dB Small Signal Gain
- 2.6 dB Noise Figure
- 100% On-Wafer RF, DC and Noise Figure Testing
- 100% Visual Inspection to MIL-STD-883 Method 2010

General Description

Mimix Broadband's three stage balanced 20.0-36.0 GHz GaAs MMIC low noise amplifier has a small signal gain of 23.0 dB with a noise figure of 2.6 dB across the band. This MMIC uses Mimix Broadband's 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 Millimeter-wave Point-to-Point Radio, LMDS, SATCOM and VSAT applications.

Chip Device Layout



Absolute Maximum Ratings

Supply Voltage (Vd)	+6.0 VDC
Supply Current (Id)	120 mA
Input Power (Pin)	+15.0 dBm
Storage Temperature (Tstg)	-65 to +165 ºC
Operating Temperature (Ta)	-55 to +85 ºC
Channel Temperature (Tch)[1]	+175 ºC

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

Electrical Characteristics (Ambient Temperature T = 25 ºC)

Parameter	Units	Min.	Typ.	Max.
Frequency Range (f)	GHz	20.0	-	36.0
Input Return Loss (S11)[3]	dB	8.0	10.0	-
Output Return Loss (S22)[3]	dB	15.0	18.0	-
Small Signal Gain (S21)[3]	dB	18.0	23.0	-
Gain Flatness (ΔS21)	dB	-	+/-1.5	-
Reverse Isolation (S12)[3]	dB	40.0	45.0	-
Noise Figure (NF)[3]	dB	-	2.6	4.0
Output Power for 1 dB Compression (P1dB)	dBm	-	+4.0[2]	-
Output Third Order Intercept Point (OIP3)	dBm	-	+16.0[2]	-
Drain Bias Voltage (V5)	VDC	-	+5.0	+5.5
Supply Current (Id)	mA	-	85	95

(2) See plots for additional information.
(3) Unless otherwise indicated min/max over 20.0-36.0 GHz and biased at Vd=5V, Id=85mA.

