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### Typical Applications

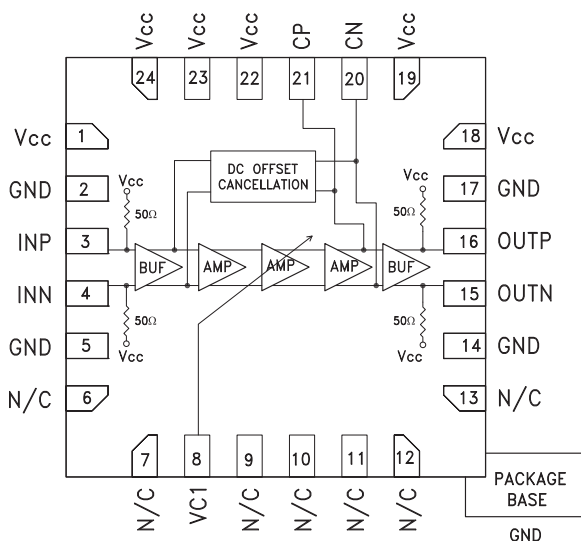
The HMC750LP4(E) is ideal for:

- OC-192 Receivers
- 10 Gbps Ethernet Receivers
- 10 Gbps Fiber Channel Receivers
- Broadband Test & Measurement

### Features

- Supports Data Rates up to 12.5 Gbps
- Differential Gain: 44 dB
- 2mV p-p input Sensitivity
- 3 dB Bandwidth: 11 GHz
- Integrated DC Offset Correction
- Adjustable Differential Saturated O/P Voltage Swing up to 880 mVp-p
- Single +5V Power Supply
- Very Low RMS Jitter Degradation
- 24 Lead Plastic 4x4mm SMT Package: 16mm<sup>2</sup>

### Functional Diagram



### General Description

HMC750LP4E is a limiting amplifier designed to support data transmission rates up to 12.5 Gbps. The amplifier can operate over a wide range of input voltage levels and provides constant-level differential output swing. HMC750LP4E also features an output level control pin, VC1, which allows for loss compensation or for signal level optimization. Differential output signal swing can be adjustable up to 880 mVp-p. Input signals higher than 3mV p-p can be amplified to saturated 880mV p-p differential signal.

All single-ended input signals to the HMC750LP4E are terminated with 50 ohms to +5V on-chip, and may be either AC or DC coupled. The outputs of the HMC750LP4E may be operated either differentially or single-ended. Outputs can be connected directly to a 50 ohm terminated system referenced to +5V, while DC blocking capacitors may be used if the terminating system is 50 ohms to a non +5V voltage. The HMC750LP4E operates from a single + 5V DC supply and is available in a plastic RoHS compliant 4x4 mm SMT package.

### Electrical Specifications, $T_A = +25^\circ \text{C}$ , $V_{CC} = +5V$ , $VC1 = +2.5V$

| Parameter                             | Conditions                | Min. | Typ. | Max. | Units  |
|---------------------------------------|---------------------------|------|------|------|--------|
| <b>Power Supply Voltage</b>           |                           | 4.6  | 5    | 5.4  | V      |
| Power Supply Current                  | VC1 = 2.5V                |      | 106  | 122  | mA     |
| Maximum Data Rate                     |                           |      | 12.5 |      | Gbps   |
| Differential Small Signal Gain        | VC1 = 2.5V                |      | 44   |      | dB     |
| Small Signal Bandwidth                | 3-dB Cutoff               |      | 11   |      | GHz    |
| Deterministic Jitter <sup>[1]</sup>   | Vin = 20 mV peak to peak  |      | 5    |      | ps p-p |
| Additive Random Jitter <sup>[2]</sup> | Vin = 200 mV peak to peak |      |      | 0.2  | ps rms |

For price, delivery and to place orders: Hittite Microwave Corporation, 20 Alpha Road, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at [www.hittite.com](http://www.hittite.com)

Application Support: Phone: 978-250-3343 or [apps@hittite.com](mailto:apps@hittite.com)

