

DC-6.0 GHz InGaP HBT MMIC Matched Gain Block Amplifier

Mimix
BROADBAND™

April 2007 - Rev 02-Apr-07

CGB7004-BD
RoHS

Features

- ✕ Low Operating Voltage: 5V
- ✕ 32.0 dBm Output IP3 @ 850 MHz
- ✕ 3.6 dB Noise Figure @ 850 MHz
- ✕ 16.5 dB Gain @ 850 MHz
- ✕ 17.0 dBm P1dB @ 850 MHz
- ✕ Low Performance Variation Over Temperature
- ✕ 100% DC On-Wafer Testing
- ✕ ESD Protection on All Die: >1000V HBM
- ✕ Low Thermal Resistance: <85°C/Watt

Description

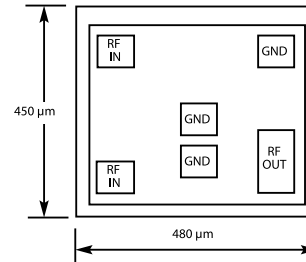
The CGB7004-BD is a Darlington Configured, high dynamic range, utility gain block amplifier. Designed for applications operating within the DC to 6.0 GHz frequency range, Mimix's broadband, cascadable, gain block amplifiers are ideal solutions for transmit, receive and IF applications.

These MMIC amplifiers are available in bare die form. Mimix's InGaP HBT technology and an industry low thermal resistance offers a thermally robust and reliable gain block solution.

The InGaP HBT die have extra pads to enable thorough DC testing. This unique test capability and the inclusion of ESD protection on all die, significantly enhances the quality, reliability and ruggedness of these products.

With a single bypass capacitor, optional RF choke and two DC blocking capacitors, this gain block amplifier offers significant ease of use in a broad range of applications.

Chip Layout



Absolute Maximum Ratings

Max Device Voltage	+6.0 V
Max Device Current	130 mA
Max Device Dissipated Power	0.63 W
RF Input Power	+17 dBm
Storage Temperature	-55°C to 150°C
Junction Temperature	150°C
Operating Temperature	-40°C to +85°C
Thermal Resistance	85° C/W
ESD (HBM)	1000 V

Operation of this device above any of these parameters may cause permanent damage.

Applications

- ✕ PA Driver Amp, IF Amp, LO Buffer Amp
- ✕ Cellular, PCS, GSM, UMTS
- ✕ Wireless Data and SATCOM
- ✕ Transmit and Receive Functions
- ✕ CATV

Typical Performance

Parameter	Temperature (°C)	850 MHz			1950 MHz			2400 MHz			3500 MHz			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Small Signal Gain	+25	15.5	16.5	17.5	14.0	15.0	16.0	13.2	14.2	15.2		13.2		dB
	-40 to +85	15.3	16.5	17.7	13.8	15.0	16.2	13.0	14.2	15.4		13.2		dB
Output P1dB	+25	16.0	17.0		15.3	16.3		14.7	15.7			13.5		dBm
	-40 to +85	15.5	17.0		14.8	16.3		14.2	15.7			13.5		dBm
Output IP3	+25	30.5	32.0		28.5	30.0		27.5	29.0			26.5		dBm
	-40 to +85	30.0	32.0		27.7	30.0		27.0	29.0			26.5		dBm
Noise Figure	+25		3.6	4.4		3.8	4.6		3.9	4.7		4.2		dB
	-40 to +85		3.6	4.8		3.8	5.0		3.9	5.1		4.2		dB
Operating Current	+25	58	62	66	58	62	66	58	62	66		62		mA
	-40 to +85	53	62	69	53	62	69	53	62	69		62		mA
Input Return Loss	+25	13	16		11	14		10.5	13.5			13.0		dB
	-40 to +85	12	16		10	14		9.5	13.5			13.0		dB
Output Return Loss	+25	15	18		12	15		12	15			16		dB
	-40 to +85	14	18		11	15		11	15			16		dB
Pout @ -45 dBc, ACP IS-95, 9 Forward Channels	+25		10			10								dBm
	-40 to +85		10			10								dBm

Notes: 1. Performance in Mimix eval board, $V_s = 5\text{ V}$, $I_d = 62\text{ mA}$ Typ., $R_{bias} = 15\ \Omega$, $Z_s = Z_L = 50\ \Omega$, OIP3 tone spacing = 1 MHz, Pout per tone = 3 dBm.
2. Values reflect performance in recommended application circuit.
3. Only on-wafer DC test is done. Devices are not tested for RF performance.

