

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

SLOS175 – FEBRUARY 1997

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

description

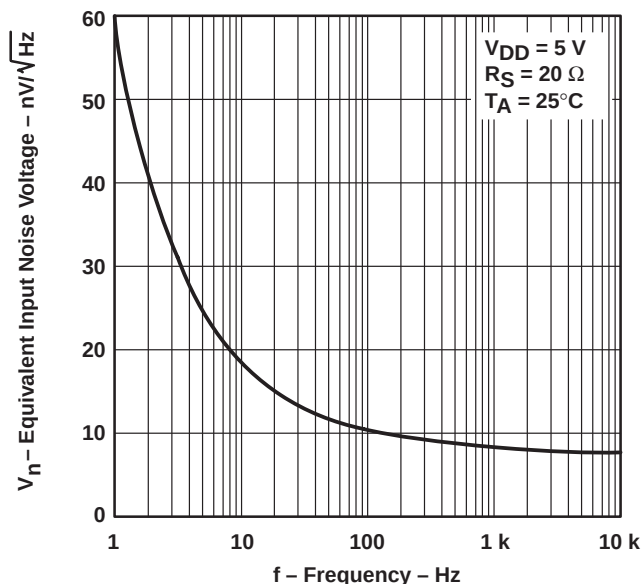
The TLC220x, TLC220xA, TLC220xB, and TLC220xY are precision, low-noise operational amplifiers using Texas Instruments Advanced LinCMOS™ process. These devices combine the noise performance of the lowest-noise JFET amplifiers with the dc precision available previously only in bipolar amplifiers. The Advanced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

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

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

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

TYPICAL EQUIVALENT
INPUT NOISE VOLTAGE
VS
FREQUENCY



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

**TEXAS
INSTRUMENTS**

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

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TLC2201 AVAILABLE OPTIONS

T _A	V _{IO} max AT 25°C	V _n max f = 10 Hz AT 25°C	V _n max f = 1 kHz AT 25°C	PACKAGED DEVICES				CHIP FORM‡ (Y)
				SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	
0°C to 70°C	200 µV 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 _A	V _{IO} max AT 25°C	V _n max f = 10 Hz AT 25°C	V _n max f = 1 kHz AT 25°C	PACKAGED DEVICES				CHIP FORM‡ (Y)
				SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	
0°C to 70°C	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.

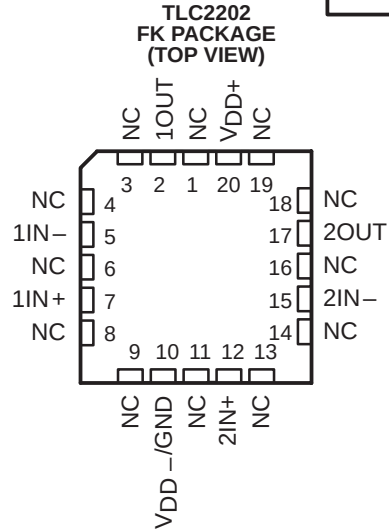
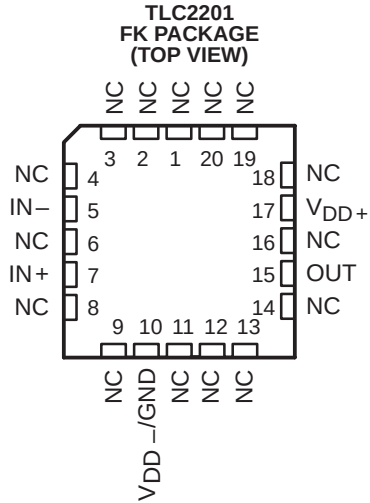
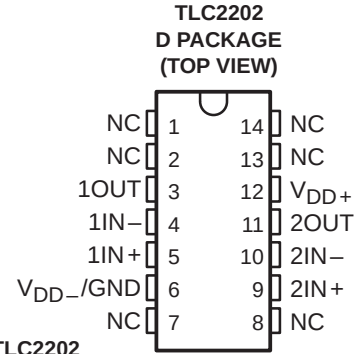
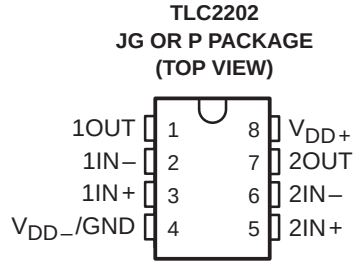
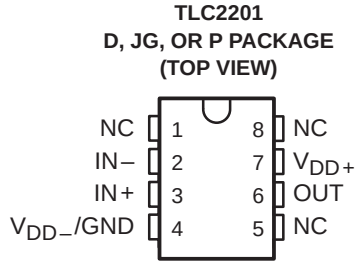


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NC – No internal connection

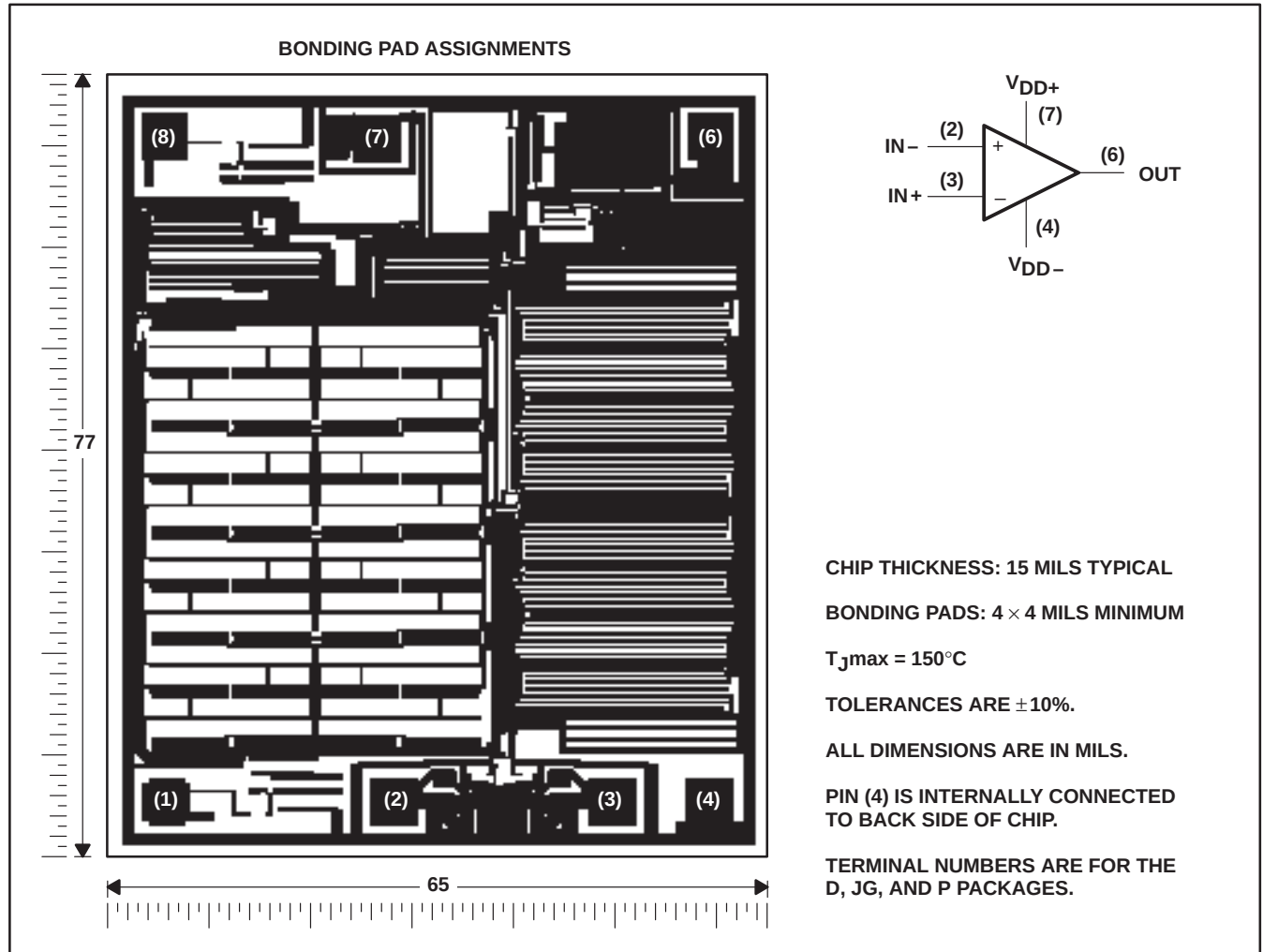
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The schematic shows a 12-bit SAR ADC. The input stage consists of a differential pair of NMOS transistors (Q1, Q2) and PMOS transistors (Q3, Q4). The inputs are labeled IN+ and IN-. The PMOS transistors (Q3, Q4) are connected to VDD+ and the NMOS transistors (Q1, Q2) are connected to VDD-/GND. The output of the input stage is connected to a 100k load resistor (R1) and a 10pF capacitor (C1). The output is labeled OUT. The output stage consists of a differential pair of NMOS transistors (Q5, Q6) and PMOS transistors (Q7, Q8). The NMOS transistors (Q5, Q6) are connected to VDD-/GND and the PMOS transistors (Q7, Q8) are connected to VDD+. The output of the output stage is connected to a 100k load resistor (R2) and a 10pF capacitor (C1). The output is labeled OUT. The output stage also includes a diode (D1) connected to VDD+ and a resistor (R2) connected to VDD-/GND. The output is labeled OUT.

Actual Device Component Count		
Component	TLC2201	TLC2202
Transistors	17	34
Resistors	2	2
Diodes	1	4
Capacitors	1	2

TLC2201Y chip information

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

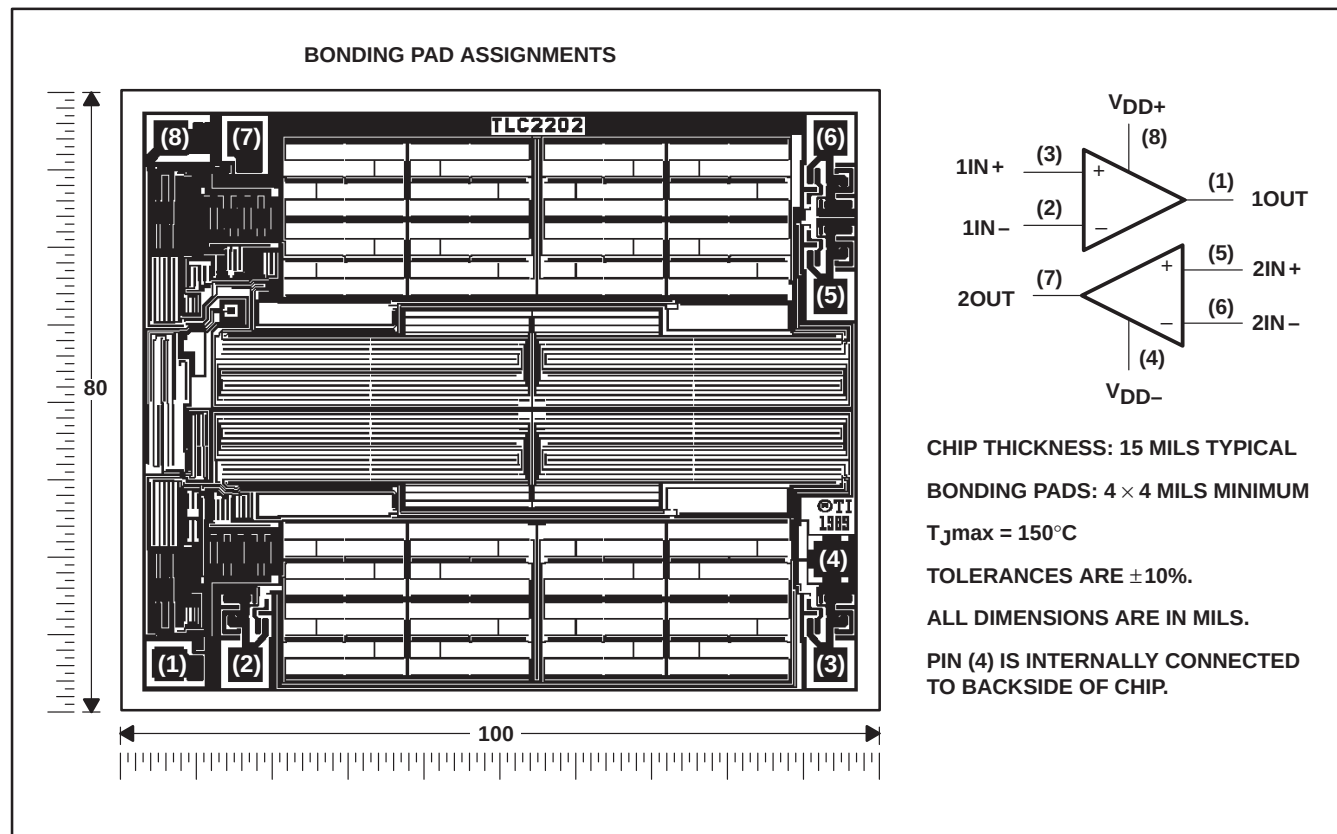


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TLC2202Y chip formation

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



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

Supply voltage, V_{DD+} (see Note 1)	8 V
Supply voltage, V_{DD-}	–8 V
Differential input voltage, V_{ID} (see Note 2)	±16 V
Input voltage, V_I (any input)	±8 V
Input current, I_I (each input)	±5 mA
Output current, I_O (each output)	±50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : C suffix	0°C to 70°C
I suffix	–40°C to 85°C
M suffix	–55°C to 125°C
Storage temperature range	–65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D 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	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ 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



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201C			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	μV
		Full range			600	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			100	
I_{IB} Input bias current		25°C		1		pA
		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	–5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	–4.7	–4.9		V
		Full range	–4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	400	560		V/mV
		Full range	300			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	90	100		
		Full range	70			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, \quad V_O = 0, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	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	$T_A^\dagger$	TLC2201C			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C	2	2.7		$\text{V}/\mu\text{s}$
		Full range	1.5			
V_n Equivalent input noise voltage	$f = 10\ \text{Hz}$	25°C		18		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7		
I_n Equivalent input noise current		25°C		0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		48°		

† Full range is 0°C to 70°C.



