

Ultra Low Phase Noise Amplifier

2 - 18 GHz



MAAL-011151
Rev. V2

Features

- Wideband Performance
- Noise Figure: 3.5 dB @ 10 GHz
- Phase Noise: -165 dBc/Hz @ 100 kHz Offset
- Bias Voltage: 5 V
- Bias Current: 60 mA
- 50 Ω Matched Input / Output
- Positive Voltage Only
- Lead-Free 5 mm 32-lead PQFN Package
- RoHS* Compliant

Applications

- Test & Measurement, EW, ECM, and Radar

Description

The MAAL-011151 is an easy to use, wideband low noise distributed amplifier in a lead-free 5 mm 32-lead PQFN package. It operates from 2 to 18 GHz and provides 15 dB of linear gain, 19 dBm of P1dB, and 3.5 dB of noise figure at 10 GHz. The input and output are fully matched to 50 Ω with typical return loss >10 dB.

The RF input and RF output ports are DC blocked. Amplifier control is available through the use of a control circuit.

This product is fabricated using a low phase noise HBT process which features full passivation for enhanced reliability.

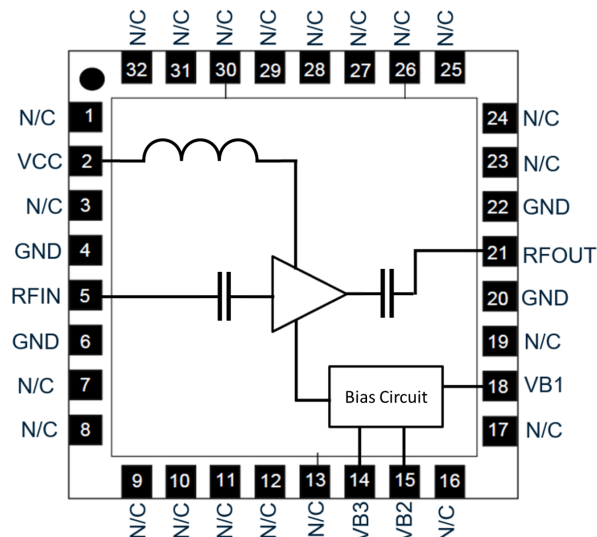
The MAAL-011151 can be used as a low noise amplifier stage for signal generation applications. This device is ideally suited for Test and Measurement, EW, ECM, and Radar applications where ultra low phase noise and drive power is required.

Ordering Information^{1,2}

| Part Number | Package |
|--------------------|----------------|
| MAAL-011151-TR0100 | 100 piece reel |
| MAAL-011151-001SMB | Sample Board |

1. Reference Application Note M513 for reel size information.
2. All sample boards include 3 loose parts.

Functional Schematic



Pin Configuration

| Pin # | Pin Name | Description |
|-------------------------|----------|-------------------|
| 1,3,7-13,16,17,19,23-32 | N/C | No Connection |
| 2 | VCC | Collector Voltage |
| 4,6,20,22 | GND | Ground |
| 5 | RFIN | RF Input |
| 14 | VB3 | Bias Voltage 3 |
| 15 | VB2 | Bias Voltage 2 |
| 18 | VB1 | Bias Voltage 1 |
| 21 | RFOUT | RF Output |
| Paddle ³ | GND | Ground |

3. 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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Electrical Specifications: $T_A = +25^\circ\text{C}$, $V_{CC} = V_{CT}^4 = 5\text{ V}$, $Z_0 = 50\ \Omega$

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|--------------------------|--|--------|----------------------|------------------------------|------|
| Gain | $P_{IN} = -15\text{ dBm}$ 2 GHz 10 GHz 18 GHz | dB | 15.0 14.0 13.5 | 16 15 15 | — |
| Output P3dB ⁵ | 2 GHz 10 GHz 18 GHz | dBm | — | 22 20 16 | — |
| Output Power | $P_{IN} = +5.7\text{ dBm}$, 2 GHz $P_{IN} = +3.0\text{ dBm}$, 10 GHz $P_{IN} = -4.0\text{ dBm}$, 18 GHz | dBm | 18.0 15.0 9.0 | 20 19 13 | — |
| Input Return Loss | $P_{IN} = -15\text{ dBm}$ | dB | — | 10 | — |
| Output Return Loss | $P_{IN} = -15\text{ dBm}$ | dB | — | 10 | — |
| Noise Figure | 2 GHz 10 GHz 18 GHz | dB | — | 7.0 3.5 8.0 | — |
| Isolation | $P_{IN} = -15\text{ dBm}$ 2 GHz 10 GHz 18 GHz | dB | — | 48 42 33 | — |
| Phase Noise | $P_{IN} = +3\text{ dBm}$, 12 GHz 100 Hz 1 kHz 10 kHz 100 kHz | dBc/Hz | — | -143 -149 -158 -165 | — |
| ICQ | — | mA | — | 60 | — |
| ICT ⁴ | Total current into R1, R2 | mA | — | 2 | — |

4. Reference detailed bias conditions on page 3.

5. MACOM does not recommend sustained operation at power levels above 3 dB compression.

Maximum Operating Conditions

| Parameter | Rating |
|-------------------------------------|---|
| Input Power | $P_{IN} < 3\text{ dB}$ Compression Point |
| ICQ | 90 mA |
| Junction Temperature ^{6,7} | 130°C |
| Operating Temperature | -40°C to +85°C |

6. Operating at nominal conditions with junction temperature $\leq 130^\circ\text{C}$ will ensure $\text{MTTF} > 1 \times 10^6$ hours.

7. Junction Temperature (T_J) = $T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$.
Typical thermal resistance (Θ_{JC}) = 120°C/W.

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

$T_J = +72^\circ\text{C}$ @ 5 V, 98 mA, $P_{OUT} = 20\text{ dBm}$, $P_{IN} = 4.5\text{ dBm}$

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

$T_J = 129^\circ\text{C}$ @ 5 V, 88 mA, $P_{OUT} = 19\text{ dBm}$, $P_{IN} = 4.5\text{ dBm}$

Absolute Maximum Ratings^{8,9}

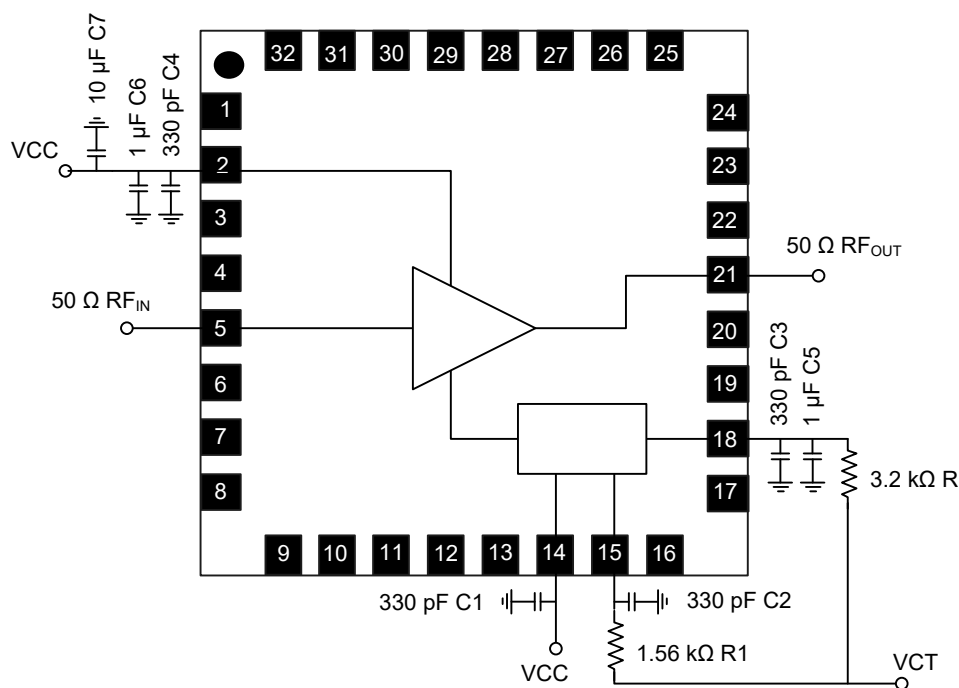
| Parameter | Absolute Maximum |
|------------------------------------|------------------|
| Input Power | 12 dBm |
| ICQ | 120 mA |
| VCC, VB1, VB2, VB3 | 6 V |
| VB1, VB2, VB3, Current | 5 mA |
| Junction Temperature ¹⁰ | 150°C |
| Storage Temperature | -65°C to +125°C |

