

Broadband Low Noise Amplifier 0.05 - 4 GHz

Rev. V2

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 Ω
- Single Voltage Bias: 3 - 5 V
- Integrated Active Bias Circuit
- Current Adjustable 20 - 120 mA
- Lead-Free 2 mm 8-Lead PDFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant
- Power Down Option

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.

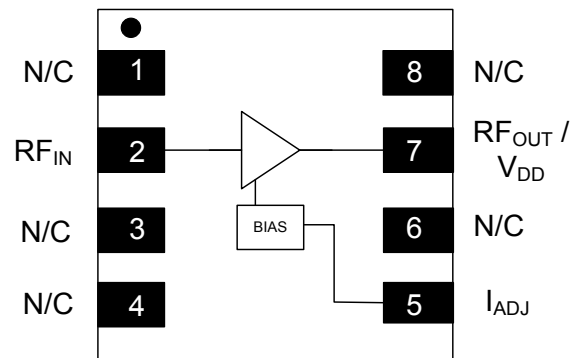
Ordering Information^{1,2}

| 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, European Union Directive 2011/65/EU.

Functional Block Diagram



Pin Configuration³

| Pin No. | Pin Name | Description |
|---------|-------------------------------------|---------------------------|
| 1 | N/C | No Connection |
| 2 | RF _{IN} | RF Input |
| 3 | N/C | No Connection |
| 4 | N/C | No Connection |
| 5 | I_{ADJ} | Bias Current Adjust |
| 6 | N/C | No Connection |
| 7 | RF _{OUT} / V _{DD} | RF Output / Drain Voltage |
| 8 | N/C | No Connection |
| 9 | Pad ⁴ | 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.

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 4 GHz | dB | 17 — | 19 18 | — — |
| Noise Figure | 0.05 - 1.2 GHz 1.2 - 3.25 GHz 4 GHz | dB | — | 1.3 1.6 2.1 | — 2.2 — |
| 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 0.05 - 1.2 GHz 1.2 - 3.25 GHz | dBm | — | 36 33 | — |
| Output IP2 | $P_{IN} = -15\text{ dBm}$ per tone, 6 MHz spacing 0.05 - 1.2 GHz 1.2 - 3.25 GHz | dBm | — | 45 36 | — |
| Output P1dB | 0.05 - 1.2 GHz 1.2 - 3.25 GHz | dBm | — | 19.5 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 ⁵ | -40°C to +85°C |
| Junction Temperature ⁶ | +150°C |

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

Absolute Maximum Ratings^{7,8}

| Parameter | Absolute Maximum |
|-----------------------------------|------------------|
| RF Input Power CW | 30 dBm |
| V_{DD} | 8 V |
| Storage Temperature | -55°C to +150°C |
| Junction Temperature ⁶ | +175°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.

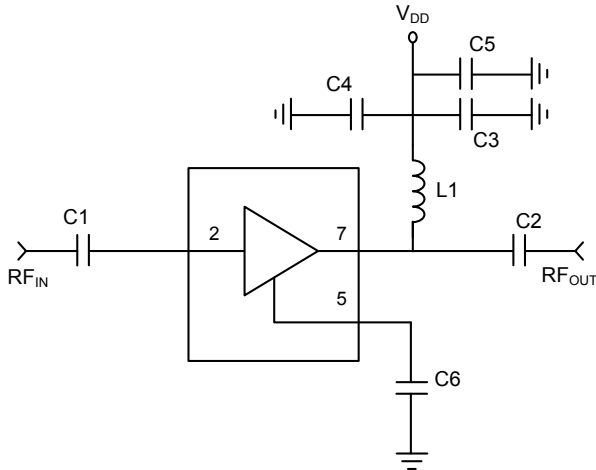
Handling Procedures

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.

Typical Application Circuit



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

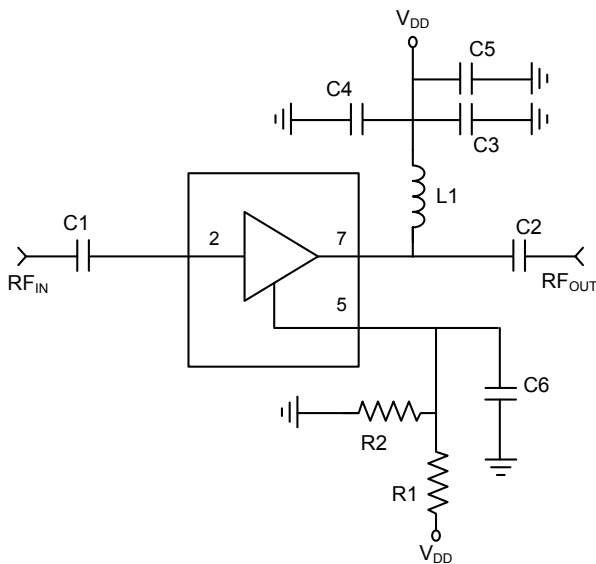
| Component | Value | Package |
|-------------|---------------------------|---------|
| C1 - C3, C6 | 1000 pF | 0402 |
| C4 | 0.1 μF | 0402 |
| C5 | 47 pF | 0402 |
| L1 | Ferrite Bead ⁹ | 0402 |

9. Murata, part number BLM15HD182SN.

Current Adjust Options

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 V .



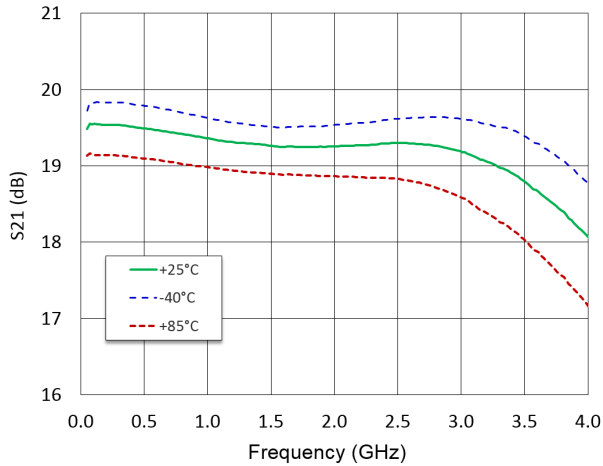
| I (mA) | $V_{DD} = 5\text{ V}$ | | $V_{DD} = 3\text{ V}$ | |
|-----------|--|----------------|--|----------------|
| | R1 | R2 | R1 | R2 |
| 20 | DNP | 820 Ω | DNP | 2.0 k Ω |
| 40 | DNP | 1.2 k Ω | DNP | 4.7 k Ω |
| 60 | DNP | 2.7 k Ω | <i>Typical application without R1 and R2</i> | |
| 80 | <i>Typical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

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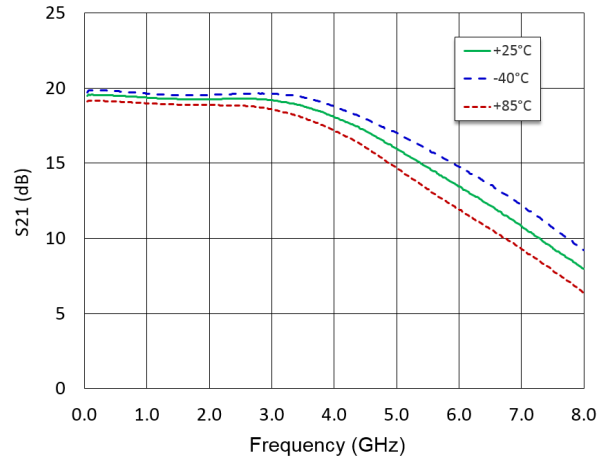
Rev. V2

