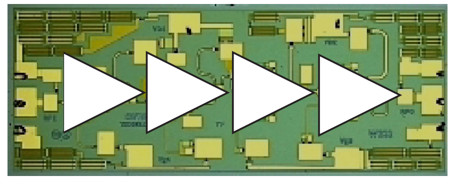
AMMC-6232

18 to 32 GHz GaAs High Linearity Low Noise Amplifier

Data Sheet



Chip Size: 800 µm x 2000µm (31.5 x 78.74 mils)
Chip Size Tolerance: ±10 µm (±0.4 mils)
Chip Thickness: 100 ± 10 µm (4 ±0.4 mils)
Pad Dimensions: 100 x 100 µm (4 x 4 mils)

Description

Avago Technologies AMMC-6232 is an easy-to-use broadband, high gain, high linearity Low Noise Amplifier that operates from 18 GHz to 32GHz. The wide band and unconditionally stable performance makes this MMIC ideal as a primary or sub-sequential low noise block or a transmitter or LO driver. The MMIC has 4 gain stages and requires a 4V, 135mA power supply for optimal performance. The two gate bias voltages can be combined for ease of use or separated for more control flexibility. DC-block capacitors are integrated at the input and output stages. Since this MMIC covers several bands, it can reduce part inventory and increase volume purchase options The MMIC is fabricated using PHEMT technology to provide exceptional low noise, gain and power performance. The backside of the chip is both RF and DC ground which helps simplify the assembly process and reduce assembly related performance variations and cost.

Attention:Observe precautions for handling electrostaticsensitive devices.
ESD Machine Model (Class A)
ESD Human Body Model (Class 1A)
Refer to Avago Application Note A004R: Electrostatic Discharge Damage and Control

Features

- 800µm x 2000µm Die Size
- Unconditionally Stable

Specifications (Vdd = 4.0V, Idd = 135mA)

- RF Frequencies: 18 - 32 GHz
- High Output IP3: 29dBm
- High Small-Signal Gain: 27dB
- Typical Noise Figure: 2.8dB
- Input, Output Match: -10dB

Applications

- Microwave Radio systems
- Satellite VSAT, DBS Up/Down Link
- LMDS & Pt-Pt mmW Long Haul
- Broadband Wireless Access (including 802.16 and 802.20 WiMax)
- WLL and MMDS loops

Note:
1. This MMIC uses depletion mode pHEMT devices.

Absolute Maximum Ratings [1]

Parameters / Conditions	Symbol	Unit	Max
Drain to Ground Voltage	Vdd	V	5.5
Gate-Drain Voltage	Vgd	V	-8
Drain Current	Idd	mA	200
Gate Bias Voltage	Vg	V	+0.8
Gate Bias Current	Ig	mA	1
RF CW Input Power Max	Pin	dBm	15
Max channel temperature	Tch	C	+150
Storage temperature	stg	C	-65 +150
Maximum Assembly Temp	Tmax	C	260 for 20s

Notes

1. Operation in excess of any of these conditions may result in permanent damage to this device. The absolute maximum ratings for Vdd, Vgd, Idd Vg, Ig and Pin were determined at an ambient temperature of 25°C unless noted otherwise.

DC Specifications/ Physical Properties [2]

Parameter and Test Condition	Symbol	Unit	Min	Typ	Max
Drain Supply Current (Vd=4.0 V)	Idd	mA		135	150
Drain Supply Voltage	Vd	V	3	4	5
Gate Bias Current	Ig	mA		0.1	
Gate Bias Voltage	Vg	V	-1.3	-0.95	-0.55
Thermal Resistance(3)	θjc	°C/W		35.1	

2. Ambient operational temperature TA=25°C unless noted
3. Channel-to-backside Thermal Resistance (Tchannel = 34°C) as measured using infrared microscopy. Thermal Resistance at backside temp. (Tb) = 25°C calculated from measured data.

AMMC-6232 RF Specifications [4]

T_A= 25°C, Vdd = 4.0 V, Idd = 135mA, Zo=50 Ω

Parameters and Test Conditions	Symbol	Unit	Frequency (GHz)	Spec Min	Spec Typ	Spec Max
Small signal gain (4)	AGain	dB	20	23	32	
			26	23	26.7	
			31	23	24.6	
Noise Figure into 50Ω (4)	NF	dB	20		3.2	4.5
			26		3.3	4.5
			31		4	4.5
Output Power at 1dB Gain Compression (4)	P1dB	dBm	20, 26, 31	15	20	
Output Third Order Intercept Point (4)	OIP3	dBm	20	26	28	
			26	26	28	
			31	26	27	
Isolation	S12	dB	20, 26, 31		-50	
Input Return Loss	S11	dB	20, 26, 31		-10	
Output Return Loss	S22	dB	20, 26, 31		-10	

