20.0-40.0 GHz GaAs MMIC Low Noise Amplifier

Mimix BROADBAND™

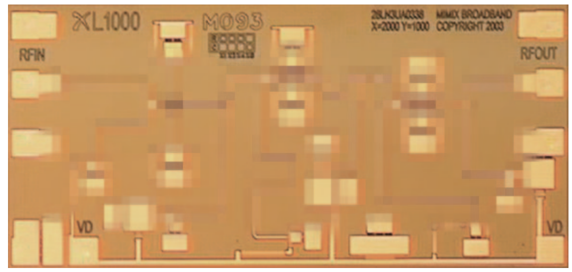
January 2010 - Rev 18-Jan-10

XL1000-BD

Features

- Self Bias Architecture
- Small Size
- 3.0 or 5.0 V Operation
- 20.0 dB Small Signal Gain
- 2.0 dB Noise Figure
- +9.0 dBm P1dB Compression Point
- 100% On-Wafer RF, DC and Noise Figure Testing
- 100% Visual Inspection to MIL-STD-883 Method 2010

Chip Device Layout



General Description

Mimix Broadband's three stage 20.0-40.0 GHz GaAs MMIC low noise amplifier has a small signal gain of 20.0 dB with a noise figure of 2.0 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.

Absolute Maximum Ratings

Supply Voltage (Vd)	+7.0 VDC
Supply Current (Id)	70 mA
Input Power (Pin)	+12 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 MTTF. 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	-	40.0
Input Return Loss (S11)[2] @ 22.0-36.0 GHz	dB	6.0	12.0	-
Output Return Loss (S22)[2] @ 22.0-36.0 GHz	dB	4.0	10.0	-
Small Signal Gain (S21)[2]	dB	12.0	20.0	-
Gain Flatness (ΔS21)	dB	-	+/-4.0	-
Reverse Isolation (S12)[2]	dB	30.0	45.0	-
Noise Figure (NF)[2] @ 24.0-40.0 GHz	dB	-	2.0	3.0
Output Power for 1 dB Compression (P1dB) @ 5.0V	dBm	-	+9.0	-
Output Third Order Intercept Point (OIP3) @ 5.0V	dBm	-	+16.0	-
Drain Bias Voltage (Vd)	VDC	-	+3.0	+5.0
Supply Current (Id) (Vd=3.0V or 5.0V)	mA	-	35	50

(2) Unless otherwise indicated min/max over 20.0-40.0 GHz and biased at Vd=5V, Id=50mA.

