Analog Devices Welcomes Hittite Microwave Corporation

NO CONTENT ON THE ATTACHED DOCUMENT HAS CHANGED
**HMC460**

**GaAs pHEMT MMIC LOW NOISE AMPLIFIER, DC - 20 GHz**

**Typical Applications**
The HMC460 is ideal for:
- Telecom Infrastructure
- Microwave Radio & VSAT
- Military & Space
- Test Instrumentation

**Features**
- Noise Figure: 2.5 dB @ 10 GHz
- Gain: 14 dB @ 10 GHz
- P1dB Output Power: +16 dBm @ 10 GHz
- Supply Voltage: +8V @ 60 mA
- 50 Ohm Matched Input/Output
- Die Size: 3.12 x 1.63 x 0.1 mm

**Functional Diagram**

**General Description**
The HMC460 is a GaAs MMIC PHEMT Low Noise Distributed Amplifier die which operates between DC and 20 GHz. The amplifier provides 14 dB of gain, 2.5 dB noise figure and +16 dBm of output power at 1 dB gain compression while requiring only 60 mA from a +8V supply. The HMC460 amplifier can easily be integrated into Multi-Chip-Modules (MCMs) due to its small size. All data is with the chip in a 50 Ohm test fixture connected via 0.025mm (1 mil) diameter wire bonds of minimal length 0.31mm (12 mils).

**Electrical Specifications, **$T_A = +25^\circ\ C, \ Vdd= 8\ V, \ Idd= 60\ mA$**

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<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>DC - 6.0</td>
<td>6.0 - 18.0</td>
<td>18.0 - 20.0</td>
<td>GHz</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gain</td>
<td>12</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td>11</td>
<td>13</td>
<td>dB</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Gain Flatness</td>
<td>± 0.5</td>
<td>± 0.15</td>
<td>± 0.25</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gain Variation Over Temperature</td>
<td>0.008</td>
<td>0.016</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>dB/ °C</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Noise Figure</td>
<td>4.0</td>
<td>5.0</td>
<td>2.5</td>
<td>3.5</td>
<td>3.0</td>
<td>4.0</td>
<td>dB</td>
<td></td>
<td></td>
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<tr>
<td>Input Return Loss</td>
<td>17</td>
<td>22</td>
<td>dB</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Output Return Loss</td>
<td>17</td>
<td>15</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power for 1 dB Compression (P1dB)</td>
<td>14</td>
<td>17</td>
<td>13</td>
<td>16</td>
<td>12</td>
<td>15</td>
<td>dBm</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Saturated Output Power (Psat)</td>
<td>18</td>
<td>18</td>
<td>17</td>
<td>dBm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Third Order Intercept (IP3)</td>
<td>27.5</td>
<td>28</td>
<td>27</td>
<td>dBm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current (Idd) (Vdd= 8V, Vgg1= -0.9V Typ.)</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

* Adjust Vgg between -2 to 0V to achieve Idd= 60 mA typical.
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Broadband Gain & Return Loss

Gain vs. Temperature

Input Return Loss vs. Temperature

Output Return Loss vs. Temperature

Low Frequency Gain & Return Loss

Noise Figure vs. Temperature
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Output P1dB vs. Temperature

Psat vs. Temperature

Output IP3 vs. Temperature

Gain, Power & Noise Figure vs. Supply Voltage @ 10 GHz, Fixed Vgg1

Reverse Isolation vs. Temperature
**Absolute Maximum Ratings**

- Drain Bias Voltage (Vdd): +9 Vdc
- Gate Bias Voltage (Vgg): -2 to 0 Vdc
- Gate Bias Voltage (Igg): 2.5 mA
- RF Input Power (RFIN) (Vdd = +8 Vdc): +18 dBm
- Channel Temperature: 175 °C
- Continuous Pdiss (T = 85 °C) (derate 24 mW/°C above 85 °C): 2.17 W
- Thermal Resistance (channel to die bottom): 41.5 °C/W
- Storage Temperature: -65 to +150 °C
- Operating Temperature: -55 to +85 °C

**Typical Supply Current vs. Vdd**

<table>
<thead>
<tr>
<th>Vdd (V)</th>
<th>Idd (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+7.5</td>
<td>59</td>
</tr>
<tr>
<td>+8.0</td>
<td>60</td>
</tr>
<tr>
<td>+8.5</td>
<td>62</td>
</tr>
</tbody>
</table>

**Outline Drawing**

**Die Packaging Information**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP-1 (Gel Pack)</td>
<td>[2]</td>
</tr>
</tbody>
</table>

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

**Notes:**
1. ALL DIMENSIONS IN INCHES [MILLIMETERS]
2. NO CONNECTION REQUIRED FOR UNLABELED BOND PADS
3. DIE THICKNESS IS 0.004 (0.100) SQUARE
4. TYPICAL BOND PAD IS 0.004 (0.100) SQUARE
5. BACKSIDE METALLIZATION: GOLD
6. BACKSIDE METAL IS GROUND
7. BOND PAD METIALIZATION: GOLD

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Phone: 978-250-3343  Fax: 978-250-3373  Order On-line at www.hittite.com
Application Support: Phone: 978-250-3343 or apps@hittite.com
### 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 DC coupled and matched to 50 Ohms.</td>
<td><img src="image" alt="RFIN ACG2" /></td>
</tr>
<tr>
<td>2</td>
<td>Vdd</td>
<td>Power supply voltage for the amplifier. External bypass capacitors are required</td>
<td><img src="image" alt="Vdd" /></td>
</tr>
<tr>
<td>3</td>
<td>ACG1</td>
<td>Low frequency termination. Attach bypass capacitor per application circuit herein.</td>
<td><img src="image" alt="ACG1 RFOUT" /></td>
</tr>
<tr>
<td>4</td>
<td>RFOUT</td>
<td>This pad is DC coupled and matched to 50 Ohms.</td>
<td><img src="image" alt="RFOUT ACG2" /></td>
</tr>
<tr>
<td>5</td>
<td>ACG2</td>
<td>Low frequency termination. Attach bypass capacitor per application circuit herein.</td>
<td><img src="image" alt="RFIN ACG2" /></td>
</tr>
<tr>
<td>6</td>
<td>Vgg</td>
<td>Gate control for amplifier. Adjust to achieve Idd= 60 mA.</td>
<td><img src="image" alt="Vgg" /></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="GND" /></td>
</tr>
</tbody>
</table>
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Assembly Diagram

TO Vdd POWER SUPPLY
1000pF CAPACITOR TO GROUND
0.1uF CAPACITOR TO GROUND
RF & DC BONDS
1mil GOLD WIRE
50 Ohm TRANSMISSION LINE
100pF BYPASS CAPACITOR
0.01uF BYPASS CAPACITOR
1000pF CAPACITOR TO GROUND
70 VgGT POWER SUPPLY
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 located 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 > ± 250V 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 may have 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

Ball or wedge bond with 0.025mm (1 mil) diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. Wirebonds should be started on the chip and terminated on the package or substrate. All bonds should be as short as possible <0.31mm (12 mils).
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Notes: