

GaAs PHEMT MMIC MODULATOR DRIVER AMPLIFIER, DC - 20.0 GHz

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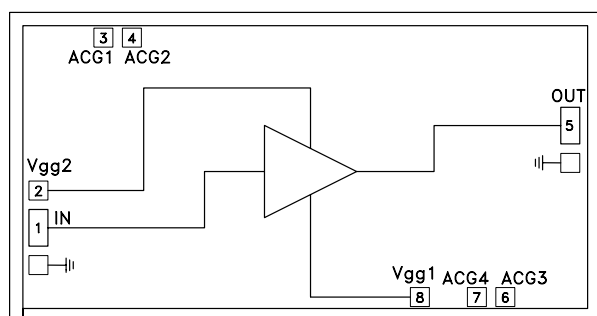
AMPLIFIERS - CHIP

Typical Applications

The HMC465 wideband driver is ideal for:

- OC192 LN/MZ Modulator Driver
- Telecom Infrastructure
- Test Instrumentation
- Military & Space

Functional Diagram



Features

- Gain: 17 dB
- Output Voltage to 10Vpk-pk
- +24 dBm Saturated Output Power
- Supply Voltage: +8V @ 160 mA
- 50 Ohm Matched Input/Output
- 3.12 mm x 1.63 mm x 0.1 mm

General Description

The HMC465 is a GaAs MMIC PHEMT Distributed Driver Amplifier die which operates between DC and 20 GHz. The amplifier provides 17 dB of gain, 2.5 dB noise figure and +24 dBm of saturated output power while requiring only 160 mA from a +8V supply. Gain flatness is excellent at ± 0.25 dB as well as ± 1 deg deviation from linear phase from DC - 10 GHz making the HMC465 ideal for OC192 fiber optic LN/MZ modulator driver amplifier as well as test equipment applications. The HMC465 amplifier I/Os are internally matched to 50 Ohms facilitating easy integration into Multi-Chip-Modules (MCMs). All data is with the chip in a 50 Ohm test fixture connected via 0.025 mm (1 mil) diameter wire bonds of minimal length 0.31mm (12 mils).

Electrical Specifications, $T_A = +25^\circ\text{C}$, $V_{dd} = 8\text{V}$, $V_{gg2} = 1.5\text{V}$, $I_{dd} = 160\text{mA}$ *

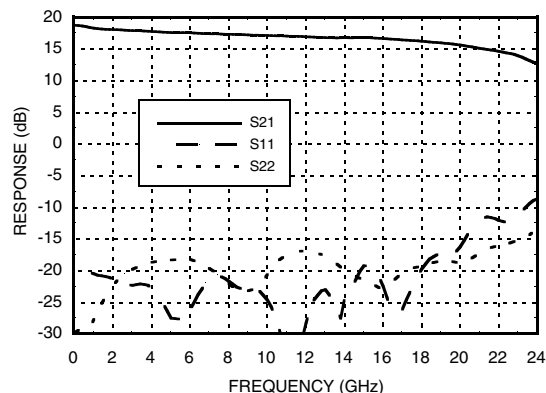
Parameter	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
Frequency Range	DC - 6.0			6.0 - 12.0			12.0 - 20.0			GHz
Gain	15	18		15	17		13	16.5		dB
Gain Flatness		± 0.5			± 0.25			± 0.5		dB
Gain Variation Over Temperature		0.015	0.025		0.015	0.025		0.02	0.03	dB/ $^\circ\text{C}$
Noise Figure		3.0	5.0		2.5	3.5		3.0	4.5	dB
Input Return Loss		18			20			16		dB
Output Return Loss		18			17			17		dB
Output Power for 1 dB Compression (P1dB)	19.5	22.5		19	22		17	20		dBm
Saturated Output Power (Psat)		24			24			22		dBm
Output Third Order Intercept (IP3)		33			30			26		dBm
Saturated Output Voltage		10			10			8		Vpk-pk
Group Delay Variation		± 3			± 3			± 3		pSec
Supply Current (Idd) (Vdd= 8V, Vgg1= -0.6V Typ.)		160			160			160		mA

* Adjust Vgg1 between -2 to 0V to achieve Idd= 160 mA typical.

