

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

SLOS183B – FEBRUARY 1997 – REVISED APRIL 2004

- **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/ μs Min Slew Rate**
- **High Gain-Bandwidth Product . . . 5.9 MHz**
- **Low V_{IO} . . . 500 μV 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**
 $V_{CC-} + 0.1 \text{ V to } V_{CC+} - 1 \text{ V}$

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/ μs 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 Ω /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- μV 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 $V_{CC-} - 0.3$ to $V_{CC+} - 1.8 \text{ V}$ 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 $V_{CC-} - 0.1$ to $V_{CC+} - 1 \text{ V}$ 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 $V_{CC\pm}$ 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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 **TEXAS
INSTRUMENTS**

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

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TLE2141 AVAILABLE OPTIONS

| TA | V_{IO}^{max} AT 25°C | PACKAGED DEVICES | | |
|----------------|----------------------------------|-------------------------|---------------------------|-------------------------|
| | | SMALL OUTLINE† (D) | CERAMIC DIP (JG) | PLASTIC DIP (P) |
| 0°C to 70°C | 500 µV 900 µV | TLE2141ACD TLE2141CD | — | TLE2141ACP TLE2141CP |
| -40°C to 105°C | 500 µV 900 µV | TLE2141AID TLE2141ID | — | TLE2141AIP TLE2141IP |
| -55°C to 125°C | 500 µV 900 µV | — TLE2141MD | TLE2141AMJG TLE2141MJG | — |

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

TLE2142 AVAILABLE OPTIONS

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

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

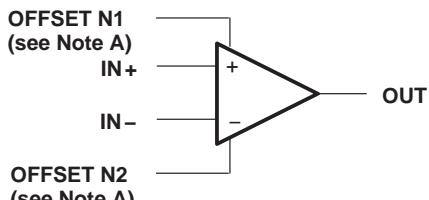
‡ The PW packages are available left-ended taped and reeled. Add LE the suffix to device type (e.g., TLC2142CPWLE).

TLE2144 AVAILABLE OPTIONS

| TA | V_{IO}^{max} AT 25°C | PACKAGED DEVICES | | | |
|----------------|----------------------------------|------------------------|---------------------------|-------------------------|-------------------------|
| | | SMALL OUTLINE† (DW) | CHIP CARRIER (FK) | CERAMIC DIP (J) | PLASTIC DIP (N) |
| 0°C to 70°C | 1.5 mV 2.4 mV | — TLE2144CDW | — — | — — | TLE2144ACN TLE2144CN |
| -40°C to 105°C | 1.5 mV 2.4 mV | — TLE2144IDW | — — | — — | TLE2144AIN TLE2144IN |
| -55°C to 125°C | 1.5 mV 2.5 mV | — TLE2144MDW | TLE2144AMFK TLE2144MFK | TLE2144AMJ 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)

| | | | |
|-------------------|---|---|-------------------|
| OFFSET N1 | 1 | 8 | NC |
| IN - | 2 | 7 | V _{CC} + |
| IN + | 3 | 6 | OUT |
| V _{CC} - | 4 | 5 | OFFSET N2 |

The diagram shows the top view of a TLE2144 package. It features a central vertical column of pins labeled 1 through 16. The outer pins are grouped into four pairs: (1, 16), (2, 15), (3, 14), and (4, 13). Pin 1 is labeled '1OUT'. Pin 2 is labeled '1IN-'. Pin 3 is labeled '1IN+'. Pin 4 is labeled 'V_{CC}'. Pin 5 is labeled '2IN+'. Pin 6 is labeled '2IN-'. Pin 7 is labeled '2OUT'. Pin 8 is labeled 'NC'. Pin 9 is labeled 'NC'. Pin 10 is labeled '3OUT'. Pin 11 is labeled '3IN-'. Pin 12 is labeled '3IN+'. Pin 13 is labeled 'V_{CC}'. Pin 14 is labeled '4IN+'. Pin 15 is labeled '4IN-'. Pin 16 is labeled '4OUT'.

The diagram shows a top-down view of a TLE2142 package. It features a central rectangular body with a U-shaped notch at the top center. On each side, there are two vertical columns of pins. The left column contains pins 1 through 8, and the right column contains pins 9 through 16. Each pin is labeled with its number and a descriptive label: Pin 1 is 'NC', Pin 2 is '1OUT', Pin 3 is '1OUT', Pin 4 is '1IN-', Pin 5 is '1IN+', Pin 6 is 'V_{CC}-', Pin 7 is 'V_{CC}-', Pin 8 is 'NC', Pin 9 is '2OUT', Pin 10 is '2IN-', Pin 11 is '2IN+', Pin 12 is '2IN+', Pin 13 is '16', Pin 14 is 'V_{CC}+', Pin 15 is 'V_{CC}+', and Pin 16 is 'NC'.

The diagram shows the top view of a TLE2142 package. It is a U-shaped package with 12 pins. The pins are numbered 1 through 12 around the perimeter. Pin 1 is at the bottom left, Pin 10 is at the top center, Pin 11 is at the top right, and Pin 12 is at the bottom right. Pin 1 is labeled 'NC' (No Connect). Pin 10 is labeled 'NC'. Pin 11 is labeled 'V_{CC}'. Pin 12 is labeled 'V_{CC}'. Pin 1 is labeled '1OUT'. Pin 2 is labeled '1IN+'. Pin 3 is labeled '1IN-'. Pin 4 is labeled 'V_{CC}-'. Pin 5 is labeled '2OUT'. Pin 6 is labeled '2IN-'. Pin 7 is labeled '2IN+'. Pin 8 is labeled '1OUT'. Pin 9 is labeled '1IN+'. Pin 10 is labeled 'V_{CC}'. Pin 11 is labeled 'V_{CC}'. Pin 12 is labeled 'V_{CC}'.

TLE2142

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

| | | | |
|-------------------|---|---|------------------|
| 1OOUT | 1 | 8 | V _{CC+} |
| 1IN- | 2 | 7 | 2OOUT |
| 1IN+ | 3 | 6 | 2IN- |
| V _{CC} - | 4 | 5 | 2IN+ |

TLE2142

**FK PACKAGE
(TOP VIEW)**

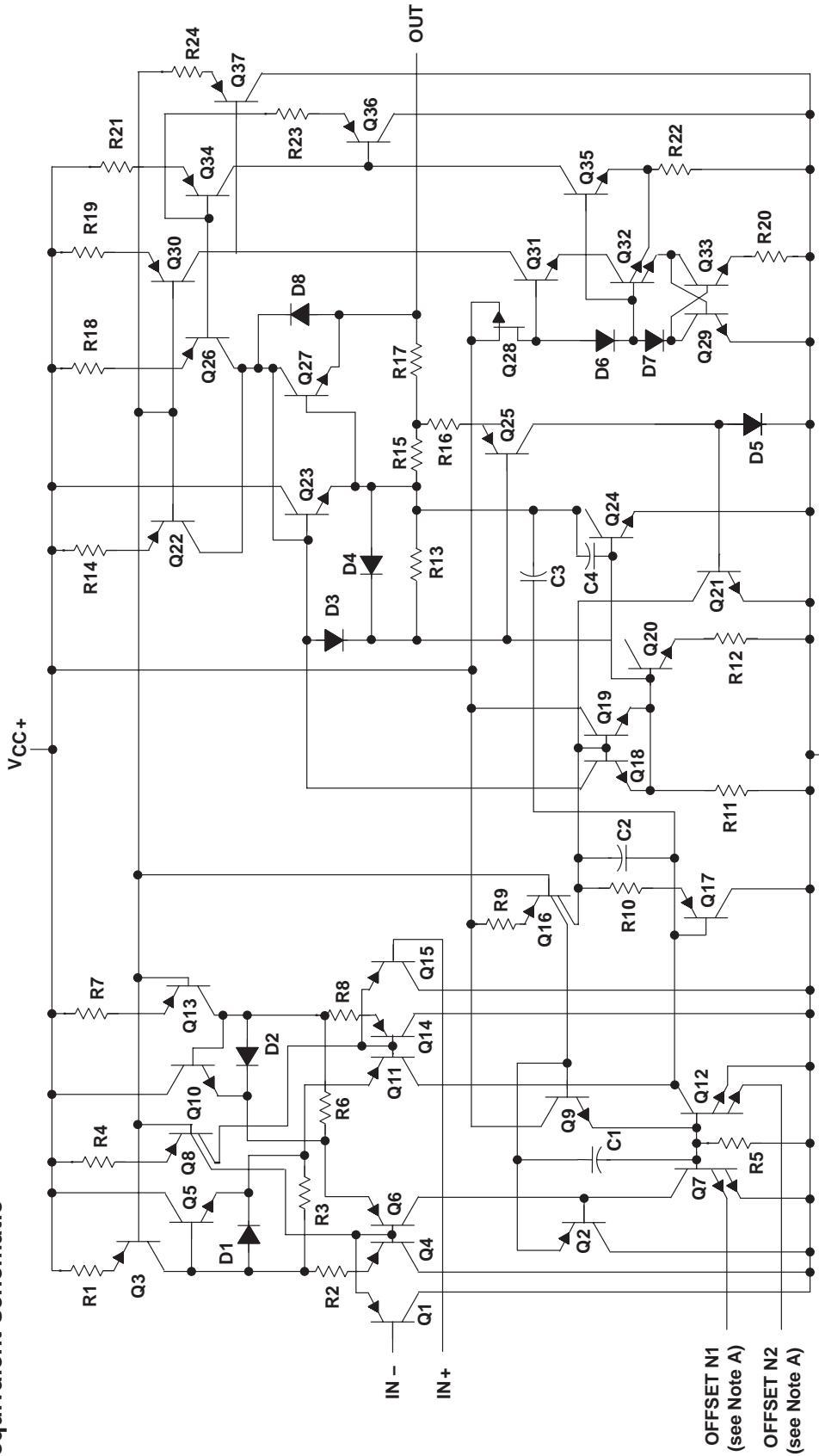
| | | | | | | | |
|----|-------------------|-------------------|------|------|------|------|------|
| NC | 1OOUT | V _{CC} + | NC | | | | |
| NC | NC | NC | NC | | | | |
| C | 3 | 2 | 1 | 20 | 19 | 18 | NC |
| - | 4 | | | | | | |
| C | 5 | | | | | | 17 |
| C | 6 | | | | | | 16 |
| + | 7 | | | | | | 15 |
| C | 8 | | | | | | 14 |
| | 9 | 10 | 11 | 12 | 13 | | |
| NC | NC | NC | NC | NC | NC | NC | NC |
| NC | V _{CC} - | NC | NC | NC | NC | NC | NC |
| NC | 2IN- | 2IN+ | 2IN- | 2IN+ | 2IN- | 2IN+ | 2IN- |

NC – No internal connection



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equivalent schematic

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

| COMPONENT | ACTUAL DEVICE COMPONENT COUNT | | |
|-------------|-------------------------------|---------|---------|
| | TLE2241 | TLE2242 | TLE2244 |
| Transistors | 46 | 65 | 130 |
| Resistors | 24 | 43 | 86 |
| Diodes | 8 | 14 | 28 |
| Capacitors | 4 | 8 | 16 |
| Epi-FET | 1 | 1 | 2 |

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

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

[†] 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 $T_J(\max)$, θ_{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 JEDEC 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} | $V_{CC} = 5 \text{ V}$ | 0 | 2.9 | 0 | 2.7 | 0 | 2.7 |
| | $V_{CC\pm} = \pm 15 \text{ V}$ | -15 | 12.9 | -15 | 12.7 | -15 | 12.7 |
| Operating free-air temperature, T_A | 0 | 70 | -40 | 105 | -55 | 125 | °C |

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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 | $V_O = 2.5\text{ V}$ $V_{IC} = 2.5\text{ V}$ $R_S = 50\ \Omega$ | 25°C | 225 | 1400 | | 200 | 1000 | | μV |
| | | Full range | | 1700 | | | 1300 | | |
| | | Full range | | 1.7 | | | 1.7 | | $\mu\text{V}/^\circ\text{C}$ |
| | | 25°C | 8 | 100 | | 8 | 100 | | nA |
| | | Full range | | 150 | | | 150 | | |
| | | 25°C | -0.8 | -2 | | -0.8 | -2 | | μA |
| I_{IB} Input bias current | | Full range | | -2.1 | | | -2.1 | | |
| $R_S = 50\ \Omega$ | 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 | | 0 to 2.9 | 0 to 2.9 | | | |
| | 25°C | 3.9 | 4.1 | | 3.9 | 4.1 | | V | |
| | Full range | 3.8 | | | 3.8 | | | | |
| | 25°C | 3.8 | 4 | | 3.8 | 4 | | | |
| | Full range | 3.7 | | | 3.7 | | | | |
| V_{OH} High-level output voltage | $I_{OH} = -150\ \mu\text{A}$ $I_{OH} = -1.5\ \text{mA}$ $I_{OH} = -15\ \text{mA}$ | 25°C | 3.2 | 3.7 | | 3.2 | 3.7 | | mV |
| | | Full range | 3.2 | | | 3.2 | | | |
| | | 25°C | 75 | 125 | | 75 | 125 | | |
| | | Full range | | 150 | | | 150 | | |
| | | 25°C | 150 | 225 | | 150 | 225 | | |
| | | Full range | | 250 | | | 250 | | |
| V_{OL} Low-level output voltage | $I_{OL} = 150\ \mu\text{A}$ $I_{OL} = 1.5\ \text{mA}$ $I_{OL} = 15\ \text{mA}$ | 25°C | 1.2 | 1.6 | | 1.2 | 1.6 | | V |
| | | Full range | | 1.7 | | | 1.7 | | |
| | | 25°C | 50 | 220 | | 50 | 220 | | |
| | | Full range | 25 | | | 25 | | | V/mV |
| | | 25°C | 70 | | | 70 | | | |
| | | 25°C | 2.5 | | | 2.5 | | | |
| r_i | Input resistance | | | | | | | | $\text{M}\Omega$ |
| c_i | Input capacitance | | | | | | | | pF |
| z_o | Open-loop output impedance | $f = 1\ \text{MHz}$ | 25°C | 30 | | 30 | | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR\min}, R_S = 50\ \Omega$ | 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 | $V_O = 2.5\ \text{V}$, $V_{IC} = 2.5\ \text{V}$ | 25°C | 3.4 | 4.4 | | 3.4 | 4.4 | mA |
| | | | Full range | | 4.6 | | | 4.6 | |

† Full range is 0°C to 70°C.

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

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

[†] R_L and C_L terminated to 2.5 V.

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

| PARAMETER | TEST CONDITIONS | T_A^\dagger | TLE2141C | | | TLE2141AC | | | UNIT | |
|--|--|--------------------|-----------------|------------|-------|-----------|-------|------|------------------|--|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{IO} Input offset voltage | $V_{IC} = 0$, $V_O = 0$ | 25°C | 200 | 900 | | 175 | 500 | | μV | |
| | | | Full range | | 1300 | | | 800 | | |
| αV_{IO} Temperature coefficient of input offset voltage | | Full range | | 1.7 | | 1.7 | | 1.7 | $\mu V/^\circ C$ | |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA | |
| | | | Full range | | 150 | | | 150 | | |
| I_{IO} Input offset current | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA | |
| | | | Full range | | -1.6 | | | -1.6 | | |
| I_{IB} Input bias current | | $R_S = 50 \Omega$ | -15 | -15.3 | | -15 | -15.3 | | V | |
| | | | to | to | | to | to | | | |
| | | | 13 | 13.2 | | 13 | 13.2 | | | |
| | | | -15 | -15.3 | | -15 | -15.3 | | | |
| | | | Full range | to | to | to | to | | | |
| | | | 12.9 | 13.1 | | 12.9 | 13.1 | | | |
| V_{ICR} Common-mode input voltage range | | $I_O = -150 \mu A$ | 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 | 13.1 | 13.7 | 13.1 | 13.7 | | |
| | | | | Full range | 13 | | 13 | | | |
| 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 | | | | |
| AVD 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 | | Ω | |
| $CMRR$ Common-mode rejection ratio | $V_{IC} = V_{ICR\min}, R_S = 50 \Omega$ | 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 | $V_O = 0$ | $V_{ID} = 1 V$ | 25°C | -25 | -50 | -25 | -50 | | mA | |
| | | | 25°C | 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 | | |

† Full range is 0°C to 70°C.

