- **Output Swing Includes Both Supply Rails**
- **Low Noise . . . 19 nV/√Hz Typ at f = 1 kHz**
- **Low Input Bias Current . . . 1 pA Typ**
- **Fully Specified for Both Single-Supply and Split-Supply Operation**
- **Very Low Power . . . 34 μA Per Channel Typ**
- **Common-Mode Input Voltage Range Includes Negative Rail**
- **Low Input Offset Voltage 850 μV Max at $T_A$ = 25°C**
- **Wide Supply Voltage Range 2.7 V to 8 V**
- **Macromodel Included**
- **Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards**

## description

The TLV2252 and TLV2254 are dual and quadruple low-voltage operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLV225x family consumes only 34 μA of supply current per channel. This micropower operation makes them good choices for battery-powered applications. This family is fully characterized at 3 V and 5 V and is optimized for low-voltage applications. The noise performance has been dramatically improved over previous generations of CMOS amplifiers. The TLV225x has a noise level of 19 nV/√Hz at 1kHz, four times lower than competitive micropower solutions.

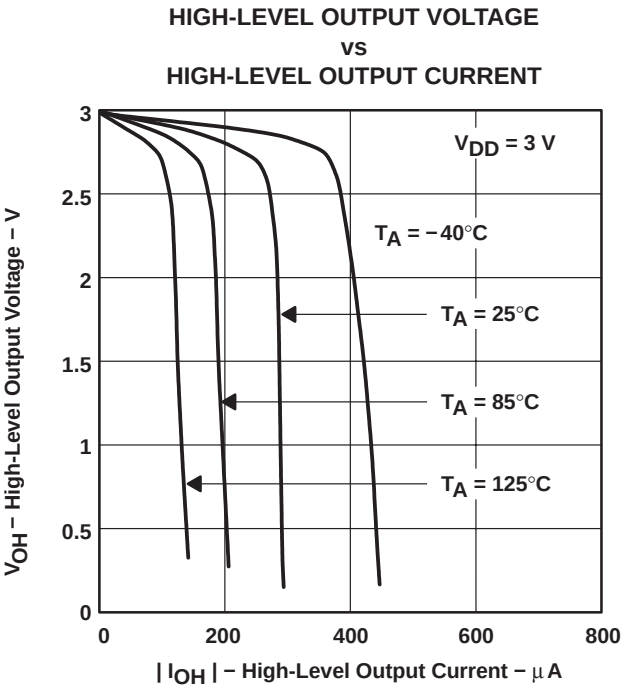



**Figure 1**

The TLV225x, exhibiting high input impedance and low noise, are excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels combined with 3-V operation, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single or split supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLV225xA family is available and has a maximum input offset voltage of 850 μV.

The TLV2252/4 also make great upgrades to the TLV2322/4 in standard designs. They offer increased output dynamic range, lower noise voltage, and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage range, see the TLV2432 and TLV2442 devices. If your design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.

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

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**TLV2252 AVAILABLE OPTIONS**

| $T_A$ | $V_{IO}$max AT 25°C | PACKAGED DEVICES | | | | | |
|---|---|---|---|---|---|---|---|
| | | SMALL OUTLINE† (D) | CHIP CARRIER (FK) | CERAMIC DIP (JG) | PLASTIC DIP (P) | TSSOP‡ (PW) | CERAMIC FLATPACK (U) |
| −40°C to 125°C | 850 μV | TLV2252AID | — | — | TLV2252AIP | TLV2252AIPWLE | — |
| | 1500 μV | TLV2252ID | — | — | TLV2252IP | — | — |
| −40°C to 125°C | 850 μV | TLV2252AQD | — | — | — | — | — |
| | 1500 μV | TLV2252QD | — | — | — | — | — |
| −55°C to 125°C | 850 μV | — | TLV2252AMFK | TLV2252AMJG | — | — | TLV2252AMU |
| | 1500 μV | — | TLV2252MFK | TLV2252MJG | — | — | TLV2252MU |

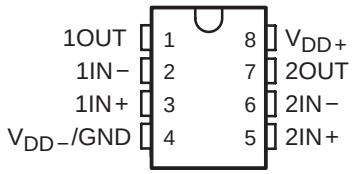
† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2252CDR).
‡ The PW package is available only left-end taped and reeled.
§ Chips are tested at 25°C.

**TLV2254 AVAILABLE OPTIONS**

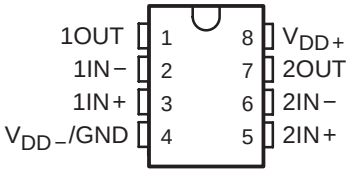
| $T_A$ | $V_{IO}$max AT 25°C | PACKAGED DEVICES | | | | | |
|---|---|---|---|---|---|---|---|
| | | SMALL OUTLINE† (D) | CHIP CARRIER (FK) | CERAMIC DIP (J) | PLASTIC DIP (N) | TSSOP‡ (PW) | CERAMIC FLATPACK (W) |
| −40°C to 125°C | 850 μV | TLV2254AID | — | — | TLV2254AIN | TLV2254AIPWLE | — |
| | 1500 μV | TLV2254ID | — | — | TLV2254IN | — | — |
| −40°C to 125°C | 850 μV | TLV2254AQD | — | — | — | — | — |
| | 1500 μV | TLV2254QD | — | — | — | — | — |
| −55°C to 125°C | 850 μV | — | TLV2254AMFK | TLV2254AMJ | — | — | TLV2254AMW |
| | 1500 μV | — | TLV2254MFK | TLV2254MJ | — | — | TLV2254MW |

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2254CDR).
‡ The PW package is available only left-end taped and reeled.
§ Chips are tested at 25°C.

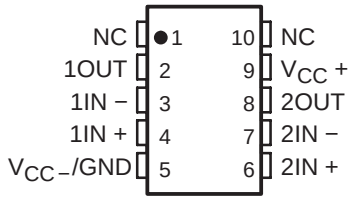
**TLV2252I, TLV2252AI**
**TLV2252Q, TLV2252AQ**
**D, P, OR PW PACKAGE**
**(TOP VIEW)**



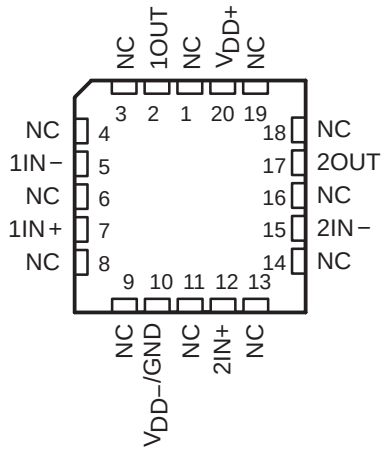

**TLV2252M, TLV2252AM . . . JG PACKAGE**
**(TOP VIEW)**



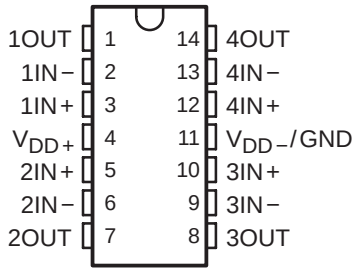

**TLV2252M, TLV2252AM . . . U PACKAGE**
**(TOP VIEW)**



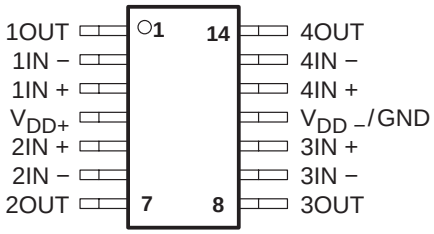

**TLV2252M, TLV2252AM . . . FK PACKAGE**
**(TOP VIEW)**



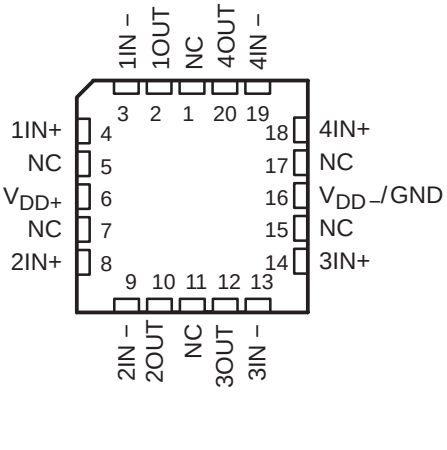

**TLV2254I, TLV2254AI, TLV2254Q, TLV2254AQ . . . D OR N PACKAGE**
**TLV2254M, TLV2254AM . . . J OR W PACKAGE**
**(TOP VIEW)**



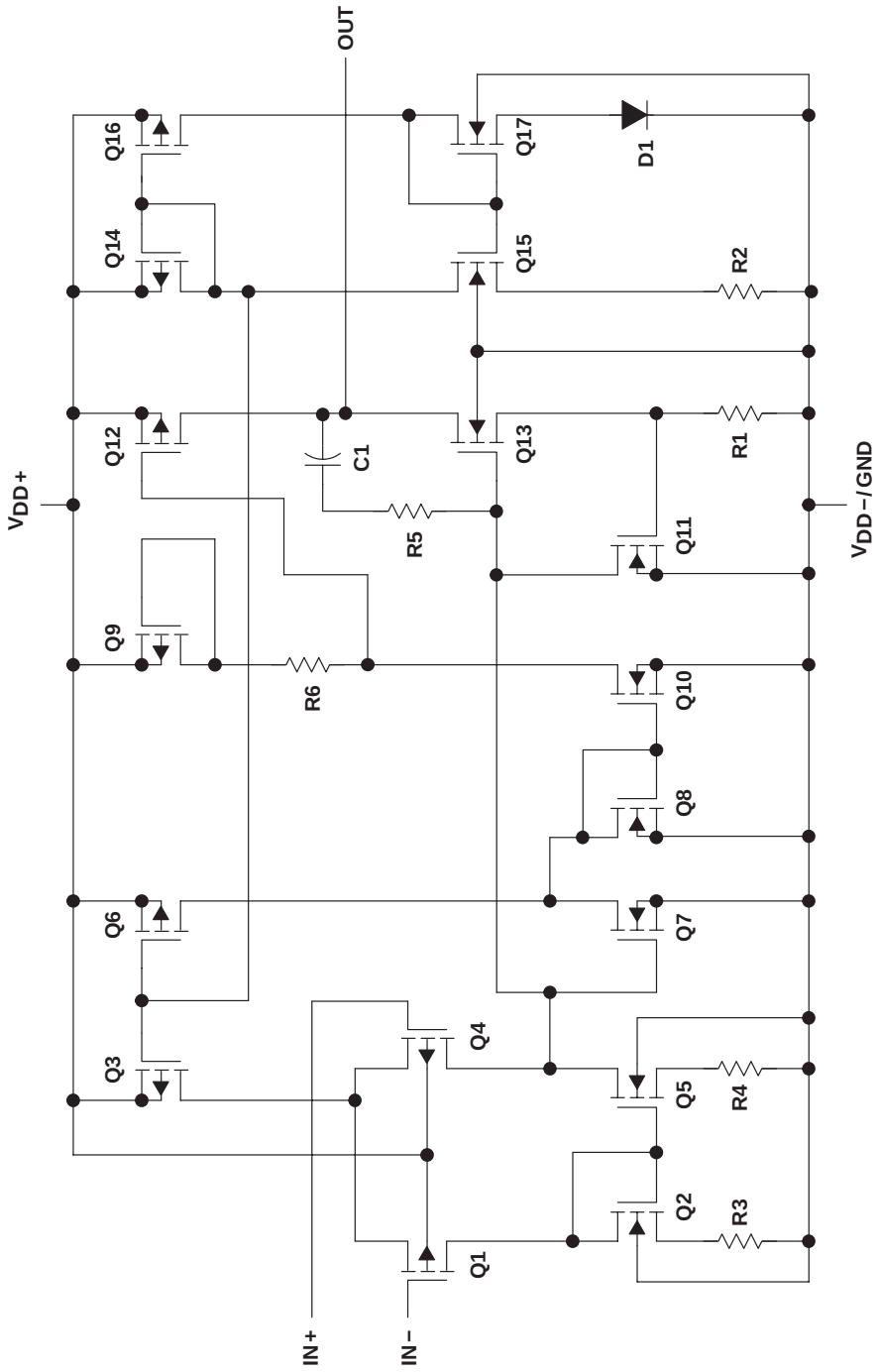

**TLV2254I, TLV2254AI . . . PW PACKAGE**
**(TOP VIEW)**




**TLV2254M, TLV2254AM . . . FK PACKAGE**
**(TOP VIEW)**



## equivalent schematic (each amplifier)




| ACTUAL DEVICE COMPONENT COUNT† | | |
|---|---|---|
| COMPONENT | TLV2252 | TLV2254 |
| Transistors | 38 | 76 |
| Resistors | 30 | 56 |
| Diodes | 9 | 18 |
| Capacitors | 3 | 6 |

† Includes both amplifiers and all ESD, bias, and trim circuitry

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

Supply voltage, $V_{DD}$ (see Note 1) . . . . . 16 V
Differential input voltage, $V_{ID}$ (see Note 2) . . . . . $\pm V_{DD}$
Input voltage range, $V_I$ (any input, see Note 1) . . . . . $V_{DD-}$ −0.3 V to $V_{DD+}$
Input current, $I_I$ (each input) . . . . . ±5 mA
Output current, $I_O$ . . . . . ±50 mA
Total current into $V_{DD+}$ . . . . . ±50 mA
Total current out of $V_{DD-}$ . . . . . ±50 mA
Duration of short-circuit current (at or below) 25°C (see Note 3) . . . . . unlimited
Continuous total power dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, $T_A$: I Suffix . . . . . −40°C to 125°C
Q Suffix . . . . . −40°C to 125°C
M Suffix . . . . . −55°C to 125°C
Storage temperature range, $T_{stg}$ . . . . . −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, P, and PW packages . . . . . 260°C
J, JG, U, and W packages . . . . . 300°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 $V_{DD-}$.
2. Differential voltages are at the noninverting input with respect to the inverting input. Excessive current flows when input is brought below $V_{DD-}$ − 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.

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \le 25°C$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25°C$ | $T_A = 85°C$ POWER RATING | $T_A = 125°C$ POWER RATING |
|---|---|---|---|---|
| D−8 | 725 mW | 5.8 mW/°C | 377 mW | 145 mW |
| D−14 | 950 mW | 7.6 mW/°C | 494 mW | 190 mW |
| FK | 1375 mW | 11.0 mW/°C | 715 mW | 275 mW |
| J | 1375 mW | 11.0 mW/°C | 715 mW | 275 mW |
| JG | 1050 mW | 8.4 mW/°C | 546 mW | 210 mW |
| N | 1150 mW | 9.2 mW/°C | 598 mW | 230 mW |
| P | 1000 mW | 8.0 mW/°C | 520 mW | 200 mW |
| PW−8 | 525 mW | 4.2 mW/°C | 273 mW | 105 mW |
| PW−14 | 700 mW | 5.6 mW/°C | 364 mW | 140 mW |
| U | 700 mW | 5.5 mW/°C | 370 mW | 150 mW |
| W | 700 mW | 5.5 mW/°C | 370 mW | 150 mW |

## recommended operating conditions

| | TLV225xI | | TLV225xQ | | TLV225xM | | UNIT |
|---|---|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | MIN | MAX | |
| Supply voltage, $V_{DD}$ (see Note 1) | 2.7 | 8 | 2.7 | 8 | 2.7 | 8 | V |
| Input voltage range, $V_I$ | $V_{DD-}$ | $V_{DD+}$ −1.3 | $V_{DD-}$ | $V_{DD+}$ −1.3 | $V_{DD-}$ | $V_{DD+}$ −1.3 | V |
| Common-mode input voltage, $V_{IC}$ | $V_{DD-}$ | $V_{DD+}$ −1.3 | $V_{DD-}$ | $V_{DD+}$ −1.3 | $V_{DD-}$ | $V_{DD+}$ −1.3 | V |
| Operating free-air temperature, $T_A$ | −40 | 125 | −40 | 125 | −55 | 125 | °C |

NOTE 1: All voltage values, except differential voltages, are with respect to $V_{DD-}$.

## TLV2252I electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2252I | | | TLV2252AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±1.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 85°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $R_S$ = 50 Ω, | $\lvert V_{IO}\rvert \le$ 5 mV | 25°C | 0 to 2 | −0.3 to 2.2 | | 0 to 2 | −0.3 to 2.2 | | V |
| | | | | Full range | 0 to 1.7 | | | 0 to 1.7 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 2.98 | | | 2.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 2.9 | | | 2.9 | | | |
| | | | | Full range | 2.8 | | | 2.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 2.8 | | | 2.8 | | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 50 µA | 25°C | | 10 | | | 10 | | mV |
| | | | | Full range | | | 80 | | | 80 | |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 500 µA | 25°C | | 100 | | | 100 | | |
| | | | | Full range | | | 150 | | | 150 | |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 1 mA | 25°C | | 200 | | | 200 | | |
| | | | | Full range | | | 300 | | | 300 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 1.5 V, $V_O$ = 1 V to 2 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 250 | | 100 | 250 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 800 | | | 800 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | P package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 220 | | | 220 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 1.7 V, $V_O$ = 1.5 V, | $R_S$ = 50 Ω | 25°C | 65 | 75 | | 65 | 77 | | dB |
| | | | | Full range | 60 | | | 60 | | | |

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2252I electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2252I | | | TLV2252AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}$ /$\Delta V_{IO}$) | $V_{DD}$ = 2.7 V to 8 V, $V_{IC}$ = $V_{DD}$/2, No load | 25°C | 80 | 95 | | 80 | 100 | | dB |
| | | | Full range | 80 | | | 80 | | | |
| $I_{DD}$ | Supply current | $V_O$ = 1.5 V, No load | 25°C | | 68 | 125 | | 68 | 125 | μA |
| | | | Full range | | | 150 | | | 150 | |

† Full range is − 40°C to 125°C.

### TLV2252I operating characteristics at specified free-air temperature, $V_{DD}$ = 3 V

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2252I | | | TLV2252AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 1.1 V to 1.9 V, $R_L$ = 100 kΩ‡, $C_L$ = 100 pF‡ | 25°C | 0.07 | 0.1 | | 0.07 | 0.1 | | V/μs |
| | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | 25°C | | 35 | | | 35 | | nV/√Hz |
| | | f = 1 kHz | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | 25°C | | 0.6 | | | 0.6 | | μV |
| | | f = 0.1 Hz to 10 Hz | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| | Gain-bandwidth product | f = 1 kHz, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 0.187 | | | 0.187 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 1 V, $A_V$ = 1, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 60 | | | 60 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | 25°C | | 15 | | | 15 | | dB |

† Full range is −40°C to 125°C.
‡ Referenced to 1.5 V

## TLV2252I electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2252I | | | TLV2252AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±2.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 85°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $\|V_{IO}\|$ ≤5 mV, | $R_S$ = 50 Ω | 25°C | 0 to 4 | −0.3 to 4.2 | | 0 to 4 | −0.3 to 4.2 | | V |
| | | | | Full range | 0 to 3.5 | | | 0 to 3.5 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 4.98 | | | 4.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 4.9 | 4.94 | | 4.9 | 4.94 | | |
| | | | | Full range | 4.8 | | | 4.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 4.8 | 4.88 | | 4.8 | 4.88 | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 50 µA | 25°C | | 0.01 | | | 0.01 | | V |
| | | | | Full range | | | 0.06 | | | 0.06 | |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 500 µA | 25°C | | 0.09 | 0.15 | | 0.09 | 0.15 | |
| | | | | Full range | | | 0.15 | | | 0.15 | |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 1 mA | 25°C | | 0.2 | 0.3 | | 0.2 | 0.3 | |
| | | | | Full range | | | 0.3 | | | 0.3 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 2.5 V, $V_O$ = 1 V to 4 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 350 | | 100 | 350 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 1700 | | | 1700 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | P package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 200 | | | 200 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 2.7 V, $R_S$ = 50 Ω | $V_O$ = 2.5 V, | 25°C | 70 | 83 | | 70 | 83 | | dB |
| | | | | Full range | 70 | | | 70 | | | |

† Full range is − 40°C to 125°C.
‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2252I electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2252I | | | TLV2252AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 4.4 V to 8 V, $V_{IC} = V_{DD}/2$, No load | 25°C | 80 | 95 | | 80 | 95 | | dB |
| | | | Full range | 80 | | | 80 | | | |
| $I_{DD}$ | Supply current | $V_O$ = 2.5 V, No load | 25°C | | 70 | 125 | | 70 | 125 | μA |
| | | | Full range | | | 150 | | | 150 | |

† Full range is − 40°C to 125°C.

