



### Typical Applications

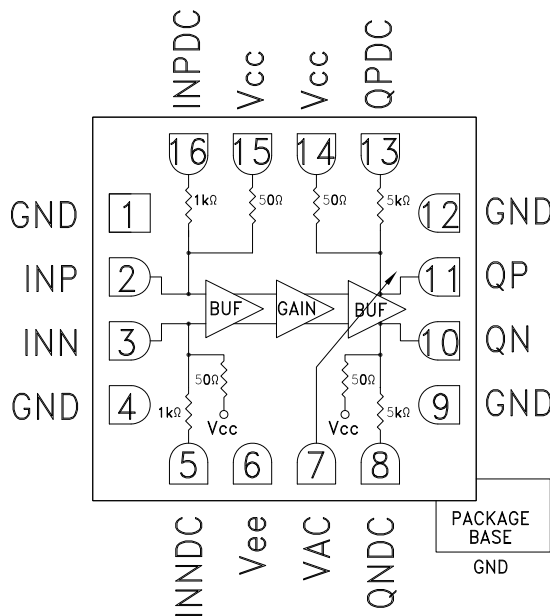
The HMC866LC3 is ideal for:

- 100 Gbps Ethernet
- 100 Gbps Long Haul
- 40 Gbps (D)QPSK Receivers
- Broadband Gain Block for Test & Measurement Equipment

### Features

- Supports Data Rates up to 43 Gbps.
- Low Power Dissipation: 280 mW @  $V_{cc} = +3.3V$
- Differential Small Signal Gain: 29 dB
- Input Sensitivity: 20 mVp-p Differential
- 3-dB Bandwidth: 26.5 GHz
- Adjustable Output Voltage  
Swing up to 800 mVp-p Differential
- 16 Lead 3x3mm SMT package: 9mm<sup>2</sup>

### Functional Diagram



### General Description

The HMC866LC3 is a Limiting Amplifier packaged in a leadless 3x3 mm ceramic surface mount package. The amplifier supports up to 43 Gbps operation and provides 29 dB of differential gain. The output voltage swing is adjustable up to 800 mVp-p differential by using the VAC analog control input and the additive RMS jitter is less than 300 fs for 32 Gbps operation. The amplifier allows external offset correction function to both inputs and outputs.

All input/output RF signals of the HMC866LC3 are terminated with 50 Ohms to +3.3V internally and may be either AC or DC coupled. The outputs of the device can be operated either differentially or single-ended. Outputs can be connected directly to 50 Ohm terminated system referenced to 3.3V, while DC blocking capacitors may be used if the terminating system is 50 Ohms to a non 3.3V level.

### Electrical Specifications, $T_A = +25^\circ C$ , $V_{cc} = +3.3V$ , $V_{ee} = 0V$ , $I_{cc} = 85mA$

| Parameter                      | Conditions              | Min. | Typ.  | Max. | Units |
|--------------------------------|-------------------------|------|-------|------|-------|
| Differential Small Signal Gain | VAC = 1.6V              |      | 29    |      | dB    |
| Data Rate                      |                         | 32   |       |      | Gbps  |
| Small Signal Bandwidth         | 3-dB cutoff             |      | 26.5  |      | GHz   |
| Input Return Loss              | Up to 26.5 GHz          | 10   |       |      | dB    |
| Output Return Loss             | Up to 26.5 GHz          | 10   |       |      | dB    |
| Input Sensitivity              | Differential            |      | 20    |      | mVp-p |
| Maximum Input Swing            | Differential            |      | 1,000 |      | mVp-p |
| Differential Output Swing      | Adjustable by using VAC | 250  |       | 800  | mVpp  |
| Rise Time [1]                  | 20% - 80% @ 32 Gbps     |      | 13    |      | ps    |

[1]  $V_{in}$  = Differential 50 mVp-p,  $f_{in}$  = 32 Gbps PRBS 2<sup>23</sup>-1 pattern