4. All tested parameters guaranteed with measurement accuracy ±5dBm for OPI3 and ± 2dB for gain, NF and P1dB.

AMMC-6232 Typical Performance[1]

(T_A = 25°C, Vdd=4V, Idd=135mA, Z_{in} = Z_{out} = 50 Ω, on-wafer unless noted)

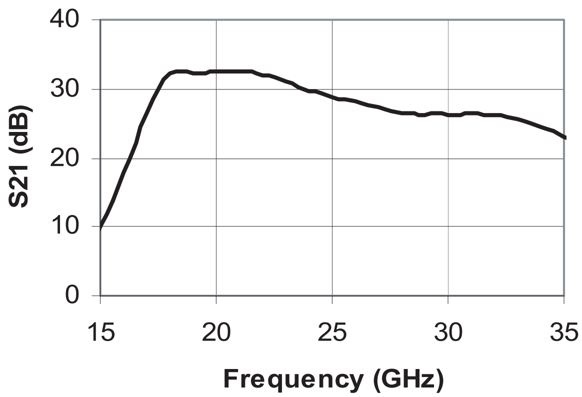


Figure 1. Small-signal Gain

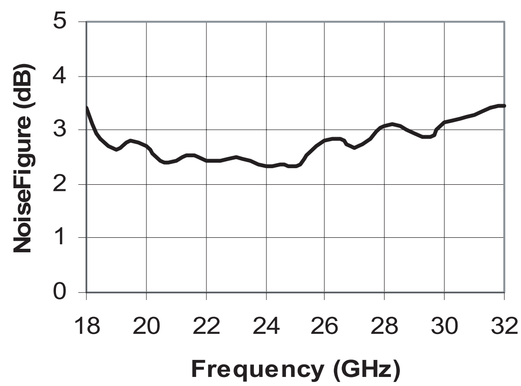


Figure 2. Noise Figure

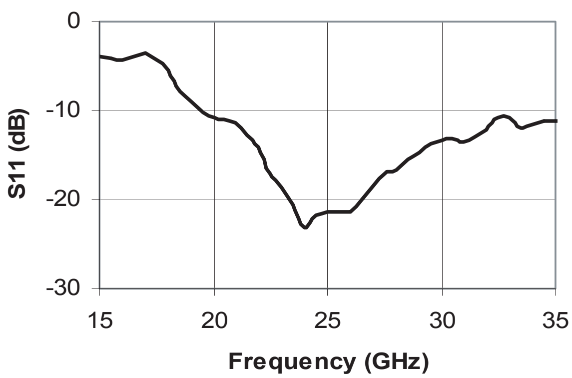


Figure 3. Input Return Loss

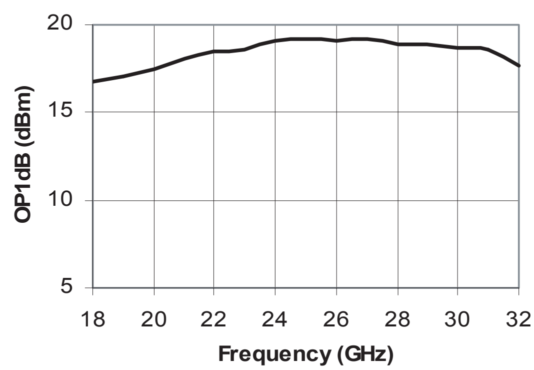


Figure 4. Output P-1dB

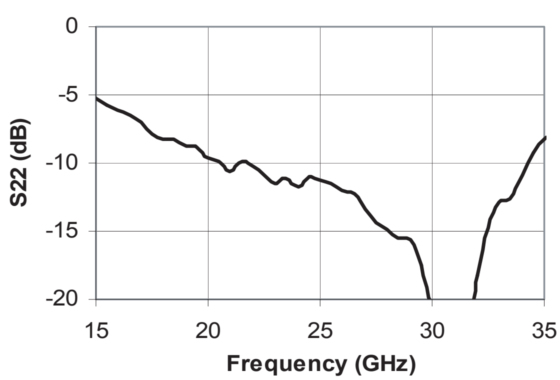


Figure 5. Output Return Loss

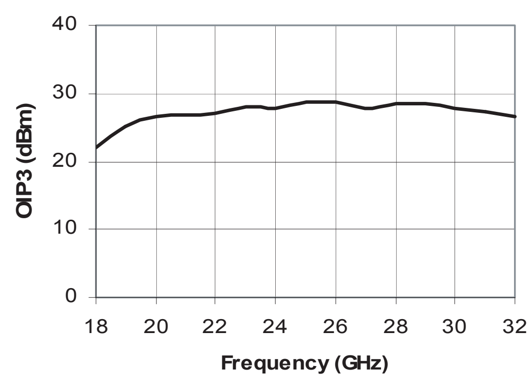


Figure 6. Output IP3

Note
1. Noise Figure is measured with a 3-dB pad at the input .