### TLV2252I operating characteristics at specified free-air temperature, $V_{DD}$ = 5 V

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2252I | | | TLV2252AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 1.5 V to 3.5 V, $C_L$ = 100 pF‡ | $R_L$ = 100 kΩ‡, | 25°C | 0.07 | 0.12 | | 0.07 | 0.12 | | V/μs |
| | | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | | 25°C | | 36 | | | 36 | | nV/√Hz |
| | | f = 1 kHz | | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | | 25°C | | 0.7 | | | 0.7 | | μV |
| | | f = 0.1 Hz to 10 Hz | | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| THD + N | Total harmonic distortion plus noise | $V_O$ = 0.5 V to 2.5 V, f = 20 kHz, $R_L$ = 50 kΩ‡ | $A_V$ = 1 | 25°C | | 0.2% | | | 0.2% | | |
| | | | $A_V$ = 10 | | | 1% | | | 1% | | |
| | Gain-bandwidth product | f = 50 kHz, $C_L$ = 100 pF‡ | $R_L$ = 50 kΩ‡, | 25°C | | 0.2 | | | 0.2 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 2 V, $R_L$ = 50 kΩ‡, | $A_V$ = 1, $C_L$ = 100 pF‡ | 25°C | | 30 | | | 30 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, | $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | | 25°C | | 15 | | | 15 | | dB |

† Full range is − 40°C to 125°C.
‡ Referenced to 2.5 V

## TLV2254I electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2254I | | | TLV2254AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±1.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 85°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $R_S$ = 50 Ω, | $\lvert V_{IO}\rvert \le$ 5 mV | 25°C | 0 to 2 | −0.3 to 2.2 | | 0 to 2 | −0.3 to 2.2 | | V |
| | | | | Full range | 0 to 1.7 | | | 0 to 1.7 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 2.98 | | | 2.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 2.9 | | | 2.9 | | | |
| | | | | Full range | 2.8 | | | 2.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 2.8 | | | 2.8 | | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 50 µA | 25°C | | 10 | | | 10 | | mV |
| | | | | Full range | | | 80 | | | 80 | |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 500 µA | 25°C | | 100 | | | 100 | | |
| | | | | Full range | | | 150 | | | 150 | |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 1 mA | 25°C | | 200 | | | 200 | | |
| | | | | Full range | | | 300 | | | 300 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 1.5 V, $V_O$ = 1 V to 2 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 225 | | 100 | 225 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 800 | | | 800 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | N package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 220 | | | 220 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 1.7 V, $R_S$ = 50 Ω | $V_O$ = 1.5 V, | 25°C | 65 | 75 | | 65 | 77 | | dB |
| | | | | Full range | 60 | | | 60 | | | |

† Full range is − 40°C to 125°C.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2254I electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2254I | | | TLV2254AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 2.7 V to 8 V, $V_{IC} = V_{DD}/2$, No load | 25°C | 80 | 95 | | 80 | 100 | | dB |
| | | | Full range | 80 | | | 80 | | | |
| $I_{DD}$ | Supply current (four amplifiers) | $V_O$ = 1.5 V, No load | 25°C | | 135 | 250 | | 135 | 250 | μA |
| | | | Full range | | | 300 | | | 300 | |

† Full range is − 40°C to 125°C.

### TLV2254I operating characteristics at specified free-air temperature, $V_{DD}$ = 3 V

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2254I | | | TLV2254AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 0.7 V to 1.7 V, $R_L$ = 100 kΩ‡, $C_L$ = 100 pF‡ | 25°C | 0.07 | 0.1 | | 0.07 | 0.1 | | V/μs |
| | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | 25°C | | 35 | | | 35 | | nV/√Hz |
| | | f = 1 kHz | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | 25°C | | 0.6 | | | 0.6 | | μV |
| | | f = 0.1 Hz to 10 Hz | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| | Gain-bandwidth product | f = 1 kHz, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 0.187 | | | 0.187 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 1 V, $A_V$ = 1, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 60 | | | 60 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | 25°C | | 15 | | | 15 | | dB |

† Full range is − 40°C to 85°C.
‡ Referenced to 1.5 V

## TLV2254I electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2254I | | | TLV2254AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±2.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 85°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | −40°C to 85°C | | | 150 | | | 150 | |
| | | | | Full range | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $\|V_{IO}\|$ ≤5 mV, | $R_S$ = 50 Ω | 25°C | 0 to 4 | −0.3 to 4.2 | | 0 to 4 | −0.3 to 4.2 | | V |
| | | | | Full range | 0 to 3.5 | | | 0 to 3.5 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 4.98 | | | 4.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 4.9 | 4.94 | | 4.9 | 4.94 | | |
| | | | | Full range | 4.8 | | | 4.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 4.8 | 4.88 | | 4.8 | 4.88 | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 50 µA | 25°C | | 0.01 | | | 0.01 | | V |
| | | | | Full range | | | 0.06 | | | 0.06 | |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 500 µA | 25°C | | 0.09 | 0.15 | | 0.09 | 0.15 | |
| | | | | Full range | | | 0.15 | | | 0.15 | |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 1 mA | 25°C | | 0.2 | 0.3 | | 0.2 | 0.3 | |
| | | | | Full range | | | 0.3 | | | 0.3 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 2.5 V, $V_O$ = 1 V to 4 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 350 | | 100 | 350 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 1700 | | | 1700 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | N package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 200 | | | 200 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 2.7 V, $R_S$ = 50 Ω | $V_O$ = 2.5 V, | 25°C | 70 | 83 | | 70 | 83 | | dB |
| | | | | Full range | 70 | | | 70 | | | |

† Full range is − 40°C to 125°C.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2254I electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2254I | | | TLV2254AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 4.4 V to 8 V, $V_{IC}$ = $V_{DD}$/2, No load | 25°C | 80 | 95 | | 80 | 95 | | dB |
| | | | Full range | 80 | | | 80 | | | |
| $I_{DD}$ | Supply current (four amplifiers) | $V_O$ = 2.5 V, No load | 25°C | | 140 | 250 | | 140 | 250 | μA |
| | | | Full range | | | 300 | | | 300 | |

† Full range is − 40°C to 125°C.

### TLV2254I operating characteristics at specified free-air temperature, $V_{DD}$ = 5 V

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2254I | | | TLV2254AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 1.4 V to 2.6 V, $C_L$ = 100 pF‡ | $R_L$ = 100 kΩ‡, | 25°C | 0.07 | 0.12 | | 0.07 | 0.12 | | V/μs |
| | | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | | 25°C | | 36 | | | 36 | | nV/√Hz |
| | | f = 1 kHz | | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | | 25°C | | 0.7 | | | 0.7 | | μV |
| | | f = 0.1 Hz to 10 Hz | | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| THD + N | Total harmonic distortion plus noise | $V_O$ = 0.5 V to 2.5 V, f = 20 kHz, $R_L$ = 50 kΩ‡ | $A_V$ = 1 | 25°C | | 0.2% | | | 0.2% | | |
| | | | $A_V$ = 10 | | | 1% | | | 1% | | |
| | Gain-bandwidth product | f = 50 kHz, $C_L$ = 100 pF‡ | $R_L$ = 50 kΩ‡, | 25°C | | 0.2 | | | 0.2 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 2 V, $R_L$ = 50 kΩ‡, | $A_V$ = 1, $C_L$ = 100 pF‡ | 25°C | | 30 | | | 30 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, | $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | | 25°C | | 15 | | | 15 | | dB |

† Full range is − 40°C to 125°C.
‡ Referenced to 2.5 V

## TLV2252Q, and TLV2252M electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2252Q, TLV2252M | | | TLV2252AQ, TLV2252AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±1.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 85°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $R_S$ = 50 Ω, | \|$V_{IO}$\| ≤5 mV | 25°C | 0 to 2 | −0.3 to 2.2 | | 0 to 2 | −0.3 to 2.2 | | V |
| | | | | Full range | 0 to 1.7 | | | 0 to 1.7 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 2.98 | | | 2.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 2.9 | | | 2.9 | | | |
| | | | | Full range | 2.8 | | | 2.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 2.8 | | | 2.8 | | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 50 µA | 25°C | | 10 | | | 10 | | mV |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 500 µA | 25°C | | 100 | 150 | | 100 | 150 | |
| | | | | Full range | | | 165 | | | 165 | |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 1 mA | 25°C | | 200 | 300 | | 200 | 300 | |
| | | | | Full range | | | 300 | | | 300 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 1.5 V, $V_O$ = 1 V to 2 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 250 | | 100 | 250 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 800 | | | 800 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | P package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 220 | | | 220 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 1.7 V, $R_S$ = 50 Ω | $V_O$ = 1.5 V, | 25°C | 65 | 75 | | 65 | 77 | | dB |
| | | | | Full range | 60 | | | 60 | | | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}$ /$\Delta V_{IO}$) | $V_{DD}$ = 2.7 V to 8 V, $V_{IC}$ = $V_{DD}$/2, | No load | 25°C | 80 | 95 | | 80 | 100 | | dB |
| | | | | Full range | 80 | | | 80 | | | |
| $I_{DD}$ | Supply current | $V_O$ = 1.5 V, | No load | 25°C | | 68 | 125 | | 68 | 125 | µA |
| | | | | Full range | | | 150 | | | 150 | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

## TLV2252Q, and TLV2252M operating characteristics at specified free-air temperature, $V_{DD}$ = 3 V

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2252Q, TLV2252M | | | TLV2252AQ, TLV2252AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 0.8 V to 1.4 V, $R_L$ = 100 kΩ‡, $C_L$ = 100 pF‡ | 25°C | 0.07 | 0.1 | | 0.07 | 0.1 | | V/μs |
| | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | 25°C | | 35 | | | 35 | | nV/√Hz |
| | | f = 1 kHz | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | 25°C | | 0.6 | | | 0.6 | | μV |
| | | f = 0.1 Hz to 10 Hz | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| | Gain-bandwidth product | f = 1 kHz, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 0.187 | | | 0.187 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 1 V, $A_V$ = 1, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 60 | | | 60 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | 25°C | | 15 | | | 15 | | dB |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V

## TLV2252Q, and TLV2252M electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2252Q, TLV2252M | | | TLV2252AQ, TLV2252AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±2.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 85°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | \|$V_{IO}$\| ≤5 mV, | $R_S$ = 50 Ω | 25°C | 0 to 4 | −0.3 to 4.2 | | 0 to 4 | −0.3 to 4.2 | | V |
| | | | | Full range | 0 to 3.5 | | | 0 to 3.5 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 4.98 | | | 4.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 4.9 | 4.94 | | 4.9 | 4.94 | | |
| | | | | Full range | 4.8 | | | 4.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 4.8 | 4.88 | | 4.8 | 4.88 | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 50 µA | 25°C | | 0.01 | | | 0.01 | | V |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 500 µA | 25°C | | 0.09 | 0.15 | | 0.09 | 0.15 | |
| | | | | Full range | | | 0.15 | | | 0.15 | |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 1 mA | 25°C | | 0.2 | 0.3 | | 0.2 | 0.3 | |
| | | | | Full range | | | 0.3 | | | 0.3 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 2.5 V, $V_O$ = 1 V to 4 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 350 | | 100 | 350 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 1700 | | | 1700 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | P package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 200 | | | 200 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 2.7 V, $V_O$ = 2.5 V, | $R_S$ = 50 Ω | 25°C | 70 | 83 | | 70 | 83 | | dB |
| | | | | Full range | 70 | | | 70 | | | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 4.4 V to 8 V, $V_{IC}$ = $V_{DD}$/2, | No load | 25°C | 80 | 95 | | 80 | 95 | | dB |
| | | | | Full range | 80 | | | 80 | | | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2252Q, and TLV2252M electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2252Q, TLV2252M | | | TLV2252AQ, TLV2252AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $I_{DD}$ | Supply current | $V_O$ = 2.5 V, No load | 25°C | | 70 | 125 | | 70 | 125 | µA |
| | | | Full range | | | 150 | | | 150 | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.

### TLV2252Q, and TLV2252M operating characteristics at specified free-air temperature, $V_{DD}$ = 5 V

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2252Q, TLV2252M | | | TLV2252AQ, TLV2252AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 1.25 V to 2.75 V, $R_L$ = 100 kΩ‡, $C_L$ = 100 pF‡ | | 25°C | 0.07 | 0.12 | | 0.07 | 0.12 | | V/µs |
| | | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | | 25°C | | 36 | | | 36 | | nV/√Hz |
| | | f = 1 kHz | | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | | 25°C | | 0.7 | | | 0.7 | | µV |
| | | f = 0.1 Hz to 10 Hz | | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| THD + N | Total harmonic distortion plus noise | $V_O$ = 0.5 V to 2.5 V, f = 20 kHz, $R_L$ = 50 kΩ‡ | $A_V$ = 1 | 25°C | | 0.2% | | | 0.2% | | |
| | | | $A_V$ = 10 | | | 1% | | | 1% | | |
| | Gain-bandwidth product | f = 50 kHz, $C_L$ = 100 pF‡ | $R_L$ = 50 kΩ‡, | 25°C | | 0.2 | | | 0.2 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 2 V, $R_L$ = 50 kΩ‡, | $A_V$ = 1, $C_L$ = 100 pF‡ | 25°C | | 30 | | | 30 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, | $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | | 25°C | | 15 | | | 15 | | dB |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V

## TLV2254Q, and TLV2254M electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2254Q, TLV2254M | | | TLV2254AQ, TLV2254AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±1.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | μV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 125°C | | 0.5 | | | 0.5 | | μV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | μV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $R_S$ = 50 Ω, | $\lvert V_{IO}\rvert \le$ 5 mV | 25°C | 0 to 2 | −0.3 to 2.2 | | 0 to 2 | −0.3 to 2.2 | | V |
| | | | | Full range | 0 to 1.7 | | | 0 to 1.7 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 μA | | 25°C | | 2.98 | | | 2.98 | | V |
| | | $I_{OH}$ = −75 μA | | 25°C | 2.9 | | | 2.9 | | | |
| | | | | Full range | 2.8 | | | 2.8 | | | |
| | | $I_{OH}$ = −150 μA | | 25°C | 2.8 | | | 2.8 | | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 50 μA | 25°C | | 10 | | | 10 | | mV |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 500 μA | 25°C | | 100 | 150 | | 100 | 150 | |
| | | | | Full range | | | 165 | | | 165 | |
| | | $V_{IC}$ = 1.5 V, | $I_{OL}$ = 1 mA | 25°C | | 200 | 300 | | 200 | 300 | |
| | | | | Full range | | | 300 | | | 300 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 1.5 V, $V_O$ = 1 V to 2 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 225 | | 100 | 225 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 800 | | | 800 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | N package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 220 | | | 220 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 1.7 V, $V_O$ = 1.5 V, $R_S$ = 50 Ω | | 25°C | 65 | 75 | | 65 | 77 | | dB |
| | | | | Full range | 60 | | | 60 | | | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 2.7 V to 8 V, $V_{IC}$ = $V_{DD}$/2, | No load | 25°C | 80 | 95 | | 80 | 100 | | dB |
| | | | | Full range | 80 | | | 80 | | | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2254Q, and TLV2254M electrical characteristics at specified free-air temperature, $V_{DD}$ = 3 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2254Q, TLV2254M | | | TLV2254AQ, TLV2254AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $I_{DD}$ | Supply current (four amplifiers) | $V_O$ = 1.5 V, No load | 25°C | | 135 | 250 | | 135 | 250 | μA |
| | | | Full range | | | 300 | | | 300 | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.

### TLV2254Q, and TLV2254M operating characteristics at specified free-air temperature, $V_{DD}$ = 3 V

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2254Q, TLV2254M | | | TLV2254AQ, TLV2254AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 0.5 V to 1.7 V, $R_L$ = 100 kΩ‡, $C_L$ = 100 pF‡ | 25°C | 0.07 | 0.1 | | 0.07 | 0.1 | | V/μs |
| | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | 25°C | | 35 | | | 35 | | nV/√Hz |
| | | f = 1 kHz | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | 25°C | | 0.6 | | | 0.6 | | μV |
| | | f = 0.1 Hz to 10 Hz | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| | Gain-bandwidth product | f = 1 kHz, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 0.187 | | | 0.187 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 1 V, $A_V$ = 1, $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 60 | | | 60 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | 25°C | | 15 | | | 15 | | dB |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 1.5 V

## TLV2254Q, and TLV2254M electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2254Q, TLV2254M | | | TLV2254AQ, TLV2254AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{DD\pm}$ = ±2.5 V, $V_O$ = 0, | $V_{IC}$ = 0, $R_S$ = 50 Ω | 25°C | | 200 | 1500 | | 200 | 850 | µV |
| | | | | Full range | | | 1750 | | | 1000 | |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | | | 25°C to 125°C | | 0.5 | | | 0.5 | | µV/°C |
| | Input offset voltage long-term drift (see Note 4) | | | 25°C | | 0.003 | | | 0.003 | | µV/mo |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.5 | 60 | | 0.5 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $I_{IB}$ | Input bias current | | | 25°C | | 1 | 60 | | 1 | 60 | pA |
| | | | | 125°C | | | 1000 | | | 1000 | |
| $V_{ICR}$ | Common-mode input voltage range | $\|V_{IO}\| \le$5 mV, | $R_S$ = 50 Ω | 25°C | 0 to 4 | −0.3 to 4.2 | | 0 to 4 | −0.3 to 4.2 | | V |
| | | | | Full range | 0 to 3.5 | | | 0 to 3.5 | | | |
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = −20 µA | | 25°C | | 4.98 | | | 4.98 | | V |
| | | $I_{OH}$ = −75 µA | | 25°C | 4.9 | 4.94 | | 4.9 | 4.94 | | |
| | | | | Full range | 4.8 | | | 4.8 | | | |
| | | $I_{OH}$ = −150 µA | | 25°C | 4.8 | 4.88 | | 4.8 | 4.88 | | |
| $V_{OL}$ | Low-level output voltage | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 50 µA | 25°C | | 0.01 | | | 0.01 | | V |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 500 µA | 25°C | | 0.09 | 0.15 | | 0.09 | 0.15 | |
| | | | | Full range | | | 0.15 | | | 0.15 | |
| | | $V_{IC}$ = 2.5 V, | $I_{OL}$ = 1 mA | 25°C | | 0.2 | 0.3 | | 0.2 | 0.3 | |
| | | | | Full range | | | 0.3 | | | 0.3 | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{IC}$ = 2.5 V, $V_O$ = 1 V to 4 V | $R_L$ = 100 kΩ‡ | 25°C | 100 | 350 | | 100 | 350 | | V/mV |
| | | | | Full range | 10 | | | 10 | | | |
| | | | $R_L$ = 1 MΩ‡ | 25°C | | 1700 | | | 1700 | | |
| $r_{i(d)}$ | Differential input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $r_{i(c)}$ | Common-mode input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | Ω |
| $c_{i(c)}$ | Common-mode input capacitance | f = 10 kHz, | N package | 25°C | | 8 | | | 8 | | pF |
| $z_o$ | Closed-loop output impedance | f = 25 kHz, | $A_V$ = 10 | 25°C | | 200 | | | 200 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = 0 to 2.7 V, $R_S$ = 50 Ω | $V_O$ = 2.5 V, | 25°C | 70 | 83 | | 70 | 83 | | dB |
| | | | | Full range | 70 | | | 70 | | | |
| $k_{SVR}$ | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD}$ = 4.4 V to 8 V, $V_{IC}$ = $V_{DD}$/2, | No load | 25°C | 80 | 95 | | 80 | 95 | | dB |
| | | | | Full range | 80 | | | 80 | | | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V
NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A$ = 150°C extrapolated to $T_A$ = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

### TLV2254Q, and TLV2254M electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$† | TLV2254Q, TLV2254M | | | TLV2254AQ, TLV2254AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $I_{DD}$ | Supply current (four amplifiers) | $V_O$ = 2.5 V, No load | 25°C | | 140 | 250 | | 140 | 250 | μA |
| | | | Full range | | | 300 | | | 300 | |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.

### TLV2254Q, and TLV2254M operating characteristics at specified free-air temperature, $V_{DD}$ = 5 V

| PARAMETER | | TEST CONDITIONS | | $T_A$† | TLV2254Q, TLV2254M | | | TLV2254AQ, TLV2254AM | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_O$ = 0.5 V to 3.5 V, $C_L$ = 100 pF‡ | $R_L$ = 100 kΩ‡, | 25°C | 0.07 | 0.12 | | 0.07 | 0.12 | | V/μs |
| | | | | Full range | 0.05 | | | 0.05 | | | |
| $V_n$ | Equivalent input noise voltage | f = 10 Hz | | 25°C | | 36 | | | 36 | | nV/√Hz |
| | | f = 1 kHz | | 25°C | | 19 | | | 19 | | |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz | | 25°C | | 0.7 | | | 0.7 | | μV |
| | | f = 0.1 Hz to 10 Hz | | 25°C | | 1.1 | | | 1.1 | | |
| $I_n$ | Equivalent input noise current | | | 25°C | | 0.6 | | | 0.6 | | fA/√Hz |
| THD + N | Total harmonic distortion plus noise | $V_O$ = 0.5 V to 2.5 V, f = 20 kHz, $R_L$ = 50 kΩ‡ | $A_V$ = 1 | 25°C | | 0.2% | | | 0.2% | | |
| | | | $A_V$ = 10 | | | 1% | | | 1% | | |
| | Gain-bandwidth product | f = 50 kHz, $C_L$ = 100 pF‡ | $R_L$ = 50 kΩ‡, | 25°C | | 0.2 | | | 0.2 | | MHz |
| $B_{OM}$ | Maximum output-swing bandwidth | $V_{O(PP)}$ = 2 V, $R_L$ = 50 kΩ‡, | $A_V$ = 1, $C_L$ = 100 pF‡ | 25°C | | 30 | | | 30 | | kHz |
| $\phi_m$ | Phase margin at unity gain | $R_L$ = 50 kΩ‡, | $C_L$ = 100 pF‡ | 25°C | | 63° | | | 63° | | |
| | Gain margin | | | 25°C | | 15 | | | 15 | | dB |

† Full range is −40°C to 125°C for Q level part, −55°C to 125°C for M level part.
‡ Referenced to 2.5 V

## TYPICAL CHARACTERISTICS

### Table of Graphs

| | | | FIGURE |
|---|---|---|---|
| $V_{IO}$ | Input offset voltage | Distribution<br>vs Common-mode voltage | 2 − 5<br>6, 7 |
| $\alpha_{VIO}$ | Input offset voltage temperature coefficient | Distribution | 8 − 11 |
| $I_{IB}/I_{IO}$ | Input bias and input offset currents | vs Free-air temperature | 12 |
| $V_I$ | Input voltage | vs Supply voltage<br>vs Free-air temperature | 13<br>14 |
| $V_{OH}$ | High-level output voltage | vs High-level output current | 15, 18 |
| $V_{OL}$ | Low-level output voltage | vs Low-level output current | 16, 17, 19 |
| $V_{O(PP)}$ | Maximum peak-to-peak output voltage | vs Frequency | 20 |
| $I_{OS}$ | Short-circuit output current | vs Supply voltage<br>vs Free-air temperature | 21<br>22 |
| $V_{ID}$ | Differential input voltage | vs Output voltage | 23, 24 |
| $A_{VD}$ | Differential voltage amplification | vs Load resistance | 25 |
| $A_{VD}$ | Large-signal differential voltage amplification | vs Frequency<br>vs Free-air temperature | 26, 27<br>28, 29 |
| $z_o$ | Output impedance | vs Frequency | 30, 31 |
| CMRR | Common-mode rejection ratio | vs Frequency<br>vs Free-air temperature | 32<br>33 |
| $k_{SVR}$ | Supply-voltage rejection ratio | vs Frequency<br>vs Free-air temperature | 34, 35<br>36 |
| $I_{DD}$ | Supply current | vs Supply voltage | 37, 38 |
| SR | Slew rate | vs Load capacitance<br>vs Free-air temperature | 39<br>40 |
| $V_O$ | Inverting large-signal pulse response | | 41, 42 |
| $V_O$ | Voltage-follower large-signal pulse response | | 43, 44 |
| $V_O$ | Inverting small-signal pulse response | | 45, 46 |
| $V_O$ | Voltage-follower small-signal pulse response | | 47, 48 |
| $V_n$ | Equivalent input noise voltage | vs Frequency | 49, 50 |
| | Input noise voltage | Over a 10-second period | 51 |
| | Integrated noise voltage | vs Frequency | 52 |
| THD + N | Total harmonic distortion plus noise | vs Frequency | 53 |
| | Gain-bandwidth product | vs Supply voltage<br>vs Free-air temperature | 54<br>55 |
| $\phi_m$ | Phase margin | vs Frequency<br>vs Load capacitance | 26, 27<br>56 |
| | Gain margin | vs Load capacitance | 57 |
| $B_1$ | Unity-gain bandwidth | vs Load capacitance | 58 |
| | Overestimation of phase margin | vs Load capacitance | 59 |

## TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLV2252
INPUT OFFSET VOLTAGE**

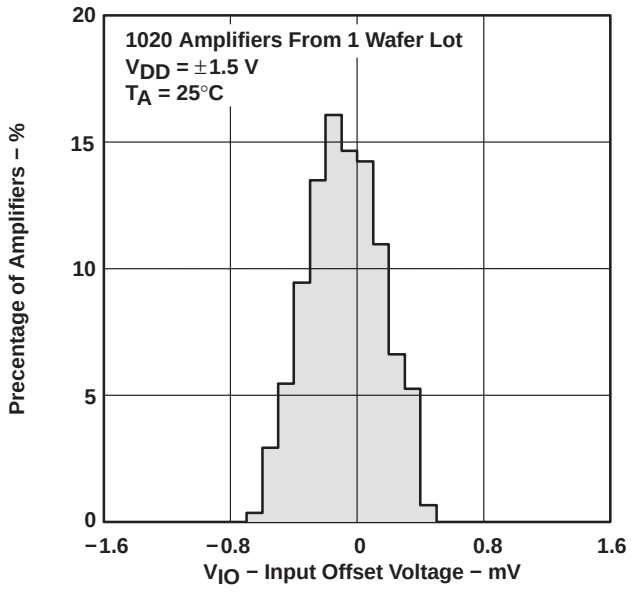



**Figure 2**

**DISTRIBUTION OF TLV2252
INPUT OFFSET VOLTAGE**

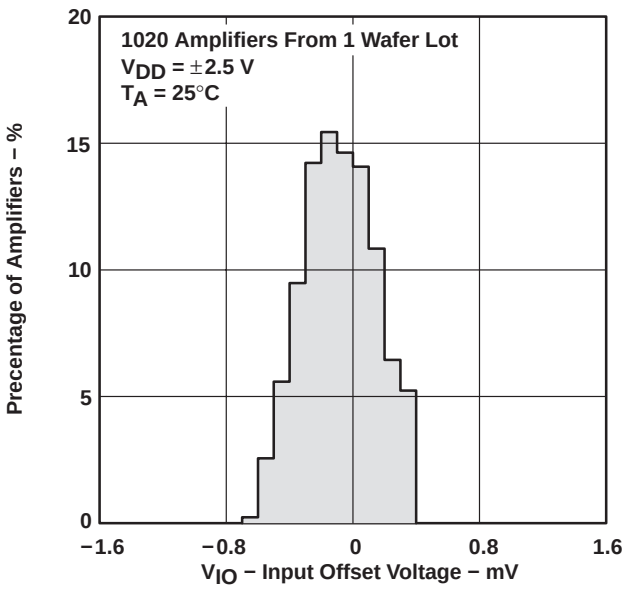



**Figure 3**

**DISTRIBUTION OF TLV2254
INPUT OFFSET VOLTAGE**

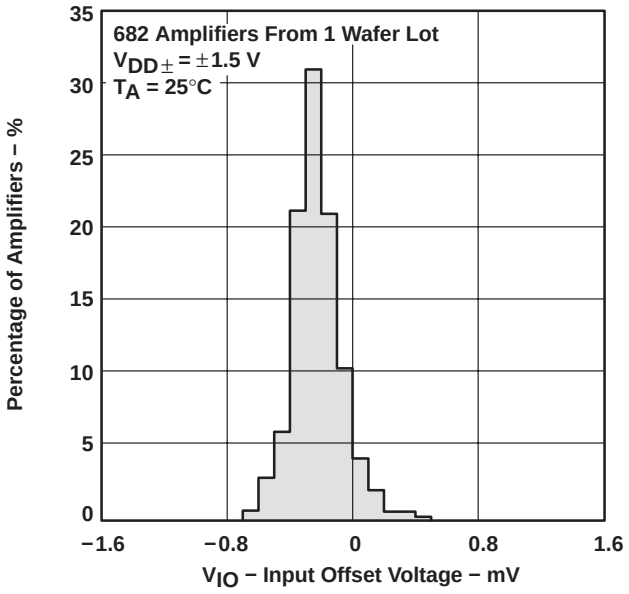



**Figure 4**

**DISTRIBUTION OF TLV2254
INPUT OFFSET VOLTAGE**

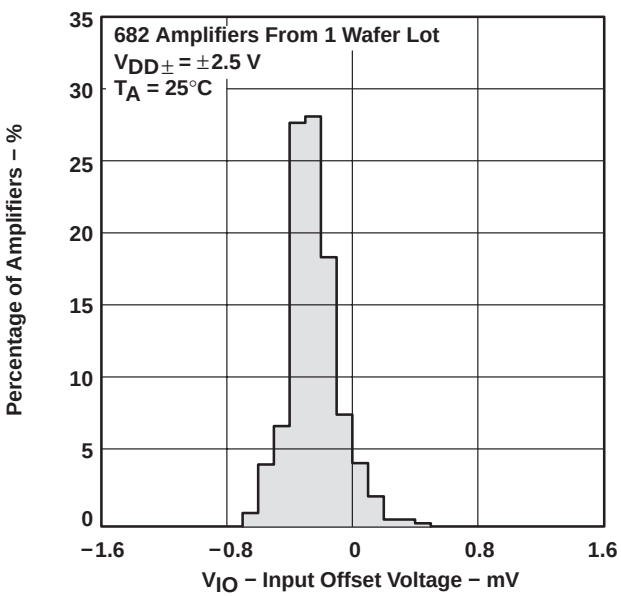



**Figure 5**

## TYPICAL CHARACTERISTICS

**INPUT OFFSET VOLTAGE† vs COMMON-MODE INPUT VOLTAGE**

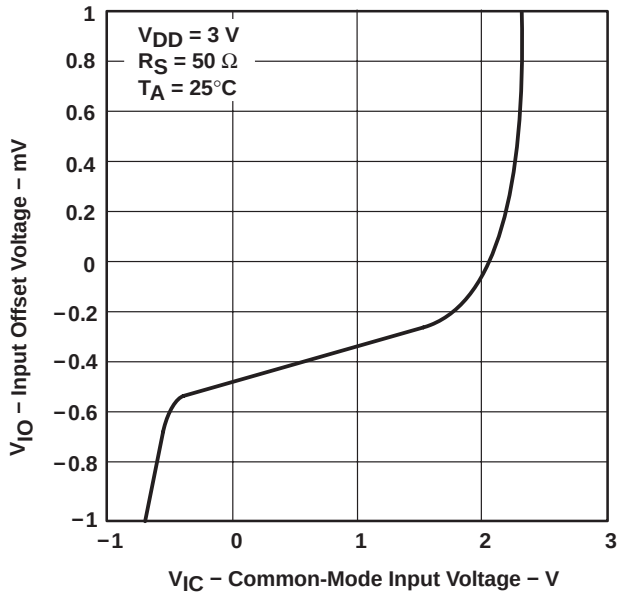



Figure 6

**INPUT OFFSET VOLTAGE† vs COMMON-MODE INPUT VOLTAGE**

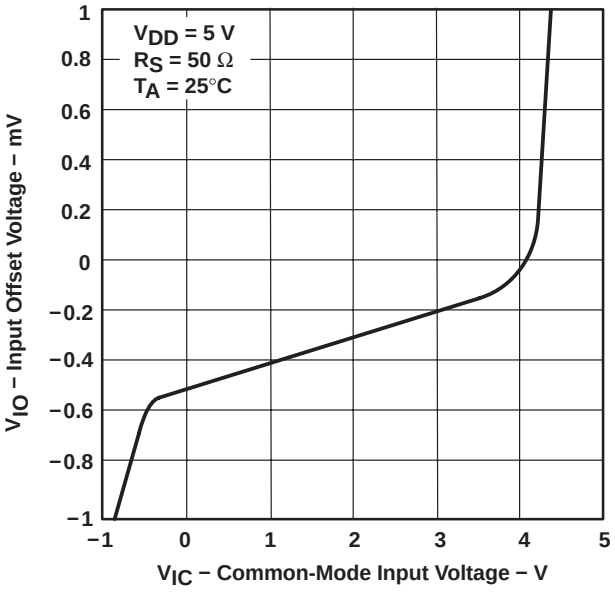



Figure 7

**DISTRIBUTION OF TLV2252 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT†**

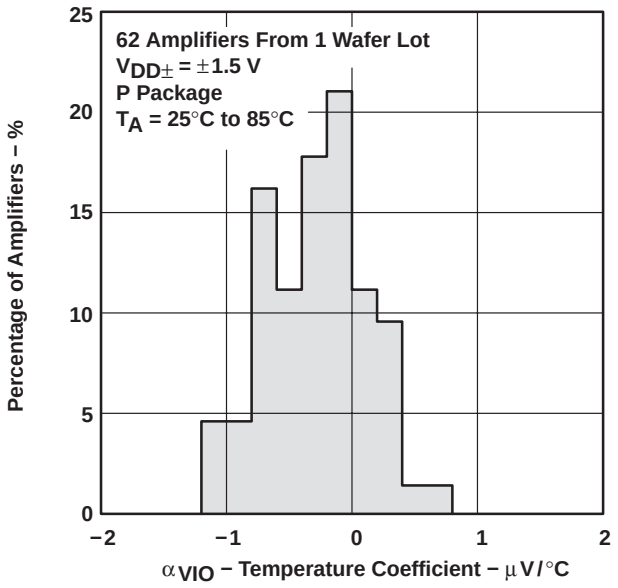



Figure 8

**DISTRIBUTION OF TLV2252 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT†**

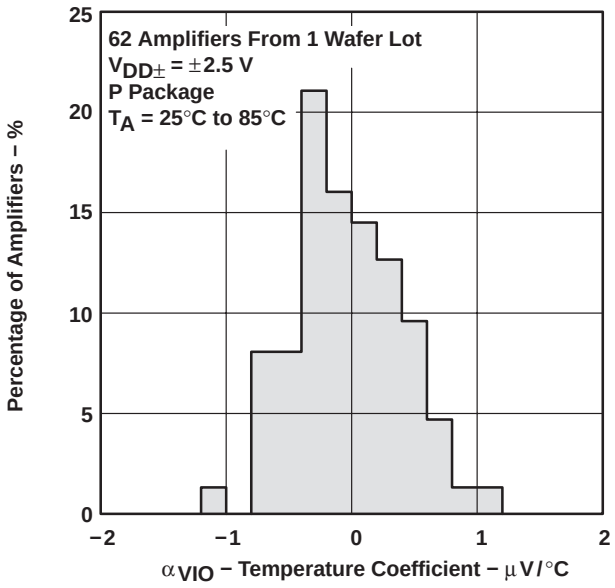



Figure 9

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2254 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

