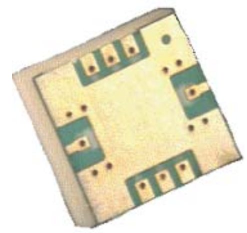
AMMP-6408

6 to 18 GHz 1 W Power Amplifier
in SMT Package

Data Sheet



Description

The AMMP-6408 MMIC is a broadband 1W power amplifier in a surface mount package designed for use in transmitters that operate in various frequency bands between 6 GHz and 18 GHz. At 8 GHz, it provides 29 dBm of output power (P-1dB) and 20 dB of small-signal gain from a small easy-to-use device. This MMIC optimized for linear operation with an output third order intercept point (OIP3) of 38 dBm.

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

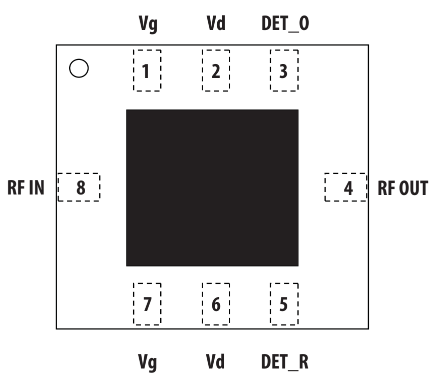
Features

- 5 x 5 mm Surface Mount Package
- Wide frequency range 6-18 GHz
- Highly linear: OIP3 = 38 dBm
- Integrated RF power detector
- Input port partially matched
  (For narrowband applications, customer may obtain optimum matching and gain with an additional matching circuit.)

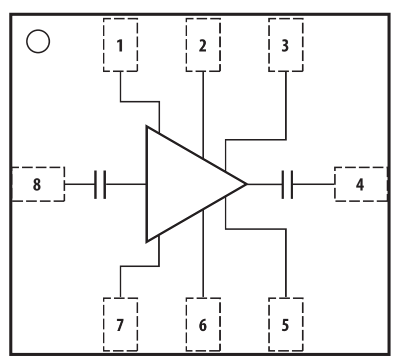
Specifications (Vd = 5 V, Idsq = 650 mA)

- Frequency range 6 to 18 GHz
- Small signal gain of 18 dB
- Return loss: input: -3 dB, Output: -9 dB
- High Power: @ 8 GHz, P-1dB = 29 dBm

Package Diagram



Functional Block Diagram



PIN	FUNCTION
1	Vg
2	Vd
3	DET_O
4	RF OUT
5	DER_R
6	Vd
7	Vg
8	RF IN

PACKAGE
BASE
GND

RoHS-Exemption

Please refer to hazardous substances table on page 10.

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model (Class A) = 40V
ESD Human Body Model (Class 0) = 200V
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Note: 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 per AMMC-6220 published specifications.
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. All tested parameters guaranteed with measurement accuracy +/-0.5 dB/ dBm for the 6 to 20 GHz, +/-0.75 dB/ dBm for the 20 to 33 GHz range and +/- 1.0dB/ dBm for the 33 to 50 GHz range
6. NF is measure on-wafer. Additional bond wires (-0.2nH) at Input could improve NF at some frequencies.

Table 1. RF Electrical Characteristics

TA=25°C, Vdd=3.0V, Idd=65mA, Zin=Zo=50 Ω

	8 GHz			17 GHz				
Parameter	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**	**Comment**
Operational Frequency, Freq	6					18	GHz	
Small Signal Gain, Gain	17.5	18		15.5	18		dB	
Output Power at 1dBGain Compression, P1dB	28	28.5		27	28.5		dBm	
Output Power at 3dBGain Compression, P3dB		29.5			29.5		dBm	
Output Third Order Intercept Point, OIP3; Δf = 100 MHz; Pin = -20 dBm		38			38		dBm	
Isolation, Iso		45			45		dB	
Input Return Loss, Rlin		3			3		dB	
Output Return Loss, RLout		9			9		dB	

Table 2. Recommended Operating Range

1. Ambient operational temperature TA = 25°C unless otherwise noted.
2. Channel-to-backside Thermal Resistance (Tchannel (Tc) = 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, Id	40	65	90	mA	Vd = 3 V, Under any RF power drive and temperature
Drain Supply Voltage, Vd		3	5	V	

Table 3. Thermal Properties

Parameter	Test Conditions	Value
Thermal Resistance (channel to baseplate), θjc		θjc = 20 °C/W

Note:

1. Assume SnPb soldering to an evaluation RF board at 80°C base plate temperatures. Worst case for the channel temperature is under the quiescent operation. At saturated output power, DC power consumption rises to 4.26 W with 1.14 W RF power delivered to load. Power dissipation is 3.11 W and the temperature rise in the channel is 68.4°C. In this condition, the base plate temperature must be remained below 86.6°C to maintain maximum operating channel temperature below 155°C.

