

TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

查询"TLC2201AM"供应商

- B Grade Is 100% Tested for Noise
30 nV/ $\sqrt{\text{Hz}}$ Max at f = 10 Hz
12 nV/ $\sqrt{\text{Hz}}$ Max at f = 1 kHz
- Low Input Offset Voltage . . . 500 μV Max
- Excellent Offset Voltage Stability
With Temperature . . . 0.5 $\mu\text{V}/^\circ\text{C}$ Typ
- Rail-to-Rail Output Swing
- Low Input Bias Current
1 pA Typ at $T_A = 25^\circ\text{C}$
- Common-Mode Input Voltage Range
Includes the Negative Rail
- Fully Specified For Both Single-Supply and
Split-Supply Operation

description

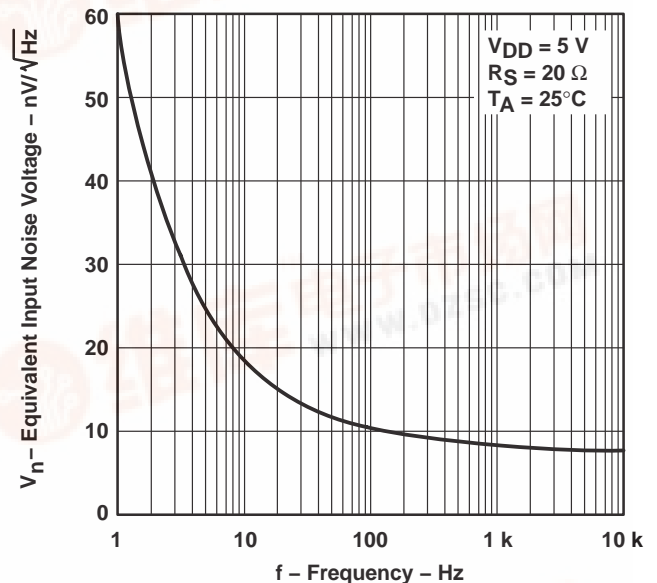
The TLC220x, TLC220xA, TLC220xB, and TLC220xY are precision, low-noise operational amplifiers using Texas Instruments Advanced LinCMOS™ process. These devices combine the noise performance of the lowest-noise JFET amplifiers with the dc precision available previously only in bipolar amplifiers. The Advanced LinCMOS™ process uses silicon-gate technology to obtain input offset voltage stability with temperature and time that far exceeds that obtainable using metal-gate technology. In addition, this technology makes possible input impedance levels that meet or exceed levels offered by top-gate JFET and expensive dielectric-isolated devices.

The combination of excellent DC and noise performance with a common-mode input voltage range that includes the negative rail makes these devices an ideal choice for high-impedance, low-level signal-conditioning applications in either single-supply or split-supply configurations.

The device inputs and outputs are designed to withstand –100-mA surge currents without sustaining latch-up. In addition, internal ESD-protection circuits prevent functional failures at voltages up to 2000 V as tested under MIL-PRF-38535, Method 3015.2; however, care should be exercised in handling these devices as exposure to ESD may result in degradation of the parametric performance.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

TYPICAL EQUIVALENT
INPUT NOISE VOLTAGE
vs
FREQUENCY



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

 **TEXAS
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS096 "TLC2201" (Rev. 11/2008) FEBRUARY 1997 / REVISED JANUARY 2008

TLC2201 AVAILABLE OPTIONS

| T _A | V _{IO} max AT 25°C | V _n max f = 10 Hz AT 25°C | V _n max f = 1 kHz AT 25°C | PACKAGED DEVICES | | | | CHIP FORM‡ (Y) |
|----------------|--------------------------------|--|--|--------------------------|-------------------------|------------------------|-----------------------|----------------------|
| | | | | SMALL OUTLINE† (D) | CHIP CARRIER (FK) | CERAMIC DIP (JG) | PLASTIC DIP (P) | |
| 0°C to 70°C | 200 μV | 35 nV/√Hz | 15 nV/√Hz | TLC2201ACD | — | — | TLC2201ACP | TLC2201Y |
| | 200 μV | 30 nV/√Hz | 12 nV/√Hz | TLC2201BCD | | | TLC2201BCP | |
| | 500 μV | — | — | TLC2201CD | | | TLC2201CP | |
| -40°C to 85°C | 200 μV | 35 nV/√Hz | 15 nV/√Hz | TLC2201AID | — | — | TLC2201AIP | — |
| | 200 μV | 30 nV/√Hz | 12 nV/√Hz | TLC2201BID | | | TLC2201BIP | |
| | 500 μV | — | — | TLC2201ID | | | TLC2201IP | |
| -55°C to 125°C | 200 μV | 35 nV/√Hz | 15 nV/√Hz | TLC2201AMD | TLC2201AMFK | TLC2201AMJG | TLC2201AMP | — |
| | 200 μV | 30 nV/√Hz | 12 nV/√Hz | TLC2201BMD | TLC2201BMFK | TLC2201BMJG | TLC2201BMP | |
| | 500 μV | — | — | TLC2201MD | TLC2201MFK | TLC2201MJG | TLC2201MP | |

† The D packages are available taped and reeled. Add R suffix to device type (e.g. TLC220xBCDR).

‡ Chip forms are tested at 25°C only.

TLC2202 AVAILABLE OPTIONS

| T _A | V _{IO} max AT 25°C | V _n max f = 10 Hz AT 25°C | V _n max f = 1 kHz AT 25°C | PACKAGED DEVICES | | | | | CHIP FORM‡ (Y) |
|----------------|--------------------------------|--|--|--------------------------|-------------------------------------|-------------------------|------------------------|-----------------------|----------------------|
| | | | | SMALL OUTLINE† (D) | PLASTIC SMALL OUTLINE (PS) | CHIP CARRIER (FK) | CERAMIC DIP (JG) | PLASTIC DIP (P) | |
| 0°C to 70°C | 500 μV | 30 nV/√Hz | 12 nV/√Hz | TLC2202BCD | — | — | — | TLC2202BCP | TLC2202Y |
| | 500 μV | 35 nV/√Hz | 15 nV/√Hz | TLC2202ACD | — | — | — | TLC2202ACP | |
| | 1 mV | — | — | TLC2202CD | TLC2202CPSR | — | — | TLC2202CP | |
| -40°C to 85°C | 500 μV | 30 nV/√Hz | 12 nV/√Hz | TLC2202BID | — | — | — | TLC2202BIP | — |
| | 500 μV | 35 nV/√Hz | 15 nV/√Hz | TLC2202AID | — | — | — | TLC2202AIP | |
| | 1 mV | — | — | TLC2202ID | — | — | — | TLC2202IP | |
| -55°C to 125°C | 500 μV | 30 nV/√Hz | 12 nV/√Hz | TLC2202BMD | — | TLC2202BMFK | TLC2202BMJG | TLC2202BMP | — |
| | 500 μV | 35 nV/√Hz | 15 nV/√Hz | TLC2202AMD | — | TLC2202AMFK | TLC2202AMJG | TLC2202AMP | |
| | 1 mV | — | — | TLC2202MD | — | TLC2202MFK | TLC2202MJG | TLC2202MP | |

† The D packages are available taped and reeled. Add R suffix to device type (e.g. TLC220xBCDR).

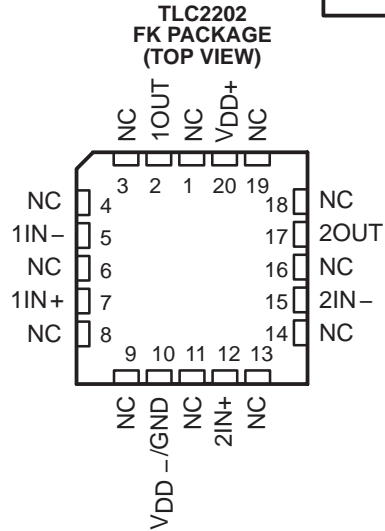
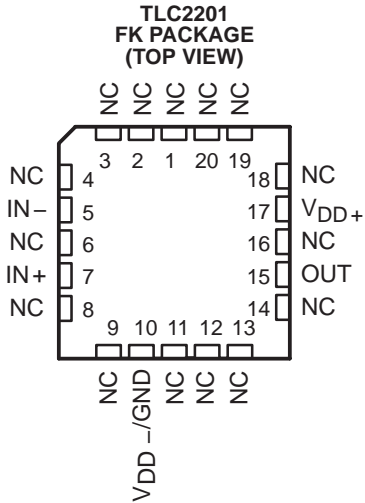
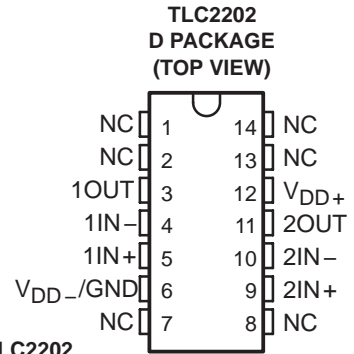
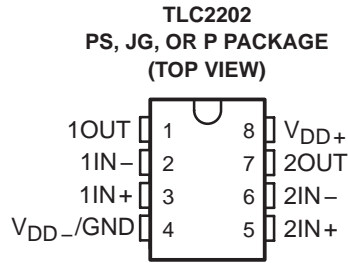
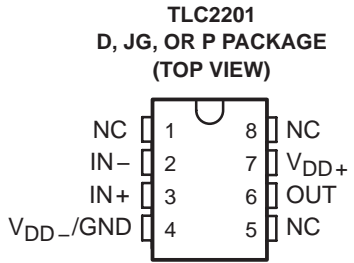
‡ Chip forms are tested at 25°C only.



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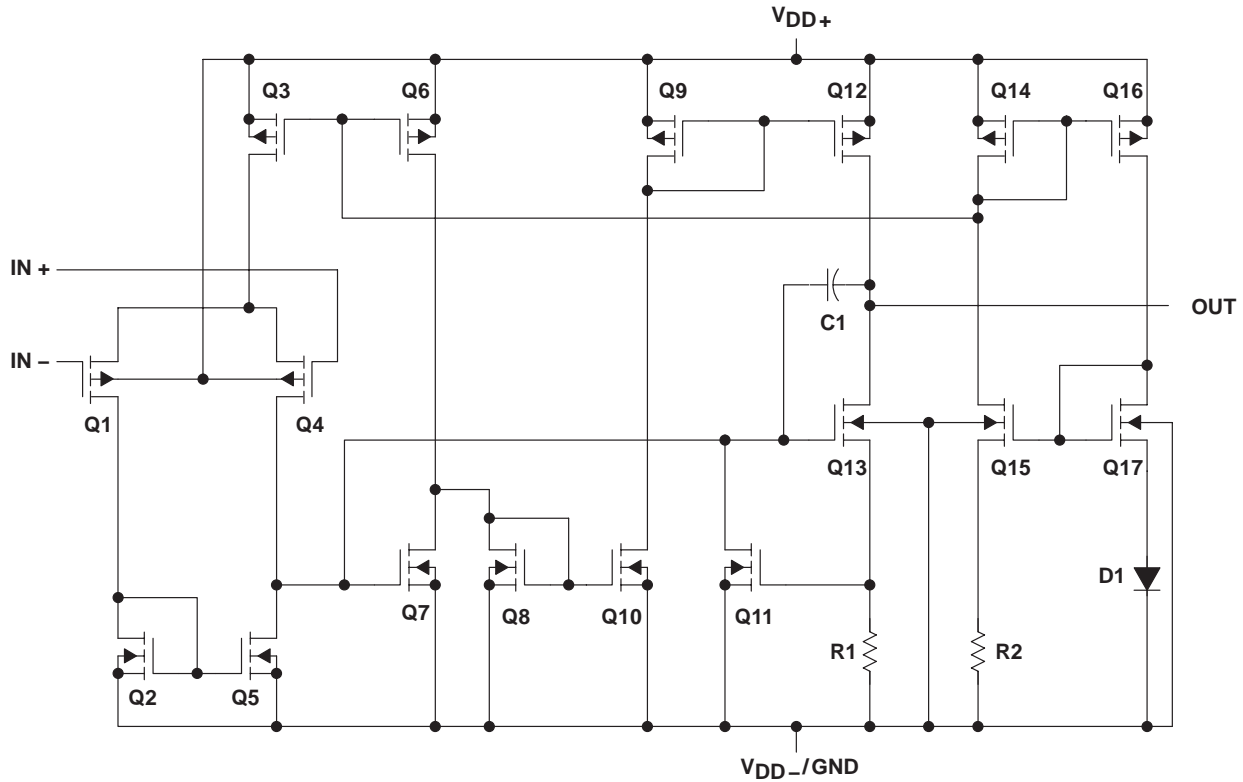
NC – No internal connection

TLC220x, TLC220xA, TLC220xB, TLC220xY

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equivalent schematic (each amplifier)



| ACTUAL DEVICE COMPONENT COUNT | | |
|-------------------------------|---------|---------|
| COMPONENT | TLC2201 | TLC2202 |
| Transistors | 17 | 34 |
| Resistors | 2 | 2 |
| Diodes | 1 | 4 |
| Capacitors | 1 | 2 |

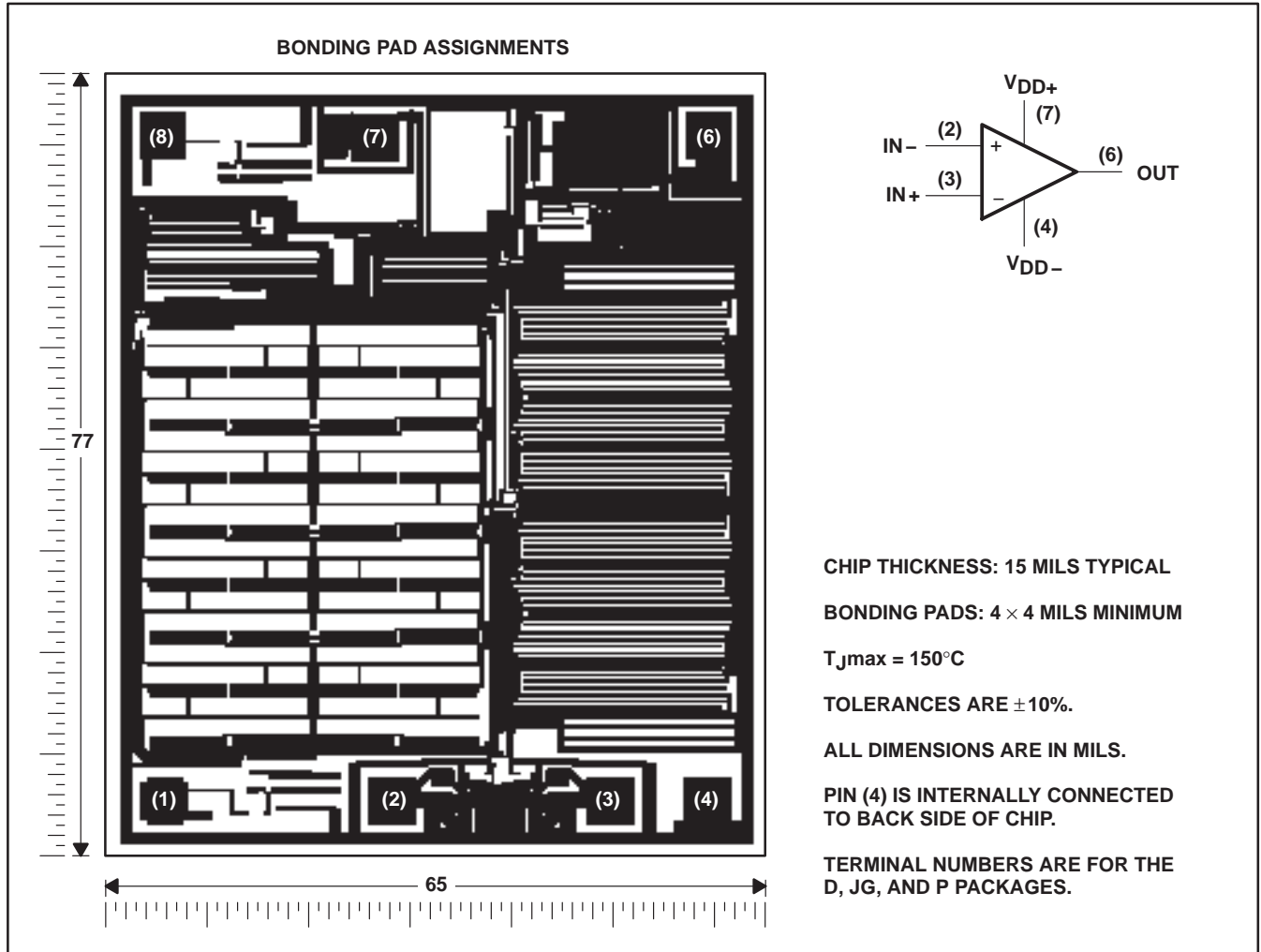
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TLC2201Y chip information

This chip, when properly assembled, displays characteristics similar to the TLC2201C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding path. Chips may be mounted with conductive epoxy or a gold-silicon preform.