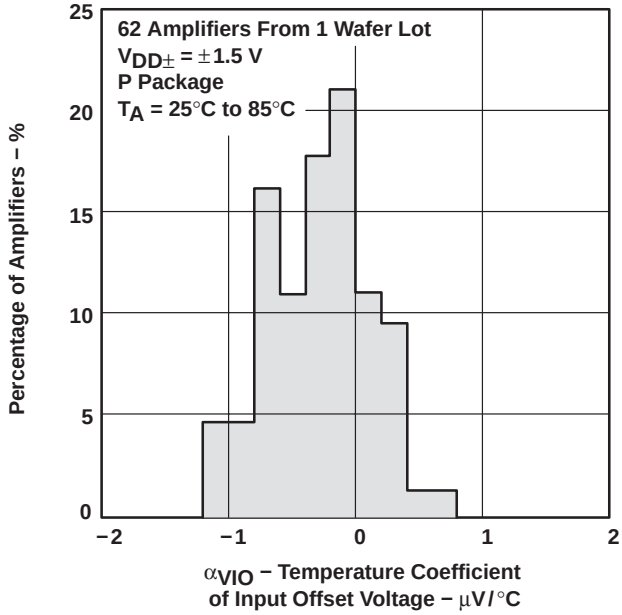



Figure 10

DISTRIBUTION OF TLV2254 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

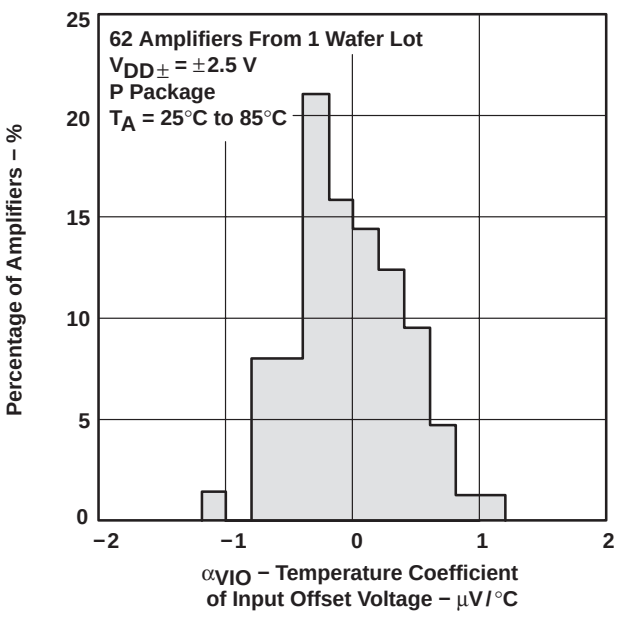



Figure 11

INPUT BIAS AND INPUT OFFSET CURRENTS† vs FREE-AIR TEMPERATURE

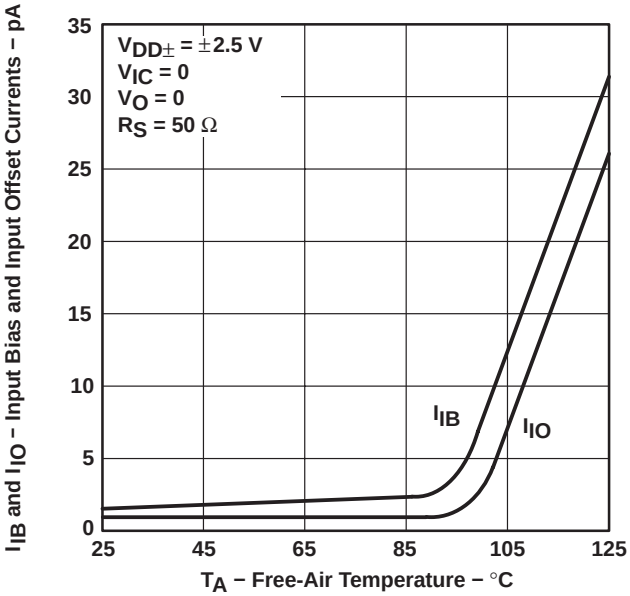



Figure 12

INPUT VOLTAGE vs SUPPLY VOLTAGE

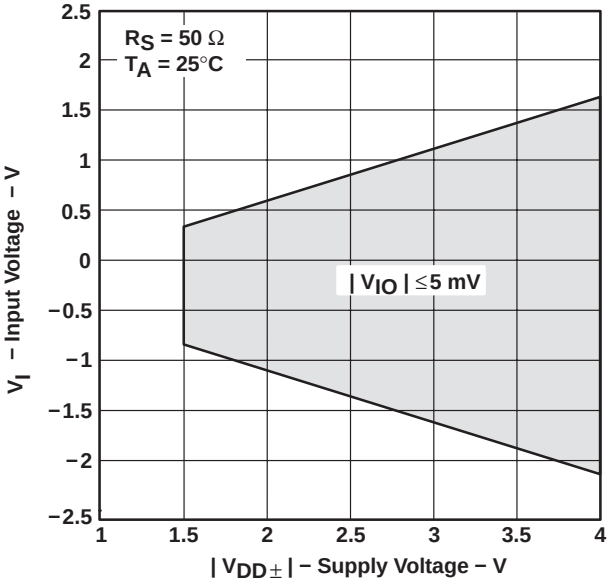



Figure 13

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

## TYPICAL CHARACTERISTICS

**INPUT VOLTAGE†‡ vs FREE-AIR TEMPERATURE**

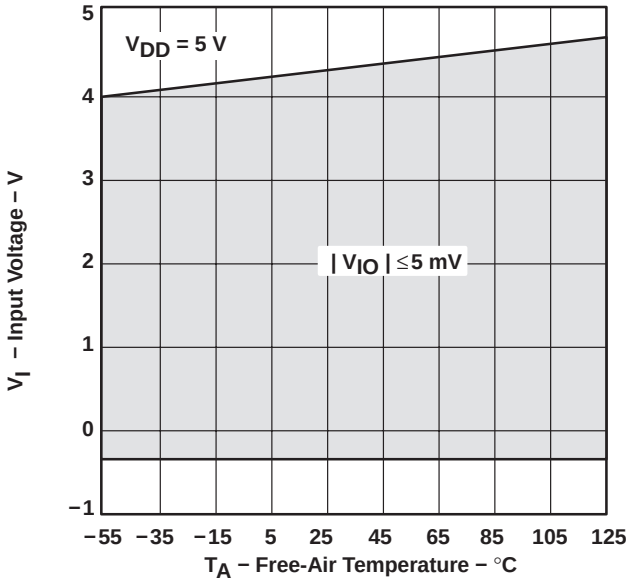



Figure 14

**HIGH-LEVEL OUTPUT VOLTAGE†‡ vs HIGH-LEVEL OUTPUT CURRENT**

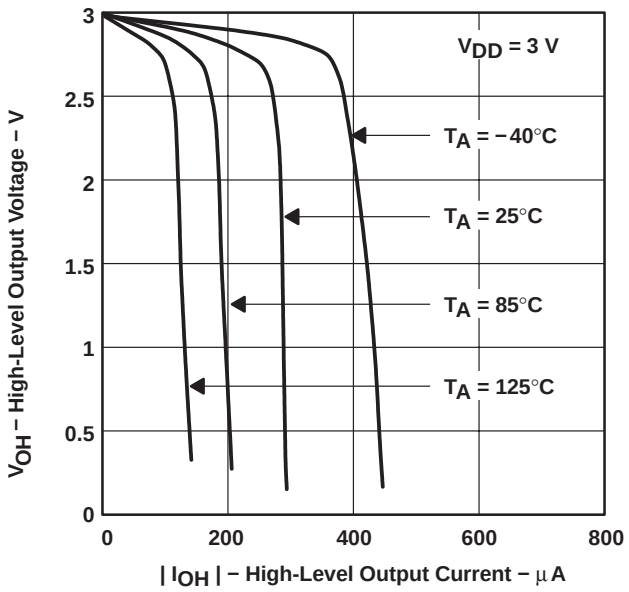



Figure 15

**LOW-LEVEL OUTPUT VOLTAGE‡ vs LOW-LEVEL OUTPUT CURRENT**

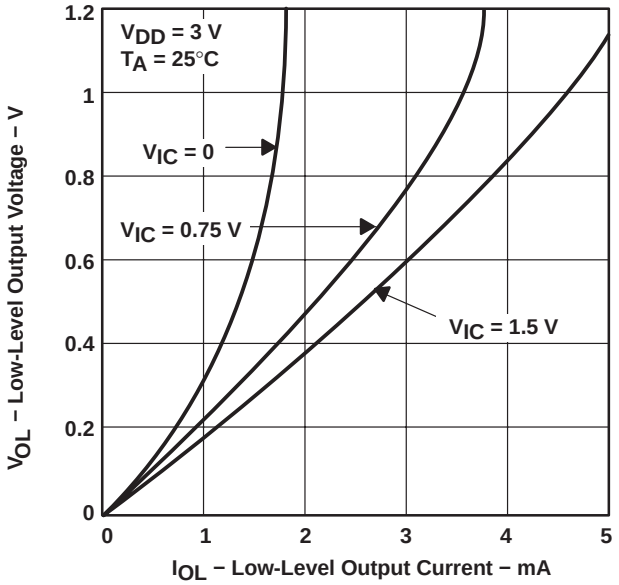



Figure 16

**LOW-LEVEL OUTPUT VOLTAGE†‡ vs LOW-LEVEL OUTPUT CURRENT**

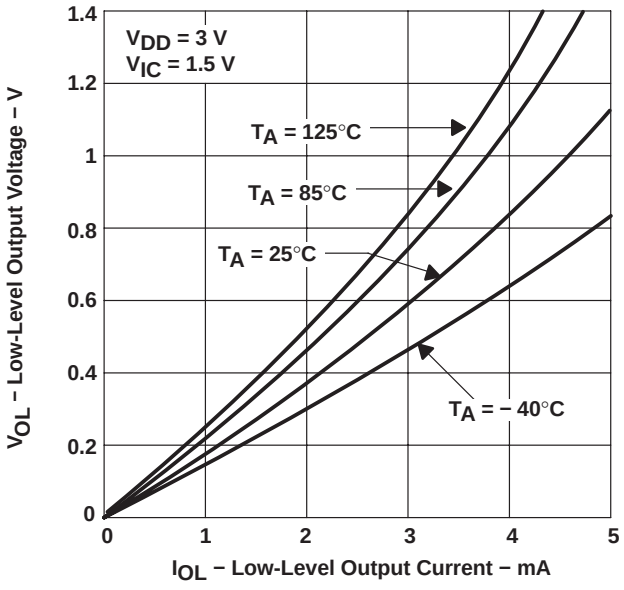



Figure 17

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**HIGH-LEVEL OUTPUT VOLTAGE†‡ vs HIGH-LEVEL OUTPUT CURRENT**

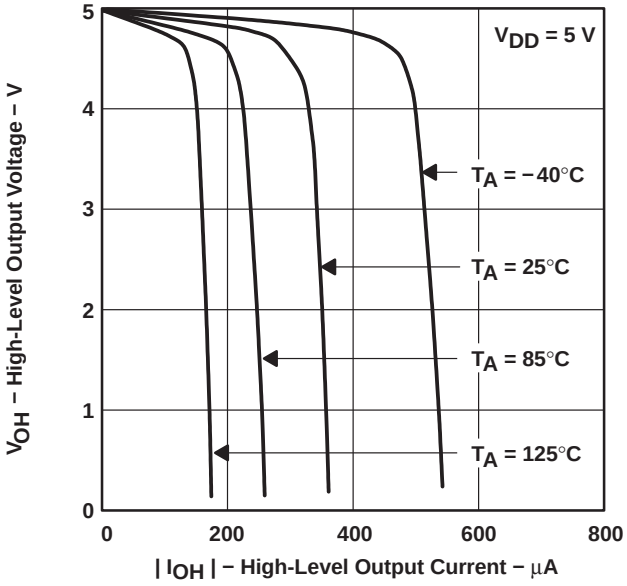



Figure 18

**LOW-LEVEL OUTPUT VOLTAGE†‡ vs LOW-LEVEL OUTPUT CURRENT**

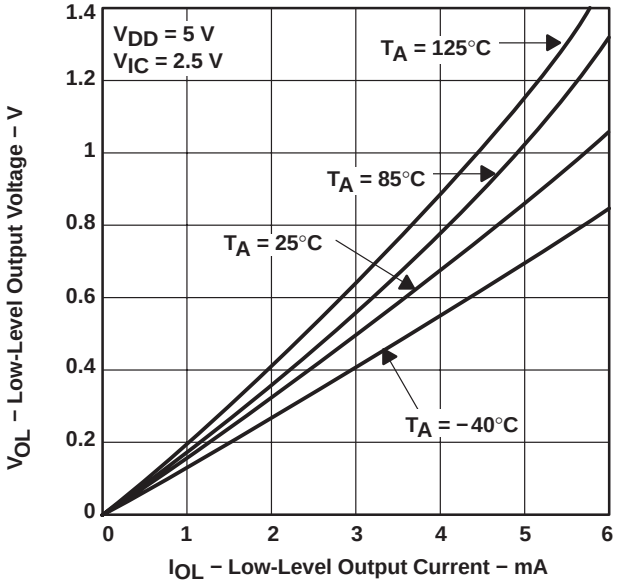



Figure 19

**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE‡ vs FREQUENCY**

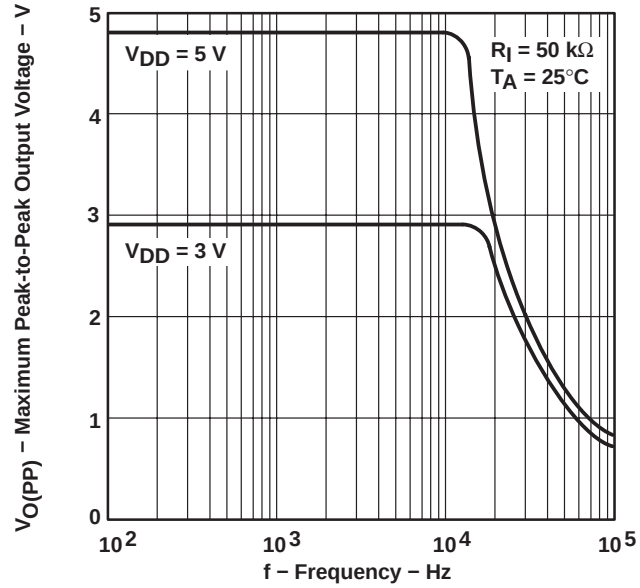



Figure 20

**SHORT-CIRCUIT OUTPUT CURRENT vs SUPPLY VOLTAGE**

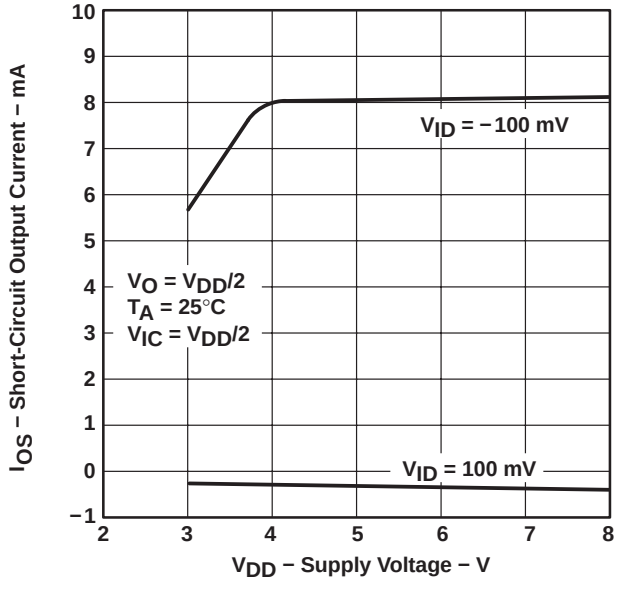



Figure 21

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**SHORT-CIRCUIT OUTPUT CURRENT† vs FREE-AIR TEMPERATURE**

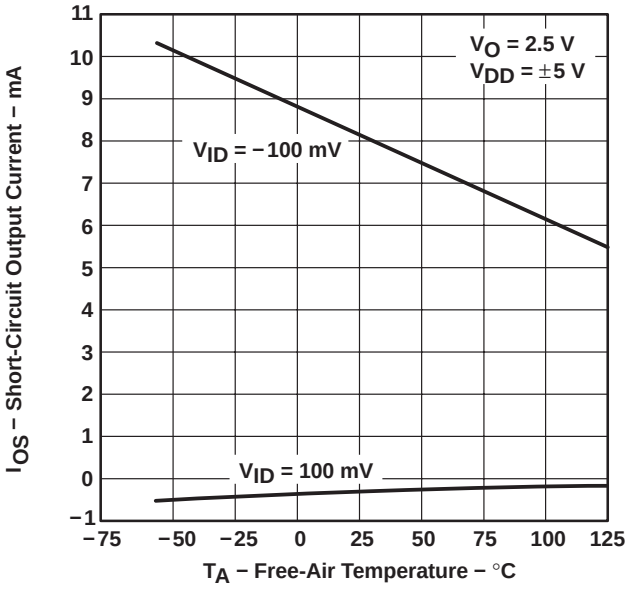



Figure 22

**DIFFERENTIAL INPUT VOLTAGE‡ vs OUTPUT VOLTAGE**

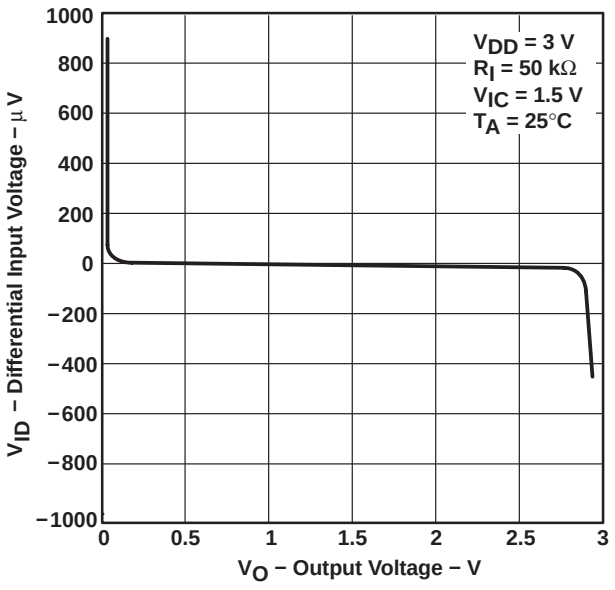



Figure 23

**DIFFERENTIAL INPUT VOLTAGE‡ vs OUTPUT VOLTAGE**

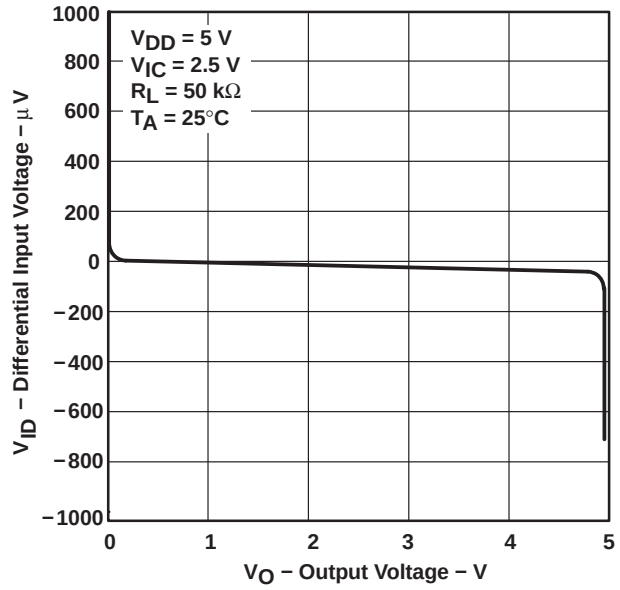



Figure 24

**DIFFERENTIAL VOLTAGE AMPLIFICATION†‡ vs LOAD RESISTANCE**

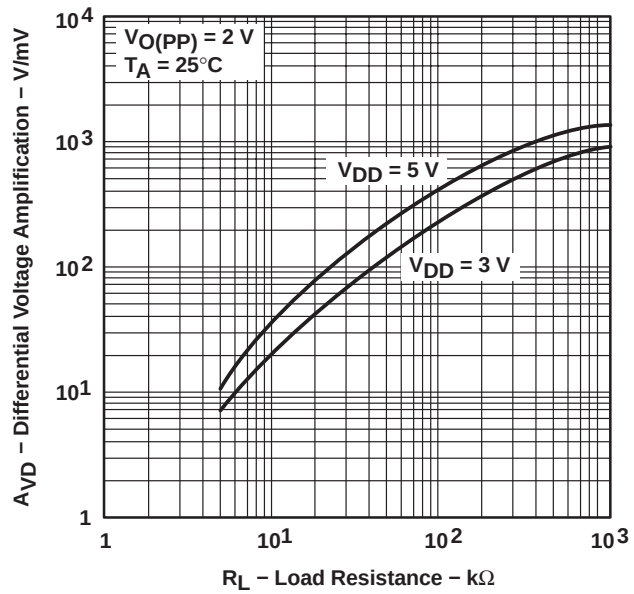



Figure 25

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE† AMPLIFICATION AND PHASE MARGIN vs FREQUENCY**

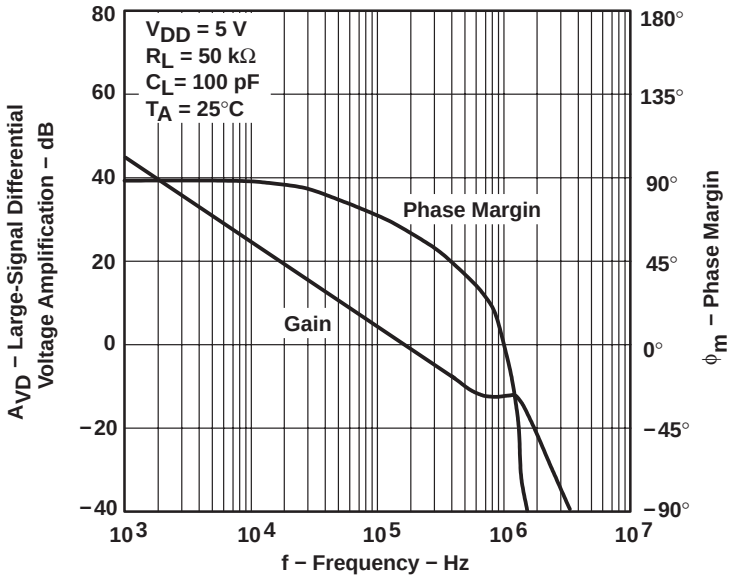



**Figure 26**

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE† AMPLIFICATION AND PHASE MARGIN vs FREQUENCY**

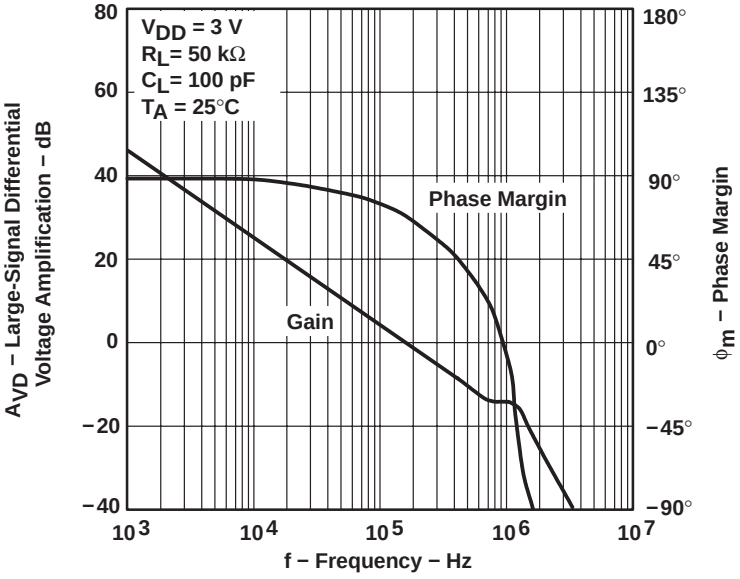



**Figure 27**

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**LARGE-SIGNAL DIFFERENTIAL†‡ VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE**

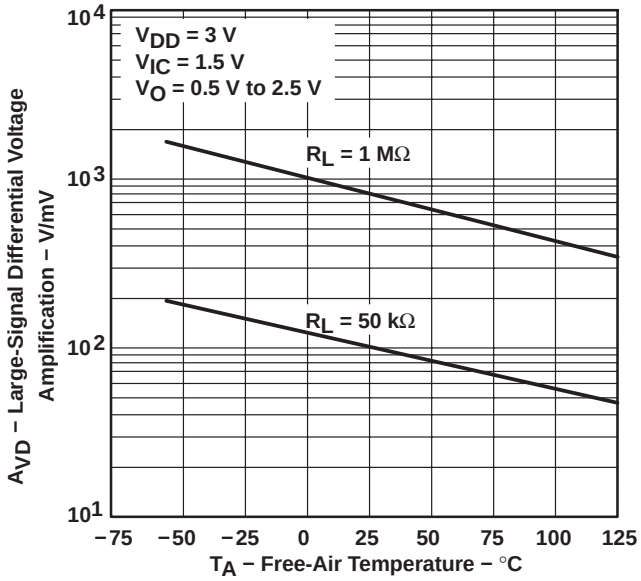



Figure 28

**LARGE-SIGNAL DIFFERENTIAL†‡ VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE**

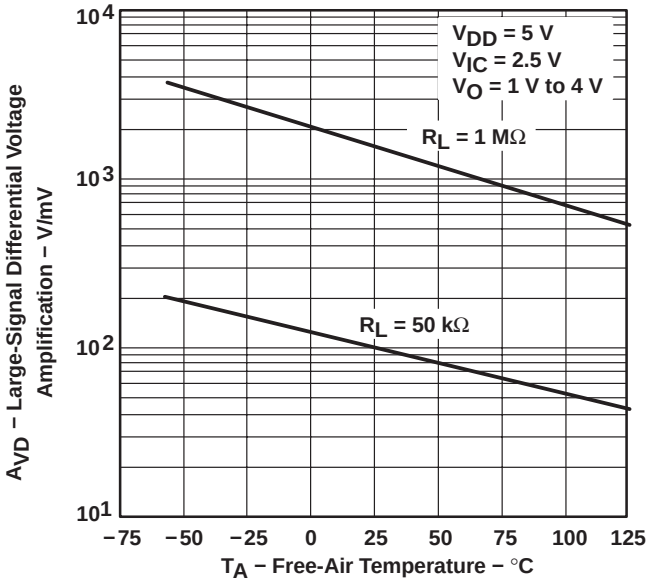



Figure 29

**OUTPUT IMPEDANCE‡ vs FREQUENCY**

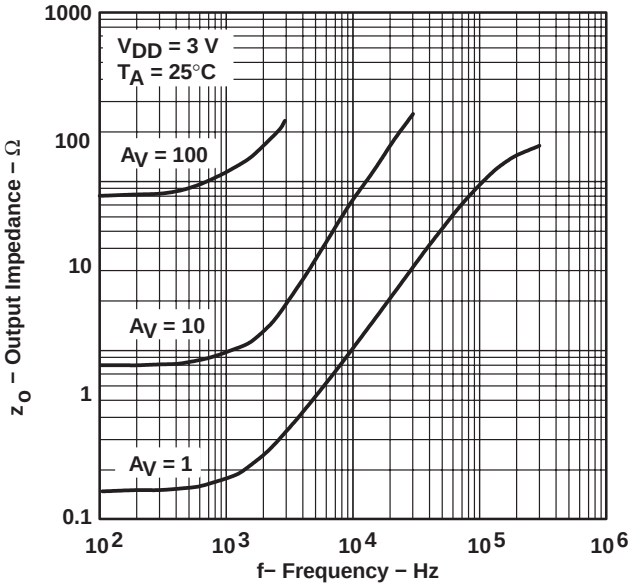



Figure 30

**OUTPUT IMPEDANCE‡ vs FREQUENCY**

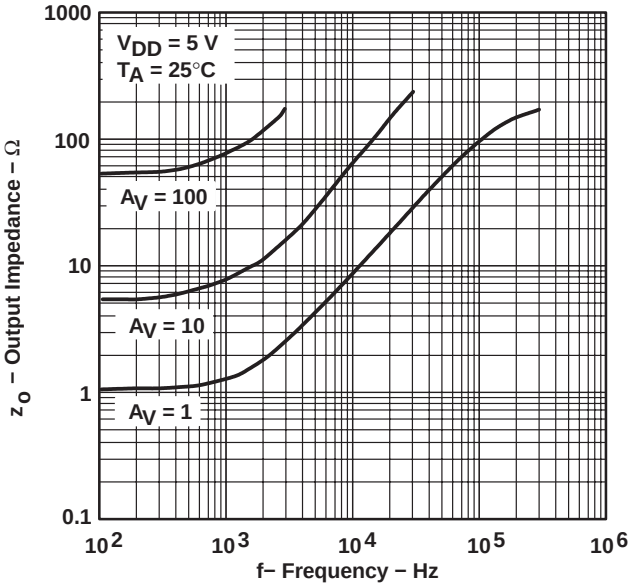



Figure 31

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**COMMON-MODE REJECTION RATIO† vs FREQUENCY**

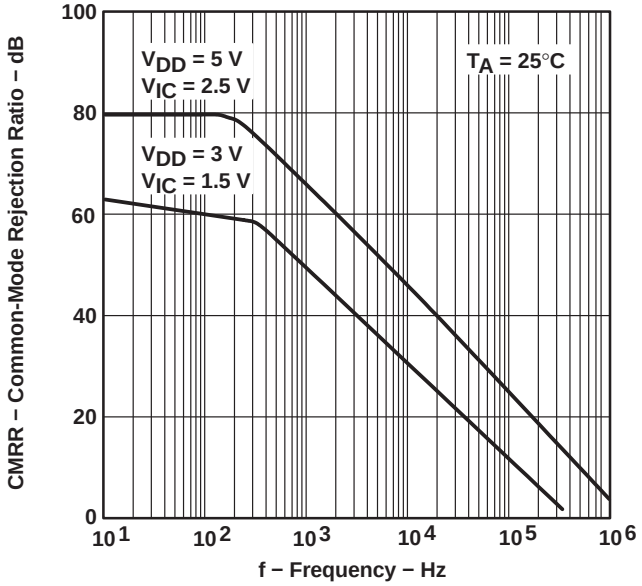



Figure 32

**COMMON-MODE REJECTION RATIO†‡ vs FREE-AIR TEMPERATURE**

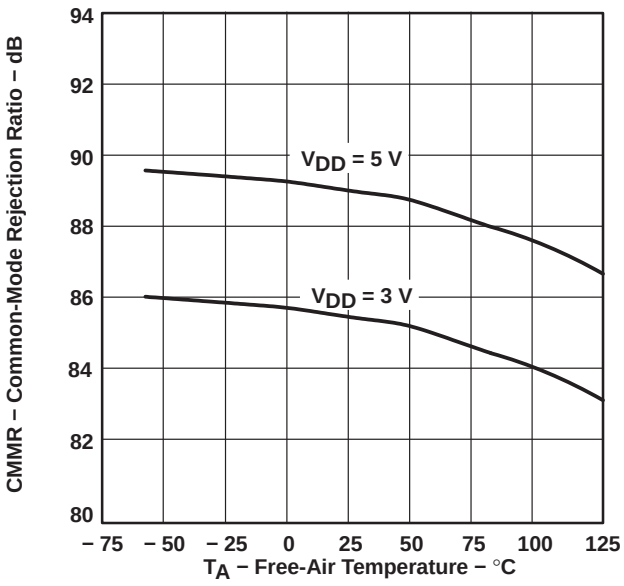



Figure 33

**SUPPLY-VOLTAGE REJECTION RATIO† vs FREQUENCY**

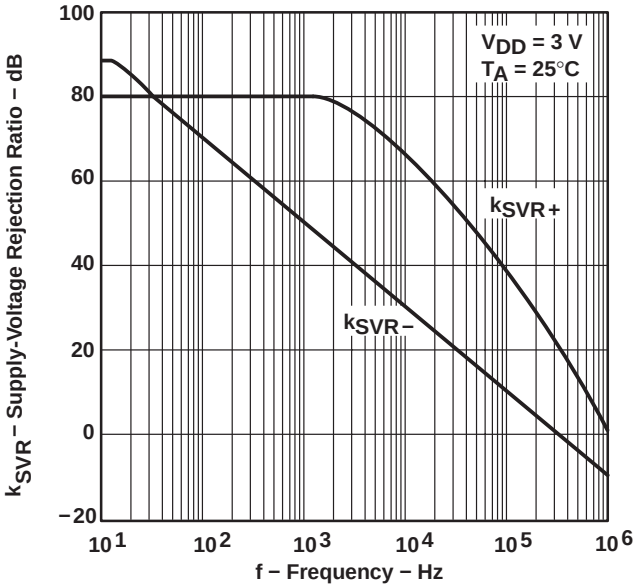



Figure 34

**SUPPLY-VOLTAGE REJECTION RATIO† vs FREQUENCY**

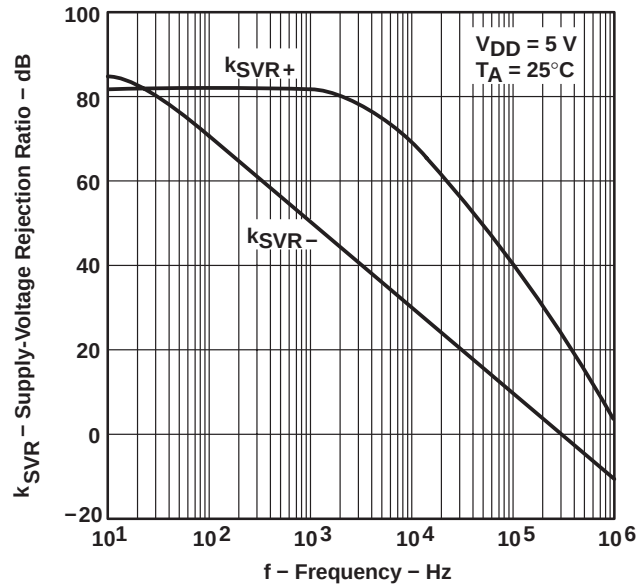



Figure 35

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.
‡ Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS

SUPPLY-VOLTAGE REJECTION RATIO† vs FREE-AIR TEMPERATURE

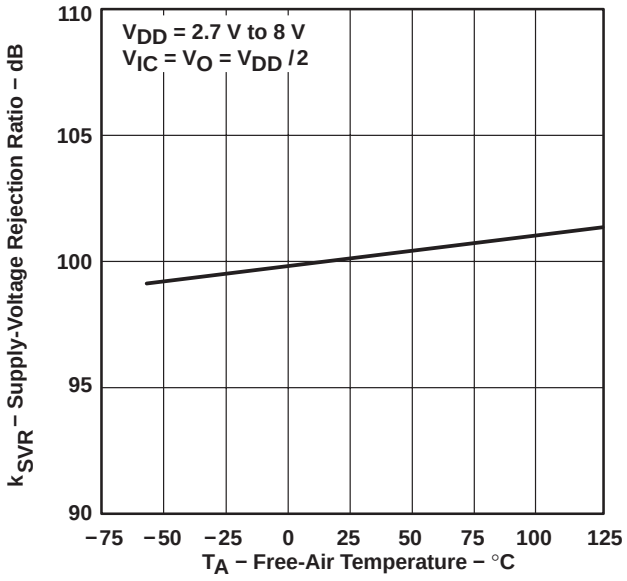



Figure 36

TLV2252 SUPPLY CURRENT† vs SUPPLY VOLTAGE

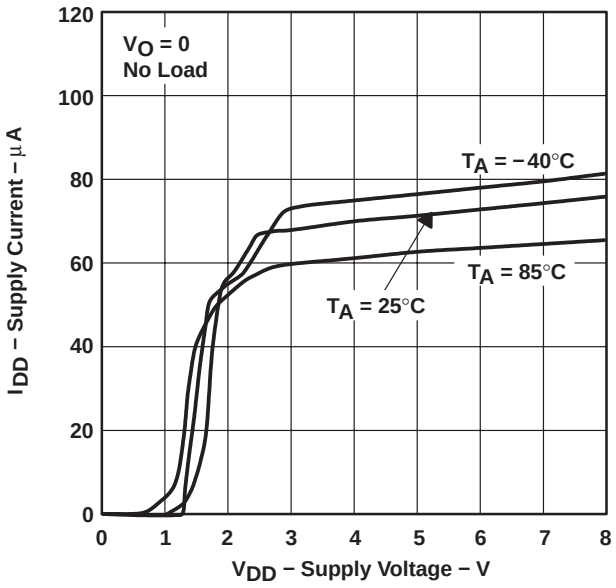



Figure 37

TLV2254 SUPPLY CURRENT† vs SUPPLY VOLTAGE

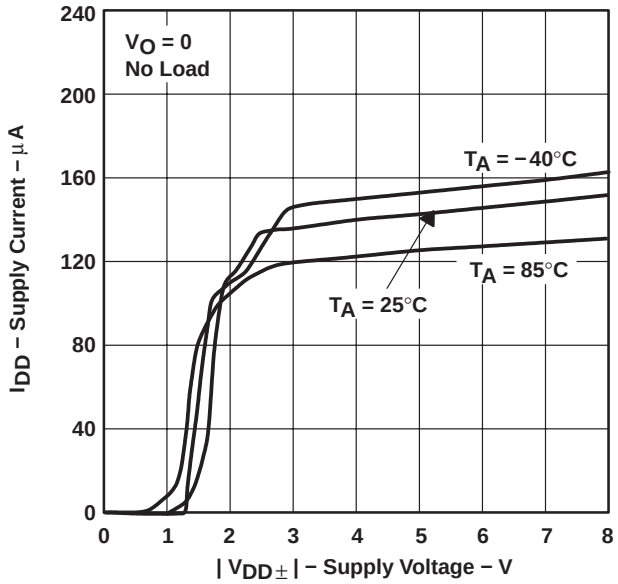



Figure 38

SLEW RATE‡ vs LOAD CAPACITANCE

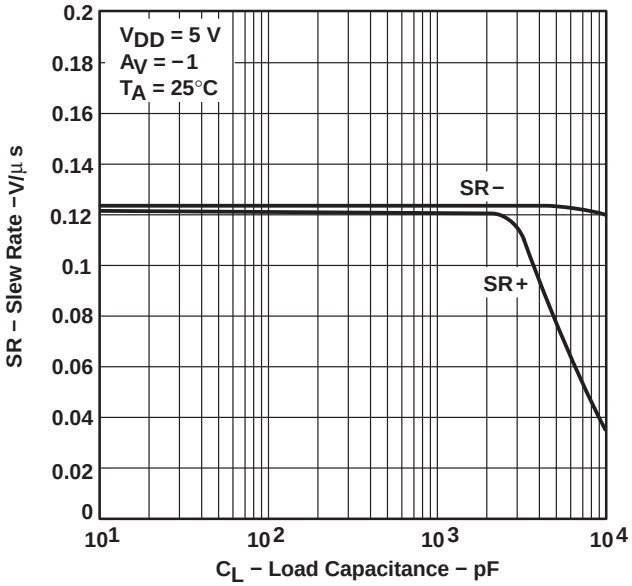



Figure 39

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**SLEW RATE†‡ vs FREE-AIR TEMPERATURE**

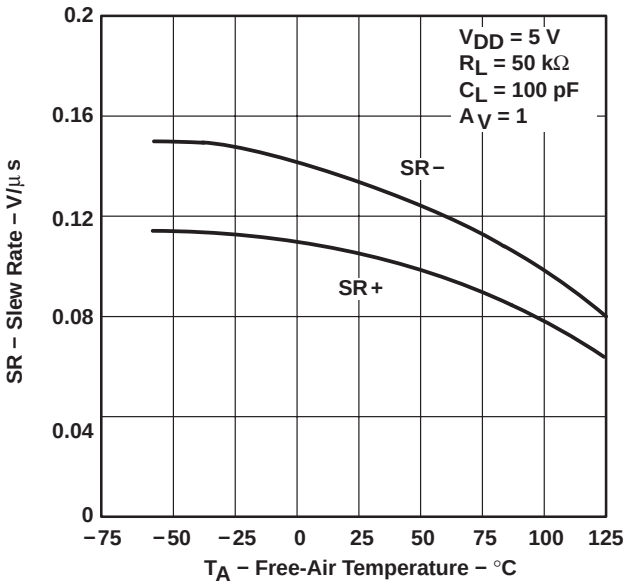



**Figure 40**

**INVERTING LARGE-SIGNAL PULSE RESPONSE†**

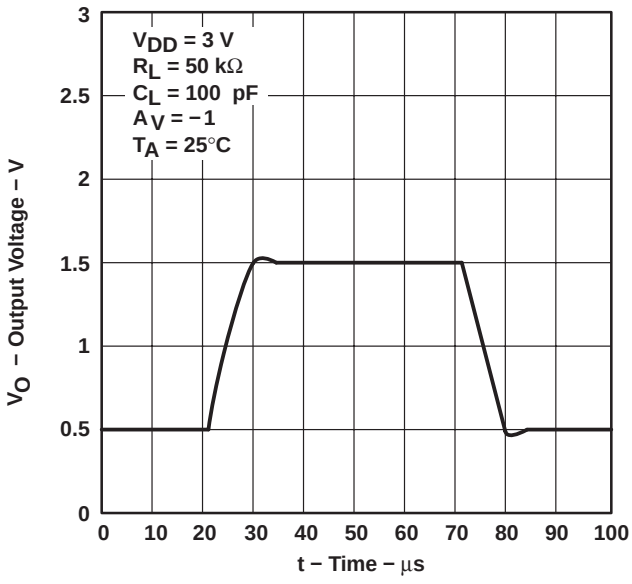



**Figure 41**

**INVERTING LARGE-SIGNAL PULSE RESPONSE†**

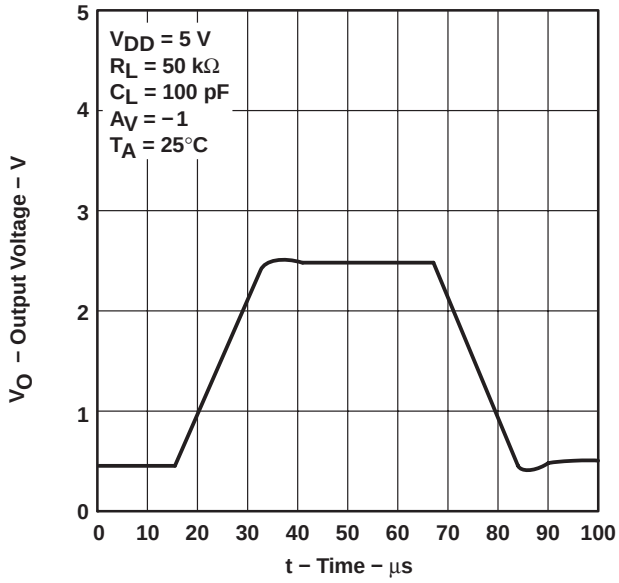



**Figure 42**

**VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†**

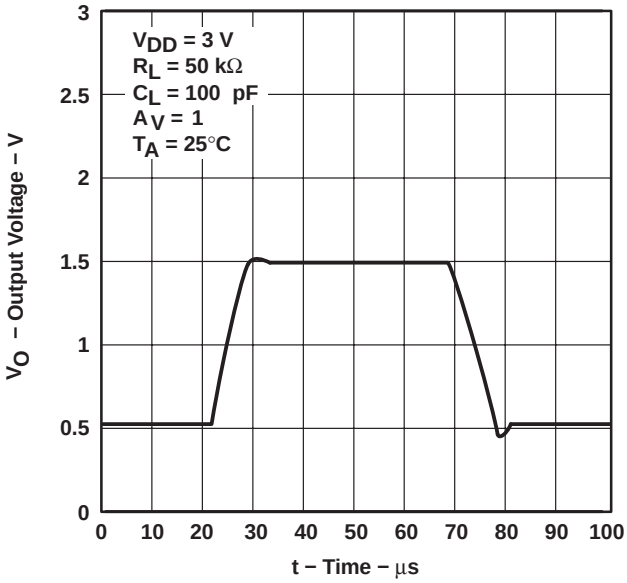



**Figure 43**

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†**

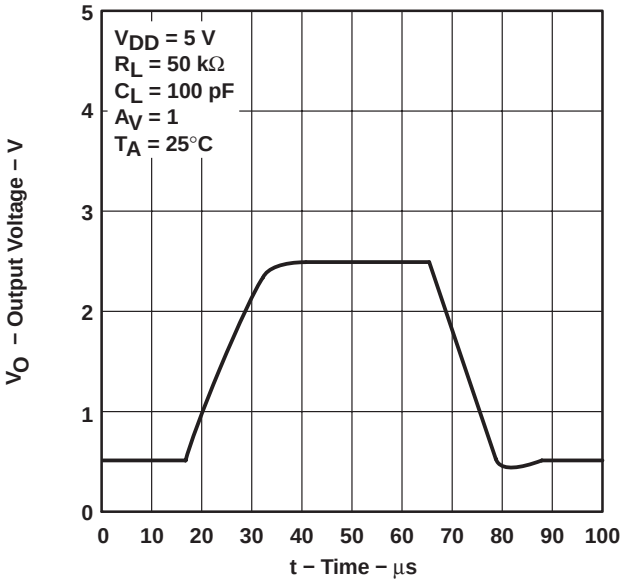



Figure 44

**INVERTING SMALL-SIGNAL PULSE RESPONSE†**

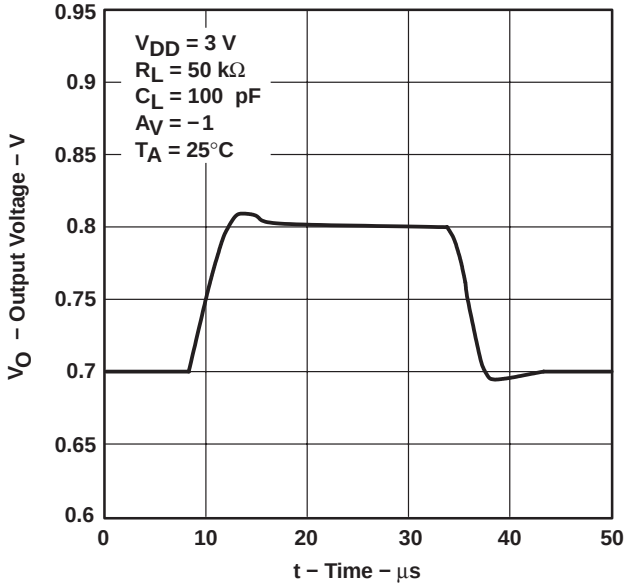



Figure 45

**INVERTING SMALL-SIGNAL PULSE RESPONSE†**

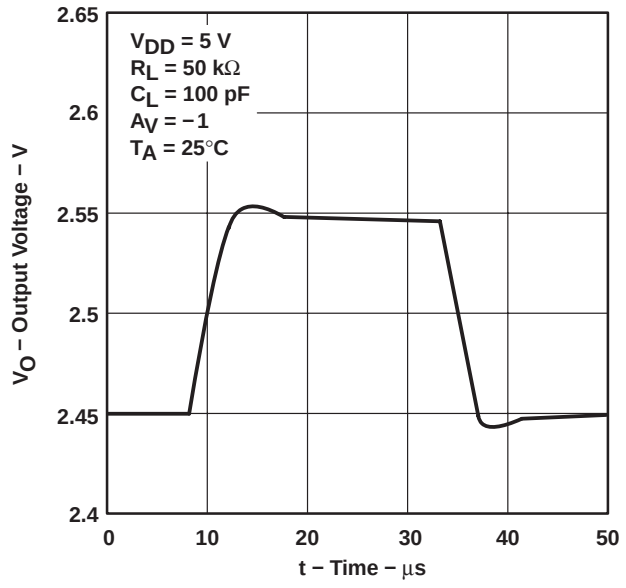



Figure 46

**VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE†**

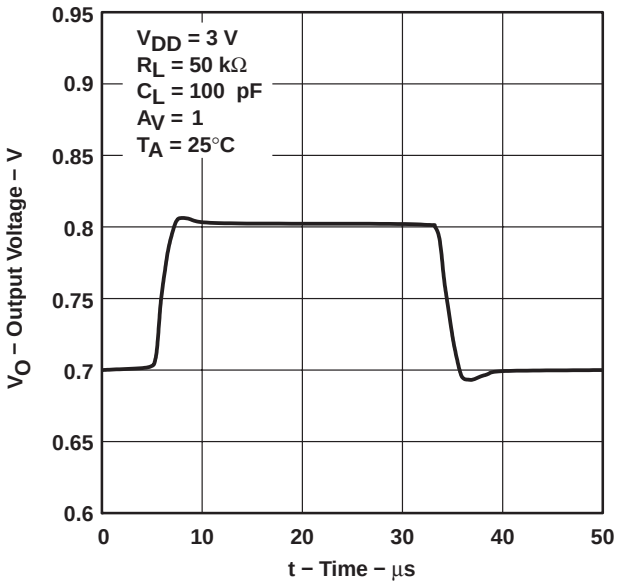



Figure 47

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE†**

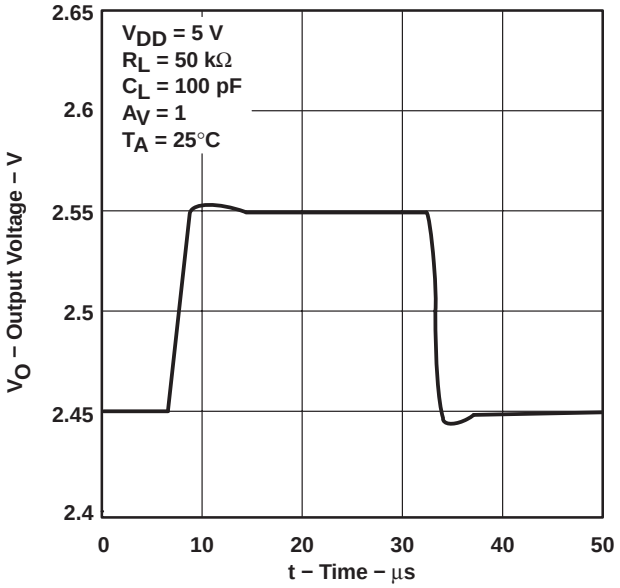



**Figure 48**

**EQUIVALENT INPUT NOISE VOLTAGE† vs FREQUENCY**

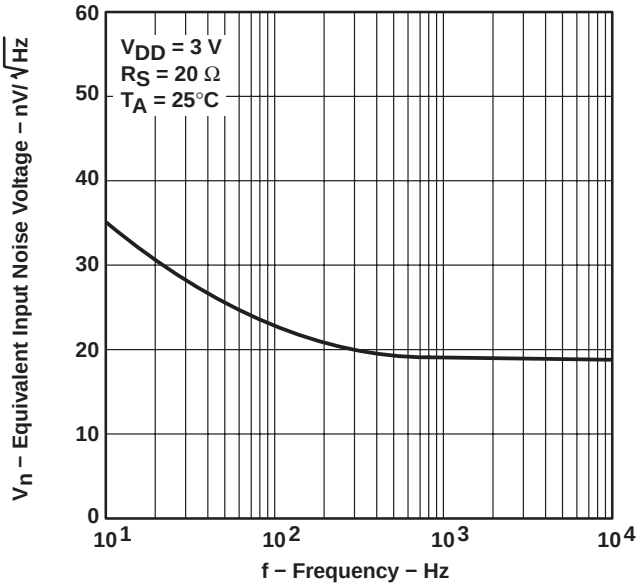



**Figure 49**

**EQUIVALENT INPUT NOISE VOLTAGE† vs FREQUENCY**

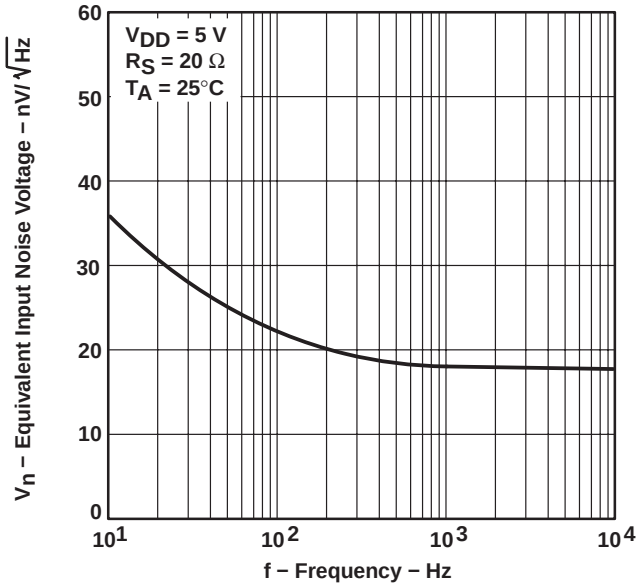



**Figure 50**

**INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD†**

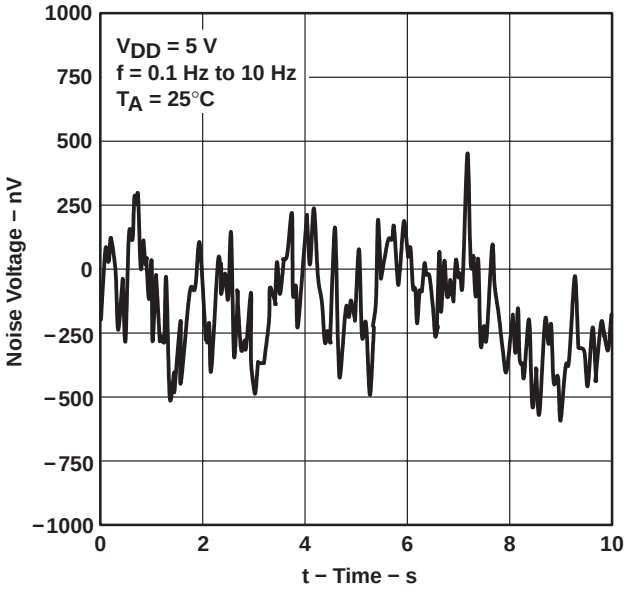



**Figure 51**

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**INTEGRATED NOISE VOLTAGE† vs FREQUENCY**

