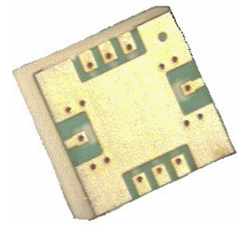
AMMP-6430

27-34 GHz, 0.5W Power Amplifier
in SMT Package

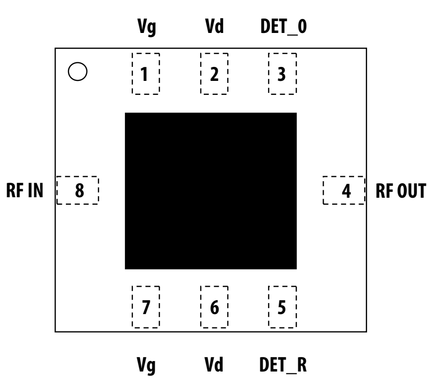
Data Sheet



Description

The AMMP-6430 MMIC is a broadband 1W power amplifier in a surface mount package designed for use in transmitters that operate in various frequency bands between 27GHz and 34GHz. At 30GHz, it provides 29dBm of output power (P-1dB) and 19dB of small-signal gain from a small easy-to-use device. The device has input and output matching circuitry for use in 50Ω environments. The AMMP-6430 also integrates a temperature compensated RF power detection circuit that enables power detection of 0.3V/W. DC bias is simple and the device operates on widely available 5V for current supply (negative voltage only needed for Vg). It is fabricated in a PHEMT process for exceptional power and gain performance.

Package Diagram



Note:
1. This MMIC uses depletion mode pHEMT devices. Negative supply is used for DC gate biasing.

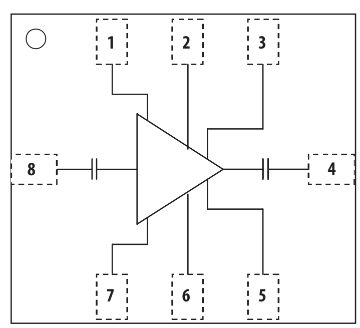
Features

- Wide Frequency Range 27-34 GHz
- Half watt output power
- 50 Ω match on input and output
- Specifications (Vd=5V, Idq=650mA)
- Frequency range 27 to 34 GHz
- Small signal Gain of 20dB
- Output power @P-1 of 27dBm (Typ.)
- Input/Output return-loss of -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

Functional Block Diagram



Pin	Function
1	Vg
2	Vd
3	DET_0
4	RF_out
5	DET_R
6	Vd
7	Vg
8	RF_in

PACKAGE
BASE
GND

Attention: Observe Precautions for handling electrostatic sensitive devices.
ESD Machine Model (Class A): 50V
ESD Human Body Model (Class 0): 150V
Refer to Avago Application Note A004R: Electrostatic Discharge Damage and Control.

Notes: MSL Rating = Level 2A

Electrical Specifications

1. Small/Large -signal data measured in a fully de-embedded test fixture form TA = 25°C.
2. Pre-assembly into package performance verified 100% on-wafer.
3. This final package part performance is verified by a functional test correlated to actual performance at one or more frequencies.
4. Specifications are derived from measurements in a 50 Ω test environment. Aspects of the amplifier performance may be improved over a more narrow bandwidth by application of additional conjugate, linearity, or low noise (Γopt) matching.
5. The Gain and P1dB tested at 27 GHz guaranteed with measurement accuracy +/-1.5dB for Gain and +/-1.6 GHz for P1dB.

