

GaAs PHEMT MMIC 2 WATT POWER AMPLIFIER, 6 - 10 GHz

Typical Applications

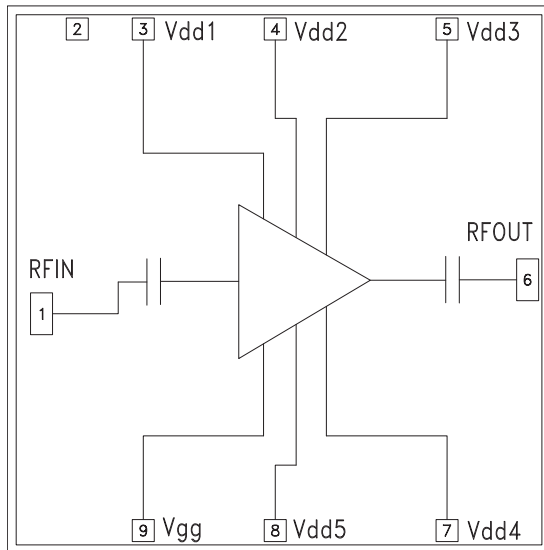
The HMC591 is ideal for use as a power amplifier for:

- Point-to-Point Radios
- Point-to-Multi-Point Radios
- Test Equipment & Sensors
- Military End-Use
- Space

Features

- Saturated Output Power: +34 dBm @ 24% PAE
- Output IP3: +43 dBm
- Gain: 23 dB
- DC Supply: +7.0 V @ 1340 mA
- 50 Ohm Matched Input/Output
- 2.47 mm x 2.49 mm x 0.1 mm

Functional Diagram



General Description

The HMC591 is a high dynamic range GaAs PHEMT MMIC 2 Watt Power Amplifier which operates from 6 to 10 GHz. This amplifier die provides 23 dB of gain and +34 dBm of saturated power, at 24% PAE from a +7.0V supply. Output IP3 is +43 dBm typical. The RF I/Os are DC blocked and matched to 50 Ohms for ease of integration into Multi-Chip-Modules (MCMs). All data is taken with the chip in a 50 ohm test fixture connected via 0.025mm (1 mil) diameter wire bonds of length 0.31mm (12 mils). For applications which require optimum OIP3, I_{dd} should be set for 940 mA, to yield +43 dBm OIP3. For applications which require optimum output P1dB, I_{dd} should be set for 1340 mA, to yield +33 dBm Output P1dB.

Electrical Specifications, $T_A = +25^\circ C$, $V_{dd} = +7V$, $I_{dd} = 1340 mA$ ^[1]

| Parameter | Min. | Typ. | Max. | Min. | Typ. | Max. | Units |
|---|--------|------|------|---------|------|------|--------|
| Frequency Range | 6 - 10 | | | 6.8 - 9 | | | GHz |
| Gain | 20 | 23 | | 20 | 23 | | dB |
| Gain Variation Over Temperature | | 0.05 | | | 0.05 | | dB/ °C |
| Input Return Loss | | 12 | | | 14 | | dB |
| Output Return Loss | | 11 | | | 10 | | dB |
| Output Power for 1 dB Compression (P1dB) | 30 | 33 | | 30.5 | 33.5 | | dBm |
| Saturated Output Power (Psat) | | 33.5 | | | 34 | | dBm |
| Output Third Order Intercept (IP3) ^[2] | | 43 | | | 43 | | dBm |
| Supply Current (I _{dd}) | | 1340 | | | 1340 | | mA |

[1] Adjust V_{gg} between -2 to 0V to achieve I_{dd}= 1340 mA typical.

