

# Power Amplifier, 0.25 W 20 - 45 GHz



MAAM-011277-DIE

Rev. V1

## Features

- Wide Frequency Range: 20 - 45 GHz
- High Gain: 24.5 dB @ 39 GHz
- P1dB: 23.5 dBm @ 39 GHz
- Output IP3: 30 dBm
- Integrated Power Detector
- Bare Die
- RoHS\* Compliant

## Applications

- ISM/MM

## Description

The MAAM-011277-DIE is a 4-stage, 0.25 W power amplifier 2.5 x 1.15 mm MMIC die. This power amplifier operates from 20 to 45 GHz and provides 22 dB of linear gain, 0.25 W at P1dB compression, and 17% efficiency (P3) while biased at 5 V.

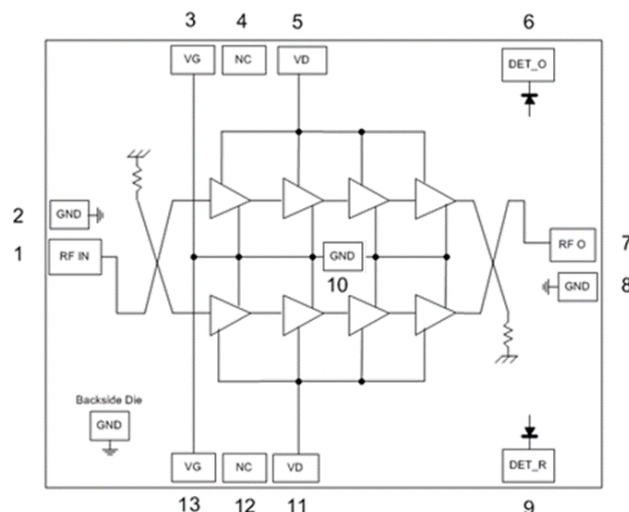
This device can be used as a driver amplifier ideally suited for various operational band in between 20 GHz and 45 GHz.

This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

## Ordering Information

Part Number	Package
MAAM-011277-DIE	Bare Die

## Functional Schematic



## Pin Configuration<sup>1</sup>

Pin #	Pin Name	Description
1	IN	RF Input
2, 8	GND	Ground
3, 13	VG	Gate Voltage
4, 10, 12	N/C	Not Connected
5, 11	VD	Drain Voltage
6	VDET_O	Detector Voltage
9	VDET_R	Detector Reference
7	OUT	RF Output

1. Backside of die must be connected to RF, DC and thermal ground.

\* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

# Power Amplifier, 0.25 W 20 - 45 GHz



MAAM-011277-DIE

Rev. V1

Electrical Specifications: Freq. = 20 - 45 GHz,  $T_A = +25^\circ\text{C}$ ,  $V_D = 5\text{ V}$ ,  $I_{DSQ} = 0.3\text{ A}$ ,  $Z_0 = 50\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	$P_{IN} = -10\text{ dBm}$ 20 GHz 30 GHz 39 GHz 45 GHz	dB	21.0 18.5 21.5 —	24.0 20.0 24.5 18.5	—
Input Return loss	—	dB	—	15	—
Output Return Loss	—	dB	—	15	—
P1dB	20 GHz 30 GHz 39 GHz 45 GHz	dBm	21.5 21.0 22.5 —	23.0 22.5 23.5 22.0	—
P3dB	—	dBm	—	25	—
OIP3	$P_{OUT}/\text{Tone} = 18\text{ dBm}$ , $\Delta f = 10\text{ MHz}$	dBm	—	30	—
Drain Voltage	—	V	—	5	—
Drain Current @ P1dB	—	mA	—	400	500
Power Added Efficiency	P3dB	%	—	17	—

## Maximum Operating Ratings

Parameter	Rating
Input Power	$P_{IN} \leq 3\text{ dB Compression}$
Junction Temperature <sup>2,3</sup>	$+160^\circ\text{C}$
Operating Temperature	$-40^\circ\text{C}$ to $+85^\circ\text{C}$

- Operating at nominal conditions with junction temperature  $\leq +160^\circ\text{C}$  will ensure MTTF  $> 1 \times 10^6$  hours.
- Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * [(V * I) - (P_{OUT} - P_{IN})]$ .  
Typical thermal resistance ( $\Theta_{JC}$ ) =  $16.7^\circ\text{C/W}$ 
  - For  $T_C = +25^\circ\text{C}$   
 $T_J = 56.2^\circ\text{C}$  @ 5 V, 443 mA,  $P_{OUT} = 25.4\text{ dBm}$ ,  $P_{IN} = 4\text{ dBm}$
  - For  $T_C = +85^\circ\text{C}$   
 $T_J = 117.1^\circ\text{C}$  @ 5 V, 434 mA,  $P_{OUT} = 24.0\text{ dBm}$ ,  $P_{IN} = 8\text{ dBm}$

## Handling Procedures

Please observe the following precautions to avoid damage:

## Static Sensitivity

These electronics devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these 250 V HBM Class 1A devices.

