

# Analog Devices Welcomes Hittite Microwave Corporation

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## GaAs PHEMT MMIC DRIVER AMPLIFIER, 5 - 20 GHz

### Typical Applications

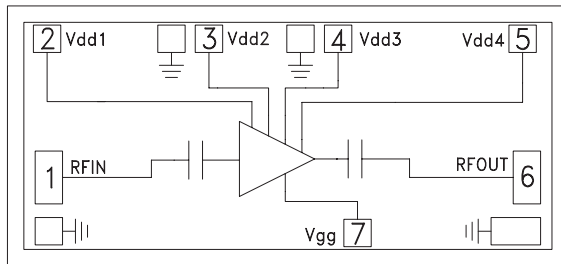
The HMC634 is ideal for:

- Point-to-Point Radios
- Point- to-Multi-Point Radios & VSAT
- LO Driver for Mixers
- Military & Space

### Features

- Gain: 22 dB
- P1dB: +23 dBm
- Output IP3: +31 dBm
- Saturated Power: 24 dBm @ 23% PAE
- Supply Voltage: +5 V @ 180 mA
- 50 Ohm Matched Input/Output
- Die Size: 2.07 x 0.97 x 0.10 mm

### Functional Diagram



### General Description

The HMC634 is a GaAs MMIC PHEMT Driver Amplifier die which operates between 5 and 20 GHz. The amplifier provides up to 22 dB of gain, +31 dBm Output IP3, and up to +23 dBm of output power at 1 dB gain compression, while requiring 180 mA from a +5V supply. The HMC634 is an ideal driver amplifier for microwave radio applications from 5 to 20 GHz, and may be biased at +5V, 130 mA to provide 2 dB lower gain with improved PAE. The HMC634 amplifier I/O's are DC blocked and internally matched to 50 Ohms facilitating easy integration into Multi-Chip-Modules (MCMs). All data is taken with die connected at input and output RF ports via one 1 mil wedge bond with minimal length of 0.31 mm (12 mils).

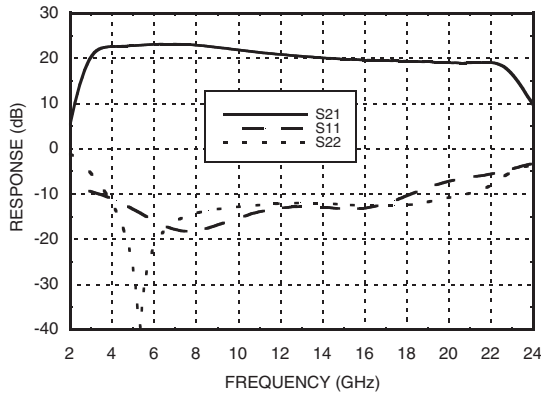
### Electrical Specifications, $T_A = +25^\circ \text{C}$ , $V_{dd1}, V_{dd2}, V_{dd3}, V_{dd4} = 5\text{V}$ , $I_{dd} = 180\text{mA}$ <sup>[1]</sup>

| Parameter                                  | Min.   | Typ.  | Max.    | Min. | Typ.  | Max.  | Units  |
|--|--------|-------|---------|------|-------|-------|--------|
| Frequency Range                            | 5 - 16 |       | 16 - 20 |      | GHz   |       |        |
| Gain                                       | 17     | 22    |         | 17   | 20    |       | dB     |
| Gain Variation Over Temperature            |        | 0.030 | 0.040   |      | 0.025 | 0.035 | dB/ °C |
| Input Return Loss                          |        | 12    |         |      | 9     |       | dB     |
| Output Return Loss                         |        | 12    |         |      | 11    |       | dB     |
| Output Power for 1 dB Compression (P1dB)   | 21     | 23    |         | 18   | 21    |       | dBm    |
| Saturated Output Power (Psat)              |        | 24    |         |      | 22    |       | dBm    |
| Output Third Order Intercept (IP3)         |        | 31    |         |      | 30    |       | dBm    |
| Noise Figure                               |        | 7     |         |      | 7.5   |       | dB     |
| Supply Current (Idd1 + Idd2 + Idd3 + Idd4) |        | 180   |         |      | 180   |       | mA     |