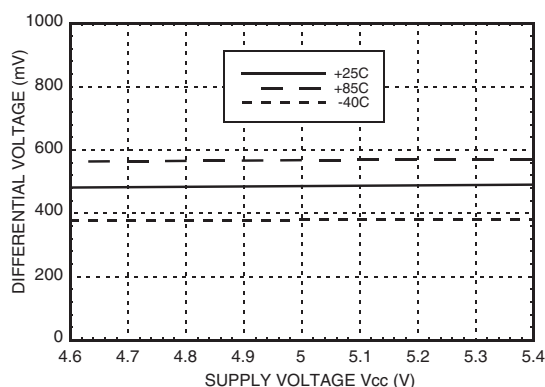
### Electrical Specifications (Conditions)

| Parameter             | Conditions                                                       | Min. | Typ. | Max. | Units |
|-----------------------|------------------------------------------------------------------|------|------|------|-------|
| Rise Time             | 20% - 80%                                                        |      | 23   | 27   | ps    |
| Fall Time             | 20% - 80%                                                        |      | 21   | 23   | ps    |
| Data Output Swing     | Differential Output Swing.<br>VC1 = 3V for maximum output swing. | 850  | 880  |      | mVp-p |
| Input Return Loss     | up to 10 GHz                                                     | 15   |      |      | dB    |
| Output Return Loss    | up to 10 GHz                                                     | 8    |      |      | dB    |
| Input Sensitivity     |                                                                  | 2    |      |      | mVp-p |
| Maximum Input Swing   |                                                                  |      | 1200 |      | mVp-p |
| Output Offset Voltage | VC1 = 3V for maximum output swing                                |      | 3    |      | mV    |
| VC1                   |                                                                  | 2    |      | 3    | V     |
| Vout DC               |                                                                  | 4.5  |      | 4.8  | V     |

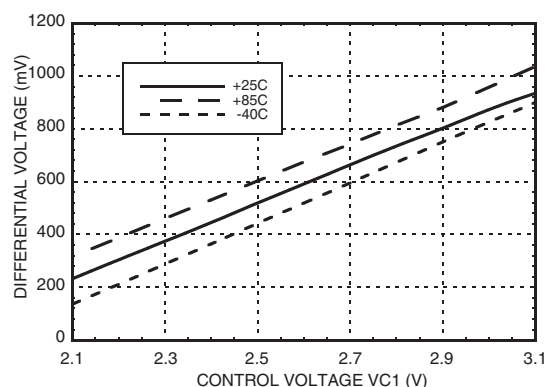
[1] Deterministic jitter measured at 10 Gbps with PRBS 2<sup>23</sup>-1 pattern. It is the peak to peak deviation from the ideal time crossing

[2] Random jitter is measured with 10 Gbps 10101... pattern

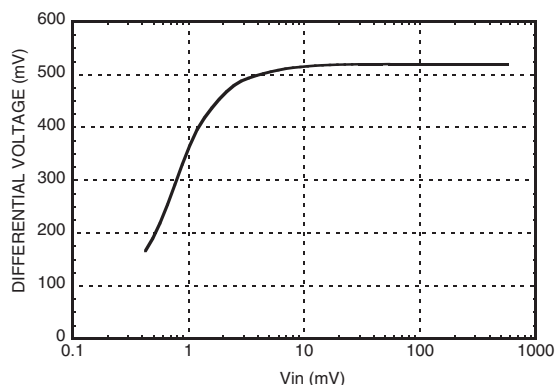
### Differential Output vs. Supply Voltage <sup>[1]</sup>



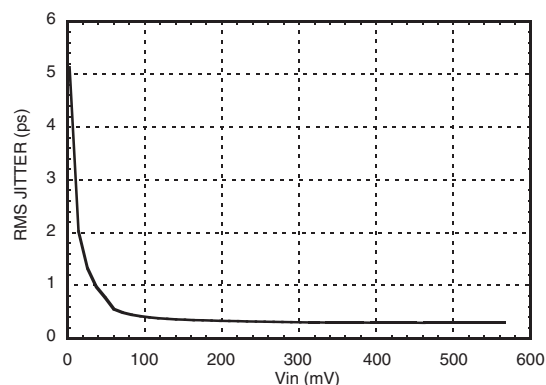
### Differential Output vs. Control Voltage <sup>[2]</sup>



