

20.0-36.0 GHz GaAs MMIC Low Noise Amplifier

July 2007 - Rev 17-Jul-07

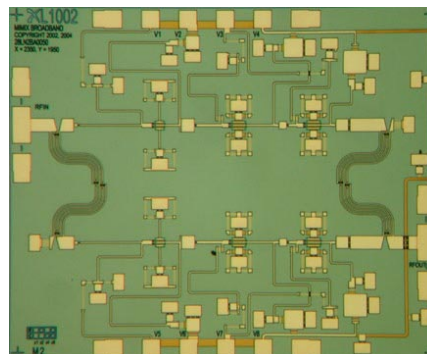
Features

- ✕ 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 0.15 μm 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 °C
Operating Temperature (Ta)	-55 to MTTF Table ¹
Channel Temperature (Tch)	MTTF Table ¹

(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 °C)

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 ($\Delta S21$)	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

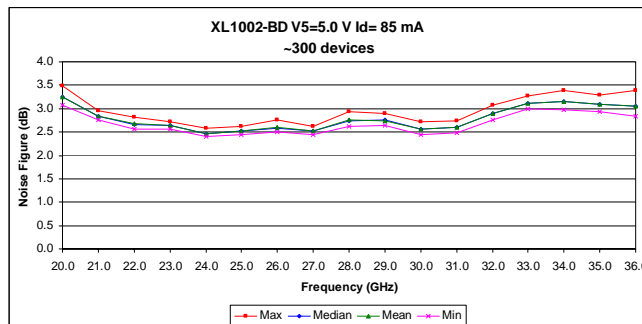
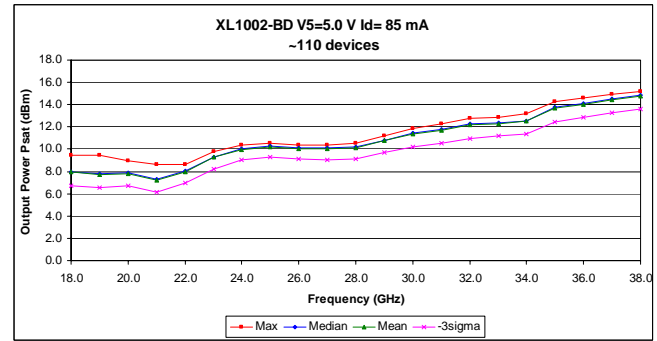
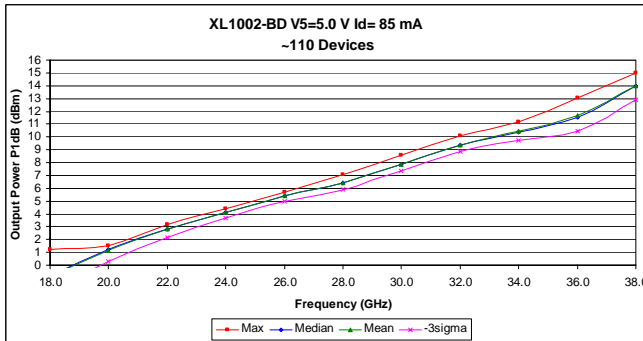
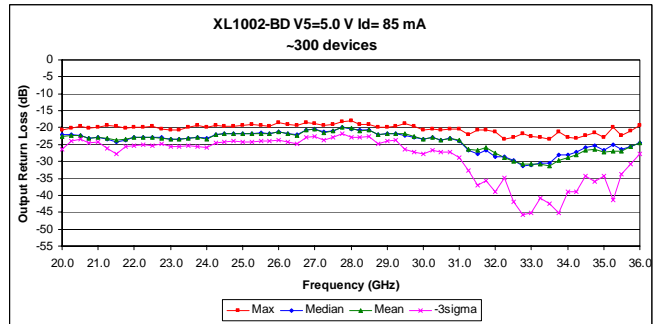
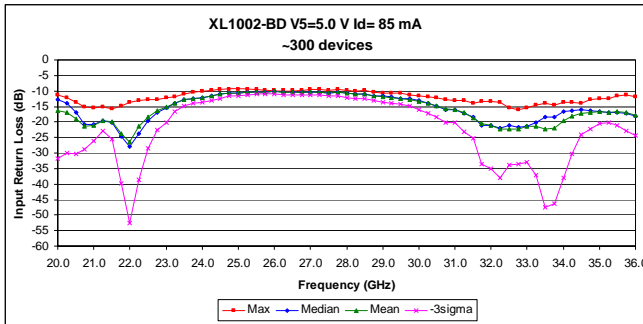
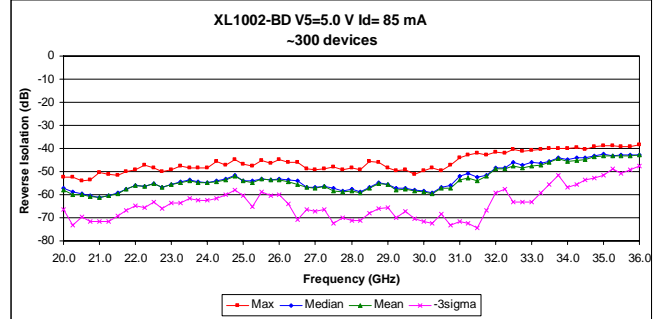
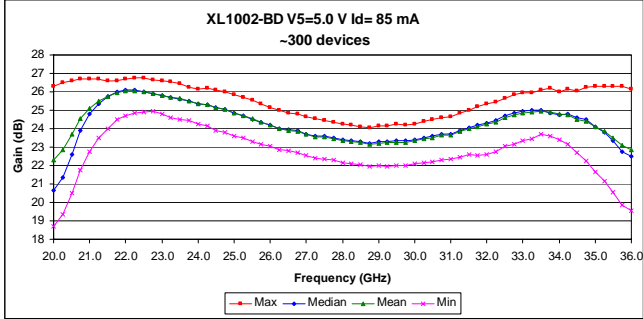
(2) See plots for additional information.

