v02.0610

# HMC616LP3 / 616LP3E

## GaAs SMT PHEMT LOW NOISE AMPLIFIER, 175 - 660 MHz

### Typical Applications

The HMC616LP3(E) is ideal for:

- Cellular/3G and LTE/WiMAX/4G
- BTS & Infrastructure
- Repeaters and Femtocells
- Public Safety Radio
- DAB Receivers

### Features

Low Noise Figure: 0.5 dB

High Gain: 24 dB

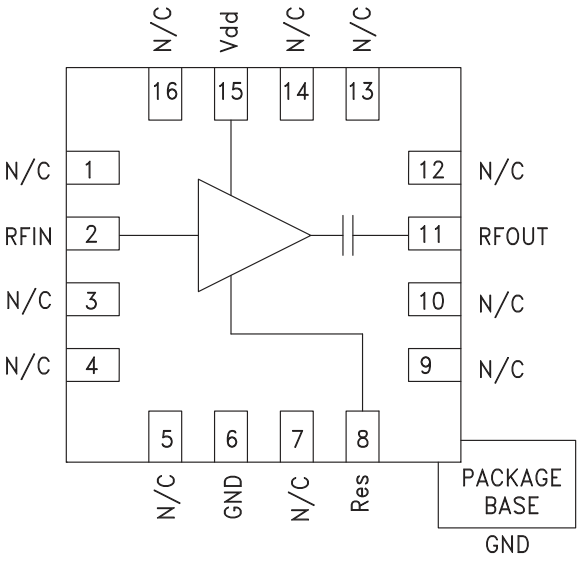
High Output IP3: +37 dBm

Single Supply: +3V to +5V

50 Ohm Matched Input/Output

16 Lead 3x3mm QFN Package: 9 $mm^2$

### Functional Diagram




### General Description

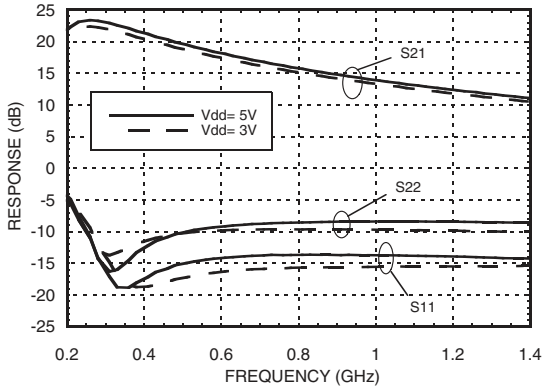
The HMC616LP3(E) is a GaAs PHEMT MMIC Low Noise Amplifier that is ideal for Cellular/3G and LTE/WiMAX/4G basestation front-end receivers operating between 175 and 660 MHz. The amplifier has been optimized to provide 0.5 dB noise figure, 24 dB gain and +37 dBm output IP3 from a single supply of +5V. Input and output return losses are excellent with minimal external matching and bias decoupling components. The HMC616LP3(E) shares the same package and pinout with the HMC617-LP3(E) and HMC618LP3(E) LNAs. The HMC616LP3(E) can be biased with +3V to +5V and features an externally adjustable supply current which allows the designer to tailor the linearity performance of the LNA for each application. The HMC616LP3(E) offers improved noise figure versus the previously released HMC356LP3(E).

### Electrical Specifications, $T_A$ = +25° C, Rbias = 3.92k Ohms*

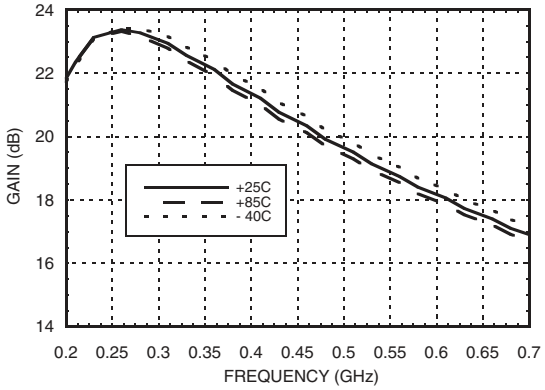
| Parameter | Vdd = +3V | | | | | | Vdd = +5V | | | | | | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Frequency Range | 175 - 230 | | | 230 - 660 | | | 175 - 230 | | | 230 - 660 | | | MHz |
| Gain | 20 | 22.5 | | 15 | 20 | | 21 | 24 | | 15 | 21 | | dB |
| Gain Variation Over Temperature | | | | | 0.002 | | | | | | 0.005 | | dB/ °C |
| Noise Figure | | 0.5 | 0.8 | | 0.5 | 0.8 | | 0.5 | 0.8 | | 0.5 | 0.8 | dB |
| Input Return Loss | | 10 | | | 16 | | | 12 | | | 14 | | dB |
| Output Return Loss | | 9 | | | 10 | | | 9 | | | 10 | | dB |
| Output Power for 1 dB Compression (P1dB) | 8 | 11 | | 10 | 15 | | 11 | 15 | | 14 | 19 | | dBm |
| Saturated Output Power (Psat) | 8.5 | 13 | | 11 | 15.5 | | 12.5 | 17.5 | | 15.5 | 19.5 | | dBm |
| Output Third Order Intercept (IP3) | | 20 | | | 30 | | | 32 | | | 37 | | dBm |
| Supply Current (Idd) | | 30 | 45 | | 30 | 45 | | 90 | 115 | | 90 | 115 | mA |

