

# Broadband Low Noise Amplifier

## 0.05 - 4 GHz



MAAM-011229

Rev. V3

### Features

- 19 dB flat Broadband Gain to 3.25 GHz
- Low Noise Figure:
  - 1.3 dB @ 1.2 GHz
  - 1.8 dB @ 3.25 GHz
- High Linearity OIP3:
  - 36 dBm @ 1.2 GHz
  - 33 dBm @ 3.25 GHz
- Internal Matching to 50  $\Omega$
- Single Voltage Bias: 3 - 5 V
- Integrated Active Bias Circuit
- Current Adjustable 20 - 120 mA
- Lead-Free 2 mm 8-Lead PDFN Package
- RoHS\* Compliant

### Applications

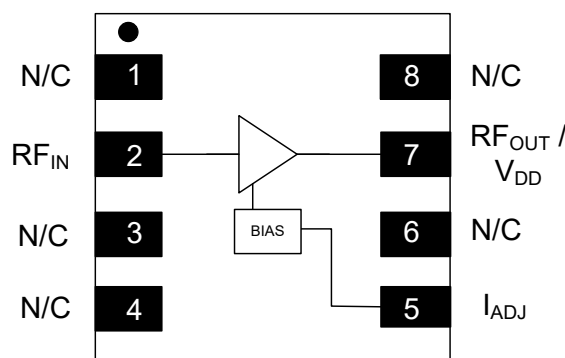
- CATV, Broadcast, ISM/MM

### Description

The MAAM-011229 is a broadband high dynamic range, single stage MMIC LNA assembled in a lead-free 2 mm 8 Lead PDFN plastic package. The amplifier is internally matched to provide flat gain and excellent return losses to 3.25 GHz without any external matching components. Use of external matching could extend usable frequency range beyond 4 GHz.

This low noise amplifier has an integrated active bias circuit allowing direct connection to 3 V or 5 V bias and minimizing variations over temperature and process. The bias current can be adjusted with an optional external resistor, so the user can customize the power consumption to fit the application.  $I_{ADJ}$  pin can be utilized as an enable pin to power the device up and down during operation.

### Functional Block Diagram



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

| Pin #         | Pin Name                            | Description               |
|---------------|-------------------------------------|---------------------------|
| 1, 3, 4, 6, 8 | N/C                                 | No Connection             |
| 2             | RF <sub>IN</sub>                    | RF Input                  |
| 5             | I <sub>ADJ</sub>                    | Bias Current Adjust       |
| 7             | RF <sub>OUT</sub> / V <sub>DD</sub> | RF Output / Drain Voltage |
| 9             | Pad <sup>4</sup>                    | Ground                    |

3. MACOM recommends connecting all No Connection (N/C) pins to ground.

4. 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         |
|--------------------|-----------------|
| MAAM-011229-TR1000 | 1000 piece reel |
| MAAM-011229-TR3000 | 3000 piece reel |
| MAAM-011229-SMB    | Sample Board    |

1. Reference Application Note M513 for reel size information.

2. All sample boards include 5 loose parts.

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

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DC-0011111

# Broadband Low Noise Amplifier

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Rev. V3

### Electrical Specifications: $V_{DD} = 5\text{ V}$ , $+25^{\circ}\text{C}$ , $Z_0 = 50\ \Omega$ , Typical Application Circuit

| Parameter          | Test Conditions                                                                       | Units | Min.    | Typ.              | Max.          |
|--------------------|---------------------------------------------------------------------------------------|-------|---------|-------------------|---------------|
| Gain               | 0.05 - 3.25 GHz<br>4 GHz                                                              | dB    | 17<br>— | 19<br>18          | —             |
| Noise Figure       | 0.05 - 1.2 GHz<br>1.2 - 3.25 GHz<br>4 GHz                                             | dB    | —       | 1.3<br>1.6<br>2.1 | —<br>2.2<br>— |
| Input Return Loss  | 0.05 - 3.25 GHz                                                                       | dB    | —       | 16                | —             |
| Output Return Loss | 0.05 - 3.25 GHz                                                                       | dB    | —       | 14                | —             |
| Output IP3         | $P_{IN} = -15\text{ dBm}$ per tone, 6 MHz spacing<br>0.05 - 1.2 GHz<br>1.2 - 3.25 GHz | dBm   | —       | 36<br>33          | —             |
| Output IP2         | $P_{IN} = -15\text{ dBm}$ per tone, 6 MHz spacing<br>0.05 - 1.2 GHz<br>1.2 - 3.25 GHz | dBm   | —       | 45<br>36          | —             |
| Output P1dB        | 0.05 - 1.2 GHz<br>1.2 - 3.25 GHz                                                      | dBm   | —       | 19.5<br>18.5      | —             |
| Current            | $I_{DD}$                                                                              | mA    | —       | 80                | 115           |

### Maximum Operating Conditions

| Parameter                          | Absolute Maximum                               |
|------------------------------------|------------------------------------------------|
| RF Input Power CW                  | 4 dBm                                          |
| $V_{DD}$                           | 7 V                                            |
| Operating Temperature <sup>5</sup> | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ |
| Junction Temperature <sup>6</sup>  | $+150^{\circ}\text{C}$                         |

5. Operating at nominal conditions with  $T_J \leq 150^{\circ}\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.
6. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$   
Typical thermal resistance ( $\Theta_{JC}$ ) =  $85^{\circ}\text{C/W}$
- a) For  $T_C = +25^{\circ}\text{C}$ ,  
 $T_J = 59^{\circ}\text{C}$  @ 5 V, 80 mA
- b) For  $T_C = +85^{\circ}\text{C}$ ,  
 $T_J = 119^{\circ}\text{C}$  @ 5 V, 80 mA

### Absolute Maximum Ratings<sup>7,8</sup>

| Parameter                         | Absolute Maximum                                |
|-----------------------------------|-------------------------------------------------|
| RF Input Power CW                 | 30 dBm                                          |
| $V_{DD}$                          | 8 V                                             |
| Storage Temperature               | $-55^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Junction Temperature <sup>6</sup> | $+175^{\circ}\text{C}$                          |

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation near these survivability limits.

### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

# Broadband Low Noise Amplifier

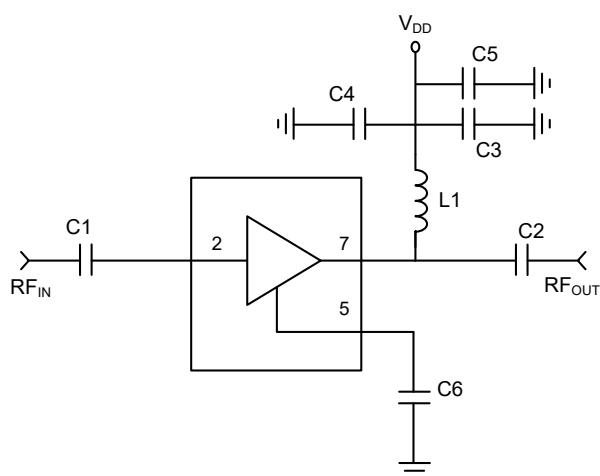
## 0.05 - 4 GHz



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### Typical Application Circuit



### Typical Parts List, $V_{DD} = 5\text{ V}$ & $3\text{ V}$

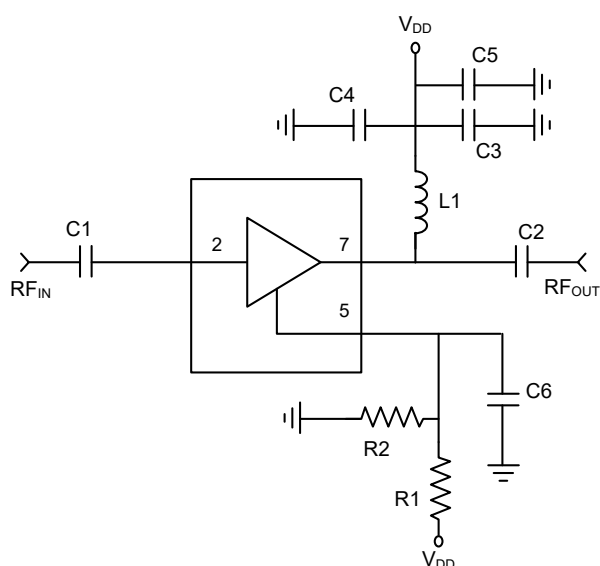
| Component   | Value                     | Package |
|-------------|---------------------------|---------|
| C1 - C3, C6 | 1000 pF                   | 0402    |
| C4          | 0.1 $\mu\text{F}$         | 0402    |
| C5          | 47 pF                     | 0402    |
| L1          | Ferrite Bead <sup>9</sup> | 0402    |

9. Murata, part number BLM15HD182SN.

### Current Adjust Options<sup>10</sup>

The  $I_{ADJ}$  (pin 5) of MAAM-011229 may be used to adjust the DC operating current by placing either R1 or R2 as shown the schematic below. Placing resistor R2 to ground will reduce the current from typical application level. When using R2 to reduce current do not place (DNP) R1. To increase current from typical application circuit install resistor R1 and connect to  $V_{DD}$ .

The table below shows values of R1 and R2 for a range of operating currents for  $V_{DD} = 5\text{ V}$  and  $3\text{ V}$ .



| I<br>(mA) | $V_{DD} = 5\text{ V}$                 |                | $V_{DD} = 3\text{ V}$                 |                |
|-----------|---------------------------------------|----------------|---------------------------------------|----------------|
|           | R1                                    | R2             | R1                                    | R2             |
| 20        | DNP                                   | 820 $\Omega$   | DNP                                   | 2.0 k $\Omega$ |
| 40        | DNP                                   | 1.2 k $\Omega$ | DNP                                   | 4.7 k $\Omega$ |
| 60        | DNP                                   | 2.7 k $\Omega$ | Typical application without R1 and R2 |                |
| 80        | Typical application without R1 and R2 |                | 5.0 k $\Omega$                        | DNP            |
| 100       | 12 k $\Omega$                         | DNP            | 2.4 k $\Omega$                        | DNP            |
| 120       | 5 k $\Omega$                          | DNP            | not recommended                       |                |

10. Some lot to lot variation in current may be observed, requiring a small adjustment in resistor value for a target current. Operation below 20 mA can result in lower gain.

