

MAAL-011229

Rev. V1

Features

- Wideband Performance
- Low Noise Figure: 3.2 dB
- Gain: 24 dB
- P_{SAT}: 22 dBm
- OIP3: 27 dBm
- Bias Voltage: V_{DD} = 3 V
- Bias Current: I_{DSQ} = 150 mA
- 50 Ω Matched Input and Output
- Lead-Free 5 mm 12-lead SMT Package
- RoHS* Compliant

Applications

- Test and Measurement
- EW
- ECM
- Radar

Description

The MAAL-011229 is an easy to use wideband low noise amplifier. It operates from 17 to 55 GHz and provides 3.2 dB noise figure, 24 dB gain and 22 dBm saturated output power. The input and output are fully matched to 50 Ω with typical return loss >12 dB.

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

The MAAL-011229 can be used as a low noise amplifier stage or as a driver stage in higher power

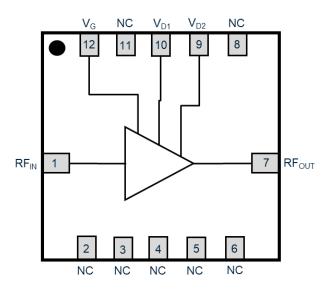
Ordering Information^{1,2}

| Part Number | Package |
|--------------------|----------------|
| MAAL-011229-TR0500 | 500 piece reel |
| MAAL-011229-SMB | Sample Board |

1. Reference Application Note M513 for reel size information.

2. All sample boards include 5 loose parts.

Functional Schematic



Pin Configuration³

| Pin # | Function | Description |
|--------------|-------------------|------------------|
| 1 | RF_{IN} | RF Input |
| 2 - 6, 8, 11 | NC | Not Connected |
| 7 | RF _{OUT} | RF Output |
| 9 | V _{D2} | Drain Supply Two |
| 10 | V _{D1} | Drain Supply One |
| 12 | V _G | Gate Supply |
| Paddle | GND ⁴ | Ground Paddle |

MACOM recommends connecting unused package pins to ground.

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

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

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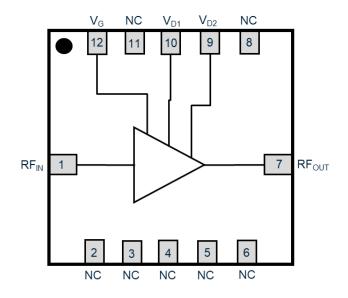
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Pin Configuration and Functional Descriptions



| Pin # | Pin Name | Description |
|----------------|-------------------|---|
| 1 | RF _{IN} | RF Signal Input. This pad is matched to 50 Ω and is AC coupled. |
| 2,3,4,5,6,8,11 | NC | These pins are not connected internally. It is recommended these are grounded on the application PCB. |
| 7 | RF _{OUT} | RF Signal Output. This pad is matched to 50 Ω and is AC coupled |
| 9 | V _{D2} | Drain bias 2. For bypassing 100 pF and 0.1 μ F SMT capacitors are recommended. The 100 pF capacitor should be placed as closely to the package as physically possible. The positioning of the 0.1 μ F capacitor is not as critical but should be placed as close as practically possible. |
| 10 | V _{D1} | Drain bias 1. For bypassing 100 pF and 0.1 μ F SMT capacitors are recommended. The 100 pF capacitor should be placed as closely to the package as physically possible. The positioning of the 0.1 μ F capacitor is not as critical but should be placed as close as practically possible. |
| 12 | V _G | Gate control voltage. Adjust from -1.5 V to 0 V to achieve the desired quiescent current. For bypassing 100 pF and 0.1 μ F SMT capacitors are recommended. The 100 pF capacitor should be placed as closely to the package as physically possible. The positioning of the 0.1 μ F capacitor is not as critical but should be placed as close as practically possible. |
| Paddle | GND | RF, DC and thermal ground |