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AC			TLC2201BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	25°C	80	200		80	200		μV
		Full range			300			300	
α_{VIO} Temperature coefficient of input offset voltage		Full range	0.5			0.5			$\mu V/^\circ C$
Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005		0.001	0.005		$\mu V/mo$
I_{IO} Input offset current		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	400	560		400	560		V/mV
		Full range	300			300			
	$V_O = \pm 4$ V, $R_L = 10 k\Omega$	25°C	90	100		90	100		
		Full range	70			70			
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 ($\Delta V_{DD\pm} / \Delta V_{IO}$)	$V_{DD\pm} = \pm 2.3$ V to ± 8 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 $T_A = 150^\circ C$ extrapolated to $T_A = 25^\circ C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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/ μs
		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		μV
	$f = 0.1\text{ to }10\text{ Hz}$	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		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.



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

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

† Full range is 0°C to 70°C.

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

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

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

† Full range is 0°C to 70°C.

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2201AC			TLC2201BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C	80 200		80 200		μV		
	Full range		300		300					
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5		0.5		μV/°C		
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	0.001	0.005	μV/mo		
I _{IO}	Input offset current		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 Ω	Full range	0 to 2.7		0 to 2.7		V		
V _{OH}	Maximum high-level output voltage	R _L = 10 kΩ	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 V to 4 V, R _L = 500 kΩ	25°C	150	315	150	315	V/mV		
			Full range	100		100				
		V _O = 1 V to 4 V, R _L = 10 kΩ	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 Ω	25°C	90	110	90	110	dB		
			Full range	85		85				
k _{SVR}	Supply voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD} = 4.6 V to 16 V	25°C	90	110	90	110	dB		
			Full range	85		85				
I _{DD}	Supply current	V _O = 2.5 V, 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.

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

PARAMETER		TEST CONDITIONS	$T_A^\dagger$	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/ μs
			Full range	1.3			1.3			
V_n	Equivalent input noise voltage (see Note 5)	$f = 10\text{ Hz}$	25°C		18	35		18	30	$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$	25°C		8	15		8	12	
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\text{ Hz}$	25°C		0.5			0.5		μV
		$f = 0.1\text{ to }10\text{ Hz}$	25°C		0.7			0.7		
I_n	Equivalent input noise current		25°C		0.6			0.6		$\text{fA}/\sqrt{\text{Hz}}$
	Gain-bandwidth product	$f = 10\text{ kHz}, R_L = 10\text{ k}\Omega,$ $C_L = 100\text{ pF}$	25°C		1.8			1.8		MHz
ϕ_m	Phase margin at unity gain	$R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}$	25°C		45°			45°		

† Full range is 0°C to 70°C.

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

TLC220x, TLC220xA, TLC220xB, TLC220xY
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TLC2202C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ V (unless otherwise specified)

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

† Full range is 0°C to 70°C.

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

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

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

† Full range is 0°C to 70°C.



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202AC			TLC2202BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		80	500		80	500	μV
		Full range			650			650	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5			0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current	$V_{IC} = 0, \quad R_S = 50\ \Omega$	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	$R_L = 10\ \text{k}\Omega$	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	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	300	560		300	560		V/mV
		Full range	200			200			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	50	100		50	100		
		Full range	25			25			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\min}, \quad V_O = 0, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	25°C		1.8	2.7		1.8	2.7	mA
		Full range			2.7			2.7	

† Full range is 0°C to 70°C.

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

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

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

† Full range is 0°C to 70°C.

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



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202C			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	1000	μV
		Full range			1150	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
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	$V_{IC} = 0, \quad R_S = 50\ \Omega$	Full range			100	pA
		25°C		1		
I_{IB} Input bias current		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	150	315		V/mV
		Full range	100			
	$V_O = 1\text{ V to }4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	25	55		
		Full range	15			
CMRR Common-mode rejection ratio	$V_O = 0, \quad V_{IC} = V_{ICRmin}, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	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	$T_A^\dagger$	TLC2202C			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C	1.6	2.5		$\text{V}/\mu\text{s}$
		Full range	1.1			
V_n Equivalent input noise voltage	$f = 10\ \text{Hz}$	25°C		18		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7		
I_n Equivalent input noise current		25°C		0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		47°		

† Full range is 0°C to 70°C.



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202AC			TLC2202BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	80	500		80	500		μV
		Full range		650			650		
α_{VIO} Temperature coefficient of input offset voltage		Full range	0.5			0.5			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0, R_S = 50\ \Omega$	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			pA
		Full range		100			100		
I_{IB} Input bias current	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	1			1			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	$T_A^\dagger$	TLC2202AC			TLC2202BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C	1.6	2.5		1.6	2.5		$\text{V}/\mu\text{s}$
		Full range	1.1			1.1			
V_n Equivalent input noise voltage (see Note 5)	$f = 10\ \text{Hz}$	25°C		18	35		18	30	$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8	15		8	12	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5			0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		47°			47°		

† Full range is 0°C to 70°C.

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



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201I			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	μV
		Full range			650	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			150	
I_{IB} Input bias current		25°C		1		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	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	400	560		V/mV
		Full range	250			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	90	100		
		Full range	65			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}},$ $V_O = 0, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	25°C		1.1	1.5	mA
		Full range			1.5	

† 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.

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

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

† Full range is -40°C to 85°C .



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TLC2201 electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AI			TLC2201BI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		80	200		80	200	μV
		Full range			350			350	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5			0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5			0.5		pA
		Full range			150			150	
I_{IB} Input bias current		25°C		1			1		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	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	400	560		400	560		V/mV
		Full range	250			250			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	90	100		90	100		
		Full range	65			65			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, \quad V_O = 0, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	25°C		1.1	1.5		1.1	1.5	mA
		Full range			1.5			1.5	

† Full range is -40°C to 85°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.

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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/ μs
		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		μV
	$f = 0.1\text{ to }10\text{ Hz}$	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\text{ kHz}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		48°			48°		

† Full range is -40°C to 85°C .

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

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

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

† Full range is -40°C to 85°C .

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

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

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

† Full range is -40°C to 85°C .



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

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

† 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.

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

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

† Full range is -40°C to 85°C .

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

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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	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C	100	1000	μV
			Full range	1200		
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	μV/mo
I _{IO}	Input offset current	V _{IC} = 0, R _S = 50 Ω	Full range	150		pA
I _{IB}	Input bias current		25°C	1		
			Full range	150		
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	−5 to 2.7		V
V _{OM+}	Maximum positive peak output voltage swing	R _L = 10 kΩ	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 = ± 4 V, R _L = 500 kΩ	25°C	300	560	V/mV
			Full range	150		
		V _O = ± 4 V, R _L = 10 kΩ	25°C	50	100	
			Full range	25		
CMRR	Common-mode rejection ratio	V _O = 0, V _{IC} = V _{ICRmin} , R _S = 50 Ω	25°C	80	115	dB
			Full range	80		
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD} = ±2.3 V to ±8 V	25°C	80	110	dB
			Full range	80		
I _{DD}	Supply current	V _O = 0, 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	$T_A^\dagger$	TLC2202I			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	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		
$V_{N(\text{PP})}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7		
I_n Equivalent input noise current		25°C		0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		48°		

† Full range is -40°C to 85°C .



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202AI			TLC2202BI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C	80	500		80	500		μV
		Full range		700			700		
α_{VIO} Temperature coefficient of input offset voltage		Full range	0.5			0.5			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005		0.001	0.005		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C	0.5			0.5			pA
		Full range		150			150		
I_{IB} Input bias current		25°C	1			1			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	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	300	560		300	560		V/mV
		Full range	150			150			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	50	100		50	100		
		Full range	25			25			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, \quad V_O = 0, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	25°C	1.8	2.7		1.8	2.7		mA
		Full range		2.7			2.7		

† Full range is -40°C to 85°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	$T_A^\dagger$	TLC2202AI			TLC2202BI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C	1.8	2.7		1.8	2.7		$\text{V}/\mu\text{s}$
		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	$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8	15		8	12	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to } 1\ \text{Hz}$	25°C		0.5			0.5		μV
	$f = 0.1\text{ to } 10\ \text{Hz}$	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		48°			48°		

† Full range is -40°C to 85°C .

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



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

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

† Full range is -40°C to 85°C .

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

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

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

† Full range is -40°C to 85°C .



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

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

† Full range is -40°C to 85°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	$T_A^\dagger$	TLC2202AI			TLC2202BI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	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		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		47°			47°		

† Full range is -40°C to 85°C

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



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201M			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	μV
		Full range			700	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			500	
I_{IB} Input bias current		25°C		1		pA
		Full range			500	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	-4.7	-4.9		V
		Full range	-4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	400	560		V/mV
		Full range	200			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	90	100		
		Full range	45			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin},$ $V_O = 0, \quad R_S = 50\ \Omega$	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	$V_O = 0, \quad \text{No load}$	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	$T_A^\dagger$	TLC2201M			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$	25°C	2	2.7		V/ μs
		Full range	1.3			
V_n Equivalent input noise voltage	$f = 10\ \text{Hz}$	25°C		18		nV/ $\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7		
I_n Equivalent input noise current		25°C		0.6		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		1.9		MHz
ϕ_m Phase margin	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		48°		

† Full range is -55°C to 125°C.



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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2201AM			TLC2210BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C	80 200		80 200		μV		
	Full range		400		400					
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5		0.5		μV/°C		
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	0.001	0.005	μV/mo		
I _{IO}	Input offset current		25°C	0.5		0.5		pA		
			Full range	500		500				
I _{IB}	Input bias current		25°C	1		1		pA		
			Full range	500		500				
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	–5 to 2.7		–5 to 2.7		V		
V _{OM+}	Maximum positive peak output voltage swing	R _L = 10 kΩ	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 = ±4 V, R _L = 500 kΩ	25°C	400	560	400	560	V/mV		
			Full range	200		200				
		V _O = ±4 V, R _L = 10 kΩ	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 Ω	25°C	90	115	90	115	dB		
			Full range	85		85				
k _{SVR}	Supply voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD±} ± = ±2.3 V to ±8 V	25°C	90	110	90	110	dB		
			Full range	85		85				
I _{DD}	Supply current	V _O = 0, No load	25°C	1.1	1.5	1.1	1.5	mA		
			Full range	1.5		1.5				

† Full range is -55°C to 125°C .

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

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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/ μs
		Full range	1.3			1.3			
V_n Equivalent input noise voltage (see Note 5)	f = 10 Hz	25°C		18	35		18	30	nV/ $\sqrt{\text{Hz}}$
	f = 1 kHz	25°C		8	15		8	12	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
	f = 0.1 to 10 Hz	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
Gain-bandwidth product	f = 10 kHz, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		48°			48°		

† Full range is -55°C to 125°C .

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201M			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	μV
		Full range			700	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005*	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			500	
I_{IB} Input bias current		25°C		1		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	$V_{IC} = V_{ICR\text{min}},$ $V_O = 0, \quad R_S = 50\ \Omega$	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	

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

† Full range is -55°C to 125°C .