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

| PARAMETER | TEST CONDITIONS | TLE2141C | | | TLE2141AC | | | UNIT |
|-------------|--|---|---|-----|-----------|-----|-----|------------------------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR+ | Positive slew rate $A_{VD} = -1$, $R_L = 2 \text{ k}\Omega$, $C_L = 500 \text{ pF}$ | 27 | 45 | | 27 | 45 | | $\text{V}/\mu\text{s}$ |
| SR- | Negative slew rate | 27 | 42 | | 27 | 42 | | |
| t_s | Settling time $A_{VD} = -1$, 10-V step | To 0.1% | 0.34 | | 0.34 | | | μs |
| | | To 0.01% | 0.4 | | 0.4 | | | |
| V_n | Equivalent input noise voltage $R_S = 20 \Omega$, $f = 10 \text{ Hz}$ | 15 | | | 15 | | | $\text{nV}/\sqrt{\text{Hz}}$ |
| | | $R_S = 20 \Omega$, $f = 1 \text{ kHz}$ | 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 | | | μV |
| | | $f = 0.1 \text{ Hz to } 10 \text{ Hz}$ | 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 $V_{O(PP)} = 20 \text{ V}$, $A_{VD} = 10$, | $R_L = 2 \text{ k}\Omega$, $f = 10 \text{ kHz}$ | 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 | $R_L = 2 \text{ k}\Omega$, $f = 100 \text{ kHz}$ | 5.9 | | 5.9 | | | MHz |
| B_{OM} | Maximum output-swing bandwidth | $V_{O(PP)} = 20 \text{ V}$, $A_{VD} = 1$, | $R_L = 2 \text{ k}\Omega$, $C_L = 100 \text{ pF}$ | 668 | | 668 | | kHz |
| ϕ_m | Phase margin at unity gain | $R_L = 2 \text{ k}\Omega$, $C_L = 100 \text{ pF}$ | 58° | | 58° | | | |

**TLE214x, TLE214xA
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TLE2142C electrical characteristics at specified free-air temperature, $V_{CC} = 5$ V (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A^\dagger | TLE2142C | | | TLE2142AC | | | UNIT | |
|---|--|---------------|----------|------|-----|-----------|------|-----|------------|--|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{IO} Input offset voltage | $V_O = 2.5$ V, $R_S = 50 \Omega$, $V_{IC} = 2.5$ V | 25°C | 220 | 1900 | | 200 | 1500 | | μ V | |
| | | Full range | | 2200 | | | 1800 | | | |
| | | Full range | | 1.7 | | | 1.7 | | μ V/°C | |
| | | 25°C | 8 | 100 | | 8 | 100 | | nA | |
| | | Full range | | 150 | | | 150 | | | |
| | | 25°C | -0.8 | -2 | | -0.8 | -2 | | μ A | |
| I_{IB} Input bias current | | Full range | | -2.1 | | | -2.1 | | | |
| | | 25°C | 0 | -0.3 | | 0 | -0.3 | | V | |
| | | | to | to | | to | to | | | |
| | | | 3 | 3.2 | | 3 | 3.2 | | | |
| | | Full range | 0 | | | 0 | | | | |
| | | | to | | | to | | | | |
| | | | 2.9 | | | 2.9 | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50 \Omega$ | 25°C | 3.9 | 4.1 | | 3.9 | 4.1 | | V | |
| | | Full range | 3.8 | | | 3.8 | | | | |
| | | 25°C | 3.8 | 4 | | 3.8 | 4 | | | |
| | | Full range | 3.7 | | | 3.7 | | | | |
| | | 25°C | 3.4 | 3.7 | | 3.4 | 3.7 | | | |
| | | Full range | 3.4 | | | 3.4 | | | | |
| V_{OH} High-level output voltage | $I_{OH} = -150 \mu$ A | 25°C | 75 | 125 | | 75 | 125 | | mV | |
| | | Full range | | 150 | | | 150 | | | |
| | | 25°C | 150 | 225 | | 150 | 225 | | | |
| | | Full range | | 250 | | | 250 | | | |
| | | 25°C | 1.2 | 1.4 | | 1.2 | 1.4 | | V | |
| | | Full range | | 1.5 | | | 1.5 | | | |
| V_{OL} Low-level output voltage | $I_{OL} = 150 \mu$ A | 25°C | 50 | 220 | | 50 | 220 | | V/mV | |
| | | Full range | 25 | | | 25 | | | | |
| | | 25°C | 150 | 225 | | 150 | 225 | | | |
| | | Full range | | 250 | | | 250 | | | |
| | | 25°C | 1.2 | 1.4 | | 1.2 | 1.4 | | | |
| | | Full range | | 1.5 | | | 1.5 | | | |
| AVD Large-signal differential voltage amplification | $V_{CC} = \pm 2.5$ V, $R_L = 2 \text{ k}\Omega$, $V_O = 1$ V to -1.5 V | 25°C | 50 | 220 | | 50 | 220 | | V/mV | |
| | | Full range | 25 | | | 25 | | | | |
| 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 | $f = 1$ MHz | 25°C | | 30 | | | 30 | | Ω | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 25°C | 85 | 118 | | 85 | 118 | | dB | |
| | | Full range | 80 | | | 80 | | | | |
| kSVR Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5$ V to ± 15 V, $R_S = 50 \Omega$ | 25°C | 90 | 106 | | 90 | 106 | | dB | |
| | | Full range | 85 | | | 85 | | | | |
| I_{CC} Supply current | $V_O = 2.5$ V, No load, $V_{IC} = 2.5$ V | 25°C | | 6.6 | 8.8 | | 6.6 | 8.8 | mA | |
| | | Full range | | | 9.2 | | | 9.2 | | |

† Full range is 0°C to 70°C.

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

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

† R_L terminates at 2.5 V.

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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 | $V_{IC} = 0$, $V_O = 0$ | 25°C | 290 | 1200 | | 275 | 750 | | μV |
| | | | Full range | | 1600 | | | 1200 | |
| | | Full range | | 1.7 | | | 1.7 | | $\mu V/^\circ C$ |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA |
| | | | Full range | | 150 | | | 150 | |
| | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA |
| | | | Full range | | -1.6 | | | -1.6 | |
| V_{ICR} Common-mode input voltage range | $R_S = 50 \Omega$ | 25°C | -15 | -15.3 | | -15 | -15.3 | | V |
| | | | to | to | | to | to | | |
| | | | 13 | 13.2 | | 13 | 13.2 | | |
| | | Full range | -15 | -15.3 | | -15 | -15.3 | | |
| | | | to | to | | to | to | | |
| | | | 12.9 | 13.1 | | 12.9 | 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 | | | |
| | $I_O = -1.5 \text{ mA}$ | 25°C | 13.7 | 14 | | 13.7 | 14 | | |
| | | Full range | 13.6 | | | 13.6 | | | |
| | $I_O = -15 \text{ mA}$ | 25°C | 13.3 | 13.7 | | 13.3 | 13.7 | | |
| | | Full range | 13.2 | | | 13.2 | | | |
| | | $I_O = 150 \mu A$ | 25°C | -14.7 | -14.9 | -14.7 | -14.9 | | V |
| | | | Full range | -14.6 | | -14.6 | | | |
| | | | 25°C | -14.5 | -14.8 | -14.5 | -14.8 | | |
| | | | Full range | -14.4 | | -14.4 | | | |
| V_{OM-} Maximum negative peak output voltage swing | $I_O = 1.5 \text{ mA}$ | 25°C | -13.4 | -13.8 | | -13.4 | -13.8 | | V |
| | | Full range | -13.3 | | | -13.3 | | | |
| | $I_O = 15 \text{ mA}$ | 25°C | -13.4 | -13.8 | | -13.4 | -13.8 | | |
| | | Full range | -13.3 | | | -13.3 | | | |
| AVD Large-signal differential voltage amplification | $V_O = \pm 10 \text{ V}$ | 25°C | 100 | 450 | | 100 | 450 | | V/mV |
| | | Full range | 75 | | | 75 | | | |
| r _j Input resistance | $R_L = 2 \text{ k}\Omega$ | 25°C | | 65 | | | 65 | | $M\Omega$ |
| c _j Input capacitance | | 25°C | | 2.5 | | | 2.5 | | pF |
| z_o Open-loop output impedance | $f = 1 \text{ MHz}$ | 25°C | | 30 | | | 30 | | Ω |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 25°C | 85 | 108 | | 85 | 108 | | dB |
| | | Full range | 80 | | | 80 | | | |
| k _{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5 \text{ V to } \pm 15 \text{ V}$, $R_S = 50 \Omega$ | 25°C | 90 | 106 | | 90 | 106 | | dB |
| | | Full range | 85 | | | 85 | | | |
| I _{OS} Short-circuit output current | $V_O = 0$ | $V_{ID} = 1 \text{ V}$ $V_{ID} = -1 \text{ V}$ | 25°C | -25 | -50 | -25 | -50 | | mA |
| | | | | 20 | 31 | 20 | 31 | | |
| I _{CC} Supply current | $V_O = 0$, No load | | 25°C | | 6.9 | 9 | | 6.9 | mA |
| | | | Full range | | | 9.4 | | 9.4 | |

[†] Full range is 0°C to 70°C.

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

| PARAMETER | TEST CONDITIONS | TLE2142C | | | TLE2142AC | | | UNIT |
|-------------|---|--|-----------------------------|-------|-----------|-------|-------|------------------------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR+ | Positive slew rate | $A_{VD} = -1$, $R_L = 2 \text{ k}\Omega$, $C_L = 500 \text{ pF}$ | 27 | 45 | 27 | 45 | 27 | $\text{V}/\mu\text{s}$ |
| SR- | Negative slew rate | | 27 | 42 | 27 | 42 | 27 | |
| t_s | Settling time | $A_{VD} = -1$, 10-V step | To 0.1% | 0.34 | 0.34 | 0.34 | 0.34 | μs |
| | | | To 0.01% | 0.4 | 0.4 | 0.4 | 0.4 | |
| V_n | Equivalent input noise voltage | $R_S = 20 \Omega$, | $f = 10 \text{ Hz}$ | 15 | 15 | 15 | 15 | $\text{nV}/\sqrt{\text{Hz}}$ |
| | | $R_S = 20 \Omega$, | $f = 1 \text{ kHz}$ | 10.5 | 10.5 | 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 | 0.48 | 0.48 | μV |
| | | $f = 0.1 \text{ Hz to } 10 \text{ Hz}$ | | 0.51 | 0.51 | 0.51 | 0.51 | |
| I_n | Equivalent input noise current | $f = 10 \text{ Hz}$ | | 1.89 | 1.89 | 1.89 | 1.89 | $\text{pA}/\sqrt{\text{Hz}}$ |
| | | $f = 1 \text{ kHz}$ | | 0.47 | 0.47 | 0.47 | 0.47 | |
| THD + N | Total harmonic distortion plus noise | $V_{O(PP)} = 20 \text{ V}$, $A_{VD} = 10$, $f = 10 \text{ kHz}$ | | 0.01% | 0.01% | 0.01% | 0.01% | |
| B_1 | Unity-gain bandwidth | $R_L = 2 \text{ k}\Omega$, | $C_L = 100 \text{ pF}$ | 6 | 6 | 6 | 6 | MHz |
| | Gain-bandwidth product | $R_L = 2 \text{ k}\Omega$, $f = 100 \text{ kHz}$ | $C_L = 100 \text{ pF}$ | 5.9 | 5.9 | 5.9 | 5.9 | MHz |
| B_{OM} | Maximum output-swing bandwidth | $V_{O(PP)} = 20 \text{ V}$, $A_{VD} = 1$, | $R_L = 2 \text{ k}\Omega$, | 668 | 668 | 668 | 668 | kHz |
| ϕ_m | Phase margin at unity gain | $R_L = 2 \text{ k}\Omega$, | $C_L = 100 \text{ pF}$ | 58° | 58° | 58° | 58° | |

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

| PARAMETER | TEST CONDITIONS | T_A^\dagger | TLE2144C | | | TLE2144AC | | | UNIT |
|--|--|--|------------|------|------|-----------|------|------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_O = 2.5$ V, $V_{IC} = 2.5$ V | 25°C | 0.5 | 3.8 | 4.4 | 0.5 | 3 | 3.6 | mV |
| | | | Full range | | | | | | |
| | | Full range | 1.7 | | | 1.7 | | | $\mu\text{V}/^\circ\text{C}$ |
| | | $R_S = 50 \Omega$, | 25°C | 8 | 100 | 8 | 100 | 150 | nA |
| | | | Full range | | | | | | |
| | | 25°C | -0.8 | -2 | -2.1 | -0.8 | -2 | -2.1 | μA |
| I_{IB} Input bias current | | | Full range | | | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50 \Omega$ | 25°C | 0 | -0.3 | 3 | 3.2 | 0 | -0.3 | V |
| | | | to | to | 3 | 3.2 | to | to | |
| | | Full range | 0 | to | 2.9 | 3.2 | 0 | to | V |
| | | | Full range | to | 2.9 | 3.2 | to | 2.9 | |
| V_{OH} High-level output voltage | $I_{OH} = -150 \mu\text{A}$ | 25°C | 3.9 | 4.1 | 3.8 | 3.9 | 4.1 | 3.8 | V |
| | | Full range | | | | | | | |
| | | $I_{OH} = -1.5 \text{ mA}$ | 25°C | 3.8 | 4 | 3.7 | 3.8 | 4 | |
| | | | Full range | | | | | | |
| | | $I_{OH} = -15 \text{ mA}$ | 25°C | 3.4 | 3.7 | 3.4 | 3.4 | 3.7 | |
| | | | Full range | | | | | | |
| V_{OL} Low-level output voltage | $I_{OL} = 150 \mu\text{A}$ | 25°C | 75 | 125 | 150 | 75 | 125 | 150 | mV |
| | | | Full range | | | | | | |
| | | $I_{OL} = 1.5 \text{ mA}$ | 25°C | 150 | 225 | 250 | 150 | 225 | |
| | | | Full range | | | | | | |
| | | $I_{OL} = 15 \text{ mA}$ | 25°C | 1.2 | 1.6 | 1.7 | 1.2 | 1.6 | V |
| | | | Full range | | | | | | |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = \pm 2.5$ V, $R_L = 2 \text{ k}\Omega$, $V_O = 1$ V to -1.5 V | 25°C | 50 | 95 | 25 | 50 | 95 | 25 | V/mV |
| | | Full range | | | | | | | |
| 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 MHz | 25°C | | 30 | | 30 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 25°C | 85 | 118 | 80 | 85 | 118 | dB |
| | | | Full range | | | | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5$ V to ± 15 V, $R_S = 50 \Omega$ | 25°C | 90 | 106 | 85 | 90 | 106 | 85 | dB |
| | | Full range | | | | | | | |
| I_{CC} Supply current | $V_O = 2.5$ V, $V_{IC} = 2.5$ V | No load, | 25°C | 13.2 | 17.6 | 18.5 | 13.2 | 17.6 | mA |
| | | | Full range | | | | | | |

[†] Full range is 0°C to 70°C.

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TLE2144C operating characteristics, $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$

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

† R_L terminates at 2.5 V

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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_A^\dagger | TLE2144C | | | TLE2144AC | | | UNIT | |
|--|--|-----------------|------------|-------|------|-----------|-------|------|-------------------|----|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{IO} Input offset voltage | $V_{IC} = 0$, $V_O = 0$ | 25°C | 0.6 | 2.4 | | 0.5 | 1.5 | | mV | |
| | | | Full range | | 3.2 | | | 2.4 | | |
| αV_{IO} Temperature coefficient of input offset voltage | | Full range | | 1.7 | | 1.7 | | 1.7 | $\mu V/^{\circ}C$ | |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA | |
| I_{IO} Input offset current | | Full range | | 150 | | 150 | | 150 | | |
| | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA | |
| | | Full range | | -1.6 | | | | -1.6 | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50 \Omega$ | 25°C | -15 | -15.3 | | -15 | -15.3 | | V | |
| | | | to | to | | to | to | | | |
| | | | 13 | 13.2 | | 13 | 13.2 | | | |
| | | Full range | -15 | -15.3 | | -15 | -15 | | | |
| | | | to | to | | to | to | | | |
| | | | 12.9 | 13.1 | | 12.9 | 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 | | | | |
| V_{OM-} Maximum negative peak output voltage swing | $I_O = -15 mA$ | 25°C | 13.1 | 13.7 | | 13.1 | 13.7 | | | |
| | | Full range | 13 | | | 13 | | | | |
| | $I_O = 150 \mu A$ | 25°C | -14.7 | -14.9 | | -14.7 | -14.9 | | V | |
| | | Full range | -14.6 | | | -14.6 | | | | |
| V_{OM-} Maximum negative peak output voltage swing | $I_O = 1.5 mA$ | 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 | | | | |
| AVD Large-signal differential voltage amplification | $V_O = \pm 10 V$ | 25°C | 100 | 170 | | 100 | 170 | | V/mV | |
| | | Full range | 75 | | | 75 | | | | |
| r_i Input resistance | $R_L = 2 k\Omega$ | 25°C | | 65 | | | 65 | | MΩ | |
| c_i Input capacitance | | 25°C | | 2.5 | | | 2.5 | | pF | |
| z_o Open-loop output impedance | $f = 1 MHz$ | 25°C | | 30 | | | 30 | | Ω | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}, R_S = 50 \Omega$ | 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 | $V_O = 0$ | $V_{ID} = 1 V$ | 25°C | -25 | -50 | | -25 | -50 | mA | |
| | | | 20 | 31 | | 20 | 31 | | | |
| | | $V_{ID} = -1 V$ | 25°C | | 13.8 | 18 | | 13.8 | 18 | |
| I_{CC} Supply current | $V_O = 0$, | No load | Full range | | 18.8 | | | 18.8 | | mA |

† Full range is 0°C to 70°C.

