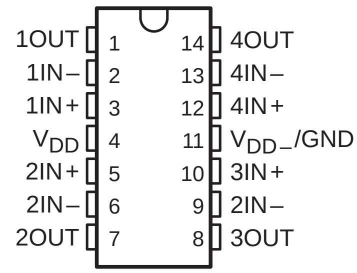
- **A-Suffix Versions Offer 5-mV $V_{IO}$**
- **B-Suffix Versions Offer 2-mV $V_{IO}$**
- **Wide Range of Supply Voltages 1.4 V to 16 V**
- **True Single-Supply Operation**
- **Common-Mode Input Voltage Includes the Negative Rail**
- **Low Noise . . . 25 nV/√Hz Typ at f = 1 kHz (High-Bias Version)**

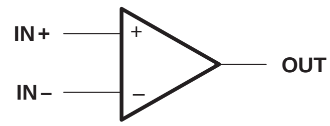
**D, N, OR PW PACKAGE (TOP VIEW)**




## description

The TLC254, TLC254A, TLC254B, TLC25L4, TLC254L4A, TLC254L4B, TLC25M4, TLC25M4A and TL25M4B are low-cost, low-power quad operational amplifiers designed to operate with single or dual supplies. These devices utilize the Texas Instruments silicon gate LinCMOS™ process, giving them stable input-offset voltages that are available in selected grades of 2, 5, or 10 mV maximum, very high input impedances, and extremely low input offset and bias currents. Because the input common-mode range extends to the negative rail and the power consumption is extremely low, this series is ideally suited for battery-powered or energy-conserving applications. The series offers operation down to a 1.4-V supply, is stable at unity gain, and has excellent noise characteristics.

### symbol (each amplifier)




These devices have internal electrostatic-discharge (ESD) protection circuits that prevent catastrophic failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.1. However, care should be exercised in handling these devices as exposure to ESD may result in degradation of the device parametric performance.

Because of the extremely high input impedance and low input bias and offset currents, applications for these devices include many areas that have previously been limited to BIFET and NFET product types. Any circuit using high-impedance elements and requiring small offset errors is a good candidate for cost-effective use of these devices. Many features associated with bipolar technology are available with LinCMOS operational amplifiers without the power penalties of traditional bipolar devices.

**Available options**

| $T_A$ | $V_{IO}max$ AT 25°C | PACKAGED DEVICES | | | CHIP FORM (Y) |
|---|---|---|---|---|---|
| | | SMALL OUTLINE (D) | PLASTIC DIP (N) | TSSOP (PW) | |
| 0°C to 70°C | 10 mV | TLC254CD | TLC254CN | TLC254CPW | TLC254Y |
| | 5 mV | TLC254ACD | TLC254ACN | — | — |
| | 2 mV | TLC254BCD | TLC254BCN | — | — |
| | 10 mV | TLC25L4CD | TLC25L4CN | TLC25L4CPW | TLC25L4Y |
| | 5 mV | TLC25L4ACD | TLC25L4ACN | — | — |
| | 2 mV | TLC25L2BCD | TLC25L4BCN | — | — |
| | 10 mV | TLC25M4CD | TLC25M4CN | TLC25M4CPW | TLC25M4Y |
| | 5 mV | TLC25M4ACD | TLC25M4ACN | — | — |
| | 2 mV | TLC25M4BCD | TLC25M4BCN | — | — |

The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC254CDR). Chips are tested at 25°C.

LinCMOS is a trademark of Texas Instruments Incorporated.

## description (continued)

General applications such as transducer interfacing, analog calculations, amplifier blocks, active filters, and signal buffering are all easily designed with these devices. Remote and inaccessible equipment applications are possible using their low-voltage and low-power capabilities. These devices are well suited to solve the difficult problems associated with single-battery and solar-cell-powered applications. This series includes devices that are characterized for the commercial temperature range and are available in 14-pin plastic dip and the small-outline packages. The device is also available in chip form.

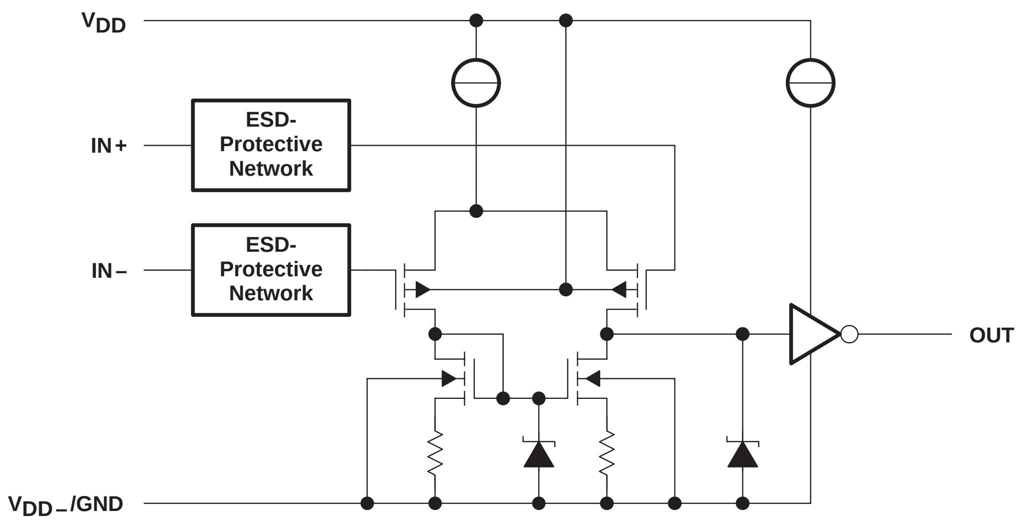
These devices are characterized for operation from 0°C to 70°C.

**DEVICE FEATURES**

| PARAMETER | TLC25L4_C (LOW BIAS) | TLC25M4_C (MEDIUM BIAS) | TLC254_C (HIGH BIAS) |
|---|---|---|---|
| Supply current (Typ) | 40 μA | 600 μA | 4000 μA |
| Slew rate (Typ) | 0.04 V/μA | 0.6 V/μA | 4.5 V/μA |
| Input offset voltage (Max) | | | |
| TLC254C, TLC25L4C, TLC25M4C | 10 mV | 10 mV | 10 mV |
| TLC254AC, TLC25L4AC, TLC25M4AC | 5 mV | 5 mV | 5 mV |
| TLC254BC, TLC25L4BC, TLC25M4BC | 2 mV | 2 mV | 2 mV |
| Offset voltage drift (Typ) | 0.1 μV/month† | 0.1 μV/month† | 0.1 μV/month† |
| Offset voltage temperature coefficient (Typ) | 0.7 μV/°C | 2 μV/°C | 5 μV/°C |
| Input bias current (Typ) | 1 pA | 1 pA | 1 pA |
| Input offset current (Typ) | 1 pA | 1 pA | 1 pA |

† The long-term drift value applies after the first month.

