HMC-ALH369
GaAs HEMT MMIC LOW NOISE AMPLIFIER, 24 - 40 GHz

Typical Applications
This HMC-ALH369 is ideal for:
• Point-to-Point Radios
• Point-to-Multi-Point Radios
• Phased Arrays
• VSAT
• SATCOM

Features
Excellent Noise Figure: 2 dB
Gain: 22 dB
P1dB Output Power: +11 dBm
Supply Voltage: +5V @ 66 mA
Die Size: 2.10 x 1.37 x 0.1 mm

General Description
The HMC-ALH369 is a GaAs MMIC HEMT three stage, self-biased Low Noise Amplifier die which operates between 24 and 40 GHz. The amplifier provides 22 dB of gain, from a single bias supply of +5V @ 66 mA with a noise figure of 2 dB. The HMC-ALH369 amplifier die is ideal for integration into Multi-Chip-Modules (MCMs) due to its small size (2.88 mm²).

Electrical Specifications [1], \( T_A = +25^\circ C, Vdd= +5V, Idd = 66mA \)

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</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>24 - 27</td>
<td>27 - 37</td>
<td>37 - 40</td>
<td>GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gain</td>
<td>22</td>
<td>24</td>
<td>18</td>
<td>20</td>
<td>15</td>
<td>17</td>
<td>dB</td>
<td></td>
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<tr>
<td>Noise Figure</td>
<td>2.2</td>
<td>2.7</td>
<td>2.0</td>
<td>2.5</td>
<td>2.2</td>
<td>2.7</td>
<td>dB</td>
<td></td>
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<tr>
<td>Input Return Loss</td>
<td>12</td>
<td>8</td>
<td>2.0</td>
<td>8</td>
<td>2.5</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Output Return Loss</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>dB</td>
<td></td>
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<tr>
<td>Output Power for 1 dB Compression</td>
<td>9</td>
<td>11</td>
<td>11</td>
<td>9</td>
<td>11</td>
<td>dBm</td>
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<tr>
<td>Supply Current (Idd)</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

[1] Unless otherwise indicated, all measurements are from probed die
HMC-ALH369
GaAs HEMT MMIC LOW NOISE AMPLIFIER, 24 - 40 GHz

Linear Gain vs. Frequency

Noise Figure vs. Frequency

Input Return Loss vs. Frequency

Output Return Loss vs. Frequency

Additive Phase Noise Vs Offset Frequency,
RF Frequency = 33 GHz,
RF Input Power = -6 dBm (Psat)
**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Drain Bias Voltage</td>
<td>+5.5 Vdc</td>
</tr>
<tr>
<td>RF Input Power (24 - 32 GHz)</td>
<td>5 dBm</td>
</tr>
<tr>
<td>RF Input Power (32 - 40 GHz)</td>
<td>-1 dBm</td>
</tr>
<tr>
<td>Channel Temperature</td>
<td>180 °C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 to +150 °C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-55 to +85 °C</td>
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</table>

**Die Packaging Information**

<table>
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<tr>
<th></th>
<th>Standard</th>
<th>Alternate</th>
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<tbody>
<tr>
<td>GP-2 (Gel Pack)</td>
<td></td>
<td>[2]</td>
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</tbody>
</table>

[1] Refer to the “Packaging Information” section for die packaging dimensions.

**NOTES:**
1. ALL DIMENSIONS ARE IN INCHES (MM).
2. TYPICAL BOND PAD IS .004" SQUARE.
3. BACKSIDE METALLIZATION: GOLD.
4. BACKSIDE METAL IS GROUND.
5. BOND PAD METALLIZATION: GOLD.
6. CONNECTION NOT REQUIRED FOR UNLABELED BOND PADS.
7. OVERALL DIE SIZE ±.002"
## Pad Descriptions

<table>
<thead>
<tr>
<th>Pad Number</th>
<th>Function</th>
<th>Description</th>
<th>Interface Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RFIN</td>
<td>This pad is AC coupled and matched to 50 Ohms.</td>
<td><img src="image" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>2</td>
<td>Vdd</td>
<td>Power Supply Voltage for the amplifier. See assembly for required external components.</td>
<td><img src="image" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>3</td>
<td>RFOUT</td>
<td>This pad is AC coupled and matched to 50 Ohms.</td>
<td><img src="image" alt="Interface Schematic" /></td>
</tr>
<tr>
<td>Die bottom</td>
<td>GND</td>
<td>Die bottom must be connected to RF/DC ground.</td>
<td><img src="image" alt="Interface Schematic" /></td>
</tr>
</tbody>
</table>
Assembly Diagram

3.0 x 0.5 mil RIBBON

50 Ohm TRANSMISSION LINE

0.1µF BYPASS

100µF BYPASS

3 mil NOMINAL GAP

TO Vdd POWER SUPPLY

Note 1: Bypass caps should be 100 pF (approximately) ceramic (single-layer) placed no farther than 30 mils from the amplifier.

Note 2: Best performance obtained from use of <10 mil (long) by 3 by 0.5mil ribbons on input and output.
Mounting & Bonding Techniques for Millimeterwave GaAs MMICs

The die should be attached directly to the ground plane eutectically or with conductive epoxy (see HMC general Handling, Mounting, Bonding Note).

50 Ohm Microstrip transmission lines on 0.127mm (5 mil) thick alumina thin film substrates are recommended for bringing RF to and from the chip (Figure 1). If 0.254mm (10 mil) thick alumina thin film substrates must be used, the die should be raised 0.150mm (6 mils) so that the surface of the die is coplanar with the surface of the substrate. One way to accomplish this is to attach the 0.102mm (4 mil) thick die to a 0.150mm (6 mil) thick molybdenum heat spreader (moly-tab) which is then attached to the ground plane (Figure 2).

Microstrip substrates should be placed as close to the die as possible in order to minimize bond wire length. Typical die-to-substrate spacing is 0.076mm to 0.152 mm (3 to 6 mils).

Handling Precautions
Follow these precautions to avoid permanent damage.

Storage: All bare die are placed in either Waffle or Gel based ESD protective containers, and then sealed in an ESD protective bag for shipment. Once the sealed ESD protective bag has been opened, all die should be stored in a dry nitrogen environment.

Cleanliness: Handle the chips in a clean environment. DO NOT attempt to clean the chip using liquid cleaning systems.

Static Sensitivity: Follow ESD precautions to protect against ESD strikes.

Transients: Suppress instrument and bias supply transients while bias is applied. Use shielded signal and bias cables to minimize inductive pick-up.

General Handling: Handle the chip along the edges with a vacuum collet or with a sharp pair of bent tweezers. The surface of the chip has fragile air bridges and should not be touched with vacuum collet, tweezers, or fingers.

Mounting
The chip is back-metallized and can be die mounted with AuSn eutectic preforms or with electrically conductive epoxy. The mounting surface should be clean and flat.

Eutectic Die Attach: A 80/20 gold tin preform is recommended with a work surface temperature of 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be 290 °C. DO NOT expose the chip to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach: Apply a minimum amount of epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip once it is placed into position. Cure epoxy per the manufacturer’s schedule.

Wire Bonding
RF bonds made with 0.003” x 0.0005” ribbon are recommended. These bonds should be thermosonically bonded with a force of 40-60 grams. DC bonds of 0.001” (0.025 mm) diameter, thermosonically bonded, are recommended. Ball bonds should be made with a force of 40-50 grams and wedge bonds at 18-22 grams. All bonds should be made with a nominal stage temperature of 150 °C. A minimum amount of ultrasonic energy should be applied to achieve reliable bonds. All bonds should be as short as possible, less than 12 mils (0.31 mm).