Absolute Minimum and Maximum Ratings

Table 4. Minimum and Maximum Ratings

Description	Min.	Max.	Unit	Comments
Drain to Ground Supply Voltage, Vd		6	V	
Gate Supply Voltage, Vg	-3	0.5	V	
Drain Current , Id		900	mA	
Power Dissipation, PD		4.6	W	
RF CW Input Power, Pin		10	dBm	CW
Channel Temperature, Tch, max		+155	°C	
Storage Case Temperature, Tstg	-65	+155	°C	
Maximum Assembly Temperature, Tmax		260	°C	20 second maximum

Notes:
1. Operation in excess of any one of these conditions may result in permanent damage to this device.

Typical Performances

(Data Obtained from 3.5-mm Connector Based Test Fixture, and This Data is Including Connecter Loss, and Board Loss.)

(T_A = 25°C, V_d = 5 V, I_D = 650 mA, Z_{in} = Z_{out} = 50 Ω)

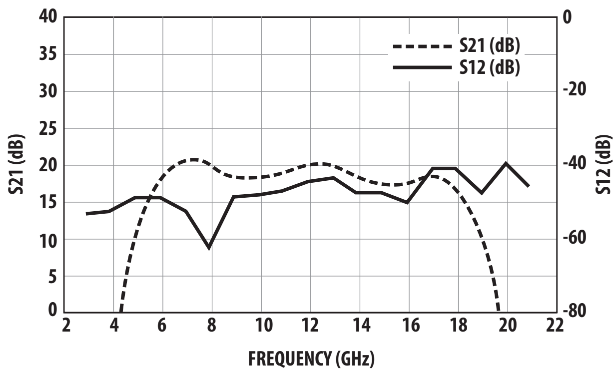


Figure 1. Typical gain and reverse isolation

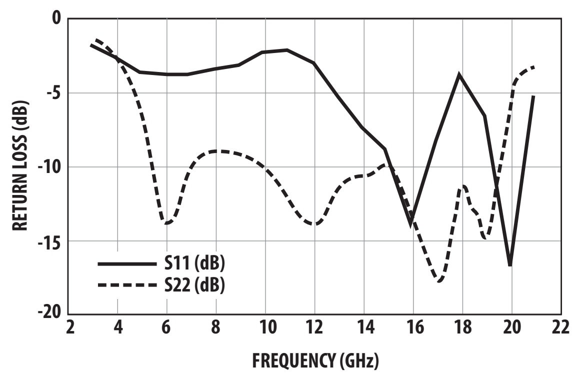


Figure 2. Typical return loss (input and output)

