# HMC465LP5 / 465LP5E

v06.1210

## 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 & C³I

### Features

Gain: 15 dB

Output Voltage to 10Vpk-pk

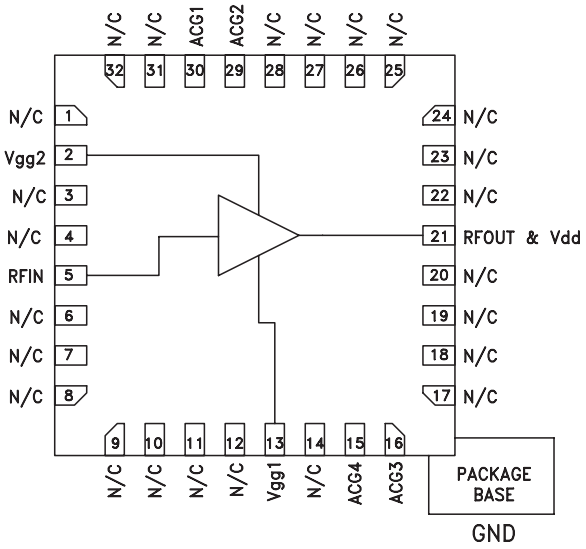
+24 dBm Saturated Output Power

Supply Voltage: +8V @160 mA

50 Ohm Matched Input/Output

32 Lead 5x5 mm QFN Package: 25 mm²

### 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° C, Vdd= 8V, Vgg2= 1.5V, Idd= 160 mA*

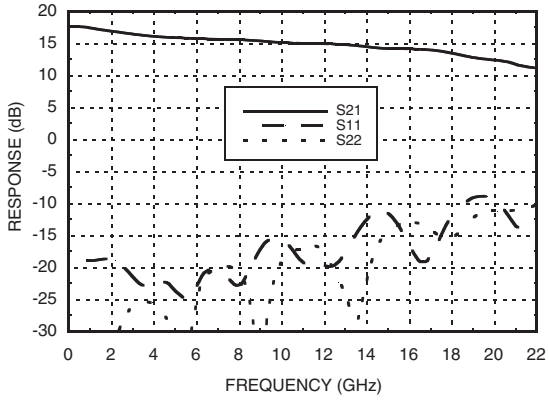
| Parameter | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| Frequency Range | | DC - 6 | | | 6.0 - 12.0 | | | 12.0 - 20.0 | | GHz |
| Gain | 13 | 16 | | 12 | 15 | | 9.5 | 12.5 | | dB |
| Gain Flatness | | ±0.75 | | | ±0.25 | | | ±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.*