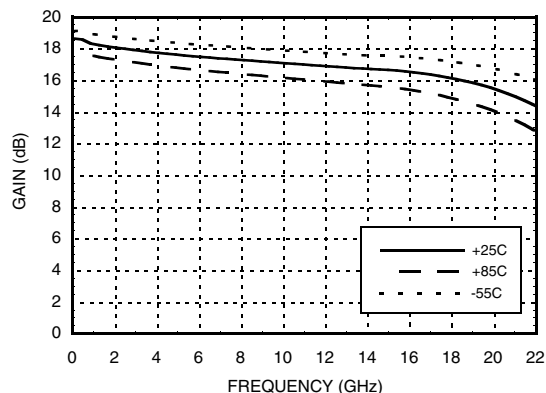
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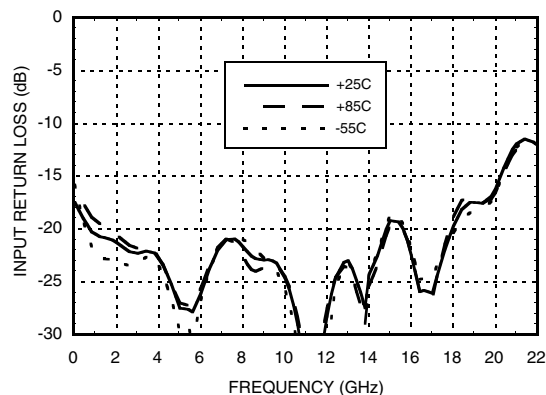
Gain & Return Loss



