

**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

- **Low Noise**  
10 Hz . . . 15 nV/ $\sqrt{\text{Hz}}$   
1 kHz . . . 10.5 nV/ $\sqrt{\text{Hz}}$
- **10000-pF Load Capability**
- **20-mA Min Short-Circuit Output Current**
- **27-V/ $\mu\text{s}$  Min Slew Rate**
- **High Gain-Bandwidth Product . . . 5.9 MHz**
- **Low  $V_{\text{IO}}$  . . . 500  $\mu\text{V}$  Max at 25°C**
- **Single or Split Supply . . . 4 V to 44 V**
- **Fast Settling Time**  
340 ns to 0.1%  
400 ns to 0.01%
- **Saturation Recovery . . . 150 ns**
- **Large Output Swing**  
 $V_{\text{CC-}} + 0.1 \text{ V}$  to  $V_{\text{CC+}} - 1 \text{ V}$

## description

The TLE214x and TLE214xA devices are high-performance, internally compensated operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. The TLE214xA is a tighter offset voltage grade of the TLE214x. Both are pin-compatible upgrades to standard industry products.

The design incorporates an input stage that simultaneously achieves low audio-band noise of 10.5 nV/ $\sqrt{\text{Hz}}$  with a 10-Hz 1/f corner and symmetrical 40-V/ $\mu\text{s}$  slew rate typically with loads up to 800 pF. The resulting low distortion and high power bandwidth are important in high-fidelity audio applications. A fast settling time of 340 ns to 0.1% of a 10-V step with a 2-k $\Omega$ /100-pF load is useful in fast actuator/positioning drivers. Under similar test conditions, settling time to 0.01% is 400 ns.

The devices are stable with capacitive loads up to 10 nF, although the 6-MHz bandwidth decreases to 1.8 MHz at this high loading level. As such, the TLE214x and TLE214xA are useful for low-droop sample-and-holds and direct buffering of long cables, including 4-mA to 20-mA current loops.

The special design also exhibits an improved insensitivity to inherent integrated circuit component mismatches as is evidenced by a 500- $\mu\text{V}$  maximum offset voltage and 1.7- $\mu\text{V}/^{\circ}\text{C}$  typical drift. Minimum common-mode rejection ratio and supply-voltage rejection ratio are 85 dB and 90 dB, respectively.

Device performance is relatively independent of supply voltage over the  $\pm 2\text{-V}$  to  $\pm 22\text{-V}$  range. Inputs can operate between  $V_{\text{CC-}} - 0.3$  to  $V_{\text{CC+}} - 1.8 \text{ V}$  without inducing phase reversal, although excessive input current may flow out of each input exceeding the lower common-mode input range. The all-npn output stage provides a nearly rail-to-rail output swing of  $V_{\text{CC-}} - 0.1$  to  $V_{\text{CC+}} - 1 \text{ V}$  under light current-loading conditions. The device can sustain shorts to either supply since output current is internally limited, but care must be taken to ensure that maximum package power dissipation is not exceeded.

Both versions can also be used as comparators. Differential inputs of  $V_{\text{CC}\pm}$  can be maintained without damage to the device. Open-loop propagation delay with TTL supply levels is typically 200 ns. This gives a good indication as to output stage saturation recovery when the device is driven beyond the limits of recommended output swing.

Both the TLE214x and TLE214xA are available in a wide variety of packages, including both the industry-standard 8-pin small-outline version and chip form for high-density system applications. The C-suffix devices are characterized for operation from 0°C to 70°C, I-suffix devices from -40°C to 105°C, and M-suffix devices over the full military temperature range of -55°C to 125°C.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

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# TLE214x, TLE214xA EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## TLE2141 AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> max<br>AT 25°C | PACKAGED DEVICES           |                           |                         |
|----------------|--------------------------------|----------------------------|---------------------------|-------------------------|
|                |                                | SMALL OUT-<br>LINE†<br>(D) | CERAMIC DIP<br>(JG)       | PLASTIC DIP<br>(P)      |
| 0°C to 70°C    | 500 µV<br>900 µV               | TLE2141ACD<br>TLE2141CD    | —                         | TLE2141ACP<br>TLE2141CP |
| –40°C to 105°C | 500 µV<br>900 µV               | TLE2141AID<br>TLE2141ID    | —                         | TLE2141AIP<br>TLE2141IP |
| –55°C to 125°C | 500 µV<br>900 µV               | —<br>TLE2141MD             | TLE2141AMJG<br>TLE2141MJG | —<br>—                  |

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2141ACDR).

## TLE2142 AVAILABLE OPTIONS

| PACKAGED DEVICES |                                |                          |                         |                        |                       |                |                             |
|------------------|--------------------------------|--------------------------|-------------------------|------------------------|-----------------------|----------------|-----------------------------|
| T <sub>A</sub>   | V <sub>IO</sub> max<br>AT 25°C | SMALL<br>OUTLINE†<br>(D) | CHIP<br>CARRIER<br>(FK) | CERAMIC<br>DIP<br>(JG) | PLASTIC<br>DIP<br>(P) | TSSOP‡<br>(PW) | CERAMIC<br>FLAT PACK<br>(U) |
| 0°C to 70°C      | 750 µV                         | TLE2142ACD               | —                       | —                      | TLE2142ACP            | —              | —                           |
|                  | 1200 µV                        | TLE2142CD                | —                       | —                      | TLE2142CP             | TLE2142CPWLE   | —                           |
| –40°C to 105°C   | 750 µV                         | TLE2142AID               | —                       | —                      | TLC2142AIP            | —              | —                           |
|                  | 1200 µV                        | TLE2142ID                | —                       | —                      | TLC2142IP             | —              | —                           |
| –55°C to 125°C   | 750 µV                         | TLE2142AMD               | TLE2142AMFK             | TLE2142AMJG            | —                     | —              | TLE2142AMU                  |
|                  | 1200 µV                        | TLE2142MD                | TLE2142MFK              | TLE2142MJG             | —                     | —              | TLE2142MU                   |

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2142ACDR).

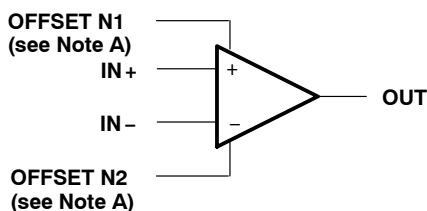
‡ The PW packages are available left-ended taped and reeled. Add LE the suffix to device type (e.g., TLC2142CPWLE).

## TLE2144 AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> max<br>AT 25°C | PACKAGED DEVICES       |                      |                    |                    |
|----------------|--------------------------------|------------------------|----------------------|--------------------|--------------------|
|                |                                | SMALL OUTLINE†<br>(DW) | CHIP CARRIER<br>(FK) | CERAMIC DIP<br>(J) | PLASTIC DIP<br>(N) |
| 0°C to 70°C    | 1.5 mV                         | —                      | —                    | —                  | TLE2144ACN         |
|                | 2.4 mV                         | TLE2144CDW             | —                    | —                  | TLE2144CN          |
| –40°C to 105°C | 1.5 mV                         | —                      | —                    | —                  | TLE2144AIN         |
|                | 2.4 mV                         | TLE2144IDW             | —                    | —                  | TLE2144IN          |
| –55°C to 125°C | 1.5 mV                         | —                      | TLE2144AMFK          | TLE2144AMJ         | —                  |
|                | 2.5 mV                         | TLE2144MDW             | TLE2144MFK           | TLE2144MJ          | —                  |

† The DW packages are available taped and reeled. Add R suffix to device type (e.g., TLE2144CDWR).

## symbol

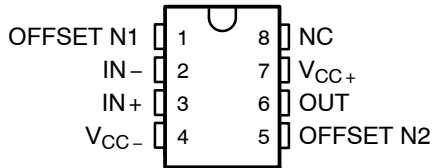


NOTES: A. OFFSET N1 AND OFFSET N2 are only available on the TLE2241x devices.

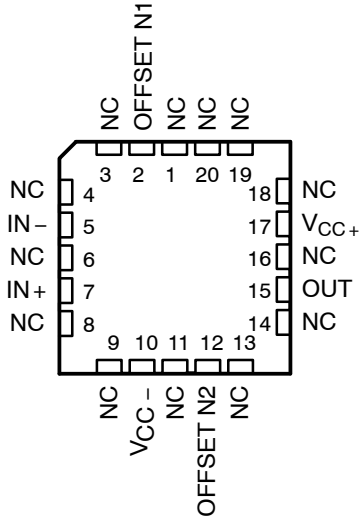
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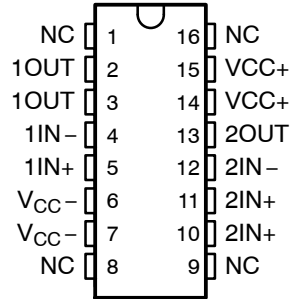
**TLE2141**  
**D, JG, OR P PACKAGE**  
**(TOP VIEW)**



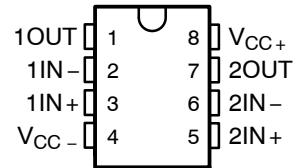
**TLE2141**  
**FK PACKAGE**  
**(TOP VIEW)**



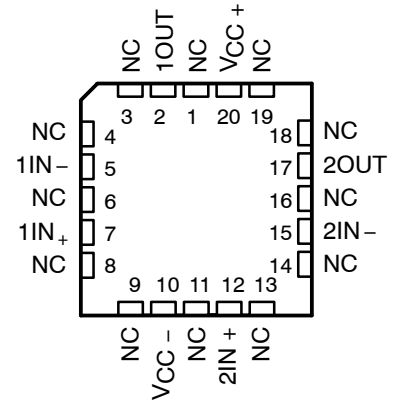
**TLE2142**  
**PW PACKAGE**  
**(TOP VIEW)**



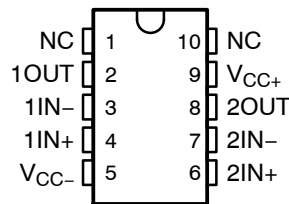
**TLE2142**  
**D, JG, OR P PACKAGE**  
**(TOP VIEW)**



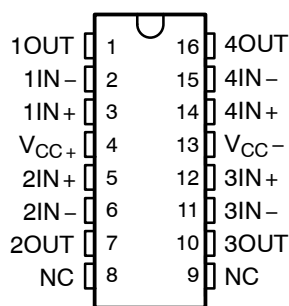
**TLE2142**  
**FK PACKAGE**  
**(TOP VIEW)**



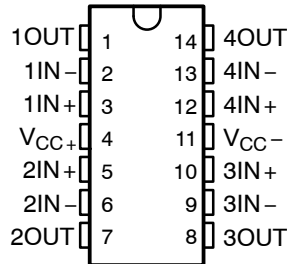
**TLE2142**  
**U PACKAGE**  
**(TOP VIEW)**



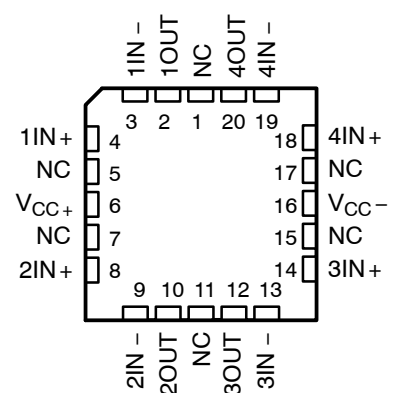
**TLE2144**  
**DW PACKAGE**  
**(TOP VIEW)**



**TLE2144**  
**J OR N PACKAGE**  
**(TOP VIEW)**

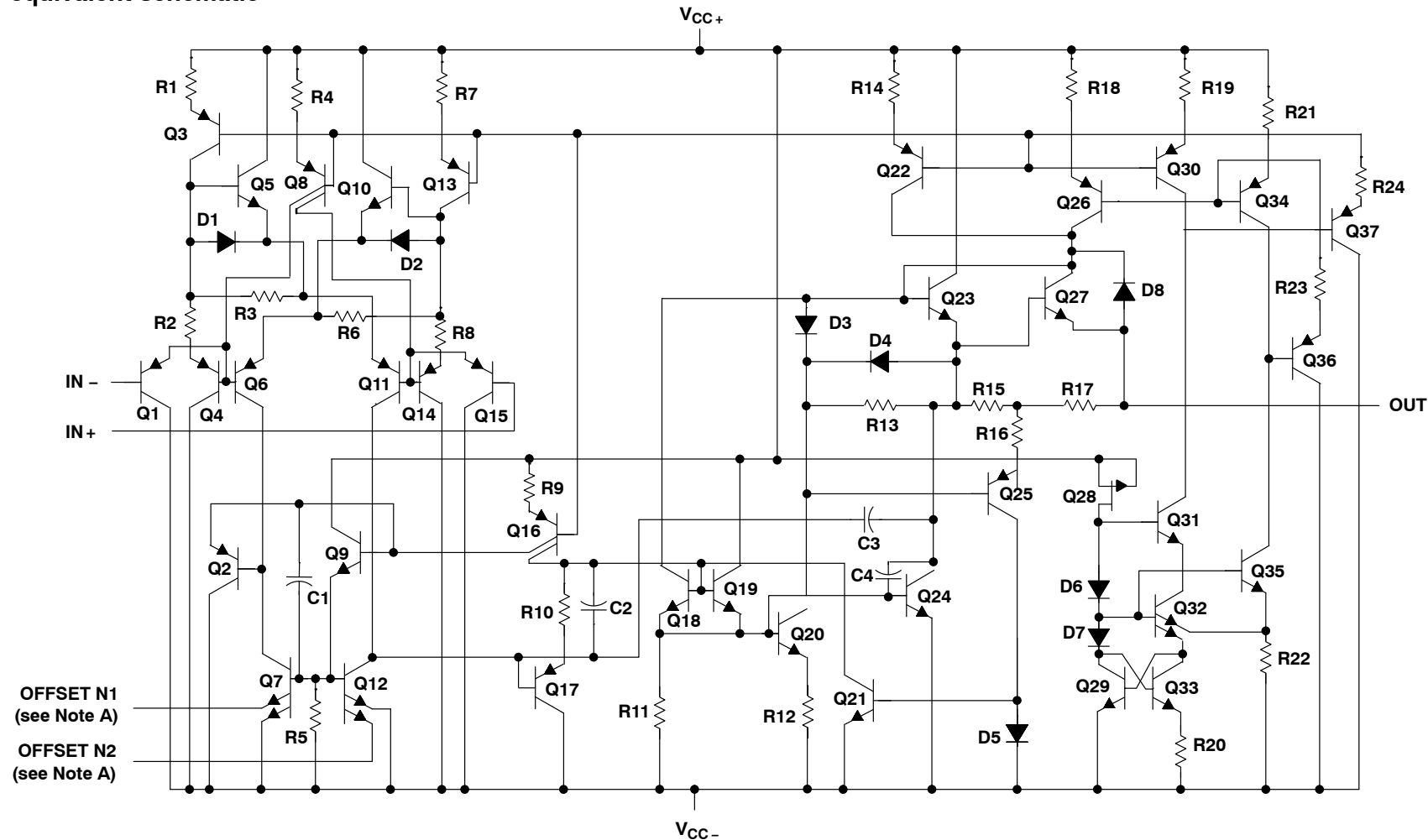


**TLE2144**  
**FK PACKAGE**  
**(TOP VIEW)**



NC – No internal connection

equivalent schematic



NOTE A: OFFSET N1 AND OFFSET N2 are only available on the TLE2141x devices.

| ACTUAL DEVICE COMPONENT COUNT |         |         |         |
|-------------------------------|---------|---------|---------|
| COMPONENT                     | TLE2141 | TLE2142 | TLE2144 |
| Transistors                   | 46      | 65      | 130     |
| Resistors                     | 24      | 43      | 86      |
| Diodes                        | 8       | 14      | 28      |
| Capacitors                    | 4       | 8       | 16      |
| Epi-FET                       | 1       | 1       | 2       |

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

|                                                                                          |                                |
|------------------------------------------------------------------------------------------|--------------------------------|
| Supply voltage, $V_{CC+}$ (see Note 1)                                                   | 22 V                           |
| Supply voltage, $V_{CC-}$                                                                | –22 V                          |
| Differential input voltage, $V_{ID}$ (see Note 2)                                        | ±44 V                          |
| Input voltage range, $V_I$ (any input)                                                   | $V_{CC+}$ to $V_{CC-} - 0.3$ V |
| Input current, $I_I$ (each input)                                                        | ±1 mA                          |
| Output current, $I_O$                                                                    | ±80 mA                         |
| Total current into $V_{CC+}$                                                             | 80 mA                          |
| Total current out of $V_{CC-}$                                                           | 80 mA                          |
| Duration of short-circuit current at (or below) 25°C (see Note 3)                        | unlimited                      |
| Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5): D package                  | 97.1°C/W                       |
| DW package                                                                               | 57.3°C/W                       |
| N package                                                                                | 79.7°C/W                       |
| P package                                                                                | 84.6°C/W                       |
| PW package                                                                               | 108.4°C/W                      |
| Package thermal impedance, $\theta_{JC}$ (see Notes 4 and 5): FK package                 | 5.6°C/W                        |
| J package                                                                                | 15.1°C/W                       |
| JG package                                                                               | 14.5°C/W                       |
| U package                                                                                | 14.7°C/W                       |
| Operating free-air temperature range, $T_A$ : C suffix                                   | 0°C to 70°C                    |
| I suffix                                                                                 | –40°C to 105°C                 |
| M suffix                                                                                 | –55°C to 125°C                 |
| Storage temperature range                                                                | –65°C to 150°C                 |
| Case temperature for 60 seconds: FK package                                              | 260°C                          |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, DW, N, P, or PW package | 260°C                          |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J or JG package            | 300°C                          |

<sup>†</sup> 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.

- NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ . Excessive current flows, if input, are brought below  $V_{CC-} - 0.3$  V.
  3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.
  4. Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  5. The package thermal impedance is calculated in accordance with JESD 51-7 (plastic) or MIL-STD-883 Method 1012 (ceramic).

**recommended operating conditions**

|                                       |                        | C SUFFIX |      | I SUFFIX |      | M SUFFIX |      | UNIT |
|---------------------------------------|------------------------|----------|------|----------|------|----------|------|------|
|                                       |                        | MIN      | MAX  | MIN      | MAX  | MIN      | MAX  |      |
| Supply voltage, $V_{CC\pm}$           |                        | ±2       | ±22  | ±2       | ±22  | ±2       | ±22  | V    |
| Common-mode input voltage, $V_{IC}$   | $V_{CC} = 5$ V         | 0        | 2.9  | 0        | 2.7  | 0        | 2.7  | V    |
|                                       | $V_{CC\pm} = \pm 15$ V | –15      | 12.9 | –15      | 12.7 | –15      | 12.7 |      |
| Operating free-air temperature, $T_A$ |                        | 0        | 70   | –40      | 105  | –55      | 125  | °C   |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

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**TLE2141C electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                                                   | $T_A^\dagger$ | TLE2141C |             |     | TLE2141AC |             |     | UNIT                         |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                               |                                                                                                   |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 2.5\text{ V}$<br>$V_{IC} = 2.5\text{ V}$<br>$R_S = 50\ \Omega$                             | 25°C          | 225      | 1400        |     | 200       | 1000        |     | $\mu\text{V}$                |
|                                                                               |                                                                                                   | Full range    |          | 1700        |     |           | 1300        |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                                                   | Full range    |          | 1.7         |     |           | 1.7         |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 |                                                                                                   | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                               |                                                                                                   | Full range    |          | 150         |     |           | 150         |     |                              |
| $I_{IB}$ Input bias current                                                   |                                                                                                   | 25°C          | –0.8     | –2          |     | –0.8      | –2          |     | $\mu\text{A}$                |
|                                                                               |                                                                                                   | Full range    |          | –2.1        |     |           | –2.1        |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                                                | 25°C          | 0 to 3   | –0.3 to 3.2 |     | 0 to 3    | –0.3 to 3.2 |     | V                            |
|                                                                               |                                                                                                   | Full range    | 0 to 2.9 |             |     | 0 to 2.9  |             |     |                              |
| $V_{OH}$ High-level output voltage                                            | $I_{OH} = -150\ \mu\text{A}$                                                                      | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                               |                                                                                                   | Full range    | 3.8      |             |     | 3.8       |             |     |                              |
|                                                                               | $I_{OH} = -1.5\text{ mA}$                                                                         | 25°C          | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                               |                                                                                                   | Full range    | 3.7      |             |     | 3.7       |             |     |                              |
|                                                                               | $I_{OH} = -15\text{ mA}$                                                                          | 25°C          | 3.2      | 3.7         |     | 3.2       | 3.7         |     |                              |
|                                                                               |                                                                                                   | Full range    | 3.2      |             |     | 3.2       |             |     |                              |
| $V_{OL}$ Low-level output voltage                                             | $I_{OL} = 150\ \mu\text{A}$                                                                       | 25°C          |          | 75          | 125 |           | 75          | 125 | mV                           |
|                                                                               |                                                                                                   | Full range    |          |             | 150 |           |             | 150 |                              |
|                                                                               | $I_{OL} = 1.5\text{ mA}$                                                                          | 25°C          |          | 150         | 225 |           | 150         | 225 |                              |
|                                                                               |                                                                                                   | Full range    |          |             | 250 |           |             | 250 |                              |
|                                                                               | $I_{OL} = 15\text{ mA}$                                                                           | 25°C          |          | 1.2         | 1.6 |           | 1.2         | 1.6 | V                            |
|                                                                               |                                                                                                   | Full range    |          |             | 1.7 |           |             | 1.7 |                              |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_{CC} = \pm 2.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$V_O = 1\text{ V}$ to $-1.5\text{ V}$ | 25°C          | 50       | 220         |     | 50        | 220         |     | V/mV                         |
|                                                                               |                                                                                                   | Full range    | 25       |             |     | 25        |             |     |                              |
| $r_i$ Input resistance                                                        |                                                                                                   | 25°C          |          | 70          |     |           | 70          |     | $\text{M}\Omega$             |
| $c_i$ Input capacitance                                                       |                                                                                                   | 25°C          |          | 2.5         |     |           | 2.5         |     | pF                           |
| $z_o$ Open-loop output impedance                                              | $f = 1\text{ MHz}$                                                                                | 25°C          |          | 30          |     |           | 30          |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                                                        | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                               |                                                                                                   | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V}$ to $\pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                       | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                               |                                                                                                   | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                       | $V_O = 2.5\text{ V}$ , No load,<br>$V_{IC} = 2.5\text{ V}$                                        | 25°C          |          | 3.4         | 4.4 |           | 3.4         | 4.4 | mA                           |
|                                                                               |                                                                                                   | Full range    |          |             | 4.6 |           |             | 4.6 |                              |

<sup>†</sup> Full range is 0°C to 70°C.

**TLE2141C operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                                                                     |          | TLE2141C |     |         | TLE2141AC |     |                        | UNIT                   |
|-------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------|----------|-----|---------|-----------|-----|------------------------|------------------------|
|             |                                             |                                                                                                                     |          | MIN      | TYP | MAX     | MIN       | TYP | MAX                    |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}^\dagger$ ,<br>$R_L = 2\text{ k}\Omega$ , $^\dagger$                         |          | 45       |     |         | 45        |     |                        | V/ $\mu$ s             |
| SR –        | Negative slew rate                          |                                                                                                                     |          | 42       |     |         | 42        |     |                        |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                                                                                       | To 0.1%  | 0.16     |     |         | 0.16      |     |                        | $\mu$ s                |
|             |                                             |                                                                                                                     | To 0.01% | 0.22     |     |         | 0.22      |     |                        |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$                                                                    | 15       |          |     | 15      |           |     | nV/ $\sqrt{\text{Hz}}$ |                        |
|             |                                             | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                                                                    | 10.5     |          |     | 10.5    |           |     |                        |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                                                  |          | 0.48     |     |         | 0.48      |     |                        | $\mu$ V                |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                                                 |          | 0.51     |     |         | 0.51      |     |                        |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                                                                  |          | 1.92     |     |         | 1.92      |     |                        | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                                                                  |          | 0.5      |     |         | 0.5       |     |                        |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,<br>$R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$   | 0.0052%  |          |     | 0.0052% |           |     |                        |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}^\dagger$                                                 | 5.9      |          |     | 5.9     |           |     | MHz                    |                        |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$ ,<br>$C_L = 100\text{ pF}^\dagger$                       | 5.8      |          |     | 5.8     |           |     | MHz                    |                        |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$ ,<br>$R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}^\dagger$ | 660      |          |     | 660     |           |     | kHz                    |                        |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}^\dagger$                                                 | 57°      |          |     | 57°     |           |     |                        |                        |

$^\dagger R_L$  and  $C_L$  terminated to 2.5 V.

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2141C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER        |                                                                       | TEST CONDITIONS                                                |                        | T <sub>A</sub> <sup>†</sup> | TLE2141C    |               |     | TLE2141AC   |               |      | UNIT  |
|------------------|-----------------------------------------------------------------------|----------------------------------------------------------------|------------------------|-----------------------------|-------------|---------------|-----|-------------|---------------|------|-------|
|                  |                                                                       |                                                                |                        |                             | MIN         | TYP           | MAX | MIN         | TYP           | MAX  |       |
| V <sub>IO</sub>  | Input offset voltage                                                  | V <sub>IC</sub> = 0, R <sub>S</sub> = 50 Ω, V <sub>O</sub> = 0 |                        | 25°C                        | 200         | 900           |     | 175         | 500           | μV   |       |
|                  | Full range                                                            |                                                                |                        | 1300                        |             |               | 800 |             |               |      |       |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |                                                                |                        | Full range                  | 1.7         |               |     | 1.7         |               |      | μV/°C |
| I <sub>IO</sub>  | Input offset current                                                  |                                                                |                        | 25°C                        | 7           | 100           |     | 7           | 100           | nA   |       |
|                  |                                                                       |                                                                |                        | Full range                  | 150         |               |     | 150         |               |      |       |
| I <sub>IB</sub>  | Input bias current                                                    |                                                                |                        | 25°C                        | –0.7        | –1.5          |     | –0.7        | –1.5          | μA   |       |
|                  |                                                                       |                                                                |                        | Full range                  | –1.6        |               |     | –1.6        |               |      |       |
| V <sub>ICR</sub> | Common-mode input voltage range                                       | R <sub>S</sub> = 50 Ω                                          |                        | 25°C                        | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 | V    |       |
|                  |                                                                       |                                                                |                        | Full range                  | –15 to 12.9 | –15.3 to 13.1 |     | –15 to 12.9 | –15.3 to 13.1 |      |       |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            | I <sub>O</sub> = –150 μA                                       |                        | 25°C                        | 13.8        | 14.1          |     | 13.8        | 14.1          | V    |       |
|                  |                                                                       |                                                                |                        | Full range                  | 13.7        |               |     | 13.7        |               |      |       |
|                  |                                                                       | I <sub>O</sub> = –1.5 mA                                       |                        | 25°C                        | 13.7        | 14            |     | 13.7        | 14            |      |       |
|                  |                                                                       |                                                                |                        | Full range                  | 13.6        |               |     | 13.6        |               |      |       |
|                  |                                                                       | I <sub>O</sub> = –15 mA                                        |                        | 25°C                        | 13.1        | 13.7          |     | 13.1        | 13.7          |      |       |
| Full range       | 13                                                                    |                                                                |                        |                             |             | 13            |     |             |               |      |       |
| V <sub>OM–</sub> | Maximum negative peak output voltage swing                            | I <sub>O</sub> = 150 μA                                        |                        | 25°C                        | –14.7       | –14.9         |     | –14.7       | –14.9         | V    |       |
|                  |                                                                       |                                                                |                        | Full range                  | –14.6       |               |     | –14.6       |               |      |       |
|                  |                                                                       | I <sub>O</sub> = 1.5 mA                                        |                        | 25°C                        | –14.5       | –14.8         |     | –14.5       | –14.8         |      |       |
|                  |                                                                       |                                                                |                        | Full range                  | –14.4       |               |     | –14.4       |               |      |       |
|                  |                                                                       | I <sub>O</sub> = 15 mA                                         |                        | 25°C                        | –13.4       | –13.8         |     | –13.4       | –13.8         |      |       |
|                  |                                                                       |                                                                |                        | Full range                  | –13.3       |               |     | –13.3       |               |      |       |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±10 V                                         |                        | 25°C                        | 100         | 450           |     | 100         | 450           | V/mV |       |
|                  |                                                                       |                                                                |                        | Full range                  | 75          |               |     | 75          |               |      |       |
| r <sub>i</sub>   | Input resistance                                                      | R <sub>L</sub> = 2 kΩ                                          |                        | 25°C                        | 65          |               |     | 65          | MΩ            |      |       |
| c <sub>i</sub>   | Input capacitance                                                     |                                                                |                        | 25°C                        | 2.5         |               |     | 2.5         | pF            |      |       |
| z <sub>o</sub>   | Open-loop output impedance                                            | f = 1 MHz                                                      |                        | 25°C                        | 30          |               |     | 30          | Ω             |      |       |
| CMRR             | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> , R <sub>S</sub> = 50 Ω  |                        | 25°C                        | 85          | 108           |     | 85          | 108           | dB   |       |
|                  |                                                                       |                                                                |                        | Full range                  | 80          |               |     | 80          |               |      |       |
| k <sub>SVR</sub> | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±2.5 V to ±15 V, R <sub>S</sub> = 50 Ω      |                        | 25°C                        | 90          | 106           |     | 90          | 106           | dB   |       |
|                  |                                                                       |                                                                |                        | Full range                  | 85          |               |     | 85          |               |      |       |
| I <sub>OS</sub>  | Short-circuit output current                                          | V <sub>O</sub> = 0                                             | V <sub>ID</sub> = 1 V  | 25°C                        | –25         | –50           |     | –25         | –50           | mA   |       |
|                  |                                                                       |                                                                | V <sub>ID</sub> = –1 V |                             | 20          | 31            |     | 20          | 31            |      |       |
| I <sub>CC</sub>  | Supply current                                                        | V <sub>O</sub> = 0, No load                                    |                        | 25°C                        | 3.5         | 4.5           |     | 3.5         | 4.5           | mA   |       |
|                  |                                                                       |                                                                |                        | Full range                  | 4.7         |               |     | 4.7         |               |      |       |

$^\dagger$  Full range is 0°C to 70°C.