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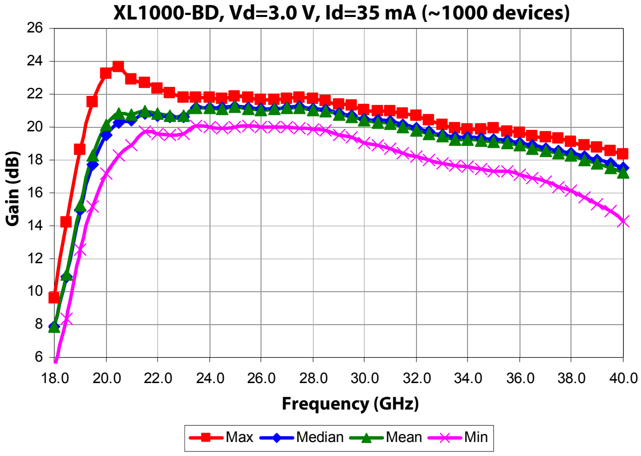
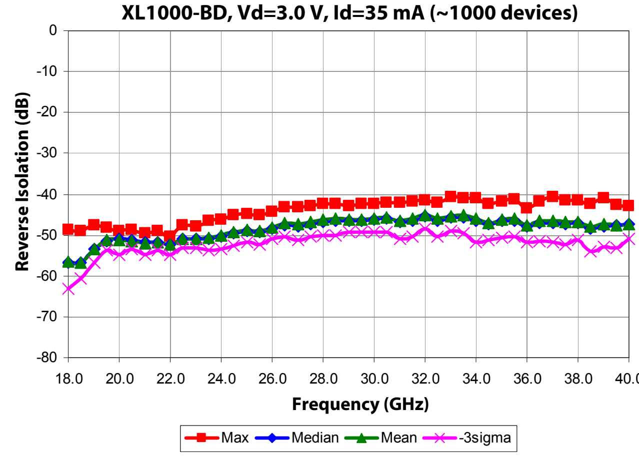
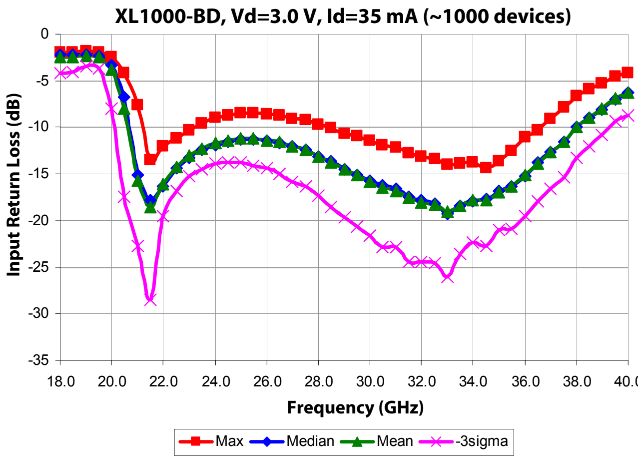
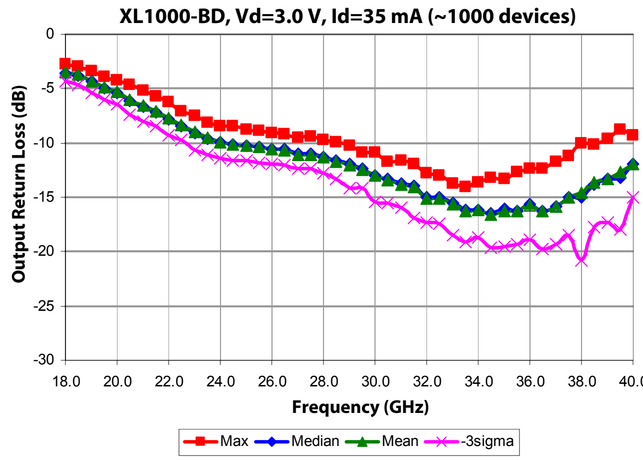
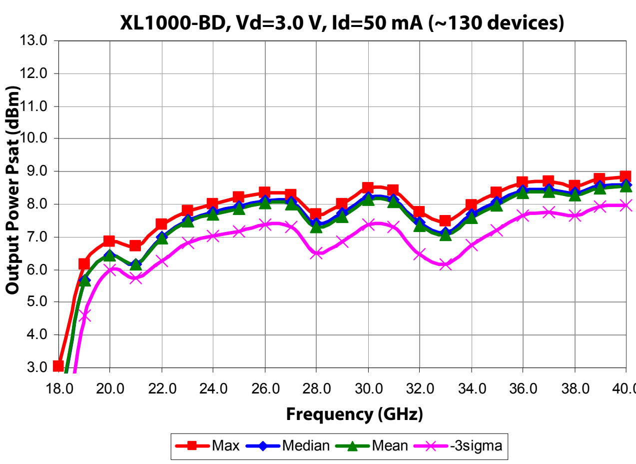
Low Noise Amplifier Measurements (On-Wafer[1])

