

# Low Noise Amplifier

## 27 - 31.5 GHz



MAAL-FR1245

Rev. V3

### Features

- Single Supply Architecture
- Noise Figure: 1.2 dB
- Gain: 26 dB
- P1dB: 5 dBm
- Input Return Loss: 15 dB
- Output Return Loss: 8 dB
- Power Supply: 48 mA @ 1.5 V
- Chip Size: 3 x 3 mm<sup>2</sup> PQFN
- 100% RF Tested, Known Good Die
- Demonstration Boards Available
- RoHS\* Compliant

### Applications

- RADAR
- SATCOM

### Description

The MAAL-FR1245 is a very low noise three stage LNA designed to operate from 27 to 31.5 GHz with 1.2 dB of noise figure and 26 dB of gain. This amplifier is a single positive and single negative voltage bias which include a DC current regulation. This LNA is matched to 50  $\Omega$  at both input and output ports.

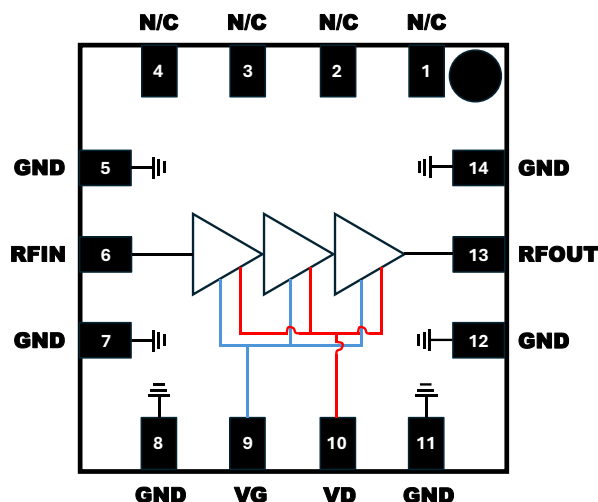
The die is manufactured using a 0.07  $\mu$ m gate length pHEMT technology. The MMIC uses gold bond pads and backside metallization and is fully protected with Silicon Nitride passivation to obtain the highest level of reliability.

This product is available in die form: MAAL-011245-DIE.

### Ordering Information

| Part Number        | Package          |
|--------------------|------------------|
| MAAL-FR1245-TR0500 | 500 part reel    |
| MAAL-FR1245-001SMB | Evaluation Board |

### Block Diagram



### Pad Configuration<sup>1</sup>

| Pad #          | Pad Name            | Function      |
|----------------|---------------------|---------------|
| 1,2,3,4        | N/C                 | Not Connected |
| 5,7,8,10,12,14 | GND                 | Ground        |
| 6              | RF <sub>IN</sub>    | RF Input      |
| 9              | V <sub>G</sub>      | Voltage Gate  |
| 10             | V <sub>D</sub>      | Voltage Drain |
| 13             | RF <sub>OUT</sub>   | RF Output     |
| 15             | Paddle <sup>2</sup> | Paddle        |

1. MACOM recommends connecting unused package pins to ground.
2. The exposed pad centered on the package bottom must be connected to RF and DC ground.

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

**Electrical Specifications: Freq. = 27 - 31.5 GHz,  $T_A = +25^{\circ}\text{C}$ ,  $V_D = +1.5\text{ V}$ ,  $V_G = -1.5\text{ V}$**

| Parameter            | Test Conditions                                  | Units | Min. | Typ. | Max. |
|----------------------|--|-------|------|------|------|
| Gain                 | —  | dB    | 21.5 | 26   | —    |
| Noise Figure         | —  | dB    | —    | 1.2  | 2.0  |
| Drain Supply Voltage | —  | V     | —    | 1.5  | —    |
| Drain Supply Current | —  | mA    | —    | 48   | —    |
| Reverse Isolation    | $\text{RF}_{\text{OUT}} / \text{RF}_{\text{IN}}$ | dB    | —    | -55  | —    |
| P1dB                 | —  | dBm   | —    | 5    | —    |
| Output IP3           | —  | dBm   | —    | 12   | —    |
| Output IM3           | Tone Spacing = 100 MHz                           | dBc   | —    | 19   | —    |
| Input Return Loss    | 50 $\Omega$                                      | dB    | —    | -15  | —    |
| Output Return Loss   | 50 $\Omega$                                      | dB    | —    | -8   | —    |

