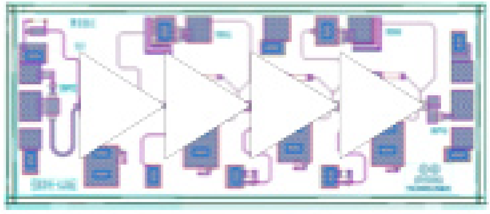
AMMC-6233

18 to 32 GHz GaAs Low Noise Amplifier

Data Sheet



Chip Size: 1900 x 800 µm (74.8 x 31.5 mils)
Chip Size Tolerance: ± 10 µm (± 0.4 mils)
Chip Thickness: 100 ± 10 µm (4 ± 0.4 mils)
RF Pad Dimensions: 110 x 90 µm (4.33 x 3.54 mils)
DC Pad Dimensions: 100 x 100 µm (3.94 x 3.94 mils)

Description

Avago Technologies' AMMC-6233 is a high gain, low-noise amplifier that operates from 18 GHz to 32 GHz. This LNA provides a wide-band solution for system design since it covers several bands, thus, reduces part inventory. The device has input / output match to 50 Ohm, is unconditionally stable and can be used as either primary or sub-sequential low noise gain stage. By eliminating the complex tuning and assembly processes typically required by hybrid (discrete- FET) amplifiers, the AMMC-6233 is a cost-effective alternative in the 18 - 32 GHz communications receivers. The backside of the chip is both RF and DC ground. This helps simplify the assembly process and reduces assembly related performance variations and costs. It is fabricated in a PHEMT process to provide exceptional noise and gain performance. For improved reliability and moisture protection, the die is passivated at the active areas.

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

Features

- Integrated DC block and choke
- 50 Ω input and output match
- Single positive supply
- No negative gate bias

Specifications (Vd = 3.0 V, Idd = 65 mA)

- RF frequencies: 18 - 32 GHz
- Small-signal gain: 22 dB
- Low gain flatness: ±1 dB
- Typical noise figure: 3.0 dB
- Typical output IP3: 19 dBm

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model (Class A)
ESD Human Body Model (Class 1A)
Refer to Avago Technologies Application Note A004R: *Electrostatic Discharge, Damage and Control.*
Note:
1. This MMIC uses depletion mode pHEMT devices.

Absolute Maximum Ratings[1]

Symbol	Parameters/Condition	Unit	Max
Vd	Drain to Ground Voltage	V	5.5
Id	Drain Current	mA	100
Pin	RF CW Input Power Max	dBm	10
Tch	Max Channel Temperature	C	+150
Tstg	Storage Temperature	C	-65 +150
Tmax	Maximum Assembly Temperature	C	260 for 20s

Note:

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

DC Specifications/ Physical Properties[2]

Symbol	Parameter and Test Condition	Unit	Min.	Typ.	Max.
Idd	Drain Current Under Any RF Power Drive and Temp.] (Vdd = 3 V)	mA		65	90
Vdd	Drain Supply Voltage	V		3	5
θjc	Thermal Resistance[3]	C/W		27	

Notes:

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-6233 RF Specifications[4]

T_A = 25°C, V_{dd} = 3.0 V, I_{dd} = 65 mA, Z_o = 50 Ω

Symbol	Parameters and Test Conditions	Frequencies (GHz)	Units	Minimum	Typical	Maximum
Gain	RF Small Signal Gain	18, 26, 31	dB	18	22	
NF	Noise Figure into 50W(5)	18, 26, 31	dB		3.0	4.0
RL_{in}	Input Return Loss		dB		-12	
RL_{out}	Output Return Loss		dB		-12	
Iso	Isolation		dB		-45	
P_{-1dB}	Output Power at 1dB(7) Gain Compression		dBm		8	
OIP3	Output Third Order Intercept Point		dBm		19	

Notes:

4. All tested parameters guaranteed with measurement accuracy +/-0.5 dB for the 6 to 20 GHz range, ±0.75 dB for the 20 to 33 GHz range and ±1.0 dB for the 33 to 50 GHz range.
5. NF is measured on-wafer. Additional bond wires (~0.2 nH) at input could improve NF at some frequencies.