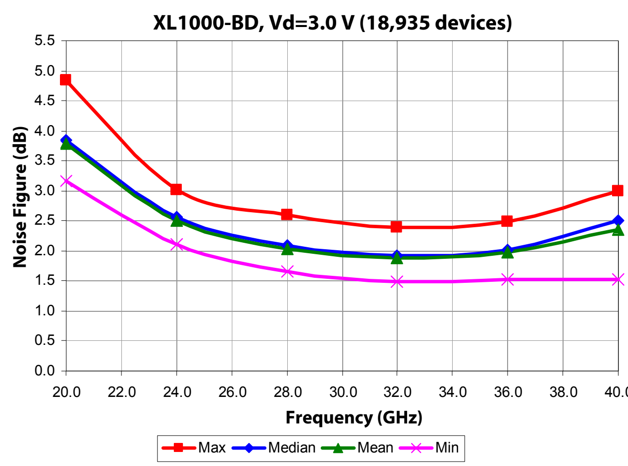








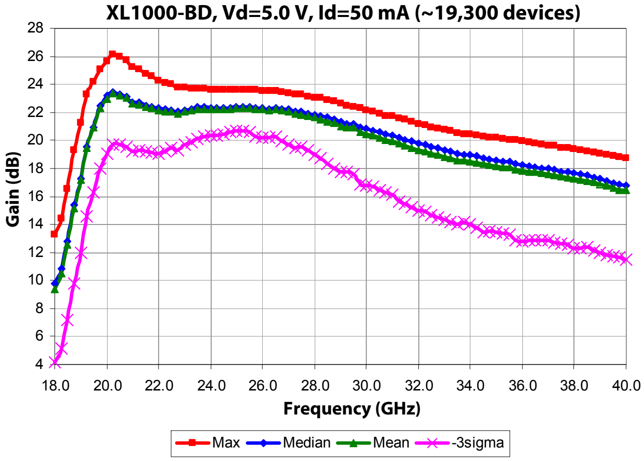




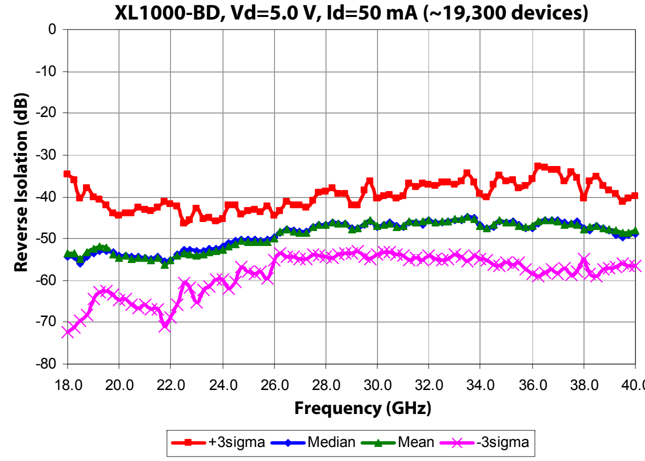
Note [1] Measurements – On-Wafer data has been taken using bias conditions as shown. Measurements are referenced 150 um in from RF In/Out pad edge. For optimum performance Mimix T-pad transition is recommended. For additional information see the Mimix "T-Pad Transition" application note.

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

XL1000-BD, Vd=5.0 V, Id=50 mA (~19,300 devices)



XL1000-BD, Vd=5.0 V, Id=50 mA (~19,300 devices)



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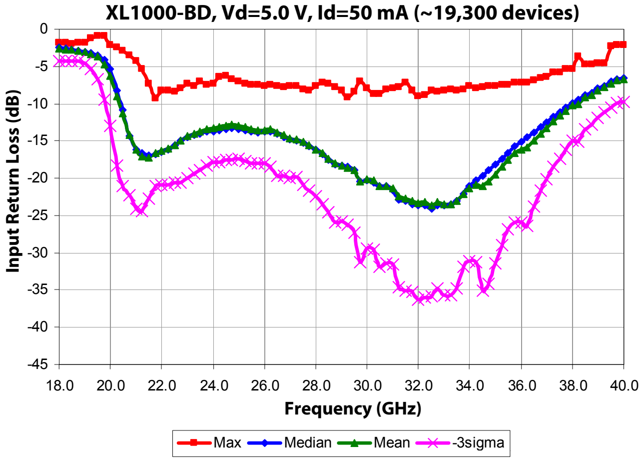

