

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

- 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

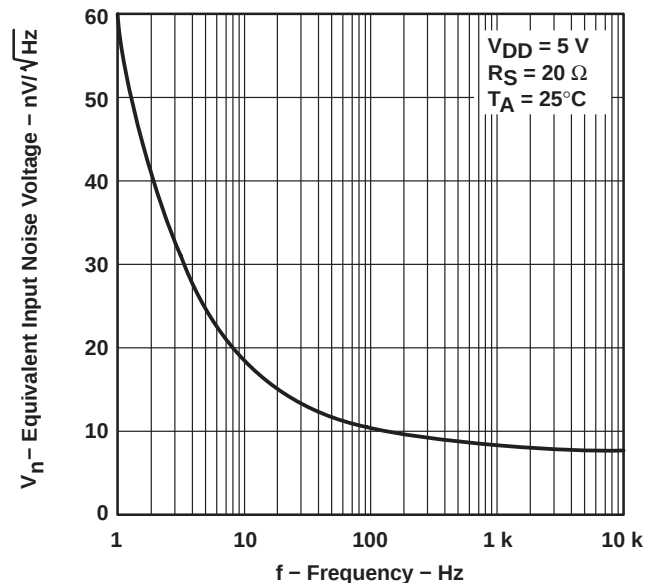
The TLC220x, TLC220xA, TLC220xB, and TLC220xY are precision, low-noise operational amplifiers using Texas Instruments Advanced LinCMOS™ process. These devices combine the noise performance of the lowest-noise JFET amplifiers with the dc precision available previously only in bipolar amplifiers. The Advanced 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



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

Advanced LinCMOS is a trademark of Texas Instruments Incorporated. All other trademarks are the property of their respective owners.

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



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1997–2008, Texas Instruments Incorporated

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

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TLC2201 AVAILABLE OPTIONS

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

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

[‡] Chip forms are tested at 25°C only.

TLC2202 AVAILABLE OPTIONS

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

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

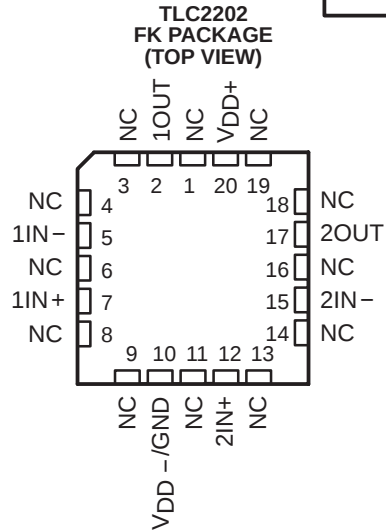
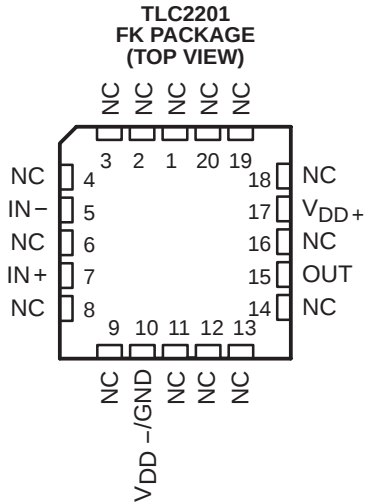
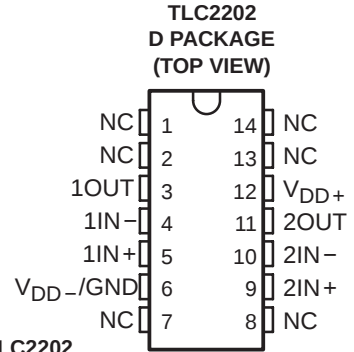
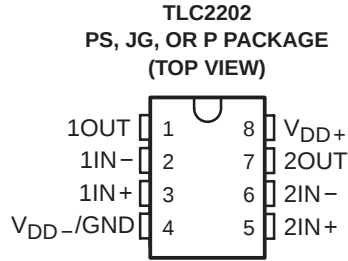
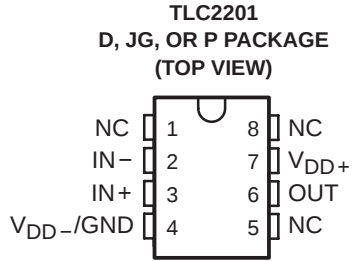
[‡] Chip forms are tested at 25°C only.



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

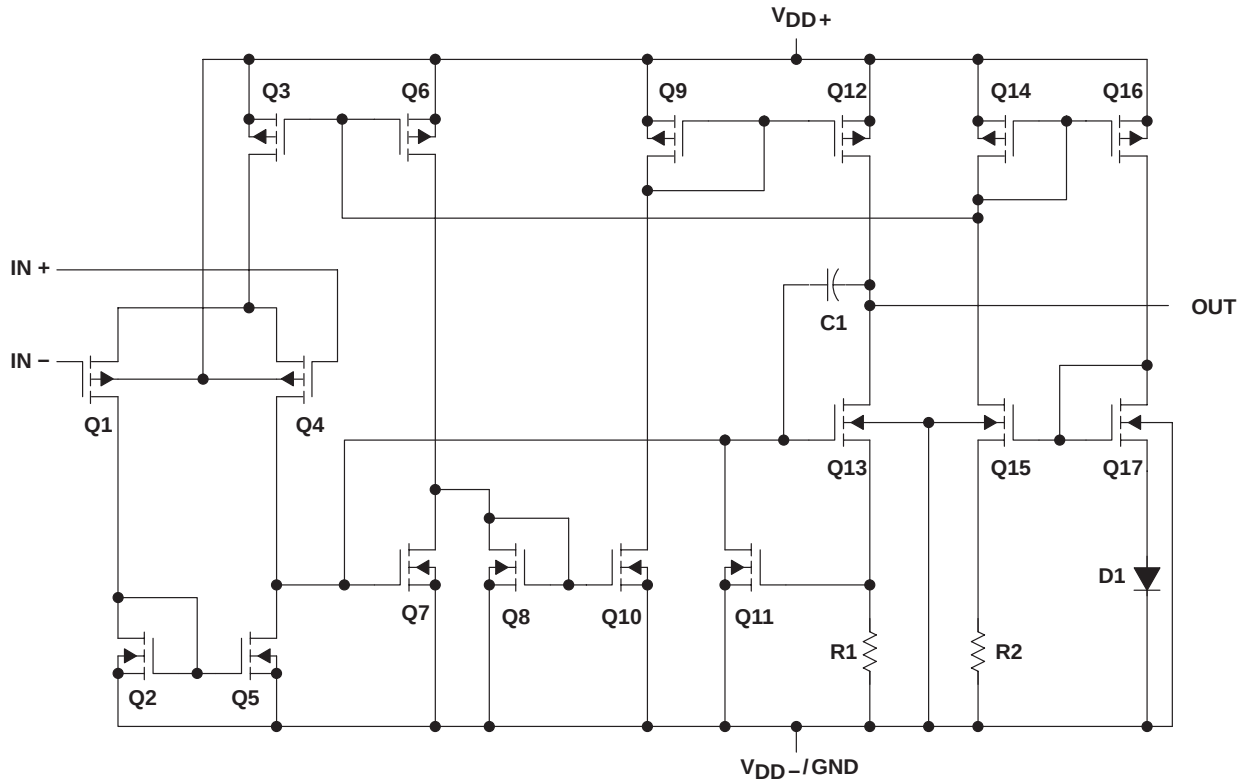


NC – No internal connection

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

equivalent schematic (each amplifier)



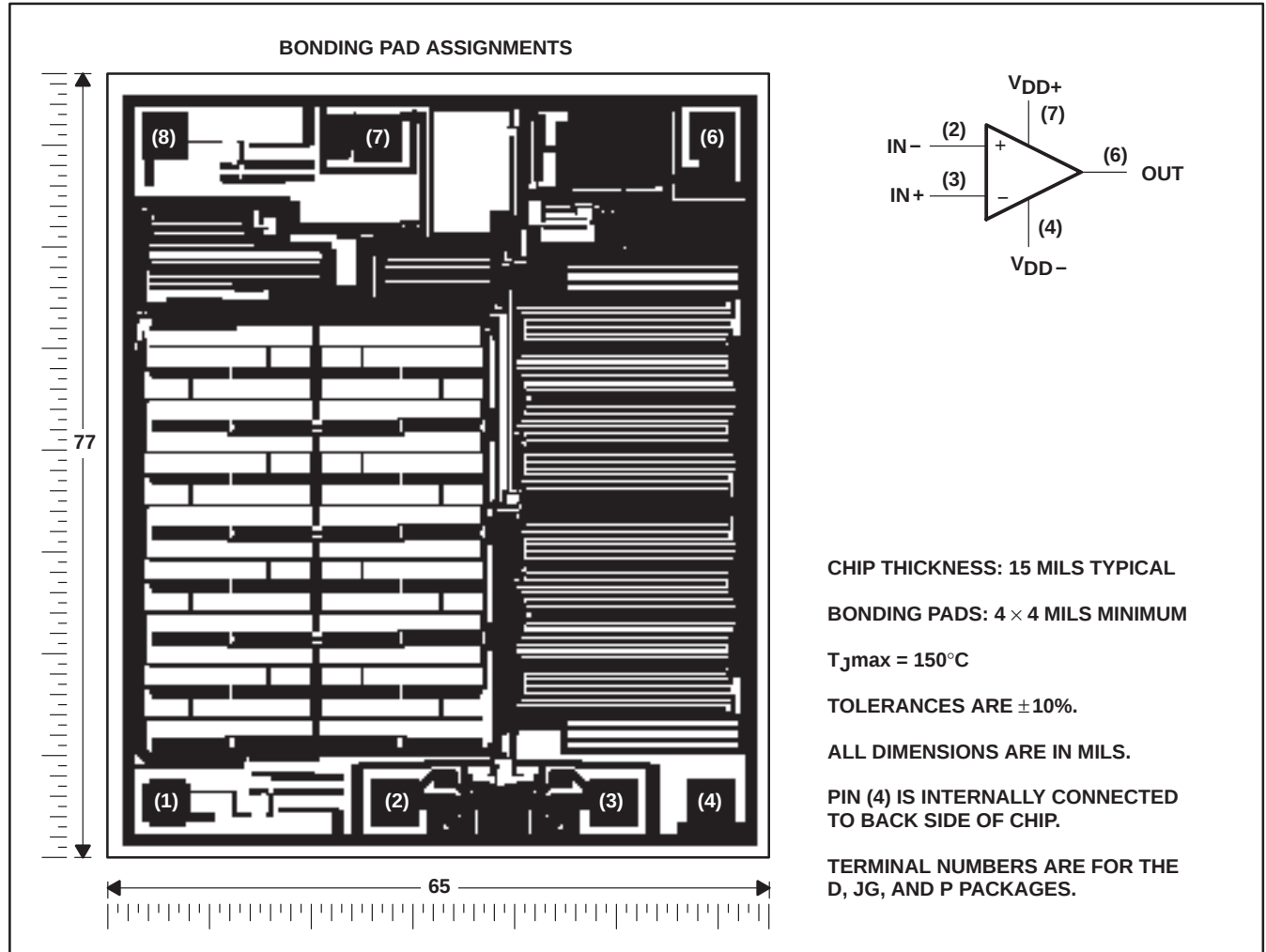
ACTUAL DEVICE COMPONENT COUNT		
COMPONENT	TLC2201	TLC2202
Transistors	17	34
Resistors	2	2
Diodes	1	4
Capacitors	1	2

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TLC2201Y chip information

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

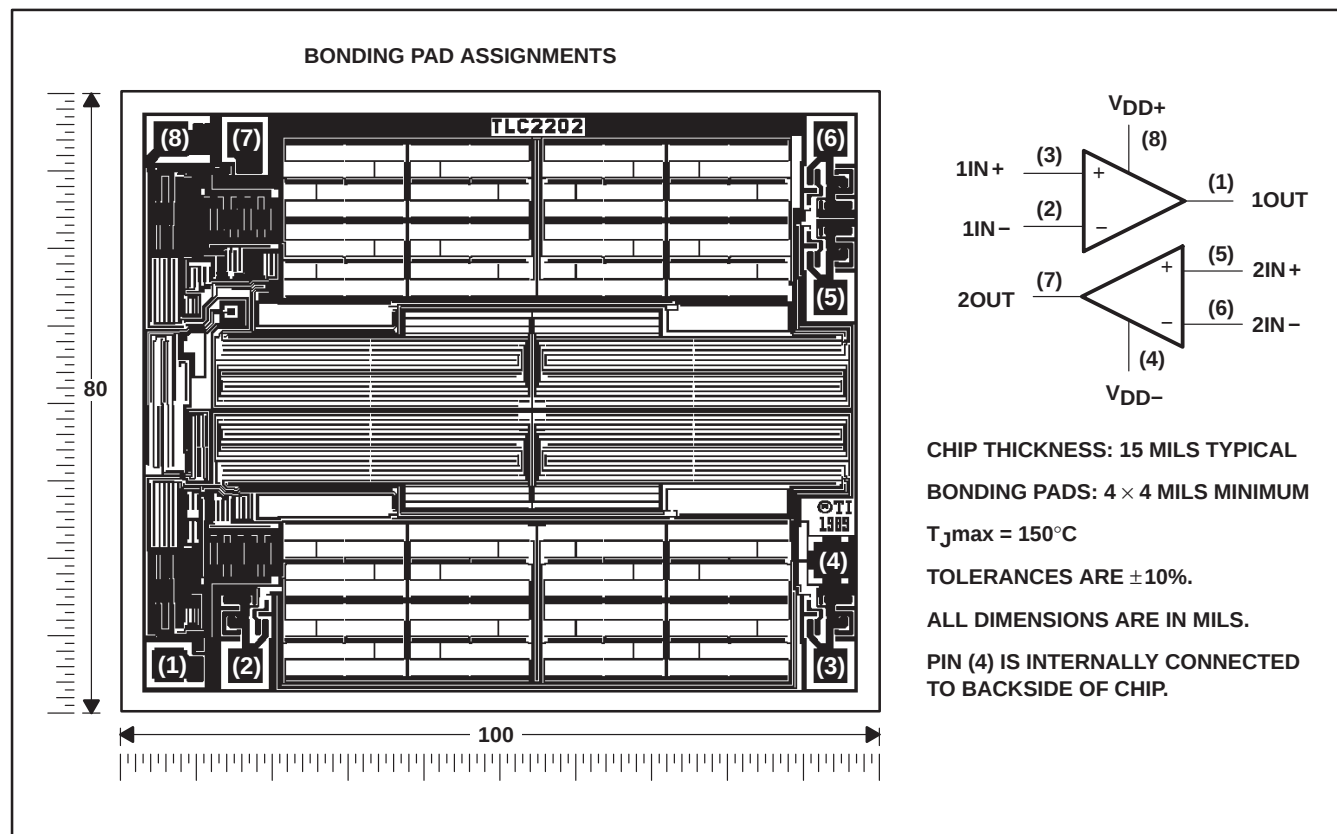


TLC220x, TLC220xA, TLC220xB, TLC220xY Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TLC2202Y chip formation

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



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

Supply voltage, V_{DD+} (see Note 1)	8 V
Supply voltage, V_{DD-}	–8 V
Differential input voltage, V_{ID} (see Note 2)	±16 V
Input voltage, V_I (any input)	±8 V
Input current, I_I (each input)	±5 mA
Output current, I_O (each output)	±50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : C suffix	0°C to 70°C
I suffix	–40°C to 85°C
M suffix	–55°C to 125°C
Storage temperature range	–65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, PS, or P package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package	300°C

[†] Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 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
PS	770 mW	6.2 mW/°C	496 mW	403 mW	155 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW

recommended operating conditions

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



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TLC2201C electrical characteristics at specified free-air temperature, $V_{DD\pm} = \pm 5$ 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		$\mu V/^\circ C$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu V/mo$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			100	
I_{IB} Input bias current		25°C		1	60	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	$R_L = 10 k\Omega$	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	400	560		V/mV
		Full range	300			
	$V_O = \pm 4$ V, $R_L = 10 k\Omega$	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 ($\Delta V_{DD\pm} / \Delta V_{IO}$)	$V_{DD\pm} = \pm 2.3$ V to ± 8 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 $T_A = 150^\circ C$ extrapolated to $T_A = 25^\circ C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201C			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	2	2.7		V/ μs
		Full range	1.5			
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.