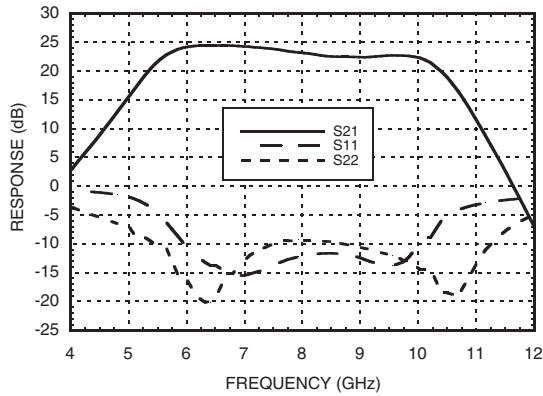
[2] Measurement taken at 7V @ 940mA, Pin / Tone = -15 dBm

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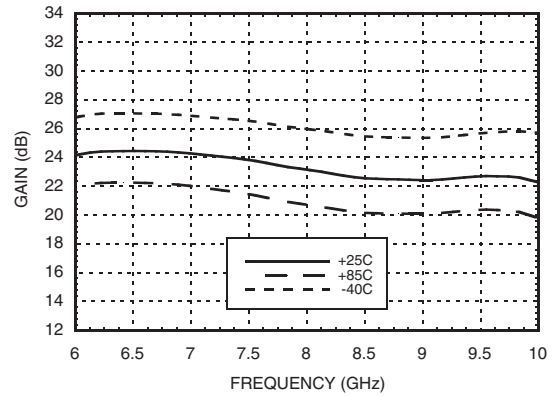
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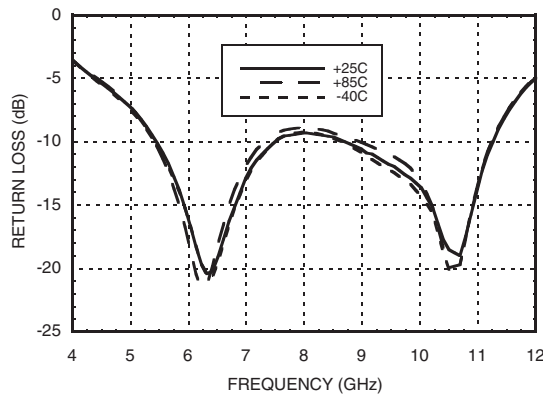
Broadband Gain & Return Loss