# Broadband Low Noise Amplifier

## 0.05 - 4 GHz

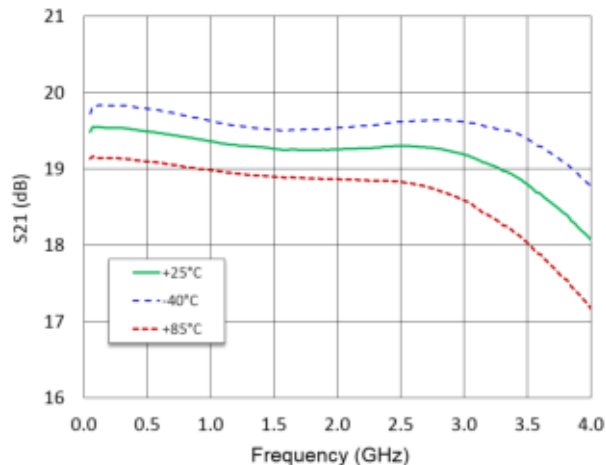


MAAM-011229

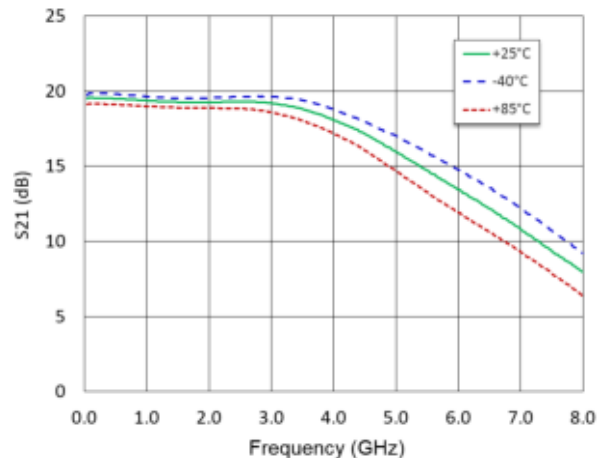
Rev. V3

### Typical Performance Curves @ 5 V / 80 mA, $Z_0 = 50 \Omega$

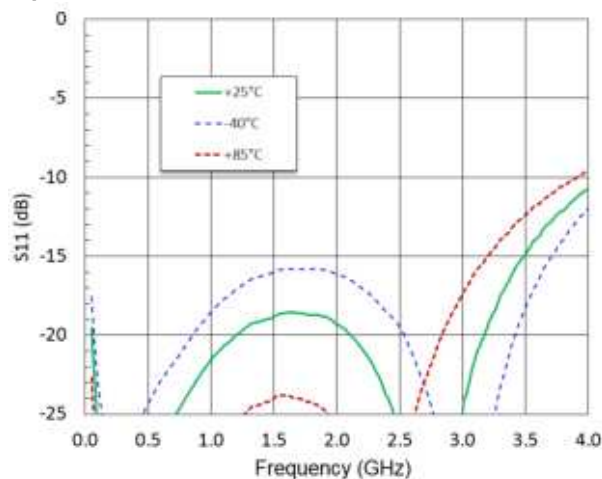
**Gain to 4 GHz**



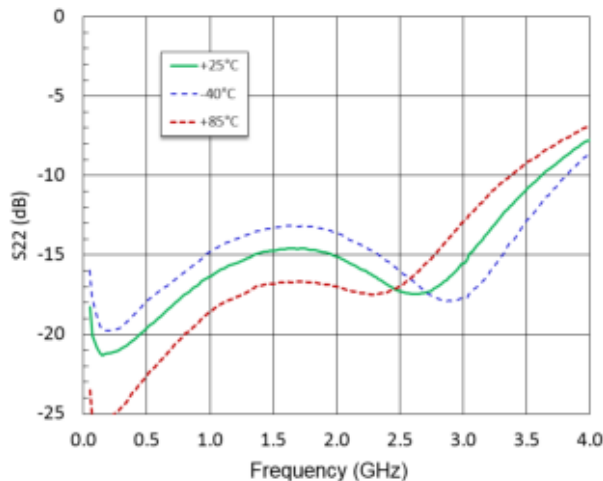
**Gain to 8 GHz**



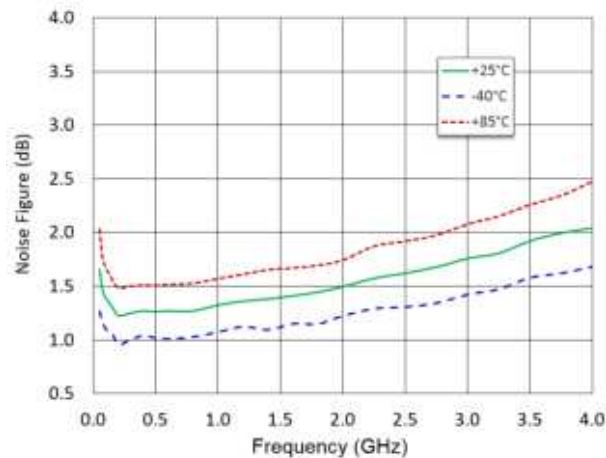
**Input Return Loss**



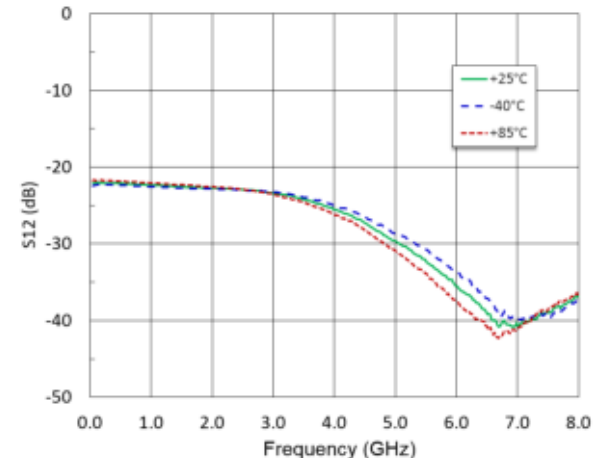
**Output Return Loss**



**Noise Figure**



**Reverse Isolation**



# Broadband Low Noise Amplifier

## 0.05 - 4 GHz

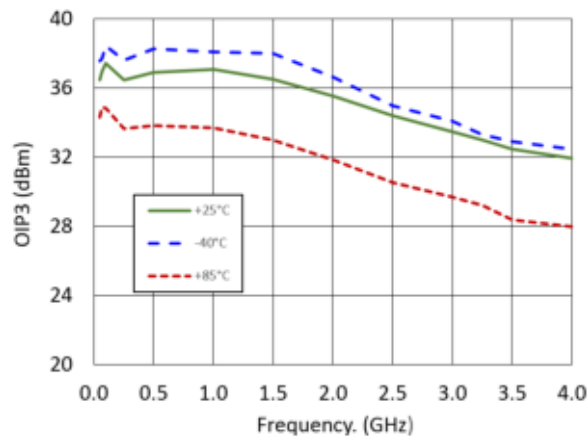


MAAM-011229

