Ultra Low Phase Noise Amplifier
2 - 18 GHz

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

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

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAAL-011151-TR0100</td>
<td>100 piece reel</td>
<td></td>
</tr>
<tr>
<td>MAAL-011151-001SMB</td>
<td>Sample Board</td>
<td></td>
</tr>
</tbody>
</table>

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

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

For further information and support please visit:
https://www.macom.com/support
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Electrical Specifications: \( T_A = +25^\circ C, \ VCC = VCT^d = 5 \ \text{V}, \ Z_0 = 50 \ \Omega \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
</table>
| Gain               | \( P_{IN} = -15 \ \text{dBm} \)  
\( 2 \ \text{GHz} \)  
\( 10 \ \text{GHz} \)  
\( 18 \ \text{GHz} \) | dB    | 15.0 | 14.0 | 13.5 | 13.5 |
| Output P3dB\(^5\) | \( P_{IN} = +5.7 \ \text{dBm}, \ 2 \ \text{GHz} \)  
\( P_{IN} = +3.0 \ \text{dBm}, \ 10 \ \text{GHz} \)  
\( P_{IN} = -4.0 \ \text{dBm}, \ 18 \ \text{GHz} \) | dBm  | 18.0 | 15.0 | 15.6 | 15.6 |
| Output Power      | \( P_{IN} = +3 \ \text{dBm}, \ 12 \ \text{GHz} \) | dBm  | 20.0 | 19.0 | 18.0 | 18.0 |
| Input Return Loss | \( P_{IN} = -15 \ \text{dBm} \) | dB    | 10.0 | 10.0 | 10.0 | 10.0 |
| Output Return Loss| \( P_{IN} = -15 \ \text{dBm} \) | dB    | 10.0 | 10.0 | 10.0 | 10.0 |
| Noise Figure      | \( P_{IN} = -15 \ \text{dBm} \)  
\( 2 \ \text{GHz} \)  
\( 10 \ \text{GHz} \)  
\( 18 \ \text{GHz} \) | dB    | 7.0  | 3.5  | 8.0  | 8.0  |
| Isolation         | \( P_{IN} = -15 \ \text{dBm} \)  
\( 2 \ \text{GHz} \)  
\( 10 \ \text{GHz} \)  
\( 18 \ \text{GHz} \) | dB    | 48.0 | 42.0 | 33.0 | 33.0 |
| Phase Noise       | \( P_{IN} = +3 \ \text{dBm}, \ 12 \ \text{GHz} \)  
\( 100 \ \text{Hz} \)  
\( 1 \ \text{kHz} \)  
\( 10 \ \text{kHz} \)  
\( 100 \ \text{kHz} \) | dBc/Hz | -143 | -149 | -158 | -165 |
| ICQ               | —                | mA    | 60.0 | 60.0 | 60.0 | 60.0 |
| ICT\(^4\)         | Total current into R1, R2 | mA    | 2.0  | 2.0  | 2.0  | 2.0  |

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
</table>
| 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 \( \leq 130^\circ C \) will ensure MTTF > 1 \times 10^6 \text{ hours}.
7. Junction Temperature (\( T_J = T_C + \Theta_{JC} \times (V \times I) - (P_{OUT} - P_{IN}) \)). Typical thermal resistance (\( \Theta_{JC} \)) = 120°C/W.
   a) For \( T_C = +25^\circ C \)  
   \( T_J = +72^\circ C @ 5 \ \text{V}, \ 98 \ \text{mA}, \ P_{OUT} = 20 \ \text{dBm}, \ P_{IN} = 4.5 \ \text{dBm} \)
   b) For \( T_C = +85^\circ C \)  
   \( T_J = 129^\circ C @ 5 \ \text{V}, \ 88 \ \text{mA}, \ P_{OUT} = 19 \ \text{dBm}, \ P_{IN} = 4.5 \ \text{dBm} \)

Absolute Maximum Ratings\(^{8,9}\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>12 dBm</td>
</tr>
<tr>
<td>ICQ</td>
<td>120 mA</td>
</tr>
<tr>
<td>VCC, VB1, VB2, VB3</td>
<td>6 V</td>
</tr>
<tr>
<td>VB1, VB2, VB3, Current</td>
<td>5 mA</td>
</tr>
<tr>
<td>Junction Temperature(^{10})</td>
<td>150°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65°C to +125°C</td>
</tr>
</tbody>
</table>

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.
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Operating Conditions
Recommended biasing conditions are VCC = 5 V applied to pin 14 (VB3) and pin 2 (VCC). Apply amplifier control (VCT) through the offset resistors (R1, R2) to pin 15 (VB2) and pin 18 (VB1) according to the application schematic shown. Setting VCT = 5 V will turn on the amplifier (ICQ ~ 60 mA from VCC = 5 V). Setting VCT = 0 V will turn off the amplifier. VB1 and VB2 will draw < 2 mA (ICT) from VCT = 5 V. All DC supplies need to be low noise to prevent degradation of the amplifier phase noise.

Parts List

<table>
<thead>
<tr>
<th>Part #</th>
<th>Value</th>
<th>Case Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 - C4</td>
<td>330 pF</td>
<td>Single Layer</td>
</tr>
<tr>
<td>C5, C6</td>
<td>1 µF</td>
<td>0402</td>
</tr>
<tr>
<td>C7</td>
<td>10 µF</td>
<td>1210</td>
</tr>
<tr>
<td>R1</td>
<td>1.56 kΩ</td>
<td>Thin film</td>
</tr>
<tr>
<td>R2</td>
<td>3.2 kΩ</td>
<td>Thin film</td>
</tr>
</tbody>
</table>
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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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Typical Performance Curves: 5 V, ICQ = 60 mA

**Phase Noise @ +25°C, 12 GHz**

![Phase Noise Graph]

**Output IP3 @ +25°C**

![Output IP3 Graph]

**Output Power @ P1dB**

![Output Power P1dB Graph]

**Output Power @ P3dB**

![Output Power P3dB Graph]
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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