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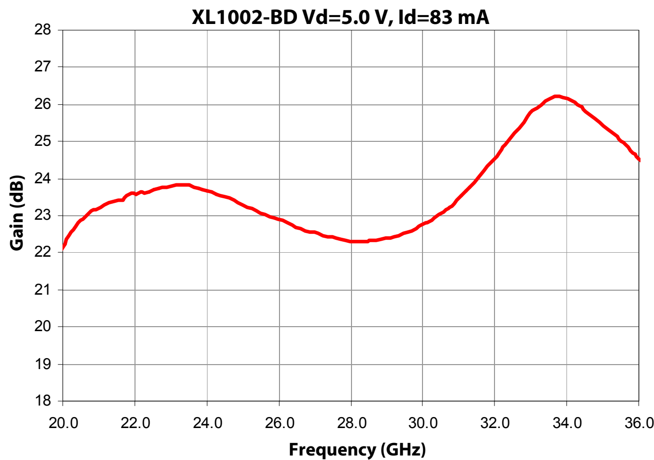
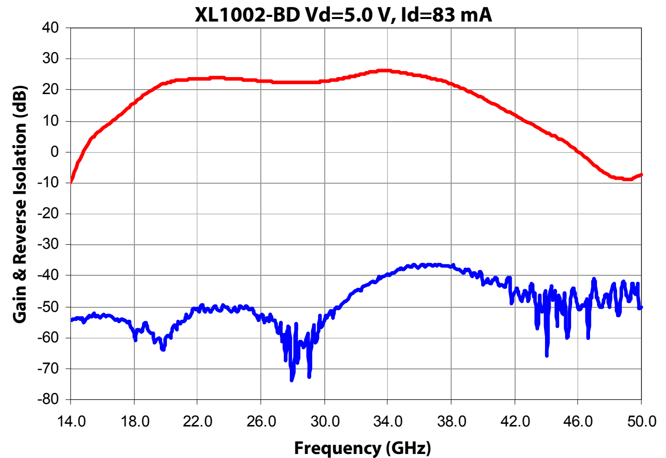
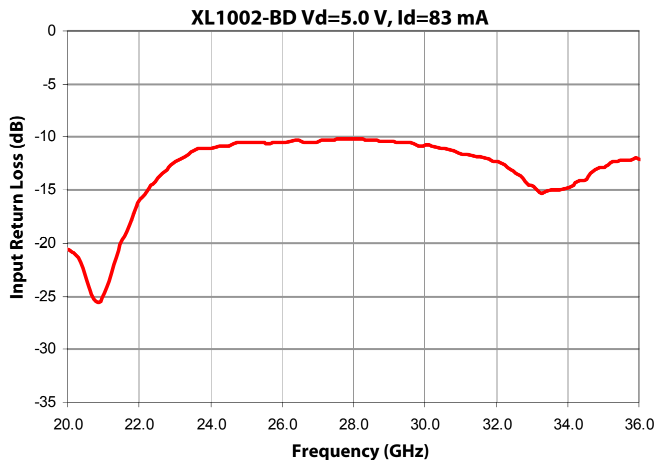
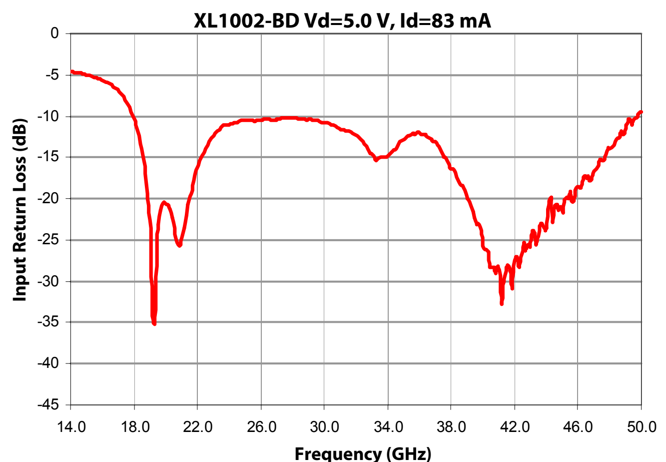
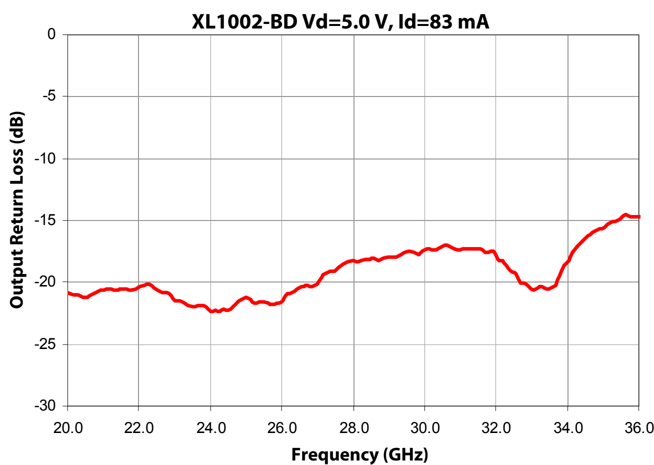
Low Noise Amplifier Measurements (On-Water[1])

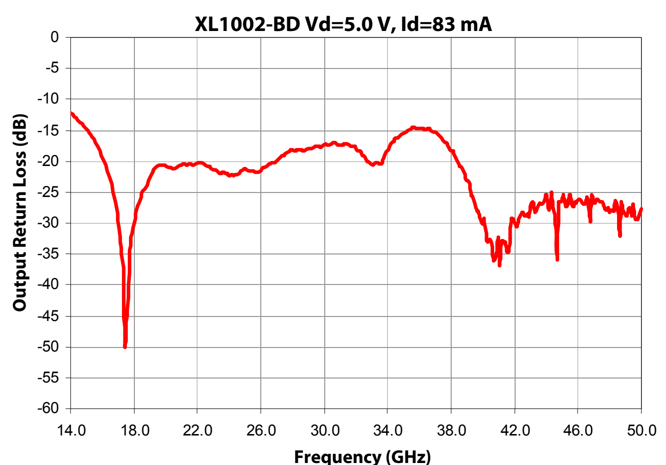












Note [1] Measurements – On-Wafer data has been taken using bias conditions as shown. Measurements are referenced 150 um in from RF In/Out pad edge. For optimum performance Mimix T-pad transition is recommended. For additional information see the Mimix "T-Pad Transition" application note.