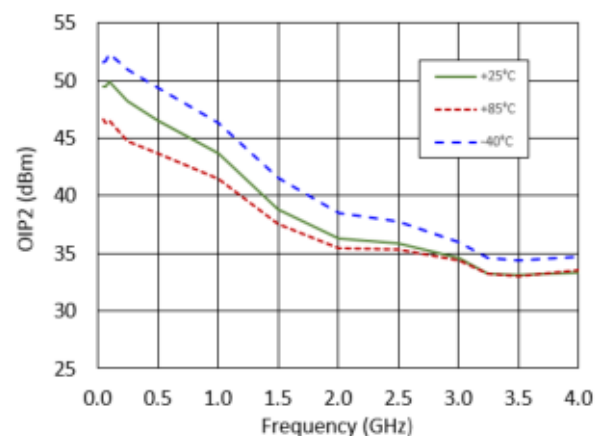
Rev. V3

### Typical Performance Curves @ 5 V / 80 mA , $Z_0 = 50 \Omega$

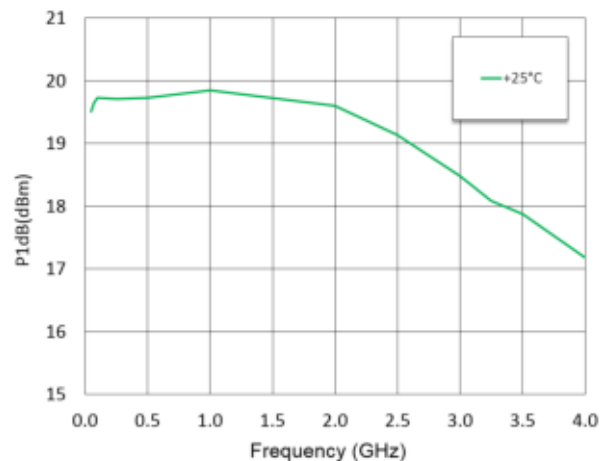
**OIP3**



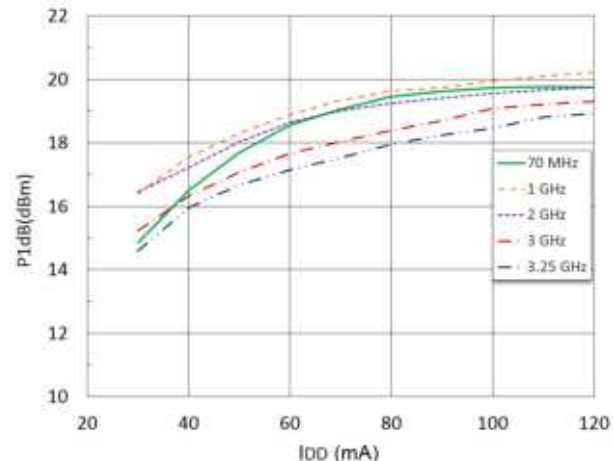
**OIP2**



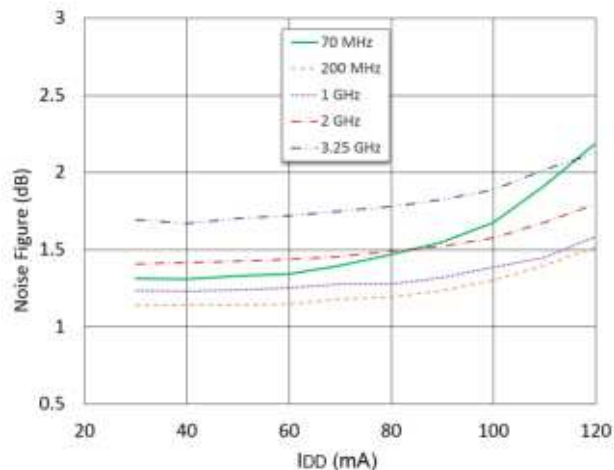
**P1dB**



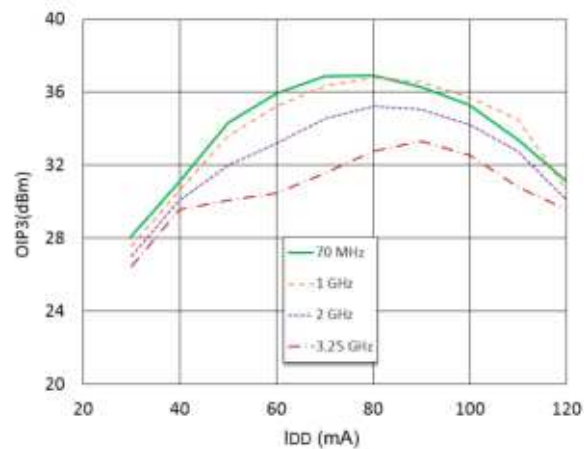
**P1dB vs. Current, +25°C**



**Noise Figure vs. Current, +25°C**



**OIP3 vs. Current, +25°C**



# Broadband Low Noise Amplifier

## 0.05 - 4 GHz



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**Electrical Specifications:  $V_{DD} = 3\text{ V}$ ,  $+25^{\circ}\text{C}$ ,  $Z_0 = 50\ \Omega$ , Typical Application Circuit**