## Absolute Maximum Ratings<sup>4,5</sup>

Parameter	Absolute Maximum
Input Power	23 dBm
Drain Voltage	6 V
Gate Voltage	-3 to 0 V
Junction Temperature <sup>6</sup>	$+175^\circ\text{C}$
Storage Temperature	$-65^\circ\text{C}$ to $+125^\circ\text{C}$

- Exceeding any one or combination of these limits may cause permanent damage to this device.
- MACOM does not recommend sustained operation near these survivability limits.
- Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

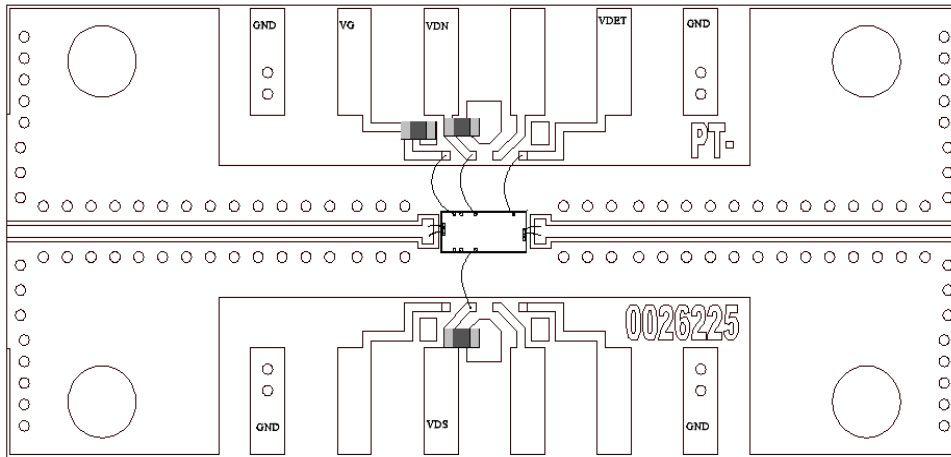
2

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice. Visit [www.macom.com](http://www.macom.com) for additional data sheets and product information.

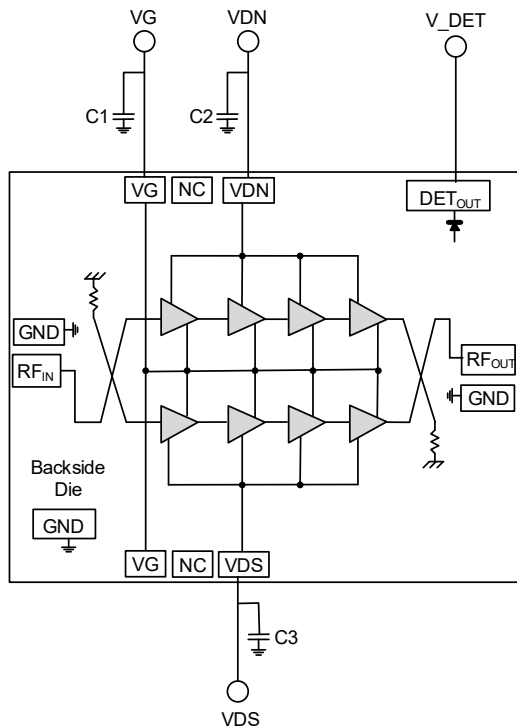
For further information and support please visit:  
<https://www.macom.com/support>

DC-0020460

**Sample Board Layout**



**Application Schematic**



**Parts List**

Part	Value	Case Style
C1 - C3	1 $\mu$ F	0402

**Sample Board Thru Loss**

Refer to the plot on page 9 for sample board thru loss.

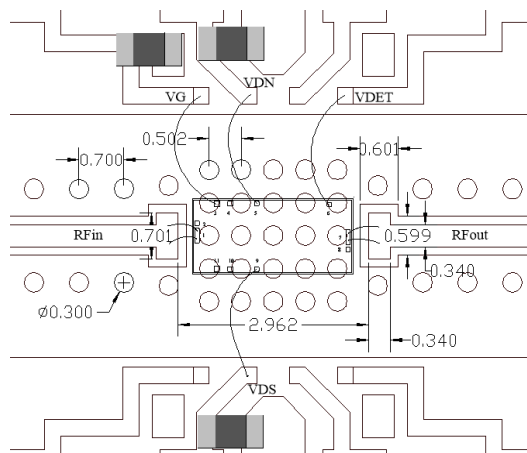
**Sample Board Material Specifications**

Top Layer: 1/2 oz Copper Cladding, 0.0175 mm thickness  
 Dielectric Layer: Rogers RO4003C 0.203 mm thickness  
 Bottom Layer: 1/2 oz Copper Cladding, 0.0175 mm thickness  
 Finished overall thickness: 0.238 mm

**Recommended Bonding Diagram and PCB Details:**

For optimum performance, RF input and output transmission lines require open stubs on the application board for bonding wire inductance compensation. The physical length for the 1 mil diameter gold wire is approximately 350  $\mu\text{m}$  each for the two wire connection.

Use copper filled and plated over vias for the thermal, DC and RF ground vias.