**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2141C operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                    |                                                     | TLE2141C |            |     | TLE2141AC |            |     | UNIT                   |
|-------------|---------------------------------------------|----------------------------------------------------|-----------------------------------------------------|----------|------------|-----|-----------|------------|-----|------------------------|
|             |                                             |                                                    |                                                     | MIN      | TYP        | MAX | MIN       | TYP        | MAX |                        |
| SR+         | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$           | $R_L = 2\text{ k}\Omega$                            | 27       | 45         |     | 27        | 45         |     | V/ $\mu\text{s}$       |
| SR–         | Negative slew rate                          |                                                    |                                                     | 27       | 42         |     | 27        | 42         |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                       | To 0.1%                                             |          | 0.34       |     |           | 0.34       |     | $\mu\text{s}$          |
|             |                                             |                                                    | To 0.01%                                            |          | 0.4        |     |           | 0.4        |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$                           | $f = 10\text{ Hz}$                                  |          | 15         |     |           | 15         |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$                           | $f = 1\text{ kHz}$                                  |          | 10.5       |     |           | 10.5       |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                 |                                                     |          | 0.48       |     |           | 0.48       |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                |                                                     |          | 0.51       |     |           | 0.51       |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                 |                                                     |          | 1.89       |     |           | 1.89       |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                 |                                                     |          | 0.47       |     |           | 0.47       |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 10$       | $R_L = 2\text{ k}\Omega$ ,<br>$f = 10\text{ kHz}$   |          | 0.01%      |     |           | 0.01%      |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$                           | $C_L = 100\text{ pF}$                               |          | 6          |     |           | 6          |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 100\text{ kHz}$ | $C_L = 100\text{ pF}$                               |          | 5.9        |     |           | 5.9        |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 1$        | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ |          | 668        |     |           | 668        |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$                           | $C_L = 100\text{ pF}$                               |          | $58^\circ$ |     |           | $58^\circ$ |     |                        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2142C electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                                                  | $T_A^\dagger$ | TLE2142C |             |     | TLE2142AC |             |     | UNIT                         |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                               |                                                                                                  |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$ ,<br>$V_{IC} = 2.5\text{ V}$                           | 25°C          | 220      | 1900        |     | 200       | 1500        |     | $\mu\text{V}$                |
|                                                                               |                                                                                                  | Full range    |          | 2200        |     |           | 1800        |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                                                  | Full range    | 1.7      |             |     | 1.7       |             |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 |                                                                                                  | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                               |                                                                                                  | Full range    |          | 150         |     |           | 150         |     |                              |
| $I_{IB}$ Input bias current                                                   |                                                                                                  | 25°C          | –0.8     | –2          |     | –0.8      | –2          |     | $\mu\text{A}$                |
|                                                                               |                                                                                                  | Full range    |          | –2.1        |     |           | –2.1        |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                                               | 25°C          | 0 to 3   | –0.3 to 3.2 |     | 0 to 3    | –0.3 to 3.2 |     | V                            |
|                                                                               |                                                                                                  | Full range    | 0 to 2.9 |             |     | 0 to 2.9  |             |     |                              |
| $V_{OH}$ High-level output voltage                                            | $I_{OH} = -150\ \mu\text{A}$                                                                     | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                               |                                                                                                  | Full range    | 3.8      |             |     | 3.8       |             |     |                              |
|                                                                               | $I_{OH} = -1.5\text{ mA}$                                                                        | 25°C          | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                               |                                                                                                  | Full range    | 3.7      |             |     | 3.7       |             |     |                              |
|                                                                               | $I_{OH} = -15\text{ mA}$                                                                         | 25°C          | 3.4      | 3.7         |     | 3.4       | 3.7         |     |                              |
|                                                                               |                                                                                                  | Full range    | 3.4      |             |     | 3.4       |             |     |                              |
| $V_{OL}$ Low-level output voltage                                             | $I_{OL} = 150\ \mu\text{A}$                                                                      | 25°C          | 75       | 125         |     | 75        | 125         |     | mV                           |
|                                                                               |                                                                                                  | Full range    |          | 150         |     |           | 150         |     |                              |
|                                                                               | $I_{OL} = 1.5\text{ mA}$                                                                         | 25°C          | 150      | 225         |     | 150       | 225         |     |                              |
|                                                                               |                                                                                                  | Full range    |          | 250         |     |           | 250         |     |                              |
|                                                                               | $I_{OL} = 15\text{ mA}$                                                                          | 25°C          | 1.2      | 1.4         |     | 1.2       | 1.4         |     | V                            |
|                                                                               |                                                                                                  | Full range    |          | 1.5         |     |           | 1.5         |     |                              |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_{CC} = \pm 2.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$ | 25°C          | 50       | 220         |     | 50        | 220         |     | V/mV                         |
|                                                                               |                                                                                                  | Full range    | 25       |             |     | 25        |             |     |                              |
| $r_i$ Input resistance                                                        |                                                                                                  | 25°C          | 70       |             |     | 70        |             |     | $\text{M}\Omega$             |
| $c_i$ Input capacitance                                                       |                                                                                                  | 25°C          | 2.5      |             |     | 2.5       |             |     | pF                           |
| $z_o$ Open-loop output impedance                                              | $f = 1\text{ MHz}$                                                                               | 25°C          | 30       |             |     | 30        |             |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                                                       | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                               |                                                                                                  | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                       | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                               |                                                                                                  | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                       | $V_O = 2.5\text{ V}$ , No load,<br>$V_{IC} = 2.5\text{ V}$                                       | 25°C          | 6.6      | 8.8         |     | 6.6       | 8.8         |     | mA                           |
|                                                                               |                                                                                                  | Full range    |          | 9.2         |     |           | 9.2         |     |                              |

$^\dagger$  Full range is 0°C to 70°C.

**TLE2142C operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                                |                                                             | TLE2142C |     |      | TLE2142AC |     |                        | UNIT                   |
|-------------|---------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------|----------|-----|------|-----------|-----|------------------------|------------------------|
|             |                                             |                                                                                |                                                             | MIN      | TYP | MAX  | MIN       | TYP | MAX                    |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$<br>$R_L = 2\text{ k}\Omega^\dagger$ , |                                                             | 45       |     |      | 45        |     |                        | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                                                |                                                             | 42       |     |      | 42        |     |                        |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                                                  | To 0.1%                                                     | 0.16     |     |      | 0.16      |     |                        | $\mu\text{s}$          |
|             |                                             |                                                                                | To 0.01%                                                    | 0.22     |     |      | 0.22      |     |                        |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$                               | 15                                                          |          |     | 15   |           |     | nV/ $\sqrt{\text{Hz}}$ |                        |
|             |                                             | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                               | 10.5                                                        |          |     | 10.5 |           |     |                        |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                             |                                                             | 0.48     |     |      | 0.48      |     |                        | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                            |                                                             | 0.51     |     |      | 0.51      |     |                        |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                             |                                                             | 1.92     |     |      | 1.92      |     |                        | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                             |                                                             | 0.5      |     |      | 0.5       |     |                        |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,                           | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$   | 0.0052%  |     |      | 0.0052%   |     |                        |                        |
| B1          | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,                                             | $C_L = 100\text{ pF}$                                       | 5.9      |     |      | 5.9       |     |                        | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$                     | $C_L = 100\text{ pF}$ ,                                     | 5.8      |     |      | 5.8       |     |                        | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$ ,                                   | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$ | 660      |     |      | 660       |     |                        | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ ,                                             | $C_L = 100\text{ pF}$                                       | 57°      |     |      | 57°       |     |                        |                        |

<sup>†</sup>  $R_L$  terminates at 2.5 V.

# TLE214x, TLE214xA EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2142C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2142C    |               |     | TLE2142AC   |               |     | UNIT             |
|-------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-----|-------------|---------------|-----|------------------|
|                                                                               |                                                          |               | MIN         | TYP           | MAX | MIN         | TYP           | MAX |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, V_O = 0, R_S = 50 \Omega$                   | 25°C          | 290         | 1200          |     | 275         | 750           |     | $\mu V$          |
|                                                                               |                                                          | Full range    |             | 1600          |     |             | 1200          |     |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                          | Full range    | 1.7         |               |     | 1.7         |               |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 |                                                          | 25°C          | 7           | 100           |     | 7           | 100           |     | nA               |
|                                                                               |                                                          | Full range    |             | 150           |     |             | 150           |     |                  |
| $I_{IB}$ Input bias current                                                   |                                                          | 25°C          | –0.7        | –1.5          |     | –0.7        | –1.5          |     | $\mu A$          |
|                                                                               |                                                          | Full range    |             | –1.6          |     |             | –1.6          |     |                  |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \Omega$                                        | 25°C          | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 |     | V                |
|                                                                               |                                                          | Full range    | –15 to 12.9 | –15.3 to 13.1 |     | –15 to 12.9 | –15.3 to 13.1 |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150 \mu A$                                       | 25°C          | 13.8        | 14.1          |     | 13.8        | 14.1          |     | V                |
|                                                                               |                                                          | Full range    | 13.7        |               |     | 13.7        |               |     |                  |
|                                                                               | $I_O = -1.5$ mA                                          | 25°C          | 13.7        | 14            |     | 13.7        | 14            |     |                  |
|                                                                               |                                                          | Full range    | 13.6        |               |     | 13.6        |               |     |                  |
|                                                                               | $I_O = -15$ mA                                           | 25°C          | 13.3        | 13.7          |     | 13.3        | 13.7          |     |                  |
|                                                                               |                                                          | Full range    | 13.2        |               |     | 13.2        |               |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150 \mu A$                                        | 25°C          | –14.7       | –14.9         |     | –14.7       | –14.9         |     | V                |
|                                                                               |                                                          | Full range    | –14.6       |               |     | –14.6       |               |     |                  |
|                                                                               | $I_O = 1.5$ mA                                           | 25°C          | –14.5       | –14.8         |     | –14.5       | –14.8         |     |                  |
|                                                                               |                                                          | Full range    | –14.4       |               |     | –14.4       |               |     |                  |
|                                                                               | $I_O = 15$ mA                                            | 25°C          | –13.4       | –13.8         |     | –13.4       | –13.8         |     |                  |
|                                                                               |                                                          | Full range    | –13.3       |               |     | –13.3       |               |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10$ V                                         | 25°C          | 100         | 450           |     | 100         | 450           |     | V/mV             |
|                                                                               |                                                          | Full range    | 75          |               |     | 75          |               |     |                  |
| $r_i$ Input resistance                                                        | $R_L = 2$ k $\Omega$                                     | 25°C          |             | 65            |     |             | 65            |     | M $\Omega$       |
| $c_i$ Input capacitance                                                       |                                                          | 25°C          |             | 2.5           |     |             | 2.5           |     | pF               |
| $z_o$ Open-loop output impedance                                              | $f = 1$ MHz                                              | 25°C          |             | 30            |     |             | 30            |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, R_S = 50 \Omega$                   | 25°C          | 85          | 108           |     | 85          | 108           |     | dB               |
|                                                                               |                                                          | Full range    | 80          |               |     | 80          |               |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          | 90          | 106           |     | 90          | 106           |     | dB               |
|                                                                               |                                                          | Full range    | 85          |               |     | 85          |               |     |                  |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$                                                | 25°C          | –25         | –50           |     | –25         | –50           |     | mA               |
|                                                                               |                                                          |               | 20          | 31            |     | 20          | 31            |     |                  |
| $I_{CC}$ Supply current                                                       | $V_O = 0, \text{ No load}$                               | 25°C          | 6.9         | 9             |     | 6.9         | 9             |     | mA               |
|                                                                               |                                                          | Full range    |             | 9.4           |     |             | 9.4           |     |                  |

$^\dagger$  Full range is 0°C to 70°C.

**TLE2142C operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                   |                          | TLE2142C |     |     | TLE2142AC |     |     | UNIT   |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------|----------|-----|-----|-----------|-----|-----|--------|
|                    |                                             |                                                                                                   |                          | MIN      | TYP | MAX | MIN       | TYP | MAX |        |
| SR +               | Positive slew rate                          | A <sub>VD</sub> = − 1, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 500 pF                          |                          | 27       | 45  |     | 27        | 45  |     | V/μs   |
| SR −               | Negative slew rate                          |                                                                                                   |                          | 27       | 42  |     | 27        | 42  |     |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = − 1,<br>10-V step                                                               | To 0.1%                  | 0.34     |     |     | 0.34      |     |     | μs     |
|                    |                                             |                                                                                                   | To 0.01%                 | 0.4      |     |     | 0.4       |     |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω, f = 10 Hz                                                                  |                          | 15       |     |     | 15        |     |     | nV/√Hz |
|                    |                                             | R <sub>S</sub> = 20 Ω, f = 1 kHz                                                                  |                          | 10.5     |     |     | 10.5      |     |     |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                                |                          | 0.48     |     |     | 0.48      |     |     | μV     |
|                    |                                             | f = 0.1 Hz to 10 Hz                                                                               |                          | 0.51     |     |     | 0.51      |     |     |        |
| I <sub>n</sub>     | Equivalent input noise current              | f = 10 Hz                                                                                         |                          | 1.89     |     |     | 1.89      |     |     | pA/√Hz |
|                    |                                             | f = 1 kHz                                                                                         |                          | 0.47     |     |     | 0.47      |     |     |        |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 10, f = 10 kHz             |                          | 0.01%    |     |     | 0.01%     |     |     |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |                          | 6        |     |     | 6         |     |     | MHz    |
|                    | Gain-bandwidth product                      | R <sub>L</sub> = 2 kΩ,,<br>f =100 kHz                                                             | C <sub>L</sub> = 100 pF, | 5.9      |     |     | 5.9       |     |     | MHz    |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 1, C <sub>L</sub> = 100 pF |                          | 668      |     |     | 668       |     |     | kHz    |
| φ <sub>m</sub>     | Phase margin at unity gain                  | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |                          | 58°      |     |     | 58°       |     |     |        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

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**TLE2144C electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER        |                                                                       | TEST CONDITIONS                                                                    | T <sub>A</sub> <sup>†</sup> | TLE2144C     |             |              | TLE2144AC   |       |     | UNIT |
|------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------|--------------|-------------|--------------|-------------|-------|-----|------|
|                  |                                                                       |                                                                                    |                             | MIN          | TYP         | MAX          | MIN         | TYP   | MAX |      |
| V <sub>IO</sub>  | Input offset voltage                                                  | V <sub>O</sub> = 2.5 V,<br>V <sub>IC</sub> = 2.5 V<br><br>R <sub>S</sub> = 50 Ω,   | 25°C                        | 0.5    3.8   |             | 0.5    3     |             | mV    |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 4.4          |             | 3.6          |             |       |     |      |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |                                                                                    | Full range                  | 1.7          |             | 1.7          |             | μV/°C |     |      |
| I <sub>IO</sub>  | Input offset current                                                  |                                                                                    | 25°C                        | 8    100     |             | 8    100     |             | nA    |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 150          |             | 150          |             |       |     |      |
| I <sub>IB</sub>  | Input bias current                                                    |                                                                                    | 25°C                        | –0.8    –2   |             | –0.8    –2   |             | μA    |     |      |
|                  |                                                                       | Full range                                                                         | –2.1                        |              | –2.1        |              |             |       |     |      |
| V <sub>ICR</sub> | Common-mode input voltage range                                       | R <sub>S</sub> = 50 Ω                                                              | 25°C                        | 0 to 3       | –0.3 to 3.2 | 0 to 3       | –0.3 to 3.2 | V     |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 0 to 2.9     |             | 0 to 2.9     |             |       |     |      |
| V <sub>OH</sub>  | High-level output voltage                                             | I <sub>OH</sub> = –150 μA                                                          | 25°C                        | 3.9          | 4.1         | 3.9          | 4.1         | V     |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 3.8          |             | 3.8          |             |       |     |      |
|                  |                                                                       | I <sub>OH</sub> = –1.5 mA                                                          | 25°C                        | 3.8          | 4           | 3.8          | 4           |       |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 3.7          |             | 3.7          |             |       |     |      |
|                  |                                                                       | I <sub>OH</sub> = –15 mA                                                           | 25°C                        | 3.4          | 3.7         | 3.4          | 3.7         |       |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 3.4          |             | 3.4          |             |       |     |      |
| V <sub>OL</sub>  | Low-level output voltage                                              | I <sub>OL</sub> = 150 μA                                                           | 25°C                        | 75    125    |             | 75    125    |             | mV    |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 150          |             | 150          |             |       |     |      |
|                  |                                                                       | I <sub>OL</sub> = 1.5 mA                                                           | 25°C                        | 150    225   |             | 150    225   |             |       |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 250          |             | 250          |             |       |     |      |
|                  |                                                                       | I <sub>OL</sub> = 15 mA                                                            | 25°C                        | 1.2    1.6   |             | 1.2    1.6   |             | V     |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 1.7          |             | 1.7          |             |       |     |      |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       | V <sub>CC</sub> = ±2.5 V, R <sub>L</sub> = 2 kΩ,<br>V <sub>O</sub> = 1 V to –1.5 V | 25°C                        | 50           | 95          | 50           | 95          | V/mV  |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 25           |             | 25           |             |       |     |      |
| r <sub>i</sub>   | Input resistance                                                      |                                                                                    | 25°C                        | 70           |             | 70           |             | MΩ    |     |      |
| c <sub>i</sub>   | Input capacitance                                                     |                                                                                    | 25°C                        | 2.5          |             | 2.5          |             | pF    |     |      |
| z <sub>o</sub>   | Open-loop output impedance                                            | f = 1 MHz                                                                          | 25°C                        | 30           |             | 30           |             | Ω     |     |      |
| CMRR             | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω                   | 25°C                        | 85           | 118         | 85           | 118         | dB    |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 80           |             | 80           |             |       |     |      |
| k <sub>SVR</sub> | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±2.5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω                       | 25°C                        | 90           | 106         | 90           | 106         | dB    |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 85           |             | 85           |             |       |     |      |
| I <sub>CC</sub>  | Supply current                                                        | V <sub>O</sub> = 2.5 V, V <sub>IC</sub> = 2.5 V<br><br>No load,                    | 25°C                        | 13.2    17.6 |             | 13.2    17.6 |             | mA    |     |      |
|                  |                                                                       |                                                                                    | Full range                  | 18.5         |             | 18.5         |             |       |     |      |

$^\dagger$  Full range is 0°C to 70°C.

**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
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**TLE2144C operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER          |                                             | TEST CONDITIONS                                                                |                                                             | TLE2144C |     |     | TLE2144AC |     |     | UNIT                   |
|--------------------|---------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------|----------|-----|-----|-----------|-----|-----|------------------------|
|                    |                                             |                                                                                |                                                             | MIN      | TYP | MAX | MIN       | TYP | MAX |                        |
| SR +               | Positive slew rate                          | $A_{VD} = -1$ ,<br>$R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 500\text{ pF}$ |                                                             | 45       |     |     | 45        |     |     | V/ $\mu\text{s}$       |
| SR –               | Negative slew rate                          |                                                                                |                                                             | 42       |     |     | 42        |     |     |                        |
| $t_s$              | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                                                  | To 0.1%                                                     | 0.16     |     |     | 0.16      |     |     | $\mu\text{s}$          |
|                    |                                             |                                                                                | To 0.01%                                                    | 0.22     |     |     | 0.22      |     |     |                        |
| $V_n$              | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$                               |                                                             | 15       |     |     | 15        |     |     | nV/ $\sqrt{\text{Hz}}$ |
|                    |                                             | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                               |                                                             | 10.5     |     |     | 10.5      |     |     |                        |
| $V_{N(\text{PP})}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                             |                                                             | 0.48     |     |     | 0.48      |     |     | $\mu\text{V}$          |
|                    |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                            |                                                             | 0.51     |     |     | 0.51      |     |     |                        |
| $I_n$              | Equivalent input noise current              | $f = 10\text{ Hz}$                                                             |                                                             | 1.92     |     |     | 1.92      |     |     | pA/ $\sqrt{\text{Hz}}$ |
|                    |                                             | $f = 1\text{ kHz}$                                                             |                                                             | 0.5      |     |     | 0.5       |     |     |                        |
| THD + N            | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,                           | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$   | 0.0052%  |     |     | 0.0052%   |     |     |                        |
| $B_1$              | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,                                             | $C_L = 100\text{ pF}$                                       | 5.9      |     |     | 5.9       |     |     | MHz                    |
|                    | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$                     | $C_L = 100\text{ pF}$ ,                                     | 5.8      |     |     | 5.8       |     |     | MHz                    |
| $B_{\text{OM}}$    | Maximum output-swing bandwidth              | $V_{\text{O(PP)}} = 2\text{ V}$ ,<br>$A_{VD} = 1$ ,                            | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$ | 660      |     |     | 660       |     |     | kHz                    |
| $\phi_m$           | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ ,                                             | $C_L = 100\text{ pF}$                                       | 57°      |     |     | 57°       |     |     |                        |

<sup>†</sup>  $R_L$  terminates at 2.5 V

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

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**TLE2144C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER        |                                                                       | TEST CONDITIONS                                                |                       | T <sub>A</sub> <sup>†</sup> | TLE2144C               |               |             | TLE2144AC |               |      | UNIT |
|------------------|-----------------------------------------------------------------------|----------------------------------------------------------------|-----------------------|-----------------------------|------------------------|---------------|-------------|-----------|---------------|------|------|
|                  |                                                                       |                                                                |                       |                             | MIN                    | TYP           | MAX         | MIN       | TYP           | MAX  |      |
| V <sub>IO</sub>  | Input offset voltage                                                  | V <sub>IC</sub> = 0, R <sub>S</sub> = 50 Ω, V <sub>O</sub> = 0 |                       | 25°C                        | 0.6                    |               | 2.4         | 0.5       |               | 1.5  | mV   |
|                  | Full range                                                            |                                                                |                       | 3.2                         |                        | 2.4           |             |           |               |      |      |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |                                                                |                       | Full range                  | 1.7                    |               | 1.7         |           | μV/°C         |      |      |
| I <sub>IO</sub>  | Input offset current                                                  |                                                                |                       | 25°C                        | 7                      |               | 100         | 7         |               | 100  | nA   |
|                  |                                                                       |                                                                |                       | Full range                  | 150                    |               | 150         |           |               |      |      |
| I <sub>IB</sub>  | Input bias current                                                    |                                                                |                       | 25°C                        | −0.7                   |               | −1.5        | −0.7      |               | −1.5 | μA   |
|                  |                                                                       | Full range                                                     | −1.6                  |                             | −1.6                   |               |             |           |               |      |      |
| V <sub>ICR</sub> | Common-mode input voltage range                                       | R <sub>S</sub> = 50 Ω                                          |                       | 25°C                        | −15 to 13              | −15.3 to 13.2 | −15 to 13   |           | −15.3 to 13.2 | V    |      |
|                  |                                                                       |                                                                |                       | Full range                  | −15 to 12.9            | −15.3 to 13.1 | −15 to 12.9 |           | −15.3 to 13.1 |      |      |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            | I <sub>O</sub> = −150 μA                                       |                       | 25°C                        | 13.8                   | 14.1          | 13.8        |           | 14.1          | V    |      |
|                  |                                                                       |                                                                |                       | Full range                  | 13.7                   |               | 13.7        |           |               |      |      |
|                  |                                                                       | I <sub>O</sub> = −1.5 mA                                       |                       | 25°C                        | 13.7                   | 14            | 13.7        |           | 14            |      |      |
|                  |                                                                       |                                                                |                       | Full range                  | 13.6                   |               | 13.6        |           |               |      |      |
|                  |                                                                       | I <sub>O</sub> = −15 mA                                        |                       | 25°C                        | 13.1                   | 13.7          | 13.1        |           | 13.7          |      |      |
|                  |                                                                       |                                                                |                       | Full range                  | 13                     |               | 13          |           |               |      |      |
| V <sub>OM−</sub> | Maximum negative peak output voltage swing                            | I <sub>O</sub> = 150 μA                                        |                       | 25°C                        | −14.7                  | −14.9         | −14.7       |           | −14.9         | V    |      |
|                  |                                                                       |                                                                |                       | Full range                  | −14.6                  |               | −14.6       |           |               |      |      |
|                  |                                                                       | I <sub>O</sub> = 1.5 mA                                        |                       | 25°C                        | −14.5                  | −14.8         | −14.5       |           | −14.8         |      |      |
|                  |                                                                       |                                                                |                       | Full range                  | −14.4                  |               | −14.4       |           |               |      |      |
|                  |                                                                       | I <sub>O</sub> = 15 mA                                         |                       | 25°C                        | −13.4                  | −13.8         | −13.4       |           | −13.8         |      |      |
|                  |                                                                       |                                                                |                       | Full range                  | −13.3                  |               | −13.3       |           |               |      |      |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±10 V                                         |                       | 25°C                        | 100                    | 170           | 100         |           | 170           | V/mV |      |
|                  |                                                                       |                                                                |                       | Full range                  | 75                     |               | 75          |           |               |      |      |
| r <sub>i</sub>   | Input resistance                                                      | R <sub>L</sub> = 2 kΩ                                          |                       | 25°C                        | 65                     |               | 65          |           | MΩ            |      |      |
| c <sub>i</sub>   | Input capacitance                                                     |                                                                |                       | 25°C                        | 2.5                    |               | 2.5         |           | pF            |      |      |
| z <sub>o</sub>   | Open-loop output impedance                                            | f = 1 MHz                                                      |                       | 25°C                        | 30                     |               | 30          |           | Ω             |      |      |
| CMRR             | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> , R <sub>S</sub> = 50 Ω  |                       | 25°C                        | 85                     | 108           | 85          |           | 108           | dB   |      |
|                  |                                                                       |                                                                |                       | Full range                  | 80                     |               | 80          |           |               |      |      |
| k <sub>SVR</sub> | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±2.5 V to ±15 V, R <sub>S</sub> = 50 Ω      |                       | 25°C                        | 90                     | 106           | 90          |           | 106           | dB   |      |
|                  |                                                                       |                                                                |                       | Full range                  | 85                     |               | 85          |           |               |      |      |
| I <sub>OS</sub>  | Short-circuit output current                                          | V <sub>O</sub> = 0                                             | V <sub>ID</sub> = 1 V | 25°C                        | −25                    | −50           | −25         |           | −50           | mA   |      |
|                  |                                                                       |                                                                |                       |                             | V <sub>ID</sub> = −1 V | 20            | 31          | 20        |               |      | 31   |
| I <sub>CC</sub>  | Supply current                                                        | V <sub>O</sub> = 0, No load                                    |                       | 25°C                        | 13.8                   |               | 18          | 13.8      |               | 18   | mA   |
|                  |                                                                       |                                                                |                       | Full range                  | 18.8                   |               | 18.8        |           |               |      |      |

$^\dagger$  Full range is 0°C to 70°C.



**TLE2144C operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                     |                                                     | TLE2144C   |     |     | TLE2144AC  |     |                  | UNIT                   |
|-------------|---------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------|------------|-----|-----|------------|-----|------------------|------------------------|
|             |                                             |                                                                     |                                                     | MIN        | TYP | MAX | MIN        | TYP | MAX              |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ , $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 500\text{ pF}$ |                                                     | 27         | 45  |     | 27         | 45  | V/ $\mu\text{s}$ |                        |
| SR –        | Negative slew rate                          |                                                                     |                                                     | 27         | 42  |     | 27         | 42  |                  |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                                        | To 0.1%                                             | 0.34       |     |     | 0.34       |     |                  | $\mu\text{s}$          |
|             |                                             |                                                                     | To 0.01%                                            | 0.4        |     |     | 0.4        |     |                  |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ , $f = 10\text{ Hz}$                       |                                                     | 15         |     |     | 15         |     |                  | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ , $f = 1\text{ kHz}$                       |                                                     | 10.5       |     |     | 10.5       |     |                  |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                  |                                                     | 0.48       |     |     | 0.48       |     |                  | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                 |                                                     | 0.51       |     |     | 0.51       |     |                  |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                  |                                                     | 1.89       |     |     | 1.89       |     |                  | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                  |                                                     | 0.47       |     |     | 0.47       |     |                  |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 10$ ,                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 10\text{ kHz}$   | 0.01%      |     |     | 0.01%      |     |                  |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$ ,                                          | $C_L = 100\text{ pF}$                               | 6          |     |     | 6          |     |                  | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 100\text{ kHz}$                  | $C_L = 100\text{ pF}$ ,                             | 5.9        |     |     | 5.9        |     |                  | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 1$ ,                       | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ | 668        |     |     | 668        |     |                  | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$ ,                                          | $C_L = 100\text{ pF}$                               | $58^\circ$ |     |     | $58^\circ$ |     |                  |                        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2141I electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                                                  | $T_A^\dagger$ | TLE2141I |             |      | TLE2141AI |             |      | UNIT                         |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------|----------|-------------|------|-----------|-------------|------|------------------------------|
|                                                                               |                                                                                                  |               | MIN      | TYP         | MAX  | MIN       | TYP         | MAX  |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>$R_S = 50\ \Omega$                          | 25°C          | 225      | 1400        |      | 200       | 1000        |      | $\mu\text{V}$                |
|                                                                               |                                                                                                  | Full range    |          |             | 1900 |           |             | 1500 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                                                  | Full range    | 1.7      |             |      | 1.7       |             |      | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 |                                                                                                  | 25°C          | 8        | 100         |      | 8         | 100         |      | nA                           |
|                                                                               |                                                                                                  | Full range    |          | 200         |      |           | 200         |      |                              |
| $I_{IB}$ Input bias current                                                   |                                                                                                  | 25°C          | –0.8     | –2          |      | –0.8      | –2          |      | $\mu\text{A}$                |
|                                                                               |                                                                                                  | Full range    |          | –2.2        |      |           | –2.2        |      |                              |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                                               | 25°C          | 0 to 3   | –0.3 to 3.2 |      | 0 to 3    | –0.3 to 3.2 |      | V                            |
|                                                                               |                                                                                                  | Full range    | 0 to 2.7 | –0.3 to 2.9 |      | 0 to 2.7  | –0.3 to 2.9 |      |                              |
| $V_{OH}$ High-level output voltage                                            | $I_{OH} = -150\ \mu\text{A}$                                                                     | 25°C          | 3.9      | 4.1         |      | 3.9       | 4.1         |      | V                            |
|                                                                               | $I_{OH} = -1.5\text{ mA}$                                                                        |               | 3.8      | 4           |      | 3.8       | 4           |      |                              |
|                                                                               | $I_{OH} = -15\text{ mA}$                                                                         |               | 3.2      | 3.7         |      | 3.2       | 3.7         |      |                              |
|                                                                               | $I_{OH} = -100\ \mu\text{A}$                                                                     | Full range    | 3.8      |             |      | 3.8       |             |      |                              |
|                                                                               | $I_{OH} = -1\text{ mA}$                                                                          |               | 3.7      |             |      | 3.7       |             |      |                              |
|                                                                               | $I_{OH} = -10\text{ mA}$                                                                         |               | 3.3      |             |      | 3.3       |             |      |                              |
| $V_{OL}$ Low-level output voltage                                             | $I_{OL} = 150\ \mu\text{A}$                                                                      | 25°C          | 75       | 125         |      | 75        | 125         |      | mV                           |
|                                                                               | $I_{OL} = 1.5\ \mu\text{A}$                                                                      |               | 150      | 225         |      | 150       | 225         |      |                              |
|                                                                               | $I_{OL} = 15\text{ mA}$                                                                          |               | 1.2      | 1.6         |      | 1.2       | 1.6         |      | V                            |
|                                                                               | $I_{OL} = 100\ \mu\text{A}$                                                                      | Full range    | 175      |             |      | 175       |             |      | mV                           |
|                                                                               | $I_{OL} = 1\text{ mA}$                                                                           |               | 225      |             |      | 225       |             |      |                              |
|                                                                               | $I_{OL} = 10\text{ mA}$                                                                          |               | 1.4      |             |      | 1.4       |             |      | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_{CC} = \pm 2.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$ | 25°C          | 50       | 220         |      | 50        | 220         |      | V/mV                         |
|                                                                               |                                                                                                  | Full range    | 10       |             |      | 10        |             |      |                              |
| $r_i$ Input resistance                                                        |                                                                                                  | 25°C          | 70       |             |      | 70        |             |      | M $\Omega$                   |
| $c_i$ Input capacitance                                                       |                                                                                                  | 25°C          | 2.5      |             |      | 2.5       |             |      | pF                           |
| $z_o$ Open-loop output impedance                                              | $f = 1\text{ MHz}$                                                                               | 25°C          | 30       |             |      | 30        |             |      | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                                                       | 25°C          | 85       | 118         |      | 85        | 118         |      | dB                           |
|                                                                               |                                                                                                  | Full range    | 80       |             |      | 80        |             |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                       | 25°C          | 90       | 106         |      | 90        | 106         |      | dB                           |
|                                                                               |                                                                                                  | Full range    | 85       |             |      | 85        |             |      |                              |
| $I_{CC}$ Supply current                                                       | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>No load,                                    | 25°C          | 3.4      | 4.4         |      | 3.4       | 4.4         |      | mA                           |
|                                                                               |                                                                                                  | Full range    |          | 4.6         |      |           | 4.6         |      |                              |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ .

**TLE2141I operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                                                               |          | TLE2141I |     |     | TLE2141AI |     |     | UNIT                   |
|-------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------|----------|-----|-----|-----------|-----|-----|------------------------|
|             |                                             |                                                                                                               |          | MIN      | TYP | MAX | MIN       | TYP | MAX |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$                                                                      |          | 45       |     |     | 45        |     |     | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                                                                               |          | 42       |     |     | 42        |     |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                                                                                 | To 0.1%  | 0.16     |     |     | 0.16      |     |     | $\mu\text{s}$          |
|             |                                             |                                                                                                               | To 0.01% | 0.22     |     |     | 0.22      |     |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ , $f = 10\text{ Hz}$                                                                 |          | 15       |     |     | 15        |     |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ , $f = 1\text{ kHz}$                                                                 |          | 10.5     |     |     | 10.5      |     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                                            |          | 0.48     |     |     | 0.48      |     |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                                           |          | 0.51     |     |     | 0.51      |     |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                                                            |          | 1.92     |     |     | 1.92      |     |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                                                            |          | 0.5      |     |     | 0.5       |     |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ , $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$A_{VD} = 2$ , $f = 10\text{ kHz}$   |          | 0.0052%  |     |     | 0.0052%   |     |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ , $C_L = 100\text{ pF}^\dagger$                                              |          | 5.9      |     |     | 5.9       |     |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$<br>$f = 100\text{ kHz}$                                                      |          | 5.8      |     |     | 5.8       |     |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ , $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$A_{VD} = 1$ , $C_L = 100\text{ pF}^\dagger$ |          | 660      |     |     | 660       |     |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ , $C_L = 100\text{ pF}^\dagger$                                              |          | 57°      |     |     | 57°       |     |     |                        |

<sup>†</sup>  $R_L$  and  $C_L$  terminated to 2.5 V.