### Differential Output vs. Vin <sup>[1][2]</sup>



### RMS Jitter vs. Vin <sup>[1][2][3]</sup>



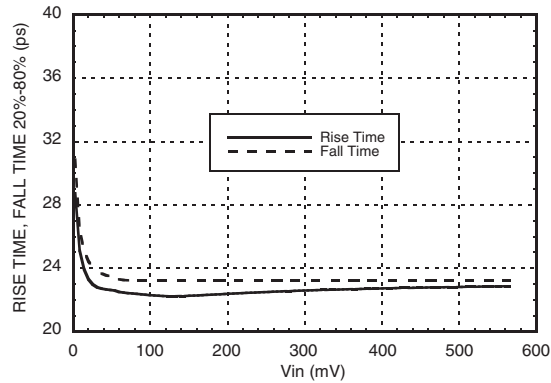
[1] VC1 = 2.5V [2] Vcc = 5V [3] Input Data Rate = 10 Gbps

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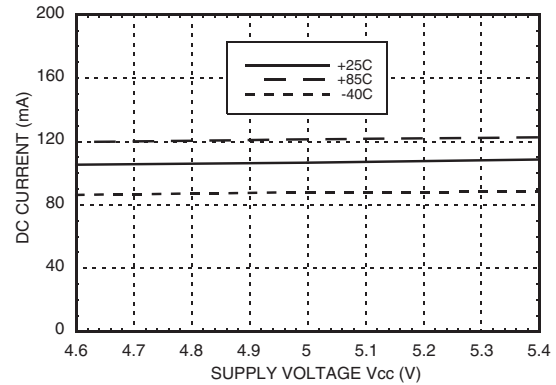
Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at [www.hittite.com](http://www.hittite.com)

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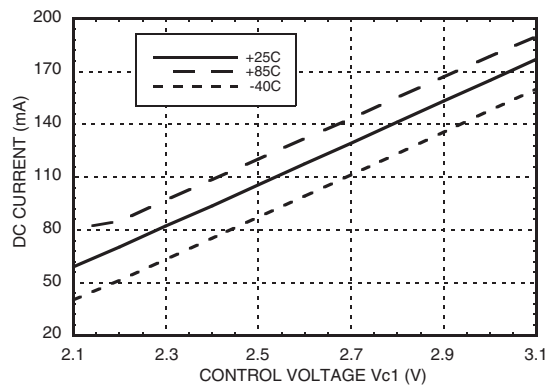
**Rise & Fall Time vs. Vinut** <sup>[1] [2] [3]</sup>



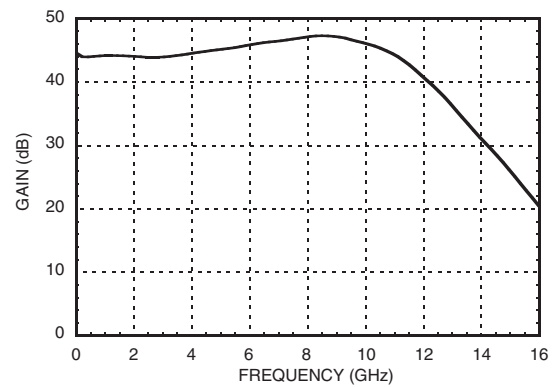
**DC Current vs. Supply Voltage** <sup>[1] [3]</sup>