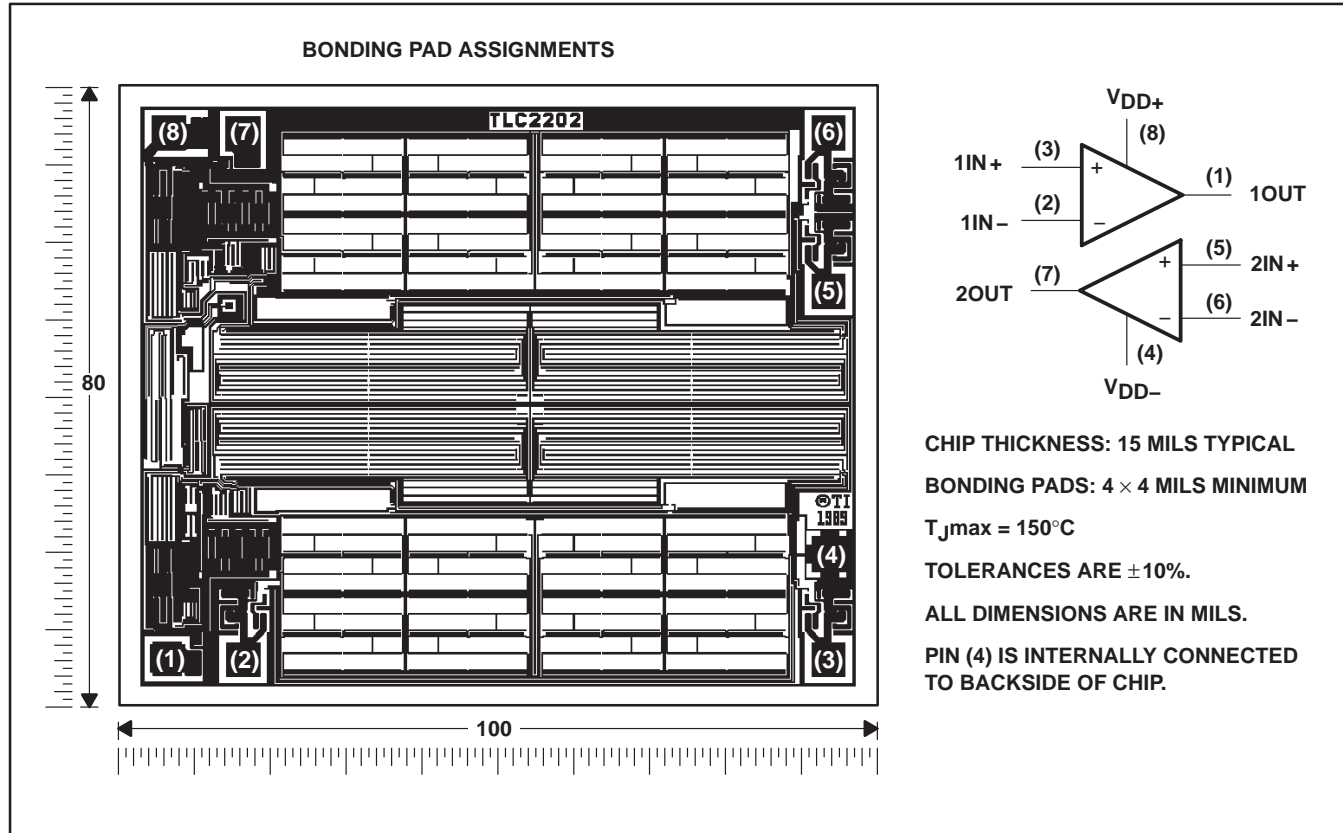


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SLOTTED DIP PACKAGE, 19-PIN, JANUARY 2008

TLC2202Y chip formation

This chip, when properly assembled, displays characteristics similar to the TLC2202C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



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

| | |
|---|------------------------------|
| Supply voltage, V_{DD+} (see Note 1) | 8 V |
| Supply voltage, V_{DD-} | -8 V |
| Differential input voltage, V_{ID} (see Note 2) | ± 16 V |
| Input voltage, V_I (any input) | ± 8 V |
| Input current, I_I (each input) | ± 5 mA |
| Output current, I_O (each output) | ± 50 mA |
| Duration of short-circuit current at (or below) 25°C (see Note 3) | unlimited |
| Continuous total dissipation | See Dissipation Rating Table |
| Operating free-air temperature range, T_A : C suffix | 0°C to 70°C |
| I suffix | -40°C to 85°C |
| M suffix | -55°C to 125°C |
| Storage temperature range | -65°C to 150°C |
| Case temperature for 60 seconds: FK package | 260°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, PS, or P package | 260°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package | 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:
- All voltage values except differential voltages are with respect to the midpoint between V_{DD+} and V_{DD-} .
 - Differential voltages are at $IN+$ with respect to $IN-$.
 - 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 | $T_A \leq 25^\circ\text{C}$ | DERATING FACTOR | $T_A = 70^\circ\text{C}$ | $T_A = 85^\circ\text{C}$ | $T_A = 125^\circ\text{C}$ |
|---------|-----------------------------|--------------------------------|--------------------------|--------------------------|---------------------------|
| | POWER RATING | ABOVE $T_A = 25^\circ\text{C}$ | POWER RATING | POWER RATING | POWER RATING |
| D-8 | 725 mW | 5.8 mW/°C | 464 mW | 377 mW | 145 mW |
| D-14 | 950 mW | 7.6 mW/°C | 608 mW | 494 mW | 190 mW |
| PS | 770 mW | 6.2 mW/°C | 496 mW | 403 mW | 155 mW |
| FK | 1375 mW | 11.0 mW/°C | 880 mW | 715 mW | 275 mW |
| JG | 1050 mW | 8.4 mW/°C | 672 mW | 546 mW | 210 mW |
| P | 1000 mW | 8.0 mW/°C | 640 mW | 520 mW | 200 mW |

recommended operating conditions

| | C SUFFIX | | I SUFFIX | | M SUFFIX | | UNIT |
|---------------------------------------|-----------|-----------------|-----------|-----------------|-----------|-----------------|------|
| | MIN | MAX | MIN | MAX | MIN | MAX | |
| Supply voltage, $V_{DD\pm}$ | ± 2.3 | ± 8 | ± 2.3 | ± 8 | ± 2.3 | ± 8 | V |
| Common-mode input voltage, V_{IC} | V_{DD-} | $V_{DD+} - 2.3$ | V_{DD-} | $V_{DD+} - 2.3$ | V_{DD-} | $V_{DD+} - 2.3$ | V |
| Operating free-air temperature, T_A | 0 | 70 | -40 | 85 | -55 | 125 | °C |



TLC220x, TLC220xA, TLC220xB, TLC220xY

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TLC2201C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201C | | | UNIT |
|---|---|------------|-----------|------------|------------------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 500 | μV | |
| | | Full range | 600 | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | pA | |
| | | Full range | 100 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | pA | |
| | | Full range | 100 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | V | | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 400 | 560 | V/mV | |
| | | Full range | 300 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 90 | 100 | | |
| | | Full range | 70 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | Full range | 85 | | dB | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\ \text{V to } \pm 8\ \text{V}$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.1 | 1.5 | mA | |
| | | Full range | 1.5 | | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201C operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201C | | | UNIT |
|---|---|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 2 | 2.7 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.5 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | μV | |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 48° | | | |

† Full range is 0°C to +70°C.



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TLC2201C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AC | | | TLC2201BC | | | UNIT |
|---|---|----------------------------|------------|-----------|-----|-----------|-----------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 200 | | 80 | 200 | μV | |
| | | Full range | | | 300 | | 300 | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | | 0.5 | | | 0.5 | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 100 | | 100 | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | | Full range | | | 100 | | 100 | | |
| V_{ICR} Common-mode input voltage range | | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | | | -5 to 2.7 | V | |
| V_{OM+} Maximum positive peak output voltage swing | | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V |
| V_{OM-} Maximum negative peak output voltage swing | Full range | | | 4.7 | | | 4.7 | | |
| | 25°C | | -4.7 | -4.9 | | -4.7 | -4.9 | V | |
| Full range | | | -4.7 | | | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | 400 | 560 | | 400 | 560 | V/mV | |
| | | Full range | | 300 | | | 300 | | |
| | $V_O = \pm 4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | 90 | 100 | | 90 | 100 | | |
| | | Full range | | 70 | | | 70 | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 115 | | 90 | 115 | dB | |
| | | Full range | | 85 | | | 85 | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\text{ V to } \pm 8\text{ V}$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | | 85 | | | 85 | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | | 1.1 | 1.5 | | 1.1 | 1.5 | mA |
| | | Full range | | | 1.5 | | | 1.5 | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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TLC2201C operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AC | | | TLC2201BC | | | UNIT |
|---|---|------------|-----------|-----|-----|-----------|-----|-----|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 2 | 2.7 | | 2 | 2.7 | | V/ μ s |
| | | Full range | 1.5 | | | 1.5 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | μ V |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 1.9 | | | 1.9 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 48° | | | 48° | | |

† Full range is 0°C to +70°C.

NOTE 5: This parameter is tested on a sample basis for the TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.

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TLC2201C electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201C | | | UNIT |
|---|---|------------|----------|-------|-------------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, \quad R_S = 50\ \Omega$ | 25°C | | 100 | 500 | μV |
| | | Full range | | | 600 | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ |
| I_{IO} Input offset current | | 25°C | | 0.5 | 60 | pA |
| | | Full range | | | 100 | |
| I_{IB} Input bias current | 25°C | | 1 | 60 | pA | |
| | Full range | | | 100 | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | V | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 50 | mV | |
| | | Full range | | 50 | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V}, \quad R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | V/mV | |
| | | Full range | 100 | | | |
| | $V_O = 1\text{ V to }4\text{ V}, \quad R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | |
| | | Full range | 15 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, \quad V_O = 0, \quad R_S = 50\ \Omega$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \quad \text{No load}$ | 25°C | | 1 1.5 | mA | |
| | | Full range | | 1.5 | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201C operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201C | | | UNIT |
|---|--|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.5 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.3 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | | 18 | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | | 8 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\ \text{Hz}$ | 25°C | | 0.5 | μV | |
| | $f = 0.1\text{ to }10\ \text{Hz}$ | 25°C | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$ | 25°C | | 1.8 | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$ | 25°C | | 45° | | |

† Full range is 0°C to +70°C.



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TLC2201C electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AC | | | TLC2201BC | | | UNIT |
|--|--|------------|-----------|-------|-----|-----------|------------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 200 | | 80 | 200 | μV | |
| | | Full range | | 300 | | 300 | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | 100 | | 100 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | | Full range | | 100 | | 100 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | | 0 to 2.7 | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 | 50 | | 0 | mV | |
| | | Full range | | | 50 | | 50 | | |
| AVD Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | | 150 | 315 | V/mV | |
| | | Full range | 100 | | | 100 | | | |
| | | 25°C | 25 | 55 | | 25 | 55 | | |
| | | Full range | 15 | | | 15 | | | |
| $CMRR$ Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$) | $V_{DD} = 4.6\ \text{V to } 16\ \text{V}$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| I_{DD} Supply current | $V_O = 2.5\ \text{V}, \text{ No load}$ | 25°C | | 1 | 1.5 | | 1 | mA | |
| | | Full range | | | 1.5 | | 1.5 | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC220x, TLC220xA, TLC220xB, TLC220xY
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TLC2201C operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AC | | | TLC2201BC | | | UNIT |
|--|---|------------|-----------|-----|-----|-----------|-----|-----|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}$ | 25°C | 1.8 | 2.5 | | 1.8 | 2.5 | | V/ μ s |
| | | Full range | 1.3 | | | 1.3 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | μ V |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}, R_L = 10\text{ k}\Omega,$ $C_L = 100\text{ pF}$ | 25°C | | 1.8 | | | 1.8 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}$ | 25°C | | 45° | | | 45° | | |

† Full range is 0°C to +70°C.

NOTE 5: This parameter is tested on a sample basis for the TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS056F FEBRUARY 1994 / REVISED JANUARY 2008

TLC2202C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V (unless otherwise specified)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202C | | | UNIT |
|---|---|------------|-----------|-------|------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50 \Omega$ | 25°C | 100 | 1000 | μV | |
| | | Full range | 1150 | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu V/^\circ C$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu V/mo$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | pA | |
| | | Full range | 100 | | | |
| I_{IB} Input bias current | 25°C | 1 | 60 | | | |
| | Full range | 100 | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50 \Omega$ | Full range | -5 to 2.7 | | V | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10 k\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4$ V, $R_L = 500 k\Omega$ | 25°C | 300 | 560 | V/mV | |
| | | Full range | 200 | | | |
| | $V_O = \pm 4$ V, $R_L = 10 k\Omega$ | 25°C | 50 | 100 | | |
| | | Full range | 25 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, R_S = 50 \Omega, V_{IC} = V_{ICRmin}$ | 25°C | 80 | 115 | dB | |
| | | Full range | 80 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3$ V to ± 8 V | 25°C | 80 | 110 | dB | |
| | | Full range | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{No load}$ | 25°C | 1.8 | 2.7 | mA | |
| | | Full range | 2.7 | | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ C$ extrapolated to $T_A = 25^\circ C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202C operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202C | | | UNIT |
|---|---|------------|----------|-----|----------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3$ V, $R_L = 10 k\Omega, C_L = 100$ pF | 25°C | 1.8 | 2.7 | $V/\mu s$ | |
| | | Full range | 1.3 | | | |
| V_n Equivalent input noise voltage | $f = 10$ Hz | 25°C | 18 | | nV/\sqrt{Hz} | |
| | $f = 1$ kHz | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1$ to 1 Hz | 25°C | 0.5 | | μV | |
| | $f = 0.1$ to 10 Hz | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | fA/\sqrt{Hz} | |
| Gain-bandwidth product | $f = 10$ kHz, $R_L = 10 k\Omega, C_L = 100$ pF | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10 k\Omega, C_L = 100$ pF | 25°C | 48° | | | |

† Full range is 0°C to +70°C.



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TLC2202C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AC | | | TLC2202BC | | | UNIT |
|---|---|------------|-----------|-------|-----|-----------|-------|-------------------------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | | 25°C | 80 | 500 | | 80 | 500 | μV | |
| | | Full range | | | 650 | | 650 | | |
| α_{VIO} Temperature coefficient of input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | Full range | 0.5 | | | 0.5 | | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| | | Full range | | | | | | | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | 100 | | | 100 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | Full range | 100 | | | 100 | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | | | -5 to 2.7 | | | V |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | 300 | 560 | | 300 | 560 | V/mV | |
| | | Full range | 200 | | | 200 | | | |
| | $V_O = \pm 4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | 50 | 100 | | 50 | 100 | | |
| | | Full range | 25 | | | 25 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 80 | 115 | | 80 | 115 | dB | |
| | | Full range | 80 | | | 80 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\text{ V to } \pm 8\text{ V}$ | 25°C | 80 | 110 | | 80 | 110 | dB | |
| | | Full range | 80 | | | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.8 | 2.7 | | 1.8 | 2.7 | mA | |
| | | Full range | 2.7 | | | 2.7 | | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202C operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AC | | | TLC2202BC | | | UNIT |
|---|--|------------|-----------|-----|-----|-----------|-----|------------------------------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.7 | | 1.8 | 2.7 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.3 | | | 1.3 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\ \text{Hz}$ | 25°C | 18 | 35 | | 18 | 30 | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | 15 | | 8 | 12 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | | 0.5 | | | μV |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | | 0.6 | | | $\text{fA}/\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | | 1.9 | | | MHz |
| ϕ_m Phase margin at unity gain | $R_I = 10\ \text{k}\Omega, C_I = 100\ \text{pF}$ | 25°C | 48° | | | 48° | | | |

† Full range is 0°C to +70°C.

NOTE 5: This parameter is tested on a sample basis for the TLC2202A and on all devices for the TLC2202B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY

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TLC2202C electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202C | | | UNIT |
|---|--|------------|----------|-------------|------------------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 1000 | μV | |
| | | Full range | 1150 | | | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| | | 25°C | 0.5 | 60 | pA | |
| I_{IO} Input offset current | | Full range | 100 | | | |
| I_{IB} Input bias current | 25°C | 1 | 60 | pA | | |
| | Full range | 100 | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | 0 | 50 | mV | |
| | | Full range | 50 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | V/mV | |
| | | Full range | 100 | | | |
| | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | |
| | | Full range | 15 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, R_S = 50\ \Omega, V_{IC} = V_{ICRmin}$ | 25°C | 75 | 110 | dB | |
| | | Full range | 75 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = 4.6\ \text{V to } 16\ \text{V}$ | 25°C | 80 | 110 | dB | |
| | | Full range | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.7 | 2.6 | mA | |
| | | Full range | 2.6 | | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202C operating characteristics at specified free-air temperature, $V_{DD} = 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202C | | | UNIT |
|---|---|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\ \text{V to } 2.5\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.6 | 2.5 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.1 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | μV | |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 47° | | | |

† Full range is 0°C to +70°C.



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TLC2202C electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AC | | | TLC2202BC | | | UNIT |
|---|---|------------|-----------|----------|----------|-----------|------------------------------|-----|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 500 | 80 | 500 | μV | | |
| | | Full range | 650 | | 650 | | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | 0.5 | 60 | pA | | |
| | | Full range | 100 | | 100 | | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | 1 | 60 | pA | | |
| | | Full range | 100 | | 100 | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | 0 to 2.7 | 0 to 2.7 | 0 to 2.7 | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | 4.7 | 4.8 | V | | |
| | | Full range | 4.7 | | 4.7 | | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | 0 | 50 | 0 | 50 | mV | | |
| | | Full range | 50 | | 50 | | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | 150 | 315 | V/mV | | |
| | | Full range | 100 | | 100 | | | | |
| | $V_O = 1\text{ V to }4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | 25 | 55 | | | |
| | | Full range | 15 | | 15 | | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 75 | 110 | 75 | 110 | dB | | |
| | | Full range | 75 | | 75 | | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | 80 | 110 | 80 | 110 | dB | | |
| | | Full range | 80 | | 80 | | | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \text{ No load}$ | 25°C | 1.7 | 2.6 | 1.7 | 2.6 | mA | | |
| | | Full range | 2.6 | | 2.6 | | | | |

† Full range is 0°C to +70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202C operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AC | | | TLC2202BC | | | UNIT |
|---|--|------------|-----------|-----|-----|-----------|------------------------------|-----|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.6 | 2.5 | 1.6 | 2.5 | $\text{V}/\mu\text{s}$ | | |
| | | Full range | 1.1 | | 1.1 | | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\ \text{Hz}$ | 25°C | 18 | 35 | 18 | 30 | $\text{nV}/\sqrt{\text{Hz}}$ | | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | 15 | 8 | 12 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\ \text{Hz}$ | 25°C | 0.5 | | 0.5 | | μV | | |
| | $f = 0.1\text{ to }10\ \text{Hz}$ | 25°C | 0.7 | | 0.7 | | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | 1.9 | | MHz | | |
| ϕ_m Phase margin at unity gain | $R_l = 10\ \text{k}\Omega, C_l = 100\ \text{pF}$ | 25°C | 47° | | 47° | | | | |

† Full range is 0°C to +70°C.

NOTE 5: This parameter is tested on a sample basis for the TLC2202A and on all devices for the TLC2202B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

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TLC2201I electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201I | | | UNIT |
|---|---|------------|----------|-------|------------------------------|-------------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 500 | μV | |
| | | Full range | 650 | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| | | 25°C | 0.5 | | 60 | |
| I_{IO} Input offset current | | Full range | 150 | | | pA |
| | | 25°C | 1 | | 60 | |
| I_{IB} Input bias current | | Full range | 150 | | | pA |
| | Full range | -5 to 2.7 | | V | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | | | V | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 400 | 560 | V/mV | |
| | | Full range | 250 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 90 | 100 | | |
| | | Full range | 65 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 115 | dB | |
| | | Full range | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\ \text{V to } \pm 8\ \text{V}$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.1 | 1.5 | mA | |
| | | Full range | 1.5 | | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201I operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201I | | | UNIT |
|---|---|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 2 | 2.7 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.4 | | | |
| V_n Equivalent input noise voltage | f = 10 Hz | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | f = 1 kHz | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | f = 0.1 to 1 Hz | 25°C | 0.5 | | μV | |
| | f = 0.1 to 10 Hz | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | f = 10 kHz, $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 48° | | | |

† Full range is -40°C to $+85^\circ\text{C}$.



TLC220x, TLC220xA, TLC220xB, TLC220xY
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TLC22011 electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AI | | | TLC2201BI | | | UNIT |
|---|--|------------|-----------|-------|-----------|-----------|------------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 200 | | 80 | 200 | μV | |
| | | Full range | | | 350 | | 350 | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 150 | | 150 | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | | Full range | | | 150 | | 150 | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | –5 to 2.7 | | –5 to 2.7 | | V | | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | –4.7 | –4.9 | | –4.7 | –4.9 | V | |
| | | Full range | –4.7 | | | –4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 400 | 560 | | 400 | 560 | V/mV | |
| | | Full range | 250 | | | 250 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 90 | 100 | | 90 | 100 | | |
| | | Full range | 65 | | | 65 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 115 | | 90 | 115 | dB | |
| | | Full range | 85 | | | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\ \text{V}$ to $\pm 8\ \text{V}$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.1 | 1.5 | | 1.1 | 1.5 | mA | |
| | | Full range | | | 1.5 | | 1.5 | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation assuming an activation energy of 0.96 eV.

TLC220x, TLC220xA, TLC220xB, TLC220xY
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SLOS096 "TLC2201A" REVISION 1.0 JANUARY 2008

TLC2201I operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AI | | | TLC2201BI | | | UNIT | |
|---|---|------------|-----------|-----|-----|-----------|-----|-----|------------------------|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 2 | 2.7 | | 2 | 2.7 | | V/ μ s | |
| | | Full range | 1.4 | | | 1.4 | | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ | |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | | μ V |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 1.9 | | | 1.9 | | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 48° | | | 48° | | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 5: This parameter is tested on a sample basis for the TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

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TLC2201I electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A^\dagger | TLC2201I | | | UNIT |
|---|--|---------------|----------|-------|-------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, \quad R_S = 50\ \Omega$ | 25°C | | 100 | 500 | μV |
| | | Full range | | | 650 | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ |
| I_{IO} Input offset current | | 25°C | | 0.5 | 60 | pA |
| | | Full range | | | 150 | |
| I_{IB} Input bias current | | 25°C | | 1 | 60 | pA |
| | | Full range | | | 150 | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | V | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 50 | mV | |
| | | Full range | | 50 | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V},$ $R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | V/mV | |
| | | Full range | 100 | | | |
| | $V_O = 1\text{ V to }4\text{ V},$ $R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | |
| | | Full range | 15 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}},$ $V_O = 0, \quad R_S = 50\ \Omega$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \quad \text{No load}$ | 25°C | | 1 1.5 | mA | |
| | | Full range | | 1.5 | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201I operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A^\dagger | TLC2201I | | | UNIT |
|---|---|---------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.5 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.2 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | | 18 | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | | 8 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\ \text{Hz}$ | 25°C | | 0.5 | μV | |
| | $f = 0.1\text{ to }10\ \text{Hz}$ | 25°C | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$ | 25°C | | 1.8 | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$ | 25°C | | 45° | | |

† Full range is -40°C to $+85^\circ\text{C}$.



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS096 "TLC220" FAMILY REFERENCE DESIGN JANUARY 2008

TLC22011 electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AI | | | TLC2201BI | | | UNIT |
|--|---|------------|-----------|-------|-----|-----------|-------------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 200 | | 80 | 200 | μA | |
| | | Full range | | | 350 | | 350 | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 150 | | 150 | | |
| I_{IB} Input bias current | 25°C | 1 | 60 | | 1 | 60 | pA | | |
| | Full range | | | 150 | | 150 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | | 0 to 2.7 | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 | 50 | | 0 | mV | |
| | | Full range | | | 50 | | 50 | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | | 150 | 315 | V/mV | |
| | | Full range | 100 | | | 100 | | | |
| | $V_O = 1\text{ V to }4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | 25 | 55 | | |
| | | Full range | 15 | | | 15 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \text{ No load}$ | 25°C | | 1 | 1.5 | | 1 | mA | |
| | | Full range | | | 1.5 | | 1.5 | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC220x, TLC220xA, TLC220xB, TLC220xY
Advanced LinCMOS™ LOW-NOISE PRECISION
OPERATIONAL AMPLIFIERS

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TLC2201I operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AI | | | TLC2201BI | | | UNIT |
|---|---|------------|-----------|-----|-----|-----------|-----|-----|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}$ | 25°C | 1.8 | 2.5 | | 1.8 | 2.5 | | V/ μ s |
| | | Full range | 1.2 | | | 1.2 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | μ V |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}, R_L = 10\text{ k}\Omega,$ $C_L = 100\text{ pF}$ | 25°C | | 1.8 | | | 1.8 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}$ | 25°C | | 45° | | | 45° | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 5: This parameter is tested on a sample basis for the TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.

TLC220x, TLC220xA, TLC220xB, TLC220xY

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SLOS096 "TLC220" (Rev. 1997) REVISIONS JANUARY 2008

TLC220I electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC220I | | | UNIT |
|---|---|----------------------------|------------|-----------|------------------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 1000 | μV | |
| | | Full range | 1200 | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | pA | |
| | | Full range | 150 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | |
| | | Full range | 150 | | | |
| V_{ICR} Common-mode input voltage range | | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | | V |
| V_{OM+} Maximum positive peak output voltage swing | | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V |
| | Full range | | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | 25°C | | -4.7 | -4.9 | V | |
| | Full range | | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 300 | 560 | V/mV | |
| | | Full range | 150 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 50 | 100 | | |
| | | Full range | 25 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, R_S = 50\ \Omega, V_{IC} = V_{ICR\text{min}}$ | 25°C | 80 | 115 | dB | |
| | | Full range | 80 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = \pm 2.3\ \text{V}$ to $\pm 8\ \text{V}$ | 25°C | 80 | 110 | dB | |
| | | Full range | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{No load}$ | 25°C | 1.8 | 2.7 | mA | |
| | | Full range | 2.7 | | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC220I operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC220I | | | UNIT |
|---|---|------------|---------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.7 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.2 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1$ to $1\ \text{Hz}$ | 25°C | 0.5 | | μV | |
| | $f = 0.1$ to $10\ \text{Hz}$ | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 48° | | | |

† Full range is -40°C to $+85^\circ\text{C}$.



TLC220x, TLC220xA, TLC220xB, TLC220xY
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TLC2202I electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AI | | | TLC2202BI | | | UNIT |
|---|--|------------|-----------|-------|-----|-----------|-------|-------------------------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | | 25°C | 80 | 500 | | 80 | 500 | μV | |
| | | Full range | | | 700 | | 700 | | |
| α_{VIO} Temperature coefficient of input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | Full range | 0.5 | | | 0.5 | | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 150 | | 150 | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | | Full range | | | 150 | | 150 | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | | | -5 to 2.7 | | | V |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 300 | 560 | | 300 | 560 | V/mV | |
| | | Full range | 150 | | | 150 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 50 | 100 | | 50 | 100 | | |
| | | Full range | 25 | | | 25 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 80 | 115 | | 80 | 115 | dB | |
| | | Full range | 80 | | | 80 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD\pm} \pm 2.3\ \text{V to } \pm 8\ \text{V}$ | 25°C | 80 | 110 | | 80 | 110 | dB | |
| | | Full range | 80 | | | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.8 | 2.7 | | 1.8 | 2.7 | mA | |
| | | Full range | 2.7 | | | 2.7 | | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202I operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AI | | | TLC2202BI | | | UNIT |
|---|---|------------|-----------|-----|-----|-----------|-----|------------------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.7 | | 1.8 | 2.7 | V/ μs | |
| | | Full range | 1.2 | | | 1.2 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\ \text{Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | $\text{nV}/\sqrt{\text{Hz}}$ |
| | $f = 1\ \text{kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | | 0.5 | | | μV |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | | 0.6 | | | $\text{fA}/\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | | 1.9 | | | MHz |
| ϕ_m Phase margin at unity gain | $R_I = 10\ \text{k}\Omega, C_I = 100\ \text{pF}$ | 25°C | 48° | | | 48° | | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 5: This parameter is tested on a sample basis for the TLC2202A and on all devices for the TLC2202B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY

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TLC2202I electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202I | | | UNIT |
|---|--|------------|----------|------------|------------------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 1000 | μV | |
| | | Full range | 1200 | | | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | pA | |
| | | Full range | 150 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | pA | |
| | | Full range | 150 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | 0 | 50 | mV | |
| | | Full range | 50 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | V/mV | |
| | | Full range | 100 | | | |
| | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | |
| | | Full range | 15 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$ | 25°C | 75 | 110 | dB | |
| | | Full range | 75 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = 4.6\ \text{V to } 16\ \text{V}$ | 25°C | 80 | 110 | dB | |
| | | Full range | 80 | | | |
| I_{DD} Supply current | $V_O = 2.5\ \text{V}, \text{ No load}$ | 25°C | 1.7 | 2.6 | mA | |
| | | Full range | 2.6 | | | |

† Full range is -40°C to $+85^\circ\text{C}$.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202I operating characteristics at specified free-air temperature, $V_{DD} = 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202I | | | UNIT |
|---|---|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\ \text{V to } 2.5\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.6 | 2.5 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | μV | |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 47° | | | |

† Full range is -40°C to $+85^\circ\text{C}$.



TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

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TLC2202I electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AI | | | TLC2202BI | | | UNIT |
|---|---|------------|-----------|-------|----------|-----------|-------|-------------------------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | | 25°C | 80 | 500 | | 80 | 500 | μV | |
| | | Full range | | | 700 | | 700 | | |
| α_{VIO} Temperature coefficient of input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | Full range | 0.5 | | | 0.5 | | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | 150 | | | 150 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | Full range | 150 | | | 150 | | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | 0 to 2.7 | | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 | 50 | | 0 | 50 | mV |
| | | Full range | 50 | | | 50 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | | 150 | 315 | V/mV | |
| | | Full range | 100 | | | 100 | | | |
| | $V_O = 1\text{ V to }4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | 25 | 55 | | |
| | | Full range | 15 | | | 15 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 75 | 110 | | 75 | 110 | dB | |
| | | Full range | 75 | | | 75 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | 80 | 110 | | 80 | 110 | dB | |
| | | Full range | 80 | | | 80 | | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \text{ No load}$ | 25°C | | 1.7 | 2.6 | | 1.7 | 2.6 | mA |
| | | Full range | 2.6 | | | 2.6 | | | |

† Full range is -40°C to $+85^\circ\text{C}$

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202I operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AI | | | TLC2202BI | | | UNIT |
|---|--|------------|-----------|-----|-----|-----------|-----|------------------|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.6 | 2.5 | | 1.6 | 2.5 | V/ μs | |
| | | Full range | 1 | | | 1 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\ \text{Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ |
| | $f = 1\ \text{kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\ \text{Hz}$ | 25°C | 0.5 | | | 0.5 | | | μV |
| | $f = 0.1\text{ to }10\ \text{Hz}$ | 25°C | 0.7 | | | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | | 0.6 | | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | | 1.9 | | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 47° | | | 47° | | | |

† Full range is -40°C to $+85^\circ\text{C}$

NOTE 5: This parameter is tested on a sample basis for the TLC2202A and on all devices for the TLC2202B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY

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TLC2201M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201M | | | UNIT |
|---|---|------------|-----------|-------|------------------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 500 | μV | |
| | | Full range | 700 | | | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| | | 25°C | 0.5 | 60 | pA | |
| I_{IO} Input offset current | | Full range | 500 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | pA | |
| | | Full range | 500 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | V | | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 400 | 560 | V/mV | |
| | | Full range | 200 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 90 | 100 | | |
| | | Full range | 45 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 115 | dB | |
| | | Full range | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\ \text{V to } \pm 8\ \text{V}$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.1 | 1.5 | mA | |
| | | Full range | 1.5 | | | |

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201M operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201M | | | UNIT |
|---|---|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 2 | 2.7 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.3 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | μV | |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 48° | | | |

† Full range is -55°C to 125°C .



TLC220x, TLC220xA, TLC220xB, TLC220xY
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TLC2201M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AM | | | TLC2201BM | | | UNIT |
|---|--|------------|-----------|-------|-----|-----------|------------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 200 | | 80 | 200 | μV | |
| | | Full range | | 400 | | 400 | | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | 500 | | 500 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | | 1 | 60 | pA | |
| | | Full range | | 500 | | 500 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | | | -5 to 2.7 | V | | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 400 | 560 | | 400 | 560 | V/mV | |
| | | Full range | 200 | | | 200 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 90 | 100 | | 90 | 100 | | |
| | | Full range | 45 | | | 45 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 115 | | 90 | 115 | dB | |
| | | Full range | 85 | | | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\ \text{V}$ to $\pm 8\ \text{V}$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.1 | 1.5 | | 1.1 | 1.5 | mA | |
| | | Full range | | 1.5 | | | 1.5 | | |

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observable through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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OPERATIONAL AMPLIFIERS

SLOS096 "TLC2201A, TLC2201B" REVISION 1.0 JANUARY 2008

[View the TLC2201A/1B datasheet](#)

TLC2201M operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AM | | | TLC2201BM | | | UNIT |
|---|--|------------|-----------|-----|-----|-----------|-----|-----|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 2 | 2.7 | | 2 | 2.7 | | V/ μs |
| | | Full range | 1.3 | | | 1.3 | | | |
| V_n Equivalent input noise voltage (see Note 5) | f = 10 Hz | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ |
| | f = 1 kHz | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | f = 0.1 to 1 Hz | 25°C | | 0.5 | | | 0.5 | | μV |
| | f = 0.1 to 10 Hz | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | f = 10 kHz, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 1.9 | | | 1.9 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 48° | | | 48° | | |

† Full range is -55°C to 125°C .

NOTE 5: This parameter is tested on a sample basis for the TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



TLC220x, TLC220xA, TLC220xB, TLC220xY
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SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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TLC2201M electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201M | | | UNIT |
|---|---|------------|----------|-------|--------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | | 100 | 500 | μV |
| | | Full range | | | 700 | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | | 0.001 | 0.005* | $\mu\text{V}/\text{mo}$ |
| I_{IO} Input offset current | | 25°C | | 0.5 | 60 | pA |
| | | Full range | | | 500 | |
| I_{IB} Input bias current | | 25°C | | 1 | 60 | pA |
| | | Full range | | | 500 | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | V | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 50 | mV | |
| | | Full range | | 50 | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | V/mV | |
| | | Full range | 75 | | | |
| | $V_O = 1\text{ V to }4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | |
| | | Full range | 10 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | 90 | 110 | dB | |
| | | Full range | 85 | | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \text{ No load}$ | 25°C | | 1 1.5 | mA | |
| | | Full range | | 1.5 | | |

*On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201M operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201M | | | UNIT |
|---|--|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.5 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.1 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | | 18 | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | | 8 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\ \text{Hz}$ | 25°C | | 0.5 | μV | |
| | $f = 0.1\text{ to }10\ \text{Hz}$ | 25°C | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | | 1.8 | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | | 45° | | |

† Full range is -55°C to 125°C .



TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

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TLC2201M electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AM | | | TLC2201BM | | | UNIT |
|--|--|------------|-----------|-------|-----|-----------|-------------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 200 | | 80 | 200 | μV | |
| | | Full range | | | 400 | | 400 | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 500 | | 500 | | |
| I_{IB} Input bias current | 25°C | 1 | 60 | | 1 | 60 | pA | | |
| | Full range | | | 500 | | 500 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | | 0 to 2.7 | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 | 50 | | 0 | V | |
| | | Full range | | | 50 | | 50 | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | | 150 | 315 | V/mV | |
| | | Full range | 75 | | | 75 | | | |
| | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | 25 | 55 | | |
| | | Full range | 10 | | | 10 | | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$) | $V_{DD} = 4.6\ \text{V to } 16\ \text{V}$ | 25°C | 90 | 110 | | 90 | 110 | dB | |
| | | Full range | 85 | | | 85 | | | |
| I_{DD} Supply current | $V_O = 2.5\ \text{V}, \text{ No load}$ | 25°C | | 1.1 | 1.5 | | 1.1 | mA | |
| | | Full range | | | 1.5 | | 1.5 | | |

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observable through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2201M operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2201AM | | | TLC2201BM | | | UNIT |
|---|--|------------|-----------|-----|-----|-----------|-----|-----|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 1.8 | 2.5 | | 1.8 | 2.5 | | V/ μs |
| | | Full range | 1.1 | | | 1.1 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35 | | 18 | 30 | nV/ $\sqrt{\text{Hz}}$ |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15 | | 8 | 12 | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | μV |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 1.8 | | | 1.8 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 45° | | | 45° | | |

† Full range is -55°C to 125°C .

NOTE 5: This parameter is tested on a sample basis for the TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.

