

- 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  $\mu\text{V}$  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

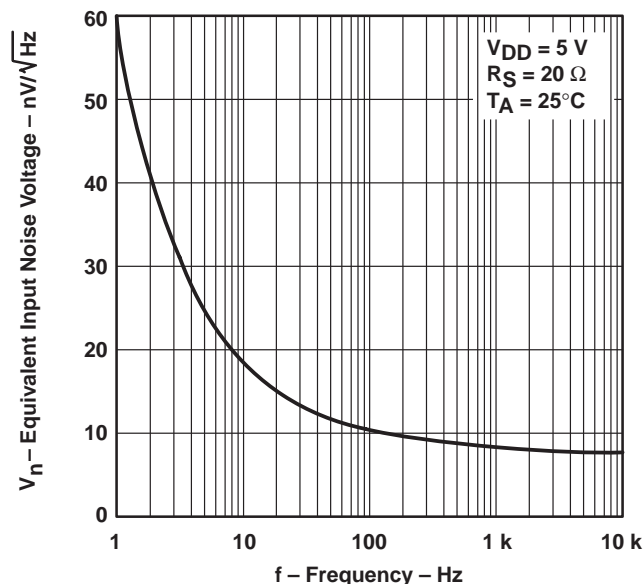
The TLC220x, TLC220xA, TLC220xB, and TLC220xY are precision, low-noise operational amplifiers using Texas Instruments Advanced LinCMOS™ process. These devices combine the noise performance of the lowest-noise JFET amplifiers with the dc precision available previously only in bipolar amplifiers. The Advanced 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  $-100\text{-mA}$  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  $0^\circ\text{C}$  to  $70^\circ\text{C}$ . The I-suffix devices are characterized for operation from  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ . The M-suffix devices are characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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.

Advanced LinCMOS is a trademark of Texas Instruments Incorporated.

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.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1997, Texas Instruments Incorporated

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

SLOS175 – FEBRUARY 1997

### TLC2201 AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	V <sub>n</sub> max f = 10 Hz AT 25°C	V <sub>n</sub> 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 200 μV 500 μV	35 nV/√Hz 30 nV/√Hz —	15 nV/√Hz 12 nV/√Hz —	TLC2201ACD TLC2201BCD TLC2201CD	—	—	TLC2201ACP TLC2201BCP TLC2201CP	TLC2201Y
–40°C to 85°C	200 μV 200 μV 500 μV	35 nV/√Hz 30 nV/√Hz —	15 nV/√Hz 12 nV/√Hz —	TLC2201AID TLC2201BID TLC2201ID	—	—	TLC2201AIP TLC2201BIP TLC2201IP	—
–55°C to 125°C	200 μV 200 μV 500 μV	35 nV/√Hz 30 nV/√Hz —	15 nV/√Hz 12 nV/√Hz —	TLC2201AMD TLC2201BMD TLC2201MD	TLC2201AMFK TLC2201BMFK TLC2201MFK	TLC2201AMJG TLC2201BMJG TLC2201MJG	TLC2201AMP TLC2201BMP 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 <sub>A</sub>	V <sub>IO</sub> max AT 25°C	V <sub>n</sub> max f = 10 Hz AT 25°C	V <sub>n</sub> 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	500 μV 500 μV 1 mV	30 nV/√Hz 35 nV/√Hz —	12 nV/√Hz 15 nV/√Hz —	TLC2202BCD TLC2202ACD TLC2202CD	— — —	— — —	TLC2202BCP TLC2202ACP TLC2202CP	TLC2202Y
–40°C to 85°C	500 μV 500 μV 1 mV	30 nV/√Hz 35 nV/√Hz —	12 nV/√Hz 15 nV/√Hz —	TLC2202BID TLC2202AID TLC2202ID	— — —	— — —	TLC2202BIP TLC2202AIP TLC2202IP	—
–55°C to 125°C	500 μV 500 μV 1 mV	30 nV/√Hz 35 nV/√Hz —	12 nV/√Hz 15 nV/√Hz —	TLC2202BMD TLC2202AMD TLC2202MD	TLC2202BMFK TLC2202AMFK TLC2202MFK	TLC2202BMJG TLC2202AMJG TLC2202MJG	TLC2202BMP TLC2202AMP TLC2202MP	—

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

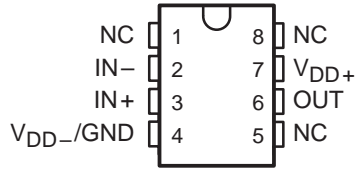
‡ Chip forms are tested at 25°C only.



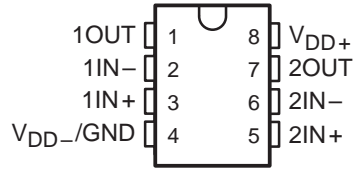
# TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175 – FEBRUARY 1997

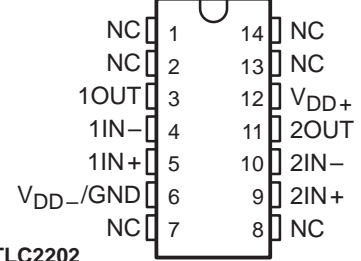
**TLC2201**  
D, JG, OR P PACKAGE  
(TOP VIEW)



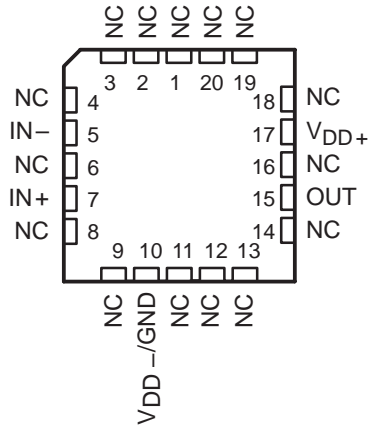
**TLC2202**  
JG OR P PACKAGE  
(TOP VIEW)



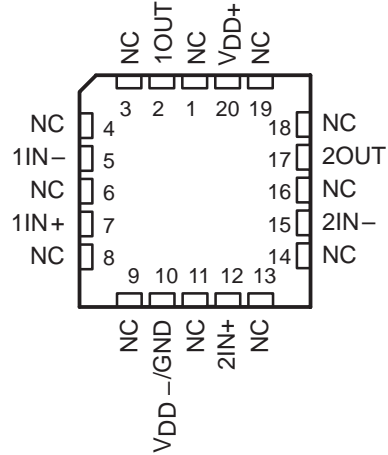
**TLC2202**  
D PACKAGE  
(TOP VIEW)



**TLC2201**  
FK PACKAGE  
(TOP VIEW)



**TLC2202**  
FK PACKAGE  
(TOP VIEW)

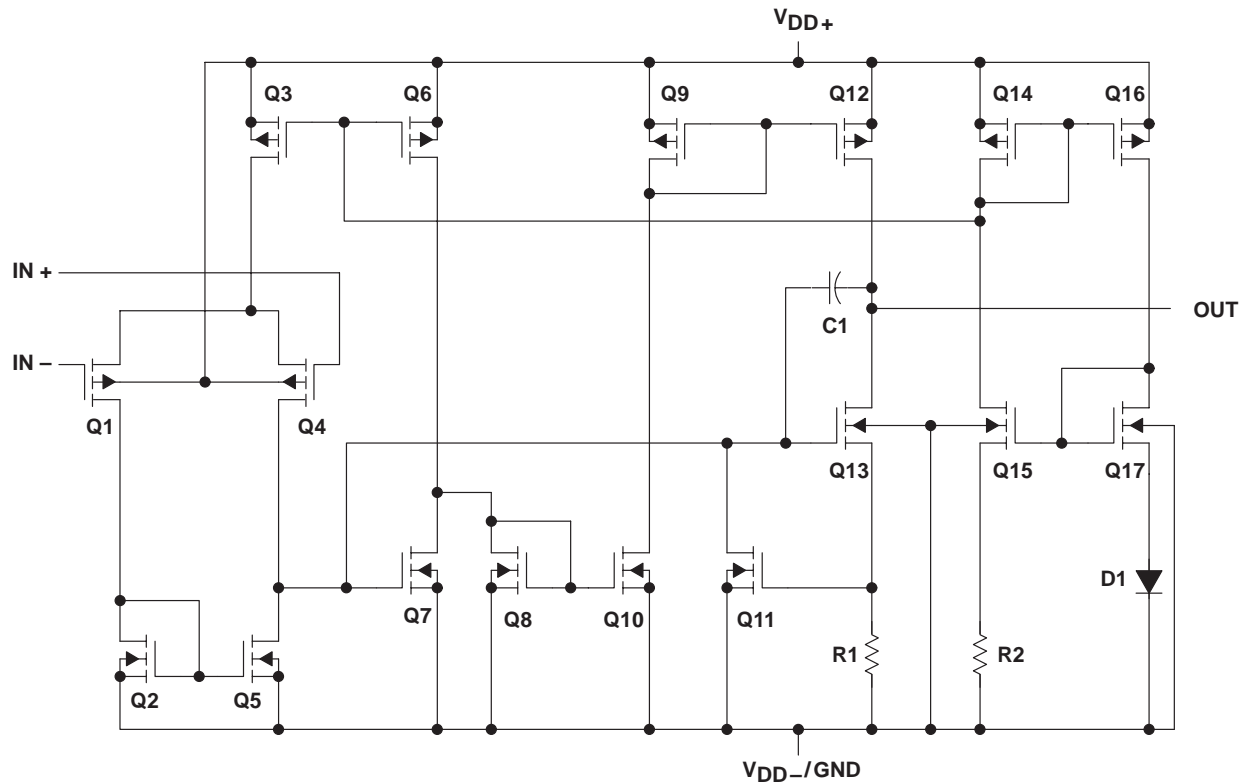


NC – No internal connection

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

SLOS175 – FEBRUARY 1997

equivalent schematic (each amplifier)



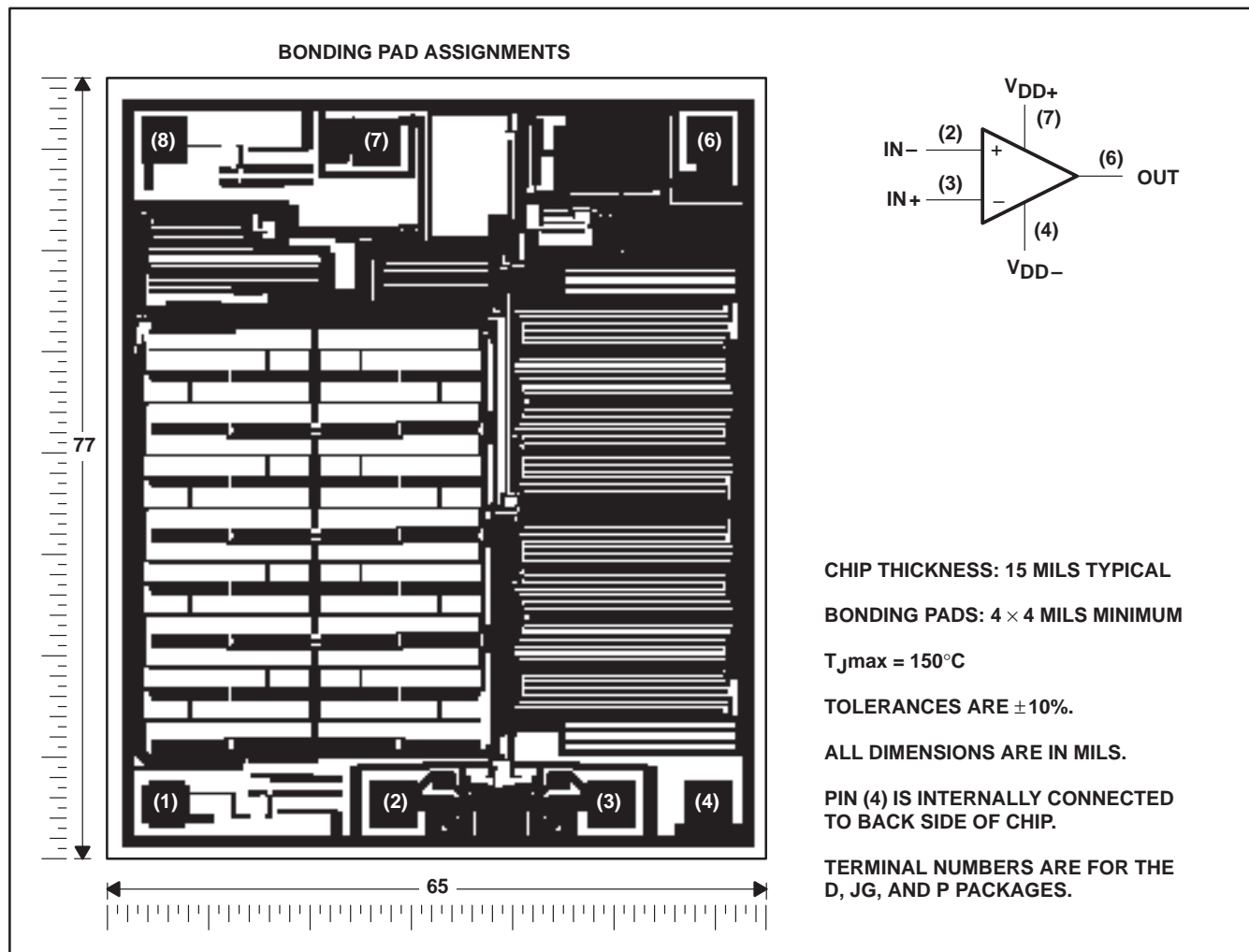
ACTUAL DEVICE COMPONENT COUNT		
COMPONENT	TLC2201	TLC2202
Transistors	17	34
Resistors	2	2
Diodes	1	4
Capacitors	1	2