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

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

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

† Full range is -55°C to 125°C .

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2201AM			TLC2210BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C	80 200		80 200		μV		
			Full range	400		400				
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5		0.5		μV/°C		
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	0.001	0.005	μV/mo		
I _{IO}	Input offset current		25°C	0.5		0.5		pA		
			Full range	500		500				
I _{IB}	Input bias current		25°C	1		1		pA		
			Full range	500		500				
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	0 to 2.7		0 to 2.7		V		
V _{OH}	Maximum high-level output voltage	R _L = 10 kΩ	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	V		
			Full range	50		50				
A _{VD}	Large-signal differential voltage amplification	V _O = 1 V to 4 V, R _L = 500 kΩ	25°C	150	315	150	315	V/mV		
			Full range	75		75				
		V _O = 1 V to 4 V, R _L = 10 kΩ	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 Ω	25°C	90	110	90	110	dB		
			Full range	85		85				
k _{SVR}	Supply voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD} = 4.6 V to 16 V	25°C	90	110	90	110	dB		
			Full range	85		85				
I _{DD}	Supply current	V _O = 2.5 V, No load	25°C	1.1	1.5	1.1	1.5	mA		
			Full range	1.5		1.5				

[†] Full range is -55°C to 125°C .

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

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

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

[†] Full range is –55°C to 125°C.

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202M			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	25°C		100	1000	μV
		Full range			1250	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu V/^\circ C$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005*	$\mu V/mo$
I_{IO} Input offset current	$V_{IC} = 0, R_S = 50 \Omega$	Full range			500	pA
		25°C		1		
I_{IB} Input bias current		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	$R_L = 10 k\Omega$	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	$V_O = 1$ V to 4 V, $R_L = 500 k\Omega$	25°C	300	560		V/mV
		Full range	100			
	$V_O = 1$ V to 4 V, $R_L = 10 k\Omega$	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 ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD} = \pm 2.3$ V to ± 8 V	25°C	80	110		dB
		Full range	80			
I_{DD} Supply current	$V_O = 0, \text{No load}$	25°C		1.8	2.7	mA
		Full range			2.7	

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

† Full range is -55°C to 125°C.

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

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

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

† Full range is -55°C to 125°C.



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

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

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

† Full range is -55°C to 125°C .

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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/ μs
		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		μV
	f = 0.1 to 10 Hz	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
Gain-bandwidth product	f = 10 kHz, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C		48°			48°		

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

† Full range is –55°C to 125°C.

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

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2202M			UNIT
				MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C	100	1000	μV	
			Full range	1250			
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5		μV/°C	
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005*	μV/mo	
I _{IO}	Input offset current	V _{IC} = 0, R _S = 50 Ω	Full range	500		pA	
I _{IB}	Input bias current		25°C	1			
			Full range	500			
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	0 to 2.7		V	
V _{OH}	Maximum high-level output voltage	R _L = 10 kΩ	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 V to 4 V, R _L = 500 kΩ	25°C	150	315	V/mV	
			Full range	75			
		V _O = 1 V to 4 V, R _L = 10 kΩ	25°C	25	55		
			Full range	10			
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin} , R _S = 50 Ω	25°C	75	110	dB	
			Full range	75			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD} = 4.6 V to 16 V	25°C	80	110	dB	
			Full range	80			
I _{DD}	Supply current	V _O = 2.5 V, No load	25°C	1.7	2.6	mA	
			Full range	2.6			

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

† Full range is -55°C to 125°C .

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

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

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

† Full range is -55°C to 125°C .



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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2202AM			TLC2202BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C	80	500		80	500	μV	
			Full range	750			750			
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5			0.5			μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005*		0.001	0.005*	μV/mo	
I _{IO}	Input offset current	V _{IC} = 0, R _S = 50 Ω	25°C	0.5			0.5		pA	
			Full range	500			500			
I _{IB}	Input bias current		25°C	1			1		pA	
			Full range	500			500			
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	0 to 2.7			0 to 2.7		V	
V _{OH}	Maximum high-level output voltage	R _L = 10 kΩ	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 V to 4 V, R _L = 500 kΩ	25°C	150	315		150	315	V/mV	
			Full range	75			75			
		V _O = 1 V to 4 V, R _L = 10 kΩ	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 Ω	25°C	75	110		75	110	dB	
			Full range	75			75			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD} = 4.6 V to 16 V	25°C	80	110		80	110	dB	
			Full range	80			80			
I _{DD}	Supply current	V _O = 2.5 V, No load	25°C	1.7	2.6		1.7	2.6	mA	
			Full range		2.6			2.6		

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

† Full range is -55°C to 125°C

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



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

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

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

† Full range is –55°C to 125°C

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

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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		μV
Input offset voltage long-term drift (see Note 4)			0.001		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current			0.5		pA
I_{IB} Input bias current			1		pA
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$		4.8		V
V_{OL} Maximum low-level output voltage	$I_O = 0$		0		mV
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}$, $R_L = 500\ \Omega$		55		V/mV
	$V_O = 1\text{ V to }4\text{ V}$, $R_L = 10\ \Omega$		55		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}$, $V_O = 0$, $R_S = 50\ \Omega$		110		dB
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm} / \Delta V_{IO}$)	$V_{DD} = 4.6\text{ to }16\text{ V}$		110		dB
I_{DD} Supply current per amplifier	$V_O = 2.5\text{ V}$, No load		1		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		
$V_{N(\text{PP})}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$		0.7		
I_n Equivalent input noise current			0.6		$\text{pA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}$, $R_L = 10\ \text{k}\Omega$, $C_L = 100\ \text{pF}$		1.8		MHz
ϕ_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		μV
Input offset voltage long-term drift (see Note 4)			0.001		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current			0.5		pA
I_{IB} Input bias current			1		pA
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$		4.8		V
V_{OL} Maximum low-level output voltage	$I_O = 0$		0		mV
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}$, $R_L = 500\ \Omega$		315		V/mV
	$V_O = 1\text{ V to }4\text{ V}$, $R_L = 10\ \Omega$		55		
CMRR Common-mode rejection ratio	$V_O = 0$, $V_{ICR\text{min}}$, $R_S = 50\ \Omega$		110		dB
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DCC}/\Delta V_{IO}$)	$V_{DD} = 4.6\text{ to }16\text{ V}$		110		dB
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load		1.7		mA

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

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

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

PARAMETER MEASUREMENT INFORMATION

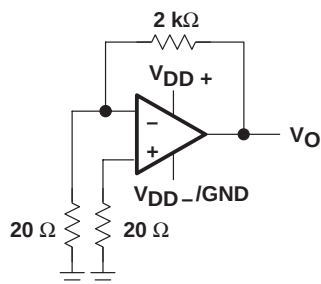
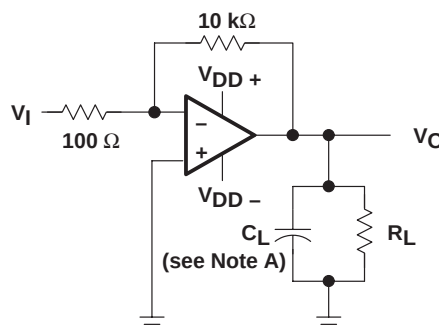
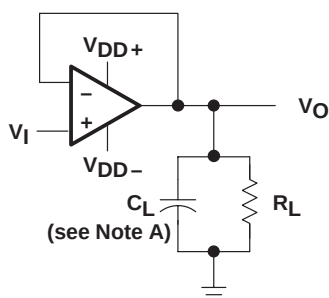


Figure 1. Noise-Voltage Test Circuit



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

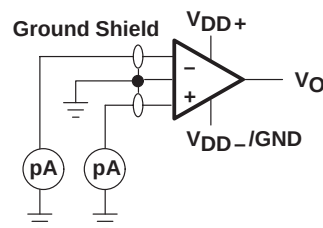


Figure 4. Input-Bias and Offset-Current Test Circuit

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 $f = 10$ Hz and $f = 1$ 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

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	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
ϕ_m	Phase margin	vs Supply voltage	36, 37
		vs Free-air temperature	38, 39
	Phase shift	vs Frequency	17

TLC220x, TLC220xA, TLC220xB, TLC220xY

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TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLC2201
INPUT OFFSET VOLTAGE**

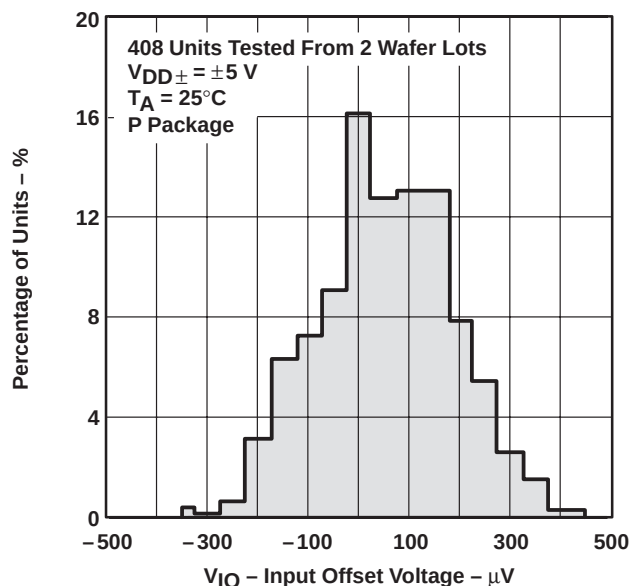


Figure 5

**TLC2202
DISTRIBUTION OF
INPUT OFFSET VOLTAGE**

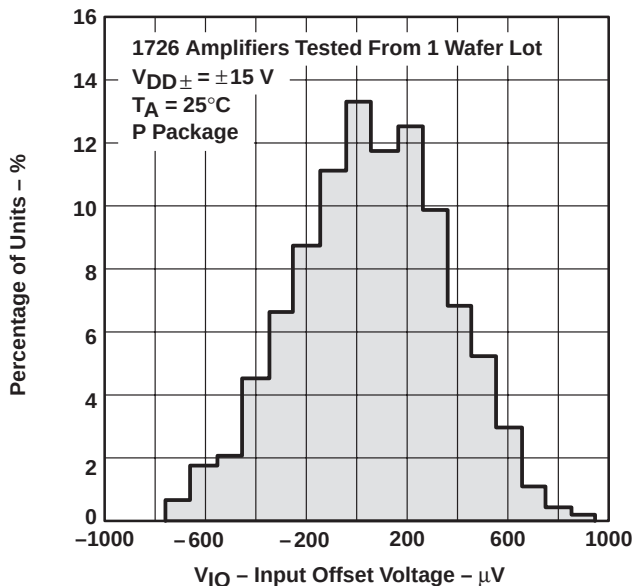


Figure 6

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

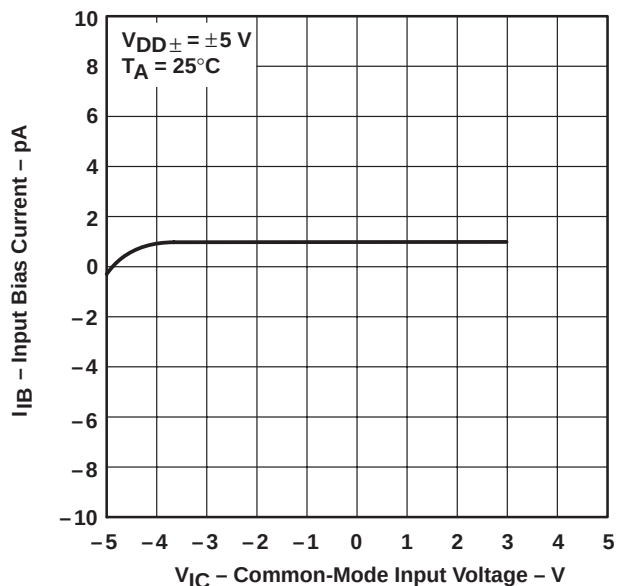


Figure 7

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

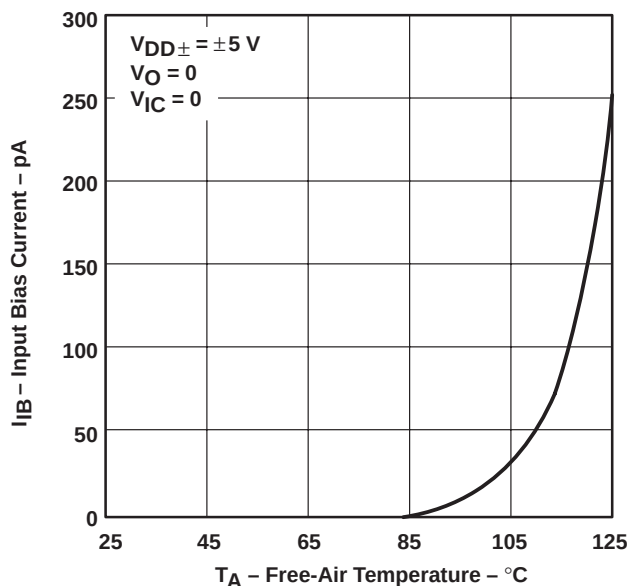


Figure 8

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

TYPICAL CHARACTERISTICS

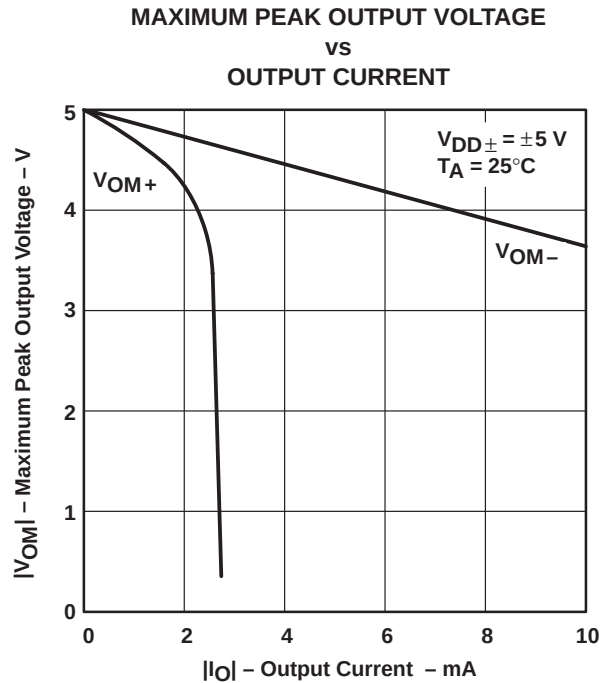


Figure 9

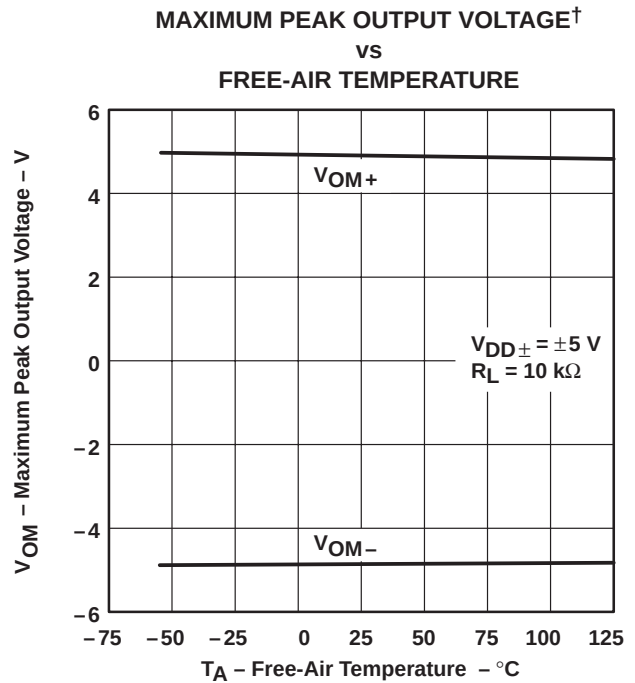


Figure 10

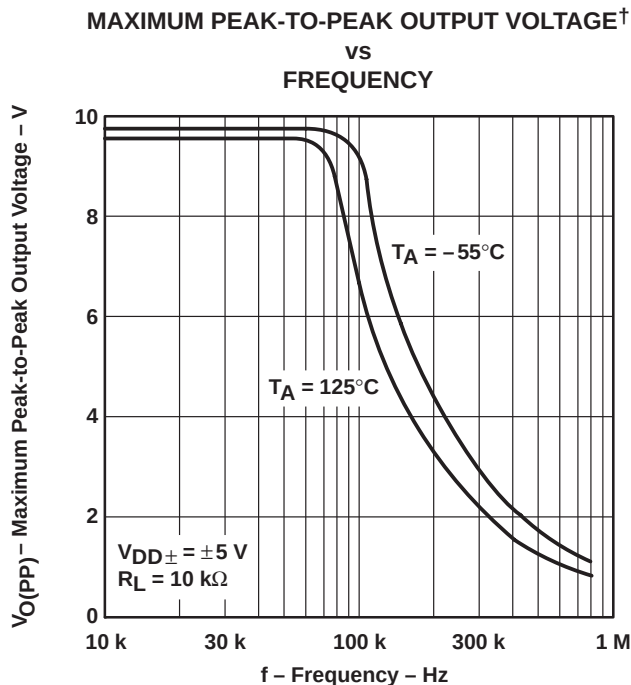


Figure 11

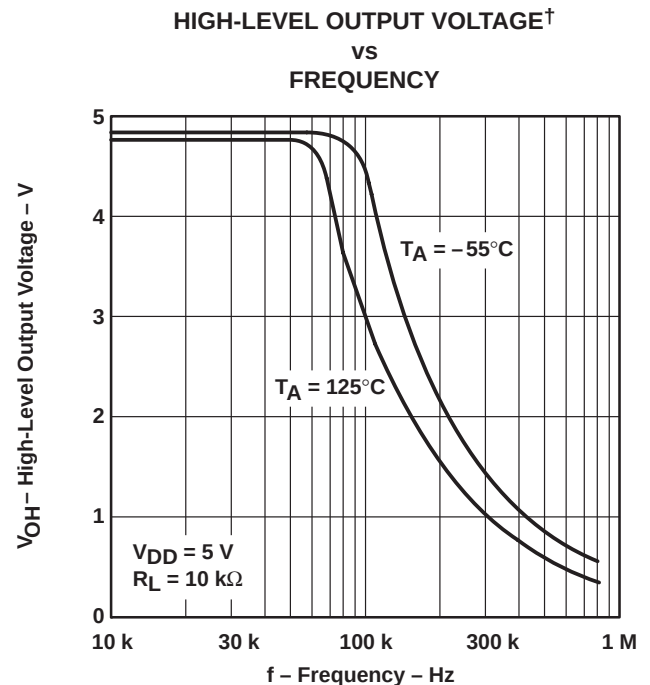


Figure 12

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

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TYPICAL CHARACTERISTICS

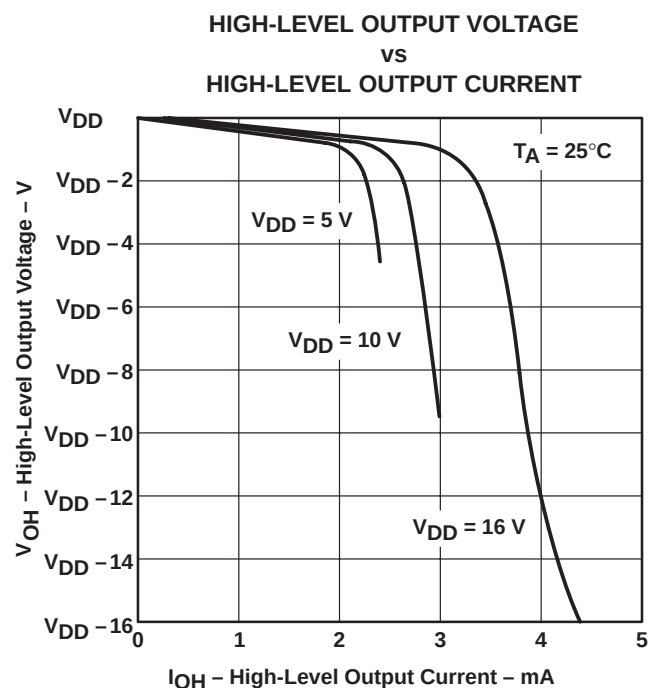


Figure 13

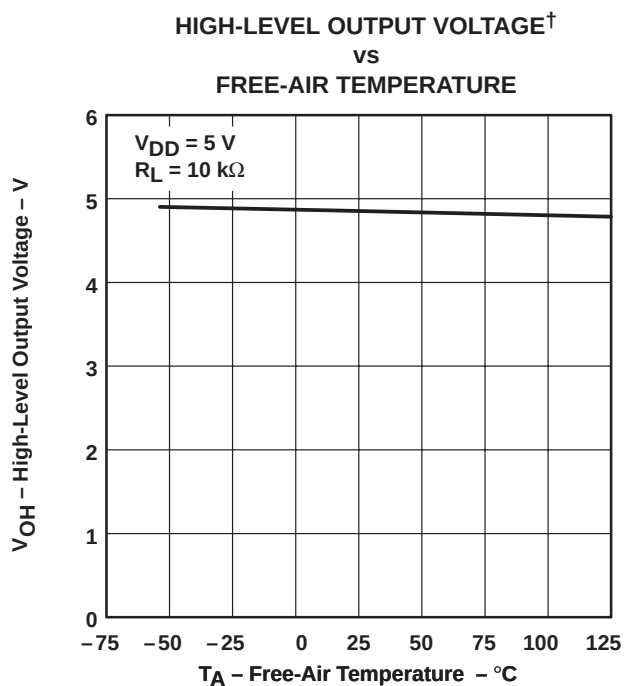


Figure 14

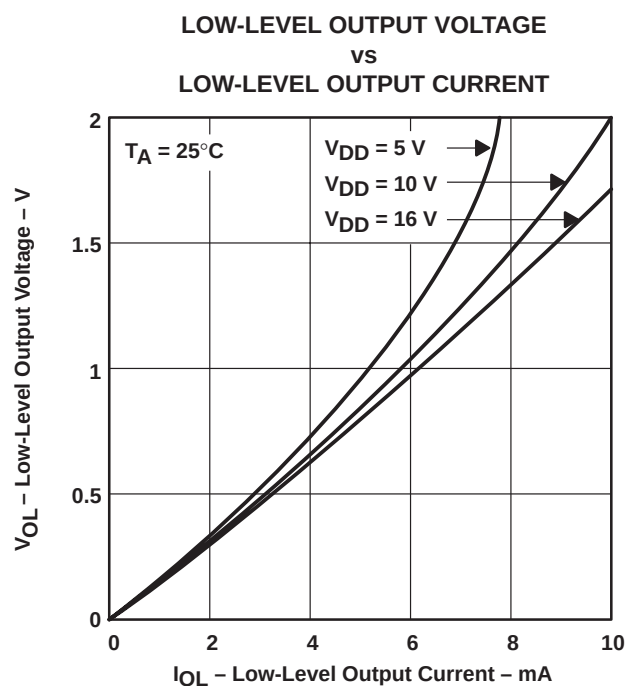


Figure 15

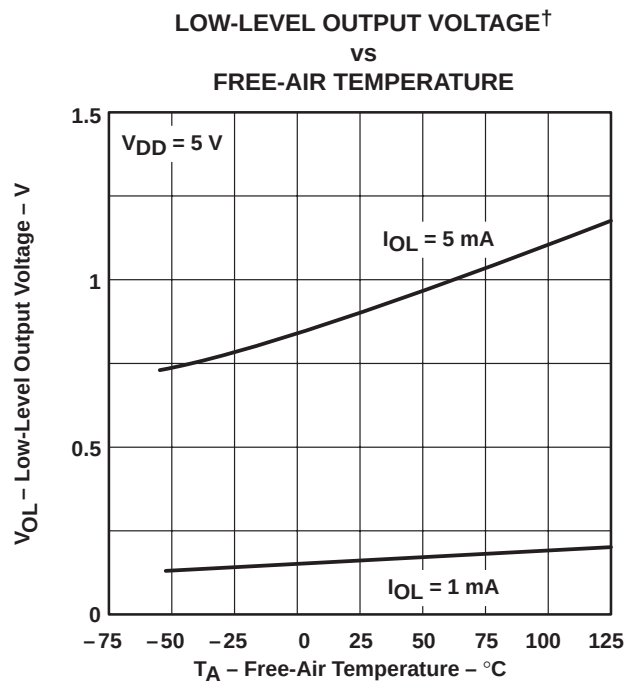


Figure 16

† 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

