

## Low Noise Amplifier 18 - 31.5 GHz

Rev. V1

### Features

- Noise Figure: 2.5 dB @ 24 GHz
- High Gain: 23 dB @ 24 GHz
- 50  $\Omega$  match on input and output
- Single Voltage Bias: 3 V to 5 V range
- Integrated Active Bias Circuit
- Current adjustable from 1 mA - 80 mA
- Lead-Free 2 mm 8-lead PDFN Package
- Halogen-Free “Green” Mold Compound
- RoHS\* Compliant

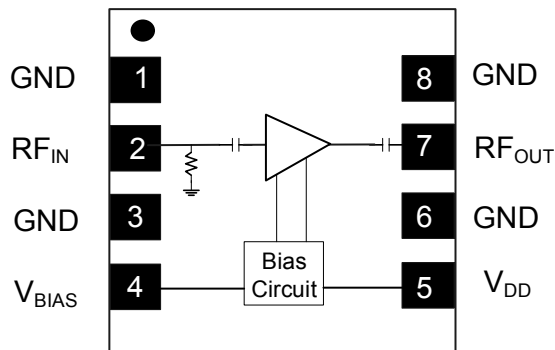
### Description

The MAAL-011129 is an easy-to-use three stage low noise amplifier with high gain and broadband 50  $\Omega$  match. It is designed for operation from 18 to 31.5 GHz and housed in a lead-free 2 mm 8-lead PDFN plastic package.

The MAAL-011129 has an integrated active bias circuit and bias tee to allow direct connection to  $V_{DD}$  without external chokes or DC blocks. The bias current is set by a simple external resistor,  $R_B$ , so the user can customize the power consumption. When  $V_{BIAS} = 0$  V, the device is placed in power down mode.

The MAAL-011129 offers a surface-mount, easy-to-use, low noise amplifier solution that is well suited to diverse receiver applications such as VSAT, Point-to-Point and 24 GHz ISM.

### Functional Schematic



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

| Pin No. | Pin Name          | Description          |
|---------|-------------------|----------------------|
| 1       | GND               | Ground               |
| 2       | RF <sub>IN</sub>  | RF Input             |
| 3       | GND               | Ground               |
| 4       | V <sub>BIAS</sub> | Bias Control Voltage |
| 5       | V <sub>DD</sub>   | Drain Voltage        |
| 6       | GND               | Ground               |
| 7       | RF <sub>OUT</sub> | RF Output            |
| 8       | GND               | Ground               |
|         | Paddle            | RF + DC Ground       |

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

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

| Part Number        | Package         |
|--------------------|-----------------|
| MAAL-011129-TR3000 | 3000 piece reel |
| MAAL-011129-SMB    | Sample Board    |

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.

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**Electrical Specifications: Freq. = 24 GHz, T<sub>A</sub> = 25°C, V<sub>DD</sub> = 5 V, R<sub>B</sub> = 1 kΩ, Z<sub>0</sub> = 50 Ω**

| Parameter          | Test Conditions   | Units | Min. | Typ. | Max. |
|--------------------|---|-------|------|------|------|
| Noise Figure       | —   | dB    | —    | 2.5  | 3.3  |
| Gain               | P <sub>IN</sub> = -20 dBm                               | dB    | 20   | 23   | —    |
| Input Return Loss  | P <sub>IN</sub> = -20 dBm                               | dB    | —    | -13  | —    |
| Output Return Loss | P <sub>IN</sub> = -20 dBm                               | dB    | —    | -13  | —    |
| Output IP3         | P <sub>IN</sub> = -22 dBm/tone<br>(10 MHz Tone Spacing) | dBm   | —    | 25   | —    |
| Output P1dB        | —   | dBm   | —    | 16   | —    |
| Isolation          | P <sub>IN</sub> = -20 dBm                               | dB    | —    | 45   | —    |
| Bias Current       | —   | mA    | —    | 50   | 65   |

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

| Parameter                           | Absolute Maximum |
|-------------------------------------|------------------|
| Input Power                         | 10 dBm           |
| Operating Voltage                   | 6 V              |
| Junction Temperature <sup>6,7</sup> | +150°C           |
| Operating Temperature               | -40°C to +85°C   |
| Storage Temperature                 | -65°C to +150°C  |