TLC220x, TLC220xA, TLC220xB, TLC220xY

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TLC2202M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202M | | | UNIT |
|---|--|------------|-----------|------------|------------------------------|------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 100 | 1000 | μV | |
| | | Full range | 1250 | | | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005 | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | pA | |
| | | Full range | 500 | | | |
| I_{IB} Input bias current | | 25°C | 1 | 60 | pA | |
| | | Full range | 500 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | V | | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | V | |
| V_{OM-} Maximum negative peak output voltage swing | | Full range | 4.7 | | | |
| | | 25°C | -4.7 | -4.9 | V | |
| Full range | | -4.7 | | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 300 | 560 | V/mV | |
| | | Full range | 100 | | | |
| | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 50 | 100 | | |
| | | Full range | 25 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$ | 25°C | 80 | 115 | dB | |
| | | Full range | 80 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$) | $V_{DD} = \pm 2.3\ \text{V to } \pm 8\ \text{V}$ | 25°C | 80 | 110 | dB | |
| | | Full range | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.8 | 2.7 | mA | |
| | | Full range | 2.7 | | | |

* On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202M operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\ \text{V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202M | | | UNIT |
|---|---|------------|----------|-----|------------------------------|------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\ \text{V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.8 | 2.7 | $\text{V}/\mu\text{s}$ | |
| | | Full range | 1.1 | | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ | |
| | $f = 1\ \text{kHz}$ | 25°C | 8 | | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{to } 1\ \text{Hz}$ | 25°C | 0.5 | | μV | |
| | $f = 0.1\ \text{to } 10\ \text{Hz}$ | 25°C | 0.7 | | | |
| I_n Equivalent input noise current | | 25°C | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ | |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 1.9 | | MHz | |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | 48° | | | |

† Full range is -55°C to 125°C .



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TLC2202M electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AM | | | TLC2202BM | | | UNIT |
|---|---|------------|-----------|--------|-----|-----------|-------------|------------------------------|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 500 | | 80 | 500 | μV | |
| | | Full range | | | 750 | | 750 | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ | |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005* | | 0.001 | 0.005* | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 500 | | 500 | | |
| I_{IB} Input bias current | 25°C | 1 | 60 | | 1 | 60 | pA | | |
| | Full range | | | 500 | | 500 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | -5 to 2.7 | | | -5 to 2.7 | V | | |
| V_{OM+} Maximum positive peak output voltage swing | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OM-} Maximum negative peak output voltage swing | | 25°C | -4.7 | -4.9 | | -4.7 | -4.9 | V | |
| | | Full range | -4.7 | | | -4.7 | | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = \pm 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 300 | 560 | | 300 | 560 | V/mV | |
| | | Full range | 100 | | | 100 | | | |
| | $V_O = \pm 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 50 | 100 | | 50 | 100 | | |
| | | Full range | 25 | | | 25 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$ | 25°C | 80 | 115 | | 80 | 115 | dB | |
| | | Full range | 80 | | | 80 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD\pm} = \pm 2.3\ \text{V to } \pm 8\ \text{V}$ | 25°C | 80 | 110 | | 80 | 110 | dB | |
| | | Full range | 80 | | | 80 | | | |
| I_{DD} Supply current | $V_O = 0, \text{ No load}$ | 25°C | 1.8 | 2.7 | | 1.8 | 2.7 | mA | |
| | | Full range | | | 2.7 | | 2.7 | | |

*On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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TLC2202M operating characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AM | | | TLC2202BM | | | UNIT |
|--|--|------------|-----------|-----|-----|-----------|-----|-----|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 1.8 | 2.7 | | 1.8 | 2.7 | | $\text{V}/\mu\text{s}$ |
| | | Full range | 1.1 | | | 1.1 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35* | | 18 | 30* | $\text{nV}/\sqrt{\text{Hz}}$ |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15* | | 8 | 12* | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | μV |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 1.9 | | | 1.9 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 48° | | | 48° | | |

*On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C .

NOTE 5: This parameter is tested on a sample basis for the TLC2202A and on all devices for the TLC2202B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.

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TLC2202M electrical characteristics at specified free-air temperatures, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202M | | | UNIT |
|---|---|--------------------|------------|----------|--------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | | 100 | 1000 | μV |
| | | Full range | | | 1250 | |
| $\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage | | Full range | | 0.5 | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | | 0.001 | 0.005* | $\mu\text{V}/\text{mo}$ |
| | | 25°C | | 0.5 | 60 | pA |
| I_{IO} Input offset current | | Full range | | | 500 | pA |
| | | 25°C | | 1 | 60 | |
| I_{IB} Input bias current | | Full range | | | 500 | |
| | V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | V |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | | 4.7 | 4.8 | V |
| | | Full range | | 4.7 | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 | 50 | mV |
| | | Full range | | | 50 | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\text{ V to }4\text{ V}, R_L = 500\ \text{k}\Omega$ | 25°C | | 150 | 315 | V/mV |
| | | Full range | | 75 | | |
| | $V_O = 1\text{ V to }4\text{ V}, R_L = 10\ \text{k}\Omega$ | 25°C | | 25 | 55 | |
| | | Full range | | 10 | | |
| CMRR Common-mode rejection ratio | $V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$ | 25°C | | 75 | 110 | dB |
| | | Full range | | 75 | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD} = 4.6\text{ V to }16\text{ V}$ | 25°C | | 80 | 110 | dB |
| | | Full range | | 80 | | |
| I_{DD} Supply current | $V_O = 2.5\text{ V}, \text{ No load}$ | 25°C | | 1.7 | 2.6 | mA |
| | | Full range | | | 2.6 | |

* On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202M operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202M | | | UNIT |
|---|--|------------|----------|-----|-----|------------------------------|
| | | | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | | 1.6 | 2.5 | $\text{V}/\mu\text{s}$ |
| | | Full range | | 0.9 | | |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | 25°C | | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| | $f = 1\ \text{kHz}$ | 25°C | | 8 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\ \text{Hz}$ | 25°C | | 0.5 | | μV |
| | $f = 0.1\text{ to }10\ \text{Hz}$ | 25°C | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | | 1.9 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$ | 25°C | | 47° | | |

† Full range is -55°C to 125°C .



TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

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TLC2202M electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AM | | | TLC2202BM | | | UNIT |
|---|--|------------|-----------|--------|----------|-----------|-------------|-------------------------|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0, R_S = 50\ \Omega$ | 25°C | 80 | 500 | | 80 | 500 | μV | |
| | | Full range | | | 750 | | 750 | | |
| α_{VIO} Temperature coefficient of input offset voltage | | Full range | 0.5 | | | 0.5 | | | $\mu\text{V}/^\circ\text{C}$ |
| Input offset voltage long-term drift (see Note 4) | | 25°C | 0.001 | 0.005* | | 0.001 | 0.005* | $\mu\text{V}/\text{mo}$ | |
| I_{IO} Input offset current | | 25°C | 0.5 | 60 | | 0.5 | 60 | pA | |
| | | Full range | | | 500 | | 500 | | |
| I_{IB} Input bias current | 25°C | 1 | 60 | | 1 | 60 | pA | | |
| | Full range | | | 500 | | 500 | | | |
| V_{ICR} Common-mode input voltage range | $R_S = 50\ \Omega$ | Full range | 0 to 2.7 | | 0 to 2.7 | | V | | |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | 25°C | 4.7 | 4.8 | | 4.7 | 4.8 | V | |
| | | Full range | 4.7 | | | 4.7 | | | |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | 25°C | | 0 | 50 | | 0 | mV | |
| | | Full range | | | 50 | | 50 | | |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$ | 25°C | 150 | 315 | | 150 | 315 | V/mV | |
| | | Full range | 75 | | | 75 | | | |
| | $V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$ | 25°C | 25 | 55 | | 25 | 55 | | |
| | | Full range | 10 | | | 10 | | | |
| CMRR Common-mode rejection ratio | $V_O = 0, V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$ | 25°C | 75 | 110 | | 75 | 110 | dB | |
| | | Full range | 75 | | | 75 | | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$) | $V_{DD} = 4.6\ \text{V to } 16\ \text{V}$ | 25°C | 80 | 110 | | 80 | 110 | dB | |
| | | Full range | 80 | | | 80 | | | |
| I_{DD} Supply current | $V_O = 2.5\ \text{V}, \text{ No load}$ | 25°C | | 1.7 | 2.6 | | 1.7 | mA | |
| | | Full range | | | 2.6 | | 2.6 | | |

*On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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TLC2202M operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

| PARAMETER | TEST CONDITIONS | T_A † | TLC2202AM | | | TLC2202BM | | | UNIT |
|--|--|------------|-----------|-----|-----|-----------|-----|-----|------------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 1.6 | 2.5 | | 1.6 | 2.5 | | $\text{V}/\mu\text{s}$ |
| | | Full range | 0.9 | | | 1.1 | | | |
| V_n Equivalent input noise voltage (see Note 5) | $f = 10\text{ Hz}$ | 25°C | | 18 | 35* | | 18 | 30* | $\text{nV}/\sqrt{\text{Hz}}$ |
| | $f = 1\text{ kHz}$ | 25°C | | 8 | 15* | | 8 | 12* | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | | 0.5 | | | 0.5 | | μV |
| | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | | 0.7 | | | 0.7 | | |
| I_n Equivalent input noise current | | 25°C | | 0.6 | | | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ |
| Gain-bandwidth product | $f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 1.9 | | | 1.9 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | | 47° | | | 47° | | |

* On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C

NOTE 5: This parameter is tested on a sample basis for the TLC2202A and on all devices for the TLC2202B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.

TLC2202Y electrical characteristics, $V_{DD} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | TLC2202Y | | | UNIT |
|---|--|----------|-------|-----|-------------------------|
| | | MIN | TYP | MAX | |
| V_{IO} Input offset voltage | $V_{IC} = 0$, $R_S = 50\ \Omega$ | | 100 | | μV |
| Input offset voltage long-term drift (see Note 4) | | | 0.001 | | $\mu\text{V}/\text{mo}$ |
| I_{IO} Input offset current | | | 0.5 | | pA |
| I_{IB} Input bias current | | | 1 | | pA |
| V_{OH} Maximum high-level output voltage | $R_L = 10\ \text{k}\Omega$ | | 4.8 | | V |
| V_{OL} Maximum low-level output voltage | $I_O = 0$ | | 0 | | mV |
| A_{VD} Large-signal differential voltage amplification | $V_O = 1\ \text{V to } 4\ \text{V}$, $R_L = 500\ \Omega$ | | 315 | | V/mV |
| | $V_O = 1\ \text{V to } 4\ \text{V}$, $R_L = 10\ \Omega$ | | 55 | | |
| CMRR Common-mode rejection ratio | $V_O = 0$, V_{ICRmin} , $R_S = 50\ \Omega$ | | 110 | | dB |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DCC}/\Delta V_{IO}$) | $V_{DD} = 4.6\ \text{ to } 16\ \text{V}$ | | 110 | | dB |
| I_{DD} Supply current | $V_O = 2.5\ \text{V}$, No load | | 1.7 | | mA |

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLC2202Y operating characteristics at $V_{DD} = 5\ \text{V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | TEST CONDITIONS | TLC2202Y | | | UNIT |
|---|---|----------|------------|-----|------------------------------|
| | | MIN | TYP | MAX | |
| SR Positive slew rate at unity gain | $V_O = 0.5\ \text{V to } 2.5\ \text{V}$, $R_L = 10\ \text{k}\Omega$, $C_L = 100\ \text{pF}$ | | 2.5 | | $\text{V}/\mu\text{s}$ |
| V_n Equivalent input noise voltage | $f = 10\ \text{Hz}$ | | 18 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| | $f = 10\ \text{kHz}$ | | 8 | | |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\ \text{ to } 1\ \text{Hz}$ | | 0.5 | | μV |
| | $f = 0.1\ \text{ to } 10\ \text{Hz}$ | | 0.7 | | |
| I_n Equivalent input noise current | | | 0.6 | | $\text{pA}/\sqrt{\text{Hz}}$ |
| B_1 Gain-bandwidth product | $f = 10\ \text{kHz}$, $C_L = 100\ \text{pF}$, $R_L = 10\ \text{k}\Omega$ | | 1.9 | | MHz |
| ϕ_m Phase margin at unity gain | $R_L = 10\ \text{k}\Omega$, $C_L = 100\ \text{pF}$ | | 47° | | |

TLC220x, TLC220xA, TLC220xB, TLC220xY

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PARAMETER MEASUREMENT INFORMATION

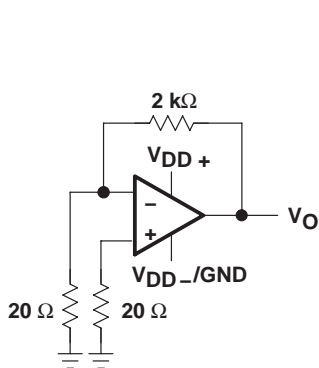
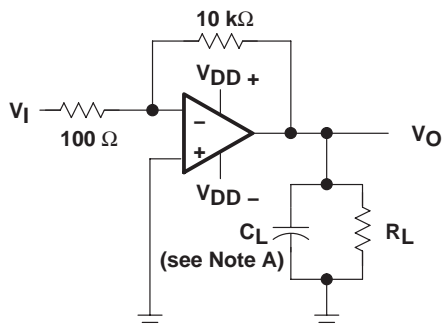
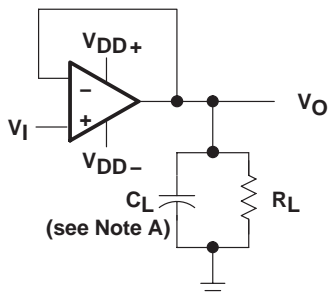


Figure 1. Noise-Voltage Test Circuit



NOTE A: C_L includes fixture capacitance.

Figure 2. Phase-Margin Test Circuit



NOTE A: C_L includes fixture capacitance.

Figure 3. Slew-Rate Test Circuit

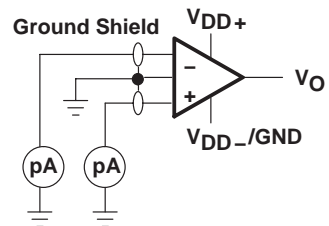


Figure 4. Input-Bias and Offset-Current Test Circuit

typical values

Typical values presented in this data sheet represent the median (50% point) of device parametric performance.

input bias and offset current

At the picoamp bias current level of the TLC220x, TLC220xA, and TLC220xB, accurate measurement of the bias current becomes difficult. Not only does this measurement require a picoammeter, but test socket leakages can easily exceed the actual device bias currents. To measure these small currents, Texas Instruments uses a two-step process. The socket leakage is measured using picoammeters with bias voltages applied but with no device in the socket. The device is then inserted in the socket, and a second test measuring both the socket leakage and the device input bias current is performed. The two measurements are then subtracted algebraically to determine the bias current of the device.

noise

Texas Instruments offers automated production noise testing to meet individual application requirements. Noise voltage at $f = 10 \text{ Hz}$ and $f = 1 \text{ kHz}$ is 100% tested on every TLC2201B device, while lot sample testing is performed on the TLC220xA. For other noise requirements, please contact the factory.

TYPICAL CHARACTERISTICS

Table of Graphs

| | | FIGURE |
|-------------|---|------------------------------|
| V_{IO} | Input offset voltage | Distribution 5, 6 |
| I_{IB} | Input bias current | vs Common-mode input voltage |
| | | vs Free-air temperature |
| V_{OM} | Maximum peak output voltage | vs Output current |
| | | vs Free-air temperature |
| $V_{O(PP)}$ | Maximum peak-to-peak output voltage | vs Frequency 11 |
| V_{OH} | High-level output voltage | vs Frequency |
| | | vs High-level output current |
| | | vs Free-air temperature |
| V_{OL} | Low-level output voltage | vs Low-level output current |
| | | vs Free-air temperature |
| A_{VD} | Large-signal differential voltage amplification | vs Frequency |
| | | vs Free-air temperature |
| I_{OS} | Short-circuit output current | vs Supply voltage |
| | | vs Free-air temperature |
| $CMRR$ | Common-mode rejection ratio | vs Frequency 21 |
| I_{DD} | Supply current | vs Supply voltage |
| | | vs Free-air temperature |
| | Pulse response | Small signal |
| | | Large signal |
| SR | Slew rate | vs Supply voltage |
| | | vs Free-air temperature |
| | Noise voltage (referred to input) | 0.1 to 1 Hz |
| | | 0.1 to 10 Hz |
| | Gain-bandwidth product | vs Supply voltage |
| | | vs Free-air temperature |
| ϕ_m | Phase margin | vs Supply voltage |
| | | vs Free-air temperature |
| | Phase shift | vs Frequency 17 |

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TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLC2201
 INPUT OFFSET VOLTAGE**