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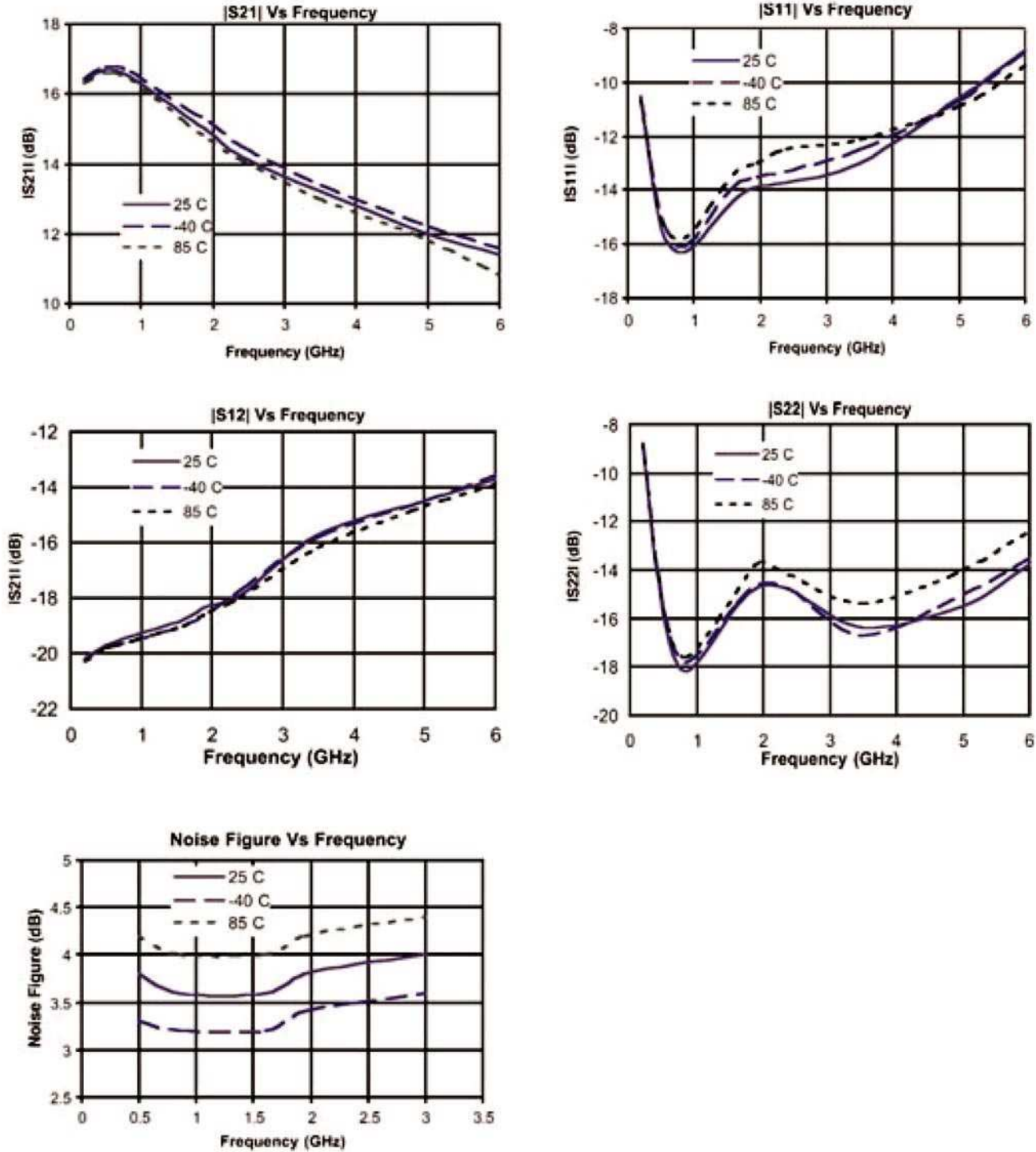
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Typical S-Parameter and Noise Performance