AMMC-6233 Typical Performances

(T_A = 25°C, V_{dd} = 3.0 V, I_{total} = 65 mA, Z_{in} = Z_{out} = 50 Ω unless otherwise stated)

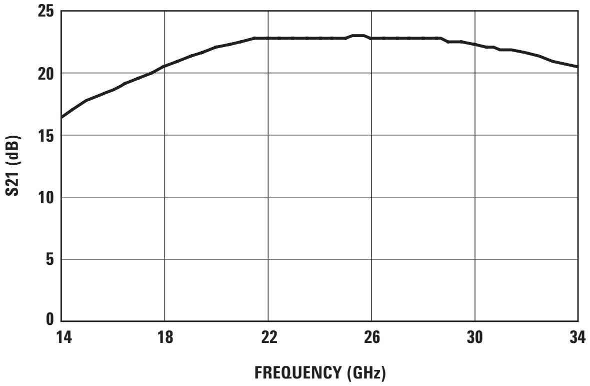


Figure 1. Typical gain

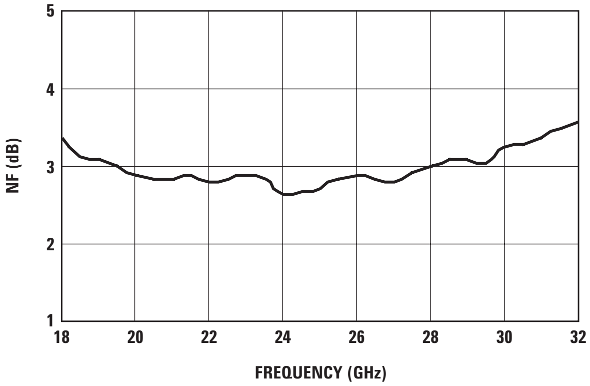


Figure 2. Typical noise figure

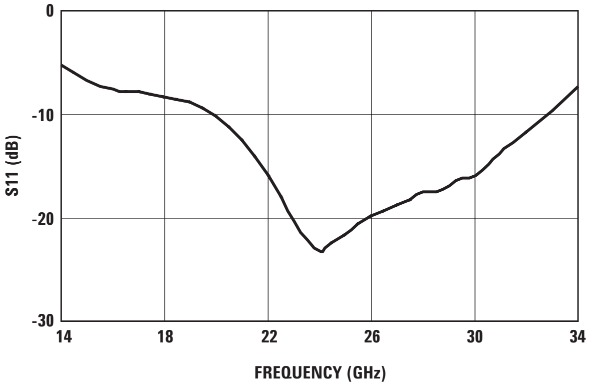


Figure 3. Typical input return loss

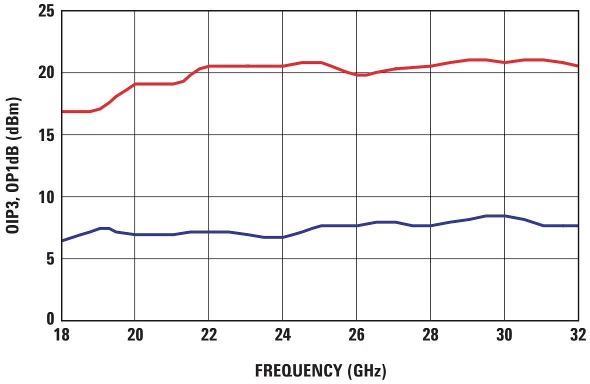


Figure 4. Typical output P-1dB

AMMC-6233 Typical Performances (Cont'd.)

(T_A = 25°C, V_{dd} = 3.0 V, I_{total} = 65 mA, Z_{in} = Z_{out} = 50 Ω unless otherwise stated)