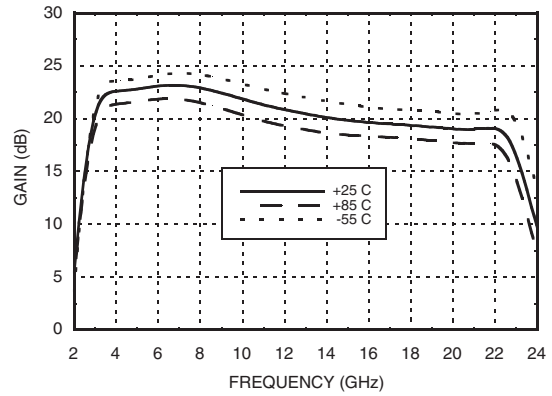
<sup>[1]</sup> Adjust Vgg between -2 to 0V to achieve Idd = 180mA Typical

**GaAs PHEMT MMIC DRIVER  
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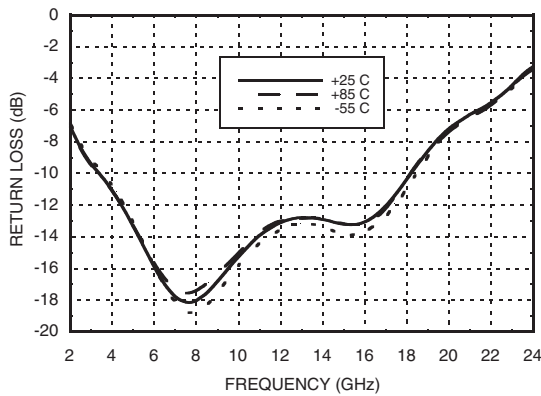
**Broadband Gain & Return Loss**