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

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

10. Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

Application Schematic



Operating Conditions

Recommended biasing conditions are $V_{CC} = 5\text{ V}$ applied to pin 14 (VB3) and pin 2 (V_{CC}). Apply amplifier control (V_{CT}) through the offset resistors (R1, R2) to pin 15 (VB2) and pin 18 (VB1) according to the application schematic shown. Setting $V_{CT} = 5\text{ V}$ will turn on the amplifier ($I_{CQ} \sim 60\text{ mA}$ from $V_{CC} = 5\text{ V}$). Setting $V_{CT} = 0\text{ V}$ will turn off the amplifier. VB1 and VB2 will draw $< 2\text{ mA}$ (I_{CT}) from $V_{CT} = 5\text{ V}$. All DC supplies need to be low noise to prevent degradation of the amplifier phase noise.

Parts List

| Part # | Value | Case Style |
|---------|------------------|--------------|
| C1 - C4 | 330 pF | Single Layer |
| C5, C6 | 1 μF | 0402 |
| C7 | 10 μF | 1210 |
| R1 | 1.56 k Ω | Thin film |
| R2 | 3.2 k Ω | Thin film |

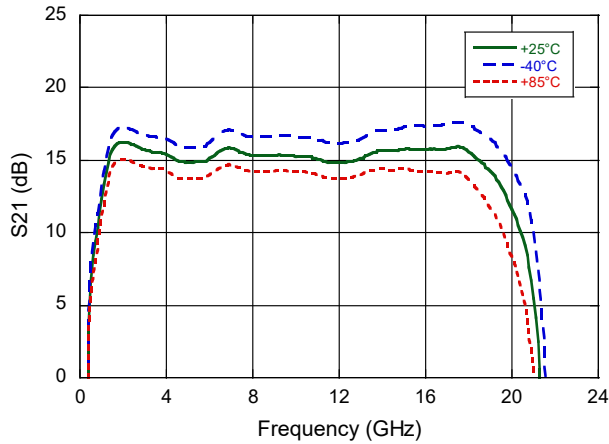
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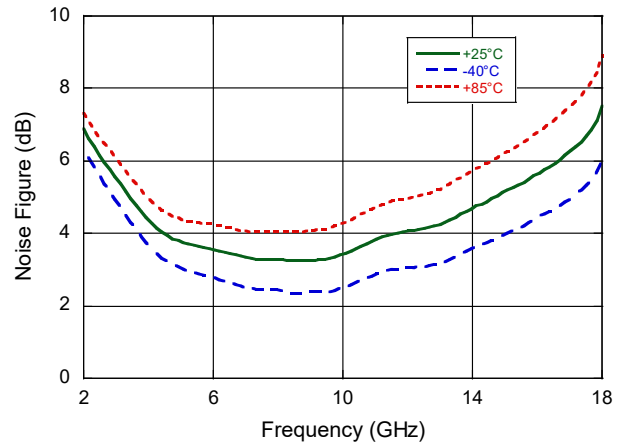
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Typical Performance Curves: 5 V, ICQ = 60 mA

