

## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

Rev. V2

### Features

- Gain: 24.5 dB
- $P_{-1dB}$ : 29 dBm
- $P_{SAT}$ : 30 dBm
- PAE at  $P_{SAT}$ : 40%
- OIP3: 40 dBm
- Typical bias conditions: 9 V, 265 mA
- Fully matched output
- Lead-Free 3 mm 16-LD PQFN package
- Halogen-Free "Green" Mold Compound
- RoHS\* Compliant

### Description

The MAAP-011232 is a 2-stage power amplifier with gain shut off, operating from 100 MHz to 3 GHz. For operation in the 100 MHz to 1 GHz frequency range no I/O matching is required. Internal DC blocking is provided at the input, while the RF output port is DC coupled through an external bias-tee. Bias current, RF gain and output power are controlled with a gate bias voltage ( $V_G$ ). Typical current consumption is less than 300 mA at maximum output power.

The MAAP-011232 is well suited to both power and driver requirements for multiple applications such as LMR, Milcom, Sensors & Telemetry, Test & Measurement and Satcom.

The MAAP-011232 is fabricated using a GaAs D-mode high breakdown process which features full passivation for increased performance and reliability.

### Ordering Information<sup>1,2</sup>

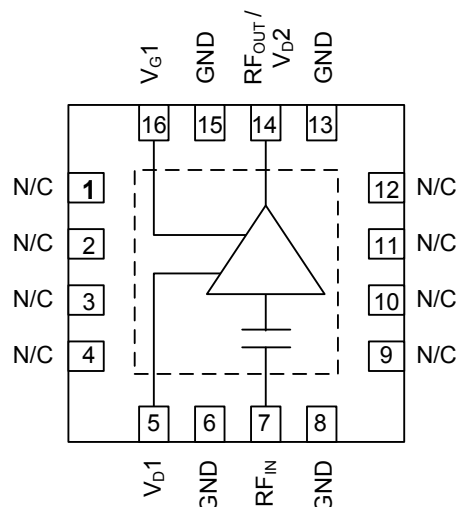
| Part Number        | Package             |
|--------------------|---------------------|
| MAAP-011232        | Bulk                |
| MAAP-011232-TR0500 | 500 Piece Reel      |
| MAAP-011232-TR1000 | 1000 Piece Reel     |
| MAAP-011232-001SMB | Sample Board Type A |
| MAAP-011232-002SMB | Sample Board Type B |

1. Reference Application Note M513 for reel size information.

2. All sample boards include 5 loose parts.

\* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

### Functional Schematic



### Pin Configuration<sup>3,4</sup>

| Pin No. | Function                             |
|---------|--------------------------------------|
| 1 - 4   | No Connection                        |
| 5       | Drain Voltage $V_{D1}$               |
| 6       | Ground                               |
| 7       | RF Input                             |
| 8       | Ground                               |
| 9 - 12  | No Connection                        |
| 13      | Ground                               |
| 14      | RF Output and Drain Voltage $V_{D2}$ |
| 15      | Ground                               |
| 16      | Shut Off Voltage $V_G$               |

3. MACOM recommends connecting unused package pins to ground.

4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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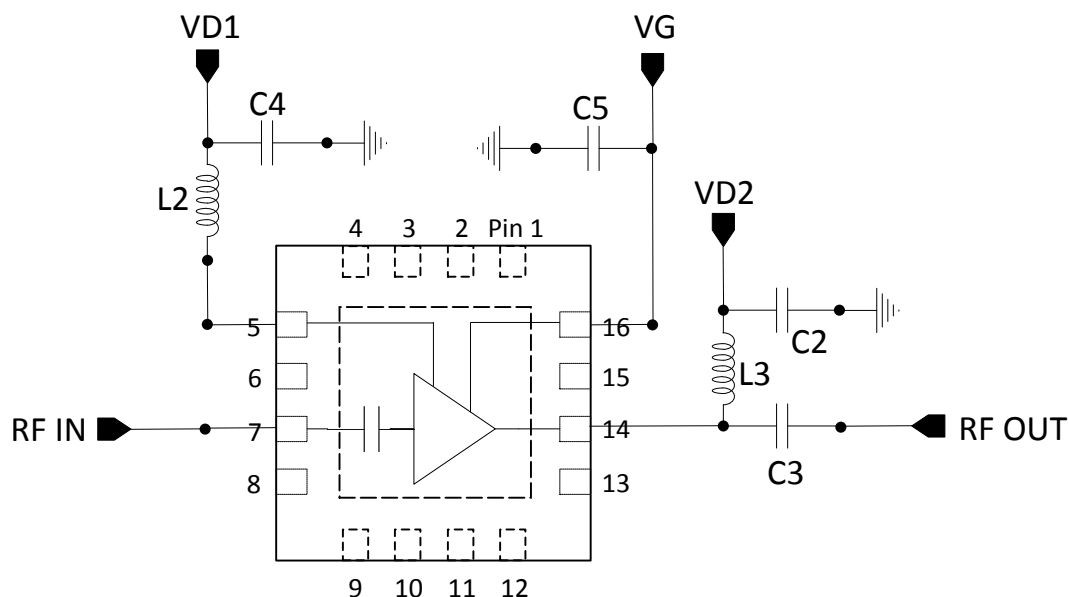
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### Electrical Specifications:

Freq. = 1 GHz,  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ ,  
 $V_G$  pulsed with 1 ms pulse width and 10% duty cycle

| Parameter                       | Symbol            | Test Conditions             | Units | Min. | Typ.  | Max. |
|---------------------------------|-------------------|-----------------------------|-------|------|-------|------|
| Small-Signal Gain               | SSG               | -10 dBm input drive level   | dB    | 23   | 24.5  | —    |
| Output Power at 1dB compression | $P_{-1\text{dB}}$ | —                           | dBm   | —    | 29    | —    |
| Saturated Output Power          | $P_{\text{SAT}}$  | 3 dB Gain compression       | dBm   | 28.5 | 30    | —    |
| Power Added Efficiency          | PAE               | 3 dB Gain compression       | %     | 35   | 40    | —    |
| Reverse Isolation               | S12               | -10 dBm input drive level   | dB    | —    | 50    | —    |
| Input Return Loss               | IRL               | -10 dBm input drive level   | dB    | —    | 8     | —    |
| Output Return Loss              | ORL               | -10 dBm input drive level   | dB    | —    | 12    | —    |
| Output Third Order Intercept    | OIP3              | -13 dBm/tone, F1-F2 = 6 MHz | dBm   | —    | 40    | —    |
| Gate Bias Voltage               | $V_G$             | —                           | V     | —    | -0.55 | —    |
| Quiescent Drain Current         | $I_{DQ1}$         | —                           | mA    | —    | 65    | —    |

### Schematic of the Production Test Board



## Absolute Maximum Ratings<sup>5,6</sup>

| Parameter                           | Absolute Maximum |
|-------------------------------------|------------------|
| RF Input Power                      | 20 dBm           |
| Gate Voltage                        | -4 V to 0 V      |
| Drain Voltage VD1                   | 10 V             |
| Drain Voltage VD2                   | 10 V             |
| Junction Temperature <sup>7,8</sup> | +150°C           |
| Operating Temperature               | -40°C to +85°C   |
| Storage Temperature                 | -55°C to +150°C  |

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with  $T_J \leq +150^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.
8. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * [(V * I) - (P_{OUT} - P_{IN})]$   
Typical thermal resistance ( $\Theta_{JC}$ ) = 29°C/W.