**Absolute Maximum Ratings<sup>3,4</sup>**

| Parameter                           | Absolute Maximum |
|-------------------------------------|------------------|
| Input RF ports                      | 15 dBm           |
| DC Voltage Drain Supply             | 2 V              |
| DC Voltage Gate Supply              | -2 V             |
| Junction Temperature <sup>5,6</sup> | +150°C           |
| Operating Temperature <sup>5</sup>  | -40°C to +85°C   |
| Storage Temperature                 | -40°C to +150°C  |

3. Exceeding any one or combination of these limits may cause permanent damage to this device.

4. MACOM does not recommend sustained operation near these survivability limits.

5. Operating at nominal conditions with  $T_J \leq +150^{\circ}\text{C}$  will ensure MTTF >  $1 \times 10^{11}$  hours.

6. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} * (V * I)$   
Typical thermal resistance ( $\Theta_{jc}$ ) = 360 °C/W.

a) For  $T_C = +25^{\circ}\text{C}$ ,

$T_J = 49.1^{\circ}\text{C}$  @ 1.5 V, 48 mA

b) For  $T_C = +85^{\circ}\text{C}$

$T_J = 113.5^{\circ}\text{C}$  @ 1.5 V, 48 mA

**Recommended Operating Conditions**

| Parameter       | Typical |
|-----------------|---------|
| Input RF ports  | -35 dBm |
| DC Supply $V_D$ | +1.5 V  |
| DC Supply $V_G$ | -1.5 V  |

**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.

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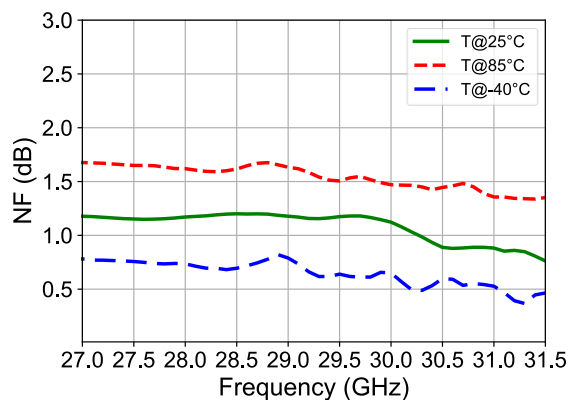


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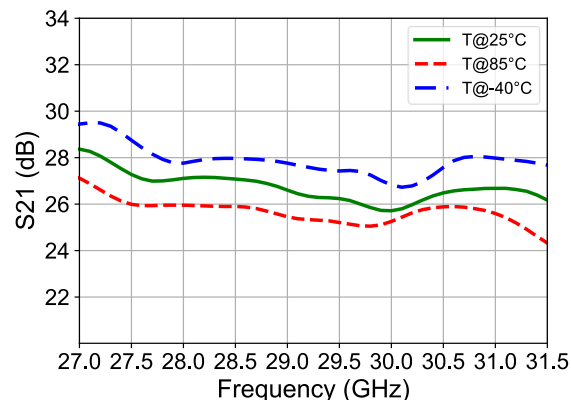
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**Typical Performance Curves: @ PCB level with De-Embedding at different temperature**  
 $V_D = +1.5\text{ V}$ ,  $V_G = -1.5\text{ V}$ ,  $I_D = 48\text{ mA}$

