



## GaAs PHEMT MMIC MODULATOR DRIVER AMPLIFIER, DC - 20 GHz

### Typical Applications

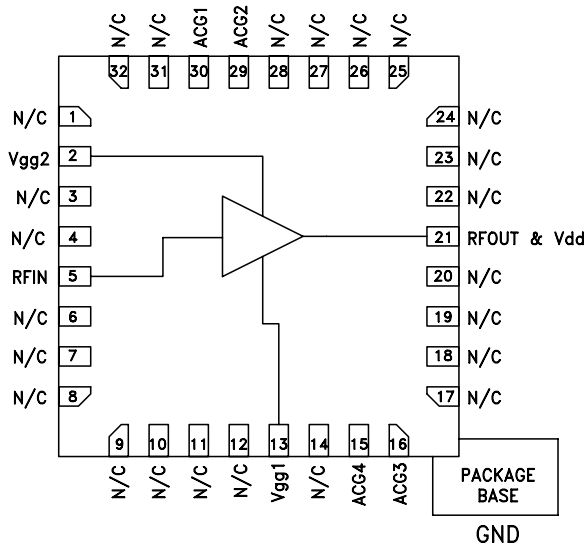
The HMC465LP5(E) wideband driver is ideal for:

- OC192 LN/MZ Modulator Driver
- Microwave Radio & VSAT
- Test Instrumentation
- Military EW, ECM & C<sup>3</sup>I

### Features

- Gain: 15 dB
- Output Voltage to 10Vpk-pk
- +24 dBm Saturated Output Power
- Supply Voltage: +8V @160 mA
- 50 Ohm Matched Input/Output
- 32 Lead 5x5 mm QFN Package: 25 mm<sup>2</sup>

### Functional Diagram



### General Description

The HMC465LP5(E) is a GaAs MMIC PHEMT Distributed Driver Amplifier packaged in leadless 5x5 mm surface mount package which operate between DC and 20 GHz. The amplifier provides 15 dB of gain, 3 dB noise figure and +25 dBm of saturated output power while requiring only 160 mA from a +8V supply. Gain flatness is excellent at ±0.5 dB as well as ±4 deg deviation from linear phase from DC - 10 GHz making the HMC465LP5(E) ideal for OC192 fiber optic LN/MZ modulator driver amplifiers as well as test equipment applications. The HMC465LP5(E) amplifiers I/Os are internally matched to 50 Ohms.

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

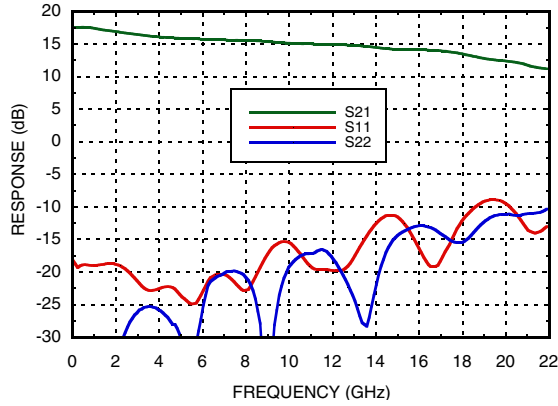
| Parameter  | Min.   | Typ.  | Max. | Min.       | Typ.  | Max.  | Min.        | Typ.  | Max.  | Units  |
|--|--------|-------|------|------------|-------|-------|-------------|-------|-------|--------|
| Frequency Range                                  | DC - 6 |       |      | 6.0 - 12.0 |       |       | 12.0 - 20.0 |       |       | GHz    |
| Gain   | 13     | 16    |      | 12         | 15    |       | 9.5         | 12.5  |       | dB     |
| Gain Flatness                                    |        | ±0.75 |      |            | ±0.25 |       |             | ±1.5  |       | dB     |
| Gain Variation Over Temperature                  |        | 0.015 | 0.02 |            | 0.020 | 0.025 |             | 0.035 | 0.045 | dB/°C  |
| Noise Figure                                     |        | 3.0   |      |            | 3.0   |       |             | 4.0   |       | dB     |
| Input Return Loss                                |        | 20    |      |            | 15    |       |             | 8     |       | dB     |
| Output Return Loss                               |        | 22    |      |            | 17    |       |             | 12    |       | dB     |
| Output Power for 1 dB Compression (P1dB)         | 21     | 24    |      | 20         | 23    |       | 16          | 20    |       | dBm    |
| Saturated Output Power (Psat)                    |        | 25.5  |      |            | 25    |       |             | 23    |       | dBm    |
| Output Third Order Intercept (IP3)               |        | 32    |      |            | 28    |       |             | 24    |       | dBm    |
| Saturated Output Voltage                         |        | 10    |      |            | 10    |       |             | 8     |       | Vpk-pk |
| Group Delay Variation                            |        | ±15   |      |            | ±15   |       |             |       |       | 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.