Table 1. RF Electrical Characteristics

TA=25°C, Vd=5.0V, Idq=650mA, Vg=-1.1V, Zo=50 Ω

Parameter	Min	Typ.	Max	Unit
Operational Frequency, Freq	27		34	GHz
Small-signal Gain Freq = 27GHz, Gain	16	20		dB
Output Power at 1dB Gain Compression, P1dB	26	27		dBm
Output Third Order Intercept Point, OIP3		35		dBm
Input Return Loss, RLin		10		dB
Output Return Loss, RLout		10		dB
Reverse Isolation, Isolation		43		dB

Table 2. Recommended Operating Range

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

Description	Min.	Typical	Max.	Unit	Comments
Drain Supply Current, Idq		650		mA	Vd = 5V, Vg set for Id Typical
Gate Voltage, Vg		-1.1		V	Idq = 650 mA

Table 3. Thermal Properties

Parameter	Test Conditions	Value
Channel Temperature, Tch		Tch=139.6 °C
Thermal Resistance (Channel-to-Base Plate), $R\theta_{ch\text{-}b}$	Ambient operational temperature TA = 25°C Channel-to-backside Thermal Resistance Tchannel(Tch)=34°C Thermal Resistance at backside temperature Tb=25°C	$R\theta_{ch\text{-}b}$ = 16.8 °C/W

Note:

1. Assume SnPb soldering to an evaluation RF board at 85 °C base plate temperatures. Worst case is at saturated output power when DC power consumption rises to 5.24W with 0.9W RF power delivered to load. Power dissipation is 4.34W and the temperature rise in the channel is 72.9 °C. In this condition, the base plate temperature must be remained below 82.1 °C to maintain maximum operating channel temperature below 155 °C.

Table 4. Absolete Minimum and Maximum Ratings

Description	Min.	Max.	Unit	Comments
Drain Supply Voltage, Vd		6	V	
Gate Supply Voltage, Vg	-3	0.5	V	
Drain Current, Idq		900	mA	
Power Dissipation, Pd		5.5	W	
CW Input Power, Pin		23	dBm	CW
Channel Temperature, Tch		+155	°C	
Storage Temperature, Tstg	-65	+155	°C	
Maximum Assembly Temperature		+260	°C	20 second maximum

Notes:

1. Operation in excess of any one of these conditions may result in permanent damage to this device.
2. Combinations of supply voltage, drain current, input power, and output power shall not exceed PD.
3. When operate at this condition with a base plate temperature of 85 °C, the median time to failure (MTTF) is significantly reduced.
4. These ratings apply to each individual FET
5. Junction operating temperature will directly affect the device MTTF. For maximum life, it is recommended that junction temperatures be maintained at the lowest possible levels.

AMMP-6430 Typical Performance

(Data obtained from 2.4-mm connector based test fixture, and this data is including connecter loss, and board loss.)
(T_A = 25°C, Vd=5V, Idq=650mA, V_g=-1.1 V, $Z_{in} = Z_{out}$ = 50Ω)