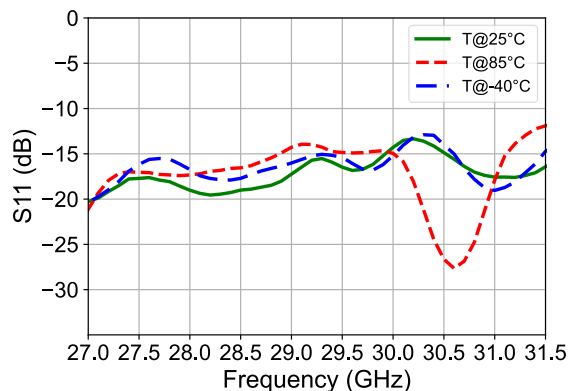
**Noise Figure over Frequency**



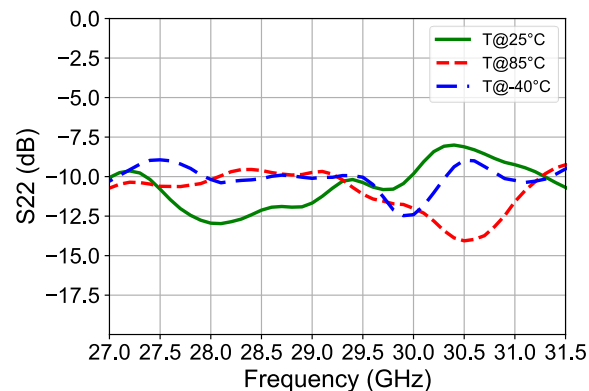
**Gain over Frequency**



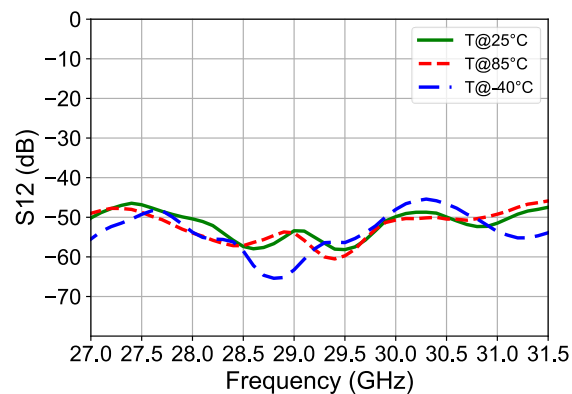
**Input Return Loss over Frequency**



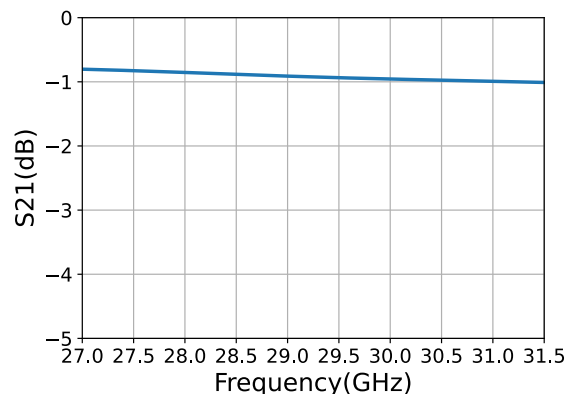
**Output Return Loss over Frequency**



**Reverse Isolation over Frequency**



**RF access line & connector Losses over Frequency**



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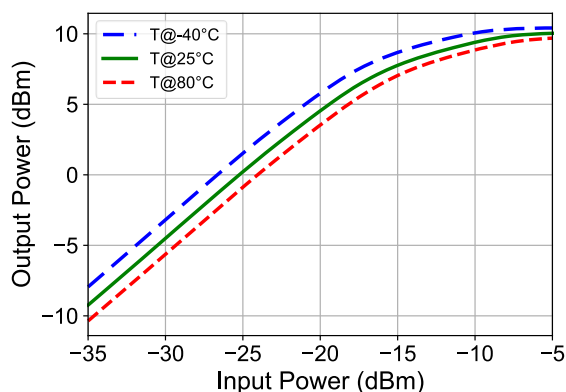


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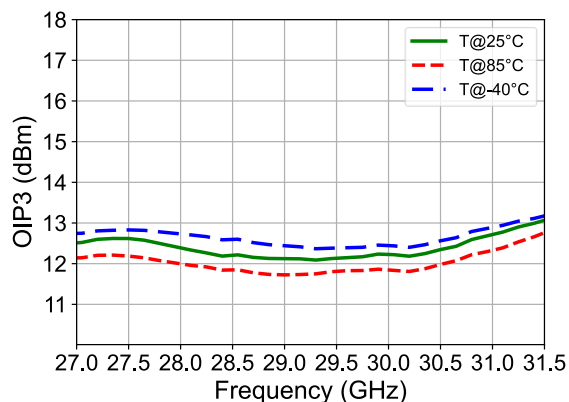
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**Typical Performance Curves: @ PCB level with De-Embedding at different temperature**  
 $V_D = +1.5$  V,  $V_G = -1.5$  V,  $I_D = 48$  mA