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2141I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2141I    |               |     | TLE2141AI   |               |     | UNIT             |
|-------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-----|-------------|---------------|-----|------------------|
|                                                                               |                                                          |               | MIN         | TYP           | MAX | MIN         | TYP           | MAX |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, R_S = 50 \Omega, V_O = 0$                   | 25°C          | 200         | 900           |     | 175         | 500           |     | $\mu V$          |
|                                                                               |                                                          | Full range    |             | 1500          |     |             | 1000          |     |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                          | Full range    | 1.7         |               |     | 1.7         |               |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 |                                                          | 25°C          | 7           | 100           |     | 7           | 100           |     | nA               |
|                                                                               |                                                          | Full range    |             | 200           |     |             | 200           |     |                  |
| $I_{IB}$ Input bias current                                                   |                                                          | 25°C          | –0.7        | –1.5          |     | –0.7        | –1.5          |     | $\mu A$          |
|                                                                               |                                                          | Full range    |             | –1.7          |     |             | –1.7          |     |                  |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \Omega$                                        | 25°C          | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 |     | V                |
|                                                                               |                                                          | Full range    | –15 to 12.7 | –15.3 to 12.9 |     | –15 to 12.7 | –15.3 to 12.9 |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150 \mu A$                                       | 25°C          | 13.8        | 14.1          |     | 13.8        | 14.1          |     | V                |
|                                                                               | $I_O = -1.5$ mA                                          |               | 13.7        | 14            |     | 13.7        | 14            |     |                  |
|                                                                               | $I_O = -15$ mA                                           |               | 13.1        | 13.7          |     | 13.1        | 13.7          |     |                  |
|                                                                               | $I_O = -100 \mu A$                                       | Full range    | 13.7        |               |     | 13.7        |               |     |                  |
|                                                                               | $I_O = -1$ mA                                            |               | 13.6        |               |     | 13.6        |               |     |                  |
|                                                                               | $I_O = -10$ mA                                           |               | 13.1        |               |     | 13.1        |               |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150 \mu A$                                        | 25°C          | –14.7       | –14.9         |     | –14.7       | –14.9         |     | V                |
|                                                                               | $I_O = 1.5$ mA                                           |               | –14.5       | –14.8         |     | –14.5       | –14.8         |     |                  |
|                                                                               | $I_O = 15$ mA                                            |               | –13.4       | –13.8         |     | –13.4       | –13.8         |     |                  |
|                                                                               | $I_O = 100 \mu A$                                        | Full range    | –14.6       |               |     | –14.6       |               |     |                  |
|                                                                               | $I_O = 1$ mA                                             |               | –14.5       |               |     | –14.5       |               |     |                  |
|                                                                               | $I_O = 10$ mA                                            |               | –13.4       |               |     | –13.4       |               |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10$ V, $R_L = 2$ k $\Omega$                   | 25°C          | 100         | 450           |     | 100         | 450           |     | V/mV             |
|                                                                               |                                                          | Full range    | 40          |               |     | 40          |               |     |                  |
| $r_i$ Input resistance                                                        |                                                          | 25°C          | 65          |               |     | 65          |               |     | M $\Omega$       |
| $c_i$ Input capacitance                                                       |                                                          | 25°C          | 2.5         |               |     | 2.5         |               |     | pF               |
| $z_o$ Open-loop output impedance                                              | $f = 1$ MHz                                              | 25°C          | 30          |               |     | 30          |               |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, R_S = 50 \Omega$                   | 25°C          | 85          | 108           |     | 85          | 108           |     | dB               |
|                                                                               |                                                          | Full range    | 80          |               |     | 80          |               |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          | 90          | 106           |     | 90          | 106           |     | dB               |
|                                                                               |                                                          | Full range    | 85          |               |     | 85          |               |     |                  |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$                                                | 25°C          | –25         | –50           |     | –25         | –50           |     | mA               |
|                                                                               |                                                          |               | 20          | 31            |     | 20          | 31            |     |                  |
| $I_{CC}$ Supply current                                                       | $V_O = 0$ , No load                                      | 25°C          | 3.5         | 4.5           |     | 3.5         | 4.5           |     | mA               |
|                                                                               |                                                          | Full range    |             | 4.7           |     |             | 4.7           |     |                  |

$^\dagger$  Full range is  $-40^\circ C$  to  $105^\circ C$ .



**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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**TLE2141I operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                    |                                                     | TLE2141I |            |     | TLE2141AI |            |     | UNIT                   |
|-------------|---------------------------------------------|----------------------------------------------------|-----------------------------------------------------|----------|------------|-----|-----------|------------|-----|------------------------|
|             |                                             |                                                    |                                                     | MIN      | TYP        | MAX | MIN       | TYP        | MAX |                        |
| SR+         | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$           | $R_L = 2\text{ k}\Omega$                            | 27       | 45         |     | 27        | 45         |     | V/ $\mu\text{s}$       |
| SR–         | Negative slew rate                          |                                                    |                                                     | 27       | 42         |     | 27        | 42         |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                       | To 0.1%                                             |          | 0.34       |     |           | 0.34       |     | $\mu\text{s}$          |
|             |                                             |                                                    | To 0.01%                                            |          | 0.4        |     |           | 0.4        |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,                         | $f = 10\text{ Hz}$                                  |          | 15         |     |           | 15         |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ ,                         | $f = 1\text{ kHz}$                                  |          | 10.5       |     |           | 10.5       |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                 |                                                     |          | 0.48       |     |           | 0.48       |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                |                                                     |          | 0.51       |     |           | 0.51       |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                 |                                                     |          | 1.89       |     |           | 1.89       |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                 |                                                     |          | 0.47       |     |           | 0.47       |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 10$ ,     | $R_L = 2\text{ k}\Omega$ ,<br>$f = 10\text{ kHz}$   |          | 0.01%      |     |           | 0.01%      |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$ ,                         | $C_L = 100\text{ pF}$                               |          | 6          |     |           | 6          |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 100\text{ kHz}$ | $C_L = 100\text{ pF}$                               |          | 5.9        |     |           | 5.9        |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 1$ ,      | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ |          | 668        |     |           | 668        |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$ ,                         | $C_L = 100\text{ pF}$                               |          | $58^\circ$ |     |           | $58^\circ$ |     |                        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2142I electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                       | TEST CONDITIONS                                                                                   | $T_A^\dagger$ | TLE2142I |             |     | TLE2142AI |             |     | UNIT                         |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                                 |                                                                                                   |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                   | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>$R_S = 50\ \Omega$                           | 25°C          | 220      | 1900        |     | 220       | 1500        |     | $\mu\text{V}$                |
|                                                                                 |                                                                                                   | Full range    |          | 2400        |     |           | 2000        |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                                                                   | Full range    | 1.7      |             |     | 1.7       |             |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                   |                                                                                                   | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                                 |                                                                                                   | Full range    |          | 200         |     |           | 200         |     |                              |
| $I_{IB}$ Input bias current                                                     |                                                                                                   | 25°C          | -0.8     | -2          |     | -0.8      | -2          |     | $\mu\text{A}$                |
|                                                                                 |                                                                                                   | Full range    |          | -2.2        |     |           | -2.2        |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50\ \Omega$                                                                                | 25°C          | 0 to 3   | -0.3 to 3.2 |     | 0 to 3    | -0.3 to 3.2 |     | V                            |
|                                                                                 |                                                                                                   | Full range    | 0 to 2.7 | -0.3 to 2.9 |     | 0 to 2.7  | -0.3 to 2.9 |     |                              |
| $V_{OH}$ High-level output voltage                                              | $I_{OH} = -150\ \mu\text{A}$                                                                      | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                                 | $I_{OH} = -1.5\text{ mA}$                                                                         |               | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                                 | $I_{OH} = -15\text{ mA}$                                                                          |               | 3.4      | 3.7         |     | 3.4       | 3.7         |     |                              |
|                                                                                 | $I_{OH} = 100\ \mu\text{A}$                                                                       | Full range    | 3.8      |             |     | 3.8       |             |     |                              |
|                                                                                 | $I_{OH} = 1\text{ mA}$                                                                            |               | 3.7      |             |     | 3.7       |             |     |                              |
|                                                                                 | $I_{OH} = 10\text{ mA}$                                                                           |               | 3.5      |             |     | 3.5       |             |     |                              |
| $V_{OL}$ Low-level output voltage                                               | $I_{OL} = 150\ \mu\text{A}$                                                                       | 25°C          | 75       | 125         |     | 75        | 125         |     | mV                           |
|                                                                                 | $I_{OL} = 1.5\text{ mA}$                                                                          |               | 150      | 225         |     | 150       | 225         |     |                              |
|                                                                                 | $I_{OL} = 15\text{ mA}$                                                                           |               | 1.2      | 1.4         |     | 1.2       | 1.4         |     | V                            |
|                                                                                 | $I_{OL} = 100\ \mu\text{A}$                                                                       | Full range    | 175      |             |     | 175       |             |     | mV                           |
|                                                                                 | $I_{OL} = 1\text{ mA}$                                                                            |               | 225      |             |     | 225       |             |     |                              |
|                                                                                 | $I_{OL} = 10\text{ mA}$                                                                           |               | 1.2      |             |     | 1.2       |             |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_{IC} = \pm 2.5\text{ V}$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$<br>$R_L = 2\text{ k}\Omega$ | 25°C          | 50       | 220         |     | 50        | 220         |     | V/mV                         |
|                                                                                 |                                                                                                   | Full range    | 10       |             |     | 10        |             |     |                              |
| $r_i$ Input resistance                                                          |                                                                                                   | 25°C          | 70       |             |     | 70        |             |     | M $\Omega$                   |
| $c_i$ Input capacitance                                                         |                                                                                                   | 25°C          | 2.5      |             |     | 2.5       |             |     | pF                           |
| $z_o$ Open-loop output impedance                                                | $f = 1\text{ MHz}$                                                                                | 25°C          | 30       |             |     | 30        |             |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICRmin}$ ,<br>$R_S = 50\ \Omega$                                                     | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                                 |                                                                                                   | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                        | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                                 |                                                                                                   | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                         | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>No load,                                     | 25°C          | 6.6      | 8.8         |     | 6.6       | 8.8         |     | mA                           |
|                                                                                 |                                                                                                   | Full range    |          | 9.2         |     |           | 9.2         |     |                              |

$^\dagger$  Full range is -40°C to 105°C.

**TLE2142I operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                            |                                                             | TLE2142I   |     |     | TLE2142AI  |     |     | UNIT                   |
|-------------|---------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------|------------|-----|-----|------------|-----|-----|------------------------|
|             |                                             |                                                            |                                                             | MIN        | TYP | MAX | MIN        | TYP | MAX |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$                   | $R_L = 2\text{ k}\Omega^\dagger$                            | 45         |     |     | 45         |     |     | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                            |                                                             | 42         |     |     | 42         |     |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                              | To 0.1%                                                     | 0.16       |     |     | 0.16       |     |     | $\mu\text{s}$          |
|             |                                             |                                                            | To 0.01%                                                    | 0.22       |     |     | 0.22       |     |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,                                 | $f = 10\text{ Hz}$                                          | 15         |     |     | 15         |     |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ ,                                 | $f = 1\text{ kHz}$                                          | 10.5       |     |     | 10.5       |     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                         |                                                             | 0.48       |     |     | 0.48       |     |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                        |                                                             | 0.51       |     |     | 0.51       |     |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                         |                                                             | 1.92       |     |     | 1.92       |     |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                         |                                                             | 0.5        |     |     | 0.5        |     |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,       | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$   | 0.0052%    |     |     | 0.0052%    |     |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,                         | $C_L = 100\text{ pF}$                                       | 5.9        |     |     | 5.9        |     |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$ | $C_L = 100\text{ pF}$ ,                                     | 5.8        |     |     | 5.8        |     |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$ ,               | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$ | 660        |     |     | 660        |     |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ ,                         | $C_L = 100\text{ pF}$                                       | $57^\circ$ |     |     | $57^\circ$ |     |     |                        |

<sup>†</sup>  $R_L$  terminates at 2.5 V.

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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**TLE2142I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                       | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2142I    |               |     | TLE2142I    |               |     | UNIT             |
|---------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-----|-------------|---------------|-----|------------------|
|                                                                                 |                                                          |               | MIN         | TYP           | MAX | MIN         | TYP           | MAX |                  |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0, R_S = 50 \Omega, V_O = 0$                   | 25°C          | 290         | 1200          |     | 275         | 750           |     | $\mu V$          |
|                                                                                 |                                                          | Full range    |             | 1800          |     |             | 1400          |     |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                          | Full range    | 1.7         |               |     | 1.7         |               |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                   |                                                          | 25°C          | 7           | 100           |     | 7           | 100           |     | nA               |
|                                                                                 |                                                          | Full range    |             | 200           |     |             | 200           |     |                  |
| $I_{IB}$ Input bias current                                                     |                                                          | 25°C          | –0.7        | –1.5          |     | –0.7        | –1.5          |     | $\mu A$          |
|                                                                                 |                                                          | Full range    |             | –1.7          |     |             | –1.7          |     |                  |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50 \Omega$                                        | 25°C          | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 |     | V                |
|                                                                                 |                                                          | Full range    | –15 to 12.7 | –15.3 to 12.9 |     | –15 to 12.7 | –15.3 to 12.9 |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $I_O = -150 \mu A$                                       | 25°C          | 13.8        | 14.1          |     | 13.8        | 14.1          |     | V                |
|                                                                                 | $I_O = -1.5$ mA                                          |               | 13.7        | 14            |     | 13.7        | 14            |     |                  |
|                                                                                 | $I_O = -15$ mA                                           |               | 13.3        | 13.7          |     | 13.3        | 13.7          |     |                  |
|                                                                                 | $I_O = -100 \mu A$                                       | Full range    | 13.7        |               |     | 13.7        |               |     |                  |
|                                                                                 | $I_O = -1$ mA                                            |               | 13.6        |               |     | 13.6        |               |     |                  |
|                                                                                 | $I_O = -10$ mA                                           |               | 13.3        |               |     | 13.3        |               |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $I_O = 150 \mu A$                                        | 25°C          | –14.7       | –14.9         |     | –14.7       | –14.9         |     | V                |
|                                                                                 | $I_O = 1.5$ mA                                           |               | –14.5       | –14.8         |     | –14.5       | –14.8         |     |                  |
|                                                                                 | $I_O = 15$ mA                                            |               | –13.4       | –13.8         |     | –13.4       | –13.8         |     |                  |
|                                                                                 | $I_O = 100 \mu A$                                        | Full range    | –14.6       |               |     | –14.6       |               |     |                  |
|                                                                                 | $I_O = 1$ mA                                             |               | –14.5       |               |     | –14.5       |               |     |                  |
|                                                                                 | $I_O = 10$ mA                                            |               | –13.4       |               |     | –13.4       |               |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 10$ V, $R_L = 2$ k $\Omega$                   | 25°C          | 100         | 450           |     | 100         | 450           |     | V/mV             |
|                                                                                 |                                                          | Full range    | 40          |               |     | 40          |               |     |                  |
| $r_i$ Input resistance                                                          |                                                          | 25°C          | 65          |               |     | 65          |               |     | M $\Omega$       |
| $c_i$ Input capacitance                                                         |                                                          | 25°C          | 2.5         |               |     | 2.5         |               |     | pF               |
| $z_o$ Open-loop output impedance                                                | $f = 1$ MHz                                              | 25°C          | 30          |               |     | 30          |               |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICRmin}$                                    | 25°C          | 85          | 108           |     | 85          | 108           |     | dB               |
|                                                                                 | $R_S = 50 \Omega$                                        | Full range    | 80          |               |     | 80          |               |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          | 90          | 106           |     | 90          | 106           |     | dB               |
|                                                                                 |                                                          | Full range    | 85          |               |     | 85          |               |     |                  |
| $I_{OS}$ Short-circuit output current                                           | $V_O = 0$                                                | 25°C          | –25         | –50           |     | –25         | –50           |     | mA               |
|                                                                                 |                                                          |               | 20          | 31            |     | 20          | 31            |     |                  |
| $I_{CC}$ Supply current                                                         | $V_O = 0, \text{ No load}$                               | 25°C          | 6.9         | 9             |     | 6.9         | 9             |     | mA               |
|                                                                                 |                                                          | Full range    |             | 9.4           |     |             | 9.4           |     |                  |

$^\dagger$  Full range is  $-40^\circ C$  to  $105^\circ C$ .



**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
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**TLE2142I operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                                                |                          | TLE2142I |            |     | TLE2142AI |            |     | UNIT                         |
|-------------|---------------------------------------------|------------------------------------------------------------------------------------------------|--------------------------|----------|------------|-----|-----------|------------|-----|------------------------------|
|             |                                             |                                                                                                |                          | MIN      | TYP        | MAX | MIN       | TYP        | MAX |                              |
| SR+         | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$                                                       | $R_L = 2\text{ k}\Omega$ | 30       | 45         |     | 30        | 45         |     | $\text{V}/\mu\text{s}$       |
| SR–         | Negative slew rate                          |                                                                                                |                          | 30       | 42         |     | 30        | 42         |     |                              |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                                                                   | To 0.1%                  |          | 0.34       |     |           | 0.34       |     | $\mu\text{s}$                |
|             |                                             |                                                                                                | To 0.01%                 |          | 0.4        |     |           | 0.4        |     |                              |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ , $f = 10\text{ Hz}$                                                  |                          |          | 15         |     |           | 15         |     | $\text{nV}/\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ , $f = 1\text{ kHz}$                                                  |                          |          | 10.5       |     |           | 10.5       |     |                              |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                             |                          |          | 0.48       |     |           | 0.48       |     | $\mu\text{V}$                |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                            |                          |          | 0.51       |     |           | 0.51       |     |                              |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                                             |                          |          | 1.89       |     |           | 1.89       |     | $\text{pA}/\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                                             |                          |          | 0.47       |     |           | 0.47       |     |                              |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$A_{VD} = 10$ , $f = 10\text{ kHz}$  |                          |          | 0.01%      |     |           | 0.01%      |     |                              |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$                                               |                          |          | 6          |     |           | 6          |     | MHz                          |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ ,<br>$f = 100\text{ kHz}$                     |                          |          | 5.9        |     |           | 5.9        |     | MHz                          |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$A_{VD} = 1$ , $C_L = 100\text{ pF}$ |                          |          | 668        |     |           | 668        |     | kHz                          |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$                                               |                          |          | $58^\circ$ |     |           | $58^\circ$ |     |                              |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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**TLE2144I electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                                             | $T_A^\dagger$ | TLE2144I |             |      | TLE2144AI |             |      | UNIT                         |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------|----------|-------------|------|-----------|-------------|------|------------------------------|
|                                                                               |                                                                                             |               | MIN      | TYP         | MAX  | MIN       | TYP         | MAX  |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, R_S = 50\ \Omega, V_O = 0$                                                     | 25°C          | 0.5      | 3.8         |      | 0.5       | 3           |      | mV                           |
|                                                                               |                                                                                             | Full range    |          |             | 4.8  |           |             | 4    |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                                             | Full range    |          | 1.7         |      |           | 1.7         |      | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 |                                                                                             | 25°C          | 8        | 100         |      | 8         | 100         |      | nA                           |
|                                                                               |                                                                                             | Full range    |          |             | 200  |           |             | 200  |                              |
| $I_{IB}$ Input bias current                                                   |                                                                                             | 25°C          | –0.8     | –2          |      | –0.8      | –2          |      | $\mu\text{A}$                |
|                                                                               |                                                                                             | Full range    |          |             | –2.2 |           |             | –2.2 |                              |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                                          | 25°C          | 0 to 3   | –0.3 to 3.2 |      | 0 to 3    | –0.3 to 3.2 |      | V                            |
|                                                                               |                                                                                             | Full range    | 0 to 2.7 | –0.3 to 2.9 |      | 0 to 2.7  | –0.3 to 2.9 |      |                              |
| $V_{OH}$ High-level output voltage                                            | $I_{OH} = -150\ \mu\text{A}$                                                                | 25°C          | 3.9      | 4.1         |      | 3.9       | 4.1         |      | V                            |
|                                                                               | $I_{OH} = -1.5\ \text{mA}$                                                                  |               | 3.8      | 4           |      | 3.8       | 4           |      |                              |
|                                                                               | $I_{OH} = -15\ \text{mA}$                                                                   |               | 3.4      | 3.7         |      | 3.4       | 3.7         |      |                              |
|                                                                               | $I_{OH} = 100\ \mu\text{A}$                                                                 | Full range    | 3.8      |             |      | 3.8       |             |      |                              |
|                                                                               | $I_{OH} = 1\ \text{mA}$                                                                     |               | 3.7      |             |      | 3.7       |             |      |                              |
|                                                                               | $I_{OH} = 10\ \text{mA}$                                                                    |               | 3.5      |             |      | 3.5       |             |      |                              |
| $V_{OL}$ Low-level output voltage                                             | $I_{OL} = 150\ \mu\text{A}$                                                                 | 25°C          | 75       | 125         |      | 75        | 125         |      | mV                           |
|                                                                               | $I_{OL} = 1.5\ \mu\text{A}$                                                                 |               | 150      | 225         |      | 150       | 225         |      |                              |
|                                                                               | $I_{OL} = 15\ \text{mA}$                                                                    |               | 1.2      | 1.6         |      | 1.2       | 1.6         |      | V                            |
|                                                                               | $I_{OL} = 100\ \mu\text{A}$                                                                 | Full range    |          | 175         |      |           | 175         |      | mV                           |
|                                                                               | $I_{OL} = 1\ \text{mA}$                                                                     |               |          | 225         |      |           | 225         |      |                              |
|                                                                               | $I_{OL} = 10\ \text{mA}$                                                                    |               |          | 1.4         |      |           | 1.4         |      | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_{IC} = \pm 2.5\ \text{V}, R_L = 2\ \text{k}\Omega, V_O = 1\ \text{V to } -1.5\ \text{V}$ | 25°C          | 50       | 95          |      | 50        | 95          |      | V/mV                         |
|                                                                               |                                                                                             | Full range    | 10       |             |      | 10        |             |      |                              |
| $r_i$ Input resistance                                                        |                                                                                             | 25°C          |          | 70          |      |           | 70          |      | M $\Omega$                   |
| $c_i$ Input capacitance                                                       |                                                                                             | 25°C          |          | 2.5         |      |           | 2.5         |      | pF                           |
| $z_o$ Open-loop output impedance                                              | $f = 1\ \text{MHz}$                                                                         | 25°C          |          | 30          |      |           | 30          |      | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$                                                     | 25°C          | 85       | 118         |      | 85        | 118         |      | dB                           |
|                                                                               |                                                                                             | Full range    | 80       |             |      | 80        |             |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\ \text{V to } \pm 15\ \text{V}, R_S = 50\ \Omega$                      | 25°C          | 90       | 106         |      | 90        | 106         |      | dB                           |
|                                                                               |                                                                                             | Full range    | 85       |             |      | 85        |             |      |                              |
| $I_{CC}$ Supply current                                                       | $V_O = 2.5\ \text{V}, V_{IC} = 2.5\ \text{V}$ No load,                                      | 25°C          | 13.2     | 17.6        |      | 13.2      | 17.6        |      | mA                           |
|                                                                               |                                                                                             | Full range    |          | 18.4        |      |           | 18.4        |      |                              |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ .

**TLE2144I operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                                                                   |          | TLE2144I |     |     | TLE2144AI |     |     | UNIT                   |
|-------------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------|----------|-----|-----|-----------|-----|-----|------------------------|
|             |                                             |                                                                                                                   |          | MIN      | TYP | MAX | MIN       | TYP | MAX |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$<br>$R_L = 2\text{ k}\Omega^\dagger$                                      |          | 45       |     |     | 45        |     |     | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                                                                                   |          | 42       |     |     | 42        |     |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                                                                                     | To 0.1%  | 0.16     |     |     | 0.16      |     |     | $\mu\text{s}$          |
|             |                                             |                                                                                                                   | To 0.01% | 0.22     |     |     | 0.22      |     |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$                                                                  |          | 15       |     |     | 15        |     |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                                                                  |          | 10.5     |     |     | 10.5      |     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                                                |          | 0.48     |     |     | 0.48      |     |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                                               |          | 0.51     |     |     | 0.51      |     |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                                                                |          | 1.92     |     |     | 1.92      |     |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 10\text{ kHz}$                                                                                               |          | 0.5      |     |     | 0.5       |     |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,<br>$R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$ |          | 0.0052%  |     |     | 0.0052%   |     |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$                                                       |          | 5.9      |     |     | 5.9       |     |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$ ,<br>$f = 100\text{ kHz}$                             |          | 5.8      |     |     | 5.8       |     |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$ ,<br>$R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$       |          | 660      |     |     | 660       |     |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$                                                       |          | 57°      |     |     | 57°       |     |     |                        |

<sup>†</sup>  $R_L$  terminates at 2.5 V

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

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**TLE2144I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2144I    |               |     | TLE2144AI   |               |     | UNIT             |
|-------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-----|-------------|---------------|-----|------------------|
|                                                                               |                                                          |               | MIN         | TYP           | MAX | MIN         | TYP           | MAX |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0,$<br>$V_O = 0$<br>$R_S = 50 \Omega$          | 25°C          | 0.6         | 2.4           |     | 0.5         | 1.5           |     | mV               |
|                                                                               |                                                          | Full range    |             |               | 3.2 |             |               | 2.8 |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                          | Full range    | 1.7         |               |     | 1.7         |               |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 |                                                          | 25°C          | 7           | 100           |     | 7           | 100           |     | nA               |
|                                                                               |                                                          | Full range    |             | 200           |     |             | 200           |     |                  |
| $I_{IB}$ Input bias current                                                   |                                                          | 25°C          | –0.7        | –1.5          |     | –0.7        | –1.5          |     | $\mu A$          |
|                                                                               |                                                          | Full range    |             | –1.7          |     |             | –1.7          |     |                  |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \Omega$                                        | 25°C          | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 |     | V                |
|                                                                               |                                                          | Full range    | –15 to 12.7 | –15.3 to 12.9 |     | –15 to 12.7 | –15.3 to 12.9 |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150 \mu A$                                       | 25°C          | 13.8        | 14.1          |     | 13.8        | 14.1          |     | V                |
|                                                                               | $I_O = -1.5$ mA                                          |               | 13.7        | 14            |     | 13.7        | 14            |     |                  |
|                                                                               | $I_O = -15$ mA                                           |               | 13.1        | 13.7          |     | 13.1        | 13.7          |     |                  |
|                                                                               | $I_O = -100 \mu A$                                       | Full range    | 13.7        |               |     | 13.7        |               |     |                  |
|                                                                               | $I_O = -1$ mA                                            |               | 13.6        |               |     | 13.6        |               |     |                  |
|                                                                               | $I_O = -10$ mA                                           |               | 13.1        |               |     | 13.1        |               |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150 \mu A$                                        | 25°C          | –14.7       | –14.9         |     | –14.7       | –14.9         |     | V                |
|                                                                               | $I_O = 1.5$ mA                                           |               | –14.5       | –14.8         |     | –14.5       | –14.8         |     |                  |
|                                                                               | $I_O = 15$ mA                                            |               | –13.4       | –13.8         |     | –13.4       | –13.8         |     |                  |
|                                                                               | $I_O = 100 \mu A$                                        | Full range    | –14.6       |               |     | –14.6       |               |     |                  |
|                                                                               | $I_O = 1$ mA                                             |               | –14.5       |               |     | –14.5       |               |     |                  |
|                                                                               | $I_O = 10$ mA                                            |               | –13.4       |               |     | –13.4       |               |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10$ V, $R_L = 2$ k $\Omega$                   | 25°C          | 100         | 170           |     | 100         | 170           |     | V/mV             |
|                                                                               |                                                          | Full range    | 40          |               |     | 40          |               |     |                  |
| $r_i$ Input resistance                                                        |                                                          | 25°C          | 65          |               |     | 65          |               |     | M $\Omega$       |
| $c_i$ Input capacitance                                                       |                                                          | 25°C          | 2.5         |               |     | 2.5         |               |     | pF               |
| $z_o$ Open-loop output impedance                                              | $f = 1$ MHz                                              | 25°C          | 30          |               |     | 30          |               |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin},$ $R_S = 50 \Omega$                 | 25°C          | 85          | 108           |     | 85          | 108           |     | dB               |
|                                                                               |                                                          | Full range    | 80          |               |     | 80          |               |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          | 90          | 106           |     | 90          | 106           |     | dB               |
|                                                                               |                                                          | Full range    | 85          |               |     | 85          |               |     |                  |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$ $\frac{V_{ID} = 1$ V<br>$V_{ID} = -1$ V        | 25°C          | –25         | –50           |     | –25         | –50           |     | mA               |
|                                                                               |                                                          |               | 20          | 31            |     | 20          | 31            |     |                  |
| $I_{CC}$ Supply current                                                       | $V_O = 0,$ No load                                       | 25°C          | 13.8        | 18            |     | 13.8        | 18            |     | mA               |
|                                                                               |                                                          | Full range    |             | 18.8          |     |             | 18.8          |     |                  |

<sup>†</sup> Full range is –40°C to 105°C.



