

## QUADRUPLE OPERATIONAL AMPLIFIER

Check for Samples: [LM124-SP](#), [LM124A-SP](#)

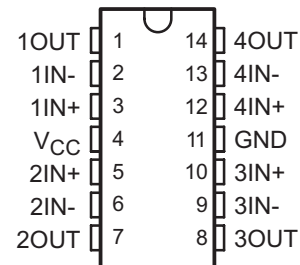
### FEATURES

- QML-V Qualified, SMD 5962-7704301VCA, 5962-9950403VCA and 5962-9950403V9B
- Rad-Tolerant: 50 kRad (Si) TID (5962-9950403VCA and 5962-9950403V9B) <sup>(1)</sup>
  - TID Dose Rate = 0.01 rad/sec (Si)
- Wide Supply Ranges
  - Single Supply: 3 V to 32 V
  - Dual Supplies:  $\pm 1.5$  V to  $\pm 16$  V
- Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA (Typ)
- Low Input Bias and Offset Parameters
  - Input Offset Voltage: 1 mV Typ
  - Input Offset Current: 2 nA Typ
  - Input Bias Current: 30 nA Typ
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground

(1) Radiation tolerance is a typical value based upon initial device qualification with dose rate = 0.01 rad/sec. Radiation lot acceptance testing is available - contact factory for details.

- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage:  $\pm 32$  V
- Open-Loop Differential Voltage Amplification: 100 V/mV Typ
- Internal Frequency Compensation

**J PACKAGE  
(TOP VIEW)**



### DESCRIPTION/ORDERING INFORMATION

These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V, and  $V_{CC}$  is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM124 can be operated directly from the standard 5-V supply that is used in digital systems and provides the required interface electronics, without requiring additional  $\pm 15$ -V supplies.

**Table 1. ORDERING INFORMATION <sup>(1)</sup>**

| $T_A$          | $V_{IOmax}$<br>AT 25°C | MAX $V_{CC}$ | PACKAGE <sup>(2)</sup> | ORDERABLE PART NUMBER          |                                | TOP-SIDE MARKING |
|----------------|------------------------|--------------|------------------------|--------------------------------|--------------------------------|------------------|
| –55°C to 125°C | 5 mV                   | 30 V         | J                      | LM124                          | 5962-7704301VCA                | 5962-7704301VCA  |
|                | 3 mV                   | 30 V         |                        | LM124A                         | 5962-9950403VCA <sup>(3)</sup> | 5962-9950403VCA  |
|                | 3 mV                   | 30 V         | KGD                    | 5962-9950403V9B <sup>(3)</sup> |                                | N/A              |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(3) Radiation tolerant



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## BARE DIE INFORMATION

| DIE THICKNESS | BACKSIDE FINISH        | BACKSIDE POTENTIAL | BON PAD METALLIZATION COMPOSITION | BOND PAD THICKNESS |
|---------------|------------------------|--------------------|-----------------------------------|--------------------|
| 15 mils       | Silicon with backgrind | Floating           | AlCu (0.5%)                       | 0.055 mils         |

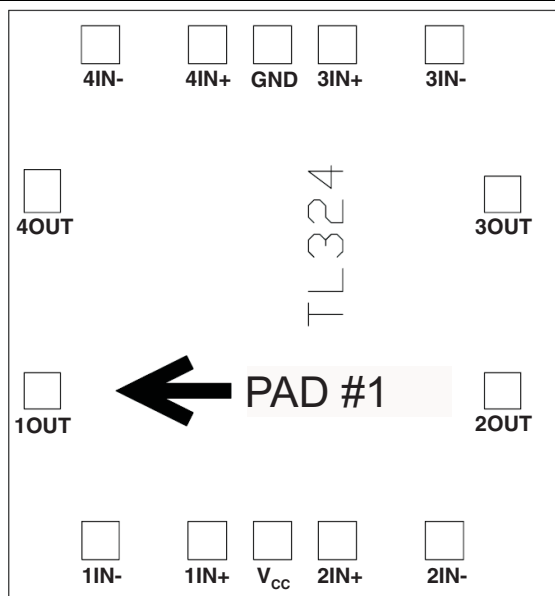
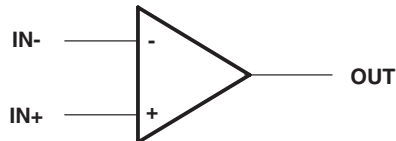