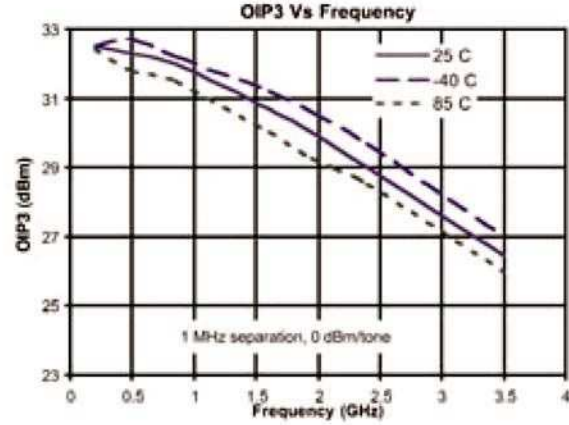
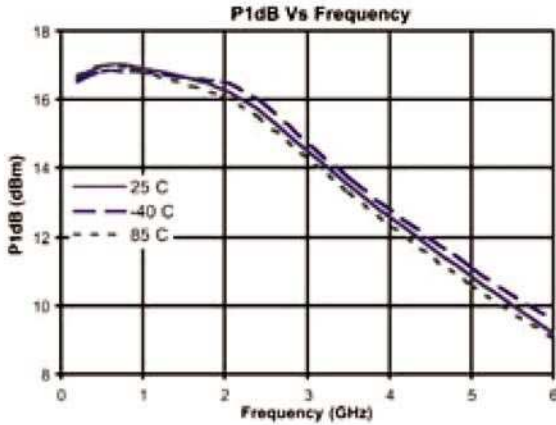
DC-6.0 GHz InGaP HBT MMIC Matched Gain Block Amplifier