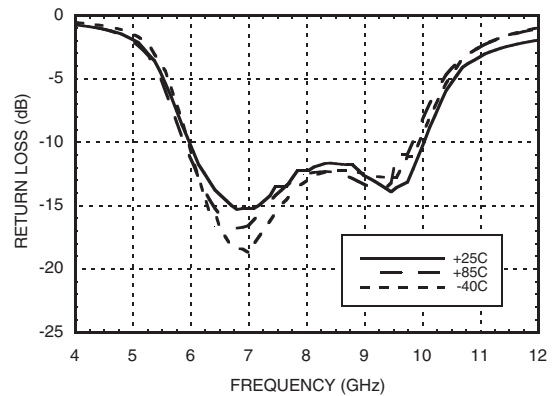
Gain vs. Temperature



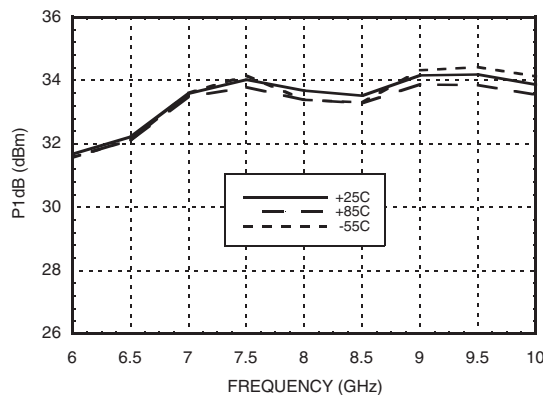
Input Return Loss vs. Temperature



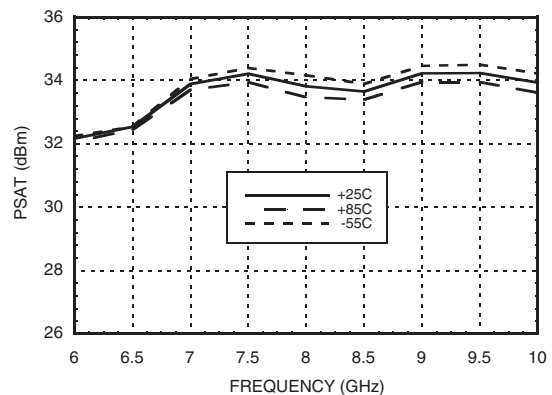
Output Return Loss vs. Temperature



P1dB vs. Temperature

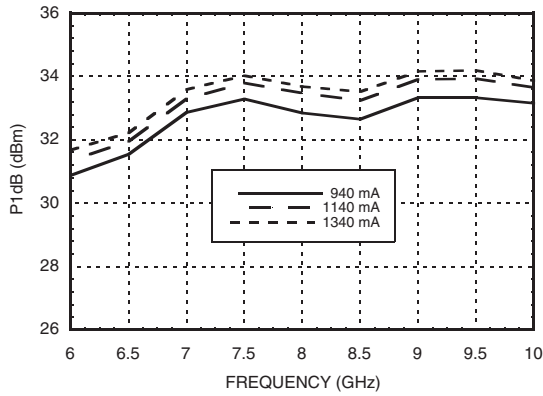


Psat vs. Temperature

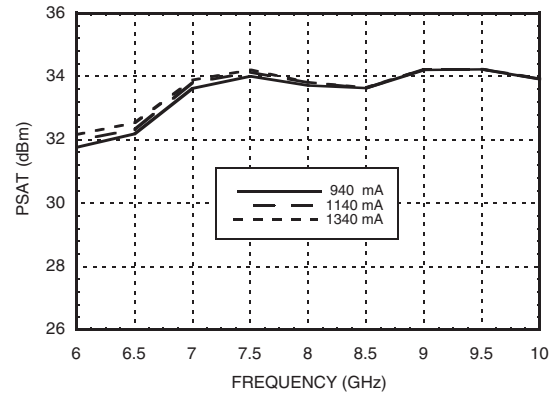


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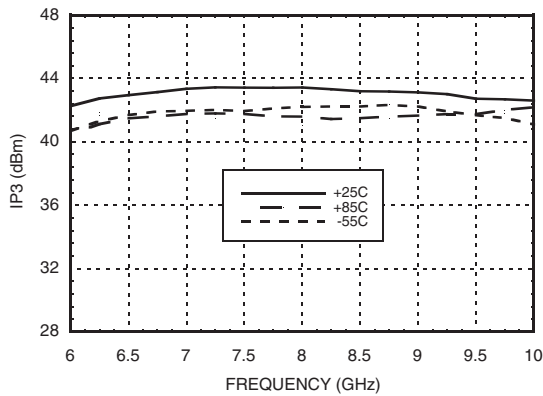
P1dB vs. Current



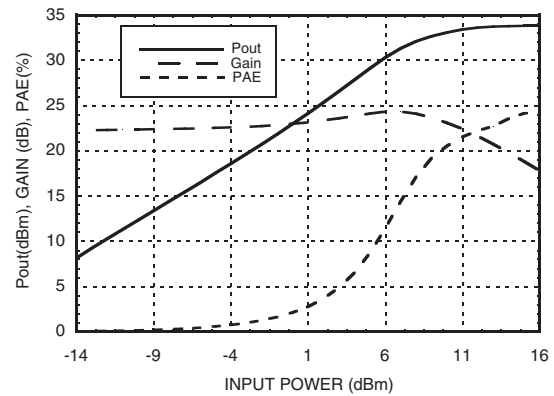
Psat vs. Current



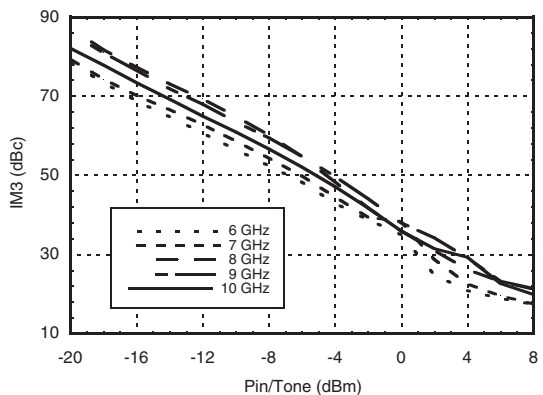
Output IP3 vs. Temperature
7V @ 940 mA, Pin/Tone = -15 dBm