Units are in mm.

**Biasing Conditions**

Recommended biasing conditions are  $V_D = 5\text{ V}$ ,  $I_{DQ} = 300\text{ mA}$  (controlled with  $V_G$ ). The drain bias voltage range is 4 to 6 V, and the quiescent drain current biasing range is 250 to 350 mA.

$V_G$  pins 3 and 11 are internally connected; therefore, interconnection is not required. Muting can be accomplished by setting the  $V_G$  to the pinched off voltage ( $V_G = -2\text{ V}$ ).

$V_D$  bias must be applied to  $V_{DN}$  and  $V_{DS}$  (north and south). North  $V_D$  supplies and south  $V_D$  supplies are not connected internally.

**Operating the MAAM-011277-DIE**

**Turn-on**

1. Apply  $V_G$  (-1.5 V).
2. Apply  $V_D$  (5.0 V typical).
3. Set  $I_{DQ}$  by adjusting  $V_G$  more positive (typically -0.9 to -1.0 V for  $I_{DQ} = 300\text{ mA}$ ).
4. Apply  $RF_{IN}$  signal.

**Turn-off**

1. Remove  $RF_{IN}$  signal.
2. Decrease  $V_G$  to -1.5 V.
3. Decrease  $V_D$  to 0 V.

# Power Amplifier, 0.25 W 20 - 45 GHz

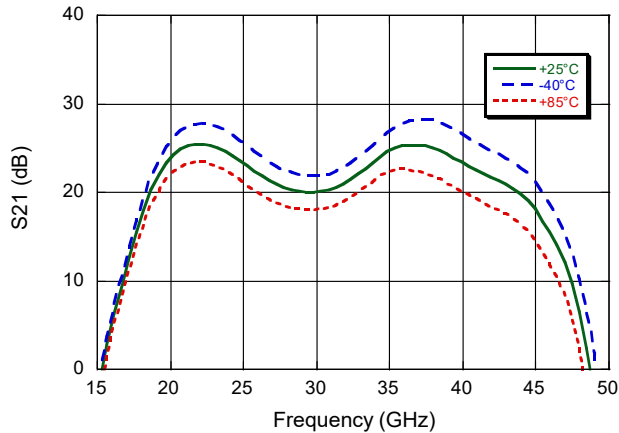


MAAM-011277-DIE

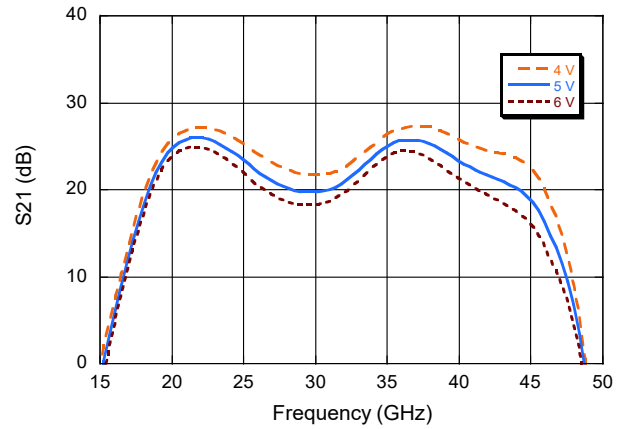
Rev. V1

Typical Performance Curves:  $V_D = 5\text{ V}$ ,  $I_{DSQ} = 300\text{ mA}$

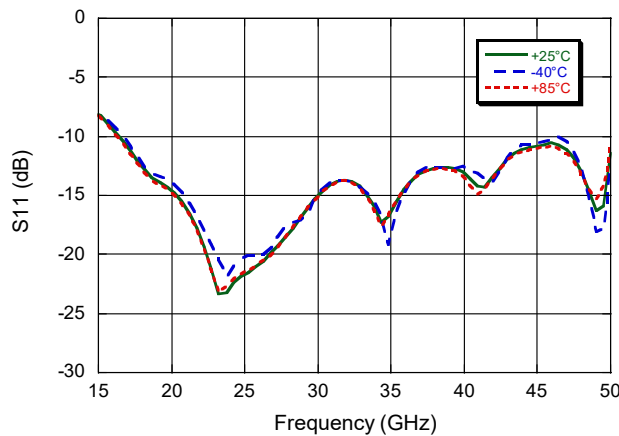
Small Signal Gain vs. Frequency



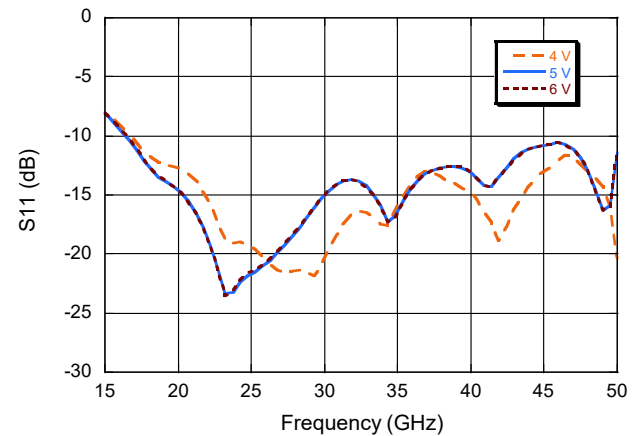
Small Signal Gain vs. Frequency