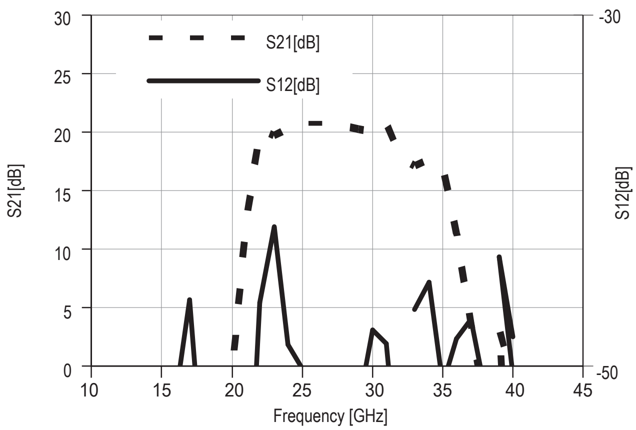


Figure 1. Typical Gain and Reverse Isolation

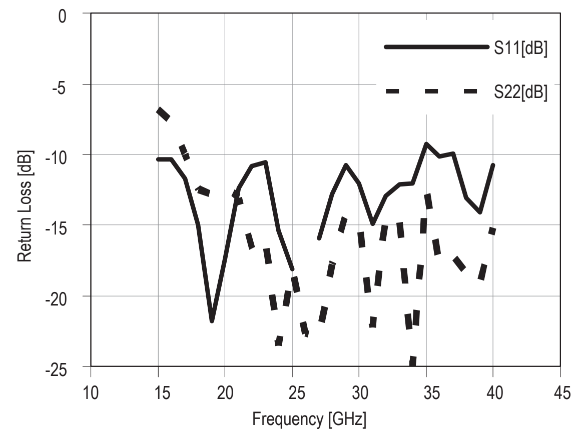


Figure 2. Typical Input & Output Return Loss

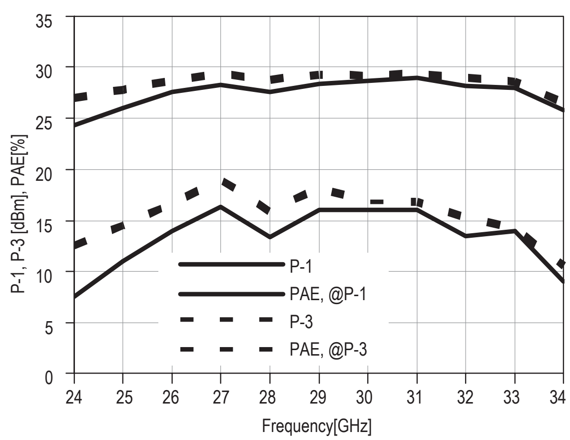


Figure 3. Typical P-1 and PAE

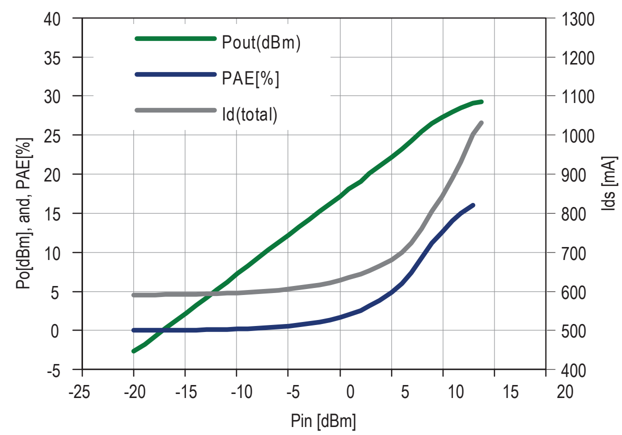


Figure 4. Typical Pout, Ids, and PAE vs. Pin at Freq=30GHz

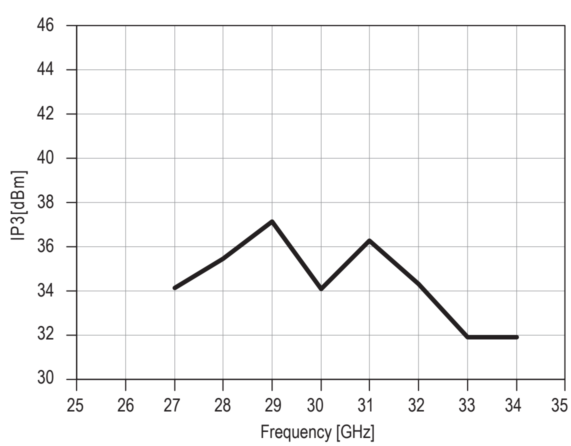


Figure 5. Typical IP3 (Third Order Intercept) @Pin=-20dBm

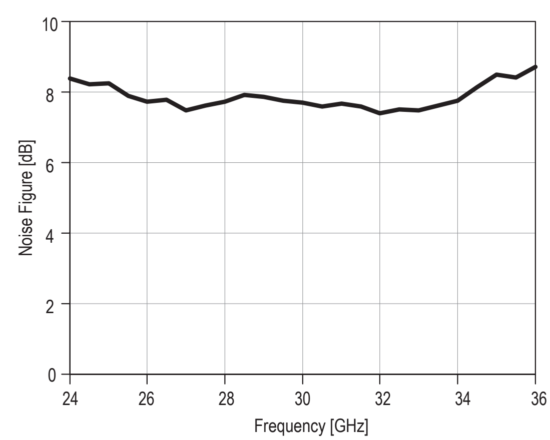