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

SLOS175 – FEBRUARY 1997

**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.

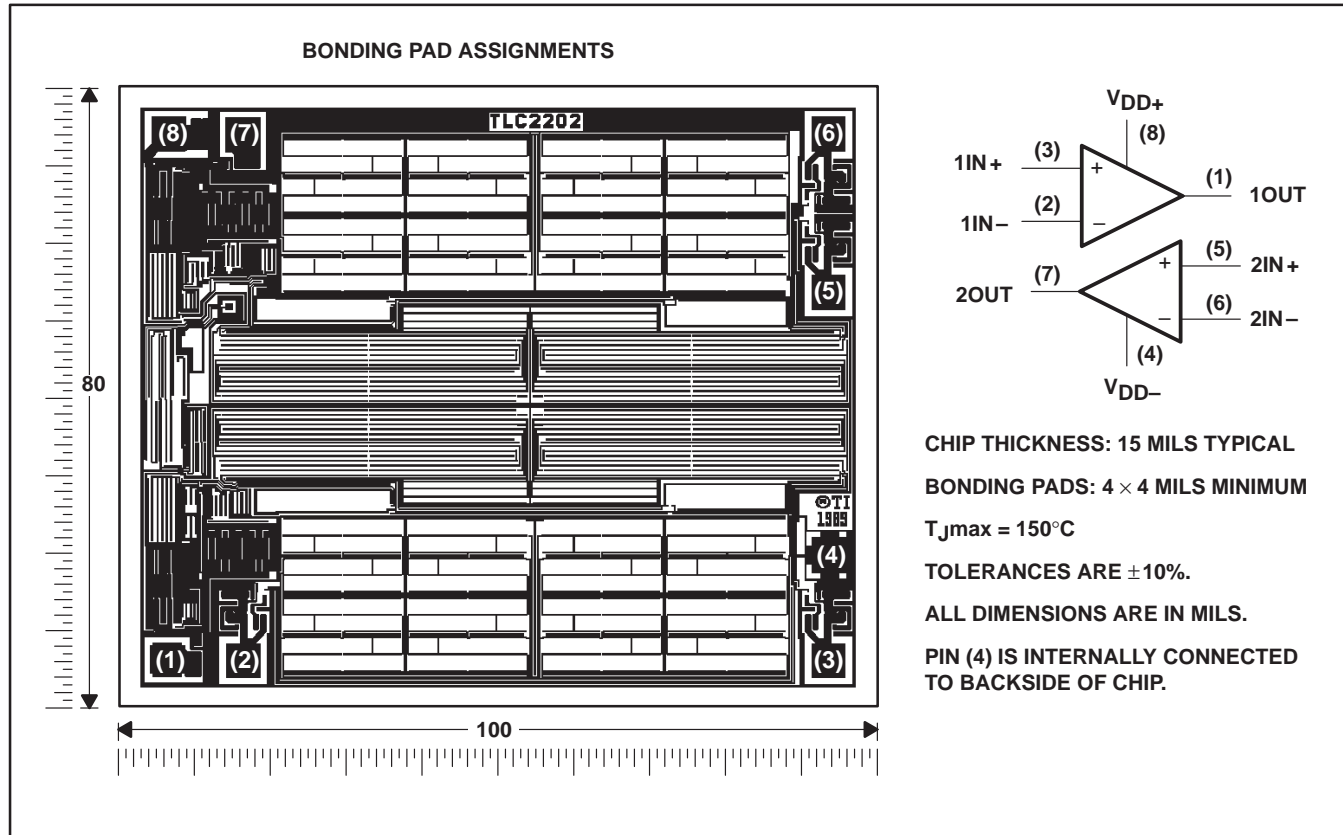


**TLC220x, TLC220xA, TLC220xB, TLC220xY**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**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.



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

SLOS175 – FEBRUARY 1997

**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 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: 1. All voltage values except differential voltages are with respect to the midpoint between  $V_{DD+}$  and  $V_{DD-}$ .  
 2. Differential voltages are at  $IN+$  with respect to  $IN-$ .  
 3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$	$T_A = 85^\circ\text{C}$	$T_A = 125^\circ\text{C}$
	POWER RATING		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
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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		Full range	600			
$\alpha_{VIO}$ 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	$\text{pA}$		
		Full range	100			
$I_{IB}$ Input bias current		25°C	1	$\text{pA}$		
		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	
$V_{OM-}$ 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	$V_O = \pm 4\text{ V}, R_L = 500\ \text{k}\Omega$	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 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		$\mu\text{V}$	
	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	
$\phi_m$ 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.





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

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		Full range			300		300		
$\alpha_{VIO}$ 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			0.5		$\text{pA}$	
		Full range			100		100		
$I_{IB}$ Input bias current		25°C	1			1		$\text{pA}$	
		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	$\text{V}$		
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8	$\text{V}$	
		Full range	4.7			4.7			
$V_{OM-}$ Maximum negative peak output voltage swing		25°C	-4.7	-4.9		-4.7	-4.9	$\text{V}$	
		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	$\text{V}/\text{mV}$	
		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.

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

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AC			TLC2210BC			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/ $\mu$ 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		$\mu$ 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	
$\phi_m$ 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.



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

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		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		$\text{pA}$	
		Full range	100			
$I_{IB}$ Input bias current		25°C	1		$\text{pA}$	
		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	$V_{IC} = V_{ICR\text{min}}, \quad V_O = 0,$ $R_S = 50\ \Omega$	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	$V_O = 2.5\text{ V}, \quad \text{No load}$	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	$V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	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		$\mu\text{V}$	
	$f = 0.1\text{ to }10\ \text{Hz}$	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	
$\phi_m$ 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.



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

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		Full range			300		300		
$\alpha_{VIO}$ 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			0.5	$\text{pA}$	
		Full range			100		100		
$I_{IB}$ Input bias current	25°C		1			1	$\text{pA}$		
	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	50	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			
	$V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$	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	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.



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

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AC			TLC2210BC			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/ $\mu$ 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		$\mu$ 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
$\phi_m$ 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**

SLOS175 – FEBRUARY 1997

**TLC2202C electrical characteristics at specified free-air temperature,  $V_{DD\pm} = \pm 5\text{ V}$  (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	$\mu\text{V}$	
		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	$\mu\text{V}/\text{mo}$	
$I_{IO}$ Input offset current	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	0.5		pA	
		Full range	100			
$I_{IB}$ Input bias current		25°C	1			
		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	300	560	V/mV	
		Full range	200			
	$V_O = \pm 4\text{ V}, R_L = 10\ \text{k}\Omega$	25°C	50	100		
		Full range	25			
CMRR Common-mode rejection ratio	$V_O = 0, V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$	25°C	80	115	dB	
		Full range	80			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD\pm} = \pm 2.3\text{ V to } \pm 8\text{ V}$	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 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	$T_A$ †	TLC2202C			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	1.3			
$V_n$ 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		$\mu\text{V}$	
	$f = 0.1\ \text{to } 10\ \text{Hz}$	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	
$\phi_m$ 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.



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

SLOS175 – FEBRUARY 1997

**TLC2202C electrical characteristics at specified free-air temperature,  $V_{DD\pm} = \pm 5$  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	$\mu$ V
		Full range			650			650	
$\alpha_{VIO}$ Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	Full range		0.5			0.5		$\mu$ V/°C
		25°C		0.001	0.005		0.001	0.005	$\mu$ V/mo
$I_{IO}$ Input offset current	$V_{IC} = 0, R_S = 50 \Omega$	25°C		0.5			0.5		pA
		Full range			100			100	
$I_{IB}$ Input bias current		25°C		1			1		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	$R_L = 10 k\Omega$	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	$V_O = \pm 4$ V, $R_L = 500 k\Omega$	25°C		300	560		300	560	V/mV
		Full range		200			200		
	$V_O = \pm 4$ V, $R_L = 10 k\Omega$	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 ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD\pm} = \pm 2.3$ V to $\pm 8$ 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,  $V_{DD\pm} = \pm 5$  V**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2202AC			TLC2202BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3$ V, $R_L = 10 k\Omega, C_L = 100$ pF	25°C		1.8	2.7		1.8	2.7	V/ $\mu$ s
		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		$\mu$ V
	$f = 0.1$ 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, $R_L = 10 k\Omega, C_L = 100$ pF	25°C		1.9			1.9	MHz	
$\phi_m$ Phase margin at unity gain	$R_L = 10 k\Omega, C_L = 100$ 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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**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		$\mu\text{V}$
		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		$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current	$V_{IC} = 0, R_S = 50\ \Omega$	Full range		100		$\text{pA}$
$I_{IB}$ Input bias current		25°C	1			
		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	$V_O = 0, V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$	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	$V_O = 0, \text{ No load}$	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		$\mu\text{V}$
	$f = 0.1\text{ to }10\ \text{Hz}$	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
$\phi_m$ 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.





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

SLOS175 – FEBRUARY 1997

**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		25°C		80	500		80	500	$\mu\text{V}$
		Full range			650			650	
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	25°C		0.5			0.5	$\text{pA}$	
		Full range			100		100		
$I_{IB}$ Input bias current		25°C		1			1	$\text{pA}$	
		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	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	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	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		$\mu\text{V}$
	$f = 0.1\text{ to }10\ \text{Hz}$	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	
$\phi_m$ 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**

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$
		Full range			650	
$\alpha_{VIO}$ 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	$\mu\text{V}/\text{mo}$
		Full range				
$I_{IO}$ Input offset current		25°C		0.5		$\text{pA}$
		Full range			150	
$I_{IB}$ Input bias current		25°C		1		$\text{pA}$
	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	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	$V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$	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  $-40^\circ\text{C}$  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	$\mu\text{V}$	
	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	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		48°		

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



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

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AI			TLC2210BI			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	$\mu\text{V}$
		Full range			350			350	
$\alpha_{VIO}$ 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			0.5		$\text{pA}$
		Full range			150			150	
$I_{IB}$ Input bias current		25°C		1			1		$\text{pA}$
		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	$V_{IC} = V_{ICR\text{min}}, V_O = 0, R_S = 50\ \Omega$	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  $-40^\circ\text{C}$  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  
**Advanced LinCMOS™ LOW-NOISE PRECISION  
 OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AI			TLC2210BI			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/ $\mu$ 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		$\mu$ 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
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		48°			48°		

† Full range is  $-40^\circ\text{C}$  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**

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC22011			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	$\mu\text{V}$
		Full range			650	
$\alpha_{VIO}$ 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		$\text{pA}$
		Full range			150	
$I_{IB}$ Input bias current		25°C		1		$\text{pA}$
		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  $-40^\circ\text{C}$  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.

**TLC22011 operating characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC22011			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	$\mu\text{V}$	
	$f = 0.1\text{ to }10\ \text{Hz}$	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	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		45°		

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



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

SLOS175 – FEBRUARY 1997

**TLC2201I 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	$\mu\text{A}$	
		Full range		350			350		
$\alpha_{VIO}$ 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			0.5		$\text{pA}$	
		Full range		150			150		
$I_{IB}$ Input bias current	25°C	1			1		$\text{pA}$		
	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	
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			
	$V_O = 1\ \text{V to } 4\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	25	55		25	55		
		Full range	15			15			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$	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	1.5	mA
		Full range			1.5			1.5	

† Full range is  $-40^\circ\text{C}$  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**

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AI			TLC2210BI			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/ $\mu$ 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		$\mu$ 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
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}$	25°C		45°			45°		

† Full range is  $-40^\circ\text{C}$  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**

SLOS175 – FEBRUARY 1997

**TLC2202I electrical characteristics at specified free-air temperature,  $V_{DD\pm} = \pm 5\text{ V}$  (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	$\mu\text{V}$	
		Full range	1200			
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	150		$\text{pA}$	
$I_{IB}$ Input bias current		25°C	1			
		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	$V_O = 0, R_S = 50\ \Omega, V_{IC} = V_{ICRmin}$	25°C	80	115	dB	
		Full range	80			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD} = \pm 2.3\ \text{V to } \pm 8\ \text{V}$	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°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	$T_A$ †	TLC2202I			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	$f = 0.1\ \text{to } 1\ \text{Hz}$	25°C	0.5		$\mu\text{V}$	
	$f = 0.1\ \text{to } 10\ \text{Hz}$	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	
$\phi_m$ 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°C.





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

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$
		Full range			700			700	
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	25°C		0.5			0.5	$\text{pA}$	
		Full range			150		150		
$I_{IB}$ Input bias current		25°C		1			1	$\text{pA}$	
		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		
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  $-40^\circ\text{C}$  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/ $\mu\text{s}$	
		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	$\mu\text{V}$	
	$f = 0.1\ \text{to } 10\ \text{Hz}$	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	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		48°			48°		

† Full range is  $-40^\circ\text{C}$  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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		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	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	150		$\text{pA}$	
$I_{IB}$ Input bias current		25°C	1			
		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  $-40^\circ\text{C}$  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		$\mu\text{V}$	
	$f = 0.1\text{ to }10\ \text{Hz}$	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	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C	47°			

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



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

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		Full range			700			700		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	Full range		0.5			0.5		$\mu\text{V}/^\circ\text{C}$	
		25°C		0.001	0.005		0.001	0.005		
Input offset voltage long-term drift (see Note 4)		25°C						$\mu\text{V}/\text{mo}$		
$I_{IO}$ Input offset current	$V_{IC} = 0, R_S = 50\ \Omega$	25°C		0.5			0.5		$\text{pA}$	
		Full range			150			150		
$I_{IB}$ Input bias current		25°C		1			1		$\text{pA}$	
		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		$\text{V}$		
$V_{OH}$ Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C		4.7	4.8		4.7	4.8	$\text{V}$	
		Full range		4.7			4.7			
$V_{OL}$ Maximum low-level output voltage	$I_O = 0$	25°C			0	50		0	50	$\text{mV}$
		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	$\text{V}/\text{mV}$	
		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	$\text{dB}$	
		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	$\text{dB}$	
		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	$\text{mA}$	
		Full range			2.6			2.6		

† Full range is  $-40^\circ\text{C}$  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	$\text{V}/\mu\text{s}$	
		Full range		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		$\mu\text{V}$
	$f = 0.1\ \text{to } 10\ \text{Hz}$	25°C			0.7			0.7		
$I_n$ Equivalent input noise current		25°C			0.6			0.6	$\text{fA}/\sqrt{\text{Hz}}$	
Gain-bandwidth product	$f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C			1.9			1.9	$\text{MHz}$	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C			47°			47°		

† Full range is  $-40^\circ\text{C}$  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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		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	$\text{pA}$		
$I_{IO}$ Input offset current		Full range	500			
$I_{IB}$ Input bias current		25°C	1	$\text{pA}$		
		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	$V_O = \pm 4\text{ V}, R_L = 500\ \text{k}\Omega$	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		$\mu\text{V}$	
	$f = 0.1\ \text{to } 10\ \text{Hz}$	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	
$\phi_m$ 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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AM			TLC2210BM			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	$\mu\text{V}$
		Full range			400			400	
$\alpha_{VIO}$ 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			0.5		$\text{pA}$
		Full range			500			500	
$I_{IB}$ Input bias current		25°C		1			1		$\text{pA}$
	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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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.

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

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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/ $\mu\text{s}$
		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		$\mu\text{V}$
	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
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		48°			48°		

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

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.



**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	$\mu\text{V}$
		Full range			700	
$\alpha_{VIO}$ 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		$\text{pA}$
		Full range			500	
$I_{IB}$ Input bias current		25°C		1		$\text{pA}$
		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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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.

**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	$\mu\text{V}$	
	$f = 0.1\text{ to }10\ \text{Hz}$	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	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		45°		

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

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

SLOS175 – FEBRUARY 1997

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2201AM			TLC2210BM			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	$\mu\text{V}$	
		Full range			400		400		
$\alpha_{VIO}$ 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			0.5		$\text{pA}$	
		Full range			500		500		
$I_{IB}$ Input bias current	25°C	1			1		$\text{pA}$		
	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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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.





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

SLOS175 – FEBRUARY 1997

**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/ $\mu$ 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	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		$\mu$ 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
$\phi_m$ 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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**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		$\mu\text{V}$
		Full range	1250			
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	500			$\text{pA}$
$I_{IB}$ Input bias current		25°C	1			
		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	$V_O = 1\ \text{V to } 4\ \text{V}, R_L = 500\ \text{k}\Omega$	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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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 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		V/ $\mu\text{s}$
		Full range	1.1			
$V_n$ Equivalent input noise voltage	f = 10 Hz	25°C	18			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			$\mu\text{V}$
	f = 0.1 to 10 Hz	25°C	0.7			
$I_n$ Equivalent input noise current		25°C	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			MHz
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C	48°			

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



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

SLOS175 – FEBRUARY 1997

**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		25°C	80	500		80	500	$\mu\text{V}$	
		Full range		750		750			
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	0.5			0.5			$\text{pA}$
		Full range		500		500			
$I_{IB}$ Input bias current		25°C	1			1			$\text{pA}$
		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	$V_O = 0, V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$	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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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**

SLOS175 – FEBRUARY 1997

**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		V/ $\mu\text{s}$
		Full range	1.1			1.1			
$V_n$ 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		$\mu\text{V}$
	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	
$\phi_m$ 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.



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

SLOS175 – FEBRUARY 1997

**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	$\mu\text{V}$	
		Full range	1250			
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	500		$\text{pA}$	
$I_{IB}$ Input bias current		25°C	1			
		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	$V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$	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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

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.

**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		$\mu\text{V}$	
	$f = 0.1\text{ to }10\ \text{Hz}$	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	
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C	47°			

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



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

SLOS175 – FEBRUARY 1997

**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		25°C		80	500		80	500	$\mu\text{V}$
		Full range			750			750	
$\alpha_{VIO}$ 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	$V_{IC} = 0, R_S = 50\ \Omega$	25°C		0.5			0.5		$\text{pA}$
		Full range			500			500	
$I_{IB}$ Input bias current		25°C		1			1		$\text{pA}$
		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		$\text{V}$	
$V_{OH}$ Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8	$\text{V}$	
		Full range	4.7			4.7			
$V_{OL}$ Maximum low-level output voltage	$I_O = 0$	25°C		0	50		0	50	$\text{mV}$
		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	$\text{V}/\text{mV}$	
		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	2.6	$\text{mA}$
		Full range			2.6			2.6	

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

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

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**

SLOS175 – FEBRUARY 1997

**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)		25°C	18	35*		18	30*	$\text{nV}/\sqrt{\text{Hz}}$
			25°C	8	15*		8	12*	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage		25°C	0.5		0.5		$\mu\text{V}$	
			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	
$\phi_m$	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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$

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**  
**Advanced LinCMOS™ LOW-NOISE PRECISION**  
**OPERATIONAL AMPLIFIERS**

SLOS175 – FEBRUARY 1997

**TLC2201Y electrical characteristics at  $V_{DD\pm} = \pm 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	TLC2201Y			UNIT	
		MIN	TYP	MAX		
$V_{IO}$ Input offset voltage	$V_{IC} = 0$ , $R_S = 50\ \Omega$		100		$\mu\text{V}$	
Input offset voltage long-term drift (see Note 4)			0.001		$\mu\text{V}/\text{mo}$	
$I_{IO}$ Input offset current				0.5		$\text{pA}$
$I_{IB}$ Input bias current				1		$\text{pA}$
$V_{OH}$ Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$		4.8		$\text{V}$	
$V_{OL}$ Maximum low-level output voltage	$I_O = 0$		0		$\text{mV}$	
$A_{VD}$ Large-signal differential voltage amplification	$V_O = 1\ \text{V to } 4\ \text{V}$ , $R_L = 500\ \Omega$		55		$\text{V}/\text{mV}$	
	$V_O = 1\ \text{V to } 4\ \text{V}$ , $R_L = 10\ \Omega$		55			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ , $V_O = 0$ , $R_S = 50\ \Omega$		110		$\text{dB}$	
$k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{DD\pm} / \Delta V_{IO}$ )	$V_{DD} = 4.6\ \text{to } 16\ \text{V}$		110		$\text{dB}$	
$I_{DD}$ Supply current per amplifier	$V_O = 2.5\ \text{V}$ , No load		1		$\text{mA}$	

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.

**TLC2201Y operating characteristics at  $V_{DD\pm} = \pm 5\ \text{V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER	TEST CONDITIONS	TLC2201Y			UNIT
		MIN	TYP	MAX	
SR Positive slew rate at unity gain	$V_O = \pm 0.5\ \text{to } 2.5\ \text{V}$ , $R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		2.5		$\text{V}/\mu\text{s}$
$V_n$ Equivalent input noise voltage	$f = 10\ \text{Hz}$		18		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$		8		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\ \text{to } 1\ \text{Hz}$		0.5		$\mu\text{V}$
	$f = 0.1\ \text{to } 10\ \text{Hz}$		0.7		
$I_n$ Equivalent input noise current			0.6		$\text{pA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}$ , $R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		1.8		$\text{MHz}$
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		48°		





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

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		$\mu\text{V}$
	$f = 0.1\ \text{ to } 10\ \text{Hz}$		0.7		
$I_n$ Equivalent input noise current			0.6		$\text{pA}/\sqrt{\text{Hz}}$
$B_1$ Gain-bandwidth product	$f = 10\ \text{kHz}$ , $R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		1.9		$\text{MHz}$
$\phi_m$ Phase margin at unity gain	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		$47^\circ$		

PARAMETER MEASUREMENT INFORMATION

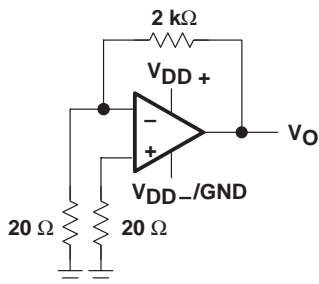
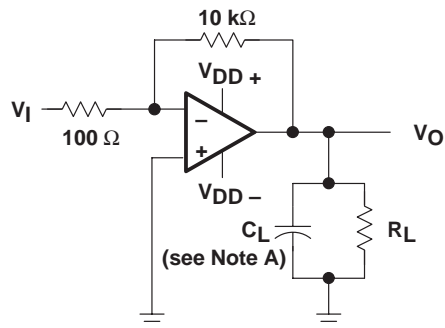
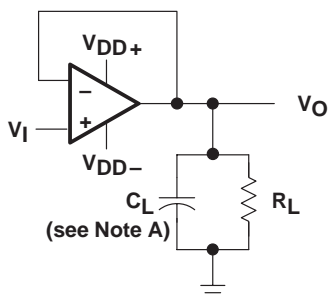


Figure 1. Noise-Voltage Test Circuit



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

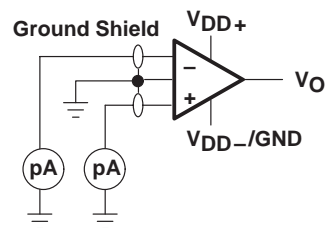


Figure 4. Input-Bias and Offset-Current Test Circuit

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	7
		vs Free-air temperature	8
$V_{OM}$	Maximum peak output voltage	vs Output current	9
		vs Free-air temperature	10
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	11
$V_{OH}$	High-level output voltage	vs Frequency	12
		vs High-level output current	13
		vs Free-air temperature	14
$V_{OL}$	Low-level output voltage	vs Low-level output current	15
		vs Free-air temperature	16
$A_{VD}$	Large-signal differential voltage amplification	vs Frequency	17
		vs Free-air temperature	18
$I_{OS}$	Short-circuit output current	vs Supply voltage	19
		vs Free-air temperature	20
$CMRR$	Common-mode rejection ratio	vs Frequency	21
$I_{DD}$	Supply current	vs Supply voltage	22
		vs Free-air temperature	23, 24
	Pulse response	Small signal	25, 26
		Large signal	27, 28
$SR$	Slew rate	vs Supply voltage	29
		vs Free-air temperature	30
	Noise voltage (referred to input)	0.1 to 1 Hz	31
		0.1 to 10 Hz	32
	Gain-bandwidth product	vs Supply voltage	33, 34
		vs Free-air temperature	35
$\phi_m$	Phase margin	vs Supply voltage	36, 37
		vs Free-air temperature	38, 39
	Phase shift	vs Frequency	17

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLC2201  
 INPUT OFFSET VOLTAGE

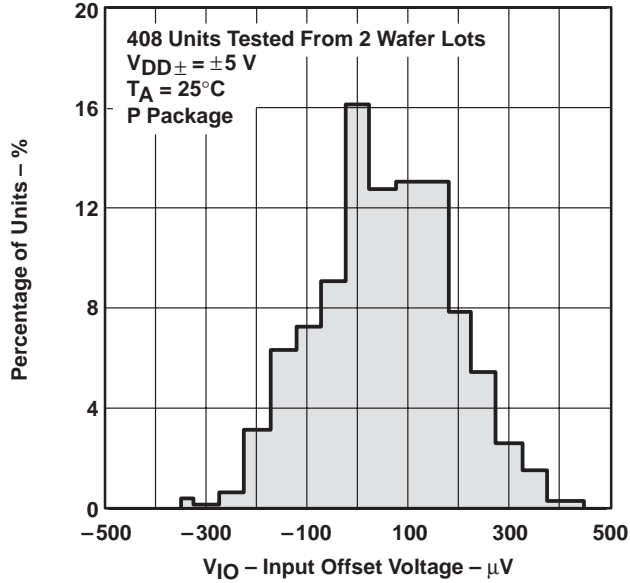


Figure 5

TLC2202  
 DISTRIBUTION OF  
 INPUT OFFSET VOLTAGE

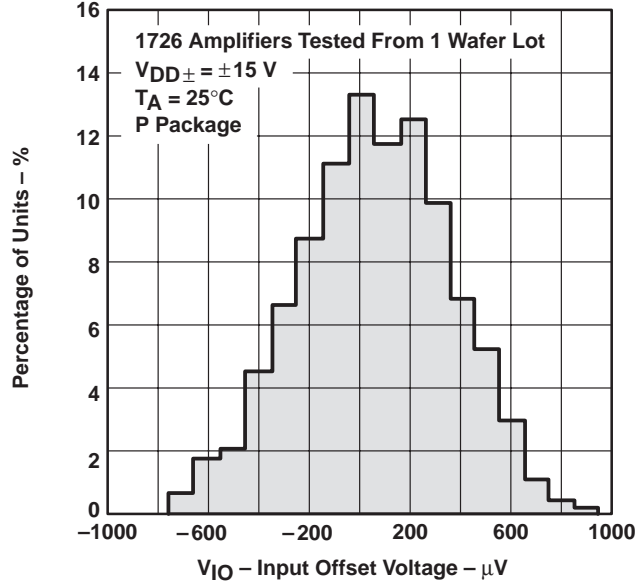


Figure 6

INPUT BIAS CURRENT  
 vs  
 COMMON-MODE INPUT VOLTAGE

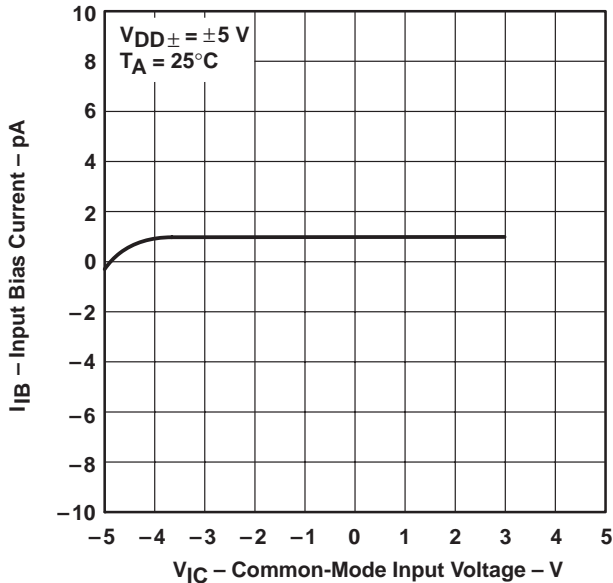


Figure 7

INPUT BIAS CURRENT†  
 vs  
 FREE-AIR TEMPERATURE

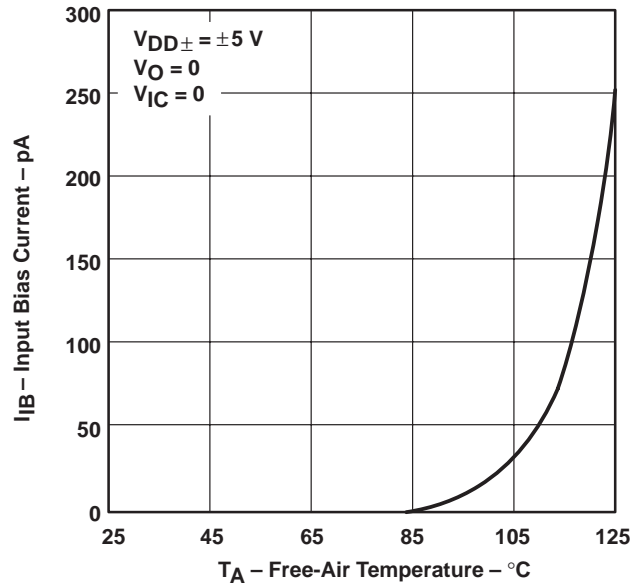


Figure 8

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

TYPICAL CHARACTERISTICS

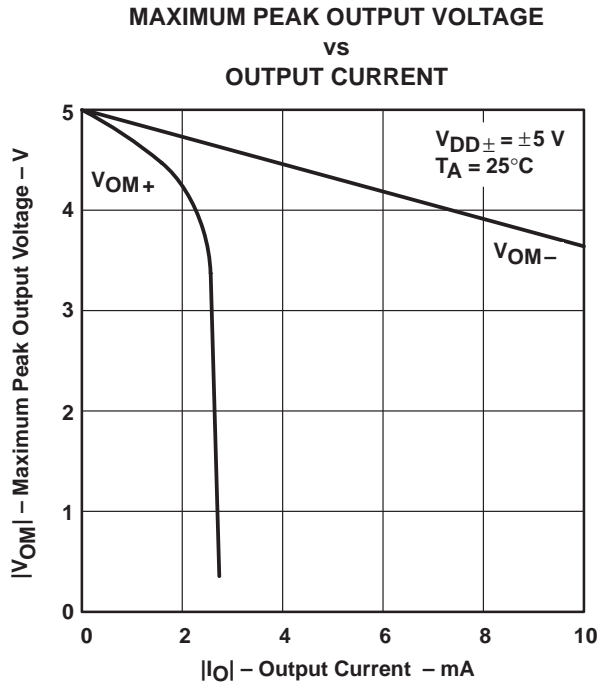


Figure 9

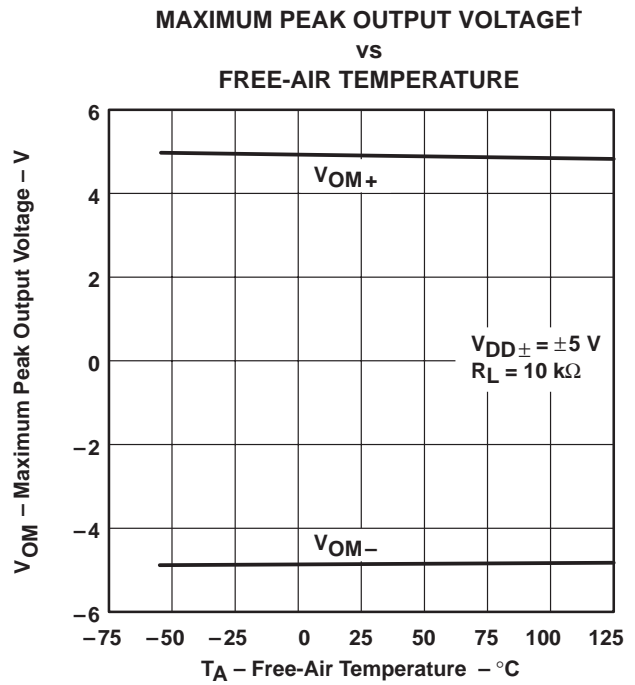


Figure 10

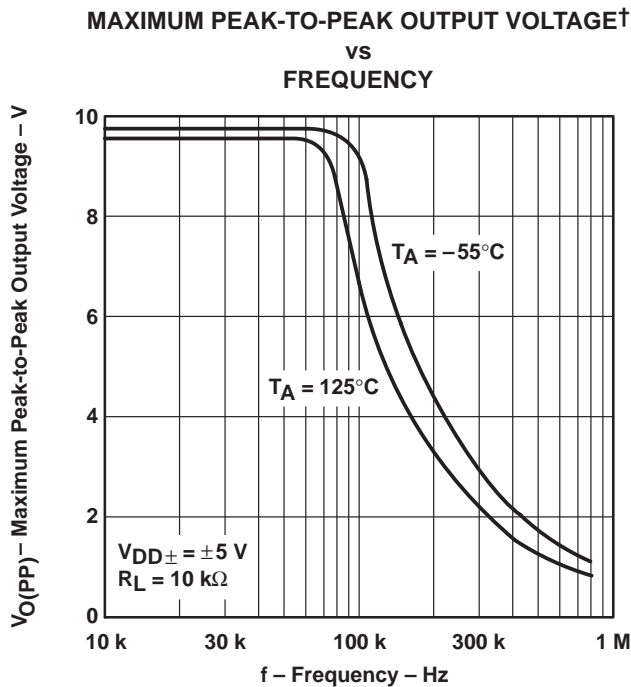


Figure 11

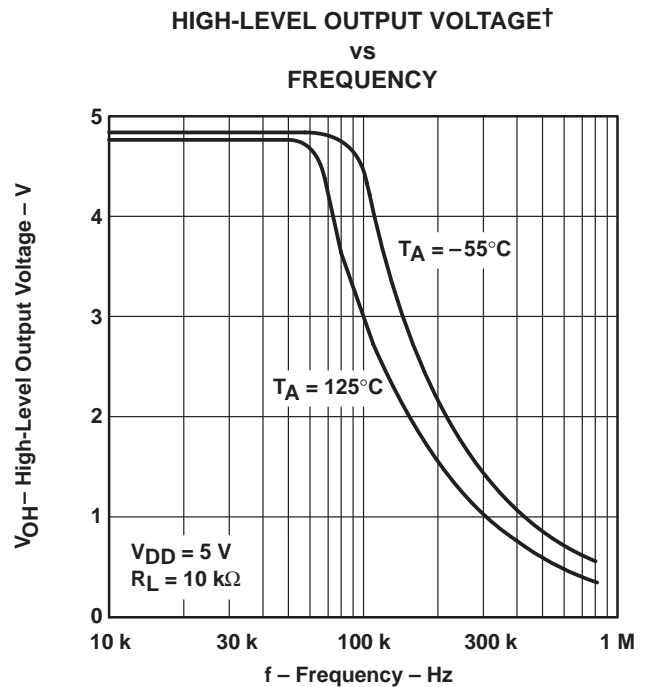
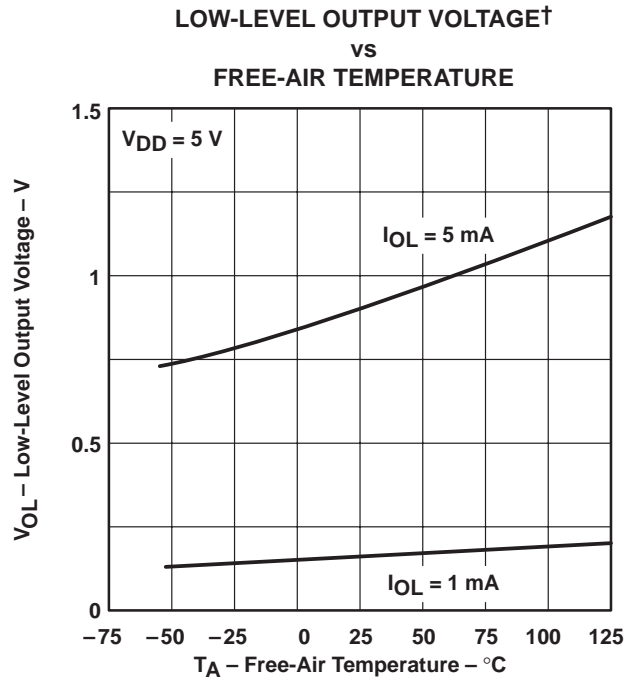
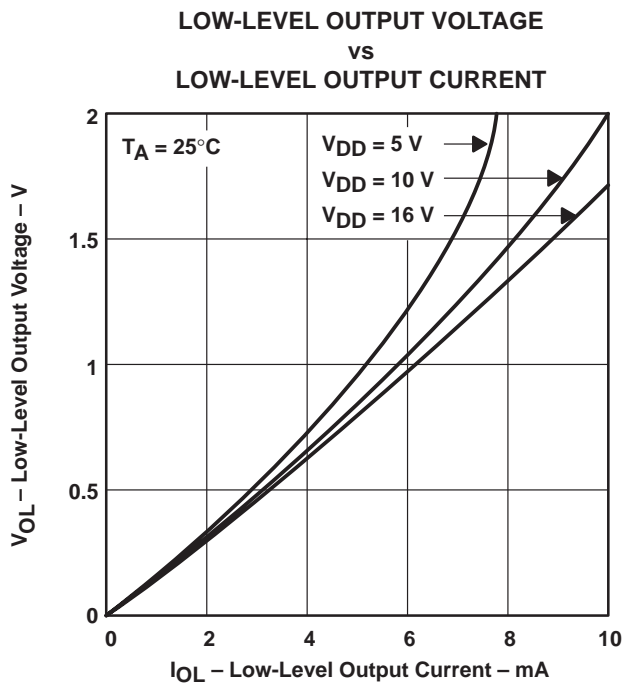
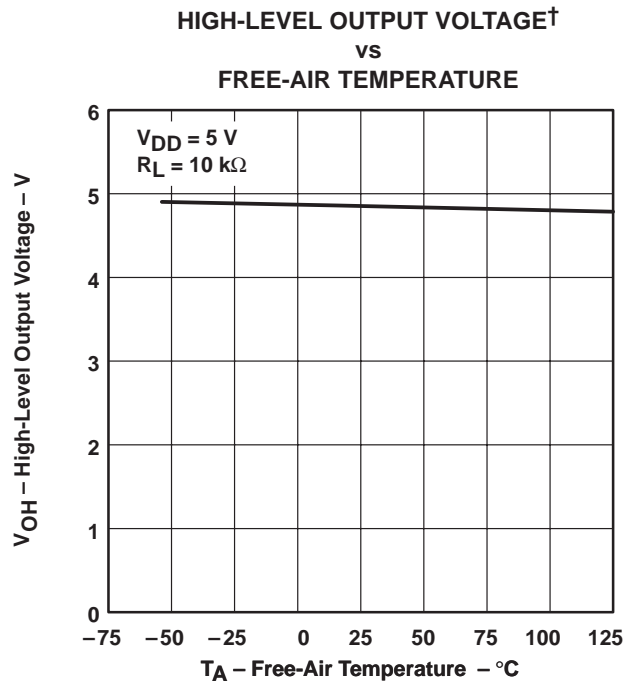
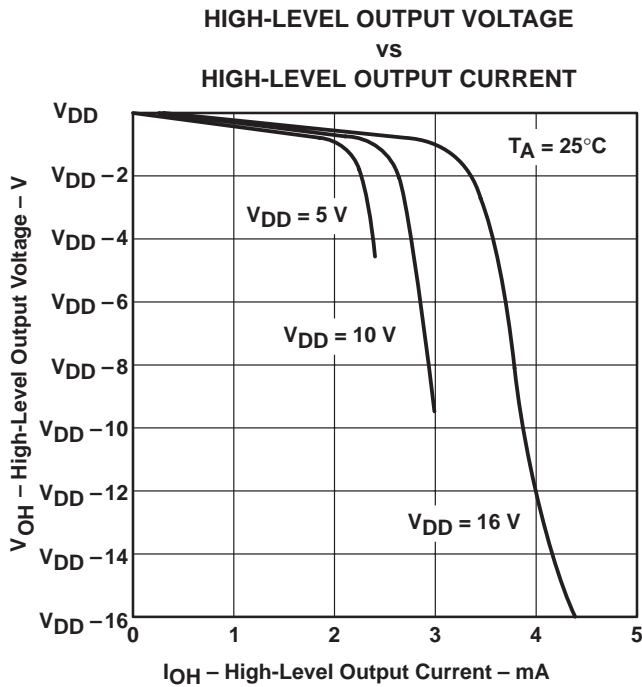


Figure 12

† 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

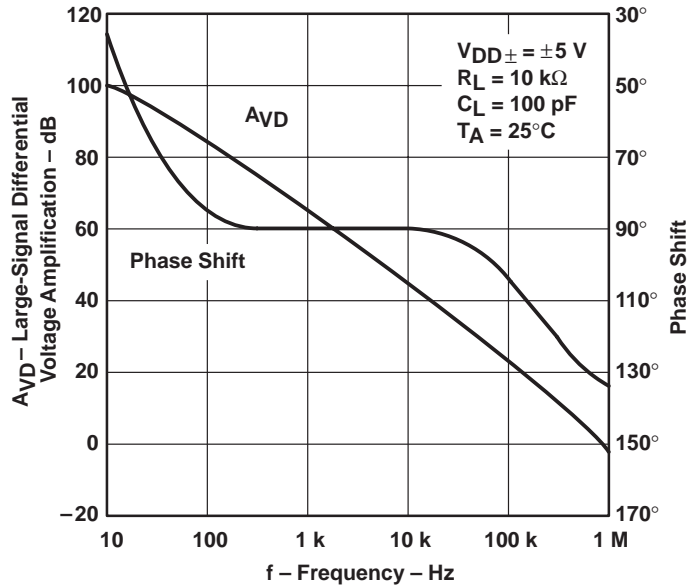


Figure 17

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

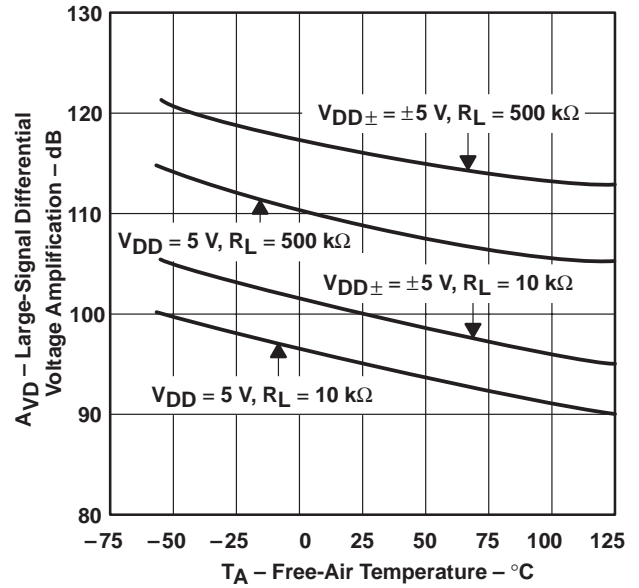


Figure 18

SHORT-CIRCUIT OUTPUT CURRENT  
vs  
SUPPLY VOLTAGE

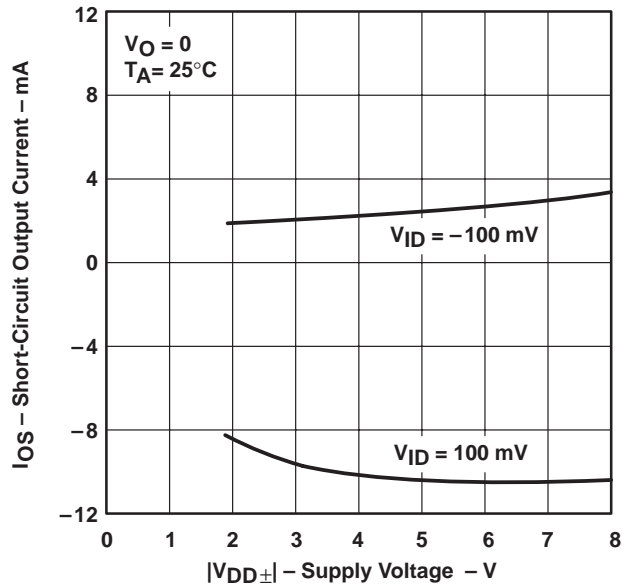


Figure 19

SHORT-CIRCUIT OUTPUT CURRENT†  
vs  
FREE-AIR TEMPERATURE

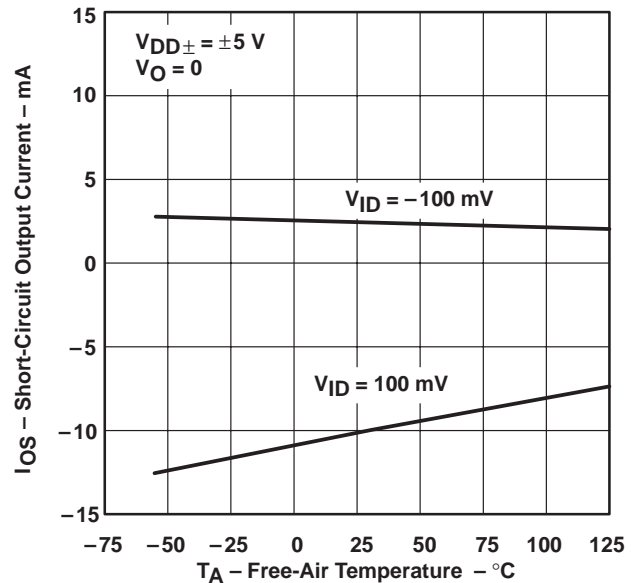
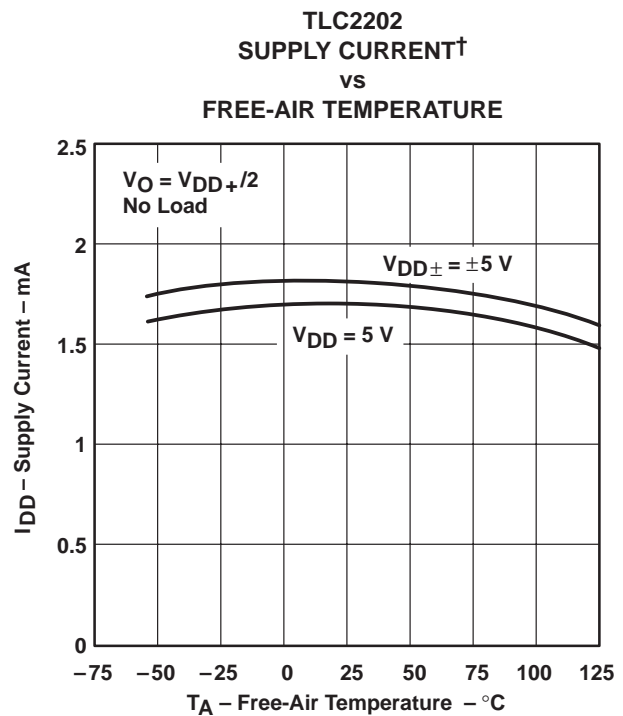
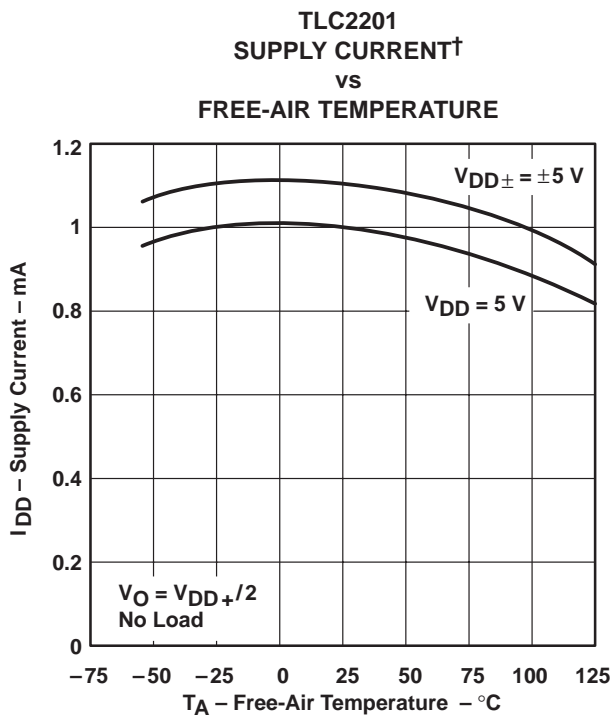
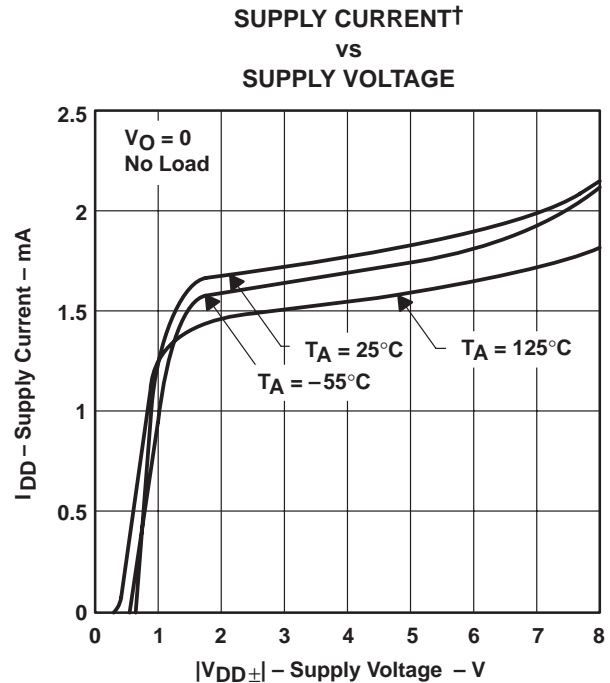
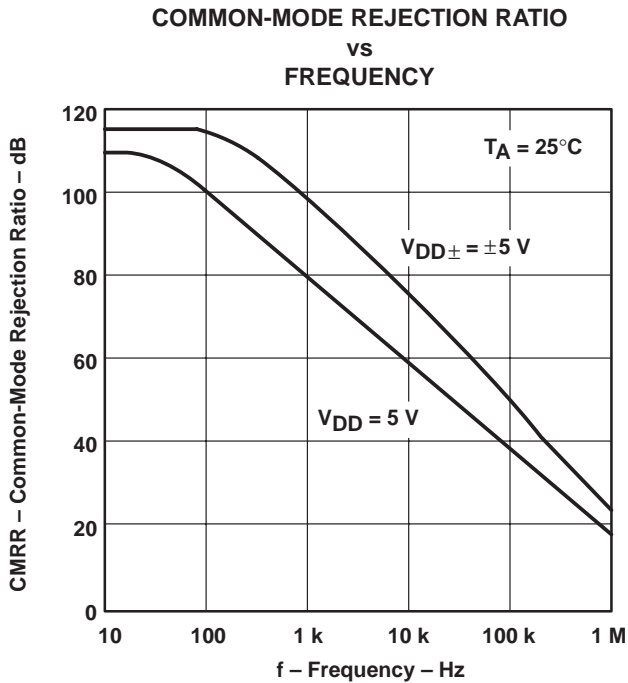


Figure 20

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

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

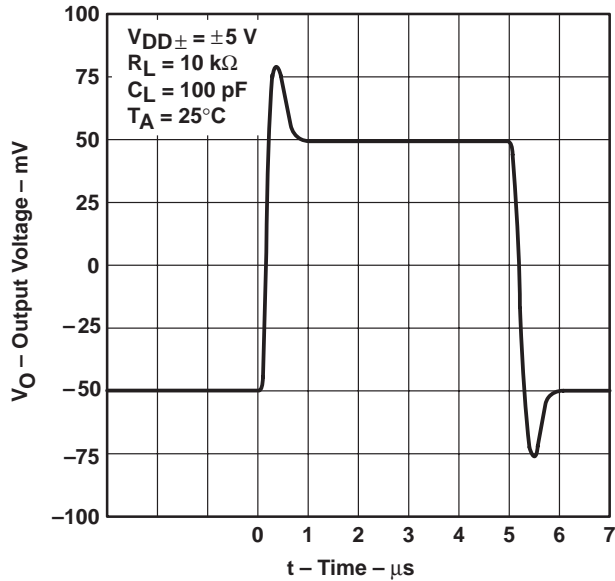


Figure 25

VOLTAGE-FOLLOWER  
 SMALL-SIGNAL  
 PULSE RESPONSE

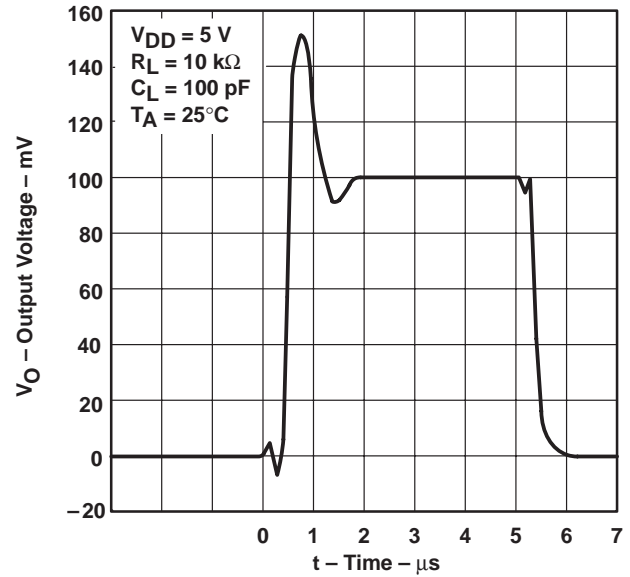


Figure 26

VOLTAGE-FOLLOWER  
 LARGE-SIGNAL  
 PULSE RESPONSE

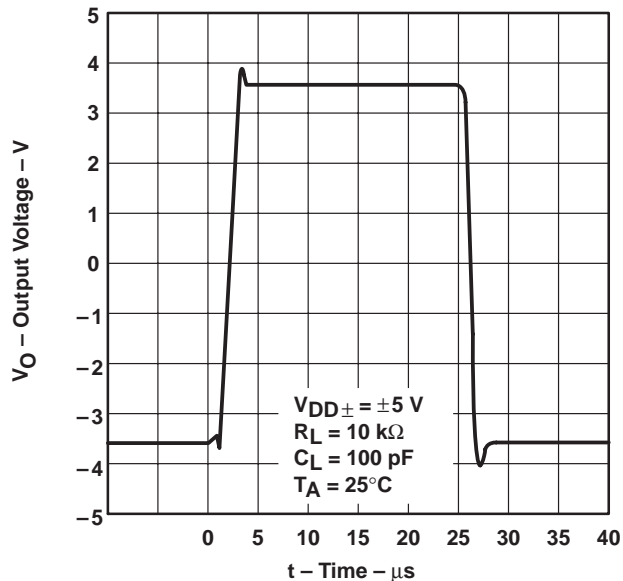


Figure 27

VOLTAGE-FOLLOWER  
 LARGE-SIGNAL  
 PULSE RESPONSE

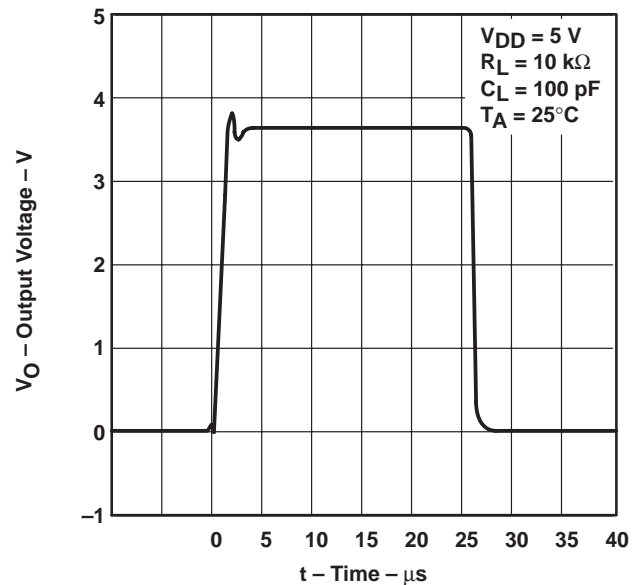


Figure 28

TYPICAL CHARACTERISTICS

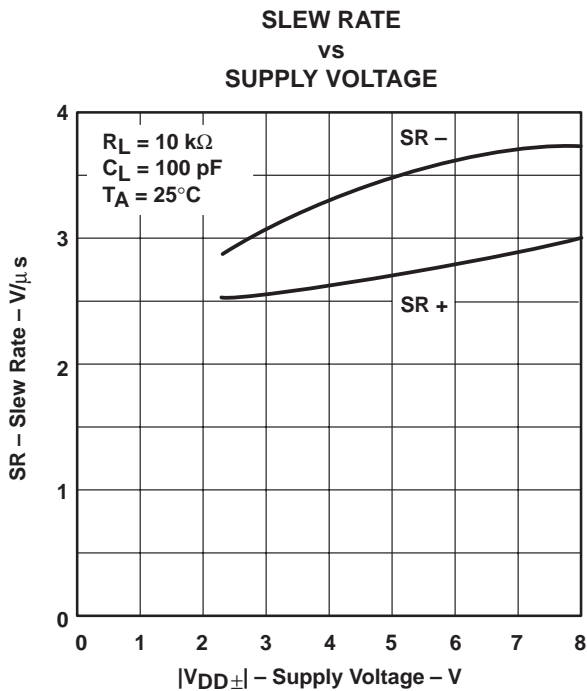


Figure 29

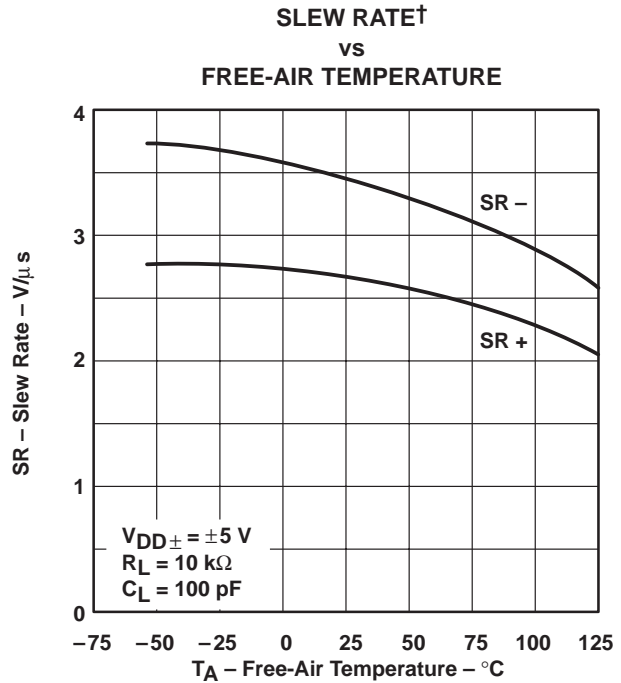


Figure 30

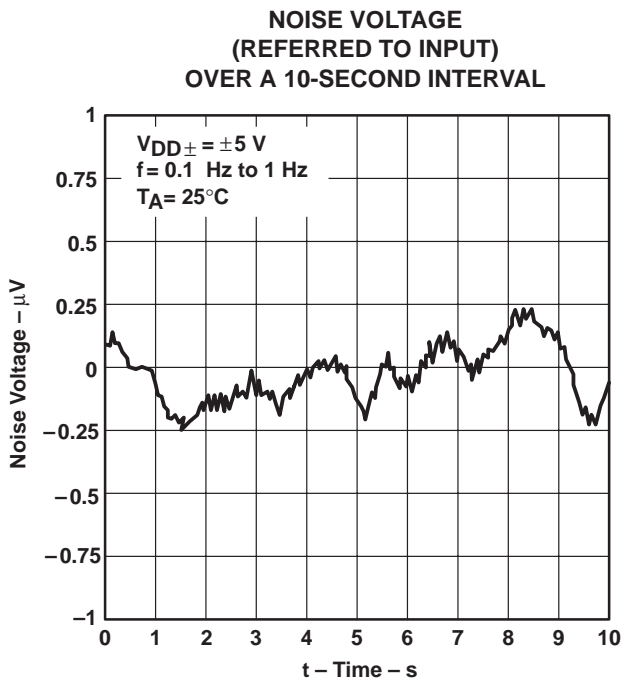


Figure 31

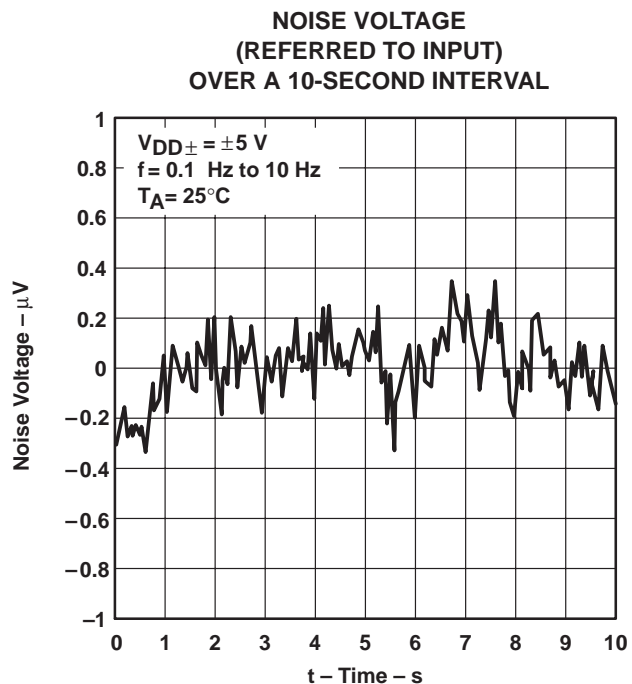


Figure 32

† 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

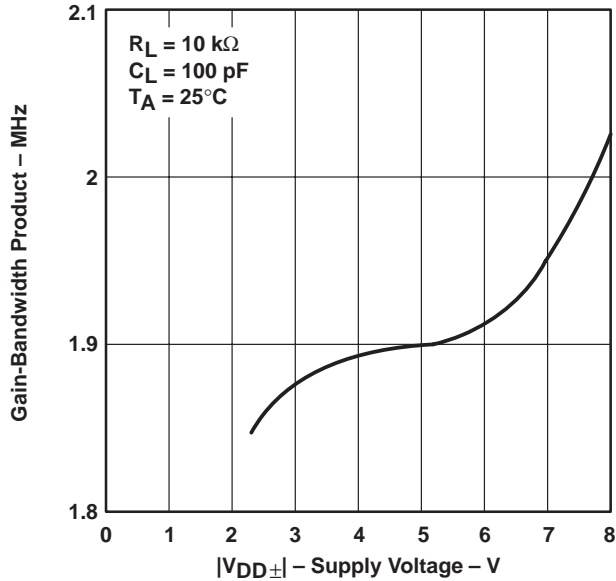


Figure 33

TLC2202  
 GAIN-BANDWIDTH PRODUCT  
 vs  
 SUPPLY VOLTAGE

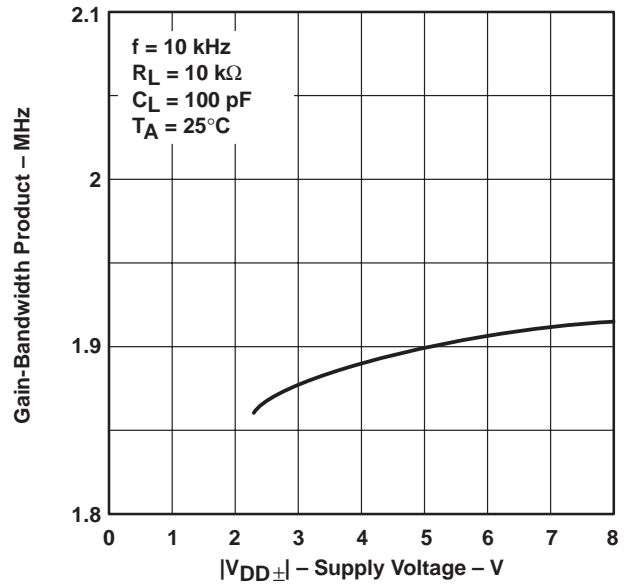


Figure 34

GAIN-BANDWIDTH PRODUCT†  
 vs  
 FREE-AIR TEMPERATURE

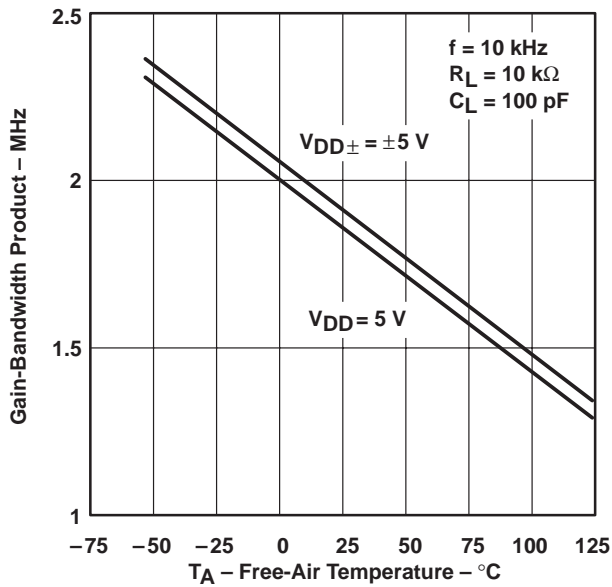


Figure 35

TLC2201  
 PHASE MARGIN  
 vs  
 SUPPLY VOLTAGE

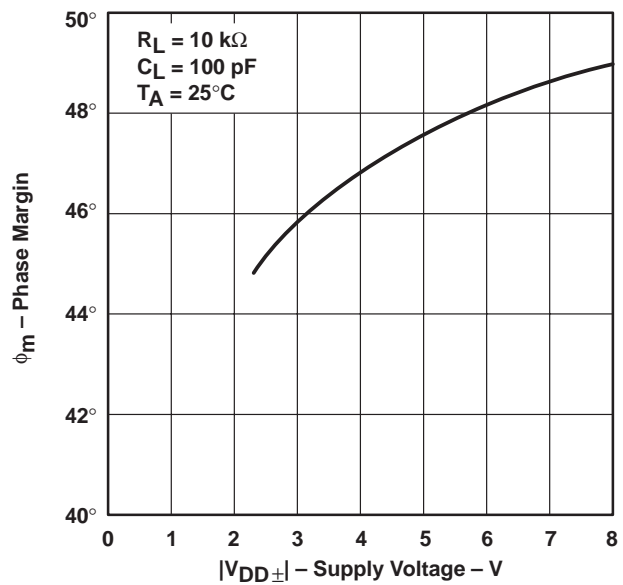


Figure 36

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

TYPICAL CHARACTERISTICS

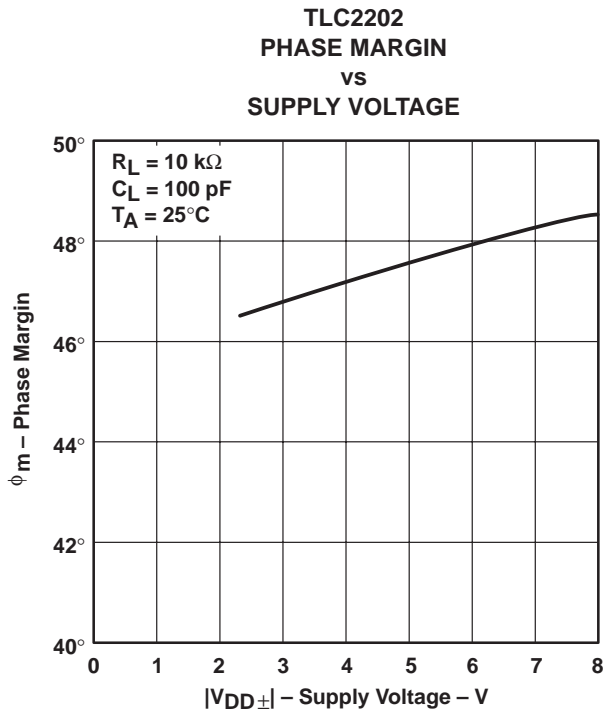


Figure 37

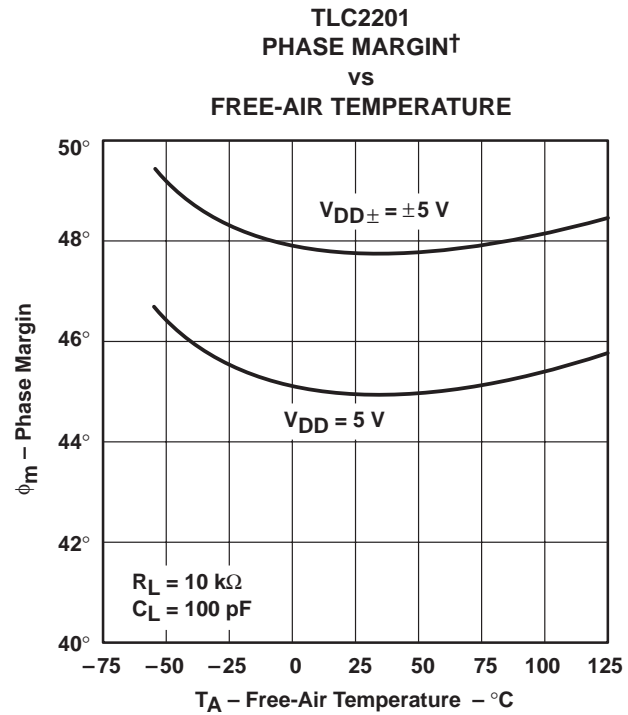


Figure 38

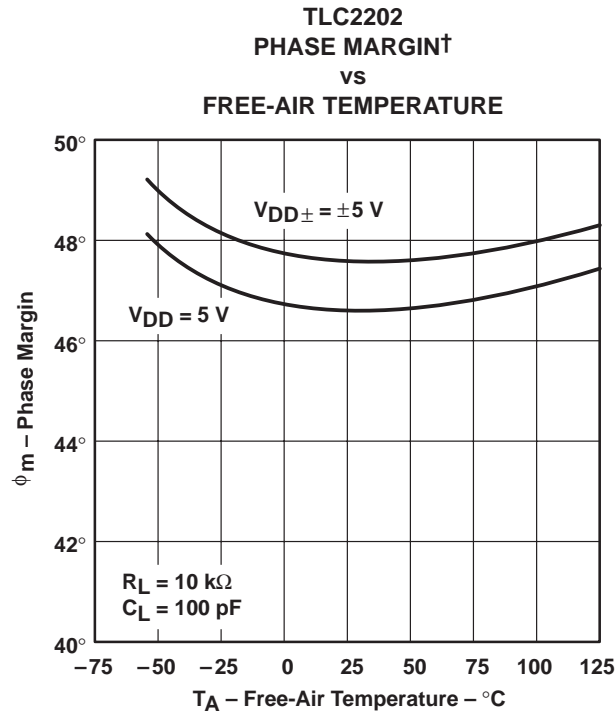


Figure 39