| Parameter          | Test Conditions                                                                       | Units | Min. | Typ.              | Max. |
|--------------------|---------------------------------------------------------------------------------------|-------|------|-------------------|------|
| Gain               | 0.05 - 3.25 GHz<br>4 GHz                                                              | dB    | —    | 19<br>18          | —    |
| Noise Figure       | 0.05 - 1.2 GHz<br>1.2 - 3.25 GHz<br>4 GHz                                             | dB    | —    | 1.3<br>1.6<br>2.1 | —    |
| Input Return Loss  | 0.05 - 3.25 GHz                                                                       | dB    | —    | 16                | —    |
| Output Return Loss | 0.05 - 3.25 GHz                                                                       | dB    | —    | 14                | —    |
| Output IP3         | $P_{IN} = -15\text{ dBm}$ per tone, 6 MHz spacing<br>0.05 - 1.2 GHz<br>1.2 - 3.25 GHz | dBm   | —    | 33<br>40          | —    |
| Output IP2         | $P_{IN} = -15\text{ dBm}$ per tone, 6 MHz spacing<br>0.05 - 1.2 GHz<br>1.2 - 3.25 GHz | dBm   | —    | 43<br>37          | —    |
| Output P1dB        | 0.05 - 1.2 GHz<br>1.2 - 3.25 GHz                                                      | dBm   | —    | 17.0<br>15.5      | —    |
| Current            | $I_{DD}$                                                                              | mA    | —    | 60                | —    |