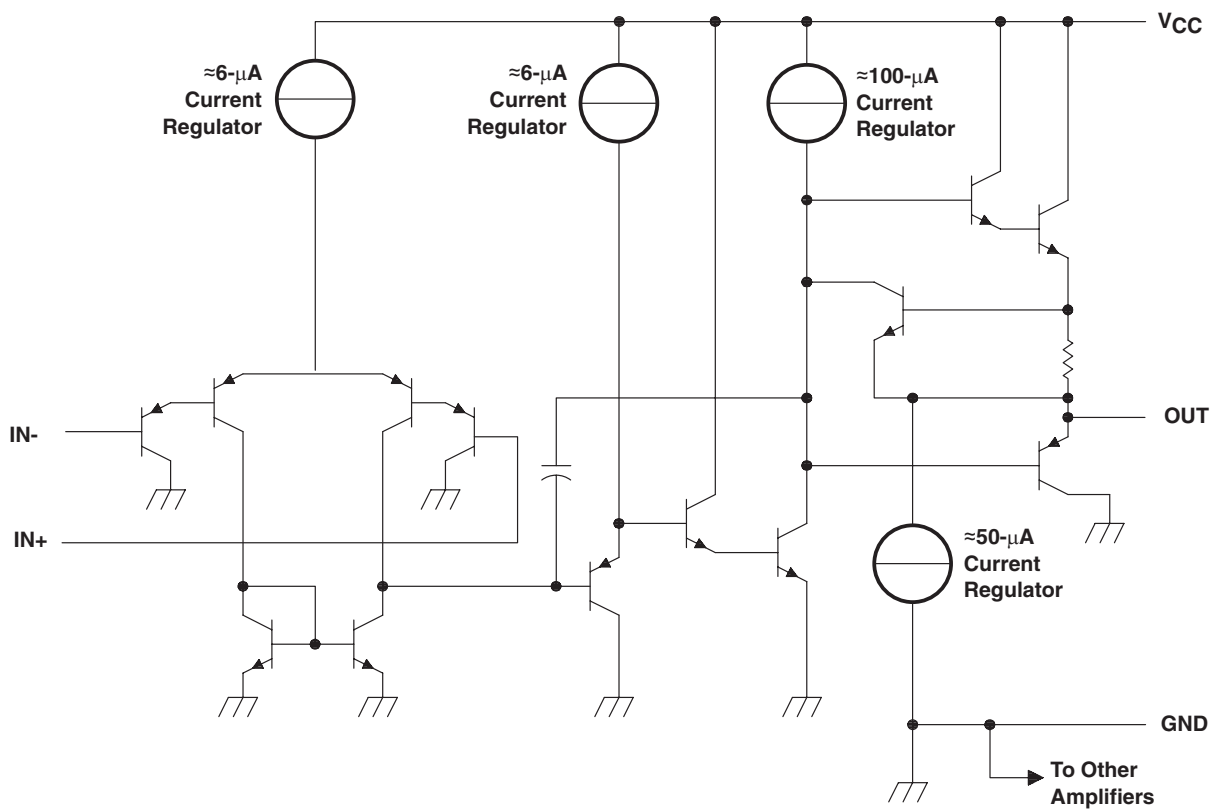
Table 2. Bond Pad Coordinates in Microns

| DISCRIPTION     | PAD NUMBER | Xmin    | Ymin    | Xmax    | Ymax    |
|-----------------|------------|---------|---------|---------|---------|
| 1OUT            | 1          | 426.72  | 1249.68 | 523.24  | 1346.20 |
| 1IN-            | 2          | 25.40   | 1093.47 | 127     | 1192.53 |
| 1IN+            | 3          | 25.40   | 808.99  | 127     | 910.59  |
| V <sub>CC</sub> | 4          | 25.40   | 635     | 127     | 734.06  |
| 2IN+            | 5          | 25.40   | 462.28  | 127     | 563.88  |
| 2IN-            | 6          | 25.40   | 177.80  | 127     | 279.40  |
| 2OUT            | 7          | 426.72  | 25.40   | 523.24  | 121.92  |
| 3OUT            | 8          | 949.96  | 25.40   | 1046.48 | 121.92  |
| 3IN-            | 9          | 1346.20 | 177.80  | 1447.80 | 279.40  |
| 3IN+            | 10         | 1346.20 | 462.28  | 1447.80 | 563.88  |
| GND             | 11         | 1346.20 | 635     | 1447.80 | 736.60  |
| 4IN+            | 12         | 1346.20 | 807.72  | 1447.80 | 909.32  |
| 4IN-            | 13         | 1346.20 | 1092.2  | 1447.80 | 1193.80 |
| 4OUT            | 14         | 949.96  | 1249.68 | 1046.48 | 1346.20 |