(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

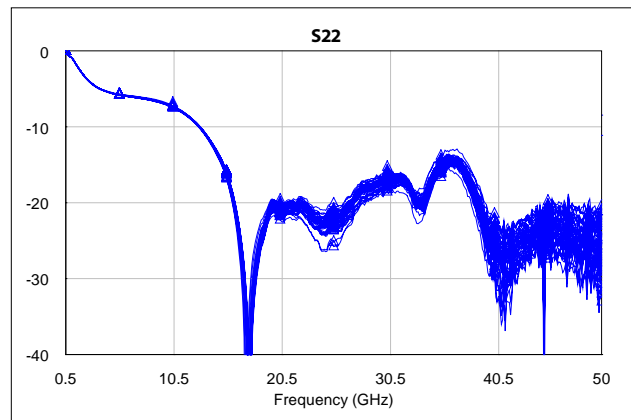
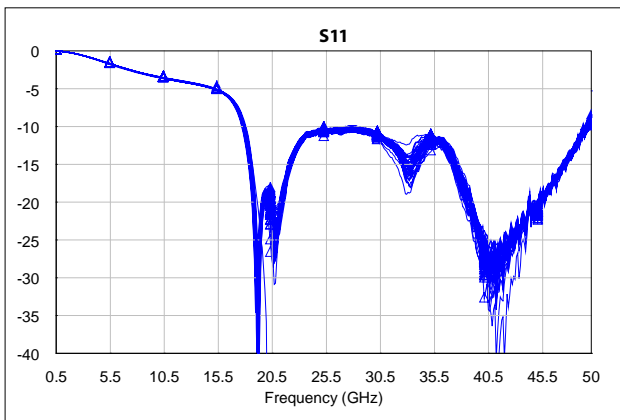
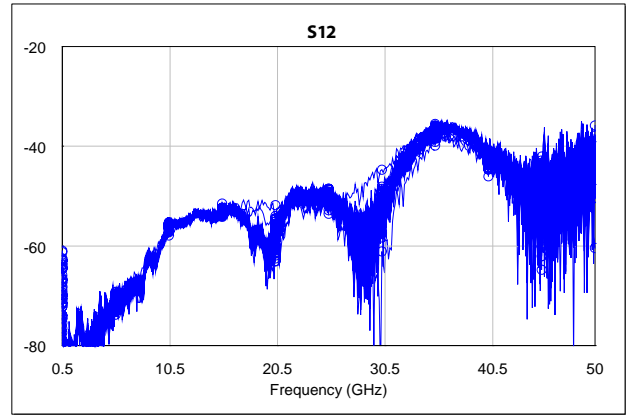
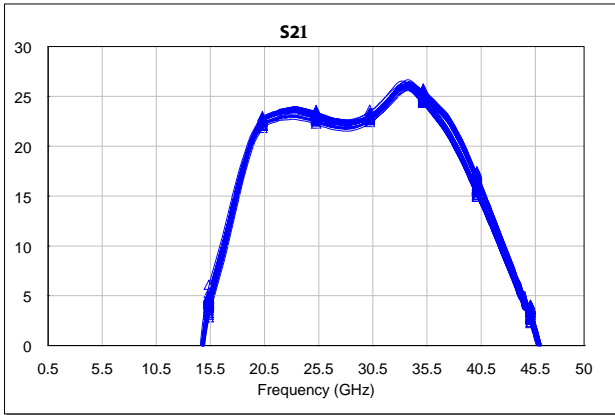