* Rbias resistor sets current, see application circuit herein

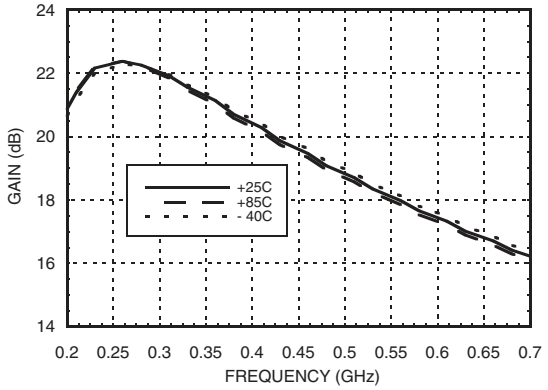
### Broadband Gain & Return Loss



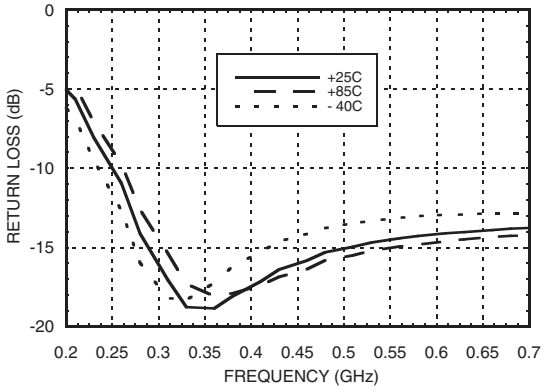

### Gain vs. Temperature [1]



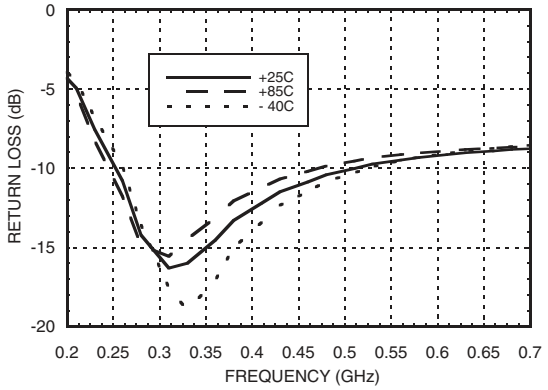

### Gain vs. Temperature [2]



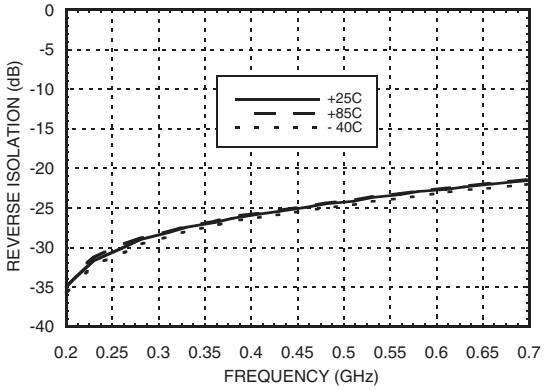

### Input Return Loss vs. Temperature [1]




### Output Return Loss vs. Temperature [1]

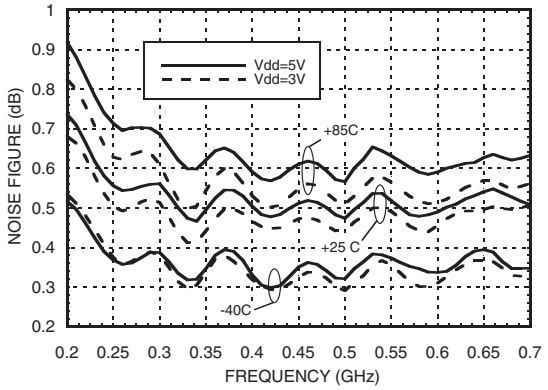



### Reverse Isolation vs. Temperature [1]

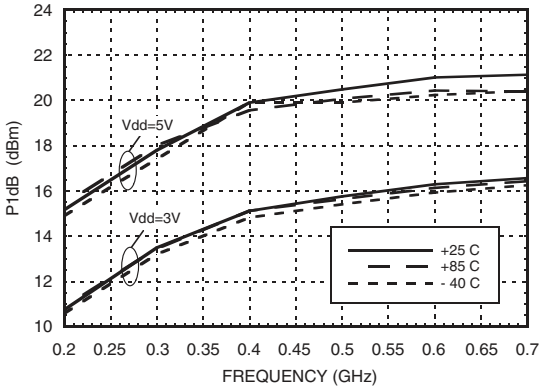



[1] Vdd = 5V [2] Vdd = 3V