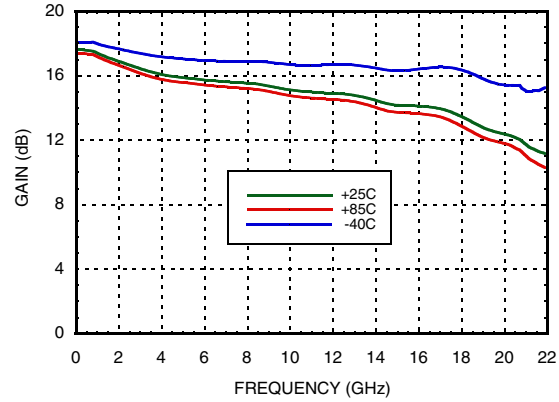


**GAAS PHEMT MMIC MODULATOR DRIVER  
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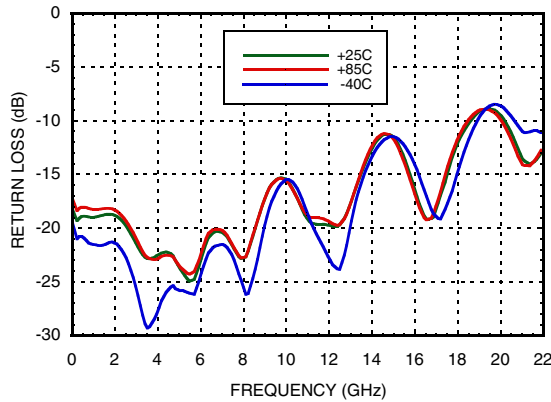
**Gain & Return Loss**