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

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

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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 | $V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$ | $R_S = 50\ \Omega$ | 25°C | 225 | 1400 | 200 | 1000 | 1500 | μV | | |
| | | | Full range | | 1900 | | | | | | |
| | | | Full range | | 1.7 | | 1.7 | | $\mu\text{V}/^\circ\text{C}$ | | |
| αV_{IO} Temperature coefficient of input offset voltage | | | 25°C | 8 | 100 | 8 | 100 | 200 | nA | | |
| | | | Full range | | 200 | | | | | | |
| | | | 25°C | -0.8 | -2 | -0.8 | -2 | -2.2 | μA | | |
| I_{IB} Input bias current | | | Full range | | -2.2 | | | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | 25°C | 0 | -0.3 | | 0 | -0.3 | | V | | |
| | | | to | to | | to | to | | | | |
| | | | 3 | 3.2 | | 3 | 3.2 | | | | |
| | | Full range | 0 | -0.3 | | 0 | -0.3 | | V | | |
| | | | to | to | | to | to | | | | |
| | | | 2.7 | 2.9 | | 2.7 | 2.9 | | | | |
| V_{OH} High-level output voltage | $I_{OH} = -150\ \mu\text{A}$, $I_{OH} = -1.5\ \text{mA}$, $I_{OH} = -15\ \text{mA}$, $I_{OH} = -100\ \mu\text{A}$, $I_{OH} = -1\ \text{mA}$, $I_{OH} = -10\ \text{mA}$ | 25°C | 3.9 | 4.1 | | 3.9 | 4.1 | | V | | |
| | | | 3.8 | 4 | | 3.8 | 4 | | | | |
| | | | 3.2 | 3.7 | | 3.2 | 3.7 | | | | |
| | | Full range | 3.8 | | | 3.8 | | | | | |
| | | | 3.7 | | | 3.7 | | | | | |
| | | | 3.3 | | | 3.3 | | | | | |
| V_{OL} Low-level output voltage | $I_{OL} = 150\ \mu\text{A}$, $I_{OL} = 1.5\ \mu\text{A}$, $I_{OL} = 15\ \text{mA}$, $I_{OL} = 100\ \mu\text{A}$, $I_{OL} = 1\ \text{mA}$, $I_{OL} = 10\ \text{mA}$ | 25°C | 75 | 125 | | 75 | 125 | | mV | | |
| | | | 150 | 225 | | 150 | 225 | | | | |
| | | | 1.2 | 1.6 | | 1.2 | 1.6 | | | | |
| | | Full range | 175 | | | 175 | | | mV | | |
| | | | 225 | | | 225 | | | | | |
| | | | 1.4 | | | 1.4 | | | | | |
| AVD Large-signal differential voltage amplification | $V_{CC} = \pm 2.5\text{ V}$, $R_L = 2\ \text{k}\Omega$, $V_O = 1\text{ V}$ to -1.5 V | 25°C | 50 | 220 | | 50 | 220 | | V/mV | | |
| | | Full range | 10 | | | 10 | | | | | |
| 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 | | Ω | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50\ \Omega$ | 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 | | 3.4 | 4.4 | | 3.4 | 4.4 | mA | | |
| | | Full range | | | 4.6 | | | 4.6 | | | |

† Full range is -40°C to 105°C .

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

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

† R_L and C_L terminated to 2.5 V.

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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 | $V_{IC} = 0$, $V_O = 0$ | $R_S = 50 \Omega$ | 25°C | 200 | 900 | 175 | 500 | | μV | | |
| | | | Full range | | 1500 | | 1000 | | | | |
| | | | Full range | | 1.7 | | 1.7 | | $\mu V/^\circ C$ | | |
| α_{VIO} Temperature coefficient of input offset voltage | | | 25°C | 7 | 100 | 7 | 100 | | nA | | |
| | | | Full range | | 200 | | 200 | | | | |
| | | | 25°C | -0.7 | -1.5 | -0.7 | -1.5 | | μA | | |
| I_{IB} Input bias current | | | Full range | | -1.7 | | -1.7 | | | | |
| $R_S = 50 \Omega$ | | 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 | | | | | |
| | | 25°C | 13.8 | 14.1 | 13.8 | 14.1 | | | | | |
| | | | 13.7 | 14 | 13.7 | 14 | | | | | |
| | | | 13.1 | 13.7 | 13.1 | 13.7 | | | | | |
| | | V_{OM+} Maximum positive peak output voltage swing | | | Full range | 13.7 | | 13.7 | | | V |
| | | | | | | 13.6 | | 13.6 | | | |
| | | | | | | 13.1 | | 13.1 | | | |
| | | | | | 25°C | -14.7 | -14.9 | -14.7 | -14.9 | | |
| | | | | | | -14.5 | -14.8 | -14.5 | -14.8 | | |
| | | | | | | -13.4 | -13.8 | -13.4 | -13.8 | | |
| | | V_{OM-} Maximum negative peak output voltage swing | | | Full range | -14.6 | | -14.6 | | | V |
| | | | | | | -14.5 | | -14.5 | | | |
| | | | | | | -13.4 | | -13.4 | | | |
| | | | | | 25°C | 100 | 450 | 100 | 450 | | |
| | | | | | | 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 | | Ω | | |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 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 ± 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 | | | | |

[†] Full range is -40°C to 105°C.

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

| PARAMETER | TEST CONDITIONS | TLE2141I | | | TLE2141AI | | | UNIT |
|-------------|---|--|---|------|-----------|-------|------------------------------|------------------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR+ | Positive slew rate | $A_{VD} = -1$, $R_L = 2 \text{ k}\Omega$, $C_L = 500 \text{ pF}$ | 27 | 45 | 27 | 45 | | $\text{V}/\mu\text{s}$ |
| SR- | Negative slew rate | | 27 | 42 | 27 | 42 | | |
| t_s | Settling time | $A_{VD} = -1$, 10-V step | To 0.1% | 0.34 | 0.34 | | μs | |
| | | | To 0.01% | 0.4 | 0.4 | | | |
| V_n | Equivalent input noise voltage | $R_S = 20 \Omega$, $f = 10 \text{ Hz}$ | 15 | | 15 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | | | $R_S = 20 \Omega$, $f = 1 \text{ kHz}$ | 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 | | μV | |
| | | | $f = 0.1 \text{ Hz to } 10 \text{ Hz}$ | 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 | $V_{O(PP)} = 20 \text{ V}$, $A_{VD} = 10$, | $R_L = 2 \text{ k}\Omega$, $f = 10 \text{ kHz}$ | | 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 | | $R_L = 2 \text{ k}\Omega$, $f = 100 \text{ kHz}$ | | 5.9 | 5.9 | | |
| B_{OM} | Maximum output-swing bandwidth | $V_{O(PP)} = 20 \text{ V}$, $A_{VD} = 1$, | $R_L = 2 \text{ k}\Omega$, $C_L = 100 \text{ pF}$ | | 668 | 668 | kHz | |
| ϕ_m | Phase margin at unity gain | $R_L = 2 \text{ k}\Omega$, | $C_L = 100 \text{ pF}$ | | 58° | 58° | | |

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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 | $V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$ | 25°C | 220 | 1900 | | 220 | 1500 | | μV |
| | | | Full range | | 2400 | | | 2000 | |
| | | Full range | | 1.7 | | | 1.7 | | $\mu\text{V}/^\circ\text{C}$ |
| | | 25°C | 8 | 100 | | 8 | 100 | | nA |
| | | | Full range | | 200 | | | 200 | |
| | | 25°C | -0.8 | -2 | | -0.8 | -2 | | μA |
| | | | Full range | | -2.2 | | | -2.2 | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\Omega$ | 25°C | 0 | -0.3 | | 0 | -0.3 | | V |
| | | | to | to | | to | to | | |
| | | Full range | 3 | 3.2 | | 3 | 3.2 | | V |
| | | | 0 | -0.3 | | 0 | -0.3 | | |
| | | Full range | to | to | | to | to | | V |
| | | | 2.7 | 2.9 | | 2.7 | 2.9 | | |
| V_{OH} High-level output voltage | $I_{OH} = -150\text{ }\mu\text{A}$, $I_{OH} = -1.5\text{ mA}$, $I_{OH} = -15\text{ mA}$, $I_{OH} = 100\text{ }\mu\text{A}$, $I_{OH} = 1\text{ mA}$, $I_{OH} = 10\text{ mA}$ | 25°C | 3.9 | 4.1 | | 3.9 | 4.1 | | V |
| | | | 3.8 | 4 | | 3.8 | 4 | | |
| | | | 3.4 | 3.7 | | 3.4 | 3.7 | | |
| | | Full range | 3.8 | | | 3.8 | | | |
| | | | 3.7 | | | 3.7 | | | |
| | | | 3.5 | | | 3.5 | | | |
| V_{OL} Low-level output voltage | $I_{OI} = 150\text{ }\mu\text{A}$, $I_{OL} = 1.5\text{ mA}$, $I_{OL} = 15\text{ mA}$, $I_{OL} = 100\text{ }\mu\text{A}$, $I_{OL} = 1\text{ mA}$, $I_{OL} = 10\text{ mA}$ | 25°C | 75 | 125 | | 75 | 125 | | mV |
| | | | 150 | 225 | | 150 | 225 | | |
| | | | 1.2 | 1.4 | | 1.2 | 1.4 | | |
| | | Full range | 175 | | | 175 | | | mV |
| | | | 225 | | | 225 | | | |
| | | | 1.2 | | | 1.2 | | | |
| AVD 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 V | 25°C | 50 | 220 | | 50 | 220 | | V/mV |
| | | Full range | 10 | | | 10 | | | |
| 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 | | Ω |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50\Omega$ | 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 | | 6.6 | 8.8 | | 6.6 | mA |
| | | | Full range | | | 9.2 | | 9.2 | |

† Full range is -40°C to 105°C .

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

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

† R_L terminates at 2.5 V.



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

SLOS183B – FEBRUARY 1997 – REVISED APRIL 2004

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 | $V_{IC} = 0$, $V_O = 0$ | 25°C | 290 | 1200 | | 275 | 750 | | μV | |
| | | | Full range | | 1800 | | 1400 | | | |
| αV_{IO} Temperature coefficient of input offset voltage | | Full range | | 1.7 | | 1.7 | | 1.7 | $\mu V/^\circ C$ | |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA | |
| | | | Full range | | 200 | | 200 | | | |
| I_{IO} Input offset current | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA | |
| | | | Full range | | -1.7 | | -1.7 | | | |
| I_{IB} Input bias current | $R_S = 50 \Omega$ | 25°C | -15 | -15.3 | | -15 | -15.3 | | V | |
| | | | to | to | | to | to | | | |
| | | Full range | 13 | 13.2 | | 13 | 13.2 | | V | |
| | | | -15 | -15.3 | | -15 | -15.3 | | | |
| V_{ICR} Common-mode input voltage range | | Full range | to | to | | to | to | | V | |
| | | | 12.7 | 12.9 | | 12.7 | 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 | |
| | | | 13.7 | 14 | | 13.7 | 14 | | | |
| | | | 13.3 | 13.7 | | 13.3 | 13.7 | | | |
| | $I_O = -1.5 mA$ | Full range | 13.7 | | | 13.7 | | | | |
| | | | 13.6 | | | 13.6 | | | | |
| | | | 13.3 | | | 13.3 | | | | |
| V_{OM-} Maximum negative peak output voltage swing | $I_O = -100 \mu A$ | 25°C | -14.7 | -14.9 | | -14.7 | -14.9 | | V | |
| | | | -14.5 | -14.8 | | -14.5 | -14.8 | | | |
| | | | -13.4 | -13.8 | | -13.4 | -13.8 | | | |
| | | Full range | -14.6 | | | -14.6 | | | | |
| | | | -14.5 | | | -14.5 | | | | |
| | | | -13.4 | | | -13.4 | | | | |
| AVD 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 | | Ω | |
| $CMRR$ Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$ | 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 | $V_O = 0$ | $V_{ID} = 1 V$ | -25 | -50 | | -25 | -50 | | mA | |
| | | | 20 | 31 | | 20 | 31 | | | |
| I_{CC} Supply current | $V_O = 0$, | No load | 25°C | | 6.9 | 9 | | 6.9 | mA | |
| | | | Full range | | | 9.4 | | 9.4 | | |

[†] Full range is $-40^\circ C$ to $105^\circ C$.

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

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



**TLE214x, TLE214xA
EXCALIBUR LOW-NOISE HIGH-SPEED
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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 | $V_{IC} = 0$, $V_O = 0$ | $R_S = 50\ \Omega$ | 25°C | 0.5 | 3.8 | 0.5 | 3 | 4 | mV | | |
| | | | Full range | | 4.8 | | | 4 | | | |
| | | | Full range | | 1.7 | | 1.7 | | $\mu\text{V}/^\circ\text{C}$ | | |
| αV_{IO} Temperature coefficient of input offset voltage | | | 25°C | 8 | 100 | 8 | 100 | 200 | nA | | |
| | | | Full range | | 200 | | | 200 | | | |
| | | | 25°C | -0.8 | -2 | -0.8 | -2 | -2.2 | μA | | |
| I_{IB} Input bias current | | | Full range | | -2.2 | | | -2.2 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | 25°C | 0 | -0.3 | 0 | -0.3 | | | | | |
| | | | to | to | to | to | | | | | |
| | | | 3 | 3.2 | 3 | 3.2 | | | | | |
| | $R_S = 50\ \Omega$ | Full range | 0 | -0.3 | 0 | -0.3 | | | | | |
| | | | to | to | to | to | | | | | |
| | | | 2.7 | 2.9 | 2.7 | 2.9 | | | | | |
| V_{OH} High-level output voltage | $I_{OH} = -150\ \mu\text{A}$ $I_{OH} = -1.5\ \text{mA}$ $I_{OH} = -15\ \text{mA}$ $I_{OH} = 100\ \mu\text{A}$ $I_{OH} = 1\ \text{mA}$ $I_{OH} = 10\ \text{mA}$ | 25°C | 3.9 | 4.1 | 3.9 | 4.1 | | | | | |
| | | | 3.8 | 4 | 3.8 | 4 | | | | | |
| | | | 3.4 | 3.7 | 3.4 | 3.7 | | | | | |
| | | Full range | 3.8 | | 3.8 | | | | | | |
| | | | 3.7 | | 3.7 | | | | | | |
| | | | 3.5 | | 3.5 | | | | | | |
| V_{OL} Low-level output voltage | $I_{OL} = 150\ \mu\text{A}$ $I_{OL} = 1.5\ \mu\text{A}$ $I_{OL} = 15\ \text{mA}$ $I_{OL} = 100\ \mu\text{A}$ $I_{OL} = 1\ \text{mA}$ $I_{OL} = 10\ \text{mA}$ | 25°C | 75 | 125 | 75 | 125 | | | mV | | |
| | | | 150 | 225 | 150 | 225 | | | | | |
| | | | 1.2 | 1.6 | 1.2 | 1.6 | | | V | | |
| | | Full range | 175 | | 175 | | | | mV | | |
| | | | 225 | | 225 | | | | | | |
| | | | 1.4 | | 1.4 | | | | V | | |
| AVD 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 V | 25°C | 50 | 95 | 50 | 95 | | | | | |
| | | Full range | 10 | | 10 | | | | V/mV | | |
| 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 | | | Ω | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50\ \Omega$ | 25°C | 85 | 118 | 85 | 118 | | | | | |
| | | Full range | 80 | | 80 | | | | dB | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5\text{ V}$ to $\pm 15\text{ V}$, $R_S = 50\ \Omega$ | 25°C | 90 | 106 | 90 | 106 | | | | | |
| | | Full range | 85 | | 85 | | | | dB | | |
| I_{CC} Supply current | $V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$ | 25°C | | 13.2 | 17.6 | 13.2 | 17.6 | | | | |
| | | Full range | | | 18.4 | | 18.4 | | mA | | |

[†] Full range is -40°C to 105°C .

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

SLOS183B – FEBRUARY 1997 – REVISED APRIL 2004

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

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

† R_L terminates at 2.5 V

**TLE214x, TLE214xA
EXCALIBUR LOW-NOISE HIGH-SPEED
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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 | $V_{IC} = 0$, $V_O = 0$ | 25°C | 0.6 | 2.4 | | 0.5 | 1.5 | | mV | | |
| | | | Full range | | 3.2 | | | 2.8 | | | |
| αV_{IO} Temperature coefficient of input offset voltage | | Full range | | 1.7 | | | 1.7 | | $\mu V/^\circ C$ | | |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA | | |
| | | | Full range | | 200 | | | 200 | | | |
| I_{IO} Input offset current | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA | | |
| | | | Full range | | -1.7 | | | -1.7 | | | |
| I_{IB} Input bias current | | $R_S = 50 \Omega$ | 25°C | -15 | -15.3 | | -15 | -15.3 | V | | |
| | | | | to | to | | to | to | | | |
| | | | Full range | 13 | 13.2 | | 13 | 13.2 | | | |
| | | | | -15 | -15.3 | | -15 | -15.3 | | | |
| | | | Full range | to | to | | to | to | | | |
| | | | | 12.7 | 12.9 | | 12.7 | 12.9 | | | |
| V_{ICR} Common-mode input voltage range | | $R_S = 50 \Omega$ | 25°C | 13.8 | 14.1 | | 13.8 | 14.1 | V | | |
| | | | | 13.7 | 14 | | 13.7 | 14 | | | |
| | | | Full range | 13.1 | 13.7 | | 13.1 | 13.7 | | | |
| | | | | 13.7 | | | 13.7 | | | | |
| V_{OM+} Maximum positive peak output voltage swing | | | Full range | 13.6 | | | 13.6 | | V | | |
| | | | | 13.1 | | | 13.1 | | | | |
| V_{OM-} Maximum negative peak output voltage swing | | | 25°C | -14.7 | -14.9 | | -14.7 | -14.9 | V | | |
| | | | | -14.5 | -14.8 | | -14.5 | -14.8 | | | |
| | | | Full range | -13.4 | -13.8 | | -13.4 | -13.8 | | | |
| | | | | -14.6 | | | -14.6 | | | | |
| AVD Large-signal differential voltage amplification | $V_O = \pm 10$ V, $R_L = 2$ k Ω | 25°C | -14.5 | | | -14.5 | | | V/mV | | |
| | | | Full range | 40 | | | 40 | | | | |
| r_i | Input resistance | | 25°C | | 65 | | | 65 | M Ω | | |
| c_i | Input capacitance | | 25°C | | 2.5 | | | 2.5 | pF | | |
| z_o | Open-loop output impedance | $f = 1$ MHz | 25°C | | 30 | | | 30 | Ω | | |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 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 ± 15 V, $R_S = 50 \Omega$ | 25°C | 90 | 106 | | 90 | 106 | dB | | |
| | | | Full range | 85 | | | 85 | | | | |
| I_{OS} | Short-circuit output current | $V_O = 0$ | $V_{ID} = 1$ V $V_{ID} = -1$ V | 25°C | -25 | -50 | | -25 | mA | | |
| | | | | | 20 | 31 | | 20 | | | |
| I_{CC} | Supply current | $V_O = 0$, No load | | 25°C | 13.8 | 18 | | 13.8 | mA | | |
| | | | | Full range | | 18.8 | | 18.8 | | | |

[†] Full range is $-40^\circ C$ to $105^\circ C$.