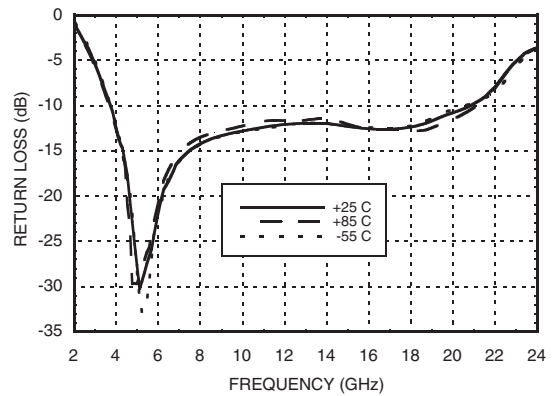
**Gain vs. Temperature**



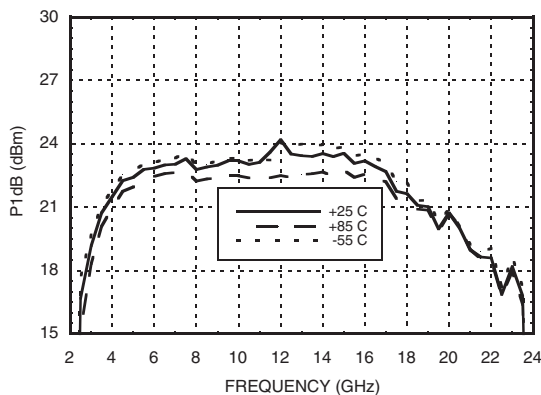
**Input Return Loss vs. Temperature**



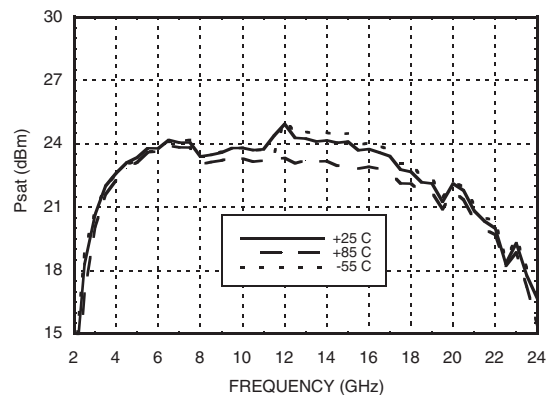
**Output Return Loss vs. Temperature**



**P1dB vs. Temperature**

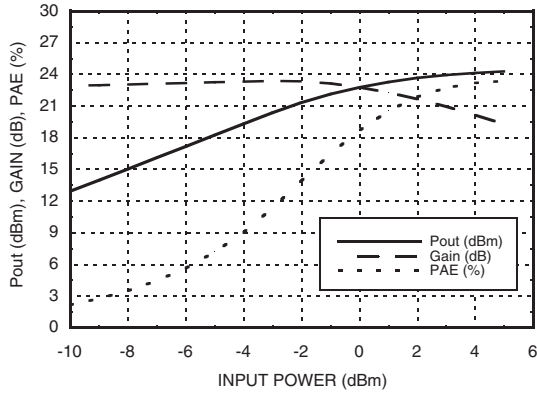


**Psat vs. Temperature**

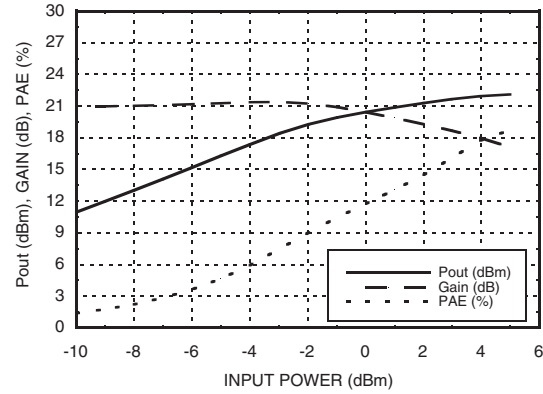


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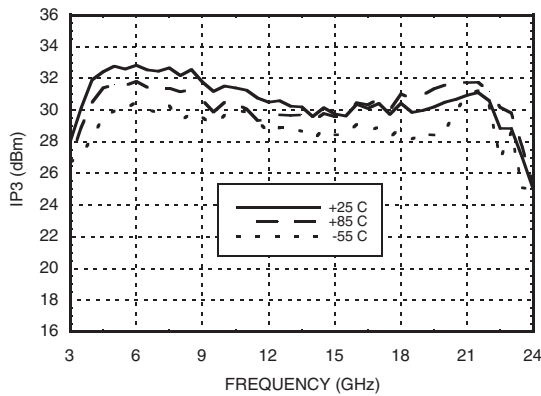
**Power Compression @ 12.5 GHz**



