



### FEATURES

- Ultralow phase noise:  $-160$  dBc/Hz typical at 10 kHz
- Output power for 1 dB compression (P1dB): 15 dBm typical at 2 GHz to 12 GHz frequency range
- Gain: 13.5 dB typical at 2 GHz to 12 GHz frequency range
- Output third-order intercept (IP3): 27 dBm typical at 2 GHz to 12 GHz frequency range
- Supply voltage: 5.0 V at 64 mA typical
- 50  $\Omega$  matched input/output
- 32-terminal, ceramic, leadless chip carrier (LCC)

### APPLICATIONS

- Radars, electronic warfare (EW), and electronic counter measures (ECMs)
- Microwave radios
- Test instrumentation
- Military and space
- Fiber optic systems

### GENERAL DESCRIPTION

The **HMC606LC5** is a gallium arsenide (GaAs), indium gallium phosphide (InGaP), heterojunction bipolar transistor (HBT), monolithic microwave integrated circuit (MMIC) distributed amplifier housed in a 32-terminal, ceramic, leadless chip carrier (LCC) package that operates from 2 GHz to 18 GHz. With an input signal of 12 GHz, the amplifier provides ultralow phase noise performance of  $-160$  dBc/Hz at a 10 kHz offset, representing a significant improvement over field effect transistor (FET)-based distributed amplifiers.

### FUNCTIONAL BLOCK DIAGRAM

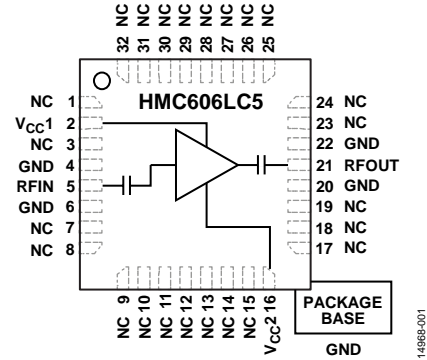


Figure 1.

The **HMC606LC5** provides 13.5 dB of small signal gain, 27 dBm output IP3, and 15 dBm of output power for 1 dB compression while requiring 64 mA from a 5.0 V supply. The input and output of the **HMC606LC5** amplifier are internally matched to 50  $\Omega$  and are internally dc blocked.

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## REVISION HISTORY

### 3/2020—Rev. I to Rev. J

|  |   |
|--|---|
| Deleted Figure 16, Figure 17, and Figure 18; Renumbered Sequentially ..... | 8 |
|--|---|

### 1/2018—Rev. H to Rev. I

|   |    |
|---|----|
| Changes to Figure 16, Figure 16 Caption, Figure 17, Figure 17 Caption, Figure 18, Figure 18 Caption, and Figure 19..... | 8  |
| Changes to Ordering Guide.....  | 10 |

### 10/2017—Rev. G to Rev. H

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| Changes to Typical Performance Characteristics Section..... | 7  |
| Added Figure 19; Renumbered Sequentially .....              | 9  |
| Updated Outline Dimensions .....                            | 10 |
| Changes to Ordering Guide.....                              | 10 |

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### 8/2017—Rev. F to Rev. G

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| Changes to Continuous Power Dissipation, $P_{DISS}$ Parameter, Table 4.....  | 4 |
| This Hittite Microwave Products data sheet has been reformatted to meet the styles and standards of Analog Devices, Inc. |   |

### 2/2017—Rev. 05.0514 to Rev. F

|   |           |
|---|-----------|
| Updated Format .....  | Universal |
| Changes to Features Section and General Description Section ..... | 1         |
| Changes to Table 4.....   | 4         |
| Updated Outline Dimensions .....                                  | 9         |
| Changes to Ordering Guide.....                                    | 9         |

**SPECIFICATIONS****ELECTRICAL SPECIFICATIONS**

$T_A = 25^\circ\text{C}$ ,  $V_{CC1} = V_{CC2} = 5\text{ V}$ , unless otherwise noted.