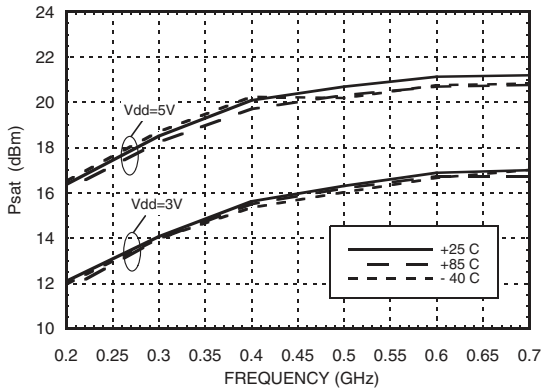
### Noise Figure vs. Temperature [1]



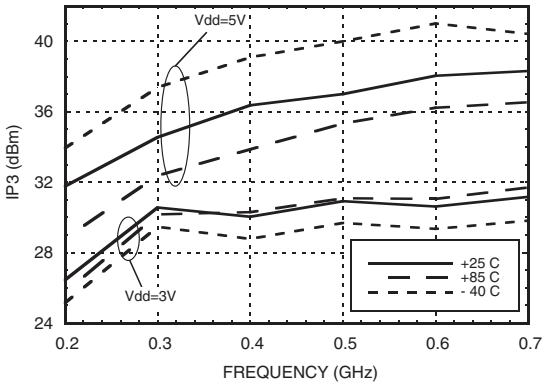

### P1dB vs. Temperature



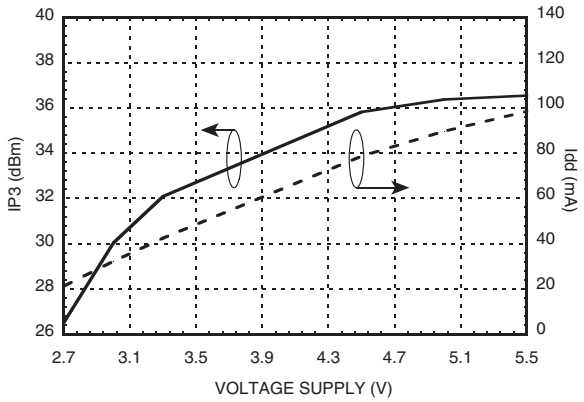

### Psat vs. Temperature



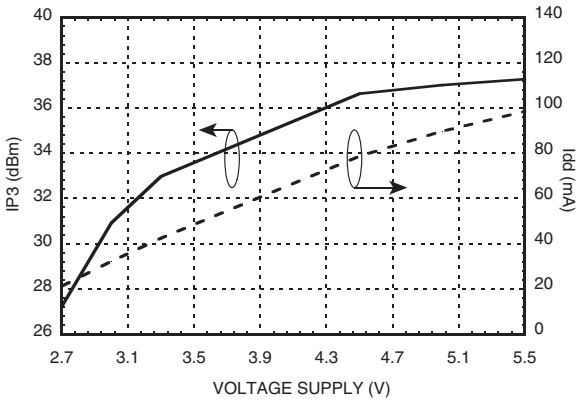

### Output IP3 vs. Temperature




### Output IP3 and Supply Current vs. Supply Voltage @ 400 MHz

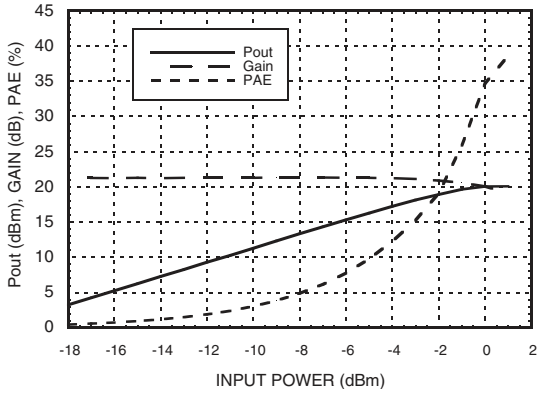



### Output IP3 and Supply Current vs. Supply Voltage @ 500 MHz

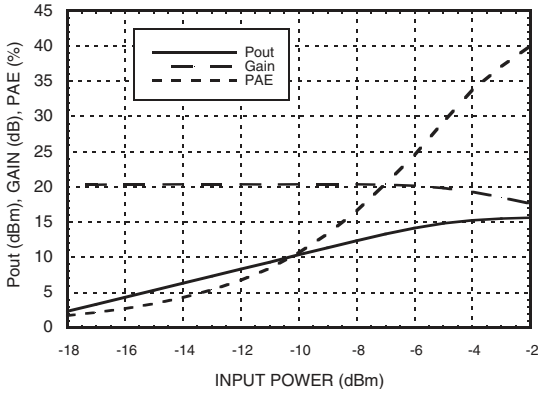



[1] Measurement reference plane shown on evaluation PCB drawing.