## equivalent schematic (each amplifier)



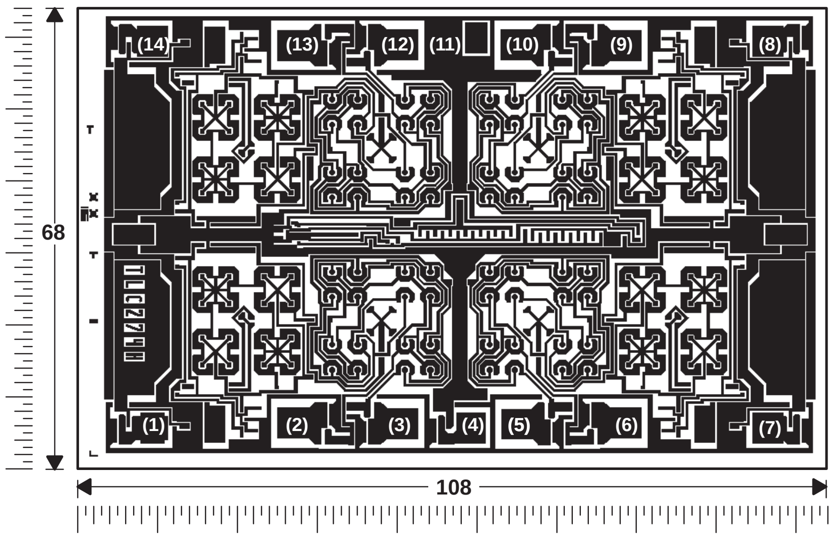


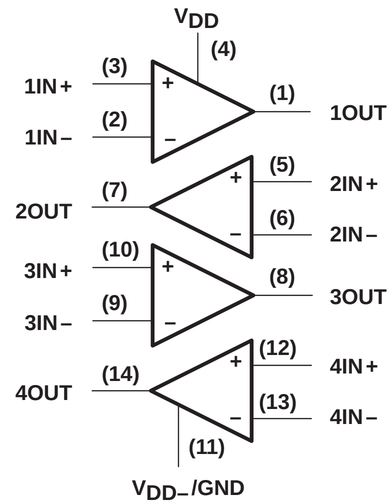
TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251–1443

## chip information

These chips, when properly assembled, display characteristics similar to the TLC25_4C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

**BONDING PAD ASSIGNMENTS**




**CHIP THICKNESS: 15 TYPICAL**

**BONDING PADS: 4 × 4 MINIMUM**

**$T_J$max = 150°C**

**TOLERANCES ARE ±10%.**

**ALL DIMENSIONS ARE IN MILS.**

**PIN (11) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.**

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

Supply voltage, $V_{DD}$ (see Note 1) ........ 18 V
Differential input voltage (see Note 2) ........ ±18 V
Input voltage range (any input) ........ –0.3 V to 18 V
Duration of short-circuit at (or below) 25°C free-air temperature (see Note 3) ........ unlimited
Continuous total dissipation ........ See Dissipation Rating Table
Operating free-air temperature range ........ 0°C to 70°C
Storage temperature range ........ –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ........ 260°C

† 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 $V_{DD-}$/GND.
2. Differential voltages are at IN+, with respect to IN–.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure the maximum dissipation rating is not exceeded.

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \le 25°C$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25°C$ | $T_A = 70°C$ POWER RATING |
|---|---|---|---|
| D | 725 mW | 5.8 mW/°C | 464 mW |
| N | 1050 mW | 9.2 mW/°C | 736 mW |
| PW | 700 mW | 5.6 mW/°C | 448 mW |

## recommended operating conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{DD}$ | | 1.4 | 16 | V |
| Common-mode input voltage, $V_{IC}$ | $V_{DD}$ = 1.4 V | 0 | 0.2 | V |
| | $V_{DD}$ = 5 V | –0.2 | 4 | |
| | $V_{DD}$ = 10 V | –0.2 | 9 | |
| | $V_{DD}$ = 16 V | –0.2 | 14 | |
| Operating free-air temperature, $T_A$ | | 0 | 70 | °C |


TEXAS INSTRUMENTS
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## electrical characteristics at specified free-air temperature, $V_{DD}$ = 1.4 V (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS† | $T_A$ | TLC254_C | | | TLC25L4_C | | | TLC25M4_C | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | TLC25_4C | $V_O$ = 0.2 V, $R_S$ = 50 Ω | 25°C | | | 10 | | | 10 | | | 10 | mV |
| | | | | 0°C to 70°C | | | 12 | | | 12 | | | 12 | |
| | | TLC25_4AC | | 25°C | | | 5 | | | 5 | | | 5 | |
| | | | | 0°C to 70°C | | | 6.5 | | | 6.5 | | | 6.5 | |
| | | TLC25_4BC | | 25°C | | | 2 | | | 2 | | | 2 | |
| | | | | 0°C to 70°C | | | 3 | | | 3 | | | 3 | |
| $a_{VIO}$ | Average temperature coefficient of input offset voltage | | | 25°C to 70°C | | 1 | | | 1 | | | 1 | | µV/°C |
| $I_{IO}$ | Input offset current | | $V_O$ = 0.2 V | 25°C | | 1 | | | 1 | | | 1 | | pA |
| | | | | 0°C to 70°C | | | 300 | | | 300 | | | 300 | |
| $I_{IB}$ | Input bias current | | $V_O$ = 0.2 V | 25°C | | 1 | | | 1 | | | 1 | | pA |
| | | | | 0°C to 70°C | | | 600 | | | 600 | | | 600 | |
| $V_{ICR}$ | Common-mode input voltage range | | | 25°C | 0 to 0.2 | | | 0 to 0.2 | | | 0 to 0.2 | | | V |
| $V_{OM}$ | Peak output voltage swing‡ | | $V_{ID}$ = 100 mV | 25°C | 450 | 700 | | 450 | 700 | | 450 | 700 | | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 100 to 300 mV, $R_S$ = 50 Ω | 25°C | | 10 | | | 20 | | | 20 | | V/mV |
| CMRR | Common-mode rejection ratio | | $V_O$ = 0.2 V, $V_{IC} = V_{ICR}min$ | 25°C | 60 | 77 | | 60 | 77 | | 60 | 77 | | dB |
| $I_{DD}$ | Supply current | | $V_O$ = 0.2 V, No load | 25°C | | 600 | 750 | | 50 | 68 | | 400 | 500 | µA |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Unless otherwise noted, an output load resistor is connected from the output to ground and has the following value: for low bias, $R_L$ = 1 MΩ, for medium bias $R_L$ = 100 kΩ, and for high bias $R_L$ = 10 kΩ.
‡ The output swings to the potential of $V_{DD-}$/GND.