## Handling Procedures

Please observe the following precautions to avoid damage:

## Static Sensitivity

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

## Operating the MAAP-011232

To operate the device, follow these steps:

1. Set VG to -2 V.
2. Turn on VD1 and VD2 to 5-9 V.
3. Adjust VG to set  $I_{DQ2}$  ( $I_{DQ1}$  varies).
4. Turn off in reverse order with VG last.

## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

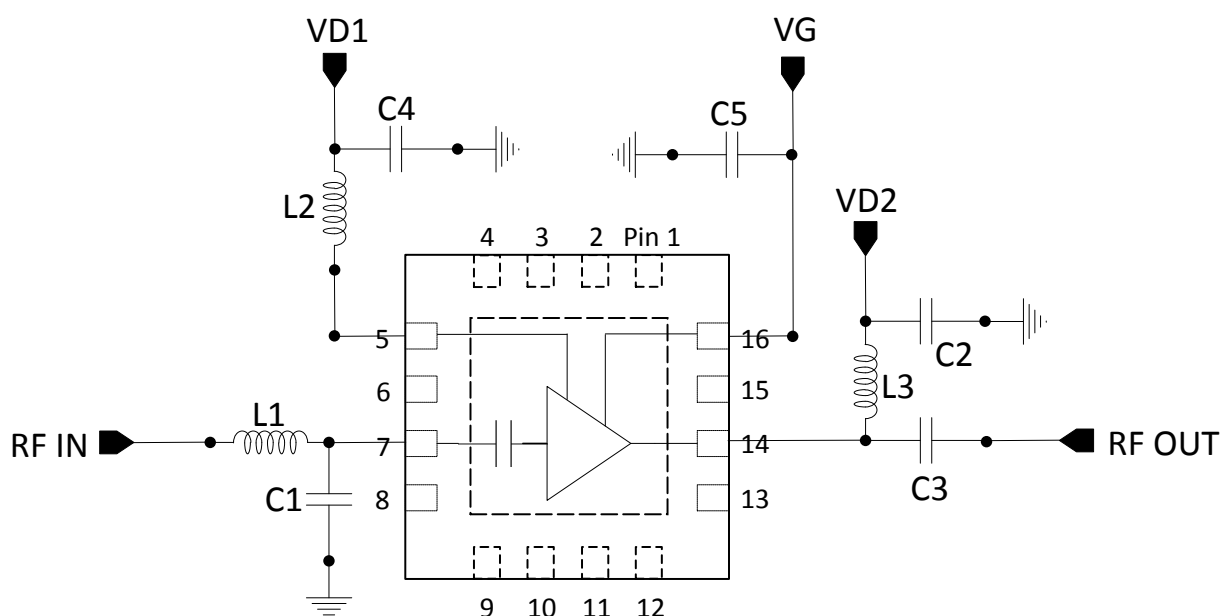
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### Typical Electrical Specifications: Test Board A: 100 - 1600 MHz Input Tuning

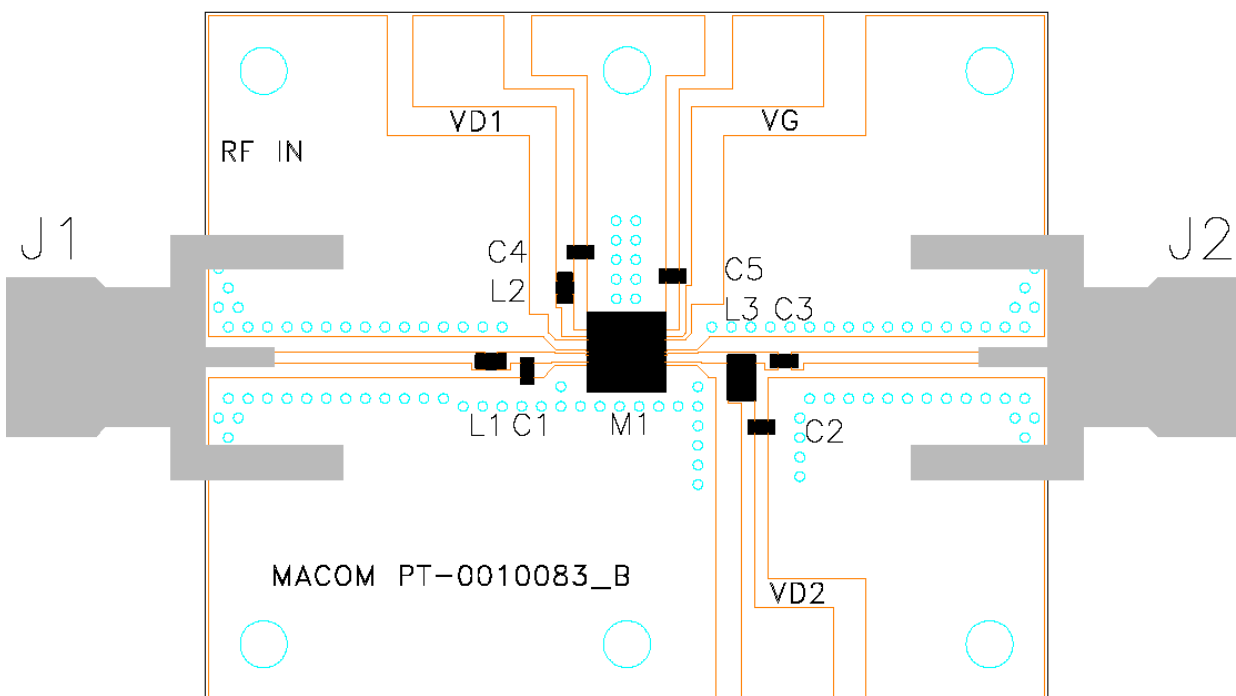
$T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

| Parameter                       | Sym-              | Test Conditions             | Units | Typical Values |     |      |      |
|---------------------------------|-------------------|-----------------------------|-------|----------------|-----|------|------|
| Frequency                       | F                 | —                           | MHz   | 100            | 700 | 1100 | 1600 |
| Small-Signal Gain               | SSG               | -10 dBm input drive level   | dB    | 16             | 26  | 25   | 21   |
| Output Power at 1dB compression | $P_{-1\text{dB}}$ | 1 dB Gain compression       | dBm   | 29             | 29  | 30   | 29   |
| Saturated Output Power          | $P_{\text{SAT}}$  | 3 dB Gain compression       | dBm   | 30             | 30  | 30.5 | 30   |
| Power Added Efficiency          | PAE               | 3 dB Gain compression       | %     | 32             | 40  | 45   | 37   |
| Reverse Isolation               | S12               | -10 dBm input drive level   | dB    | 79             | 56  | 55   | 53   |
| Input Return Loss               | IRL               | -10 dBm input drive level   | dB    | 4              | 17  | 28   | 7    |
| Output Return Loss              | ORL               | -10 dBm input drive level   | dB    | 17             | 16  | 15   | 14   |
| Output Third Order Intercept    | OIP3              | -13 dBm/tone, F1-F2 = 6 MHz | dBm   | 41             | 44  | 43   | 40   |
| Gate Bias Voltage               | $V_G$             | —                           | V     | -0.55          |     |      |      |
| Quiescent Drain Current         | $I_{DQ1}$         | —                           | mA    | 65             |     |      |      |