AMMC-6232 Typical Performance (Cont)

(T_A = 25°C, Vdd=4V, Idd=135mA, Z_{in} = Z_{out} = 50 Ω, on-wafer unless noted)

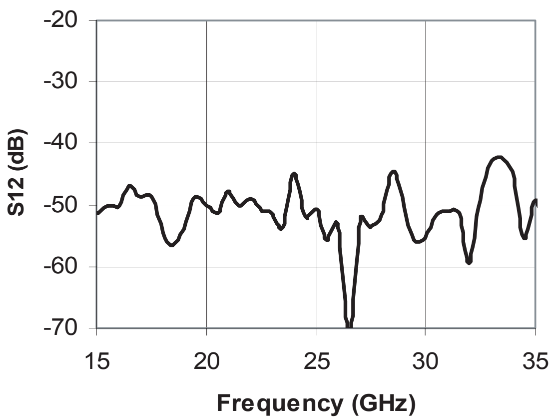


Figure 7. Isolation

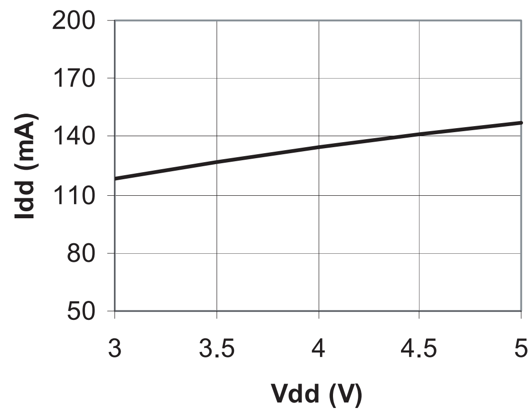


Figure 8. Idd Over Vdd (same Vg)

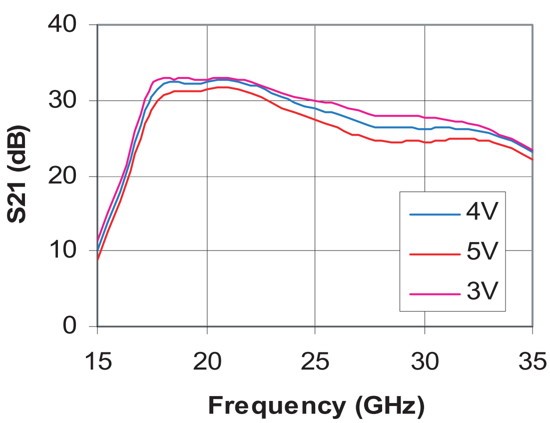


Figure 9. Small-signal Gain Over Vdd

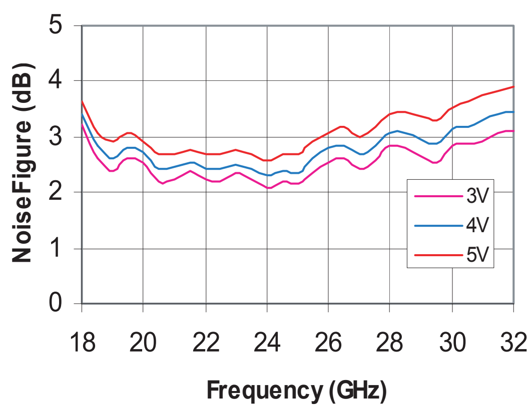


Figure 10. Noise Figure Over Vdd

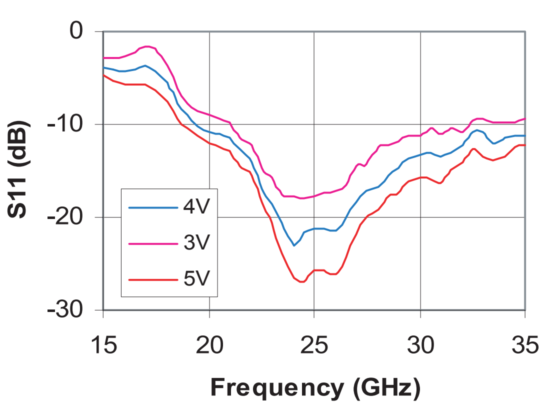


Figure 11. Input Return Loss Over Vdd

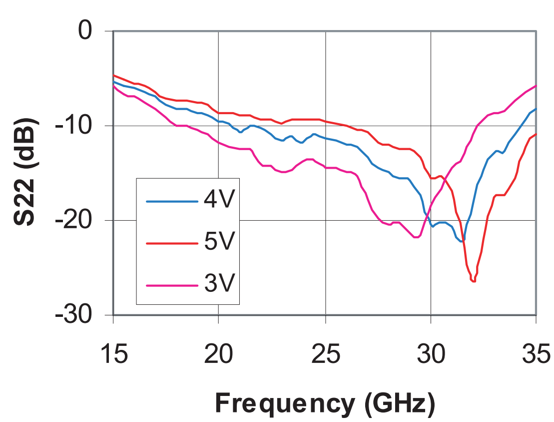


Figure 12. Output Returrn Loss Over Vdd

AMMC-6232 Typical Performance (Cont)