TLE214x, TLE214xA
EXCALIBUR LOW-NOISE HIGH-SPEED
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TLE2144I operating characteristics, $V_{CC\pm} = \pm 15$ V, $T_A = 25^\circ C$

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

**TLE214x, TLE214xA
EXCALIBUR LOW-NOISE HIGH-SPEED
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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 | $V_O = 2.5\text{ V}$ $V_{IC} = 2.5\text{ V}$ | $R_S = 50\ \Omega$ | 25°C | 225 | 1400 | 200 | 1000 | 1700 | μV | | |
| | | | Full range | | 2100 | | | | | | |
| | | | Full range | | 1.7 | | 1.7 | | $\mu\text{V}/^\circ\text{C}$ | | |
| αV_{IO} Temperature coefficient of input offset voltage | | | 25°C | 8 | 100 | 8 | 100 | 250 | nA | | |
| | | | Full range | | 250 | | | | | | |
| | | | 25°C | -0.8 | -2 | -0.8 | -2 | -2.3 | μA | | |
| I_{IB} Input bias current | | | Full range | | -2.3 | | | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | 25°C | 0 | -0.3 | 0 | -0.3 | 0 | 3.2 | V | | |
| | | | to | to | to | to | to | 3.2 | | | |
| | | | 3 | 3.2 | 3 | 3.2 | 2.7 | 2.9 | | | |
| | | Full range | 0 | -0.3 | 0 | -0.3 | 0 | 3.2 | V | | |
| | | | to | to | to | to | 2.7 | 2.9 | | | |
| | | | 2.7 | 2.9 | 2.7 | 2.9 | | | | | |
| V_{OH} High-level output voltage | | 25°C | $I_{OH} = -150\ \mu\text{A}$ | 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 | | | | |
| | | Full range | $I_{OH} = -100\ \mu\text{A}$ | 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 | | 25°C | $I_{OL} = 150\ \mu\text{A}$ | 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 | | | | |
| | | Full range | $I_{OL} = 100\ \mu\text{A}$ | 200 | | 200 | | | mV | | |
| | | | $I_{OL} = 1\text{ mA}$ | 250 | | 225 | | | | | |
| | | | $I_{OL} = 10\text{ mA}$ | 1.25 | | 1.25 | | | | | |
| AVD 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 | 220 | 50 | 220 | | | 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 | | | Ω | | |
| $CMRR$ Common-mode rejection ratio | $V_{IC} = V_{ICR\min}, R_S = 50\ \Omega$ | 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 | 3.4 | 4.4 | 3.4 | 4.4 | | mA | | |
| | | | Full range | | 4.6 | | | | | | |

† Full range is -55°C to 125°C .

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

SLOS183B – FEBRUARY 1997 – REVISED APRIL 2004

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

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

† R_L and C_L terminated to 2.5 V.

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

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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 | | | μV | |
| | | Full range | | 1700 | | 1200 | | | | |
| | | Full range | | 1.7 | | 1.7 | | | $\mu V/^\circ C$ | |
| | | 25°C | 7 | 100 | 7 | 100 | | | | |
| | | Full range | | 250 | | 250 | | | nA | |
| | | 25°C | -0.7 | -1.5 | -0.7 | -1.5 | | | | |
| I_{IB} Input bias current | | Full range | | -1.8 | | -1.8 | | | μA | |
| | | | | | | | | | | |
| | | 25°C | -15 to 13 | -15.3 to 13.2 | -15 | -15.3 | | | V | |
| | | Full range | -15 to 12.7 | -15.3 to 12.9 | -15 | -15.3 | | | | |
| | | | | | | | | | V | |
| | | | | | | | | | | |
| V_{OM+} Maximum positive peak output voltage swing | $I_O = -150\mu A$ $I_O = -1.5mA$ $I_O = -15mA$ $I_O = -100\mu A$ $I_O = -1mA$ $I_O = -10mA$ | 25°C | 13.8 | 14.1 | 13.8 | 14.1 | | | V | |
| | | | 13.7 | 14 | 13.7 | 14 | | | | |
| | | | 13.1 | 13.7 | 13.1 | 13.7 | | | | |
| | | Full range | 13.7 | | 13.7 | | | | | |
| | | | 13.6 | | 13.6 | | | | | |
| | | | 13.1 | | 13.1 | | | | | |
| V_{OM-} Maximum negative peak output voltage swing | $I_O = 150\mu A$ $I_O = 1.5mA$ $I_O = 15mA$ $I_O = 100\mu A$ $I_O = 1mA$ $I_O = 10mA$ | 25°C | -14.7 | -14.9 | -14.7 | -14.9 | | | V | |
| | | | -14.5 | -14.8 | -14.5 | -14.8 | | | | |
| | | | -13.4 | -13.8 | -13.4 | -13.8 | | | | |
| | | Full range | -14.6 | | -14.6 | | | | | |
| | | | -14.5 | | -14.5 | | | | | |
| | | | -13.4 | | -13.4 | | | | | |
| AVD Large-signal differential voltage amplification | $V_O = \pm 10V$, $R_L = 2k\Omega$ | 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 | $f = 1MHz$ | 25°C | | 30 | | 30 | | | Ω | |
| 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 ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5V$ to $\pm 15V$, $R_S = 50\Omega$ | 25°C | 90 | 106 | 90 | 106 | | | dB | |
| | | Full range | 85 | | 85 | | | | | |
| I_{OS} Short-circuit output current | $V_O = 0$ | $V_{ID} = 1V$ $V_{ID} = -1V$ | 25°C | -25 | -50 | -25 | -50 | | mA | |
| | | | | 20 | 31 | 20 | 31 | | | |
| I_{CC} Supply current | $V_O = 0$, $V_{IC} = 2.5V$ | No load, | 25°C | 3.5 | 4.5 | 3.5 | 4.5 | | mA | |
| | | | Full range | | 4.7 | | 4.7 | | | |

[†] Full range is $-55^\circ C$ to $125^\circ C$.

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

SLOS183B – FEBRUARY 1997 – REVISED APRIL 2004

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

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

**TLE214x, TLE214xA
EXCALIBUR LOW-NOISE HIGH-SPEED
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SLOS183B – FEBRUARY 1997 – REVISED APRIL 2004

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 | $V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$ $R_S = 50\ \Omega$ | 25°C | 220 | 1900 | | 200 | 1500 | | μV |
| | | Full range | | 2600 | | | 2200 | | |
| | | Full range | | 1.7 | | | 1.7 | | $\mu\text{V}/^\circ\text{C}$ |
| | | 25°C | 8 | 100 | | 8 | 100 | | nA |
| | | Full range | | 200 | | | 200 | | |
| | | 25°C | -0.8 | -2 | | -0.8 | -2 | | μA |
| I_{IB} Input bias current | | Full range | | -2.3 | | | -2.3 | | |
| $R_S = 50\ \Omega$ | 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 | | | |
| | 25°C | 3.9 3.8 3.4 | 4.1 4 3.7 | | 3.9 3.8 3.4 | 4.1 4 3.7 | | V | |
| | Full range | 3.75 3.65 3.45 | | | 3.75 3.65 3.45 | | | | |
| | 25°C | 75 150 1.2 | 125 225 1.4 | | 75 150 1.2 | 125 225 1.4 | | mV | |
| V_{OL} Low-level output voltage | $I_{OL} = 150\ \mu\text{A}$ $I_{OL} = 1.5\text{ mA}$ $I_{OL} = 15\text{ mA}$ $I_{OL} = 100\ \mu\text{A}$ $I_{OL} = 1\text{ mA}$ $I_{OL} = 10\text{ mA}$ | 25°C | 200 | | | 200 | | | mV |
| | | Full range | 250 | | | 250 | | | |
| | | 25°C | | 1.25 | | | 1.25 | | V |
| | | Full range | | | | | | | mV |
| | | 25°C | 75 150 1.2 | 125 225 1.4 | | 75 150 1.2 | 125 225 1.4 | | |
| | | Full range | 200 250 1.25 | | | 200 250 1.25 | | | V |
| AVD 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 V | 25°C | 50 | 220 | | 50 | 220 | | 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 | | Ω |
| $CMRR$ Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50\ \Omega$ | 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 | | 6.6 9.2 | | 6.6 9.2 | | mA |
| | | | Full range | | | | | | |

[†] Full range is -55°C to 125°C .



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TLE214x, TLE214xA
**EXCALIBUR LOW-NOISE HIGH-SPEED
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TLE2142M operating characteristics, $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$

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

† 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 | | μV |
| | | Full range | | 2000 | | | 1600 | | |
| | | Full range | | 1.7 | | | 1.7 | | $\mu V/^\circ C$ |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA |
| | | Full range | | 250 | | | 250 | | |
| | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA |
| I_{IB} Input bias current | | Full range | | -1.8 | | | -1.8 | | |
| $R_S = 50\Omega$ | 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 | | | |
| | $I_O = -150\mu A$ | | 13.8 | 14.1 | 13.8 | 14.1 | | V | |
| | $I_O = -1.5mA$ | | 13.7 | 14 | 13.7 | 14 | | | |
| | $I_O = -15mA$ | | 13.3 | 13.7 | 13.3 | 13.7 | | | |
| V_{OM+} Maximum positive peak output voltage swing | $I_O = -100\mu A$ | | 13.7 | | | 13.7 | | | V |
| | | $I_O = -100\mu A$ | | 13.6 | | 13.6 | | | |
| | | $I_O = -10mA$ | | 13.3 | | 13.3 | | | |
| | | $I_O = 150\mu A$ | | -14.7 | -14.9 | -14.7 | -14.9 | | V |
| | | $I_O = 1.5mA$ | | -14.5 | -14.8 | -14.5 | -14.8 | | |
| | | $I_O = 15mA$ | | -13.4 | -13.8 | -13.4 | -13.8 | | |
| V_{OM-} Maximum negative peak output voltage swing | $I_O = 100\mu A$ | 25°C | -14.6 | | | -14.6 | | | V |
| | | | $I_O = 1mA$ | | | -14.5 | | | |
| | | | $I_O = 10mA$ | | | -13.4 | | | |
| | | Full range | $I_O = 150\mu A$ | -14.7 | -14.9 | -14.7 | -14.9 | | |
| | | | $I_O = 1.5mA$ | -14.5 | -14.8 | -14.5 | -14.8 | | |
| | | | $I_O = 15mA$ | -13.4 | -13.8 | -13.4 | -13.8 | | |
| AVD Large-signal differential voltage amplification | $V_O = \pm 10V$, $R_L = 2k\Omega$ | 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 | $f = 1MHz$ | 25°C | | 30 | | | 30 | | Ω |
| 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 ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5V$ to $\pm 15V$, $R_S = 50\Omega$ | 25°C | 90 | 106 | | 90 | 106 | | dB |
| | | Full range | 85 | | | 85 | | | |
| I_{OS} Short-circuit output current | $V_O = 0$ | $V_{ID} = 1V$ | 25°C | -25 | -50 | | -25 | -50 | mA |
| | | $V_{ID} = -1V$ | | 20 | 31 | | 20 | 31 | |
| I_{CC} Supply current | $V_O = 0$, $V_{IC} = 2.5V$ | No load, | 25°C | 6.9 | 9 | | 6.9 | 9 | mA |
| | | | Full range | | | 9.4 | | | |

[†] 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, $V_{CC\pm} = \pm 15$ V, $T_A = 25^\circ C$

| PARAMETER | TEST CONDITIONS | TLE2142M | | | TLE2142AM | | | UNIT |
|-------------|---|--|---|-------|-----------|-------|-------|------------------------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR+ | Positive slew rate | $R_L = 2 \text{ k}\Omega$, $A_{VD} = -1$, $C_L = 100 \text{ pF}$ | 27 | 45 | 27 | 45 | 27 | $\text{V}/\mu\text{s}$ |
| SR- | Negative slew rate | | 27 | 42 | 27 | 42 | 27 | |
| t_s | Settling time | $A_{VD} = -1$, 10-V step | To 0.1% | 0.34 | 0.34 | 0.34 | 0.34 | μs |
| | | | To 0.01% | 0.4 | 0.4 | 0.4 | 0.4 | |
| V_n | Equivalent input noise voltage | $R_S = 20 \Omega$, | $f = 10 \text{ Hz}$ | 15 | 15 | 15 | 15 | $\text{nV}/\sqrt{\text{Hz}}$ |
| | | $R_S = 20 \Omega$, | $f = 1 \text{ kHz}$ | 10.5 | 10.5 | 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 | 0.48 | 0.48 | μV |
| | | $f = 0.1 \text{ Hz to } 10 \text{ Hz}$ | | 0.51 | 0.51 | 0.51 | 0.51 | |
| I_n | Equivalent input noise current | $f = 10 \text{ Hz}$ | | 1.89 | 1.89 | 1.89 | 1.89 | $\text{pA}/\sqrt{\text{Hz}}$ |
| | | $f = 1 \text{ kHz}$ | | 0.47 | 0.47 | 0.47 | 0.47 | |
| THD + N | Total harmonic distortion plus noise | $V_O(PP) = 20 \text{ V}$, $A_{VD} = 10$, | $R_L = 2 \text{ k}\Omega$, $f = 10 \text{ kHz}$ | 0.01% | 0.01% | 0.01% | 0.01% | |
| B_1 | Unity-gain bandwidth | $R_L = 2 \text{ k}\Omega$, | $C_L = 100 \text{ pF}$ | 6 | 6 | 6 | 6 | MHz |
| | Gain-bandwidth product | $R_L = 2 \text{ k}\Omega$, $f = 100 \text{ kHz}$ | $C_L = 100 \text{ pF}$ | 5.9 | 5.9 | 5.9 | 5.9 | MHz |
| B_{OM} | Maximum output-swing bandwidth | $V_O(PP) = 20 \text{ V}$, $A_{VD} = 1$, | $R_L = 2 \text{ k}\Omega$, $C_L = 100 \text{ pF}$ | 668 | 668 | 668 | 668 | kHz |
| ϕ_m | Phase margin at unity gain | $R_L = 2 \text{ k}\Omega$, | $C_L = 100 \text{ pF}$ | 58° | 58° | 58° | 58° | |

**TLE214x, TLE214xA
EXCALIBUR LOW-NOISE HIGH-SPEED
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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 | $V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$ | 25°C | 0.5 | 3.8 | 5.2 | 0.5 | 3 | 4.4 | mV | |
| | | | Full range | | | 1.7 | | 1.7 | | |
| | | | Full range | | | 8 | 100 | 250 | μV/°C | |
| α_{VIO} Temperature coefficient of input offset voltage | | 25°C | 8 | 100 | 100 | 8 | 100 | 250 | nA | |
| | | Full range | | | 250 | | | | | |
| | | 25°C | -0.8 | -2 | -2 | -0.8 | -2 | -2 | μA | |
| I_{IB} Input bias current | | 25°C | | | -2.3 | | | -2.3 | V | |
| | | | 0 | -0.3 | 3.2 | 0 | -0.3 | 3.2 | | |
| | | | to | to | 3.2 | to | to | 3.2 | | |
| | | Full range | 0 | -0.3 | 2.9 | 0 | -0.3 | 2.9 | V | |
| | | | to | to | 2.9 | to | to | 2.9 | | |
| | | | 2.7 | 2.9 | | 2.7 | 2.9 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\Omega$ | 25°C | 3.9 | 4.1 | 4.1 | 3.9 | 4.1 | 4.1 | V | |
| | | | 3.8 | 4 | 4 | 3.8 | 4 | 4 | | |
| | | | 3.4 | 3.7 | 3.7 | 3.4 | 3.7 | 3.7 | | |
| | | Full range | 3.75 | | | 3.75 | | | V | |
| | | | 3.65 | | | 3.65 | | | | |
| | | | 3.45 | | | 3.45 | | | | |
| V_{OH} High-level output voltage | $I_{OH} = -150\mu\text{A}$ $I_{OH} = -1.5\text{ mA}$ $I_{OH} = -15\text{ mA}$ $I_{OH} = 100\mu\text{A}$ $I_{OH} = 1\text{ mA}$ $I_{OH} = 10\text{ mA}$ | 25°C | 75 | 125 | 125 | 75 | 125 | 125 | mV | |
| | | | 150 | 225 | 225 | 150 | 225 | 225 | | |
| | | | 1.2 | 1.6 | 1.6 | 1.2 | 1.6 | 1.6 | | |
| | | Full range | 200 | | | 200 | | | mV | |
| | | | 250 | | | 250 | | | | |
| | | | 1.45 | | | 1.45 | | | | |
| V_{OL} Low-level output voltage | $I_{OL} = 150\mu\text{A}$ $I_{OL} = 1.5\mu\text{A}$ $I_{OL} = 15\text{ mA}$ $I_{OL} = 100\mu\text{A}$ $I_{OL} = 1\text{ mA}$ $I_{OL} = 10\text{ mA}$ | 25°C | 75 | 125 | 125 | 75 | 125 | 125 | mV | |
| | | | 150 | 225 | 225 | 150 | 225 | 225 | | |
| | | | 1.2 | 1.6 | 1.6 | 1.2 | 1.6 | 1.6 | | |
| | | Full range | 200 | | | 200 | | | mV | |
| | | | 250 | | | 250 | | | | |
| | | | 1.45 | | | 1.45 | | | | |
| AVD 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 V | 25°C | 50 | 95 | 95 | 50 | 95 | 95 | V/mV | |
| | | Full range | 5 | | | 5 | | | | |
| r_i | Input resistance | 25°C | | 70 | | | 70 | | MΩ | |
| c_i | Input capacitance | 25°C | | 2.5 | | | 2.5 | | pF | |
| z_o | Open-loop output impedance | f = 1 MHz | 25°C | | 30 | | 30 | | Ω | |
| $CMRR$ Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50\Omega$ | 25°C | 85 | 118 | 118 | 85 | 118 | 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 | 106 | 90 | 106 | 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 | | | | |

† Full range is -55°C to 125°C .