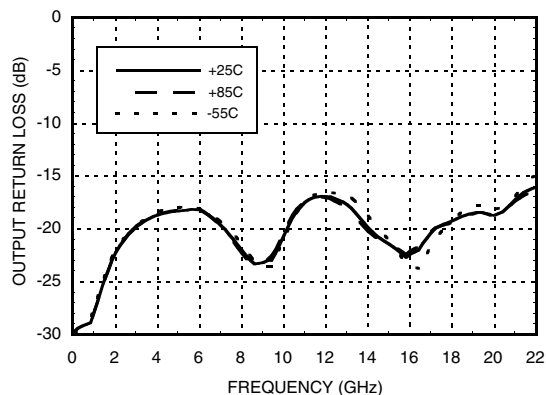
Gain vs. Temperature



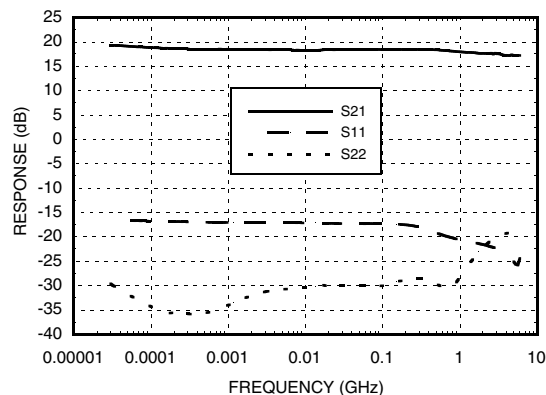
Input Return Loss vs. Temperature



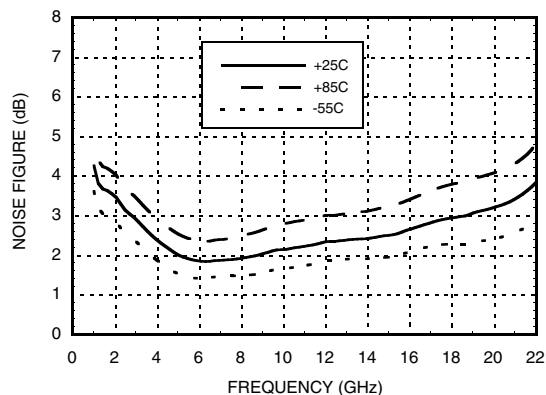
Output Return Loss vs. Temperature



Low Frequency Gain & Return Loss



Noise Figure vs. Temperature

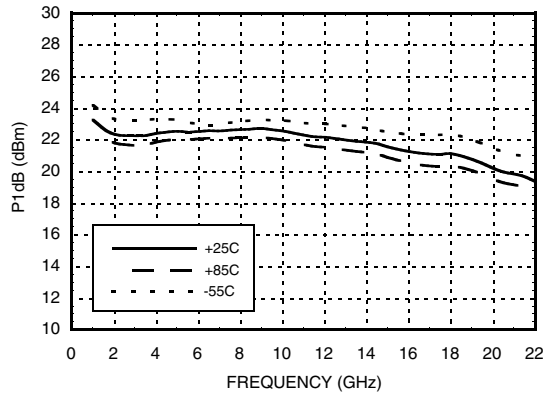


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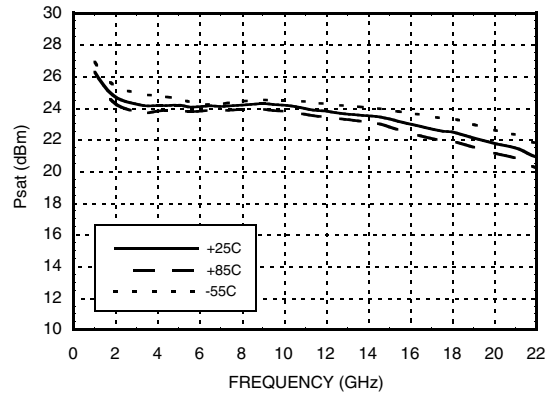
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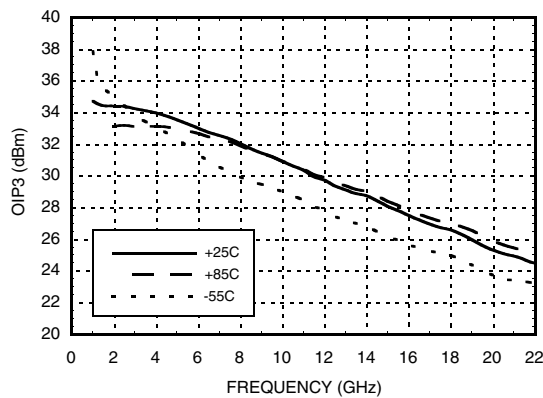
P1dB vs. Temperature



