

TLC2202, TLC2202A, TLC2202B, TLC2202Y Advanced LinCMOS™ LOW-NOISE PRECISION DUAL OPERATIONAL AMPLIFIERS

SLOS056A – MAY 1990 – REVISED AUGUST 1994

- **TLC2202B 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 μ V Max**
- **Excellent Offset Voltage Stability**
With Temperature . . . 0.5 μ V/°C Typ
- **Rail-to-Rail Output Swing**
- **Low Input Bias Current**
1 pA Typ at $T_A = 25^\circ\text{C}$
- **Common-Mode Input Voltage Range**
Includes the Negative Rail

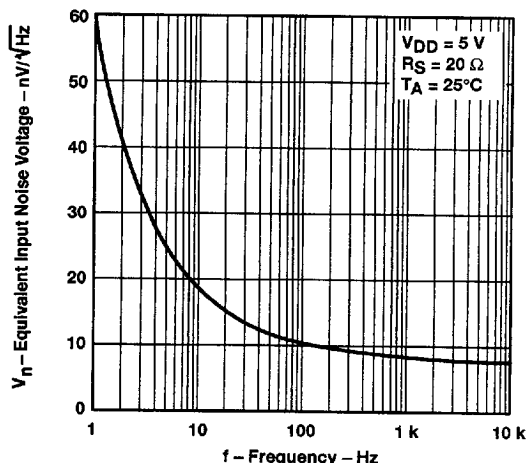
description

The TLC2202, TLC2202A, TLC2202B, and TLC2202Y 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-STD-883C, Method 3015.2; however, care should be exercised in handling these devices as exposure to ESD may result in degradation of the parametric performance.

TYPICAL EQUIVALENT
INPUT NOISE VOLTAGE
VS
FREQUENCY



AVAILABLE OPTIONS

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

The D packages are available taped and reeled. Add R suffix to device type (e.g. TLC2202BCDR). Chips are tested at 25°C.

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



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On products compliant to MIL-STD-883, Class B, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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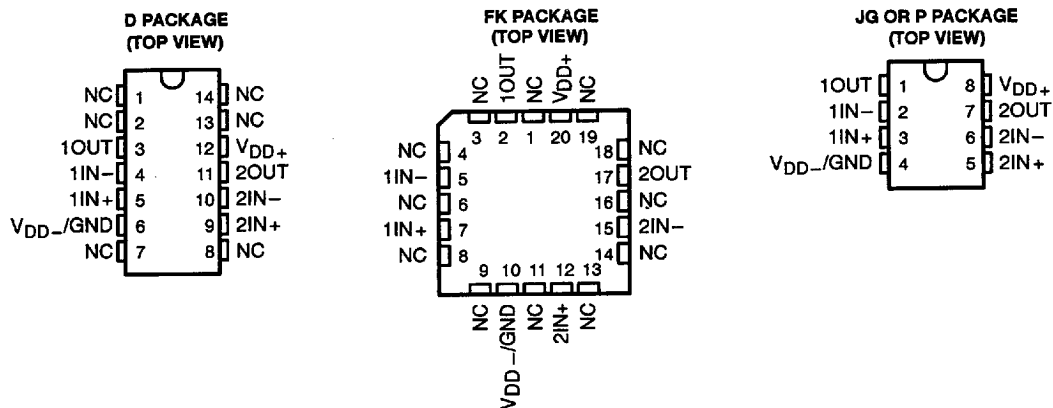
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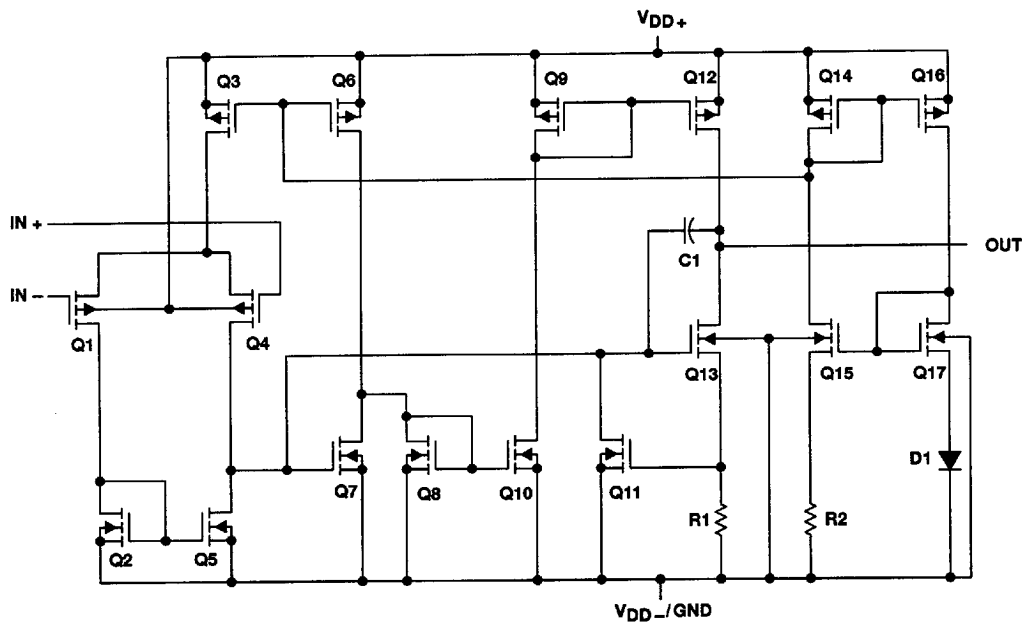
description (continued)