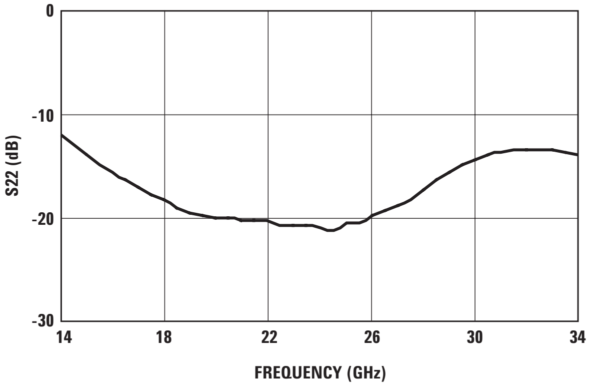


Figure 5. Typical output return loss

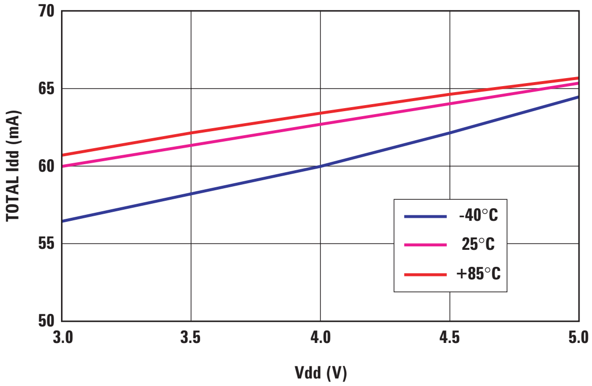


Figure 6. Total Idd over temp vs. Vdd

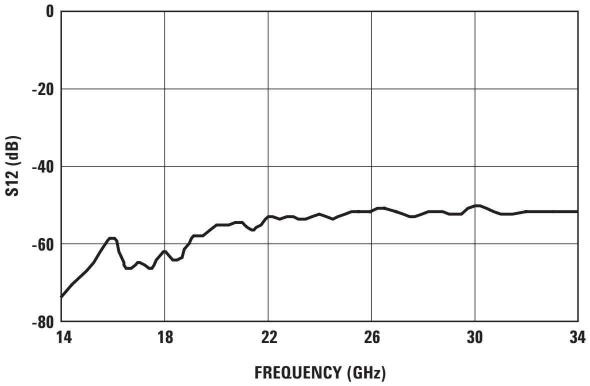


Figure 7. Typical isolation

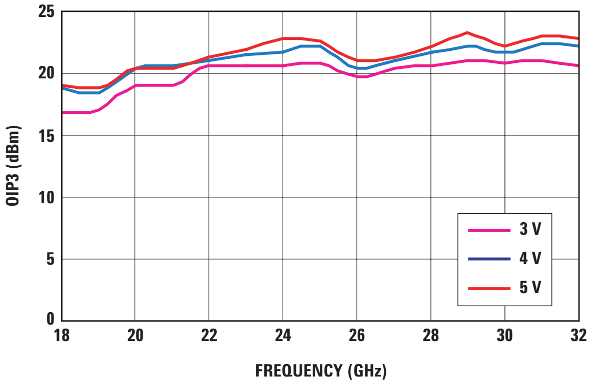


Figure 8. Typical output IP3 over Vdd

AMMC-6233 Typical Performances (Cont'd.)

(T_A = 25°C, V_{dd} = 3.0 V, I_{total} = 65 mA, Z_{in} = Z_{out} = 50 Ω unless otherwise stated)