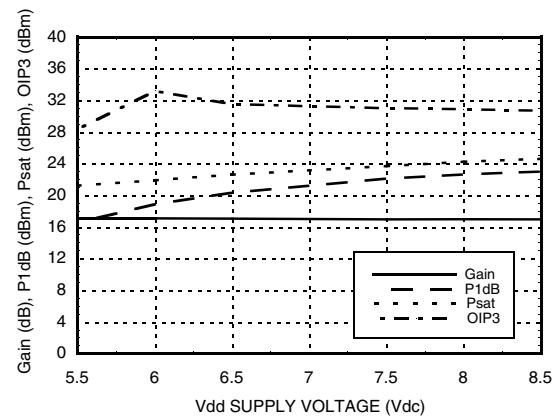
Psat vs. Temperature



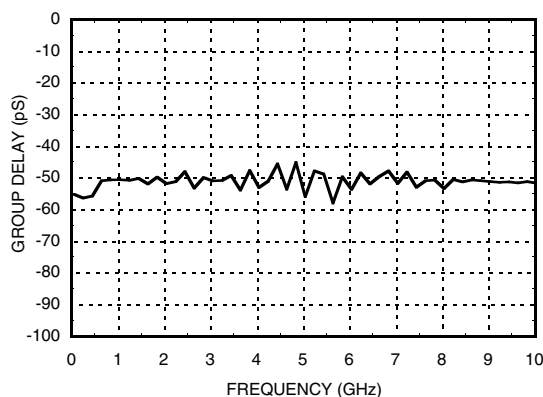
Output IP3 vs. Temperature



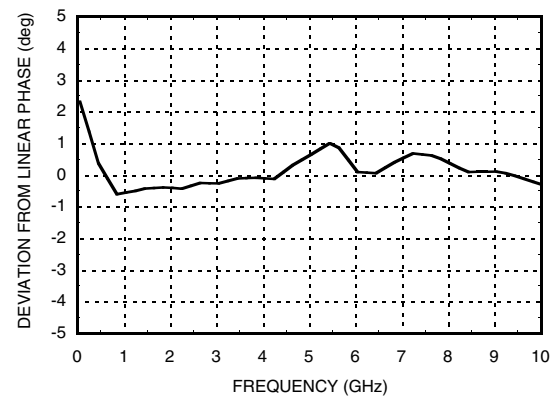
**Gain, Power & OIP3 vs. Supply Voltage
@ 10 GHz, Idd= 160mA**



Group Delay



Deviation from Linear Phase



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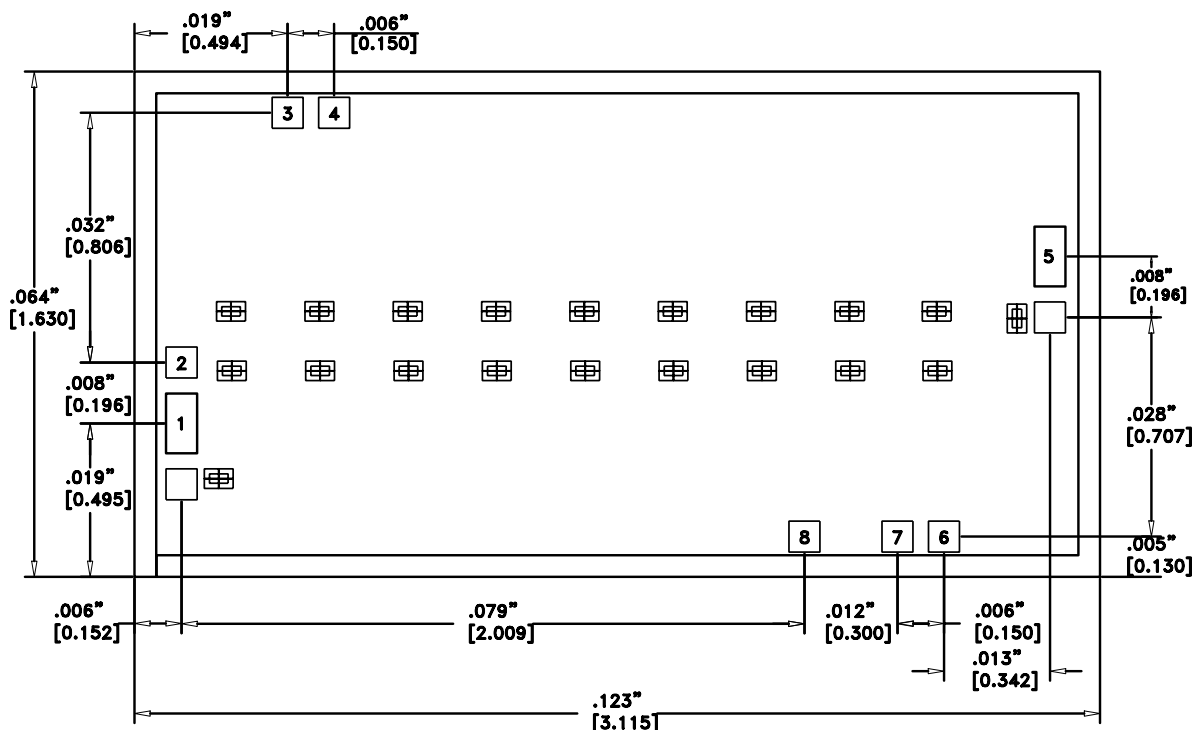
Absolute Maximum Ratings

Drain Bias Voltage (Vdd)	+9.0 Vdc
Gate Bias Voltage (Vgg1)	-2.0 to 0 Vdc
Gate Bias Voltage (Vgg2)	(Vdd - 8.0) Vdc to Vdd
RF Input Power (RFIn)(Vdd = +8.0 Vdc)	+23 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