(T_A = 25°C, Vdd=4V, Idd=135mA, $Z_{in} = Z_{out}$ = 50 Ω, on-wafer unless noted)

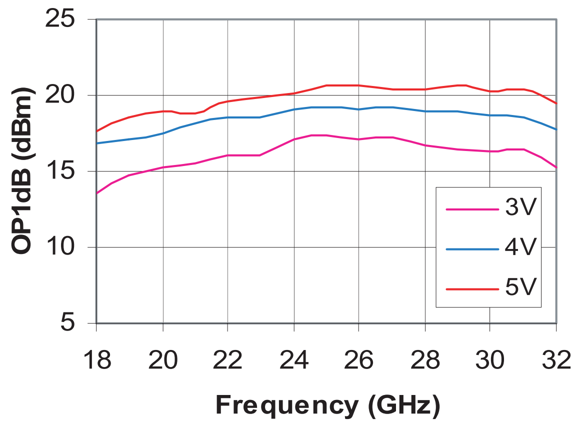


Figure 13. Output P1dB Over Vdd

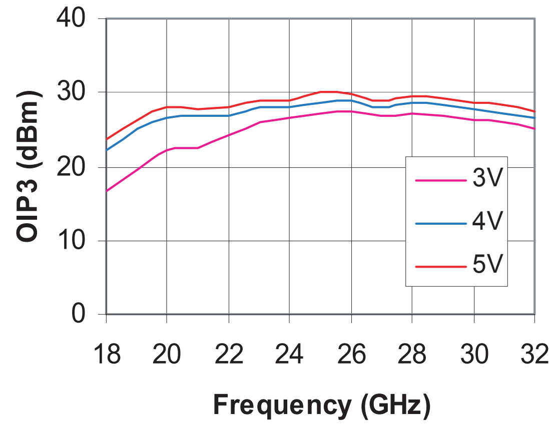


Figure 14. Output IP3 Over Vdd

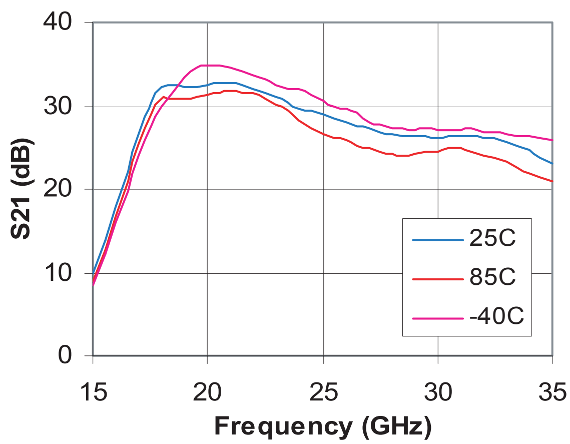


Figure 15. Small-signal Gain Over Temperature

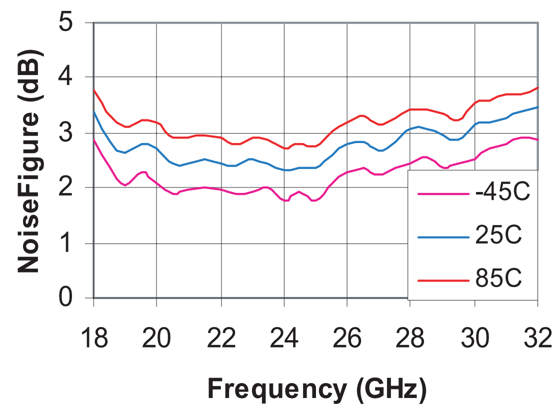


Figure 16. Noise Figure Over Temperature

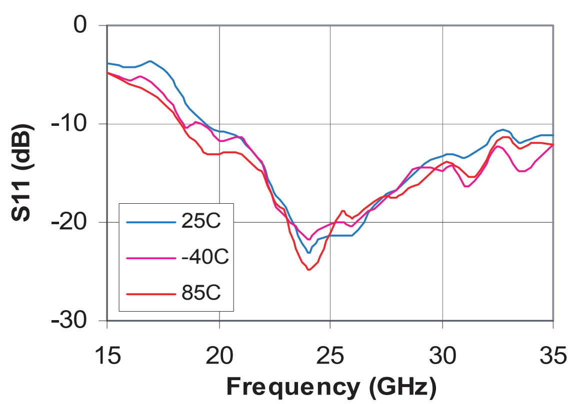


Figure 17. Output P-1dB Over Vdd

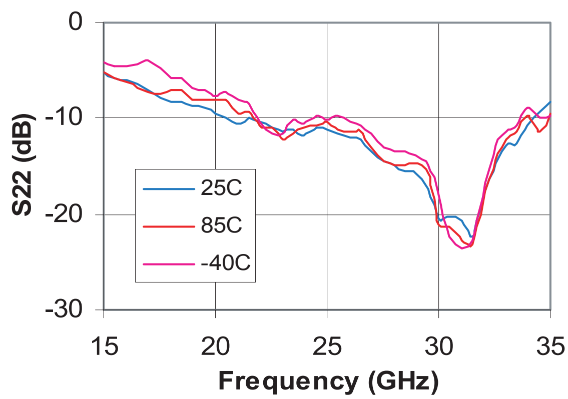


Figure 18. Output IP3 Over Vdd

AMMC-6232 Typical S-parameters

(T_A = 25°C, Vdd=4V, Idd=135mA, Z_{in} = Z_{out} = 50 Ω unless noted)