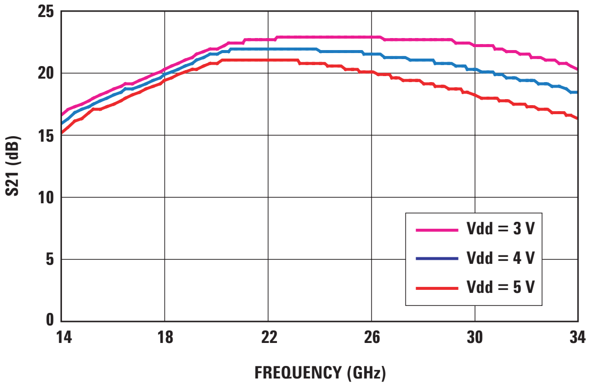


Figure 9. Typical gain over Vdd

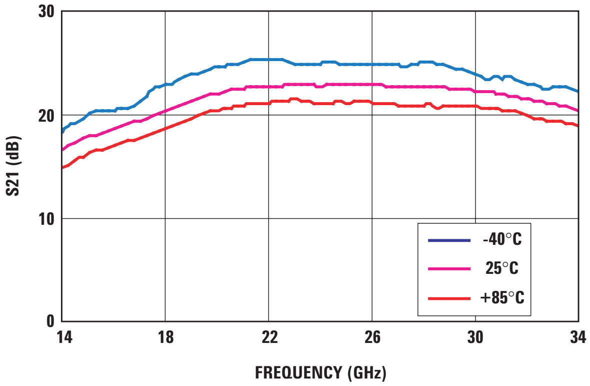


Figure 10. Typical gain over temp

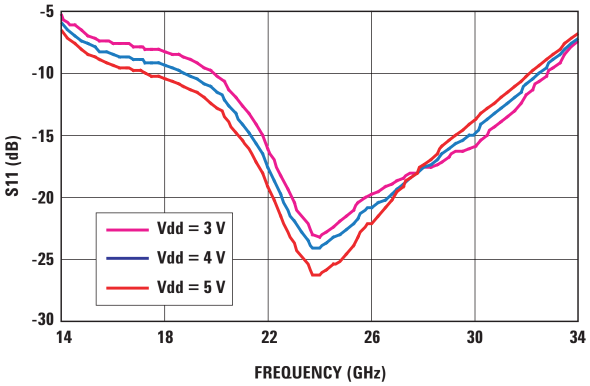


Figure 11. Typical input return loss over Vdd

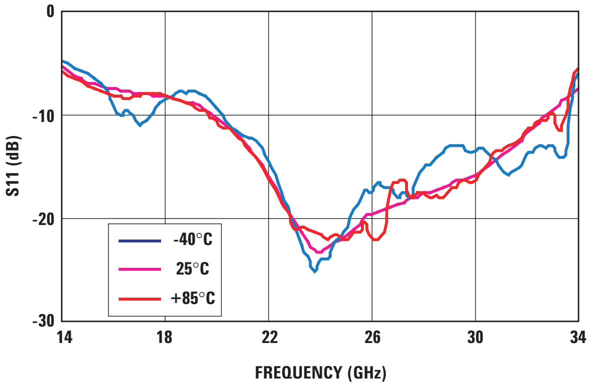


Figure 12. Typical input return loss over temp

AMMC-6233 Typical Performances (Cont'd.)

(T_A = 25°C, V_{dd} = 3.0 V, I_{total} = 65 mA, Z_{in} = Z_{out} = 50 Ω unless otherwise stated)

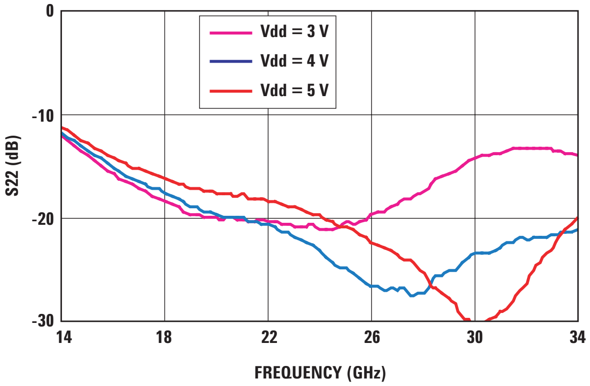


Figure 13. Typical output return loss over Vdd.