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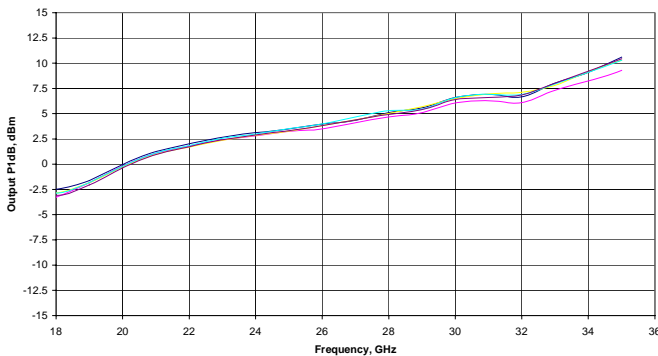
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XL1002-BD

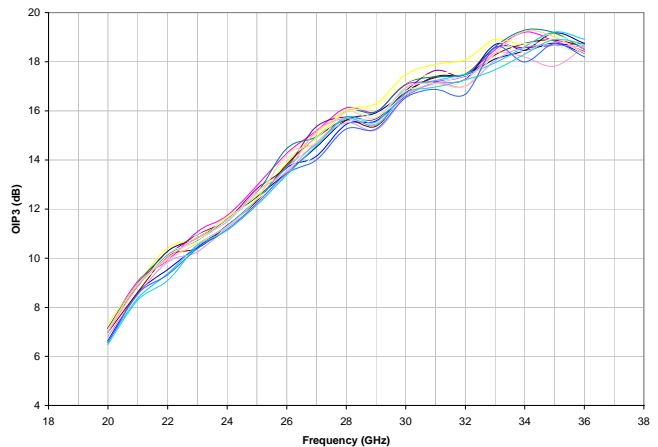
Low Noise Amplifier Measurements (cont.)



