Ultra Low Phase Noise Amplifier
2 - 18 GHz

Features
- Wideband Performance
- Noise Figure: 4 dB @ 8 GHz
- Phase Noise: -154 dBc/Hz @ 1 kHz
- Bias Voltage: 5 V
- Bias Current: 60 mA
- 50 Ω Matched Input / Output
- Positive Voltage Only
- Die Size: 2.8 x 1.73 x 0.1 mm
- RoHS* Compliant

Description
The MAAL-011151-DIE is an easy to use, wideband low noise distributed amplifier die. It operates from 2 to 18 GHz and provides 17 dB of linear gain, 16 dBm of P1dB and 4 dB of noise figure at 8 GHz. The input and output are fully matched to 50 Ω with typical return loss >15 dB.

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

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

The MAAL-011151-DIE 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>
</tr>
</thead>
<tbody>
<tr>
<td>MAAL-011151-DIE</td>
<td>gel pack</td>
</tr>
</tbody>
</table>

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
Electrical Specifications: $T_A = +25^\circ C$, $VC = VCT^3 = 5\, V$, $Z_0 = 50\, \Omega$

<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            | $P_{IN} = -15\, dBm$  
2 GHz  
10 GHz  
18 GHz  | dB     | 15.0  | 14.0 | 13.5 | —    |
| Output P3dB$^4$ | 2 GHz  
10 GHz  
18 GHz  | dBm   | —    | 23   | 19   | 14   |
| Output Power    | $P_{IN} = +4.5\, dBm$, 2 GHz  
$P_{IN} = +2.8\, dBm$, 10 GHz  
$P_{IN} = -3.0\, dBm$, 18 GHz  | dBm   | 18.0  | 15.0 | 9.0  | 20.0  | 17.5 | — |
| Input Return Loss | $P_{IN} = -15\, dBm$  | dB     | —    | 10   | —    | —    |
| Output Return Loss | $P_{IN} = -15\, dBm$  | dB     | —    | 10   | —    | —    |
| Noise Figure    | 2 GHz  
10 GHz  
18 GHz  | dB     | —    | 8    | 5    | 8    |
| Isolation       | $P_{IN} = -15\, dBm$  
2 GHz  
10 GHz  
18 GHz  | dB     | —    | 50   | 42   | 30   |
| Phase Noise     | $P_{IN} = +3\, dBm$, 12 GHz  
100 Hz  
1 kHz  
10 kHz  
1 MHz  | dBC/Hz | —    | -144 | -150 | -156 | -162 | — |
| ICQ            | $-15\, dBm$ $P_{IN}$, $VC = 5\, V$  | mA     | —    | 60   | —    | —    |
| ICT$^3$         | Total current into R1, R2  | mA     | —    | 2    | —    | —    |

3. Reference detailed bias conditions on pages 3-4.  
4. MACOM does not recommend sustained operation at power levels above 3 dB compression.
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.

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Application Schematic

Operating Conditions
Recommended biasing conditions are VC = 5 V applied to the VB4 and VCC pads. Apply 5 V to the amplifier control VCT node through the offset resistors to VB2 and VB3 pads according to the application schematic as shown. Applying VCT = 5 V will turn the LNA on, which should draw 60 mA from VC. Applying VCT = 0 V will turn off the LNA. The VCT will draw <2 mA at 5 V. All DC supplies need to be low noise to prevent degradation of the amplifier phase noise.
Recommended Bonding Diagram & PCB Layout
RF input and output port matching circuit patterns are designed to compensate for bonding wires. Input and output bonding configuration are identical.

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>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>
Typical Performance Curves: 5 V, ICQ = 60 mA

**Gain**

- **S21 (dB)**
  - 0 to 20 dB
  - Frequency: 0 to 24 GHz
  - Three temperature points: +25°C, -40°C, +85°C

**Noise Figure**

- Noise Figure (dB)
  - 0 to 10 dB
  - Frequency (GHz)
  - Three temperature points: +25°C, -40°C, +85°C

**Input Return Loss**

- S11 (dB)
  - -30 to 0 dB
  - Frequency: 0 to 24 GHz
  - Three temperature points: +25°C, -40°C, +85°C

**Output Return Loss**

- S22 (dB)
  - -20 to 0 dB
  - Frequency: 0 to 24 GHz
  - Three temperature points: +25°C, -40°C, +85°C

**Phase Noise @ +25°C**

- Phase Noise (dBc/Hz)
  - -200 to 0 dBc/Hz
  - Frequency Offset (Hz)
  - Frequency Offset: 10 to 1000000 Hz

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Typical Performance Curves: $P_{1\text{dB}}$ @ ICQ = 60 mA

![Graph showing typical performance curves for $P_{1\text{dB}}$ at different temperatures (25°C, -40°C, 85°C) across frequencies from 2 to 18 GHz.]

Typical Performance Curves: $P_{3\text{dB}}$ @ ICQ = 60 mA

![Graph showing typical performance curves for $P_{3\text{dB}}$ at different temperatures (25°C, -40°C, 85°C) across frequencies from 2 to 18 GHz.]

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MMIC Die Outline

Bond Pad Detail

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Size (x)</th>
<th>Size (y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 2</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td>4 - 8</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

10. All dimensions shown as microns (µm) with a tolerance of +/-5 µm, unless otherwise noted.
11. Die thickness is 100 µm +/-10 µm.

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