	S11			S21			S12			S22		
Freq	Mag	dB	Phase	Mag	dB	Phase	Mag	dB	Phase	Mag	dB	Phase
1.0	0.818	-1.746	-60.021	0.025	-31.992	-173.734	0.003	-49.134	72.088	0.954	-0.405	-72.004
3.0	0.804	-1.897	-116.721	0.014	-36.892	-107.504	0.002	-54.203	-170.740	0.590	-4.586	-135.849
5.0	0.887	-1.039	-156.457	0.002	-52.654	165.254	0.002	-52.786	169.502	0.836	-1.555	-171.399
7.0	0.899	-0.929	173.389	0.001	-61.276	178.332	0.002	-52.130	89.767	0.784	-2.113	157.037
9.0	0.886	-1.052	146.339	0.016	-35.917	-29.907	0.001	-64.067	-146.750	0.743	-2.583	136.088
11.0	0.777	-2.188	121.351	0.193	-14.294	-3.415	0.001	-58.094	-30.428	0.743	-2.575	110.111
13.0	0.735	-2.669	90.767	0.661	-3.593	-106.340	0.002	-55.057	41.432	0.661	-3.600	78.986
14.0	0.678	-3.381	71.345	1.397	2.907	-146.177	0.004	-49.054	-113.664	0.609	-4.312	62.630
15.0	0.638	-3.905	50.092	3.160	9.993	173.145	0.003	-51.286	12.903	0.547	-5.241	47.093
16.0	0.613	-4.256	22.797	7.829	17.874	127.412	0.003	-50.242	-7.415	0.496	-6.087	28.418
17.0	0.660	-3.612	-17.199	21.310	26.572	66.397	0.004	-48.669	132.091	0.448	-6.966	11.714
18.0	0.529	-5.528	-78.705	40.832	32.220	-25.727	0.002	-54.514	-150.466	0.385	-8.281	-4.471
18.5	0.406	-7.827	-102.424	41.585	32.379	-68.344	0.001	-56.637	-23.683	0.384	-8.305	-12.762
19.0	0.354	-9.008	-119.585	40.952	32.246	-103.547	0.002	-53.933	125.705	0.365	-8.753	-22.510
19.5	0.312	-10.119	-133.759	41.088	32.274	-134.623	0.004	-48.533	-99.868	0.359	-8.899	-30.282
20.0	0.290	-10.761	-151.887	41.954	32.455	-163.735	0.003	-50.000	-84.512	0.332	-9.567	-38.594
20.5	0.283	-10.954	-175.381	42.834	32.636	166.906	0.003	-51.175	101.027	0.321	-9.865	-53.085
21.0	0.268	-11.450	161.839	42.840	32.637	136.860	0.004	-47.869	-35.577	0.295	-10.589	-58.661
21.5	0.232	-12.699	147.124	41.949	32.455	108.907	0.003	-50.079	141.804	0.319	-9.931	-73.699
22.0	0.196	-14.174	120.747	40.151	32.074	80.907	0.004	-49.044	-66.647	0.305	-10.307	-75.111
22.5	0.142	-16.979	98.811	37.945	31.583	55.254	0.003	-51.053	-43.775	0.286	-10.877	-83.302
23.0	0.118	-18.530	74.852	35.378	30.975	30.342	0.003	-51.240	-54.194	0.268	-11.448	-92.687
23.5	0.094	-20.582	50.063	32.869	30.336	7.146	0.002	-53.496	-170.142	0.279	-11.087	-101.188
24.0	0.070	-23.065	33.219	30.641	29.726	-14.152	0.006	-44.954	125.867	0.258	-11.772	-103.724
24.5	0.082	-21.723	-23.615	29.175	29.300	-35.291	0.003	-51.886	59.279	0.283	-10.968	-109.636
25.0	0.086	-21.283	-48.577	27.913	28.916	-55.741	0.003	-50.720	-117.666	0.274	-11.231	-120.741
25.5	0.086	-21.326	-61.417	26.734	28.541	-76.327	0.002	-55.542	-174.291	0.267	-11.484	-134.054
26.0	0.086	-21.335	-72.999	25.441	28.111	-96.844	0.002	-53.122	129.172	0.252	-11.956	-141.622
26.5	0.100	-20.009	-85.033	24.006	27.607	-116.383	0.000	-70.458	-6.235	0.243	-12.272	-147.702