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### Electrical Specifications (Continued)

| Parameter                    | Conditions                    | Min. | Typ. | Max. | Units   |
|------------------------------|-------------------------------|------|------|------|---------|
| Fall Time [1]                | 20% - 80% @ 32 Gbps           |      | 13   |      | ps      |
| Additive Random Jitter [2]   | Vin = 50 mVp-p (Differential) |      |      | 300  | fs      |
| Input referred voltage noise | @ 15 GHz                      |      | 32   |      | nV/rtHz |
|                              | @ 25 GHz                      |      | 32   |      | nV/rtHz |
| VAC Input                    |                               | 1    |      | 1.6  | V       |
| Output P1dB                  | @ 16 GHz                      |      | -6   |      | dBm     |
| Power Supply Voltage         |                               | 3.13 | 3.3  | 3.47 | V       |
| Supply Current               | VAC = 1.6V                    |      | 85   |      | mA      |

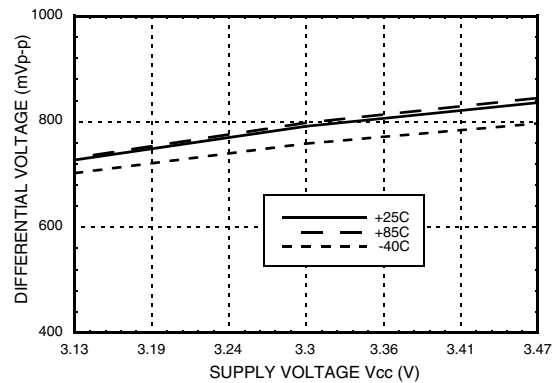
[1] Vin = Differential 50 mVp-p, fin = 32 Gbps PRBS 2<sup>23</sup>-1 pattern

[2] Random jitter is measured with 32 Gbps 10101... pattern

### Differential Gain & Return Loss vs. Frequency [1][2]



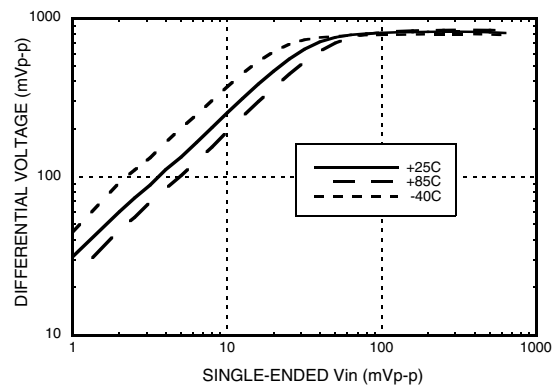
### Differential Output vs. Supply Voltage [1]