### SYMBOL (EACH COMPARATOR)



### SCHEMATIC (EACH AMPLIFIER)



| COMPONENT COUNT<br>(total device) |    |
|-----------------------------------|----|
| Epi-FET                           | 1  |
| Transistors                       | 95 |
| Diodes                            | 4  |
| Resistors                         | 11 |
| Capacitors                        | 4  |

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|                  |                                                                | MIN       | MAX          | UNIT       |
|------------------|----------------------------------------------------------------|-----------|--------------|------------|
| V <sub>CC</sub>  | Supply voltage <sup>(2)</sup>                                  |           | ±16 or<br>32 | V          |
| V <sub>ID</sub>  | Differential input voltage <sup>(3)</sup>                      |           | ±32          | V          |
| V <sub>I</sub>   | Input voltage range (either input)                             | –0.3      | 32           | V          |
|                  | Duration of output short circuit to ground <sup>(4)</sup>      |           | Unlimited    |            |
| θ <sub>JC</sub>  | Package thermal impedance, junction to case <sup>(5) (6)</sup> | J package |              | 15.05 °C/W |
| T <sub>J</sub>   | Operating virtual-junction temperature                         |           | 150          | °C         |
|                  | Lead temperature 1,6 mm (1/16 in) from case for 60 s           |           | 300          | °C         |
| T <sub>stg</sub> | Storage temperature range                                      | –65       | 150          | °C         |

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to network ground.
- (3) Differential voltages are at IN+ with respect to IN–.
- (4) Short circuits from outputs to V<sub>CC</sub> can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of T<sub>J</sub> (max), θ<sub>JC</sub>, and T<sub>C</sub>. The maximum allowable power dissipation at any allowable case temperature is P<sub>D</sub> = (T<sub>J</sub> (max) – T<sub>C</sub>)/θ<sub>JC</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with MIL-STD-883.

## ELECTRICAL CHARACTERISTICS FOR LM124

at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER                            |                                                                      |                                                                                                    | TEST CONDITIONS <sup>(1)</sup> |            | T <sub>A</sub> <sup>(2)</sup> | MIN | TYP <sup>(3)</sup>            | MAX  | UNIT |
|--------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------|------------|-------------------------------|-----|-------------------------------|------|------|
| V <sub>IO</sub>                      | Input offset voltage                                                 | V <sub>CC</sub> = 5 V to MAX,<br>V <sub>IC</sub> = V <sub>ICR</sub> min,<br>V <sub>O</sub> = 1.4 V |                                | 25°C       |                               |     | 3                             | 5    | mV   |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     |                               | 7    |      |
| I <sub>IO</sub>                      | Input offset current                                                 | V <sub>O</sub> = 1.4 V                                                                             |                                | 25°C       |                               |     | 2                             | 30   | nA   |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     |                               | 100  |      |
| I <sub>IB</sub>                      | Input bias current                                                   | V <sub>O</sub> = 1.4 V                                                                             |                                | 25°C       |                               |     | −20                           | −150 | nA   |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     |                               | −300 |      |
| V <sub>ICR</sub>                     | Common-mode input-voltage range                                      | V <sub>CC</sub> = 5 V to MAX                                                                       |                                | 25°C       |                               |     | 0 to<br>V <sub>CC</sub> − 1.5 |      | V    |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     | 0 to<br>V <sub>CC</sub> − 2   |      |      |
| V <sub>OH</sub>                      | High-level output voltage                                            | R <sub>L</sub> = 2 kΩ                                                                              |                                | 25°C       |                               |     | V <sub>CC</sub> − 1.5         |      | V    |
|                                      |                                                                      | R <sub>L</sub> = 10 kΩ                                                                             |                                | 25°C       |                               |     |                               |      |      |
|                                      |                                                                      | V <sub>CC</sub> = MAX                                                                              | R <sub>L</sub> = 2 kΩ          | Full range |                               |     | 26                            |      |      |
|                                      |                                                                      |                                                                                                    | R <sub>L</sub> ≥ 10 kΩ         | Full range |                               |     | 27                            | 28   |      |
| V <sub>OL</sub>                      | Low-level output voltage                                             | R <sub>L</sub> ≤ 10 kΩ                                                                             |                                | Full range |                               |     | 5                             | 20   | mV   |
| A <sub>VD</sub>                      | Large-signal differential-voltage amplification                      | V <sub>CC</sub> = 15 V, V <sub>O</sub> = 1 V to 11 V,<br>R <sub>L</sub> ≥ 2 kΩ                     |                                | 25°C       |                               |     | 50                            | 100  | V/mV |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     | 25                            |      |      |
| CMRR                                 | Common-mode rejection ratio                                          | V <sub>IC</sub> = V <sub>ICR</sub> min                                                             |                                | 25°C       |                               |     | 70                            | 80   | dB   |
| k <sub>SVR</sub>                     | Supply-voltage rejection ratio (ΔV <sub>CC</sub> /ΔV <sub>IO</sub> ) |                                                                                                    |                                | 25°C       |                               |     | 65                            | 100  | dB   |
| V <sub>O1</sub> /<br>V <sub>O2</sub> | Crosstalk attenuation                                                | f = 1 kHz to 20 kHz                                                                                |                                | 25°C       |                               |     | 120                           |      | dB   |
| I <sub>O</sub>                       | Output current                                                       | V <sub>CC</sub> = 15 V,<br>V <sub>ID</sub> = 1 V,<br>V <sub>O</sub> = 0                            | Source                         | 25°C       |                               |     | −20                           | −30  | mA   |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     | −10                           |      |      |
|                                      |                                                                      | V <sub>CC</sub> = 15 V,<br>V <sub>ID</sub> = −1 V,<br>V <sub>O</sub> = 15 V                        | Sink                           | 25°C       |                               |     | 10                            | 20   |      |
|                                      |                                                                      |                                                                                                    |                                | Full range |                               |     | 5                             |      |      |
|                                      |                                                                      | V <sub>ID</sub> = −1 V,                                                                            | V <sub>O</sub> = 200 mV        | 25°C       |                               |     | 12                            | 30   |      |
| I <sub>OS</sub>                      | Short-circuit output current                                         | V <sub>CC</sub> at 5 V,<br>GND at −5 V,                                                            | V <sub>O</sub> = 0 V           | 25°C       |                               |     | ±40                           | ±60  |      |
| I <sub>CC</sub>                      | Supply current (four amplifiers)                                     | V <sub>O</sub> = 2.5 V,                                                                            | No load                        | Full range |                               |     | 0.7                           | 1.2  | mA   |
|                                      |                                                                      | V <sub>CC</sub> = MAX,<br>V <sub>O</sub> = 0.5 V <sub>CC</sub> ,                                   | No load                        | Full range |                               |     | 1.4                           | 3    |      |