Figure 6. Typical Noise Figure

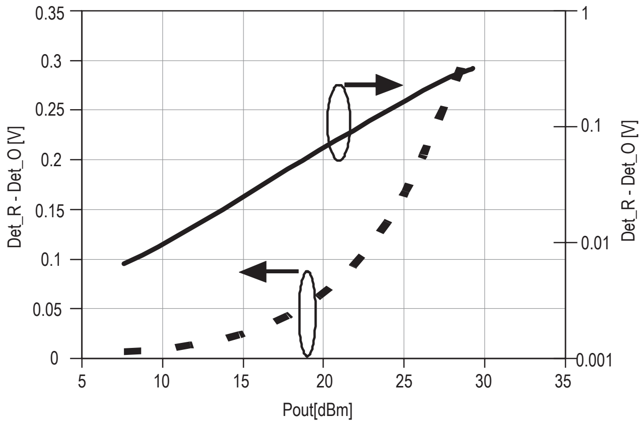


Figure 7. Typical Detector voltage vs. Output Power @30GHz

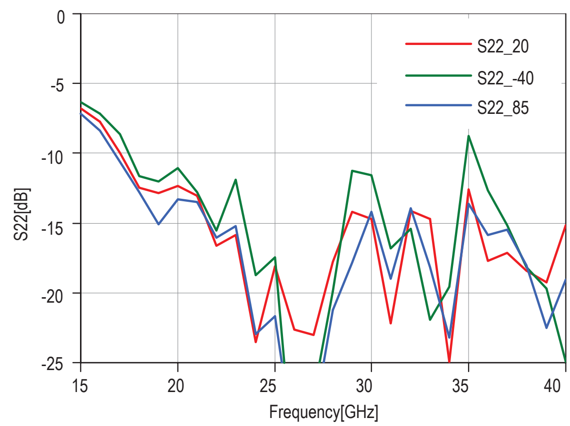


Figure 8. Typical S22 over temperature

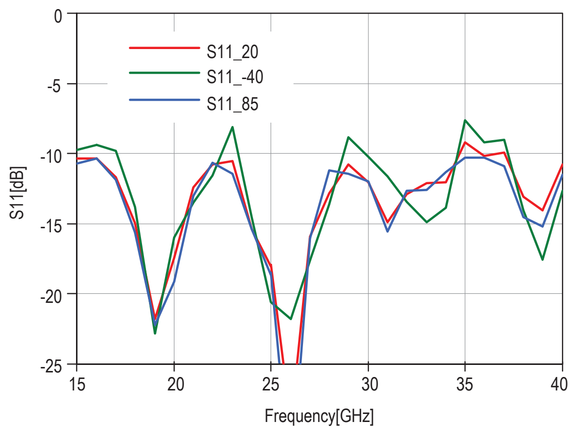


Figure 9. Typical S11 over temperature

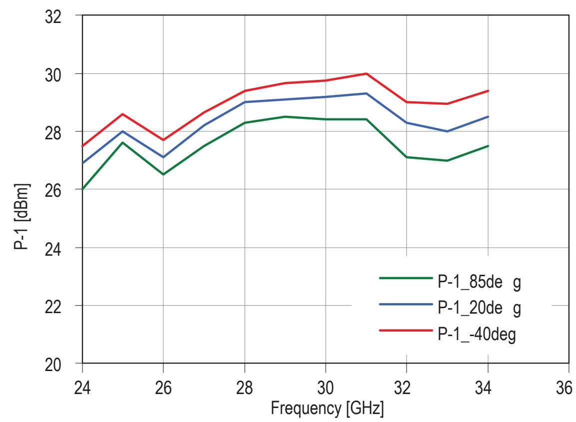


Figure 10. Typical P-1 over temperature

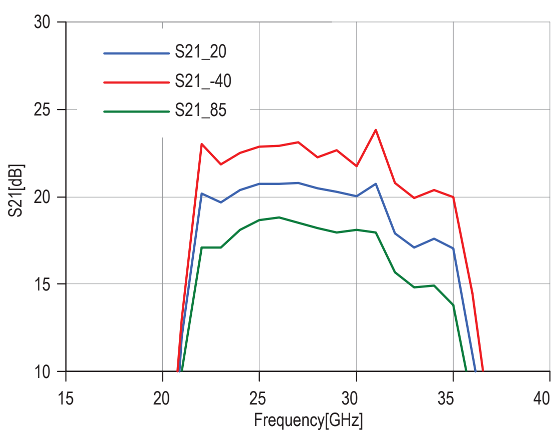


Figure 11. Typical Gain over temperature

Typical Scattering Parameters [1]