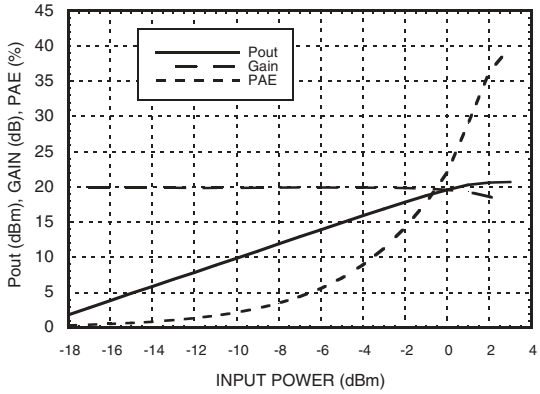
### Power Compression @ 400 MHz [1]



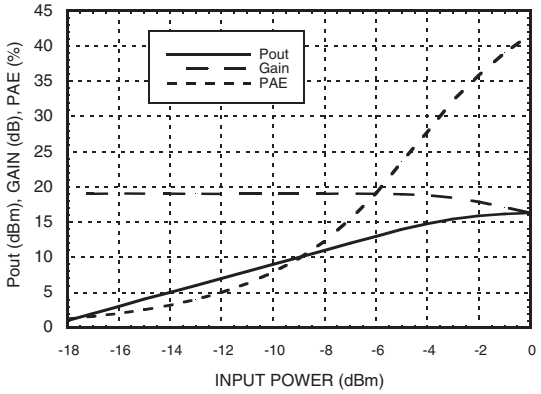

### Power Compression @ 400 MHz [2]



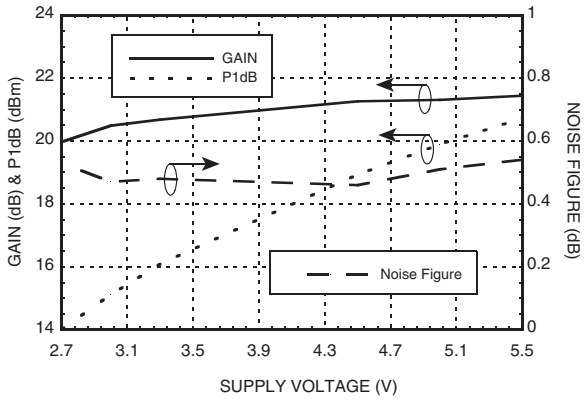

### Power Compression @ 500 MHz [1]



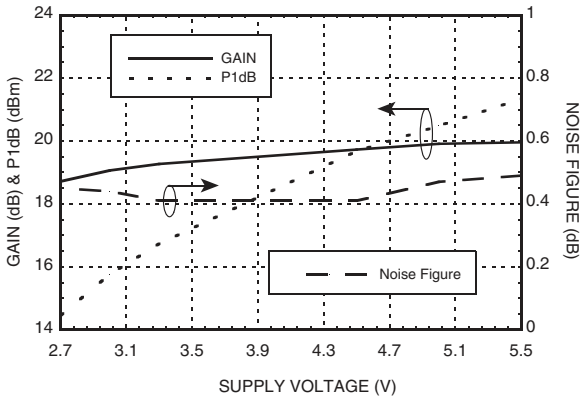

### Power Compression @ 500 MHz [2]




### Gain, Power & Noise Figure vs. Supply Voltage @ 400 MHz




### Gain, Power & Noise Figure vs. Supply Voltage @ 500 MHz

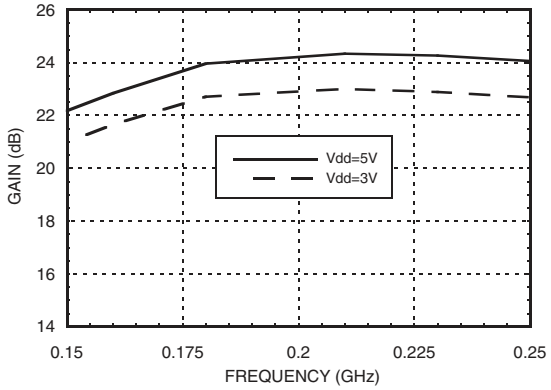



[1] Vdd = 5V [2] Vdd = 3V

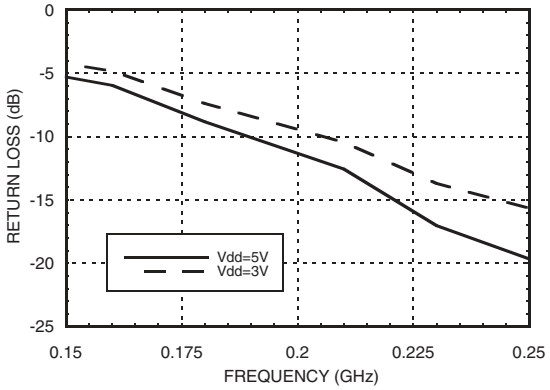
# HMC616LP3 / 616LP3E

## GaAs SMT PHEMT LOW NOISE AMPLIFIER, 175 - 660 MHz

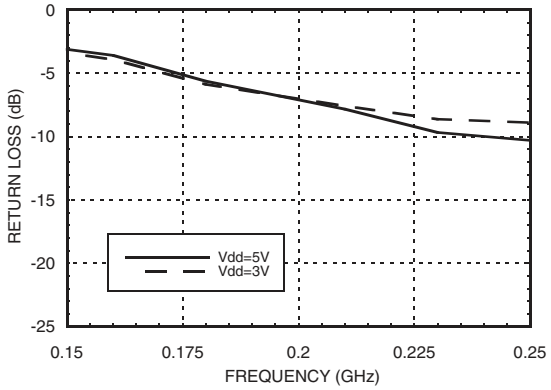