### Differential Output vs. Control Voltage [2]



### Differential Output vs. Vininput & Temperature @ 16 GHz [1][2]



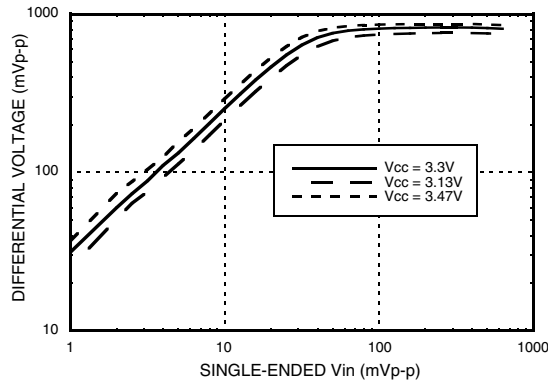
[1] VAC = 1.6V [2] Vcc = 3.3V



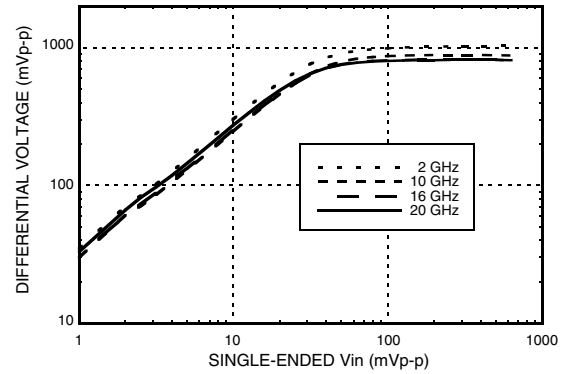
**32 Gbps LIMITING AMPLIFIER**

LIMITING AMPLIFIERS - SMT

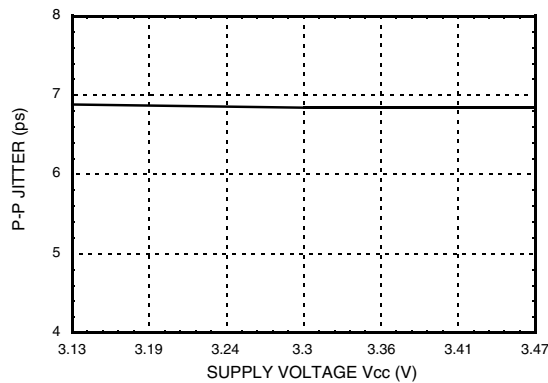
**Differential Output vs. Vininput & Supply Voltage @ 16 GHz [1]**



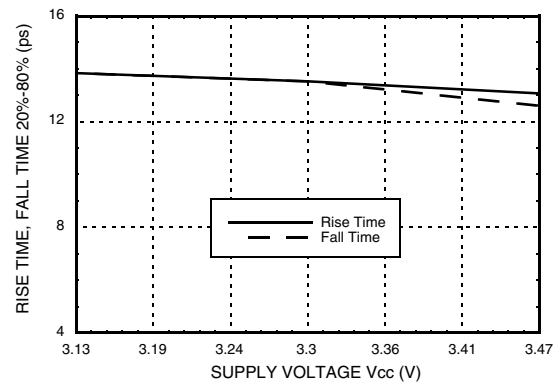
**Differential Output vs. Vininput & Frequency [1] [2]**



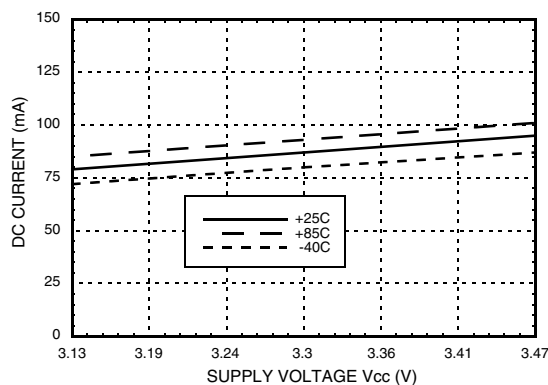
**Peak to Peak Jitter vs. Supply Voltage [1][3]**



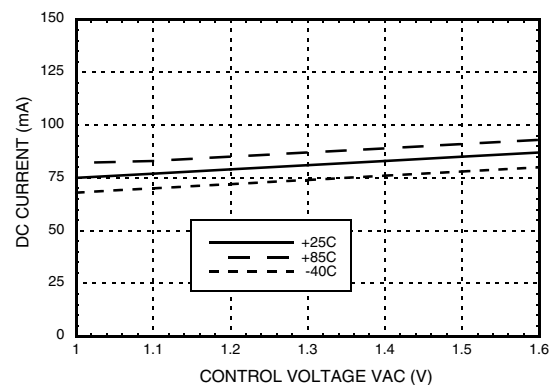
**Rise & Fall Time vs. Supply Voltage [1][3]**



**DC Current vs. Supply Voltage [1][3]**



**DC Current vs. Control Voltage [2][3]**



[1] VAC = 1.6V [2] Vcc = 3.3V [3] Input Data: Differential 50 mVp-p 32 Gbps NRZ PRBS 2<sup>23</sup>-1 pattern