**Table 1.**

| Parameter                         | Min  | Typ       | Max | Unit                 |
|-----------------------------------|------|-----------|-----|----------------------|
| FREQUENCY RANGE                   | 2    |           | 12  | GHz                  |
| GAIN                              | 10.5 | 13.5      |     | dB                   |
| Flatness                          |      | $\pm 1.0$ |     | dB                   |
| Variation Over Temperature        |      | 0.021     |     | dB/ $^\circ\text{C}$ |
| NOISE FIGURE                      |      | 5         |     | dB                   |
| INPUT RETURN LOSS                 |      | 20        |     | dB                   |
| OUTPUT                            |      |           |     |                      |
| Return Loss                       |      | 15        |     | dB                   |
| Power for 1 dB Compression (P1dB) | 12   | 15        |     | dBm                  |
| Saturated Power ( $P_{SAT}$ )     |      | 17        |     | dBm                  |
| Third-Order Intercept (IP3)       |      | 27        |     | dBm                  |
| PHASE NOISE                       |      |           |     |                      |
| At 100 Hz                         |      | -140      |     | dBc/Hz               |
| At 1 kHz                          |      | -150      |     | dBc/Hz               |
| At 10 kHz                         |      | -160      |     | dBc/Hz               |
| At 1 MHz                          |      | -170      |     | dBc/Hz               |
| SUPPLY CURRENT                    |      | 64        | 95  | mA                   |

**Table 2.**

| Parameter                         | Min | Typ       | Max | Unit                 |
|-----------------------------------|-----|-----------|-----|----------------------|
| FREQUENCY RANGE                   | 2   |           | 18  | GHz                  |
| GAIN                              | 9.5 | 12.5      |     | dB                   |
| Flatness                          |     | $\pm 1.0$ |     | dB                   |
| Variation Over Temperature        |     | 0.024     |     | dB/ $^\circ\text{C}$ |
| NOISE FIGURE                      |     | 7         |     | dB                   |
| INPUT RETURN LOSS                 |     | 18        |     | dB                   |
| OUTPUT                            |     |           |     |                      |
| Return Loss                       |     | 15        |     | dB                   |
| Power for 1 dB Compression (P1dB) | 10  | 13        |     | dBm                  |
| Saturated Power ( $P_{SAT}$ )     |     | 15        |     | dBm                  |
| Third-Order Intercept (IP3)       |     | 22        |     | dBm                  |
| PHASE NOISE                       |     |           |     |                      |
| At 100 Hz                         |     | -140      |     | dBc/Hz               |
| At 1 kHz                          |     | -150      |     | dBc/Hz               |
| At 10 kHz                         |     | -160      |     | dBc/Hz               |
| At 1 MHz                          |     | -170      |     | dBc/Hz               |
| SUPPLY CURRENT                    |     | 64        | 95  | mA                   |

**Table 3.  $V_{CC1}$ ,  $V_{CC2}$  vs. Typical Supply Current**

| $V_{CC1}$ , $V_{CC2}$ (V) | $I_{CC1} + I_{CC2}$ (mA) |
|---------------------------|--------------------------|
| 4.5                       | 53                       |
| 5.0                       | 64                       |
| 5.5                       | 71                       |

## ABSOLUTE MAXIMUM RATINGS

Table 4.

| Parameter   | Rating              |
|---|---------------------|
| $V_{CC1} = V_{CC2}$   | 7 V                 |
| RF Input Power (RFIN)   | 15 dBm              |
| Channel Temperature   | 175°C               |
| Continuous Power Dissipation, $P_{DISS}$ ( $T_A = 85^\circ\text{C}$ , Derate 10.9 mW/°C Above 85°C) | 0.978 W             |
| Maximum Peak Reflow Temperature (MSL3) <sup>1</sup>   | 260°C               |
| Thermal Resistance (Channel to Ground Paddle)   | 92°C/W              |
| Storage Temperature Range   | -65°C to +150°C     |
| Operating Temperature Range   | -40°C to +85°C      |
| ESD Sensitivity (Human Body Model, HBM)   | Class 0, Pass 100 V |

<sup>1</sup> See the Ordering Guide section.

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

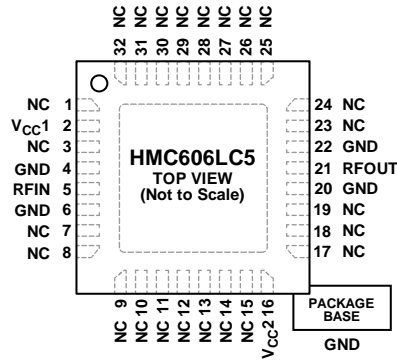
### ESD CAUTION



#### ESD (electrostatic discharge) sensitive device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

# PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



**NOTES**  
 1. NC = NO CONNECT. THESE PINS MAY BE CONNECTED TO RF GROUND. PERFORMANCE WILL NOT BE AFFECTED.  
 2. THE EXPOSED PAD MUST BE CONNECTED TO RF/DC GROUND.