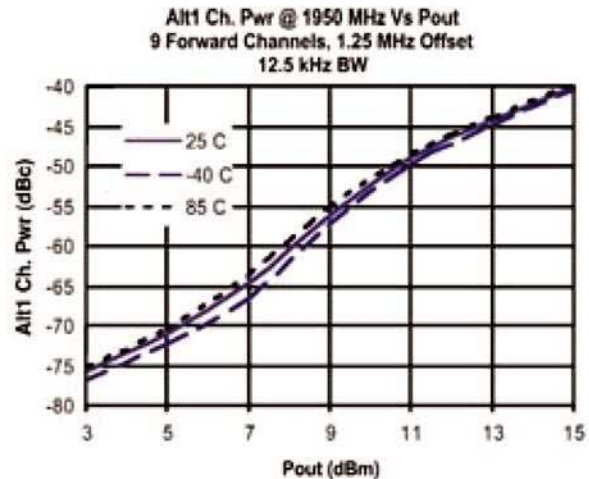
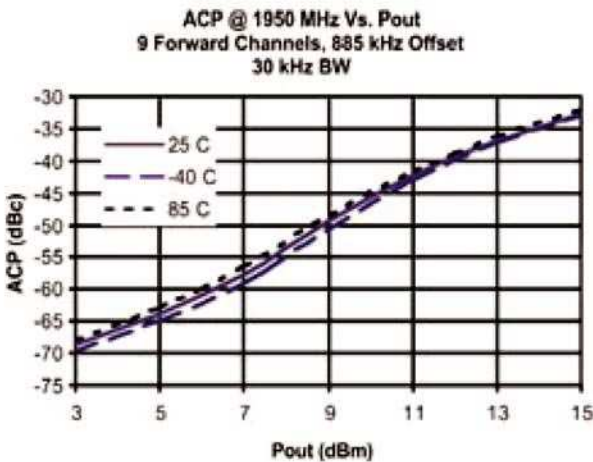
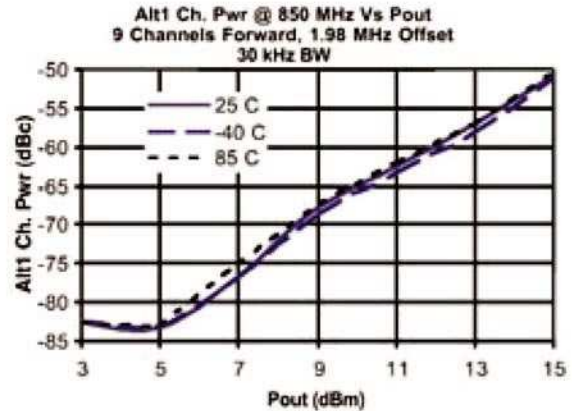
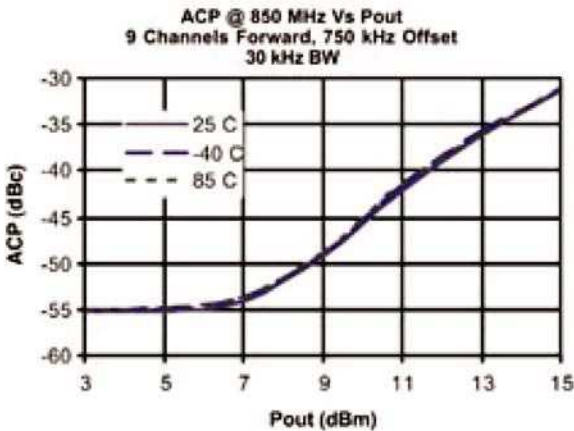
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Typical Power and Linearity Performance



Linearity Performance - Base Station ACP - IS-95



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Typical Scattering Parameters (Vd = +4.2V, Icc = 61.2 mA, T = 23°C, device in a 50 ohm system)