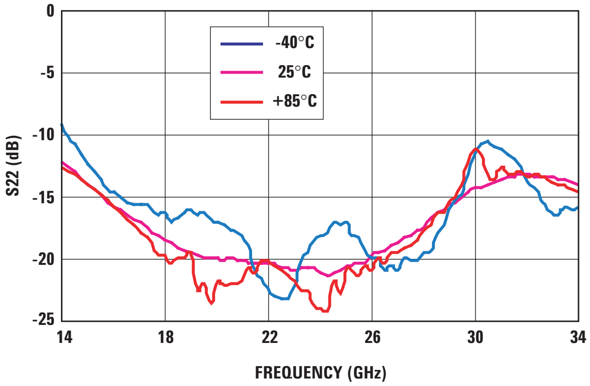


Figure 14. Typical output return loss over temp

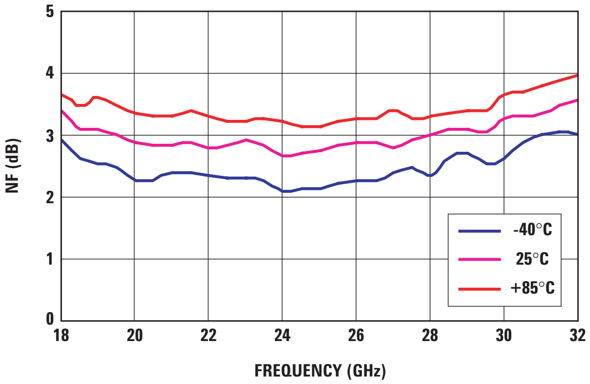


Figure 15. Typical noise figure over temp

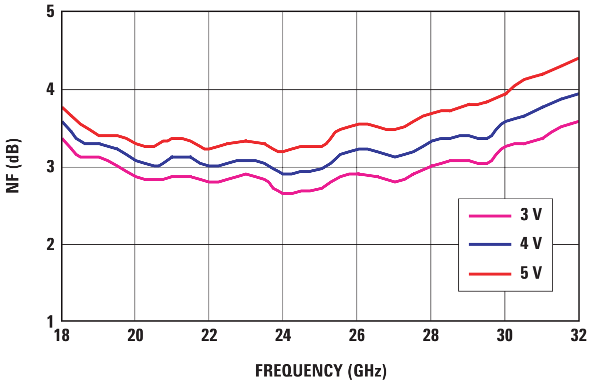


Figure 16. Typical noise figure over Vdd

AMMC-6233 Typical Scattering Parameters[1] (T_c =25°C, V_{DD} = 3 V, I_{total} = 65 mA, Z_{in} = Z_{out} = 50 Ω)