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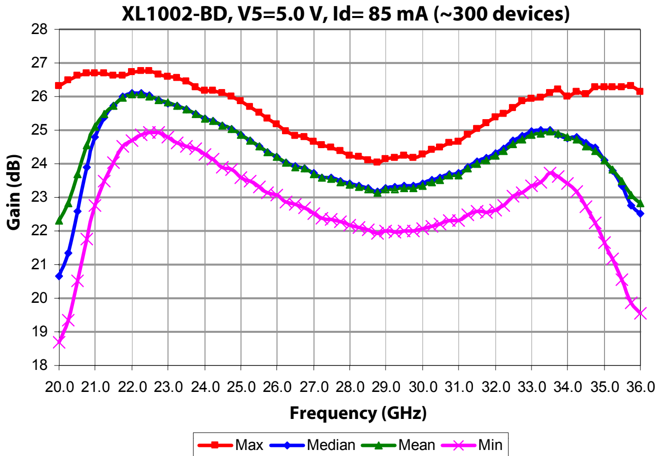
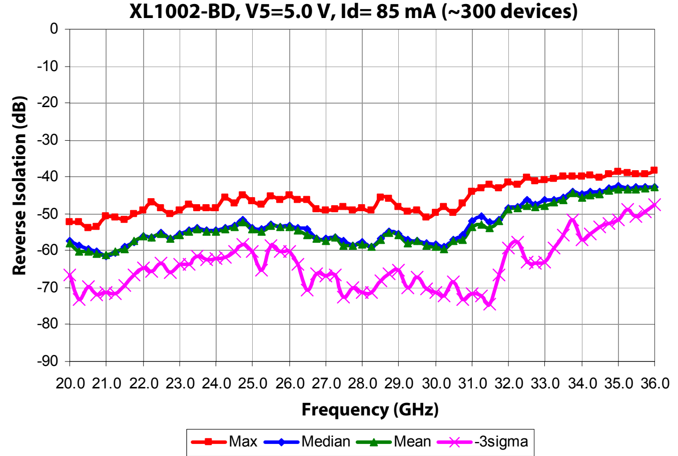
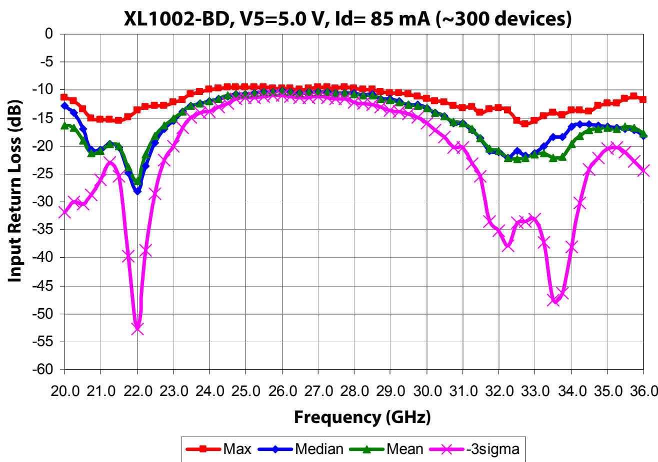
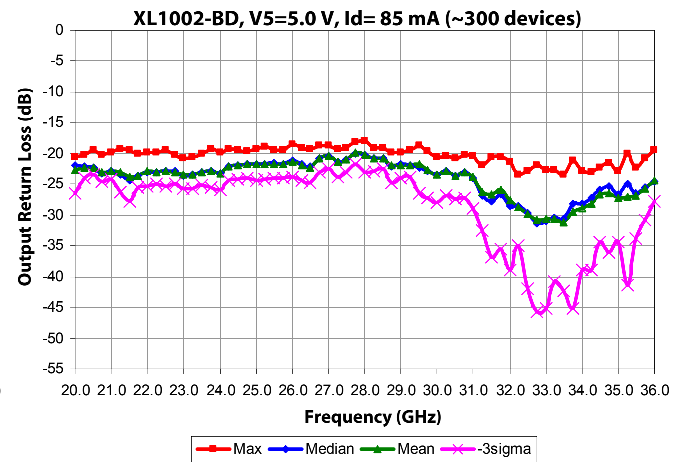
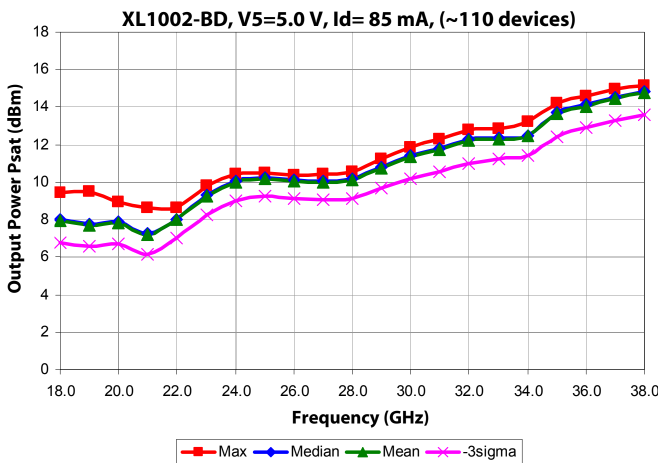
Low Noise Amplifier Measurements (On-Water[1]) (cont.)