(T_A = 25°C, Vd =5 V, I_{dq} = 650 mA, Z_{in} = Z_{out} = 50Ω)

Freq	S11			S21			S12			S22		
[GHz]	dB	Mag	Phase	dB	Mag	Phase	dB	Mag	Phase	dB	Mag	Phase
1	-0.077	0.991	-30.672	-60.460	0.001	156.200	-81.678	8.24E-05	13.553	-0.075	0.991	-31.001
2	-0.244	0.972	-61.135	-52.134	0.002	7.598	-79.982	1.00E-04	-1.433	-0.218	0.975	-61.826
3	-0.507	0.943	-91.481	-55.059	0.002	-178.810	-78.816	1.15E-04	-26.240	-0.450	0.949	-92.759
4	-0.857	0.906	-121.770	-62.791	0.001	135.030	-73.965	2.00E-04	-79.414	-0.847	0.907	-123.780
5	-1.286	0.862	-152.370	-43.769	0.006	72.309	-66.459	4.75E-04	-89.529	-1.465	0.845	-152.600
6	-1.834	0.810	176.860	-43.125	0.007	-55.096	-61.854	8.08E-04	-141.380	-1.593	0.832	177.570
7	-2.497	0.750	146.160	-47.710	0.004	-138.310	-59.371	1.08E-03	-174.860	-2.056	0.789	145.900
8	-3.218	0.690	115.480	-50.926	0.003	167.090	-58.859	1.14E-03	151.750	-2.614	0.740	114.510
9	-3.952	0.634	84.820	-48.273	0.004	127.030	-51.689	2.60E-03	128.260	-3.234	0.689	82.673
10	-4.734	0.580	54.869	-47.156	0.004	82.462	-49.760	3.25E-03	76.311	-3.919	0.637	51.597
11	-5.372	0.539	26.213	-46.361	0.005	37.278	-47.391	4.27E-03	33.764	-4.545	0.593	21.330
12	-5.892	0.507	-1.577	-49.213	0.003	16.009	-48.433	3.79E-03	-0.070	-5.413	0.536	-7.654
13	-6.334	0.482	-28.136	-43.321	0.007	-18.990	-47.536	4.20E-03	-31.732	-4.738	0.580	-29.552
14	-6.785	0.458	-52.977	-49.276	0.003	-50.499	-50.113	3.12E-03	-62.027	-4.740	0.579	-63.489
15	-7.246	0.434	-75.942	-48.968	0.004	-66.480	-47.510	4.21E-03	-80.734	-5.196	0.550	-93.519
16	-7.822	0.406	-95.873	-50.759	0.003	79.915	-49.051	3.53E-03	-117.620	-5.850	0.510	-122.580
17	-8.056	0.396	-113.940	-31.831	0.026	37.293	-53.232	2.18E-03	-135.710	-6.891	0.452	-151.530
18	-8.011	0.398	-130.700	-19.650	0.104	-11.371	-54.404	1.90E-03	-136.240	-8.605	0.371	179.660
19	-8.003	0.398	-150.530	-8.565	0.373	-65.975	-52.389	2.40E-03	-100.790	-11.491	0.266	151.610
20	-8.086	0.394	-172.380	2.944	1.404	-130.730	-45.317	5.42E-03	-135.360	-15.971	0.159	128.630
21	-10.147	0.311	160.910	16.205	6.460	130.360	-44.518	5.94E-03	179.470	-32.906	0.023	80.680
22	-10.495	0.299	156.560	19.584	9.533	-6.027	-44.477	5.97E-03	146.120	-18.247	0.122	-170.070
23	-12.051	0.250	132.580	19.712	9.674	-99.417	-44.466	5.98E-03	129.370	-18.242	0.122	169.400
24	-15.378	0.170	122.010	20.404	10.476	174.220	-44.254	6.13E-03	102.170	-17.689	0.130	159.240
25	-16.652	0.147	127.100	20.339	10.398	91.597	-44.452	5.99E-03	63.925	-18.009	0.126	147.290