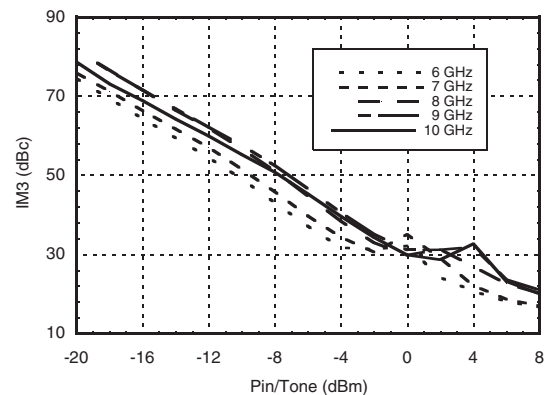
Power Compression @ 8 GHz,
7V @ 1340 mA



Output IM3, 7V @ 940 mA

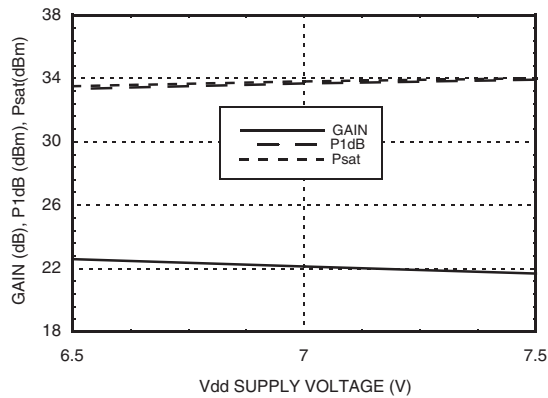


Output IM3, 7V @ 1340 mA

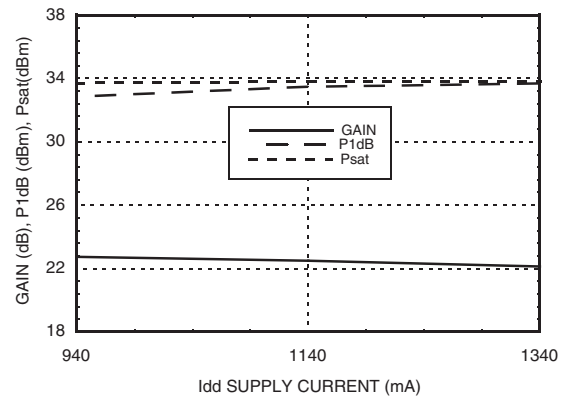


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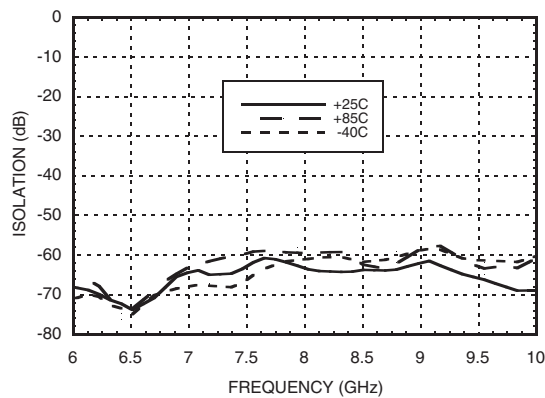
Gain & Power vs. Supply Voltage @ 8 GHz