Figure 2. Pin Configuration

Table 5. Pin Function Descriptions

| Pin No.                           | Mnemonic                            | Description  |
|-----------------------------------|-------------------------------------|--|
| 1, 3, 7 to 15, 17 to 19, 23 to 32 | NC                                  | No Connect. These pins may be connected to RF ground. Performance will not be affected.          |
| 2, 16                             | V <sub>CC1</sub> , V <sub>CC2</sub> | Power Supply Voltages for the Amplifier. See Figure 3 for the interface schematic.               |
| 4, 6, 20, 22                      | GND                                 | Ground. These pins must be connected to RF/dc ground. See Figure 4 for the interface schematic.  |
| 5                                 | RFIN                                | RF Input. This pin is ac-coupled and matched to 50 Ω. See Figure 5 for the interface schematic.  |
| 21                                | RFOUT                               | RF Output. This pin is ac-coupled and matched to 50 Ω. See Figure 6 for the interface schematic. |
|                                   | EPAD                                | Exposed Pad. The exposed pad must be connected to RF/dc ground.                                  |

## INTERFACE SCHEMATICS

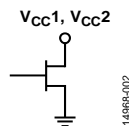


Figure 3. V<sub>CC1</sub>, V<sub>CC2</sub> Interface Schematic



Figure 4. GND Interface Schematic

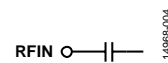


Figure 5. RFIN Interface Schematic

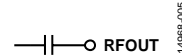


Figure 6. RFOUT Interface Schematic

TYPICAL PERFORMANCE CHARACTERISTICS

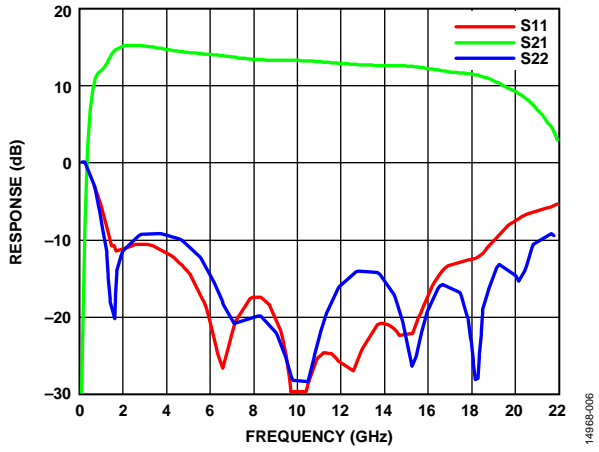


Figure 7. Response (Gain and Return Loss) vs. Frequency

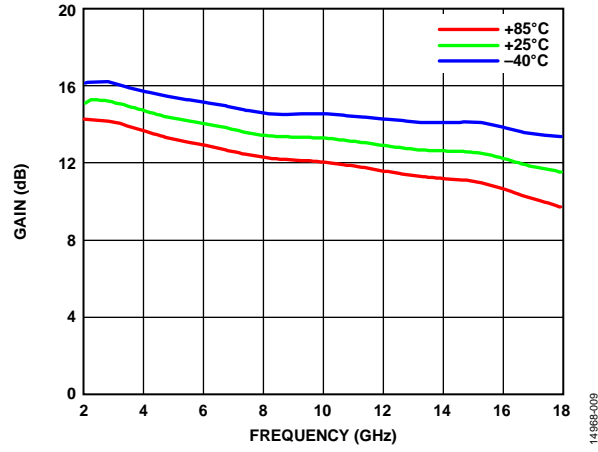


Figure 10. Gain vs. Frequency for Various Temperatures

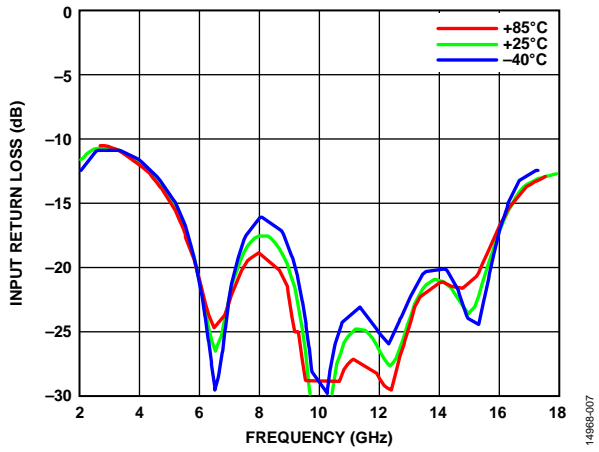


Figure 8. Input Return Loss vs. Frequency for Various Temperatures

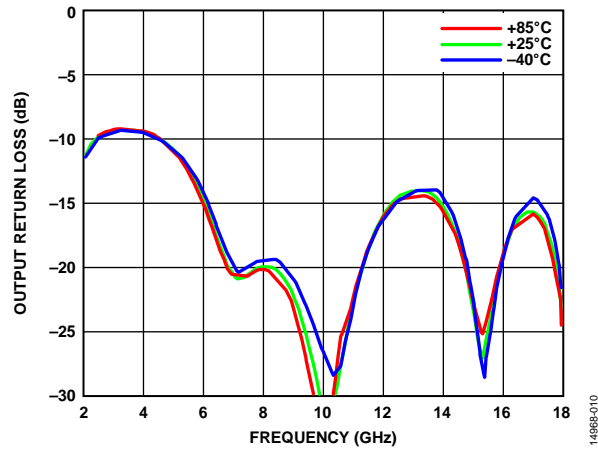


Figure 11. Output Return Loss vs. Frequency for Various Temperatures

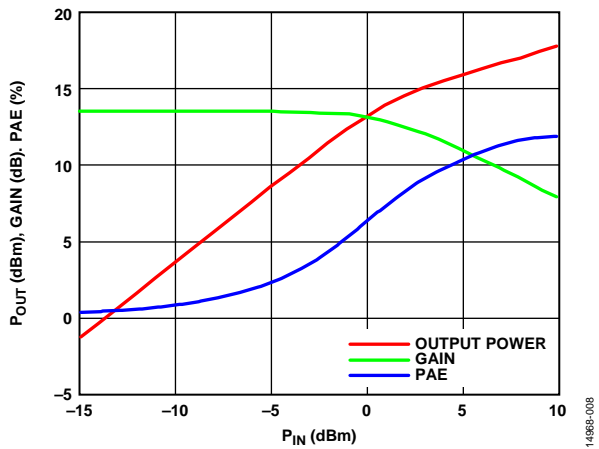


Figure 9. Output Power ( $P_{OUT}$ ), Gain, and Power Added Efficiency (PAE) vs. Input Power ( $P_{IN}$ )

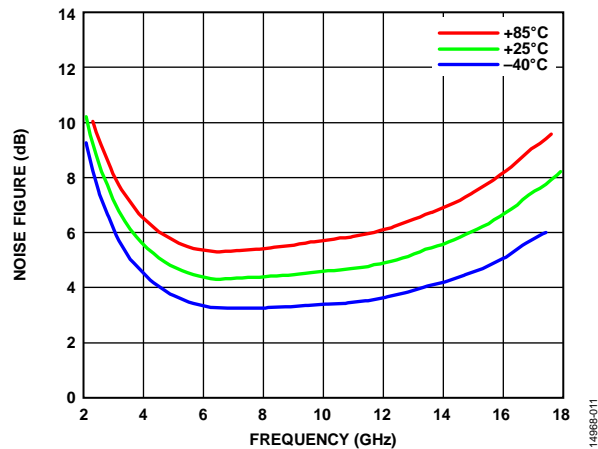


Figure 12. Noise Figure vs. Frequency for Various Temperatures

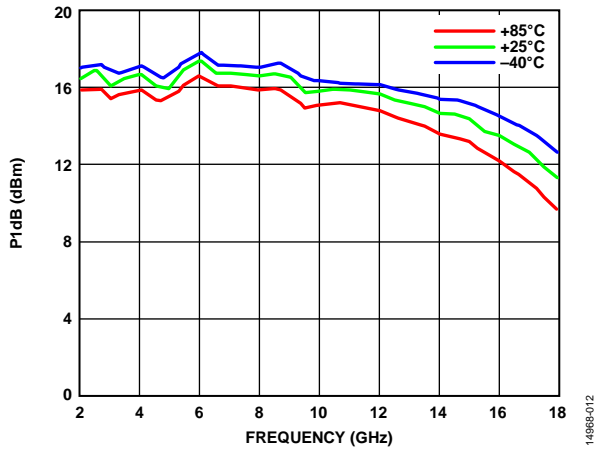


Figure 13. Power for 1 dB Compression ( $P_{1dB}$ ) vs. Frequency for Various Temperatures