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AC Electrical Specifications: Freq. = 17 - 55 GHz, $T_A = 25^{\circ}C$, $V_{D1} = V_{D2} = 3 V$, $Z_0 = 50 \Omega$

| Parameter | Test Conditions | Units | Min. | Тур. | Max. |
|---|----------------------------|-------|----------------|----------------|------|
| Small Signal Gain | 17 GHz 40 GHz 50 GHz | dB | 20 | 23 24 24 | _ |
| Small Signal Gain Variation over Temperature | _ | dB/°C | _ | 0.06 | _ |
| Gain Flatness | _ | dB | | ±2 | |
| Noise Figure | 25 GHz | dB | _ | 3.2 | 3.7 |
| Input Return Loss | _ | dB | | 12 | — |
| Output Return Loss | _ | dB | | 12 | |
| Saturated Output Power (P _{SAT}) | 17 GHz 40 GHz 50 GHz | dB | 18 21 20 | 20 24 23 | _ |
| Output 3rd Order Intercept | _ | dBm | | 27 | _ |
| Supply Current | _ | mA | — | 150 | — |

DC Electrical Specifications: V_{D1} , V_{D2} = 3 V, T_A = 25°C

| Parameter | Test Conditions | Units | Min. | Тур. | Max. |
|--|--|-------|------|-------------------|------|
| DC Current: Quiescent (I _{DQ}) Drain (I _{DD}) Gate (I _{GS}) | P _{OUT} = 0 dBm P _{OUT} = 22 dBm @ 50 GHz P _{OUT} = 22 dBm @ 50 GHz | mA | _ | 150 375 0.5 | |

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Recommended Operating Conditions

| Parameter | Unit |
|-----------------------|----------------|
| RF Input Power | 21 dBm |
| DC Supply Voltage | 3 V to 4 V |
| Junction Temperature | +150°C |
| Operating Temperature | -40°C to +85°C |

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 class 1B HBM and class C2A CDM devices.

Absolute Maximum Ratings^{5,6}

| Parameter | Unit |
|-------------------------------------|-----------------|
| RF Input Power | 22 dBm |
| DC Supply | 4.3 V |
| Junction Temperature ^{7,8} | +175°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.
- Operating at nominal conditions with $T_J \le +150^{\circ}C$ will ensure 7. $MTTF > 1 \times 10^6$ hours.
- 8. Junction Temperature $(T_J) = T_C + \Theta jc * (V * I)$ Typical thermal resistance (Θ c) = 11°C/W.
 - a) For T_c = +25°C, T_J = 30°C @ 3.5 V, 130 mA

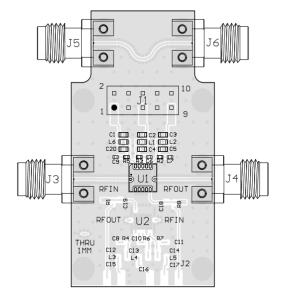
 - b) For T_c = +85°C, T_J = 90°C @ 3.5 V, 130 mA

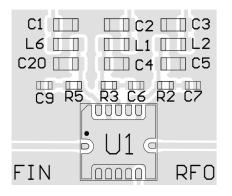
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Evaluation Board Layout

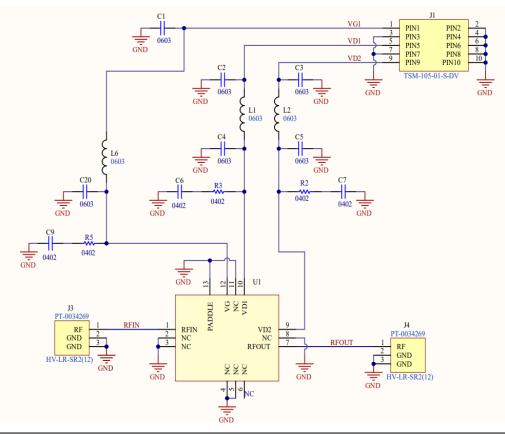




Design notes:

- RO4003C, 8 mil thick, 1/2 copper, soft Au plating
- RF Trace: 14 mil width and 6.5 mil spacing
- Edge wrap on J3, J4, J5, J6