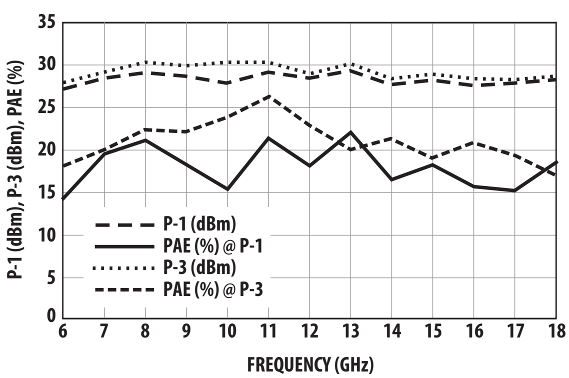


Figure 3. Typical output power (@P-1, P-3) and PAE and frequency

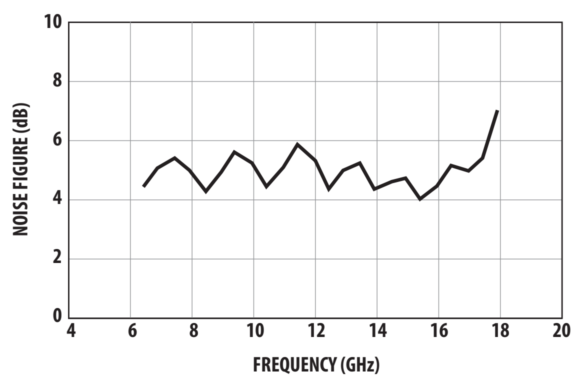


Figure 4. Typical noise figure

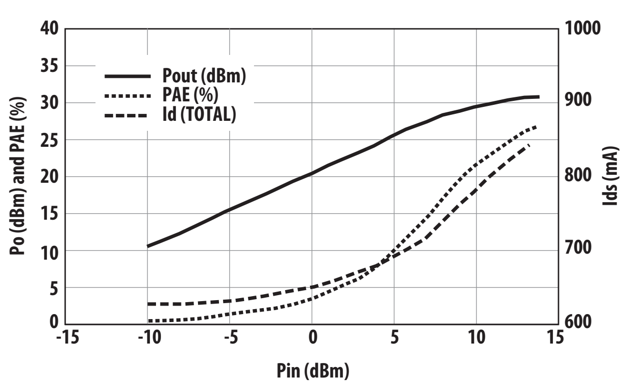


Figure 5. Typical output power, PAE, and total drain current versus input power at 8 GHz

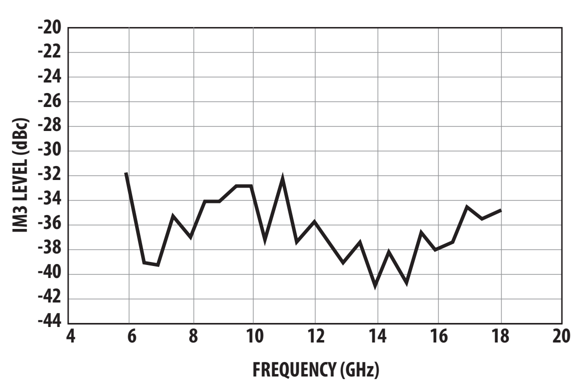


Figure 6. Typical IM3 level vs. frequency at +20 dBm output single carrier level (SCL)