Freq GHz		S11			S21			S12			S22	
	dB	Mag	Phase	dB	Mag	Phase	dB	Mag	Phase	dB	Mag	Phase
11.0	-2.349	0.763049	94.09268	-1.489	0.842446	-21.3333	-70.874	0.000286	69.51336	-6.574	0.469123	165.652
12.0	-2.831	0.721884	60.39973	6.597	2.137292	-102.78	-78.885	0.000114	106.1791	-8.193	0.389361	147.3224
13.0	-3.639	0.657746	22.62143	12.838	4.384324	178.5468	-67.000	0.000447	96.14425	-9.985	0.31676	128.8437
14.0	-5.257	0.545917	-15.0803	16.445	6.641446	99.76884	-73.434	0.000213	-168.964	-12.057	0.249533	112.3379
15.0	-6.821	0.456007	-45.926	17.826	7.785794	31.45928	-66.470	0.000475	-166.65	-13.990	0.199762	98.40607
16.0	-7.539	0.419825	-73.1573	18.620	8.531229	-25.575	-58.581	0.001178	164.3204	-15.729	0.163519	86.00244
16.5	-7.710	0.411613	-86.6582	19.031	8.944062	-51.443	-65.814	0.000512	144.8339	-16.451	0.150471	80.85362
17.0	-7.877	0.403773	-100.097	19.461	9.397838	-76.2203	-64.611	0.000588	139.3233	-17.081	0.139942	75.62067
17.5	-8.056	0.395568	-113.442	19.904	9.890278	-100.232	-66.021	0.0005	142.2024	-17.788	0.129002	70.78852
18.0	-8.257	0.38648	-126.65	20.378	10.44466	-123.672	-62.064	0.000788	140.5163	-18.374	0.120584	66.50803
18.5	-8.550	0.373666	-139.685	20.826	10.99711	-146.836	-64.114	0.000623	90.2394	-19.008	0.1121	63.06891
19.0	-8.930	0.357671	-152.21	21.278	11.58536	-169.714	-58.746	0.001155	135.5786	-19.563	0.105157	59.89891
19.5	-9.468	0.336199	-164.843	21.692	12.15078	167.3367	-57.575	0.001322	131.7732	-19.836	0.10191	57.89853
20.0	-10.225	0.308143	-177.034	22.032	12.63514	144.6769	-54.947	0.001789	117.8577	-19.982	0.100211	55.31375
20.5	-11.199	0.275453	171.1243	22.316	13.05575	122.1392	-55.050	0.001768	112.1715	-20.024	0.099719	52.913
21.0	-12.517	0.236673	160.4605	22.520	13.36524	100.0025	-54.209	0.001948	97.05257	-20.198	0.097742	48.15782
21.5	-13.985	0.199868	151.4995	22.655	13.57596	78.2942	-56.478	0.0015	97.55393	-20.360	0.095938	46.77354
22.0	-15.874	0.160798	144.5777	22.746	13.71832	56.85629	-52.655	0.002329	86.87749	-20.315	0.09644	43.96343
22.5	-18.042	0.125292	141.0916	22.780	13.77231	36.2191	-53.353	0.002149	76.84304	-20.662	0.092666	41.56831
23.0	-20.351	0.096035	144.2364	22.812	13.8222	15.9253	-52.574	0.002351	73.4899	-20.825	0.090936	39.68448
23.5	-22.137	0.078186	152.7016	22.818	13.83284	-3.81822	-53.815	0.002038	67.95007	-20.829	0.0909	39.65156
24.0	-23.285	0.068506	167.6592	22.786	13.78216	-23.2519	-52.498	0.002372	58.91645	-21.054	0.088575	37.36209
24.5	-22.352	0.076278	179.2708	22.841	13.86875	-42.6854	-53.705	0.002064	55.72765	-21.106	0.088044	40.20195
25.0	-21.654	0.082658	-175.165	22.830	13.85124	-61.923	-52.363	0.002409	50.50487	-20.546	0.093904	40.9853
25.5	-20.587	0.09346	-171.845	22.842	13.87022	-80.8688	-51.790	0.002573	46.10271	-20.410	0.095388	41.72367
26.0	-19.773	0.102644	-173.525	22.820	13.83515	-99.8029	-51.138	0.002774	32.01681	-19.834	0.101933	43.50478
26.5	-19.259	0.108911	-173.001	22.782	13.77483	-118.619	-50.854	0.002866	31.28349	-19.341	0.107879	43.1206
27.0	-18.703	0.11611	-173.338	22.734	13.69857	-137.271	-51.453	0.002675	23.96313	-18.686	0.116327	42.91914
27.5	-18.131	0.124012	-173.508	22.719	13.6757	-155.791	-53.056	0.002224	23.95399	-18.194	0.123119	41.6739
28.0	-17.558	0.132469	-174.581	22.708	13.65816	-174.496	-52.152	0.002468	21.81781	-17.410	0.134748	41.67056
28.5	-17.404	0.134829	-175.139	22.630	13.5361	166.5557	-51.597	0.002631	9.25092	-16.296	0.153171	38.78395
29.0	-16.833	0.143999	-173.619	22.560	13.42741	147.7949	-51.989	0.002515	6.732967	-15.680	0.164446	35.35194
29.5	-16.271	0.153616	-174.645	22.463	13.27896	128.8982	-52.041	0.0025	11.57442	-14.995	0.177937	32.53478
30.0	-15.911	0.160113	-173.134	22.300	13.03121	109.84	-49.936	0.003186	-1.98556	-14.282	0.193145	27.05136
30.5	-14.929	0.179283	-172.407	22.113	12.75443	91.30458	-50.458	0.003	-6.96747	-13.978	0.200034	21.91237
31.0	-13.954	0.200581	-173.323	21.922	12.47648	72.76954	-51.970	0.002521	-26.8448	-13.704	0.206449	17.35203
32.0	-11.832	0.2561	-174.736	21.483	11.86206	35.36896	-51.657	0.002613	-26.1216	-13.293	0.216445	7.16786
33.0	-9.663	0.328738	179.3253	20.986	11.2019	-2.39273	-51.701	0.0026	-37.1835	-13.456	0.21241	-0.91524
34.0	-7.410	0.426065	170.2477	20.404	10.47666	-41.0669	-51.720	0.002594	-44.8451	-13.941	0.200884	-5.84805
35.0	-5.356	0.539757	157.4976	19.675	9.632708	-82.6699	-54.688	0.001843	-51.2692	-14.304	0.192657	-4.96141
36.0	-3.519	0.666862	142.1866	18.300	8.222064	-126.39	-54.425	0.0019	-68.6103	-13.970	0.200223	-1.63464
37.0	-2.278	0.769282	125.7972	15.919	6.250824	-170.91	-62.812	0.000723	-113.482	-12.407	0.239678	-2.09342
38.0	-1.616	0.830255	108.3899	12.714	4.322148	147.8419	-52.522	0.002365	-54.8753	-11.194	0.275602	-7.29699
39.0	-1.284	0.862564	92.95263	8.852	2.770862	111.5034	-59.931	0.001008	-44.7734	-10.503	0.298449	-15.7192
40.0	-1.152	0.875805	79.81563	4.733	1.724376	79.74362	-55.859	0.001611	-52.8287	-10.042	0.314688	-23.2788
41.0	-1.103	0.880774	67.52757	0.380	1.044766	51.4617	-55.953	0.001594	-35.8358	-9.805	0.323403	-29.8824
42.0	-1.070	0.88412	56.2657	-4.296	0.609794	26.8078	-58.313	0.001214	-48.97	-9.700	0.327323	-36.1307
43.0	-1.005	0.890776	46.2681	-9.511	0.334545	6.071765	-54.001	0.001995	-88.8673	-9.677	0.32822	-42.4137
44.0	-0.993	0.891989	36.48963	-15.870	0.160872	-7.61507	-55.336	0.001711	-39.9805	-9.675	0.328278	-47.7329
45.0	-0.979	0.893391	27.17473	-23.877	0.063995	3.187742	-55.849	0.001613	-93.3539	-9.797	0.323704	-52.5319