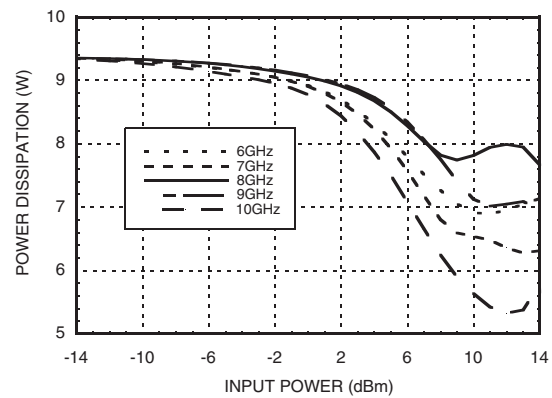
Gain & Power vs. Supply Current @ 8 GHz



**Reverse Isolation
vs. Temperature, 7V @ 1340 mA**



Power Dissipation



Absolute Maximum Ratings

| | |
|---|----------------|
| Drain Bias Voltage (Vdd) | +8 Vdc |
| Gate Bias Voltage (Vgg) | -2 to 0 Vdc |
| RF Input Power (RFIN)(Vdd = +7.0 Vdc) | +15 dBm |
| Channel Temperature | 175 °C |
| Continuous Pdiss (T= 85 °C) (derate 117.6 mW/°C above 85 °C) | 10.59 W |
| Thermal Resistance (channel to die bottom) | 8.5 °C/W |
| Storage Temperature | -65 to +150 °C |
| Operating Temperature | -55 to +85 °C |

Typical Supply Current vs. Vdd

| Vdd (V) | Idd (mA) |
|---------|----------|
| +6.5 | 1355 |
| +7.0 | 1340 |
| +7.5 | 1325 |

Note: Amplifier will operate over full voltage ranges shown above Vgg adjusted to achieve Idd = 1340 mA at +7.0V



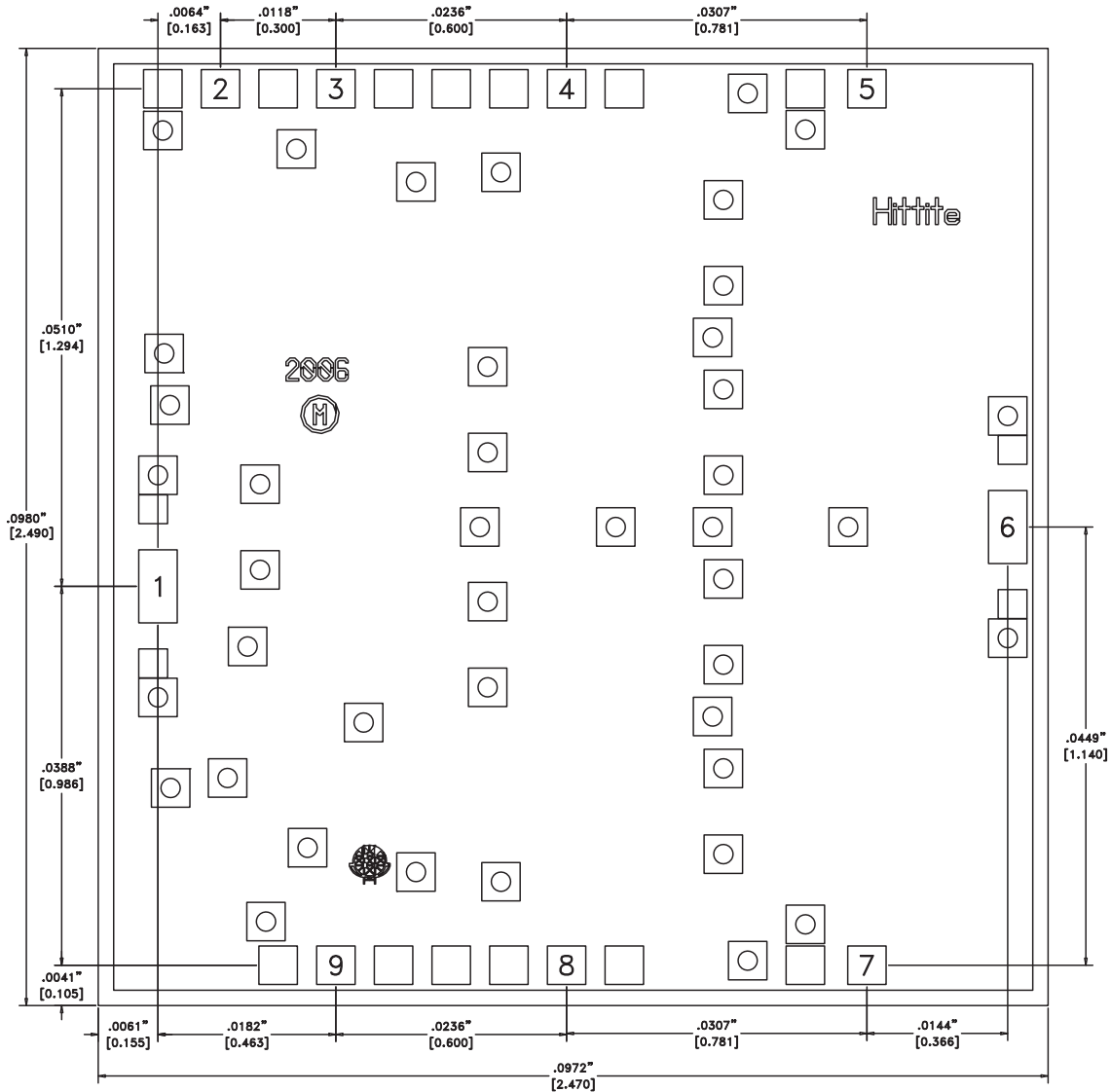
ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