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

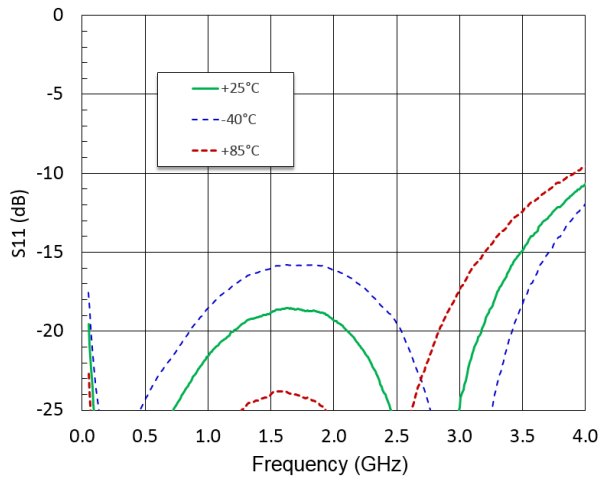
Gain to 4 GHz



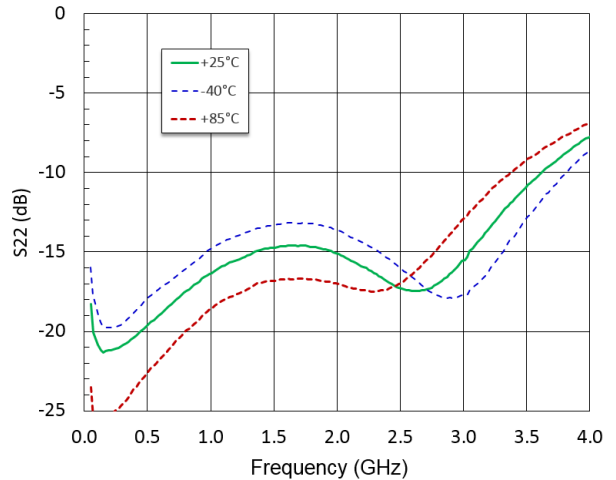
Gain to 8 GHz



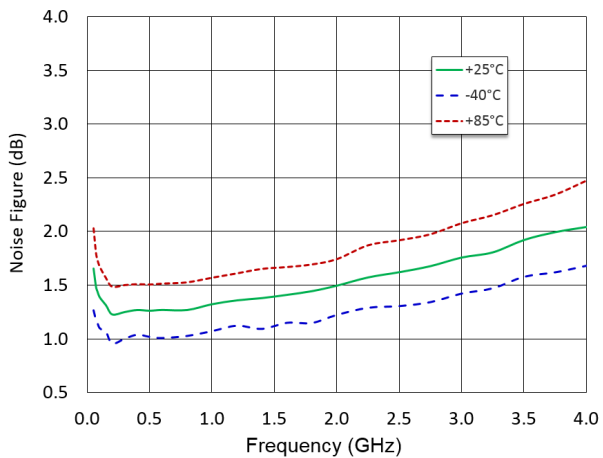
Input Return Loss



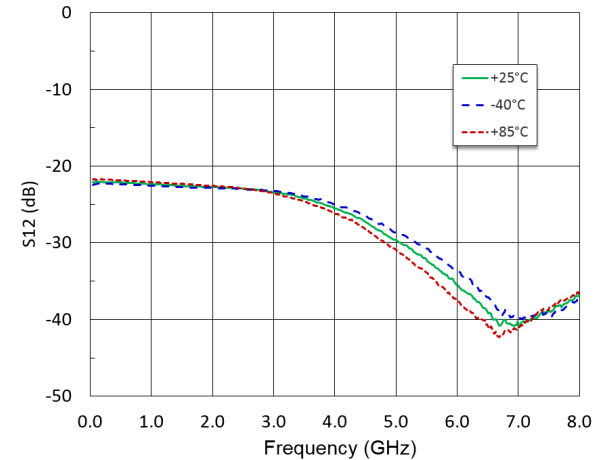
Output Return Loss



Noise Figure



Reverse Isolation

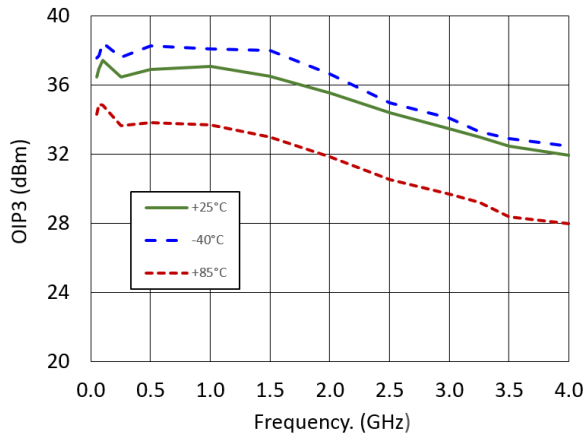


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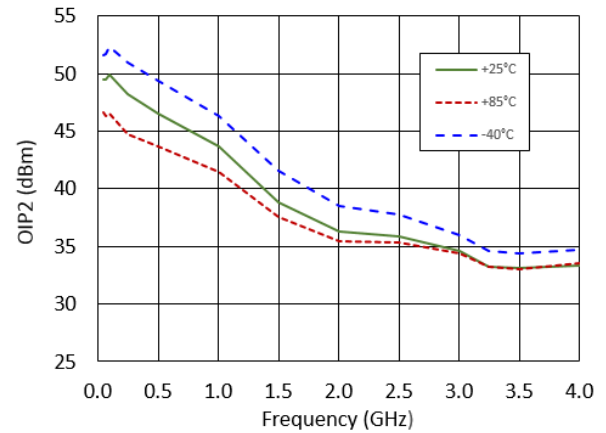
Rev. V2

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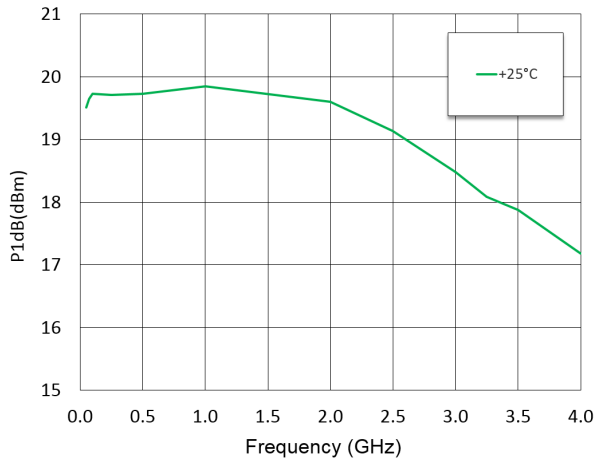
OIP3