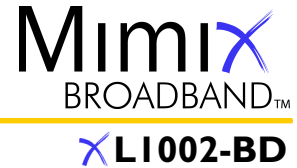
XL1002-BD P1dB vs Frequency



OIP3 with -9dBm per Tone Output Power



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S-Parameters

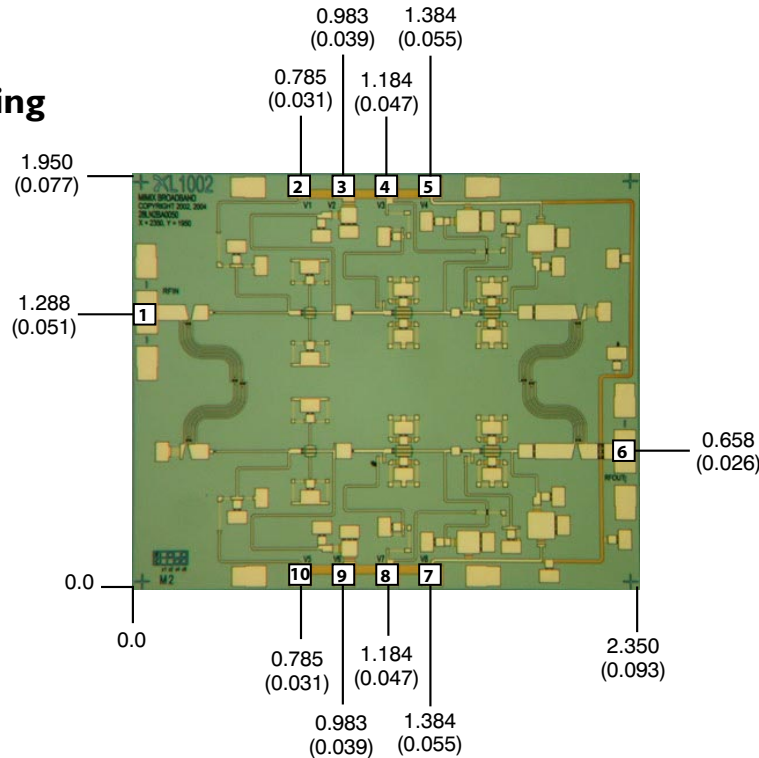
Typical S-Parameter Data for XL1002-BD
Vd=5 V Id=85 mA