### Gain Low Frequency Tune [1]



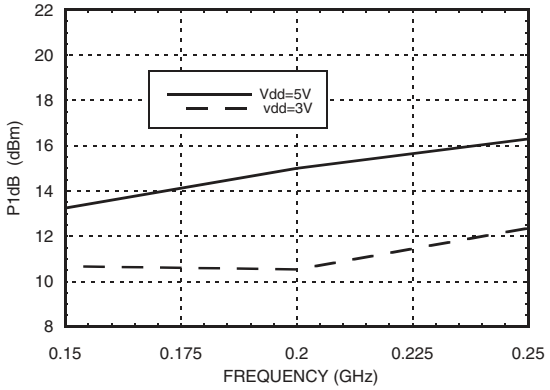

### Input Return Loss Low Frequency Tune [1]



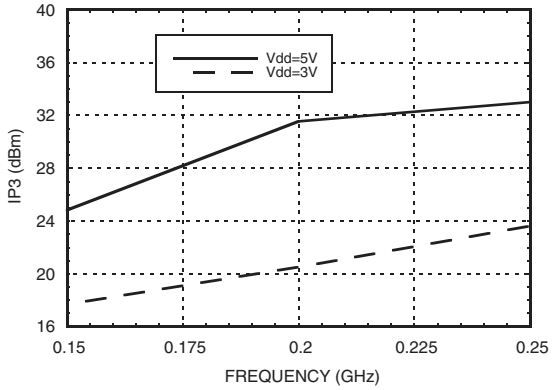

### Output Return Loss Low Frequency Tune [1]



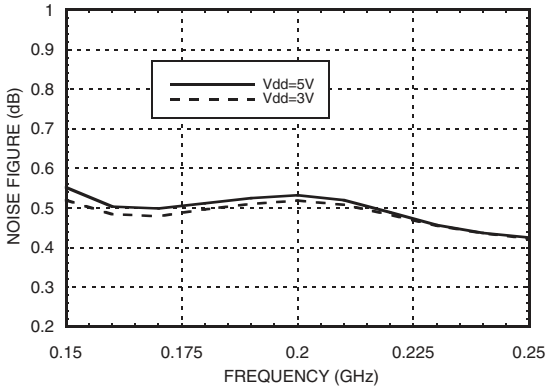

### P1dB Low Frequency Tune [1]




### Output IP3 Low Frequency Tune [1]

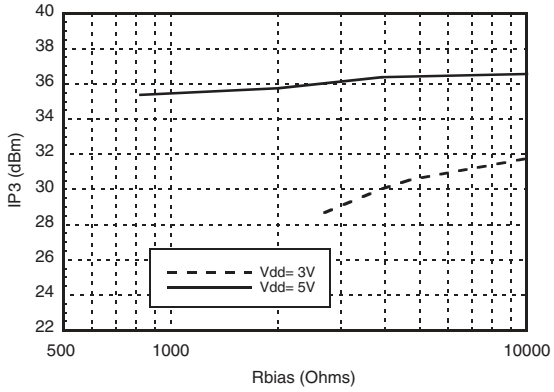



### Noise Figure Low Frequency Tune [1] [2]

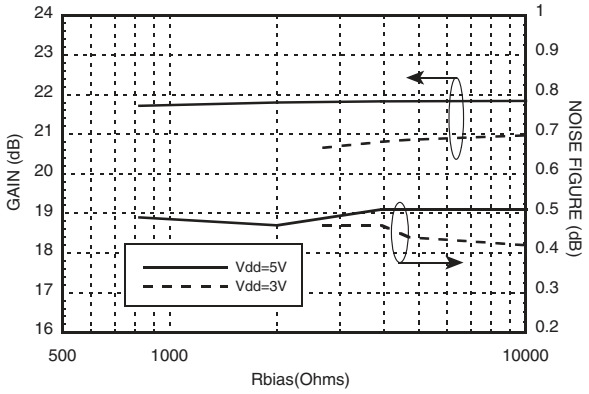



[1] Rbias = 2kΩ, L1 = 82 nH, L2 = 82 nH [2] Measurement reference plane shown on evaluation PCB drawing.