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AC			TLC2201BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C	80	200		80	200		μV
		Full range		300			300		
α_{VIO} Temperature coefficient of input offset voltage		Full range	0.5			0.5			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005		0.001	0.005		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C	0.5	60		0.5	60		pA
		Full range		100			100		
I_{IB} Input bias current		25°C	1	60		1	60		pA
		Full range		100			100		
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	–5 to 2.7			–5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
		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	300			300			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	90	100		90	100		
		Full range	70			70			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin},$ $V_O = 0, \quad R_S = 50\ \Omega$	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 0°C to +70°C.

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

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AC			TLC2201BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C	2	2.7		2	2.7		V/ 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.

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			100	
I_{IB} Input bias current		25°C		1	60	pA
		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	150	315		V/mV
		Full range	100			
	$V_O = 1\text{ V to }4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	25	55		
		Full range	15			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, \quad V_O = 0, \quad R_S = 50\ \Omega$	25°C	90	110		dB
		Full range	85			
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD\pm}/\Delta V_{IO}$)	$V_{DD} = 4.6\text{ V to }16\text{ V}$	25°C	90	110		dB
		Full range	85			
I_{DD} Supply current	$V_O = 2.5\text{ V}, \quad \text{No load}$	25°C		1	1.5	mA
		Full range			1.5	

† Full range is 0°C to +70°C.

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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.



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	60	0.5	60	pA		
			Full range	100			100			
I _{IB}	Input bias current		25°C	1	60	1	60	pA		
			Full range	100			100			
V _{ICR}	Common-mode input voltage range	R _S = 50 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.

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AC			TLC2201BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\text{ k}\Omega, \quad C_L = 100\text{ pF}$	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		$f = 10\text{ kHz}, \quad R_L = 10\text{ k}\Omega,$ $C_L = 100\text{ pF}$	25°C	1.8			1.8		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega, \quad C_L = 100\text{ pF}$	25°C		45°			45°		

† Full range is 0°C to +70°C.

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



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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	
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		Full range		0.5		$\mu V/^\circ C$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu V/mo$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			100	
I_{IB} Input bias current		25°C		1	60	
		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50 \Omega$	Full range	-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10 k\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	-4.7	-4.9		V
		Full range	-4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4$ V, $R_L = 500 k\Omega$	25°C	300	560		V/mV
		Full range	200			
	$V_O = \pm 4$ V, $R_L = 10 k\Omega$	25°C	50	100		
		Full range	25			
CMRR Common-mode rejection ratio	$V_O = 0, \quad V_{IC} = V_{ICRmin}, \quad R_S = 50 \Omega$	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.



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2202AC			TLC2202BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	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	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	60		0.5	60	pA
			Full range			100			100	
I _{IB}	Input bias current		25°C		1	60		1	60	pA
			Full range			100			100	
V _{ICR}	Common-mode input voltage range	R _S = 50 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		300	560		300	560	V/mV
			Full range		200			200		
		V _O = ±4 V, R _L = 10 kΩ	25°C		50	100		50	100	
			Full range		25			25		
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin} , V _O = 0, R _S = 50 Ω	25°C		80	115		80	115	dB
			Full range		80			80		
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD±} /ΔV _{IO})	V _{DD±} = ±2.3 V to ±8 V	25°C		80	110		80	110	dB
			Full range		80			80		
I _{DD}	Supply current	V _O = 0, 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	
$V_{N(\text{PP})}$ 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.



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	$V_{IC} = 0, \quad R_S = 50\ \Omega$	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		25°C	0.5	60		0.5	60		pA
		Full range			100			100	
I_{IB} Input bias current		25°C	1	60		1	60		pA
		Full range			100			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
		Full range	4.7			4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C	0	50		0	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 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	$V_O = 0.5\text{ V to }2.5\text{ V}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C	1.6	2.5		1.6	2.5		$\text{V}/\mu\text{s}$
		Full range	1.1			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	$R_I = 10\ \text{k}\Omega, \quad C_I = 100\ \text{pF}$	25°C		47°			47°		

† Full range is 0°C to +70°C.

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



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	60	pA
		Full range			150	
I_{IB} Input bias current		25°C		1	60	pA
		Full range			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	-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	$V_{IC} = V_{ICRmin},$ $V_O = 0, \quad R_S = 50\ \Omega$	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 -40°C to $+85^\circ\text{C}$.

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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 $+85^\circ\text{C}$.



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TLC2201I 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	60		0.5	60	pA
		Full range			150			150	
I_{IB} Input bias current		25°C		1	60		1	60	pA
		Full range			150			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	–5 to 2.7			–5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
		Full range	4.7			4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	–4.7	–4.9		–4.7	–4.9		V
		Full range	–4.7			–4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	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.

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AI			TLC2201BI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	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 $+85^\circ\text{C}$.

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

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	60	pA
		Full range			150	
I_{IB} Input bias current		25°C		1	60	pA
		Full range			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 500\ \text{k}\Omega$	25°C	150	315		V/mV
		Full range	100			
	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 10\ \text{k}\Omega$	25°C	25	55		
		Full range	15			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}},$ $V_O = 0, \quad R_S = 50\ \Omega$	25°C	90	110		dB
		Full range	85			
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} \pm \Delta V_{IO}$)	$V_{DD} = 4.6\text{ V to }16\text{ V}$	25°C	90	110		dB
		Full range	85			
I_{DD} Supply current	$V_O = 2.5\text{ V}, \quad \text{No load}$	25°C		1	1.5	mA
		Full range			1.5	

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

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

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

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

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



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	T_A †	TLC2201AI			TLC2201BI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	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	60		0.5	60		pA
		Full range		150			150		
I_{IB} Input bias current		25°C	1	60		1	60		pA
		Full range		150			150		
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
		Full range	4.7			4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50		0	50	mV
		Full range			50			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	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	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 $+85^\circ\text{C}$.

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

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	$V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\text{ k}\Omega, \quad C_L = 100\text{ pF}$	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)	$f = 10\text{ Hz}$	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		$f = 10\text{ kHz}, \quad R_L = 10\text{ k}\Omega,$ $C_L = 100\text{ pF}$	25°C	1.8			1.8		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\text{ k}\Omega, \quad C_L = 100\text{ pF}$	25°C		45°			45°		

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

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

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202I			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C	100	1000		μV
		Full range		1200		
α_{VIO} Temperature coefficient of input offset voltage		Full range	0.5			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C	0.5	60		pA
		Full range		150		
I_{IB} Input bias current		25°C	1	60		
		Full range		150		
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	–5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	–4.7	–4.9		V
		Full range	–4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	300	560		V/mV
		Full range	150			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	50	100		
		Full range	25			
CMRR Common-mode rejection ratio	$V_O = 0, \quad V_{IC} = V_{ICR\text{min}}, \quad R_S = 50\ \Omega$	25°C	80	115		dB
		Full range	80			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$)	$V_{DD} = \pm 2.3\text{ V to } \pm 8\text{ V}$	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 -40°C to $+85^\circ\text{C}$.

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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		
$V_{N(PP)}$ 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 $+85^\circ\text{C}$.



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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		25°C	0.5	60		0.5	60		pA
		Full range			150			150	
I_{IB} Input bias current		25°C	1	60		1	60		pA
		Full range			150			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	–5 to 2.7			–5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
		Full range	4.7			4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	–4.7	–4.9		–4.7	–4.9		V
		Full range	–4.7			–4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	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 $+85^\circ\text{C}$.

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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 $+85^\circ\text{C}$.

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



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202I			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	1000	μV
		Full range			1200	
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			150	
I_{IB} Input bias current		25°C		1	60	
		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	$V_O = 1\text{ V to }4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	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	$V_O = 2.5\text{ V}, \quad \text{No load}$	25°C		1.7	2.6	mA
		Full range			2.6	

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

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202I			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	V/ μs
		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	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	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 -40°C to $+85^\circ\text{C}$.



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2202AI			TLC2202BI			UNIT	
				MIN	TYP	MAX	MIN	TYP	MAX		
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C		80	500		80	500	μV	
			Full range			700			700		
αV _{IO}	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	60		0.5	60	pA	
			Full range			150			150		
I _{IB}	Input bias current		25°C		1	60		1	60	pA	
			Full range			150			150		
V _{ICR}	Common-mode input voltage range	R _S = 50 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			
			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		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		

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

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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 $+85^\circ\text{C}$

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



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			500	
I_{IB} Input bias current		25°C		1	60	pA
		Full range			500	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		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	$V_{IC} = V_{ICR\min},$ $V_O = 0, \quad R_S = 50\ \Omega$	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 -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		$\text{V}/\mu\text{s}$
		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	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$	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 .



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2201AM			TLC2201BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 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		60	0.5		60	pA
			Full range	500			500			
I _{IB}	Input bias current		25°C	1		60	1		60	pA
			Full range	500			500			
V _{ICR}	Common-mode input voltage range	R _S = 50 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 _{ICR} min, 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.

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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.

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	60	pA
		Full range			500	
I_{IB} Input bias current		25°C		1	60	pA
		Full range			500	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range		0 to 2.7		V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C		4.7	4.8	V
		Full range		4.7		
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 500\ \text{k}\Omega$	25°C		150	315	V/mV
		Full range		75		
	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 10\ \text{k}\Omega$	25°C		25	55	
		Full range		10		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}},$ $V_O = 0, \quad R_S = 50\ \Omega$	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 .



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2201AM			TLC2201BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 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	60		0.5	60	pA	
			Full range	500			500			
I _{IB}	Input bias current		25°C	1	60		1	60	pA	
			Full range	500			500			
V _{ICR}	Common-mode input voltage range	R _S = 50 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.

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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.

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	$V_{IC} = 0, \quad R_S = 50 \Omega$	25°C		100	1000	μV
		Full range			1250	
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage		Full range		0.5		$\mu V/^\circ C$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu V/mo$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			500	
I_{IB} Input bias current		25°C		1	60	
		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	$V_O = 0, \quad V_{IC} = V_{ICRmin},$ $R_S = 50 \Omega$	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	$V_O = 0, \quad$ 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	$R_L = 10 k\Omega, \quad C_L = 100$ pF	25°C		48°		

† Full range is -55°C to 125°C.



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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER		TEST CONDITIONS	T _A [†]	TLC2202AM			TLC2202BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 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		25°C		0.5	60		0.5	60	pA
			Full range			500			500	
I _{IB}	Input bias current		25°C		1	60		1	60	pA
			Full range			500			500	
V _{ICR}	Common-mode input voltage range	R _S = 50 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	300	560		300	560	V/mV	
			Full range	100			100			
		V _O = ± 4 V, R _L = 10 kΩ	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 Ω	25°C	80	115		80	115	dB	
			Full range	80			80			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD±} / ΔV _{IO})	V _{DD±} = ±2.3 V to ±8 V	25°C	80	110		80	110	dB	
			Full range	80			80			
I _{DD}	Supply current	V _O = 0, 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.

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION

OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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.

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202M			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	1000	μV
		Full range			1250	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005*	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5	60	pA
		Full range			500	pA
I_{IB} Input bias current		25°C		1	60	
		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	$V_{IC} = V_{ICR\text{min}}, \quad R_S = 50\ \Omega$	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	$V_O = 2.5\text{ V}, \quad \text{No load}$	25°C		1.7	2.6	mA
		Full range			2.6	

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

† Full range is -55°C to 125°C .

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	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		
$V_{N(\text{PP})}$ 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	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$	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 .



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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		25°C	0.5	60	0.5	60	pA		
			Full range	500		500				
I _{IB}	Input bias current		25°C	1	60	1	60	pA		
			Full range	500		500				
V _{ICR}	Common-mode input voltage range	R _S = 50 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.

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

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

† Full range is –55°C to 125°C

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

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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	$V_{IC} = V_{ICRmin}$, $V_O = 0$, $R_S = 50\ \Omega$		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		
$V_{N(PP)}$ 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°		

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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°		



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

PARAMETER MEASUREMENT INFORMATION

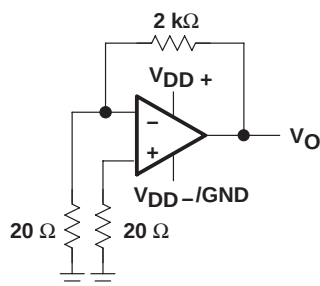
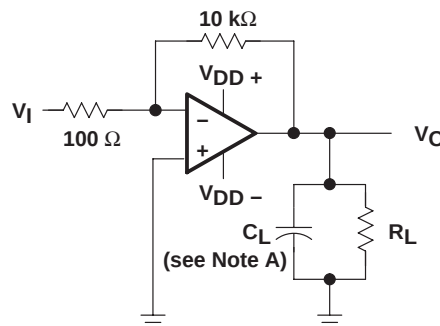
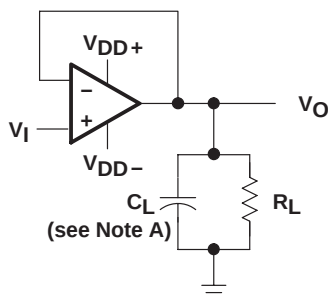


Figure 1. Noise-Voltage Test Circuit



NOTE A: C_L includes fixture capacitance.

Figure 2. Phase-Margin Test Circuit



NOTE A: C_L includes fixture capacitance.

Figure 3. Slew-Rate Test Circuit

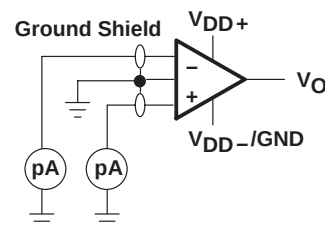


Figure 4. Input-Bias and Offset-Current Test Circuit

typical values

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

input bias and offset current

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

noise

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

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

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	Distribution	5, 6
I_{IB}	Input bias current	vs Common-mode input voltage	7
		vs Free-air temperature	8
V_{OM}	Maximum peak output voltage	vs Output current	9
		vs Free-air temperature	10
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	11
V_{OH}	High-level output voltage	vs Frequency	12
		vs High-level output current	13
		vs Free-air temperature	14
V_{OL}	Low-level output voltage	vs Low-level output current	15
		vs Free-air temperature	16
A_{VD}	Large-signal differential voltage amplification	vs Frequency	17
		vs Free-air temperature	18
I_{OS}	Short-circuit output current	vs Supply voltage	19
		vs Free-air temperature	20
$CMRR$	Common-mode rejection ratio	vs Frequency	21
I_{DD}	Supply current	vs Supply voltage	22
		vs Free-air temperature	23, 24
	Pulse response	Small signal	25, 26
		Large signal	27, 28
SR	Slew rate	vs Supply voltage	29
		vs Free-air temperature	30
	Noise voltage (referred to input)	0.1 to 1 Hz	31
		0.1 to 10 Hz	32
	Gain-bandwidth product	vs Supply voltage	33, 34
		vs Free-air temperature	35
ϕ_m	Phase margin	vs Supply voltage	36, 37
		vs Free-air temperature	38, 39
	Phase shift	vs Frequency	17



TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLC2201
INPUT OFFSET VOLTAGE**

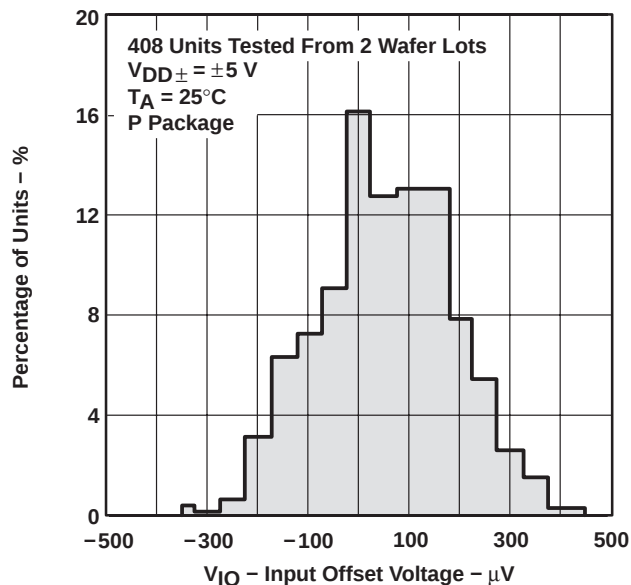


Figure 5

**TLC2202
DISTRIBUTION OF
INPUT OFFSET VOLTAGE**

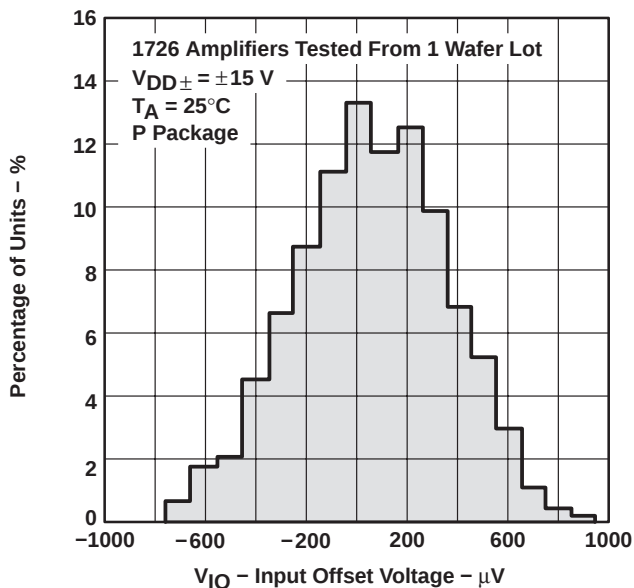


Figure 6

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

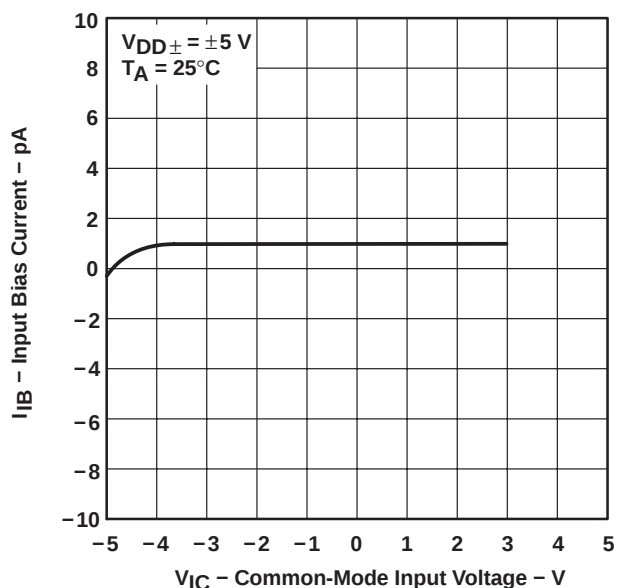


Figure 7

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

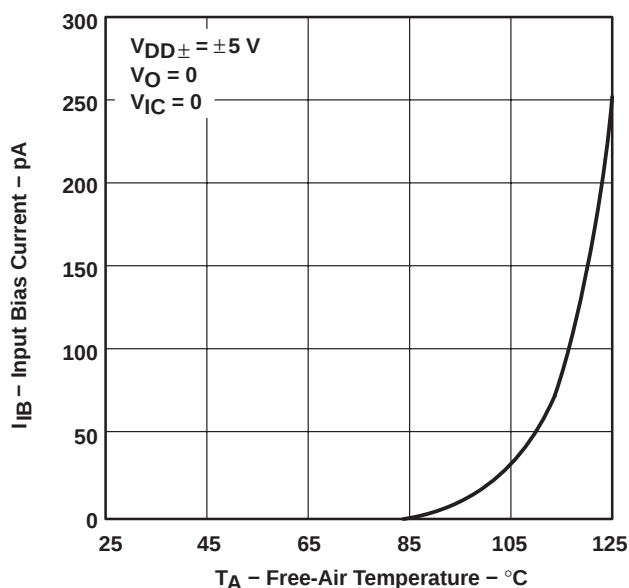


Figure 8

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

TYPICAL CHARACTERISTICS

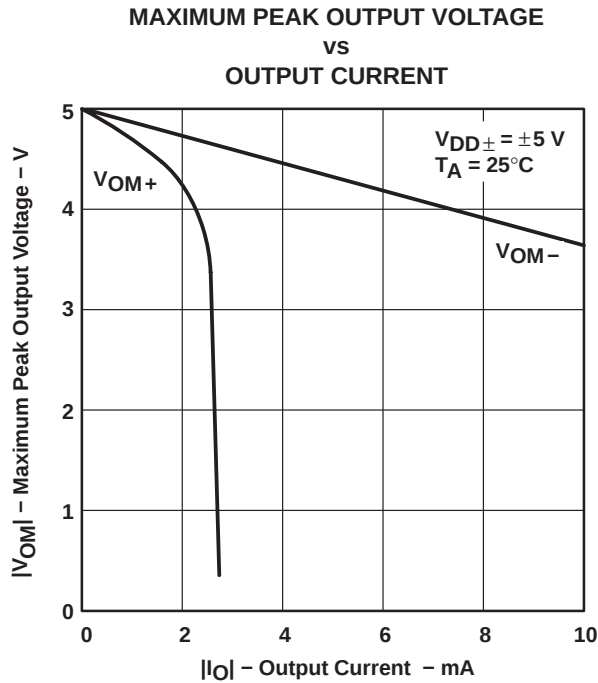


Figure 9

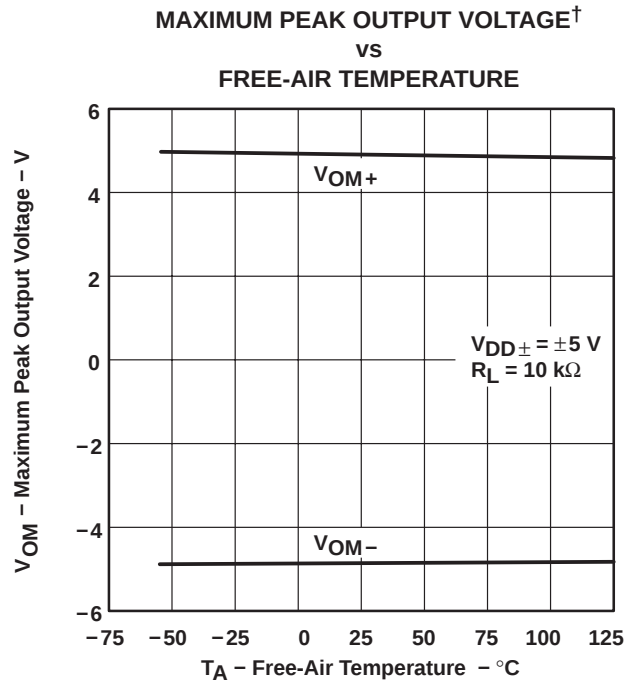


Figure 10

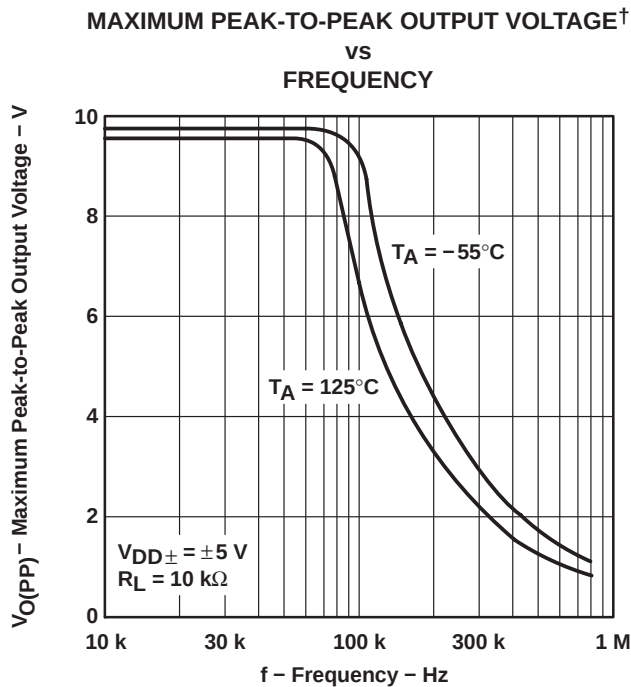


Figure 11

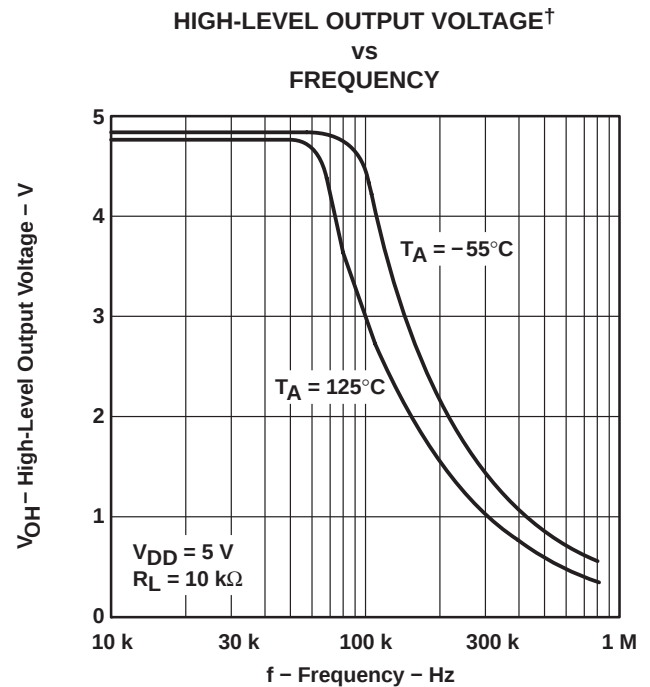


Figure 12

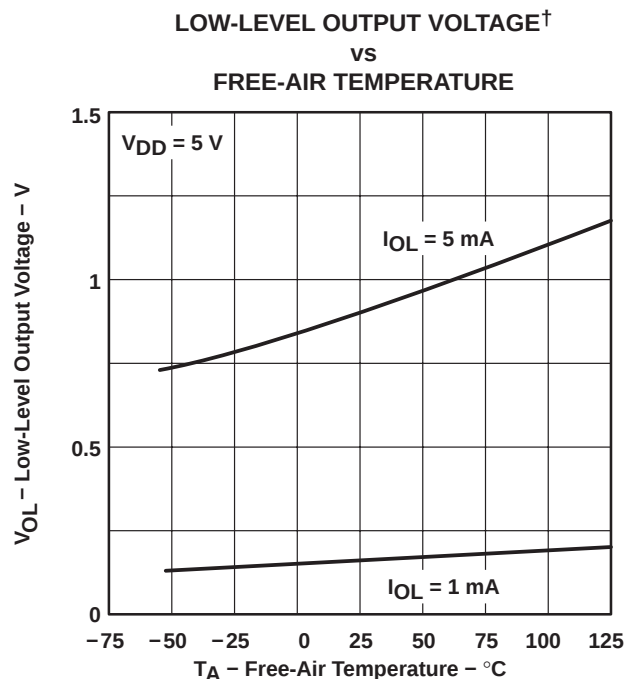
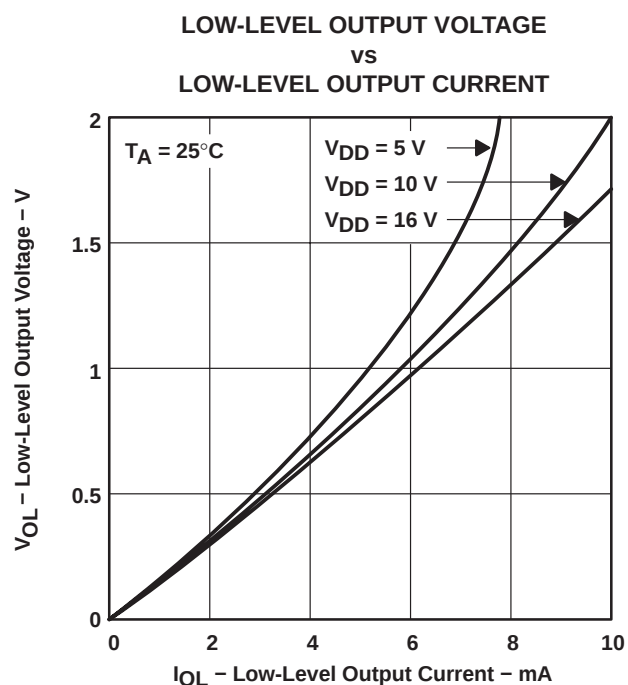
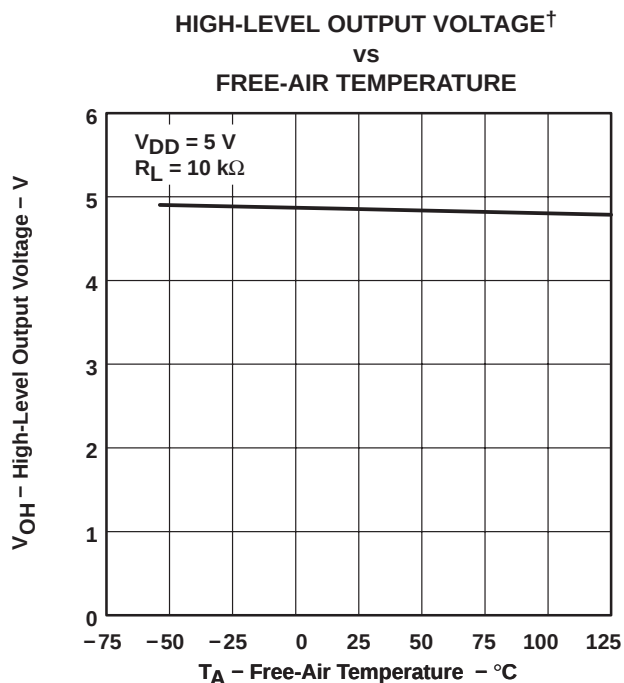
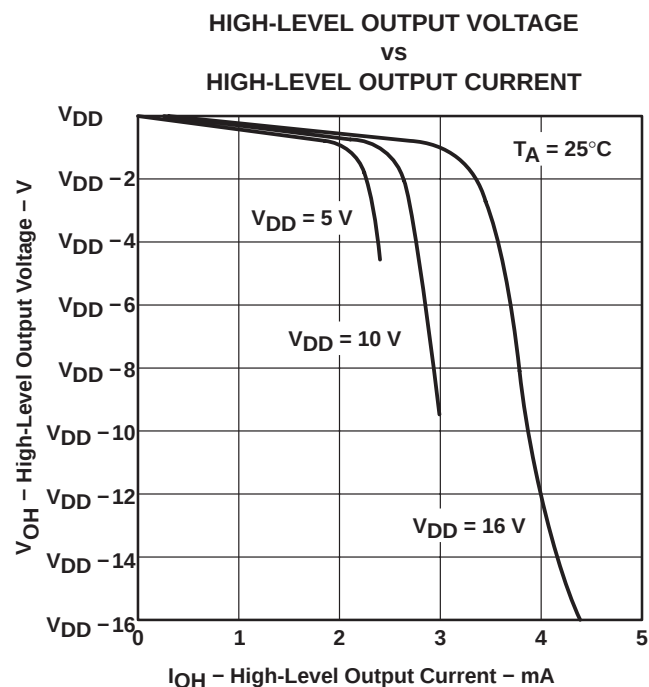
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TYPICAL CHARACTERISTICS



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

TYPICAL CHARACTERISTICS

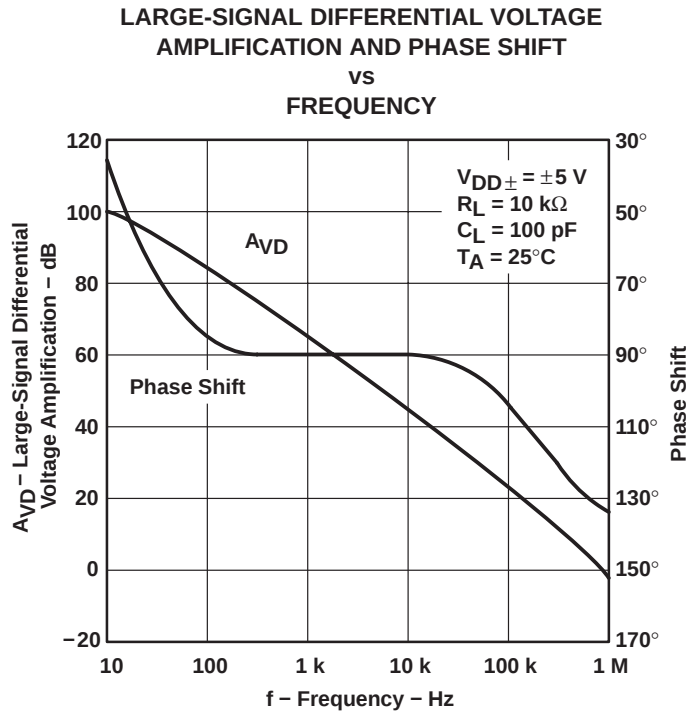


Figure 17

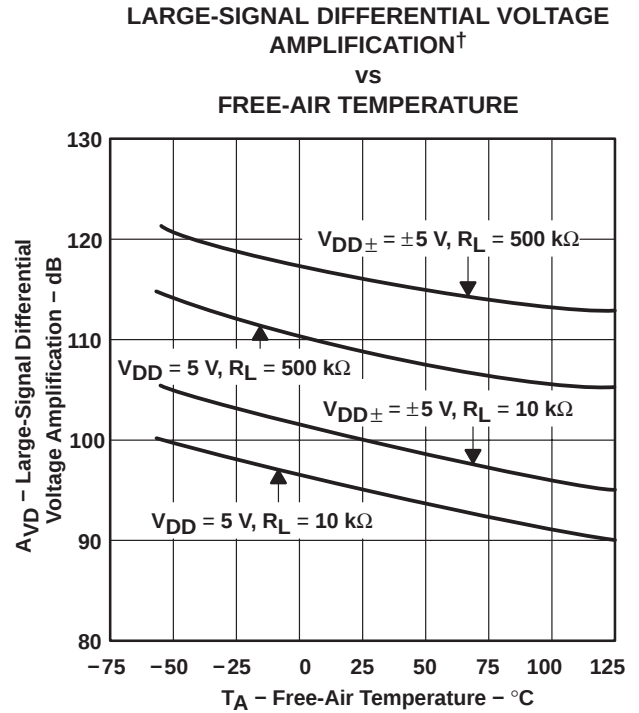


Figure 18

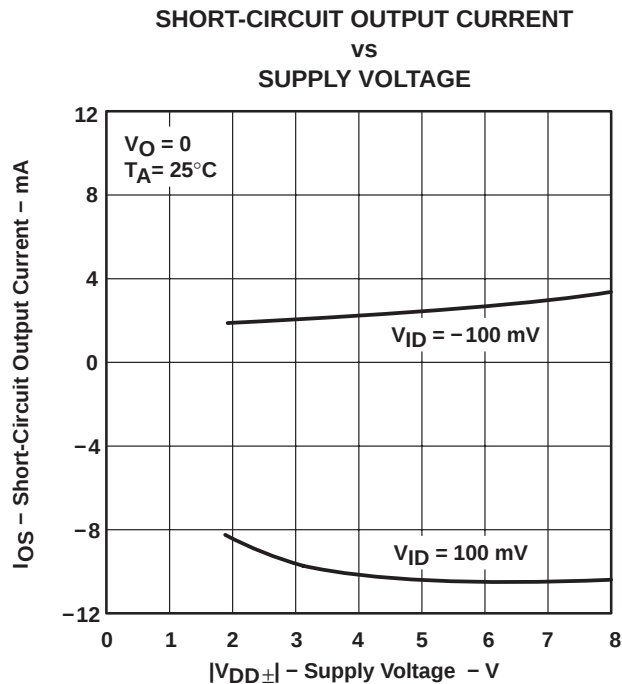


Figure 19

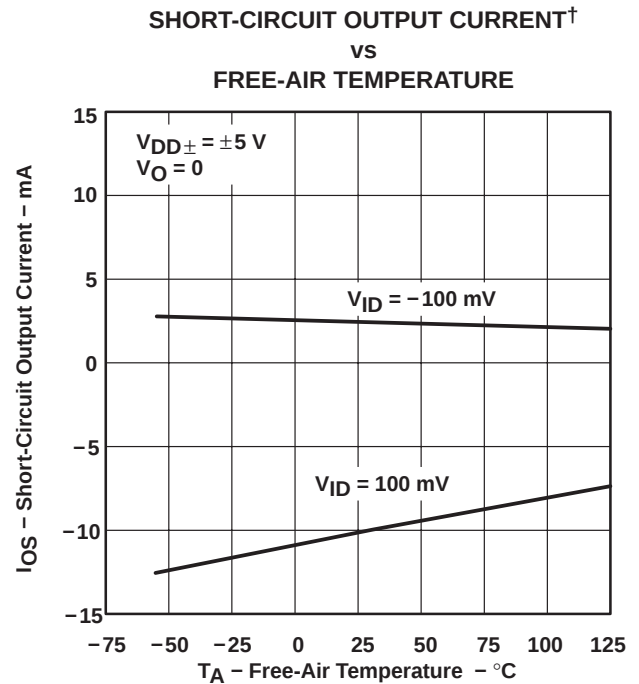


Figure 20

† 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

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TYPICAL CHARACTERISTICS

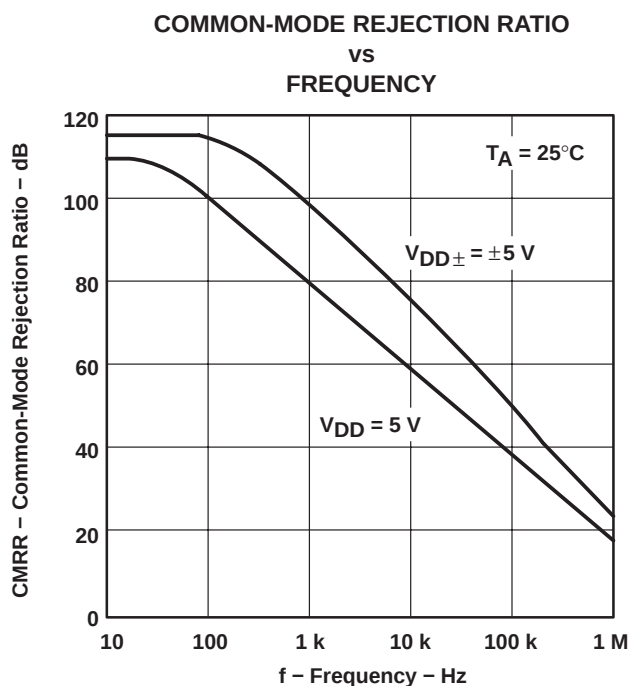


Figure 21

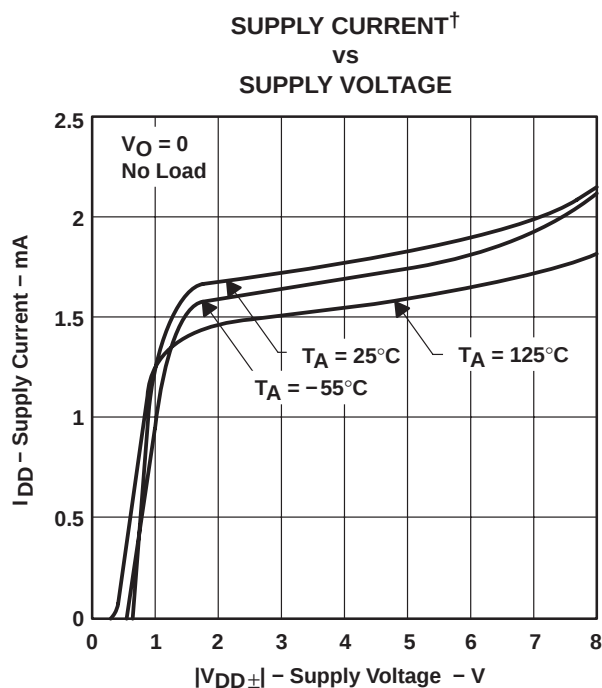


Figure 22

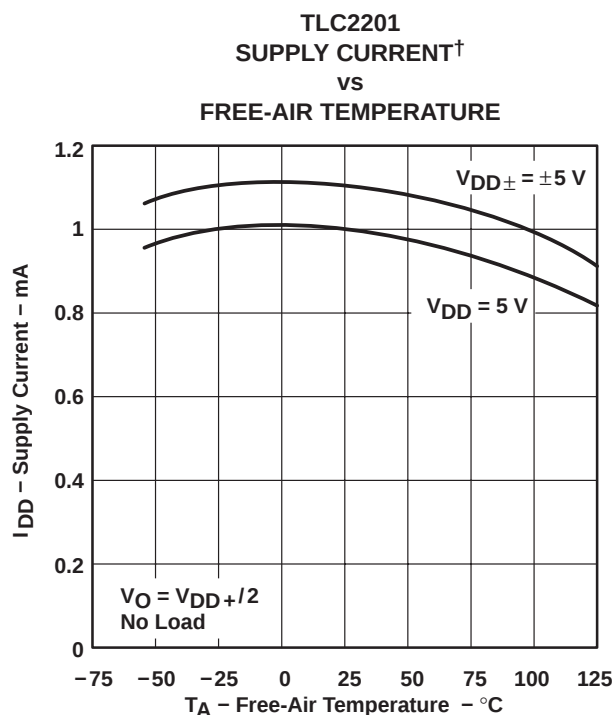


Figure 23

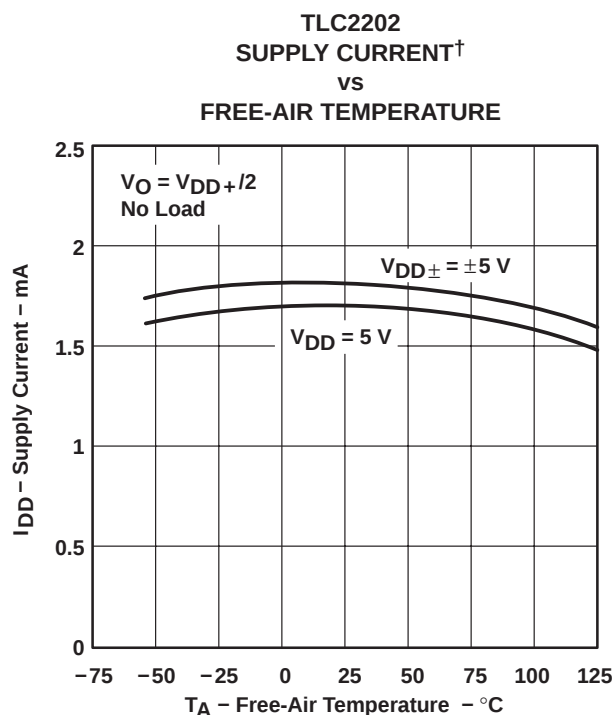


Figure 24

† 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**

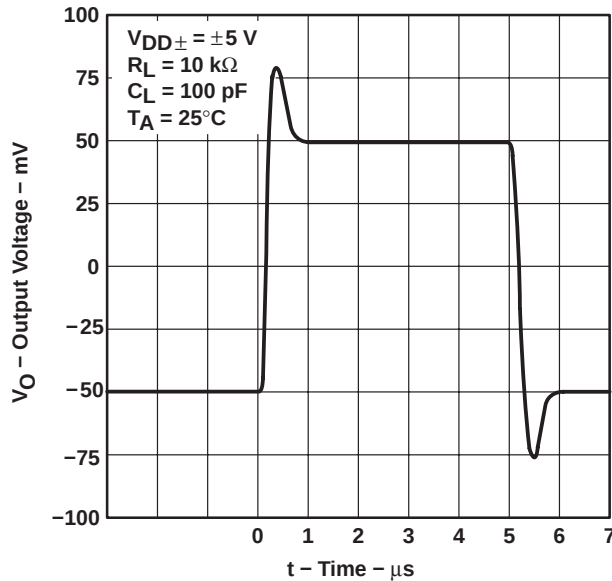


Figure 25

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

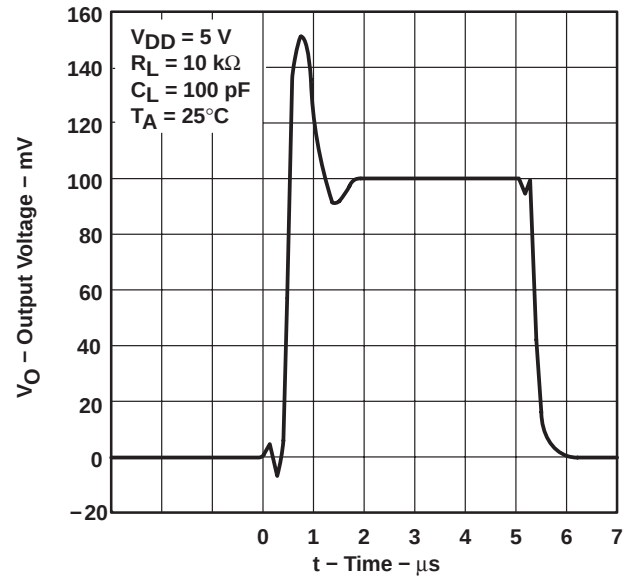


Figure 26

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

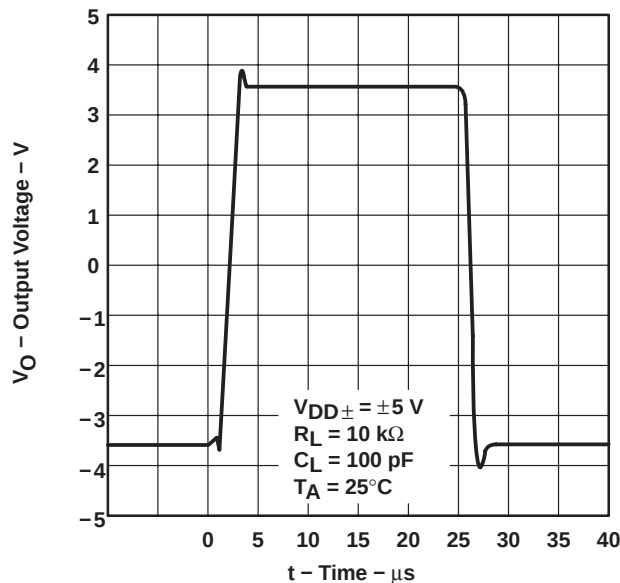


Figure 27

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

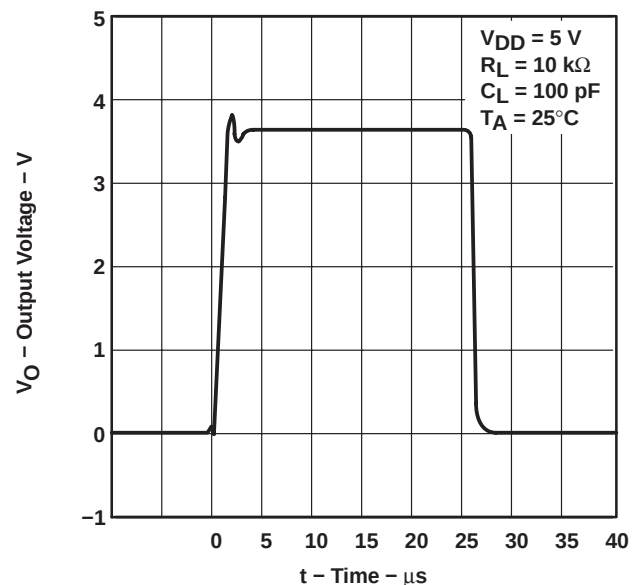


Figure 28

TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TYPICAL CHARACTERISTICS

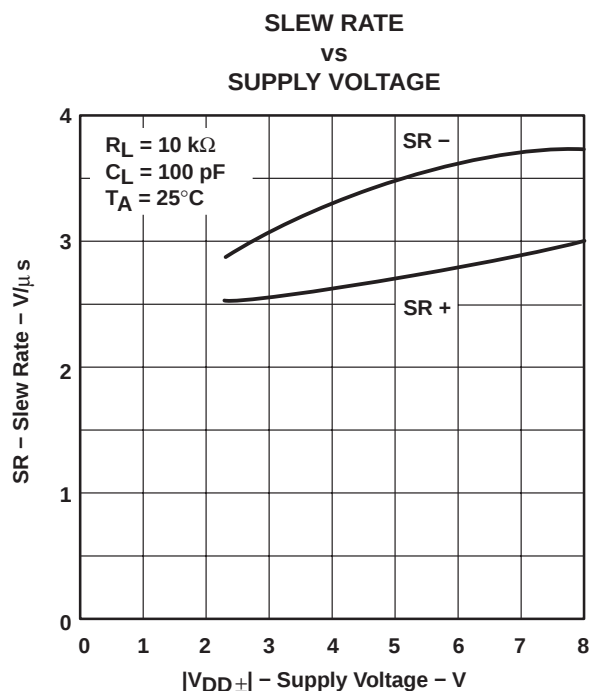


Figure 29

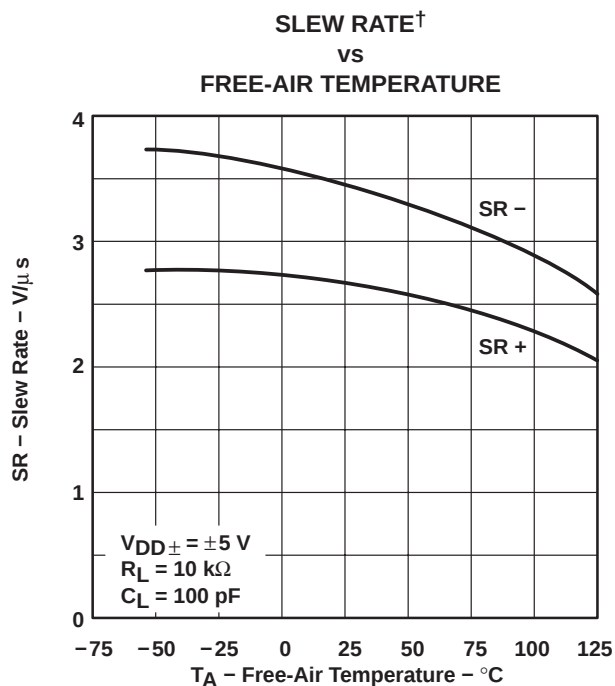


Figure 30

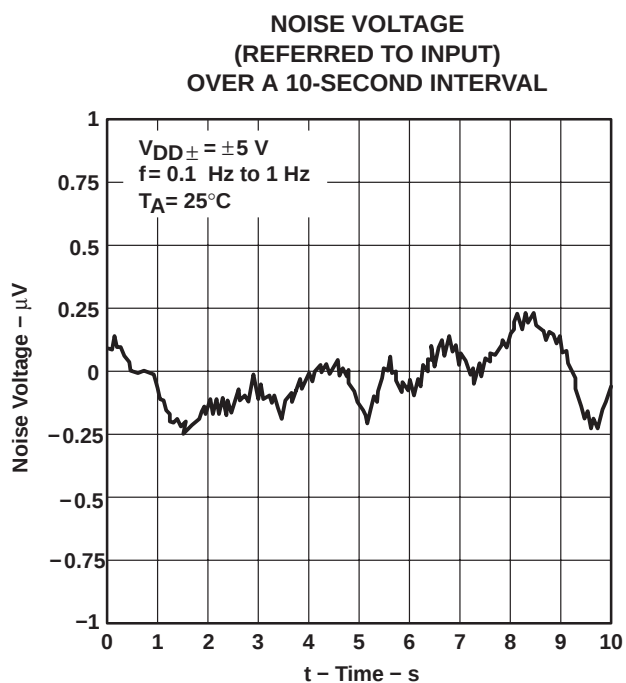


Figure 31

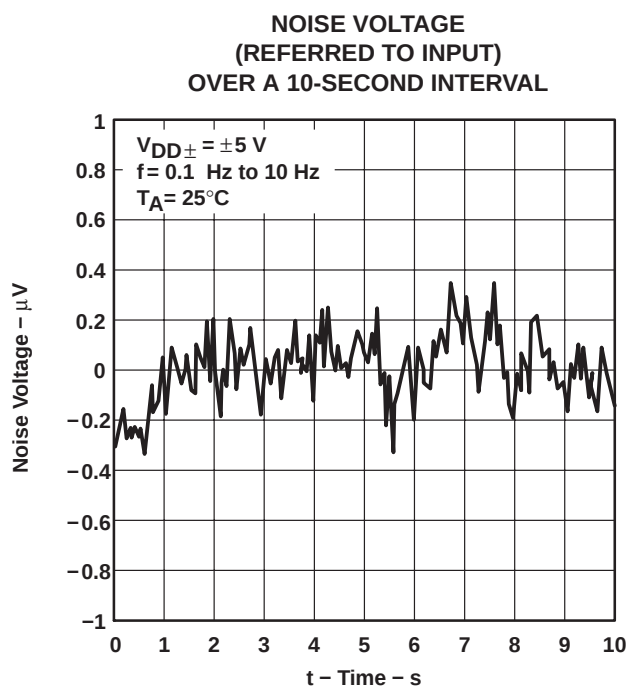


Figure 32

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

TYPICAL CHARACTERISTICS

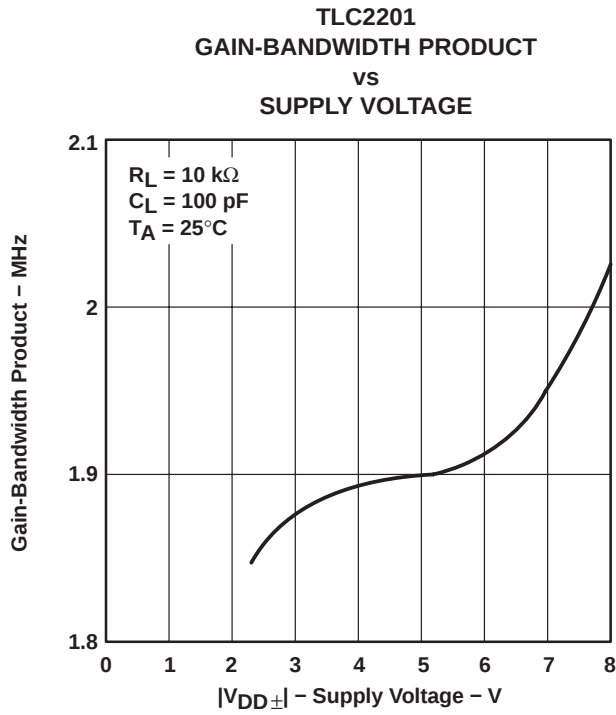


Figure 33

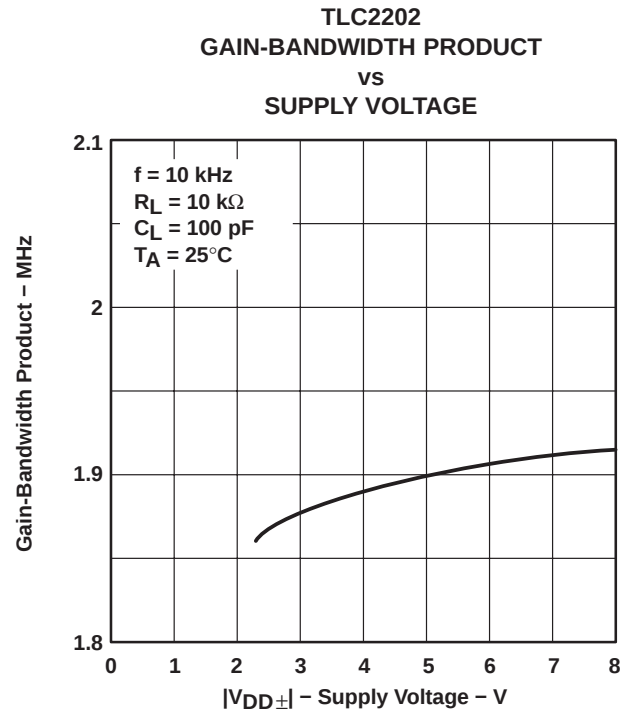


Figure 34

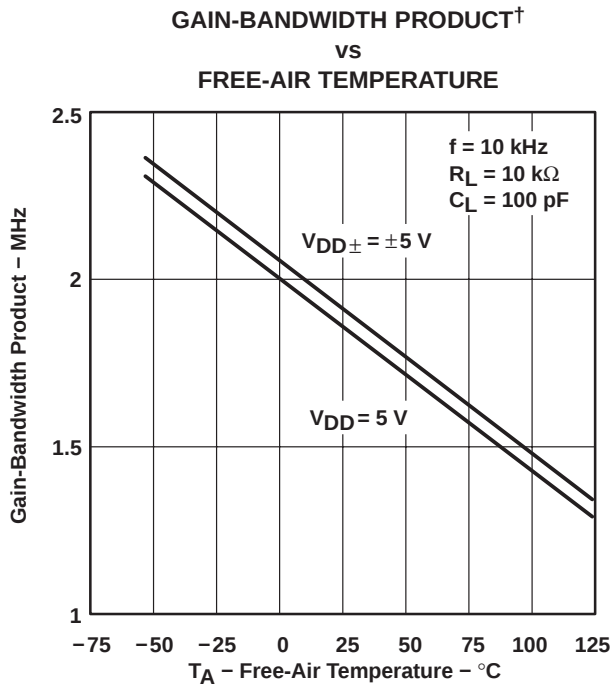


Figure 35

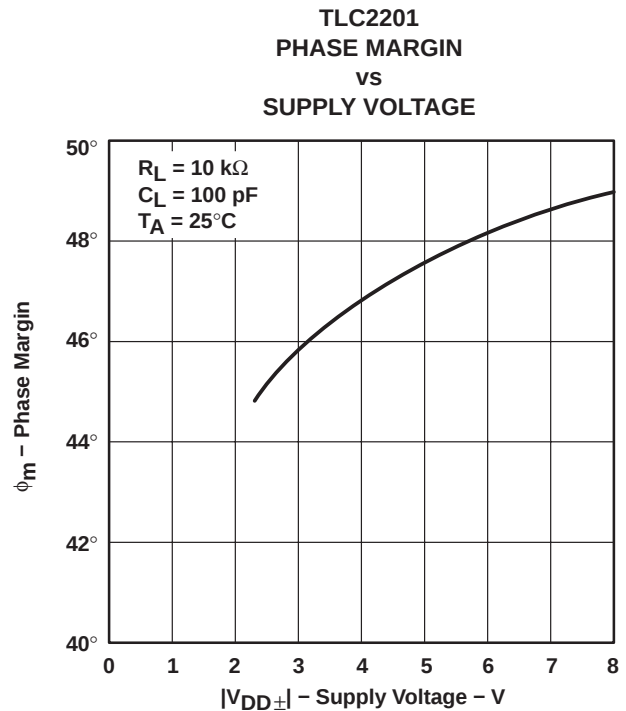


Figure 36

† 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

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

TYPICAL CHARACTERISTICS

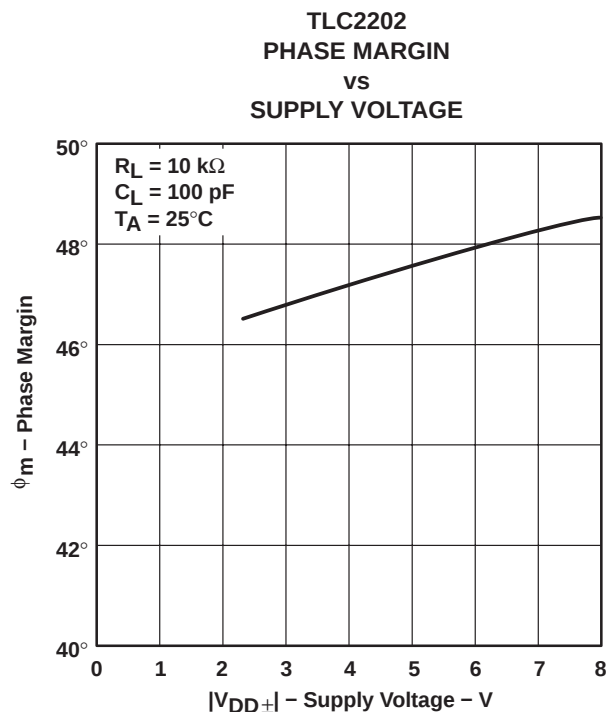


Figure 37

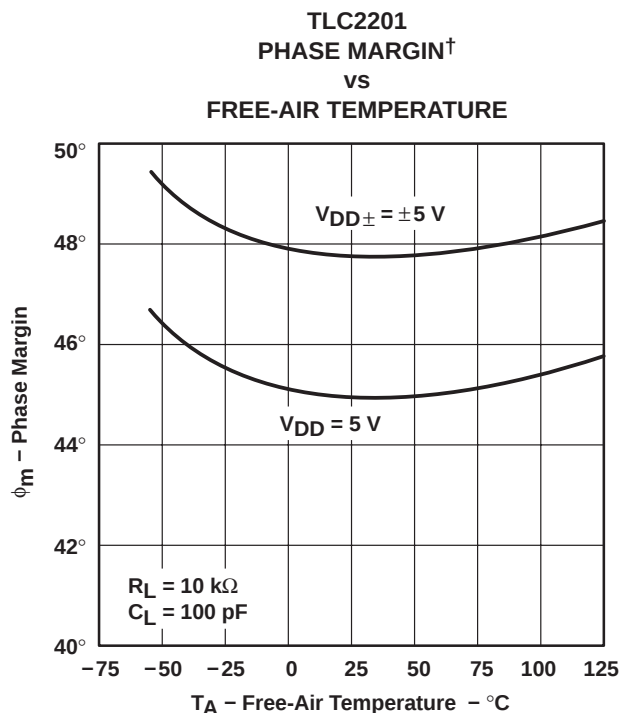


Figure 38

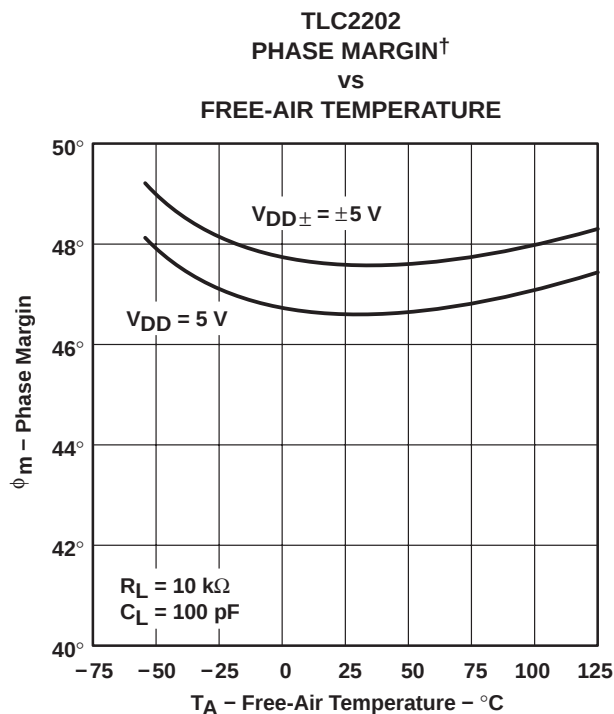


Figure 39

† 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.



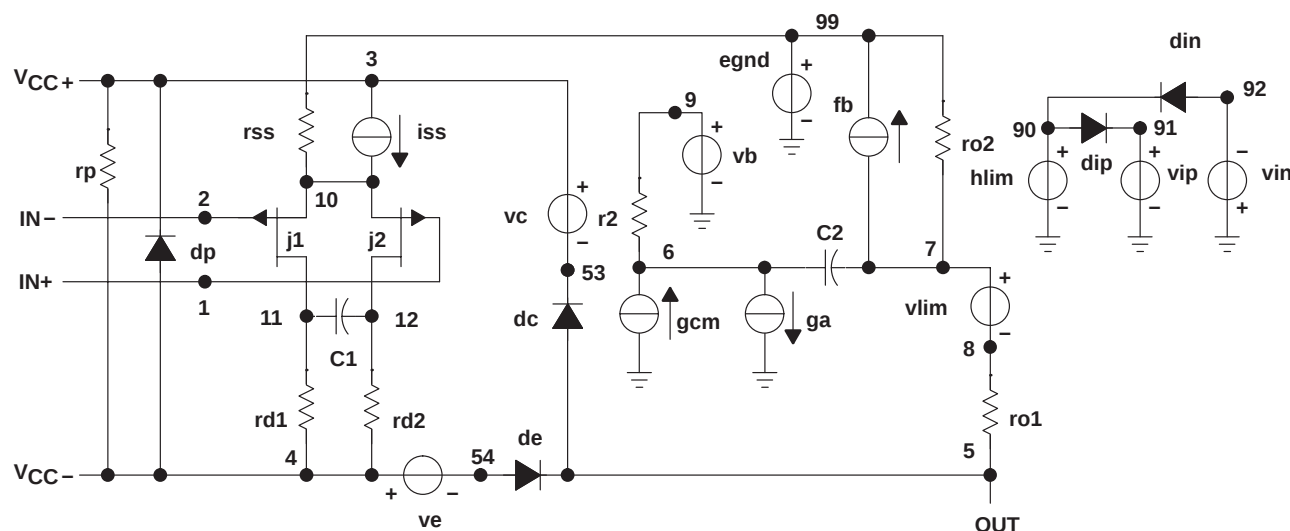
TLC220x, TLC220xA, TLC220xB, TLC220xY

Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS175B – FEBRUARY 1997 – REVISED JANUARY 2008

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

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-9088201M2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-9088201M2A TLC2201MFKB	Samples
5962-9088201MPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088201MPA TLC2201M	Samples
5962-9088202M2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-9088202M2A TLC2202MFKB	Samples
5962-9088202MPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088202MPA TLC2202M	Samples
5962-9088203QPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088203QPA TLC2201AM	Samples
5962-9088204Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-9088204Q2A TLC2202 AMFKB	Samples
5962-9088204QPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088204QPA TLC2202AM	Samples
TLC2201ACD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201AC	Samples
TLC2201ACDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201AC	Samples
TLC2201ACDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201AC	Samples
TLC2201ACDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201AC	Samples
TLC2201AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201AI	Samples
TLC2201AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201AI	Samples
TLC2201AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201AI	Samples
TLC2201AMD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	2201AM	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TLC2201AMDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201AM	Samples
TLC2201AMJG	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	TLC2201 AMJG	Samples
TLC2201AMJGB	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088203QPA TLC2201AM	Samples
TLC2201CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201C	Samples
TLC2201CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201C	Samples
TLC2201CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201C	Samples
TLC2201CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2201C	Samples
TLC2201CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TLC2201CP	Samples
TLC2201CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	TLC2201CP	Samples
TLC2201ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201I	Samples
TLC2201IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201I	Samples
TLC2201IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2201I	Samples
TLC2201IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type		TLC2201IP	Samples
TLC2201IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type		TLC2201IP	Samples
TLC2201MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962- 9088201M2A TLC2201MFKB	Samples
TLC2201MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088201MPA TLC2201M	Samples
TLC2202ACD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2202AC	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TLC2202ACDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2202AC	Samples
TLC2202ACDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2202AC	Samples
TLC2202ACDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		2202AC	Samples
TLC2202AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	2202AI	Samples
TLC2202AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	2202AI	Samples
TLC2202AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962- 9088204Q2A TLC2202 AMFKB	Samples
TLC2202AMJG	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	TLC2202 AMJG	Samples
TLC2202AMJGB	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088204QPA TLC2202AM	Samples