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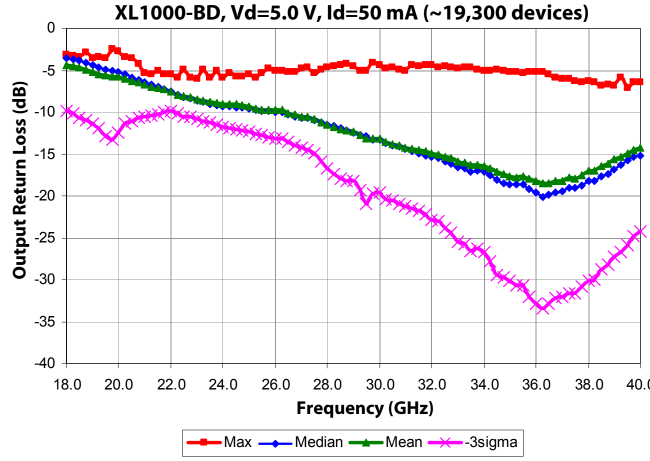
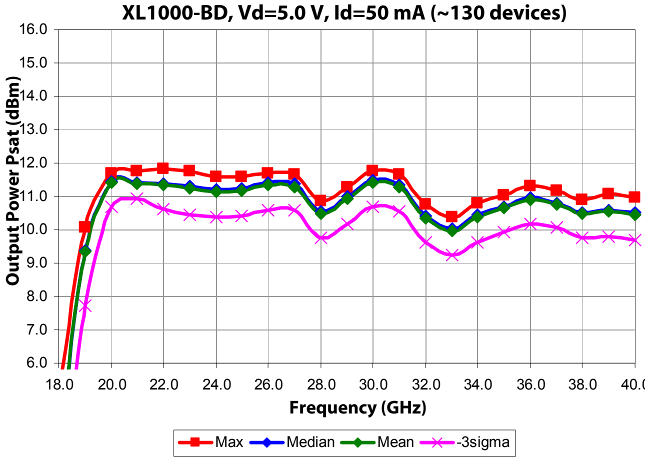
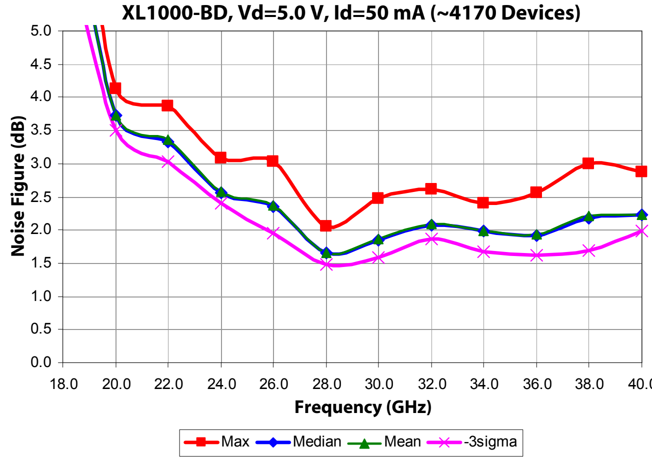


XL1000-BD, Vd=5.0 V, Id=50 mA (~130 devices)



XL1000-BD, Vd=5.0 V, Id=50 mA (~4170 Devices)



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.