26	-17.111	0.139	113.670	19.880	9.862	16.978	-44.351	6.06E-03	36.998	-19.138	0.110	134.330
27	-23.026	0.071	100.620	20.040	10.046	-54.022	-45.333	5.41E-03	1.733	-23.261	0.069	137.140
28	-20.256	0.097	166.160	20.218	10.255	-128.560	-52.770	2.30E-03	-49.664	-18.834	0.114	161.640
29	-14.571	0.187	152.630	20.087	10.100	157.600	-49.161	3.48E-03	-75.571	-15.869	0.161	147.670
30	-13.363	0.215	128.640	19.761	9.729	85.669	-57.520	1.33E-03	15.834	-15.535	0.167	128.380
31	-11.814	0.257	107.980	19.830	9.807	10.808	-86.823	4.56E-05	-92.886	-14.211	0.195	109.870
32	-10.715	0.291	83.770	19.352	9.282	-68.718	-58.807	1.15E-03	-82.154	-13.484	0.212	82.184
33	-10.889	0.285	65.105	18.619	8.531	-150.100	-62.898	7.16E-04	92.036	-14.452	0.189	72.563
34	-11.417	0.269	41.069	18.093	8.028	124.500	-51.835	2.56E-03	-4.332	-15.301	0.172	53.869
35	-12.098	0.248	36.792	15.162	5.730	14.850	-52.719	2.31E-03	-115.640	-12.933	0.226	56.976
36	-11.897	0.254	24.365	7.101	2.265	-75.509	-58.568	1.18E-03	-48.164	-12.205	0.245	32.346
37	-11.125	0.278	13.967	-0.825	0.909	-142.060	-57.430	1.34E-03	-124.980	-12.066	0.249	15.583
38	-10.020	0.316	-0.758	-7.753	0.410	161.700	-52.497	2.37E-03	-154.340	-11.605	0.263	0.967
39	-9.222	0.346	-16.019	-13.812	0.204	110.760	-56.625	1.47E-03	116.090	-11.065	0.280	-12.574
40	-8.609	0.371	-32.089	-19.209	0.110	62.155	-55.294	1.72E-03	91.256	-10.402	0.302	-26.857
41	-8.175	0.390	-47.230	-24.340	0.061	13.948	-56.805	1.44E-03	1.705	-9.889	0.320	-40.144
42	-7.588	0.417	-62.593	-29.416	0.034	-31.372	-57.472	1.34E-03	-87.233	-9.293	0.343	-52.531
43	-7.587	0.417	-78.246	-34.254	0.019	-72.562	-64.193	6.17E-04	-136.190	-8.532	0.374	-64.211
44	-7.506	0.421	-89.361	-38.657	0.012	-112.560	-69.135	3.49E-04	-109.180	-7.654	0.414	-77.188
45	-7.332	0.430	-101.290	-43.475	0.007	-145.910	-60.759	9.16E-04	-29.843	-7.062	0.444	-90.938

Note:
1. Data obtained from a 2.4-mm connecter based module, and this data is including connecter loss, and board loss.

Biasing and Operation

Recommended quiescent DC bias condition for optimum power and linearity performances is Vd=5 volts with Vg (-1.1V) set for Id=650 mA. Minor improvements in performance are possible depending on the application. The drain bias voltage range is 3 to 5V. A single DC gate supply connected to Vg will bias all gain stages. Muting can be accomplished by setting Vg to the pinch-off voltage Vp.