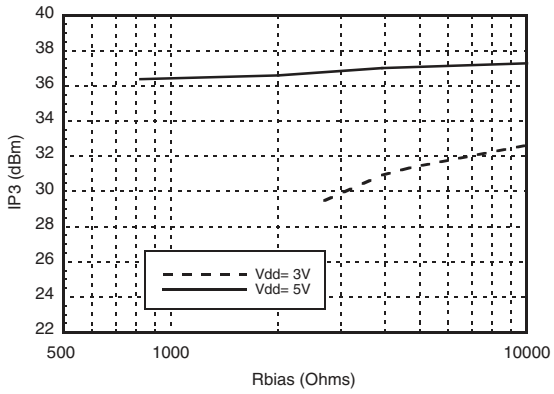
### Output IP3 vs. Rbias @ 400 MHz



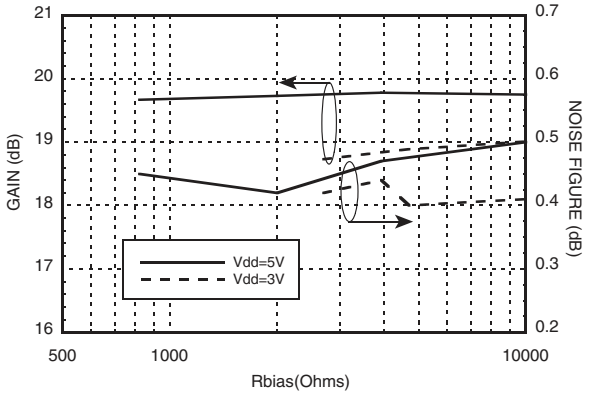

### Gain, Noise Figure & Rbias @ 400 MHz




### Output IP3 vs. Rbias @ 500 MHz




### Gain, Noise Figure & Rbias @ 500 MHz



## Absolute Bias Resistor Range & Recommended Bias Resistor Values for Idd

| Vdd (V) | Rbias (Ω) | | | Idd (mA) |
|---|---|---|---|---|
| | Min | Max | Recommended | |
| 3V | 1k [1] | Open Circuit | 2.7k | 27 |
| | | | 3.92k | 31 |
| | | | 4.7k | 33 |
| | | | 10k | 39 |
| 5V | 0 | Open Circuit | 820 | 73 |
| | | | 2k | 84 |
| | | | 3.92k | 91 |
| | | | 10k | 95 |

[1] With Vdd = 3V, Rbias < 1k Ohm is not recommended and may result in the LNA becoming conditionally stable.

## Absolute Maximum Ratings

| | |
|---|---|
| Drain Bias Voltage (Vdd) | +6 V |
| RF Input Power (RFIN) (Vdd = +5 Vdc) | +10 dBm |
| Channel Temperature | 150 °C |
| Continuous Pdiss (T= 85 °C) (derate 8.93 mW/°C above 85 °C) | 0.58 W |
| Thermal Resistance (channel to ground paddle) | 112 °C/W |
| Storage Temperature | -65 to +150 °C |
| Operating Temperature | -40 to +85 °C |