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.



NC – No internal connection

equivalent schematic (each amplifier)



**TEXAS
INSTRUMENTS**

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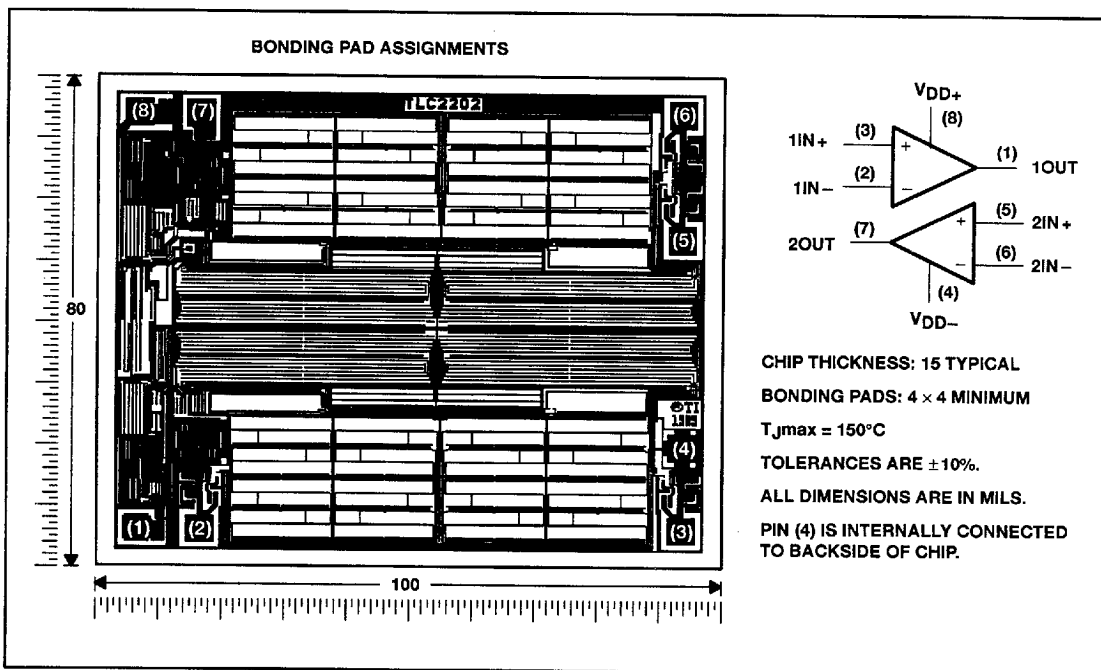
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TLC2202Y chip formation

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



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

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

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

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

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW

recommended operating conditions

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

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

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

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

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

† Full range is 0°C to 70°C.

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



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

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

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

PARAMETER	TEST CONDITIONS	T_A †	TLC2202AC			TLC2202BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3$ V, $R_L = 10 k\Omega, C_L = 100$ pF	25°C	1.8	2.7		1.8	2.7		V/ 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/ $\sqrt{Hz}$
	$f = 1$ 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/ $\sqrt{Hz}$
Gain-bandwidth product	$f = 10$ kHz, $R_L = 10 k\Omega, C_L = 100$ pF	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10 k\Omega, C_L = 100$ pF	25°C		48°			48°		

† Full range is 0°C to 70°C.

NOTES: 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.