### Schematic of the Test Board Type A: 100-1600 MHz Input Tuning



## Test Board Type A: 100 - 1600 MHz Input Tuning



PCB Material: R4003C LoPro, 0.008" THICK, Solid Copper filled vias

## Parts List

| Part   | Description   | Value       | Size | Manufacturer         |
|--------|---------------|-------------|------|----------------------|
| C1     | Capacitor     | 0.6 pF      | 0402 | Murata               |
| C2, C4 | Capacitor     | 0.1 $\mu$ F | 0402 | Murata               |
| C3     | Capacitor     | 100 pF      | 0402 | Murata               |
| C5     | Capacitor     | 10 nF       | 0402 | Murata               |
| L1     | Inductor      | 7.5 nH      | 0402 | 0402CS, Coilcraft    |
| L2     | Inductor      | 560 nH      | 0402 | 0402AF, Coilcraft    |
| L3     | Inductor      | 110 nH      | 0603 | 0603HP, Coilcraft    |
| J1, J2 | SMA Connector | —           | —    | 142-0701-881 Emerson |

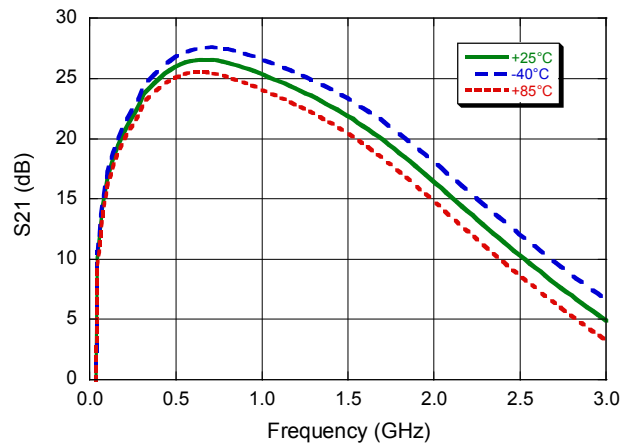
## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

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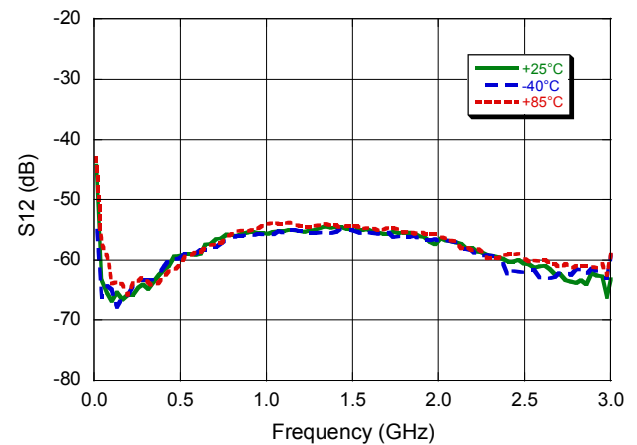
### Test Board Type A: S-parameters over Temperature

Test Conditions:  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ1} = 65\text{ mA}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

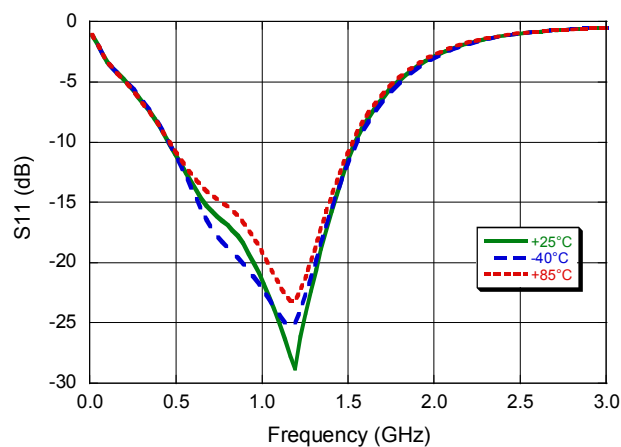
**Insertion Gain vs. Frequency**



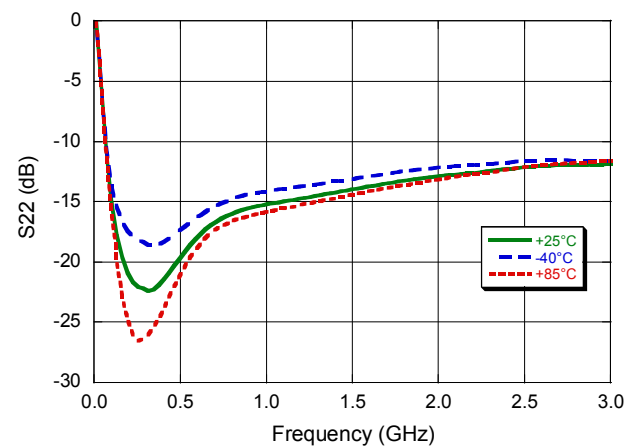
**Isolation vs. Frequency**



**Input Return Loss vs. Frequency**



**Output Return Loss vs. Frequency**



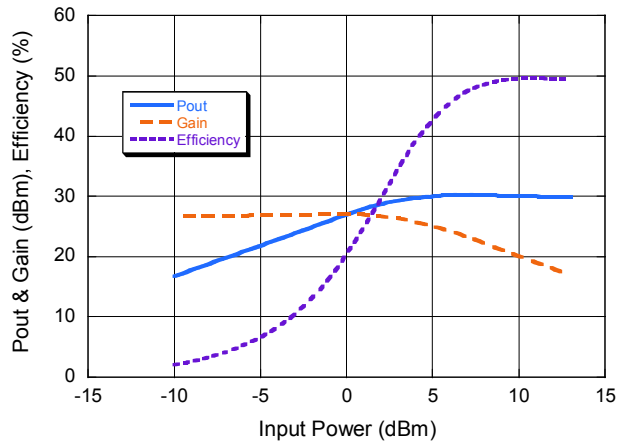
## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

Rev. V2

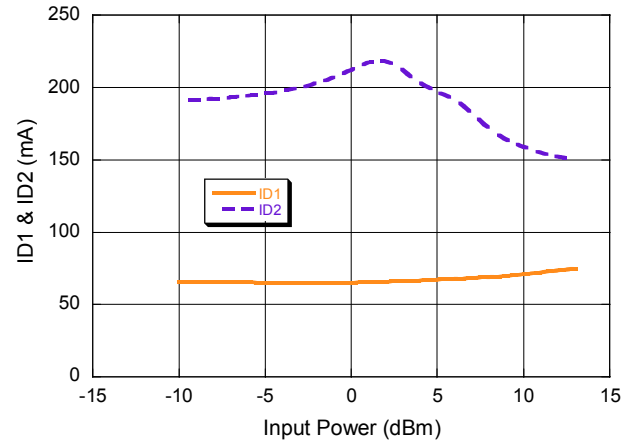
### Test Board Type A - Power Performance @ Room Temperature

Test Conditions:  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ1} = 65\text{ mA}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

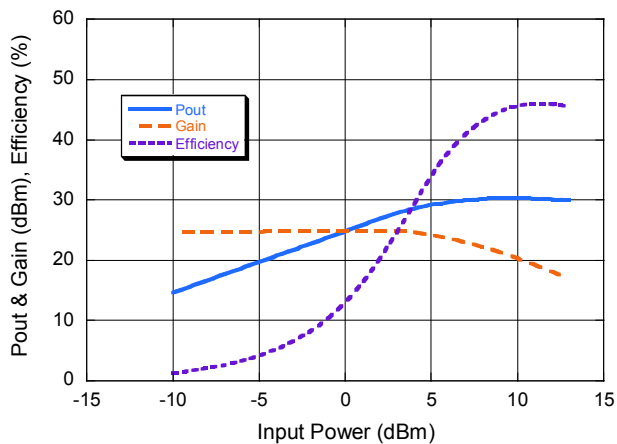
**$P_{OUT}$ , Gain and Efficiency vs.  $P_{IN}$  @ 700 MHz**



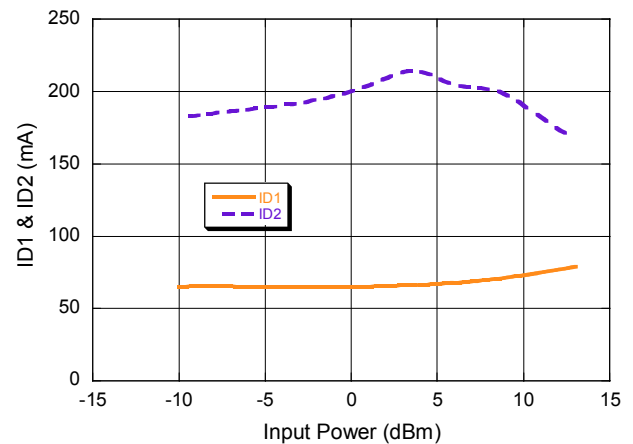
**Bias Current vs.  $P_{IN}$  @ 700 MHz**



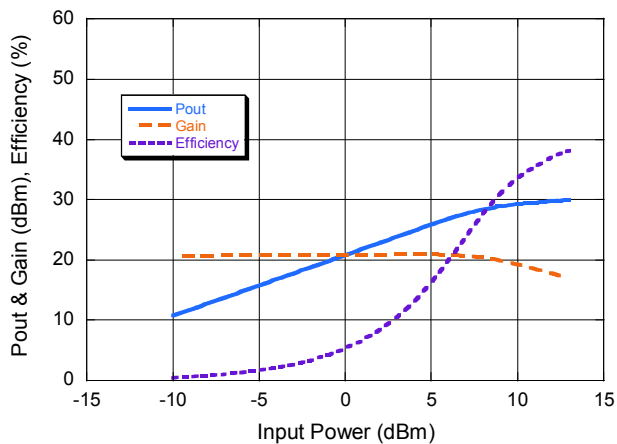
**$P_{OUT}$ , Gain and Efficiency vs.  $P_{IN}$  @ 1100 MHz**



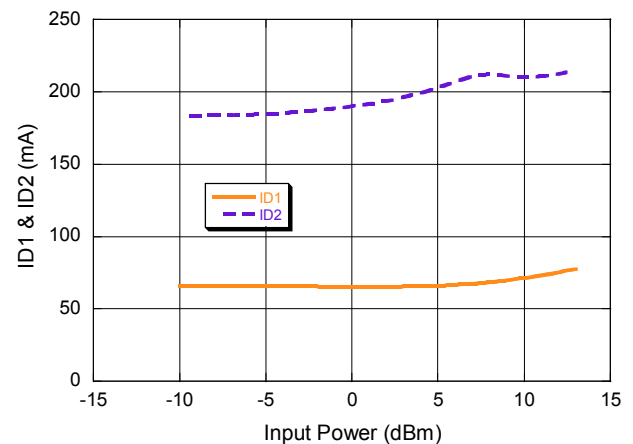
**Bias Current vs.  $P_{IN}$  @ 1100 MHz**



**$P_{OUT}$ , Gain and Efficiency vs.  $P_{IN}$  @ 1600 MHz**



**Bias Current vs.  $P_{IN}$  @ 1600 MHz**



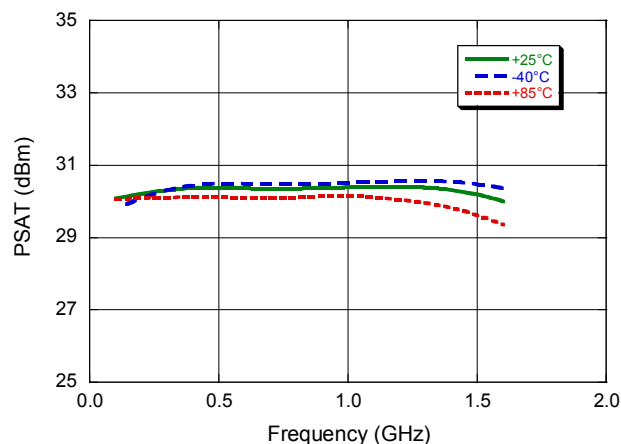
## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

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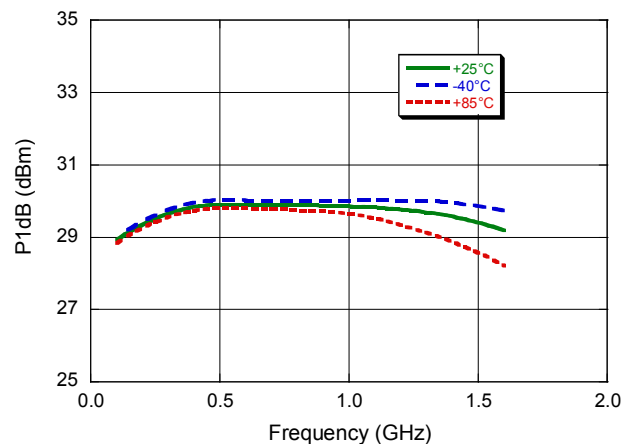
### Test Board Type A - Power Performance over Temperature

Test Conditions:  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ1} = 65\text{ mA}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