# Broadband Low Noise Amplifier

## 0.05 - 4 GHz

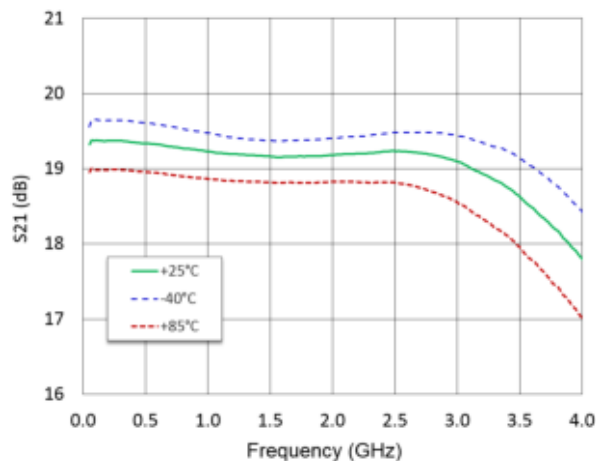


MAAM-011229

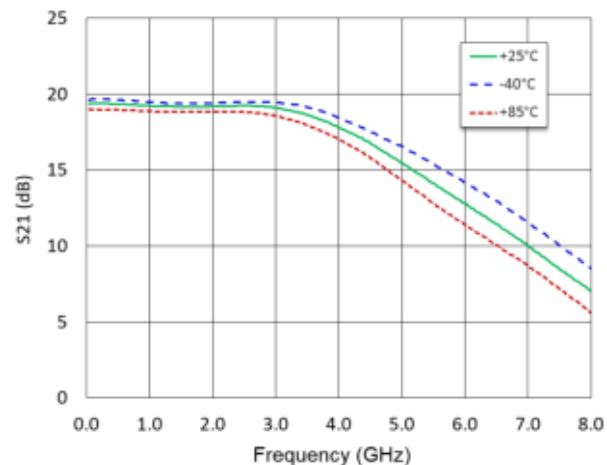
Rev. V3

### Typical Performance Curves @ 3 V / 60 mA, $Z_0 = 50 \Omega$

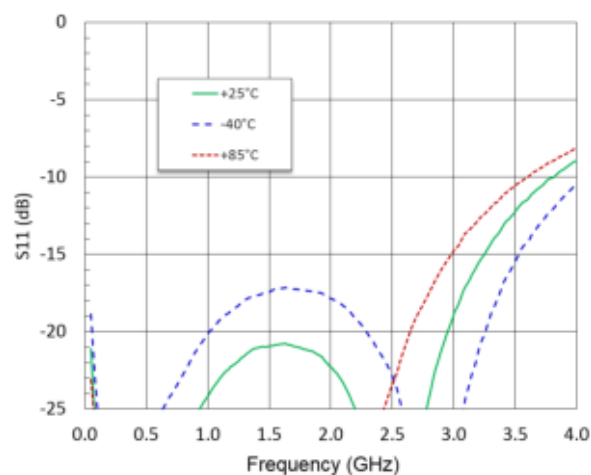
Gain to 4 GHz



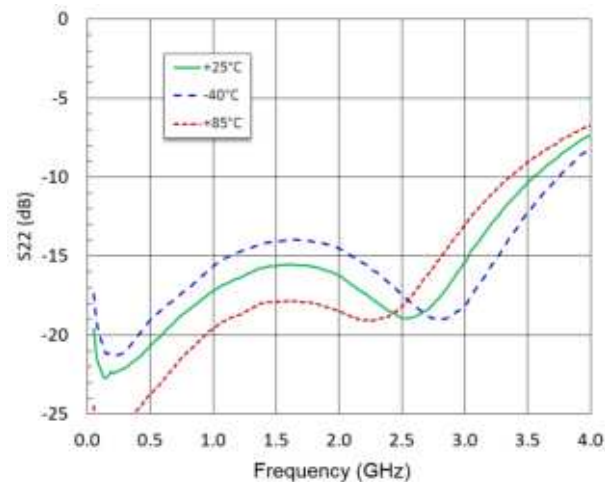
Gain to 8 GHz



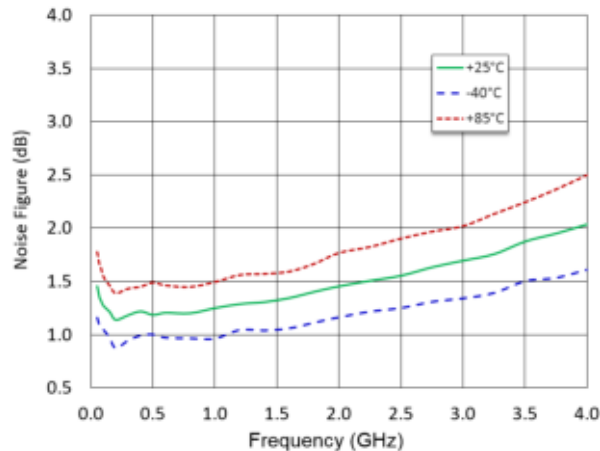
Input Return Loss



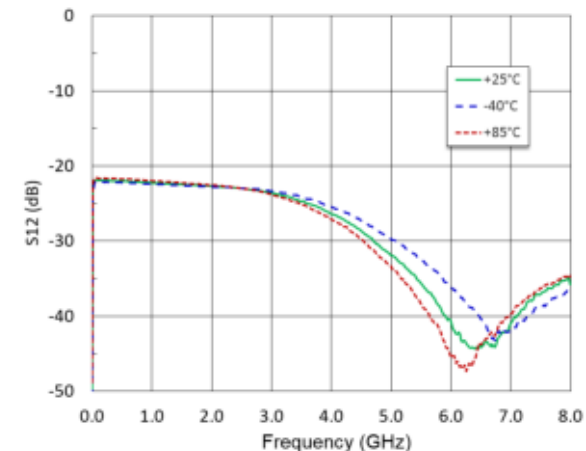
Output Return Loss



Noise Figure



Reverse Isolation



# Broadband Low Noise Amplifier

## 0.05 - 4 GHz

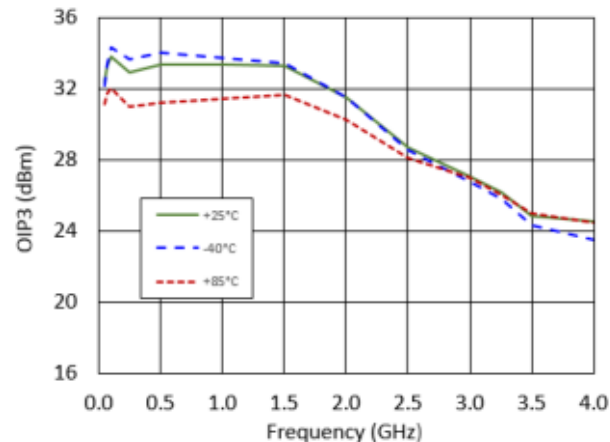


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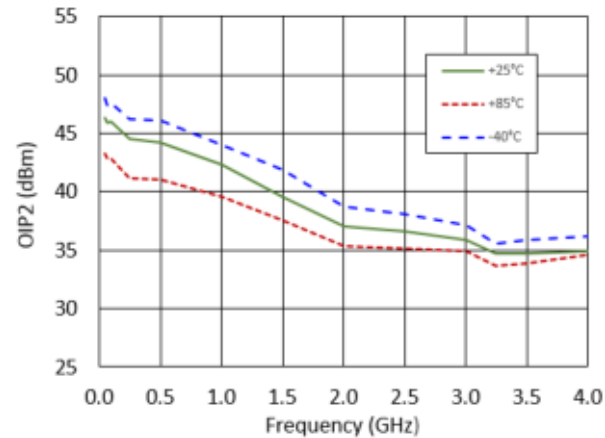
Rev. V3