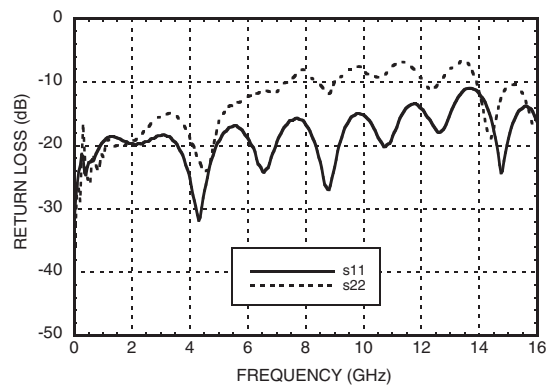
**DC Current vs. Control Voltage** <sup>[2] [3]</sup>



**Differential Gain vs. Frequency** <sup>[1] [2]</sup>

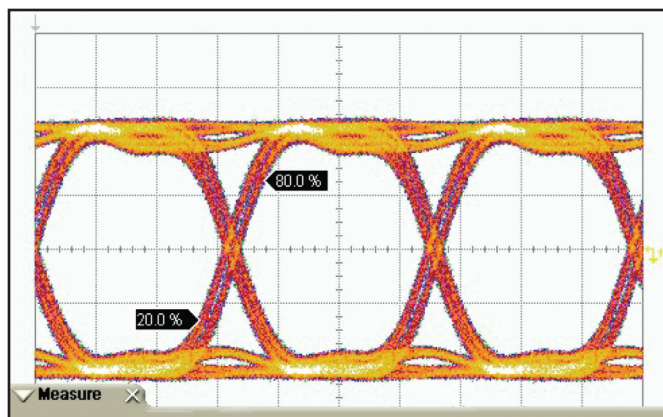


**Return Loss** <sup>[1] [2]</sup>



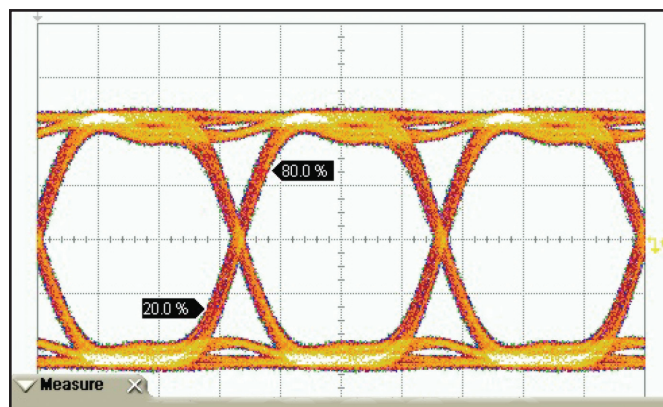
[1] VC1 = 2.5V [2] Vcc = 5V [3] Input Data Rate = 10 Gbps

### Output Eye Diagram



|                                 | Current       | Minimum  | Maximum  | Total Meas |
|---------------------------------|---------------|----------|----------|------------|
| Rise Time (f1)                  | 23.33 ps      | 23.33 ps | 23.33 ps | 32         |
| Fall Time (f1)                  | 24.67 ps      | 24.00 ps | 25.33 ps | 32         |
| Differential Eye Amplitude (f1) | 860 mV        | 858 mV   | 860 mV   | 32         |
| Eye S/N (f1)                    | 15.35         | 15.28    | 15.50    | 32         |
| Vertical Scale                  | 100 mV / div  |          |          |            |
| Horizontal Scale                | 30.0 ps / div |          |          |            |

### Output Eye Diagram



|                                 | Current       | Minimum  | Maximum  | Total Meas |
|---------------------------------|---------------|----------|----------|------------|
| Rise Time (f1)                  | 23.33 ps      | 22.67 ps | 23.33 ps | 30         |
| Fall Time (f1)                  | 24.67 ps      | 24.67 ps | 26.00 ps | 30         |
| Differential Eye Amplitude (f1) | 862 mV        | 861 mV   | 862 mV   | 30         |
| Eye S/N (f1)                    | 15.27         | 15.19    | 15.35    | 30         |
| Vertical Scale                  | 100 mV / div  |          |          |            |
| Horizontal Scale                | 30.0 ps / div |          |          |            |