27.0	0.121	-18.335	-90.393	22.974	27.225	-135.333	0.002	-52.072	96.583	0.215	-13.349	-151.808
27.5	0.140	-17.079	-92.085	21.829	26.781	-153.561	0.002	-53.736	175.096	0.190	-14.435	-157.448
28.0	0.147	-16.671	-93.567	21.205	26.529	-171.261	0.003	-51.674	-150.054	0.180	-14.901	-169.765
28.5	0.168	-15.504	-104.424	20.735	26.334	170.769	0.006	-44.656	-42.304	0.169	-15.457	-174.716
29.0	0.184	-14.710	-106.694	20.656	26.301	152.609	0.003	-50.322	-50.809	0.164	-15.678	179.624
29.5	0.206	-13.734	-112.920	20.761	26.345	133.333	0.002	-55.781	-91.759	0.134	-17.439	169.927
30.0	0.217	-13.275	-114.467	20.431	26.206	114.454	0.002	-55.378	-142.825	0.095	-20.401	156.964
30.5	0.222	-13.092	-115.644	20.688	26.314	94.813	0.003	-51.486	97.286	0.097	-20.267	115.370
31.0	0.212	-13.457	-121.023	20.734	26.334	73.377	0.003	-51.134	116.486	0.093	-20.671	90.295
31.5	0.225	-12.964	-128.559	20.612	26.282	52.636	0.003	-51.287	-43.352	0.077	-22.279	45.612
32.0	0.246	-12.171	-130.429	20.304	26.152	31.050	0.001	-59.538	47.465	0.122	-18.257	4.816
33.0	0.289	-10.784	-129.264	19.283	25.703	-13.920	0.007	-42.943	-140.352	0.227	-12.866	-23.228
34.0	0.267	-11.479	-149.919	16.963	24.590	-60.335	0.006	-44.688	37.600	0.288	-10.820	-45.951
35.0	0.276	-11.175	-154.786	14.380	23.155	-106.453	0.003	-49.125	29.465	0.389	-8.194	-60.818
36.0	0.231	-12.724	-162.131	11.218	20.999	-153.267	0.003	-50.088	-115.073	0.414	-7.655	-71.849
37.0	0.215	-13.355	-179.755	8.435	18.522	161.897	0.003	-50.724	-89.514	0.502	-5.992	-87.410
38.0	0.218	-13.217	-179.314	6.181	15.821	120.672	0.006	-44.152	-113.404	0.547	-5.242	-93.971
39.0	0.162	-15.796	150.316	4.695	13.433	80.964	0.006	-44.523	10.595	0.582	-4.699	-105.709
40.0	0.188	-14.505	101.424	3.671	11.297	39.388	0.004	-47.382	-175.209	0.664	-3.554	-111.896
41.0	0.331	-9.592	20.449	2.964	9.438	-9.143	0.007	-43.734	-17.567	0.660	-3.604	-120.779
42.0	0.671	-3.471	-34.435	1.992	5.985	-70.226	0.005	-45.667	45.831	0.722	-2.826	-128.518
43.0	0.822	-1.701	-80.398	0.906	-0.862	-124.255	0.004	-48.650	77.675	0.735	-2.670	-132.437
44.0	0.744	-2.570	-102.406	0.350	-9.118	-164.509	0.012	-38.071	-38.925	0.768	-2.293	-143.230
45.0	0.745	-2.557	-120.374	0.146	-16.688	162.943	0.019	-34.517	-30.836	0.822	-1.706	-144.474
46.0	0.756	-2.425	-128.181	0.042	-27.587	142.437	0.014	-36.790	-116.379	0.778	-2.186	-154.332
47.0	0.698	-3.125	-138.988	0.039	-28.136	139.233	0.008	-41.590	4.635	0.870	-1.206	-160.348
48.0	0.716	-2.899	-145.786	0.018	-34.910	131.635	0.013	-37.614	-168.514	0.840	-1.514	-161.626
49.0	0.715	-2.916	-151.057	0.012	-38.392	-129.632	0.029	-30.658	148.528	0.856	-1.353	-170.390
50.0	0.748	-2.517	-163.929	0.020	-33.979	113.911	0.051	-25.798	-6.722	0.927	-0.657	-171.490

Note: S-parameters are measured on wafer.