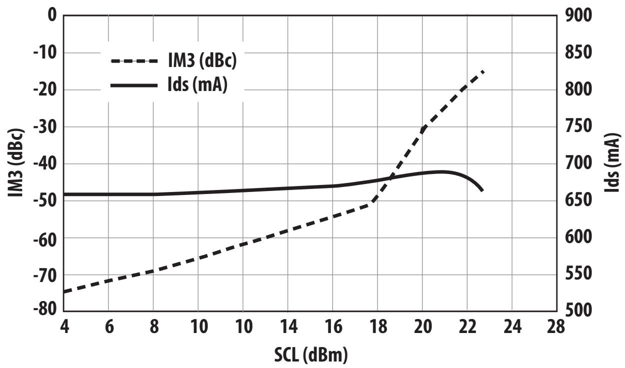


Figure 7. Typical IM3 level and Ids vs. single carrier output level at 6 GHz

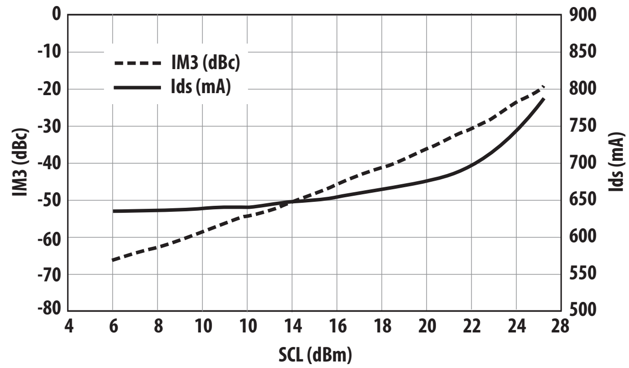


Figure 8. Typical IM3 level and Ids vs. single carrier output level at 8 GHz

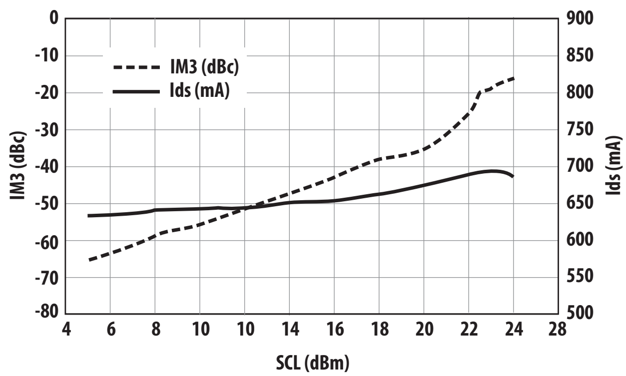


Figure 9. Typical IM3 level and Ids vs. single carrier output level at 12 GHz

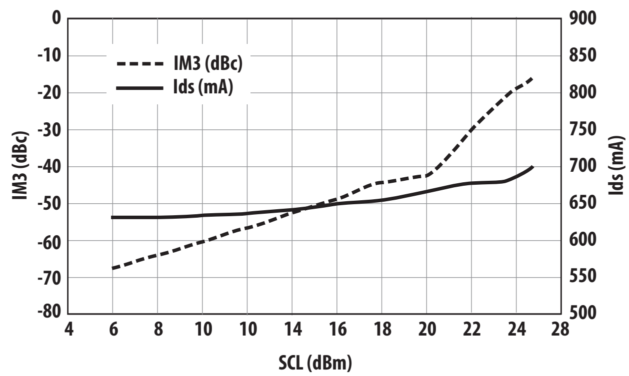


Figure 10. Typical IM3 level and Ids vs. single carrier output level at 14 GHz

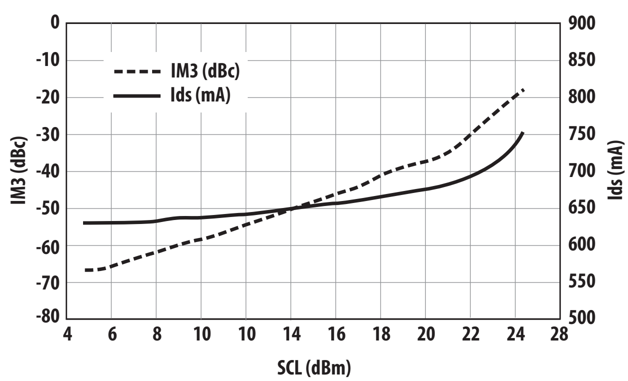


Figure 11. Typical IM3 level and Ids vs. single carrier output level at 16 GHz

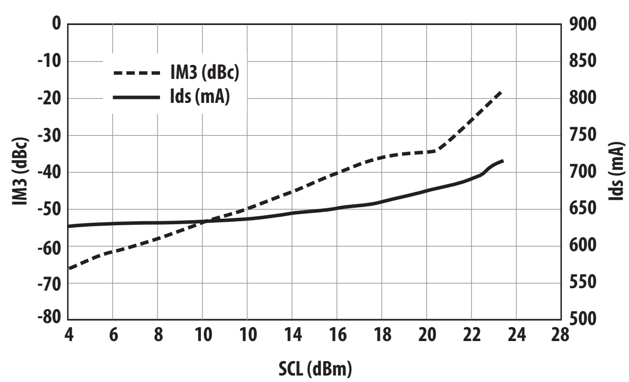


Figure 12. Typical IM3 level and Ids vs. single carrier output level at 18 GHz

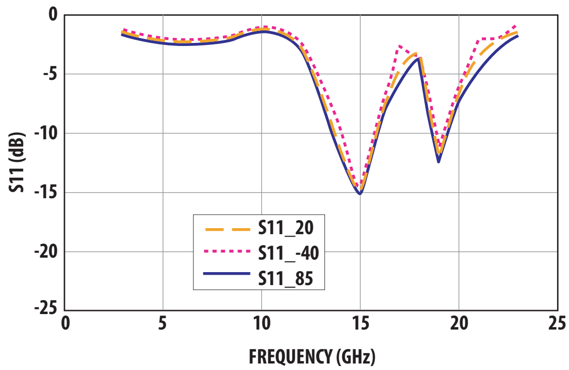


Figure 13. Typical S11 over temperature

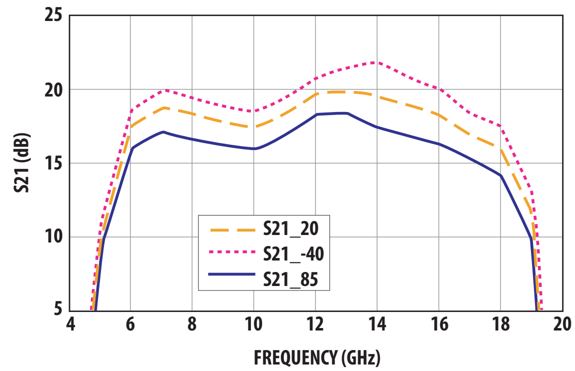


Figure 14. Typical gain over temperature

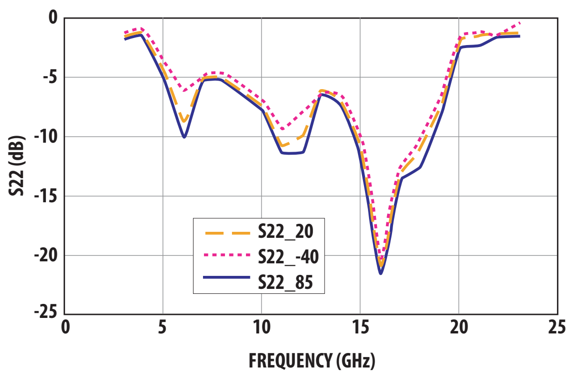


Figure 15. Typical S22 over temperature

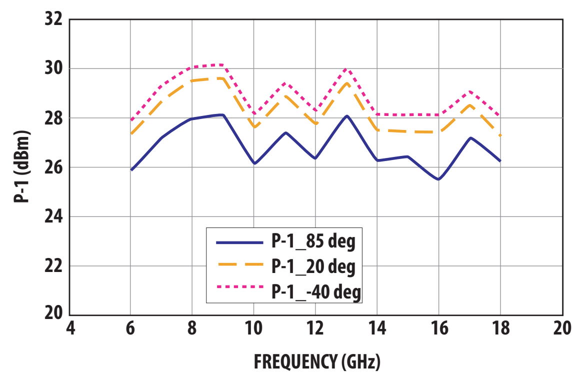


Figure 16. Typical P-1 over temperature

Biasing and Operation

The recommended quiescent DC bias condition for optimum efficiency, performance, and reliability is Vdd = 5 volts with Vg set for Idd = 650 mA. Minor improvements in performance are possible depending on the application. The drain bias voltage range is 3 to 5 V. A single DC gate supply connected to Vg will bias all gain stages. Muting can be accomplished by setting Vgg to the pinch-off voltage Vp.

A simplified schematic for the AMMP6408 MMIC die is shown in Figure 17. The MMIC die contains ESD and over voltage protection diodes for Vg, Vd1, and Vd2 terminals. In a finalized package form, Vd1 and Vd2 terminals are commonly connected to the Vdd terminal. The package diagram for the recommended assembly is shown in Figure 18. In finalized package form, ESD diodes protect all possible ESD or over voltage damages between Vgg and ground, Vgg and Vdd, Vdd and ground. Typical ESD diode current versus diode voltage for 11-connected diodes in series is shown in Figure 13. Under the recommended DC quiescent biasing condition at Vds = 5 V, Ids = 650 mA, Vgg = -1 V, typical gate terminal current is approximately 0.3mA. If an active biasing technique is selected for the AMMP6408 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. A typical measured detector voltage versus output power at 18 GHz is shown Figure 20. 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,

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

where V_{ref} is the voltage at the *DET _R* port, V_{det} is a voltage at the *DET _O* port, and V_{ofs} is the zero-input-power offset voltage. There are three methods to calculate V_{ofs}:

1. V_{ofs} can be measured before each detectore 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 0.01 dB/50°C.
2. V_{ofs} can be measured at a single reference temperature. The drift error will be less than 0.25 dB.
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.