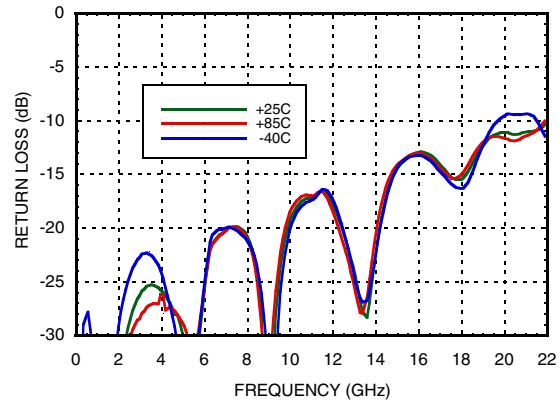
**Gain vs. Temperature**



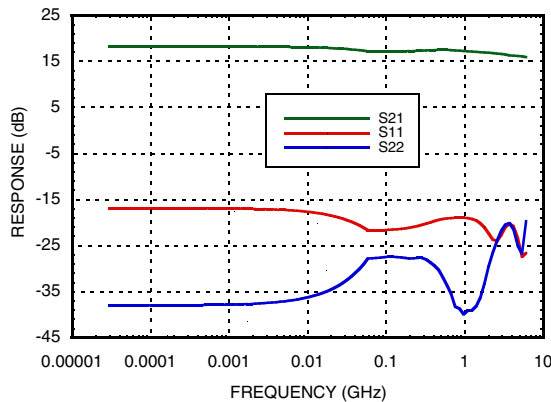
**Input Return Loss vs. Temperature**



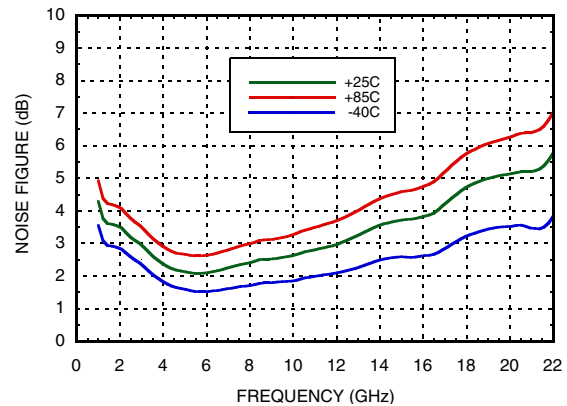
**Output Return Loss vs. Temperature**



**Low Frequency Gain & Return Loss**



**Noise Figure vs. Temperature**

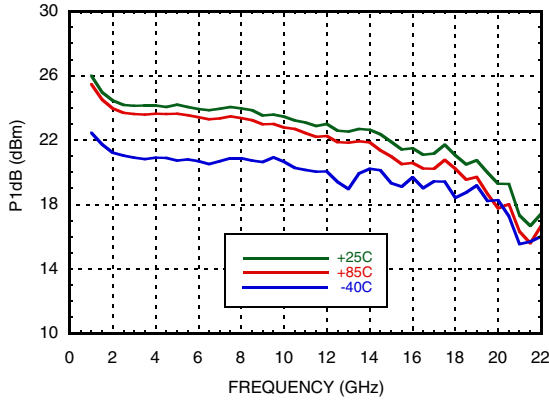




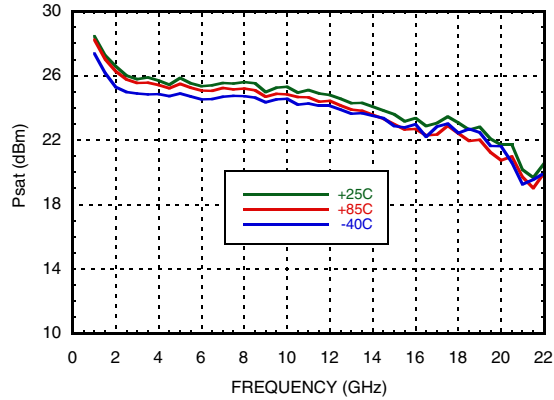
**GAAS PHEMT MMIC MODULATOR DRIVER  
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AMPLIFIERS - DRIVER & GAIN BLOCK - SMT