AMMC-6232 Application and Usage

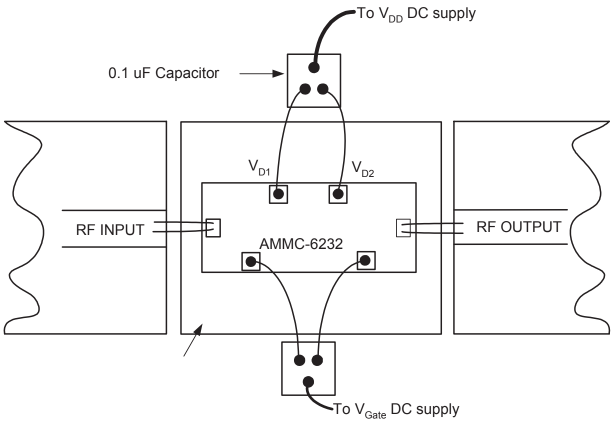


Figure 19. Gate Bias Combined Together

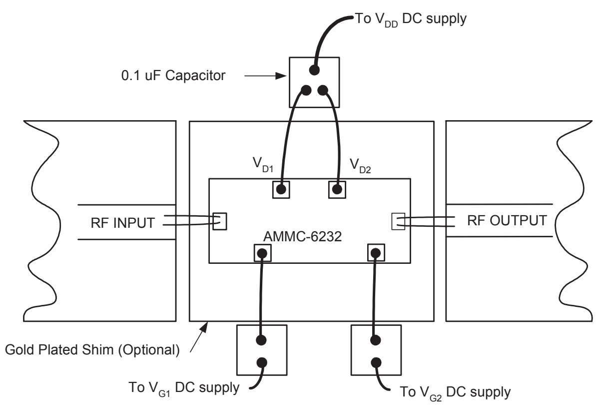


Figure 20. Separated Gate Bias

Biasing and Operation

The AMMC-6232 is normally biased with a positive drain supply connected to the VD1 and VD2 pads through bypass capacitor as shown in Figures 15 and 16. The recommended drain voltage and gate voltage for general usage is 4V and -0.95V respectively. With Vdd=4V, Vg=-0.95V, the corresponding drain current is approximately 135mA. It is important to have at least 0.1upF bypass capacitor and the capacitor should be placed as close to the component as possible. Aspects of the amplifier performance may be improved over a narrower bandwidth by application of additional conjugate, linearity, or low noise (Topt) matching.

After adjusting the gate bias to obtain 135mA at Vdd = 4V, the AMMC-6232 can be safely biased at Vdd= 3V or 5V (while fixing the gate bias) as desired. At 4V, the performance is an optimal compromise between power consumption, gain and power/linearity. It is both applicable to be used as a low noise block or driver. At 3V, the amplifier is ideal as a front end low noise block where linearity is not highly required. At 5V, the amplifier can provide ~ 2dB more output power for LO or transmitter driver applications where high output power and linearity are often required.

The two gate voltages can be combined as shown in Figure 15 or separated as in Figure 16. Combining the two gate voltages simplifies the usage whereas separating them provides flexibility to overall biasing scheme.

In both cases, bonding wires at the input and output in the range of 0.15nH would likely improve the overall Noise Figure and input, output match at most frequencies.

No ground wires are needed because ground connection is made with plated through-holes to the backside of the substrate.

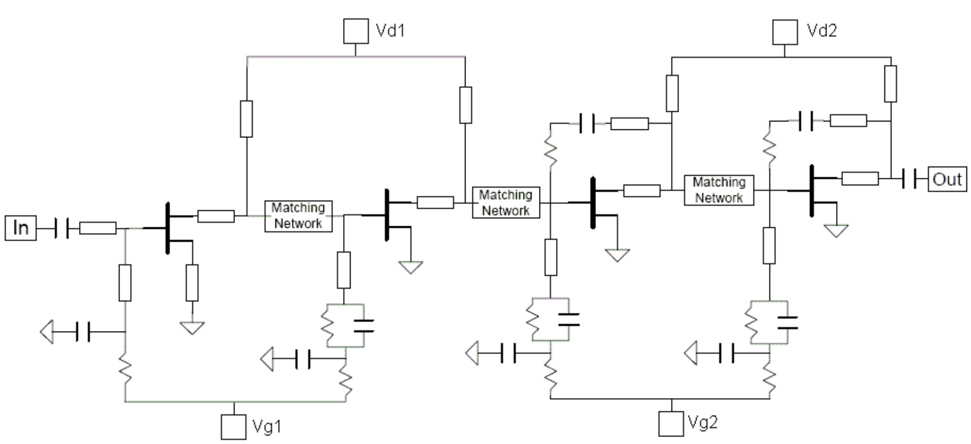


Figure 21. Simplified High Linearity LNA Schematic

Assembly Techniques

The backside of the MMIC chip is RF ground. For microstrip applications the chip should be attached directly to the ground plane (e.g. circuit carrier or heatsink) using electrically conductive epoxy [1,2].