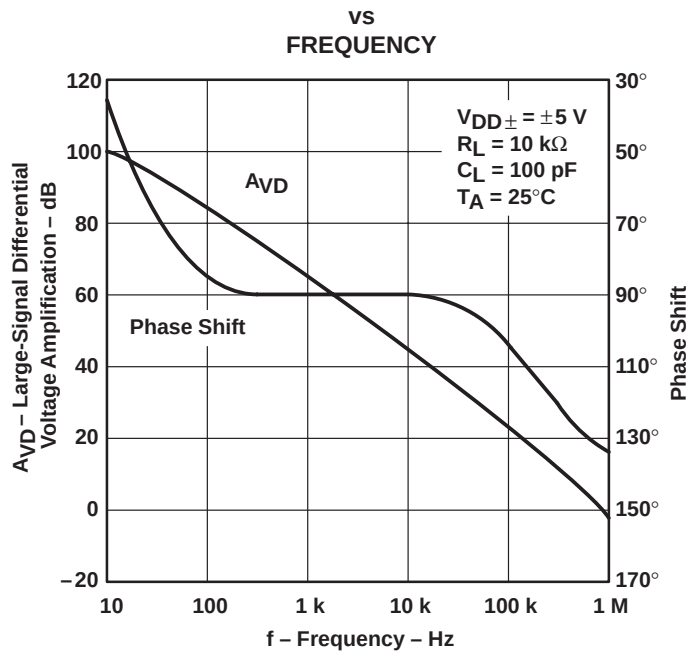


Figure 17

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
AMPLIFICATION†

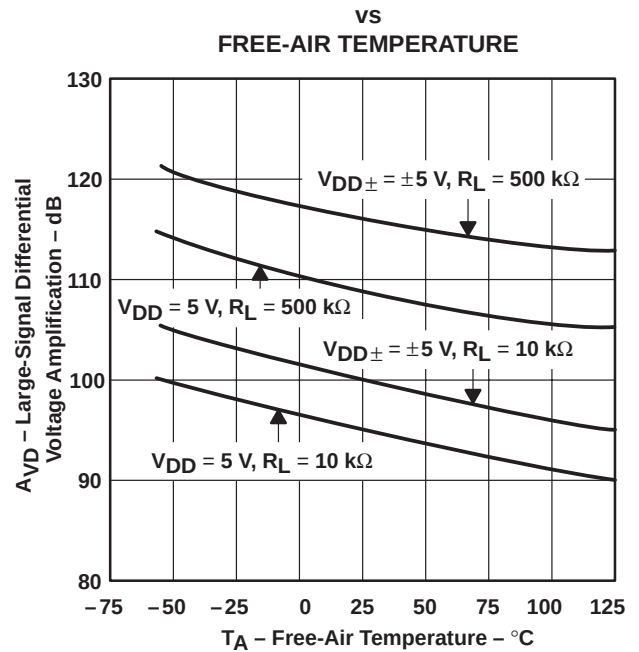


Figure 18

SHORT-CIRCUIT OUTPUT CURRENT

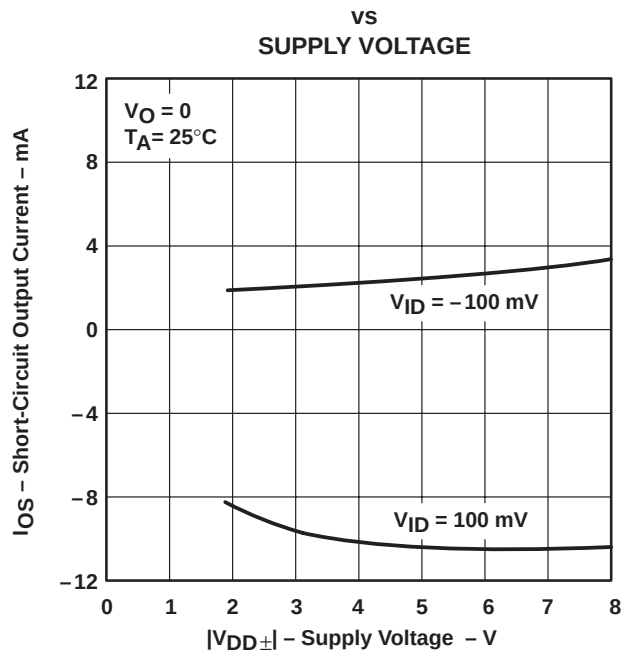


Figure 19

SHORT-CIRCUIT OUTPUT CURRENT†

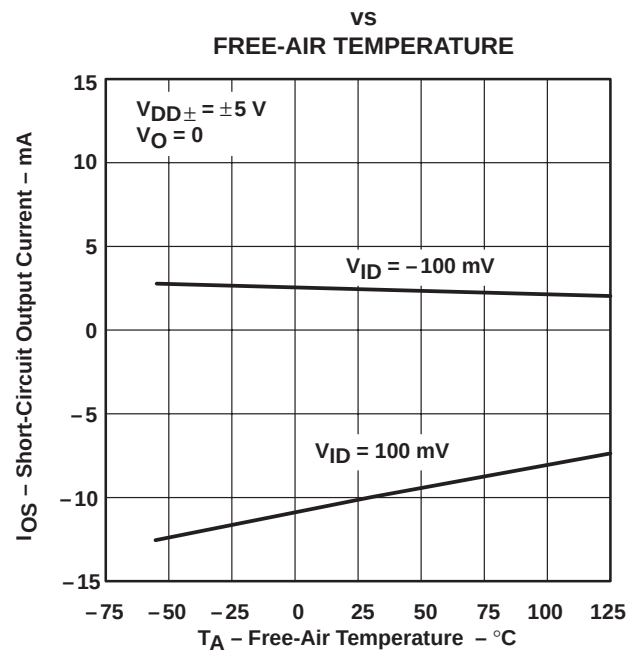


Figure 20

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

TLC220x, TLC220xA, TLC220xB, TLC220xY

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TYPICAL CHARACTERISTICS

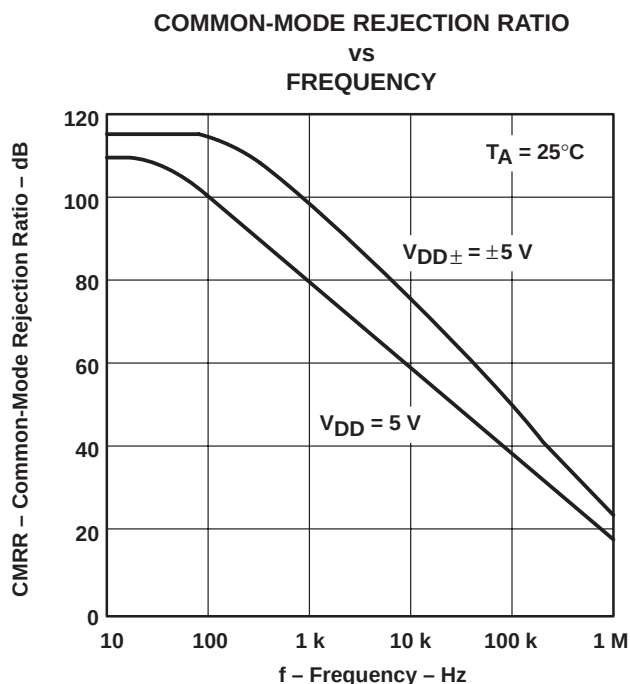


Figure 21

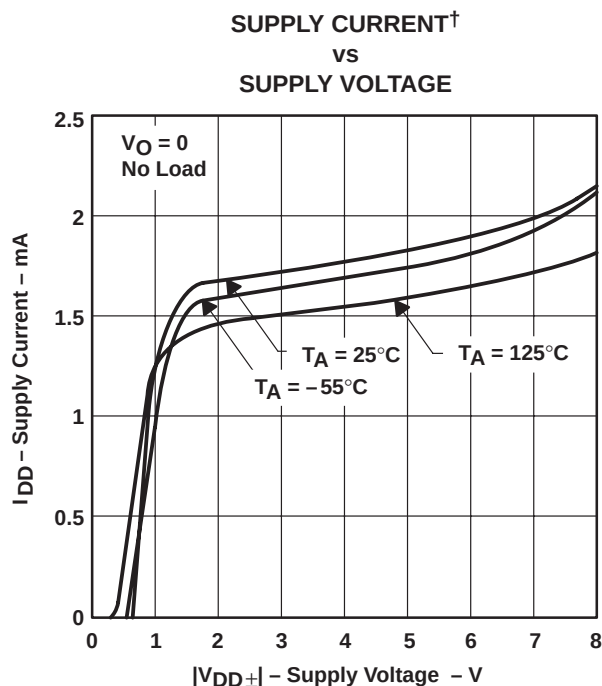


Figure 22

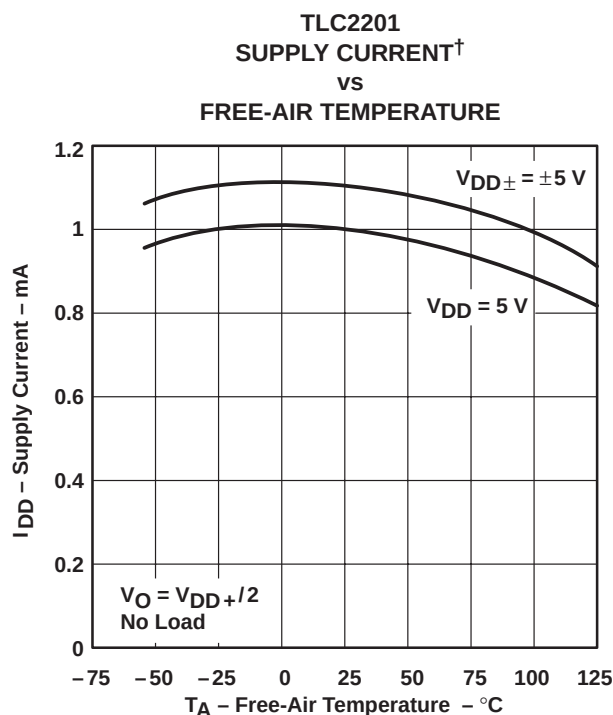


Figure 23

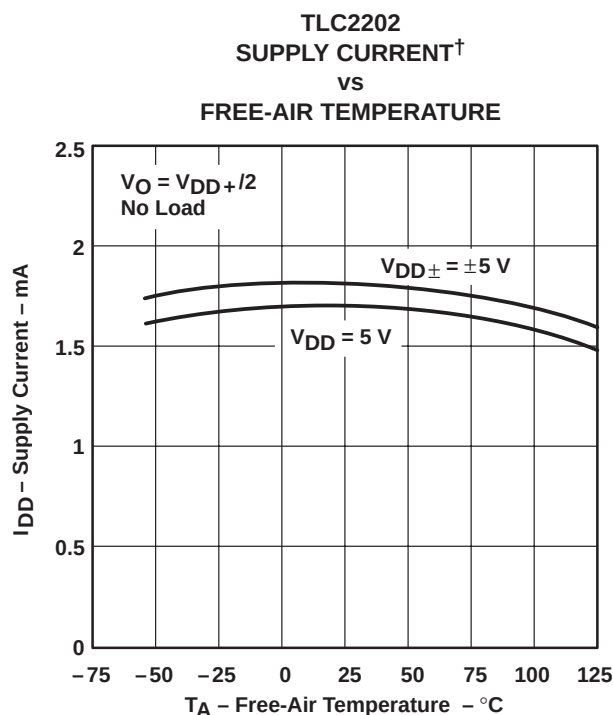


Figure 24

† 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

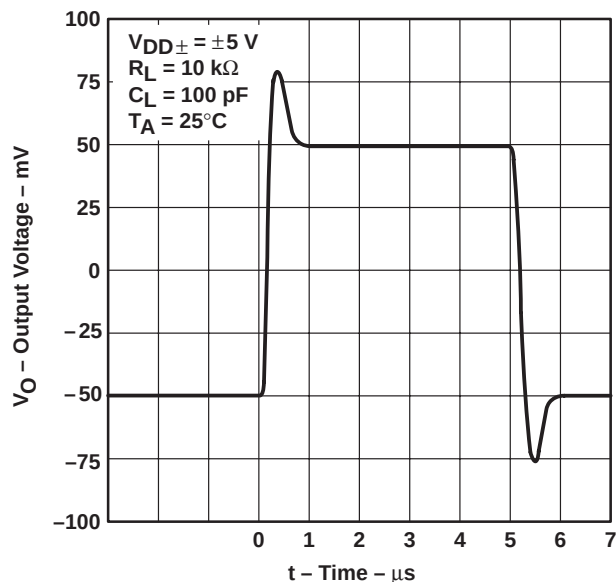


Figure 25

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

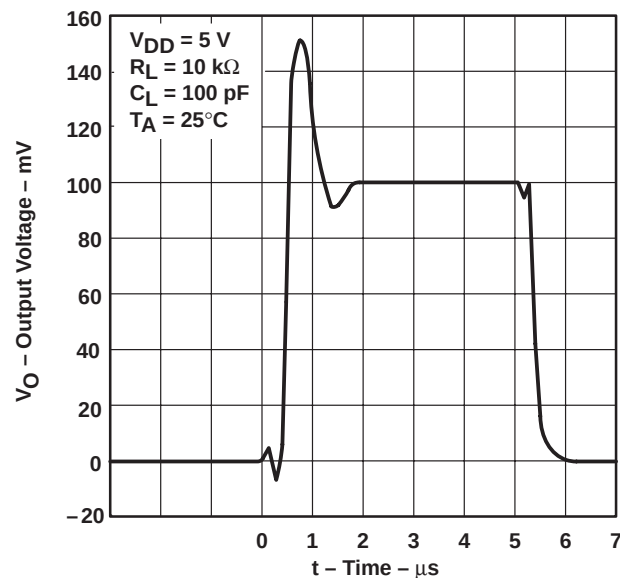


Figure 26

VOLTAGE-FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

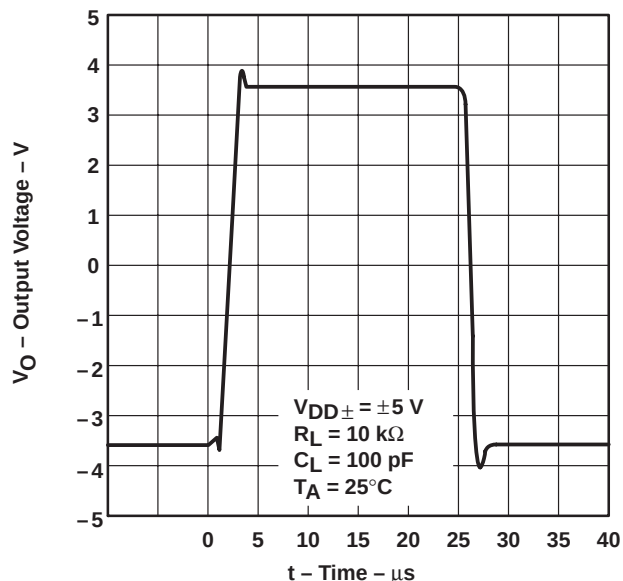


Figure 27