† 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  $\mu$ 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).

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

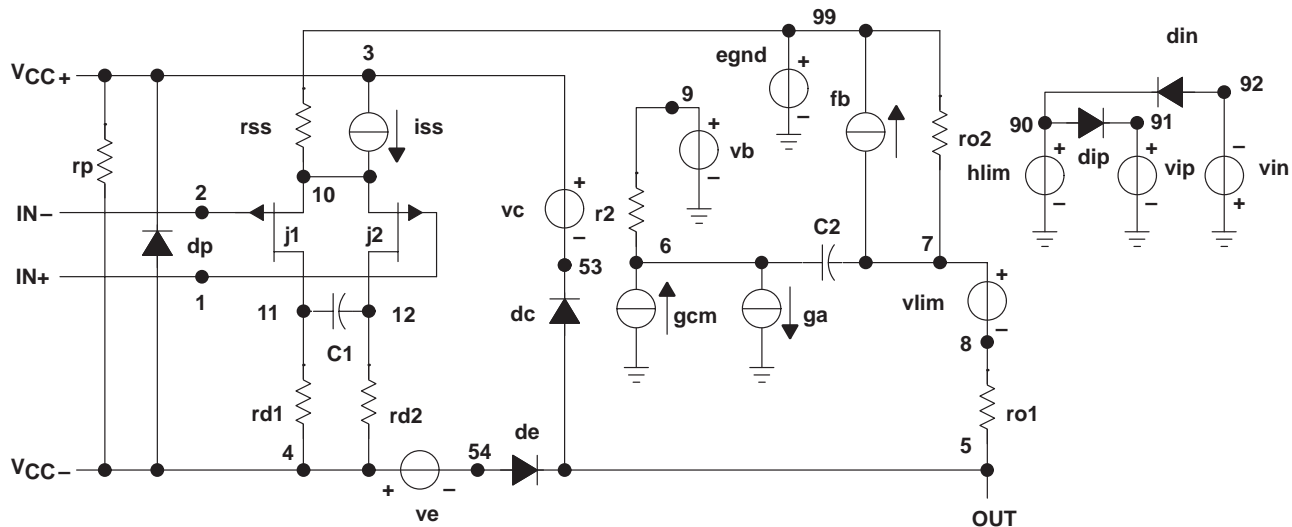


TLC220x, TLC220xA, TLC220xB, TLC220xY  
 Advanced LinCMOS™ LOW-NOISE PRECISION  
 OPERATIONAL AMPLIFIERS

SLOS175 – FEBRUARY 1997

APPLICATION INFORMATION

macromodel information (continued)



```
.subckt TLC220x 1 2 3 4 5
*
c1 11 12 8.51E-12
c2 6 7 50.00E-12
cpsr 85 86 79.6E-9
dcm+ 81 82 dx
dcm- 83 81 dx
dc 5 53 dx
de 54 5 dx
dlp 90 91 dx
dln 92 90 dx
dp 4 3 dx
ecmr 84 99 (2,99) 1
egnd 99 0 poly(2) (3,0) (4,0) 0 .5 .5
epsr 85 0 poly(1) (3,4) -200E-6 20E-6
ense 89 2 poly(1) (88,0) 100E-6 1
fb 7 99 poly(6) vb vc ve vlp vln
+ vpsr 0 + 895.9E3 -90E3 90E3 90E3 -90E3 895E3
ga 6 0 11 12 314.2E-6
gcm 0 6 10 99 1.295E-9
gpsr 85 86 (85,86) 100E-6
grd1 60 11 (60,11) 3.141E-4
grd2 60 12 (60,12) 3.141E-4
hlim 90 0 vlim 1k
hcmr 80 1 poly(2) vcm+ vcm- 0 1E2 1E2
irp 3 4 965E-6
iss 3 10 dc 135.0E-6
iio 2 0 .5E-12
il 88 0 1E-21
j1 11 89 10 jx
j2 12 80 10 jx
r2 6 9 100.0E3
rcm 84 81 1k
rn1 88 0 1500
ro1 8 5 188
ro2 7 99 187
rss 10 99 1.481E6
vad 60 4 -.3v
vcm+ 82 99 2.2
vcm- 83 99 -4.5
vb 9 0 dc 0
vc 3 53 dc .9
ve 54 4 dc .8
vlim 7 8 dc 0
vlp 91 0 dc 2.8
vln 0 92 dc 2.8
vpsr 0 86 dc 0
.model dx d(is=800.0E-18)
.model jx pjf(is=500.0E-15 beta=1.462E-3
+ vto=-.155 kf=1E-17)
.endsx
```

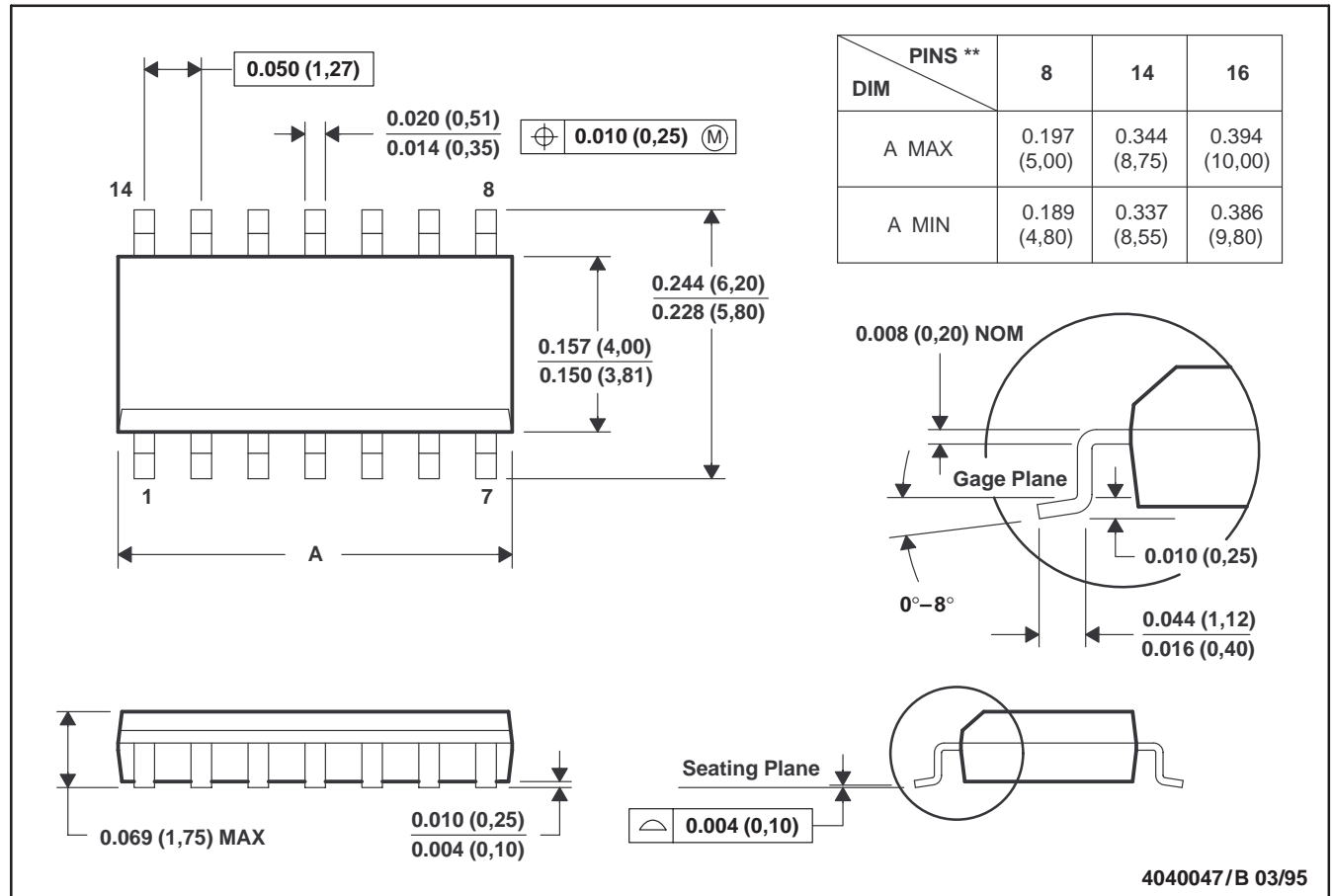
Figure 40. Boyle Macromodel and Subcircuit