## operating characteristics, $V_{DD}$ = 1.4 V, $T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | TLC254_C | | | TLC25L4_C | | | TLC25M4_C | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | See Figure 1 | | 0.1 | | | 0.001 | | | 0.01 | | V/µs |
| $B_1$ | Unity-gain bandwidth | $A_V$ = 40 dB, $C_L$ = 10 pF, $R_S$ = 50 Ω, See Figure 1 | | 12 | | | 12 | | | 12 | | kHz |
| | Overshoot factor | See Figure 1 | | 30% | | | 35% | | | 35% | | |

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

| PARAMETER | | | TEST CONDITIONS | | $T_A$† | TLC254, TLC254AC, TLC254BC | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | TLC254C | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 10 kΩ | 25°C | | 1.1 | 10 | mV |
| | | | | | Full range | | | 12 | |
| | | TLC254AC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 10 kΩ | 25°C | | 0.9 | 5 | |
| | | | | | Full range | | | 6.5 | |
| | | TLC254BC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 10 kΩ | 25°C | | 0.34 | 2 | |
| | | | | | Full range | | | 3 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 25°C to 70°C | | 1.8 | | μV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | | $V_O$ = 2.5 V, | $V_{IC}$ = 2.5 V | 25°C | | 0.1 | | pA |
| | | | | | 70°C | | 7 | 300 | |
| $I_{IB}$ | Input bias current (see Note 4) | | $V_O$ = 2.5 V, | $V_{IC}$ = 2.5 V | 25°C | | 0.6 | | pA |
| | | | | | 70°C | | 40 | 600 | |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | | | 25°C | –0.2 to 4 | –0.3 to 4.2 | | V |
| | | | | | Full range | –0.2 to 3.5 | | | |
| $V_{OH}$ | High-level output voltage | | $V_{ID}$ = 100 mV, | $R_L$ = 10 kΩ | 0°C | 3 | 3.8 | | V |
| | | | | | 25°C | 3.2 | 3.8 | | |
| | | | | | 70°C | 3 | 3.8 | | |
| $V_{OL}$ | Low-level output voltage | | $V_{ID}$ = –100 mV, | $I_{OL}$ = 0 | 0°C | | 0 | 50 | mV |
| | | | | | 25°C | | 0 | 50 | |
| | | | | | 70°C | | 0 | 50 | |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 0.25 V to 2 V, | $R_L$ = 10 kΩ | 0°C | 4 | 27 | | V/mV |
| | | | | | 25°C | 5 | 23 | | |
| | | | | | 70°C | 4 | 20 | | |
| CMRR | Common-mode rejection ratio | | $V_{IC} = V_{ICR}$min | | 0°C | 60 | 84 | | dB |
| | | | | | 25°C | 65 | 80 | | |
| | | | | | 70°C | 60 | 85 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | $V_{DD}$ = 5 V to 10 V, | $V_O$ = 1.4 V | 0°C | 60 | 94 | | dB |
| | | | | | 25°C | 65 | 95 | | |
| | | | | | 70°C | 60 | 96 | | |
| $I_{DD}$ | Supply current (four amplifiers) | | $V_O$ = 2.5 V, No load | $V_{IC}$ = 2.5 V, | 0°C | | 3.1 | 7.2 | mA |
| | | | | | 25°C | | 2.7 | 6.4 | |
| | | | | | 70°C | | 2.3 | 5.2 | |

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

## electrical characteristics at specified free-air temperature, $V_{DD}$ = 10 V (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS | | $T_A$† | TLC254C, TLC254AC, TLC254BC | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | TLC254C | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 10 kΩ | 25°C | | 1.1 | 10 | mV |
| | | | | | Full range | | | 12 | |
| | | TLC254AC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 10 kΩ | 25°C | | 0.9 | 5 | |
| | | | | | Full range | | | 6.5 | |
| | | TLC254BC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 10 kΩ | 25°C | | 0.39 | 2 | |
| | | | | | Full range | | | 3 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 25°C to 70°C | | 2 | | µV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | | $V_O$ = 5 V, | $V_{IC}$ = 5 V | 25°C | | 0.1 | | pA |
| | | | | | 70°C | | 7 | 300 | |
| $I_{IB}$ | Input bias current (see Note 4) | | $V_O$ = 5 V, | $V_{IC}$ = 5 V | 25°C | | 0.7 | | pA |
| | | | | | 70°C | | 50 | 600 | |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | | | 25°C | –0.2 to 9 | –0.3 to 9.2 | | V |
| | | | | | Full range | –0.2 to 8.5 | | | |
| $V_{OH}$ | High-level output voltage | | $V_{ID}$ = 100 mV, | $R_L$ = 10 kΩ | 0°C | 7.8 | 8.5 | | V |
| | | | | | 25°C | 8 | 8.5 | | |
| | | | | | 70°C | 7.8 | 8.4 | | |
| $V_{OL}$ | Low-level output voltage | | $V_{ID}$ = –100 mV, | $I_{OL}$ = 0 | 0°C | | 0 | 50 | mV |
| | | | | | 25°C | | 0 | 50 | |
| | | | | | 70°C | | 0 | 50 | |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 1 V to 6 V, | $R_L$ = 10 kΩ | 0°C | 7.5 | 42 | | V/mV |
| | | | | | 25°C | 10 | 36 | | |
| | | | | | 70°C | 7.5 | 32 | | |
| CMRR | Common-mode rejection ratio | | $V_{IC} = V_{ICR}$min | | 0°C | 60 | 88 | | dB |
| | | | | | 25°C | 65 | 85 | | |
| | | | | | 70°C | 60 | 88 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | $V_{DD}$ = 5 V to 10 V, | $V_O$ = 1.4 V | 0°C | 60 | 94 | | dB |
| | | | | | 25°C | 65 | 95 | | |
| | | | | | 70°C | 60 | 96 | | |
| $I_{DD}$ | Supply current (four amplifiers) | | $V_O$ = 5 V, No load | $V_{IC}$ = 5 V, | 0°C | | 4.5 | 8.8 | mA |
| | | | | | 25°C | | 3.8 | 8 | |
| | | | | | 70°C | | 3.2 | 6.8 | |

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

## operating characteristics, $V_{DD}$ = 5 V

| PARAMETER | | TEST CONDITIONS | | | $T_A$ | TLC254C, TLC254AC, TLC254BC | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $R_L$ = 10 kΩ, See Figure 1 | $C_L$ = 20 pF, | $V_{I(PP)}$ = 1 V | 0°C | | 4 | | V/µs |
| | | | | | 25°C | | 3.6 | | |
| | | | | $V_{I(PP)}$ = 1 V | 70°C | | 3 | | |
| | | | | $V_{I(PP)}$ = 2.5 V | 0°C | | 3.1 | | |
| | | | | | 25°C | | 2.9 | | |
| | | | | | 70°C | | 2.5 | | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, | $R_S$ = 20 Ω, | See Figure 2 | 25°C | | 25 | | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O = V_{OH}$, See Figure 1 | $C_L$ = 20 pF, | $R_L$ = 10 kΩ, | 0°C | | 340 | | kHz |
| | | | | | 25°C | | 320 | | |
| | | | | | 70°C | | 260 | | |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, | $C_L$ = 20 pF, | See Figure 1 | 0°C | | 2 | | MHz |
| | | | | | 25°C | | 1.7 | | |
| | | | | | 70°C | | 1.3 | | |
| $\phi_m$ | Phase margin | $V_I$ = 10 mV, See Figure 3 | f = $B_1$, | $C_L$ = 20 pF, | 0°C | | 47° | | |
| | | | | | 25°C | | 46° | | |
| | | | | | 70°C | | 43° | | |