VOLTAGE-FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

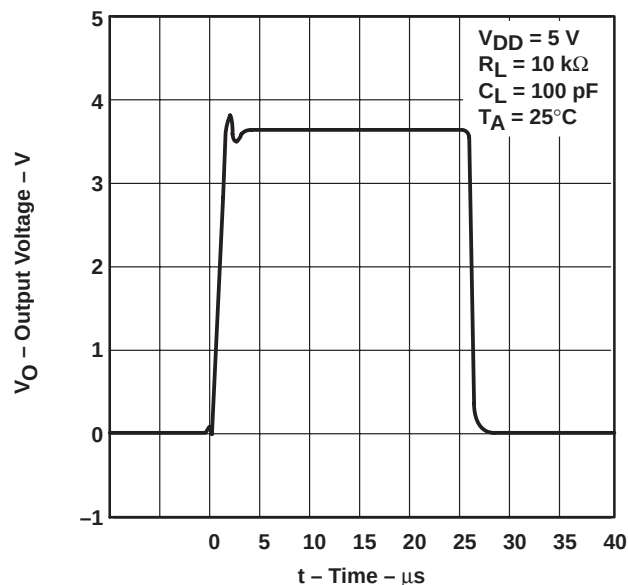


Figure 28

TLC220x, TLC220xA, TLC220xB, TLC220xY

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TYPICAL CHARACTERISTICS

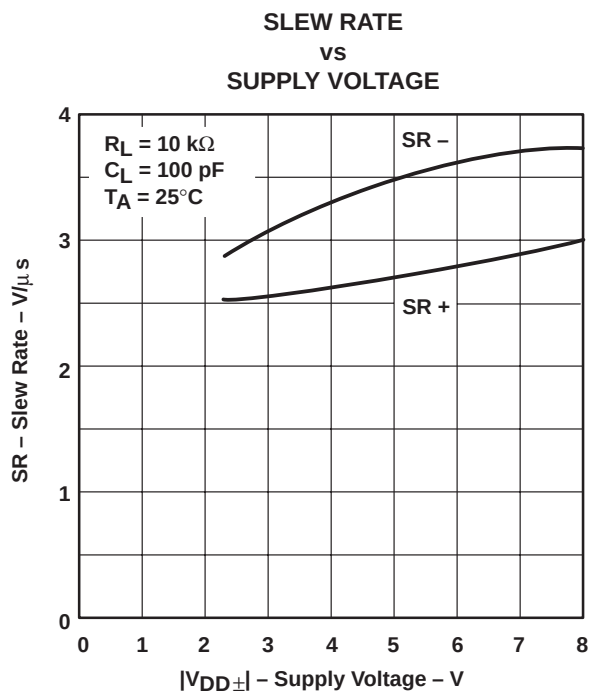


Figure 29

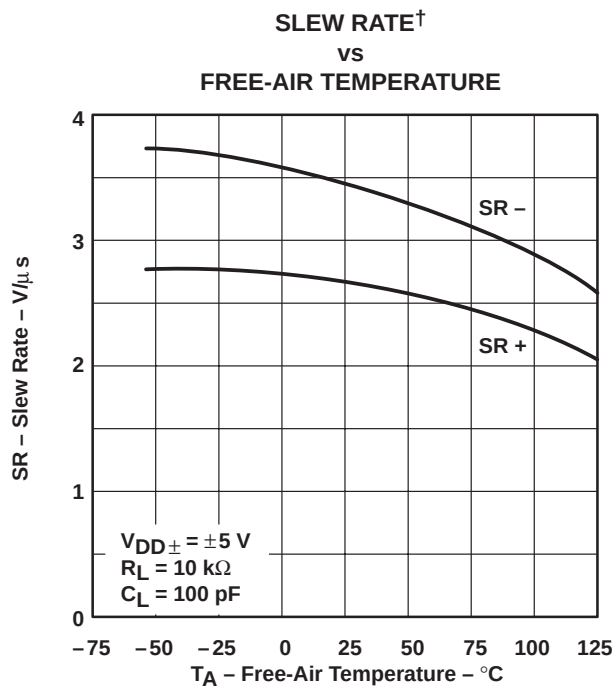


Figure 30

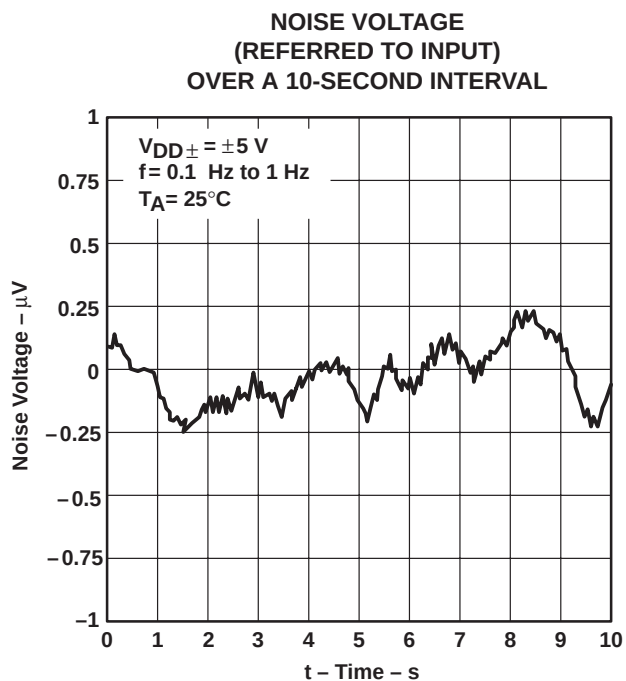


Figure 31

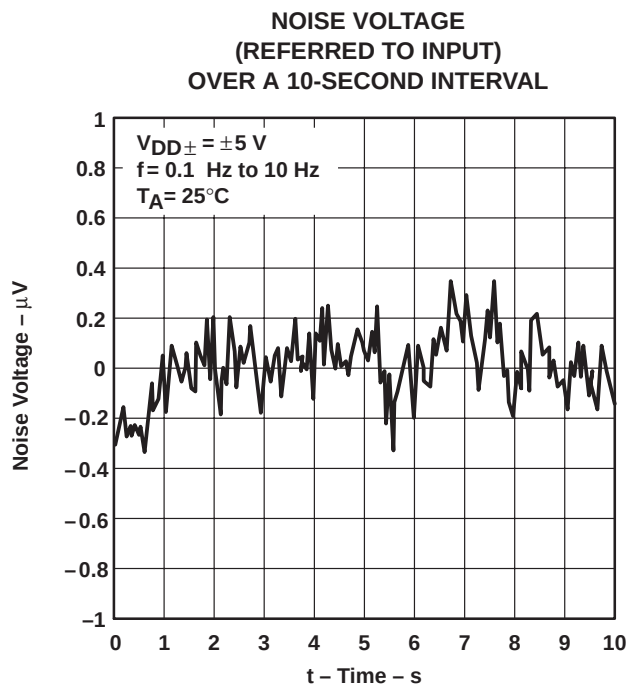


Figure 32

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

TYPICAL CHARACTERISTICS

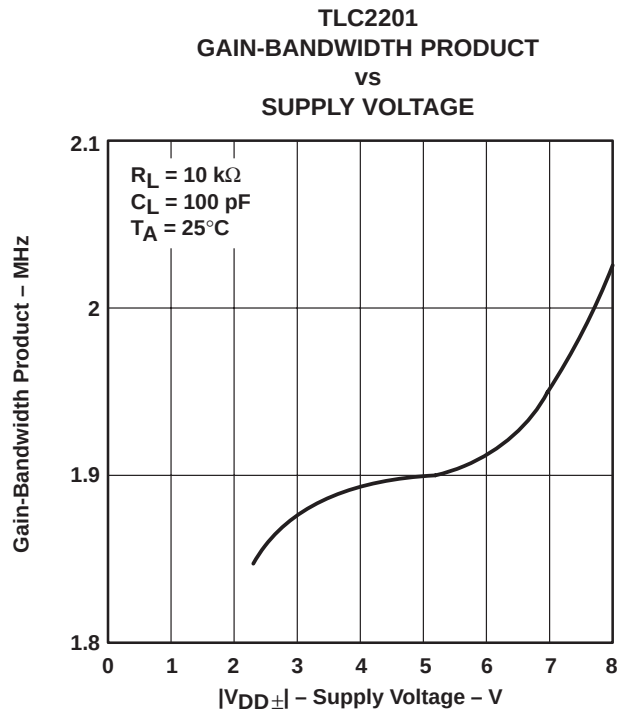


Figure 33

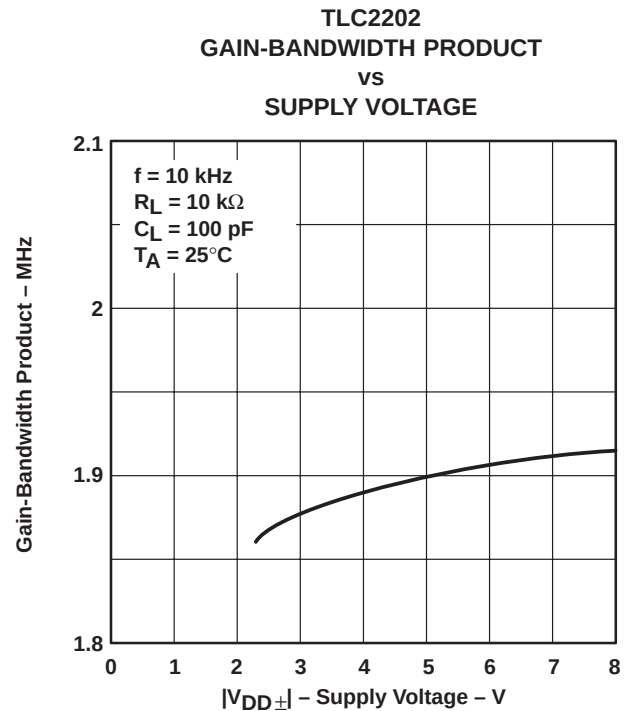


Figure 34

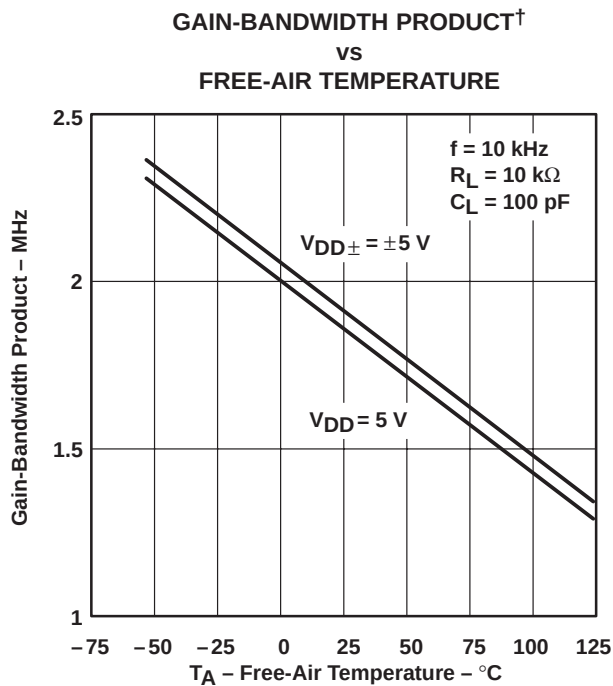


Figure 35

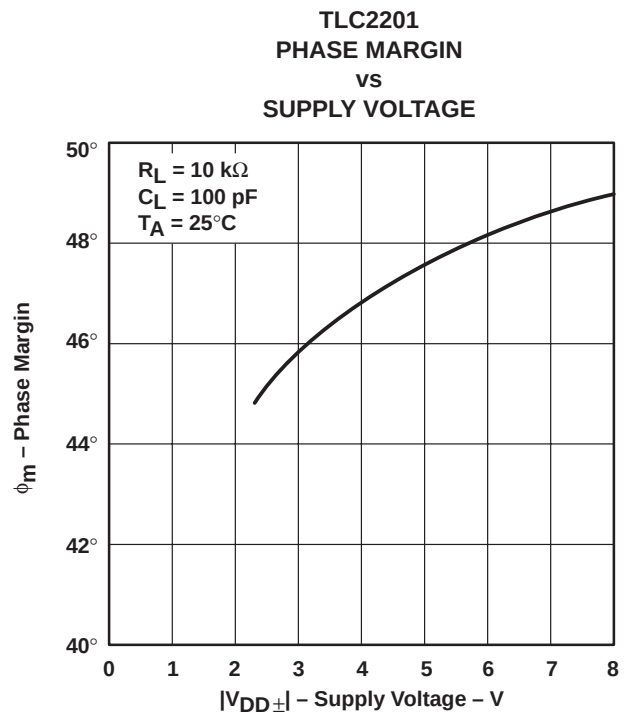


Figure 36

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

TLC220x, TLC220xA, TLC220xB, TLC220xY

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TYPICAL CHARACTERISTICS

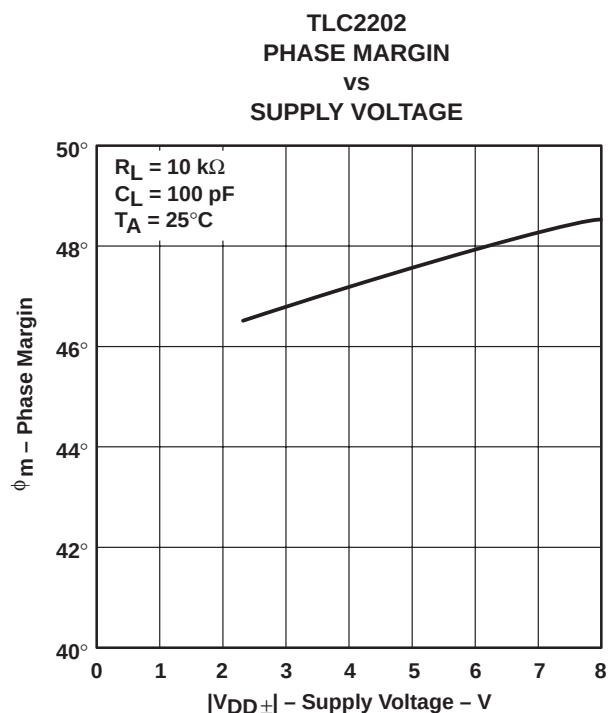


Figure 37

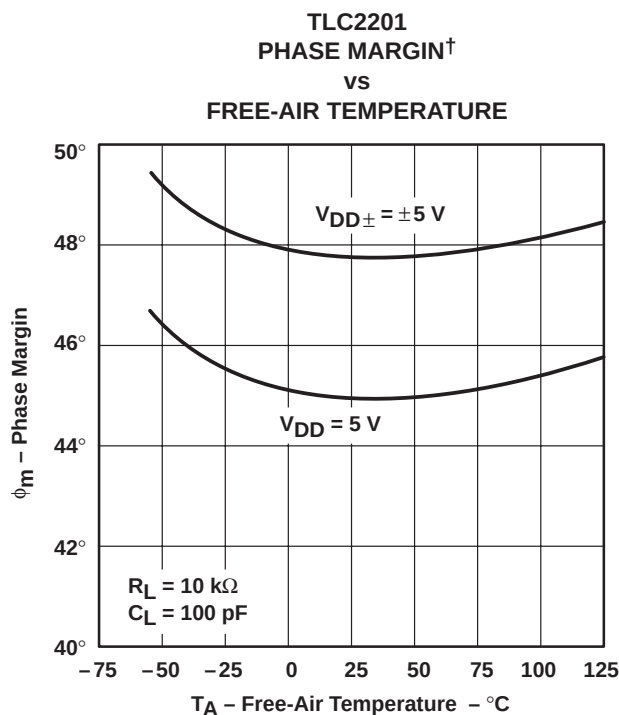


Figure 38

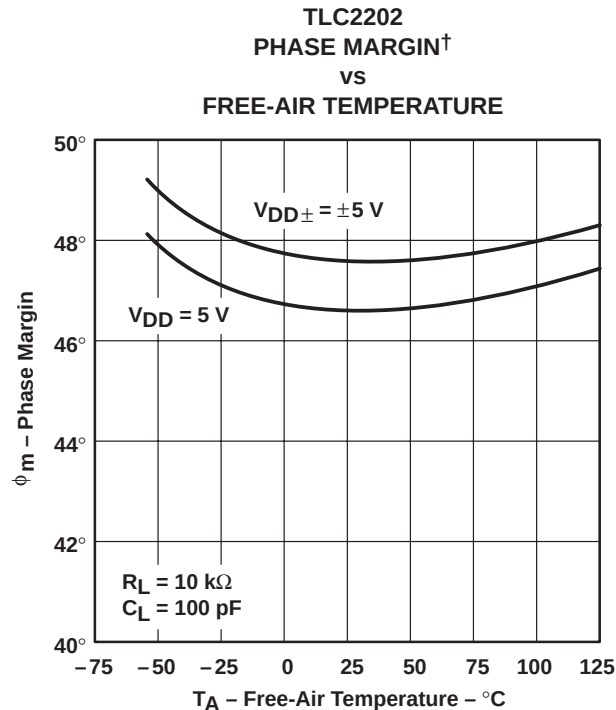


Figure 39