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at nominal conditions with T<sub>J</sub> ≤ +150°C will ensure MTTF > 1 x 10<sup>6</sup> hours.
7. Junction Temperature (T<sub>J</sub>) = T<sub>C</sub> + Θ<sub>JC</sub> \* (V \* I)  
Typical thermal resistance (Θ<sub>JC</sub>) = 102°C/W.
  - a) T<sub>C</sub> = +25°C,  
T<sub>J</sub> = 51°C @ 5 V, 50 mA
  - b) T<sub>C</sub> = +85°C,  
T<sub>J</sub> = 111°C @ 5 V, 50 mA

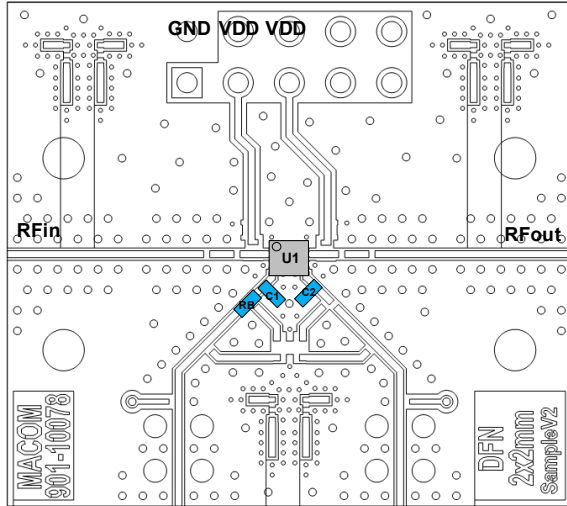
### Handling Procedures

Please observe the following precautions to avoid damage:

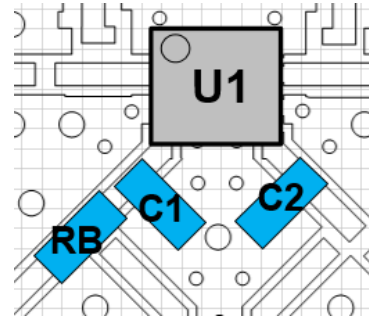
### Static Sensitivity

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 devices.

## Sample PCB



## Sample PCB Layout



## Application Information

The MAAL-011129 is designed to be easy to use yet provide high performance. The ultra small size, with no matching, and simple bias application allows easy placement on system boards.

## Parts List

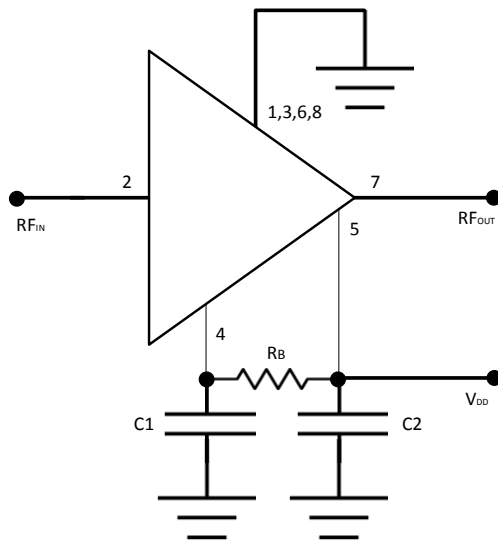
| Des      | Value        | Size | Part Number                  | Purpose          |
|----------|--------------|------|------------------------------|------------------|
| C1<br>C2 | 0.01 $\mu$ F | 0201 | Murata<br>GRM033R70J103KA01D | Bypass           |
| RB       | See<br>chart | 0201 | various                      | Bias<br>Resistor |
| U1       | —            | 2 mm | MACOM<br>MAAL-011129         | LNA              |

## Single Bias Operation

Connecting  $V_{DD}$  to  $V_{BIAS}$  using an external resistor  $R_B$  enables single bias operation of the amplifier, and the value of external resistor  $R_B$  sets the desired current  $I_{DD}$ . The following table shows drain current ( $I_{DD}$ ) versus external resistor ( $R_B$ ) values for  $V_{DD}$  voltages of 5 V and 3.3 V:

| $V_{DD} = 3.3 \text{ V}$ |                      | $V_{DD} = 5 \text{ V}$ |                      |
|--------------------------|----------------------|------------------------|----------------------|
| $R_B (\Omega)$           | $I_{DD} (\text{mA})$ | $R_B (\Omega)$         | $I_{DD} (\text{mA})$ |
| Open                     | 15                   | Open                   | 25                   |
| 200                      | 50                   | 200                    | 80                   |
| 400                      | 40                   | 400                    | 70                   |
| 1k                       | 30                   | 1k                     | 50                   |
| 2k                       | 25                   | 2k                     | 40                   |