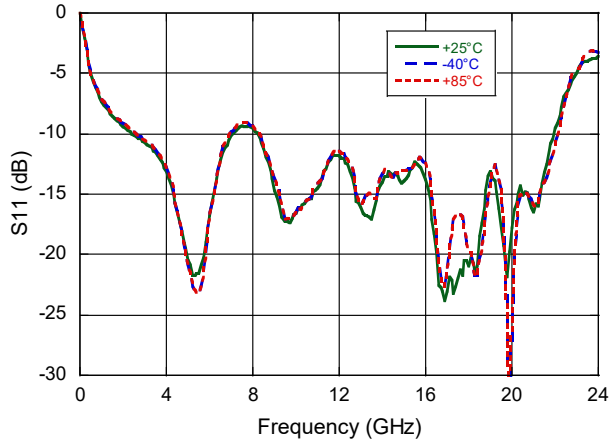
Gain



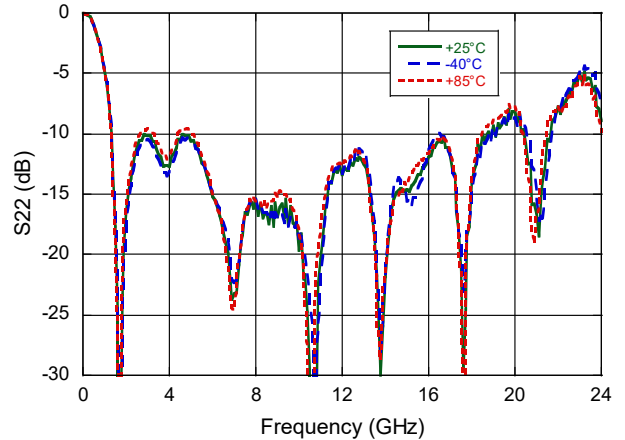
Noise Figure



Input Return Loss



Output Return Loss



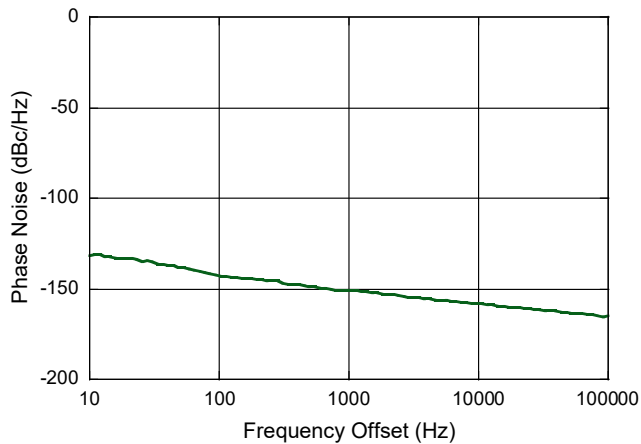
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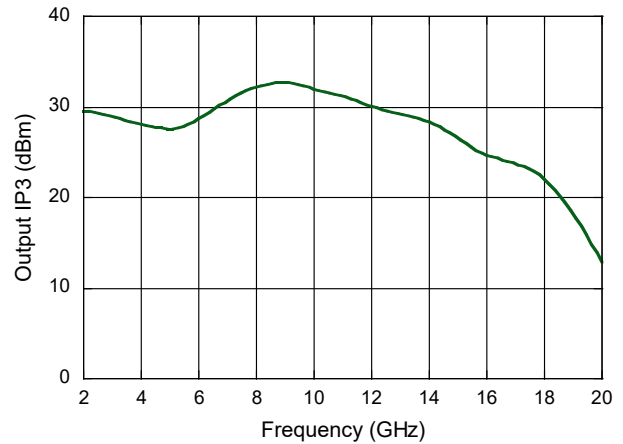
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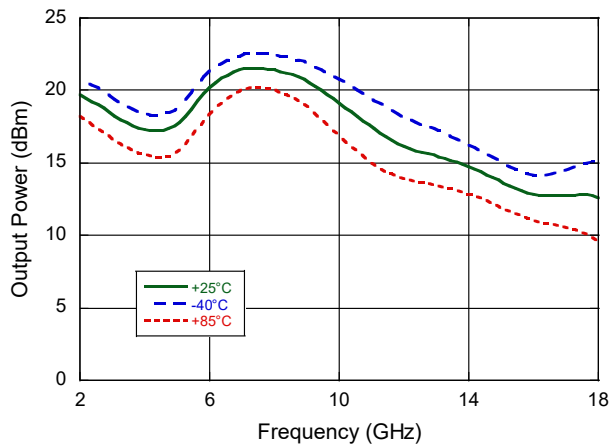
Phase Noise @ +25°C, 12 GHz