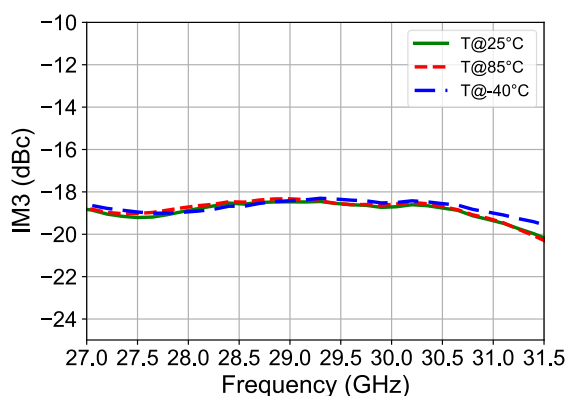
Output power over Input power



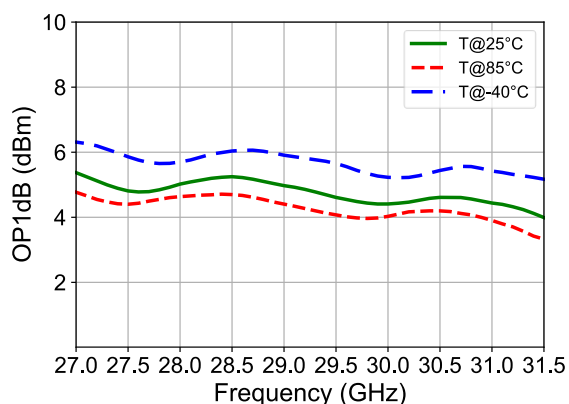
OIP3 over Frequency



IM3 over Frequency



P1db over Frequency



## Biasing Procedure

| Biasing UP   |
|--|
| Set $I_D$ limit to 60 mA                             |
| Ensure voltages are at 0 before turning on DC supply |
| Set $V_G$ to -1.5 V                                  |
| Set $V_D$ to +1.5 V                                  |

| Biasing DOWN       |
|--------------------|
| Set $V_D$ to 0 V   |
| Set $V_S$ to 0 V   |
| Turn off DC supply |

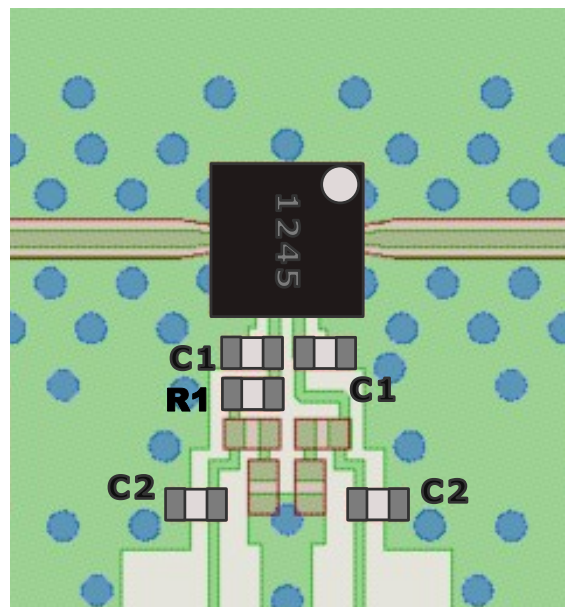
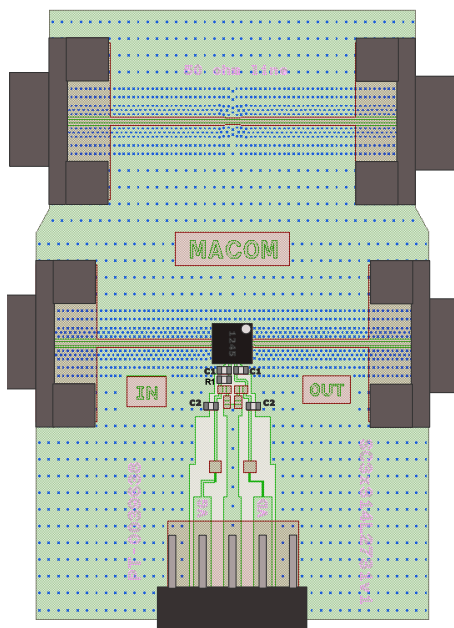
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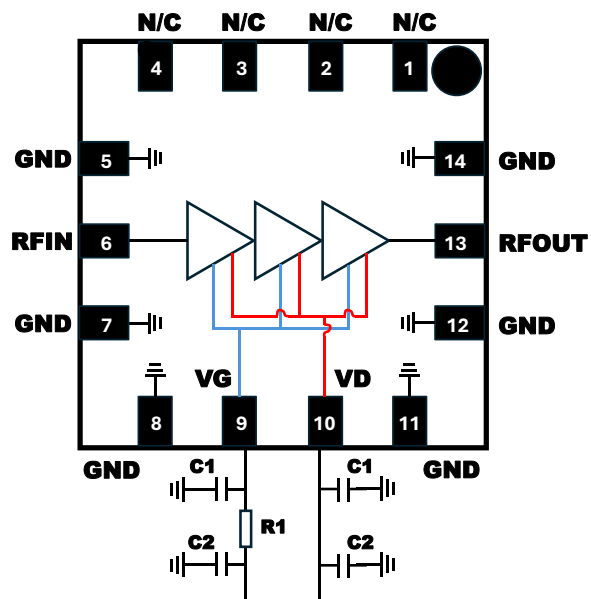
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## PCB Layout