### Typical Performance Curves @ 3 V / 60 mA, $Z_0 = 50 \Omega$

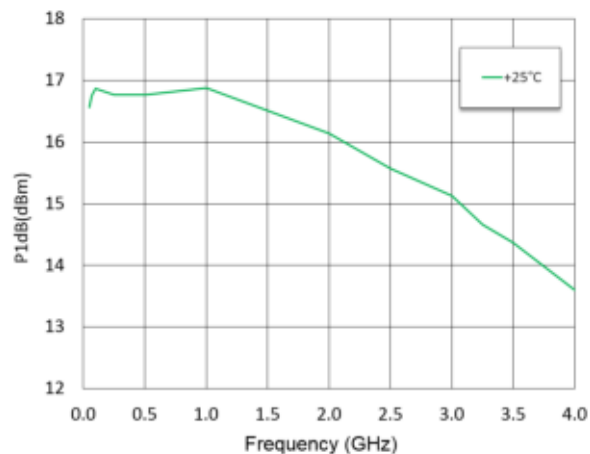
**OIP3**



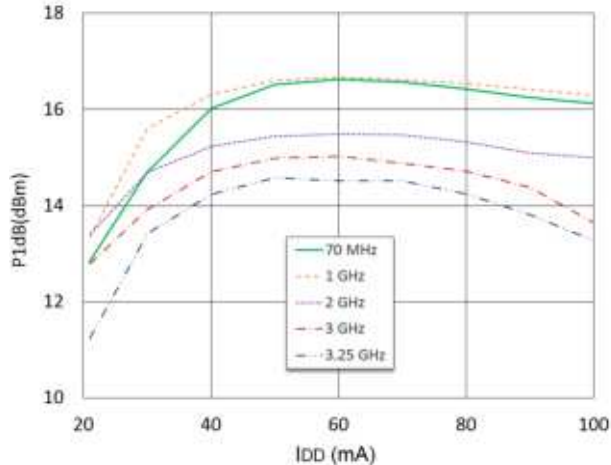
**OIP2**



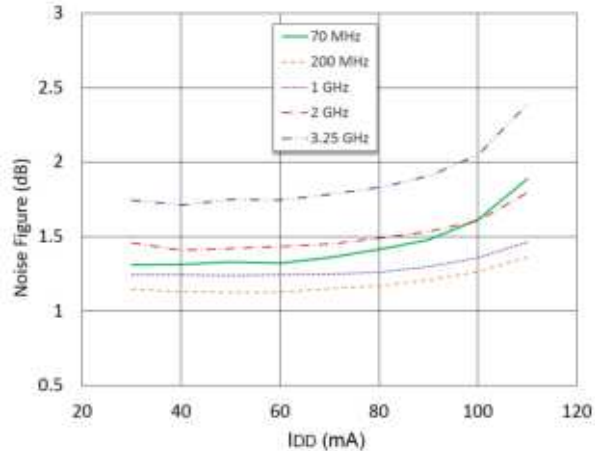
**P1dB vs. Frequency**



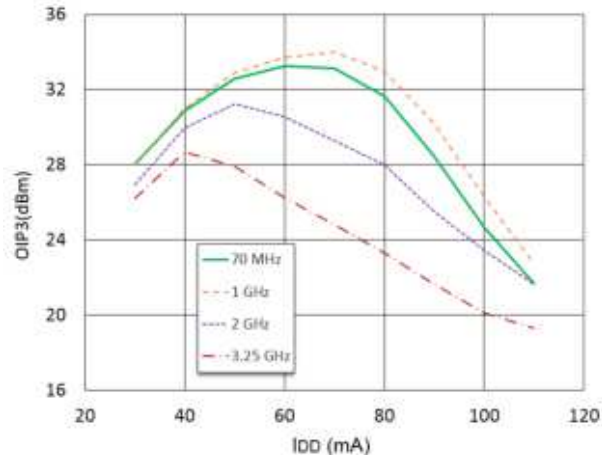
**P1dB vs. Current, +25°C**



**Noise Figure vs. Current, +25°C**



**OIP3 vs Current, +25°C**



# Broadband Low Noise Amplifier

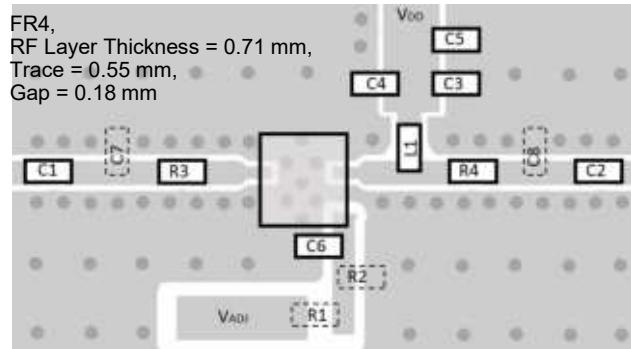
## 0.05 - 4 GHz



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### Recommended PCB Layout



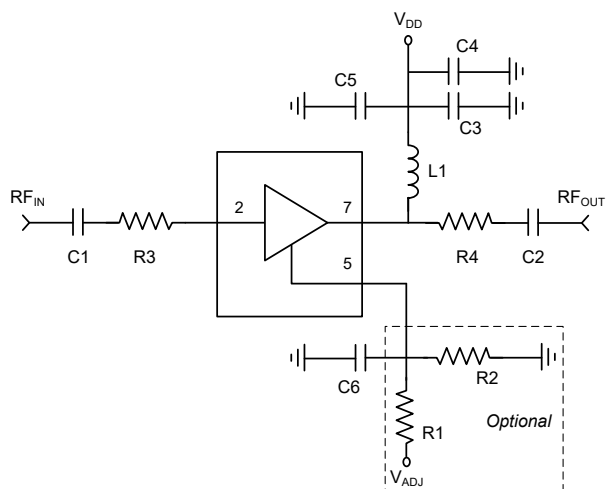
The recommended PCB layout includes place holders for additional components that are not necessary for typical applications but may be useful for extending performance to higher frequencies or optimizing a particular performance parameter at different bias conditions.

### Sample Board Parts List

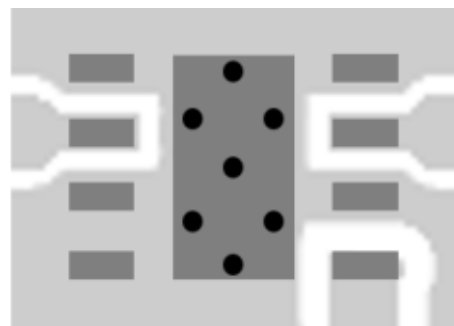
| Component   | Value                      | Package |
|-------------|----------------------------|---------|
| C1 - C3, C6 | 1000 pF                    | 0402    |
| C4          | 0.1 $\mu$ F                | 0402    |
| C5          | 47 pF                      | 0402    |
| C7, C8      | DNP                        | 0402    |
| R3, R4      | 0 $\Omega$                 | 0402    |
| R1, R2      | DNP                        | 0402    |
| R3, R4      | 0 $\Omega$                 | 0402    |
| L1          | Ferrite Bead <sup>10</sup> | 0402    |