TLC2202CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2202C	Samples
TLC2202CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2202C	Samples
TLC2202CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2202C	Samples
TLC2202CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	2202C	Samples
TLC2202CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type		TLC2202CP	Samples
TLC2202CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		P2202	Samples
TLC2202ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		TLC2202I	Samples
TLC2202IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM		TLC2202I	Samples
TLC2202IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type		TLC2202IP	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TLC2202IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type		TLC2202IP	Samples
TLC2202MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962- 9088202M2A TLC2202MFKB	Samples
TLC2202MJG	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	TLC2202MJG	Samples
TLC2202MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	9088202MPA TLC2202M	Samples

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

ACTIVE: Product device recommended for new designs.

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

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

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

OBSOLETE: TI has discontinued the production of the device.

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

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

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

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

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

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

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

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

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

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

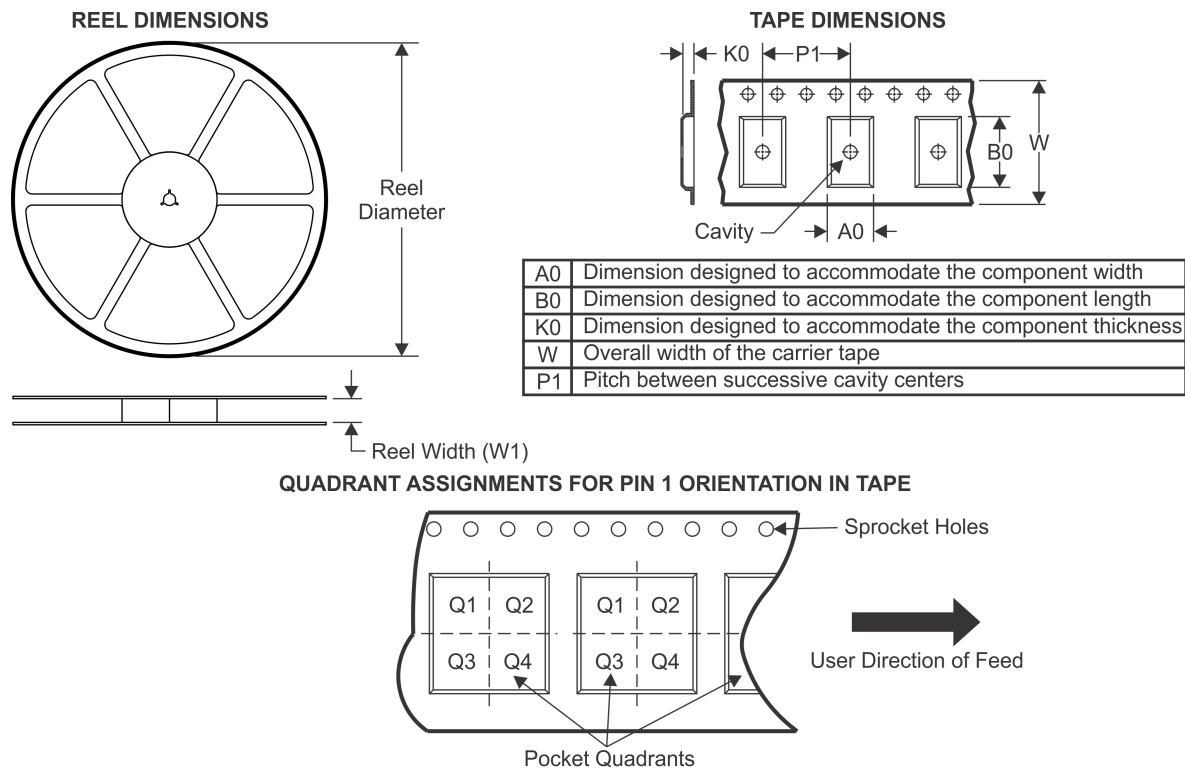
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF TLC2201, TLC2201A, TLC2201AM, TLC2201M, TLC2202, TLC2202A, TLC2202AM, TLC2202M :

- Catalog: [TLC2201A](#), [TLC2201](#), [TLC2202A](#), [TLC2202](#)
- Military: [TLC2201M](#), [TLC2201AM](#), [TLC2202M](#), [TLC2202AM](#)
- Space: [TLC2201-SP](#), [TLC2201-SP](#)

NOTE: Qualified Version Definitions:

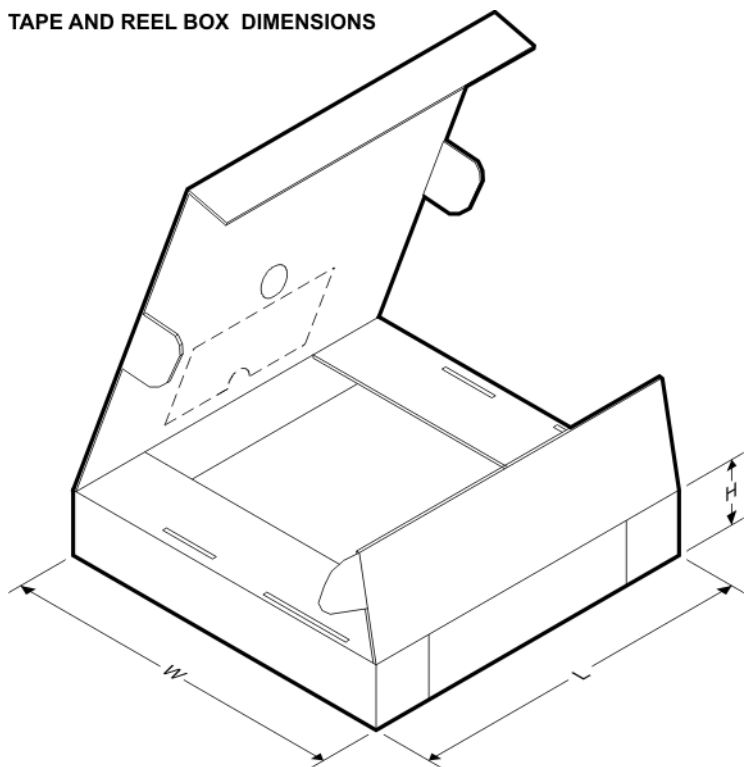
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLC2201ACDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLC2201AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLC2201CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLC2201IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLC2202ACDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC2202CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