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	(Mag)	(Ang)	(Mag)	(Ang)	(Mag)	(Ang)	(Mag)	(Ang)
100	0.104	-7.1	7.06	174.7	0.103	-1.0	0.145	-6.7
200	0.105	-14.8	7.03	169.3	0.104	-1.5	0.146	-13.1
300	0.107	-22.0	7.00	164.1	0.104	-2.3	0.147	-19.7
400	0.109	-29.0	6.96	158.9	0.104	-3.1	0.148	-25.7
500	0.112	-35.7	6.92	153.8	0.105	-3.8	0.150	-32.0
600	0.115	-42.2	6.86	148.7	0.106	-4.7	0.152	-38.1
700	0.118	-48.5	6.81	143.6	0.106	-5.5	0.153	-44.1
800	0.122	-54.5	6.75	138.6	0.107	-6.4	0.155	-49.9
900	0.127	-60.1	6.69	133.6	0.108	-7.2	0.157	-55.5
1000	0.131	-65.8	6.63	128.7	0.109	-8.2	0.159	-61.2
1100	0.136	-71.1	6.56	123.7	0.110	-9.2	0.161	-66.7
1200	0.140	-76.1	6.49	118.9	0.112	-10.3	0.163	-71.7
1300	0.145	-81.0	6.41	114.0	0.113	-11.3	0.166	-77.0
1400	0.150	-85.7	6.34	109.2	0.114	-12.4	0.168	-81.9
1500	0.155	-90.1	6.26	104.5	0.116	-13.5	0.170	-86.7
1600	0.160	-94.6	6.18	99.8	0.117	-14.7	0.171	-91.2
1700	0.166	-98.8	6.10	95.1	0.119	-15.9	0.174	-95.7
1800	0.171	-103.0	6.02	90.5	0.121	-17.3	0.176	-100.2
1900	0.176	-106.9	5.94	85.9	0.123	-18.6	0.178	-104.4
2000	0.181	-110.8	5.86	81.4	0.124	-19.8	0.179	-108.7
2100	0.186	-114.7	5.78	76.9	0.126	-21.2	0.181	-112.6
2200	0.191	-118.4	5.70	72.4	0.128	-22.8	0.183	-116.6
2300	0.196	-122.2	5.63	68.0	0.130	-24.2	0.184	-120.6
2400	0.201	-125.8	5.55	63.6	0.132	-25.7	0.185	-124.5
2500	0.205	-129.4	5.48	59.3	0.134	-27.2	0.185	-128.5
2600	0.208	-133.0	5.40	55.0	0.137	-28.8	0.186	-132.2
2700	0.212	-136.5	5.33	50.7	0.139	-30.5	0.186	-136.0
2800	0.216	-140.0	5.26	46.5	0.141	-32.1	0.187	-139.7
2900	0.219	-143.7	5.20	42.3	0.143	-33.8	0.188	-143.6
3000	0.223	-147.1	5.13	38.1	0.146	-35.6	0.188	-147.4
3100	0.226	-150.7	5.07	34.0	0.148	-37.3	0.188	-151.2
3200	0.230	-154.2	5.01	29.8	0.151	-39.2	0.189	-155.1
3300	0.233	-157.9	4.95	25.7	0.153	-41.0	0.189	-159.1
3400	0.237	-161.8	4.90	21.5	0.156	-42.9	0.189	-163.2
3500	0.241	-165.5	4.84	17.4	0.159	-44.9	0.190	-167.2
3600	0.244	-169.3	4.79	13.3	0.162	-46.9	0.190	-171.1
3700	0.247	-173.1	4.74	9.3	0.164	-48.9	0.190	-175.4
3800	0.250	-177.0	4.69	5.2	0.167	-50.9	0.190	-180.0
3900	0.253	178.6	4.64	1.1	0.170	-53.1	0.190	175.8
4000	0.256	174.5	4.60	-2.9	0.173	-55.1	0.190	171.1
4100	0.259	170.2	4.55	-6.9	0.176	-57.3	0.190	166.3
4200	0.260	165.9	4.51	-11.0	0.179	-59.5	0.191	161.3
4300	0.261	161.3	4.47	-15.1	0.182	-61.8	0.191	156.0
4400	0.263	156.5	4.43	-19.1	0.185	-64.1	0.192	150.3
4500	0.265	151.7	4.39	-23.2	0.188	-66.4	0.192	144.6
4600	0.266	146.9	4.36	-27.3	0.191	-68.7	0.194	138.9
4700	0.267	142.0	4.32	-31.3	0.194	-71.2	0.196	133.2
4800	0.268	136.8	4.29	-35.4	0.197	-73.6	0.199	127.0
4900	0.270	131.3	4.25	-39.5	0.201	-76.2	0.203	120.6
5000	0.272	125.6	4.22	-43.7	0.204	-78.8	0.207	113.9

Continues Next Page. S-Parameter Data Files are available online at: www.mimixbroadband.com