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Outline Drawing



Die Packaging Information [1]

| Standard | Alternate |
|-----------------|-----------|
| GP-1 (Gel Pack) | [2] |

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

[2] For alternate packaging information contact Hittite Microwave Corporation.

NOTES:

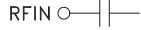
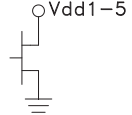
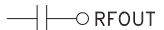
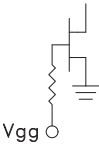

1. ALL DIMENSIONS ARE IN INCHES [MM]
2. DIE THICKNESS IS .004"
3. TYPICAL BOND PAD IS .004" SQUARE
4. BACKSIDE METALLIZATION: GOLD
5. BOND PAD METALLIZATION: GOLD
6. BACKSIDE METAL IS GROUND.
7. CONNECTION NOT REQUIRED FOR UNLABELED BOND PADS.
8. OVERALL DIE SIZE ± .002

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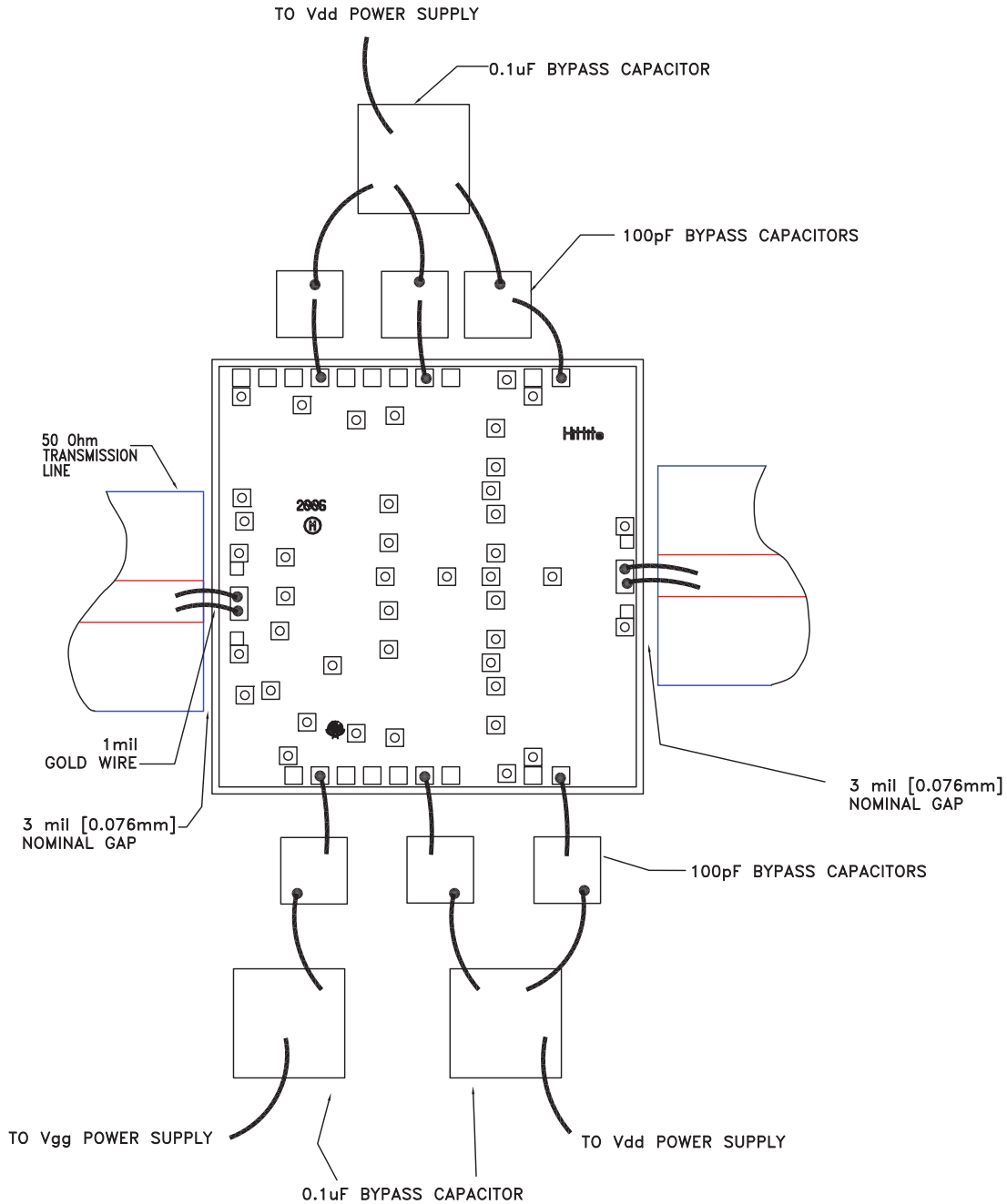
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Pad Descriptions