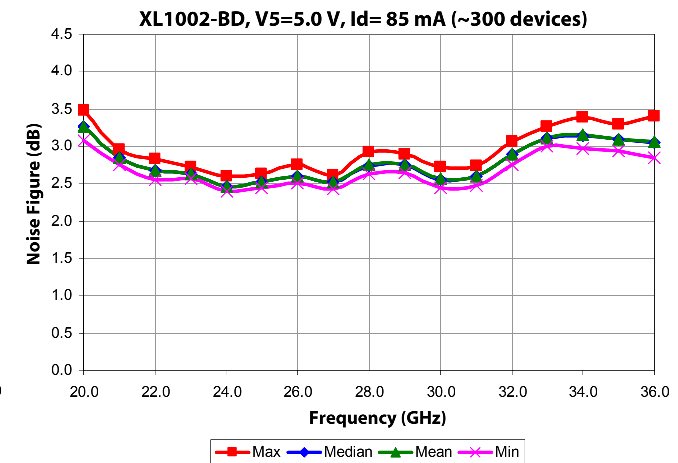












Note [1] Measurements – On-Wafer data has been taken using bias conditions as shown. Measurements are referenced 150 um in from RF In/Out pad edge. For optimum performance Mimix T-pad transition is recommended. For additional information see the Mimix "T-Pad Transition" application note.

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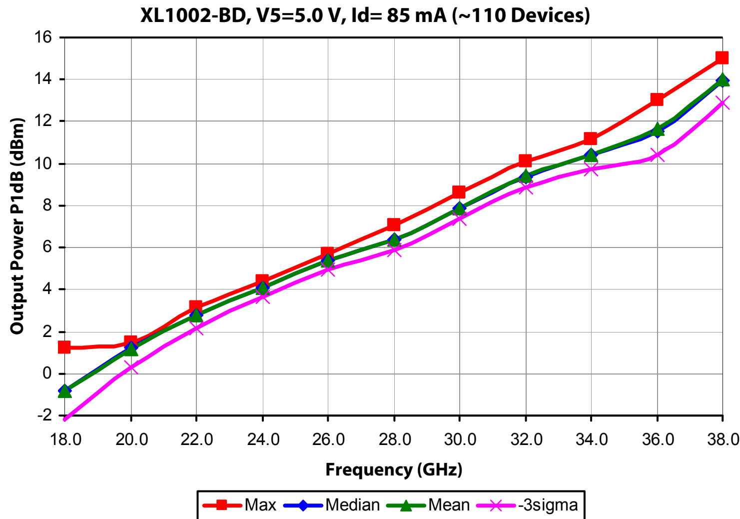