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

| PARAMETER | TEST CONDITIONS | TLE2144M | | | TLE2144AM | | | UNIT | |
|-------------|---|--|-----------------------------------|--|-----------|-----|------|------------------------------|--|
| | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| SR+ | Positive slew rate | $\text{AVD} = -1$, $R_L = 2 \text{ k}\Omega^\dagger$, $C_L = 500 \text{ pF}$ | | 45 | | | 45 | $\text{V}/\mu\text{s}$ | |
| SR- | Negative slew rate | | | 42 | | | 42 | | |
| t_s | Settling time | $\text{AVD} = -1$, 2.5-V step | To 0.1% | 0.16 | | | 0.16 | μs | |
| | | | To 0.01% | 0.22 | | | 0.22 | | |
| V_n | Equivalent input noise voltage | $R_S = 20 \Omega$, $f = 10 \text{ Hz}$ | | 15 | | | 15 | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | | | | $R_S = 20 \Omega$, $f = 1 \text{ kHz}$ | | | 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 | μV | |
| | | | | $f = 0.1 \text{ Hz to } 10 \text{ Hz}$ | | | 0.51 | | |
| I_n | Equivalent input noise current | $f = 10 \text{ Hz}$ | | 1.92 | | | 1.92 | $\text{pA}/\sqrt{\text{Hz}}$ | |
| | | | | $f = 1 \text{ kHz}$ | | | 0.5 | | |
| THD + N | Total harmonic distortion plus noise | $V_O = 1 \text{ V to } 3 \text{ V}$, $\text{AVD} = 2$, $f = 10 \text{ kHz}$ | | 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 | $R_L = 2 \text{ k}\Omega^\dagger$, $f = 100 \text{ kHz}$ | $C_L = 100 \text{ pF}$ | 5.8 | | | 5.8 | | |
| B_{OM} | Maximum output-swing bandwidth | $V_O(\text{PP}) = 2 \text{ V}$, $\text{AVD} = 1$ | $R_L = 2 \text{ k}\Omega^\dagger$ | 660 | 660 | | | kHz | |
| ϕ_m | Phase margin | $R_L = 2 \text{ k}\Omega^\dagger$ | $C_L = 100 \text{ pF}$ | 57° | 57° | | | | |

† R_L terminates at 2.5 V

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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 | $V_{IC} = 0$, $R_S = 50\Omega$ | 25°C | 0.6 | 2.4 | | 0.5 | 1.5 | | mV | |
| | | Full range | | 4 | | | 3.2 | | | |
| | | Full range | | 1.7 | | | 1.7 | | $\mu V/^\circ C$ | |
| | | 25°C | 7 | 100 | | 7 | 100 | | nA | |
| | | Full range | | 250 | | | 250 | | | |
| | | 25°C | -0.7 | -1.5 | | -0.7 | -1.5 | | μA | |
| I_{IB} Input bias current | | Full range | | -1.8 | | | -1.8 | | | |
| $R_S = 50\Omega$ | 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 | | | | |
| | $I_O = -150\mu A$ | | 13.8 | 14.1 | 13.8 | 14.1 | | V | | |
| | $I_O = -1.5\text{ mA}$ | | 13.7 | 14 | 13.7 | 14 | | | | |
| | $I_O = -15\text{ mA}$ | | 13.1 | 13.7 | 13.1 | 13.7 | | | | |
| | V_{OM+} Maximum positive peak output voltage swing | | $I_O = -100\mu A$ | | 13.7 | | 13.7 | | | V |
| | | | $I_O = -1\text{ mA}$ | | 13.6 | | 13.6 | | | |
| | | | $I_O = -10\text{ mA}$ | | 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 | | |
| | $I_O = 1.5\text{ mA}$ | | -14.5 | -14.8 | -14.5 | -14.8 | | | | |
| | $I_O = 15\text{ mA}$ | | -13.4 | -13.8 | -13.4 | -13.8 | | | | |
| | $I_O = 100\mu A$ | Full range | -14.6 | | -14.6 | | | | | |
| | $I_O = 1\text{ mA}$ | | -14.5 | | -14.5 | | | | | |
| | $I_O = 10\text{ mA}$ | | -13.4 | | -13.4 | | | | | |
| AVD Large-signal differential voltage amplification | $V_O = \pm 10\text{ V}$, $R_L = 2\text{ k}\Omega$ | 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 | $f = 1\text{ MHz}$ | 25°C | | 30 | | | 30 | | Ω | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\min}$, $R_S = 50\Omega$ | 25°C | 85 | 108 | | 85 | 108 | | dB | |
| | | Full range | 80 | | | 80 | | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$, $R_S = 50\Omega$ | 25°C | 90 | 106 | | 90 | 106 | | dB | |
| | | Full range | 85 | | | 85 | | | | |
| I_{OS} Short-circuit output current | $V_O = 0$ | $V_{ID} = 1\text{ V}$ | 25°C | -25 | -50 | -25 | -50 | | mA | |
| | | $V_{ID} = -1\text{ V}$ | | 20 | 31 | 20 | 31 | | | |
| I_{CC} Supply current | $V_O = 0$, $V_{IC} = 2.5\text{ V}$ | No load, | 25°C | 13.8 | 18 | 13.8 | 18 | | mA | |
| | | | Full range | | 18.8 | | 18.8 | | | |

[†] Full range is $-55^\circ C$ to $125^\circ C$



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TLE214x, TLE214xA
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PRECISION OPERATIONAL AMPLIFIERS

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

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

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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} | $V_{IC} = 0$, $V_O = 0$ | $R_S = 50 \Omega$, | 200 | 1000 | μV |
| I_{IO} | | | 7 | 100 | nA |
| I_{IB} | | | -0.7 | -1.5 | μA |
| V_{ICR} | $R_S = 50 \Omega$ | -15 to 13 | | -15.3 to 13.2 | V |
| V_{OM+} | | $I_O = -150 \mu\text{A}$ | 13.8 | 14.1 | |
| V_{OM-} | $I_O = -1.5 \text{ mA}$ | 13.7 | | 14 | V |
| | $I_O = -15 \text{ mA}$ | 13.3 | | 13.7 | |
| | $I_O = 150 \mu\text{A}$ | -14.7 to 13.4 | | -14.9 to 13.8 | |
| A_{VD} | $V_O = \pm 10 \text{ V}$, $R_L = 2 \text{ k}\Omega$ | 100 | 450 | | V/mV |
| r_i | | | | 65 | $\text{M}\Omega$ |
| c_i | | | | 2.5 | pF |
| z_o | $f = 1 \text{ MHz}$ | | | 30 | Ω |
| $CMRR$ | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 80 | 108 | | dB |
| k_{SVR} | $V_{CC\pm} = \pm 2.5 \text{ V}$ to $\pm 15 \text{ V}$, $R_S = 50 \Omega$ | 85 | 106 | | dB |
| I_{OS} | $V_O = 0$ | $V_{ID} = 1 \text{ V}$ | -25 to 20 | | mA |
| | | $V_{ID} = -1 \text{ V}$ | -50 to 31 | | |
| I_{CC} | $V_O = 0$, No load | | | 3.5 to 4.5 | mA |

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

| PARAMETER | TEST CONDITIONS | TLE2142Y | | | UNIT |
|-----------|---|---------------------|--|---------------------|---------------|
| | | MIN | TYP | MAX | |
| V_{IO} | $V_{IC} = 0$, $V_O = 0$ | $R_S = 50 \Omega$, | 150 | 875 | μV |
| I_{IO} | | | 7 | 100 | nA |
| I_{IB} | | | -0.7 | -1.5 | μA |
| V_{ICR} | $R_S = 50 \Omega$ | | -15 to 13 | -15.3 to 13.2 | V |
| V_{OM+} | | | $I_O = -150 \mu\text{A}$ | 13.8 14.1 | |
| V_{OM-} | | | $I_O = -1.5 \text{ mA}$ | 13.7 14 | V |
| | | | $I_O = -15 \text{ mA}$ | 13.3 13.7 | |
| | | | $I_O = 150 \mu\text{A}$ | -14.7 -14.9 | |
| A_{VD} | $V_O = \pm 10 \text{ V}$, $R_L = 2 \text{ k}\Omega$ | | $I_O = 1.5 \text{ mA}$ | -14.5 -14.8 | V |
| | | | $I_O = 15 \text{ mA}$ | -13.4 -13.8 | |
| | | | 100 450 | V/mV | |
| r_i | | | 65 | M Ω | |
| c_i | | | 2.5 | pF | |
| z_o | | | 30 | Ω | |
| $CMRR$ | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | | 80 108 | dB | |
| k_{SVR} | | | $V_{CC\pm} = \pm 2.5 \text{ V}$ to $\pm 15 \text{ V}$, $R_S = 50 \Omega$ | 85 106 | |
| I_{OS} | | | $V_{ID} = 1 \text{ V}$ $V_{ID} = -1 \text{ V}$ | -25 -50 20 31 | |
| I_{CC} | $V_O = 0$, No load | | 6.9 9 | mA | |



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

| PARAMETER | TEST CONDITIONS | TLE2144Y | | | UNIT |
|-----------|--|-------------------------|-------|------|------------------|
| | | MIN | TYP | MAX | |
| V_{IO} | $V_{IC} = 0$, $V_O = 0$, $R_S = 50 \Omega$, | | 0.3 | 1.8 | mV |
| I_{IO} | | | 7 | 100 | nA |
| I_{IB} | | | -0.7 | -1.5 | μA |
| V_{ICR} | $R_S = 50 \Omega$ | -15 | -15.3 | | V |
| | | to | to | | |
| | | 13 | 13.2 | | |
| V_{OM+} | $I_O = -150 \mu\text{A}$ | 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-} | $I_O = 150 \mu\text{A}$ | -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} | $V_O = \pm 10 \text{ V}$, $R_L = 2 \text{ k}\Omega$ | 100 | 450 | | V/mV |
| r_i | | | 65 | | $\text{M}\Omega$ |
| c_i | | | 2.5 | | pF |
| z_o | $f = 1 \text{ MHz}$ | | 30 | | Ω |
| CMRR | $V_{IC} = V_{ICR\min}$, $R_S = 50 \Omega$ | 80 | 108 | | dB |
| kSVR | $V_{CC\pm} = \pm 2.5 \text{ V to } \pm 15 \text{ V}$, $R_S = 50 \Omega$ | 85 | 106 | | dB |
| I_{OS} | $V_O = 0$ | $V_{ID} = 1 \text{ V}$ | -25 | -50 | mA |
| | | $V_{ID} = -1 \text{ V}$ | 20 | 31 | |
| I_{CC} | $V_O = 0$, No load | | 13.8 | 18 | mA |

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TYPICAL CHARACTERISTICS

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| CMRR | Common-mode rejection ratio | vs Frequency vs Free-air temperature | 19 20 |
| k _{SVR} | Supply-voltage rejection ratio | vs Frequency vs Free-air temperature | 21 22 |
| I _{CC} | Supply current | vs Supply voltage vs Free-air temperature | 23 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 vs Load capacitance | 29 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 |
| φ _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