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## 32 Gbps LIMITING AMPLIFIER

### 32 Gbps Output Eye Diagram



| Measurements |          |          |          |            |
|--------------|----------|----------|----------|------------|
|              | Current  | Minimum  | Maximum  | Total Meas |
| Eye Amp      | 383 mV   | 383 mV   | 384 mV   | 69         |
| Jitter p-p   | 6.378 ps | 5.289 ps | 6.378 ps | 69         |
| Rise Time    | 13.22 ps | 13.07 ps | 13.53 ps | 69         |
| Fall Time    | 13.22 ps | 10.11 ps | 13.53 ps | 69         |

Time Scale: 7 ps/div  
Amplitude Scale: 100 mV/div

Test Conditions:

VAC = 1.6V, Vcc = 3.3V  
Input Data: Differential 50 mVp-p 32 Gbps NRZ PRBS 2<sup>23</sup>-1 pattern

### 22.5 Gbps Output Eye Diagram



| Measurements |          |          |          |            |
|--------------|----------|----------|----------|------------|
|              | Current  | Minimum  | Maximum  | Total Meas |
| Eye Amp      | 403 mV   | 402 mV   | 404 mV   | 83         |
| Jitter p-p   | 8.889 ps | 7.111 ps | 8.889 ps | 83         |
| Rise Time    | 13.33 ps | 13.33 ps | 13.78 ps | 83         |
| Fall Time    | 14.22 ps | 13.78 ps | 15.11 ps | 83         |

Time Scale: 20 ps/div  
Amplitude Scale: 81.3 mV/div

Test Conditions:

VAC = 1.6V, Vcc = 3.3V  
Input Data: Differential 50 mVp-p 22.5 Gbps NRZ PRBS 2<sup>23</sup>-1 pattern

### 40 Gbps Output Eye Diagram



| Measurements |          |          |          |            |
|--------------|----------|----------|----------|------------|
|              | Current  | Minimum  | Maximum  | Total Meas |
| Eye Amp      | 351 mV   | 351 mV   | 352 mV   | 62         |
| Jitter p-p   | 6.222 ps | 5.333 ps | 6.222 ps | 62         |
| Rise Time    | 11.56 ps | 11.33 ps | 11.56 ps | 62         |
| Fall Time    | 11.78 ps | 11.56 ps | 12.00 ps | 62         |

Time Scale: 10 ps/div  
Amplitude Scale: 80.1 mV/div

Test Conditions:

VAC = 1.6V, Vcc = 3.3V  
Input Data: Differential 80 mVp-p 40 Gbps NRZ PRBS 2<sup>23</sup>-1 pattern