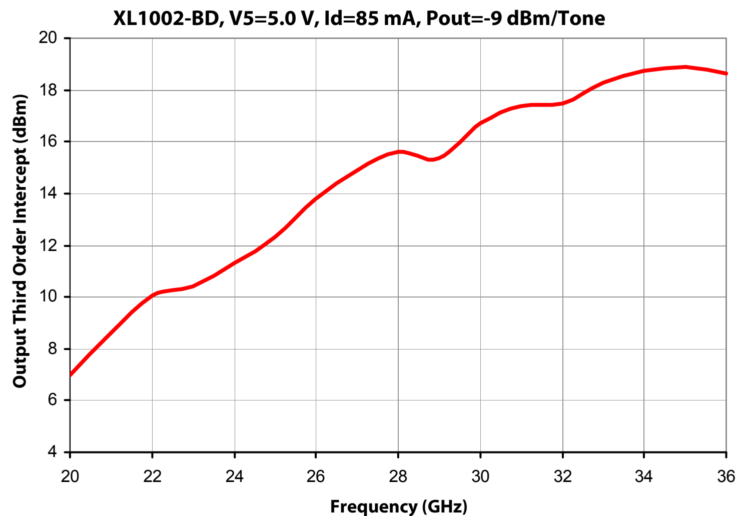

Note [1] Measurements – On-Wafer data has been taken using bias conditions as shown. Measurements are referenced 150 um in from RF In/Out pad edge. For optimum performance Mimix T-pad transition is recommended. For additional information see the Mimix "T-Pad Transition" application note.

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S-Parameters (On-Wafer[1])

Typcial S-Parameter Data for XL1002-BD
Vd=5.0 V, Id=83 mA

Frequency (GHz)	S11 (Mag)	S11 (Ang)	S21 (Mag)	S21 (Ang)	S12 (Mag)	S12 (Ang)	S22 (Mag)	S22 (Ang)
15.0	0.564	-178.06	1.188	-0.85	0.0020	147.49	0.184	68.29
16.0	0.525	163.99	2.314	-58.87	0.0022	133.71	0.112	49.27
17.0	0.456	140.66	3.626	-100.08	0.0020	112.54	0.038	32.34
18.0	0.316	109.41	5.986	-139.81	0.0013	85.19	0.029	178.18
19.0	0.056	59.74	9.885	168.14	0.0012	85.72	0.075	168.57
20.0	0.093	163.76	12.918	114.84	0.0010	144.44	0.090	146.46
21.0	0.058	-156.59	14.491	66.39	0.0018	140.58	0.093	144.99
22.0	0.160	-143.70	15.112	25.32	0.0029	125.69	0.096	140.86
23.0	0.242	-162.31	15.499	-11.89	0.0031	110.27	0.085	134.01
24.0	0.281	176.38	15.248	-47.77	0.0029	97.46	0.077	139.02
25.0	0.299	159.52	14.603	-80.38	0.0031	65.70	0.087	143.92
26.0	0.298	145.31	13.982	-109.27	0.0022	45.87	0.083	150.17
27.0	0.300	130.99	13.414	-136.06	0.0016	16.85	0.099	152.13
28.0	0.310	113.94	13.037	-161.27	0.0002	111.34	0.123	143.92
29.0	0.300	96.78	13.159	175.05	0.0011	-5.16	0.127	139.80
30.0	0.288	75.52	13.717	151.93	0.0017	-100.50	0.134	131.23
31.0	0.264	45.92	15.046	125.04	0.0033	-129.95	0.136	119.99
32.0	0.243	6.28	16.970	98.07	0.0058	-173.10	0.124	108.25
33.0	0.186	-58.03	19.555	65.63	0.0082	171.61	0.092	112.48
34.0	0.182	-153.97	20.286	27.29	0.0108	152.32	0.122	125.58
35.0	0.229	128.76	18.664	-8.42	0.0125	130.81	0.167	108.67
36.0	0.248	72.56	16.858	-42.32	0.0137	103.83	0.185	84.48
37.0	0.223	24.56	14.957	-75.99	0.0149	74.05	0.173	55.66
38.0	0.151	-13.76	12.471	-110.66	0.0138	60.14	0.120	31.74
39.0	0.103	-54.50	9.781	-143.05	0.0120	35.11	0.070	10.04
40.0	0.055	-103.89	7.306	-171.68	0.0073	5.53	0.031	15.51
41.0	0.039	-131.64	5.482	161.77	0.0072	16.95	0.024	65.20
42.0	0.039	165.29	3.987	137.96	0.0051	-9.93	0.033	89.31
43.0	0.051	138.97	2.903	116.93	0.0042	49.71	0.036	80.11
44.0	0.067	118.55	2.036	95.48	0.0005	-39.52	0.054	72.26
45.0	0.082	108.67	1.527	75.61	0.0024	47.48	0.054	59.12