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	(Mag)	(Ang)	(Mag)	(Ang)	(Mag)	(Ang)	(Mag)	(Ang)
5100	0.273	120.0	4.19	-47.9	0.207	-81.4	0.211	107.4
5200	0.275	114.5	4.15	-52.0	0.210	-83.9	0.217	101.4
5300	0.278	108.8	4.12	-56.2	0.213	-86.6	0.225	95.0
5400	0.280	102.4	4.09	-60.4	0.216	-89.4	0.233	88.2
5500	0.284	96.0	4.06	-64.7	0.219	-92.2	0.241	81.5
5600	0.288	89.8	4.02	-68.9	0.222	-95.0	0.250	75.2
5700	0.294	83.5	4.00	-73.2	0.225	-97.9	0.262	69.2
5800	0.299	77.2	3.96	-77.5	0.228	-100.9	0.274	62.7
5900	0.304	70.3	3.92	-81.9	0.230	-104.0	0.288	56.2
6000	0.311	63.4	3.89	-86.3	0.232	-107.0	0.303	50.0
6100	0.319	56.7	3.85	-90.7	0.235	-110.1	0.319	43.8
6200	0.328	50.1	3.81	-95.2	0.237	-113.2	0.336	38.0
6300	0.337	43.5	3.76	-99.6	0.239	-116.4	0.352	32.3
6400	0.345	36.7	3.72	-104.1	0.240	-119.6	0.371	26.9
6500	0.356	29.9	3.67	-108.6	0.241	-122.9	0.391	21.3
6600	0.368	23.3	3.62	-113.2	0.242	-126.1	0.411	15.8
6700	0.380	17.2	3.56	-117.7	0.243	-129.4	0.430	10.7
6800	0.392	11.1	3.51	-122.2	0.243	-132.6	0.450	5.8
6900	0.402	4.9	3.45	-126.7	0.243	-136.0	0.471	0.9
7000	0.415	-1.4	3.39	-131.3	0.243	-139.4	0.492	-4.0
7100	0.428	-7.6	3.32	-135.8	0.242	-142.8	0.512	-8.8
7200	0.442	-13.3	3.25	-140.4	0.241	-146.1	0.532	-13.6
7300	0.453	-18.8	3.19	-144.8	0.240	-149.4	0.550	-18.1
7400	0.464	-24.5	3.12	-149.3	0.238	-152.7	0.569	-22.5
7500	0.475	-30.1	3.04	-153.8	0.237	-155.9	0.587	-26.9
7600	0.488	-35.6	2.97	-158.2	0.234	-159.3	0.605	-31.3
7700	0.500	-40.9	2.89	-162.6	0.232	-162.5	0.623	-35.6
7800	0.511	-45.8	2.82	-166.8	0.229	-165.6	0.639	-39.8
7900	0.519	-50.6	2.74	-171.1	0.226	-168.7	0.654	-43.7
8000	0.528	-55.6	2.67	-175.4	0.223	-171.8	0.668	-47.5
8100	0.537	-60.5	2.59	-179.6	0.220	-174.9	0.683	-51.4
8200	0.547	-65.1	2.51	-176.2	0.217	-177.9	0.697	-55.2
8300	0.555	-69.3	2.44	-172.2	0.213	-179.2	0.709	-58.8
8400	0.560	-73.4	2.36	-168.3	0.209	-176.3	0.719	-62.3
8500	0.564	-77.7	2.30	-164.4	0.206	-173.5	0.730	-65.6
8600	0.568	-82.0	2.23	-160.5	0.203	-170.7	0.739	-68.9
8700	0.574	-86.2	2.16	-156.6	0.199	-167.9	0.748	-72.2
8800	0.579	-89.8	2.09	-152.9	0.195	-165.4	0.757	-75.3
8900	0.580	-93.4	2.03	-149.2	0.191	-162.9	0.764	-78.3
9000	0.580	-97.1	1.97	-145.5	0.188	-160.3	0.769	-81.2
9100	0.580	-100.9	1.91	-141.8	0.185	-157.8	0.775	-84.0
9200	0.581	-104.9	1.85	-138.2	0.181	-155.3	0.782	-86.9
9300	0.582	-108.3	1.79	-134.6	0.178	-152.8	0.787	-89.7
9400	0.582	-111.6	1.74	-131.1	0.174	-150.5	0.792	-92.4
9500	0.579	-114.8	1.68	-127.7	0.171	-148.3	0.795	-95.0
9600	0.575	-118.3	1.63	-124.2	0.168	-146.0	0.799	-97.5
9700	0.573	-121.9	1.58	-120.7	0.165	-143.6	0.802	-100.1
9800	0.573	-125.2	1.53	-117.3	0.161	-141.5	0.805	-102.6
9900	0.571	-128.1	1.48	-114.0	0.158	-139.2	0.808	-105.1
10000	0.566	-130.9	1.44	-110.8	0.155	-137.3	0.810	-107.4