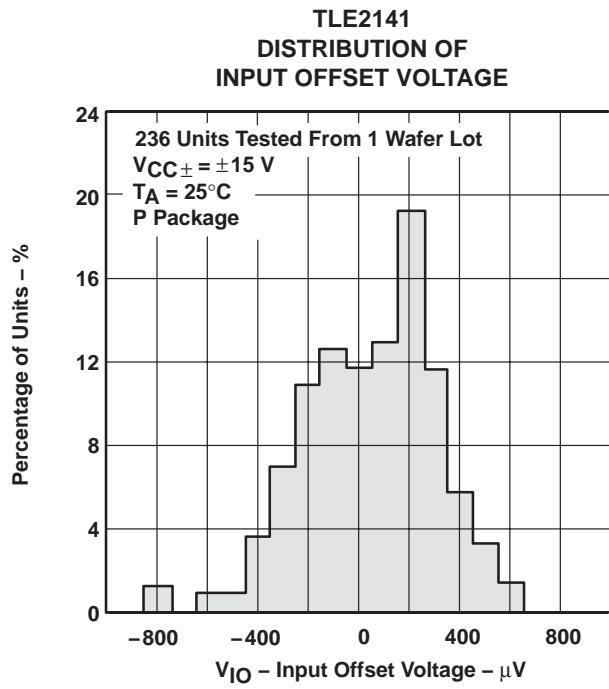


Figure 1

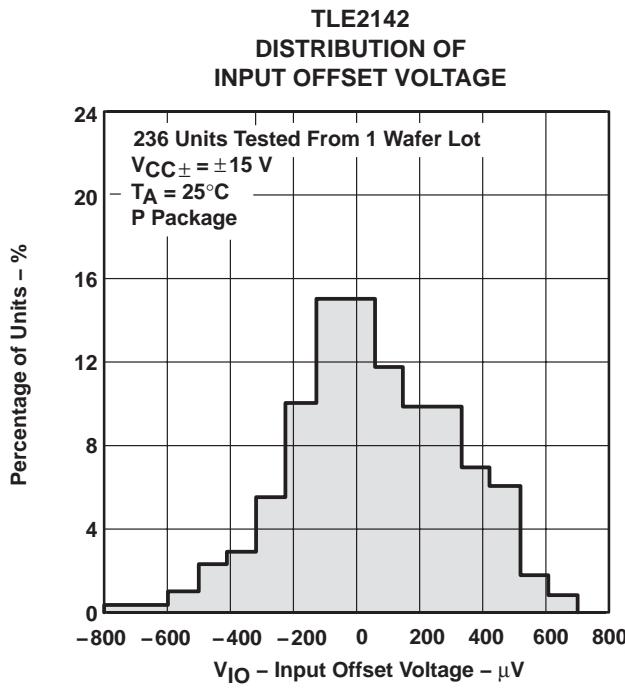


Figure 2

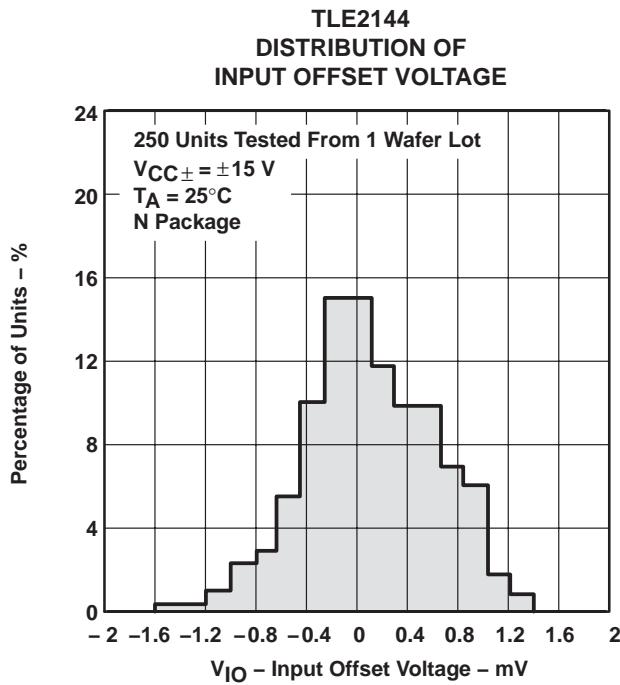


Figure 3

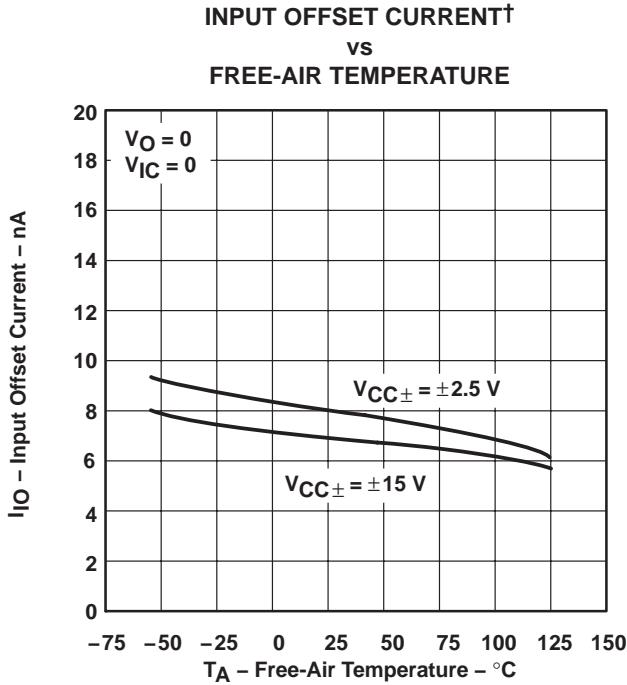


Figure 4

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

TYPICAL CHARACTERISTICS

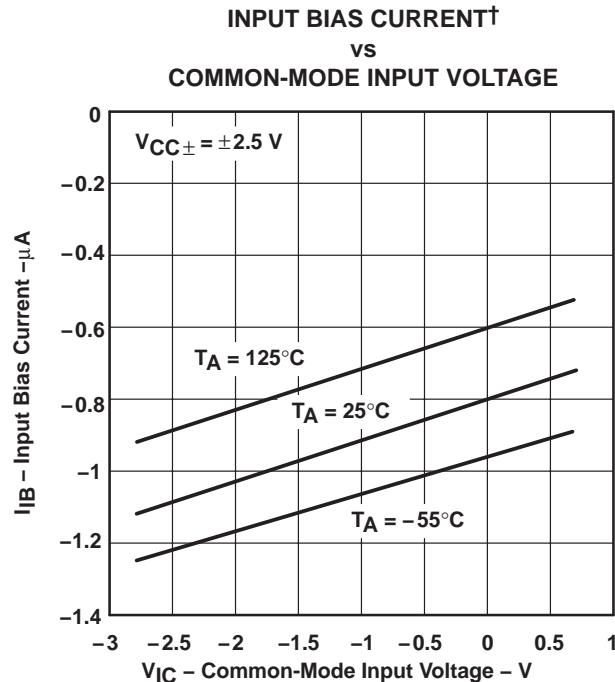


Figure 5

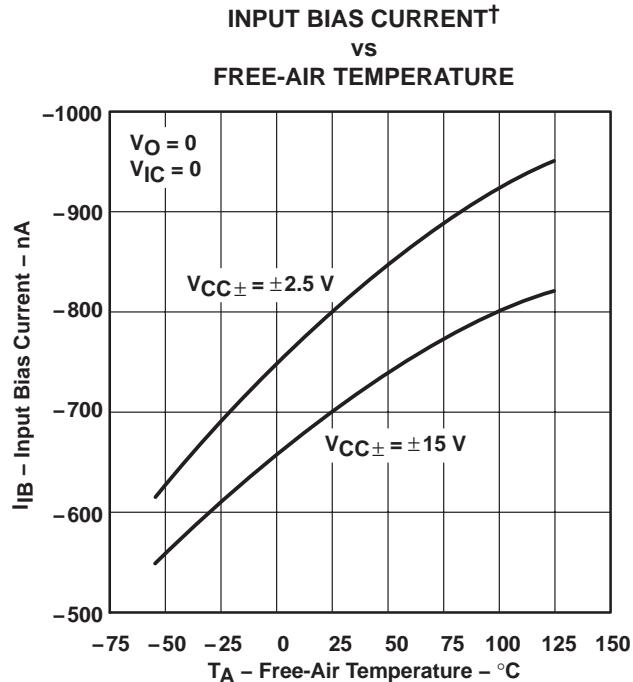


Figure 6

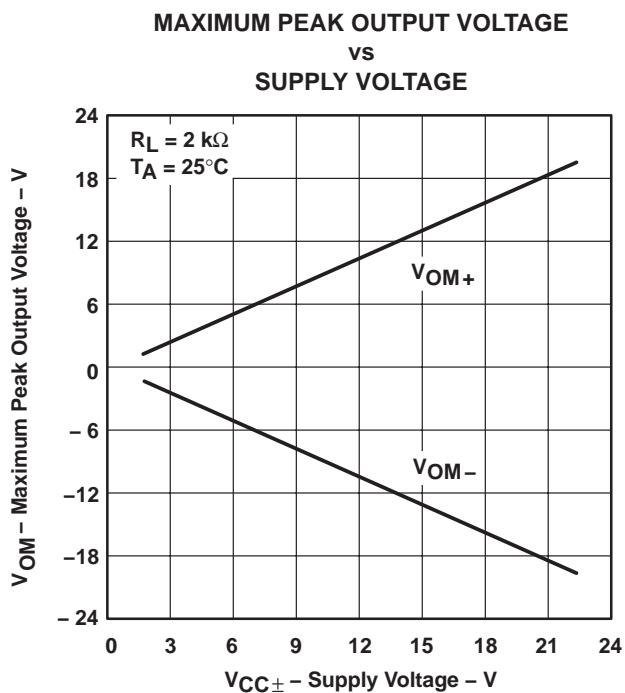


Figure 7

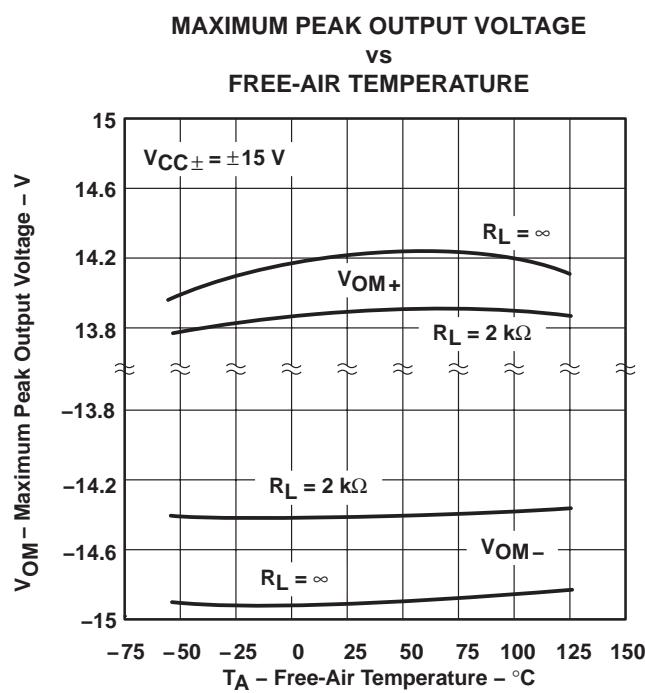


Figure 8

[†] 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

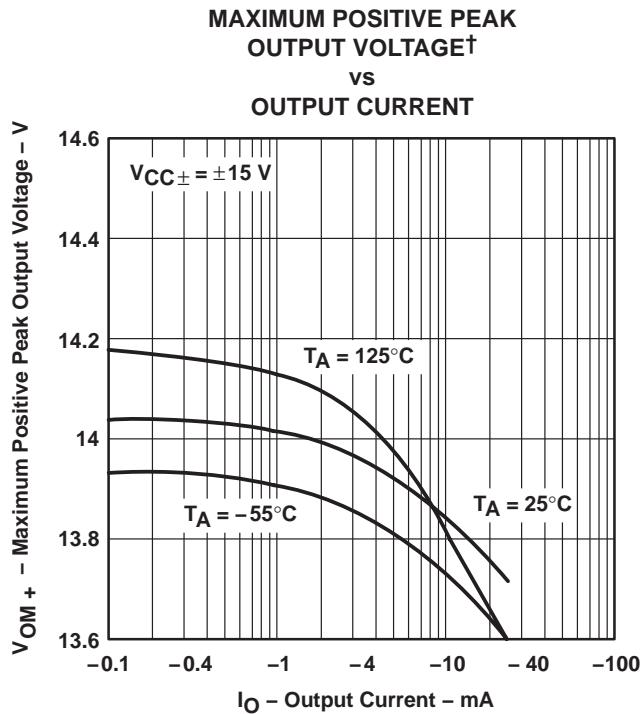


Figure 9

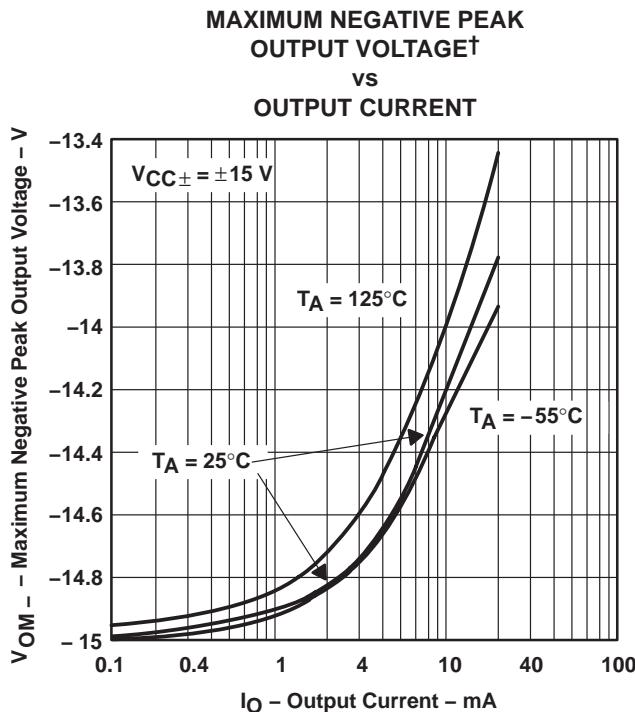


Figure 10

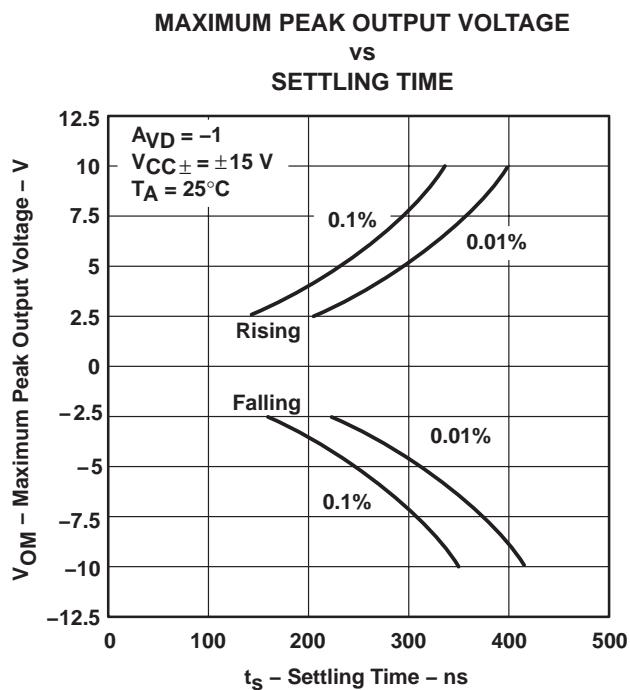


Figure 11

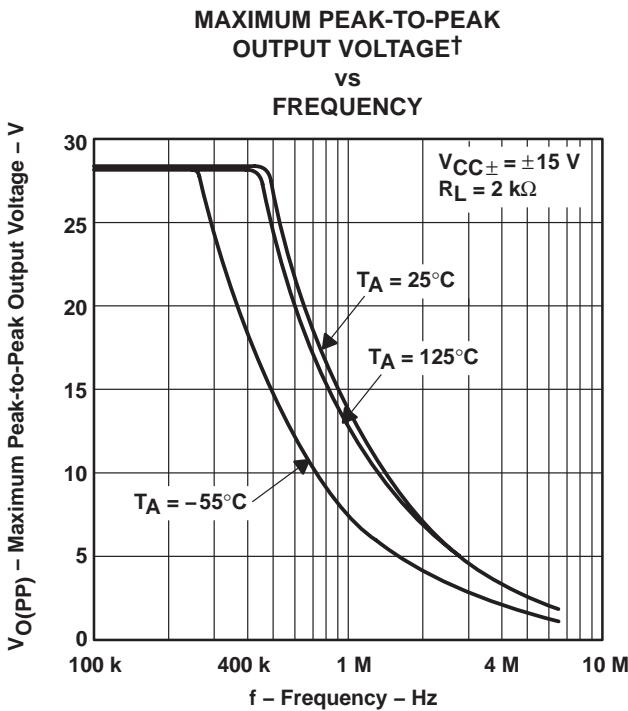


Figure 12

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

TYPICAL CHARACTERISTICS

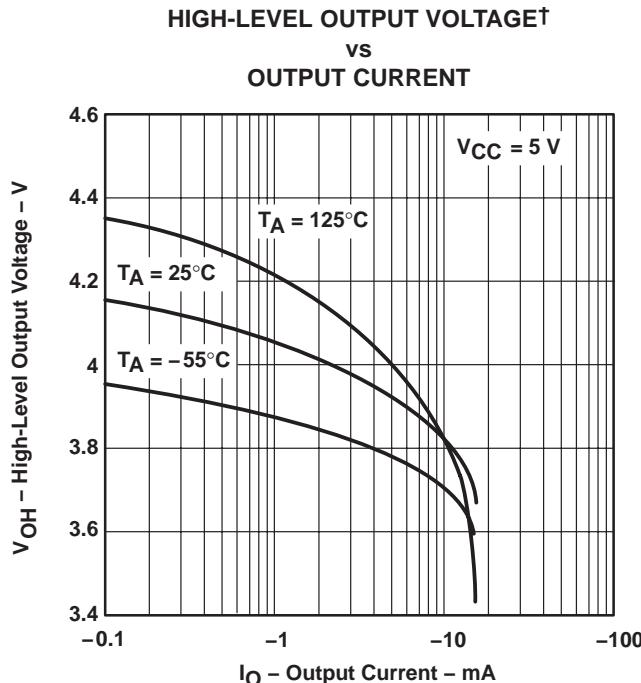


Figure 13

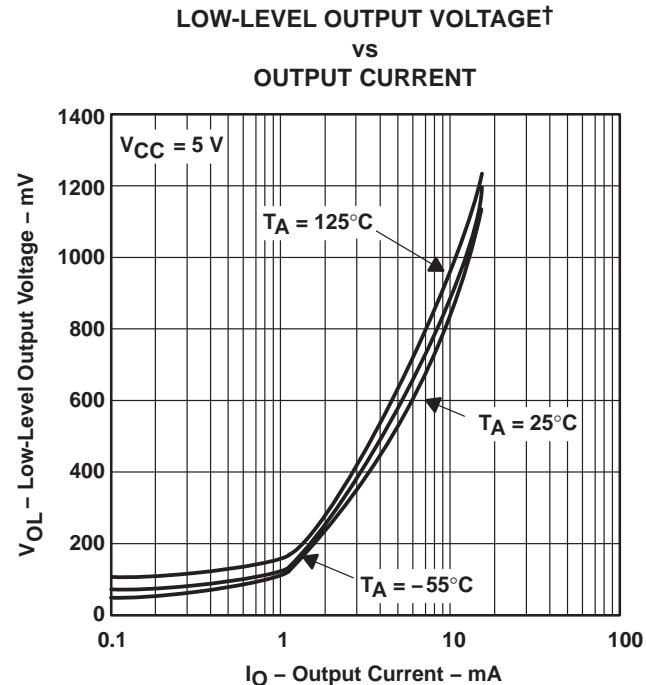


Figure 14

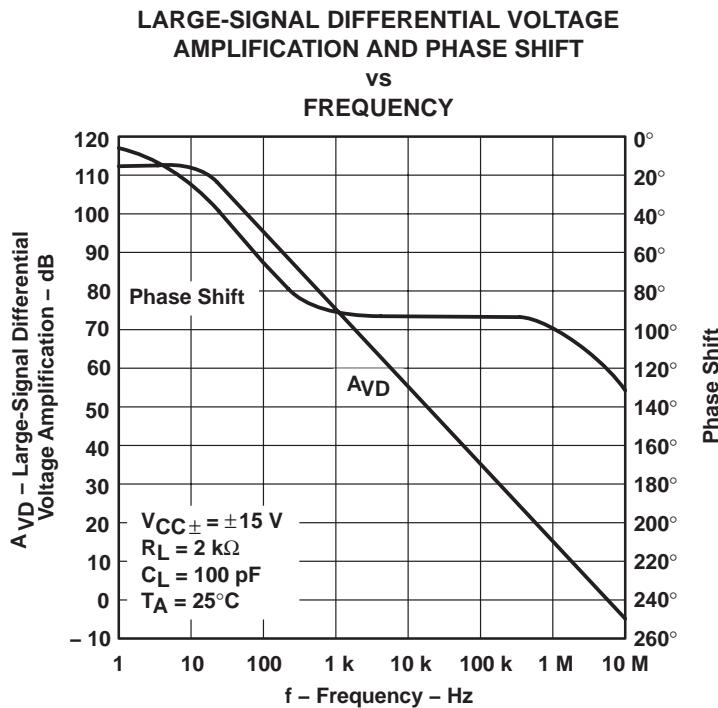


Figure 15

[†] 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

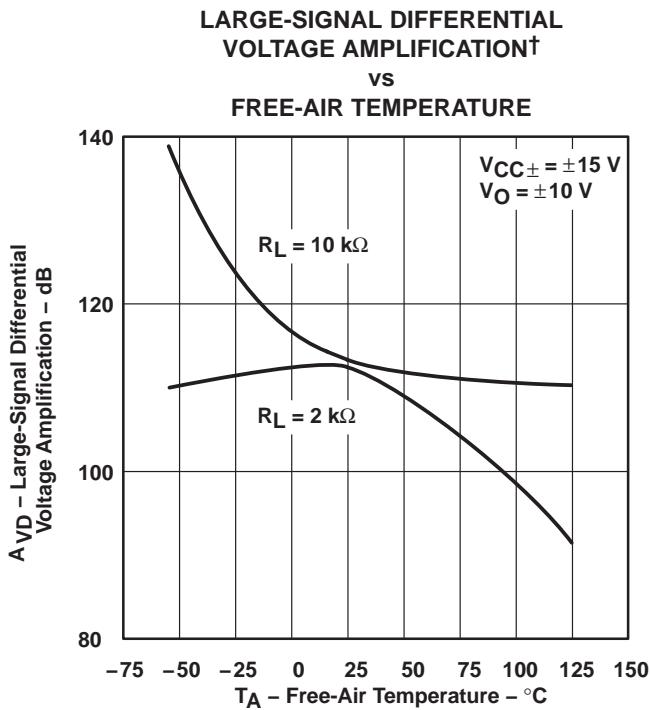


Figure 16

CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY

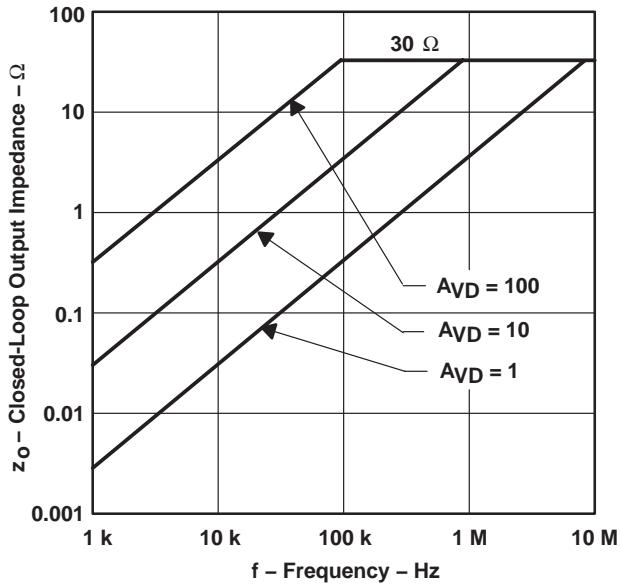


Figure 17

SHORT-CIRCUIT OUTPUT CURRENT[†] vs FREE-AIR TEMPERATURE

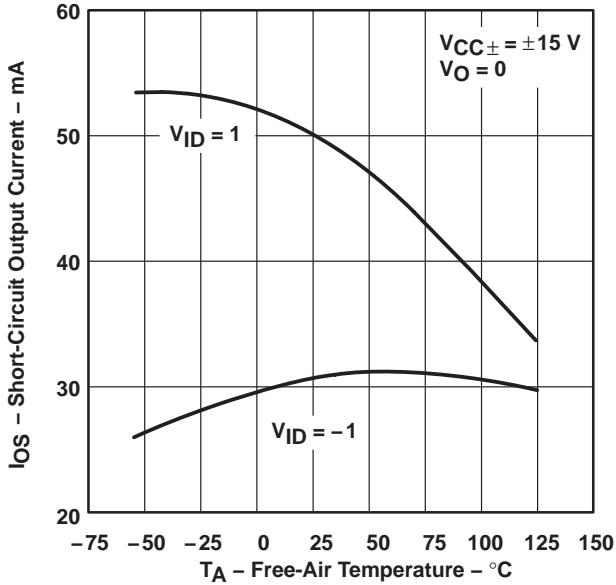


Figure 18

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

TYPICAL CHARACTERISTICS

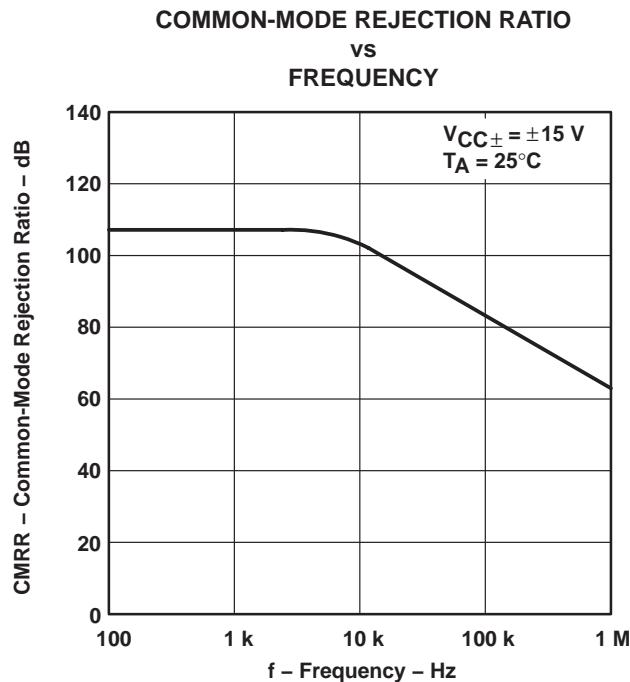


Figure 19

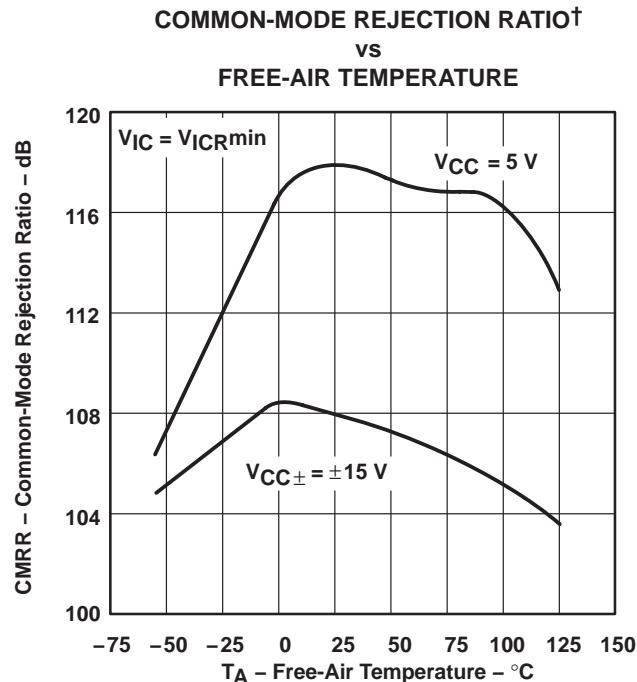


Figure 20

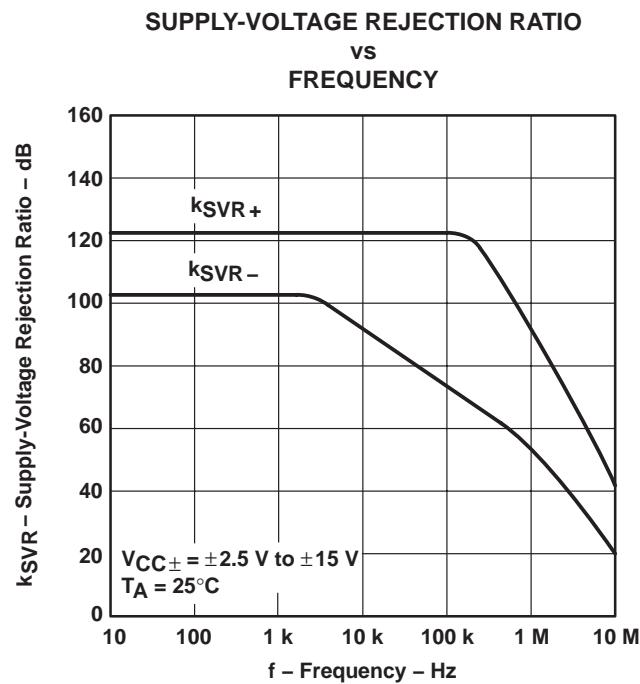


Figure 21

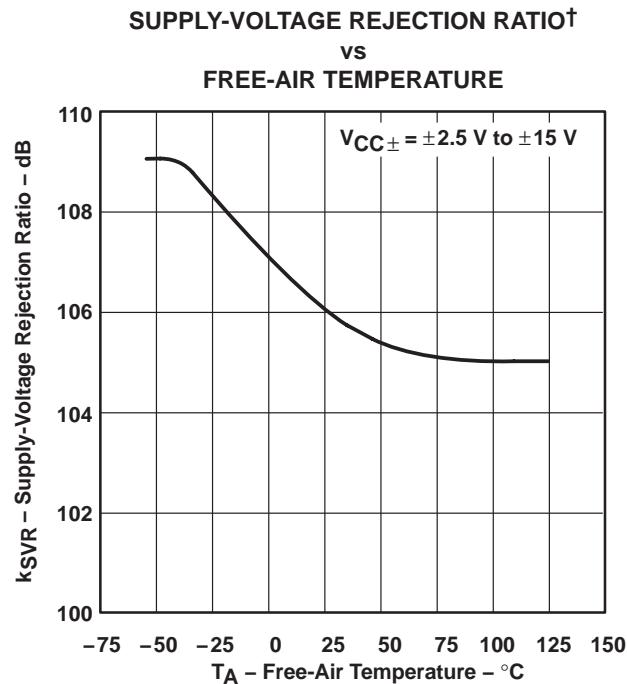


Figure 22

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

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

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TYPICAL CHARACTERISTICS

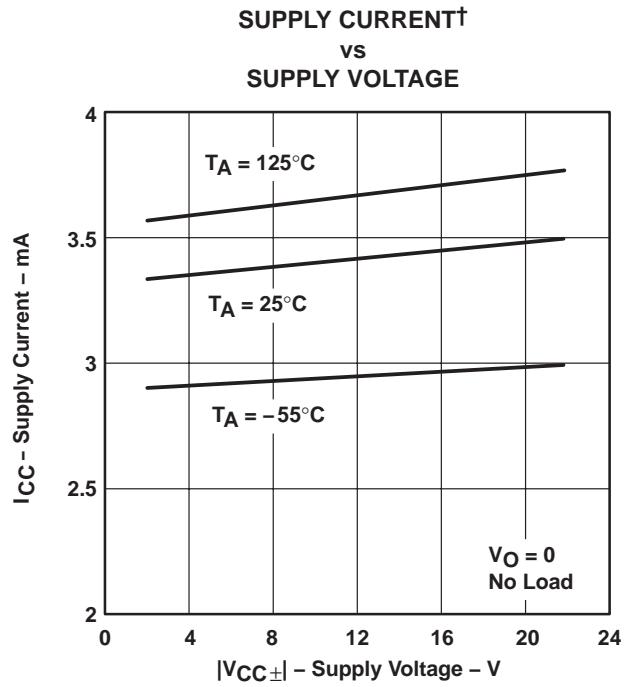


Figure 23

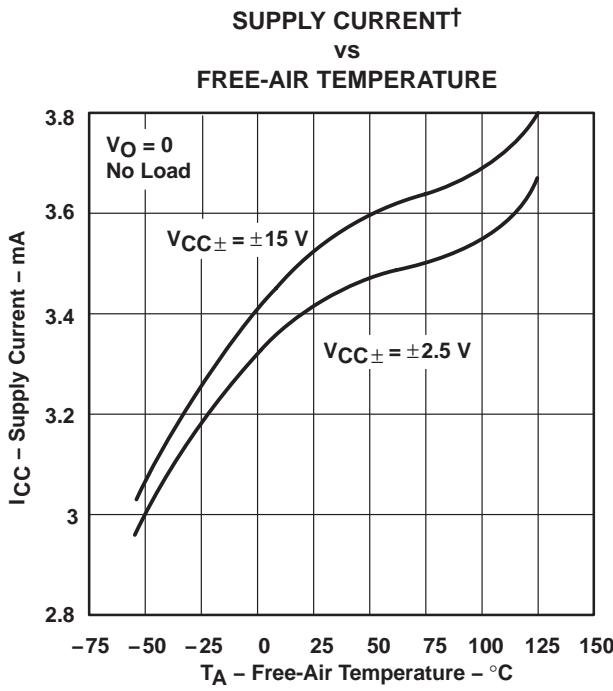


Figure 24

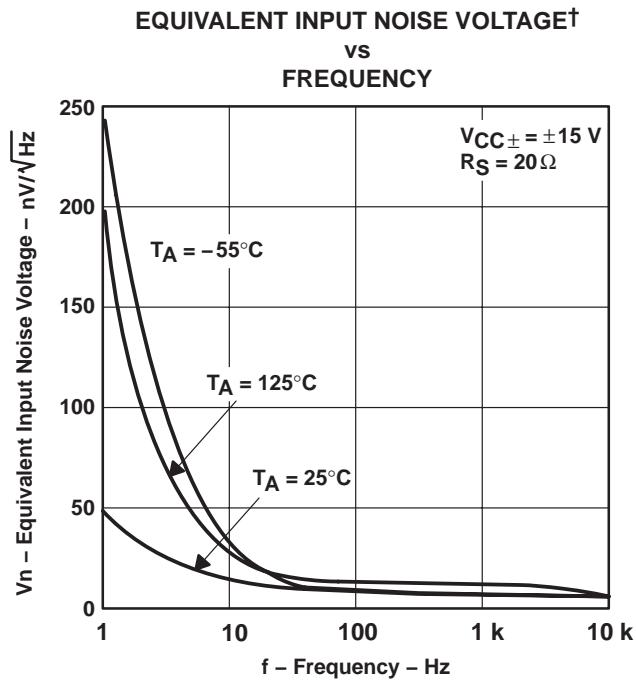


Figure 25

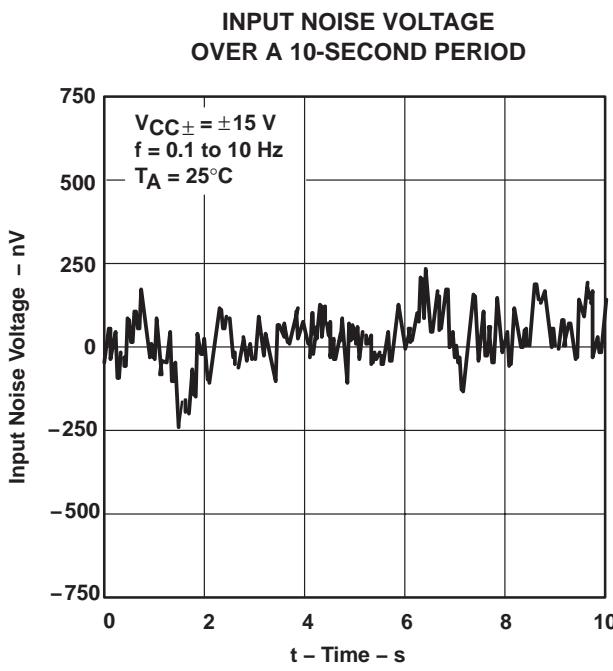


Figure 26

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

TYPICAL CHARACTERISTICS

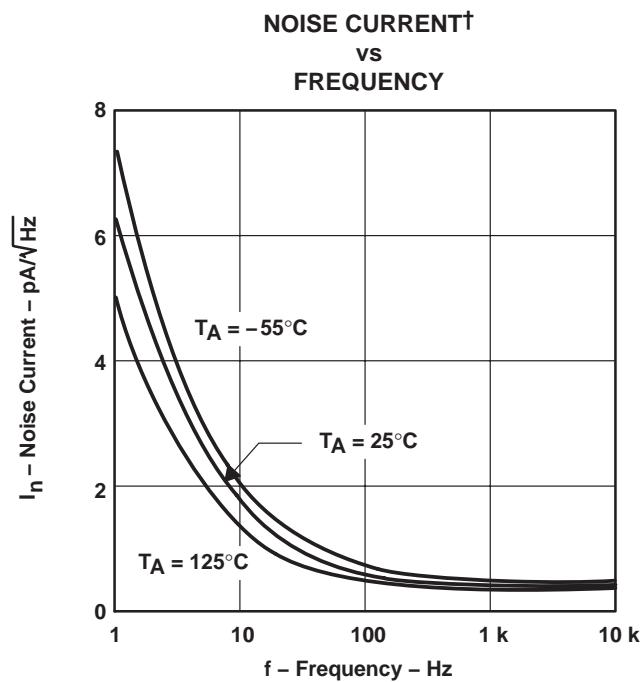


Figure 27

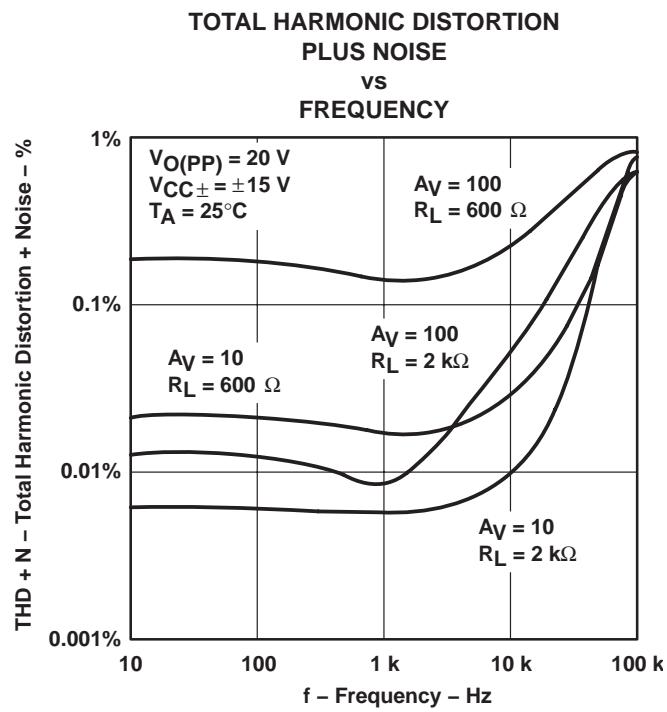


Figure 28

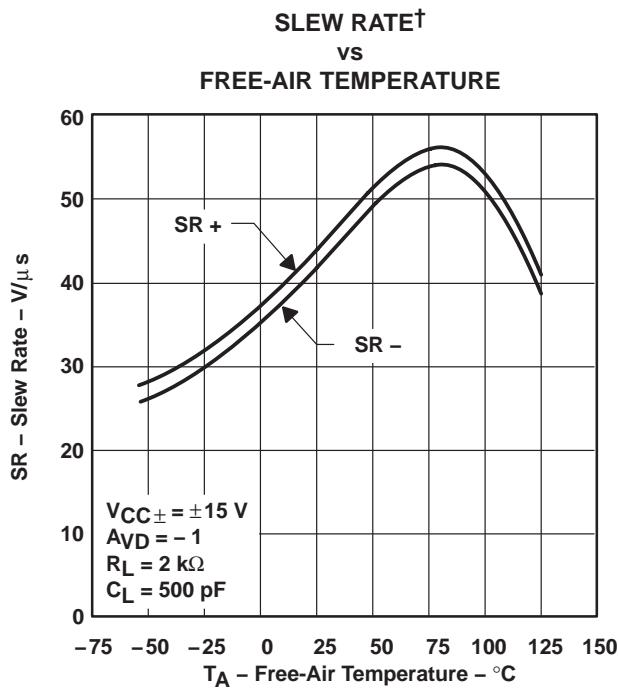


Figure 29

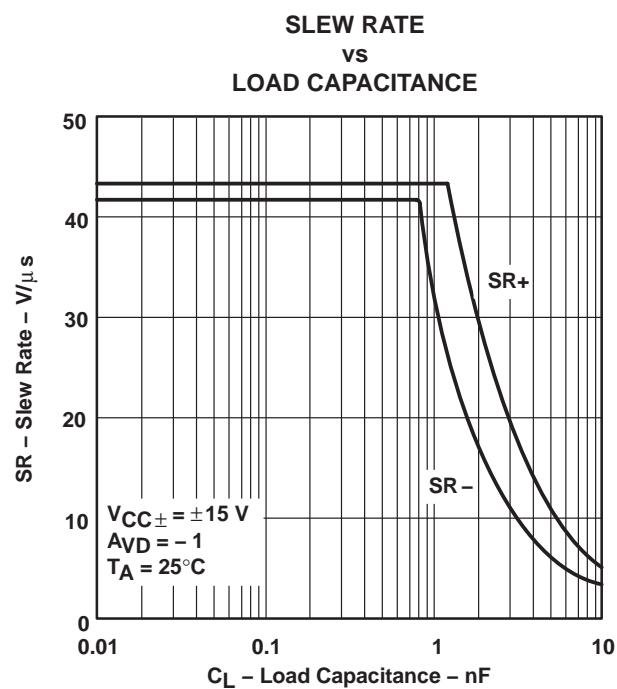


Figure 30

† 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

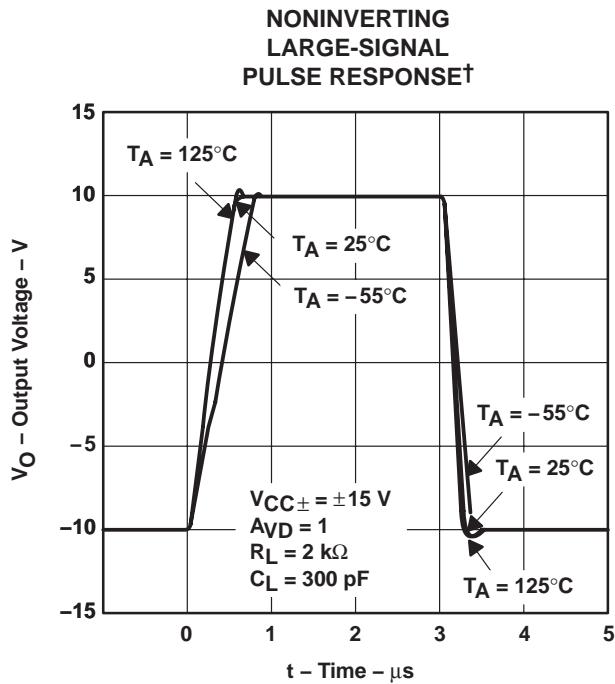


Figure 31

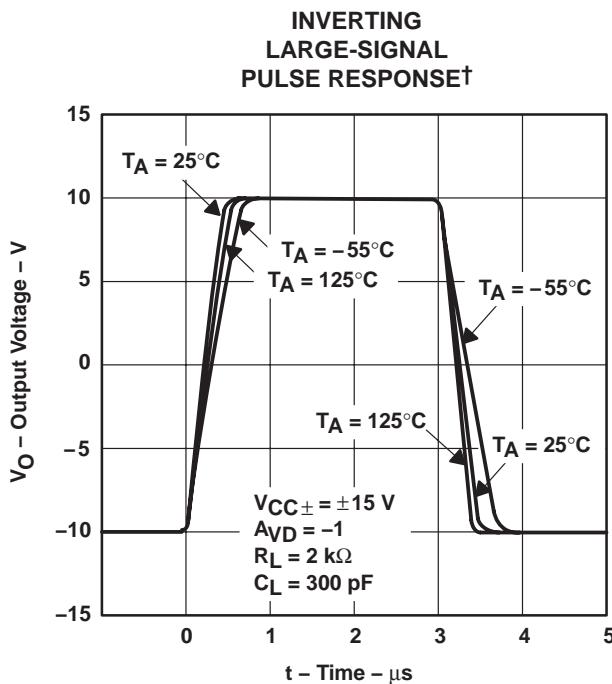


Figure 32

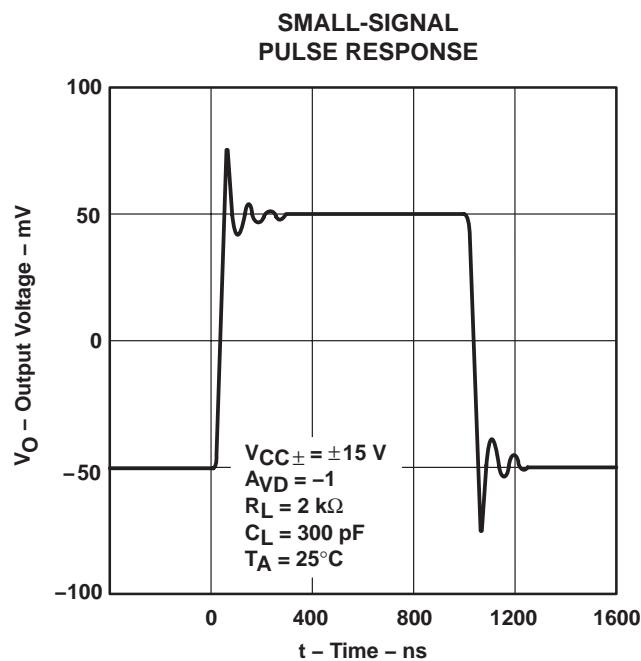


Figure 33

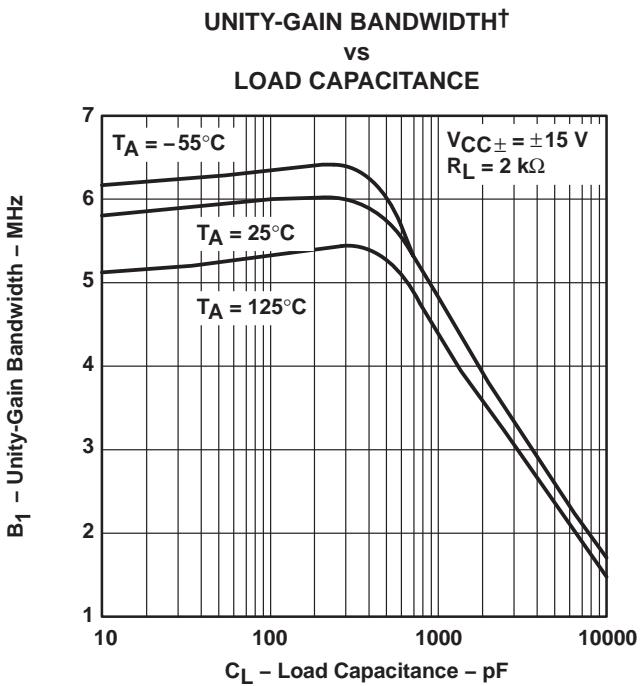


Figure 34

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

TYPICAL CHARACTERISTICS

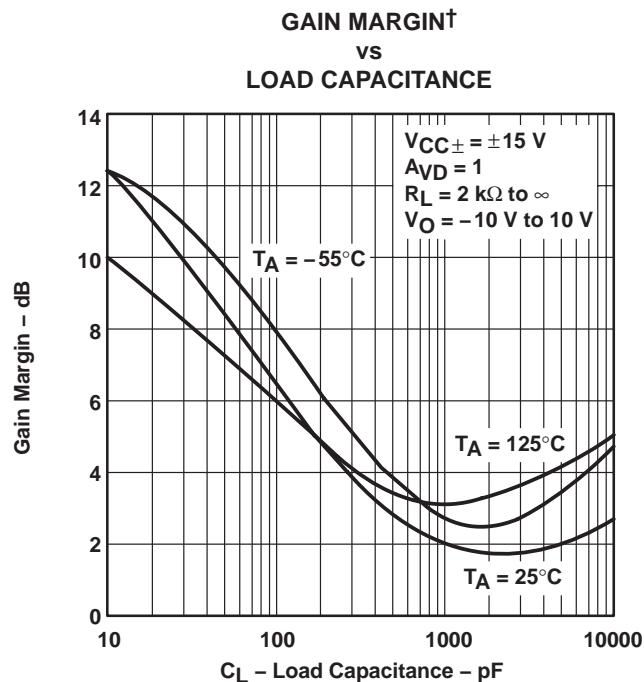


Figure 35

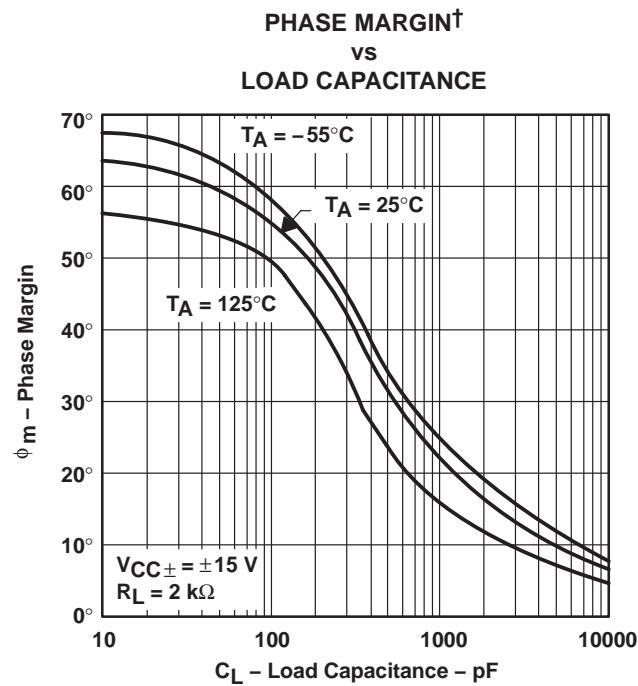


Figure 36

[†] 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.

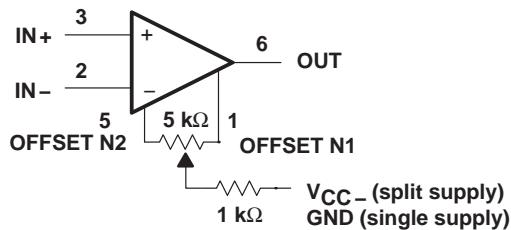