For best performance, the topside of the MMIC should be brought up to the same height as the circuit surrounding it. This can be accomplished by mounting a gold plated metal shim (same length as the MMIC) under the chip which is of correct thickness to make the chip and adjacent circuit the same height. The amount of epoxy used for the chip or shim attachment should be just enough to provide a thin fillet around the bottom perimeter of the chip. The ground plane should be free of any residue that may jeopardize electrical or mechanical attachment.

RF connections should be kept as short as reasonable to minimize performance degradation due to undesirable series inductance. A single bond wire is normally sufficient for signal connections, however double bonding with 0.7mil gold wire will reduce series inductance. Gold thermo-sonic wedge bonding is the preferred method for wire attachment to the bond pads. The recommended wire bond stage temperature is 150°c ± 2°c.

Caution should be taken to not exceed the Absolute Maximum Rating for assembly temperature and time.

The chip is 100um thick and should be handled with care. This MMIC has exposed air bridges on the top surface and should be handled by the edges or with a custom collet (do not pick up the die with a vacuum on die center). Bonding pads and chip backside metallization are gold.

This MMIC is also static sensitive and ESD precautions should be taken

Notes:
1. Ablebond 84-1 LMI silver epoxy is recommended.
2. Eutectic attach is not recommended and may jeopardize reliability of the device.

Ordering Information:

AMMC-6232-W10 = 10 devices per tray

AMMC-6232-W50 = 50 devices per tray

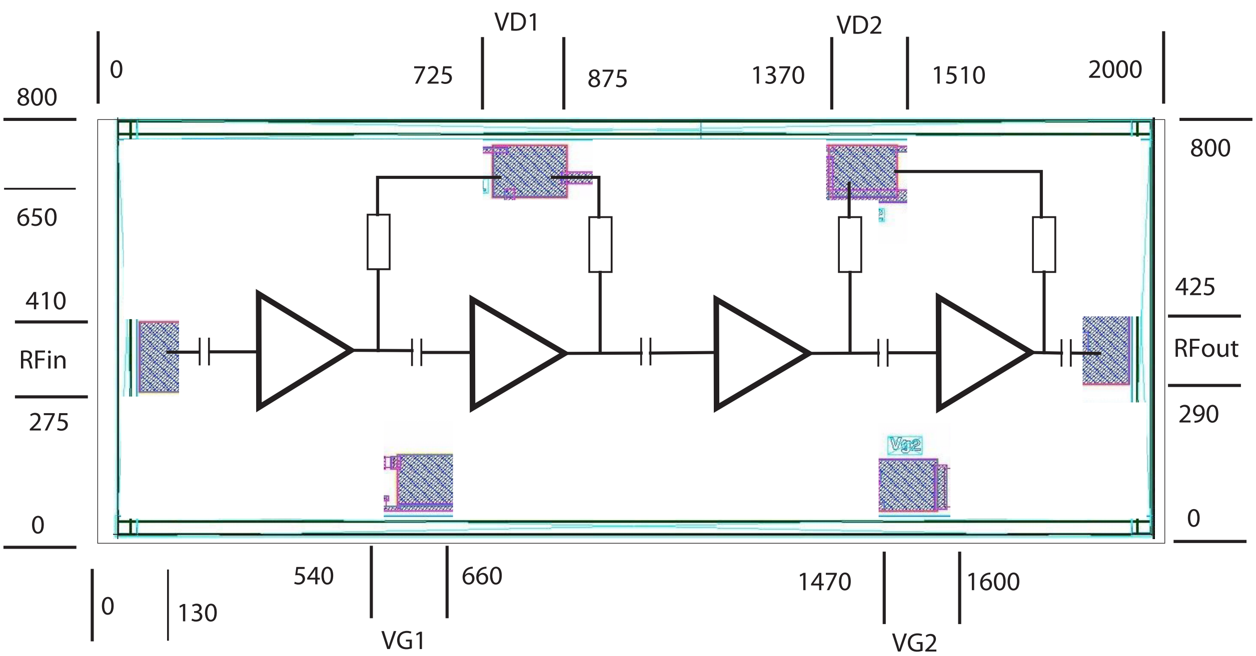


Figure 22. Bond Pad Locations

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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