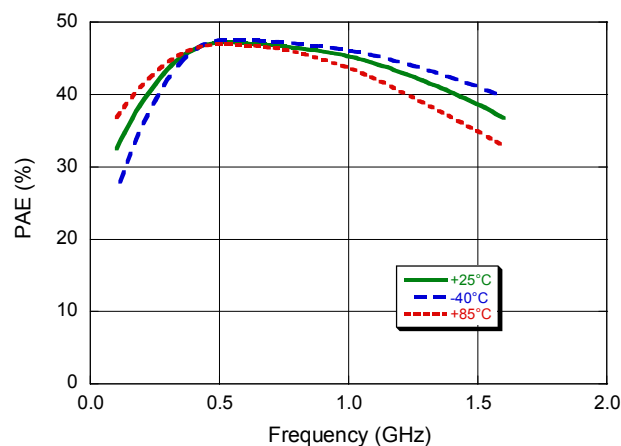
#### Saturated Power vs. Frequency



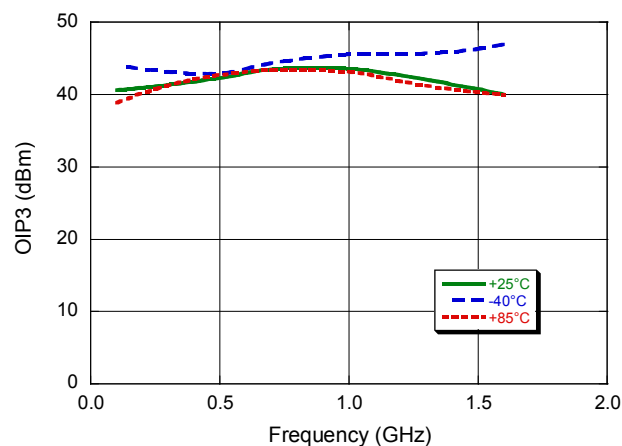
#### P1dB vs. Frequency



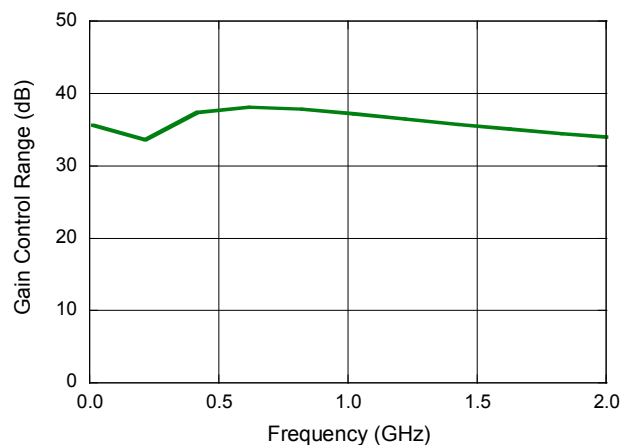
#### PAE vs. Frequency



#### Output IP3 vs. Frequency



#### Gain Control Range vs. Frequency



$P_{IN} = -13\text{ dBm/ tone}$ , tone separation = 6 MHz

Measured for  $V_G$  between -0.4 V and -1.4 V



## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

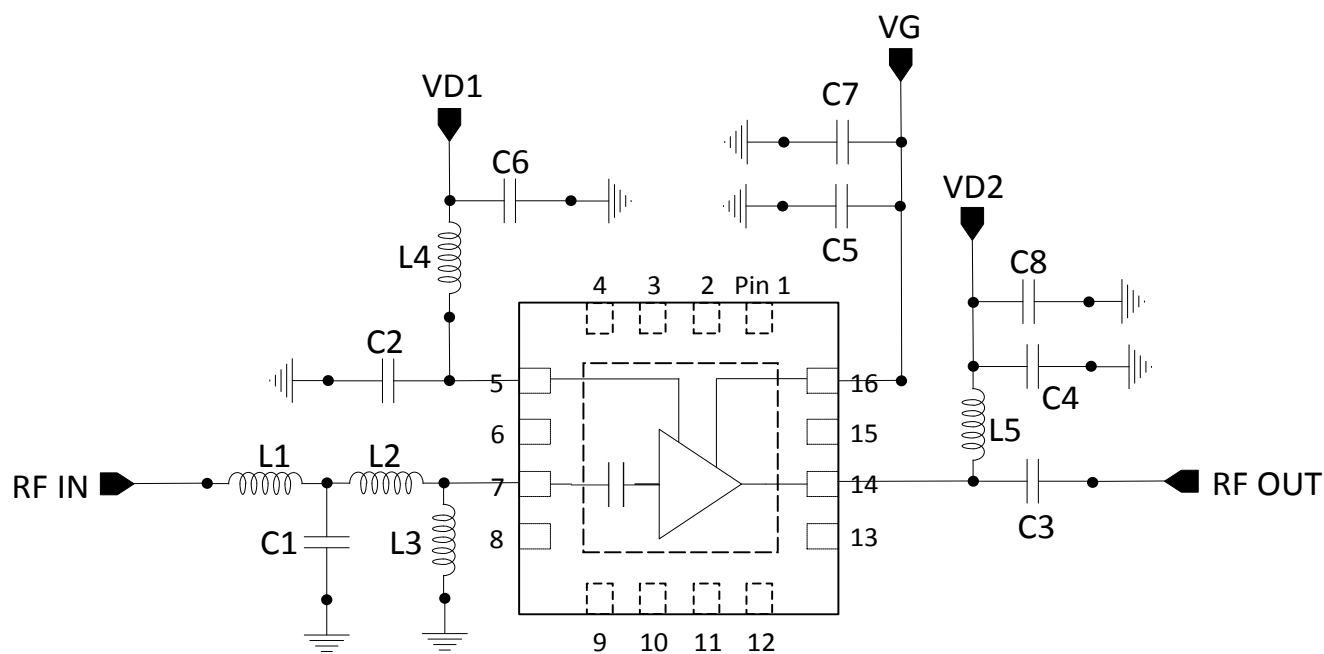
Rev. V2

### Typical Electrical Specifications: Test Board B: 1600 - 3000 MHz Input Tuning

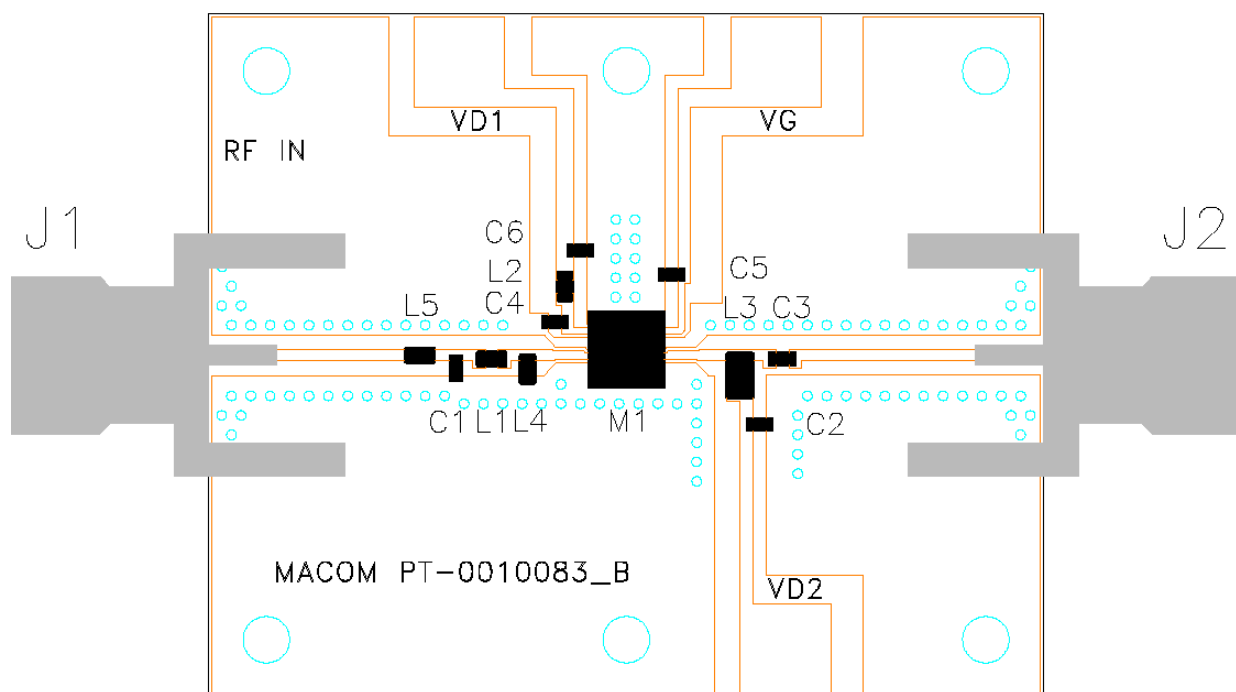
$T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

| Parameter                      | Symbol            | Test Conditions             | Units | Typical Values |      |      |
|--------------------------------|-------------------|-----------------------------|-------|----------------|------|------|
| Frequency                      | F                 | —                           | MHz   | 2000           | 2500 | 3000 |
| Small-Signal Gain              | SSG               | -10 dBm input drive level   | dB    | 24             | 24   | 17   |
| Output Power @ 1dB compression | $P_{-1\text{dB}}$ | 1 dB Gain compression       | dBm   | 29             | 29   | 30   |
| Saturated Output Power         | $P_{\text{SAT}}$  | 3 dB Gain compression       | dBm   | 30             | 30   | 30.5 |
| Power Added Efficiency         | PAE               | 3 dB Gain compression       | %     | 37             | 40.5 | 37   |
| Reverse Isolation              | S12               | -10 dBm input drive level   | dB    | 51             | 52   | 54   |
| Input Return Loss              | IRL               | -10 dBm input drive level   | dB    | 9              | 11   | 2    |
| Output Return Loss             | ORL               | -10 dBm input drive level   | dB    | 10             | 9    | 9    |
| Output Third Order Intercept   | OIP3              | -13 dBm/tone, F1-F2 = 6 MHz | dBm   | 40             | 42   | 40   |
| Gate Bias Voltage              | $V_G$             | —                           | V     | -0.55          |      |      |
| Quiescent Drain Current        | $I_{DQ1}$         | —                           | mA    | 65             |      |      |