- (1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX  $V_{CC}$  for testing purposes is 30 V.
- (2) Full range is –55°C to 125°C for LM124.
- (3) All typical values are at  $T_A = 25^\circ\text{C}$ .

## ELECTRICAL CHARACTERISTICS FOR LM124A

at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER                             | TEST CONDITIONS <sup>(1)</sup>                                                      | $T_A$ <sup>(2)</sup> | MIN  | TYP <sup>(3)</sup> | MAX | UNIT |
|---------------------------------------|-------------------------------------------------------------------------------------|----------------------|------|--------------------|-----|------|
| $V_{IO}$ Input offset voltage         | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 15\text{ V}$     | 25°C                 |      |                    | ±3  | mV   |
|                                       |                                                                                     | Full range           |      |                    | ±5  |      |
|                                       | $+V_{CC} = 2\text{ V}$ ,<br>$-V_{CC} = -28\text{ V}$ ,<br>$V_{CM} = -13\text{ V}$   | 25°C                 |      |                    | ±3  | mV   |
|                                       |                                                                                     | Full range           |      |                    | ±5  |      |
|                                       | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 1.4\text{ V}$     | 25°C                 |      |                    | ±3  | mV   |
|                                       |                                                                                     | Full range           |      |                    | ±5  |      |
| $I_{IO}$ Input offset current         | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 15\text{ V}$     | 25°C                 |      |                    | ±10 | nA   |
|                                       |                                                                                     | Full range           |      |                    | ±30 |      |
|                                       | $+V_{CC} = 2\text{ V}$ ,<br>$-V_{CC} = -28\text{ V}$ ,<br>$V_{CM} = -13\text{ V}$   | 25°C                 |      |                    | ±10 | nA   |
|                                       |                                                                                     | Full range           |      |                    | ±30 |      |
|                                       | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 1.4\text{ V}$     | 25°C                 |      |                    | ±10 | nA   |
|                                       |                                                                                     | Full range           |      |                    | ±30 |      |
| $+I_{IB}$ Input bias current          | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 15\text{ V}$     | 25°C                 | -85  |                    | 0.1 | nA   |
|                                       |                                                                                     | Full range           | -100 |                    | 0.1 |      |
|                                       | $+V_{CC} = 2\text{ V}$ ,<br>$-V_{CC} = -28\text{ V}$ ,<br>$V_{CM} = -13\text{ V}$   | 25°C                 | -50  |                    | 0.1 | nA   |
|                                       |                                                                                     | Full range           | -100 |                    | 0.1 |      |
|                                       | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 1.4\text{ V}$     | 25°C                 | -50  |                    | 0.1 | nA   |
|                                       |                                                                                     | Full range           | -100 |                    | 0.1 |      |
| $-I_{IB}$ Input bias current          | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 15\text{ V}$     | 25°C                 | -85  |                    | 0.1 | nA   |
|                                       |                                                                                     | Full range           | -100 |                    | 0.1 |      |
|                                       | $+V_{CC} = 2\text{ V}$ ,<br>$-V_{CC} = -28\text{ V}$ ,<br>$V_{CM} = -13\text{ V}$   | 25°C                 | -50  |                    | 0.1 | nA   |
|                                       |                                                                                     | Full range           | -100 |                    | 0.1 |      |
|                                       | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = -1.4\text{ V}$    | 25°C                 | -50  |                    | 0.1 | nA   |
|                                       |                                                                                     | Full range           | -100 |                    | 0.1 |      |
| PSRR Power supply rejection ratio     | $-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 1.4\text{ V}$<br>5 V = $V_{CC} = 30\text{ V}$ | Full range           | -100 |                    | 100 | μV/V |
| CMRR Common-mode rejection ratio      | $V_{IC} = V_{ICRmin}$                                                               | Full range           | 76   |                    |     | dB   |
| $I_{OS}$ Short-circuit output current | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{OUT} = 25\text{ V}$    | Full range           | -70  |                    |     | mA   |