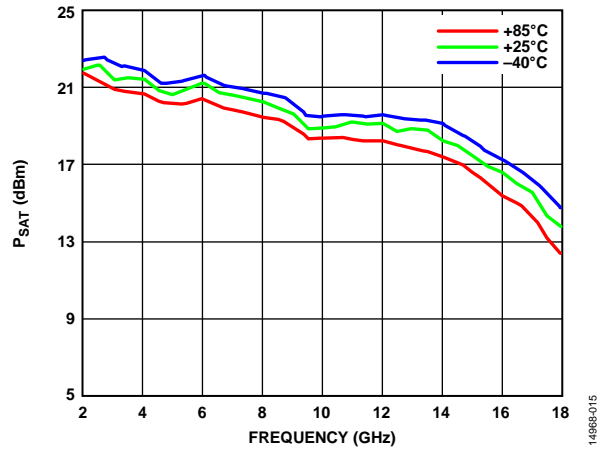


Figure 15. Saturated Power ( $P_{SAT}$ ) vs. Frequency for Various Temperatures

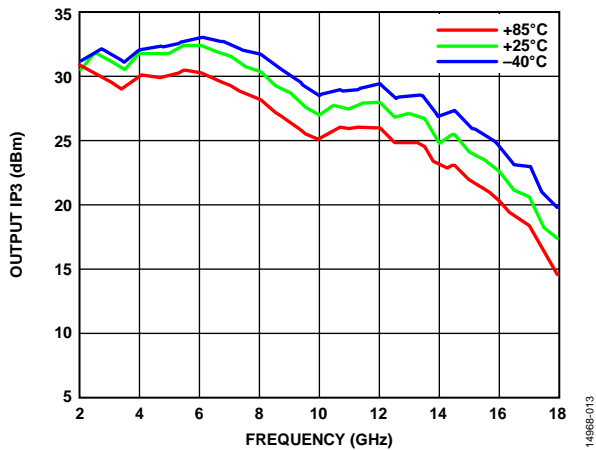


Figure 14. Output Third-Order Intercept ( $IP_3$ ) vs. Frequency for Various Temperatures

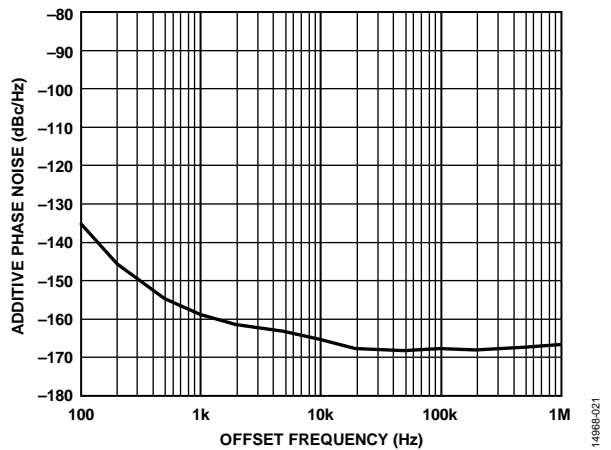


Figure 16. Additive Phase Noise vs. Offset Frequency, RF Frequency = 8 GHz, RF Input Power = 12 dBm ( $P_{SAT}$ )

## APPLICATIONS INFORMATION

### EVALUATION PRINTED CIRCUIT BOARD (PCB)

The circuit board used in the application must use RF circuit design techniques. Signal lines must have 50 Ω impedance, and the package ground leads and package bottom must be connected directly to the ground plane similar to that shown in Figure 17.

Use a sufficient number of via holes to connect the top and bottom ground planes. Mount the evaluation PCB to an appropriate heat sink. The evaluation PCB shown in Figure 17 is available from Analog Devices, Inc., upon request.