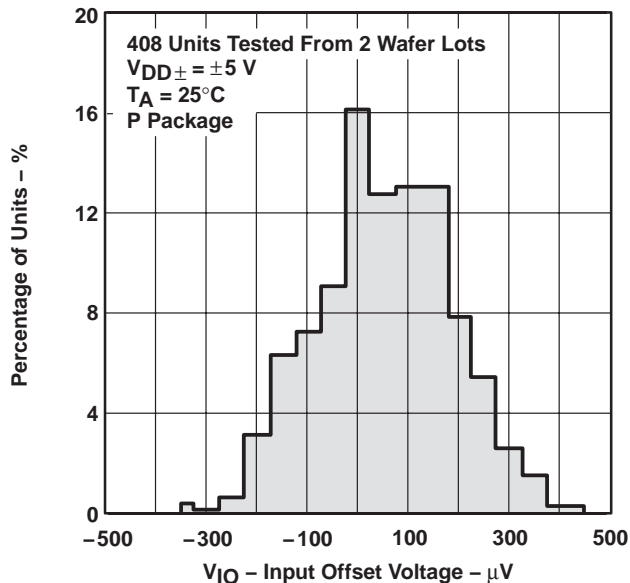


Figure 5

**TLC2202
 DISTRIBUTION OF
 INPUT OFFSET VOLTAGE**

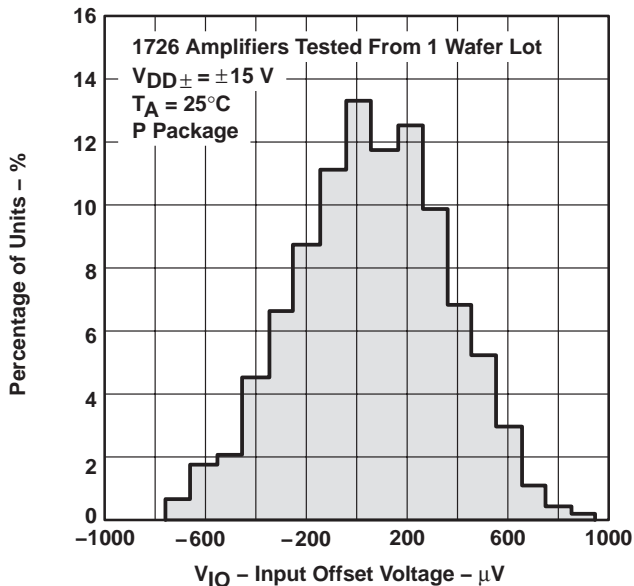


Figure 6

**INPUT BIAS CURRENT
 VS
 COMMON-MODE INPUT VOLTAGE**

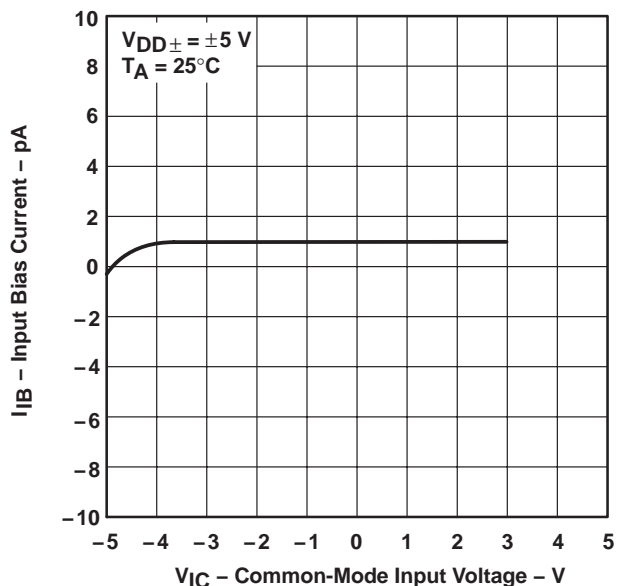


Figure 7

**INPUT BIAS CURRENT†
 VS
 FREE-AIR TEMPERATURE**

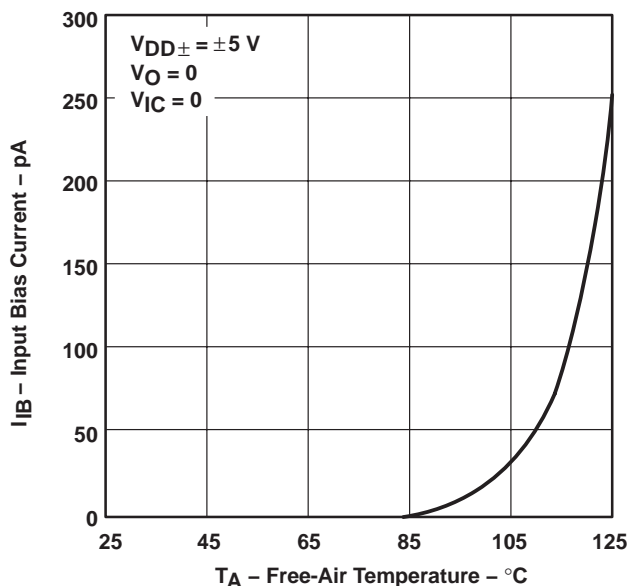


Figure 8

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



TYPICAL CHARACTERISTICS

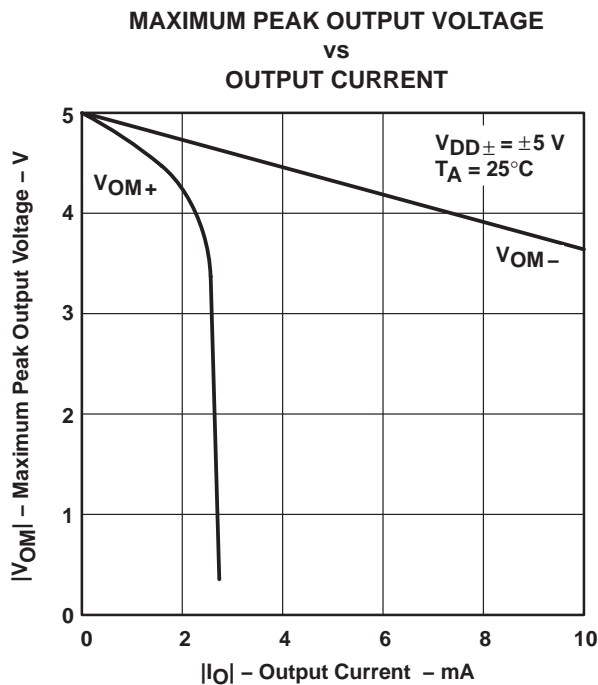


Figure 9

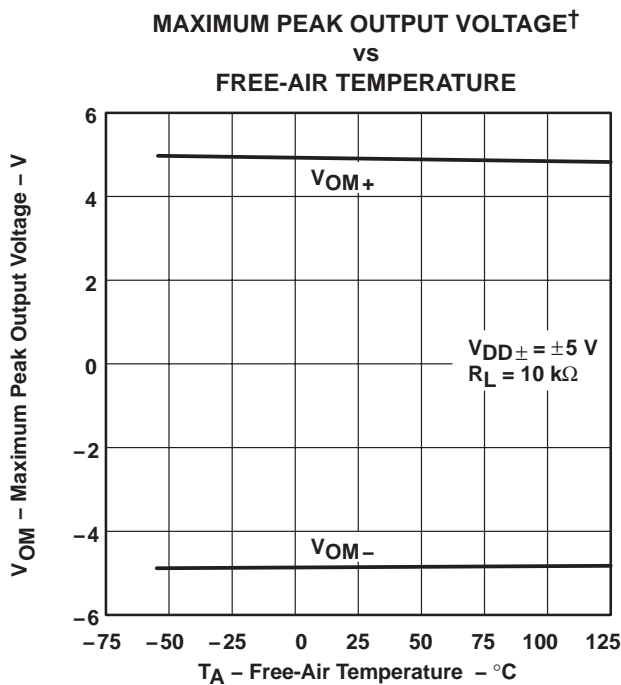


Figure 10

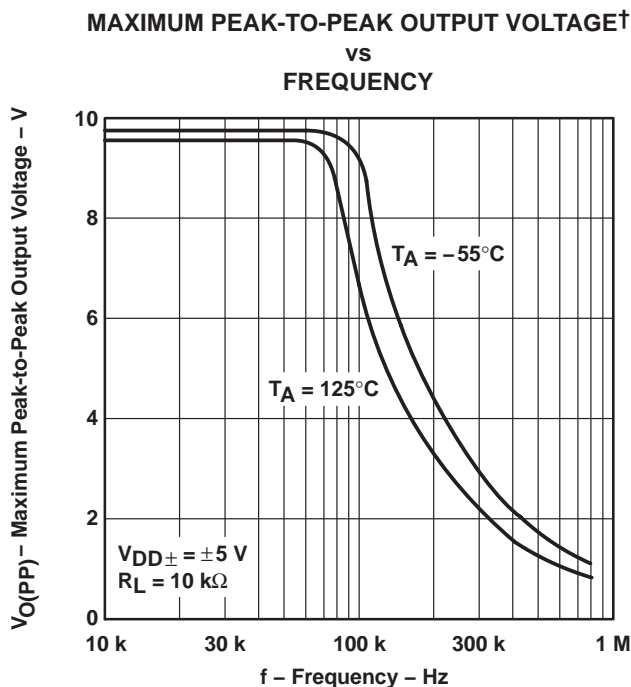


Figure 11

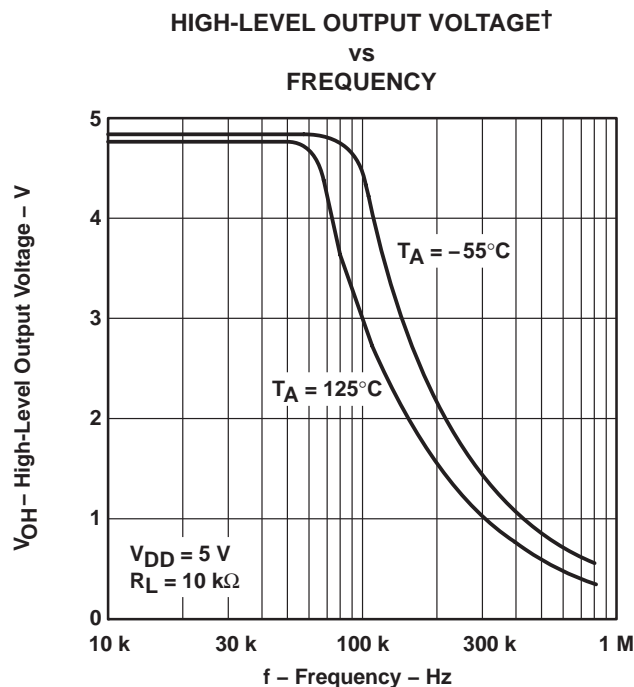
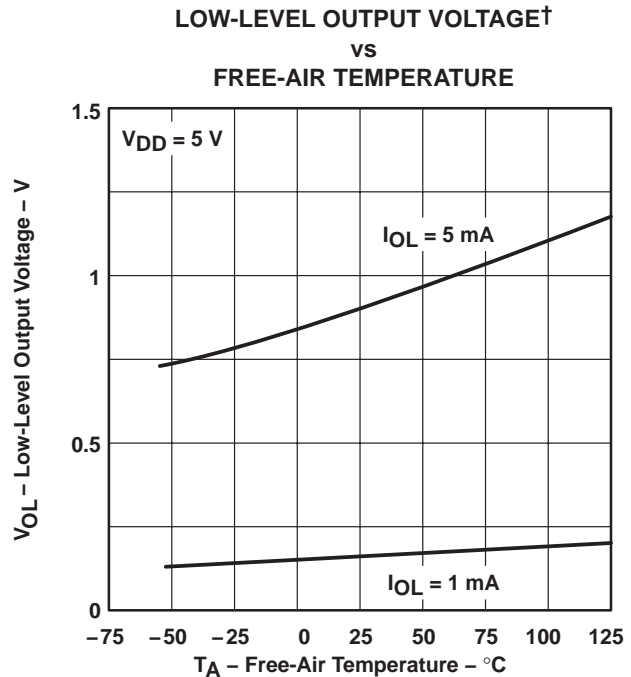
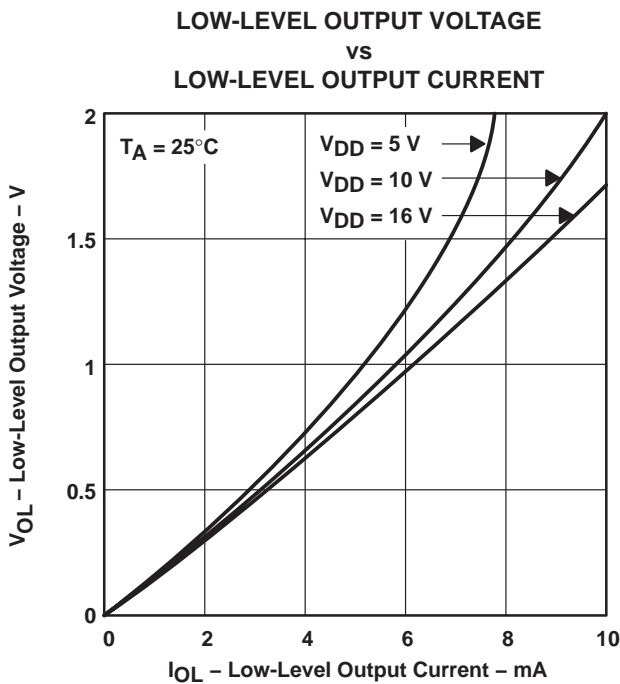
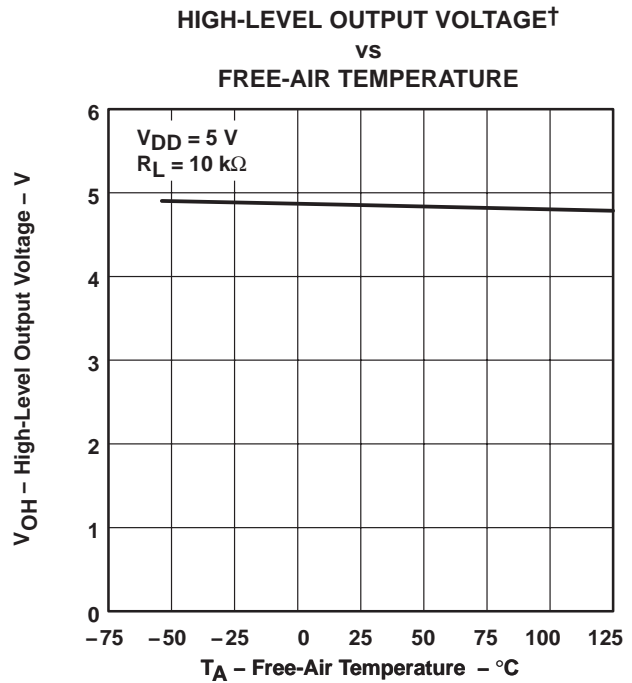
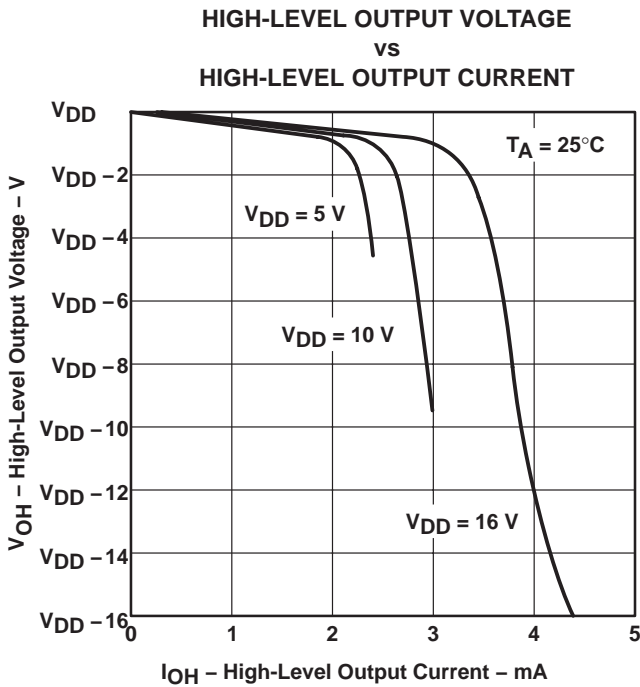