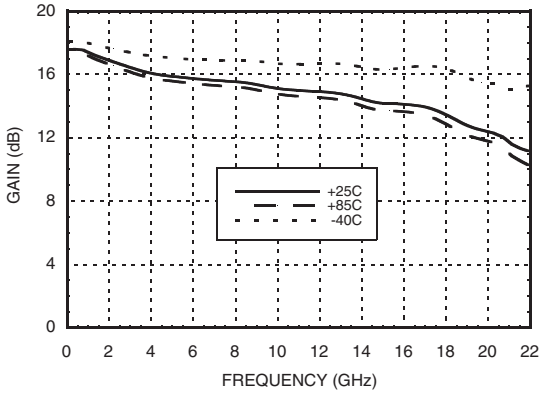


*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

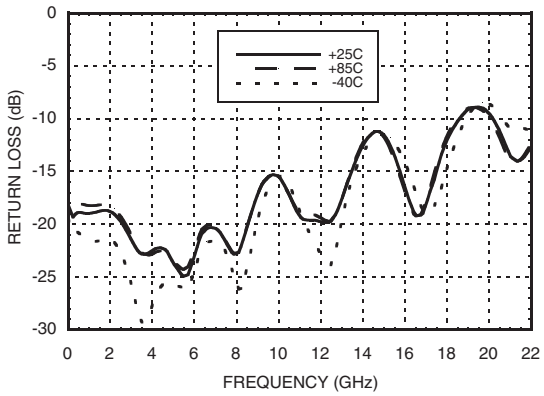
### Gain & Return Loss



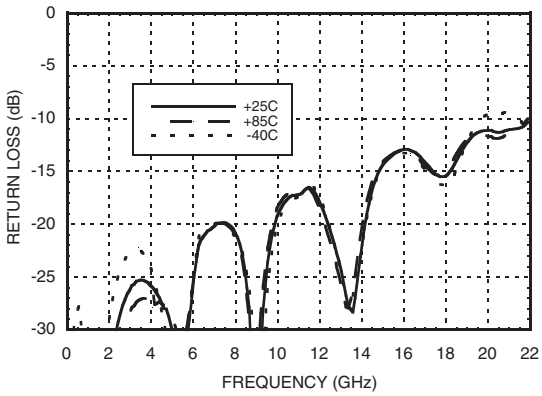

### Gain vs. Temperature



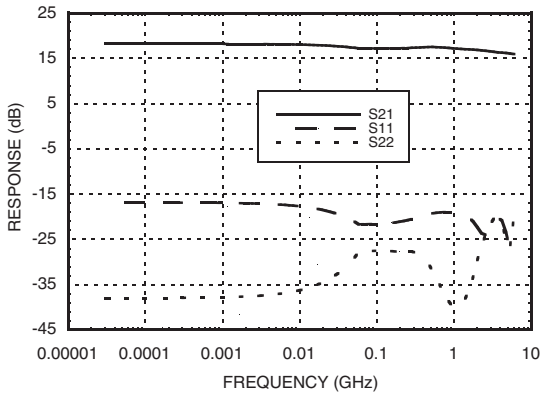

### Input Return Loss vs. Temperature



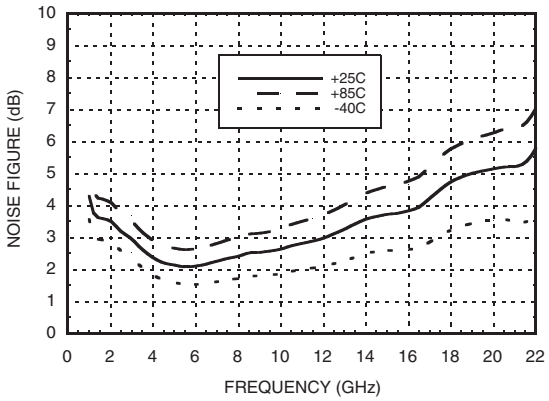

### Output Return Loss vs. Temperature




### Low Frequency Gain & Return Loss



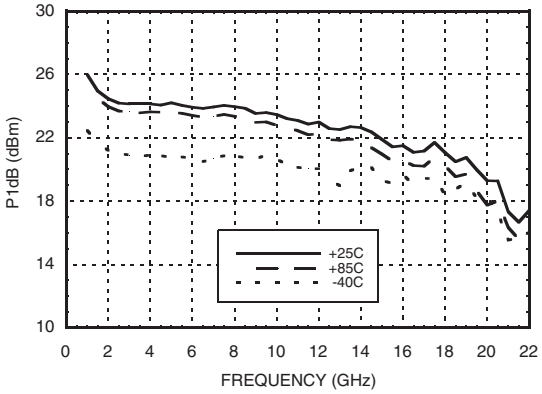

### Noise Figure vs. Temperature



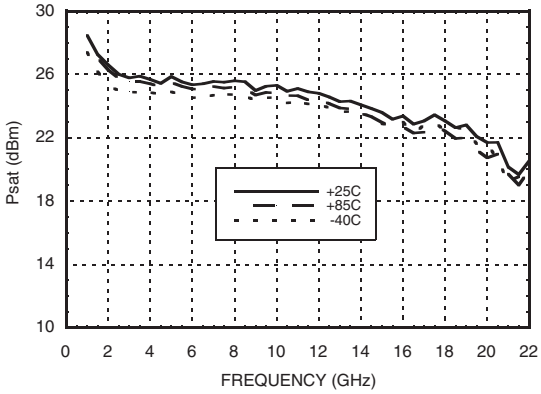



*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

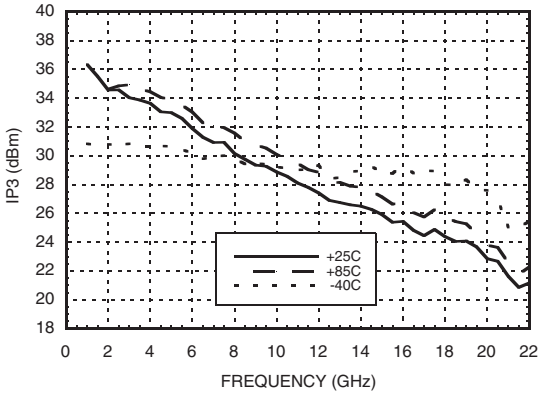
### P1dB vs. Temperature



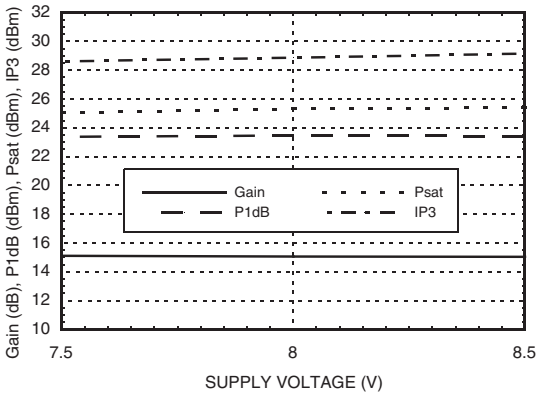

### Psat vs. Temperature



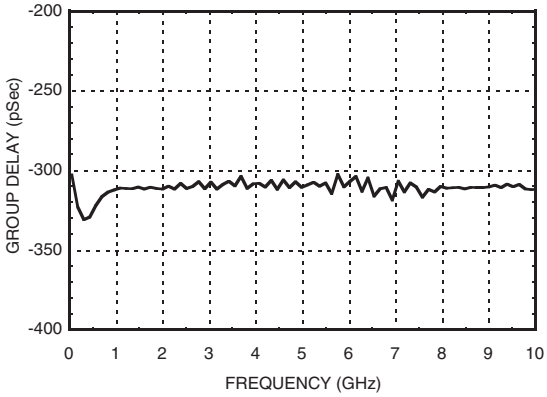

### Output IP3 vs. Temperature



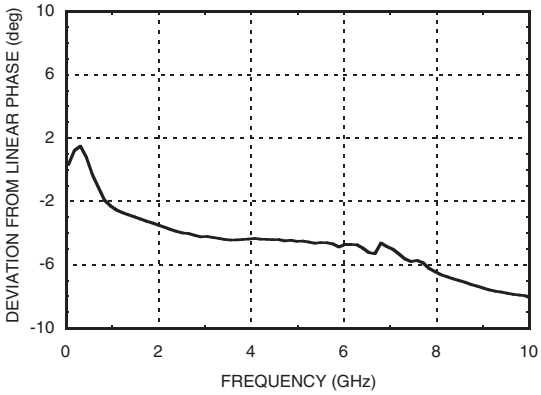