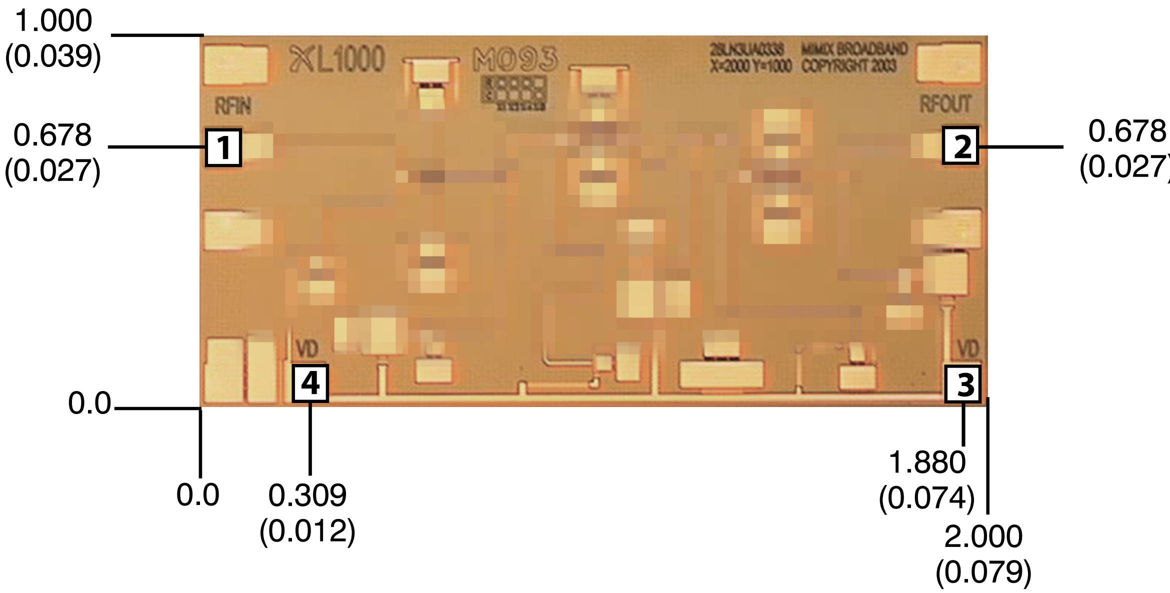
S-Parameters (On-Wafer[1])

Typcial S-Parameter Data for XL1000-BD
Vd=5.0 V, Id=52 mA

Frequency (GHz)	S11 (Mag)	S11 (Ang)	S21 (Mag)	S21 (Ang)	S12 (Mag)	S12 (Ang)	S22 (Mag)	S22 (Ang)
18.0	0.746	-165.97	2.544	24.56	0.0017	168.35	0.684	-124.58
19.0	0.660	149.17	6.840	-14.35	0.0024	126.40	0.625	-138.66
20.0	0.142	2.00	14.715	-120.61	0.0021	52.59	0.534	-163.12
21.0	0.100	-163.20	13.152	-170.24	0.0018	12.19	0.474	176.63
22.0	0.140	129.51	12.237	154.80	0.0017	-16.42	0.395	152.50
23.0	0.170	86.23	11.946	125.13	0.0017	-49.65	0.337	128.14
24.0	0.200	42.30	12.003	84.11	0.0028	-88.17	0.286	90.54
25.0	0.211	21.38	11.981	58.08	0.0024	-116.99	0.274	65.73
26.0	0.212	3.82	11.914	33.30	0.0029	-127.87	0.269	43.21
27.0	0.191	-16.13	11.573	-2.82	0.0034	-150.83	0.263	15.00
28.0	0.176	-25.82	11.181	-25.58	0.0038	-173.21	0.254	-0.75
29.0	0.159	-34.54	10.740	-47.03	0.0037	-176.89	0.243	-14.39
30.0	0.127	-47.28	9.961	-77.92	0.0036	151.73	0.217	-32.44
31.0	0.121	-53.64	9.490	-96.70	0.0037	138.19	0.206	-42.09
32.0	0.111	-64.48	9.060	-115.14	0.0043	118.88	0.190	-51.51
33.0	0.111	-89.94	8.472	-141.75	0.0035	109.21	0.170	-67.19
34.0	0.122	-110.67	8.150	-158.94	0.0021	95.25	0.160	-80.04
35.0	0.138	-130.72	7.851	-176.20	0.0029	104.56	0.147	-92.90
36.0	0.185	-155.73	7.420	158.47	0.0038	59.79	0.139	-111.00
37.0	0.237	-171.07	7.107	140.91	0.0030	68.81	0.136	-128.23
38.0	0.291	175.33	6.778	124.00	0.0036	40.92	0.137	-144.49
39.0	0.382	158.32	6.264	98.04	0.0013	10.28	0.149	-167.73
40.0	0.446	148.19	5.900	80.75	0.0028	-17.50	0.162	179.76
41.0	0.506	138.34	5.471	63.80	0.0023	-7.95	0.176	167.50
42.0	0.591	124.05	4.767	38.77	0.0021	7.75	0.197	153.19
43.0	0.633	115.88	4.314	22.90	0.0020	-8.93	0.210	143.72

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.