## operating characteristics, $V_{DD}$ = 10 V

| PARAMETER | | TEST CONDITIONS | | | $T_A$ | TLC254C, TLC254AC, TLC254BC | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $R_L$ = 10 kΩ, See Figure 1 | $C_L$ = 20 pF, | $V_{I(PP)}$ = 1 V | 0°C | | 5.9 | | V/µs |
| | | | | | 25°C | | 5.3 | | |
| | | | | | 70°C | | 4.3 | | |
| | | | | $V_{I(PP)}$ = 5.5 V | 0°C | | 5.1 | | |
| | | | | | 25°C | | 4.6 | | |
| | | | | | 70°C | | 3.8 | | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, | $R_S$ = 20 Ω, | See Figure 2 | 25°C | | 25 | | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O = V_{OH}$, See Figure 1 | $C_L$ = 20 pF, | $R_L$ = 10 kΩ, | 0°C | | 220 | | kHz |
| | | | | | 25°C | | 200 | | |
| | | | | | 70°C | | 140 | | |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, | $C_L$ = 20 pF, | See Figure 1 | 0°C | | 2.5 | | MHz |
| | | | | | 25°C | | 2.2 | | |
| | | | | | 70°C | | 1.8 | | |
| $\phi_m$ | Phase margin | $V_I$ = 10 mV, See Figure 3 | f = $B_1$, | $C_L$ = 20 pF, | 0°C | | 50° | | |
| | | | | | 25°C | | 49° | | |
| | | | | | 70°C | | 46° | | |

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

| PARAMETER | | | TEST CONDITIONS | | $T_A$† | TLC25L4C TLC25L4AC TLC25L4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | TLC25L4C | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 1 MΩ | 25°C | | 1.1 | 10 | mV |
| | | | | | Full range | | | 12 | |
| | | TLC25L4AC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 1 MΩ | 25°C | | 0.9 | 5 | |
| | | | | | Full range | | | 6.5 | |
| | | TLC25L4BC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 1 MΩ | 25°C | | 0.24 | 2 | |
| | | | | | Full range | | | 3 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 25°C to 70°C | | 1.1 | | µV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | | $V_O$ = 2.5 V, | $V_{IC}$ = 2.5 V | 25°C | | 0.1 | | pA |
| | | | | | 70°C | | 7 | 300 | |
| $I_{IB}$ | Input bias current (see Note 4) | | $V_O$ = 2.5 V, | $V_{IC}$ = 2.5 V | 25°C | | 0.6 | | pA |
| | | | | | 70°C | | 40 | 600 | |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | | | 25°C | –0.2 to 4 | –0.3 to 4.2 | | V |
| | | | | | Full range | –0.2 to 3.5 | | | V |
| $V_{OH}$ | High-level output voltage | | $V_{ID}$ = 100 mV, | $R_L$ = 1 MΩ | 0°C | 3 | 4.1 | | V |
| | | | | | 25°C | 3.2 | 4.1 | | |
| | | | | | 70°C | 3 | 4.2 | | |
| $V_{OL}$ | Low-level output voltage | | $V_{ID}$ = –100 mV, | $I_{OL}$ = 0 | 0°C | | 0 | 50 | mV |
| | | | | | 25°C | | 0 | 50 | |
| | | | | | 70°C | | 0 | 50 | |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 0.25 V to 2 V, | $R_L$ = 1 MΩ | 0°C | 50 | 680 | | V/mV |
| | | | | | 25°C | 50 | 520 | | |
| | | | | | 70°C | 50 | 380 | | |
| CMRR | Common-mode rejection ratio | | $V_{IC} = V_{ICR}min$ | | 0°C | 60 | 95 | | dB |
| | | | | | 25°C | 65 | 94 | | |
| | | | | | 70°C | 60 | 95 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | $V_{DD}$ = 5 V to 10 V, | $V_O$ = 1.4 V | 0°C | 60 | 97 | | dB |
| | | | | | 25°C | 70 | 98 | | |
| | | | | | 70°C | 60 | 97 | | |
| $I_{DD}$ | Supply current (four amplifiers) | | $V_O$ = 2.5 V, No load | $V_{IC}$ = 2.5 V, | 0°C | | 48 | 84 | µA |
| | | | | | 25°C | | 40 | 68 | |
| | | | | | 70°C | | 31 | 56 | |

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

## electrical characteristics at specified free-air temperature, $V_{DD}$ = 10 V (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS | | $T_A$† | TLC25L4C, TLC25L4AC, TLC25L4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | TLC25L4C | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 1 MΩ | 25°C | | 1.1 | 10 | mV |
| | | | | | Full range | | | 12 | |
| | | TLC25L4AC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 1 MΩ | 25°C | | 0.9 | 5 | |
| | | | | | Full range | | | 6.5 | |
| | | TLC25L4BC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 1 MΩ | 25°C | | 0.26 | 2 | |
| | | | | | Full range | | | 3 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 25°C to 70°C | | 1 | | μV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | | $V_O$ = 5 V, | $V_{IC}$ = 5 V | 25°C | | 0.1 | | pA |
| | | | | | 70°C | | 7 | 300 | |
| $I_{IB}$ | Input bias current (see Note 4) | | $V_O$ = 5 V, | $V_{IC}$ =.5 V | 25°C | | 0.7 | | pA |
| | | | | | 70°C | | 50 | 600 | |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | | | 25°C | –0.2 to 9 | –0.3 to 9.2 | | V |
| | | | | | Full range | –0.2 to 8.5 | | | V |
| $V_{OH}$ | High-level output voltage | | $V_{ID}$ = 100 mV, | $R_L$ = 1 MΩ | 0°C | 7.8 | 8.9 | | V |
| | | | | | 25°C | 8 | 8.9 | | |
| | | | | | 70°C | 7.8 | 8.9 | | |
| $V_{OL}$ | Low-level output voltage | | $V_{ID}$ = –100 mV, | $I_{OL}$ = 0 | 0°C | | 0 | 50 | mV |
| | | | | | 25°C | | 0 | 50 | |
| | | | | | 70°C | | 0 | 50 | |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 1 V to 6 V, | $R_L$ = 1 MΩ | 0°C | 50 | 1025 | | V/mV |
| | | | | | 25°C | 50 | 870 | | |
| | | | | | 70°C | 50 | 660 | | |
| CMRR | Common-mode rejection ratio | | $V_{IC} = V_{ICR}min$ | | 0°C | 60 | 97 | | dB |
| | | | | | 25°C | 65 | 97 | | |
| | | | | | 70°C | 60 | 97 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | $V_{DD}$ = 5 V to 10 V, | $V_O$ = 1.4 V | 0°C | 60 | 97 | | dB |
| | | | | | 25°C | 70 | 97 | | |
| | | | | | 70°C | 60 | 98 | | |
| $I_{DD}$ | Supply current (four amplifiers) | | $V_O$ = 5 V, No load | $V_{IC}$ = 5 V, | 0°C | | 72 | 132 | μA |
| | | | | | 25°C | | 57 | 92 | |
| | | | | | 70°C | | 44 | 80 | |