## Application Schematic



With pin 4 ( $V_{BIAS}$ ) left open the amplifier will default to low power mode. When pin 4 ( $V_{BIAS}$ ) is set to 0 V through  $R_B$ , the device enters power down mode. In order to use power down mode a second supply is required that directly drives the  $R_B$  resistor.

## Grounding

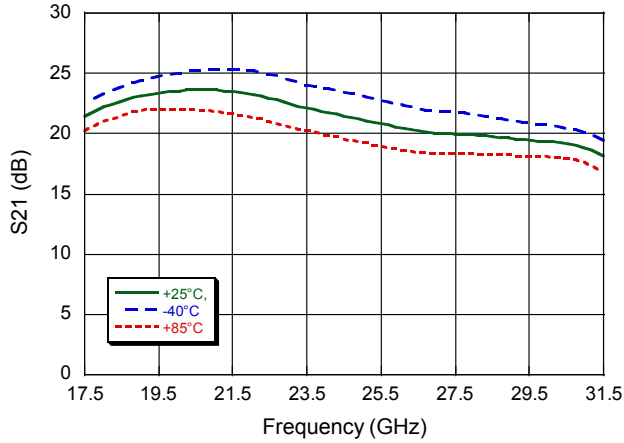
It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200- $\mu$ m) diameter vias under the device, assuming an 8-mil (200- $\mu$ m) thick RF layer to ground.

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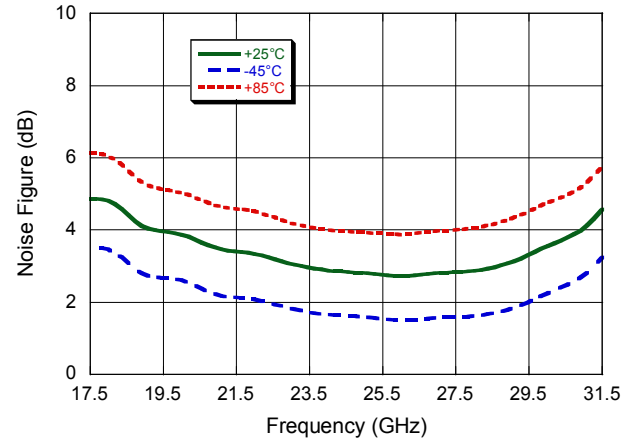
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### Typical Performance Curves $V_{DD} = 5\text{ V}$ , $R_B = 1\text{ k}\Omega$