### Gain, Power & Output IP3 vs. Supply Voltage @ 10 GHz, Idd = 160mA




### Group Delay




### Deviation from Linear Phase






*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

v06.1210

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



## Absolute Maximum Ratings

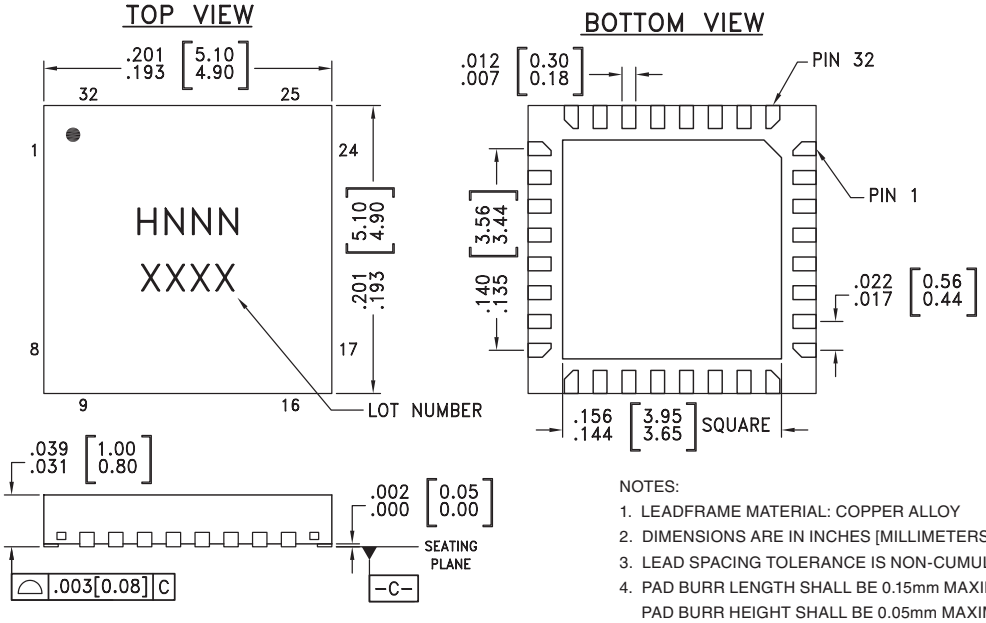
| | |
|---|---|
| Drain Bias Voltage (Vdd) | +9 Vdc |
| Gate Bias Voltage (Vgg1) | -2 to 0 Vdc |
| Gate Bias Current (Igg1) | +3.2mA |
| Gate Bias Voltage (Vgg2) | (Vdd -8) Vdc to +3 Vdc |
| Gate Bias Current (Igg2) | +3.2mA |
| RF Input Power (RFIN)(Vdd = +8 Vdc) | +23 dBm |
| Channel Temperature |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




NOTES:

1. LEADFRAME MATERIAL: COPPER ALLOY
2. DIMENSIONS ARE IN INCHES [MILLIMETERS]
3. LEAD SPACING TOLERANCE IS NON-CUMULATIVE.
4. PAD BURR LENGTH SHALL BE 0.15mm MAXIMUM. PAD BURR HEIGHT SHALL BE 0.05mm MAXIMUM.
5. PACKAGE WARP SHALL NOT EXCEED 0.05mm.
6. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
7. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED LAND PATTERN.

## Package Information

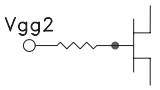
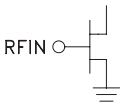
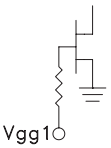
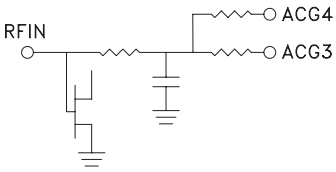
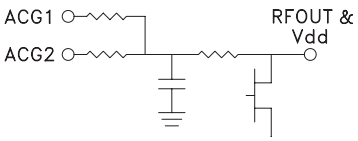
| Part Number | Package Body Material | Lead Finish | MSL Rating | Package Marking [3] |
|---|---|---|---|---|
| HMC465LP5 | Low Stress Injection Molded Plastic | Sn/Pb Solder | MSL1 [1] | H465<br>XXXX |
| HMC465LP5E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 [2] | H465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

[1] Max peak reflow temperature of 235 °C
[2] Max peak reflow temperature of 260 °C
[3] 4-Digit lot number XXXX