Figure 37. Input Offset Voltage Null Circuit

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|---------------------------------------|
| 5962-9321601QPA | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321602QPA | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321603Q2A | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| 5962-9321603QHA | ACTIVE | CFP | U | 10 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321603QPA | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321604Q2A | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| 5962-9321604QHA | ACTIVE | CFP | U | 10 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321604QPA | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321605Q2A | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| 5962-9321605QCA | ACTIVE | CDIP | J | 14 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| 5962-9321606Q2A | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| 5962-9321606QCA | ACTIVE | CDIP | J | 14 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2141ACD | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141ACP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2141AID | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141AIDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141AIP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2141AMFKB | OBSOLETE | LCCC | FK | 20 | | None | POST-PLATE | Level-NC-NC-NC |
| TLE2141AMJGB | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2141CD | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141CDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2141ID | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141IDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2141IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2141MD | ACTIVE | SOIC | D | 8 | 75 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2141MDR | ACTIVE | SOIC | D | 8 | 2500 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2141MFKB | OBSOLETE | LCCC | FK | 20 | | None | POST-PLATE | Level-NC-NC-NC |
| TLE2141MJGB | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2142ACD | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2142ACDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/Level-1-220C-UNLIM |
| TLE2142ACP | OBSOLETE | PDIP | P | 8 | | None | Call TI | Call TI |
| TLE2142AID | ACTIVE | SOIC | D | 8 | 75 | Pb-Free | CU NIPDAU | Level-2-260C-1YEAR/ |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|--|
| | | | | | | (RoHS) | | Level-1-220C-UNLIM |
| TLE2142AIDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/ Level-1-220C-UNLIM |
| TLE2142AIP | OBSOLETE | PDIP | P | 8 | | None | Call TI | Call TI |