Figure 12

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

TYPICAL CHARACTERISTICS



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

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

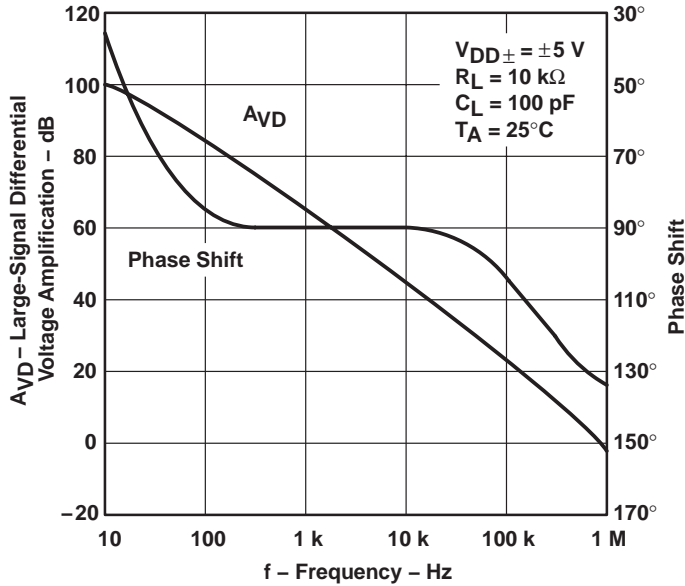


Figure 17

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

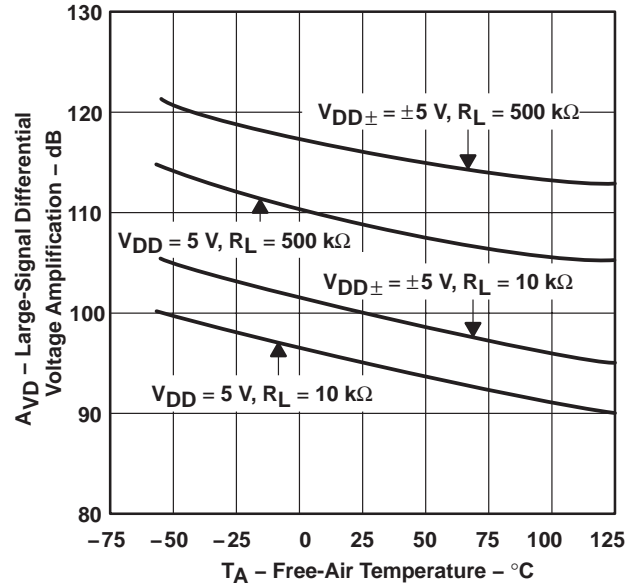


Figure 18

SHORT-CIRCUIT OUTPUT CURRENT vs SUPPLY VOLTAGE

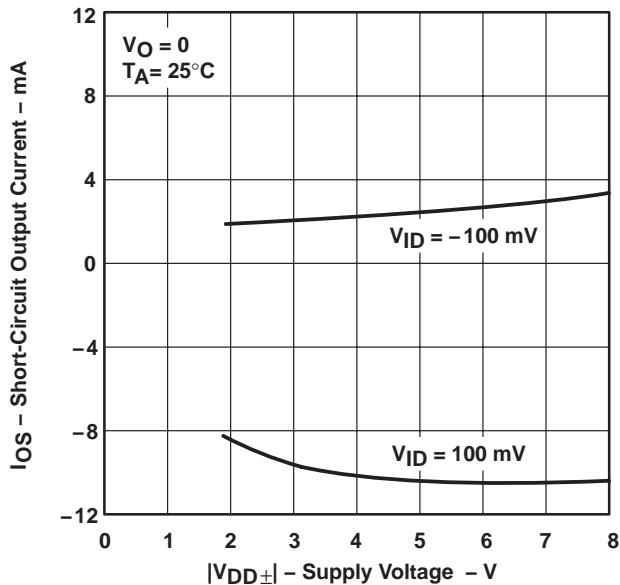


Figure 19

SHORT-CIRCUIT OUTPUT CURRENT† vs FREE-AIR TEMPERATURE

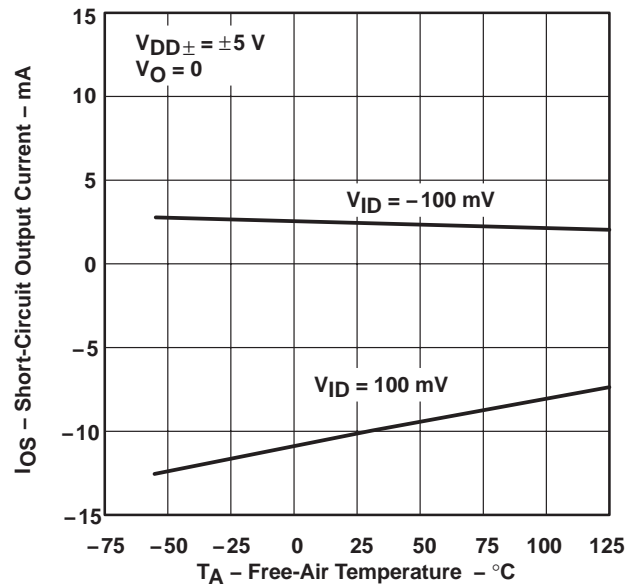


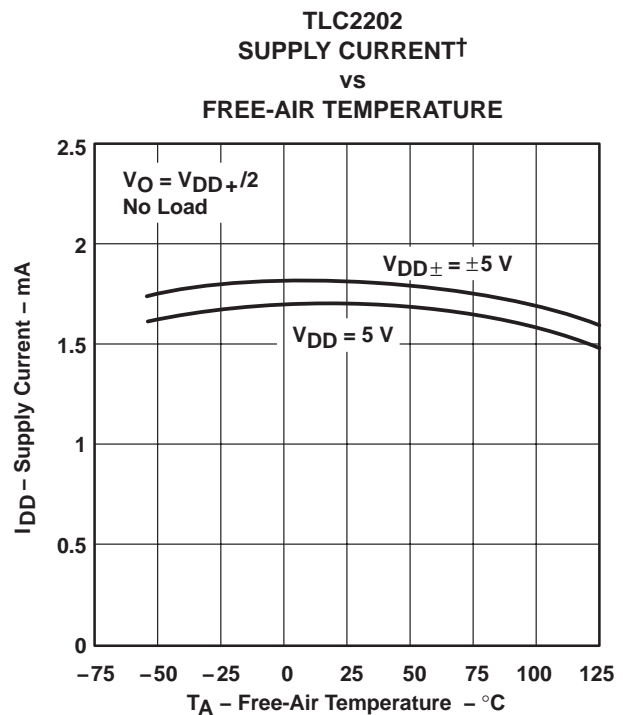
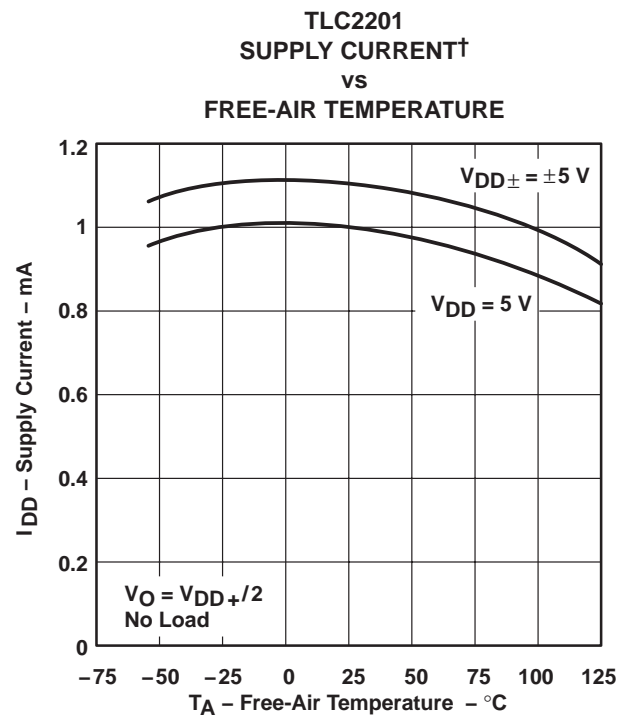
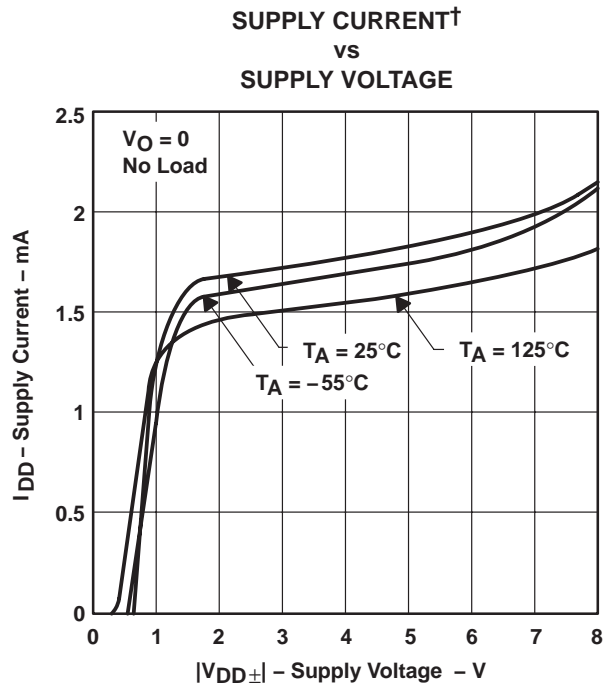
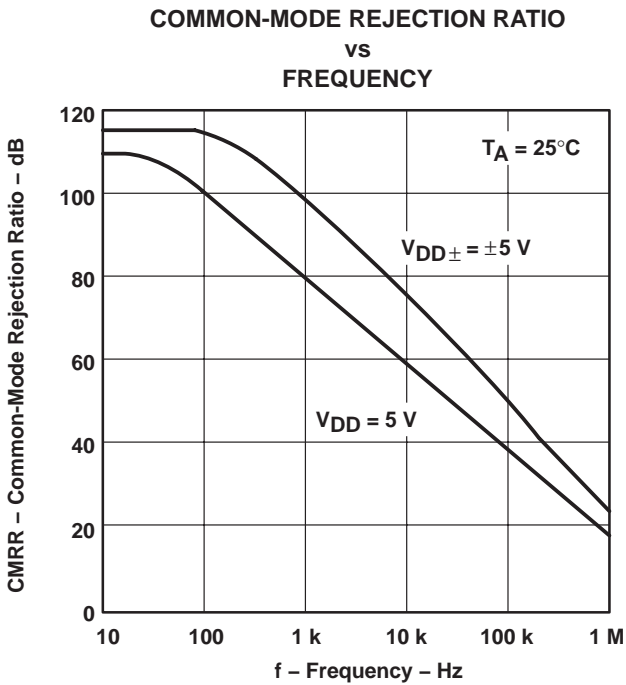
Figure 20

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

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TYPICAL CHARACTERISTICS



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

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER
 SMALL-SIGNAL
 PULSE RESPONSE