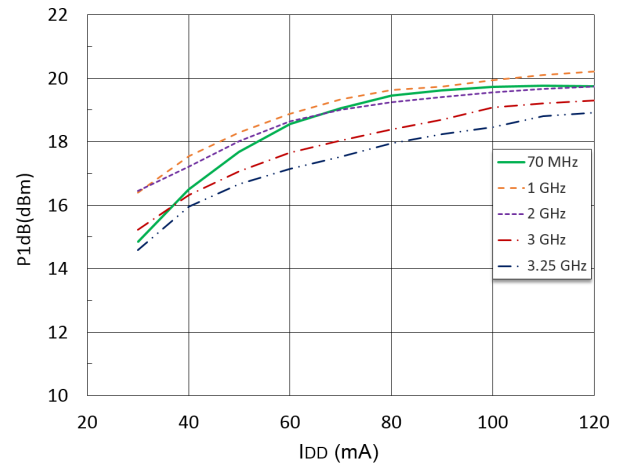
OIP2



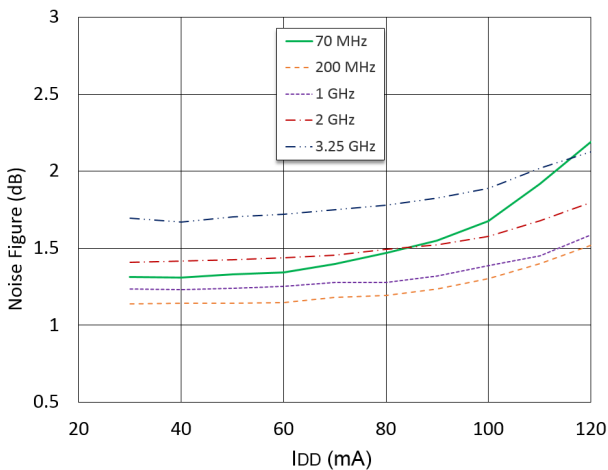
P1dB



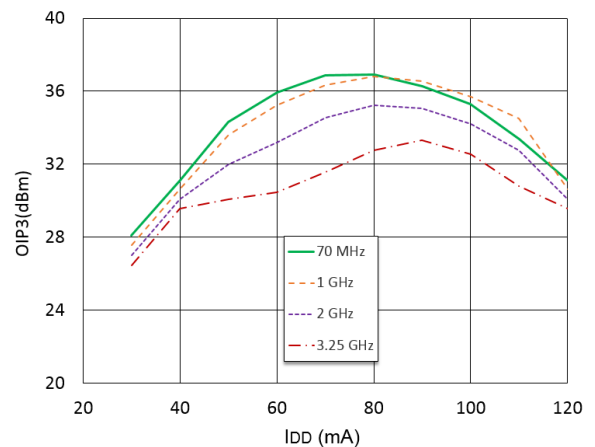
P1dB vs. Current, +25°C



Noise Figure vs. Current, +25°C



OIP3 vs. Current, +25°C



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

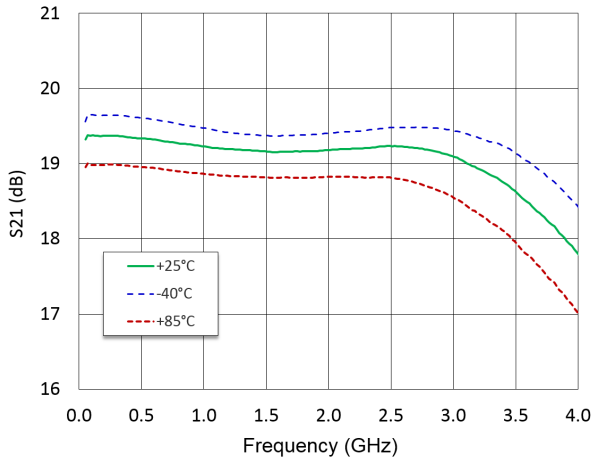
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| Output P1dB | 0.05 - 1.2 GHz 1.2 - 3.25 GHz | dBm | — | 17.0 15.5 | — |
| Current | I_{DD} | mA | — | 60 | — |

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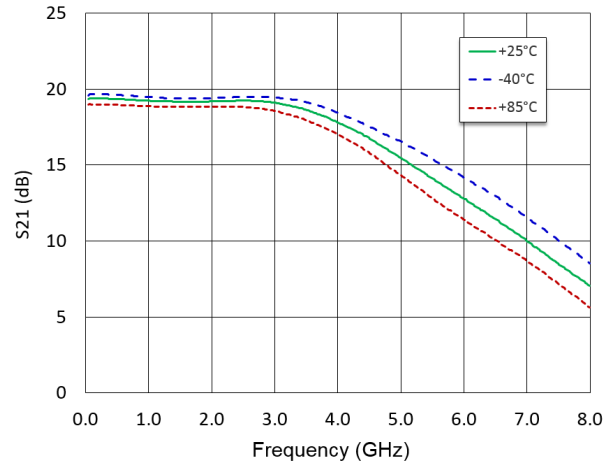
Rev. V2