- (1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX  $V_{CC}$  for testing purposes is 30 V.
- (2) Full range is -55°C to 125°C for LM124A.
- (3) All typical values are at  $T_A = 25^\circ\text{C}$ .

**ELECTRICAL CHARACTERISTICS FOR LM124A (continued)**

at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER                |                                                             | TEST CONDITIONS <sup>(1)</sup>                                                                                                     | $T_A$ <sup>(2)</sup> | MIN  | TYP <sup>(3)</sup> | MAX | UNIT                         |
|--------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|--------------------|-----|------------------------------|
| $I_{CC}$                 | Power supply current                                        | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,                                                                              | 125°C                |      |                    | 3   | mA                           |
|                          |                                                             |                                                                                                                                    | -55°C                |      |                    | 4   |                              |
| $\Delta V_{IO}/\Delta T$ | Input offset voltage temperature sensitivity <sup>(4)</sup> | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 1.4\text{ V}$                                                    | 125°C, -55°C         | -30  |                    | 30  | $\mu\text{V}/^\circ\text{C}$ |
| $\Delta I_{IO}/\Delta T$ | Input offset current temperature sensitivity <sup>(4)</sup> | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{CM} = 1.4\text{ V}$                                                    | 125°C                | -400 |                    | 400 | $\text{pA}/^\circ\text{C}$   |
|                          |                                                             |                                                                                                                                    | -55°C                | -700 |                    | 700 |                              |
| $V_{OL}$                 | Low-level output voltage                                    | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$R_L = 10\text{ k}\Omega$                                                 | Full range           |      |                    | 35  | mV                           |
|                          |                                                             | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$I_{OL} = 5\text{ mA}$                                                    | Full range           |      |                    | 1.5 | V                            |
|                          |                                                             | $+V_{CC} = 4.5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$I_{OL} = 2\text{ }\mu\text{A}$                                          | Full range           |      |                    | 0.4 |                              |
| $V_{OH}$                 | High-level output voltage                                   | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$I_{OH} = 10\text{ mA}$                                                   | Full range           | 27   |                    |     | V                            |
|                          |                                                             | $+V_{CC} = 4.5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$I_{OH} = -10\text{ mA}$                                                 | Full range           | 2.4  |                    |     |                              |
| $A_{VS+}$                | Voltage gain                                                | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$1\text{ V} \leq V_{OUT} \leq 26\text{ V}$ ,<br>$R_L = 10\text{ k}\Omega$ | 25°C                 | 50   |                    |     | V/mV                         |
|                          |                                                             |                                                                                                                                    | Full range           | 25   |                    |     |                              |
|                          |                                                             | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$5\text{ V} \leq V_{OUT} \leq 20\text{ V}$ ,<br>$R_L = 2\text{ k}\Omega$  | 25°C                 | 50   |                    |     |                              |
|                          |                                                             |                                                                                                                                    | Full range           | 25   |                    |     |                              |
| $A_{VS}$                 | Voltage gain                                                | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$1\text{ V} \leq V_{OUT} \leq 2.5\text{ V}$ ,<br>$R_L = 10\text{ k}\Omega$ | Full range           | 10   |                    |     | V/mV                         |
|                          |                                                             | $+V_{CC} = 5\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$5\text{ V} \leq V_{OUT} \leq 2.5\text{ V}$ ,<br>$R_L = 2\text{ k}\Omega$  | Full range           | 10   |                    |     |                              |
| $+V_{OP}$                | Maximum output voltage swing                                | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{OUT} = 30\text{ V}$ ,<br>$R_L = 10\text{ k}\Omega$                    | Full range           | 27   |                    |     | V                            |
|                          |                                                             | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$ ,<br>$V_{OUT} = 30\text{ V}$ ,<br>$R_L = 2\text{ k}\Omega$                     | Full range           | 26   |                    |     |                              |
| $TR(t_r)$                | Transient response: rise time <sup>(4)</sup>                | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$                                                                                | Full range           |      |                    | 1   | $\mu\text{s}$                |
| SR+                      | Slew rate: rise <sup>(4)</sup>                              | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$                                                                                | Full range           | 0.1  |                    |     | V/ $\mu\text{s}$             |
| SR-                      | Slew rate: fall <sup>(4)</sup>                              | $+V_{CC} = 30\text{ V}$ ,<br>$-V_{CC} = \text{GND}$                                                                                | Full range           | 0.1  |                    |     | V/ $\mu\text{s}$             |
| NI(BB)                   | Noise broadband <sup>(4)</sup>                              | $+V_{CC} = 15\text{ V}$ ,<br>$-V_{CC} = -15\text{ V}$ ,<br>BW = 10 Hz to 5 kHz                                                     | 25°C                 |      |                    | 15  | $\mu\text{V}/\text{rms}$     |