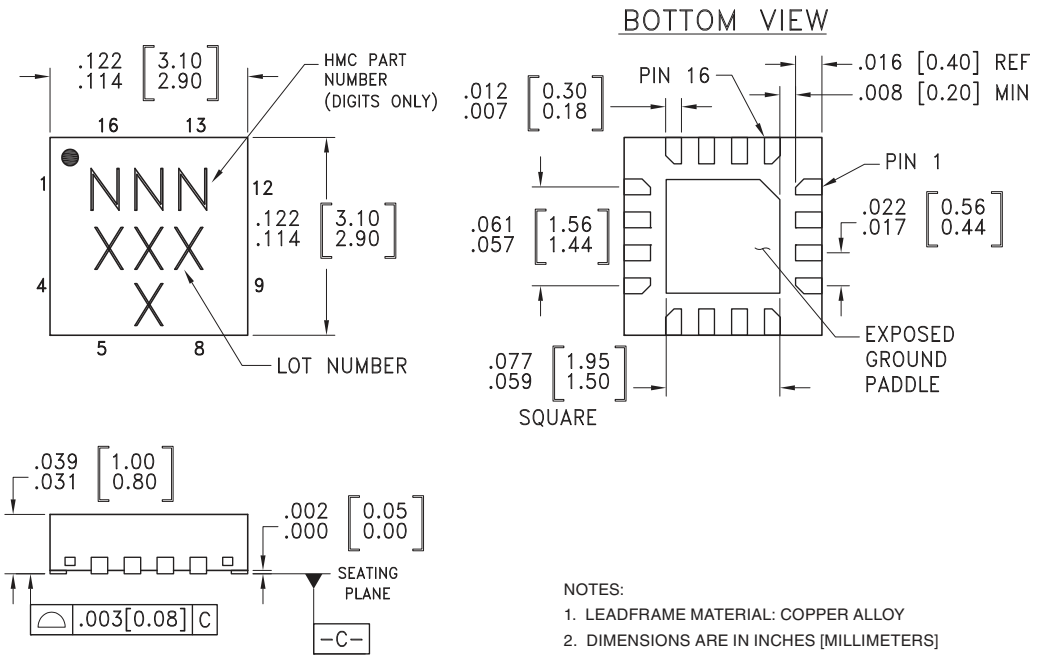
ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

## Typical Supply Current vs. Vdd (Rbias = 3.92kΩ)

| Vdd (V) | Idd (mA) |
|---|---|
| 2.7 | 20 |
| 3.0 | 30 |
| 3.3 | 40 |
| 4.5 | 80 |
| 5.0 | 90 |
| 5.5 | 100 |

*Note: Amplifier will operate over full voltage range shown above.*

## Outline Drawing




NOTES:

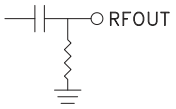
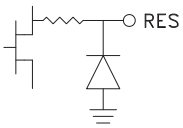
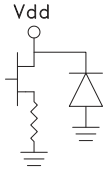
1. LEADFRAME MATERIAL: COPPER ALLOY
2. DIMENSIONS ARE IN INCHES [MILLIMETERS]
3. LEAD SPACING TOLERANCE IS NON-CUMULATIVE
4. PAD BURR LENGTH SHALL BE 0.15mm MAXIMUM. PAD BURR HEIGHT SHALL BE 0.05mm MAXIMUM.
5. PACKAGE WARP SHALL NOT EXCEED 0.05mm.
6. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED 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] |
|---|---|---|---|---|
| HMC616LP3 | Low Stress Injection Molded Plastic | Sn/Pb Solder | MSL1 [1] | 616<br>XXXX |
| HMC616LP3E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 [2] | 616<br>XXXX |

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

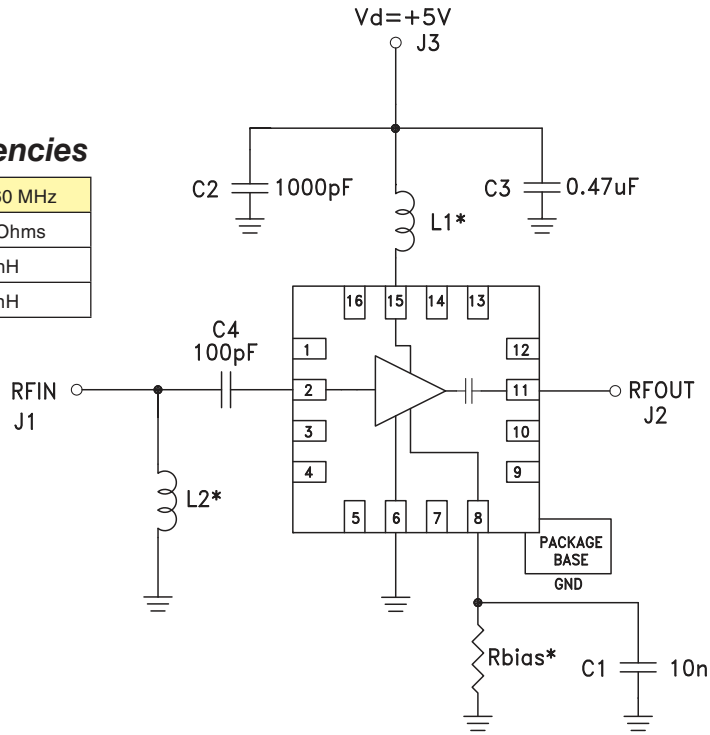
## Pin Descriptions

| Pin Number | Function | Description | Interface Schematic |
|---|---|---|---|
| 1, 3 - 5, 7, 9, 10, 12 - 14, 16 | N/C | No connection required. These pins may be connected to RF/DC ground without affecting performance. | |
| 2 | RFIN | This pin is DC coupled. DC blocking capacitor required. See application circuit. | |
| 6 | GND | This pin and ground paddle must be connected to RF/DC ground. | |
| 11 | RFOUT | This pin is matched to 50 Ohms. |   |
| 8 | RES | This pin is used to set the DC current of the amplifier by selection of external bias resistor. See application circuit. |   |
| 15 | Vdd | Power Supply Voltage. Choke inductor and bypass capacitors are required. See application circuit. |   |