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

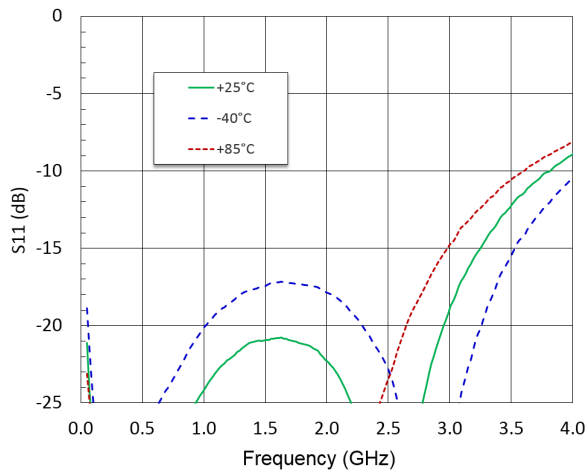
Gain to 4 GHz



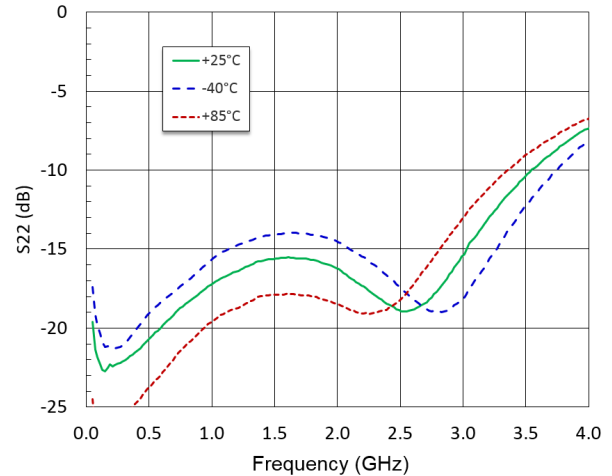
Gain to 8 GHz



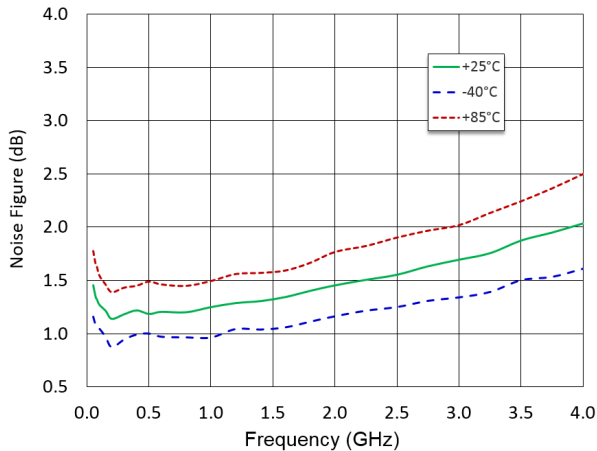
Input Return Loss



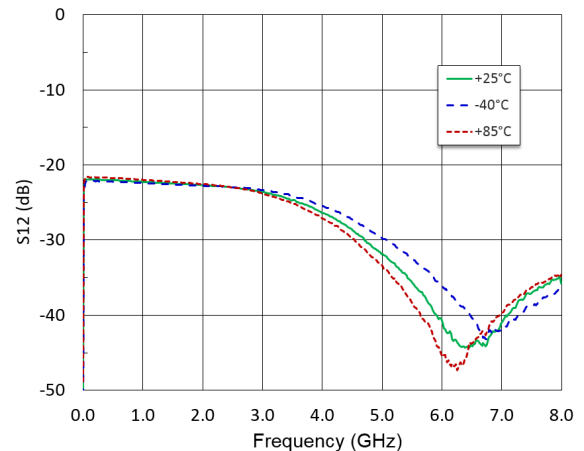
Output Return Loss



Noise Figure



Reverse Isolation

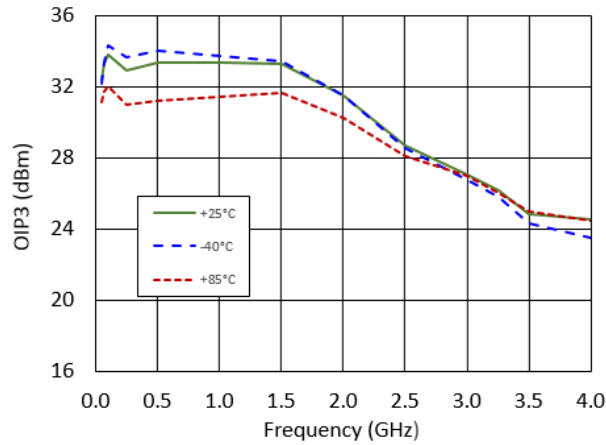


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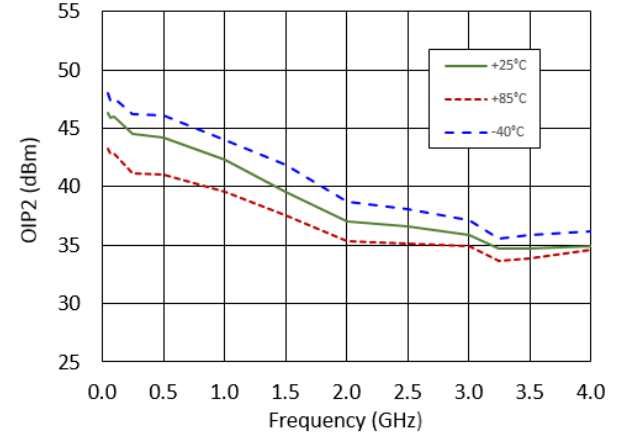
Rev. V2