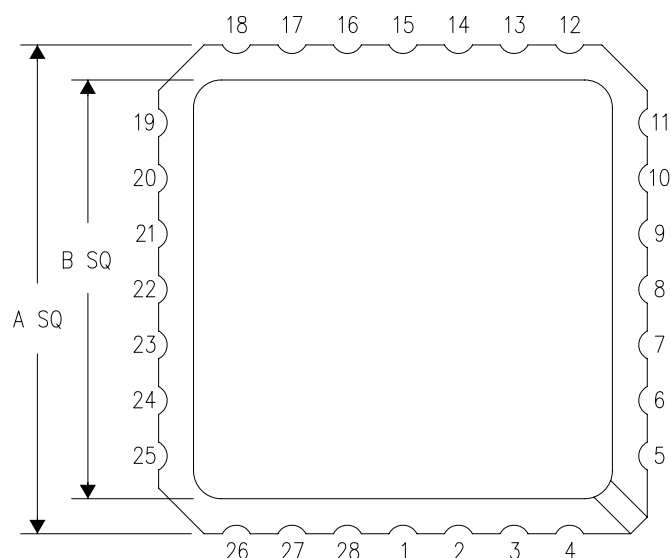
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLC2201ACDR	SOIC	D	8	2500	340.5	338.1	20.6
TLC2201AIDR	SOIC	D	8	2500	340.5	338.1	20.6
TLC2201CDR	SOIC	D	8	2500	340.5	338.1	20.6
TLC2201IDR	SOIC	D	8	2500	340.5	338.1	20.6
TLC2202ACDR	SOIC	D	14	2500	367.0	367.0	38.0
TLC2202CDR	SOIC	D	14	2500	367.0	367.0	38.0

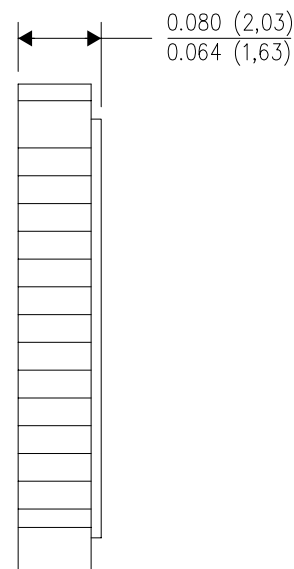
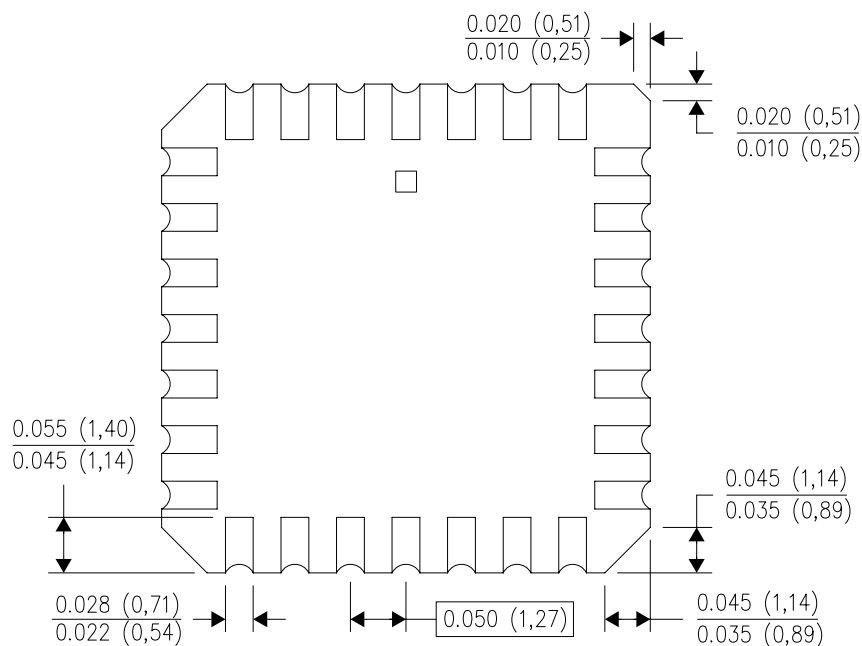
FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)

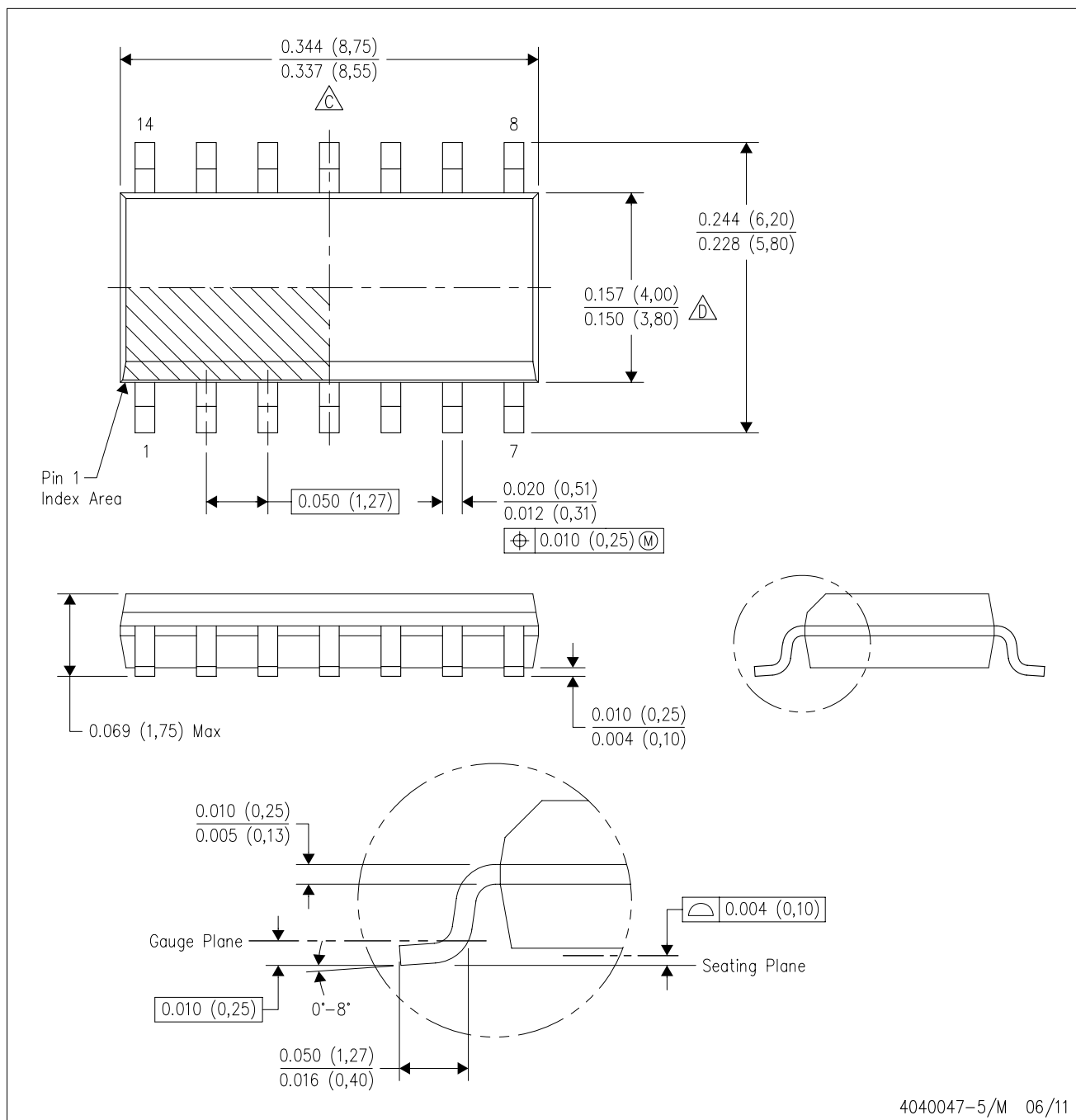


4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a metal lid.
 - Falls within JEDEC MS-004

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



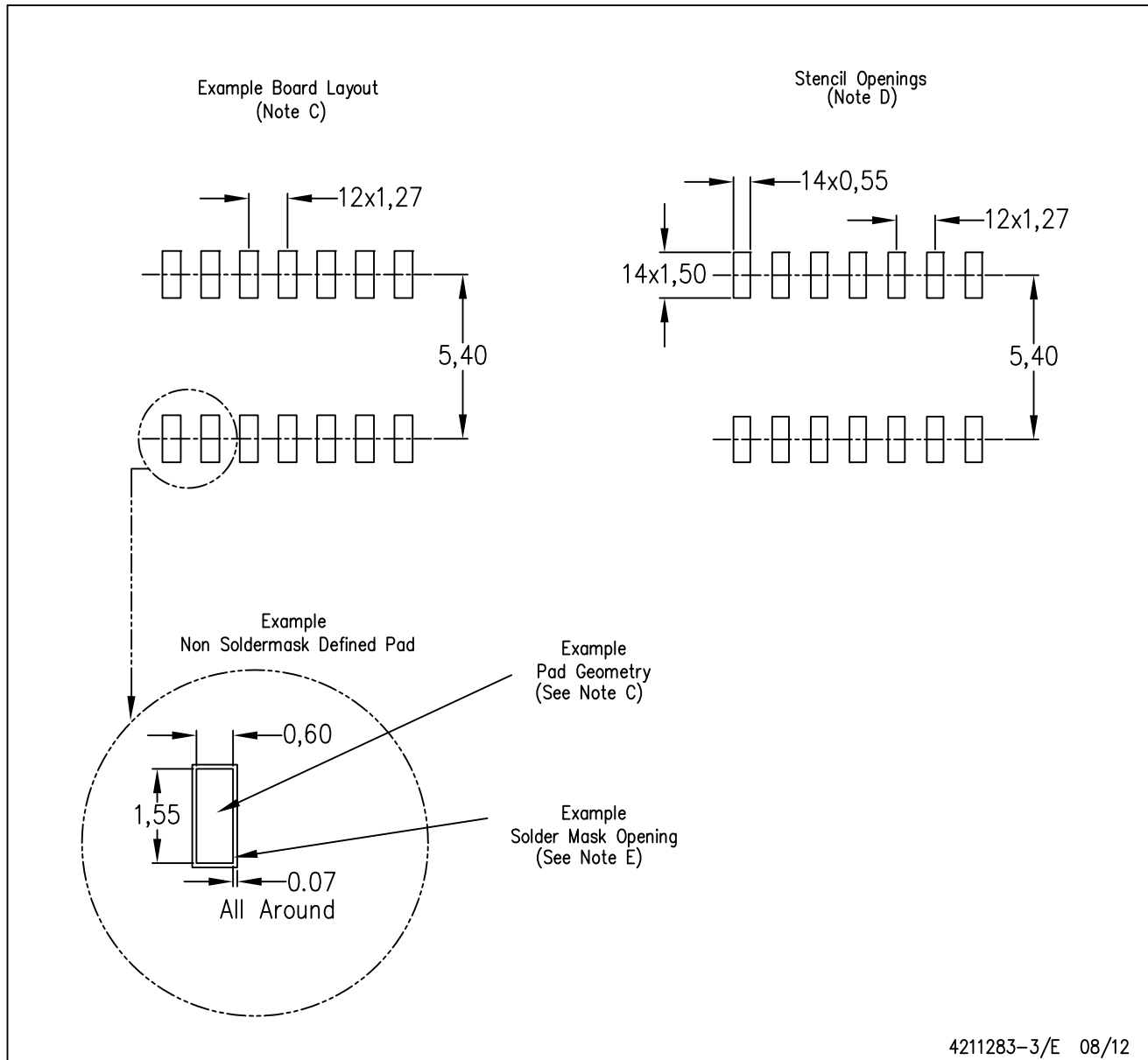
4040047-5/M 06/11

NOTES:

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

D (R-PDSO-G14)

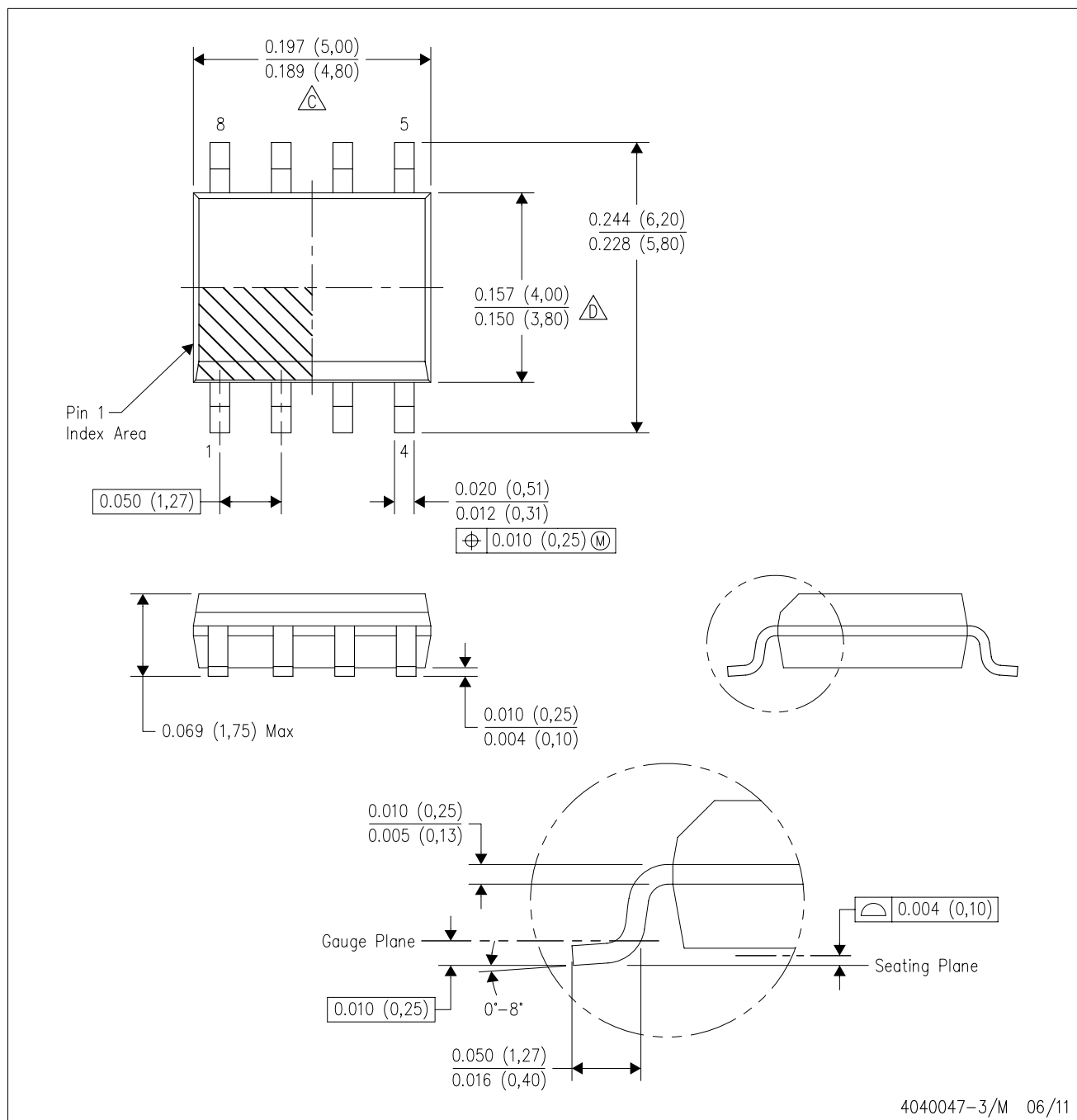
PLASTIC SMALL OUTLINE



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

D (R-PDSO-G8)