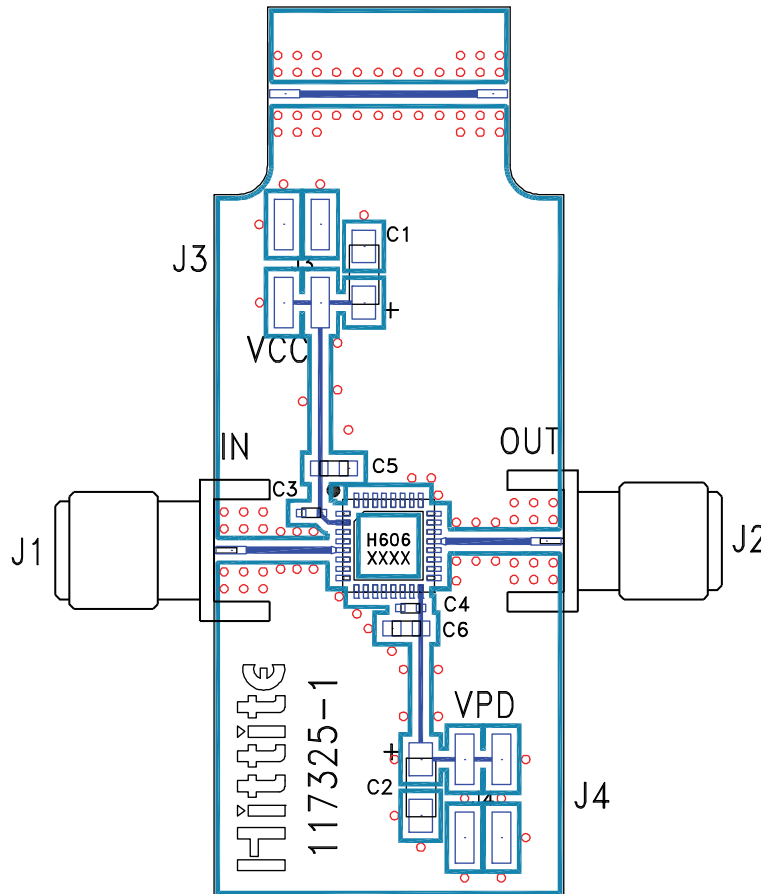


Figure 17. Evaluation PCB

Table 6. List of Materials for Evaluation PCB (117156-HMC606LC5<sup>1</sup>)

| Item   | Description  |
|--------|--|
| J1, J2 | SRI K connectors   |
| J3, J4 | 2 mm Molex headers   |
| C1, C2 | 4.7 μF, tantalum capacitors                                  |
| C3, C4 | 100 pF capacitors, 0402 package                              |
| C5, C6 | 1000 pF capacitors, 0603 package                             |
| U1     | <a href="#">HMC606LC5</a>                                    |
| PCB    | 117325-1 evaluation PCB; circuit board material: Rogers 4350 |

<sup>1</sup> Reference this number when ordering the complete evaluation PCB.



# OUTLINE DIMENSIONS

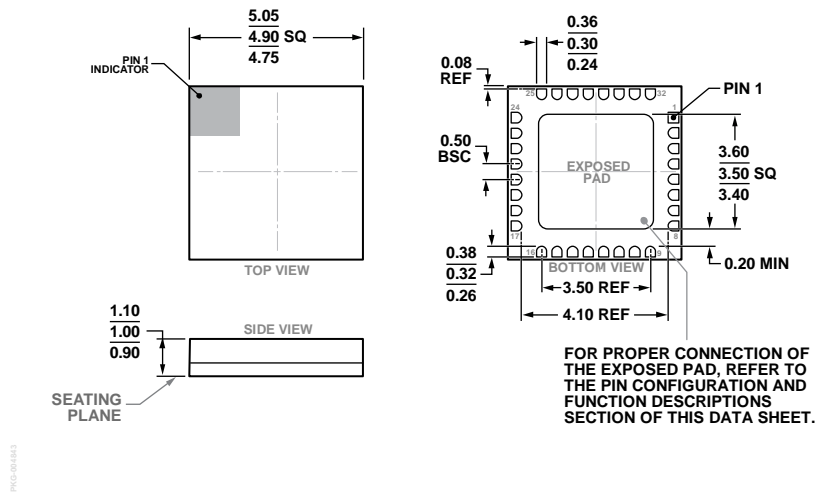


Figure 18. 32-Terminal Ceramic Leadless Chip Carrier [LCC] (E-32-1)  
Dimensions shown in millimeters

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | MSL Rating <sup>2</sup> | Package Description                             | Package Option |
|--------------------|-------------------|-------------------------|---|----------------|
| HMC606LC5          | -40°C to +85°C    | MSL3                    | 32-Terminal Ceramic Leadless Chip Carrier [LCC] | E-32-1         |
| HMC606LC5TR        | -40°C to +85°C    | MSL3                    | 32-Terminal Ceramic Leadless Chip Carrier [LCC] | E-32-1         |
| HMC606LC5TR-R5     | -40°C to +85°C    | MSL3                    | 32-Terminal Ceramic Leadless Chip Carrier [LCC] | E-32-1         |
| 117156-HMC606LC5   |                   |                         | Evaluation Board                                |                |

<sup>1</sup> All models are RoHS Compliant.

<sup>2</sup> See the Absolute Maximum Ratings section.