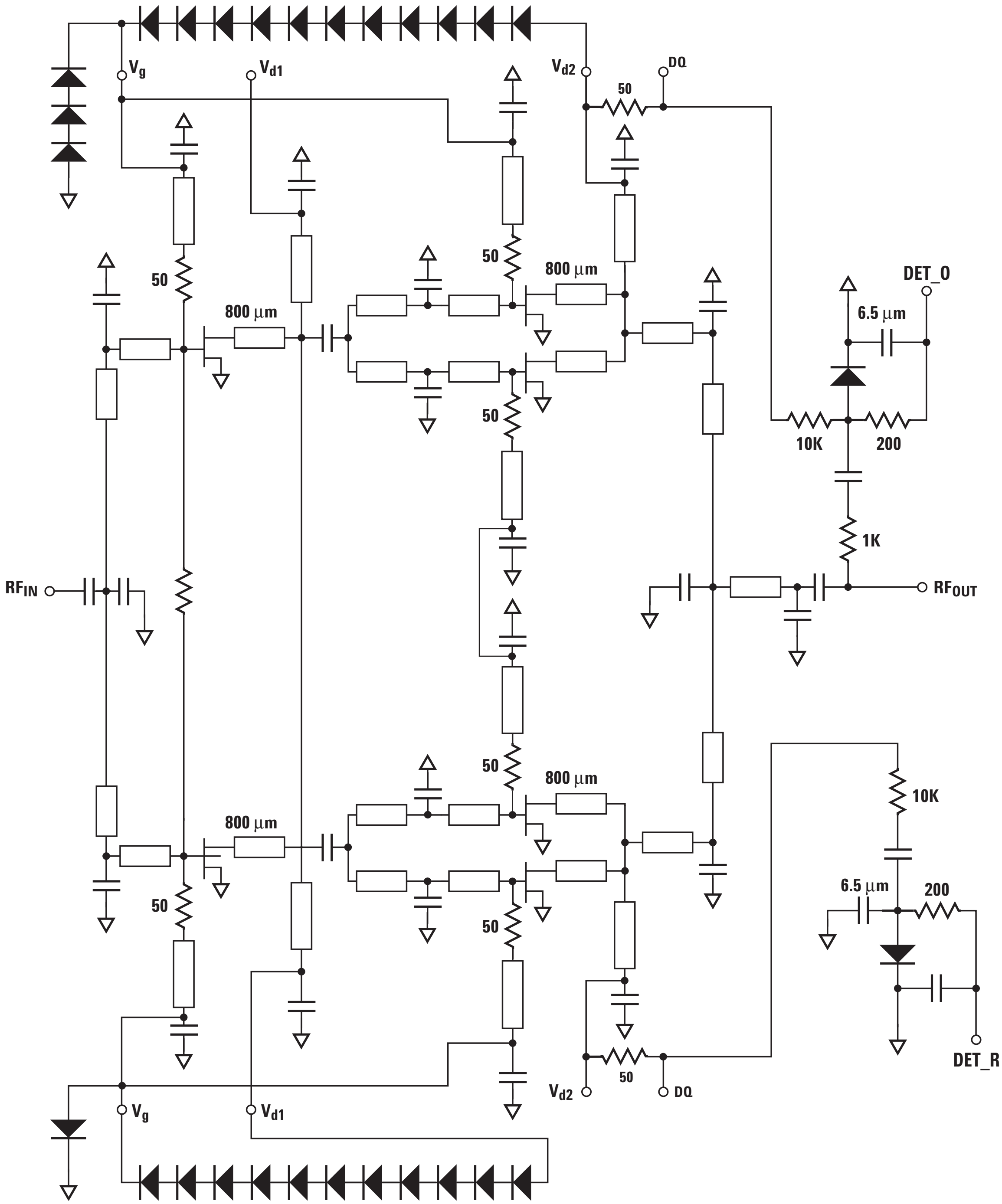
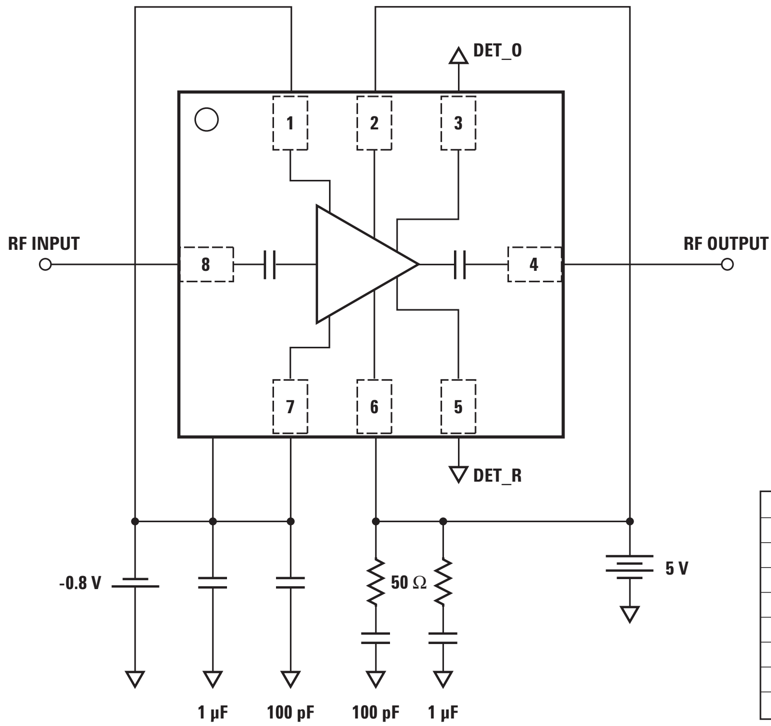