## Functional Schematic



## Parts List

| Part | Value      | Case Style | Manufacturer | Manufacturer's Part number |
|------|------------|------------|--------------|----------------------------|
| C1   | 47 pF      | 0402       | Murata       | GRT1555C1H470JA02D         |
| C2   | 10 nF      | 0402       | Murata       | GRT188R71E474KE13D         |
| R1   | 0 $\Omega$ | 0402       | Panasonic    | ERJ2GE0R00X                |

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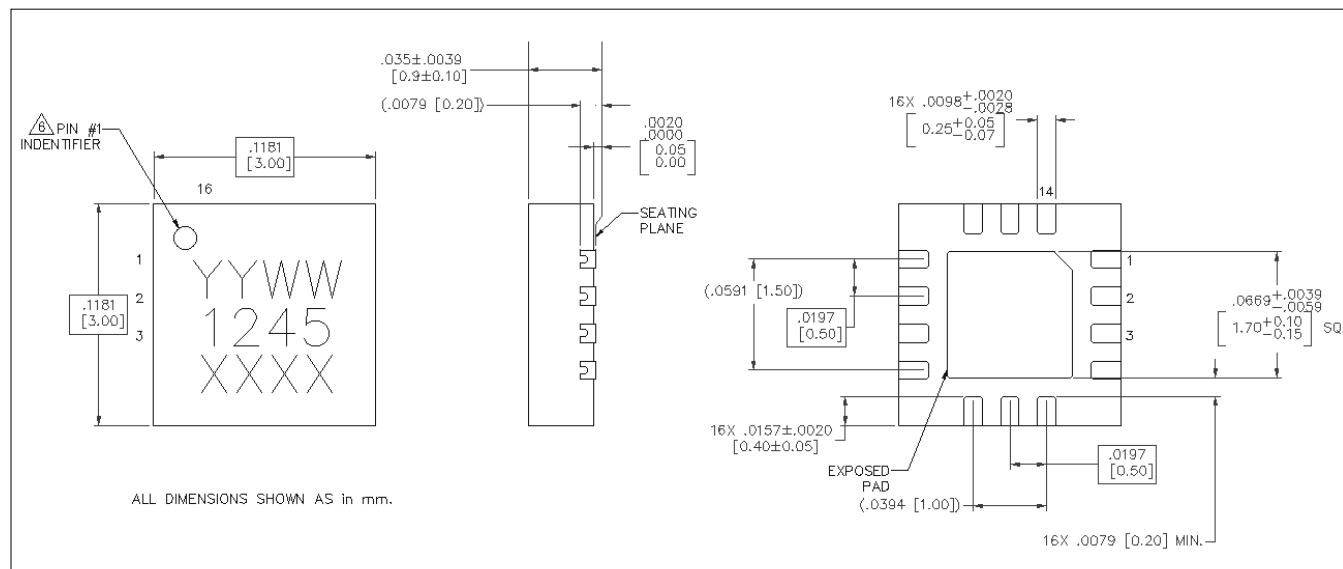
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### Lead-Free 3mm 14-Lead SMT<sup>†</sup>



<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensivity level 3 requirements in accordance to JEDEC J-STD-020D.  
Plating is NiPdAu over Copper.

### Revision History

| Rev | Date     | Change Description                     |
|-----|----------|--|
| V1  | 17/12/24 | Initial Release                        |
| V2  | 28/01/25 | Change of chip size by QFN dimensions. |
| V3  | 03/06/25 | Thermal resistance value updated       |

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