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

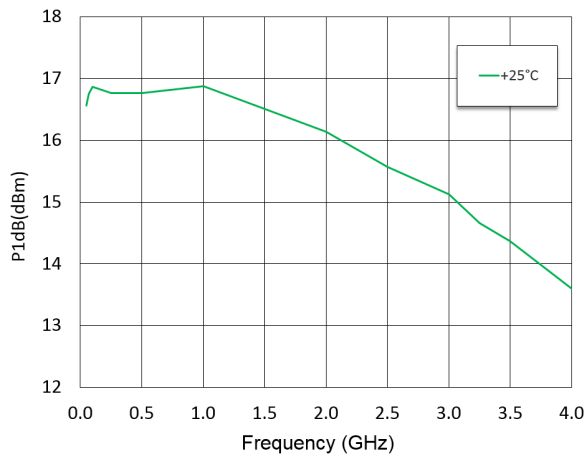
OIP3



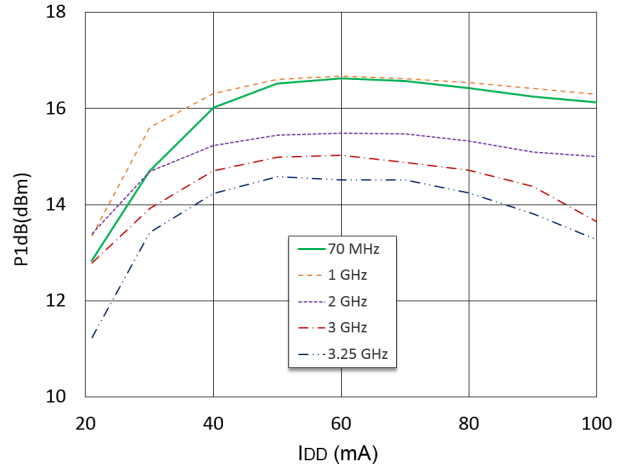
OIP2



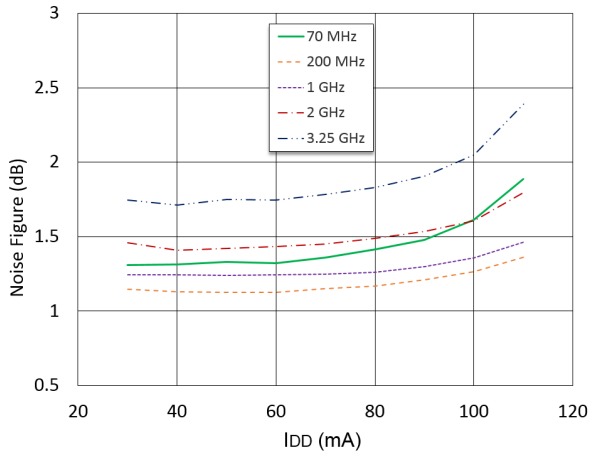
P1dB vs. Frequency



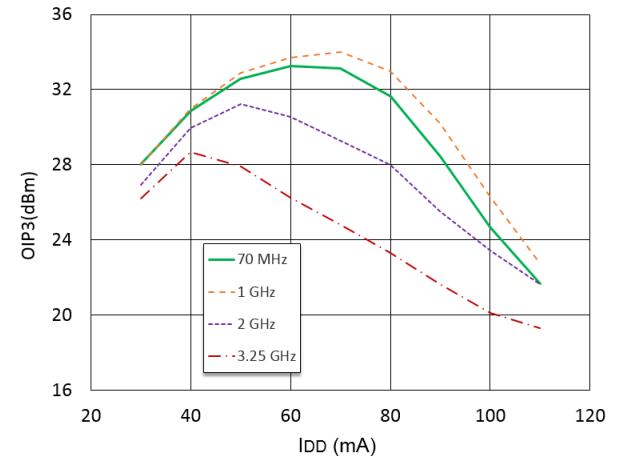
P1dB vs. Current, +25°C



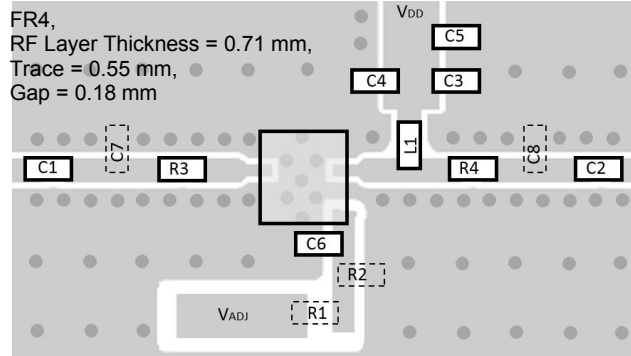
Noise Figure vs. Current, +25°C



OIP3 vs Current, +25°C



Recommended PCB Layout



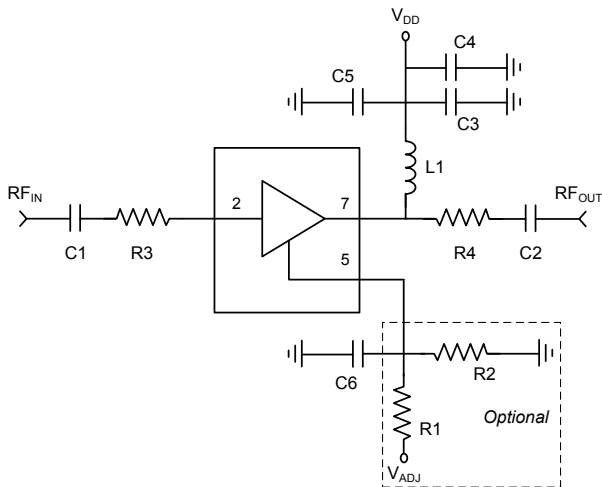
The recommended PCB layout includes place holders for additional components that are not necessary for typical applications but may be useful for extending performance to higher frequencies or optimizing a particular performance parameter at different bias conditions.

Sample Board Parts List

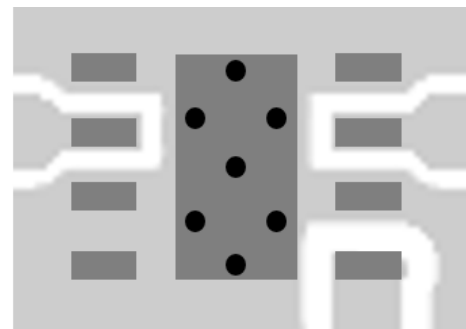
| Component | Value | Package |
|-------------|----------------------------|---------|
| C1 - C3, C6 | 1000 pF | 0402 |
| C4 | 0.1 μ F | 0402 |
| C5 | 47 pF | 0402 |
| C7, C8 | DNP | 0402 |
| R3, R4 | 0 Ω | 0402 |
| R1, R2 | DNP | 0402 |
| R3, R4 | 0 Ω | 0402 |
| L1 | Ferrite Bead ¹⁰ | 0402 |