Figure 17. Simplified schematic for the MMIC die



PIN	FUNCTION
1	Vgg
2	Vdd
3	DET_O
4	RF_out
5	DER_R
6	Vdd
7	Vgg
8	RF_in

Note:
1. Vdd may be applied to either Pin 2 or Pin 6.
2. Vgg may be applied to either Pin 1 or Pin 7.

Figure 18. Schematic for recommended Bias circuitry

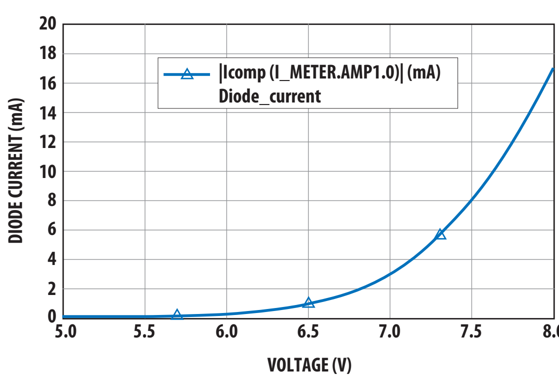


Figure 19. Typical ESD diode current versus diode voltage for 11-connected diodes in series

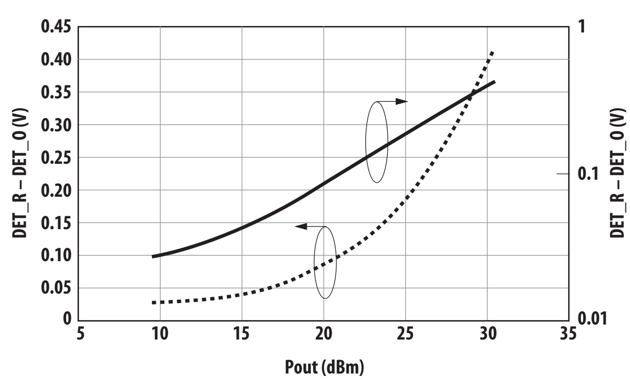


Figure 20. Typical detector voltage and output power, freq. = 18 GHz

Typical Scattering Parameters

Please refer to <http://www.avagotech.com> for typical scattering parameters data.

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).

Ordering Information

AMMP-6408 Part Number Ordering Information

Part Number	Devices per Container	Container
AMMP-6408-BLKG	10	Antistatic bag
AMMP-6408-TR1G	100	7” Reel
AMMP-6408-TR2G	500	7” Reel

Names and Contents of the Toxic and Hazardous Substances or Elements in the Products
产品中有毒有害物质或元素的名称及含量

Part Name 部件名称	Toxic and Hazardous Substances or Elements 有毒有害物质或元素					
	Lead (Pb) 铅 (Pb)	Mercury (Hg) 汞 （Hg ）	Cadmium (Cd) 镉 （Cd ）	Hexavalent (Cr(VI)) 六价铬（Cr(VI) ）	Polybrominated biphenyl (PBB) 多溴联苯（PBB ）	Polybrominated diphenylether (PBDE) 多溴二苯醚（PBDE ）
100pF capacitor	×	○	○	○	○	○

○: indicates that the content of the toxic and hazardous substance in all the homogeneous materials of the part is below the concentration limit requirement as described in SJ/T 11363-2006.
×: indicates that the content of the toxic and hazardous substance in at least one homogeneous material of the part exceeds the concentration limit requirement as described in SJ/T 11363-2006.
(The enterprise may further explain the technical reasons for the “x” indicated portion in the table in accordance with the actual situations.)

○：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。
（企业可在此处，根据实际情况对上表中打“×” 的技术原因进行进一步说明。）

Note: EU RoHS compliant under exemption clause of “lead in electronic ceramic parts (e.g. piezoelectronic devices)”

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

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