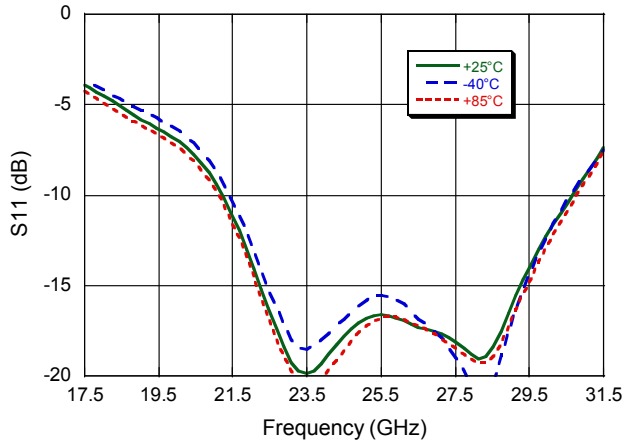
**Gain**



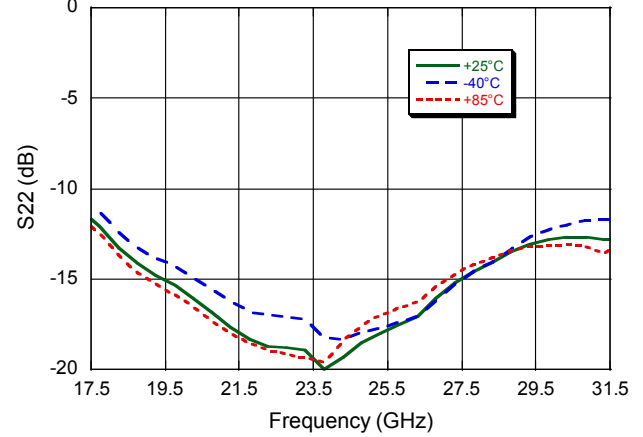
**Noise Figure**



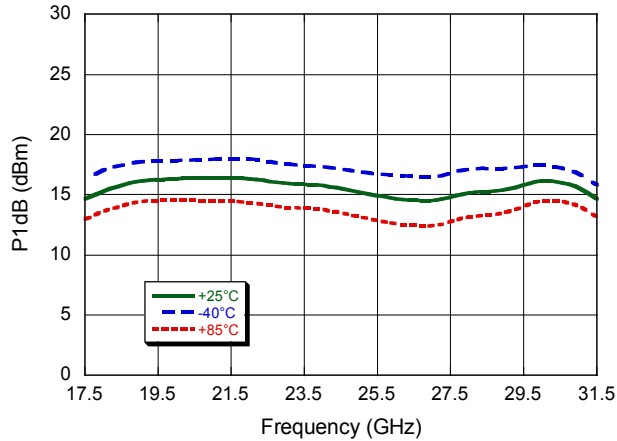
**Input Return Loss**



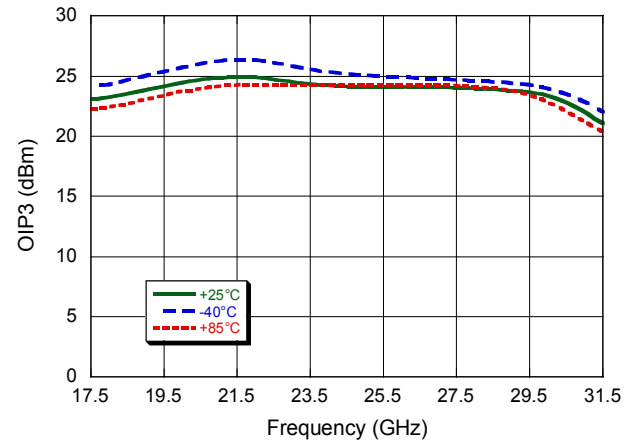
**Output Return Loss**



**P1dB**



**OIP3**

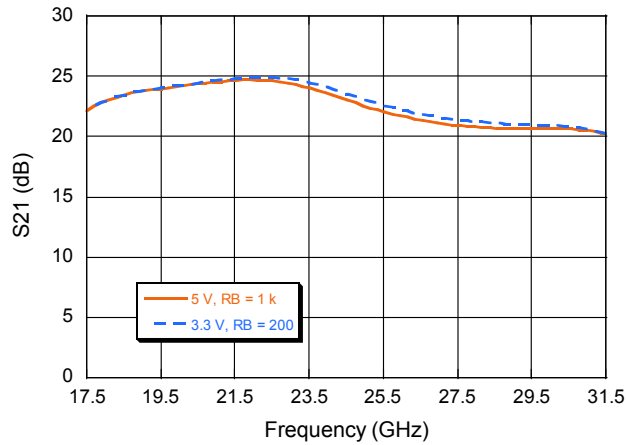


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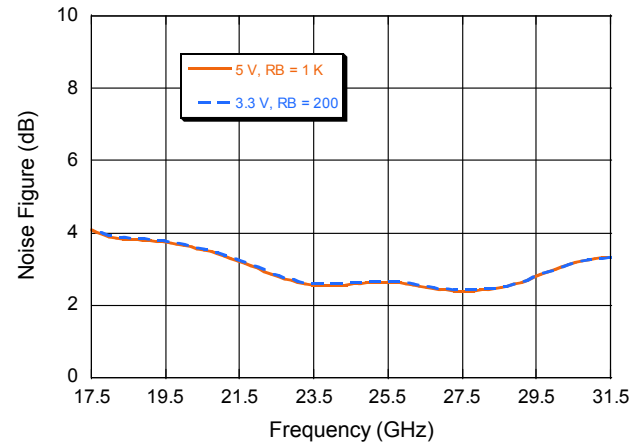
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### Typical Performance Curves $V_{DD} = 3.3\text{ V} \& 5\text{ V}$