### Schematic of the Test Board Type B: 1600-3000 MHz Input Tuning



## Test Board Type B: 1600 - 3000 MHz Input Tuning



PCB Material: R4003C LoPro, 0.008" THICK, Solid Copper filled vias

## Parts List

| Part   | Description   | Value       | Size | Manufacturer         |
|--------|---------------|-------------|------|----------------------|
| C1     | Capacitor     | 1.2 pF      | 0402 | PPI                  |
| C4, C5 | Capacitor     | 10 nF       | 0402 | Murata               |
| C2, C6 | Capacitor     | 0.1 $\mu$ F | 0402 | Murata               |
| C3     | Capacitor     | 100 pF      | 0402 | Murata               |
| L1     | Inductor      | 5.6 nH      | 0402 | 0402HP, Coilcraft    |
| L2     | Inductor      | 560 nH      | 0402 | 0402AF, Coilcraft    |
| L3     | Inductor      | 110 nH      | 0603 | 0603HP, Coilcraft    |
| L4     | Inductor      | 10 nH       | 0402 | 0402HP, Coilcraft    |
| L5     | Inductor      | 3.3 nH      | 0402 | 0402HP, Coilcraft    |
| J1, J2 | SMA Connector | —           | —    | 142-0701-881 Emerson |

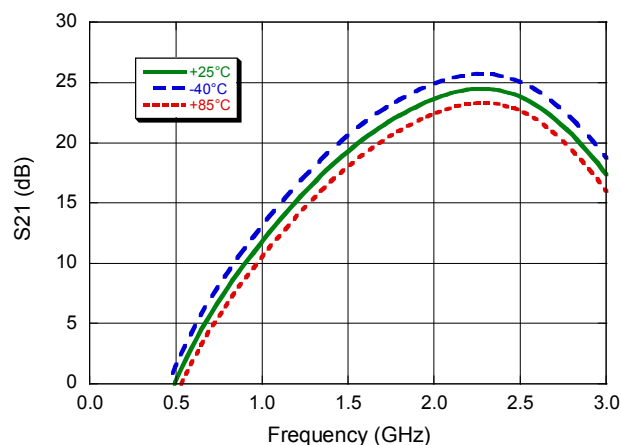
## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

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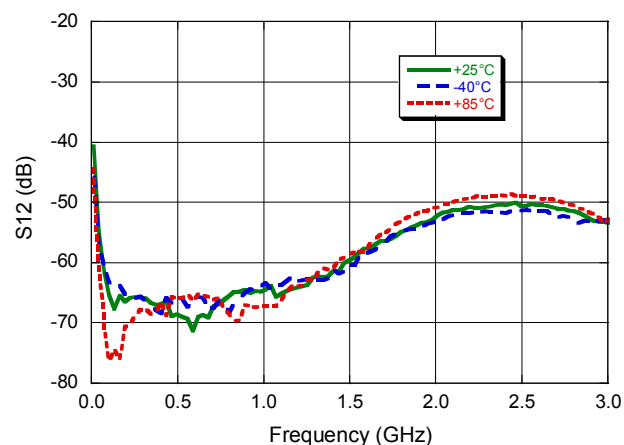
### Test Board Type B: S-parameters over Temperature

Test Conditions:  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ1} = 65\text{ mA}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

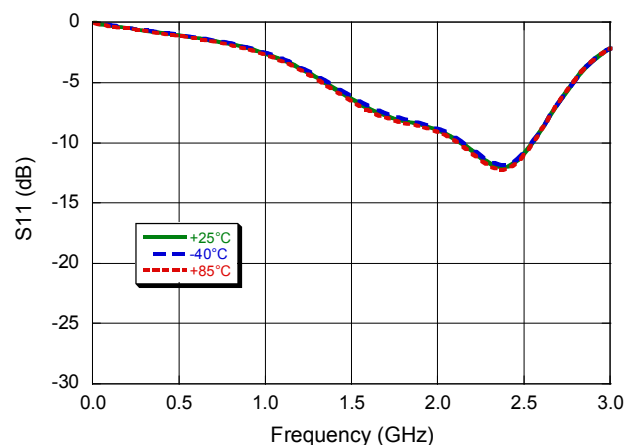
**Insertion Gain vs. Frequency**



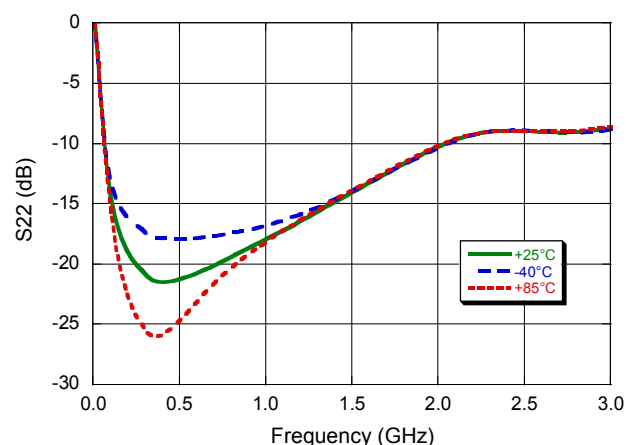
**Isolation vs. Frequency**



**Input Return Loss vs. Frequency**



**Output Return Loss vs. Frequency**



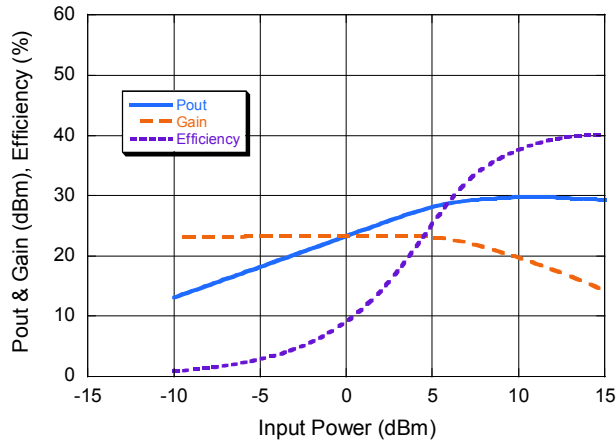
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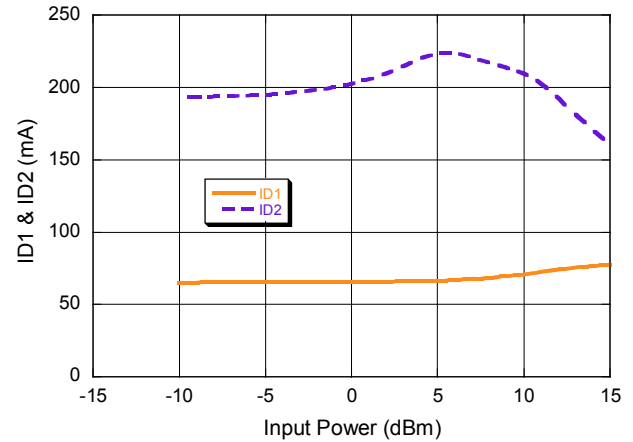
### Test Board Type B - Power Performance @ Room Temperature