Frequency (GHz)	S11 Mag dB	S11 Phase Ang°	S12 Mag dB	S12 Phase Ang°	S21 Mag dB	S21 Phase Ang°	S22 Mag dB	S22 Phase Ang°
20.00	-15.9002655	99.41715	-57.90350115	101.9094	22.22250962	-154.2999	-22.49957736	-70.49445
20.25	-16.43574807	96.25477	-60.06449295	96.44559	22.75796631	-160.736	-22.13714429	-119.0193
20.50	-18.5758231	94.37966	-60.03069173	94.0485	23.59476641	78.77438	-22.06794793	132.4458
20.75	-20.74547537	100.5674	-60.87795519	93.20361	24.45479346	156.0269	-22.93131945	34.66102
21.00	-20.43342219	111.0863	-61.09356564	87.72672	25.03383696	138.7359	-22.61802128	-52.58735
21.25	-19.36768433	107.6506	-60.26458968	81.15953	25.41837192	121.9571	-22.89230213	-133.1146
21.50	-19.64108343	91.84838	-59.46756779	81.13116	25.65097173	106.1357	-23.50517258	124.573
21.75	-23.12356246	65.82703	-57.49984404	109.8655	25.89466551	88.76563	-23.31595729	29.77395
22.00	-25.70343264	-59.76379	-56.19925978	124.5537	25.99519109	74.54252	-22.74851851	-53.15651
22.25	-21.50526684	-135.146	-56.48290494	117.0626	25.9929542	60.20918	-22.7949938	-130.3867
22.50	-19.05440757	-142.7634	-55.33883304	124.7403	25.9423841	46.84296	-22.62239821	127.8174
22.75	-17.11360745	-151.3966	-56.8362217	114.5476	25.83090276	31.59475	-22.84857194	23.23565
23.00	-15.60085198	-153.3808	-55.6578959	119.6489	25.74209128	20.0863	-23.28188137	-58.70689
23.25	-14.35135052	-158.2446	-54.97808349	129.8279	25.64659449	8.80714	-23.24126	-134.4498
23.50	-13.3856983	-163.8366	-54.22745571	127.8824	25.56033298	-2.513484	-22.91076976	133.5038
23.75	-12.9610338	-158.746	-54.70896	122.1129	25.42409663	-15.46905	-22.73361635	37.09391
24.00	-12.50086666	67.2726	-54.95818513	114.179	25.27623067	-25.76448	-23.04809951	-45.12844
24.25	-12.06691459	119.7928	-54.29656888	126.9418	25.22525942	-35.47941	-21.99137851	-119.9143
24.50	-11.58946547	161.3251	-53.62176635	110.5392	25.08452821	-46.34036	-21.74262638	128.6337
24.75	-11.2979335	157.9966	-52.18634317	113.2611	24.96671538	-58.1165	-21.62856073	44.90618
25.00	-11.32741982	154.2951	-54.08715853	106.5829	24.78959987	-67.59283	-21.62569444	-32.37592
25.25	-11.23230046	148.4569	-54.94380763	101.8688	24.62454087	-77.28712	-21.61341775	-118.6259
25.50	-11.04605362	142.5693	-53.16410471	102.6103	24.4671767	-86.12781	-21.5418503	113.3838
25.75	-11.1529744	137.0566	-53.71351535	99.48512	24.28572042	-96.1563	-21.62914881	49.17649
26.00	-11.09572929	130.2404	-53.58539439	93.90759	24.1381749	-105.1414	-21.2125731	-33.18256
26.25	-11.27702909	124.5444	-54.47886939	81.87852	23.96408885	-112.6464	-21.75579699	-113.6358
26.50	-11.43853895	119.0629	-55.66924506	69.55863	23.8413767	-120.1498	-22.08721058	110.4341
26.75	-11.43486595	115.6168	-56.70952349	53.09699	23.7868134	-128.4113	-20.78555945	56.52972
27.00	-11.28678905	110.2075	-57.25326869	79.59267	23.63861901	-135.7376	-20.49282547	-36.71297
27.25	-11.34777459	104.7375	-56.53117138	70.9152	23.51304131	-142.3337	-21.37648611	-106.4817
27.50	-11.51007882	98.59031	-58.55320978	57.19768	23.48823535	-149.245	-21.02814687	88.21476
27.75	-11.29711339	92.73546	-58.68407574	79.07403	23.39653728	-157.9324	-20.01566356	50.2382
28.00	-11.50124587	85.50809	-58.46419327	71.95325	23.30976833	-164.1288	-20.22980389	-35.7298
28.25	-11.67581095	78.95515	-59.08923314	67.20771	23.25062965	-164.0344	-20.94266272	-121.211
28.50	-11.5999179	71.436	-57.24375686	97.31866	23.18229439	92.78526	-20.90978365	137.5318
28.75	-12.08401878	62.25452	-55.08474631	89.09316	23.07224788	163.845	-22.01464821	54.20456
29.00	-12.32326669	56.34512	-55.85084224	63.9235	23.16958513	160.8435	-21.88938435	-22.73862
29.25	-12.57066321	50.79592	-57.92653183	35.59597	23.18119548	153.8734	-21.93832634	-109.8906
29.50	-12.91250529	43.62169	-57.45546939	24.88255	23.21183157	146.7522	-21.92378164	106.3921
29.75	-13.08294897	36.6775	-58.49704375	46.75286	23.21908721	138.7173	-22.69867079	60.67097
30.00	-13.59342423	28.90627	-58.96497436	35.39265	23.29855763	131.9668	-23.45147647	-22.15091
30.25	-14.28213289	22.68205	-59.56790776	12.49677	23.40011131	124.998	-22.9535738	-105.3933
30.50	-14.84559477	19.09998	-57.17543413	7.012173	23.46412715	118.5168	-23.62144702	100.2677
30.75	-15.7254765	10.55204	-56.93909051	-60.67441	23.59381369	109.437	-23.16302839	35.66673
31.00	-15.90116976	4.344876	-53.52393465	-50.78241	23.61091237	103.3517	-23.800209526	-46.45742
31.25	-16.8008456	-14.37604	-52.81794612	26.27111	23.79057747	96.39056	-26.12970435	-19.27615
31.50	-18.32421289	-28.50865	-53.87054849	10.349	23.94433776	89.07619	-26.39217891	54.0527
31.75	-19.99854207	-43.5048	-52.00611753	18.02956	24.05633327	79.39088	-25.70923593	-2.863796
32.00	-20.44644404	-57.39901	-48.80423045	73.397	24.19003022	73.00694	-27.21957623	-88.84454
32.25	-21.47570219	-46.32822	-48.61408215	101.2055	24.3159758	65.29271	-28.25768699	47.03237
32.50	-21.59085903	12.20464	-47.74026811	140.0738	24.52605952	57.20591	-29.32655316	53.69983
32.75	-21.43986593	66.29778	-48.20522772	134.0072	24.67999458	46.23425	-30.04729082	-18.60548
33.00	-20.83623058	114.3232	-47.67629224	135.8989	24.80556365	36.68279	-29.94541134	-49.4307
33.25	-20.61684761	95.46846	-47.03746128	123.2578	24.85037032	27.5361	-29.86332125	79.87144
33.50	-21.32345805	80.8164	-46.05225247	130.9735	24.9077924	18.42938	-30.46836945	46.90621
33.75	-21.13134146	62.16114	-44.26385394	125.1967	24.82881038	7.853101	-28.83884143	-73.26851
34.00	-18.99137156	55.54688	-45.49549946	112.3785	24.7265201	-3.003329	-28.18807261	-51.08787
34.25	-17.71584369	41.11835	-45.09410426	112.7556	24.67845093	-12.65763	-27.41534684	92.06107
34.50	-16.76564374	30.60429	-44.63013596	109.4201	24.44645503	-23.62889	-26.1361376	11.42629
34.75	-16.52865188	21.73982	-43.73190615	104.1454	24.33217176	-35.01781	-25.90936158	-99.27038
35.00	-16.32542763	10.87974	-43.22180567	95.66795	24.03197753	-45.82063	-26.54870881	31.09902
35.25	-16.49280006	-3.310292	-43.29445734	87.2572	23.77255849	-56.46471	-26.44112422	69.25852
35.50	-16.22838581	-11.03301	-43.23875833	86.82874	23.41443288	-67.09972	-26.27478401	-10.89797
35.75	-16.44814918	-28.32576	-43.16730423	76.42503	23.00810401	-79.22389	-25.12049058	-92.98486
36.00	-17.34240915	-33.73981	-42.84589814	74.05479	22.76467429	-84.40869	-23.93343529	-104.399