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



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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	
αV_{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)	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		Full range			100	
I_{IB} Input bias current		25°C		1		pA
		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	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	$V_O = 0, \quad V_{IC} = V_{ICR\text{min}},$ $R_S = 50\ \Omega$	25°C	75	110		dB
		Full range	75			
kSVR 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	

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		
$V_{N(\text{PP})}$ 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 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.



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

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

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202AC			TLC2202BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C	1.6	2.5		1.6	2.5		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		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		47°			47°		

† Full range is 0°C to 70°C.

NOTES: 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.

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



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TLC2202, TLC2202A, TLC2202B, TLC2202Y
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electrical characteristics at specified free-air temperature, $V_{DD} = \pm 5$ 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	
αV_{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	$V_{IC} = 0, \quad R_S = 50 \Omega$	Full range			150	pA
I_{IB} Input bias current		25°C		1		
		Full range			150	
V_{ICR} Common-mode input voltage range	$R_S = 50 \Omega$	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	150			
	$V_O = \pm 4$ 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			
KSVR Supply-voltage rejection ratio ($\Delta V_{DD} / \Delta V_{IO}$)	$V_{DD} = \pm 2.3$ 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	

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202I			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	1.2			
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 -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 $T_A = 150^\circ C$ extrapolated to $T_A = 25^\circ C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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

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	$V_O = \pm 2.3 \text{ V}, R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$	25°C	1.8	2.7		1.8	2.7		$\text{V}/\mu\text{s}$
		Full range	1.2			1.2			
V_n Equivalent input noise voltage (see Note 5)	$f = 10 \text{ Hz}$	25°C		18	35		18	30	$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1 \text{ kHz}$	25°C		8	15		8	12	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1 \text{ to } 1 \text{ Hz}$	25°C		0.5			0.5		μV
	$f = 0.1 \text{ to } 10 \text{ Hz}$	25°C		0.7			0.7		
I_n Equivalent input noise current		25°C		0.6			0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10 \text{ kHz}, R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$	25°C		1.9			1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$	25°C		48°			48°		

† Full range is -40°C to 85°C .

NOTES: 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.

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 non-testing of other parameters.



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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	
αV_{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)	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		Full range			150	
I_{IB} Input bias current		25°C		1		pA
		Full range			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 500\ \text{k}\Omega$	25°C		150	315	V/mV
		Full range		100		
	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 10\ \text{k}\Omega$	25°C		25	55	
		Full range		15		
CMRR Common-mode rejection ratio	$V_O = 0, \quad V_{IC} = V_{ICR\text{min}},$ $R_S = 50\ \Omega$	25°C		75	110	dB
		Full range		75		
kSVR 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	

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	$V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		1.6	2.5	V/ μs
		Full range		1		
V_n Equivalent input noise voltage	$f = 10\ \text{Hz}$	25°C		18		nV/ $\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7		
I_n Equivalent input noise current		25°C		0.6		fA/ $\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$	25°C		1.9		MHz
ϕ_m Phase margin 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°C .

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



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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			
α _{VIO}	Temperature coefficient of input offset voltage		Full range	0.5			0.5	μV/°C		
	Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	0.001	0.005	μV/mo		
I _{IO}	Input offset current	V _{IC} = 0, R _S = 50 Ω	25°C	0.5		0.5		pA		
			Full range	150			150			
I _{IB}	Input bias current		25°C	1		1		pA		
			Full range	150			150			
V _{ICR}	Common-mode input voltage range	R _S = 50 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 V _O = 1 V to 4 V, R _L = 10 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 _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				

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

† Full range is -40°C to 85°C

NOTES: 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.

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



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electrical characteristics at specified free-air temperature, $V_{DD} \pm \pm 5\text{ V}$ (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	$V_{IC} = 0, \quad R_S = 50\ \Omega$	Full range			500	pA
I_{IB} Input bias current		25°C		1		
		Full range			500	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	-4.7	-4.9		V
		Full range	-4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 500\ \text{k}\Omega$	25°C	300	560		V/mV
		Full range	100			
	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 10\ \text{k}\Omega$	25°C	50	100		
		Full range	25			
CMRR Common-mode rejection ratio	$V_O = 0, \quad V_{IC} = V_{ICRmin},$ $R_S = 50\ \Omega$	25°C	80	115		dB
		Full range	80			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$)	$V_{DD} = \pm 2.3\text{ V to } \pm 8\text{ V}$	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	

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2202M			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	1.8	2.7		V/ μs
		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		48°		

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C.

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



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

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

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range is –55°C to 125°C.

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



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

PARAMETER	TEST CONDITIONS	T_A †	TLC2202AM			TLC2202BM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$	25°C	1.8	2.7		1.8	2.7		V/ 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-STD-883, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C.