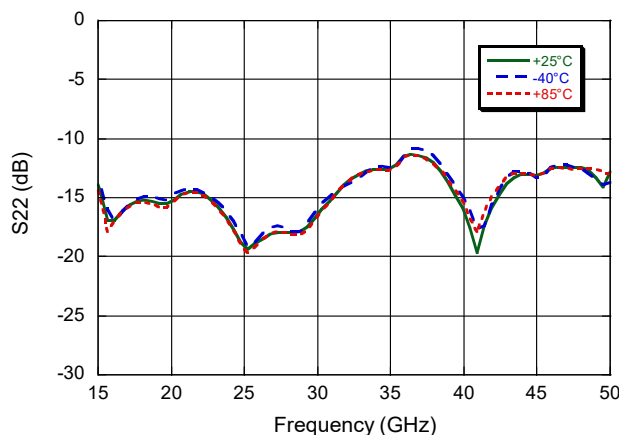
Input Return Loss vs. Frequency



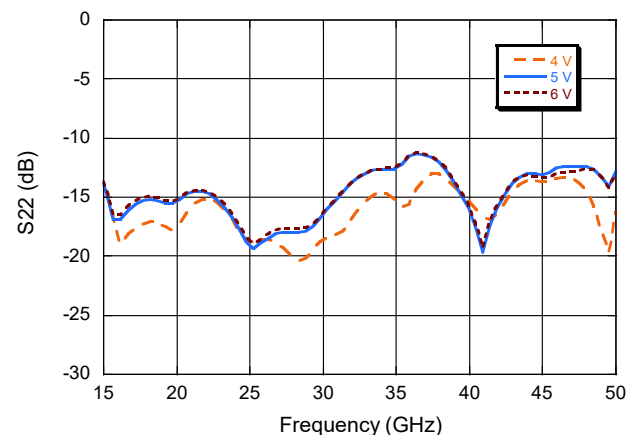
Input Return Loss vs. Frequency



Output Return Loss vs. Frequency

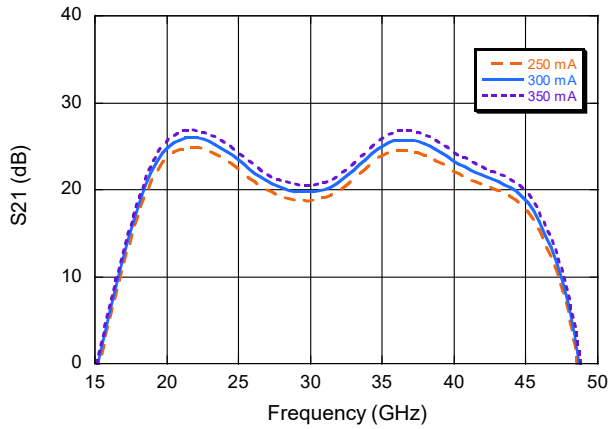


Output Return Loss vs. Frequency

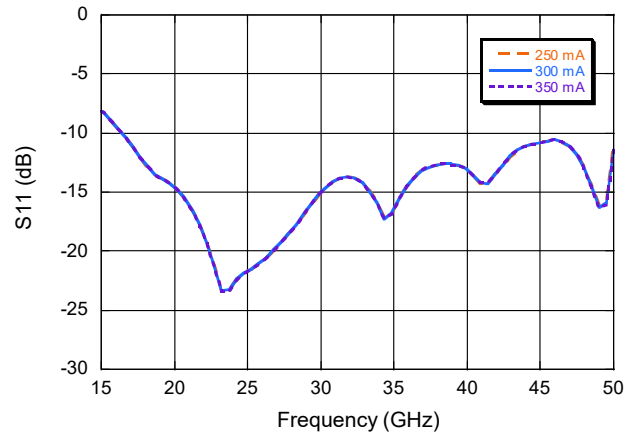


**Typical Performance Curves:  $V_D = 5\text{ V}$**

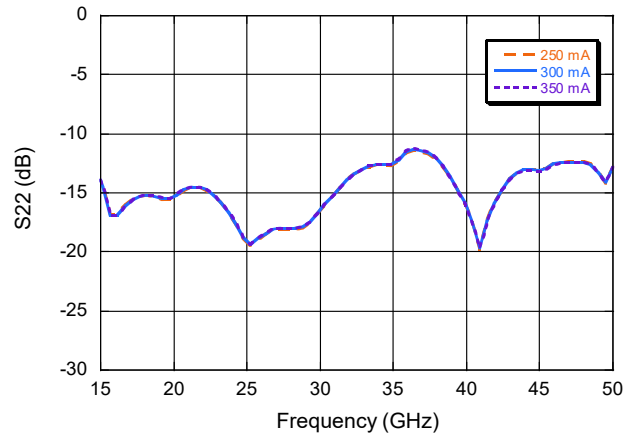
**Small Signal Gain vs. Frequency**



**Input Return Loss vs. Frequency**



**Output Return Loss vs. Frequency**



# Power Amplifier, 0.25 W 20 - 45 GHz

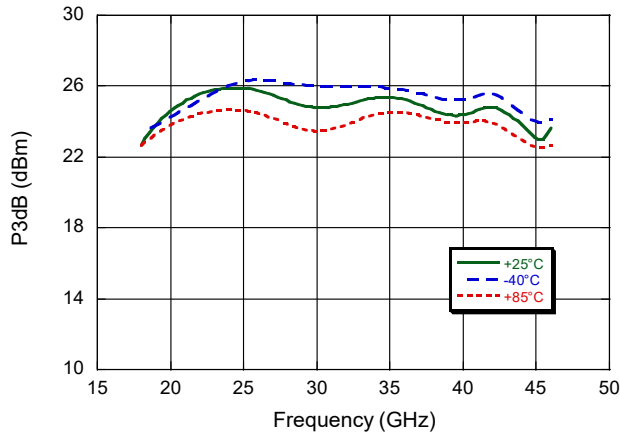


MAAM-011277-DIE

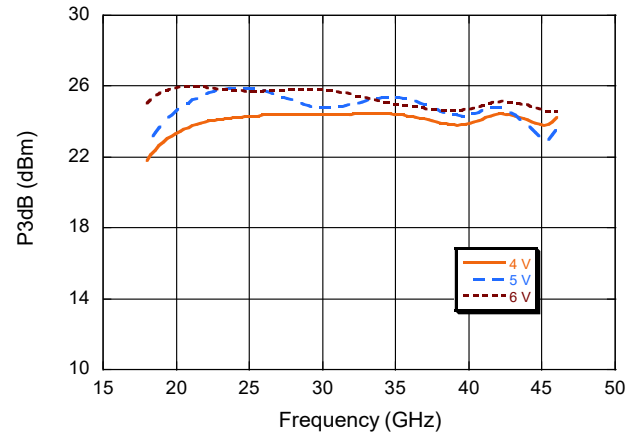