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**TLE2144I operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                        |                                                     | TLE2144I |     |       | TLE2144AI |                        |            | UNIT |
|-------------|---------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------|----------|-----|-------|-----------|------------------------|------------|------|
|             |                                             |                                                                        |                                                     | MIN      | TYP | MAX   | MIN       | TYP                    | MAX        |      |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$R_L = 2\text{ k}\Omega$ ,<br>$C_L = 500\text{ pF}$ |                                                     | 27       | 45  |       | 27        | 45                     | V/ $\mu$ s |      |
| SR –        | Negative slew rate                          |                                                                        |                                                     | 27       | 42  |       | 27        | 42                     |            |      |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                                           | To 0.1%                                             | 0.34     |     | 0.34  |           | $\mu$ s                |            |      |
|             |                                             |                                                                        | To 0.01%                                            | 0.4      |     | 0.4   |           |                        |            |      |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,                                             | $f = 10\text{ Hz}$                                  | 15       |     | 15    |           | nV/ $\sqrt{\text{Hz}}$ |            |      |
|             |                                             | $R_S = 20\text{ }\Omega$ ,                                             | $f = 1\text{ kHz}$                                  | 10.5     |     | 10.5  |           |                        |            |      |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                     |                                                     | 0.48     |     | 0.48  |           | $\mu$ V                |            |      |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                    |                                                     | 0.51     |     | 0.51  |           |                        |            |      |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                     |                                                     | 1.89     |     | 1.89  |           | pA/ $\sqrt{\text{Hz}}$ |            |      |
|             |                                             | $f = 1\text{ kHz}$                                                     |                                                     | 0.47     |     | 0.47  |           |                        |            |      |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 10$ ,                         | $R_L = 2\text{ k}\Omega$ ,<br>$f = 10\text{ kHz}$   | 0.01%    |     | 0.01% |           |                        |            |      |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$ ,                                             | $C_L = 100\text{ pF}$                               | 6        |     | 6     |           | MHz                    |            |      |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 100\text{ kHz}$                     | $C_L = 100\text{ pF}$ ,                             | 5.9      |     | 5.9   |           | MHz                    |            |      |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 1$ ,                          | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ | 668      |     | 668   |           | kHz                    |            |      |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$ ,                                             | $C_L = 100\text{ pF}$                               | 58°      |     | 58°   |           |                        |            |      |

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**TLE2141M electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                                                  | $T_A^\dagger$ | TLE2141M |             |     | TLE2141AM |             |     | UNIT                         |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                               |                                                                                                  |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 2.5\text{ V}$<br>$V_{IC} = 2.5\text{ V}$<br>$R_S = 50\ \Omega$                            | 25°C          | 225      | 1400        |     | 200       | 1000        |     | $\mu\text{V}$                |
|                                                                               |                                                                                                  | Full range    |          | 2100        |     |           | 1700        |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                                                  | Full range    |          | 1.7         |     |           | 1.7         |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 |                                                                                                  | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                               |                                                                                                  | Full range    |          | 250         |     |           | 250         |     |                              |
| $I_{IB}$ Input bias current                                                   |                                                                                                  | 25°C          | –0.8     | –2          |     | –0.8      | –2          |     | $\mu\text{A}$                |
|                                                                               |                                                                                                  | Full range    |          | –2.3        |     |           | –2.3        |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                                               | 25°C          | 0 to 3   | –0.3 to 3.2 |     | 0 to 3    | –0.3 to 3.2 |     | V                            |
|                                                                               |                                                                                                  | Full range    | 0 to 2.7 | –0.3 to 2.9 |     | 0 to 2.7  | –0.3 to 2.9 |     |                              |
| $V_{OH}$ High-level output voltage                                            | $I_{OH} = -150\ \mu\text{A}$                                                                     | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                               | $I_{OH} = -1.5\text{ mA}$                                                                        |               | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                               | $I_{OH} = -15\text{ mA}$                                                                         |               | 3.2      | 3.7         |     | 3.2       | 3.7         |     |                              |
|                                                                               | $I_{OH} = -100\ \mu\text{A}$                                                                     | Full range    | 3.75     |             |     | 3.75      |             |     |                              |
|                                                                               | $I_{OH} = -1\text{ mA}$                                                                          |               | 3.65     |             |     | 3.65      |             |     |                              |
|                                                                               | $I_{OH} = -10\text{ mA}$                                                                         |               | 3.25     |             |     | 3.25      |             |     |                              |
| $V_{OL}$ Low-level output voltage                                             | $I_{OL} = 150\ \mu\text{A}$                                                                      | 25°C          | 75       | 125         |     | 75        | 125         |     | mV                           |
|                                                                               | $I_{OL} = 1.5\ \mu\text{A}$                                                                      |               | 150      | 225         |     | 150       | 225         |     |                              |
|                                                                               | $I_{OL} = 15\text{ mA}$                                                                          |               | 1.2      | 1.4         |     | 1.2       | 1.4         |     | V                            |
|                                                                               | $I_{OL} = 100\ \mu\text{A}$                                                                      | Full range    | 200      |             |     | 200       |             |     | mV                           |
|                                                                               | $I_{OL} = 1\text{ mA}$                                                                           |               | 250      |             |     | 225       |             |     |                              |
|                                                                               | $I_{OL} = 10\text{ mA}$                                                                          |               | 1.25     |             |     | 1.25      |             |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_{IC} = \pm 2.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$ | 25°C          | 50       | 220         |     | 50        | 220         |     | V/mV                         |
|                                                                               |                                                                                                  | Full range    | 5        |             |     | 5         |             |     |                              |
| $r_i$ Input resistance                                                        |                                                                                                  | 25°C          |          | 70          |     |           | 70          |     | M $\Omega$                   |
| $c_i$ Input capacitance                                                       |                                                                                                  | 25°C          |          | 2.5         |     |           | 2.5         |     | pF                           |
| $z_o$ Open-loop output impedance                                              | $f = 1\text{ MHz}$                                                                               | 25°C          |          | 30          |     |           | 30          |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                                                       | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                               |                                                                                                  | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                       | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                               |                                                                                                  | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                       | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$ No load,                                       | 25°C          | 3.4      | 4.4         |     | 3.4       | 4.4         |     | mA                           |
|                                                                               |                                                                                                  | Full range    |          | 4.6         |     |           | 4.6         |     |                              |

$^\dagger$  Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

**TLE2141M operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                            |                                                           | TLE2141M |     |      | TLE2141AM |     |                        | UNIT                   |
|-------------|---------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------|----------|-----|------|-----------|-----|------------------------|------------------------|
|             |                                             |                                                            |                                                           | MIN      | TYP | MAX  | MIN       | TYP | MAX                    |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$                   |                                                           | 45       |     |      | 45        |     |                        | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                            |                                                           | 42       |     |      | 42        |     |                        |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                              | To 0.1%                                                   | 0.16     |     |      | 0.16      |     |                        | $\mu\text{s}$          |
|             |                                             |                                                            | To 0.01%                                                  | 0.22     |     |      | 0.22      |     |                        |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$           | 15                                                        |          |     | 15   |           |     | nV/ $\sqrt{\text{Hz}}$ |                        |
|             |                                             | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$           | 10.5                                                      |          |     | 10.5 |           |     |                        |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                         |                                                           | 0.48     |     |      | 0.48      |     |                        | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                        |                                                           | 0.51     |     |      | 0.51      |     |                        |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                         |                                                           | 1.92     |     |      | 1.92      |     |                        | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                         |                                                           | 0.5      |     |      | 0.5       |     |                        |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,       | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$ | 0.0052%  |     |      | 0.0052%   |     |                        |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,                         | $C_L = 100\text{ pF}^\dagger$                             | 5.9      |     |      | 5.9       |     |                        | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$ | $C_L = 100\text{ pF}^\dagger$ ,                           | 5.8      |     |      | 5.8       |     |                        | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$                 | $R_L = 2\text{ k}\Omega^\dagger$ ,                        | 660      |     |      | 660       |     |                        | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ ,                         | $C_L = 100\text{ pF}^\dagger$                             | 57°      |     |      | 57°       |     |                        |                        |

$^\dagger R_L$  and  $C_L$  terminated to 2.5 V.

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**TLE2141M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2141M    |               |     | TLE2141AM   |               |     | UNIT             |
|-------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-----|-------------|---------------|-----|------------------|
|                                                                               |                                                          |               | MIN         | TYP           | MAX | MIN         | TYP           | MAX |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, R_S = 50 \Omega$                            | 25°C          | 200         | 900           |     | 175         | 500           |     | $\mu V$          |
|                                                                               |                                                          | Full range    |             | 1700          |     |             | 1200          |     |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                          | Full range    | 1.7         |               |     | 1.7         |               |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 |                                                          | 25°C          | 7           | 100           |     | 7           | 100           |     | nA               |
|                                                                               |                                                          | Full range    |             | 250           |     |             | 250           |     |                  |
| $I_{IB}$ Input bias current                                                   |                                                          | 25°C          | –0.7        | –1.5          |     | –0.7        | –1.5          |     | $\mu A$          |
|                                                                               |                                                          | Full range    |             | –1.8          |     |             | –1.8          |     |                  |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \Omega$                                        | 25°C          | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 |     | V                |
|                                                                               |                                                          | Full range    | –15 to 12.7 | –15.3 to 12.9 |     | –15 to 12.7 | –15.3 to 12.9 |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150 \mu A$                                       | 25°C          | 13.8        | 14.1          |     | 13.8        | 14.1          |     | V                |
|                                                                               | $I_O = -1.5$ mA                                          |               | 13.7        | 14            |     | 13.7        | 14            |     |                  |
|                                                                               | $I_O = -15$ mA                                           |               | 13.1        | 13.7          |     | 13.1        | 13.7          |     |                  |
|                                                                               | $I_O = -100 \mu A$                                       | Full range    | 13.7        |               |     | 13.7        |               |     |                  |
|                                                                               | $I_O = -1$ mA                                            |               | 13.6        |               |     | 13.6        |               |     |                  |
|                                                                               | $I_O = -10$ mA                                           |               | 13.1        |               |     | 13.1        |               |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150 \mu A$                                        | 25°C          | –14.7       | –14.9         |     | –14.7       | –14.9         |     | V                |
|                                                                               | $I_O = 1.5$ mA                                           |               | –14.5       | –14.8         |     | –14.5       | –14.8         |     |                  |
|                                                                               | $I_O = 15$ mA                                            |               | –13.4       | –13.8         |     | –13.4       | –13.8         |     |                  |
|                                                                               | $I_O = 100 \mu A$                                        | Full range    | –14.6       |               |     | –14.6       |               |     |                  |
|                                                                               | $I_O = 1$ mA                                             |               | –14.5       |               |     | –14.5       |               |     |                  |
|                                                                               | $I_O = 10$ mA                                            |               | –13.4       |               |     | –13.4       |               |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10$ V, $R_L = 2$ k $\Omega$                   | 25°C          | 100         | 450           |     | 100         | 450           |     | V/mV             |
|                                                                               |                                                          | Full range    | 20          |               |     | 20          |               |     |                  |
| $r_i$ Input resistance                                                        |                                                          | 25°C          | 65          |               |     | 65          |               |     | M $\Omega$       |
| $c_i$ Input capacitance                                                       |                                                          | 25°C          | 2.5         |               |     | 2.5         |               |     | pF               |
| $z_o$ Open-loop output impedance                                              | $f = 1$ MHz                                              | 25°C          | 30          |               |     | 30          |               |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, R_S = 50 \Omega$                   | 25°C          | 85          | 108           |     | 85          | 108           |     | dB               |
|                                                                               |                                                          | Full range    | 80          |               |     | 80          |               |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          | 90          | 106           |     | 90          | 106           |     | dB               |
|                                                                               |                                                          | Full range    | 85          |               |     | 85          |               |     |                  |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$                                                | 25°C          | –25         | –50           |     | –25         | –50           |     | mA               |
|                                                                               |                                                          |               | 20          | 31            |     | 20          | 31            |     |                  |
| $I_{CC}$ Supply current                                                       | $V_O = 0, V_{IC} = 2.5$ V No load,                       | 25°C          | 3.5         | 4.5           |     | 3.5         | 4.5           |     | mA               |
|                                                                               |                                                          | Full range    |             | 4.7           |     |             | 4.7           |     |                  |

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$ .

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**TLE2141M operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                      |                                                     | TLE2141M |     |     | TLE2141AM |     |     | UNIT                   |
|-------------|---------------------------------------------|----------------------------------------------------------------------|-----------------------------------------------------|----------|-----|-----|-----------|-----|-----|------------------------|
|             |                                             |                                                                      |                                                     | MIN      | TYP | MAX | MIN       | TYP | MAX |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 100\text{ pF}$<br>$R_L = 2\text{ k}\Omega$ |                                                     | 27       | 45  |     | 27        | 45  |     | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                                      |                                                     | 27       | 42  |     | 27        | 42  |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                                         | To 0.1%                                             | 0.34     |     |     | 0.34      |     |     | $\mu\text{s}$          |
|             |                                             |                                                                      | To 0.01%                                            | 0.4      |     |     | 0.4       |     |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ , $f = 10\text{ Hz}$                        |                                                     | 15       |     |     | 15        |     |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ , $f = 1\text{ kHz}$                        |                                                     | 10.5     |     |     | 10.5      |     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                   |                                                     | 0.48     |     |     | 0.48      |     |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                  |                                                     | 0.51     |     |     | 0.51      |     |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                   |                                                     | 1.89     |     |     | 1.89      |     |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                   |                                                     | 0.47     |     |     | 0.47      |     |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 10$ ,                       | $R_L = 2\text{ k}\Omega$ ,<br>$f = 10\text{ kHz}$   | 0.01%    |     |     | 0.01%     |     |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$ ,                                           | $C_L = 100\text{ pF}$                               | 6        |     |     | 6         |     |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 100\text{ kHz}$                   | $C_L = 100\text{ pF}$ ,                             | 5.9      |     |     | 5.9       |     |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 1$ ,                        | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ | 668      |     |     | 668       |     |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$ ,                                           | $C_L = 100\text{ pF}$                               | 58°      |     |     | 58°       |     |     |                        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2142M electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                       | TEST CONDITIONS                                                                                   | $T_A^\dagger$ | TLE2142M |             |     | TLE2142AM |             |     | UNIT                         |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                                 |                                                                                                   |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                   | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>$R_S = 50\ \Omega$                           | 25°C          | 220      | 1900        |     | 200       | 1500        |     | $\mu\text{V}$                |
|                                                                                 |                                                                                                   | Full range    |          | 2600        |     |           | 2200        |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                                                                   | Full range    | 1.7      |             |     | 1.7       |             |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                   |                                                                                                   | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                                 |                                                                                                   | Full range    |          | 200         |     |           | 200         |     |                              |
| $I_{IB}$ Input bias current                                                     |                                                                                                   | 25°C          | -0.8     | -2          |     | -0.8      | -2          |     | $\mu\text{A}$                |
|                                                                                 |                                                                                                   | Full range    |          | -2.3        |     |           | -2.3        |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50\ \Omega$                                                                                | 25°C          | 0 to 3   | -0.3 to 3.2 |     | 0 to 3    | -0.3 to 3.2 |     | V                            |
|                                                                                 |                                                                                                   | Full range    | 0 to 2.7 | -0.3 to 2.9 |     | 0 to 2.7  | -0.3 to 2.9 |     |                              |
| $V_{OH}$ High-level output voltage                                              | $I_{OH} = -150\ \mu\text{A}$                                                                      | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                                 | $I_{OH} = -1.5\text{ mA}$                                                                         |               | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                                 | $I_{OH} = -15\text{ mA}$                                                                          |               | 3.4      | 3.7         |     | 3.4       | 3.7         |     |                              |
|                                                                                 | $I_{OH} = 100\ \mu\text{A}$                                                                       | Full range    | 3.75     |             |     | 3.75      |             |     |                              |
|                                                                                 | $I_{OH} = 1\text{ mA}$                                                                            |               | 3.65     |             |     | 3.65      |             |     |                              |
|                                                                                 | $I_{OH} = 10\text{ mA}$                                                                           |               | 3.45     |             |     | 3.45      |             |     |                              |
| $V_{OL}$ Low-level output voltage                                               | $I_{OL} = 150\ \mu\text{A}$                                                                       | 25°C          | 75       | 125         |     | 75        | 125         |     | mV                           |
|                                                                                 | $I_{OL} = 1.5\text{ mA}$                                                                          |               | 150      | 225         |     | 150       | 225         |     |                              |
|                                                                                 | $I_{OL} = 15\text{ mA}$                                                                           |               | 1.2      | 1.4         |     | 1.2       | 1.4         |     | V                            |
|                                                                                 | $I_{OL} = 100\ \mu\text{A}$                                                                       | Full range    | 200      |             |     | 200       |             |     | mV                           |
|                                                                                 | $I_{OL} = 1\text{ mA}$                                                                            |               | 250      |             |     | 250       |             |     |                              |
|                                                                                 | $I_{OL} = 10\text{ mA}$                                                                           |               | 1.25     |             |     | 1.25      |             |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_{IC} = \pm 2.5\text{ V}$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$<br>$R_L = 2\text{ k}\Omega$ | 25°C          | 50       | 220         |     | 50        | 220         |     | V/mV                         |
|                                                                                 |                                                                                                   | Full range    | 5        |             |     | 5         |             |     |                              |
| $r_i$ Input resistance                                                          |                                                                                                   | 25°C          | 70       |             |     | 70        |             |     | M $\Omega$                   |
| $c_i$ Input capacitance                                                         |                                                                                                   | 25°C          | 2.5      |             |     | 2.5       |             |     | pF                           |
| $z_o$ Open-loop output impedance                                                | $f = 1\text{ MHz}$                                                                                | 25°C          | 30       |             |     | 30        |             |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICRmin}$ ,<br>$R_S = 50\ \Omega$                                                     | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                                 |                                                                                                   | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                        | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                                 |                                                                                                   | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                         | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>No load,                                     | 25°C          | 6.6      | 8.8         |     | 6.6       | 8.8         |     | mA                           |
|                                                                                 |                                                                                                   | Full range    |          | 9.2         |     |           | 9.2         |     |                              |

$^\dagger$  Full range is -55°C to 125°C.

**TLE2142M operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                                                                             |                                                             | TLE2142M |     |     | TLE2142AM |     |     | UNIT                   |
|-------------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|----------|-----|-----|-----------|-----|-----|------------------------|
|             |                                             |                                                                                                             |                                                             | MIN      | TYP | MAX | MIN       | TYP | MAX |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 500\text{ pF}$                              |                                                             | 45       |     |     | 45        |     |     | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                                                                             |                                                             | 42       |     |     | 42        |     |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                                                                               | To 0.1%                                                     | 0.16     |     |     | 0.16      |     |     | $\mu\text{s}$          |
|             |                                             |                                                                                                             | To 0.01%                                                    | 0.22     |     |     | 0.22      |     |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ , $f = 10\text{ Hz}$                                                               |                                                             | 15       |     |     | 15        |     |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ , $f = 1\text{ kHz}$                                                               |                                                             | 10.5     |     |     | 10.5      |     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                                          |                                                             | 0.48     |     |     | 0.48      |     |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                                         |                                                             | 0.51     |     |     | 0.51      |     |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                                                                          |                                                             | 1.92     |     |     | 1.92      |     |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                                                                          |                                                             | 0.5      |     |     | 0.5       |     |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ , $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$A_{VD} = 2$ , $f = 10\text{ kHz}$ |                                                             | 0.0052%  |     |     | 0.0052%   |     |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$                                                                            | $C_L = 100\text{ pF}$                                       | 5.9      |     |     | 5.9       |     |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$                                                  | $C_L = 100\text{ pF}$                                       | 5.8      |     |     | 5.8       |     |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$ ,                                                                | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 100\text{ pF}$ | 660      |     |     | 660       |     |     | kHz                    |
| $\phi_m$    | Phase margin                                | $R_L = 2\text{ k}\Omega^\dagger$                                                                            | $C_L = 100\text{ pF}$                                       | 57°      |     |     | 57°       |     |     |                        |

$^\dagger R_L$  terminates at 2.5 V.

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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**TLE2142M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                       | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2142M    |               |     | TLE2142AM   |               |     | UNIT             |
|---------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-----|-------------|---------------|-----|------------------|
|                                                                                 |                                                          |               | MIN         | TYP           | MAX | MIN         | TYP           | MAX |                  |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0, R_S = 50 \Omega$                            | 25°C          | 290         | 1200          |     | 275         | 750           |     | $\mu V$          |
|                                                                                 |                                                          | Full range    |             | 2000          |     |             | 1600          |     |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                          | Full range    | 1.7         |               |     | 1.7         |               |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                   |                                                          | 25°C          | 7           | 100           |     | 7           | 100           |     | nA               |
|                                                                                 |                                                          | Full range    |             | 250           |     |             | 250           |     |                  |
| $I_{IB}$ Input bias current                                                     |                                                          | 25°C          | –0.7        | –1.5          |     | –0.7        | –1.5          |     | $\mu A$          |
|                                                                                 |                                                          | Full range    |             | –1.8          |     |             | –1.8          |     |                  |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50 \Omega$                                        | 25°C          | –15 to 13   | –15.3 to 13.2 |     | –15 to 13   | –15.3 to 13.2 |     | V                |
|                                                                                 |                                                          | Full range    | –15 to 12.7 | –15.3 to 12.9 |     | –15 to 12.7 | –15.3 to 12.9 |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $I_O = -150 \mu A$                                       | 25°C          | 13.8        | 14.1          |     | 13.8        | 14.1          |     | V                |
|                                                                                 | $I_O = -1.5$ mA                                          |               | 13.7        | 14            |     | 13.7        | 14            |     |                  |
|                                                                                 | $I_O = -15$ mA                                           |               | 13.3        | 13.7          |     | 13.3        | 13.7          |     |                  |
|                                                                                 | $I_O = -100 \mu A$                                       | Full range    | 13.7        |               |     | 13.7        |               |     |                  |
|                                                                                 | $I_O = -1$ mA                                            |               | 13.6        |               |     | 13.6        |               |     |                  |
|                                                                                 | $I_O = -10$ mA                                           |               | 13.3        |               |     | 13.3        |               |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $I_O = 150 \mu A$                                        | 25°C          | –14.7       | –14.9         |     | –14.7       | –14.9         |     | V                |
|                                                                                 | $I_O = 1.5$ mA                                           |               | –14.5       | –14.8         |     | –14.5       | –14.8         |     |                  |
|                                                                                 | $I_O = 15$ mA                                            |               | –13.4       | –13.8         |     | –13.4       | –13.8         |     |                  |
|                                                                                 | $I_O = 100 \mu A$                                        | Full range    | –14.6       |               |     | –14.6       |               |     |                  |
|                                                                                 | $I_O = 1$ mA                                             |               | –14.5       |               |     | –14.5       |               |     |                  |
|                                                                                 | $I_O = 10$ mA                                            |               | –13.4       |               |     | –13.4       |               |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 10$ V, $R_L = 2$ k $\Omega$                   | 25°C          | 100         | 450           |     | 100         | 450           |     | V/mV             |
|                                                                                 |                                                          | Full range    | 20          |               |     | 20          |               |     |                  |
| $r_i$ Input resistance                                                          |                                                          | 25°C          | 65          |               |     | 65          |               |     | M $\Omega$       |
| $c_i$ Input capacitance                                                         |                                                          | 25°C          | 2.5         |               |     | 2.5         |               |     | pF               |
| $z_o$ Open-loop output impedance                                                | $f = 1$ MHz                                              | 25°C          | 30          |               |     | 30          |               |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICRmin}, R_S = 50 \Omega$                   | 25°C          | 85          | 108           |     | 85          | 108           |     | dB               |
|                                                                                 |                                                          | Full range    | 80          |               |     | 80          |               |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          | 90          | 106           |     | 90          | 106           |     | dB               |
|                                                                                 |                                                          | Full range    | 85          |               |     | 85          |               |     |                  |
| $I_{OS}$ Short-circuit output current                                           | $V_O = 0$                                                | 25°C          | –25         | –50           |     | –25         | –50           |     | mA               |
|                                                                                 |                                                          |               | 20          | 31            |     | 20          | 31            |     |                  |
| $I_{CC}$ Supply current                                                         | $V_O = 0, V_{IC} = 2.5$ V No load,                       | 25°C          | 6.9         | 9             |     | 6.9         | 9             |     | mA               |
|                                                                                 |                                                          | Full range    |             | 9.4           |     |             | 9.4           |     |                  |

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$ .

**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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**TLE2142M operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                 |                                                   | TLE2142M |     |     | TLE2142AM |     |      | UNIT   |
|--------------------|---------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------|----------|-----|-----|-----------|-----|------|--------|
|                    |                                             |                                                                                                 |                                                   | MIN      | TYP | MAX | MIN       | TYP | MAX  |        |
| SR +               | Positive slew rate                          | R <sub>L</sub> = 2 kΩ,      A <sub>VD</sub> = − 1,<br>C <sub>L</sub> = 100 pF                   |                                                   | 27       | 45  |     | 27        | 45  | V/μs |        |
| SR −               | Negative slew rate                          |                                                                                                 |                                                   | 27       | 42  |     | 27        | 42  |      |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = − 1,<br>10-V step                                                             | To 0.1%                                           | 0.34     |     |     | 0.34      |     |      | μs     |
|                    |                                             |                                                                                                 | To 0.01%                                          | 0.4      |     |     | 0.4       |     |      |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω,      f = 10 Hz                                                           |                                                   | 15       |     |     | 15        |     |      | nV/√Hz |
|                    |                                             | R <sub>S</sub> = 20 Ω,      f = 1 kHz                                                           |                                                   | 10.5     |     |     | 10.5      |     |      |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                              |                                                   | 0.48     |     |     | 0.48      |     |      | μV     |
|                    |                                             | f = 0.1 Hz to 10 Hz                                                                             |                                                   | 0.51     |     |     | 0.51      |     |      |        |
| I <sub>n</sub>     | Equivalent input noise current              | f = 10 Hz                                                                                       |                                                   | 1.89     |     |     | 1.89      |     |      | pA/√Hz |
|                    |                                             | f = 1 kHz                                                                                       |                                                   | 0.47     |     |     | 0.47      |     |      |        |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V,      R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 10,      f = 10 kHz |                                                   | 0.01%    |     |     | 0.01%     |     |      |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | R <sub>L</sub> = 2 kΩ,                                                                          | C <sub>L</sub> = 100 pF                           | 6        |     |     | 6         |     |      | MHz    |
|                    | Gain-bandwidth product                      | R <sub>L</sub> = 2 kΩ,<br>f = 100 kHz                                                           | C <sub>L</sub> = 100 pF,                          | 5.9      |     |     | 5.9       |     |      | MHz    |
| B <sub>OM</sub>    | Maximum output-swing band-width             | V <sub>O(PP)</sub> = 20 V,<br>A <sub>VD</sub> = 1,                                              | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF | 668      |     |     | 668       |     |      | kHz    |
| φ <sub>m</sub>     | Phase margin at unity gain                  | R <sub>L</sub> = 2 kΩ,                                                                          | C <sub>L</sub> = 100 pF                           | 58°      |     |     | 58°       |     |      |        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

SLOS183D – FEBRUARY 1997 – REVISED OCTOBER 2012

**TLE2144M electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                                                   | $T_A^\dagger$ | TLE2144M |             |     | TLE2144AM |             |     | UNIT                         |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                               |                                                                                                   |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>$R_S = 50\ \Omega$                           | 25°C          | 0.5      | 3.8         |     | 0.5       | 3           |     | mV                           |
|                                                                               |                                                                                                   | Full range    |          | 5.2         |     |           | 4.4         |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                                                   | Full range    |          | 1.7         |     |           | 1.7         |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 |                                                                                                   | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                               |                                                                                                   | Full range    |          | 250         |     |           | 250         |     |                              |
| $I_{IB}$ Input bias current                                                   |                                                                                                   | 25°C          | –0.8     | –2          |     | –0.8      | –2          |     | $\mu\text{A}$                |
|                                                                               |                                                                                                   | Full range    |          | –2.3        |     |           | –2.3        |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                                                | 25°C          | 0 to 3   | –0.3 to 3.2 |     | 0 to 3    | –0.3 to 3.2 |     | V                            |
|                                                                               |                                                                                                   | Full range    | 0 to 2.7 | –0.3 to 2.9 |     | 0 to 2.7  | –0.3 to 2.9 |     |                              |
| $V_{OH}$ High-level output voltage                                            | $I_{OH} = -150\ \mu\text{A}$                                                                      | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                               | $I_{OH} = -1.5\text{ mA}$                                                                         |               | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                               | $I_{OH} = -15\text{ mA}$                                                                          |               | 3.4      | 3.7         |     | 3.4       | 3.7         |     |                              |
|                                                                               | $I_{OH} = 100\ \mu\text{A}$                                                                       | Full range    | 3.75     |             |     | 3.75      |             |     |                              |
|                                                                               | $I_{OH} = 1\text{ mA}$                                                                            |               | 3.65     |             |     | 3.65      |             |     |                              |
|                                                                               | $I_{OH} = 10\text{ mA}$                                                                           |               | 3.45     |             |     | 3.45      |             |     |                              |
| $V_{OL}$ Low-level output voltage                                             | $I_{OL} = 150\ \mu\text{A}$                                                                       | 25°C          | 75       | 125         |     | 75        | 125         |     | mV                           |
|                                                                               | $I_{OL} = 1.5\ \mu\text{A}$                                                                       |               | 150      | 225         |     | 150       | 225         |     |                              |
|                                                                               | $I_{OL} = 15\text{ mA}$                                                                           |               | 1.2      | 1.6         |     | 1.2       | 1.6         |     | V                            |
|                                                                               | $I_{OL} = 100\ \mu\text{A}$                                                                       | Full range    | 200      |             |     | 200       |             |     | mV                           |
|                                                                               | $I_{OL} = 1\text{ mA}$                                                                            |               | 250      |             |     | 250       |             |     |                              |
|                                                                               | $I_{OL} = 10\text{ mA}$                                                                           |               | 1.45     |             |     | 1.45      |             |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_{IC} = \pm 2.5\text{ V}$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$<br>$R_L = 2\text{ k}\Omega$ | 25°C          | 50       | 95          |     | 50        | 95          |     | V/mV                         |
|                                                                               |                                                                                                   | Full range    | 5        |             |     | 5         |             |     |                              |
| $r_i$ Input resistance                                                        |                                                                                                   | 25°C          |          | 70          |     |           | 70          |     | $\text{M}\Omega$             |
| $c_i$ Input capacitance                                                       |                                                                                                   | 25°C          |          | 2.5         |     |           | 2.5         |     | pF                           |
| $z_o$ Open-loop output impedance                                              | $f = 1\text{ MHz}$                                                                                | 25°C          |          | 30          |     |           | 30          |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ ,<br>$R_S = 50\ \Omega$                                                     | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                               |                                                                                                   | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                        | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                               |                                                                                                   | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                       | $V_O = 2.5\text{ V}$ ,<br>$V_{IC} = 2.5\text{ V}$<br>No load,                                     | 25°C          | 13.2     | 17.6        |     | 13.2      | 17.6        |     | mA                           |
|                                                                               |                                                                                                   | Full range    |          | 18.4        |     |           | 18.4        |     |                              |

$^\dagger$  Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .



**TLE214x, TLE214xA**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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**TLE2144M operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                            |                                                           | TLE2144M |     |      | TLE2144AM |     |                        | UNIT                   |
|-------------|---------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------|----------|-----|------|-----------|-----|------------------------|------------------------|
|             |                                             |                                                            |                                                           | MIN      | TYP | MAX  | MIN       | TYP | MAX                    |                        |
| SR +        | Positive slew rate                          | $A_{VD} = -1$ ,<br>$C_L = 500\text{ pF}$                   |                                                           | 45       |     |      | 45        |     |                        | V/ $\mu\text{s}$       |
| SR –        | Negative slew rate                          |                                                            |                                                           | 42       |     |      | 42        |     |                        |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>2.5-V step                              | To 0.1%                                                   | 0.16     |     |      | 0.16      |     |                        | $\mu\text{s}$          |
|             |                                             |                                                            | To 0.01%                                                  | 0.22     |     |      | 0.22      |     |                        |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$           | 15                                                        |          |     | 15   |           |     | nV/ $\sqrt{\text{Hz}}$ |                        |
|             |                                             | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$           | 10.5                                                      |          |     | 10.5 |           |     |                        |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                         |                                                           | 0.48     |     |      | 0.48      |     |                        | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                        |                                                           | 0.51     |     |      | 0.51      |     |                        |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                         |                                                           | 1.92     |     |      | 1.92      |     |                        | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 1\text{ kHz}$                                         |                                                           | 0.5      |     |      | 0.5       |     |                        |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ ,<br>$A_{VD} = 2$ ,       | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 10\text{ kHz}$ | 0.0052%  |     |      | 0.0052%   |     |                        |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ ,                         | $C_L = 100\text{ pF}$                                     | 5.9      |     |      | 5.9       |     |                        | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$f = 100\text{ kHz}$ | $C_L = 100\text{ pF}$ ,                                   | 5.8      |     |      | 5.8       |     |                        | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$                 | $R_L = 2\text{ k}\Omega^\dagger$ ,                        | 660      |     |      | 660       |     |                        | kHz                    |
| $\phi_m$    | Phase margin                                | $R_L = 2\text{ k}\Omega^\dagger$ ,                         | $C_L = 100\text{ pF}$                                     | 57°      |     |      | 57°       |     |                        |                        |

$^\dagger R_L$  terminates at 2.5 V

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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**TLE2144M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                       | $T_A^\dagger$ | TLE2144M    |               |      | TLE2144AM   |               |      | UNIT             |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------|---------------|-------------|---------------|------|-------------|---------------|------|------------------|
|                                                                               |                                                                       |               | MIN         | TYP           | MAX  | MIN         | TYP           | MAX  |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, \quad R_S = 50 \, \Omega$                                | 25°C          | 0.6         | 2.4           |      | 0.5         | 1.5           |      | mV               |
|                                                                               |                                                                       | Full range    |             |               | 4    |             |               | 3.2  |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                       | Full range    |             | 1.7           |      |             | 1.7           |      | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 |                                                                       | 25°C          | 7           | 100           |      | 7           | 100           |      | nA               |
|                                                                               |                                                                       | Full range    |             | 250           |      |             | 250           |      |                  |
| $I_{IB}$ Input bias current                                                   |                                                                       | 25°C          | –0.7        | –1.5          |      | –0.7        | –1.5          |      | $\mu A$          |
|                                                                               |                                                                       | Full range    |             | –1.8          |      |             | –1.8          |      |                  |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \, \Omega$                                                  | 25°C          | –15 to 13   | –15.3 to 13.2 |      | –15 to 13   | –15.3 to 13.2 |      | V                |
|                                                                               |                                                                       | Full range    | –15 to 12.7 | –15.3 to 12.9 |      | –15 to 12.7 | –15.3 to 12.9 |      |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150 \, \mu A$                                                 | 25°C          | 13.8        | 14.1          |      | 13.8        | 14.1          |      | V                |
|                                                                               | $I_O = -1.5 \, mA$                                                    |               | 13.7        | 14            |      | 13.7        | 14            |      |                  |
|                                                                               | $I_O = -15 \, mA$                                                     |               | 13.1        | 13.7          |      | 13.1        | 13.7          |      |                  |
|                                                                               | $I_O = -100 \, \mu A$                                                 | Full range    | 13.7        |               |      | 13.7        |               |      |                  |
|                                                                               | $I_O = -1 \, mA$                                                      |               | 13.6        |               |      | 13.6        |               |      |                  |
|                                                                               | $I_O = -10 \, mA$                                                     |               | 13.1        |               |      | 13.1        |               |      |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150 \, \mu A$                                                  | 25°C          | –14.7       | –14.9         |      | –14.7       | –14.9         |      | V                |
|                                                                               | $I_O = 1.5 \, mA$                                                     |               | –14.5       | –14.8         |      | –14.5       | –14.8         |      |                  |
|                                                                               | $I_O = 15 \, mA$                                                      |               | –13.4       | –13.8         |      | –13.4       | –13.8         |      |                  |
|                                                                               | $I_O = 100 \, \mu A$                                                  | Full range    | –14.6       |               |      | –14.6       |               |      |                  |
|                                                                               | $I_O = 1 \, mA$                                                       |               | –14.5       |               |      | –14.5       |               |      |                  |
|                                                                               | $I_O = 10 \, mA$                                                      |               | –13.4       |               |      | –13.4       |               |      |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10 \, V, \quad R_L = 2 \, k\Omega$                         | 25°C          | 100         | 170           |      | 100         | 170           |      | V/mV             |
|                                                                               |                                                                       | Full range    | 20          |               |      | 20          |               |      |                  |
| $r_i$ Input resistance                                                        |                                                                       | 25°C          |             | 65            |      |             | 65            |      | $M\Omega$        |
| $c_i$ Input capacitance                                                       |                                                                       | 25°C          |             | 2.5           |      |             | 2.5           |      | pF               |
| $z_o$ Open-loop output impedance                                              | $f = 1 \, MHz$                                                        | 25°C          |             | 30            |      |             | 30            |      | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, \quad R_S = 50 \, \Omega$                       | 25°C          | 85          | 108           |      | 85          | 108           |      | dB               |
|                                                                               |                                                                       | Full range    | 80          |               |      | 80          |               |      |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5 \, V$ to $\pm 15 \, V, \quad R_S = 50 \, \Omega$ | 25°C          | 90          | 106           |      | 90          | 106           |      | dB               |
|                                                                               |                                                                       | Full range    | 85          |               |      | 85          |               |      |                  |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$                                                             | 25°C          | –25         | –50           |      | –25         | –50           |      | mA               |
|                                                                               |                                                                       |               | 20          | 31            |      | 20          | 31            |      |                  |
| $I_{CC}$ Supply current                                                       | $V_O = 0, \quad V_{IC} = 2.5 \, V$                                    | 25°C          |             | 13.8          | 18   |             | 13.8          | 18   | mA               |
|                                                                               |                                                                       | Full range    |             |               | 18.8 |             |               | 18.8 |                  |

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$



**TLE2144M operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                             | TEST CONDITIONS                                     |                                                     | TLE2144M |            |     | TLE2144AM |            |     | UNIT                   |
|-------------|---------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|----------|------------|-----|-----------|------------|-----|------------------------|
|             |                                             |                                                     |                                                     | MIN      | TYP        | MAX | MIN       | TYP        | MAX |                        |
| SR+         | Positive slew rate                          | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ | $A_{VD} = -1$ ,                                     | 27       | 45         |     | 27        | 45         |     | V/ $\mu\text{s}$       |
| SR–         | Negative slew rate                          |                                                     |                                                     | 27       | 42         |     | 27        | 42         |     |                        |
| $t_s$       | Settling time                               | $A_{VD} = -1$ ,<br>10-V step                        | To 0.1%                                             |          | 0.34       |     |           | 0.34       |     | $\mu\text{s}$          |
|             |                                             |                                                     | To 0.01%                                            |          | .4         |     |           | .4         |     |                        |
| $V_n$       | Equivalent input noise voltage              | $R_S = 20\text{ }\Omega$ ,                          | $f = 10\text{ Hz}$                                  |          | 15         |     |           | 15         |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $R_S = 20\text{ }\Omega$ ,                          | $f = 1\text{ kHz}$                                  |          | 10.5       |     |           | 10.5       |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                  |                                                     |          | 0.48       |     |           | 0.48       |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                 |                                                     |          | 0.51       |     |           | 0.51       |     |                        |
| $I_n$       | Equivalent input noise current              | $f = 10\text{ Hz}$                                  |                                                     |          | 1.89       |     |           | 1.89       |     | pA/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 10\text{ kHz}$                                 |                                                     |          | 0.47       |     |           | 0.47       |     |                        |
| THD + N     | Total harmonic distortion plus noise        | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 10$ ,      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 10\text{ kHz}$   |          | 0.01%      |     |           | 0.01%      |     |                        |
| $B_1$       | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega$ ,                          | $C_L = 100\text{ pF}$                               |          | 6          |     |           | 6          |     | MHz                    |
|             | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega$ ,<br>$f = 100\text{ kHz}$  | $C_L = 100\text{ pF}$ ,                             |          | 5.9        |     |           | 5.9        |     | MHz                    |
| $B_{OM}$    | Maximum output-swing bandwidth              | $V_{O(PP)} = 20\text{ V}$ ,<br>$A_{VD} = 1$ ,       | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ |          | 668        |     |           | 668        |     | kHz                    |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega$ ,                          | $C_L = 100\text{ pF}$                               |          | $58^\circ$ |     |           | $58^\circ$ |     |                        |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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**TLE2141Y electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                               | TLE2141Y                |                     |      | UNIT          |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------|---------------------|------|---------------|
|                                                                               |                                                                               | MIN                     | TYP                 | MAX  |               |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0$ , $R_S = 50\ \Omega$ ,<br>$V_O = 0$                              |                         | 200                 | 1000 | $\mu\text{V}$ |
| $I_{IO}$ Input offset current                                                 |                                                                               |                         | 7                   | 100  | nA            |
| $I_{IB}$ Input bias current                                                   |                                                                               |                         | -0.7                | -1.5 | $\mu\text{A}$ |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                            | -15<br>to<br>13         | -15.3<br>to<br>13.2 |      | V             |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150\ \mu\text{A}$                                                     | 13.8                    | 14.1                |      | V             |
|                                                                               | $I_O = -1.5\ \text{mA}$                                                       | 13.7                    | 14                  |      |               |
|                                                                               | $I_O = -15\ \text{mA}$                                                        | 13.3                    | 13.7                |      |               |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150\ \mu\text{A}$                                                      | -14.7                   | -14.9               |      | V             |
|                                                                               | $I_O = 1.5\ \text{mA}$                                                        | -14.5                   | -14.8               |      |               |
|                                                                               | $I_O = 15\ \text{mA}$                                                         | -13.4                   | -13.8               |      |               |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10\ \text{V}$ , $R_L = 2\ \text{k}\Omega$                          | 100                     | 450                 |      | V/mV          |
| $r_i$ Input resistance                                                        |                                                                               |                         | 65                  |      | M $\Omega$    |
| $c_i$ Input capacitance                                                       |                                                                               |                         | 2.5                 |      | pF            |
| $z_o$ Open-loop output impedance                                              | $f = 1\ \text{MHz}$                                                           |                         | 30                  |      | $\Omega$      |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                                    | 80                      | 108                 |      | dB            |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\ \text{V}$ to $\pm 15\ \text{V}$ ,<br>$R_S = 50\ \Omega$ | 85                      | 106                 |      | dB            |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$                                                                     | $V_{ID} = 1\ \text{V}$  | -25                 | -50  | mA            |
|                                                                               |                                                                               | $V_{ID} = -1\ \text{V}$ | 20                  | 31   |               |
| $I_{CC}$ Supply current                                                       | $V_O = 0$ , No load                                                           |                         | 3.5                 | 4.5  | mA            |

**TLE214x, TLE214xA**  
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**TLE2142Y electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER |                                                                       | TEST CONDITIONS                                                            | TLE2142Y               |                     |         | UNIT          |
|-----------|-----------------------------------------------------------------------|----------------------------------------------------------------------------|------------------------|---------------------|---------|---------------|
|           |                                                                       |                                                                            | MIN                    | TYP                 | MAX     |               |
| $V_{IO}$  | Input offset voltage                                                  | $V_{IC} = 0$ ,<br>$V_O = 0$<br>$R_S = 50\ \Omega$                          |                        | 150                 | 875     | $\mu\text{V}$ |
| $I_{IO}$  | Input offset current                                                  |                                                                            |                        | 7                   | 100     | nA            |
| $I_{IB}$  | Input bias current                                                    |                                                                            |                        | -0.7                | -1.5    | $\mu\text{A}$ |
| $V_{ICR}$ | Common-mode input voltage range                                       | $R_S = 50\ \Omega$                                                         | -15<br>to<br>13        | -15.3<br>to<br>13.2 |         | V             |
| $V_{OM+}$ | Maximum positive peak output voltage swing                            | $I_O = -150\ \mu\text{A}$                                                  | 13.8                   | 14.1                |         | V             |
|           |                                                                       | $I_O = -1.5\text{ mA}$                                                     | 13.7                   | 14                  |         |               |
|           |                                                                       | $I_O = -15\text{ mA}$                                                      | 13.3                   | 13.7                |         |               |
| $V_{OM-}$ | Maximum negative peak output voltage swing                            | $I_O = 150\ \mu\text{A}$                                                   | -14.7                  | -14.9               |         | V             |
|           |                                                                       | $I_O = 1.5\text{ mA}$                                                      | -14.5                  | -14.8               |         |               |
|           |                                                                       | $I_O = 15\text{ mA}$                                                       | -13.4                  | -13.8               |         |               |
| $A_{VD}$  | Large-signal differential voltage amplification                       | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$                         | 100                    | 450                 |         | V/mV          |
| $r_i$     | Input resistance                                                      |                                                                            |                        | 65                  |         | M $\Omega$    |
| $c_i$     | Input capacitance                                                     |                                                                            |                        | 2.5                 |         | pF            |
| $z_o$     | Open-loop output impedance                                            | $f = 1\text{ MHz}$                                                         |                        | 30                  |         | $\Omega$      |
| CMRR      | Common-mode rejection ratio                                           | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                                 | 80                     | 108                 |         | dB            |
| $k_{SVR}$ | Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$ | 85                     | 106                 |         | dB            |
| $I_{OS}$  | Short-circuit output current                                          | $V_O = 0$                                                                  | $V_{ID} = 1\text{ V}$  |                     | -25 -50 | mA            |
|           |                                                                       |                                                                            | $V_{ID} = -1\text{ V}$ |                     | 20 31   |               |
| $I_{CC}$  | Supply current                                                        | $V_O = 0$ , No load                                                        |                        | 6.9                 | 9       | mA            |

# TLE214x, TLE214xA

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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### TLE2144Y electrical characteristics at $V_{CC\pm} = \pm 15\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER                                                                     | TEST CONDITIONS                                                         | TLE2144Y               |                     |      | UNIT             |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------|---------------------|------|------------------|
|                                                                               |                                                                         | MIN                    | TYP                 | MAX  |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0$ , $V_O = 0$ , $R_S = 50\ \Omega$ ,                         |                        | 0.3                 | 1.8  | mV               |
| $I_{IO}$ Input offset current                                                 |                                                                         |                        | 7                   | 100  | nA               |
| $I_{IB}$ Input bias current                                                   |                                                                         |                        | -0.7                | -1.5 | $\mu\text{A}$    |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50\ \Omega$                                                      | -15<br>to<br>13        | -15.3<br>to<br>13.2 |      | V                |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -150\ \mu\text{A}$                                               | 13.8                   | 14.1                |      | V                |
|                                                                               | $I_O = -1.5\text{ mA}$                                                  | 13.7                   | 14                  |      |                  |
|                                                                               | $I_O = -15\text{ mA}$                                                   | 13.3                   | 13.7                |      |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 150\ \mu\text{A}$                                                | -14.7                  | -14.9               |      | V                |
|                                                                               | $I_O = 1.5\text{ mA}$                                                   | -14.5                  | -14.8               |      |                  |
|                                                                               | $I_O = 15\text{ mA}$                                                    | -13.4                  | -13.8               |      |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$                      | 100                    | 450                 |      | V/mV             |
| $r_i$ Input resistance                                                        |                                                                         |                        | 65                  |      | $\text{M}\Omega$ |
| $c_i$ Input capacitance                                                       |                                                                         |                        | 2.5                 |      | pF               |
| $z_o$ Open-loop output impedance                                              | $f = 1\text{ MHz}$                                                      |                        | 30                  |      | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$                              | 80                     | 108                 |      | dB               |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ , $R_S = 50\ \Omega$ | 85                     | 106                 |      | dB               |
| $I_{OS}$ Short-circuit output current                                         | $V_O = 0$                                                               | $V_{ID} = 1\text{ V}$  | -25                 | -50  | mA               |
|                                                                               |                                                                         | $V_{ID} = -1\text{ V}$ | 20                  | 31   |                  |
| $I_{CC}$ Supply current                                                       | $V_O = 0$ , No load                                                     |                        | 13.8                | 18   | mA               |

## TYPICAL CHARACTERISTICS

**Table of Graphs**

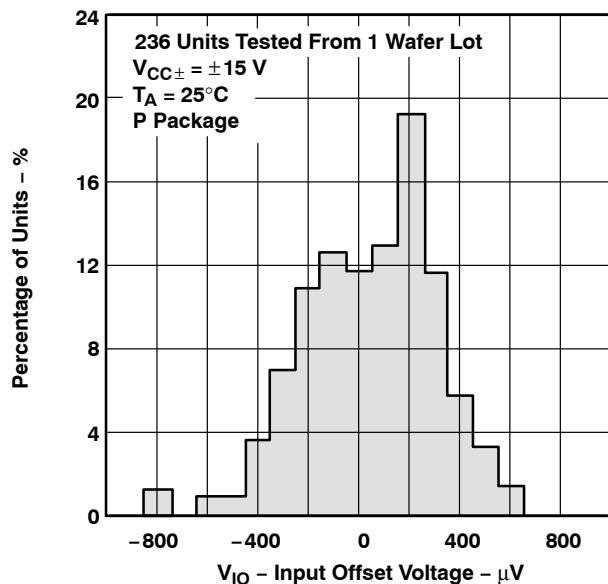
|                |                                                 |                                                                                       | FIGURE             |
|----------------|-------------------------------------------------|---------------------------------------------------------------------------------------|--------------------|
| $V_{IO}$       | Input offset voltage                            | Distribution                                                                          | 1, 2, 3            |
| $I_{IO}$       | Input offset current                            | vs Free-air temperature                                                               | 4                  |
| $I_{IB}$       | Input bias current                              | vs Common-mode input voltage<br>vs Free-air temperature                               | 5<br>6             |
| $V_{OM+}$      | Maximum positive peak output voltage            | vs Supply voltage<br>vs Free-air temperature<br>vs Output current<br>vs Settling time | 7<br>8<br>9<br>11  |
| $V_{OM-}$      | Maximum negative peak output voltage            | vs Supply voltage<br>vs Free-air temperature<br>vs Output current<br>vs Settling time | 7<br>8<br>10<br>11 |
| $V_{O(PP)}$    | Maximum peak-to-peak output voltage             | vs Frequency                                                                          | 12                 |
| $V_{OH}$       | High-level output voltage                       | vs Output current                                                                     | 13                 |
| $V_{OL}$       | Low-level output voltage                        | vs Output current                                                                     | 14                 |
| $A_{VD}$       | Large-signal differential voltage amplification | vs Frequency<br>vs Free-air temperature                                               | 15<br>16           |
| $z_o$          | Closed-loop output impedance                    | vs Frequency                                                                          | 17                 |
| $I_{OS}$       | Short-circuit output current                    | vs Free-air temperature                                                               | 18                 |
| CMRR           | Common-mode rejection ratio                     | vs Frequency<br>vs Free-air temperature                                               | 19<br>20           |
| $k_{SVR}$      | Supply-voltage rejection ratio                  | vs Frequency<br>vs Free-air temperature                                               | 21<br>22           |
| $I_{CC}$       | Supply current                                  | vs Supply voltage<br>vs Free-air temperature                                          | 23<br>24           |
| $V_n$          | Equivalent input noise voltage                  | vs Frequency                                                                          | 25                 |
| $V_n$          | Input noise voltage                             | Over a 10-second period                                                               | 26                 |
| $I_n$          | Noise current                                   | vs Frequency                                                                          | 27                 |
| THD + N        | Total harmonic distortion plus noise            | vs Frequency                                                                          | 28                 |
| SR             | Slew rate                                       | vs Free-air temperature<br>vs Load capacitance                                        | 29<br>30           |
| Pulse response | Noninverting large signal                       | vs Time                                                                               | 31                 |
|                | Inverting large signal                          | vs Time                                                                               | 32                 |
|                | Small signal                                    | vs Time                                                                               | 33                 |
| $B_1$          | Unity-gain bandwidth                            | vs Load capacitance                                                                   | 34                 |
|                | Gain margin                                     | vs Load capacitance                                                                   | 35                 |
| $\phi_m$       | Phase margin                                    | vs Load capacitance                                                                   | 36                 |
|                | Phase shift                                     | vs Frequency                                                                          | 15                 |

# TLE214x, TLE214xA EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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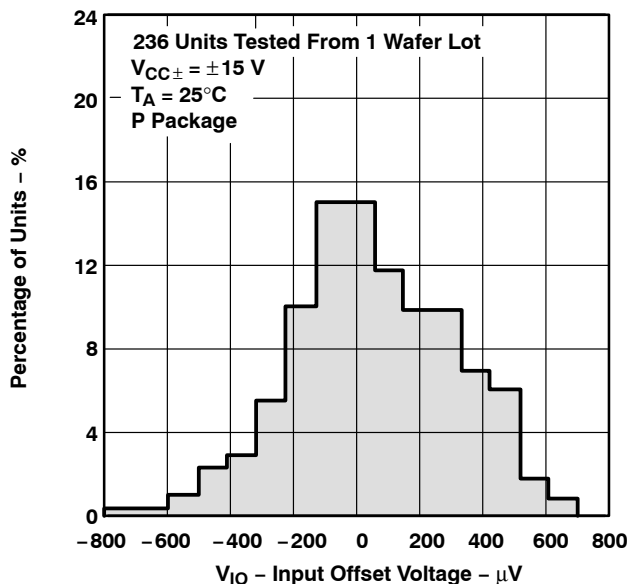
## TYPICAL CHARACTERISTICS

**TLE2141  
DISTRIBUTION OF  
INPUT OFFSET VOLTAGE**



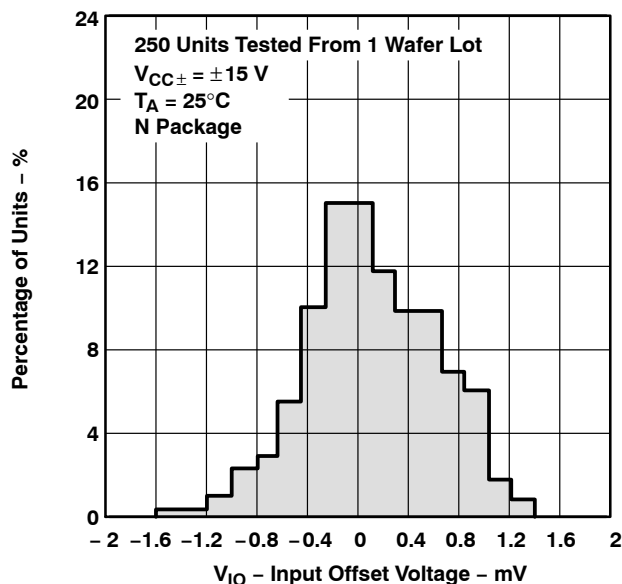
**Figure 1**

**TLE2142  
DISTRIBUTION OF  
INPUT OFFSET VOLTAGE**



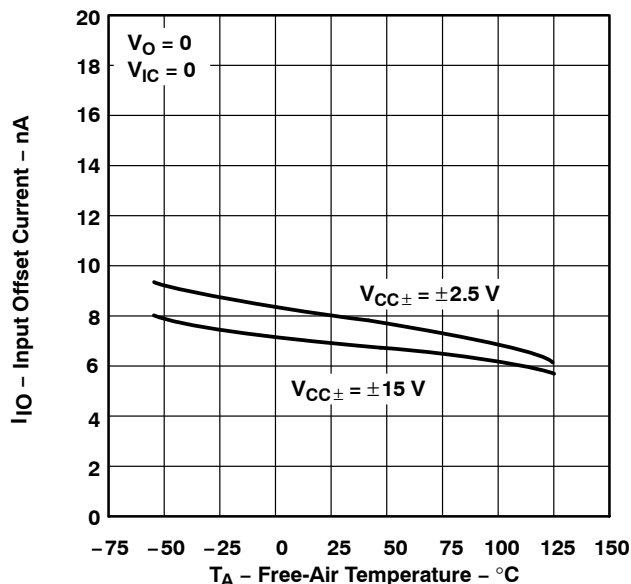
**Figure 2**

**TLE2144  
DISTRIBUTION OF  
INPUT OFFSET VOLTAGE**



**Figure 3**

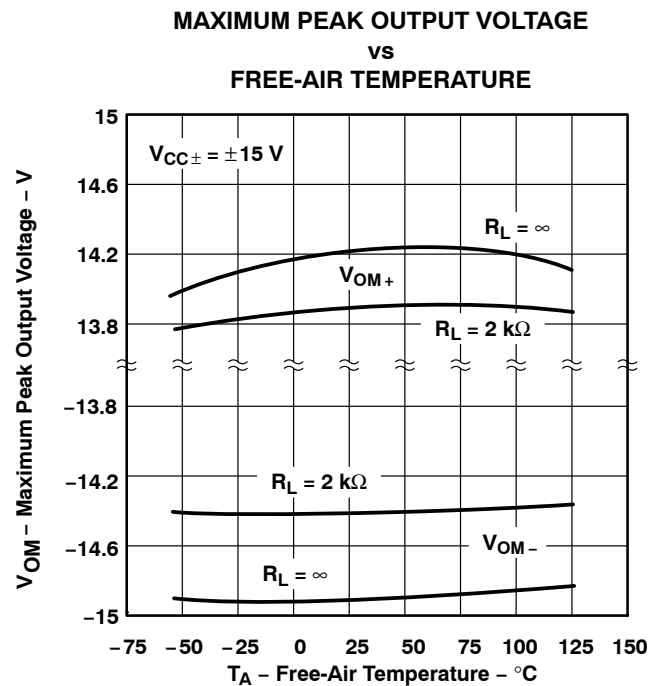
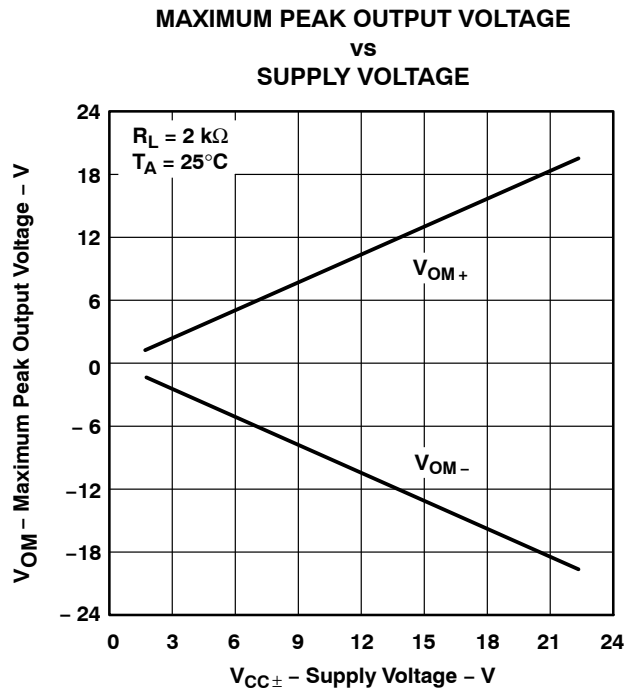
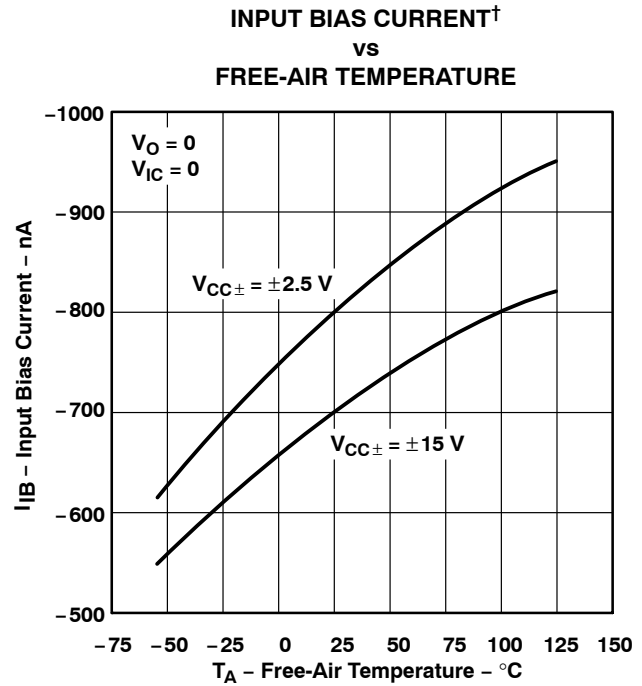
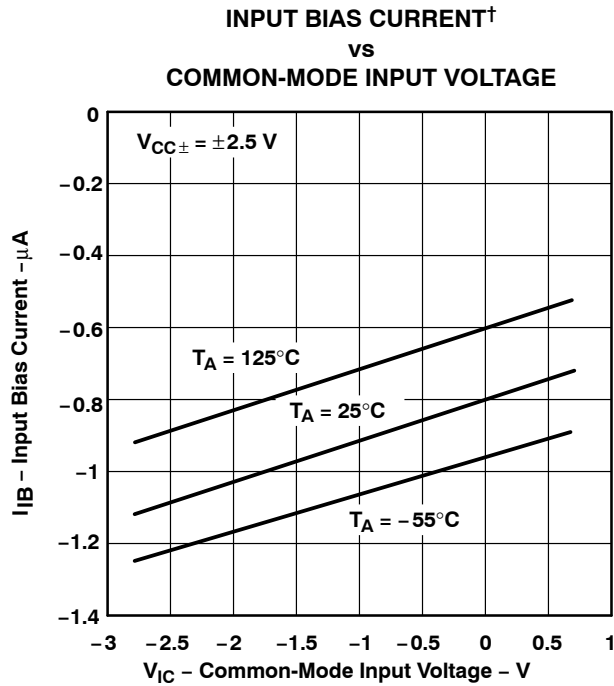
**INPUT OFFSET CURRENT<sup>†</sup>  
vs  
FREE-AIR TEMPERATURE**



**Figure 4**

<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS



<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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## TYPICAL CHARACTERISTICS

MAXIMUM POSITIVE PEAK  
OUTPUT VOLTAGE<sup>†</sup>  
vs  
OUTPUT CURRENT

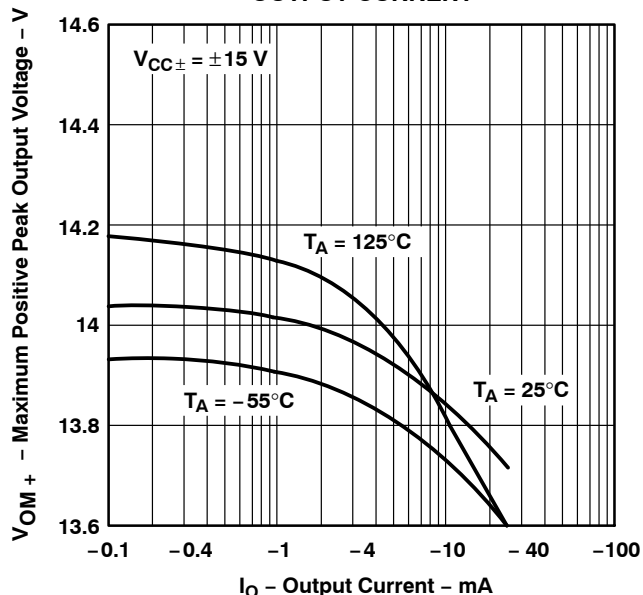


Figure 9

MAXIMUM NEGATIVE PEAK  
OUTPUT VOLTAGE<sup>†</sup>  
vs  
OUTPUT CURRENT

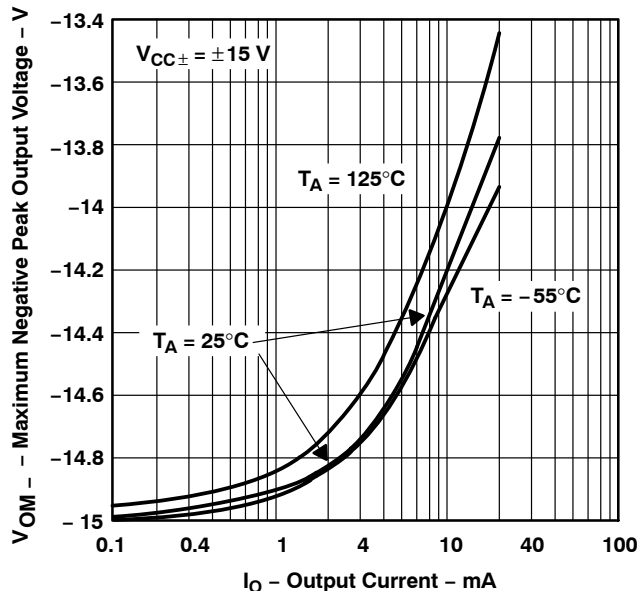


Figure 10

MAXIMUM PEAK OUTPUT VOLTAGE  
vs  
SETTLING TIME

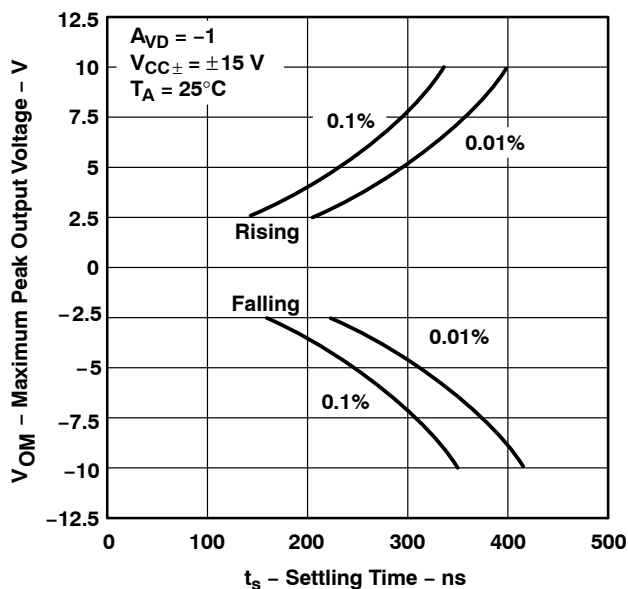


Figure 11

MAXIMUM PEAK-TO-PEAK  
OUTPUT VOLTAGE<sup>†</sup>  
vs  
FREQUENCY

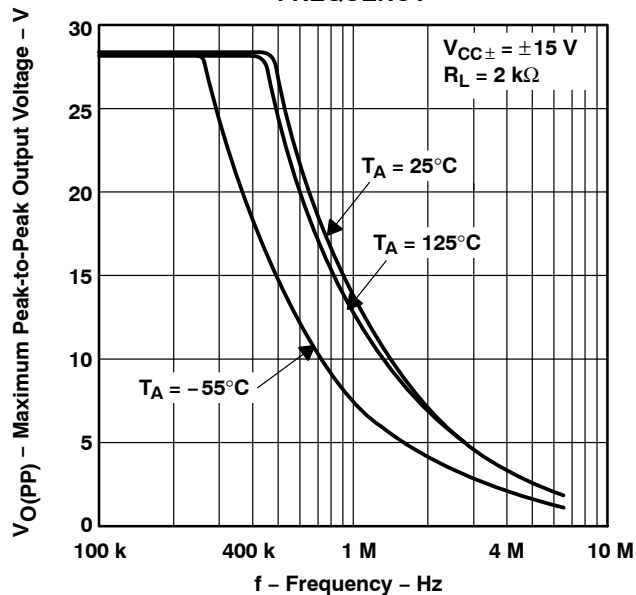
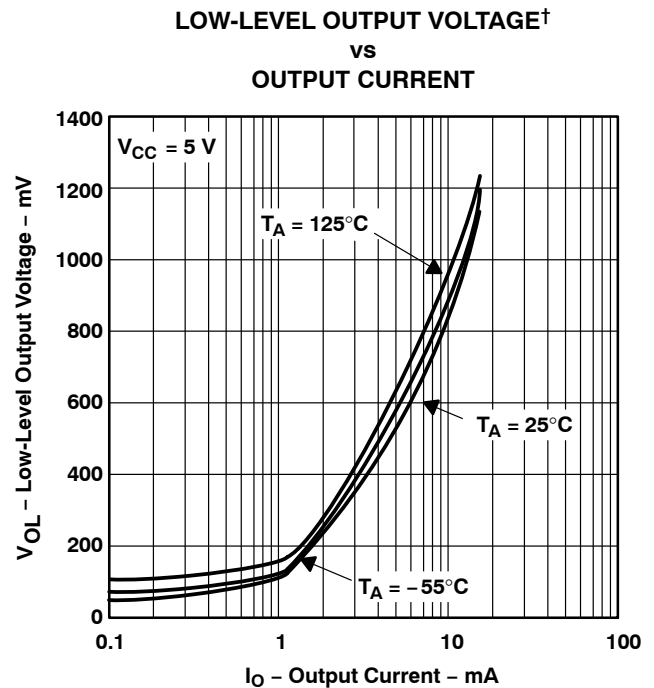
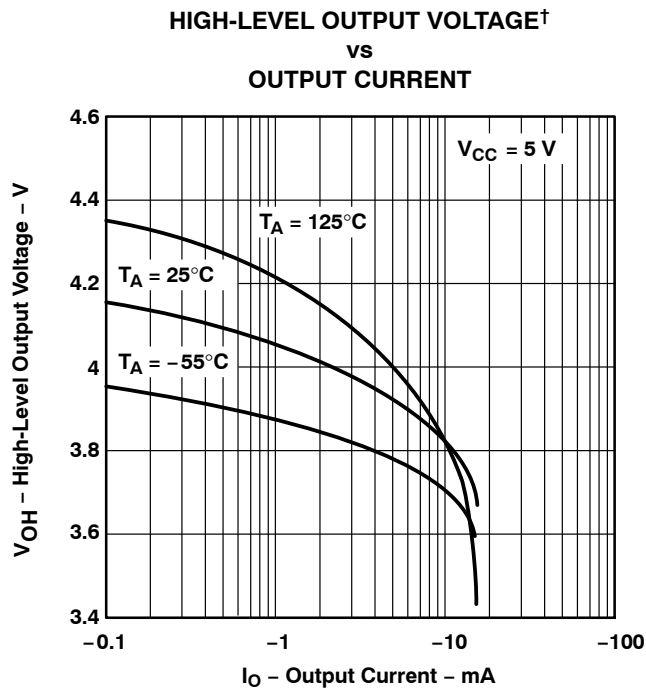