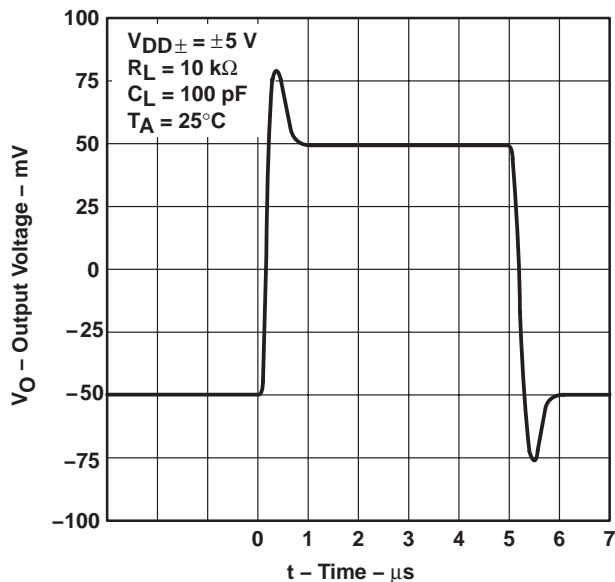


Figure 25

VOLTAGE-FOLLOWER
 SMALL-SIGNAL
 PULSE RESPONSE

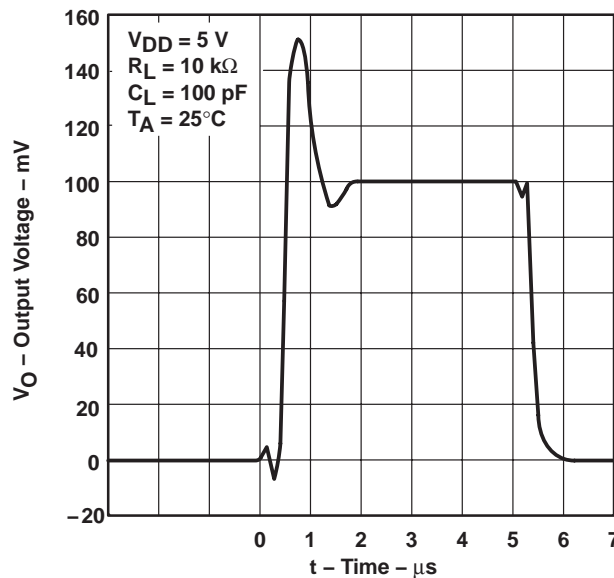


Figure 26

VOLTAGE-FOLLOWER
 LARGE-SIGNAL
 PULSE RESPONSE

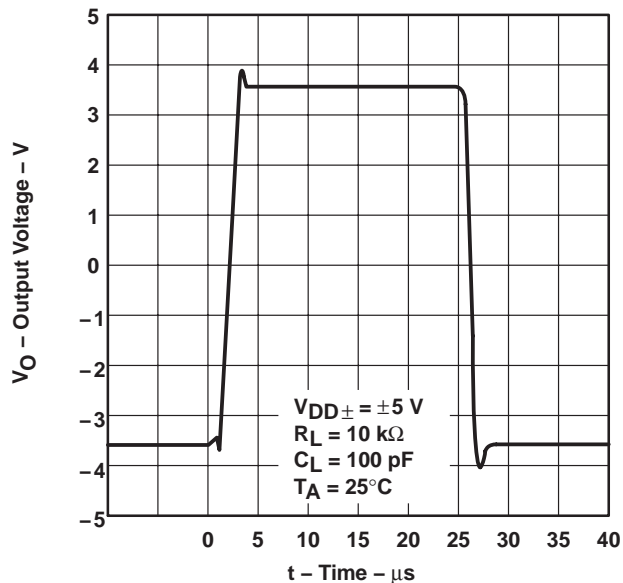


Figure 27

VOLTAGE-FOLLOWER
 LARGE-SIGNAL
 PULSE RESPONSE

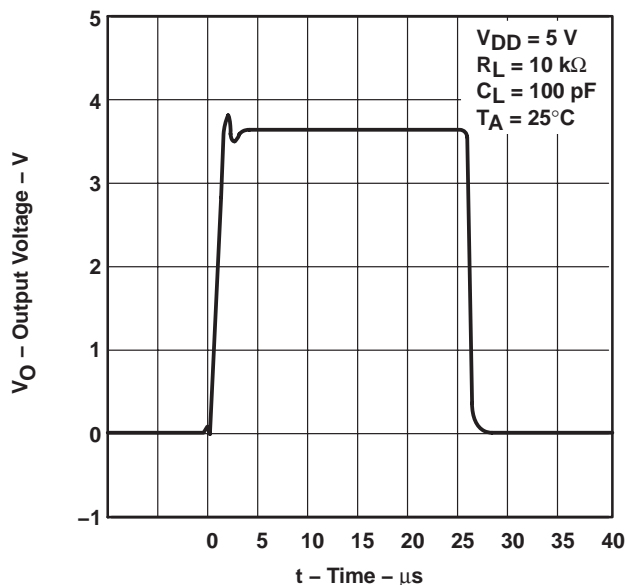


Figure 28

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TYPICAL CHARACTERISTICS

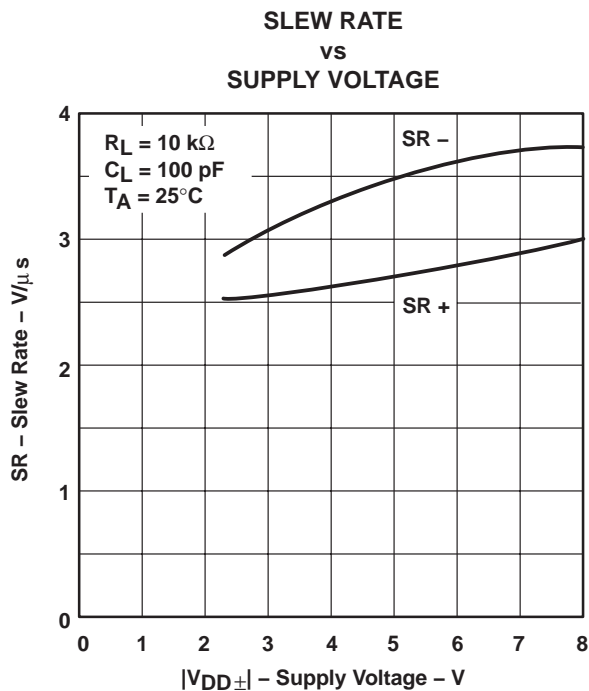


Figure 29

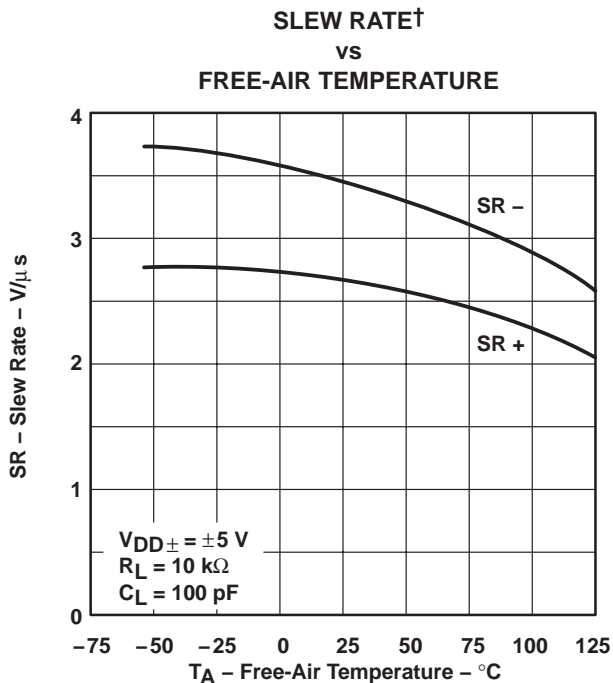


Figure 30

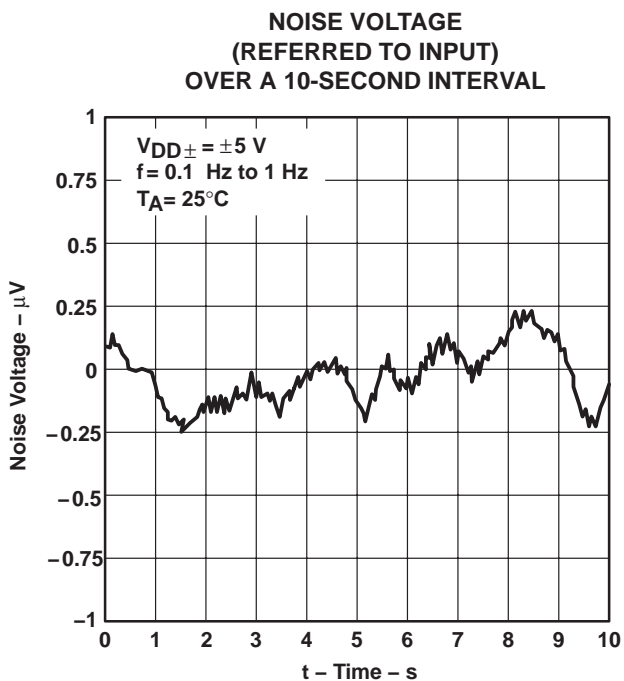


Figure 31

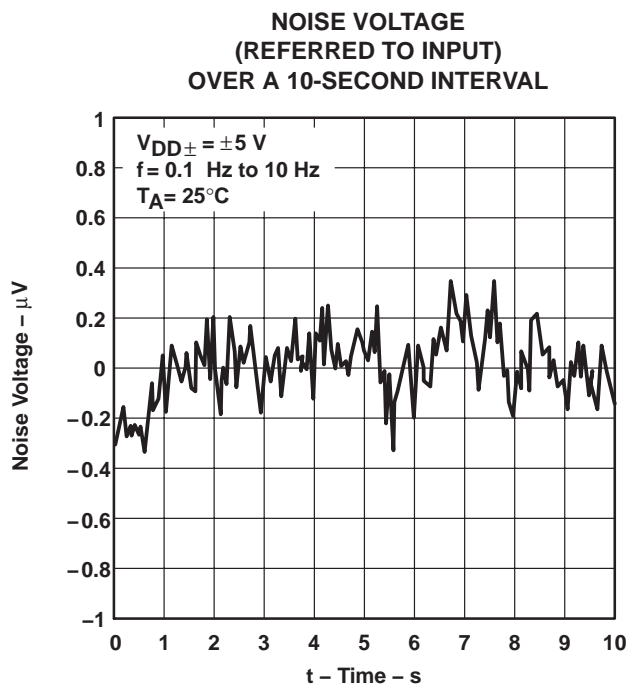


Figure 32

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

TYPICAL CHARACTERISTICS

TLC2201
GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

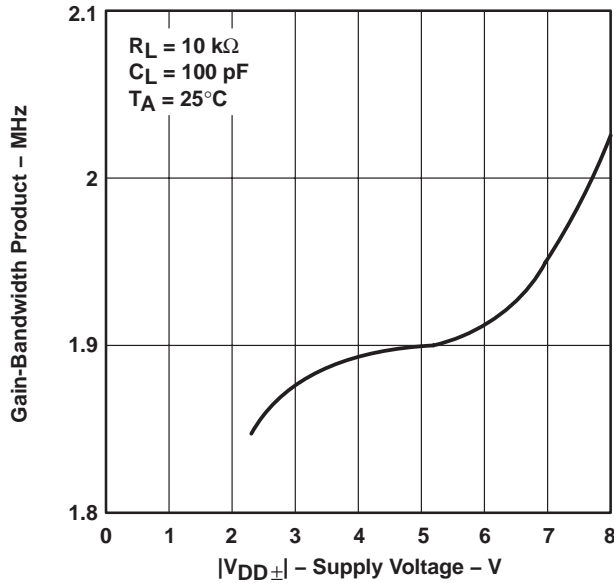


Figure 33

TLC2202
GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

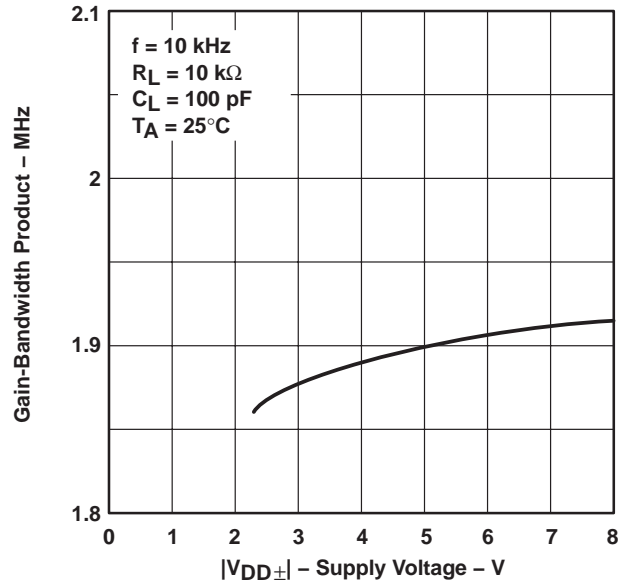


Figure 34

GAIN-BANDWIDTH PRODUCT†
vs
FREE-AIR TEMPERATURE

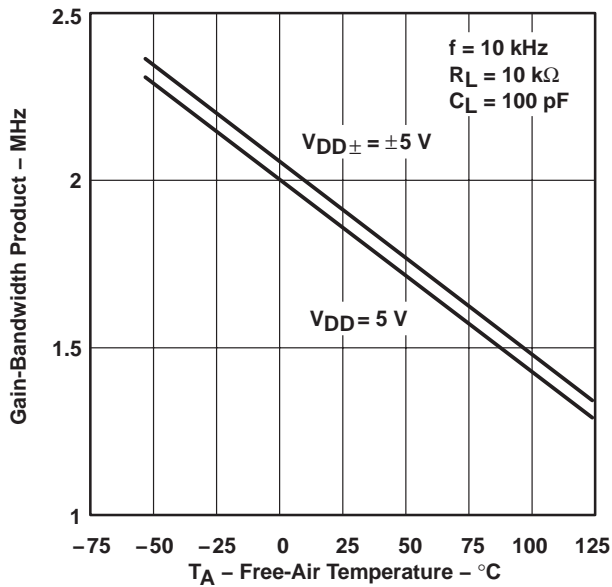


Figure 35

TLC2201
PHASE MARGIN
vs
SUPPLY VOLTAGE

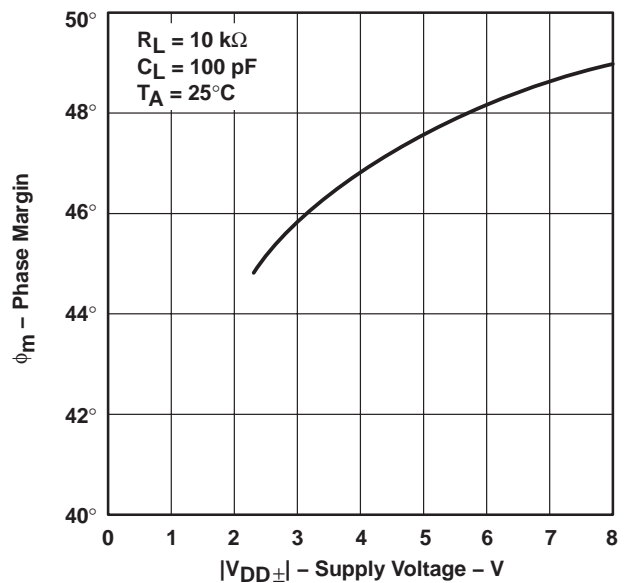


Figure 36

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

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查詢 TLC220 系列產品

TYPICAL CHARACTERISTICS

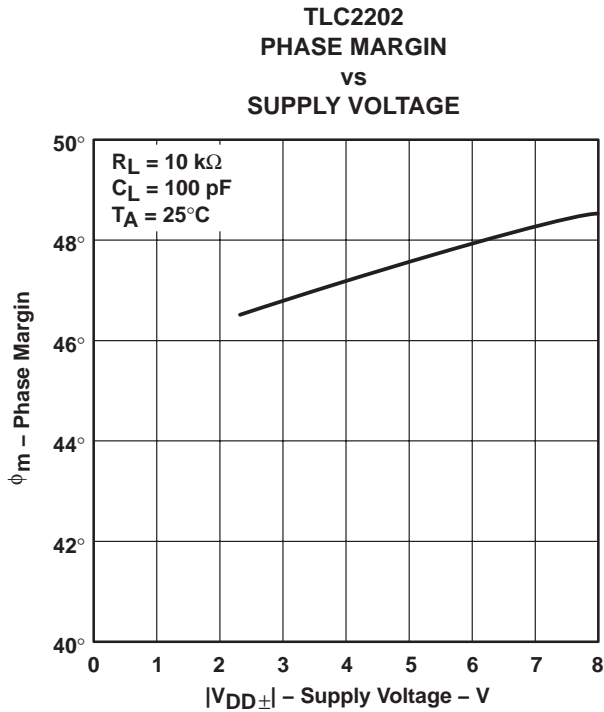


Figure 37

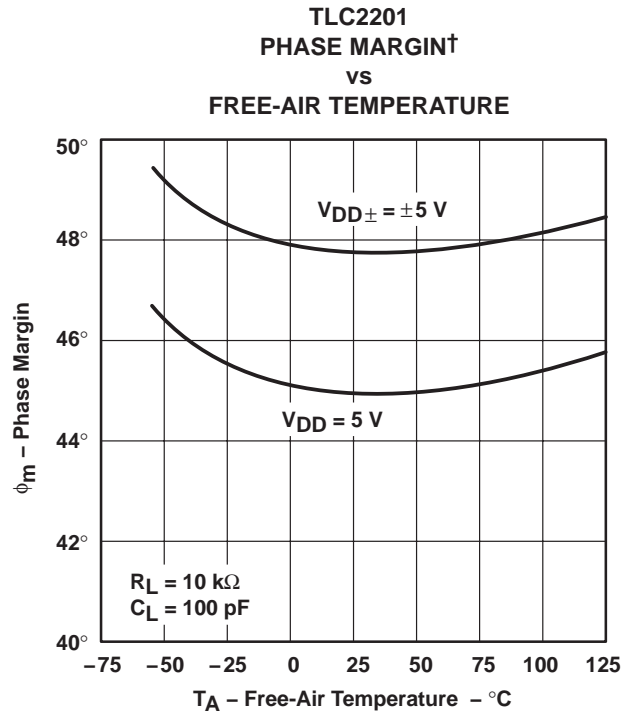


Figure 38

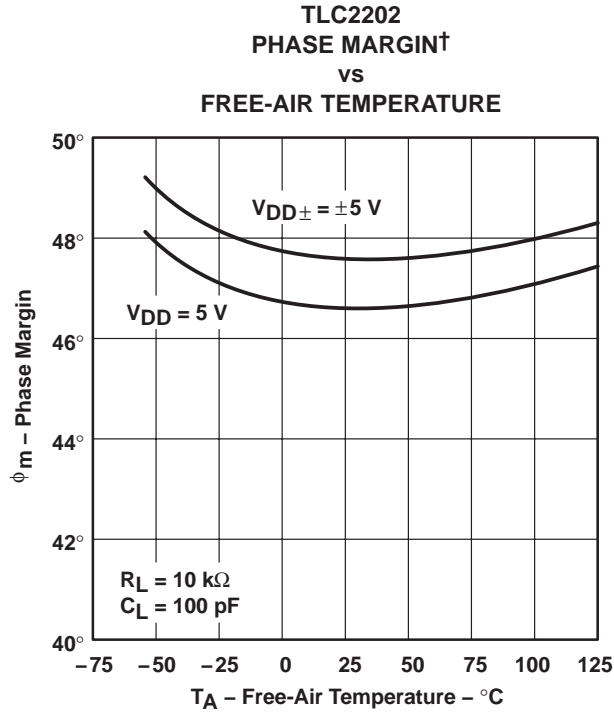


Figure 39

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

APPLICATION INFORMATION

latch-up avoidance

Because CMOS devices are susceptible to latch-up due to their inherent parasitic thyristors, the TLC220x, TLC220xA, and TLC220xB inputs and outputs are designed to withstand –100-mA surge currents without sustaining latch-up; however, techniques reducing the chance of latch-up should be used whenever possible. Internal protection diodes should not be forward biased in normal operation. Applied input and output voltages should not exceed the supply voltage by more than 300 mV. Care should be exercised when using capacitive coupling on pulse generators. Supply transients should be shunted by the use of decoupling capacitors (0.1 μ F typical) located across the supply rails as close to the device as possible.

electrostatic discharge protection

These devices use internal ESD-protection circuits that prevent functional failures at voltages at or below 2000 V. Care should be exercised in handling these devices as exposure to ESD may result in degradation of the device parametric performance.

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 40 were generated using the TLC220x typical electrical and operating characteristics at 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).

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PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-9088201M2A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| 5962-9088201MPA | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| 5962-9088202M2A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| 5962-9088202MPA | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| 5962-9088203Q2A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| 5962-9088203QPA | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| 5962-9088204Q2A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| 5962-9088204QPA | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2201AMD | ACTIVE | SOIC | D | 8 | 75 | TBD | CU NIPDAU | Level-1-220C-UNLIM |
| TLC2201AMDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201AMFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| TLC2201AMJG | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2201AMJGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2201AMP | OBSOLETE | PDIP | P | 8 | | TBD | Call TI | Call TI |
| TLC2201CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201CDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201CDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2201CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2201CPSR | OBSOLETE | SO | PS | 8 | | TBD | Call TI | Call TI |
| TLC2201ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201IDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2201IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2201IPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2201MFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| TLC2201MJGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2202AMFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| TLC2202AMJG | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2202AMJGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2202CD | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| | | | | | | no Sb/Br) | | |
| TLC2202CDG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202CDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202CDRG4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2202CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2202CPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202CPSRG4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202ID | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202IDG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC2202IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2202IPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC2202MFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| TLC2202MJG | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |
| TLC2202MJGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 | N / A for Pkg Type |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

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

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

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

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

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

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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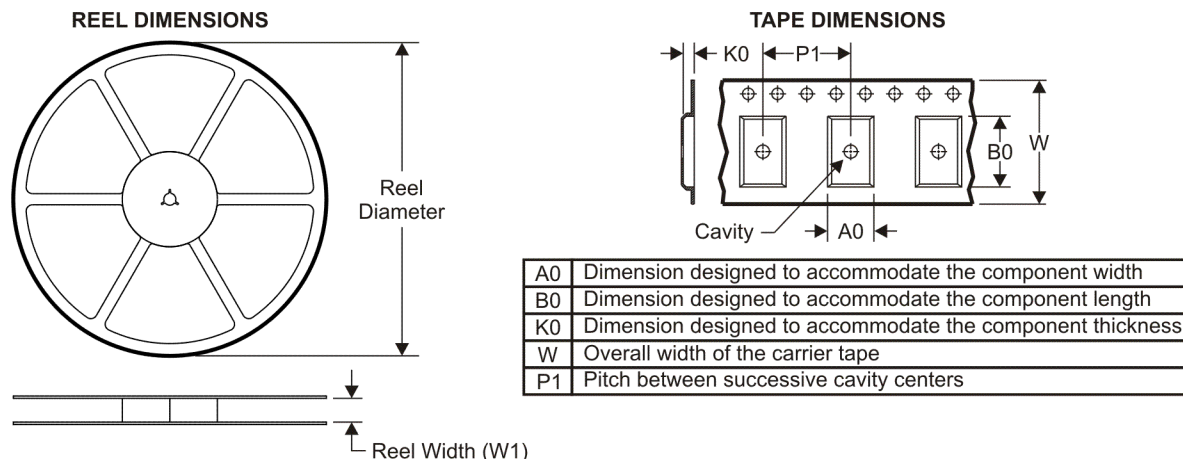
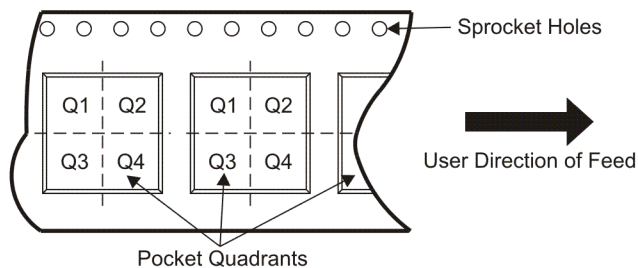
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OTHER QUALIFIED VERSIONS OF TLC2201, TLC2201AM, TLC2201M, TLC2202, TLC2202AM, TLC2202M :

- Catalog: [TLC2201A](#), [TLC2202A](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLC2201CDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TLC2201IDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TLC2202CDR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| TLC2202CPSR | SO | PS | 8 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

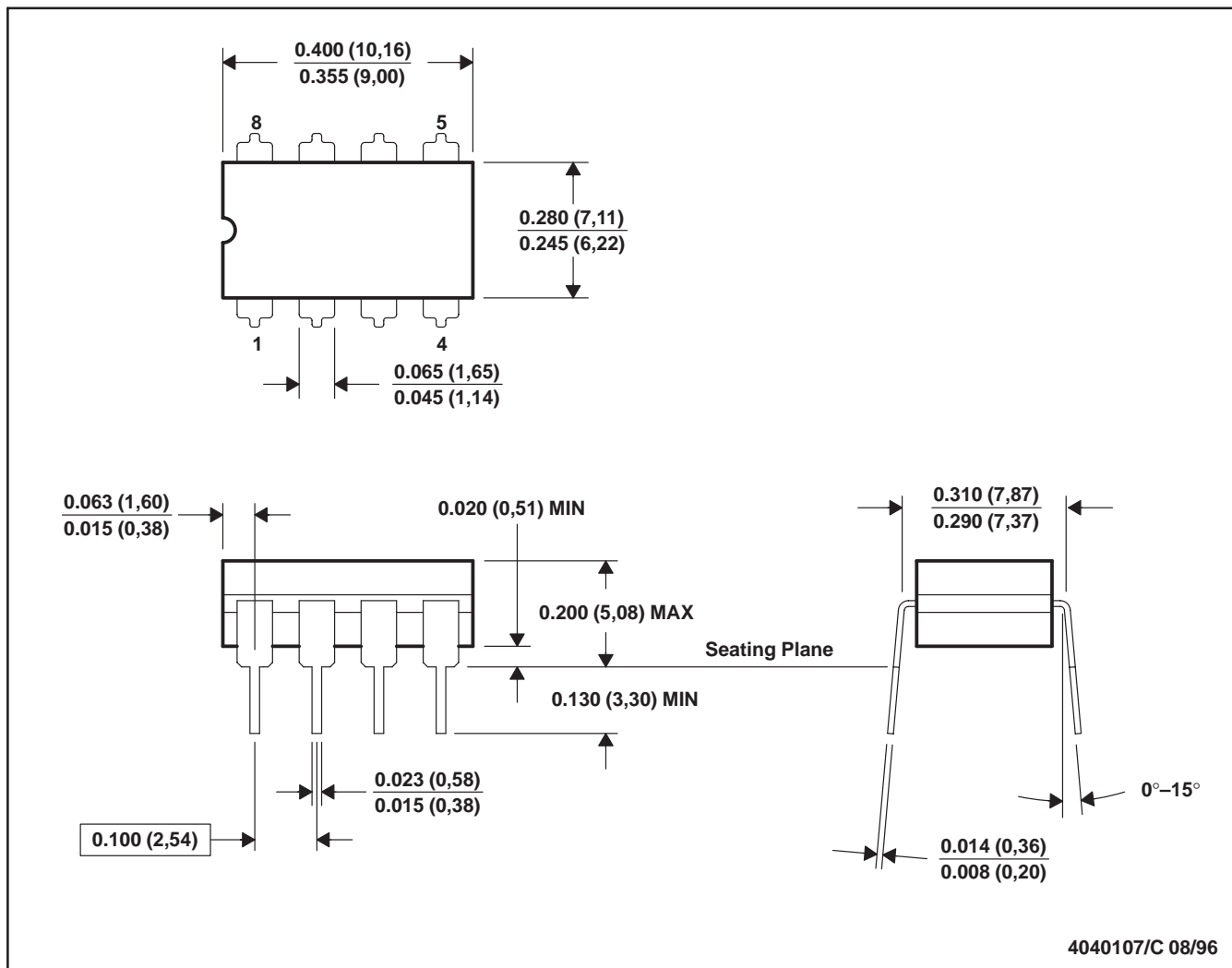


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLC2201CDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TLC2201IDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TLC2202CDR | SOIC | D | 14 | 2500 | 346.0 | 346.0 | 33.0 |
| TLC2202CPSR | SO | PS | 8 | 2000 | 346.0 | 346.0 | 33.0 |