Rev. V1

Typical Performance Curves:  $V_D = 5\text{ V}$ ,  $I_{DSQ} = 300\text{ mA}$

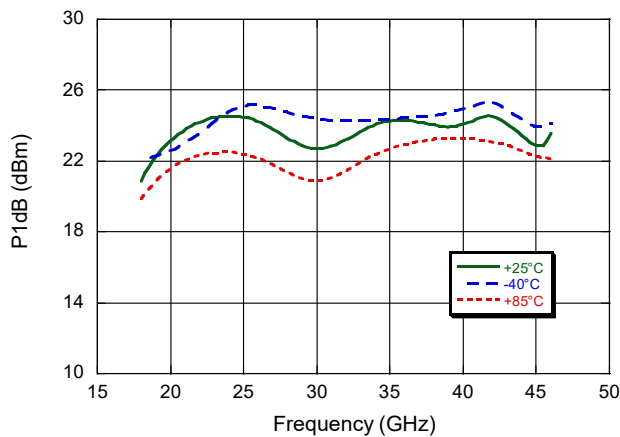
**P3dB vs. Frequency**



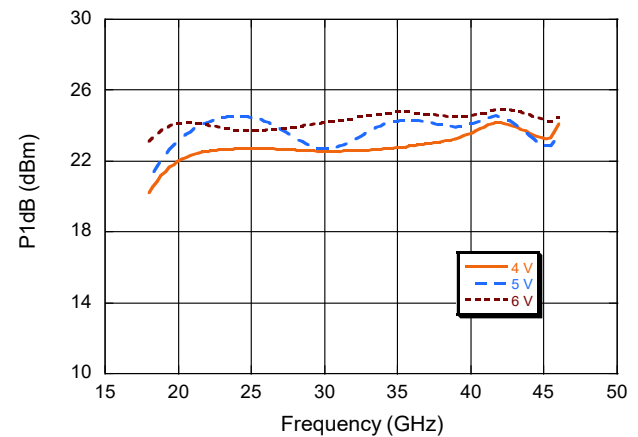
**P3dB vs. Frequency**



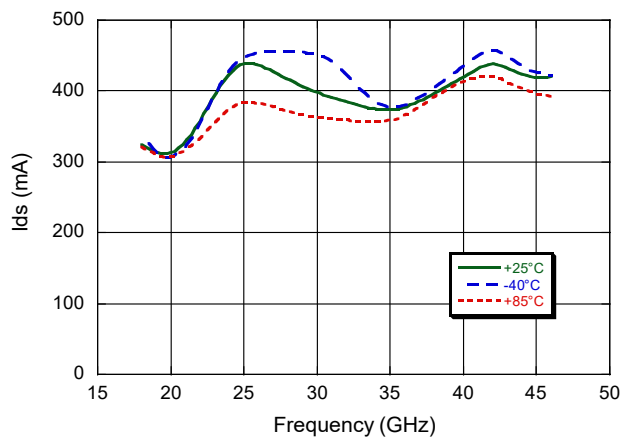
**P1dB vs. Frequency**



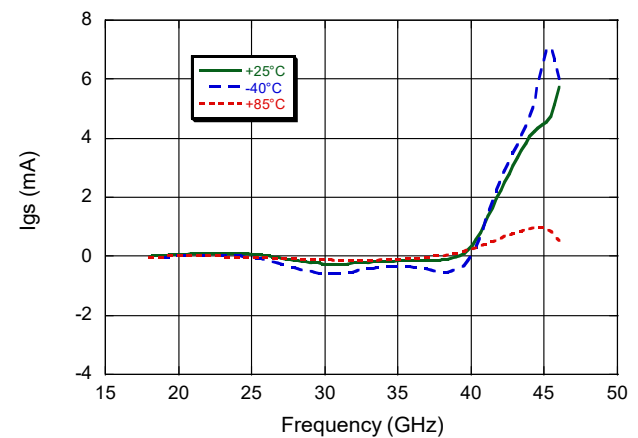
**P1dB vs. Frequency**



**I<sub>ds</sub> vs. Frequency @ P3dB**



**I<sub>gs</sub> vs. Frequency @ P3dB**



# Power Amplifier, 0.25 W 20 - 45 GHz

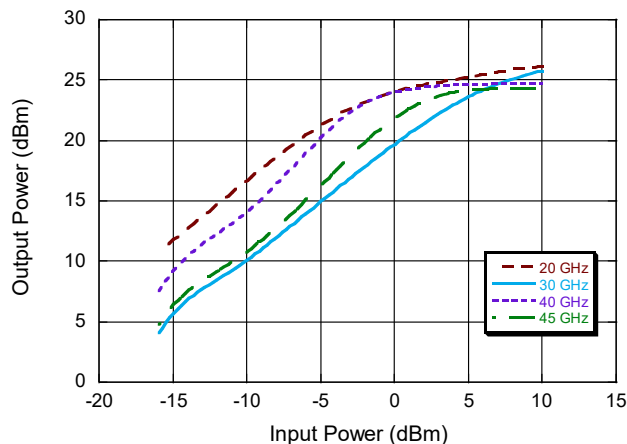


MAAM-011277-DIE

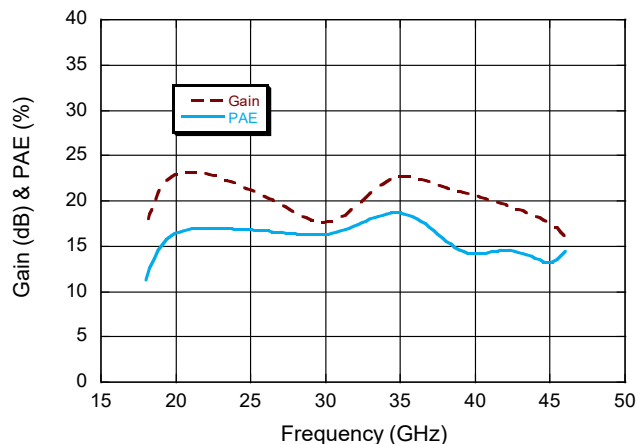
Rev. V1

Typical Performance Curves:  $V_D = 5\text{ V}$ ,  $I_{DSQ} = 300\text{ mA}$