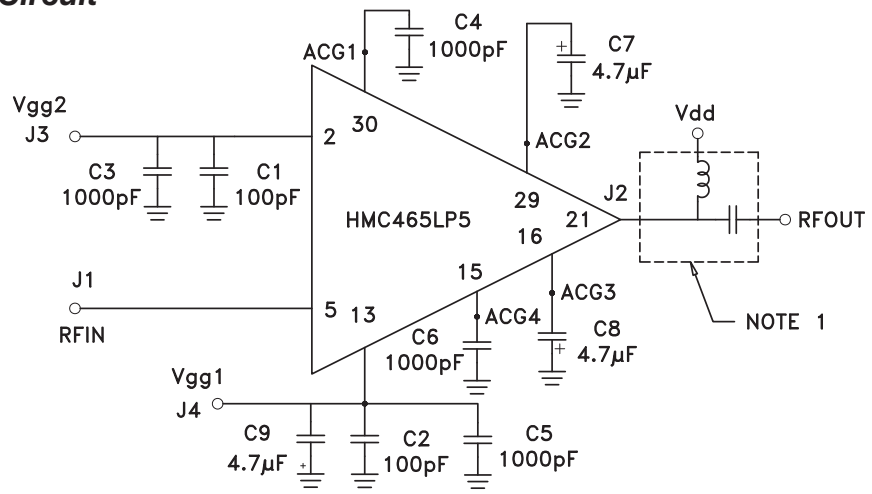


*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

## 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

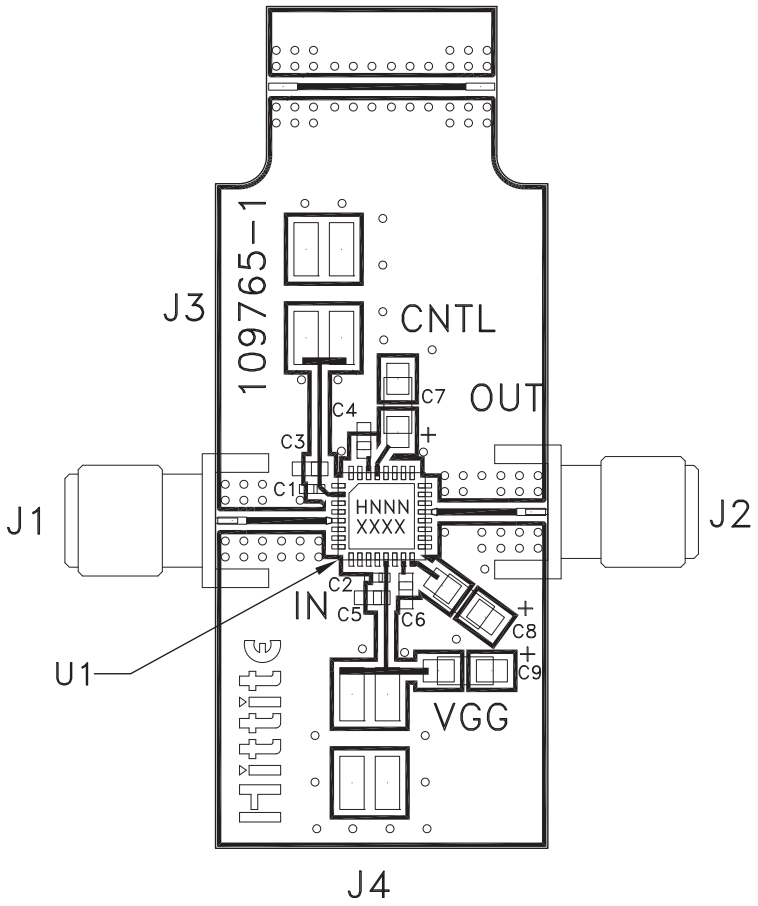



*NOTE 1: Drain Bias (Vdd) must be applied through a broadband bias tee or external bias network.*



*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

## 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 Hittite upon request.



*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

## Device Operation

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 Vgg to -2V (no drain current)
3. Set Vctl to +1V (no drain current)
4. Set Vdd to +5V (no drain current)
5. Adjust Vgg for Idd = 140mA

- Vgg 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.
- Vdd may be increased to +7V if required to achieve greater output voltage swing.
- Vctl 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.



*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*

**Notes:**





*For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106*
*Phone: 781-329-4700 • Order online at www.analog.com*
*Application Support: Phone: 1-800-ANALOG-D*