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

## operating characteristics, $V_{DD}$ = 5 V

| PARAMETER | TEST CONDITIONS | $T_A$ | TLC25L4C, TLC25L4AC, TLC25L4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SR | Slew rate at unity gain | $R_L$ = 1 MΩ, $C_L$ = 20 pF, See Figure 1 | $V_{I(PP)}$ = 1 V | 0°C | | 0.04 | | V/µs |
| | | | | 25°C | | 0.03 | | |
| | | | | 70°C | | 0.03 | | |
| | | | $V_{I(PP)}$ = 2.5 V | 0°C | | 0.03 | | |
| | | | | 25°C | | 0.03 | | |
| | | | | 70°C | | 0.02 | | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, $R_S$ = 20 Ω, | See Figure 2 | 25°C | | 70 | | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O$ = $V_{OH}$, $C_L$ = 20 pF, See Figure 1 | $R_L$ = 1 MΩ, | 0°C | | 6 | | kHz |
| | | | | 25°C | | 5 | | |
| | | | | 70°C | | 4.5 | | |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, $C_L$ = 20 pF, | See Figure 1 | 0°C | | 100 | | kHz |
| | | | | 25°C | | 85 | | |
| | | | | 70°C | | 65 | | |
| $\phi_m$ | Phase margin | $V_I$ = 10 mV, f = $B_1$, See Figure 3 | $C_L$ = 20 pF, | 0°C | | 36° | | |
| | | | | 25°C | | 34° | | |
| | | | | 70°C | | 30° | | |

## operating characteristics, $V_{DD}$ = 10 V

| PARAMETER | | TEST CONDITIONS | | $T_A$ | TLC25L4C TLC25L4AC TLC25L4BC | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $R_L$ = 1 MΩ, $C_L$ = 20 pF, See Figure 1 | $V_{I(PP)}$ = 1 V | 0°C | | 0.05 | | V/µs |
| | | | | 25°C | | 0.05 | | |
| | | | | 70°C | | 0.04 | | |
| | | | $V_{I(PP)}$ = 5.5 V | 0°C | | 0.05 | | |
| | | | | 25°C | | 0.04 | | |
| | | | | 70°C | | 0.04 | | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, $R_S$ = 20 Ω, | See Figure 2 | 25°C | | 70 | | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O$ = $V_{OH}$, $C_L$ = 20 pF, See Figure 1 | $R_L$ = 1 MΩ, | 0°C | | 1.3 | | kHz |
| | | | | 25°C | | 1 | | |
| | | | | 70°C | | 0.9 | | |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, $C_L$ = 20 pF, | See Figure 1 | 0°C | | 125 | | kHz |
| | | | | 25°C | | 110 | | |
| | | | | 70°C | | 90 | | |
| $\phi_m$ | Phase margin | $V_I$ = 10 mV, f = $B_1$, See Figure 3 | $C_L$ = 20 pF, | 0°C | | 40° | | |
| | | | | 25°C | | 38° | | |
| | | | | 70°C | | 34° | | |

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

| PARAMETER | | | TEST CONDITIONS | | $T_A$† | TLC25M4C, TLC25M4AC, TLC25M4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | TLC25M4C | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 100 kΩ | 25°C | | 1.1 | 10 | mV |
| | | | | | Full range | | | 12 | |
| | | TLC25M4AC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 100 kΩ | 25°C | | 0.9 | 5 | |
| | | | | | Full range | | | 6.5 | |
| | | TLC25M4BC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 100 kΩ | 25°C | | 0.25 | 2 | |
| | | | | | Full range | | | 3 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 25°C to 70°C | | 1.7 | | μV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | | $V_O$ = 2.5 V, | $V_{IC}$ = 2.5 V | 25°C | | 0.1 | | pA |
| | | | | | 70°C | | 7 | 300 | |
| $I_{IB}$ | Input bias current (see Note 4) | | $V_O$ = 2.5 V, | $V_{IC}$ = 2.5 V | 25°C | | 0.6 | | pA |
| | | | | | 70°C | | 40 | 600 | |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | | | 25°C | –0.2 t0 4 | –0.3 to 4.2 | | V |
| | | | | | Full range | –0.2 to 3.5 | | | V |
| $V_{OH}$ | High-level output voltage | | $V_{ID}$ = 100 mV, | $R_L$ = 100 kΩ | 0°C | 3 | 3.9 | | V |
| | | | | | 25°C | 3.2 | 3.9 | | |
| | | | | | 70°C | 3 | 4 | | |
| $V_{OL}$ | Low-level output voltage | | $V_{ID}$ = –100 mV, | $I_{OL}$ = 0 | 0°C | | 0 | 50 | mV |
| | | | | | 25°C | | 0 | 50 | |
| | | | | | 70°C | | 0 | 50 | |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 0.25 V to 2 V, | $R_L$ = 100 kΩ | 0°C | 15 | 200 | | V/mV |
| | | | | | 25°C | 25 | 170 | | |
| | | | | | 70°C | 15 | 140 | | |
| CMRR | Common-mode rejection ratio | | $V_{IC}$ = $V_{ICR}$min | | 0°C | 60 | 91 | | dB |
| | | | | | 25°C | 65 | 91 | | |
| | | | | | 70°C | 60 | 92 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | $V_{DD}$ = 5 V to 10 V, | $V_O$ = 1.4 V | 0°C | 60 | 92 | | dB |
| | | | | | 25°C | 70 | 93 | | |
| | | | | | 70°C | 60 | 94 | | |
| $I_{DD}$ | Supply current (four amplifiers) | | $V_O$ = 2.5 V, No load | $V_{IC}$ = 2.5 V, | 0°C | | 500 | 1280 | μA |
| | | | | | 25°C | | 420 | 1120 | |
| | | | | | 70°C | | 340 | 880 | |

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

## electrical characteristics at specified free-air temperature, $V_{DD}$ = 10 V (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS | | $T_A$† | TLC25M4C TLC25M4AC TLC25M4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | TLC25M4C | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 100 kΩ | 25°C | | 1.1 | 10 | mV |
| | | | | | Full range | | | 12 | |
| | | TLC25M4AC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 100 kΩ | 25°C | | 0.9 | 5 | |
| | | | | | Full range | | | 6.5 | |
| | | TLC25M4BC | $V_O$ = 1.4 V, $R_S$ = 50 Ω, | $V_{IC}$ = 0, $R_L$ = 100 kΩ | 25°C | | 0.26 | 2 | |
| | | | | | Full range | | | 3 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 25°C to 70°C | | 2.1 | | µV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | | $V_O$ = 5 V, | $V_{IC}$ = 5 V | 25°C | | 0.1 | | pA |
| | | | | | 70°C | | 7 | 300 | |
| $I_{IB}$ | Input bias current (see Note 4) | | $V_O$ = 5 V, | $V_{IC}$ = 5 V | 25°C | | 0.7 | | pA |
| | | | | | 70°C | | 50 | 600 | |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | | | 25°C | –0.2 to 9 | –0.3 to 9.2 | | V |
| | | | | | Full range | –0.2 to 8.5 | | | V |
| $V_{OH}$ | High-level output voltage | | $V_{ID}$ = 100 mV, | $R_L$ = 100 kΩ | 0°C | 7.8 | 8.7 | | V |
| | | | | | 25°C | 8 | 8.7 | | |
| | | | | | 70°C | 7.8 | 8.7 | | |
| $V_{OL}$ | Low-level output voltage | | $V_{ID}$ = –100 mV, | $I_{OL}$ = 0 | 0°C | | 0 | 50 | mV |
| | | | | | 25°C | | 0 | 50 | |
| | | | | | 70°C | | 0 | 50 | |
| $A_{VD}$ | Large-signal differential voltage amplification | | $V_O$ = 1 V to 6 V, | $R_L$ = 100 kΩ | 0°C | 15 | 320 | | V/mV |
| | | | | | 25°C | 25 | 275 | | |
| | | | | | 70°C | 15 | 230 | | |
| CMRR | Common-mode rejection ratio | | $V_{IC} = V_{ICR}min$ | | 0°C | 60 | 94 | | dB |
| | | | | | 25°C | 65 | 94 | | |
| | | | | | 70°C | 60 | 94 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | $V_{DD}$ = 5 V to 10 V, | $V_O$ = 1.4 V | 0°C | 60 | 92 | | dB |
| | | | | | 25°C | 70 | 93 | | |
| | | | | | 70°C | 60 | 94 | | |
| $I_{DD}$ | Supply current (four amplifiers) | | $V_O$ = 5 V, No load | $V_{IC}$ = 5 V, | 0°C | | 690 | 1600 | µA |
| | | | | | 25°C | | 570 | 1200 | |
| | | | | | 70°C | | 440 | 1120 | |