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Mechanical Drawing

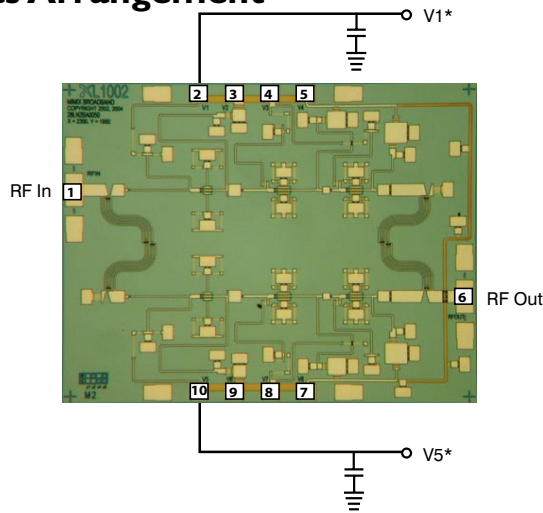


(Note: Engineering designator is 28LN3BA0050)

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.

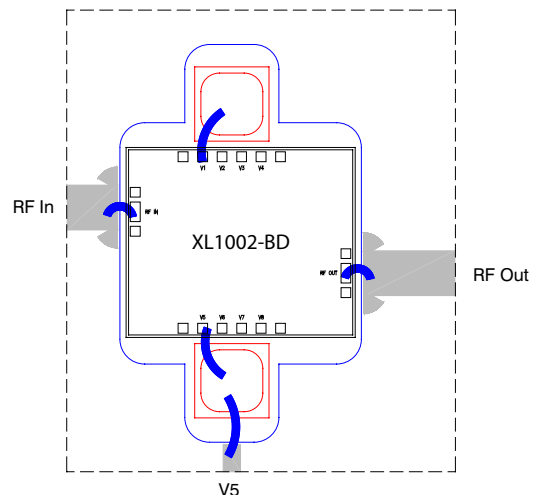
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|---------------------|----------------------|-------------------|
| Bond Pad #1 (RF In) | Bond Pad #4 (V3) | Bond Pad #7 (V8) |
| Bond Pad #2 (V1) | Bond Pad #5 (V4) | Bond Pad #8 (V7) |
| Bond Pad #3 (V2) | Bond Pad #6 (RF Out) | Bond Pad #9 (V6)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