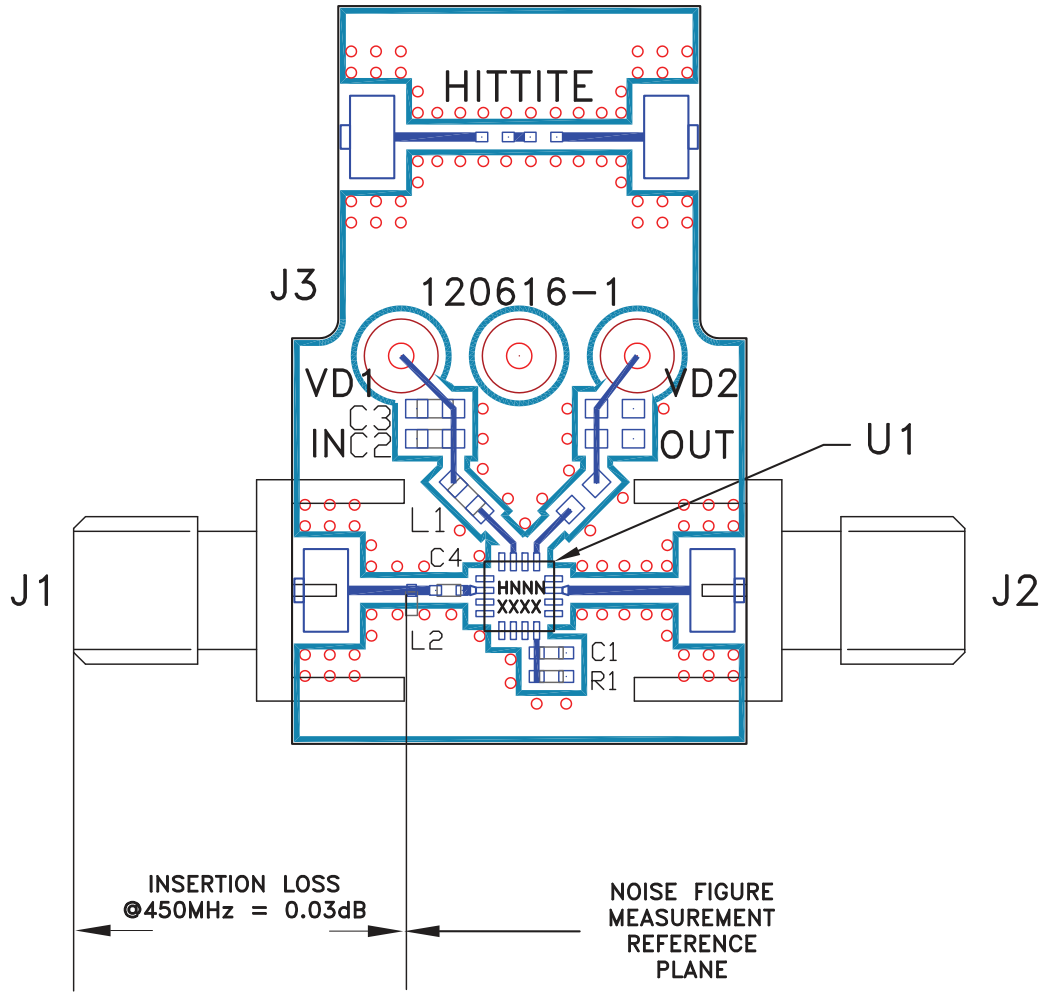
## Application Circuit

## Components for Selected Frequencies

| Tuned Frequency | 175 - 230 MHz | 230 - 660 MHz |
|---|---|---|
| Rbias | 2.0k Ohms | 3.92k Ohms |
| L1 | 82 nH | 47 nH |
| L2 | 82 nH | 51 nH |



## Evaluation PCB




## List of Materials for Evaluation PCB 120728 [1]

| Item | Description |
|---|---|
| J1, J2 | PCB Mount SMA RF Connector |
| J3, J4 | DC Pin |
| C1 | 10nF Capacitor, 0402 Pkg. |
| C2 | 1000 pF Capacitor, 0603 Pkg. |
| C3 | 0.47 µF Capacitor, 0603 Pkg. |
| C4 | 100 pF Capacitor, 0402 Pkg. |
| L1 | 47 nH Inductor, 0603 Pkg. |
| L2 | 51 nH Inductor, 0402 Pkg. |
| R1 (Rbias) | 3.92 kΩ Resistor, 0402 Pkg. |
| U1 | HMC616LP3(E) Amplifier |
| PCB [2] | 120616 Evaluation PCB |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350.

The circuit board used in this application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle 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.