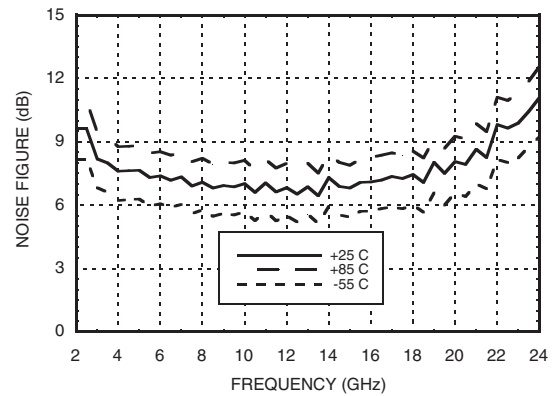
**Power Compression @ 20 GHz**



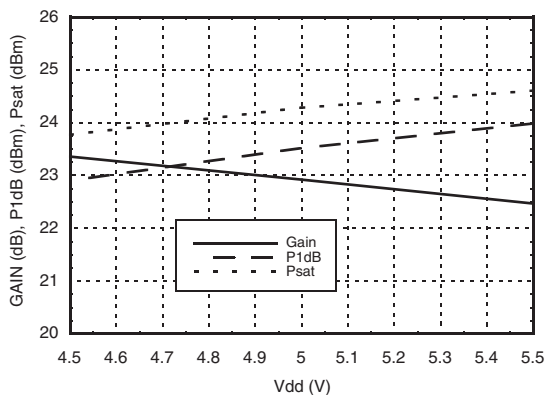
**Output IP3 vs. Temperature**



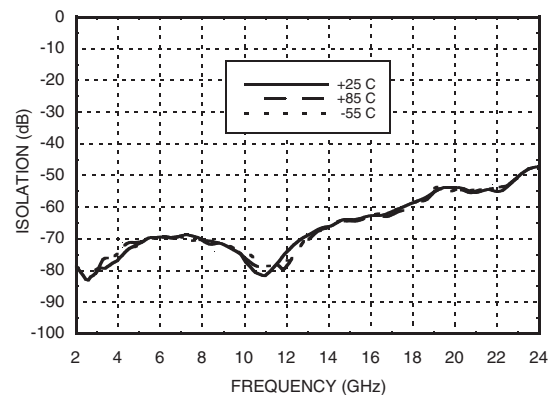
**Noise Figure vs. Temperature**



**Gain & Power vs. Supply Voltage @ 12.5 GHz**

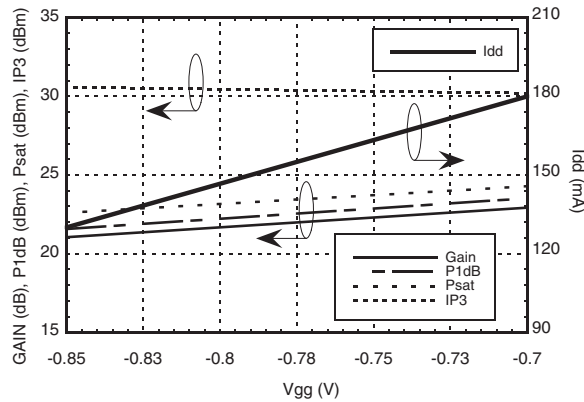


**Reverse Isolation vs. Temperature**



**GaAs PHEMT MMIC DRIVER  
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**Gain, Power & Output IP3  
vs. Gate Voltage @ 12.5 GHz**



**Absolute Maximum Ratings**

|   |                |
|---|----------------|
| Drain Bias Voltage (V <sub>dd1</sub> , V <sub>dd2</sub> , V <sub>dd3</sub> , V <sub>dd4</sub> ) | +5.5 Vdc       |
| Gate Bias Voltage (V <sub>gg</sub> )  | -3 to 0 Vdc    |
| RF Input Power (RFIN)(V <sub>dd</sub> = +5 Vdc)   | +10 dBm        |
| Channel Temperature   | 175 °C         |
| Continuous P <sub>diss</sub> (T= 85 °C)<br>(derate 11.93 mW/°C above 85 °C)                     | 1.07 W         |
| Thermal Resistance<br>(channel to die bottom)   | 83.8 °C/W      |
| Storage Temperature   | -65 to +150 °C |
| Operating Temperature   | -55 to +85 °C  |