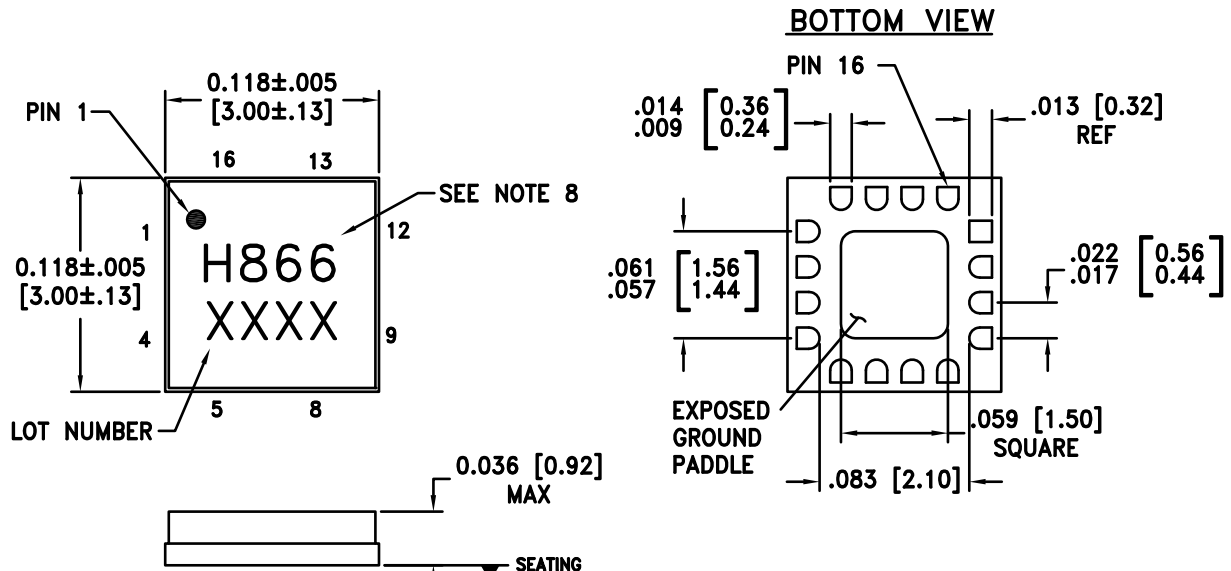

**32 Gbps LIMITING AMPLIFIER**
**Absolute Maximum Ratings**

|  |                              |
|--|------------------------------|
| Power Supply Voltage (Vcc)   | -0.5V to +3.6V               |
| Input Voltage  | (Vcc -1.3V) to<br>(Vcc +0.5) |
| Output Voltage   | (Vcc -1V) to<br>(Vcc +0.5)   |
| Output Amplitude Control Voltage (VAC)                                     | -0.5V to +2.5V               |
| Junction Temperature   | 125 °C                       |
| Continuous P <sub>diss</sub> (T = 85°C)<br>(Derate 12.22 mW/°C above 85°C) | 0.49W                        |
| Thermal Resistance (R <sub>th</sub> )<br>(junction to ground paddle)       | 81.83 °C/W                   |
| Storage Temperature  | -65 to 125 °C                |
| Operating Temperature  | -40 to +85 °C                |
| ESD Sensitivity (HBM)  | Class 1A                     |


**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**



**Outline Drawing**



- NOTES:
1. PACKAGE BODY MATERIAL: ALUMINA
  2. LEAD AND GROUND PADDLE PLATING: 30-80 MICROINCHES GOLD OVER 50 MICROINCHES MINIMUM NICKEL.
  3. DIMENSIONS ARE IN INCHES [MILLIMETERS].
  4. LEAD SPACING TOLERANCE IS NON-CUMULATIVE.
  5. CHARACTERS TO BE BLACK INK MARKED WITH .018"MIN TO .030"MAX HEIGHT REQUIREMENTS. UTILIZE MAXIMUM CHARACTER HEIGHT BASED ON LID DIMENSIONS AND BEST FIT. LOCATE APPROX. AS SHOWN.
  6. PACKAGE WARP SHALL NOT EXCEED 0.05MM DATUM -C-
  7. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
  8. PART NUMBER MARKING CONFIGURATION:  
HXXX FOR 3 DIGIT HMC #'S (IE. H123)  
XXXX FOR 4 DIGIT HMC #'S (IE. 1234)

**Package Information**

| Part Number | Package Body Material | Lead Finish      | MSL Rating | Package Marking [2] |
|-------------|-----------------------|------------------|------------|---------------------|
| HMC866LC3   | Alumina, White        | Gold over Nickel | MSL3 [1]   | H866<br>XXXX        |

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



### Pin Descriptions

| Pin Number  | Function     | Description                               | Interface Schematic |
|-------------|--------------|---|---------------------|
| 1, 4, 9, 12 | GND          | Signal grounds should be connected to 0V. |                     |
| 2, 3        | INP, INN     | Data Inputs                               |                     |
| 5, 16       | INNDC, INPDC | DC Offset Inputs                          |                     |
| 6           | Vee          | Supply grounds should be connected to 0V. |                     |
| 7           | VAC          | Output amplitude control voltage          |                     |
| 8, 13       | QNDC, QPDC   | DC monitor outputs.                       |                     |