Note: Data obtained from on-wafer measurements.

Biasing and Operation

The AMMC-6233 is normally biased with a positive supply connected to both VD1 and VD2 bond pads through the 100pF bypass capacitor as shown in Figure 19. The recommended supply voltage is 3 V. It is important to place the bypass capacitor as close to the die as possible. No negative gate bias voltage is needed for the AMMC-6233. Input and output 50-ohm match are achieved on-chip; therefore no other external component is required at the input or output. In addition, the input and output are DC-blocked with internal coupling capacitors.

No ground wires are needed because all ground connections are made with plated through-holes to the backside of the device.

Refer the Absolute Maximum Ratings table for allowed DC and thermal conditions.

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 plate metal shim (same length and width 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 and/or shim attachment should be just enough to provide a thin fillet around the bottom perimeter of the chip or shim. The ground plan should be free of any residue that may jeopardize electrical or mechanical attachment.

The location of the RF bond pads is shown in Figure 12. Note that all the RF input and output ports are in a Ground-Signal-Ground configuration.

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 0.7 mil gold wire or use of gold mesh is recommended for best performance, especially near the high end of the frequency band.

Thermosonic wedge bonding is preferred method for wire attachment to the bond pads. Gold mesh can be attached using a 2 mil round tracking tool and a tool force of approximately 22 grams and a ultrasonic power of roughly 55 dB for a duration of 76 ± 8 mS. The guided wedge at an untrasonic power level of 64 dB can be used for 0.7 mil wire. The recommended wire bond stage temperature is 150 ± 2C.

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).

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

Notes:

1. Ablebond 84-1 LM1 silver epoxy is recommended.
2. Eutectic attach is not recommended and may jeopardize reliability of the device.