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

APPLICATION INFORMATION

latch-up avoidance

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

electrostatic discharge protection

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

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 40 were generated using the TLC220x typical electrical and operating characteristics at 25°C. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

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

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

PSpice and *Parts* are trademarks of MicroSim Corporation.



TLC220x, TLC220xA, TLC220xB, TLC220xY

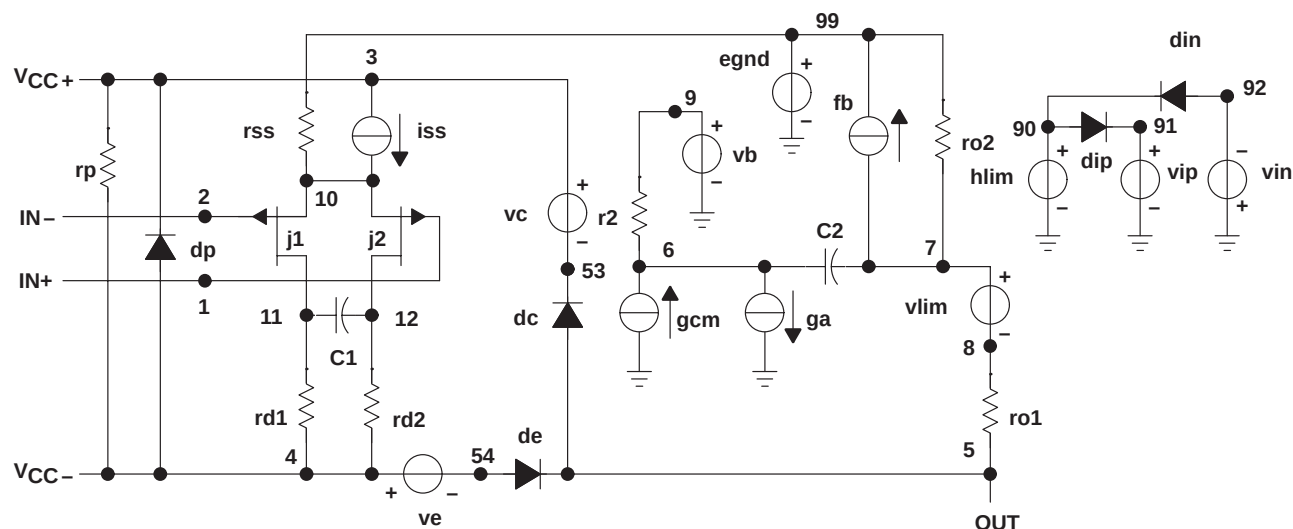
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APPLICATION INFORMATION

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
i1 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

TLC220x, TLC220xA, TLC220xB, TLC220xY
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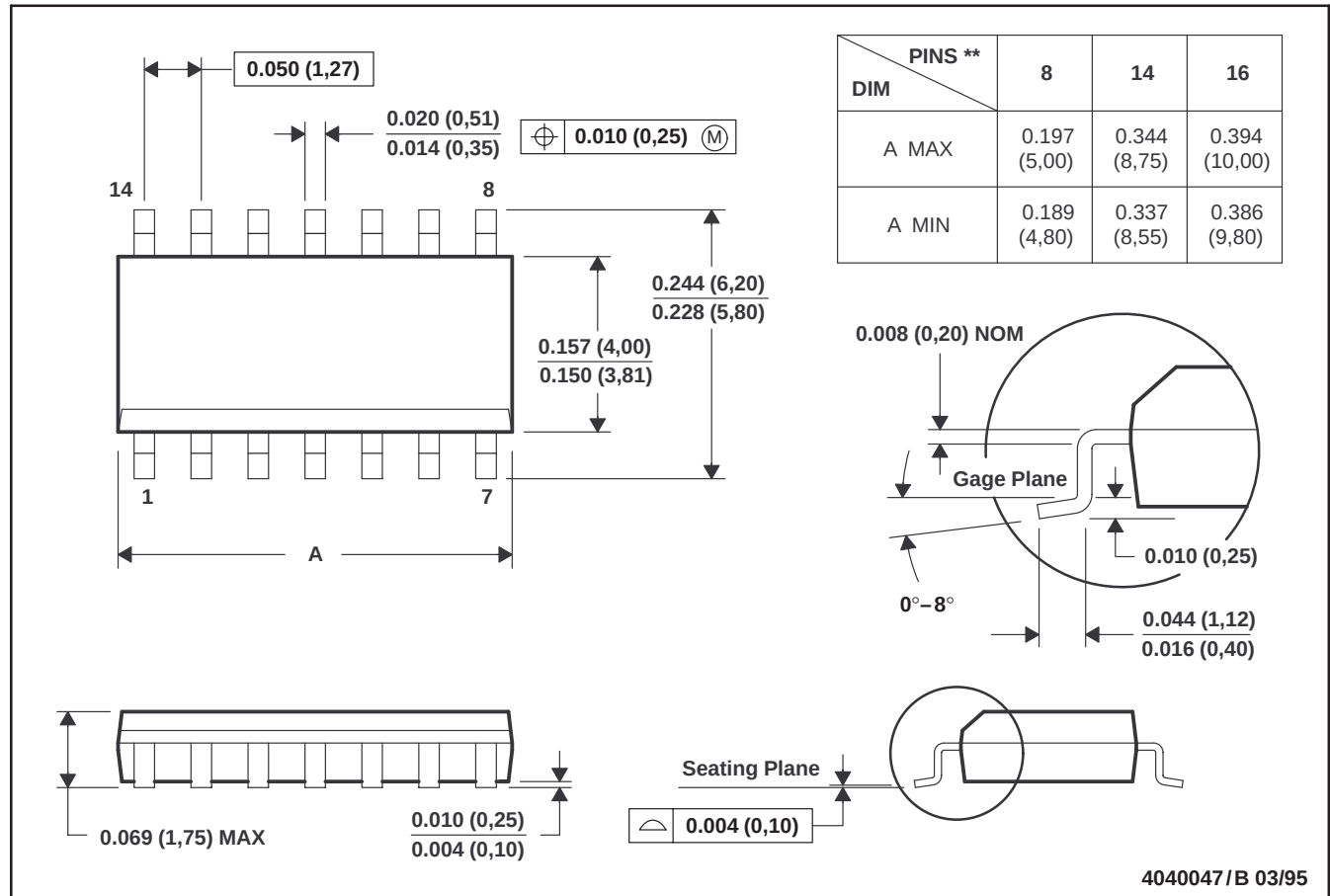
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MECHANICAL INFORMATION