#### Test Conditions

Eye diagram data presented on an Infinium DCA 86100A

Rate = 10 Gb/s

Pseudo Random Code = 2<sup>23</sup> -1

Vin = 100 mVpp differential, VC1 = 3V

#### Test Conditions

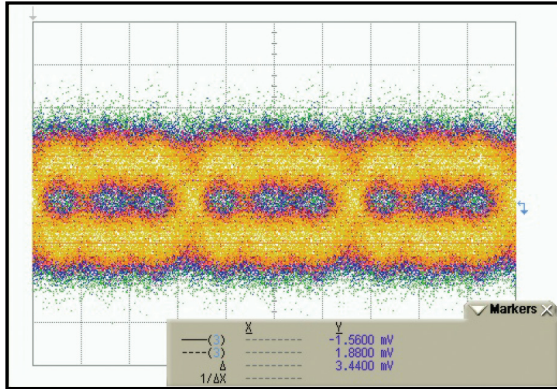
Eye diagram data presented on an Infinium DCA 86100A

Rate = 10 Gb/s

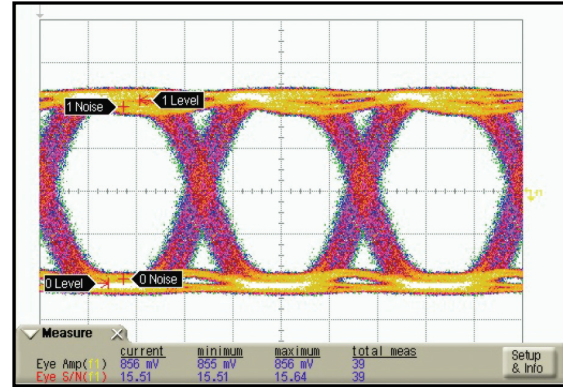
Pseudo Random Code = 2<sup>23</sup> -1

Vin = 500 mVpp differential, VC1 = 3V

### Input Signal



### Output Signal

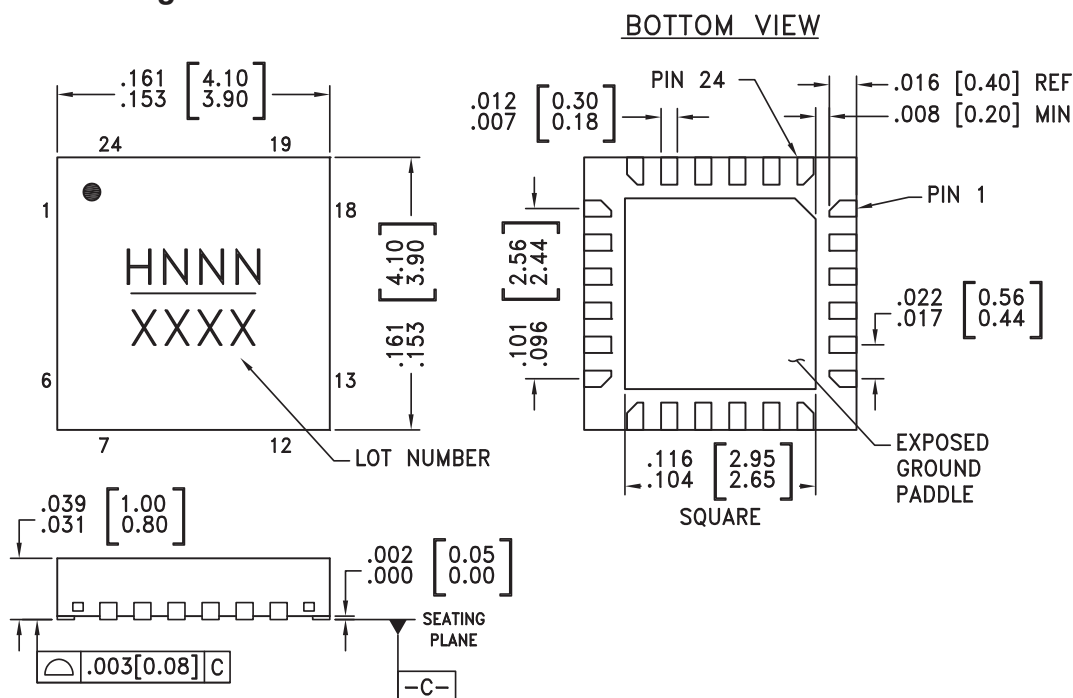


Input and output signal for 10 Gbps, PRBS 2<sup>23</sup> -1, 3.5mV p-p differential, VC1 = 3V.