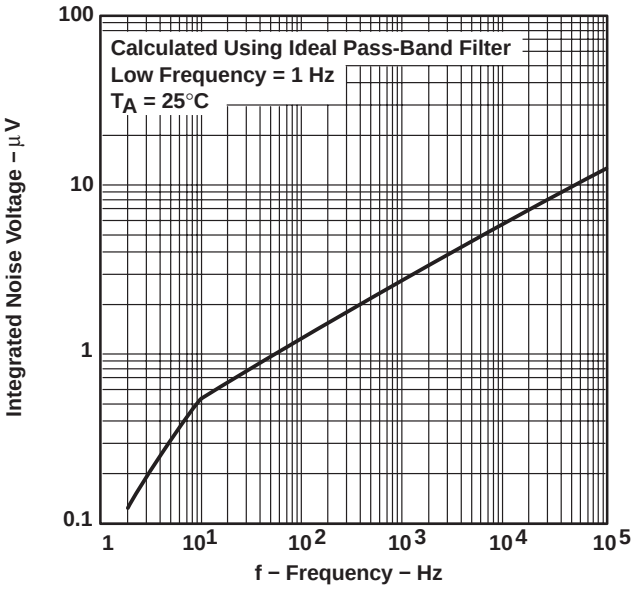



Figure 52

**TOTAL HARMONIC DISTORTION PLUS NOISE† vs FREQUENCY**

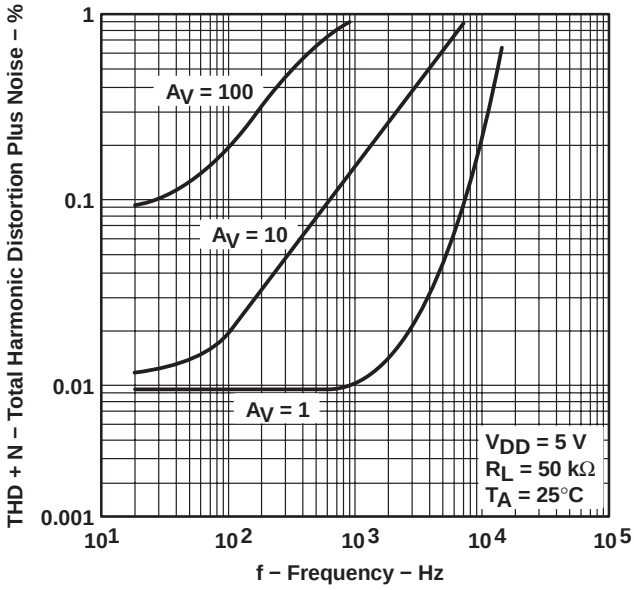



Figure 53

**GAIN-BANDWIDTH PRODUCT vs SUPPLY VOLTAGE**

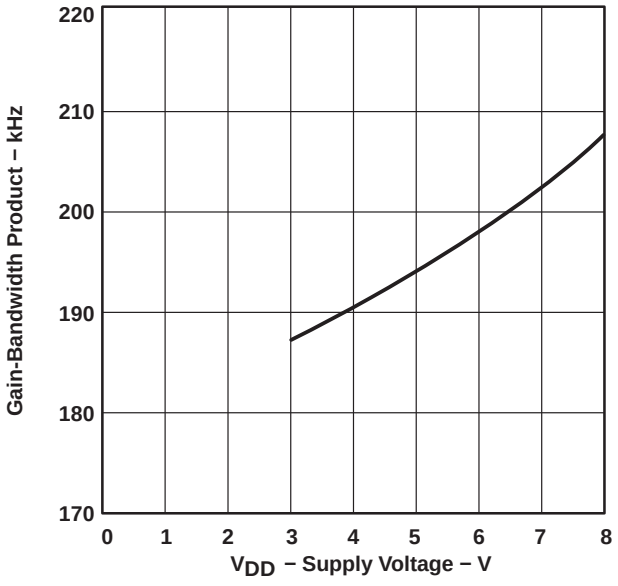



Figure 54

**GAIN-BANDWIDTH PRODUCT†‡ vs FREE-AIR TEMPERATURE**

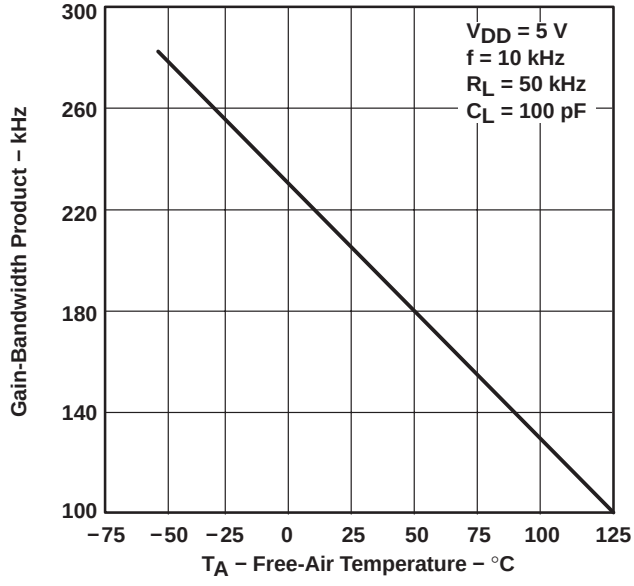



Figure 55

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.

## TYPICAL CHARACTERISTICS

**PHASE MARGIN vs LOAD CAPACITANCE**

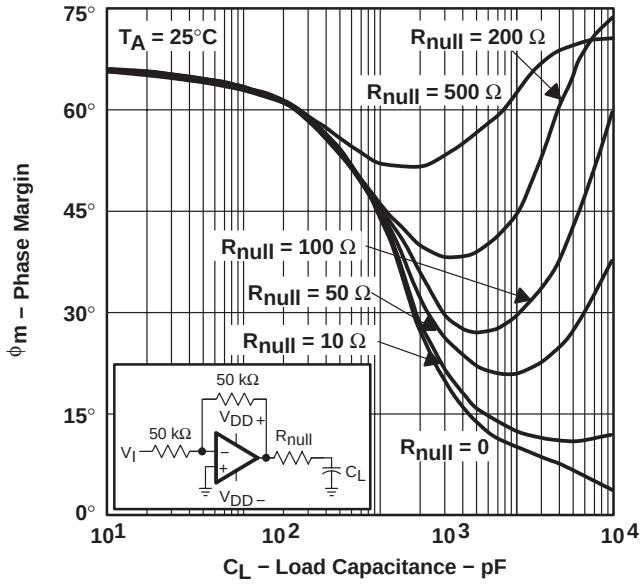



Figure 56

**GAIN MARGIN vs LOAD CAPACITANCE**

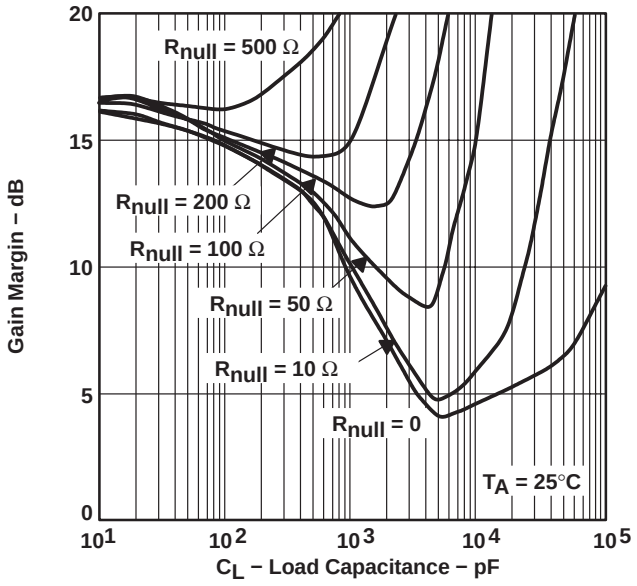



Figure 57

**UNITY-GAIN BANDWIDTH vs LOAD CAPACITANCE**

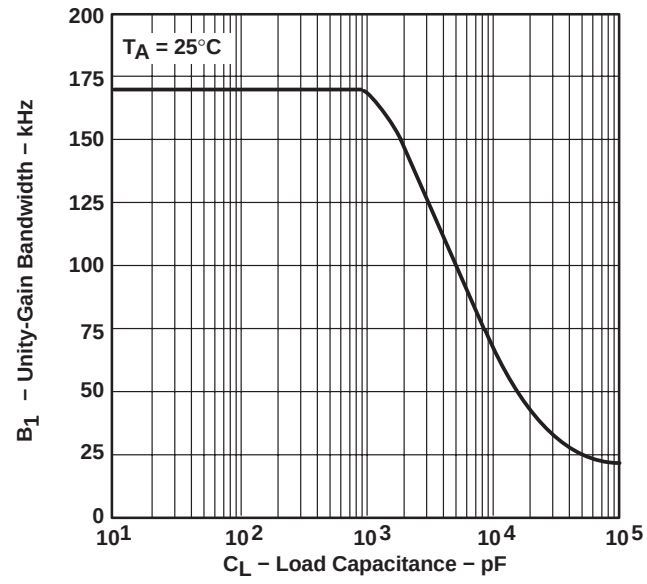
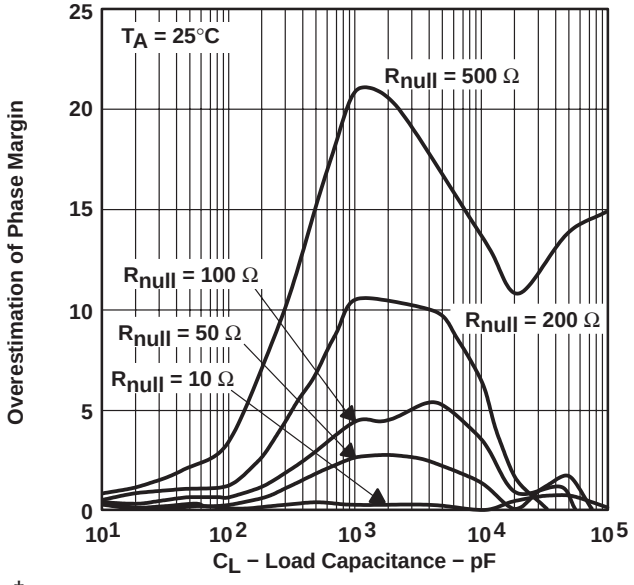



Figure 58

**OVERESTIMATION OF PHASE MARGIN† vs LOAD CAPACITANCE**




† See application information

Figure 59

† For all curves where $V_{DD}$ = 5 V, all loads are referenced to 2.5 V. For all curves where $V_{DD}$ = 3 V, all loads are referenced to 1.5 V.
‡ Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## APPLICATION INFORMATION

### driving large capacitive loads

The TLV2252 is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 56 and Figure 57 illustrate its ability to drive loads up to 1000 pF while maintaining good gain and phase margins ($R_{null}$ = 0).

A smaller series resistor ($R_{null}$) at the output of the device (see Figure 60) improves the gain and phase margins when driving large capacitive loads. Figure 55 and Figure 56 show the effects of adding series resistances of 10 Ω, 50 Ω, 100 Ω, 200 Ω, and 500 Ω. The addition of this series resistor has two effects: the first adds a zero to the transfer function and the second reduces the frequency of the pole associated with the output load in the transfer function.

The zero introduced to the transfer function is equal to the series resistance times the load capacitance. To calculate the improvement in phase margin, equation 1 can be used.

$$\Delta\phi_{m1} = \tan^{-1}\left(2 \times \pi \times \text{UGBW} \times R_{null} \times C_L\right) \quad (1)$$

Where :

$\Delta\phi_{m1}$ = improvement in phase margin
UGBW = unity-gain bandwidth frequency
$R_{null}$ = output series resistance
$C_L$ = load capacitance

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 58). To use equation 1, UGBW must be approximated from Figure 58.

Using equation 1 alone overestimates the improvement in phase margin as illustrated in Figure 59. The overestimation is caused by the decrease in the frequency of the pole associated with the load, providing additional phase shift and reducing the overall improvement in phase margin.

Using Figure 60, with equation 1 enables the designer to choose the appropriate output series resistance to optimize the design of circuits driving large capacitance loads.

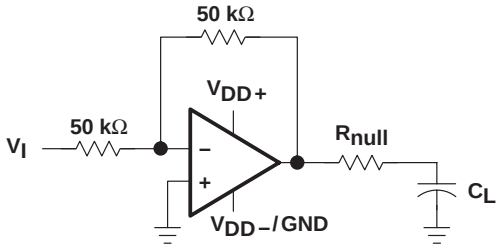



**Figure 60. Series-Resistance Circuit**

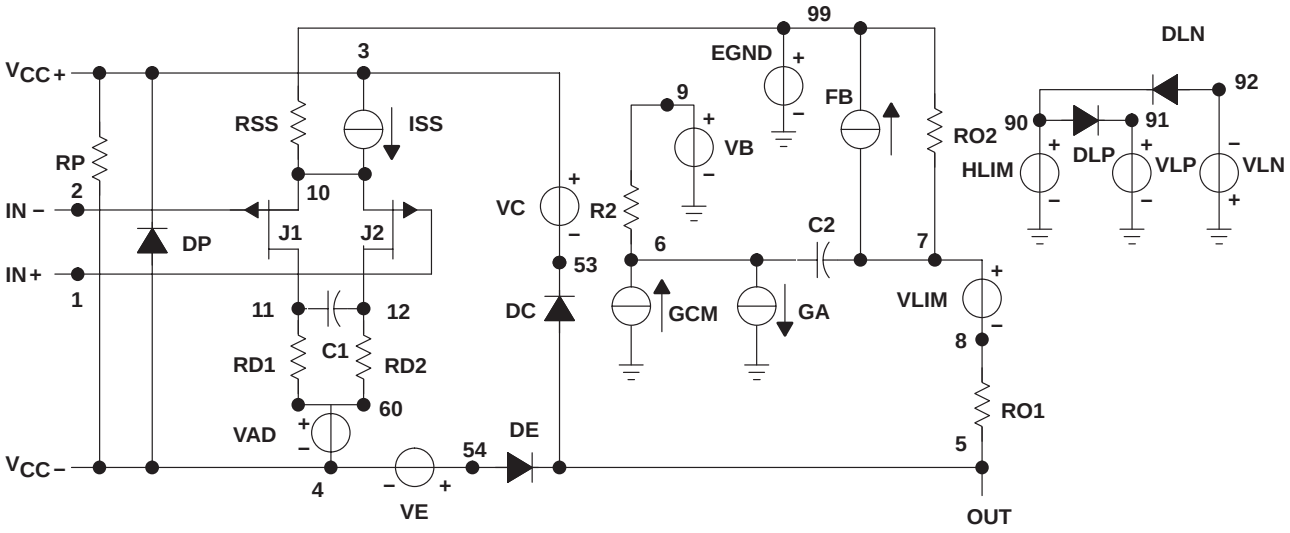
## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 61 are generated using the TLV2252 typical electrical and operating characteristics at $T_A$ = 25°C. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 5: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, “Macromodeling of Integrated Circuit Operational Amplifiers,” *IEEE Journal of Solid-State Circuits,* SC-9, 353 (1974).




```
.SUBCKT TLV225x 1 2 3 4 5
C1      11      12      6.369E−12
C2      6       7       25.00E−12
DC      5       53      DX
DE      54      5       DX
DLP     90      91      DX
DLN     92      90      DX
DP      4       3       DX
EGND    99      0       POLY (2) (3,0) (4,0) 0 .5 .5
FB      7       99      POLY (5) VB VC VE VLP
+ VLN 0 57.62E6 −60E6 60E6 60E6 −60E6
GA      6       0       11      12 26.86E−6
GCM     0       6       10      99 2.686E−9
ISS     3       10      DC 3.1E−6
HLIM    90      0       VLIM 1K
J1      11      2       10 JX
J2      12      1       10 JX
R2      6       9       100.0E3
RD1     60      11      37.23E3
RD2     60      12      37.23E3
R01     8       5       84
R02     7       99      84
RP      3       4       71.43E3
RSS     10      99      64.52E6
VAD     60      4       −.5
VB      9       0       DC 0
VC      3       53      DC .605
VE      54      4       DC .605
VLIM    7       8       DC 0
VLP     91      0       DC −0.235
VLN     0       92      DC 7.5
.MODEL DX D (IS=800.0E−18)
.MODEL JX PJF (IS=500.0E−15 BETA=139E−6
+ VTO=−.05)
.ENDS
```

**Figure 61. Boyle Macromodel and Subcircuit**

*PSpice* and *Parts* are trademarks of MicroSim Corporation.

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5962-9550401QPA | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9550401QPA TLV2262M | Samples |
| 5962-9550403QHA | ACTIVE | CFP | U | 10 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9550403QHA TLV2262AM | Samples |
| 5962-9550403QPA | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9550403QPA TLV2262AM | Samples |
| 5962-9566601QPA | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9566601QPA TLV2252M | Samples |
| 5962-9566603QPA | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9566603QPA TLV2252AM | Samples |
| TLV2252AID | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252A | Samples |
| TLV2252AIDG4 | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252A | Samples |
| TLV2252AIDR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252A | Samples |
| TLV2252AIDRG4 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252A | Samples |
| TLV2252AIP | ACTIVE | PDIP | P | 8 | 50 | RoHS & Green | NIPDAU | N / A for Pkg Type | -40 to 125 | TLV2252AI | Samples |
| TLV2252AIPW | ACTIVE | TSSOP | PW | 8 | 150 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TY252A | Samples |
| TLV2252AIPWG4 | ACTIVE | TSSOP | PW | 8 | 150 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TY252A | Samples |
| TLV2252AIPWR | ACTIVE | TSSOP | PW | 8 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TY252A | Samples |
| TLV2252AMJGB | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9566603QPA TLV2252AM | Samples |
| TLV2252AQDRG4 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | | V2252A | Samples |
| TLV2252ID | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252I | Samples |
| TLV2252IDR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252I | Samples |
| TLV2252IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2252I | Samples |
| TLV2252IP | ACTIVE | PDIP | P | 8 | 50 | RoHS & Green | NIPDAU | N / A for Pkg Type | -40 to 125 | TLV2252IP | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TLV2252MJGB | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9566601QPA TLV2252M | Samples |
| TLV2254AID | ACTIVE | SOIC | D | 14 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2254AI | Samples |
| TLV2254AIDR | ACTIVE | SOIC | D | 14 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | V2254AI | Samples |
| TLV2254AIN | ACTIVE | PDIP | N | 14 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | -40 to 125 | TLV2254AIN | Samples |
| TLV2254AIPW | ACTIVE | TSSOP | PW | 14 | 90 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TY2254A | Samples |
| TLV2254AIPWR | ACTIVE | TSSOP | PW | 14 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TY2254A | Samples |
| TLV2254AIPWRG4 | ACTIVE | TSSOP | PW | 14 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TY2254A | Samples |
| TLV2254AQD | ACTIVE | SOIC | D | 14 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLV2254A | Samples |
| TLV2254ID | ACTIVE | SOIC | D | 14 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLV2254I | Samples |
| TLV2254IDG4 | ACTIVE | SOIC | D | 14 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLV2254I | Samples |
| TLV2254IDR | ACTIVE | SOIC | D | 14 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLV2254I | Samples |
| TLV2254IN | ACTIVE | PDIP | N | 14 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | -40 to 125 | TLV2254IN | Samples |
| TLV2262AMJGB | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9550403QPA TLV2262AM | Samples |
| TLV2262AMUB | ACTIVE | CFP | U | 10 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9550403QHA TLV2262AM | Samples |
| TLV2262MJGB | ACTIVE | CDIP | JG | 8 | 1 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 9550401QPA TLV2262M | Samples |

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

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

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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

**OTHER QUALIFIED VERSIONS OF TLV2252, TLV2252A, TLV2252AM, TLV2252M, TLV2254A, TLV2262AM, TLV2262M :**

- Catalog : TLV2252A, TLV2252, TLV2262A, TLV2262
- Automotive : TLV2252-Q1, TLV2252A-Q1, TLV2252A-Q1, TLV2252-Q1, TLV2262A-Q1
- Enhanced Product : TLV2252A-EP, TLV2252A-EP, TLV2254A-EP
- Military : TLV2252M, TLV2252AM

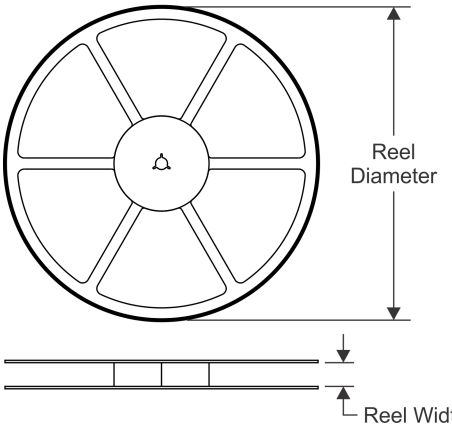
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

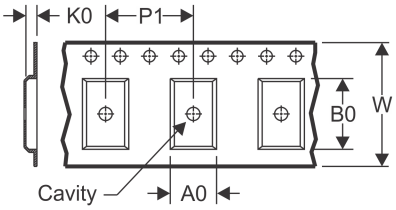
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