Mechanical Drawing

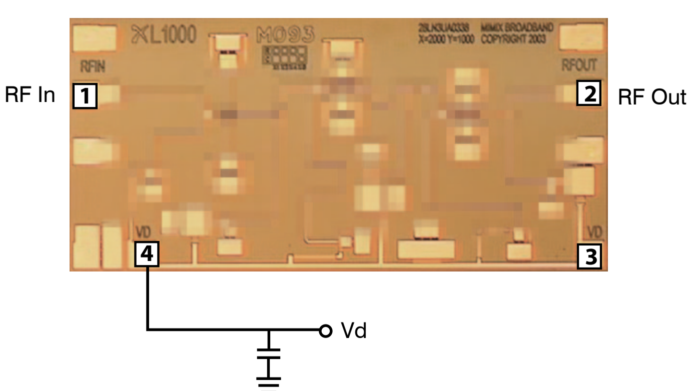


(Note: Engineering designator is 28LN3UA0338)

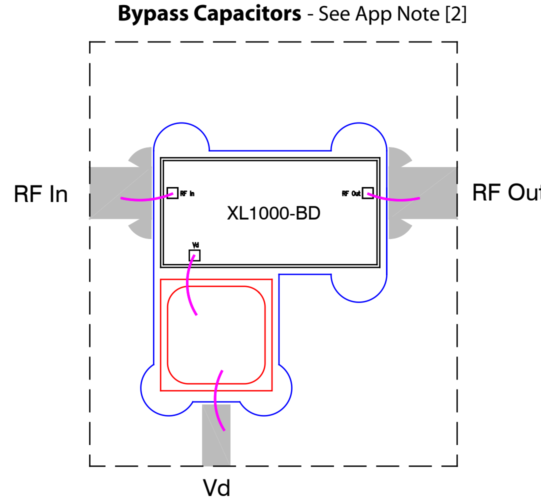
Units: millimeters (inches) Bond pad dimensions are shown to center of bond pad.
Thickness: 0.110 +/- 0.010 (0.0043 +/- 0.0004), Backside is ground, Bond Pad/Backside Metallization: Gold
All Bond Pads are 0.100 x 0.100 (0.004 x 0.004).
Bond pad centers are approximately 0.109 (0.004) from the edge of the chip.
Dicing tolerance: +/- 0.005 (+/- 0.0002). Approximate weight: 1.239 mg.

Bond Pad #1 (RF In) Bond Pad #2 (RF Out) Bond Pad #3 (Vd) Bond Pad #4 (Vd)

Bias Arrangement

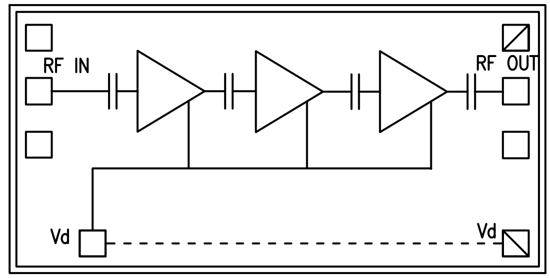


Bypass Capacitors - See App Note [2]