A simplified schematic for the AMMP6430 MMIC die is shown in Figure 12. The MMIC die contains ESD and over voltage protection diodes for Vg, and Vd terminals. The package diagram for the recommended assembly is shown in Figure 13. In finalized package form, ESD diodes protect all possible ESD or over voltage damages between Vgg and ground, Vg and Vd, Vd and ground. Typical ESD diode current versus diode voltage for 11-connected diodes in series is shown in Figure 14. Under the recommended DC quiescent biasing condition at Vds=5V, Ids=650mA, Vg=-1V, typical gate terminal current is approximately 0.3mA. If an active biasing technique is selected for the AMMP6430 MMIC PA DC biasing, the active biasing circuit must have more than 10-times higher internal current that the gate terminal current.

An optional output power detector network is also provided. The differential voltage between the Det-Ref and Det-Out pads can be correlated with the RF power emerging from the RF output port. The detected voltage is given by :

$$V = \left(V_{ref} - V_{det}\right) - V_{ofs}$$

where V_{ref} is the voltage at the DET_R port, V_{det} is a voltage at the DET_0 port, V_{ofs} and is the zero-input-power offset voltage.

There are three methods to calculate V_{ofs} :

1. V_{ofs} can be measured before each detector measurement (by removing or switching off the power source and measuring V_{ref} - V_{det}). This method gives an error due to temperature drift of less than 0.01dB/50°C.
2. V_{ofs} can be measured at a single reference temperature. The drift error will be less than 0.25dB.
3. V_{ofs} can either be characterized over temperature and stored in a lookup table, or it can be measured at two temperatures and a linear fit used to calculate V_{ofs} at any temperature. This method gives an error close to the method #1.

The RF ports are AC coupled at the RF input to the first stage and the RF output of the final stage. No ground wired are needed since ground connections are made with plated through-holes to the backside of the device.

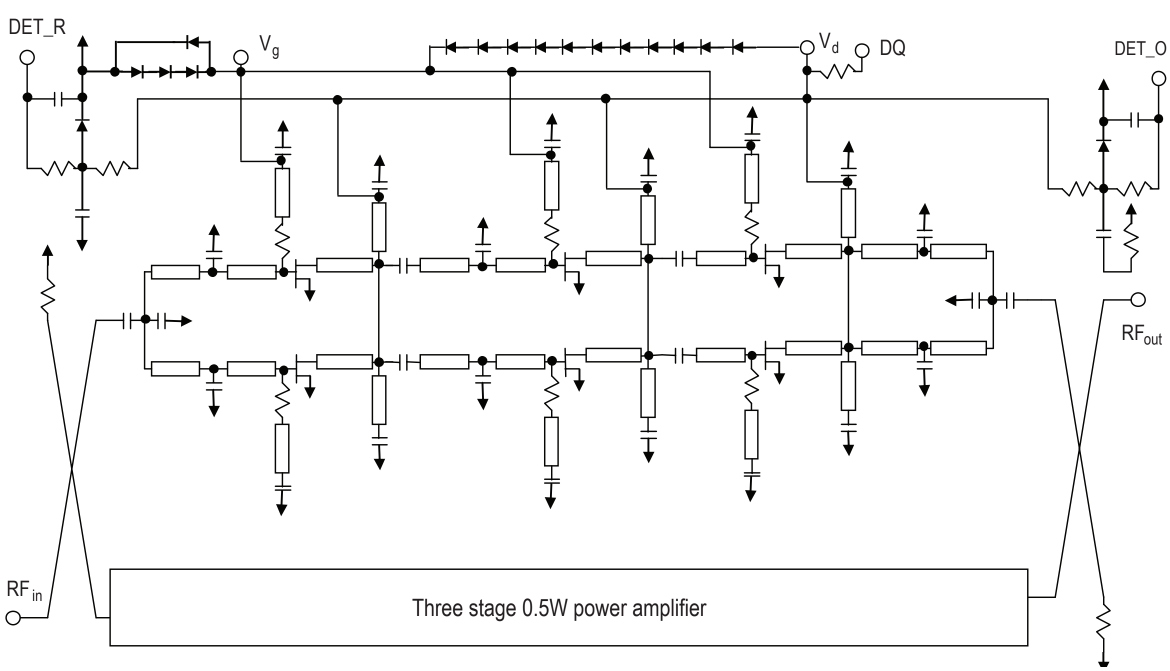
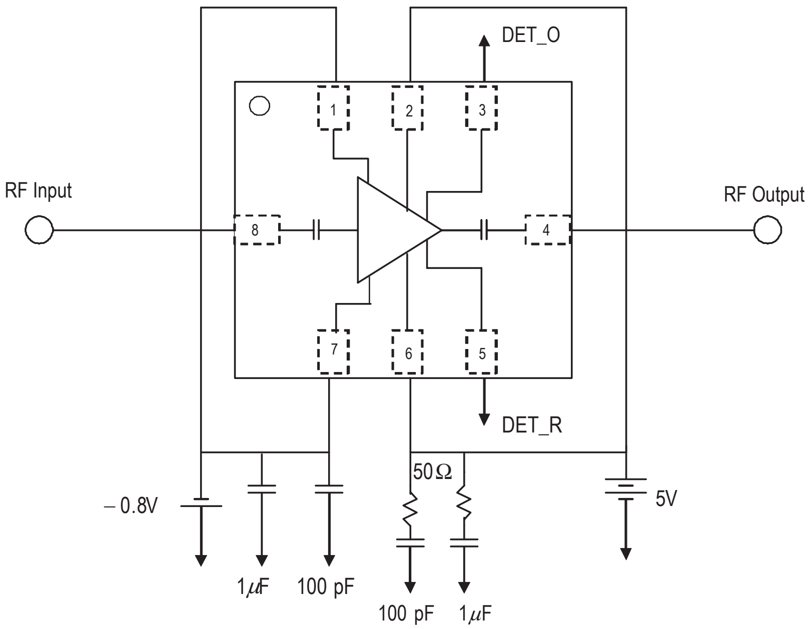