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.

## operating characteristics, $V_{DD}$ = 5 V

| PARAMETER | TEST CONDITIONS | $T_A$ | TLC25M4C TLC25M4AC TLC25M4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| SR | Slew rate at unity gain | $R_L$ = 100 kΩ, $C_L$ = 20 pF, See Figure 1 | $V_{I(PP)}$ = 1 V | 0°C | 0.46 | V/µs |
| | | | | 25°C | 0.43 | V/µs |
| | | | | 70°C | 0.36 | V/µs |
| | | | $V_{I(PP)}$ = 2.5 V | 0°C | 0.43 | |
| | | | | 25°C | 0.40 | |
| | | | | 70°C | 0.34 | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, $R_S$ = 20 Ω, See Figure 2 | | 25°C | 32 | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O = V_{OH}$, $C_L$ = 20 pF, $R_L$ = 100 kΩ, See Figure 1 | | 0°C | 60 | kHz |
| | | | | 25°C | 55 | |
| | | | | 70°C | 50 | |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, $C_L$ = 20 pF, See Figure 1 | | 0°C | 610 | kHz |
| | | | | 25°C | 525 | |
| | | | | 70°C | 400 | |
| $\phi_m$ | Phase margin | $V_I$ = 10 mV, f = $B_1$, $C_L$ = 20 pF, See Figure 3 | | 0°C | 41° | |
| | | | | 25°C | 40° | |
| | | | | 70°C | 39° | |

## operating characteristics, $V_{DD}$ = 10 V

| PARAMETER | | TEST CONDITIONS | | $T_A$ | TLC25M4C TLC25M4AC TLC25M4BC MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| SR | Slew rate at unity gain | $R_L$ = 100 kΩ, $C_L$ = 20 pF, See Figure 1 | $V_{I(PP)}$ = 1 V | 0°C | | 0.67 | | V/µs |
| | | | | 25°C | | 0.62 | | |
| | | | | 70°C | | 0.51 | | |
| | | | $V_{I(PP)}$ = 5.5 V | 0°C | | 0.61 | | |
| | | | | 25°C | | 0.56 | | |
| | | | | 70°C | | 0.46 | | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, $R_S$ = 20 Ω, See Figure 2 | | 25°C | | 32 | | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O = V_{OH}$, $C_L$ = 20 pF, $R_L$ = 100 kΩ, See Figure 1 | | 0°C | | 40 | | kHz |
| | | | | 25°C | | 35 | | |
| | | | | 70°C | | 30 | | |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, $C_L$ = 20 pF, See Figure 1 | | 0°C | | 710 | | kHz |
| | | | | 25°C | | 635 | | |
| | | | | 70°C | | 510 | | |
| $\phi_m$ | Phase margin | $V_I$ = 10 mV, f = $B_1$, $C_L$ = 20 pF, See Figure 3 | | 0°C | | 44° | | |
| | | | | 25°C | | 43° | | |
| | | | | 70°C | | 42° | | |

## electrical characteristics, $V_{DD}$ = 5 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | TLC254Y | | | TLC25L4Y | | | TLC25M4Y | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_O$ = 1.4 V, $V_{IC}$ = 0 V, $R_S$ = 50 Ω, See Note 6 | | 1.1 | 10 | | 1.1 | 10 | | 1.1 | 10 | mV |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | 1.8 | | | 1.1 | | | 1.7 | | μV/°C |
| $I_{IO}$ | Input offset current (see Note 4) | $V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$ | | 0.1 | | | 0.1 | | | 0.1 | | pA |
| $I_{IB}$ | Input bias current (see Note 4) | $V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$ | | 0.6 | | | 0.6 | | | 0.6 | | pA |
| $V_{ICR}$ | Common-mode input voltage range (see Note 5) | | –0.2 to 4 | –0.3 to 4.2 | | –0.2 to 4 | –0.3 to 4.2 | | –0.2 to 4 | –0.3 to 4.2 | | V |
| $V_{OH}$ | High-level output voltage | $V_{ID}$ = 100 mV, $R_L$ = 100 kΩ | 3.2 | 3.8 | | 3.2 | 4.1 | | 3.2 | 3.9 | | V |
| $V_{OL}$ | Low-level output voltage | $V_{ID}$ = –100 mV, $I_{OL}$ = 0 | | 0 | 50 | | 0 | 50 | | 0 | 50 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_O$ = 0.25 V, See Note 6 | 5 | 23 | | 50 | 520 | | 25 | 170 | | V/mV |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR}min$ | 65 | 80 | | 65 | 94 | | 65 | 91 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 5 V to 10 V, $V_O$ = 1.4 V | 65 | 95 | | 70 | 97 | | 70 | 93 | | dB |
| $I_{DD}$ | Supply current | $V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$, No load | | 2.7 | 6.4 | | 0.04 | 0.068 | | 0.42 | 1.12 | mA |

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
5. This range also applies to each input individually.
6. For low-bias mode, $R_L$ = 1 MΩ, for medium-bias mode, $R_L$ = 100 kΩ, and for high-bias mode, $R_L$ = 10 kΩ.