Evaluation Board Schematic



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Parts List

| Part | Value | Case Style |
|------------|-------------|------------|
| R2,R3,R5 | 10 Ω | 0402 |
| C6,C7,C9 | 100 pF | 0402 |
| C4,C5,C20 | 0.1 µF | 0602 |
| C1,C2,C3 | 1 µF | 0602 |
| L1, L2, L6 | 10 nH | 0603 |
| U1 | MAAL-011229 | 5 mm SMT |

Operating the MAAL-011229

Turn-on

- 1. Apply V_G -2 V.
- 2. Increase V_{DD} to 3 V.
- 3. Set I_{DSQ} by adjusting V_G more positive. (typically -0.6 V for I_{DSQ} = 150 mA).
- 4. Apply RF_{IN} signal.

Turn-off

- 1. Remove RF_{IN} signal.
- 2. Decrease V_G to -2 V.
- 3. Decrease V_{DD} to 0 V.

Biasing Conditions

Recommended biasing conditions are V_{DD} = 3 V, I_{DSQ} = 150 mA (controlled with V_G).

Recommended PCB Information

RF input and output are 50 Ω transmission lines. Single layer 8 mil Rogers RO4003C with 1/2 oz. Cu. Use copper filled vias under ground paddle.

Grounding

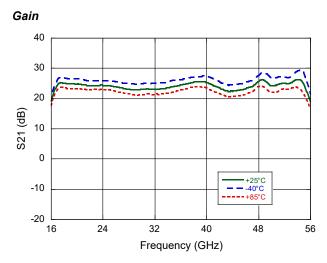
It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200- μ m) diameter vias under the device, assuming an 8-mil (200- μ m) thick RF layer to ground.

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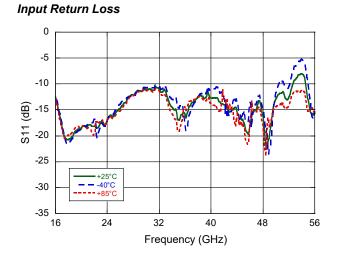


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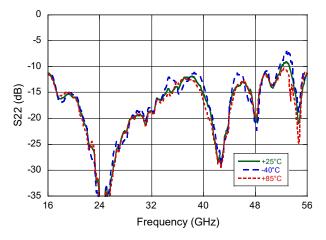
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Typical Performance Curves @ V_D = 3 V, I_D = 150 mA, Z₀ = 50 Ω



Output Return Loss



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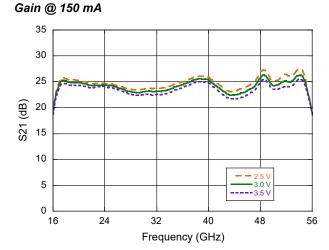
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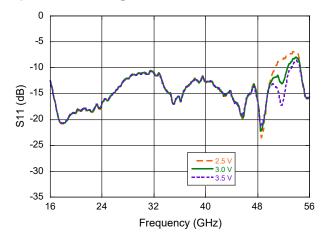
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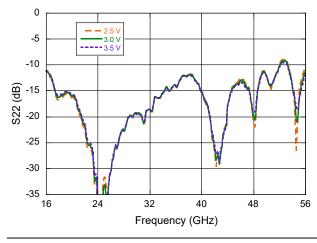
Typical Performance Curves: $T_A = 25^{\circ}C$, $Z_0 = 50 \Omega$