Figure 12. Simplified schematic for the MMIC die



Pin	Function
1	Vg
2	Vd
3	DET_O
4	RF_out
5	DET_R
6	Vd
7	Vg
8	RF_in

Note:
1. Vd may be applied to either Pin 2 or Pin 6.
2. Vg may be applied to either Pin 1 or Pin 7.

Figure 13. Schematic for recommended Bias circuitry

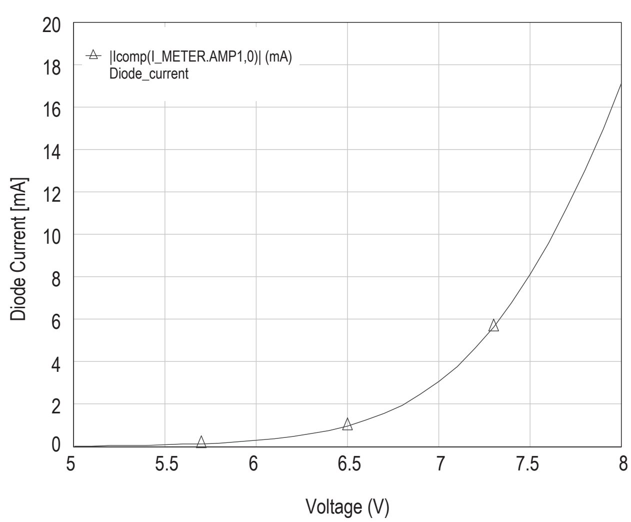


Figure 14. Typical ESD diode current versus diode voltage for 11-connected diodes in series

AMMP-6430 Part Number Ordering Information

Part Number	Devices Per Container	Container
AMMP-6430-BLKG	10	Antistatic bag
AMMP-6430-TR1G	100	7” Reel
AMMP-6430-TR2G	500	7” Reel

Package Dimension, PCB Layout and Tape and Reel information

Please refer to Avago Technologies Application Note 5520, AMxP-xxxx production Assembly Process (Land Pattern A).

AV02-0623EN - July 9, 2013