10. Murata, part number BLM15HD182SN.

Sample Board Schematic

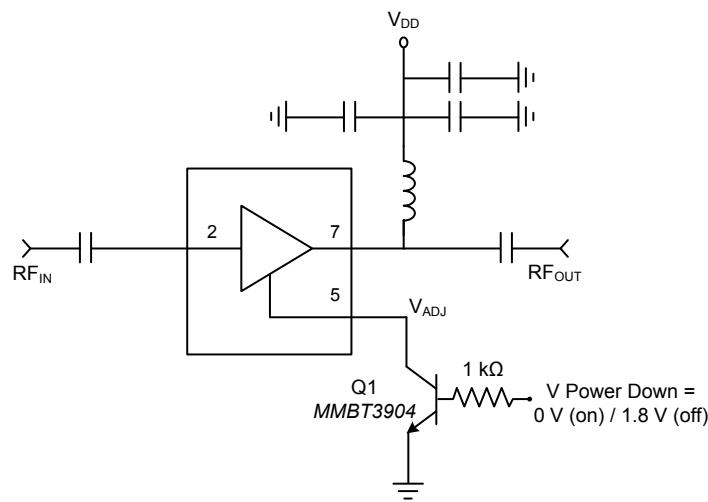


PCB Land Pattern

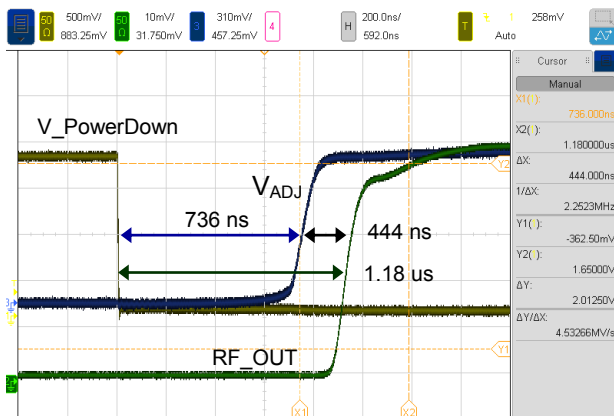


Applications Section: Power Down Option

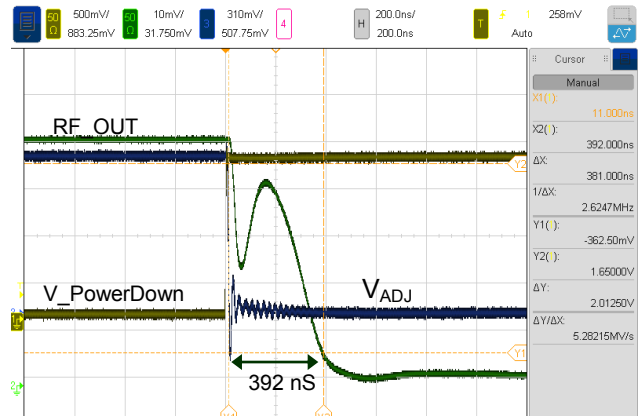
The I_{ADJ} (pin 5) of MAAM-011229 may be used to power down and turn on the amplifier. The critical characteristics of the power down circuit are that it presents a low impedance to DC ground in the off mode and that it presents a high impedance (much greater than 5 k Ω) in the on mode. The single very low cost MMBT3904 NPN switching transistor (available from many suppliers) may be added externally along with a 1 k Ω 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 μ 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.



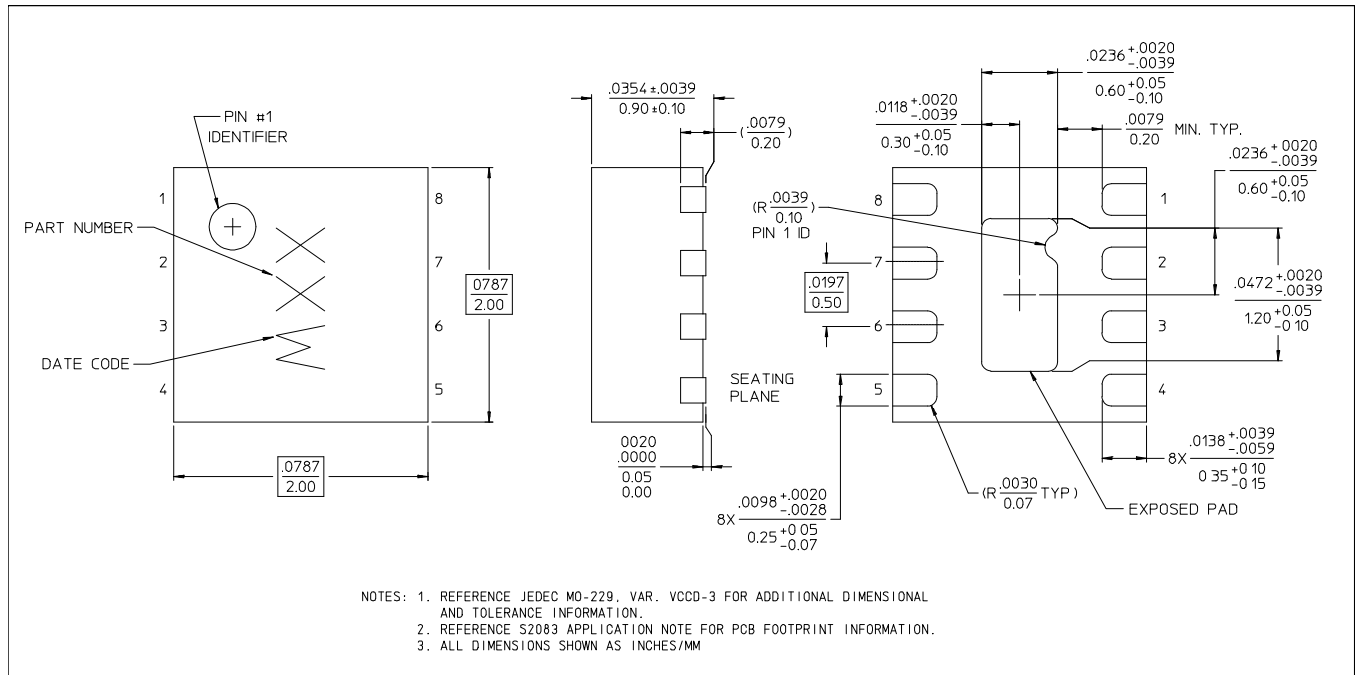
Turn ON Time



Turn OFF Time



Lead-Free 2 mm 8-Lead PDFN[†]



[†] 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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