## operating characteristics, $V_{DD}$ = 5 V, $T_A$ = 25°C

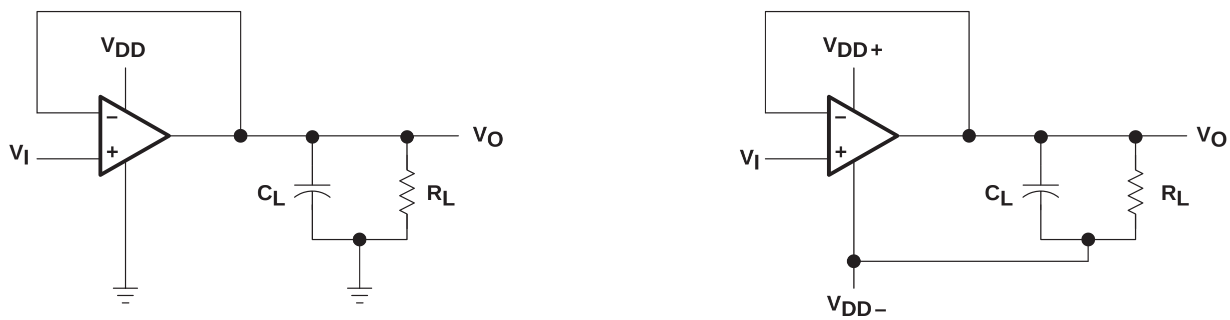
| PARAMETER | | TEST CONDITIONS | | TLC254Y | | | TLC25L4Y | | | TLC25M4Y | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $C_L$ = 20 pF, See Note 6 | $V_{I(PP)}$ = 1 V | | 3.6 | | | 0.03 | | | 0.43 | | V/μs |
| | | | $V_{I(PP)}$ = 2.5 V | | 2.9 | | | 0.03 | | | 0.40 | | |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz, | $R_S$ = 20 Ω | | 2.5 | | | 70 | | | 32 | | nV/√Hz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_O = V_{OH}$, $R_L$ = 10 kΩ | $C_L$ = 20 pF, | | 320 | | | 5 | | | 55 | | kHz |
| $B_1$ | Unity-gain bandwidth | $V_I$ = 10 mV, | $C_L$ = 20 pF | | 1.7 | | | 0.085 | | | 0.525 | | MHz |
| $\phi_m$ | Phase margin | f = $B_1$, $C_L$ = 20 pF | $V_I$ = 10 mV, | | 46° | | | 34° | | | 40° | | |

NOTE 6: For low-bias mode, $R_L$ = 1 MΩ, for medium-bias mode, $R_L$ = 100 kΩ, and for high-bias mode, $R_L$ = 10 kΩ.

## PARAMETER MEASUREMENT INFORMATION

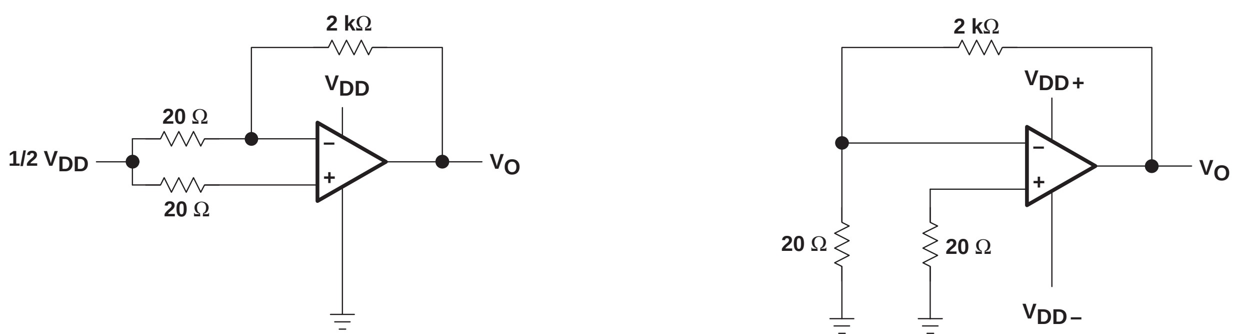
### single-supply versus split-supply test circuits

Because the TLC25_4, TLC25_4A, and TLC25_4B are optimized for single-supply operation, circuit configurations used for the various tests often present some inconvenience since the input signal, in many cases, must be offset from ground. This inconvenience can be avoided by testing the device with split supplies and the output load tied to the negative rail. A comparison of single-supply versus split-supply test circuits is shown below. The use of either circuit gives the same result.



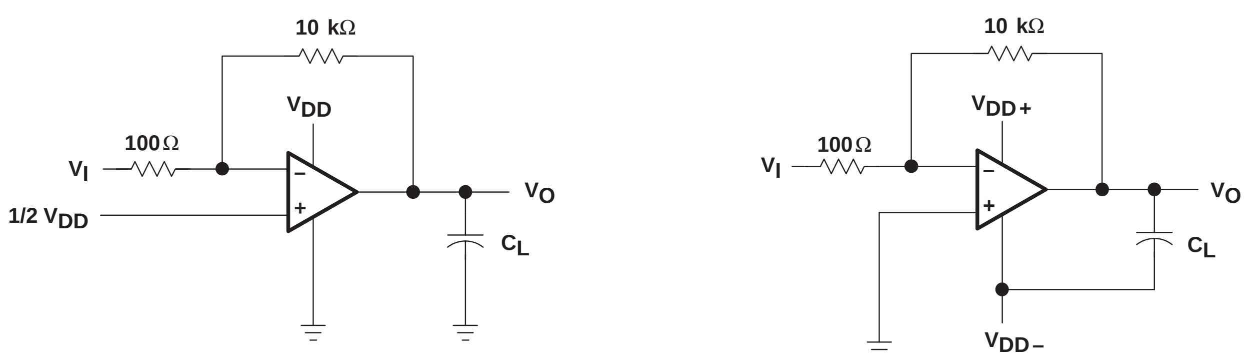

(a) SINGLE-SUPPLY (b) SPLIT-SUPPLY

**Figure 1. Unity-Gain Amplifier**




(a) SINGLE-SUPPLY (b) SPLIT-SUPPLY

**Figure 2. Noise-Test Circuit**




(a) SINGLE-SUPPLY (b) SPLIT-SUPPLY

**Figure 3. Gain-of-100 Inverting Amplifier**

## TYPICAL CHARACTERISTICS

**Table of Graphs**

| | | | | FIGURE |
|---|---|---|---|---|
| $I_{DD}$ | Supply current | | vs Supply voltage<br>vs Free-air temperature | 4<br>5 |
| $A_{VD}$ | Large-signal differential voltage amplification | Low bias | vs Frequency | 6 |
| | | Medium bias | vs Frequency | 7 |
| | | High bias | vs Frequency | 8 |
| | Phase shift | Low bias | vs Frequency | 6 |
| | | Medium bias | vs Frequency | 7 |
| | | High bias | vs Frequency | 8 |