(4) Parameter characterized over temperature, but not production tested.

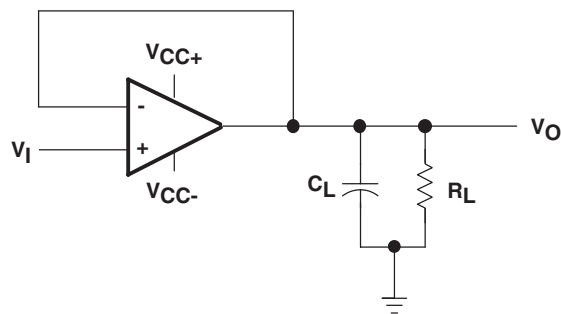
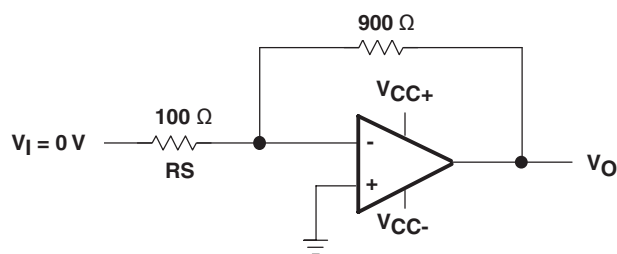
**ELECTRICAL CHARACTERISTICS FOR LM124A (continued)**at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER                           | TEST CONDITIONS <sup>(1)</sup>                                                                                   | $T_A$ <sup>(2)</sup> | MIN | TYP <sup>(3)</sup> | MAX | UNIT               |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------|-----|--------------------|-----|--------------------|
| NI(PC) Noise popcorn <sup>(5)</sup> | +V <sub>CC</sub> = 15 V,<br>-V <sub>CC</sub> = -15 V,<br>R <sub>S</sub> = 20 k $\Omega$ ,<br>BW = 10 Hz to 5 kHz | 25°C                 |     |                    | 50  | $\mu\text{V/peak}$ |
| CS Channel separation               | +V <sub>CC</sub> = 30 V,<br>-V <sub>CC</sub> = GND,<br>R <sub>L</sub> = 2 k $\Omega$                             | 25°C                 | 80  |                    |     | dB                 |
|                                     | R <sub>L</sub> = 2 k $\Omega$ ,<br>V <sub>IN</sub> = 1 V and 16 V                                                | 25°C                 | 80  |                    |     |                    |

(5) Parameter characterized over temperature, but not production tested.