Test Conditions:  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ1} = 65\text{ mA}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

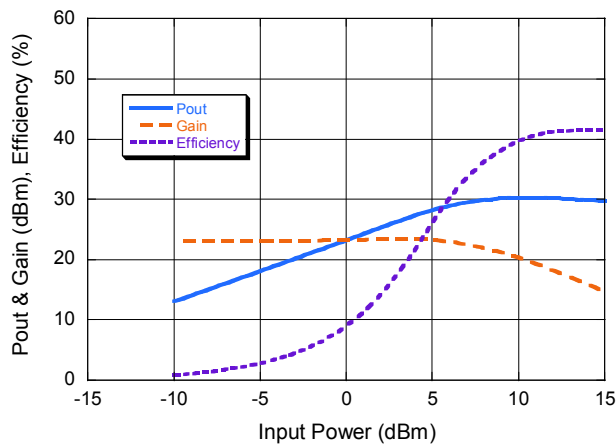
**$P_{OUT}$ , Gain and Efficiency vs.  $P_{IN}$  @ 2 GHz**



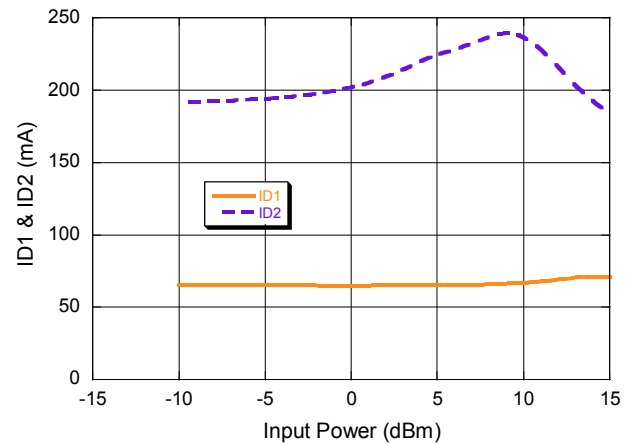
**Bias Current vs.  $P_{IN}$  @ 2 GHz**



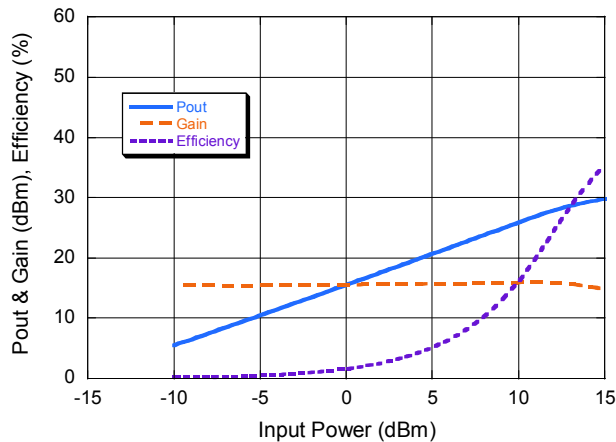
**$P_{OUT}$ , Gain and Efficiency vs.  $P_{IN}$  @ 2.5 GHz**



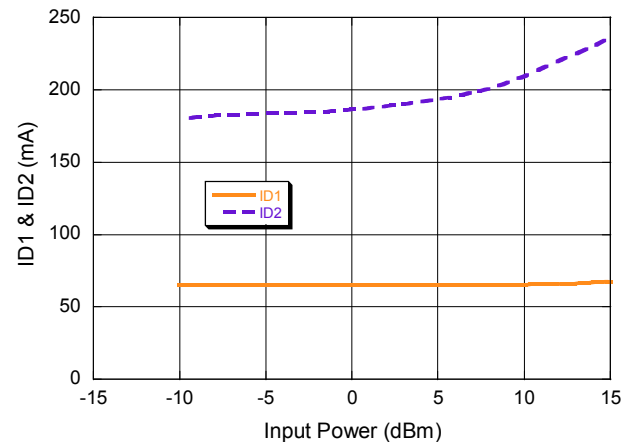
**Bias Current vs.  $P_{IN}$  @ 2.5 GHz**



**$P_{OUT}$ , Gain and Efficiency vs.  $P_{IN}$  @ 3 GHz**



**Bias Current vs.  $P_{IN}$  @ 3 GHz**



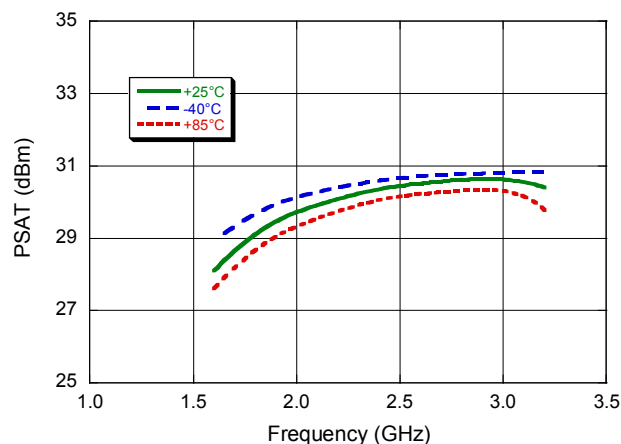
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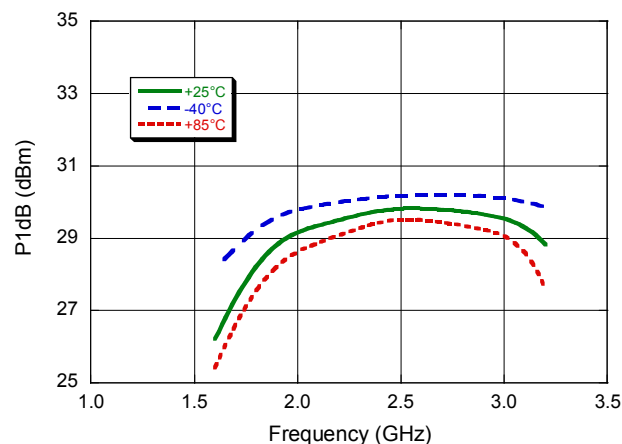
### Test Board Type B - Power Performance over Temperature

Test Conditions:  $T_A = +25^\circ\text{C}$ ,  $V_{D1} = V_{D2} = 9\text{ V}$ ,  $I_{DQ1} = 65\text{ mA}$ ,  $I_{DQ2} = 200\text{ mA}$ ,  $Z_0 = 50\ \Omega$ , CW