Note [1] S-Parameters – On-Wafer S-Parameters have been taken using bias conditions as shown. Measurements are referenced 150 um in from RF In/Out pad edge.

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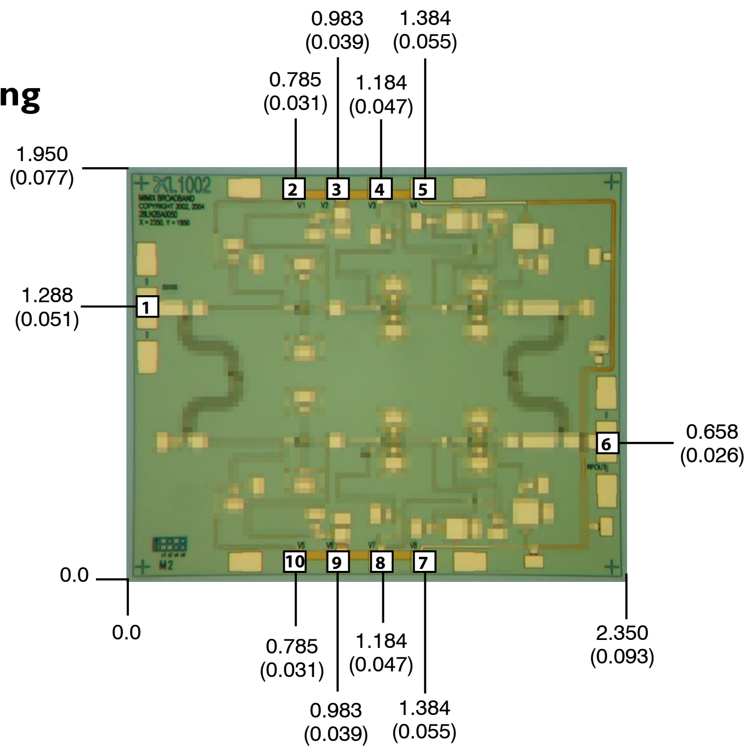
Mechanical Drawing

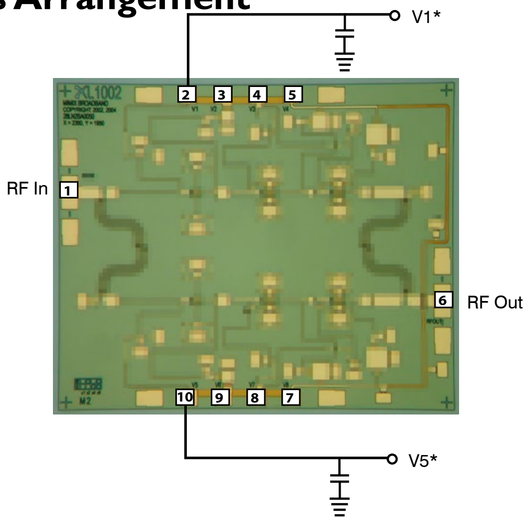


(Note: Engineering designator is 28LN3BA0050)

Units: millimeters (inches) Bond pad dimensions are shown to center of bond pad.
Thickness: 0.115 +/- 0.010 (0.0045 +/- 0.0004), Backside is ground, Bond Pad/Backside Metallization: Gold
All DC Bond Pads are 0.100 x 0.100 (0.004 x 0.004). All RF Bond Pads are 0.100 x 0.200 (0.004 x 0.008)
Bond pad centers are approximately 0.109 (0.004) from the edge of the chip.
Dicing tolerance: +/- 0.005 (+/- 0.0002). Approximate weight: 2.838 mg.