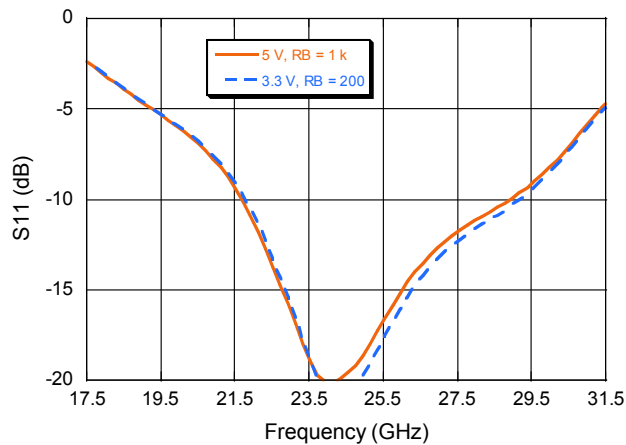
**Gain**



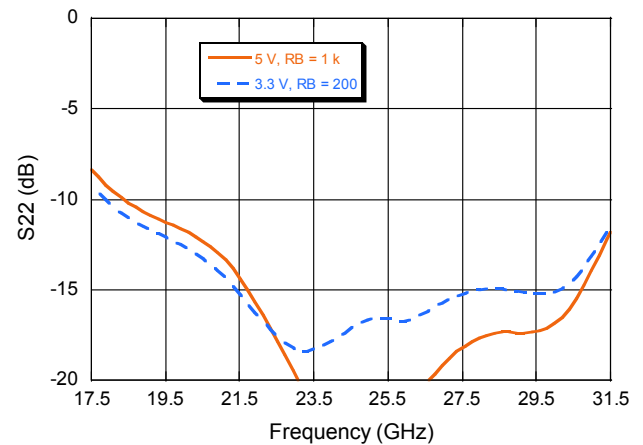
**Noise Figure**



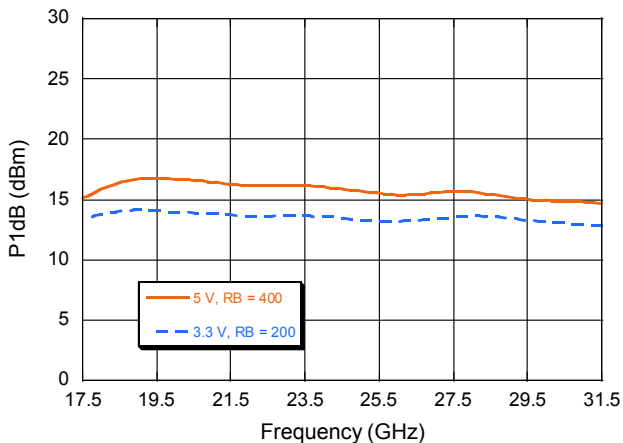
**Input Return Loss**



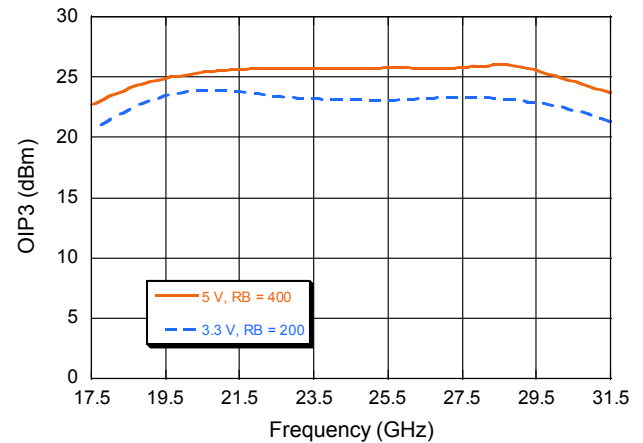
**Output Return Loss**



**P1dB**



**OIP3**

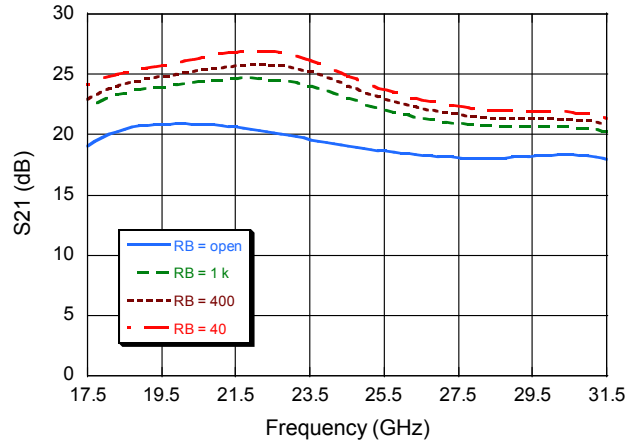


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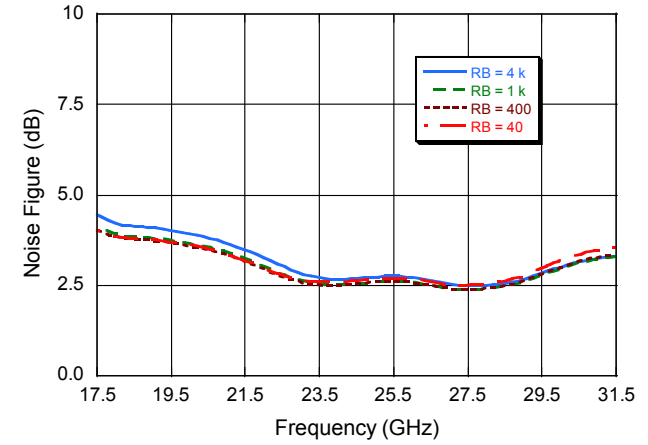
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### Typical Performance Curves VDD = 5 V, I<sub>DD</sub> varied by R<sub>B</sub>