MTTF Table

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

Backplate Temperature	Channel Temperature	Rth	MTTF Hours	FITs
55 deg Celsius	87.7 deg Celsius	88.4° C/W	1.56E+10	6.42E-02
75 deg Celsius	110.1 deg Celsius	94.9° C/W	1.05E+09	9.50E-01
95 deg Celsius	132.3 deg Celsius	100.8° C/W	9.83E+07	1.02E+01

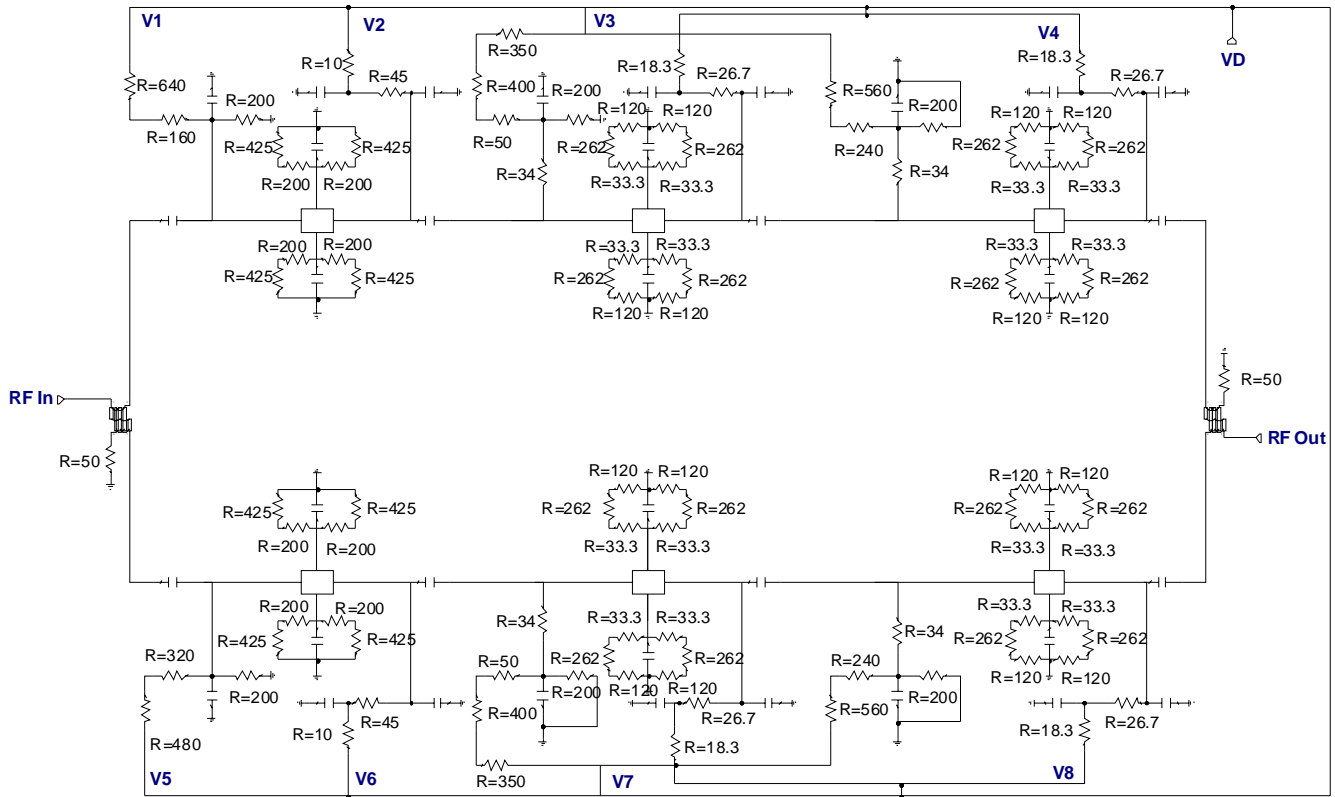
Bias Conditions: V1 or V5=5.0V, Id=85 mA

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LI002-BD

Device Schematic



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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 0.001² 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.

Ordering Information

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