10. Murata, part number BLM15HD182SN.

### Sample Board Schematic

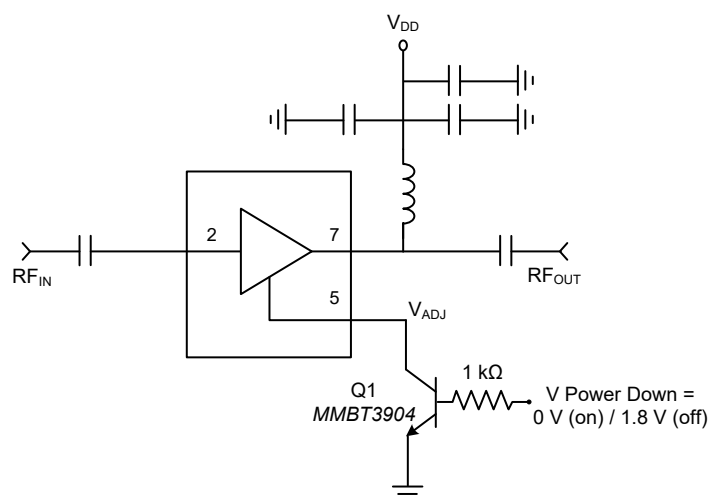


### PCB Land Pattern

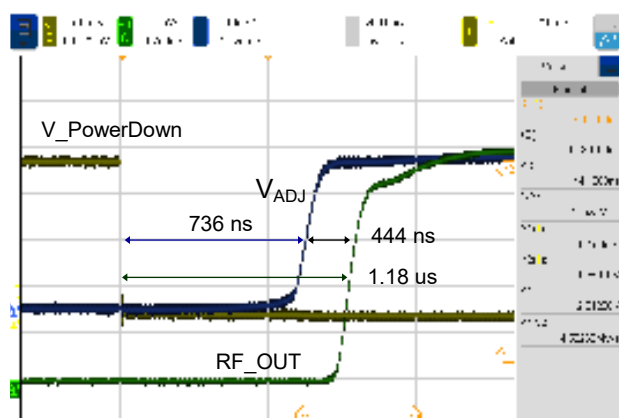


## Applications Section: Power Down Option

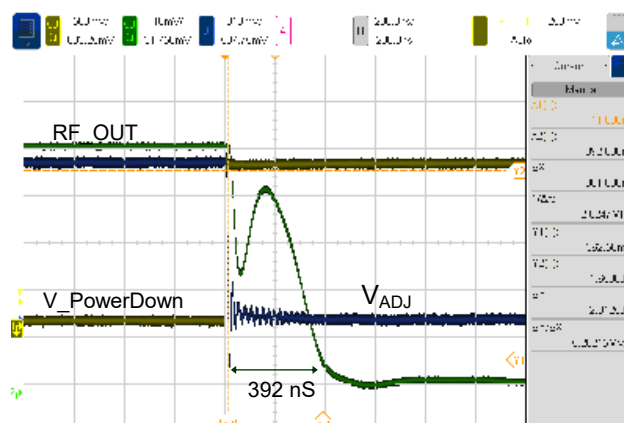
The  $I_{ADJ}$  (pin 5) of MAAM-011229 may be used to power down and turn on the amplifier. The critical characteristics of the power down circuit are that it presents a low impedance to DC ground in the off mode and that it presents a high impedance (much greater than 5 k $\Omega$ ) in the on mode. The single very low cost MMBT3904 NPN switching transistor (available from many suppliers) may be added externally along with a 1 k $\Omega$  resistor to provide this function. As shown in plots below, the time from when voltage on the  $I_{ADJ}$  pin ( $V_{ADJ}$ ) goes HIGH to the time RF reaches 90% of final amplitude is 444 ns. The total turn-on time, however, from change of power down signal is 1.18  $\mu$ s (736 ns of this time is consumed in time for MMBT3904 to transition). Alternate choice for switching transistor could reduce total turn-on time. Total turn off time is 392 ns.



**Turn ON Time**



**Turn OFF Time**





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The drawing consists of three views: a top view (left), a side view (middle), and an end view (right).

- Top View (Left):** Shows a rectangular package with pins 1 through 5. Pin 1 is marked with a circle containing a cross and labeled "PIN #1 IDENTIFIER". The package has a "PART NUMBER" area and a "DATE CODE" area. Dimensions include a width of  $0.787 \pm 0.002$  and a height of  $2.00 \pm 0.00$ .
- Side View (Middle):** Shows the profile of the package. Dimensions include a total width of  $0.354 \pm 0.0039$  and a pin pitch of  $0.90 \pm 0.10$ . The pin diameter is  $0.0079 \pm 0.0020$ .
- End View (Right):** Shows the package from the side, highlighting the "SEATING PLANE" and "EXPOSED PAD". Dimensions include a pin diameter of  $0.0197 \pm 0.0039$  and a pin pitch of  $0.50 \pm 0.00$ . The exposed pad dimensions are  $0.0236 \pm 0.0020$  and  $0.60 \pm 0.05$ .

**NOTES:**

- REFERENCE JEDEC MO-229, VAR. VCCD-3 FOR ADDITIONAL DIMENSIONAL AND TOLERANCE INFORMATION.
- REFERENCE S2083 APPLICATION NOTE FOR PCB FOOTPRINT INFORMATION.
- ALL DIMENSIONS SHOWN AS INCHES/MM

† Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 1 requirements.  
Plating is 100% matte tin.

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