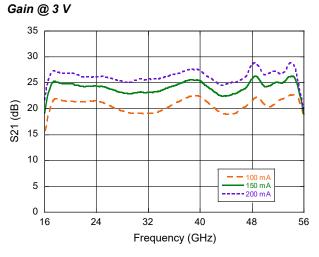
Input Return Loss @ 150 mA



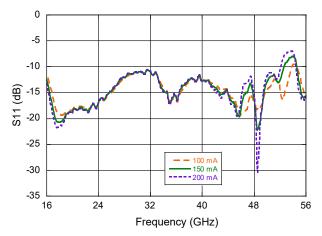




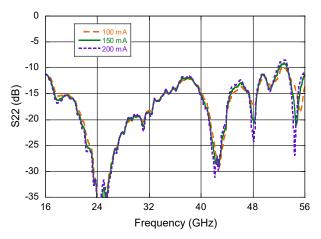




Input Return Loss @ 3 V

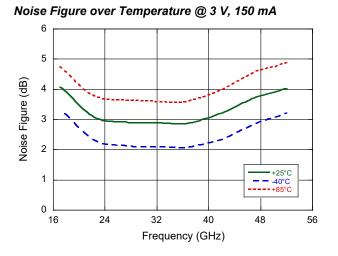






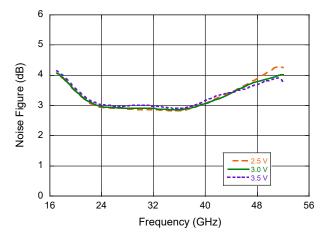


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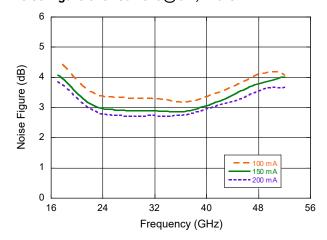


Typical Performance Curves: $Z_0 = 50 \Omega$

Noise Figure over Voltage @ 150 mA, +25°C

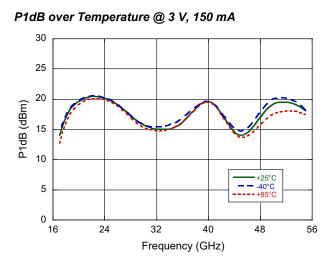


Noise Figure over Current @ 3 V, +25°C



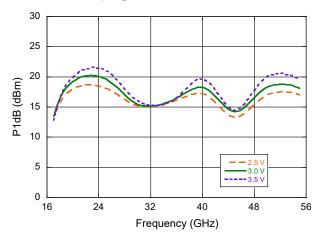


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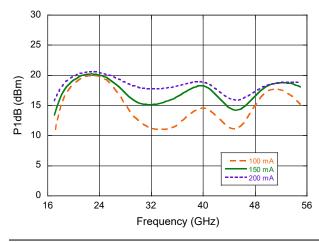


Typical Performance Curves: $Z_0 = 50 \Omega$

P1dB over Voltage @ 150 mA, +25°C

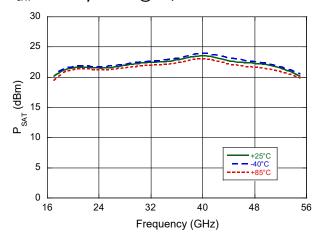




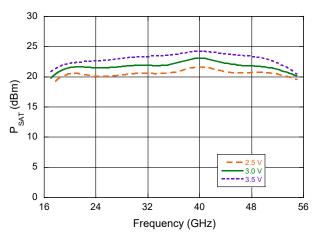


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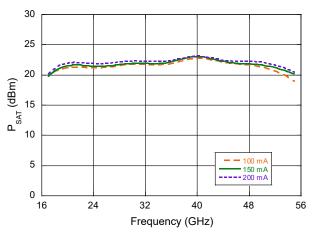
P_{SAT} over Temperature @ 3 V, 150 mA



P_{SAT} over Voltage @ 150 mA, +25°C



P3dB over Current @ 3 V, +25°C

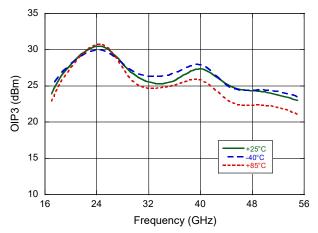




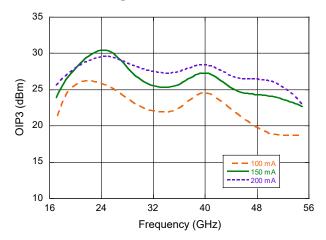
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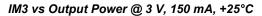
Typical Performance Curves: $Z_0 = 50 \Omega$