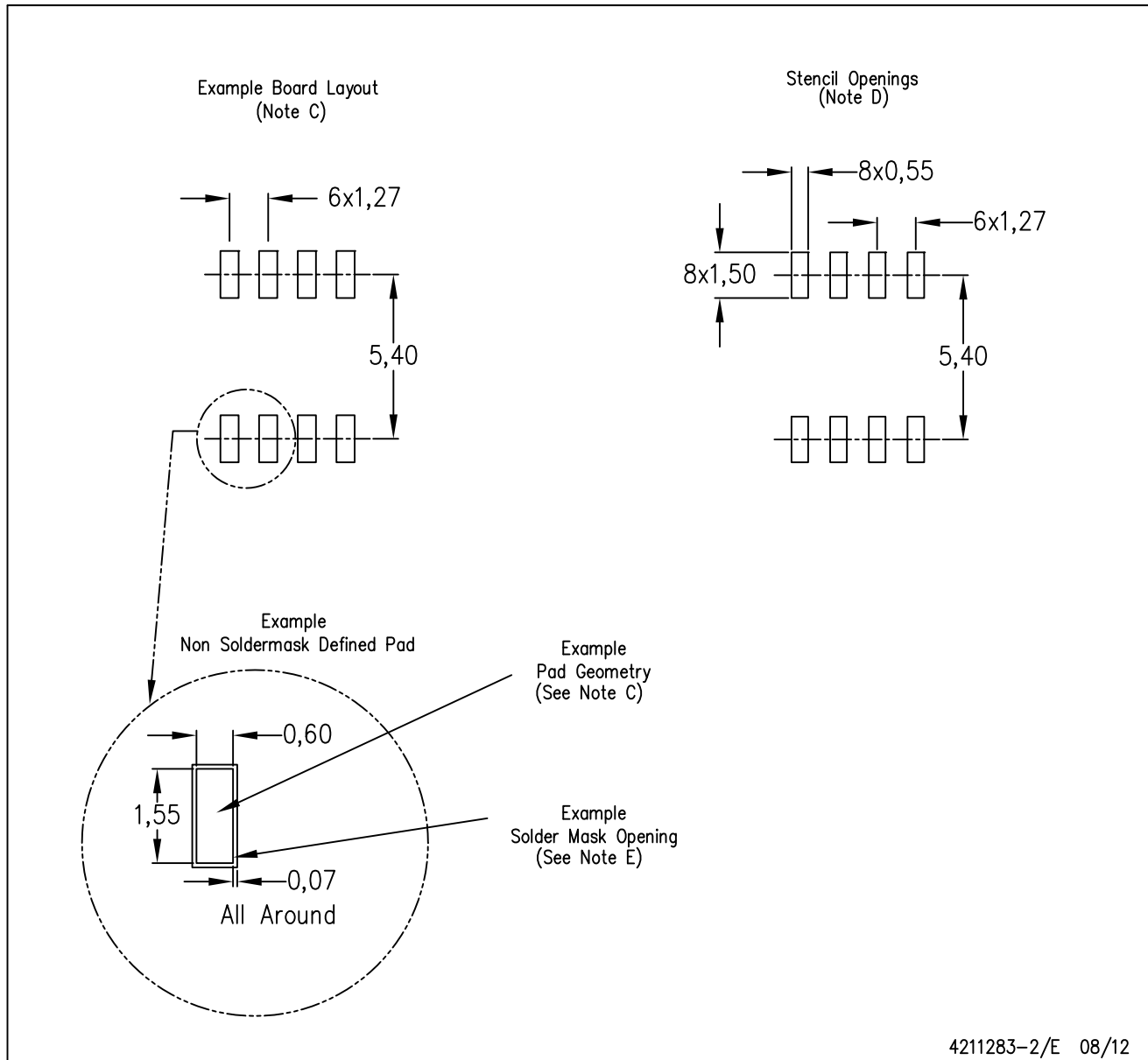
PLASTIC SMALL OUTLINE



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

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE

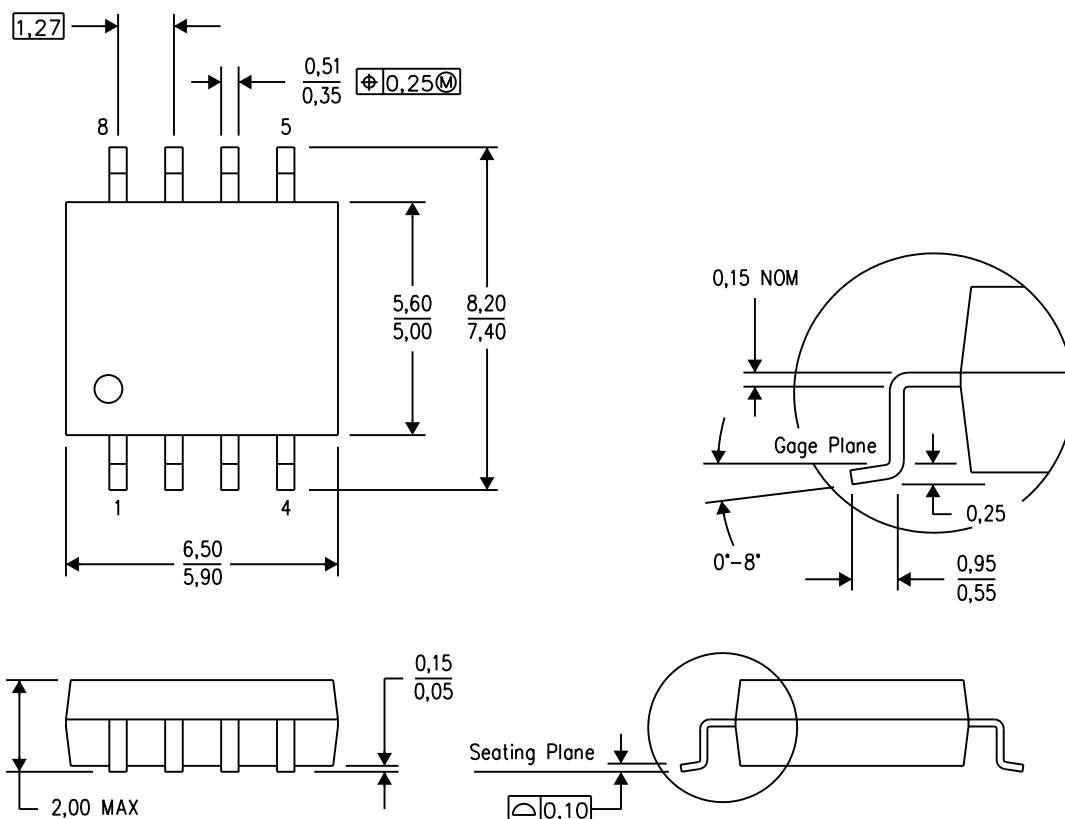


- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

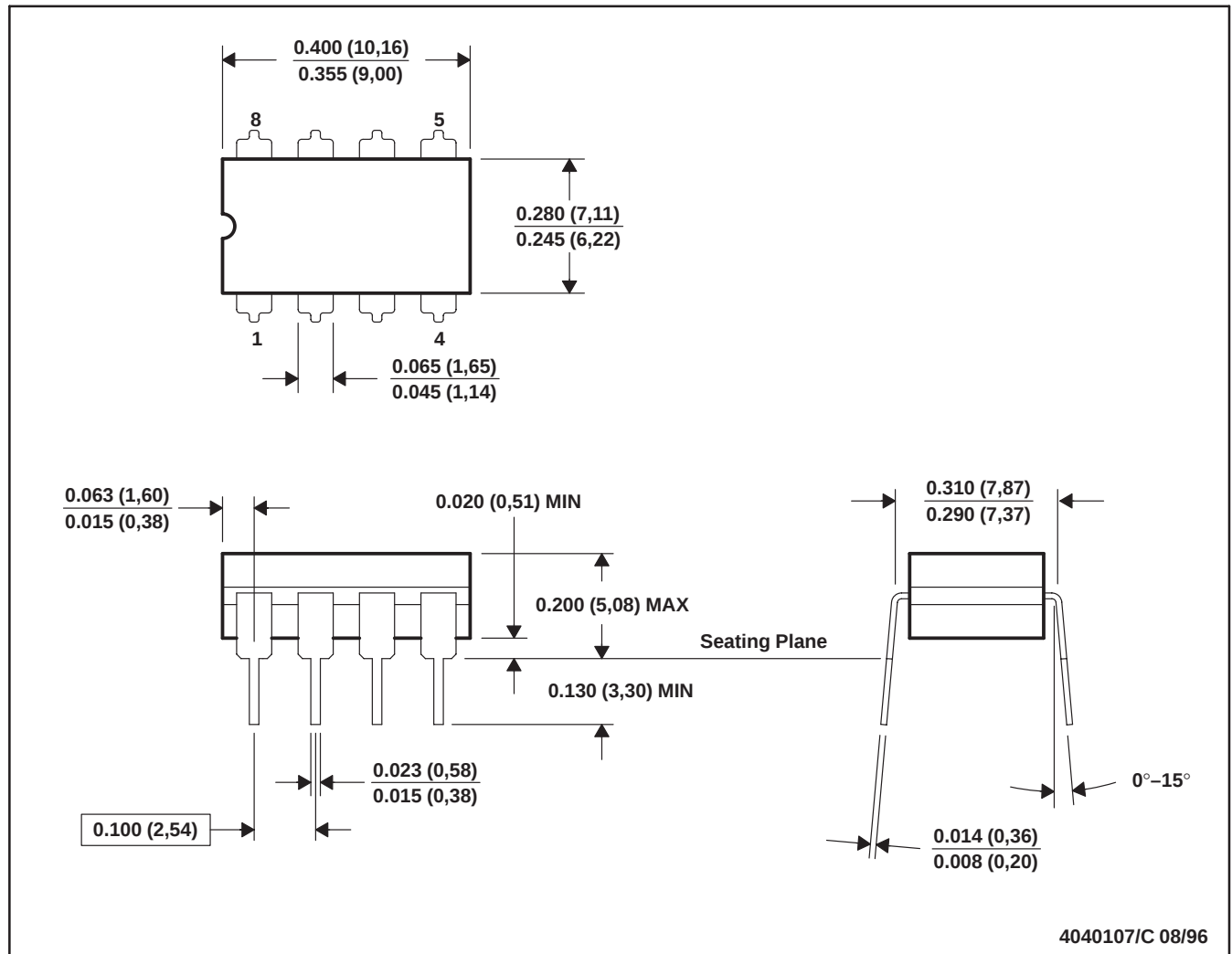


4040063/C 03/03

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

JG (R-GDIP-T8)

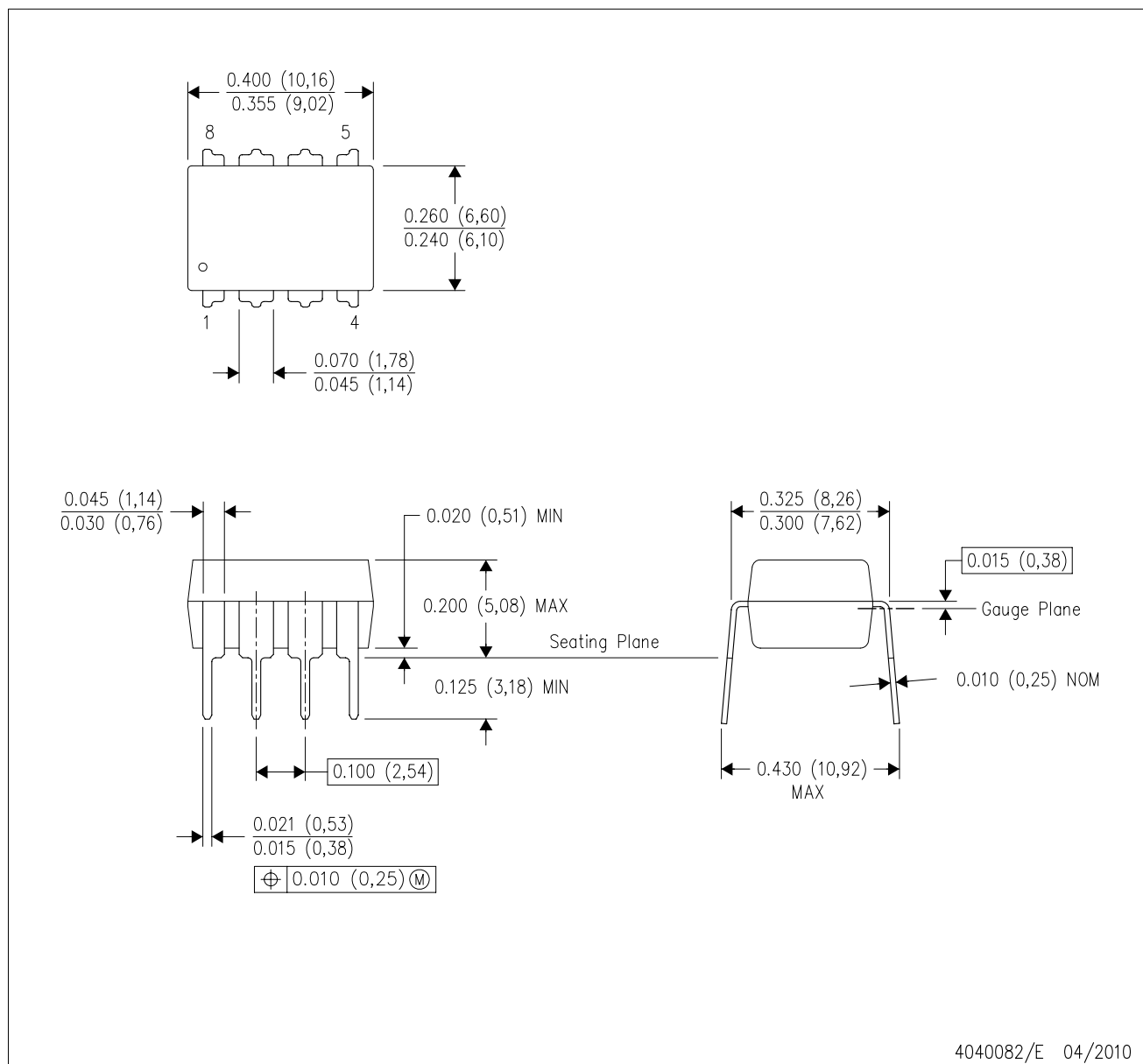
CERAMIC DUAL-IN-LINE



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

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



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

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced documentation. Information of third parties may be subject to additional restrictions. Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.