| TLE2142AMD | ACTIVE | SOIC | D | 8 | 75 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2142AMDR | ACTIVE | SOIC | D | 8 | 2500 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2142AMFKB | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| TLE2142AMJGB | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2142AMUB | ACTIVE | CFP | U | 10 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2142CD | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/ Level-1-220C-UNLIM |
| TLE2142CDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/ Level-1-220C-UNLIM |
| TLE2142CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2142CPW | ACTIVE | TSSOP | PW | 16 | 90 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2142CPWLE | OBSOLETE | TSSOP | PW | 16 | | None | Call TI | Call TI |
| TLE2142CPWR | ACTIVE | TSSOP | PW | 16 | 2000 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2142ID | ACTIVE | SOIC | D | 8 | 75 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/ Level-1-220C-UNLIM |
| TLE2142IDR | ACTIVE | SOIC | D | 8 | 2500 | Pb-Free (RoHS) | CU NIPDAU | Level-2-260C-1YEAR/ Level-1-220C-UNLIM |
| TLE2142IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2142MD | ACTIVE | SOIC | D | 8 | 75 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2142MDR | ACTIVE | SOIC | D | 8 | 2500 | None | CU NIPDAU | Level-1-220C-UNLIM |
| TLE2142MFKB | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| TLE2142MJGB | ACTIVE | CDIP | JG | 8 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2142MUB | ACTIVE | CFP | U | 10 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2144ACN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2144AIN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2144AMFKB | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| TLE2144AMJB | ACTIVE | CDIP | J | 14 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2144CDW | ACTIVE | SOIC | DW | 16 | 40 | Pb-Free (RoHS) | CU NIPDAU | Level-2-250C-1YEAR/ Level-1-220C-UNLIM |
| TLE2144CDWR | ACTIVE | SOIC | DW | 16 | 2000 | Pb-Free (RoHS) | CU NIPDAU | Level-2-250C-1YEAR/ Level-1-220C-UNLIM |
| TLE2144CN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2144IDW | ACTIVE | SOIC | DW | 16 | 40 | Pb-Free (RoHS) | CU NIPDAU | Level-2-250C-1YEAR/ Level-1-220C-UNLIM |
| TLE2144IDWR | ACTIVE | SOIC | DW | 16 | 2000 | Pb-Free (RoHS) | CU NIPDAU | Level-2-250C-1YEAR/ Level-1-220C-UNLIM |
| TLE2144IN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TLE2144MDW | ACTIVE | SOIC | DW | 16 | 40 | None | CU NIPDAU | Level-1-220C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLE2144MFKB | ACTIVE | LCCC | FK | 20 | 1 | None | POST-PLATE | Level-NC-NC-NC |
| TLE2144MJB | ACTIVE | CDIP | J | 14 | 1 | None | A42 SNPB | Level-NC-NC-NC |
| TLE2144MN | OBSOLETE | PDIP | N | 14 | | None | Call TI | Call TI |

⁽¹⁾ 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.

⁽²⁾ Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

None: Not yet available Lead (Pb-Free).

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

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