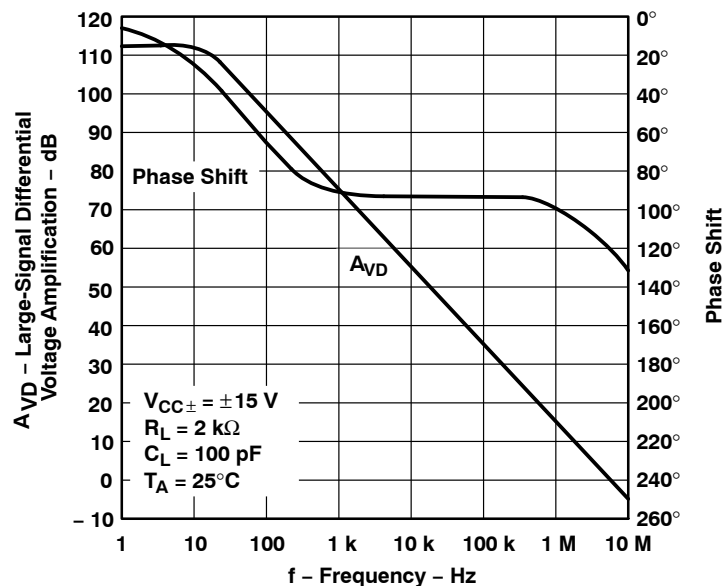
Figure 12

<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS



## LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY



<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# TLE214x, TLE214xA EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

### LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION†

vs

FREE-AIR TEMPERATURE

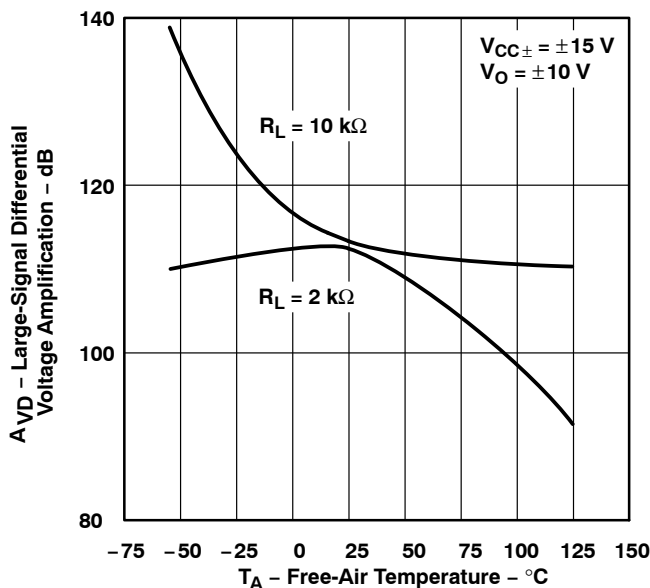


Figure 16

### CLOSED-LOOP OUTPUT IMPEDANCE

vs

FREQUENCY

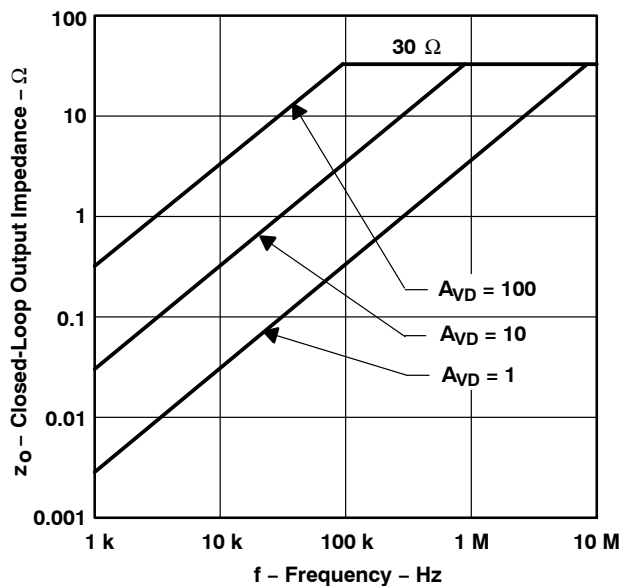


Figure 17

### SHORT-CIRCUIT OUTPUT CURRENT†

vs

FREE-AIR TEMPERATURE

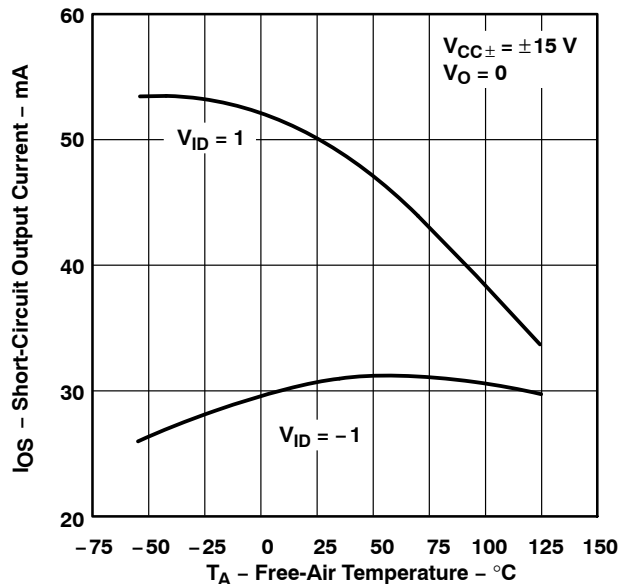


Figure 18

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS

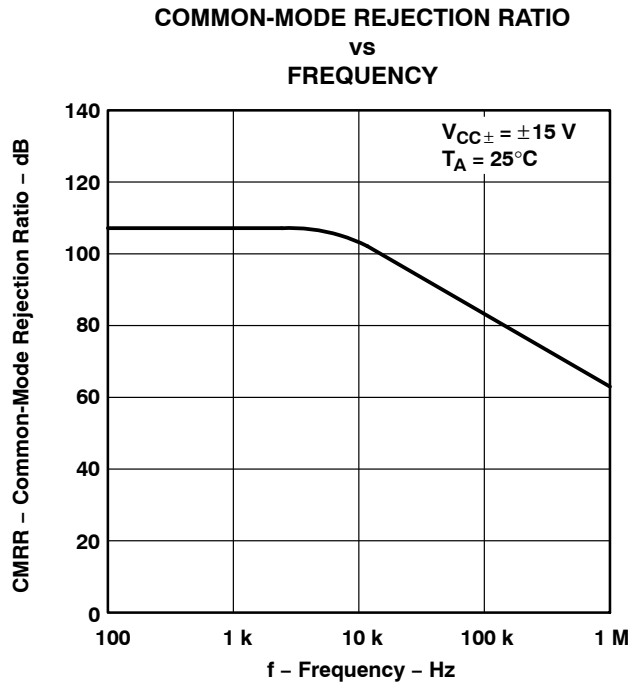


Figure 19

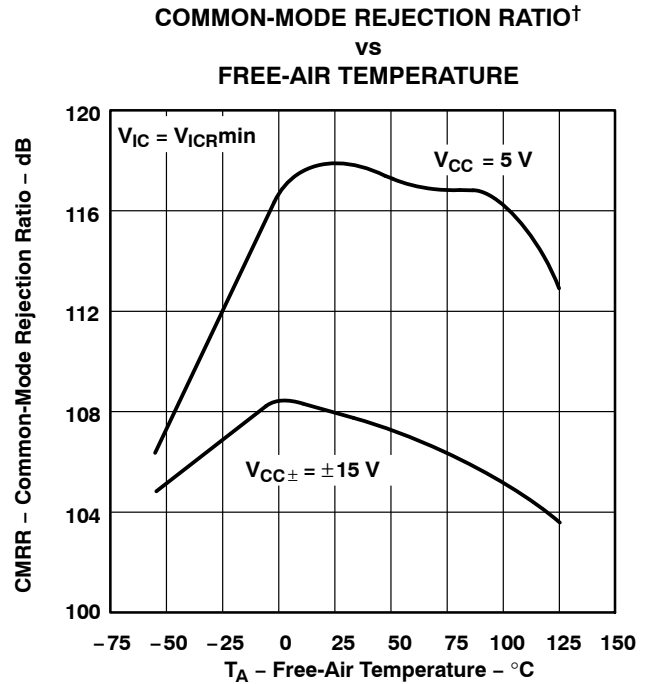


Figure 20

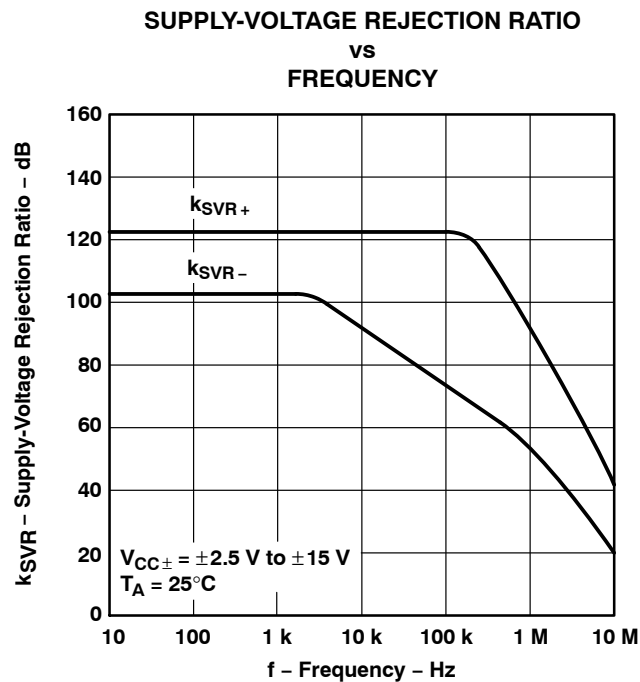


Figure 21

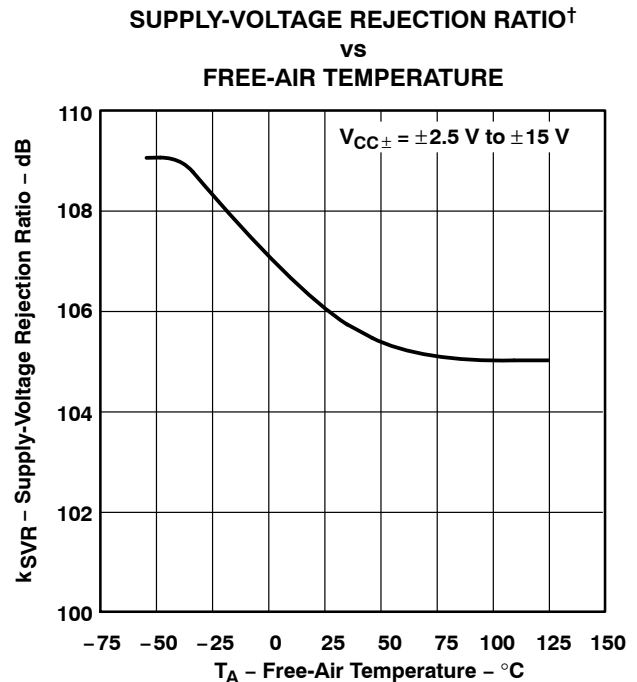


Figure 22

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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## TYPICAL CHARACTERISTICS

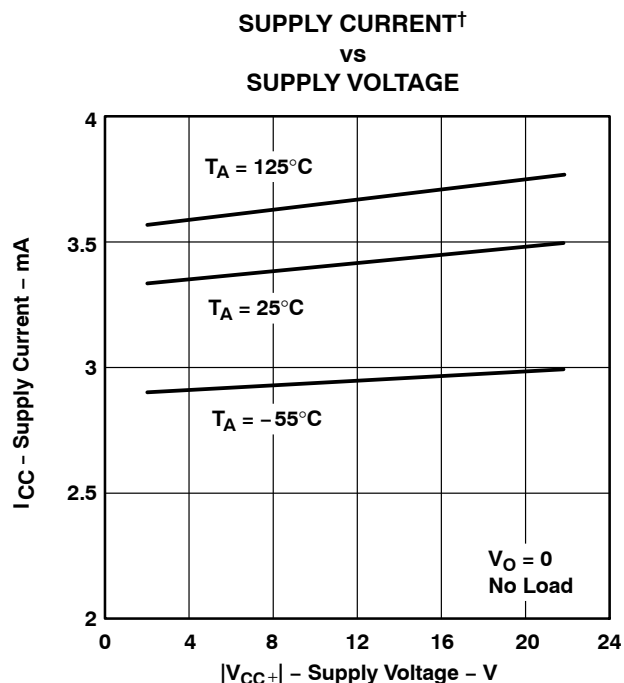


Figure 23

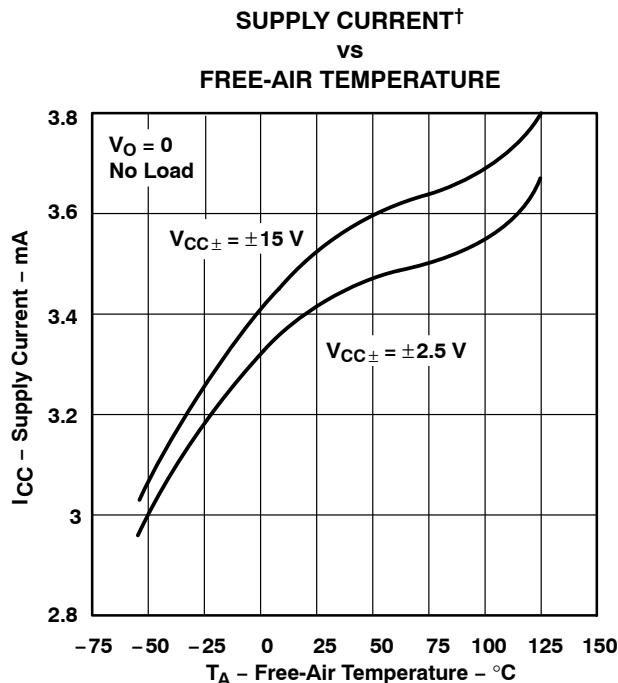


Figure 24

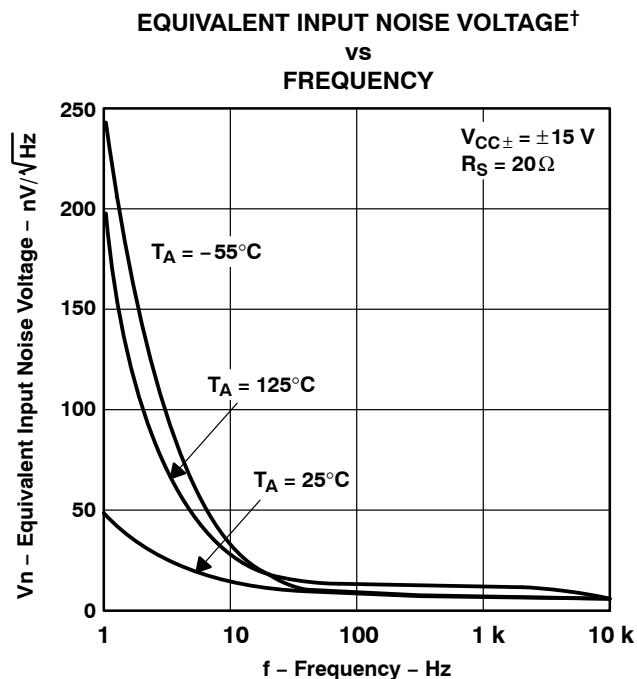


Figure 25

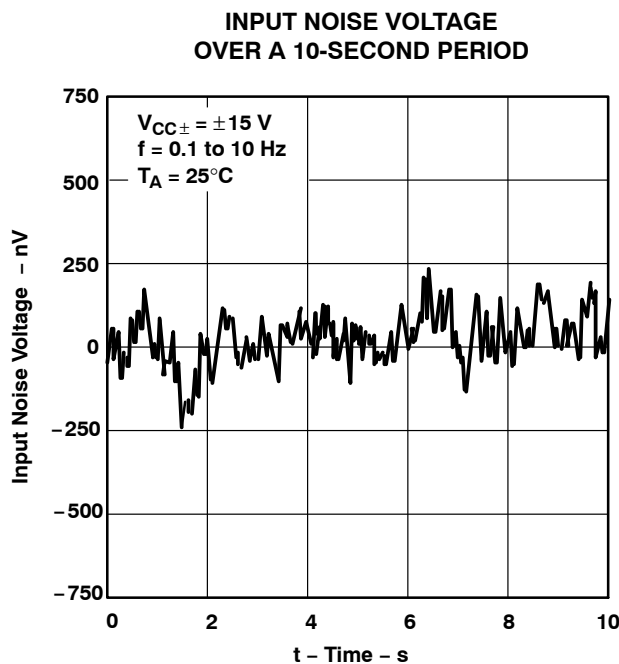
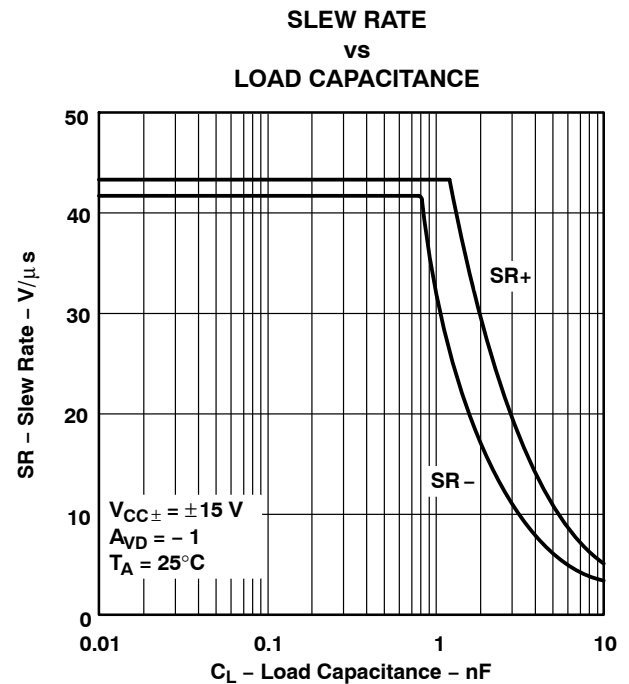
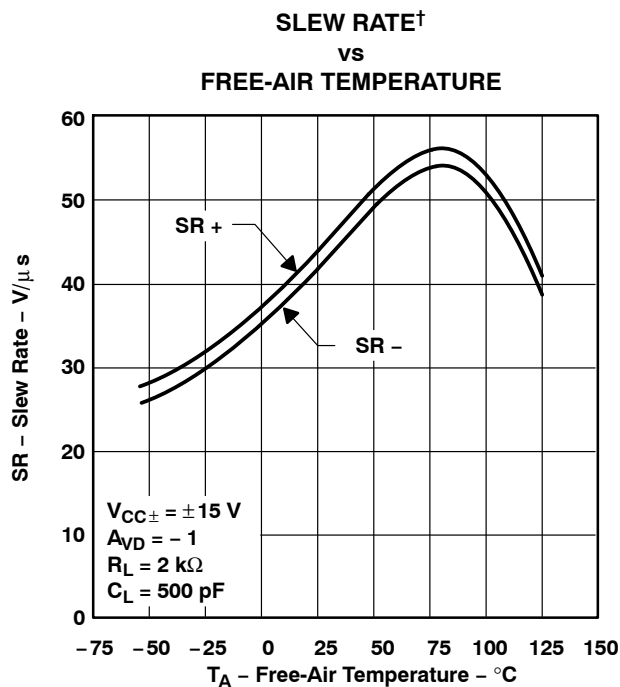
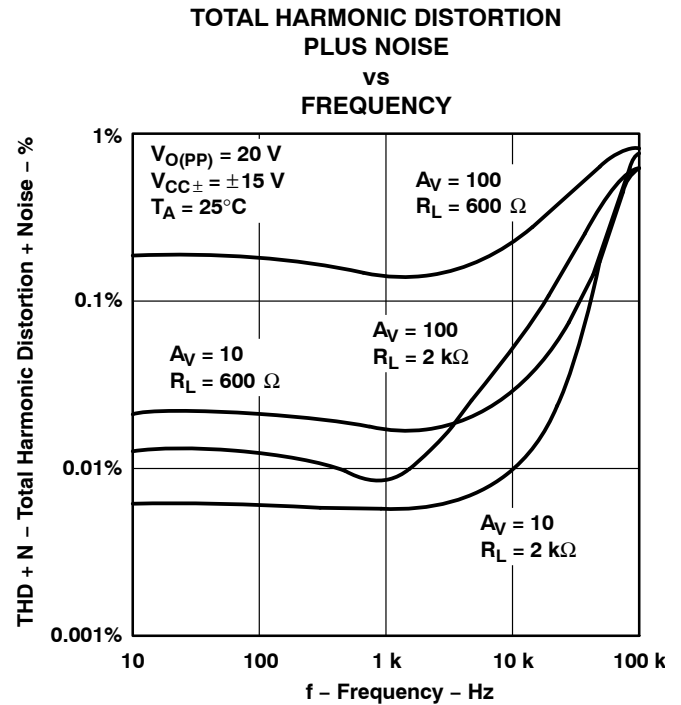
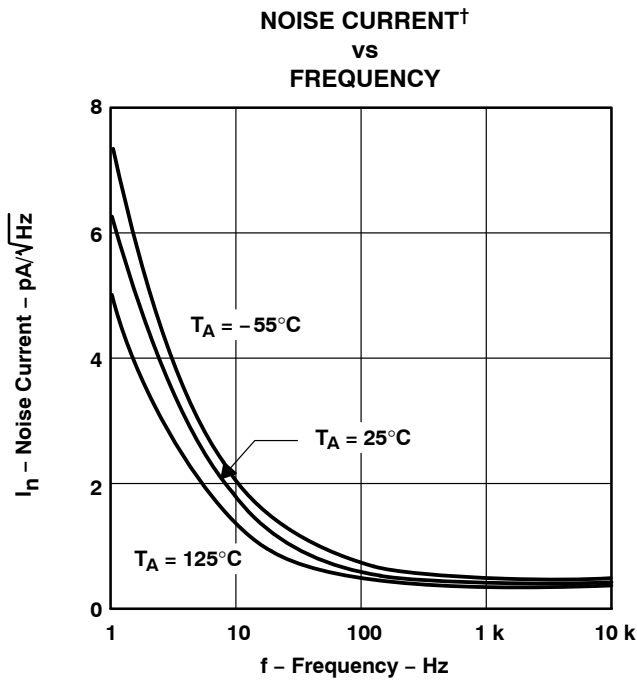


Figure 26

<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS

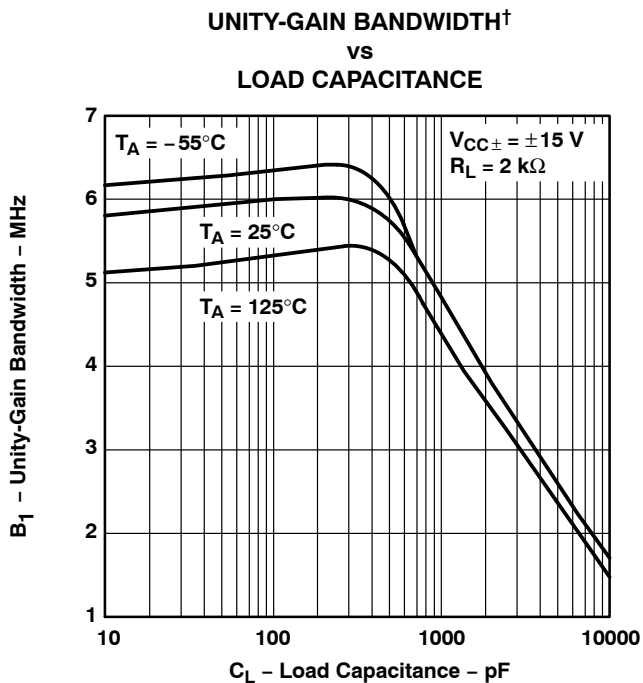
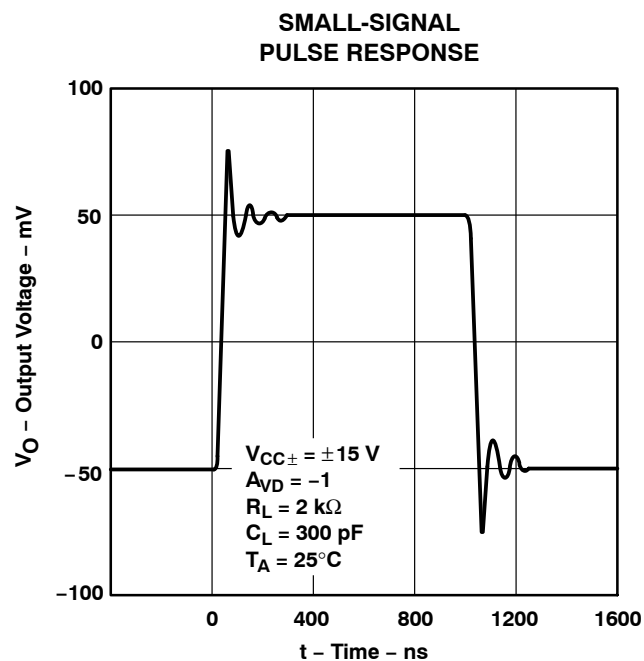
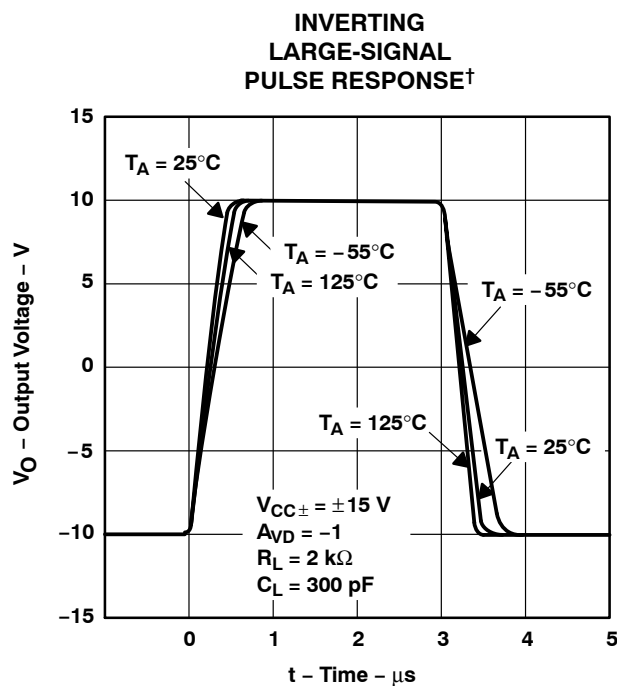
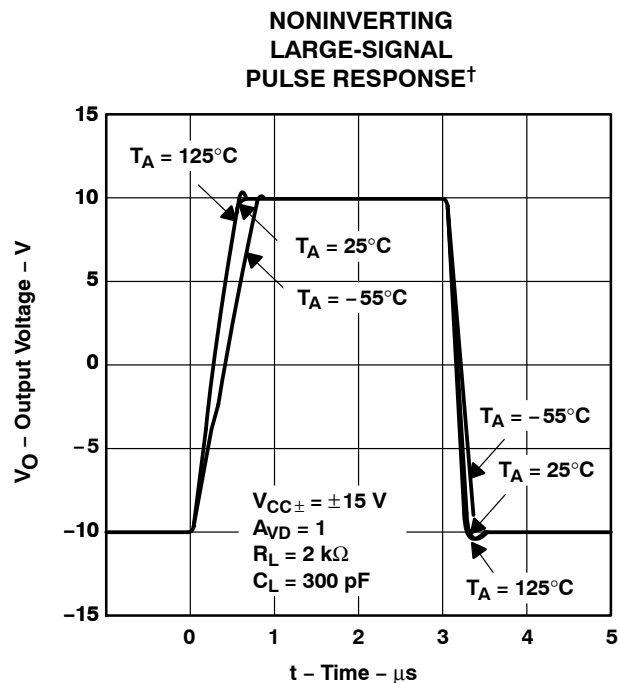


† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# TLE214x, TLE214xA EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS

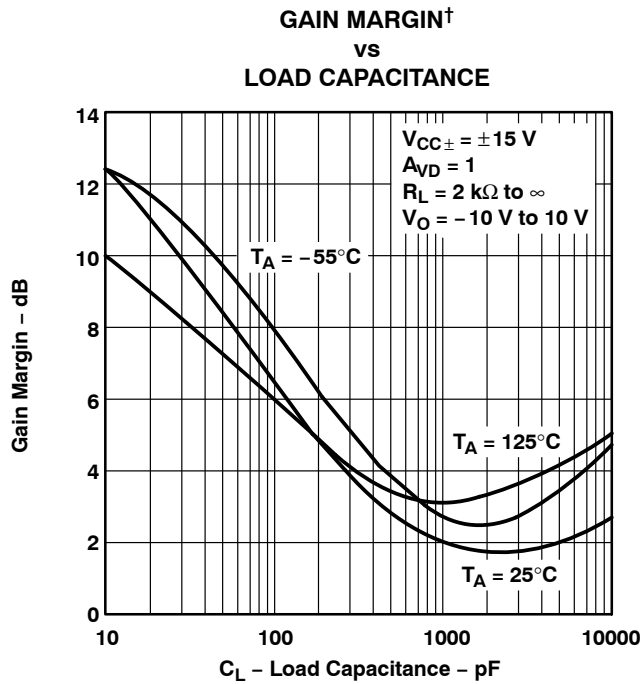


Figure 35

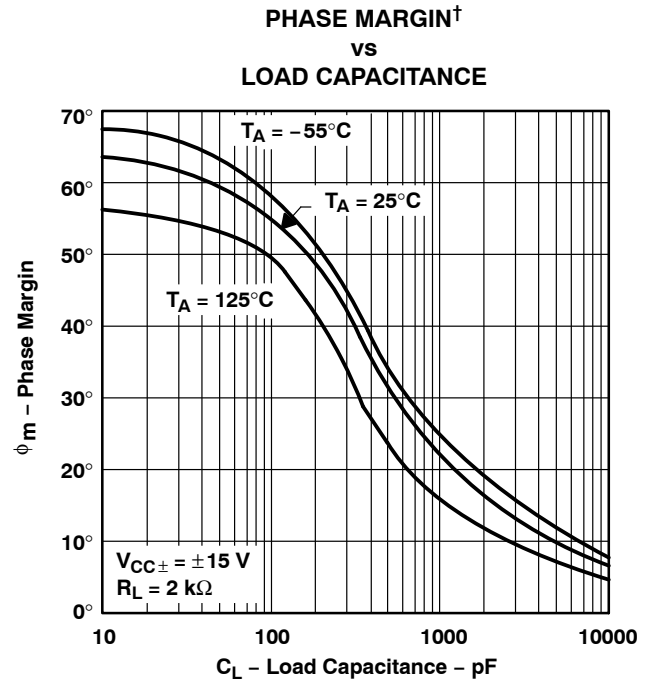


Figure 36

<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# TLE214x, TLE214xA EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## APPLICATION INFORMATION

### input offset voltage nulling

The TLE2141 series offers external null pins that can be used to further reduce the input offset voltage. If this feature is desired, connect the circuit of Figure 37 as shown. If external nulling is not needed, the null pins may be left unconnected.