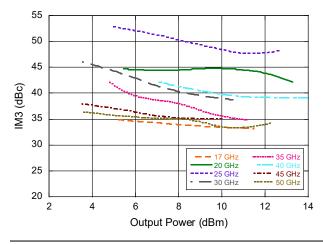
OIP3 over Temperature @ 3 V, 150 mA



OIP3 over Current @ 3 V, +25°C

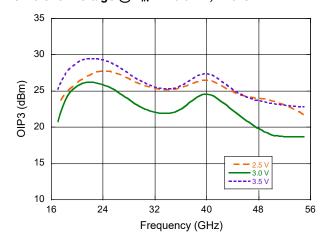




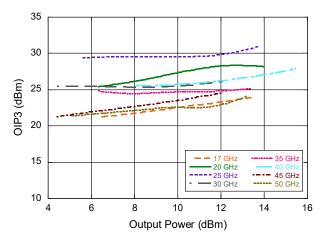


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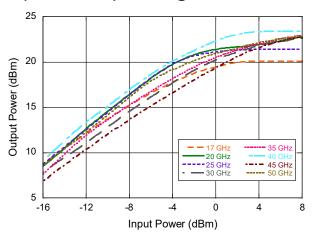
OIP3 over Voltage @ PIN = -10 dBm, +25°C



OIP3 vs Output Power @ 3 V, 150 mA, +25°C



Output Power vs Input Power @ 3 V, 150 mA, +25°C

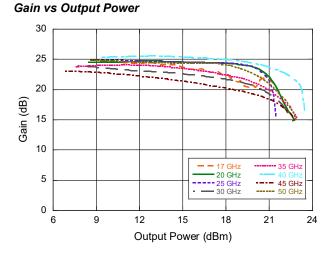




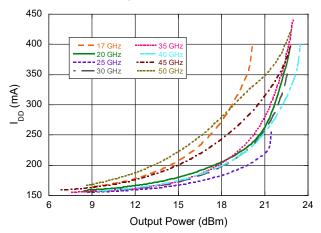
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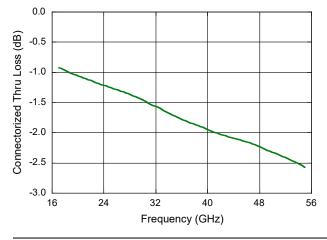
Typical Performance Curves @ V_D = 3 V, I_D = 150 mA, T_A = 25°C, Z_0 = 50 Ω



Drain Current vs Output Power

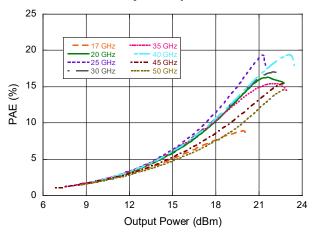


Evaluation Board Through Loss

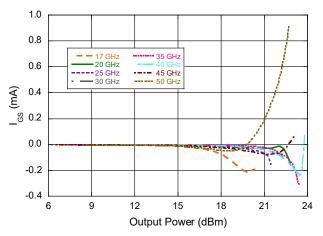


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Power Added Efficiency vs Output Power



Gate Source Current vs Output Power



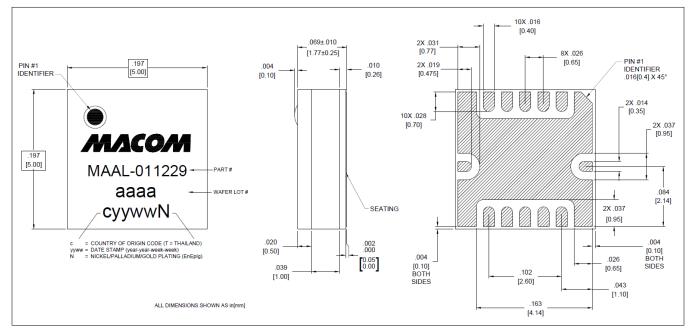
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Lead-Free 5 mm 12-Lead SMT^{9,10}



9. Reference Application Note S2083 for lead-free solder reflow recommendations.

10. Meets JEDEC moisture sensitivity level 3 requirements.



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