## TAPE AND REEL INFORMATION

REEL DIMENSIONS

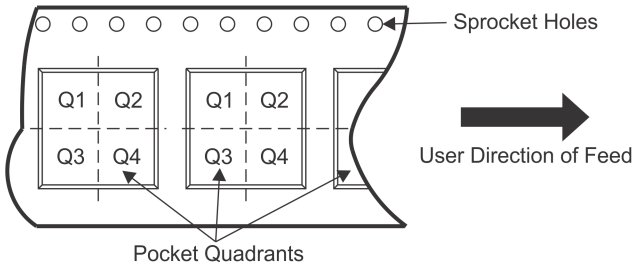



TAPE DIMENSIONS




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

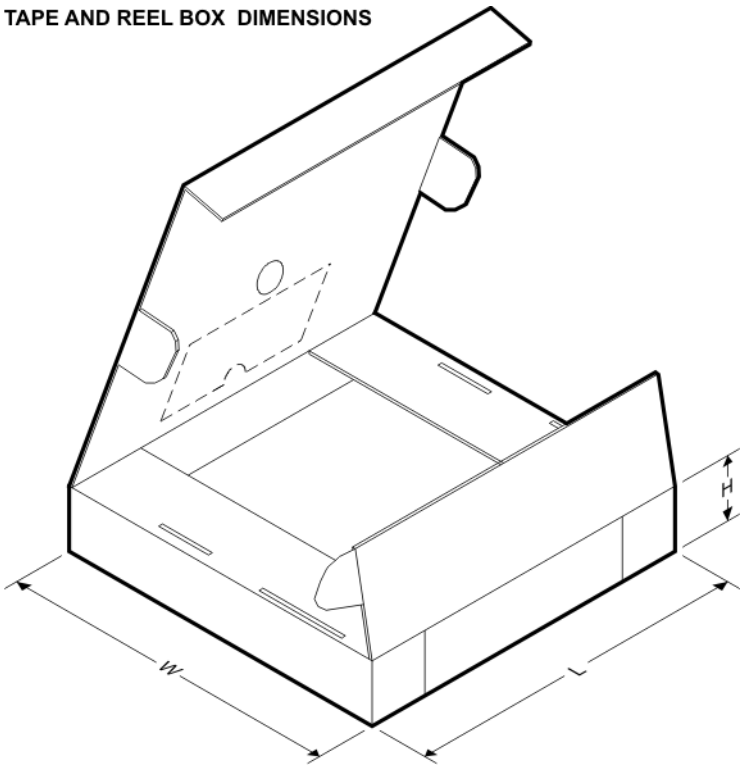
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TLV2252AIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TLV2252AIPWR | TSSOP | PW | 8 | 2000 | 330.0 | 12.4 | 7.0 | 3.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TLV2252IDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TLV2254AIDR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| TLV2254AIPWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TLV2254IDR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |

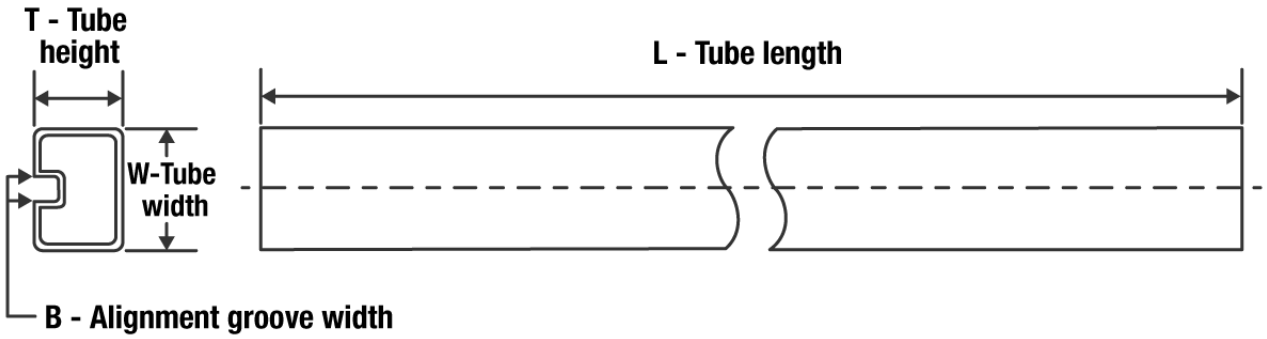
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TLV2252AIDR | SOIC | D | 8 | 2500 | 340.5 | 336.1 | 25.0 |
| TLV2252AIPWR | TSSOP | PW | 8 | 2000 | 853.0 | 449.0 | 35.0 |
| TLV2252IDR | SOIC | D | 8 | 2500 | 340.5 | 336.1 | 25.0 |
| TLV2254AIDR | SOIC | D | 14 | 2500 | 350.0 | 350.0 | 43.0 |
| TLV2254AIPWR | TSSOP | PW | 14 | 2000 | 853.0 | 449.0 | 35.0 |
| TLV2254IDR | SOIC | D | 14 | 2500 | 350.0 | 350.0 | 43.0 |

## TUBE




*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (µm) | B (mm) |
|---|---|---|---|---|---|---|---|---|
| TLV2252AID | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| TLV2252AID | D | SOIC | 8 | 75 | 505.46 | 6.76 | 3810 | 4 |
| TLV2252AIDG4 | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| TLV2252AIDG4 | D | SOIC | 8 | 75 | 505.46 | 6.76 | 3810 | 4 |
| TLV2252AIP | P | PDIP | 8 | 50 | 506 | 13.97 | 11230 | 4.32 |
| TLV2252AIPW | PW | TSSOP | 8 | 150 | 530 | 10.2 | 3600 | 3.5 |
| TLV2252AIPWG4 | PW | TSSOP | 8 | 150 | 530 | 10.2 | 3600 | 3.5 |
| TLV2252ID | D | SOIC | 8 | 75 | 505.46 | 6.76 | 3810 | 4 |
| TLV2252ID | D | SOIC | 8 | 75 | 507 | 8 | 3940 | 4.32 |
| TLV2252IP | P | PDIP | 8 | 50 | 506 | 13.97 | 11230 | 4.32 |
| TLV2254AID | D | SOIC | 14 | 50 | 505.46 | 6.76 | 3810 | 4 |
| TLV2254AIN | N | PDIP | 14 | 25 | 506 | 13.97 | 11230 | 4.32 |
| TLV2254AIPW | PW | TSSOP | 14 | 90 | 530 | 10.2 | 3600 | 3.5 |
| TLV2254AQD | D | SOIC | 14 | 50 | 505.46 | 6.76 | 3810 | 4 |
| TLV2254ID | D | SOIC | 14 | 50 | 505.46 | 6.76 | 3810 | 4 |
| TLV2254IDG4 | D | SOIC | 14 | 50 | 505.46 | 6.76 | 3810 | 4 |
| TLV2254IN | N | PDIP | 14 | 25 | 506 | 13.97 | 11230 | 4.32 |

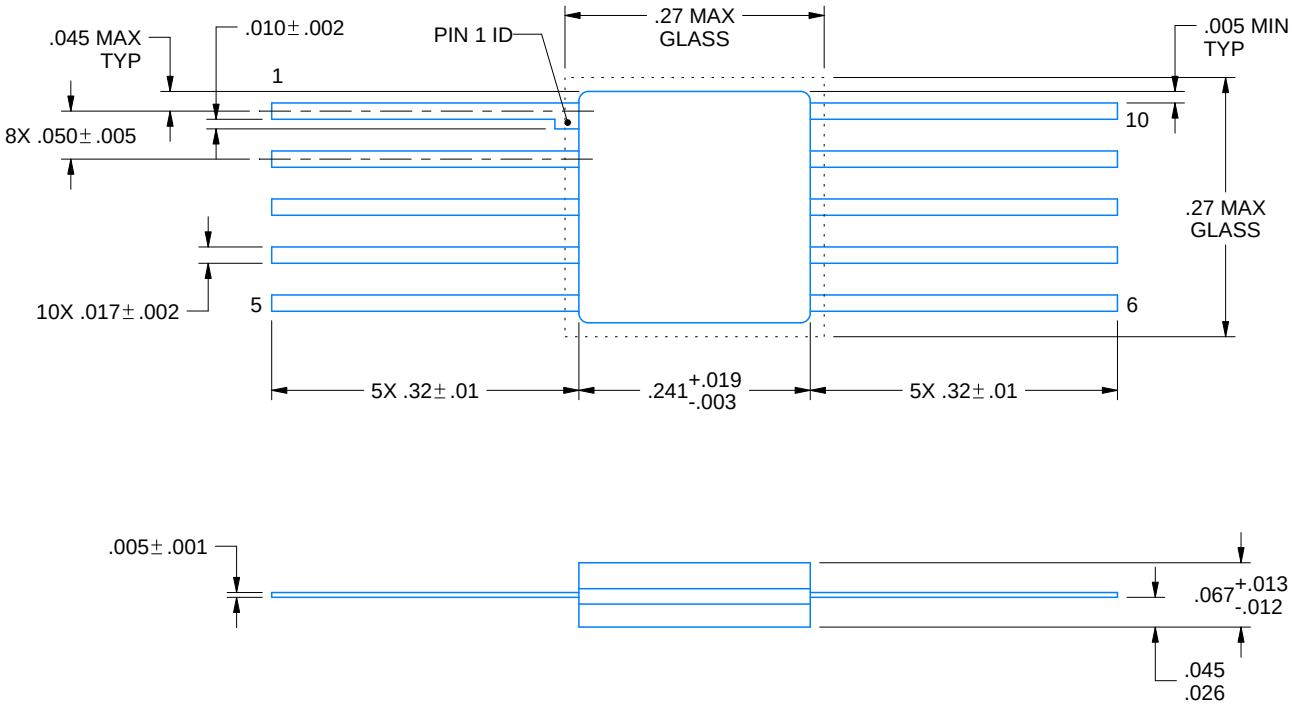
# U0010A



# PACKAGE OUTLINE

## CFP - 2.03 mm max height

CERAMIC FLATPACK





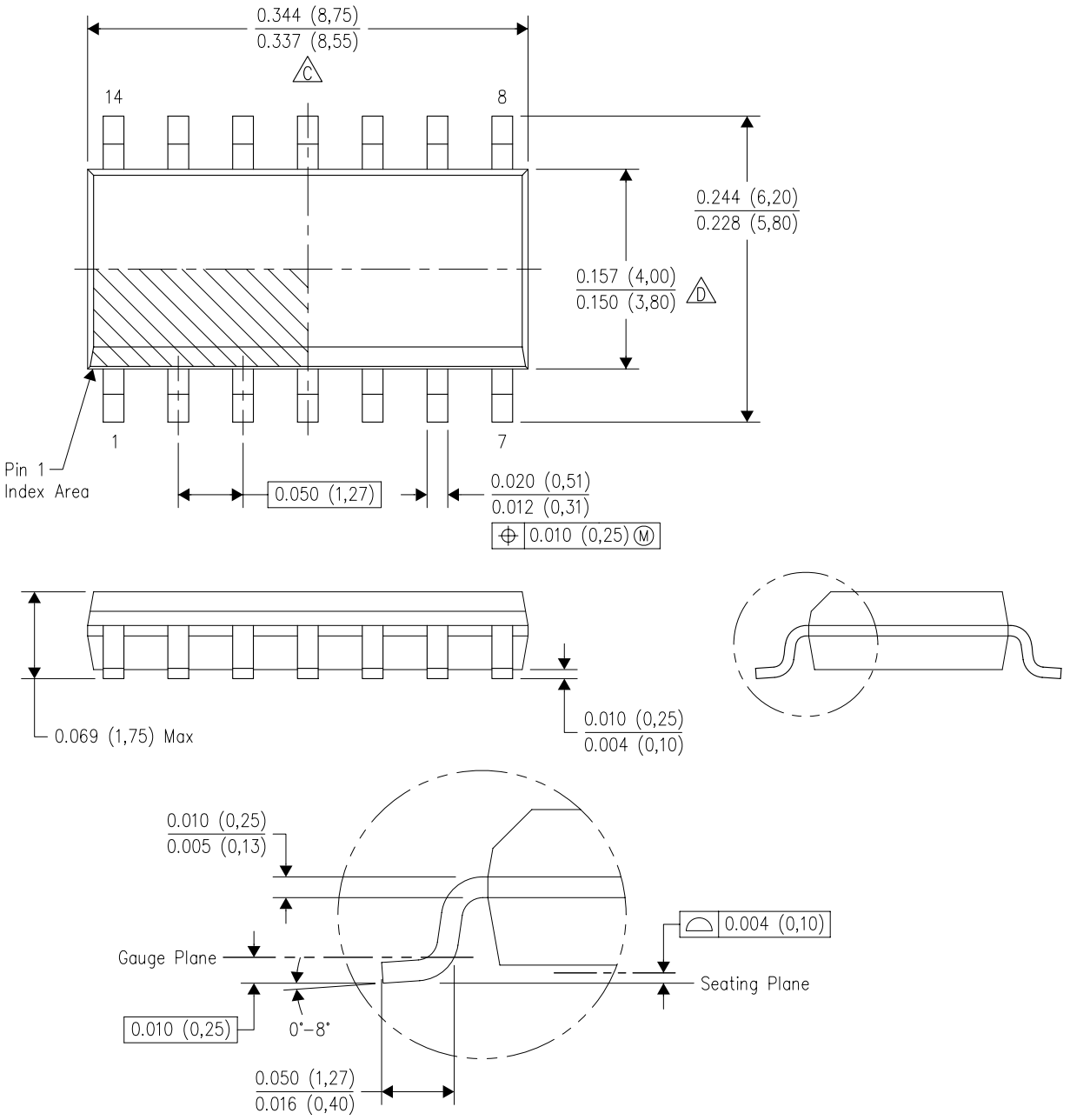


4225582/A 01/2020

NOTES:

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

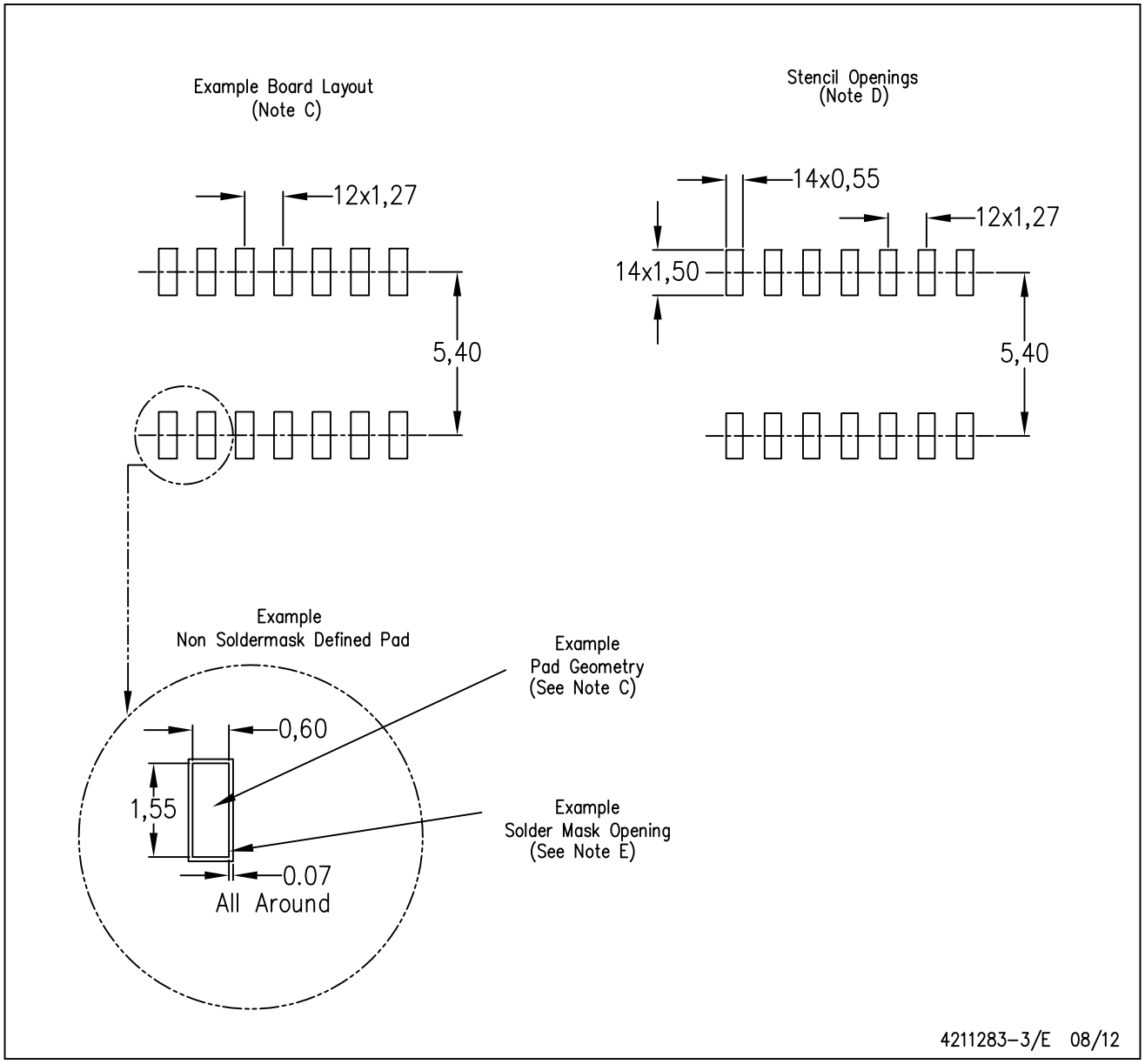
D (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040047–5/M 06/11

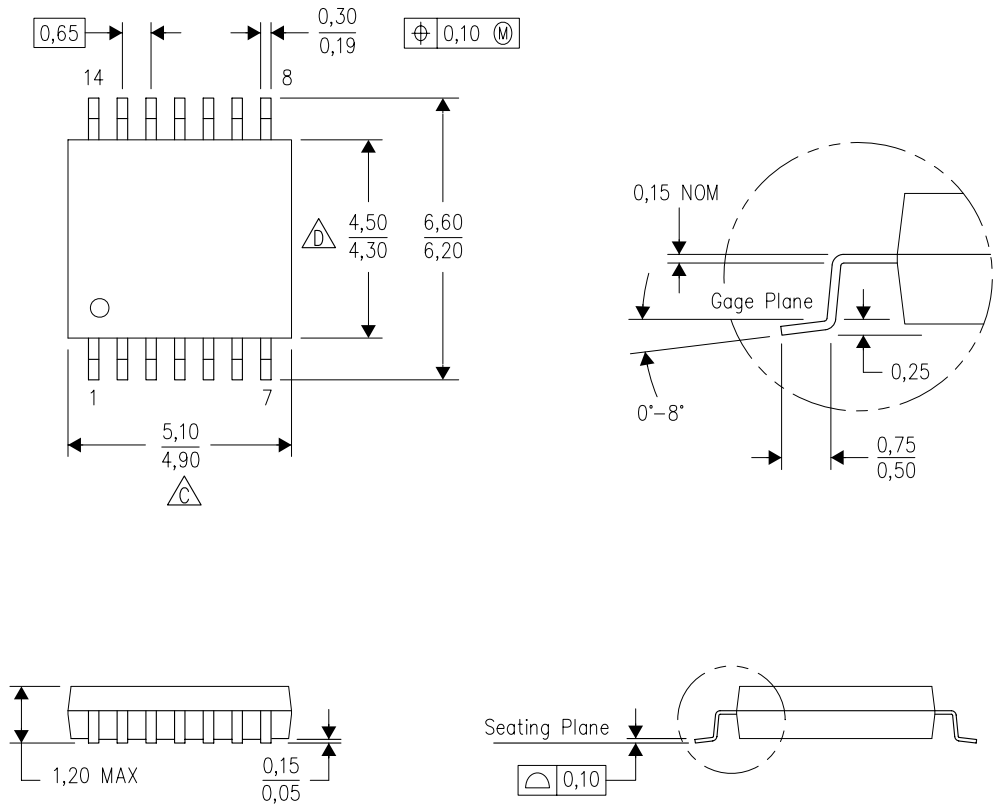
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AB.