| Pad Number | Function | Description | Interface Schematic |
|-------------|----------|--|---|
| 1 | RFIN | This pad is AC coupled and matched to 50 Ohms. |  |
| 3 - 5, 7, 8 | Vdd 1-5 | Power Supply Voltage for the amplifier. External bypass capacitors of 100 pF and 0.1 μF are required. |  |
| 6 | RFOUT | This pad is AC coupled and matched to 50 Ohms. |  |
| 9 | Vgg | Gate control for amplifier. Adjust to achieve I _{dd} of 1340 mA. Please follow "MMIC Amplifier Biasing Procedure" Application Note. External bypass capacitors of 100 pF and 0.1 μF are required. |  |
| Die Bottom | GND | Die bottom must be connected to RF/DC ground. |  |

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Assembly Diagram



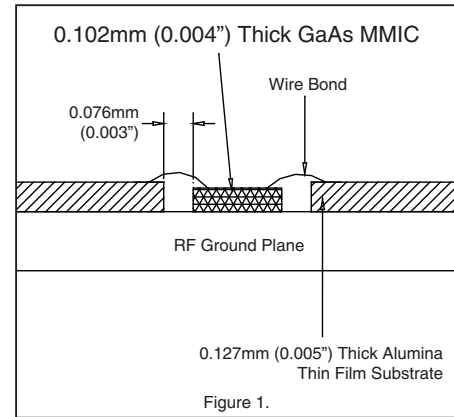
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Mounting & Bonding Techniques for Millimeterwave GaAs MMICs

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

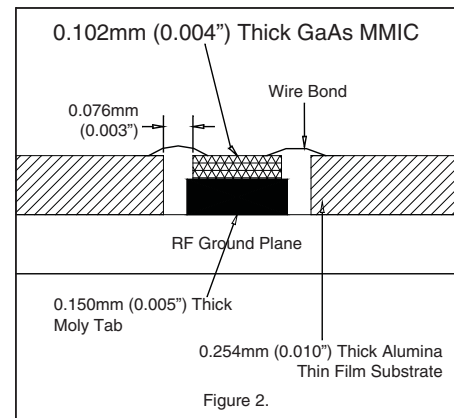
Follow these precautions to avoid permanent damage.

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 electrically conductive epoxy. The mounting surface should be clean and flat.

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).