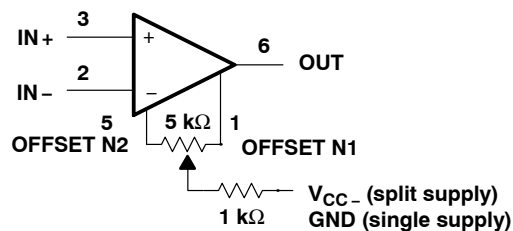


Figure 37. Input Offset Voltage Null Circuit

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)     | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                 | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|---------------------|--------------------------------------|----------------------|--------------|-----------------------------------------|-------------------------|
| 5962-9321603Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321603Q2A<br>TLE2142MFKB      | <a href="#">Samples</a> |
| 5962-9321603QHA  | ACTIVE        | CFP          | U                  | 10   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321603QHA<br>TLE2142M                  | <a href="#">Samples</a> |
| 5962-9321603QPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321603QPA<br>TLE2142M                  | <a href="#">Samples</a> |
| 5962-9321604Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321604Q2A<br>TLE2142<br>AMFKB | <a href="#">Samples</a> |
| 5962-9321604QHA  | ACTIVE        | CFP          | U                  | 10   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321604QHA<br>TLE2142AM                 | <a href="#">Samples</a> |
| 5962-9321604QPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321604QPA<br>TLE2142AM                 | <a href="#">Samples</a> |
| 5962-9321605Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321605Q2A<br>TLE2144MFKB      | <a href="#">Samples</a> |
| 5962-9321605QCA  | ACTIVE        | CDIP         | J                  | 14   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-9321605QC<br>A<br>TLE2144MJB       | <a href="#">Samples</a> |
| 5962-9321606Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321606Q2A<br>TLE2144<br>AMFKB | <a href="#">Samples</a> |
| 5962-9321606QCA  | ACTIVE        | CDIP         | J                  | 14   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-9321606QC<br>A<br>TLE2144AMJB      | <a href="#">Samples</a> |
| TLE2141ACD       | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141AC                                  | <a href="#">Samples</a> |
| TLE2141ACP       | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   |              | TLE2141AC                               | <a href="#">Samples</a> |
| TLE2141AID       | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141AI                                  | <a href="#">Samples</a> |
| TLE2141AIDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141AI                                  | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TLE2141AIP       | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | TLE2141AI               | <a href="#">Samples</a> |
| TLE2141CD        | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141C                   | <a href="#">Samples</a> |
| TLE2141CDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141C                   | <a href="#">Samples</a> |
| TLE2141CDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141C                   | <a href="#">Samples</a> |
| TLE2141CP        | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   |              | TLE2141CP               | <a href="#">Samples</a> |
| TLE2141CPE4      | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   |              | TLE2141CP               | <a href="#">Samples</a> |
| TLE2141ID        | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141I                   | <a href="#">Samples</a> |
| TLE2141IDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2141I                   | <a href="#">Samples</a> |
| TLE2141IP        | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   |              | TLE2141IP               | <a href="#">Samples</a> |
| TLE2141IPE4      | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   |              | TLE2141IP               | <a href="#">Samples</a> |
| TLE2141MD        | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | 2141M                   | <a href="#">Samples</a> |
| TLE2141MDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | 2141M                   | <a href="#">Samples</a> |
| TLE2142ACD       | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 2142AC                  | <a href="#">Samples</a> |
| TLE2142ACDG4     | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 2142AC                  | <a href="#">Samples</a> |
| TLE2142ACDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2142AC                  | <a href="#">Samples</a> |
| TLE2142AID       | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 85    | 2142AI                  | <a href="#">Samples</a> |
| TLE2142AIDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | 2142AI                  | <a href="#">Samples</a> |
| TLE2142AMD       | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | E2142A                  | <a href="#">Samples</a> |
| TLE2142AMDG4     | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | E2142A                  | <a href="#">Samples</a> |
| TLE2142AMDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | E2142A                  | <a href="#">Samples</a> |
| TLE2142AMDRG4    | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   |              | E2142A                  | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)     | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                 | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|---------------------|--------------------------------------|----------------------|--------------|-----------------------------------------|-------------------------|
| TLE2142AMFKB     | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321604Q2A<br>TLE2142<br>AMFKB | <a href="#">Samples</a> |
| TLE2142AMJG      | ACTIVE        | CDIP         | JG                 | 8    | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   |              | TLE2142AMJG                             | <a href="#">Samples</a> |
| TLE2142AMJGB     | ACTIVE        | CDIP         | JG                 | 8    | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321604QPA<br>TLE2142AM                 | <a href="#">Samples</a> |
| TLE2142AMUB      | ACTIVE        | CFP          | U                  | 10   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321604QHA<br>TLE2142AM                 | <a href="#">Samples</a> |
| TLE2142CD        | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 2142C                                   | <a href="#">Samples</a> |
| TLE2142CDG4      | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 2142C                                   | <a href="#">Samples</a> |
| TLE2142CDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 2142C                                   | <a href="#">Samples</a> |
| TLE2142CDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | 2142C                                   | <a href="#">Samples</a> |
| TLE2142CP        | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | TLE2142CP                               | <a href="#">Samples</a> |
| TLE2142CPWR      | ACTIVE        | TSSOP        | PW                 | 16   | 2000           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | Q2142                                   | <a href="#">Samples</a> |
| TLE2142ID        | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 105   | 2142I                                   | <a href="#">Samples</a> |
| TLE2142IDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 105   | 2142I                                   | <a href="#">Samples</a> |
| TLE2142IDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 105   | 2142I                                   | <a href="#">Samples</a> |
| TLE2142IP        | ACTIVE        | PDIP         | P                  | 8    | 50             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   | -40 to 105   | TLE2142IP                               | <a href="#">Samples</a> |
| TLE2142MD        | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | 2142M                                   | <a href="#">Samples</a> |
| TLE2142MDG4      | ACTIVE        | SOIC         | D                  | 8    | 75             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   |              | 2142M                                   | <a href="#">Samples</a> |
| TLE2142MDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | 2142M                                   | <a href="#">Samples</a> |
| TLE2142MDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   |              | 2142M                                   | <a href="#">Samples</a> |
| TLE2142MFKB      | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321603Q2A                     | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)     | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                 | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|---------------------|--------------------------------------|----------------------|--------------|-----------------------------------------|-------------------------|
|                  |               |              |                    |      |                |                     |                                      |                      |              | TLE2142MFKB                             |                         |
| TLE2142MJGB      | ACTIVE        | CDIP         | JG                 | 8    | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321603QPA<br>TLE2142M                  | <a href="#">Samples</a> |
| TLE2142MUB       | ACTIVE        | CFP          | U                  | 10   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 9321603QHA<br>TLE2142M                  | <a href="#">Samples</a> |
| TLE2144ACN       | ACTIVE        | PDIP         | N                  | 14   | 25             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | TLE2144ACN                              | <a href="#">Samples</a> |
| TLE2144AIN       | ACTIVE        | PDIP         | N                  | 14   | 25             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   | -40 to 85    | TLE2144AIN                              | <a href="#">Samples</a> |
| TLE2144AMFKB     | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321606Q2A<br>TLE2144<br>AMFKB | <a href="#">Samples</a> |
| TLE2144AMJB      | ACTIVE        | CDIP         | J                  | 14   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-9321606QC<br>A<br>TLE2144AMJB      | <a href="#">Samples</a> |
| TLE2144CDW       | ACTIVE        | SOIC         | DW                 | 16   | 40             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | TLE2144C                                | <a href="#">Samples</a> |
| TLE2144CDWR      | ACTIVE        | SOIC         | DW                 | 16   | 2000           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | TLE2144C                                | <a href="#">Samples</a> |
| TLE2144CDWRG4    | ACTIVE        | SOIC         | DW                 | 16   | 2000           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | 0 to 70      | TLE2144C                                | <a href="#">Samples</a> |
| TLE2144CN        | ACTIVE        | PDIP         | N                  | 14   | 25             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | TLE2144CN                               | <a href="#">Samples</a> |
| TLE2144IDW       | ACTIVE        | SOIC         | DW                 | 16   | 40             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 105   | TLE2144I                                | <a href="#">Samples</a> |
| TLE2144IDWR      | ACTIVE        | SOIC         | DW                 | 16   | 2000           | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 105   | TLE2144I                                | <a href="#">Samples</a> |
| TLE2144IN        | ACTIVE        | PDIP         | N                  | 14   | 25             | RoHS & Green        | NIPDAU                               | N / A for Pkg Type   | -40 to 105   | TLE2144IN                               | <a href="#">Samples</a> |
| TLE2144MDW       | ACTIVE        | SOIC         | DW                 | 16   | 40             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   | -55 to 125   | TLE2144M                                | <a href="#">Samples</a> |
| TLE2144MDWG4     | ACTIVE        | SOIC         | DW                 | 16   | 40             | RoHS & Green        | NIPDAU                               | Level-1-260C-UNLIM   |              | TLE2144M                                | <a href="#">Samples</a> |
| TLE2144MFKB      | ACTIVE        | LCCC         | FK                 | 20   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-<br>9321605Q2A<br>TLE2144MFKB      | <a href="#">Samples</a> |
| TLE2144MJB       | ACTIVE        | CDIP         | J                  | 14   | 1              | Non-RoHS<br>& Green | SNPB                                 | N / A for Pkg Type   | -55 to 125   | 5962-9321605QC<br>A<br>TLE2144MJB       | <a href="#">Samples</a> |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

<sup>(3)</sup> MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices 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.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TLE2141, TLE2141A, TLE2142, TLE2142A, TLE2142AM, TLE2142M, TLE2144, TLE2144A, TLE2144AM, TLE2144M :**

• Catalog : [TLE2142A](#), [TLE2142](#), [TLE2144A](#), [TLE2144](#)

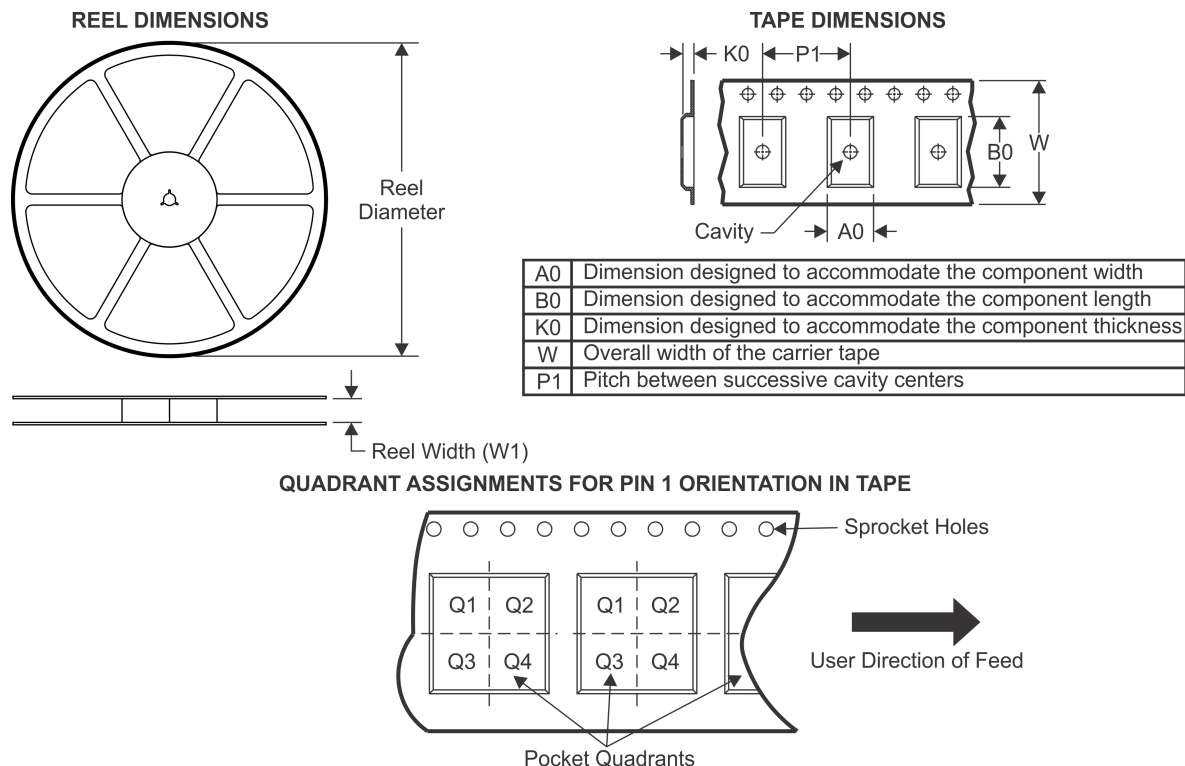
• Automotive : [TLE2141-Q1](#), [TLE2142-Q1](#), [TLE2142-Q1](#)

• Enhanced Product : [TLE2141-EP](#), [TLE2144-EP](#), [TLE2144-EP](#)

- Military : [TLE2141M](#), [TLE2141AM](#), [TLE2142M](#), [TLE2142AM](#), [TLE2144M](#), [TLE2144AM](#)

NOTE: Qualified Version Definitions:

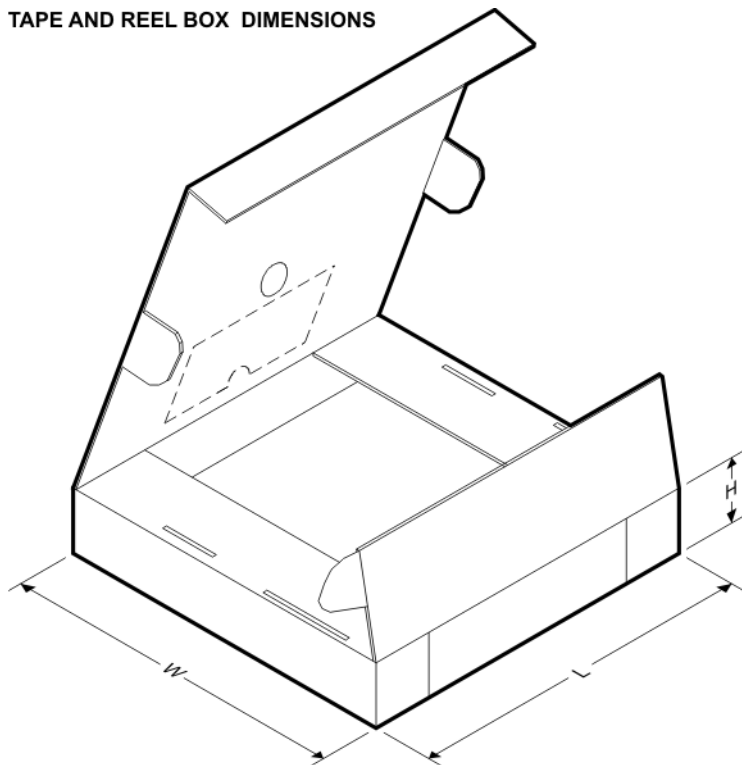
- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLE2141AIDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2141CDR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2141IDR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2141MDR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142ACDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142AIDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142AMDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142AMDRG4 | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142CDR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142CPWR   | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLE2142IDR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142MDR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2142MDRG4  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2144CDWR   | SOIC         | DW              | 16   | 2000 | 330.0              | 16.4               | 10.75   | 10.7    | 2.7     | 12.0    | 16.0   | Q1            |
| TLE2144IDWR   | SOIC         | DW              | 16   | 2000 | 330.0              | 16.4               | 10.75   | 10.7    | 2.7     | 12.0    | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

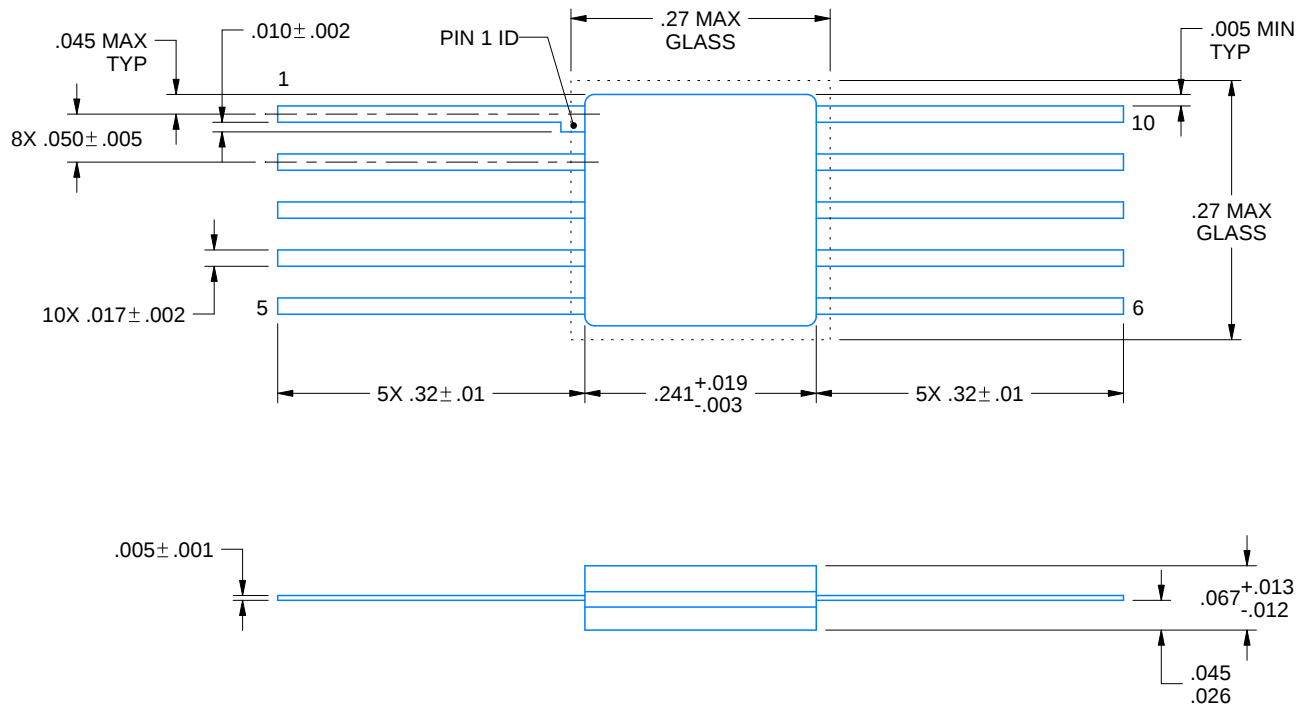
| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLE2141AIDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2141CDR    | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2141IDR    | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2141MDR    | SOIC         | D               | 8    | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2142ACDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2142AIDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2142AMDR   | SOIC         | D               | 8    | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2142AMDRG4 | SOIC         | D               | 8    | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2142CDR    | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2142CPWR   | TSSOP        | PW              | 16   | 2000 | 853.0       | 449.0      | 35.0        |
| TLE2142IDR    | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2142MDR    | SOIC         | D               | 8    | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2142MDRG4  | SOIC         | D               | 8    | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2144CDWR   | SOIC         | DW              | 16   | 2000 | 350.0       | 350.0      | 43.0        |
| TLE2144IDWR   | SOIC         | DW              | 16   | 2000 | 350.0       | 350.0      | 43.0        |

**U0010A**

## PACKAGE OUTLINE

**CFP - 2.03 mm max height**

CERAMIC FLATPACK



4225582/A 01/2020

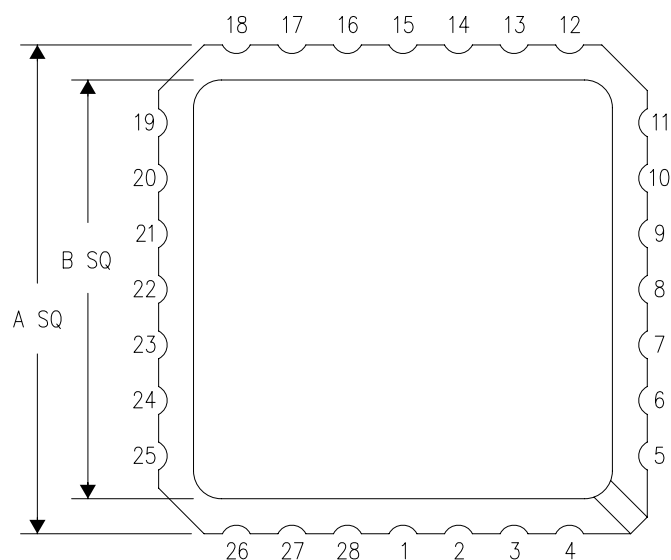
NOTES:

1. All linear dimensions are in inches. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

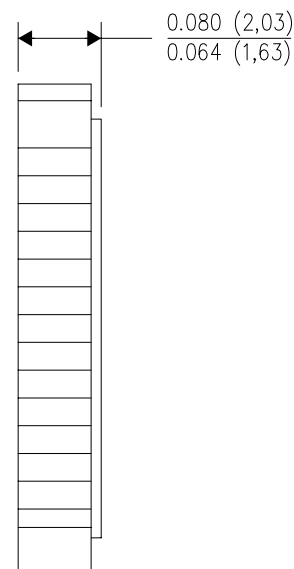
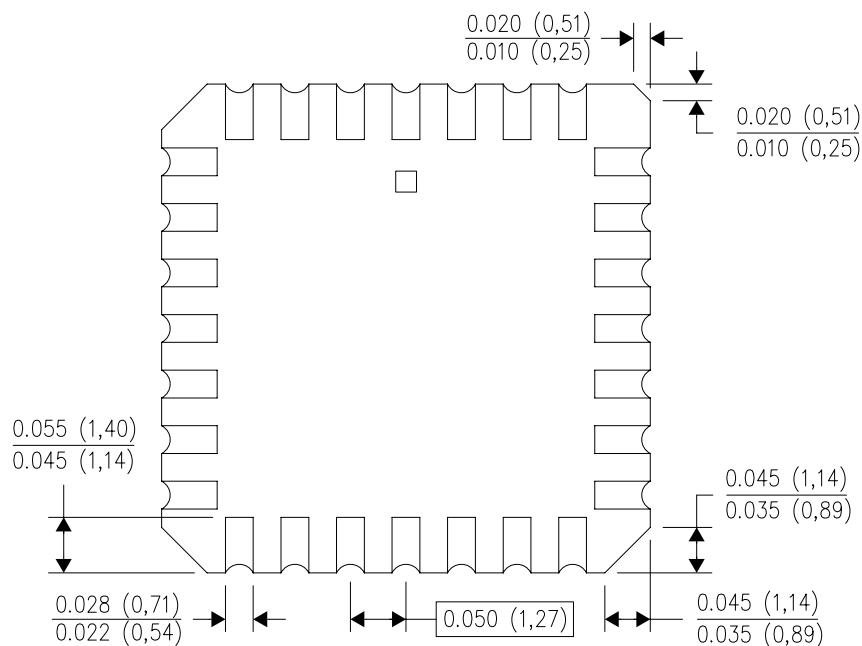
FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



| NO. OF<br>TERMINALS<br>** | A                |                  | B                |                  |
|---------------------------|------------------|------------------|------------------|------------------|
|                           | MIN              | MAX              | MIN              | MAX              |
| 20                        | 0.342<br>(8,69)  | 0.358<br>(9,09)  | 0.307<br>(7,80)  | 0.358<br>(9,09)  |
| 28                        | 0.442<br>(11,23) | 0.458<br>(11,63) | 0.406<br>(10,31) | 0.458<br>(11,63) |
| 44                        | 0.640<br>(16,26) | 0.660<br>(16,76) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 52                        | 0.740<br>(18,78) | 0.761<br>(19,32) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 68                        | 0.938<br>(23,83) | 0.962<br>(24,43) | 0.850<br>(21,6)  | 0.858<br>(21,8)  |
| 84                        | 1.141<br>(28,99) | 1.165<br>(29,59) | 1.047<br>(26,6)  | 1.063<br>(27,0)  |



4040140/D 01/11

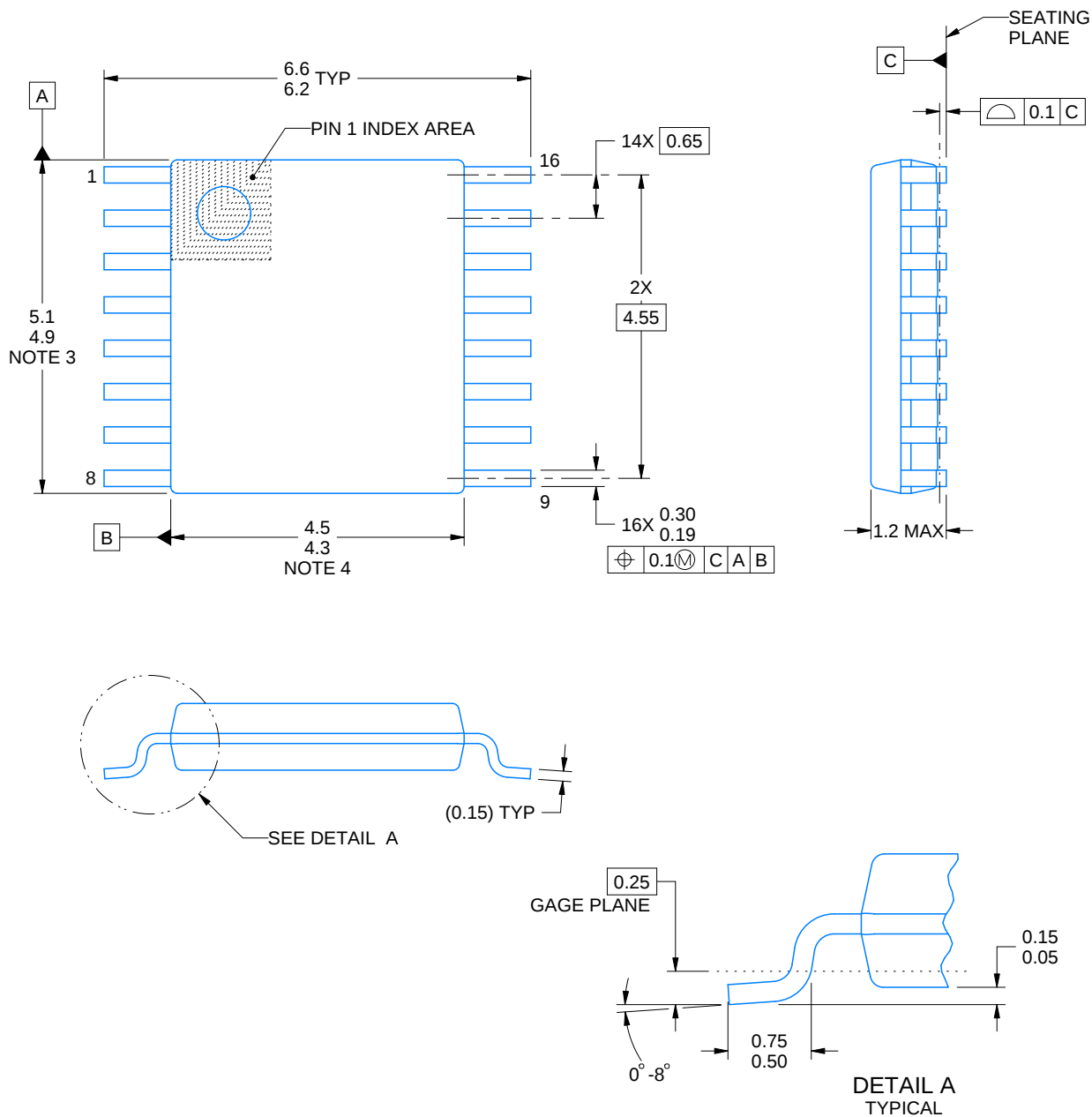
- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004



**PW0016A**

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220204/A 02/2017

NOTES:

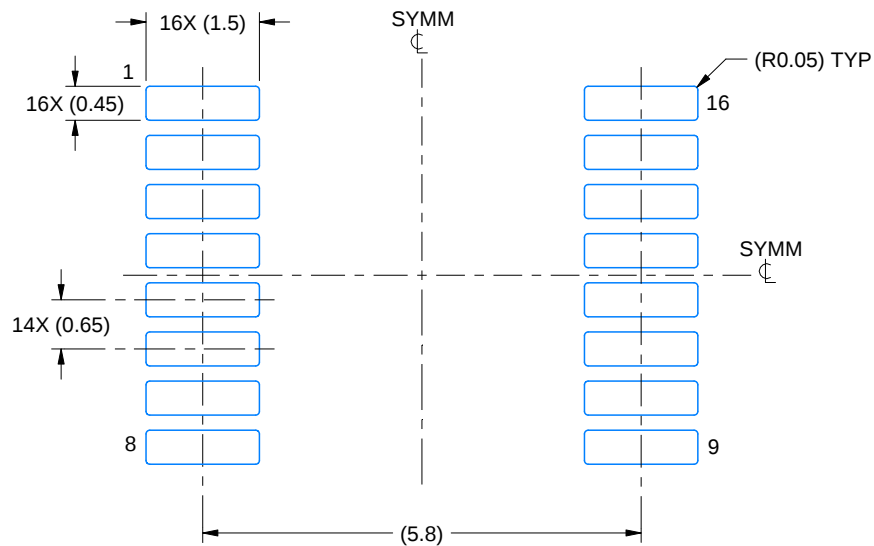
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