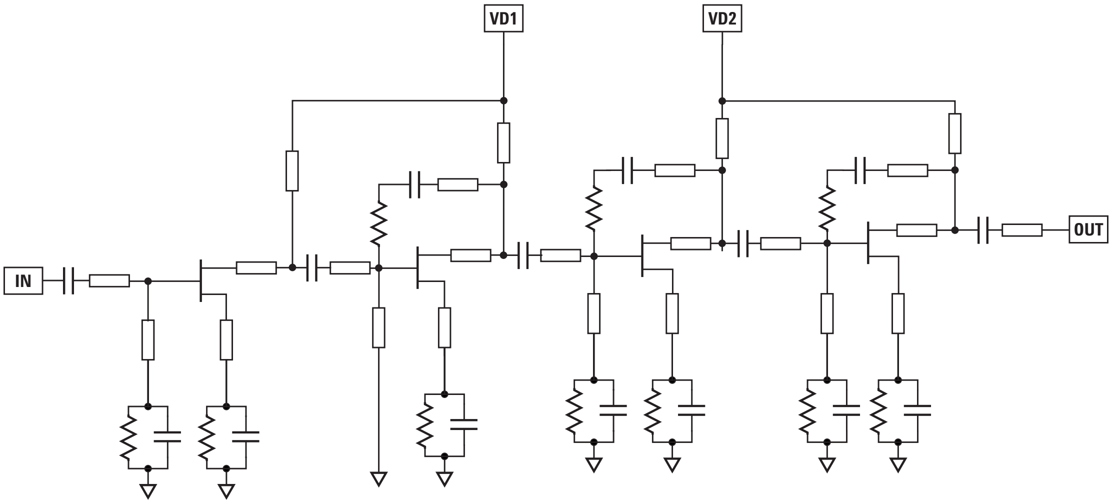


Figure 17. AMMC-6233 simplified schematic

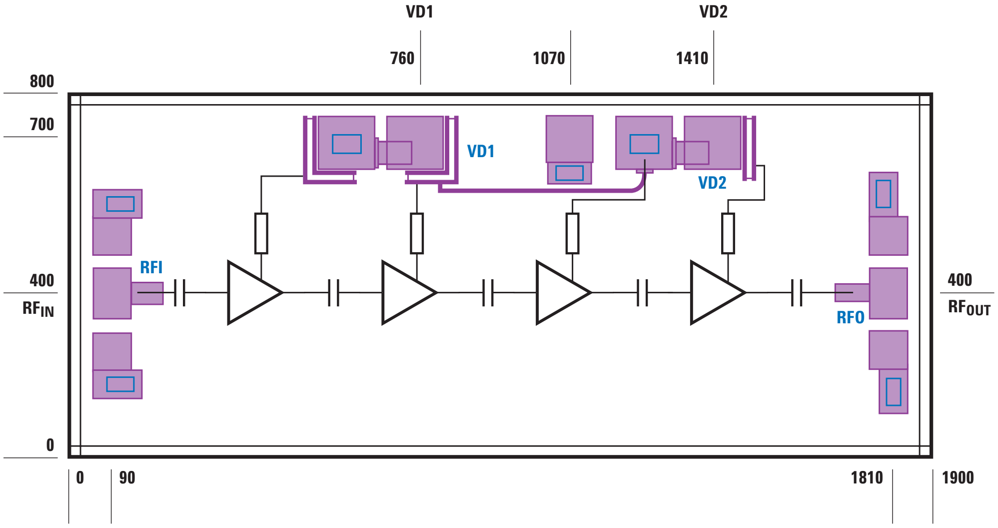


Figure 18. AMMC-6233 bonding pad locations

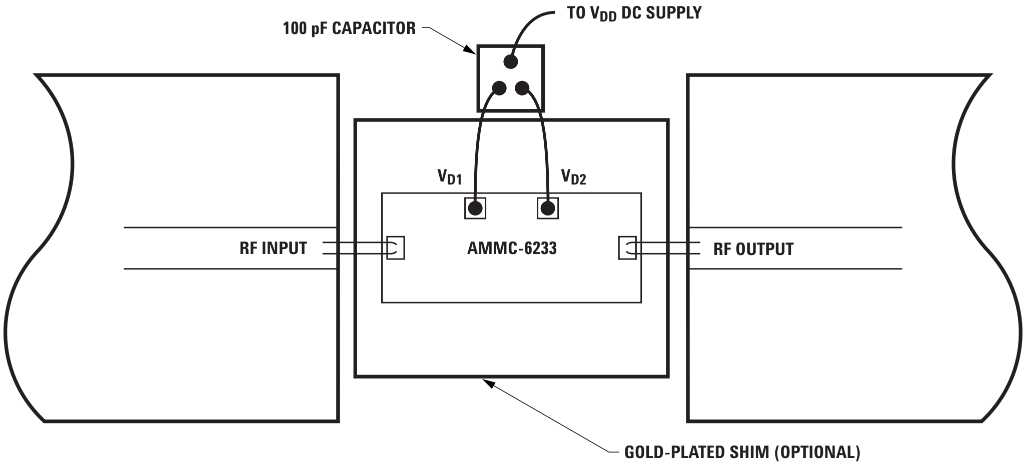


Figure 19. AMMC-6233 assembly diagram

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