**OPERATING CONDITIONS** $V_{CC} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$ 

| PARAMETER                                     | TEST CONDITIONS                                                                                           | TYP | UNIT                   |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----|------------------------|
| SR Slew rate at unity gain                    | R <sub>L</sub> = 1 M $\Omega$ , C <sub>L</sub> = 30 pF, V <sub>I</sub> = $\pm 10\text{ V}$ (see Figure 1) | 0.5 | V/ $\mu\text{s}$       |
| B <sub>1</sub> Unity-gain bandwidth           | R <sub>L</sub> = 1 M $\Omega$ , C <sub>L</sub> = 20 pF (see Figure 1)                                     | 1.2 | MHz                    |
| V <sub>n</sub> Equivalent input noise voltage | R <sub>S</sub> = 100 $\Omega$ , V <sub>I</sub> = 0 V, f = 1 kHz (see Figure 2)                            | 35  | nV/ $\sqrt{\text{Hz}}$ |

**Figure 1. Unity-Gain Amplifier****Figure 2. Noise-Test Circuit**

## PACKAGING INFORMATION

| Orderable part number           | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                |
|---------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|------------------------------------|
| <a href="#">5962-7704301VCA</a> | Active        | Production           | CDIP (J)   14   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-7704301VC<br>A<br>LM124JQMLV  |
| 5962-7704301VCA.A               | Active        | Production           | CDIP (J)   14   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-7704301VC<br>A<br>LM124JQMLV  |
| 5962-9950403V9B                 | Active        | Production           | XCEPT (KGD)   0 | 100   BULK            | Yes         | Call TI                              | N/A for Pkg Type                  | -55 to 125   |                                    |
| 5962-9950403V9B.A               | Active        | Production           | XCEPT (KGD)   0 | 100   BULK            | Yes         | Call TI                              | N/A for Pkg Type                  | -55 to 125   |                                    |
| <a href="#">5962-9950403VCA</a> | Active        | Production           | CDIP (J)   14   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-9950403VC<br>A<br>LM124AJQMLV |
| 5962-9950403VCA.A               | Active        | Production           | CDIP (J)   14   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-9950403VC<br>A<br>LM124AJQMLV |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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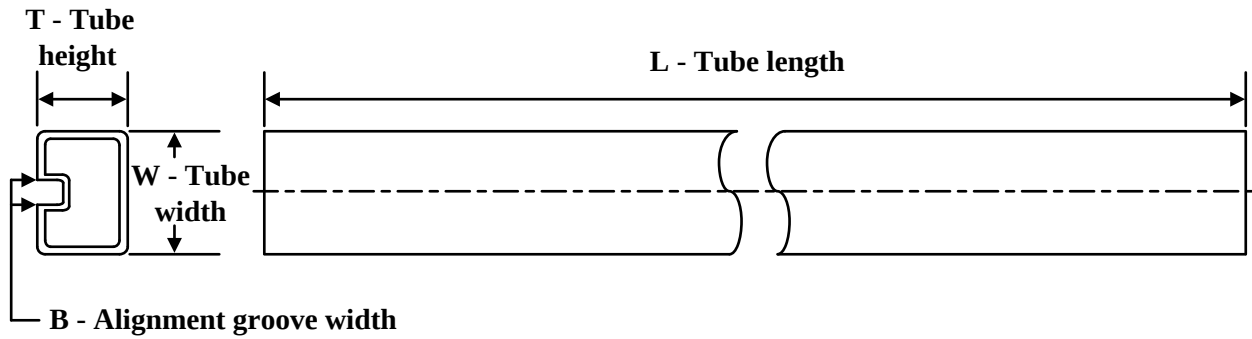
**OTHER QUALIFIED VERSIONS OF LM124-SP :**

- Catalog : [LM124](#)
- Military : [LM124M](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

## TUBE



\*All dimensions are nominal

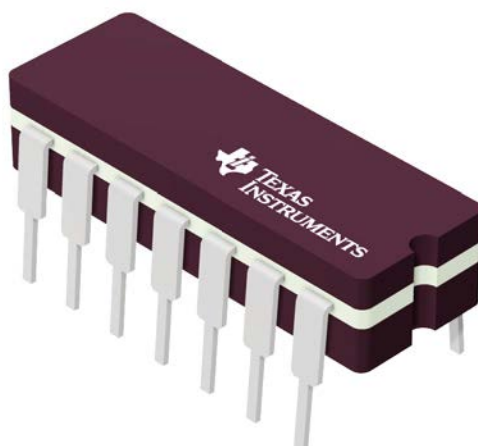
| Device            | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-------------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| 5962-9950403VCA   | J            | CDIP         | 14   | 25  | 506.98 | 15.24  | 13440  | NA     |
| 5962-9950403VCA.A | J            | CDIP         | 14   | 25  | 506.98 | 15.24  | 13440  | NA     |