### Absolute Maximum Ratings

|                                                                      |               |
|----------------------------------------------------------------------|---------------|
| Supply Voltage                                                       | 5.6V          |
| Input Signals                                                        | 4V to 5.5V    |
| RF Input Power                                                       | 10 dBm        |
| Junction Temperature                                                 | 125 °C        |
| Continuous Pdiss (T = 85°C)<br>(Derate 24 mW/°C above 85°C)          | 0.95 Watts    |
| Thermal Resistance (R <sub>th</sub> )<br>(junction to ground paddle) | 42 °C/W       |
| Storage Temperature                                                  | -65 to 150 °C |
| Operating Temperature                                                | -40 to +85 °C |

### 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 HMC APPLICATION NOTE FOR SUGGESTED PCB LAND PATTERN.

### Package Information

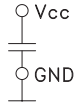
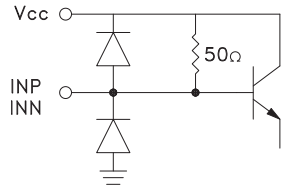
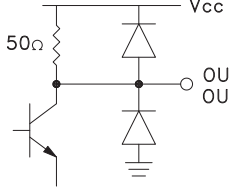
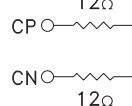
| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[3]</sup> |
|-------------|----------------------------------------------------|---------------|---------------------|--------------------------------|
| HMC750LP4   | Low Stress Injection Molded Plastic                | Sn/Pb Solder  | MSL1 <sup>[1]</sup> | H750<br>XXXX                   |
| HMC750LP4E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H750<br>XXXX                   |

[1] Max peak reflow temperature of 235 °C

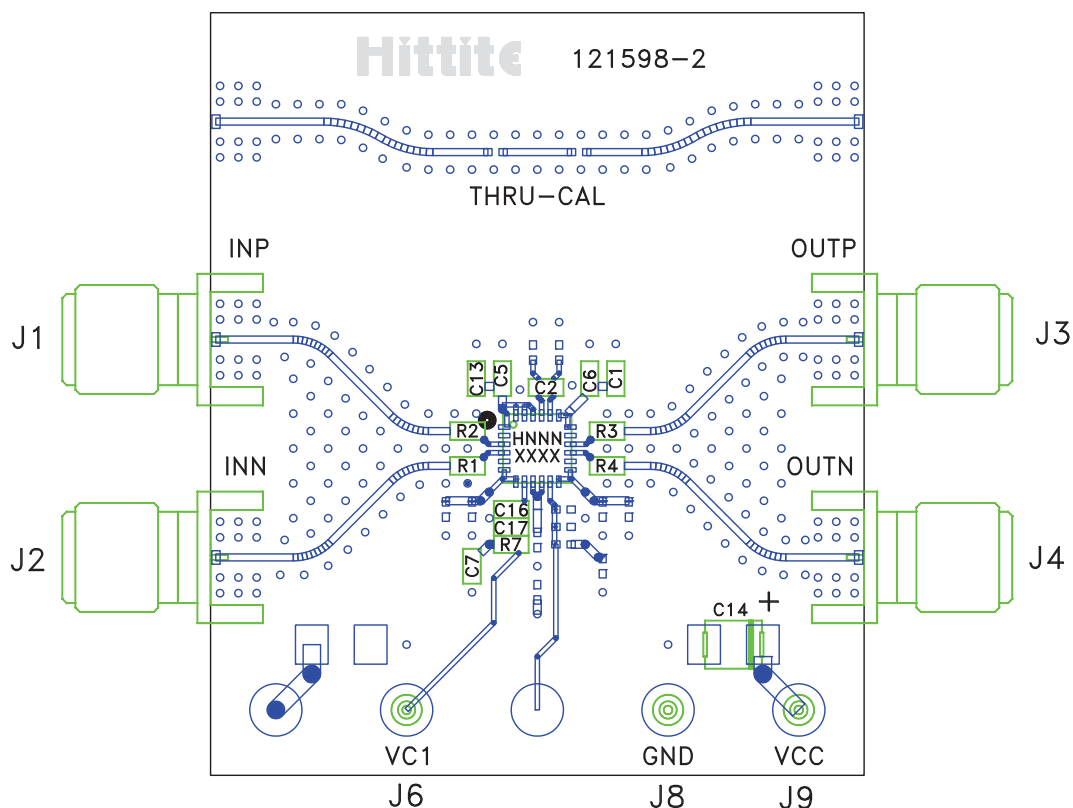
[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