D (R–PDSO–G14) PLASTIC SMALL OUTLINE



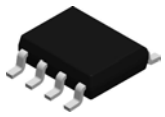

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040064–3/G 02/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

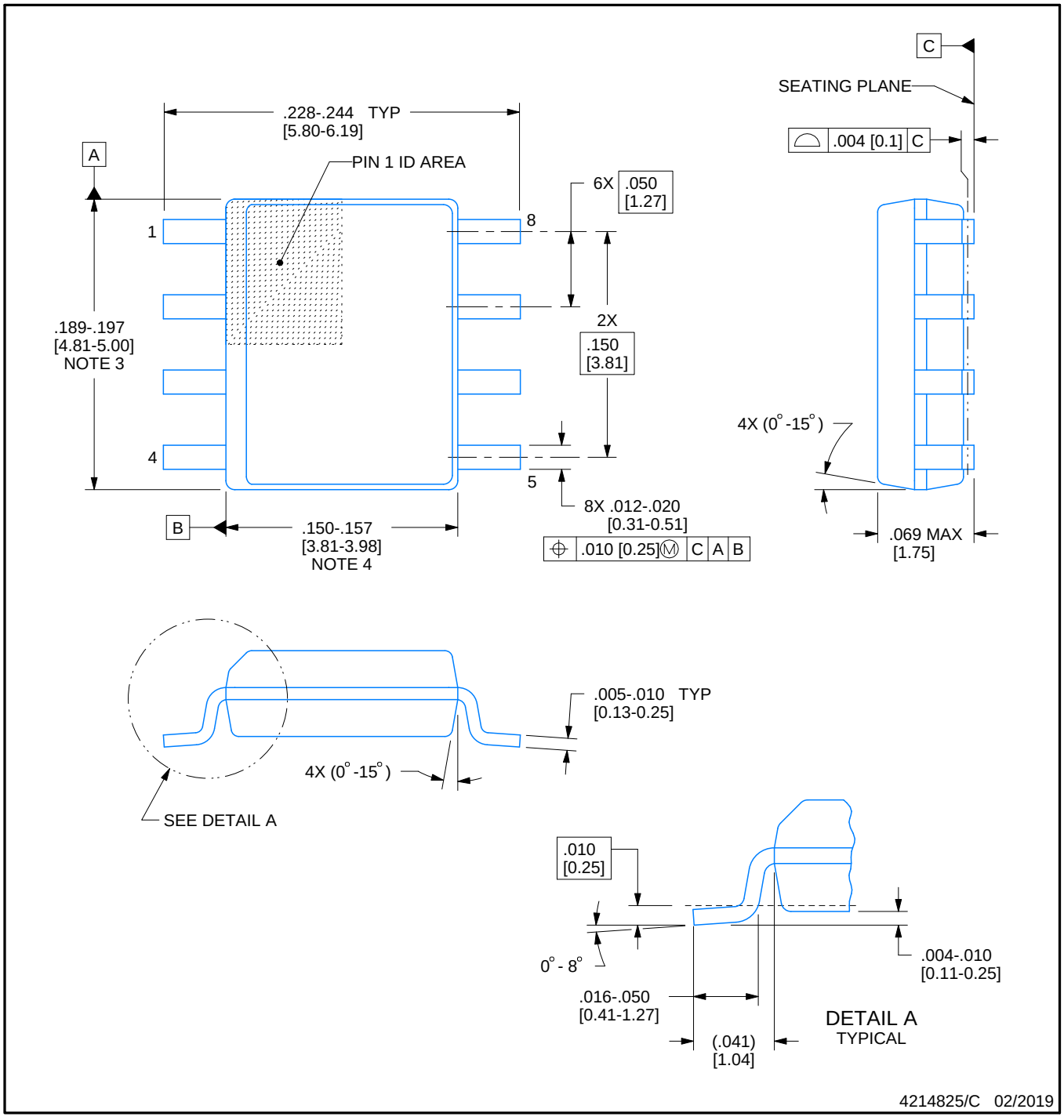


# PACKAGE OUTLINE

## D0008A

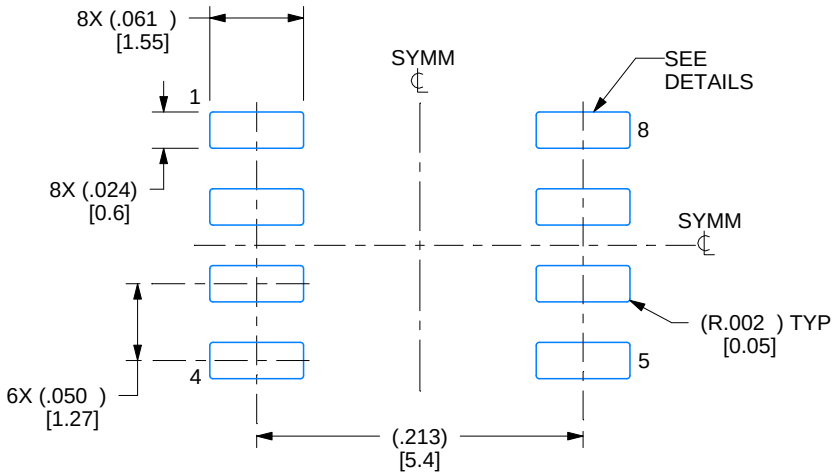
## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

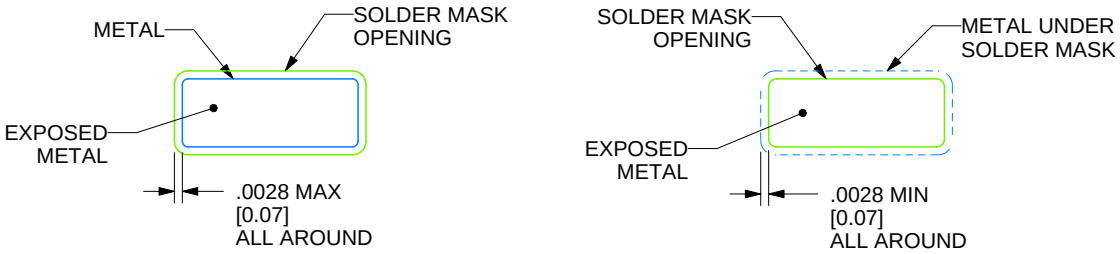



NOTES:

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




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X




SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

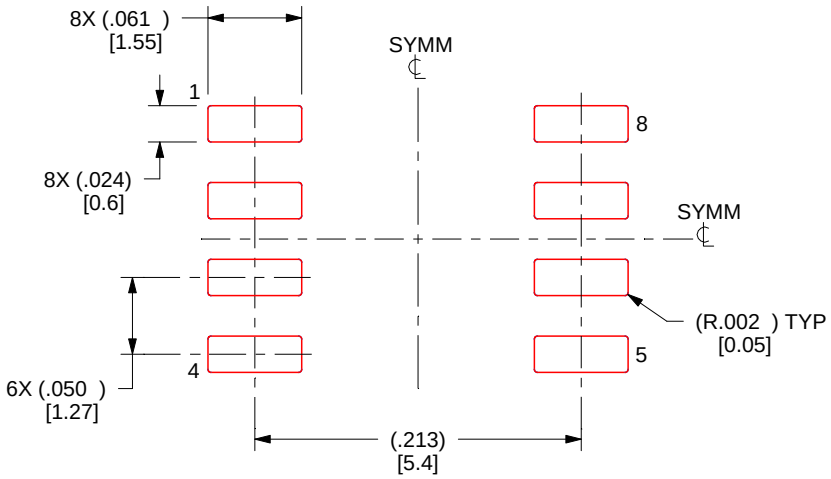
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

## D0008A

## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT




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

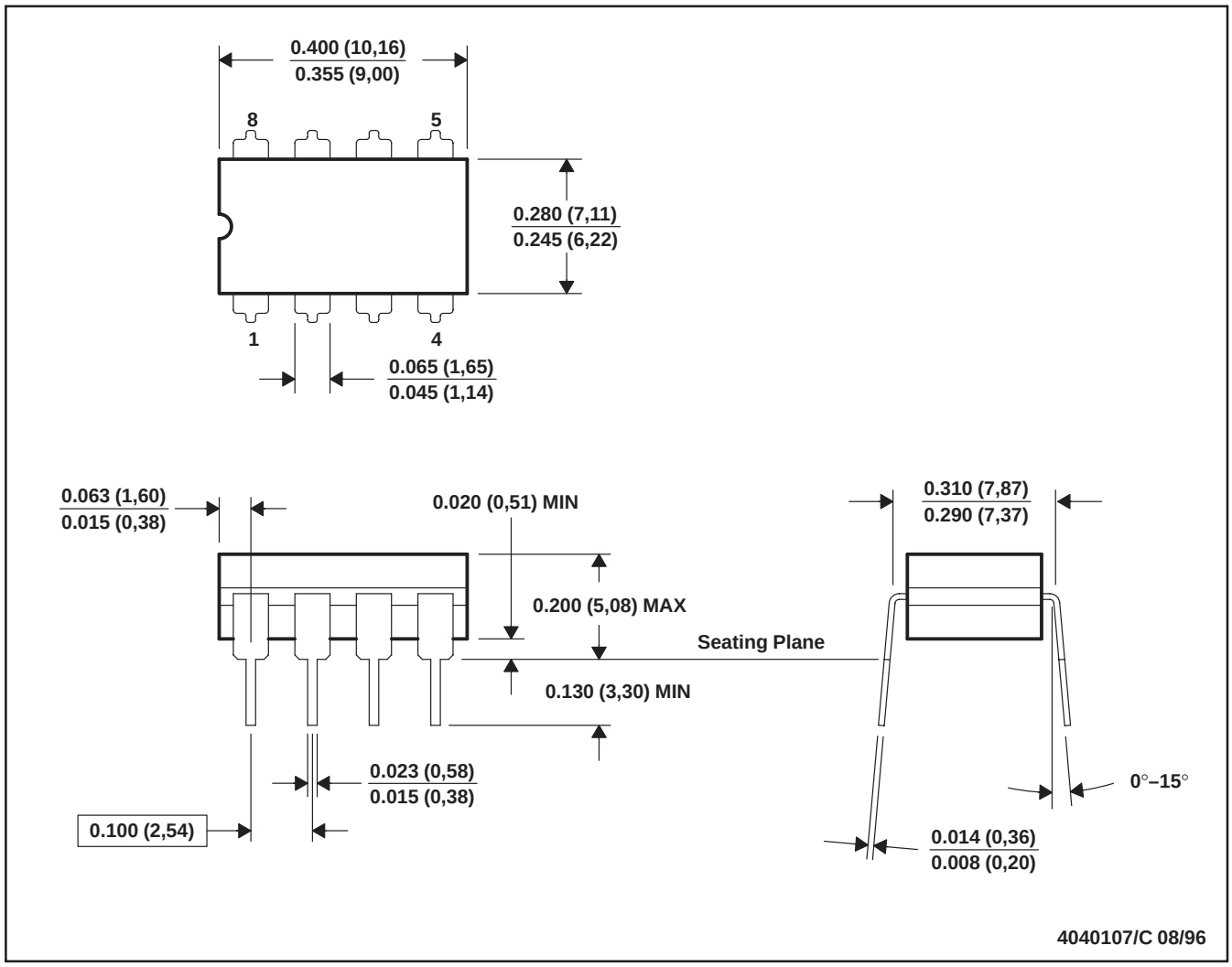
4214825/C 02/2019

NOTES: (continued)

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

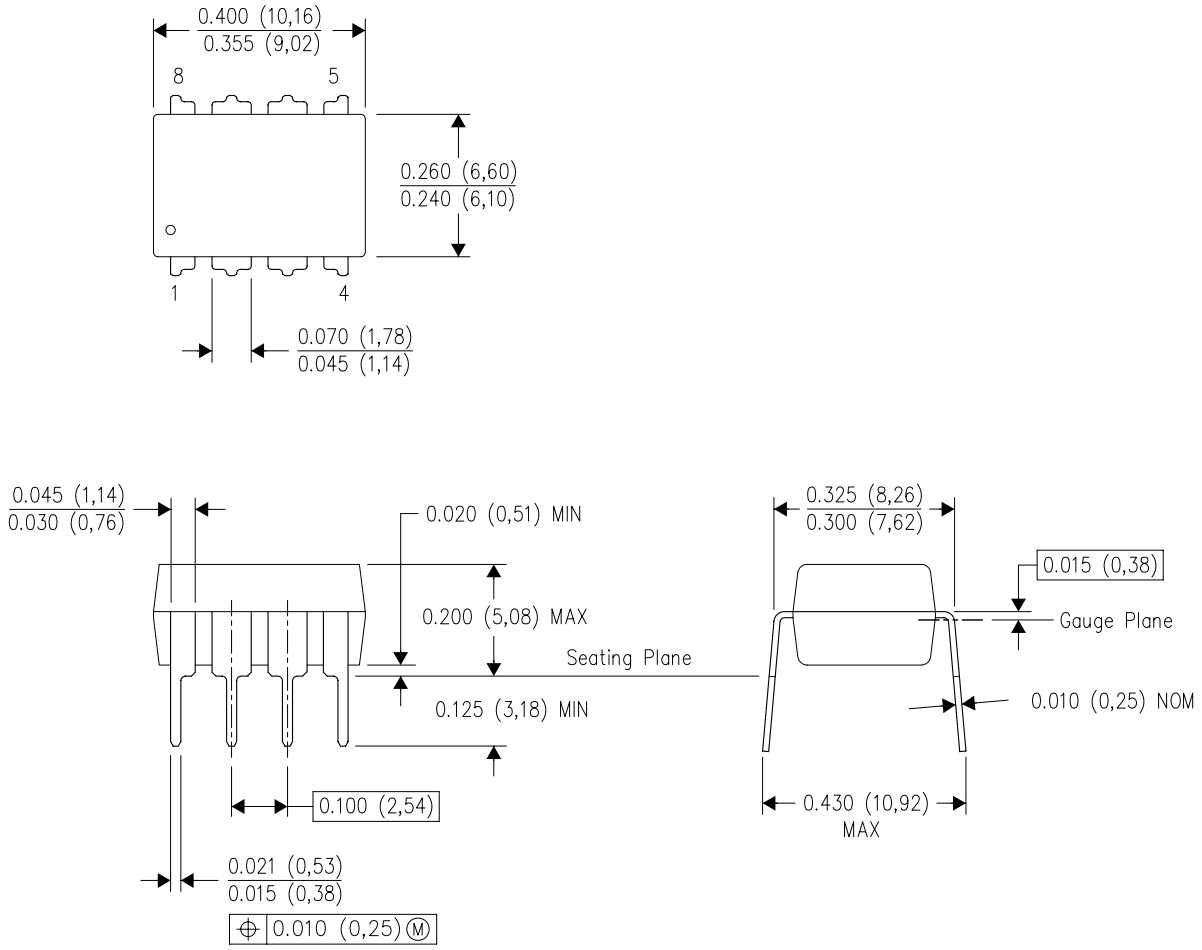
MCER001A – JANUARY 1995 – REVISED JANUARY 1997

**JG (R-GDIP-T8)** **CERAMIC DUAL-IN-LINE**




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

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE

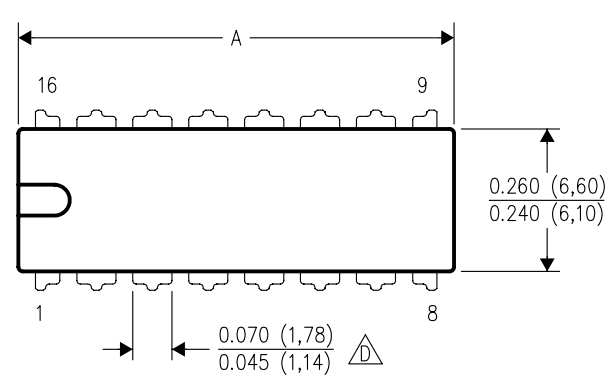



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

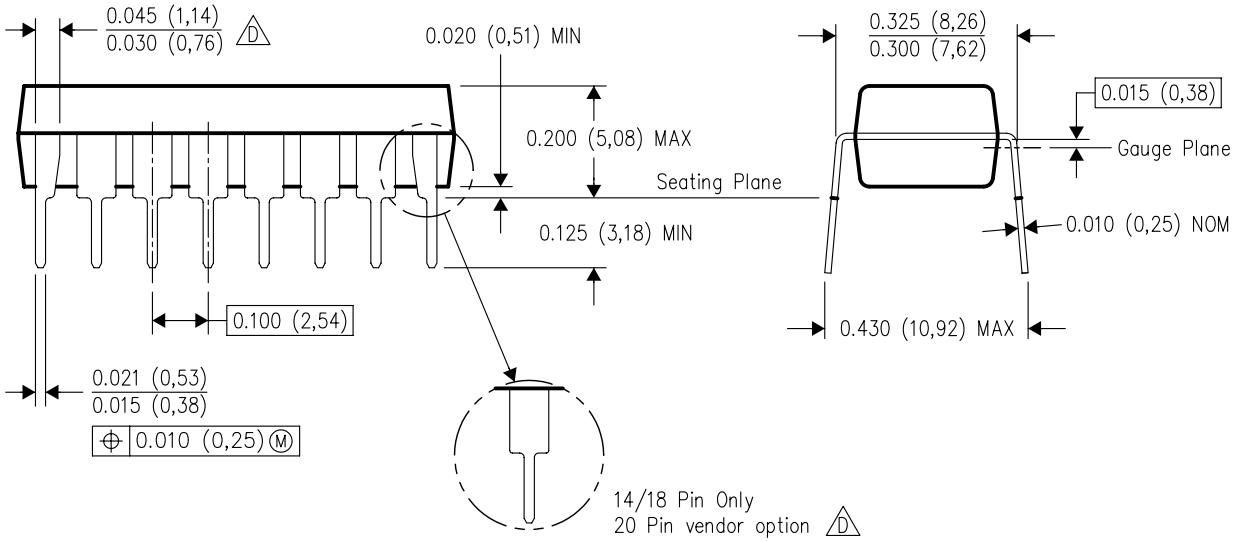
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN




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




4040049/E 12/2002

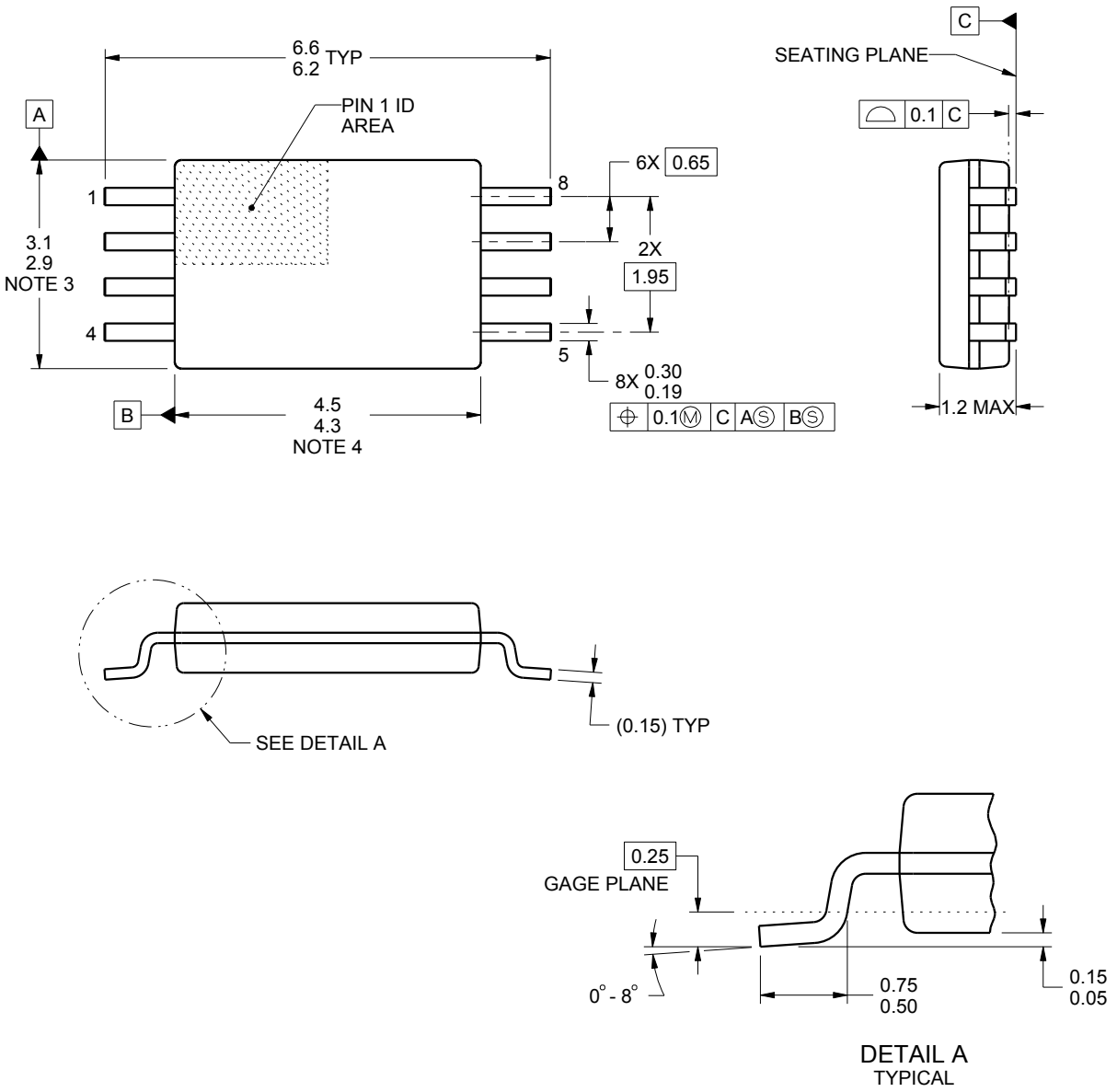
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

# PACKAGE OUTLINE

## PW0008A

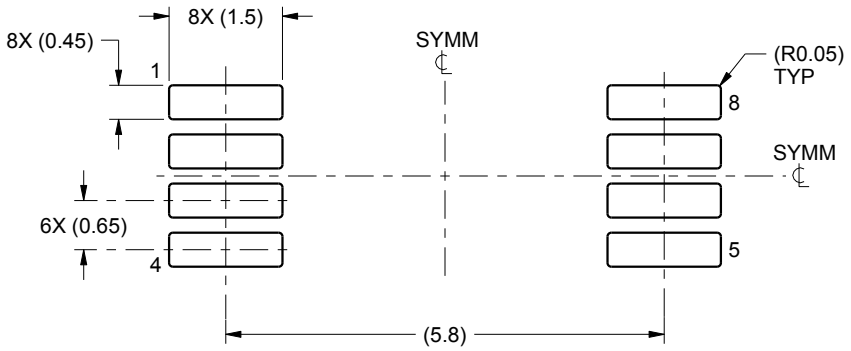
## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

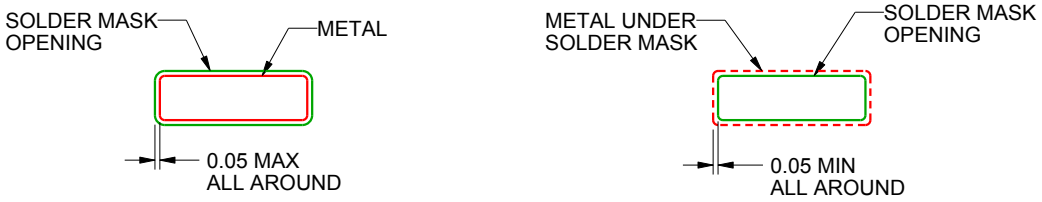



NOTES:

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




LAND PATTERN EXAMPLE
SCALE:10X

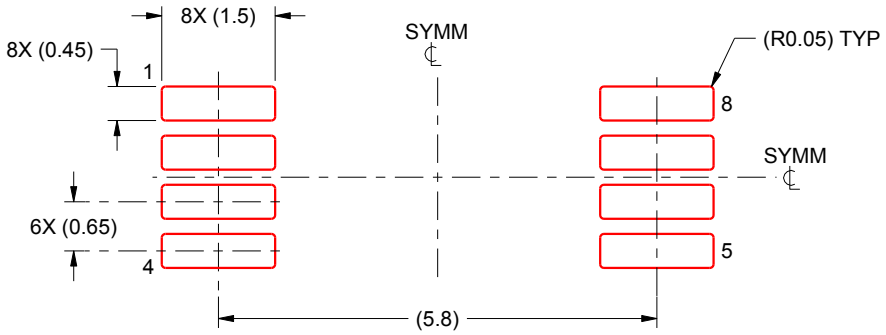



SOLDER MASK DETAILS
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.




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

4221848/A 02/2015

NOTES: (continued)

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

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