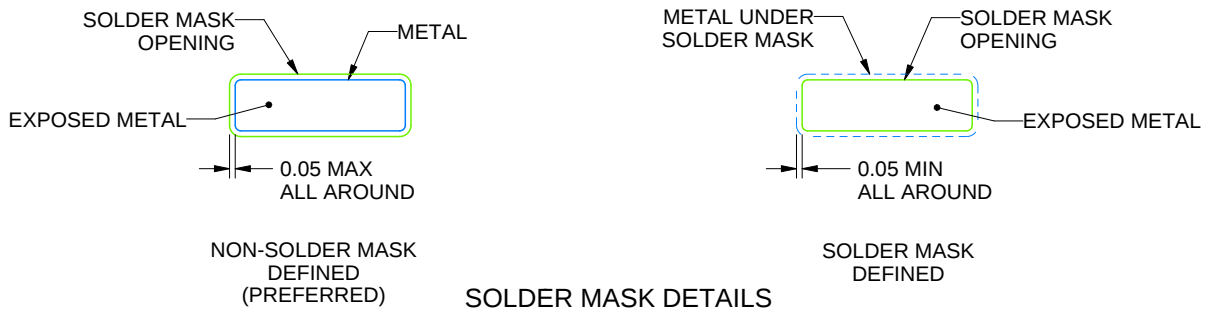
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220204/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

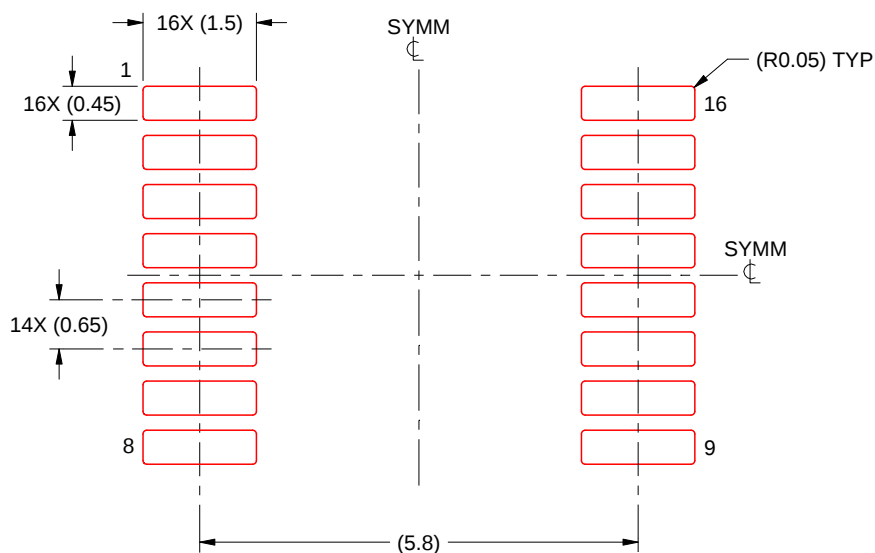
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220204/A 02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## GENERIC PACKAGE VIEW

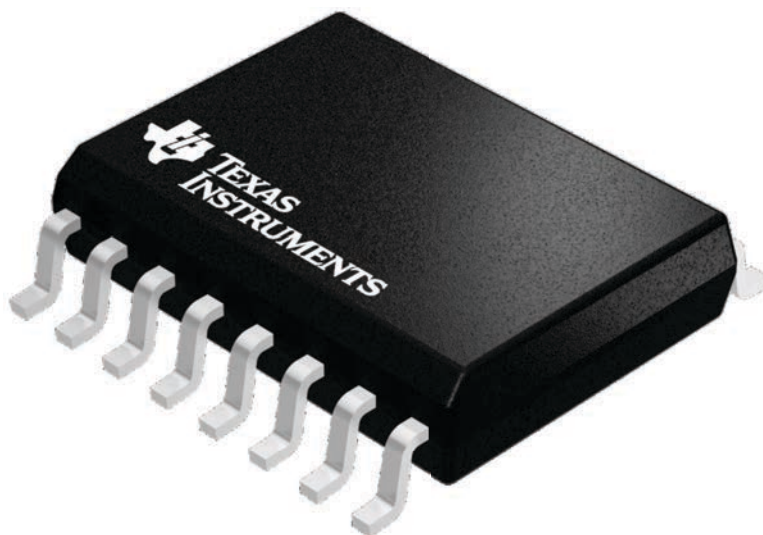
**DW 16**

**SOIC - 2.65 mm max height**

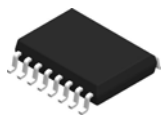
7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4224780/A

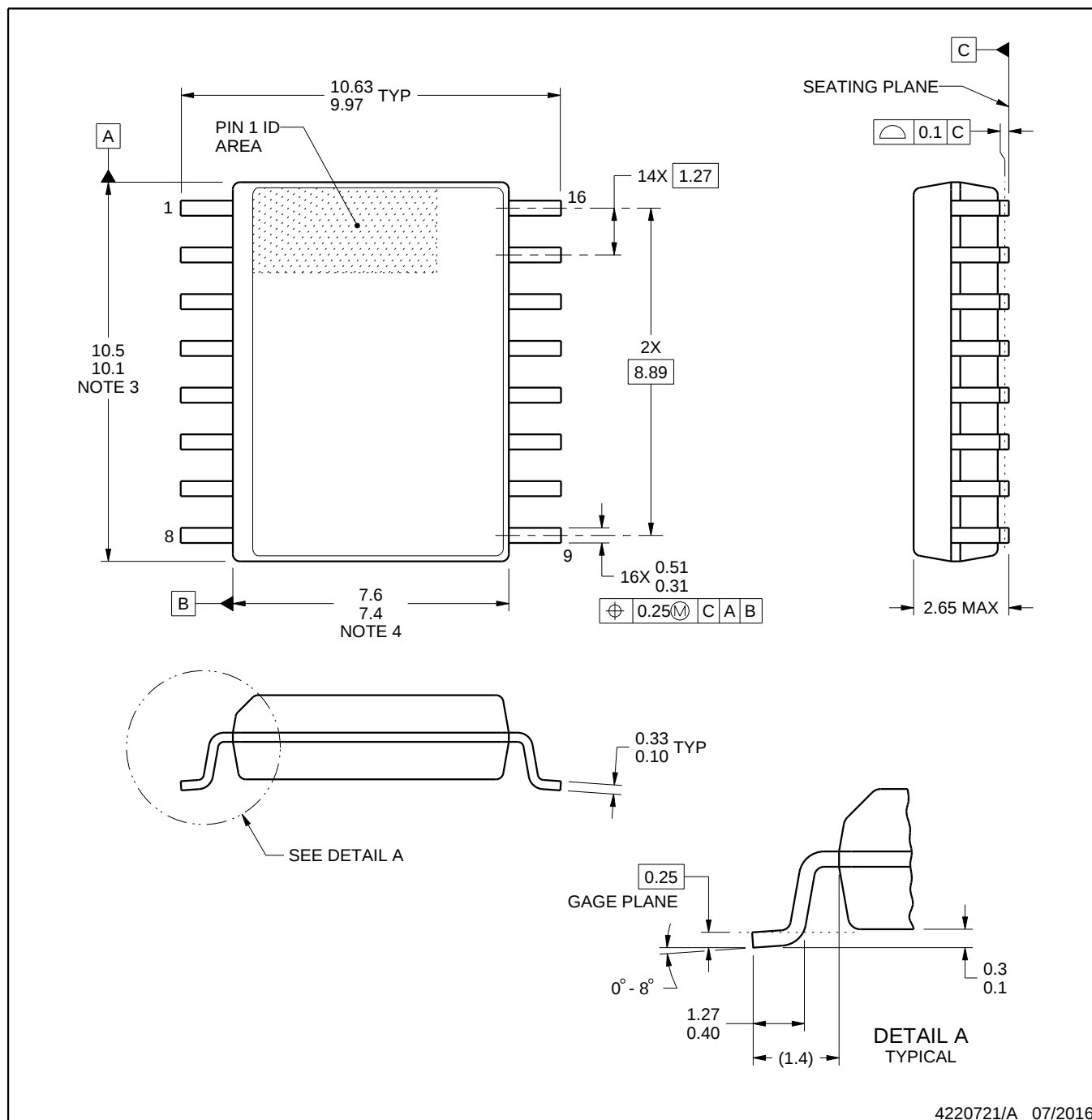


DW0016A

# PACKAGE OUTLINE

## SOIC - 2.65 mm max height

SOIC



4220721/A 07/2016

### NOTES:

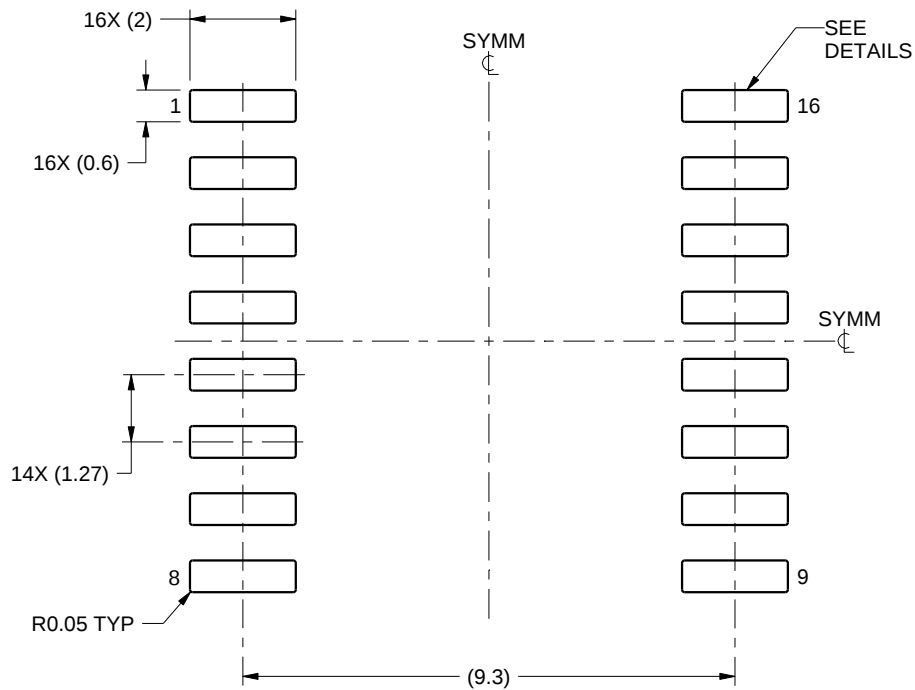
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.

# EXAMPLE BOARD LAYOUT

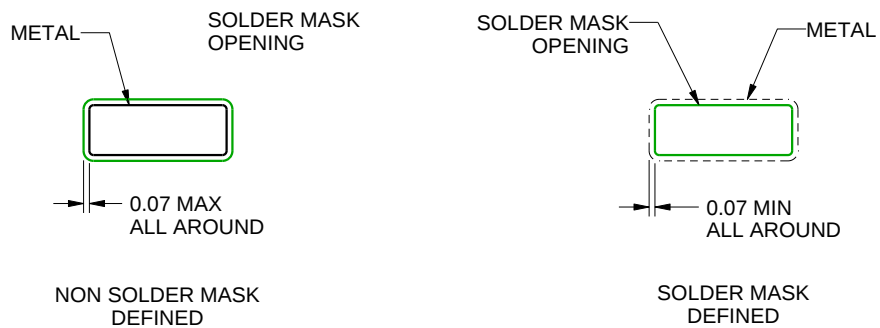
DW0016A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:7X



SOLDER MASK DETAILS

4220721/A 07/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

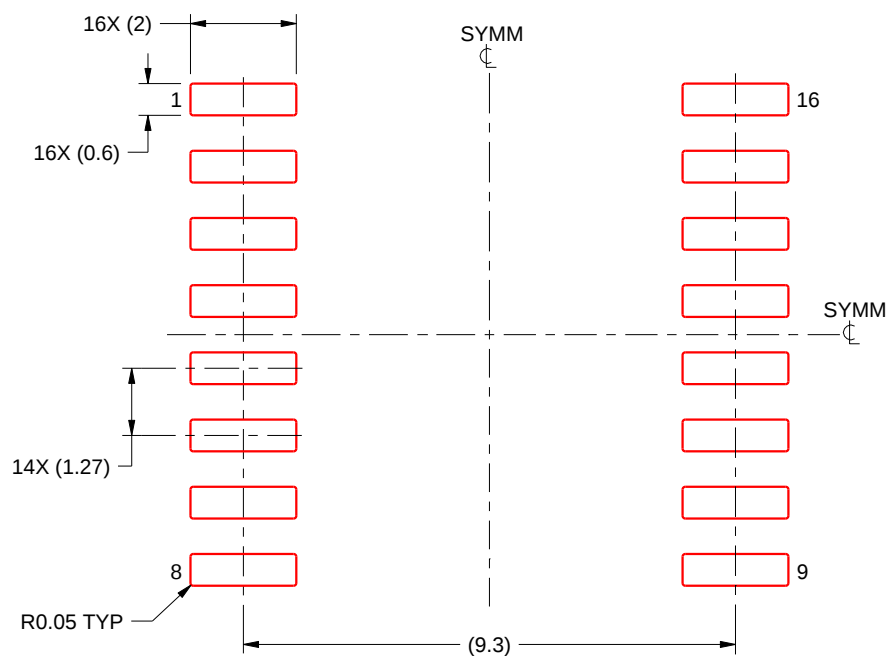
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DW0016A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:7X

4220721/A 07/2016

NOTES: (continued)

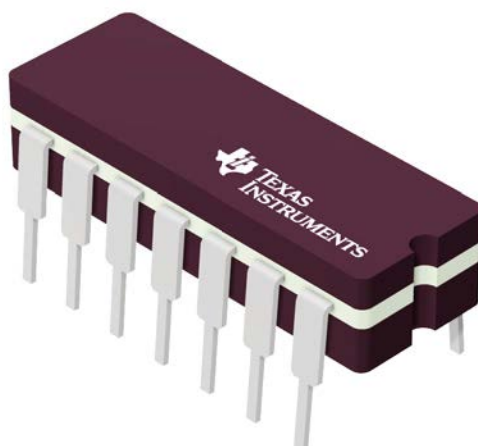
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

**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

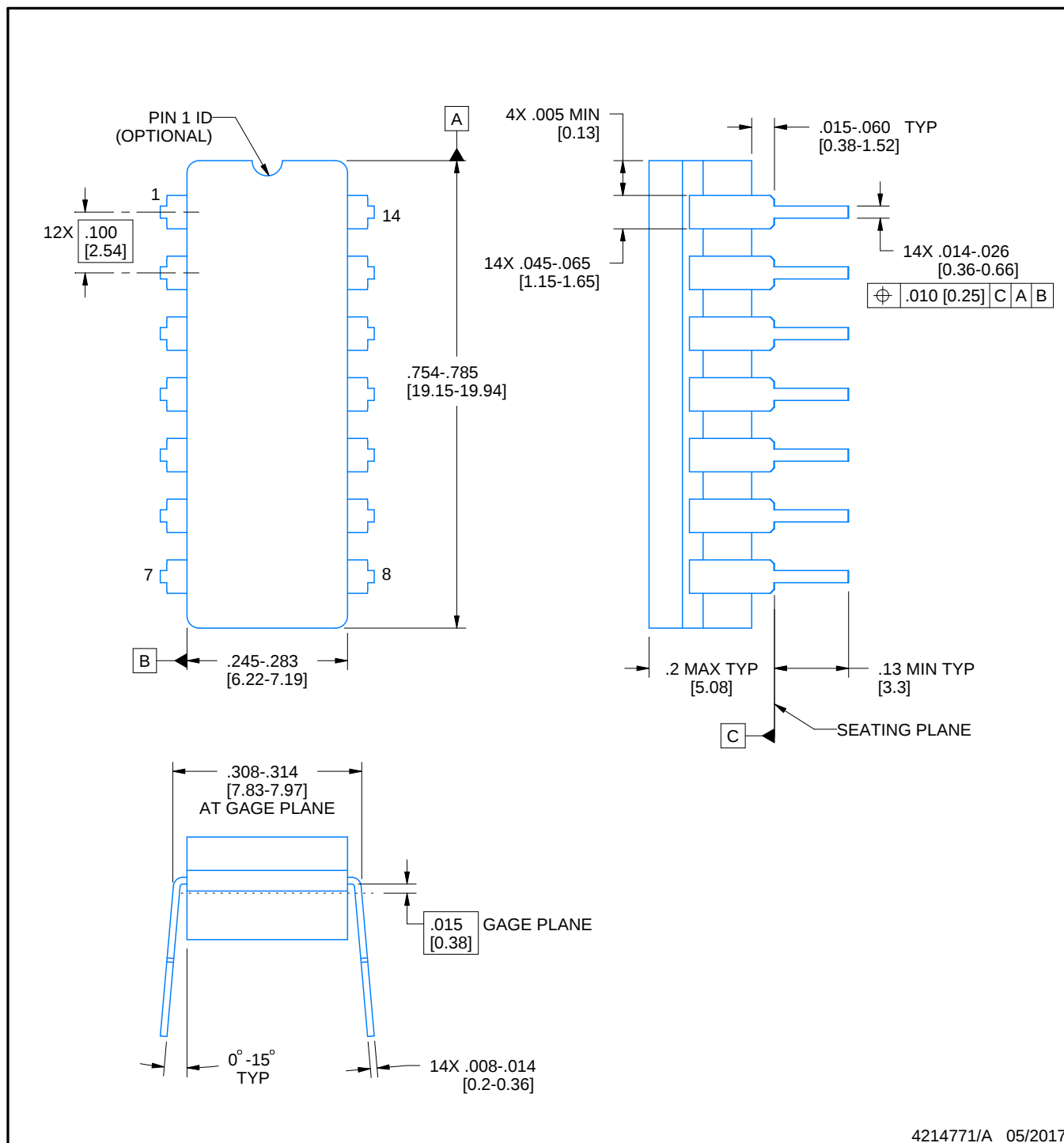


**J0014A**

# PACKAGE OUTLINE

**CDIP - 5.08 mm max height**

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

## NOTES:

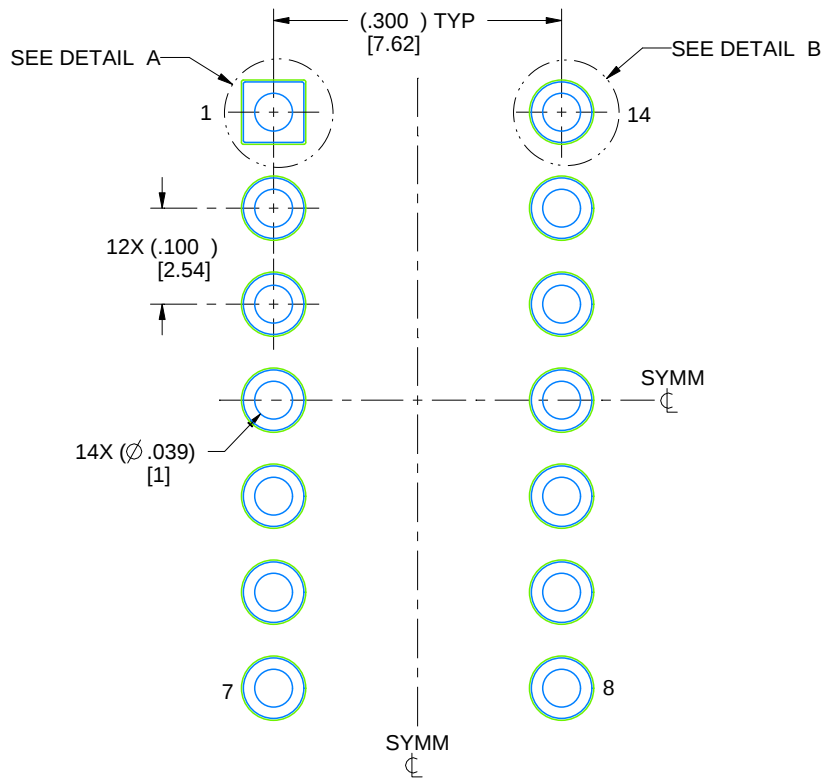
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with 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.

# EXAMPLE BOARD LAYOUT

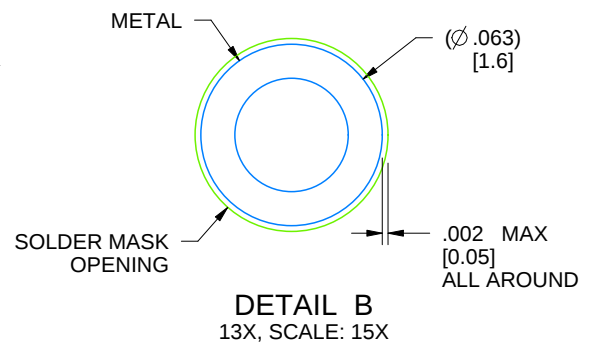
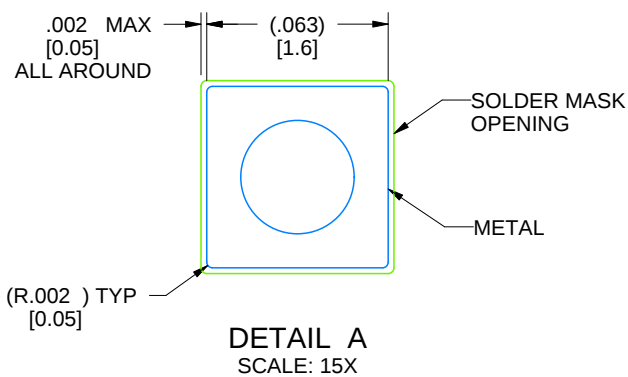
J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE  
NON-SOLDER MASK DEFINED  
SCALE: 5X



4214771/A 05/2017



## PACKAGE OUTLINE

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT

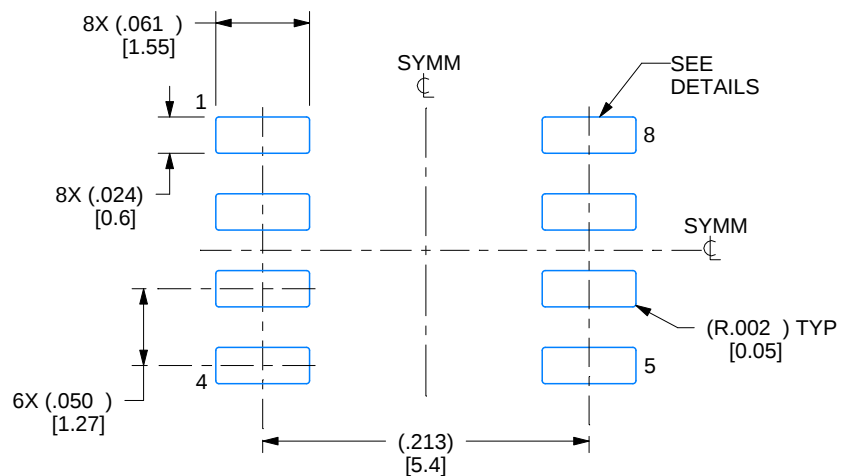


1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

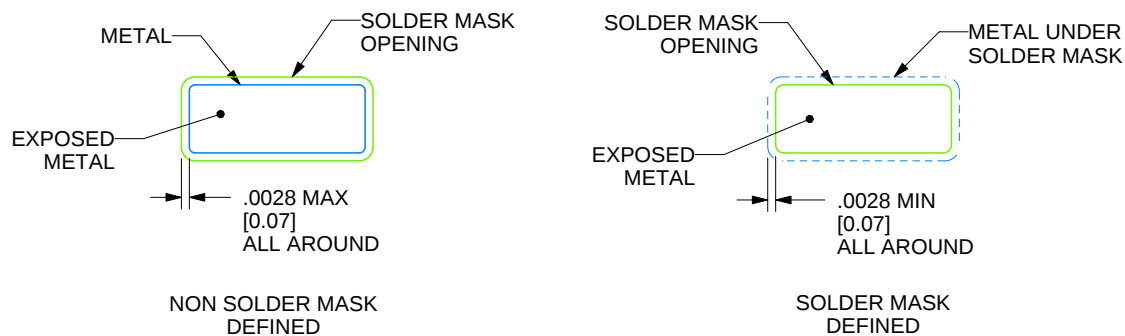
**D0008A**

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



## SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

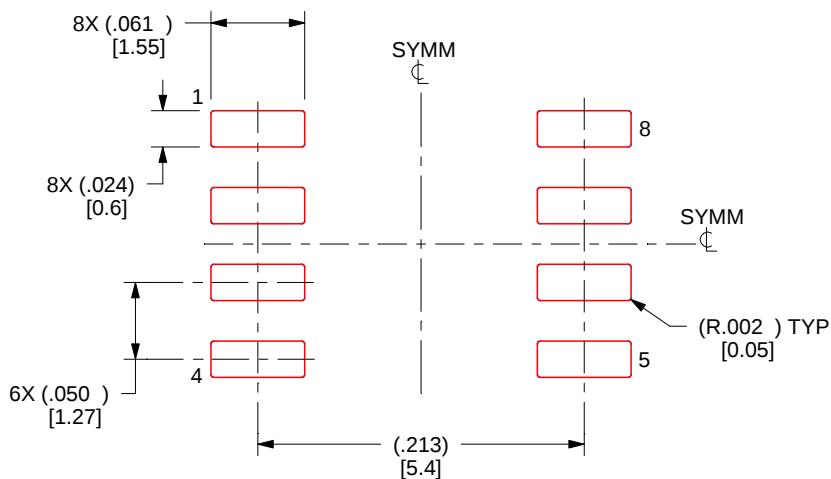
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

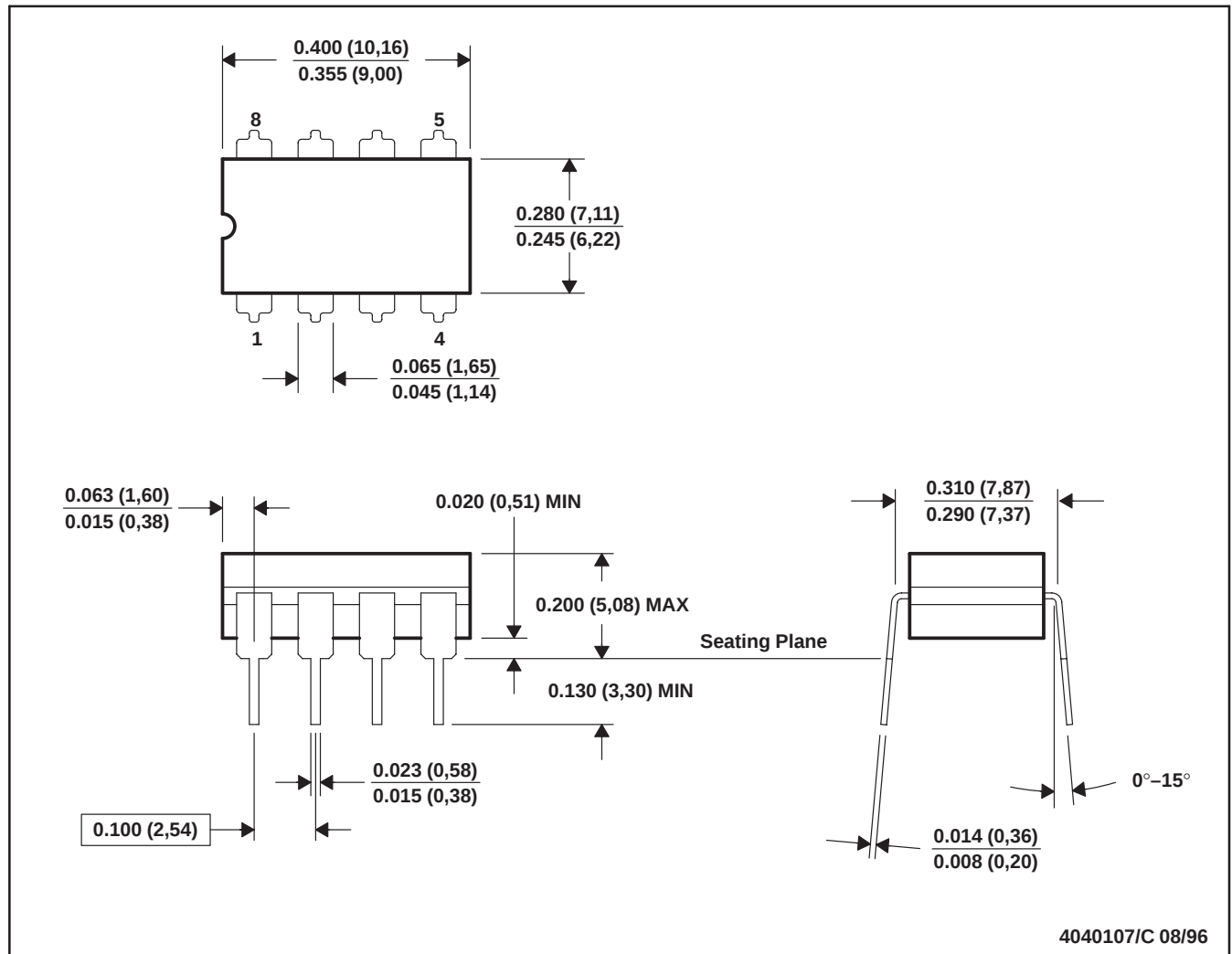
4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## JG (R-GDIP-T8)

## CERAMIC DUAL-IN-LINE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification.  
 E. Falls within MIL STD 1835 GDIP1-T8

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE

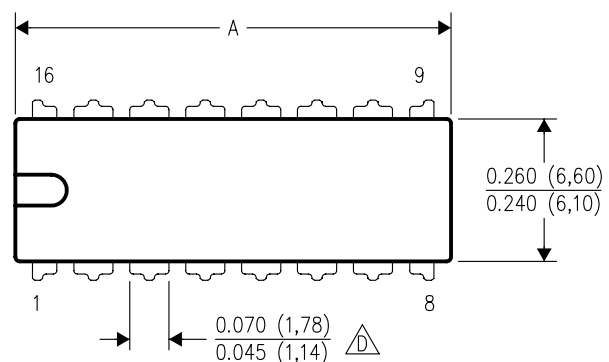


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

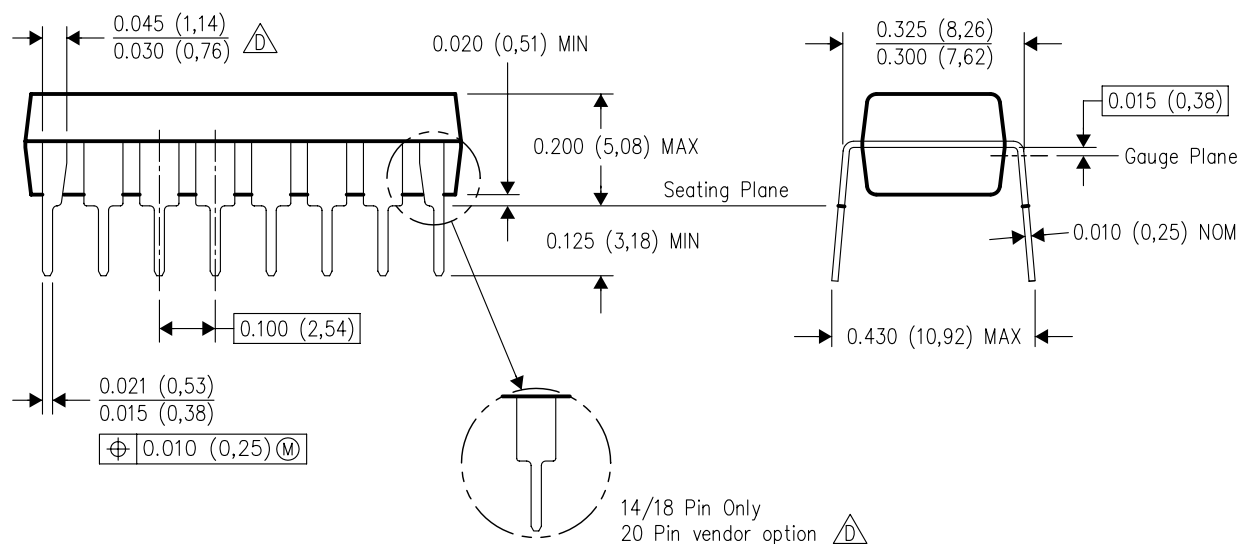
## N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **             | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| DIM                 |                  |                  |                  |                  |
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |



4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

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