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### Pin Descriptions (Continued)

| Pin Number    | Function | Description                                   | Interface Schematic |
|---------------|----------|---|---------------------|
| 10, 11        | QN, QP   | Data outputs.                                 |                     |
| 14, 15        | Vcc      | Positive Supply                               |                     |
| Ground Paddle | GND      | Ground paddle must be connected to DC ground. |                     |





**Evaluation PCB**



**List of Materials for Evaluation PCB EVAL01-HMC866LC3 [1]**

| Item                     | Description                      |
|--------------------------|----------------------------------|
| J1 - J8                  | DC Pin                           |
| J9 - J12                 | K-type Connector                 |
| C1, C3, C5, C7, C11, C13 | 0.1 $\mu$ F Capacitor, 0603 Pkg. |
| C2, C4, C6, C8, C12, C14 | 1000 pF Capacitor, 0603 Pkg.     |
| C16, C18, C22            | 4.7 $\mu$ F Capacitor, Tantalum  |
| R1, R2, R4, R6, R7       | 0 Ohm Resistor, 0402 Pkg.        |
| R8                       | 0 Ohm Resistor, 0603 Pkg.        |
| U1                       | HMC866LC3C Limiting Amplifier    |
| PCB [2]                  | 126150 Evaluation PCB            |

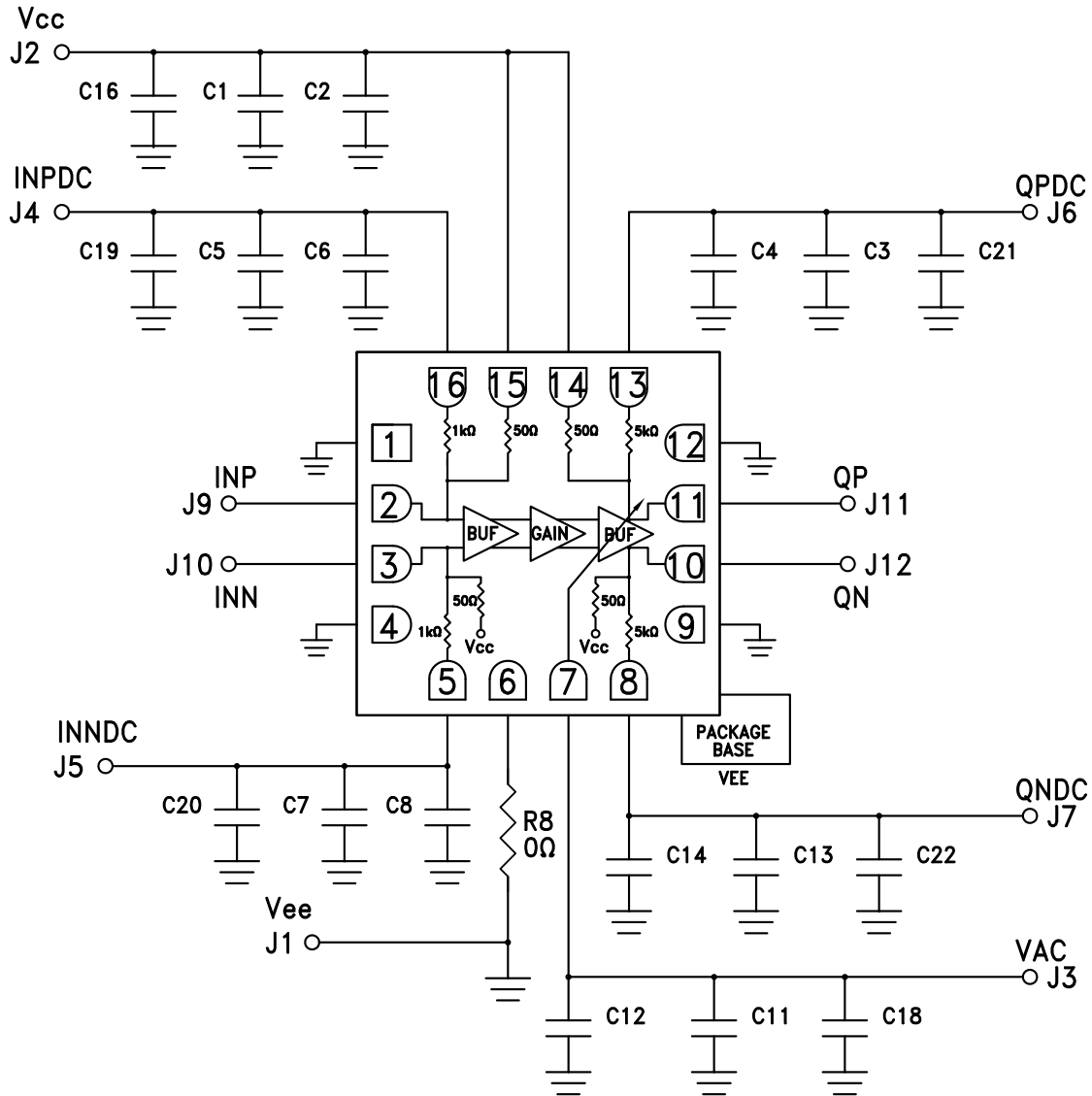
The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect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