**SUPPLY CURRENT vs SUPPLY VOLTAGE**

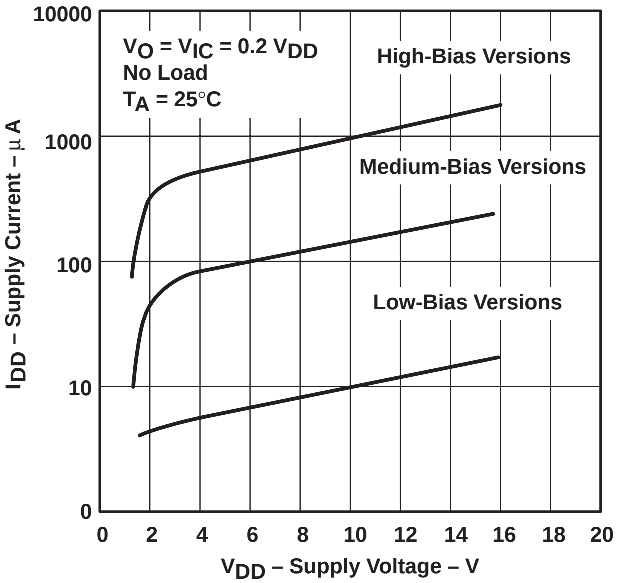



**Figure 4**

**SUPPLY CURRENT vs FREE-AIR TEMPERATURE**

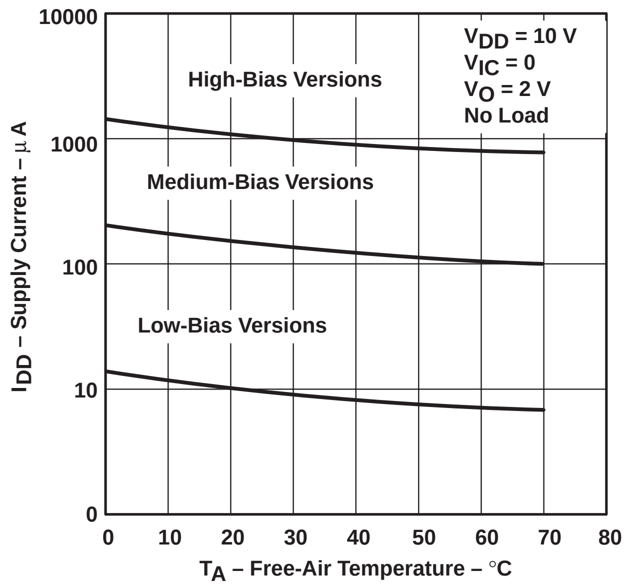



**Figure 5**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## TYPICAL CHARACTERISTICS

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

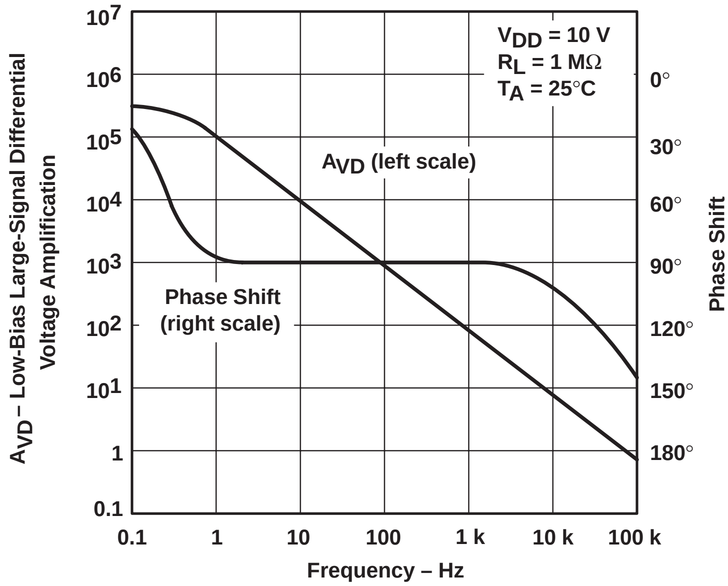


Figure 6

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

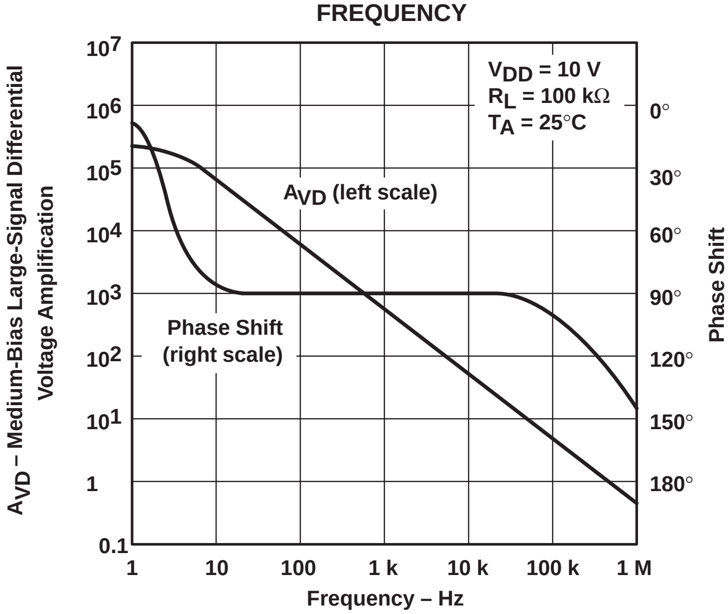


Figure 7

## TYPICAL CHARACTERISTICS

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

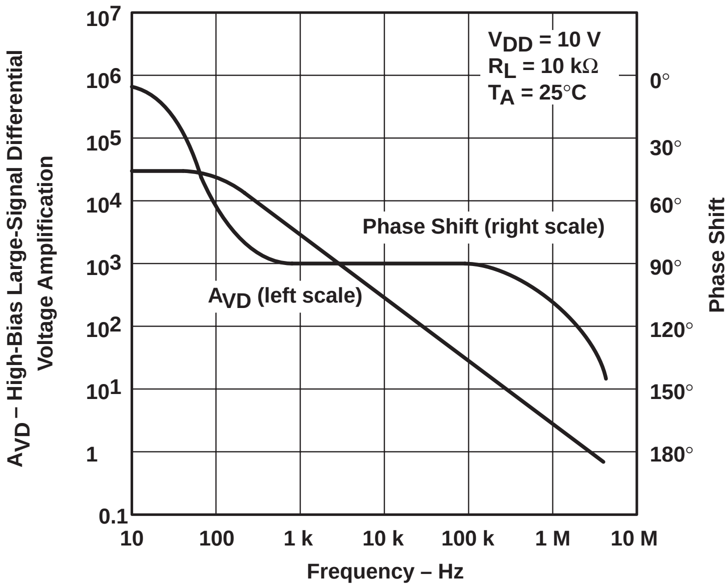


Figure 8



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## APPLICATION INFORMATION

### latch-up avoidance

Junction-isolated CMOS circuits have an inherent parasitic PNPN structure that can function as an SCR. Under certain conditions, this SCR may be triggered into a low-impedance state, resulting in excessive supply current. To avoid such conditions, no voltage greater than 0.3 V beyond the supply rails should be applied to any pin. In general, the operational amplifiers supplies should be established simultaneously with, or before, application of any input signals.

### output stage considerations

The amplifier’s output stage consists of a source-follower-connected pullup transistor and an open-drain pulldown transistor. The high-level output voltage ($V_{OH}$) is virtually independent of the $I_{DD}$ selection and increases with higher values of $V_{DD}$ and reduced output loading. The low-level output voltage ($V_{OL}$) decreases with reduced output current and higher input common-mode voltage. With no load, $V_{OL}$ is essentially equal to the potential of $V_{DD-}$/GND.

### supply configurations

Even though the TLC25_4C series is are characterized for single-supply operation, they can be used effectively in a split-supply configuration if the input common-mode voltage ($V_{ICR}$), output swing ($V_{OL}$ and $V_{OH}$), and supply voltage limits are not exceeded.

### circuit layout precautions

Whenever extremely high circuit impedances are used, care must be exercised in layout, construction, board cleanliness, and supply filtering to avoid hum and noise pickup as well as excessive dc leakages.

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