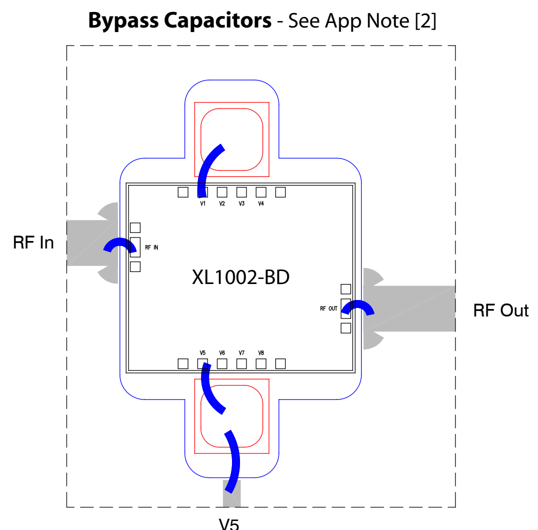
Bond Pad #1 (RF In)
Bond Pad #2 (V1)
Bond Pad #3 (V2)
Bond Pad #4 (V3)
Bond Pad #5 (V4)
Bond Pad #6 (RF Out)
Bond Pad #7 (V8)
Bond Pad #8 (V7)
Bond Pad #9 (V6)
Bond Pad #10 (V5)

Bias Arrangement



*V1 or V5 may be used, but both are not required.

Bypass Capacitors - See App Note [2]



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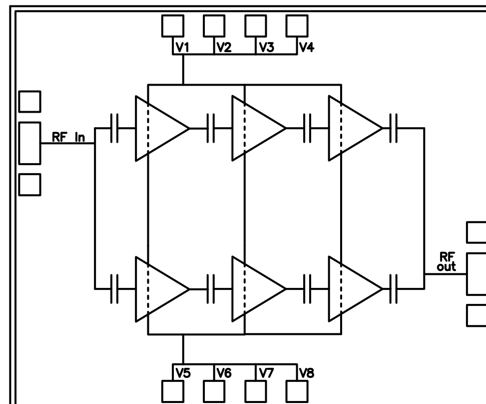
App Note [1] Biasing - As shown in the bonding diagram, this device operates using a self-biased architecture and only requires a single bias voltage. All DC pads (V1 through V8) are tied together on-chip, even though V1 or V5 are shown as main connections, any of the eight DC pads may be used to bias the device. Bias is nominally V1 or V5=5V, Id=85 mA.



App Note [2] Bias Arrangement - The DC pad at the top (V1) should be connected to one DC bypass capacitor (~100-200 pf) and the DC pad at the bottom (V5) should be connected using another DC bypass capacitor (~100-200 pf). Additional DC bypass capacitance (~0.01 pf) is also recommended. Capacitance should be as close to the device as possible.