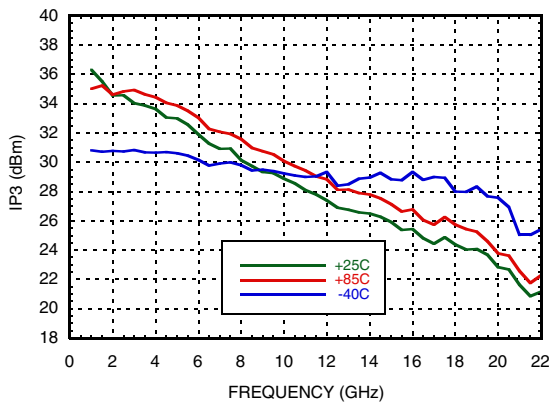
**P1dB vs. Temperature**



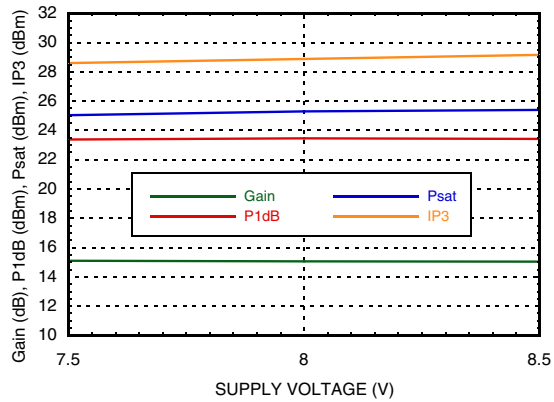
**Psat vs. Temperature**



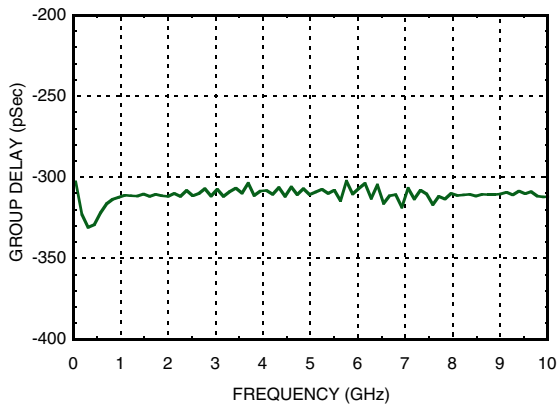
**Output IP3 vs. Temperature**



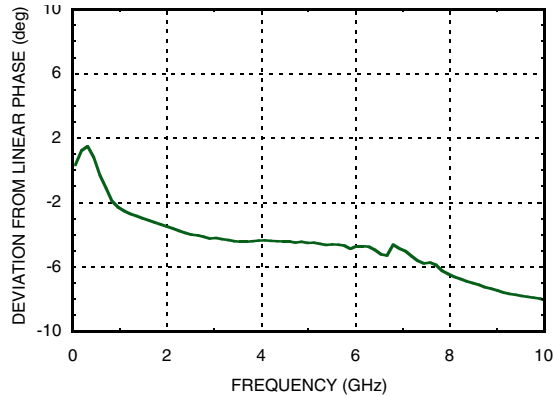
**Gain, Power & Output IP3 vs. Supply Voltage @ 10 GHz, I<sub>dd</sub> = 160mA**



**Group Delay**



**Deviation from Linear Phase**





## GAAS PHEMT MMIC MODULATOR DRIVER AMPLIFIER, DC - 20 GHz

### Absolute Maximum Ratings

|   |                        |
|---|------------------------|
| Drain Bias Voltage (Vdd)                                      | +9 Vdc                 |
| Gate Bias Voltage (Vgg1)                                      | -2 to 0 Vdc            |
| Gate Bias Current (Igg1)                                      | +3.2mA                 |
| Gate Bias Voltage (Vgg2)                                      | (Vdd -8) Vdc to +3 Vdc |
| Gate Bias Current (Igg2)                                      | +3.2mA                 |
| RF Input Power (RFIN)(Vdd = +8 Vdc)                           | +23 dBm                |
| Channel Temperature   | 150 °C                 |
| Continuous Pdiss (T = 85 °C)<br>(derate 24 mW/°C above 85 °C) | 1.56 W                 |
| Thermal Resistance<br>(channel to ground paddle)              | 41.5 °C/W              |
| Storage Temperature   | -65 to +150 °C         |
| Operating Temperature   | -40 to +85 °C          |

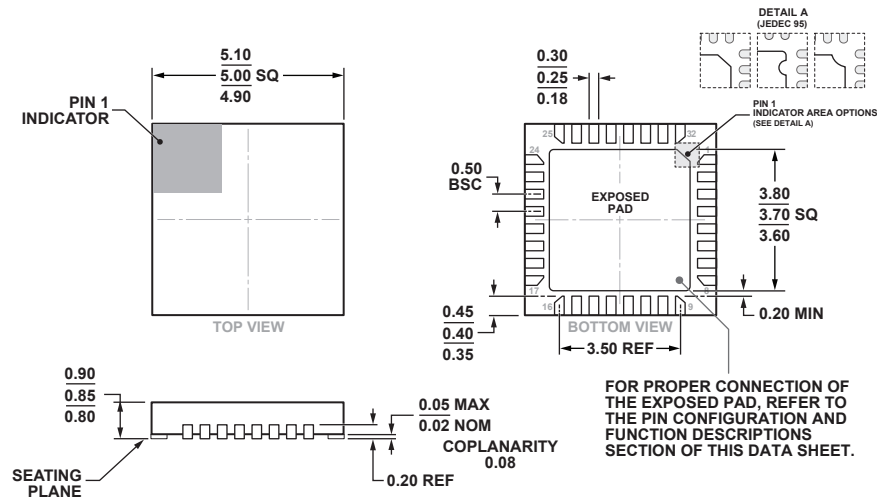
### Typical Supply Current vs. Vdd

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



ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS

### Outline Drawing



COMPLIANT TO JEDEC STANDARDS MO-220-VHHD-4.