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE

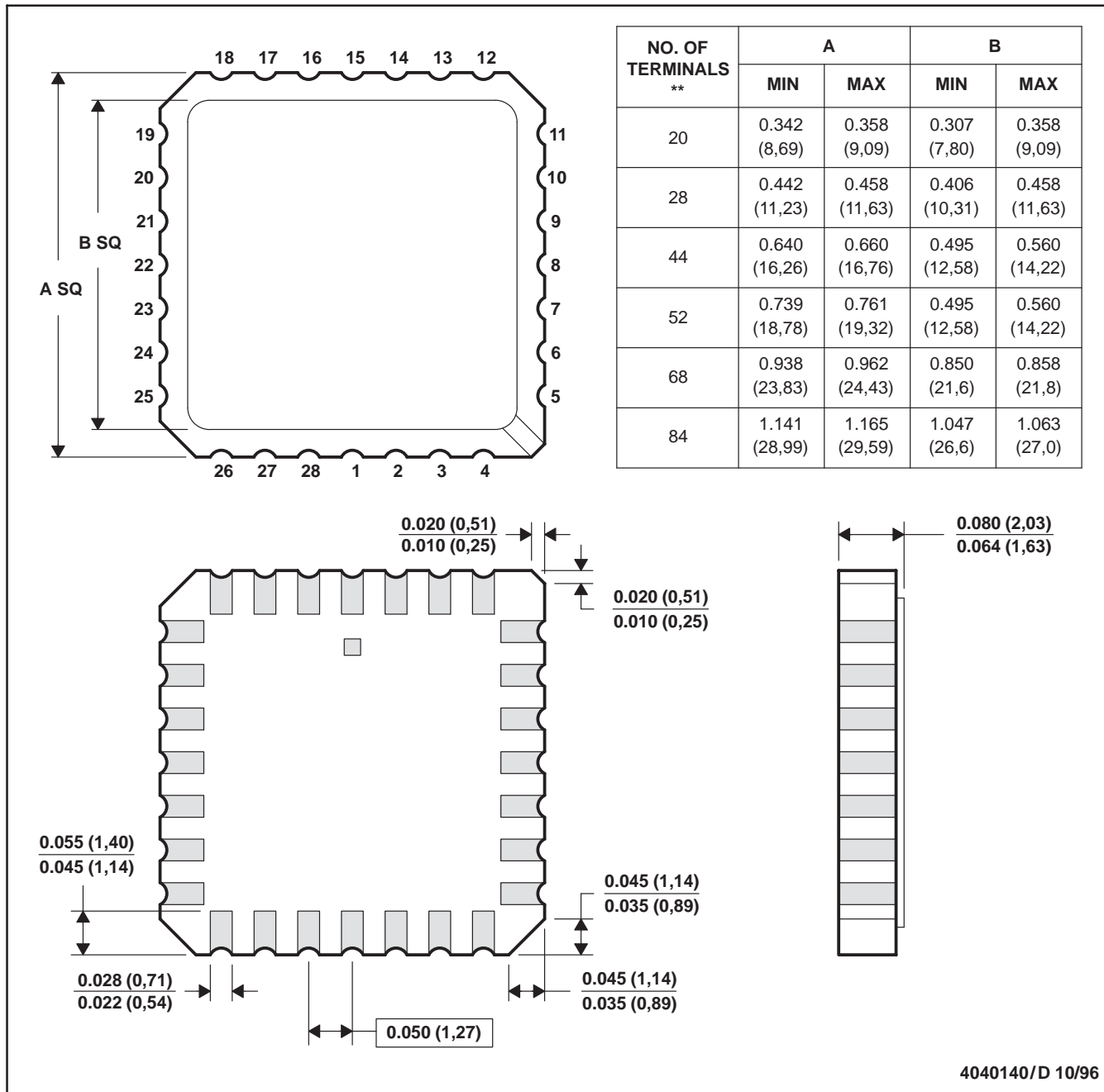


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification.
 E. Falls within MIL STD 1835 GDIP1-T8

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

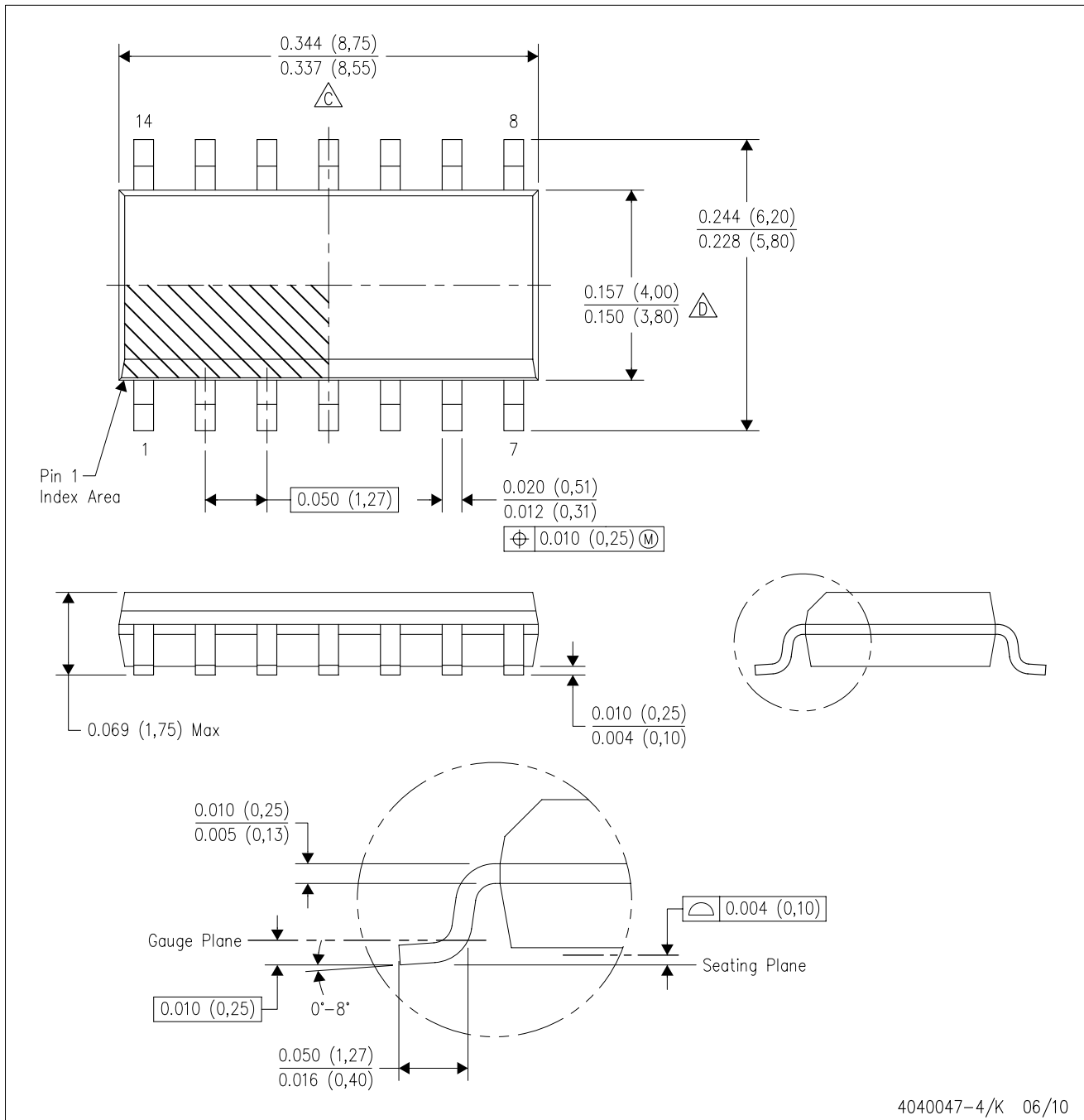


4040140/D 10/96

- 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 metal lid.
 - D. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

D (R-PDSO-G14)

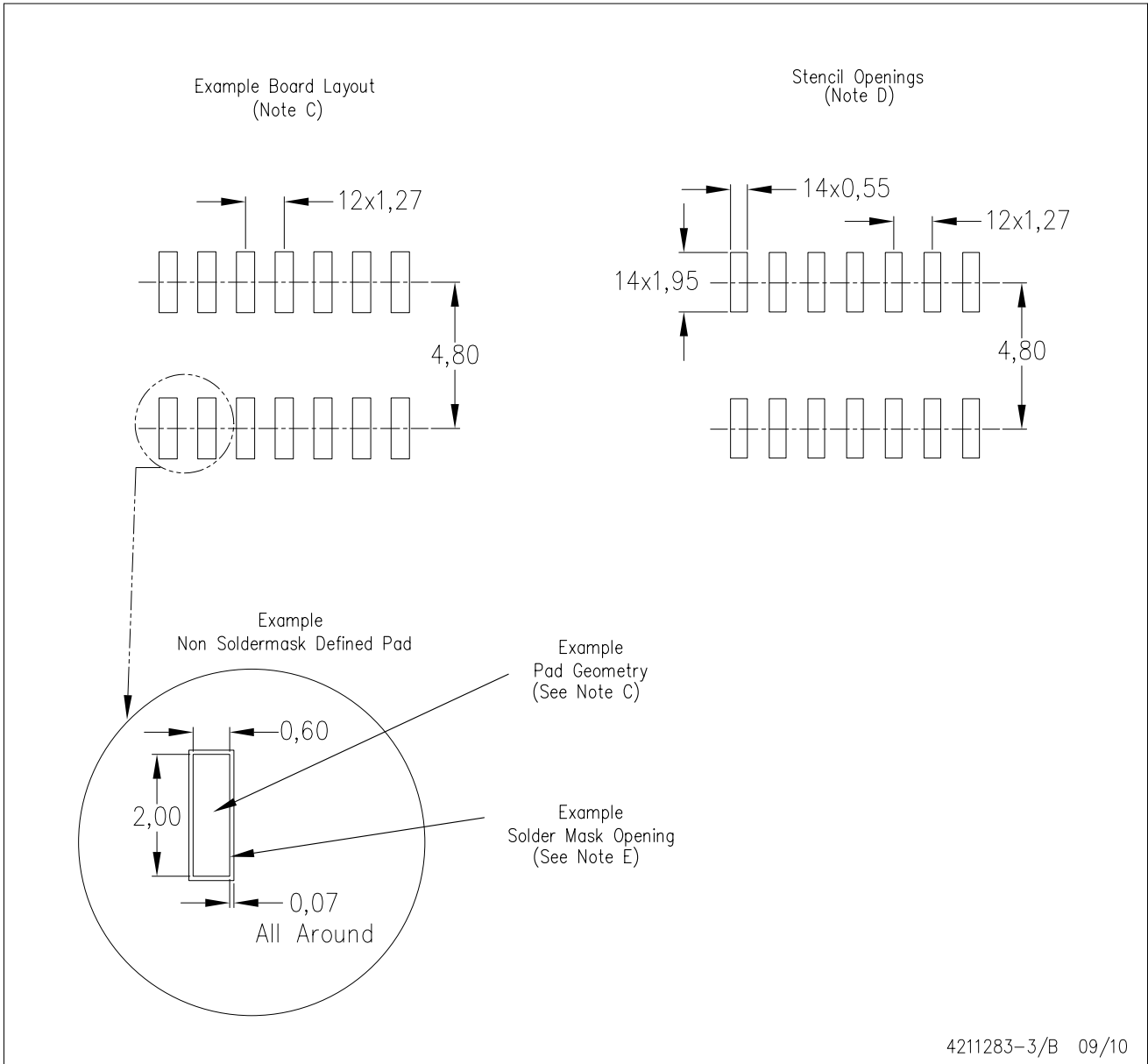
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G14)

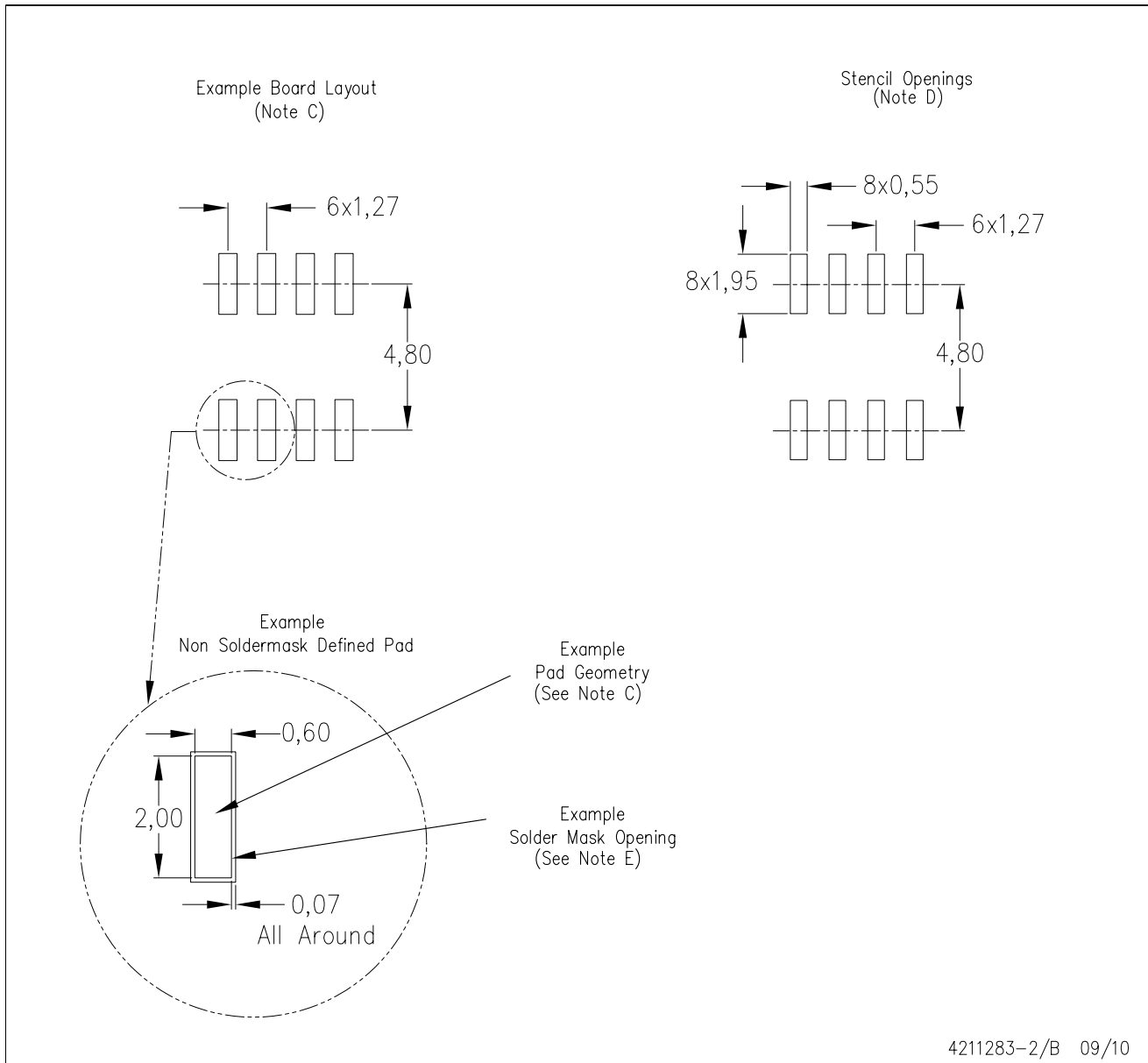
PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - 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.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE

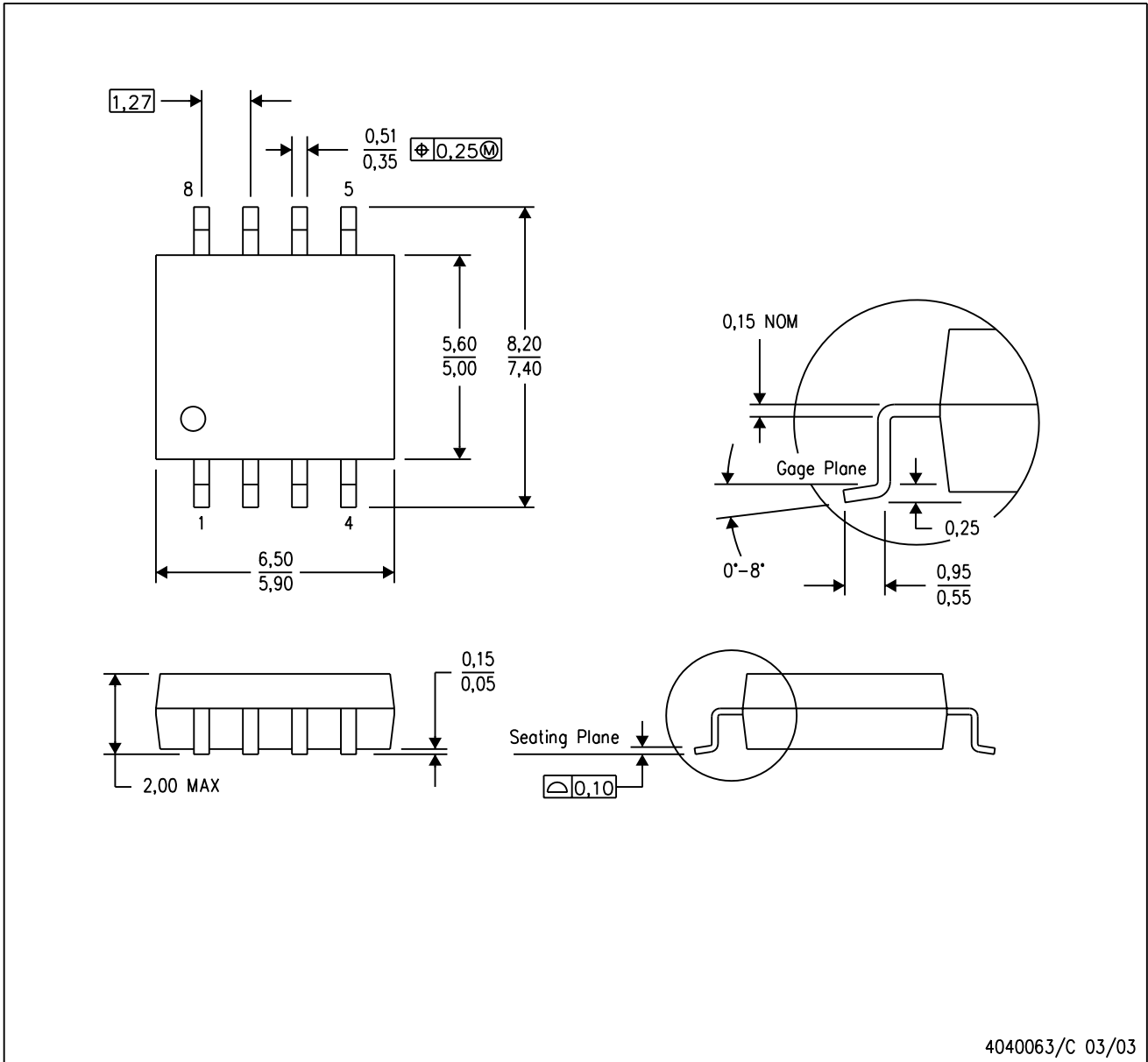


- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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| Power Mgmt | power.ti.com | Medical | www.ti.com/medical |
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