D (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



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

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

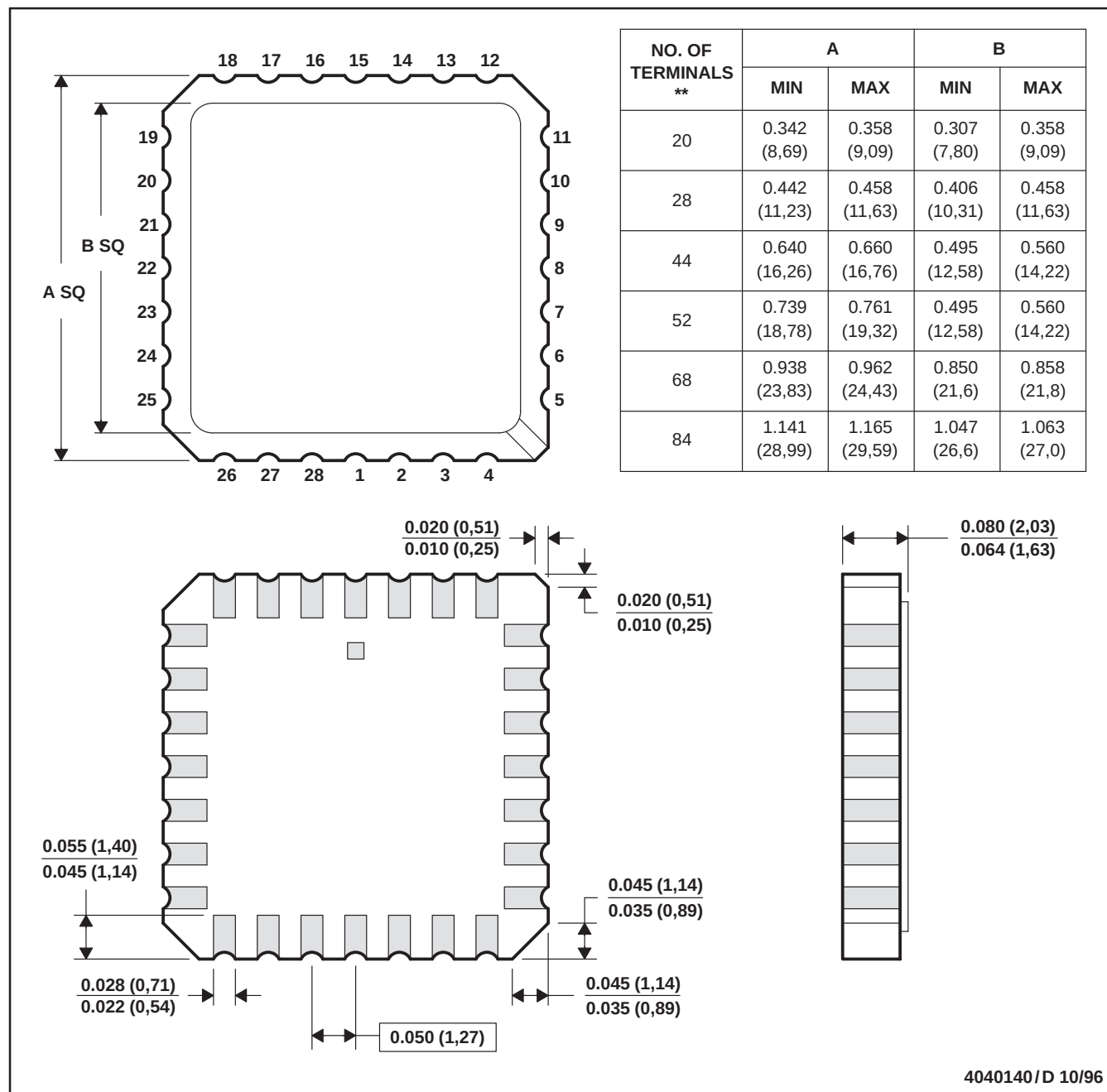
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MECHANICAL INFORMATION

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



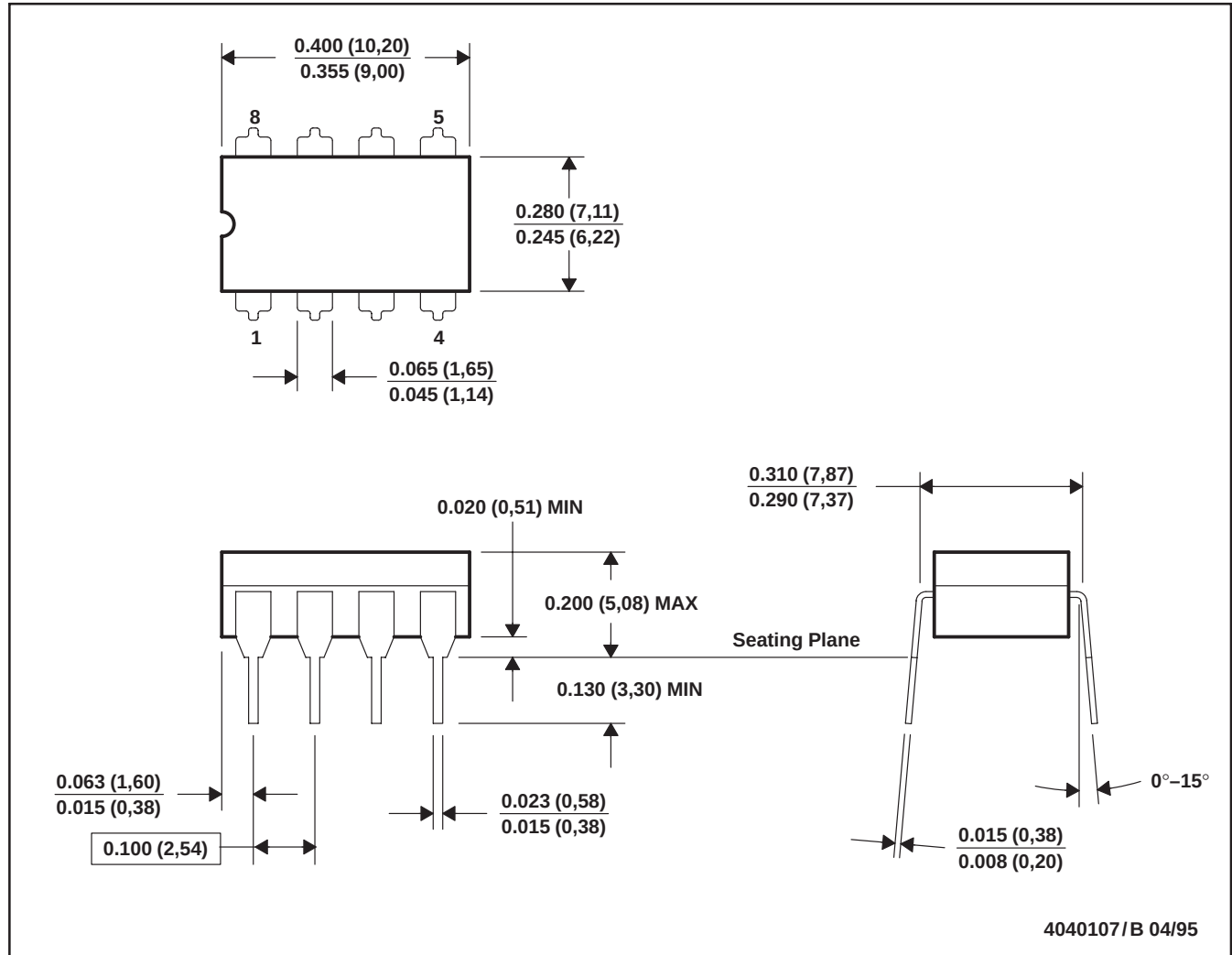
4040140/D 10/96

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

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

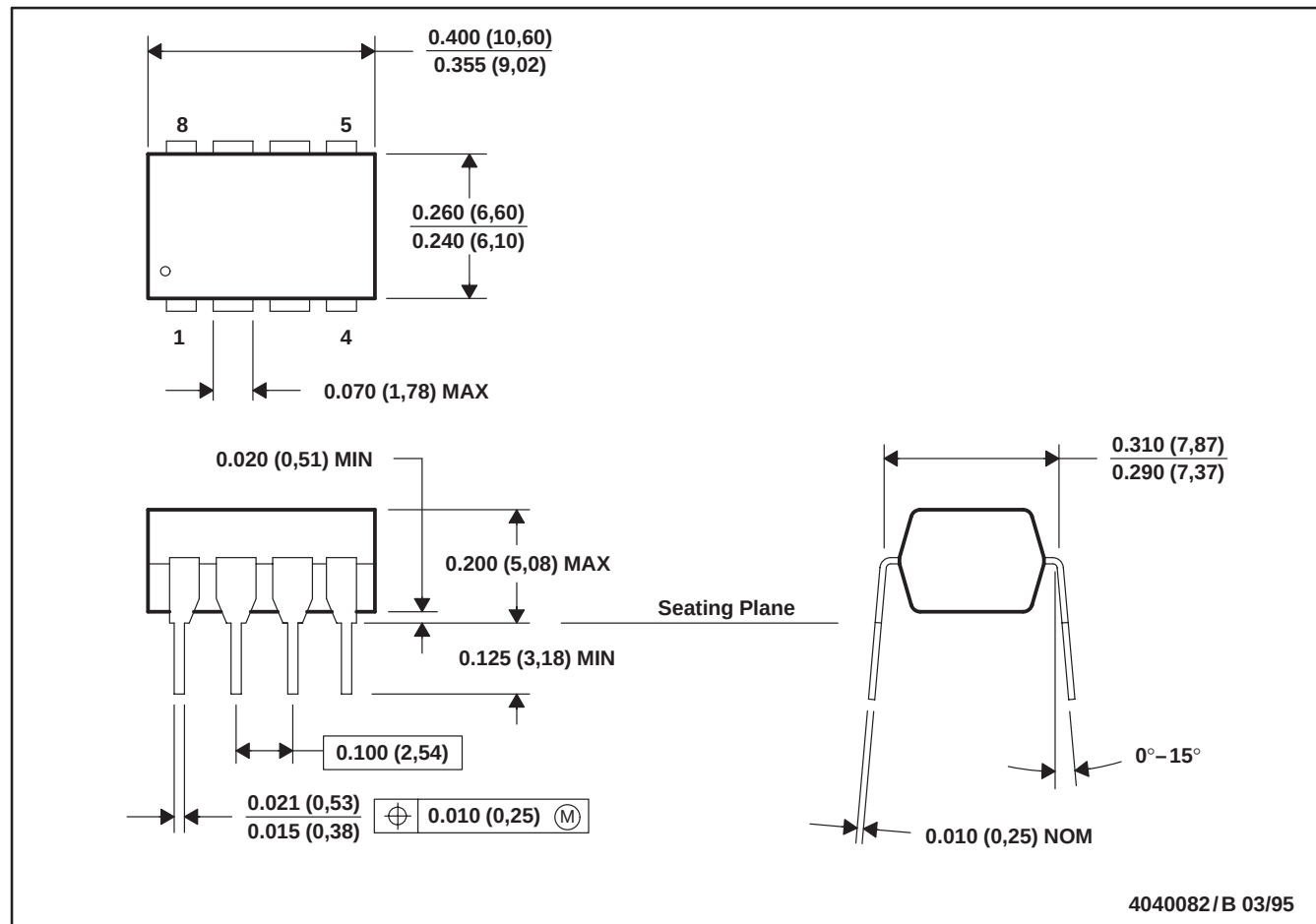
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OPERATIONAL AMPLIFIERS

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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

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