32-Lead Lead Frame Chip Scale Package [LFCSP]  
5 mm x 5 mm and 0.85 mm Package Height  
(HCP-32-1)

Dimensions shown in millimeters.

### Package Information

| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[3]</sup> |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC465LP5   | Low Stress Injection Molded Plastic                | Sn/Pb Solder  | MSL1 <sup>[1]</sup> | H465<br>XXXX                   |
| HMC465LP5E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H465<br>XXXX                   |

[1] Max peak reflow temperature of 235 °C

[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

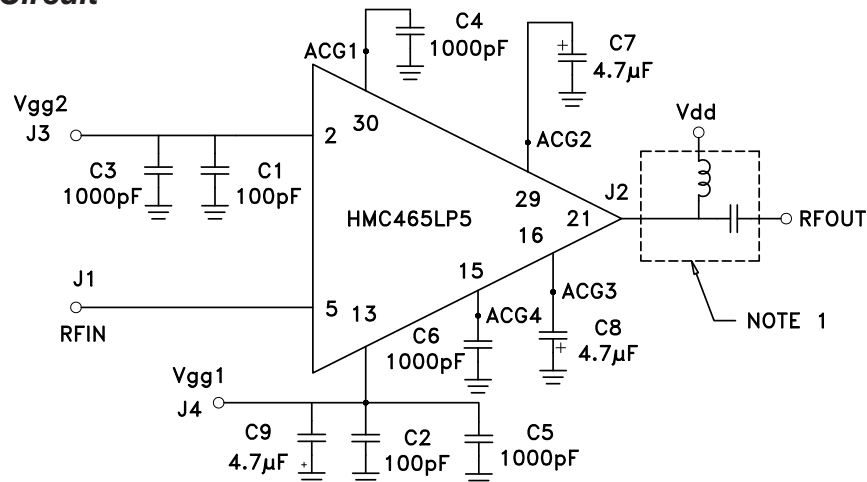


**GAAS PHEMT MMIC MODULATOR DRIVER  
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**Pin Descriptions**

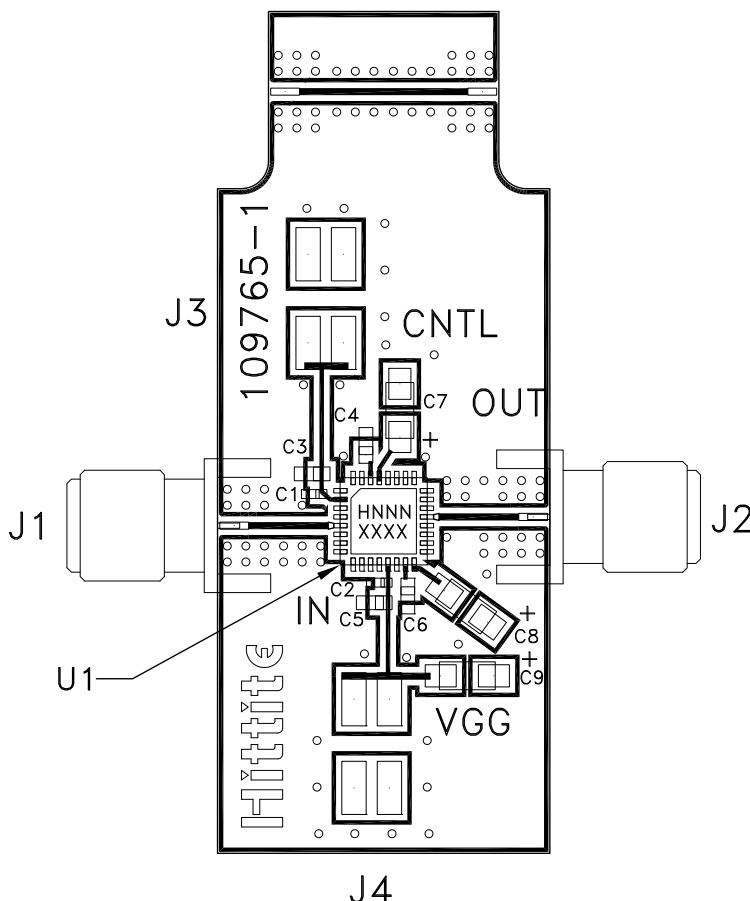
| Pin Number   | Function    | Description  | Interface Schematic |
|--|-------------|--|---------------------|
| 1, 3, 4, 6 - 12, 14, 17, 18, 19, 20, 22 - 28, 31, 32 | N/C         | The pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally. |                     |
| 2  | Vgg2        | Gate Control 2 for amplifier. +1.5V should be applied to Vgg2 for nominal operation.   |                     |
| 5  | RFIN        | This pad is DC coupled and matched to 50 Ohms.   |                     |
| 13   | Vgg1        | Gate Control 1 for amplifier.  |                     |
| 15   | ACG4        | Low frequency termination. Attach bypass capacitor per application circuit herein.   |                     |
| 16   | ACG3        |  |                     |
| 21   | RFOUT & Vdd | RF output for amplifier. Connect the DC bias (Vdd) network to provide drain current (Idd). See application circuit herein.               |                     |
| 29   | ACG2        | Low frequency termination. Attach bypass capacitor per application circuit herein.   |                     |
| 30   | ACG1        |  |                     |
| Ground Paddle  | GND         | Ground paddle must be connected to RF/DC ground.   |                     |

**Application Circuit**



NOTE 1: Drain Bias (Vdd) must be applied through a broadband bias tee or external bias network.