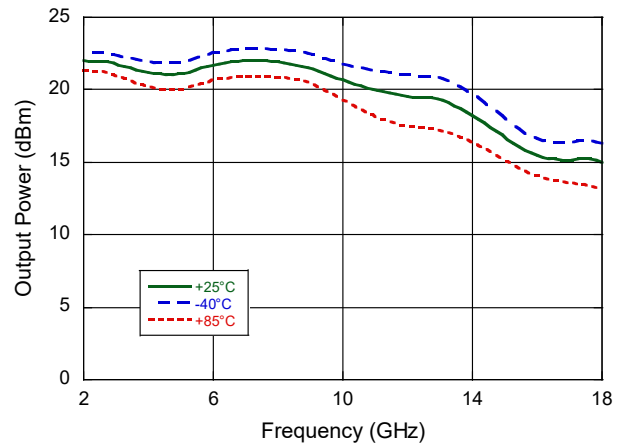
Output IP3 @ +25°C



Output Power @ P1dB



Output Power @ P3dB



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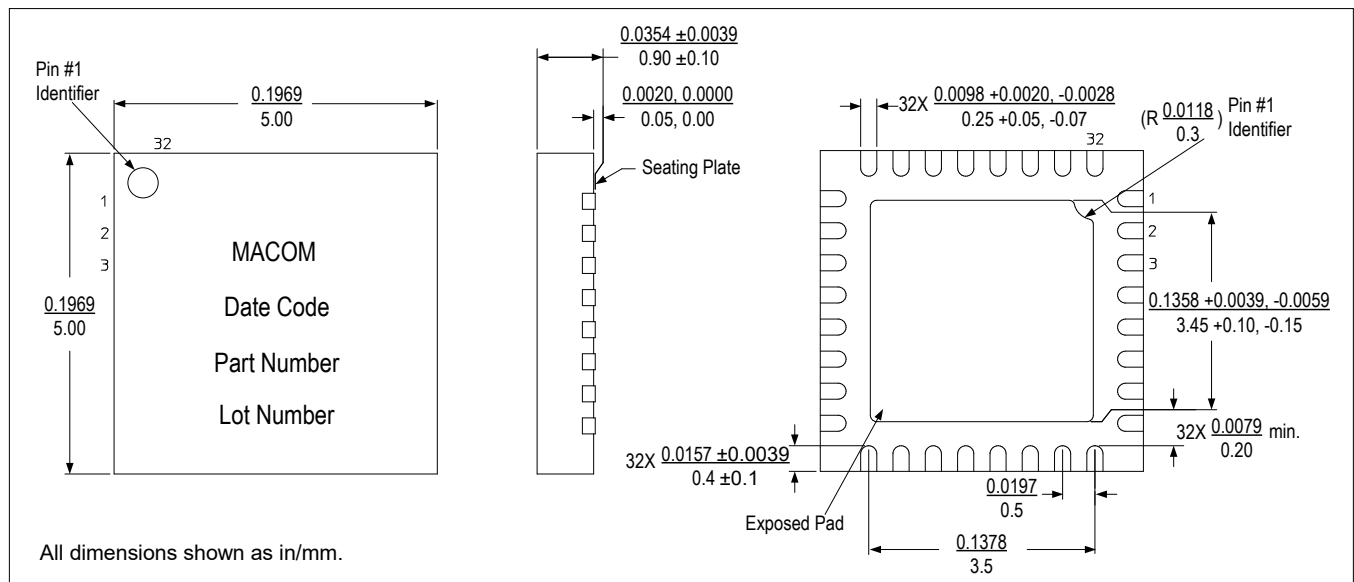
Handling Procedures

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 HBM Class 1A devices.

Lead-Free 5 mm 32-Lead PQFN Package[†]



[†] Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is NiPdAuAg.

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