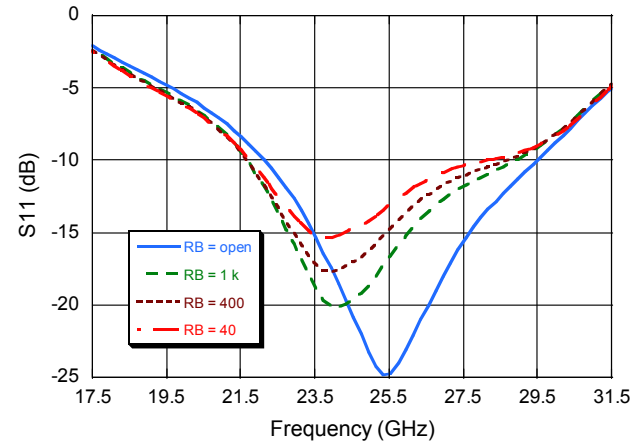
**Gain**



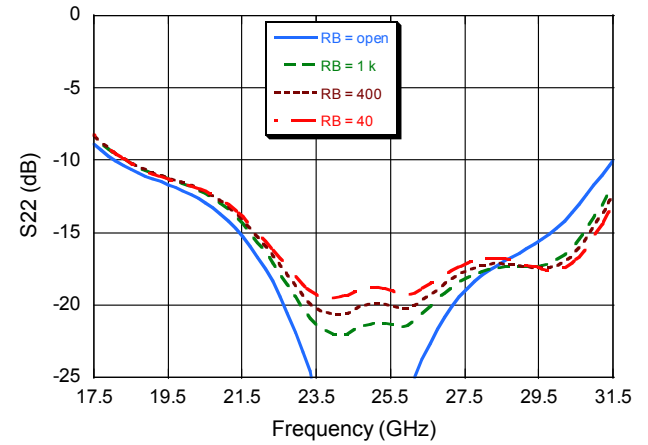
**Noise Figure**



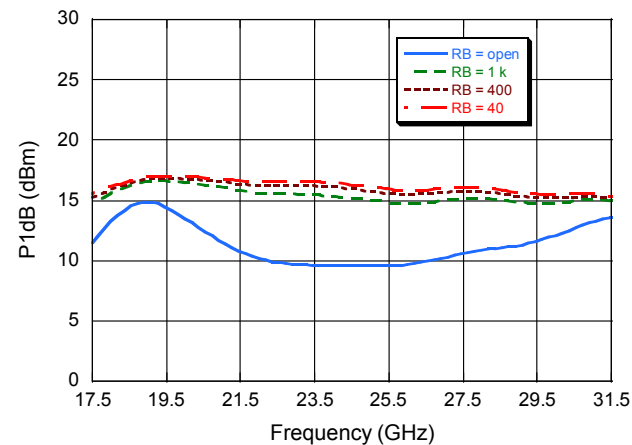
**Input Return Loss**



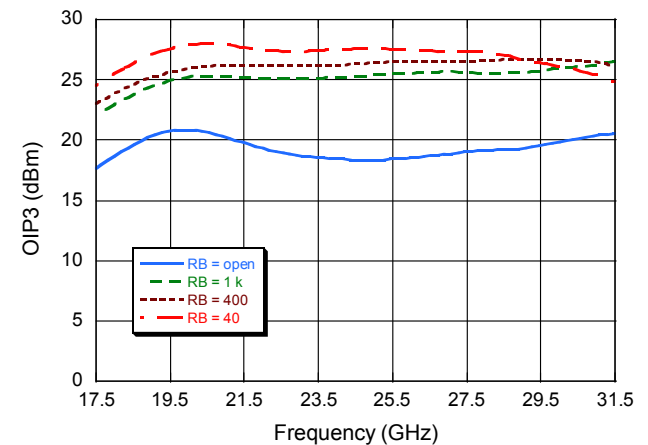
**Output Return Loss**



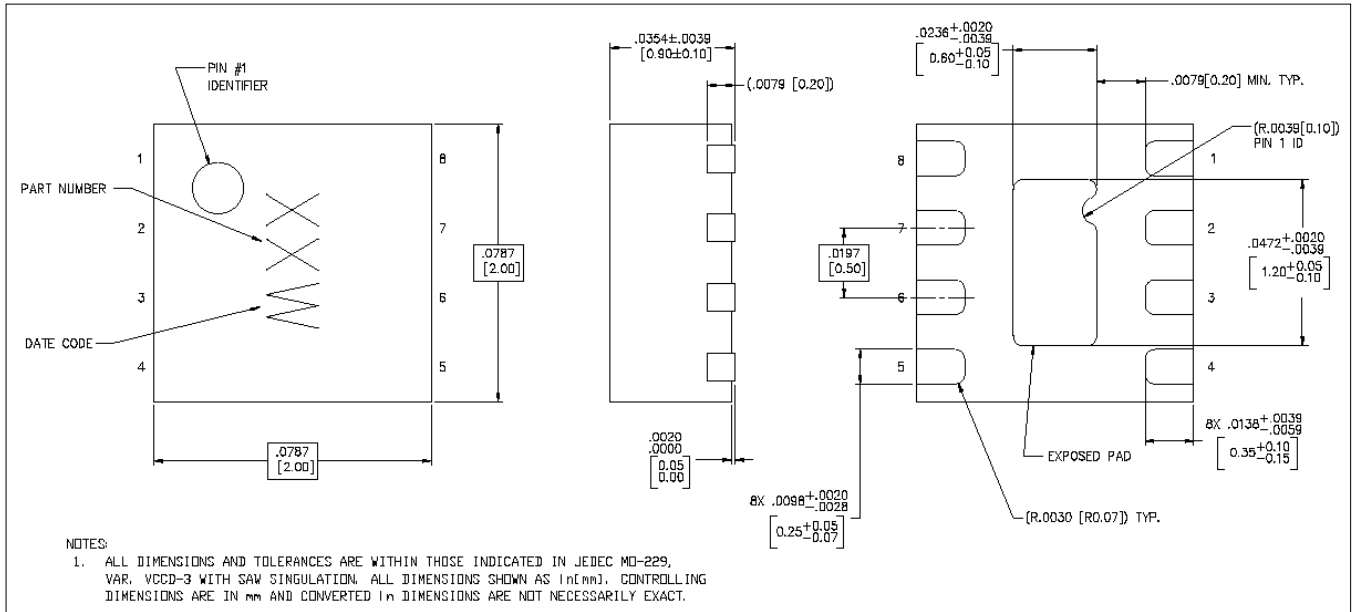
**P1dB**



**OIP3**



## Lead Free 2 mm 8 Lead PDFN Package<sup>†</sup>



<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 1 requirements.  
Plating is 100% Matte Tin over Copper

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