**Evaluation PCB**



**List of Materials for Evaluation PCB 108347 [1]**

| Item    | Description                  |
|---------|------------------------------|
| J1 - J2 | SRI K Connector              |
| J3 - J4 | 2mm Molex Header             |
| C1, C2  | 100 pF Capacitor, 0402 Pkg.  |
| C3 - C6 | 1000 pF Capacitor, 0603 Pkg. |
| C7 - C9 | 4.7 μF Capacitor, Tantalum   |
| U1      | HMC465LP5 / HMC465LP5E       |
| PCB [2] | 109765 Evaluation PCB        |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350

The circuit board used in the final application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and package bottom should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation board should be mounted to an appropriate heat sink. The evaluation circuit board shown is available from Analog Devices, upon request.

**GAAS PHEMT MMIC MODULATOR DRIVER  
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These devices are susceptible to damage from Electrostatic Discharge. Proper precautions should be observed during handling, assembly and test.

The input to this device should be AC-coupled. To provide the typical 8Vp-p output voltage swing, a 1.2Vp-p AC-coupled input voltage swing is required.

**Device Power Up Instructions**

1. Ground the device
  2. Set V<sub>gg</sub> to -2V (no drain current)
  3. Set V<sub>ctl</sub> to +1V (no drain current)
  4. Set V<sub>dd</sub> to +5V (no drain current)
  5. Adjust V<sub>gg</sub> for I<sub>dd</sub> = 140mA
- V<sub>gg</sub> may be varied between -1V and 0V to provide the desired eye crossing point percentage (i.e. 50% crosspoint) and a limited cross point control capability.
  - V<sub>dd</sub> may be increased to +8V if required to achieve greater output voltage swing.
  - V<sub>ctl</sub> may be adjusted between +2V and +0V to vary the output voltage swing.

**Device Power Down Instructions**

1. Reverse the sequence identified above in steps 1 through 4.



# HMC465LP5 / 465LP5E

v07.0418

## GAAS PHEMT MMIC MODULATOR DRIVER AMPLIFIER, DC - 20 GHz

**Notes:**



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