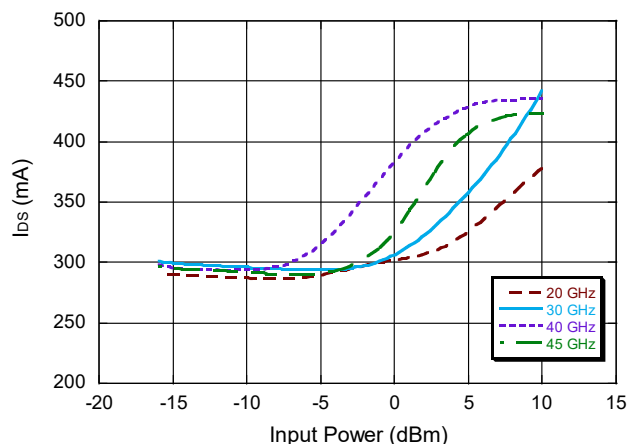
Output Power vs. Input Power



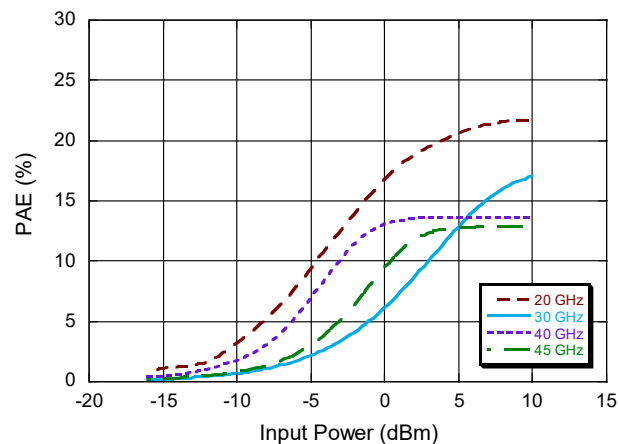
Gain and PAE @ P3dB vs. Frequency



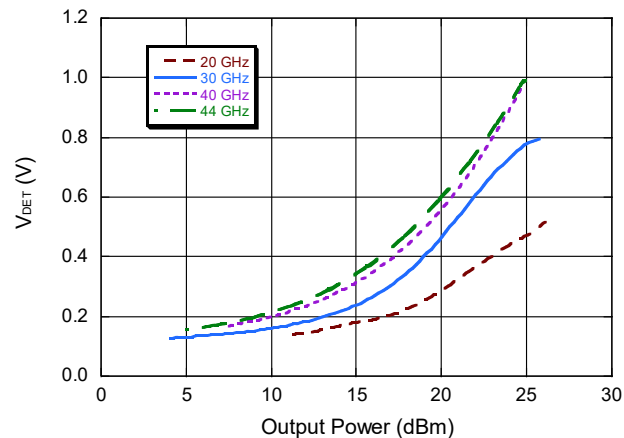
Drain Current vs. Input Power



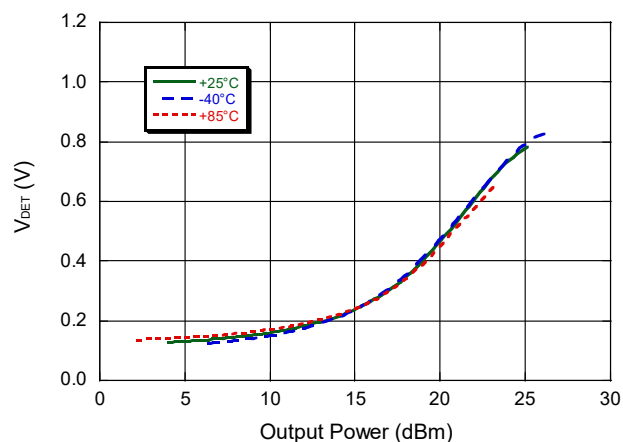
PAE vs. Input Power



Detector Voltage vs. Output Power



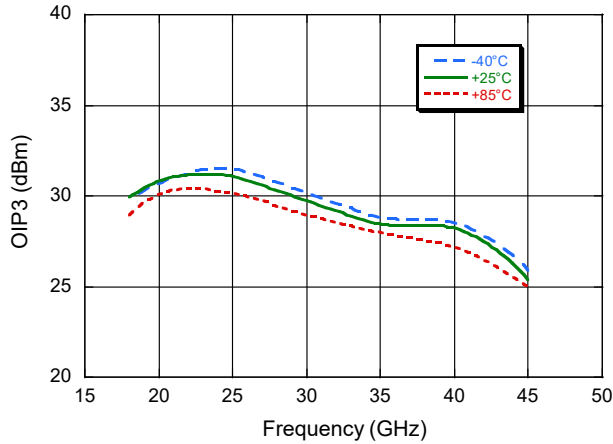
Detector Voltage vs. Output Power @ 30 GHz



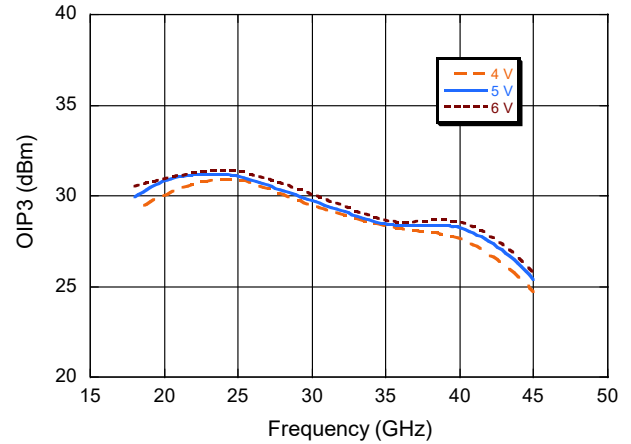


**Typical Performance Curves:  $V_D = 5\text{ V}$ ,  $I_{DSQ} = 300\text{ mA}$**

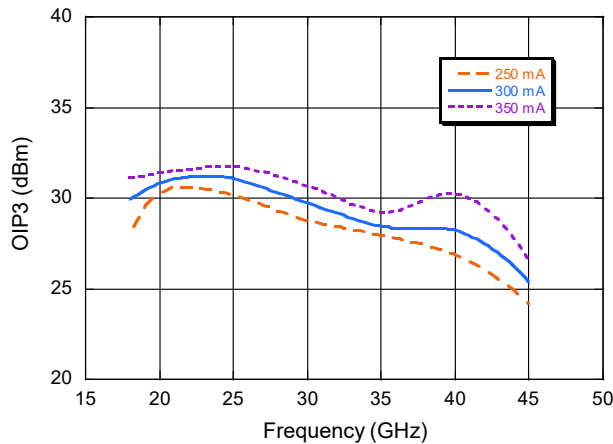
**Output IP3 vs. Frequency @  $P_{out} = 18\text{ dBm}$  / Tone**