**Typical Supply Current vs. V<sub>dd</sub>**

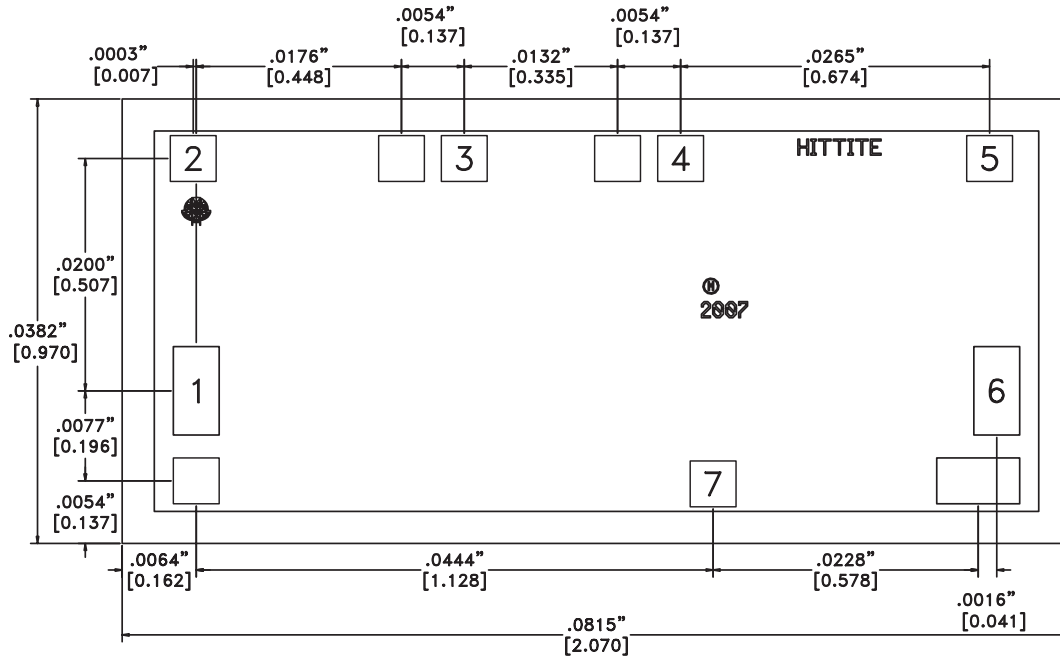
| V <sub>dd</sub> (V) | I <sub>dd</sub> (mA) |
|---------------------|----------------------|
| 4.5                 | 175                  |
| 5.0                 | 180                  |
| 5.5                 | 182                  |

Note: Amplifier will operate over full voltage ranges shown above



**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**

**Outline Drawing**



**NOTES:**

1. ALL DIMENSIONS ARE IN INCHES [MM]
2. DIE THICKNESS IS .004"
3. TYPICAL BOND 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.

**Die Packaging Information** [1]

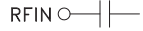
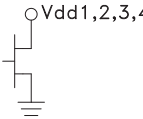
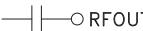
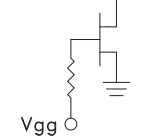
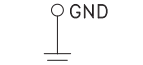
| Standard        | Alternate |
|-----------------|-----------|
| GP-2 (Gel Pack) | [2]       |