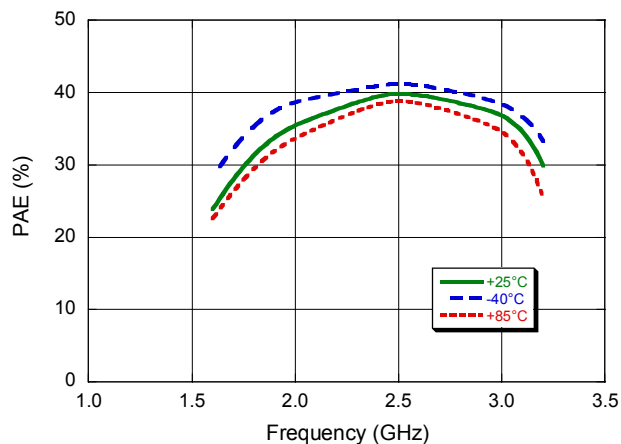
#### Saturated Power vs. Frequency



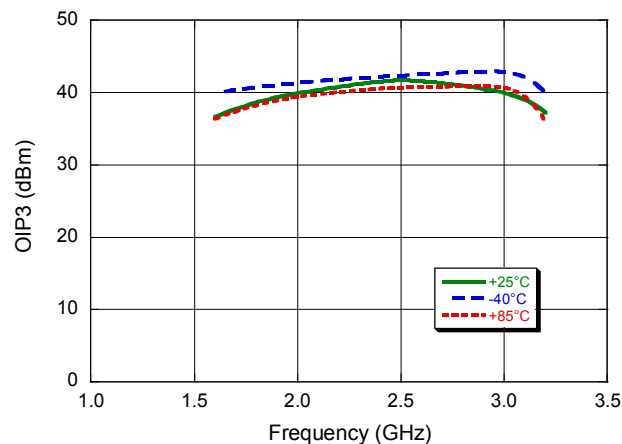
#### P1dB vs. Frequency



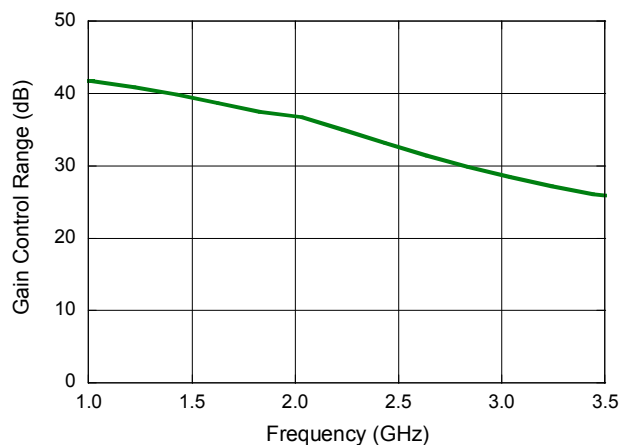
#### PAE vs. Frequency



#### Output IP3 vs. Frequency



#### Gain Control Range vs. Frequency



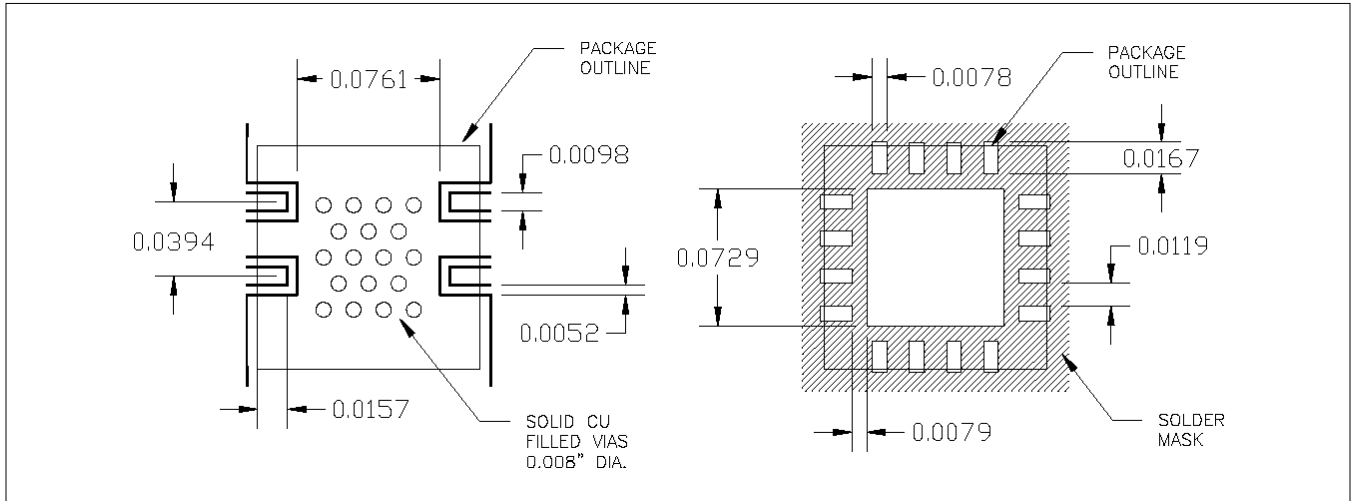
$P_{IN} = -13\text{ dBm/ tone}$ , tone separation = 6 MHz

Measured for  $V_G$  between -0.4 V and -1.4 V

## 1 W Driver Amplifier with VG Enable 0.1 - 3.0 GHz

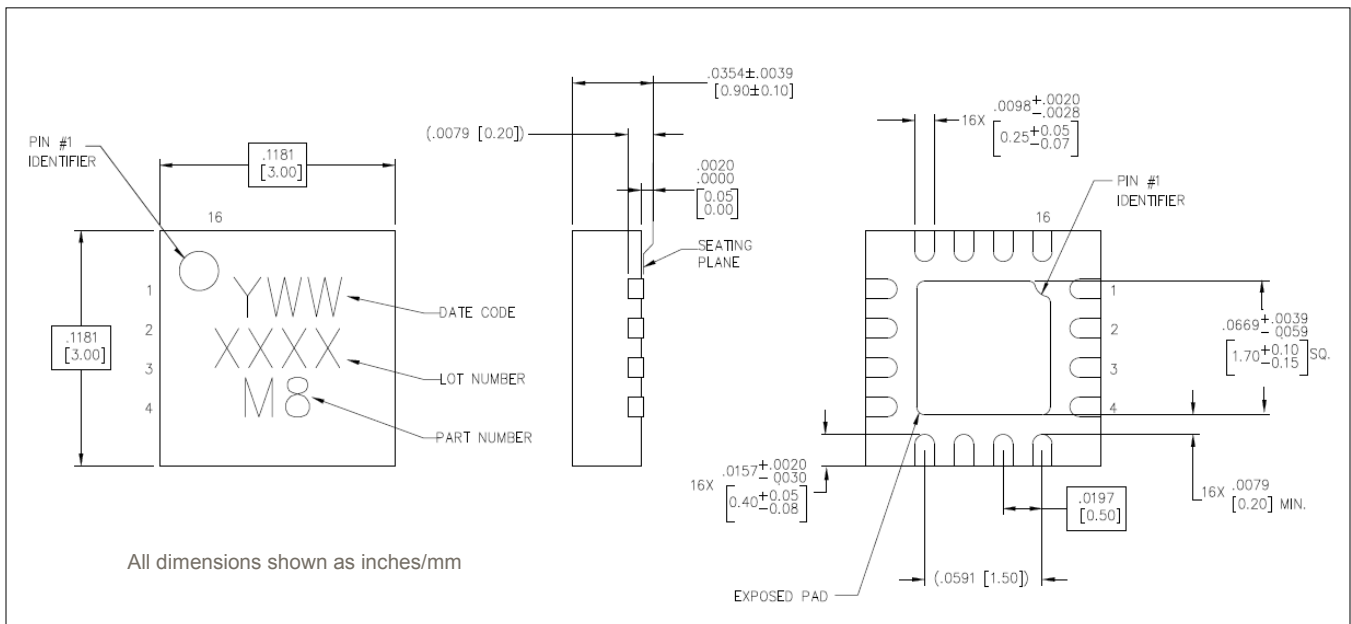
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### Recommended Landing Pattern<sup>9,10</sup>



9. All dimensions are in inches.  
10. Landing pattern indicates solder mask opening. Cu-filled via-holes under the ground are used for optimal thermal performance. Recommended pattern: 8-mil diameter, 8-mil spacing.

### Lead-Free 3 mm 16-Lead PQFN<sup>†</sup>



<sup>†</sup> Reference Application Note M538 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 1 requirements.  
Plating is 100% matte tin over copper.

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