Vdd (V)	Idd (mA)
+7.5	161
+8.0	160
+8.5	159

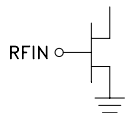
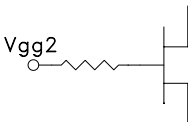
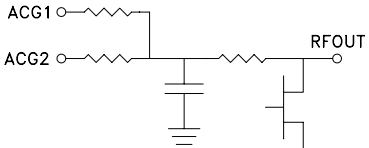
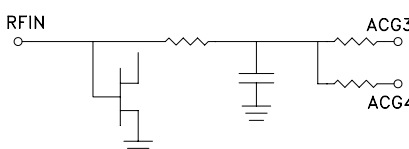
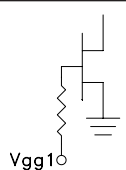
Outline Drawing



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

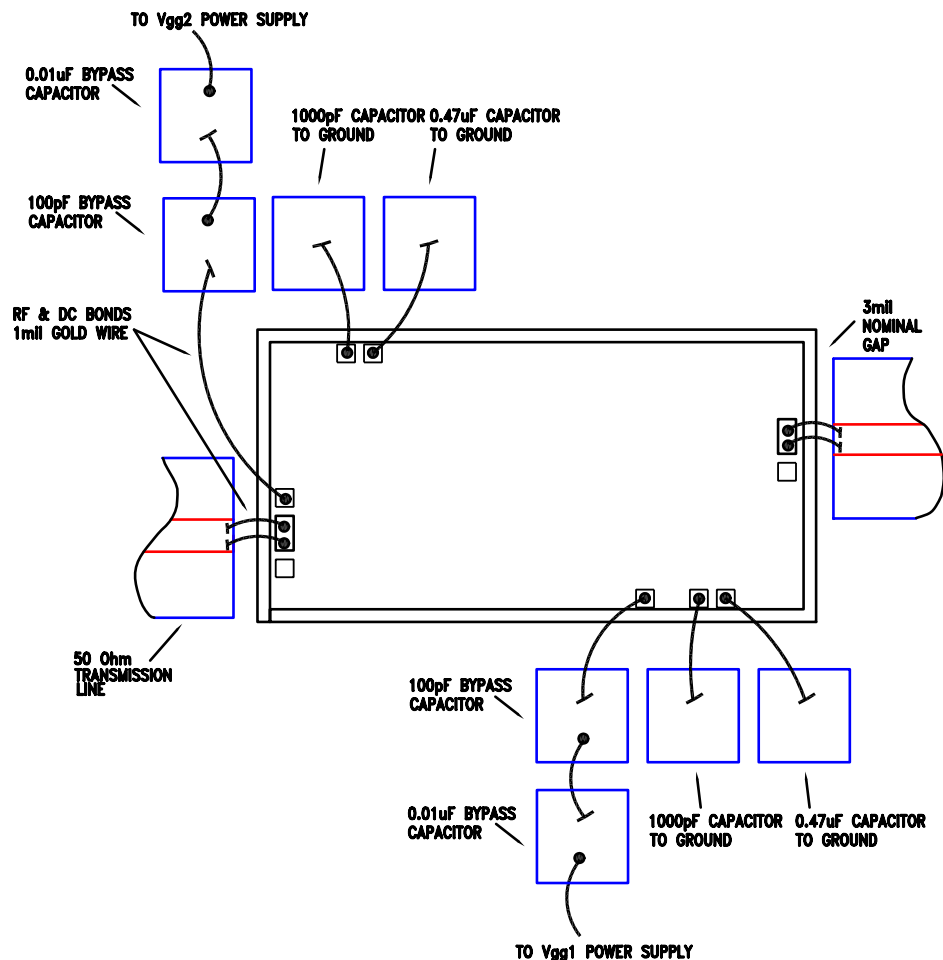
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Pad Descriptions