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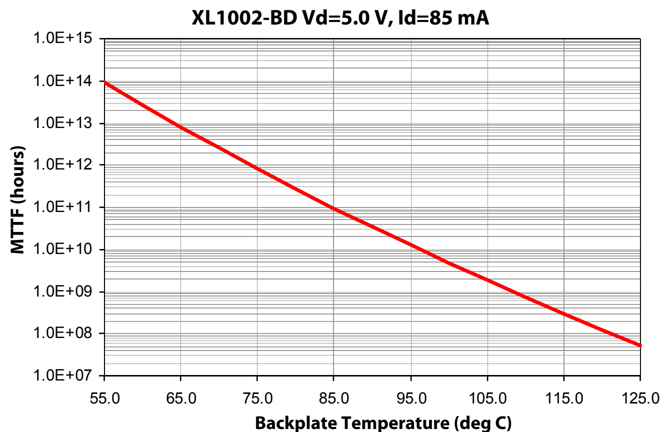
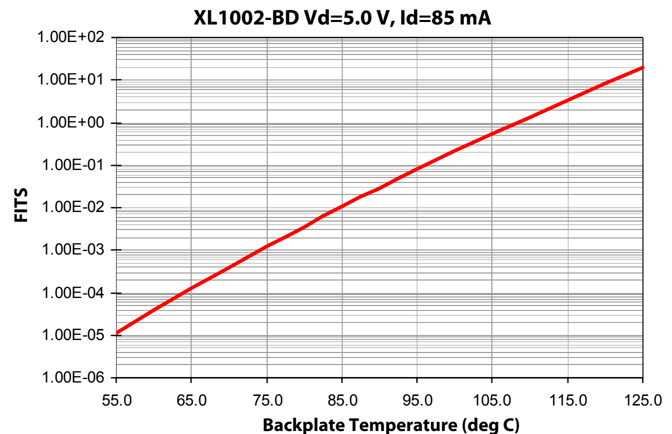
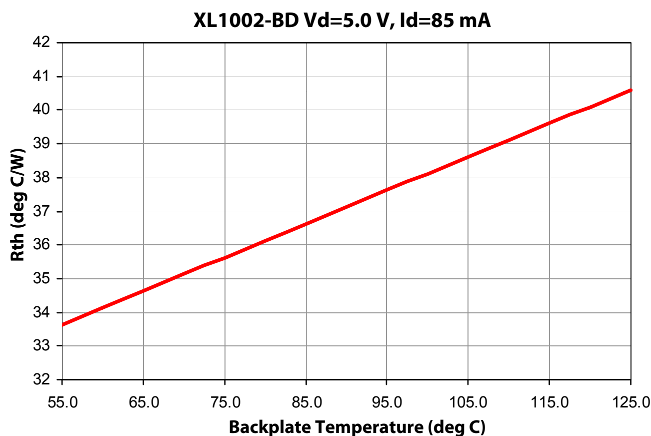
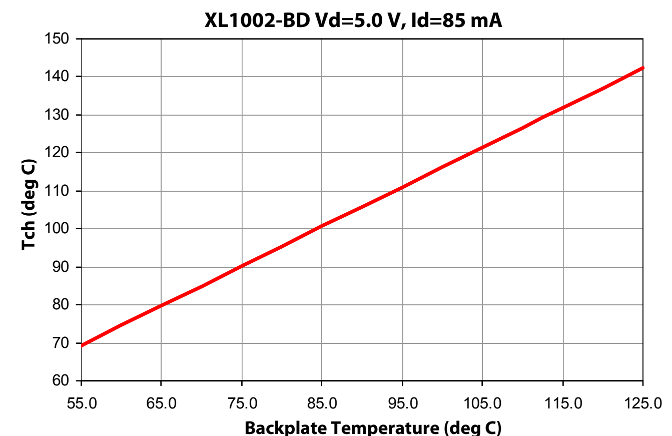
MTTF Graphs

These numbers were calculated based upon accelerated life test information received from the fabricating foundry and extensive thermal modeling/ finite element analysis done at Mimix Broadband. The values shown here are only to be used as a guideline against the end application requirements and only represent reliability information under one bias condition. Ultimately bias conditions and resulting power dissipation along with the practical aspects, i.e. thermal material stack-up, attach method of device placement are the key parts in determining overall reliability for a specific application, see previous pages. If the data shown below does not meet your reliability requirements or if the bias conditions are not within your operating limits please contact technical sales for additional information.









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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 anti-static 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 0.001^2 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 ºC (Note: Gold Germanium should be avoided). The work station temperature should be 310 ºC +/- 10 ºC. 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.

Ordering Information

Part Number for Ordering	Description
XL1002-BD-000V	RoHS compliant die packed in vacuum release gel paks
XL1002-BD-EV1	XL1002 die evaluation module

Caution: ESD Sensitive
Appropriate precautions in handling, packaging and testing devices must be observed.

Proper ESD procedures should be followed when handling this device.

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