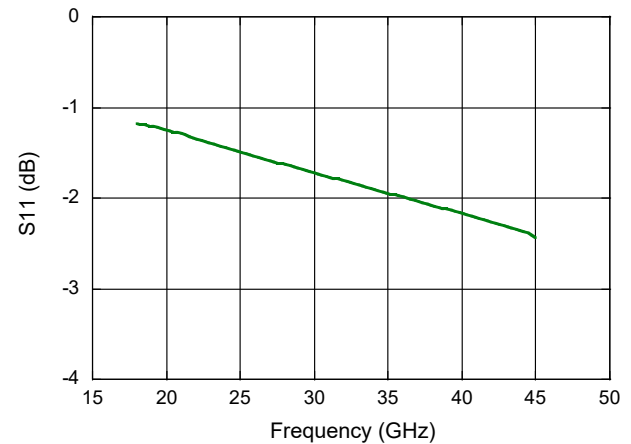
**Output IP3 vs. Frequency @  $P_{out} = 18\text{ dBm}$  / Tone**



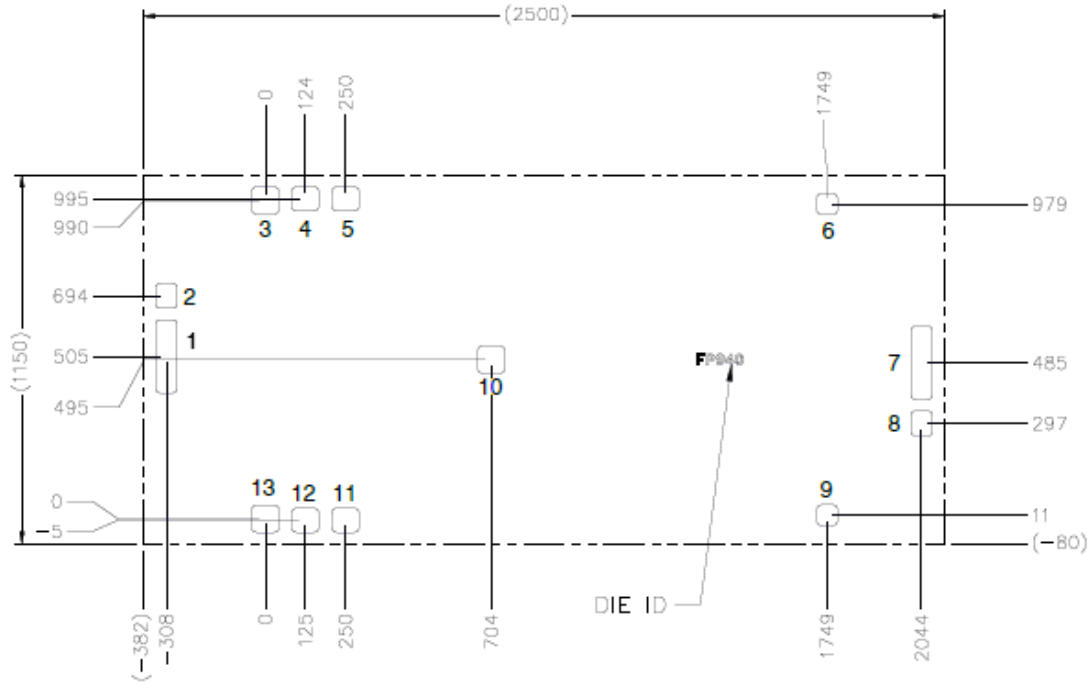
**Output IP3 vs. Frequency @  $P_{out} = 18\text{ dBm}$  / Tone**



**Sample Board Thru Losses  
Includes Two 2.4 mm Connectors**



**Die Dimensions**



Units are in micro meters with a tolerance of  $\pm 5 \mu\text{m}$ , except for die exterior dimensions which are street-center-to-street-center – nominal saw or laser kerf is  $\sim 25 \mu\text{m}$  each dimension. Pads and backside metal are gold. Die thickness is  $100 \pm 10 \mu\text{m}$ .

**Pad Dimensions ( $\mu\text{m}$ )**

Pad #	X	Y
1, 7	68	228
2, 8	68	78
3, 10, 13	85	85
4, 5, 11, 12	75	85
6, 9	65	65

MACOM Technology Solutions Inc. ("MACOM"). All rights reserved.

These materials are provided in connection with MACOM's products as a service to its customers and may be used for informational purposes only. Except as provided in its Terms and Conditions of Sale or any separate agreement, MACOM assumes no liability or responsibility whatsoever, including for (i) errors or omissions in these materials; (ii) failure to update these materials; or (iii) conflicts or incompatibilities arising from future changes to specifications and product descriptions, which MACOM may make at any time, without notice. These materials grant no license, express or implied, to any intellectual property rights.

THESE MATERIALS ARE PROVIDED "AS IS" WITH NO WARRANTY OR LIABILITY, EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHT, ACCURACY OR COMPLETENESS, OR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.