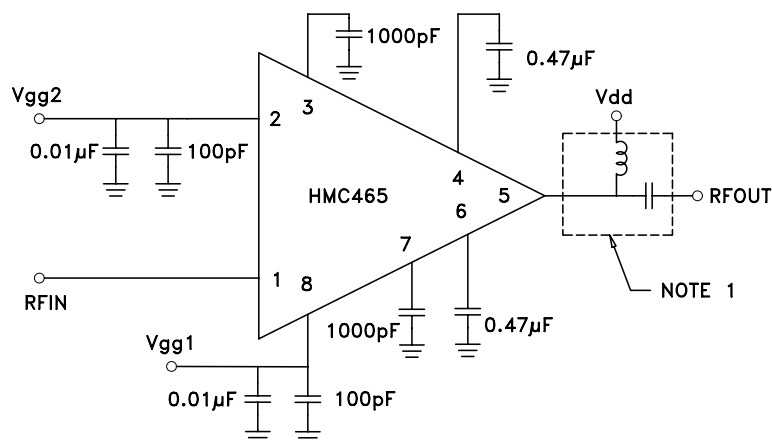
Pad Number	Function	Description	Interface Schematic
1	RFIN	This pad is DC coupled and matched to 50 Ohms from DC - 20.0 GHz	
2	Vgg2	Gate Control 2 for amplifier. +1.5V should be applied to Vgg2 for nominal operation.	
3	ACG1	Low frequency termination. Attach bypass capacitor per application circuit herein.	
4	ACG2		
5	RFOUT & Vdd	RF output for amplifier. Connect the DC bias (Vdd) network to provide drain current (Idd). See application circuit herein.	
6	ACG3	Low frequency termination. Attach bypass capacitor per application circuit herein.	
7	ACG4		
8	Vgg1	Gate Control 2 for amplifier.	
Die Bottom	GND	Die bottom must be connected to RF/DC ground.	

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Assembly Diagram



Application Circuit



NOTE 1: Drain Bias (V_{dd}) must be applied through a broadband bias tee or external bias network.

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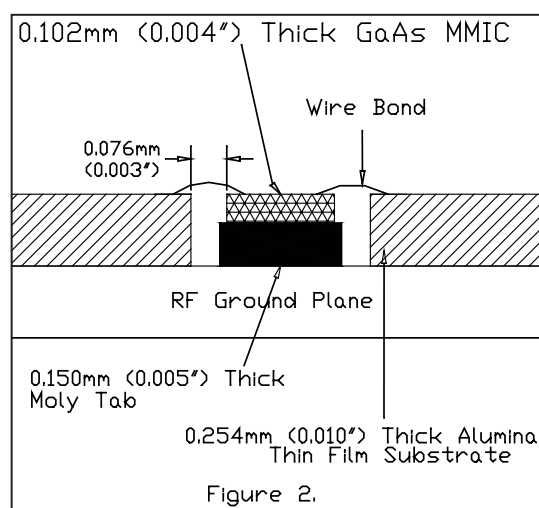
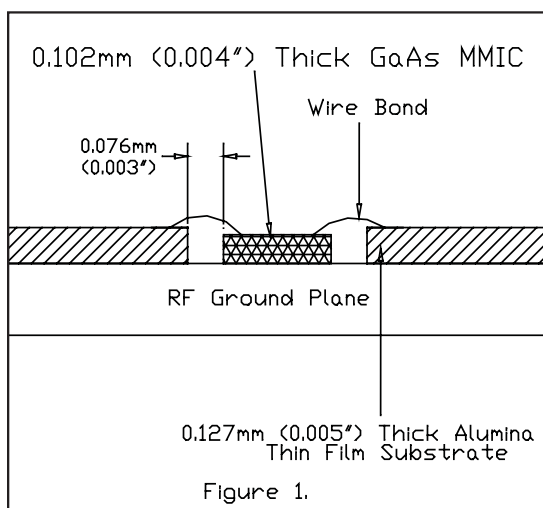
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Mounting & Bonding Techniques for Millimeterwave GaAs MMICs

The die should be attached directly to the ground plane 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).



**GaAs PHEMT MMIC MODULATOR DRIVER
AMPLIFIER, DC - 20.0 GHz****Handling Precautions**

Follow these precautions to avoid permanent damage.

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 $> \pm 250\text{V}$ 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 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 deg. 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 $< 0.31\text{mm}$ (12 mils).