**J 14**

## GENERIC PACKAGE VIEW

**CDIP - 5.08 mm max height**

CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4040083-5/G

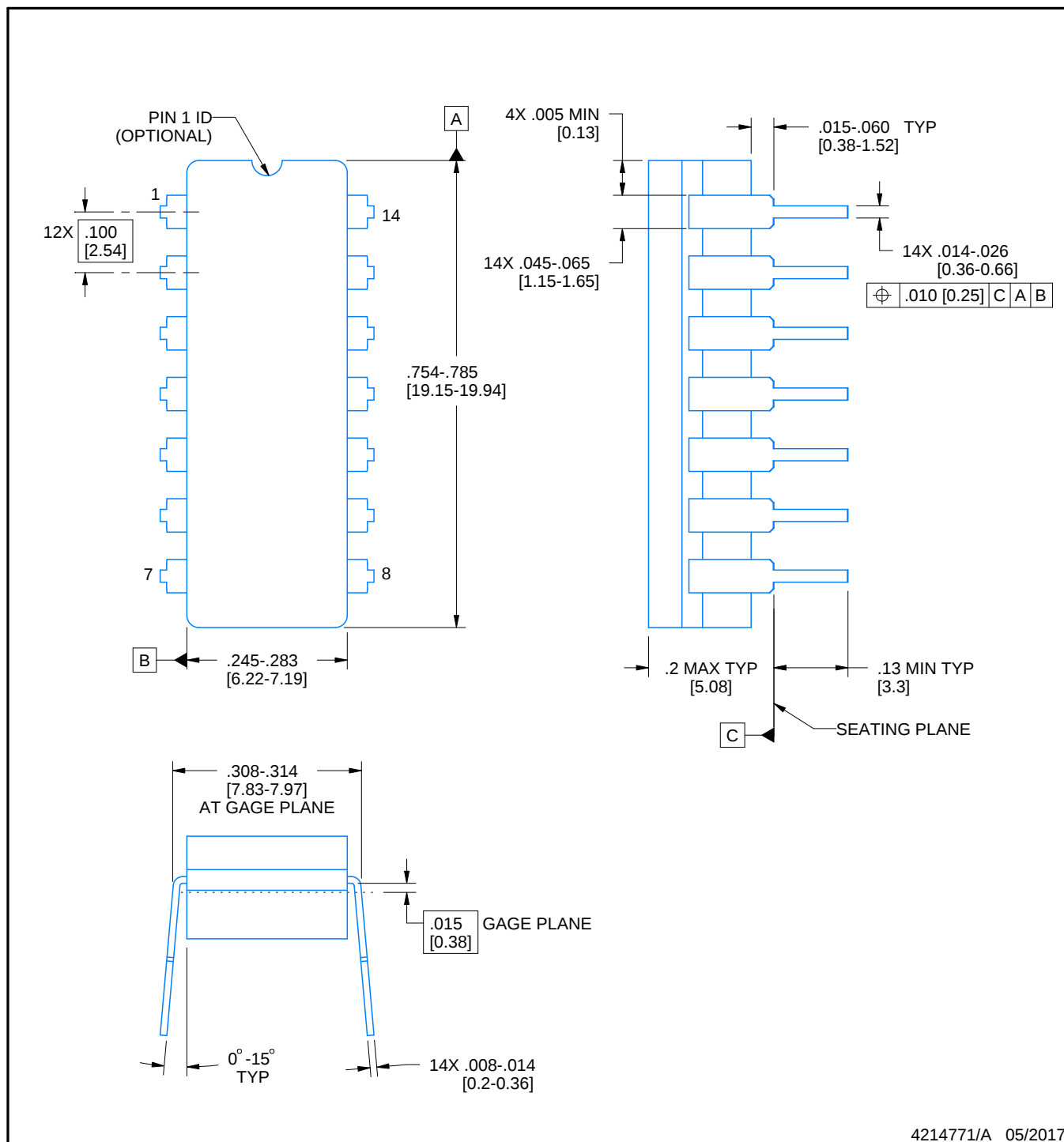


**J0014A**

## PACKAGE OUTLINE

**CDIP - 5.08 mm max height**

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

### NOTES:

1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.



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