### Pin Descriptions

| Pin Number                     | Function   | Description                                                                                           | Interface Schematic                                                                   |
|--------------------------------|------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1, 18, 19,<br>22 - 24          | Vcc        | Positive supply.                                                                                      |    |
| 2, 5, 14, 17,<br>Ground Paddle | GND        | Signal and supply ground. Package base must be connected to DC ground.                                |    |
| 3, 4                           | INP, INN   | Data inputs                                                                                           |    |
| 6, 7,<br>9 - 13                | N/C        | No connection. These pins are not connected internally, but should be connected to ground externally. |                                                                                       |
| 8                              | VC1        | Gain, output level control.                                                                           |   |
| 15, 16                         | OUTN, OUTP | Data outputs                                                                                          |  |
| 20, 21                         | CN, CP     | Filter capacitor for offset correction.<br>Connect 100nF capacitor between CP and CN.                 |  |

**Evaluation PCB**



**List of Materials for Evaluation PCB 121600 [1]**

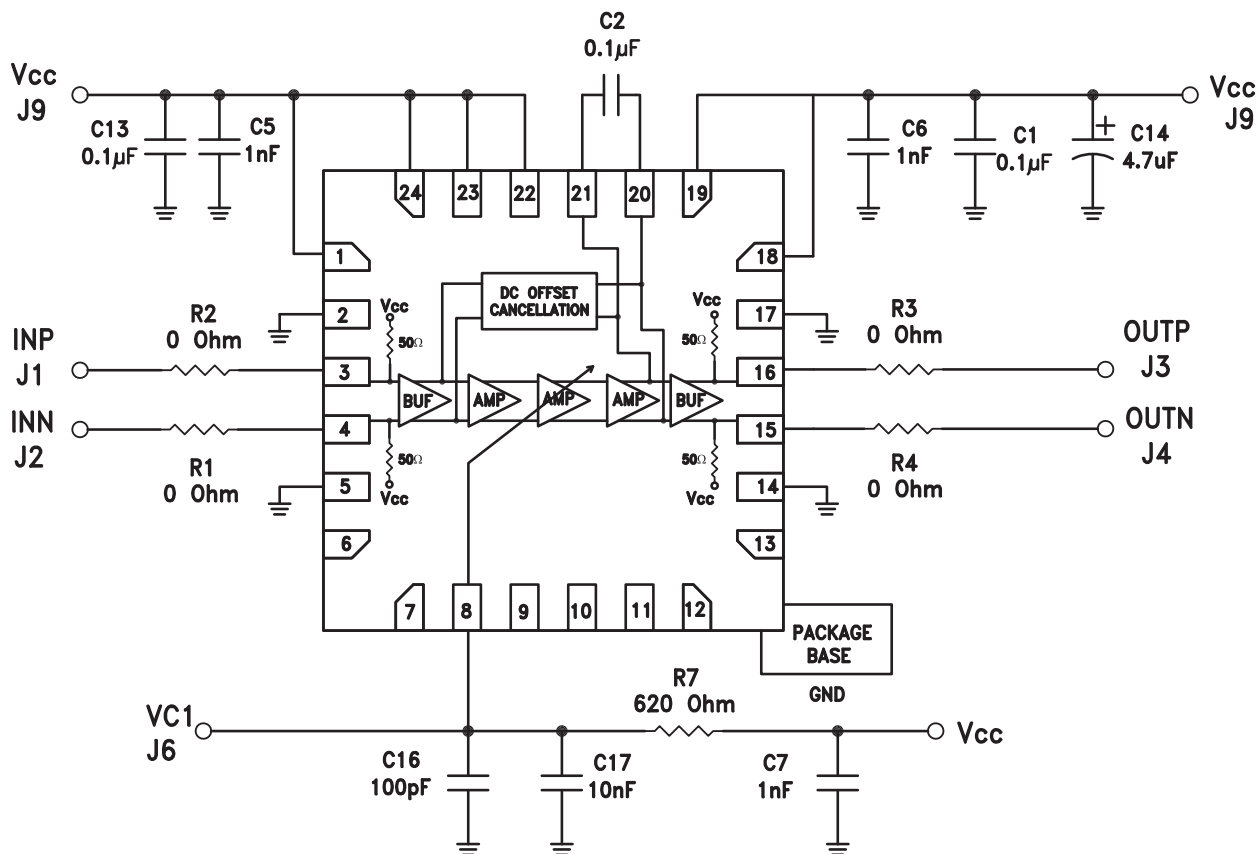
| Item        | Description                      |
|-------------|----------------------------------|
| J1 - J4     | PCB Mount SMA Connector          |
| J6, J8, J9  | DC Pin                           |
| C1, C2, C13 | 0.1 $\mu$ F Capacitor, 0402 Pkg. |
| C5 - C7     | 1 nF Capacitor, 0402 Pkg.        |
| C14         | 4.7 $\mu$ F Capacitor, 0402 Pkg. |
| C16         | 100 pF Capacitor, 0402 Pkg.      |
| C17         | 10 nF Capacitor, 0402 Pkg.       |
| R1 -R4      | 0 Ohm Resistor, 0402 Pkg.        |
| R7          | 620 Ohm Resistor, 0402 Pkg.      |
| U1          | HMC750LP4(E) Limiting Amplifier  |
| PCB [2]     | 121598 Evaluation PCB            |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Arlon 25FR

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.

### Application Circuit

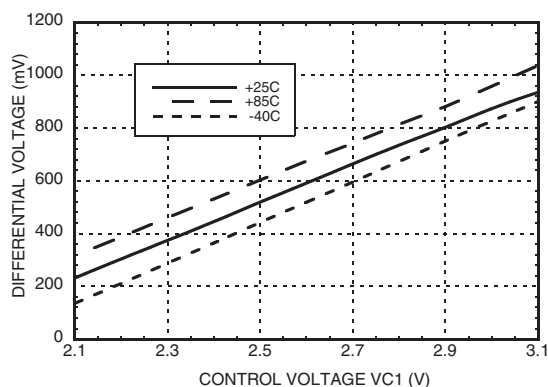


### Application Information

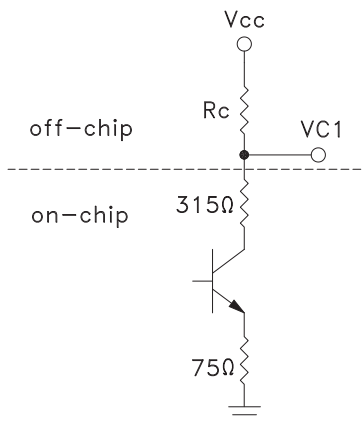
#### Setting the output swing using external resistor $R_c$

The HMC750LP4E features output swing level adjustment by using VC1 pin. Output swing can be adjusted to the desired level by applying a DC voltage to VC1 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 VC1 pin a resistor,  $R_c$  (R7 in application circuit), should be connected between VC1 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 VC1. VC1 DC voltage value can be chosen by using the plot given above.

$$R_c = \frac{390(V_{CC} - VC1)}{VC1 - 1.73}$$