S-Parameter Data Files are available online at: www.mimixbroadband.com

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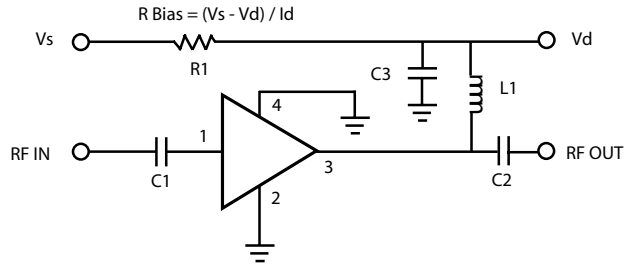
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Application Circuit

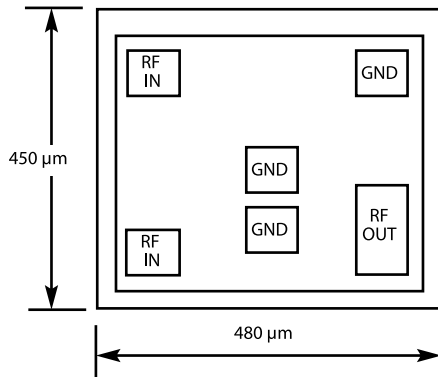
Note: This schematic represents the topology of the application circuit recommended by Mimix.

Recommended Bias Resistor Values for ID = 62 mA						
Supply Voltage (Vs)	5V	6V	7V	8V	10V	12V
Rbias (1/8W)	15Ω	31Ω	—	—	—	—
Rbias (1/4W)	—	—	47Ω	63Ω	—	—
Rbias (1/2W)	—	—	—	—	100Ω	130Ω

Note: Rbias provides DC bias stability over temperature.



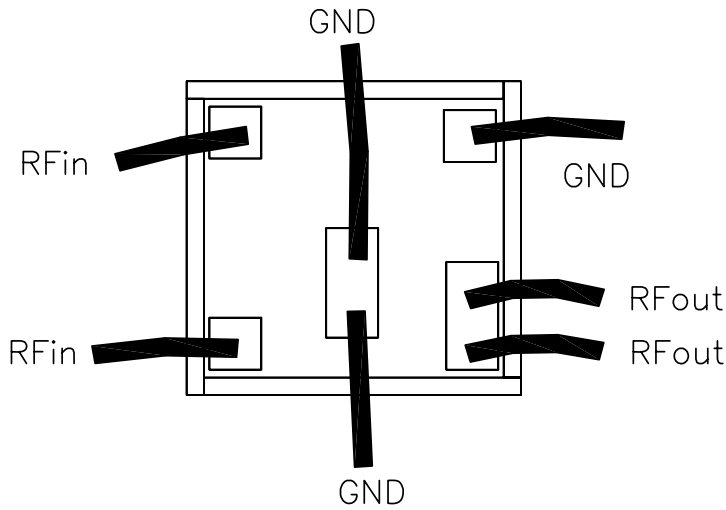
Physical Dimensions



Notes:
RF OUT bonding pad is 75 μm x 155 μm.
All other pads are 75 μm x 75 μm.

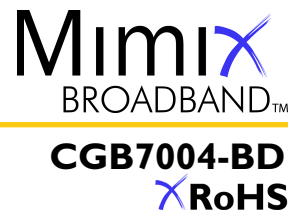
Ref Designator	Value
C1, C2	1000 pF
C3	1.0 μF
L1	56 nH
R1	$R_{Bias} = (V_s - V_d) / I_d$

Bonding Configuration



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

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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. 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.

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 Gold 0.025 mm (0.001") diameter ball bonds. 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	Description
CGB7004-BD-000V	RoHS compliant die packed in vacuum release gel paks