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Arlon 25FR or Rogers 4350



**Application Circuit**



| Component                | Value       |
|--------------------------|-------------|
| C2, C4, C6, C8, C12, C14 | 1 nF        |
| C1, C3, C5, C7, C11, C13 | 0.1 $\mu$ F |
| C16, C18 - C22           | 4.7 $\mu$ F |



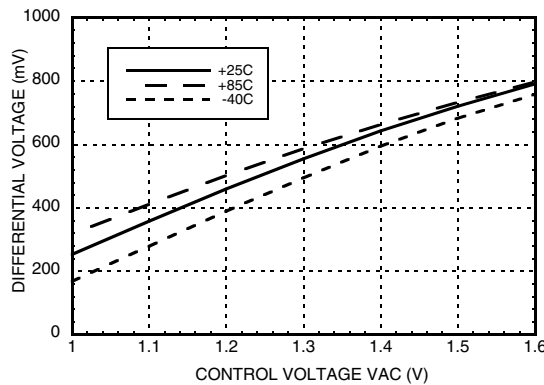
**32 Gbps LIMITING AMPLIFIER**

**Application Information**

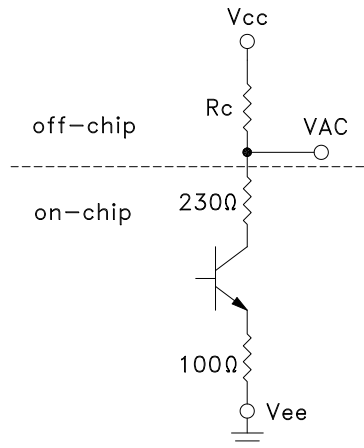
**Setting the output swing using external resistor Rc**

The HMC866LC3 features output swing level adjustment by using VAC pin. Output swing can be adjusted to the desired level by applying a DC voltage to VAC pin. Differential output swing vs. control voltage relationship is given in the plot below.

**Differential Output vs. Control Voltage**



In order to adjust the DC voltage on VAC pin a resistor, Rc, should be connected between VAC pin and VCC as shown in the figure below.



The value of the resistor can be chosen using the following equation as a function of VAC. VAC DC voltage value can be chosen by using the plot given above.

$$R_c = \frac{330(V_{CC} - V_{AC})}{V_{AC} - 0.86}$$





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