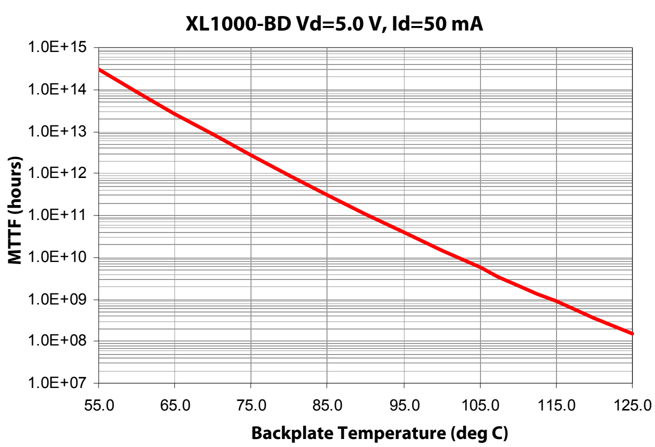
App Note [1] Biasing - As shown in the bonding diagram, this device operates using a self-biased architecture and only requires one drain bias. Bias is nominally Vd=3V, I=35mA or Vd=5V, I=50mA.

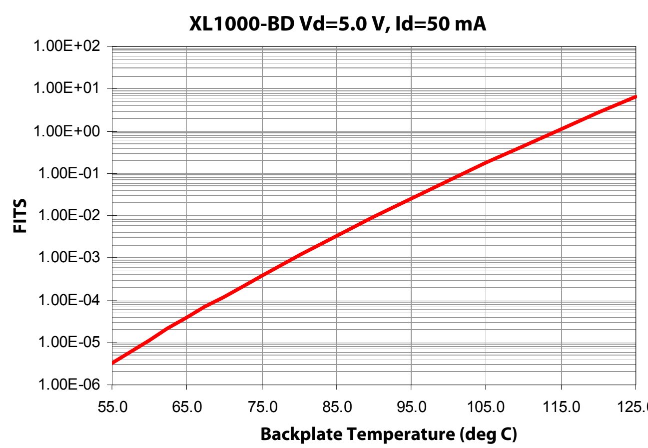
App Note [2] Bias Arrangement - Each DC pad (Vd) needs to have DC bypass capacitance (~100-200 pF) as close to the device as possible. Additional DC bypass capacitance (~0.01 uF) is also recommended.

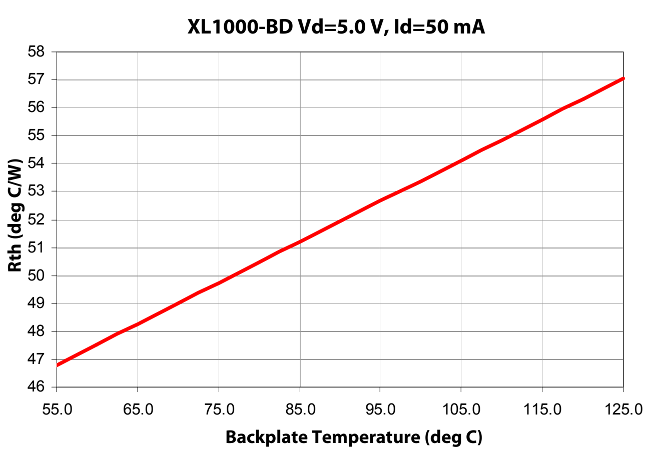


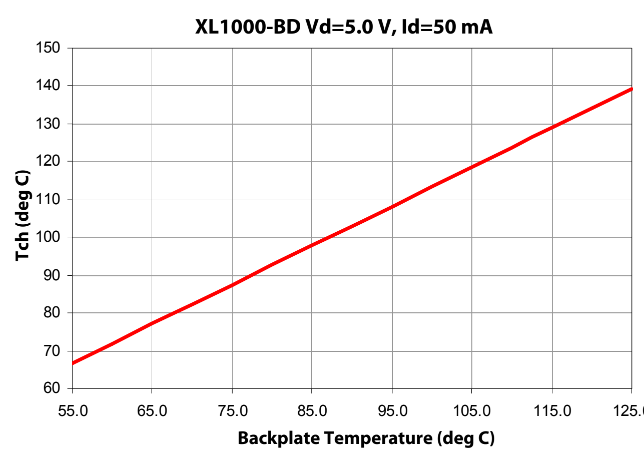
MTTF Graphs

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.









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
XL1000-BD-000V	RoHS compliant die packed in vacuum release gel paks
XL1000-BD-EV1	XL1000 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.