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

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

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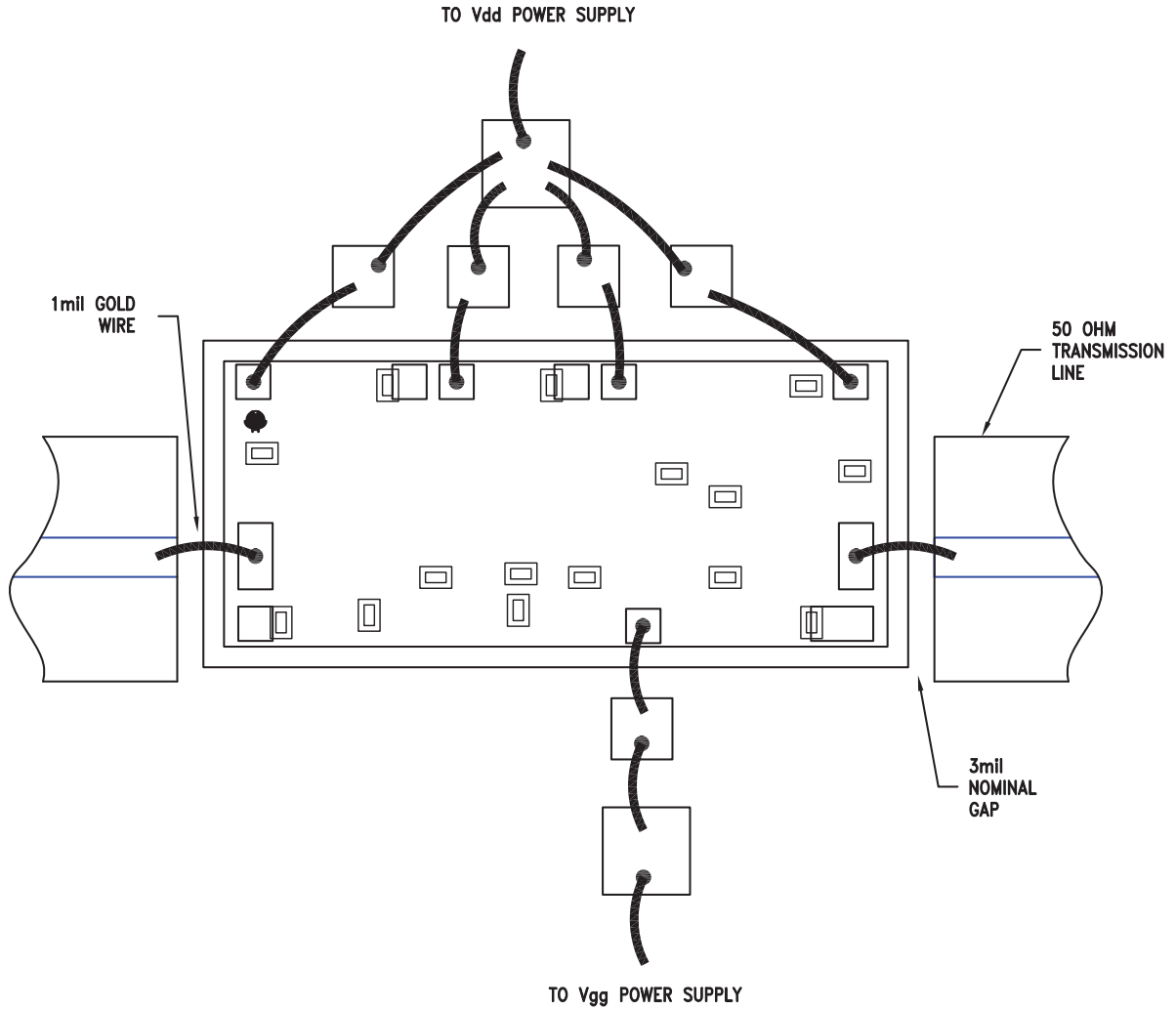
**Pad Descriptions**

| Pad Number | Function               | Description   | Interface Schematic   |
|------------|------------------------|---|---|
| 1          | RFIN                   | This pad is AC coupled and matched to 50 Ohms.  |  |
| 2, 3, 4, 5 | Vdd1, Vdd2, Vdd3, Vdd4 | Power Supply Voltage for the amplifier. See assembly diagram for required external components.  |  |
| 6          | RFOUT                  | This pad is AC coupled and matched to 50 Ohms.  |  |
| 7          | Vgg                    | Gate control for amplifier, please follow "MMIC Amplifier Biasing Procedure" Application Note. See assembly diagram for required external components. |  |
| Die Bottom | GND                    | Die bottom must be connected to RF/DC ground.   |  |



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**Assembly Diagram**



 0.1 $\mu$ F  
BYPASS  
CAPACITOR

 100pF  
BYPASS  
CAPACITOR

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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 brought 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**

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).