MECHANICAL INFORMATION

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
D. Four center pins are connected to die mount pad.  
E. Falls within JEDEC MS-012

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

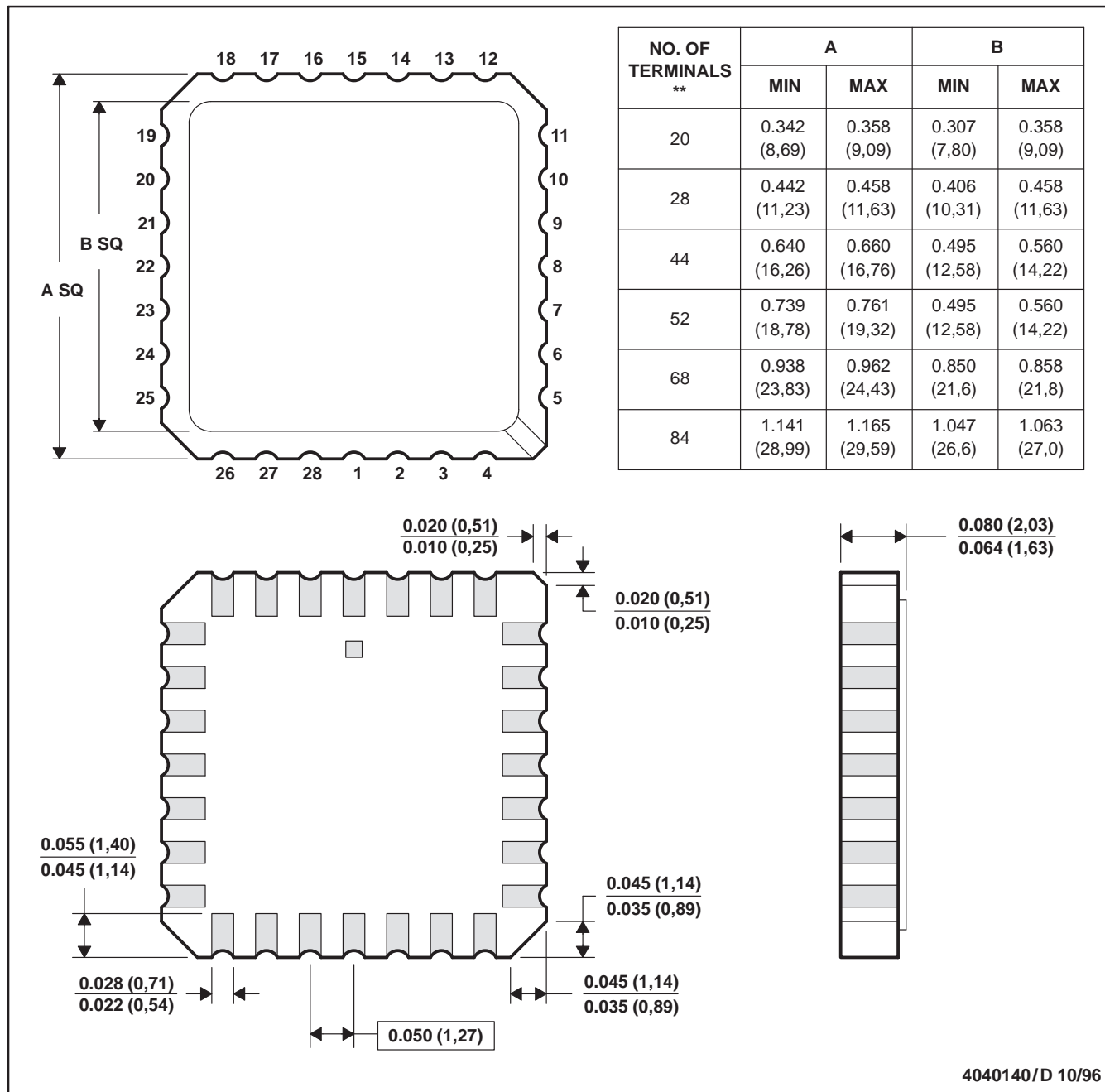
SLOS175 – FEBRUARY 1997

MECHANICAL INFORMATION

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

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



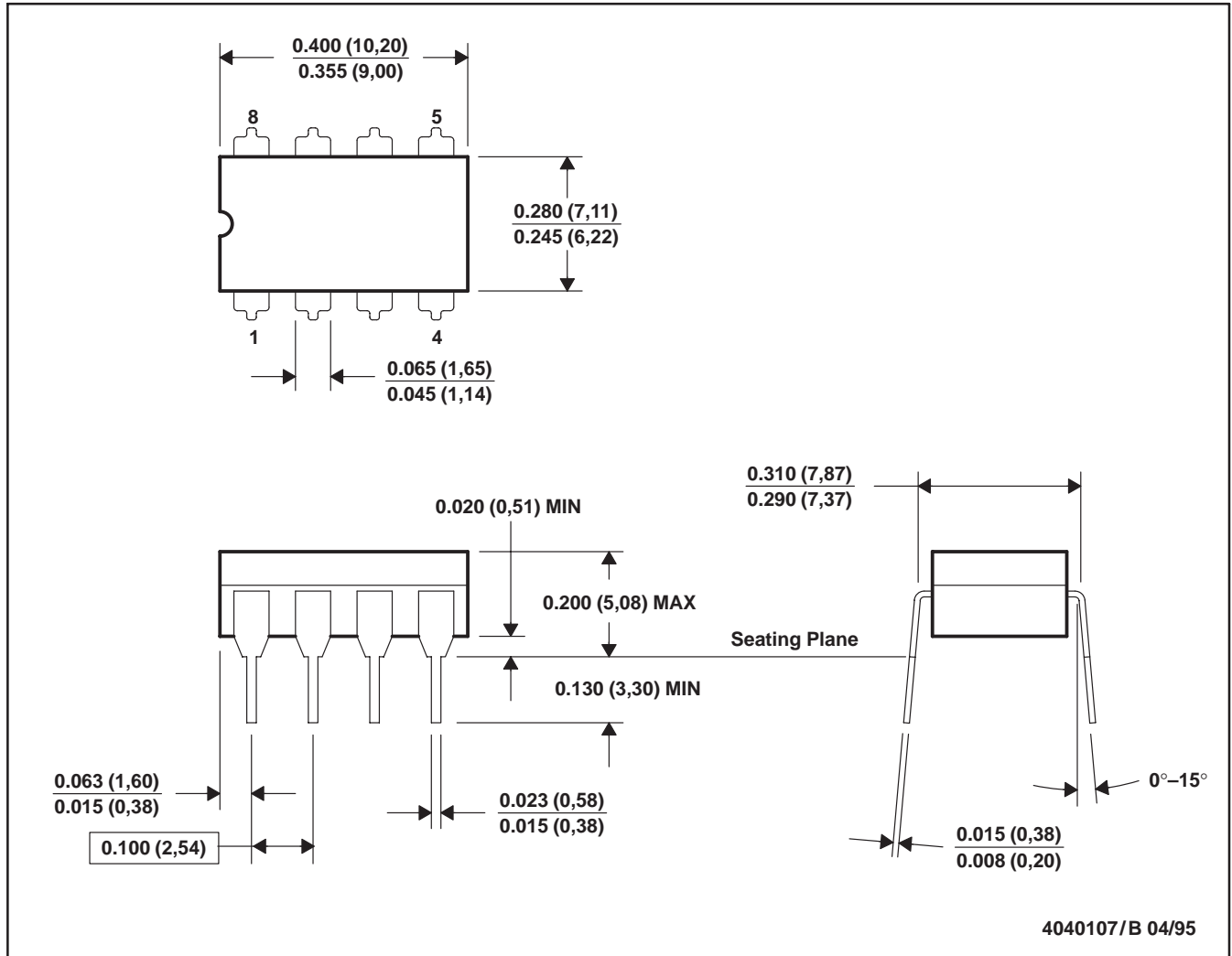
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a metal lid.  
 D. The terminals are gold plated.  
 E. Falls within JEDEC MS-004



MECHANICAL INFORMATION

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE PACKAGE



- 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 only on press ceramic glass frit seal only  
 E. Falls within MIL-STD-1835 GDIP1-T8

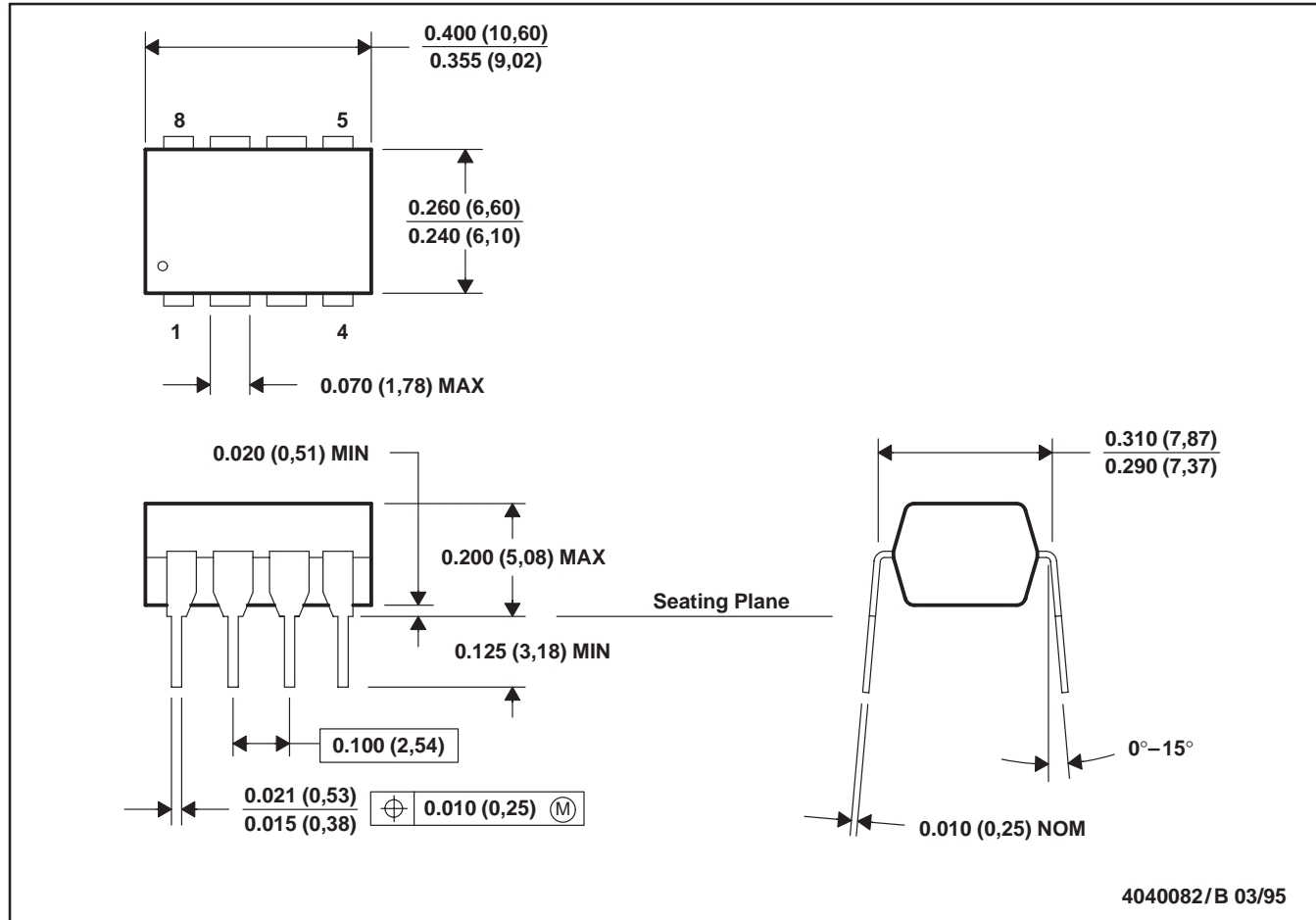
TLC220x, TLC220xA, TLC220xB, TLC220xY  
 Advanced LinCMOS™ LOW-NOISE PRECISION  
 OPERATIONAL AMPLIFIERS

SLOS175 – FEBRUARY 1997

MECHANICAL INFORMATION

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



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

## **IMPORTANT NOTICE**

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.