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



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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	$V_{IC} = 0, R_S = 50\ \Omega$	25°C		100	1000	μV
		Full range			1250	
αV_{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)	$V_{IC} = 0, R_S = 50\ \Omega$	25°C		0.001	0.005*	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		Full range			500	pA
I_{IB} Input bias current		25°C		1		
		Full range			500	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}, R_L = 500\ \text{k}\Omega$	25°C	150	315		V/mV
		Full range	75			
	$V_O = 1\text{ V to }4\text{ V}, R_L = 10\ \text{k}\Omega$	25°C	25	55		
		Full range	10			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$	25°C	75	110		dB
		Full range	75			
kSVR Supply-voltage rejection ratio ($\Delta V_{DD} \pm \Delta V_{IO}$)	$V_{DD} = 4.6\text{ V to }16\text{ V}$	25°C	80	110		dB
		Full range	80			
I_{DD} Supply current	$V_O = 2.5\text{ V}, \text{ No load}$	25°C		1.7	2.6	mA
		Full range			2.6	

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	$V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	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	$f = 10\ \text{kHz}, R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		1.9		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, C_L = 100\ \text{pF}$	25°C		47°		

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C .

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



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

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

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C

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



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

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

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range is -55°C to 125°C

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



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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	1000	μV
Input offset voltage long-term drift (see Note 4)			0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current			0.5		pA
I_{IB} Input bias current			1		pA
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	4.7	4.8		V
V_{OL} Maximum low-level output voltage	$I_O = 0$		0	50	mV
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}$, $R_L = 500\ \Omega$	150	315		V/mV
	$V_O = 1\text{ V to }4\text{ V}$, $R_L = 10\ \Omega$	25	55		
CMRR Common-mode rejection ratio	$V_O = 0$, $V_{ICR\text{min}}$, $R_S = 50\ \Omega$	75	110		dB
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DCC}/\Delta V_{IO}$)	$V_{DD} = 4.6\text{ to }16\text{ V}$	80	110		dB
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load		1.7	2.6	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.

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	$V_O = 0.5\text{ V to }2.5\text{ V}$, $R_L = 10\ \text{k}\Omega$, $C_L = 100\ \text{pF}$	1.6	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		
$V_{N(\text{PP})}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$		0.7		
I_n Equivalent input noise current			0.6		$\text{pA}/\sqrt{\text{Hz}}$
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°		



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PARAMETER MEASUREMENT INFORMATION

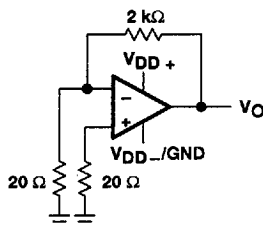
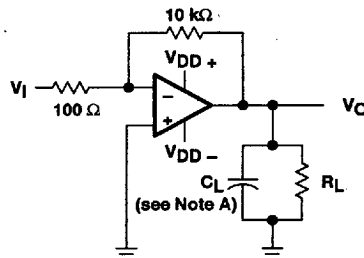
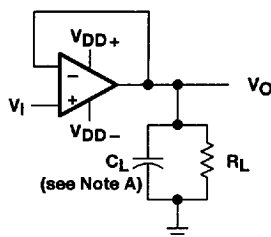


Figure 1. Noise-Voltage Test Circuit



NOTE A: C_L includes fixture capacitance.

Figure 2. Phase-Margin Test Circuit



NOTE A: C_L includes fixture capacitance.

Figure 3. Slew-Rate Test Circuit

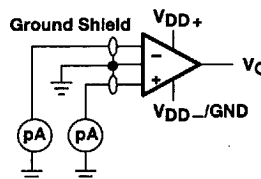


Figure 4. Input-Bias and Offset-Current Test Circuit

typical values

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

Input bias and offset current

At the picoamp bias current level of the TLC2202, TLC2202A, and TLC2202B, accurate measurement of the bias current becomes difficult. Not only does this measurement require a picoammeter, but test socket leakages can easily exceed the actual device bias currents. To measure these small currents, Texas Instruments uses a two-step process. The socket leakage is measured using picoammeters with bias voltages applied but with no device in the socket. The device is then inserted in the socket, and a second test measuring both the socket leakage and the device input bias current is performed. The two measurements are then subtracted algebraically to determine the bias current of the device.

noise

Texas Instruments offers automated production noise testing to meet individual application requirements. Noise voltage at $f = 10$ Hz and $f = 1$ kHz is 100% tested on every TLC2201B device, while lot sample testing is performed on the TLC2202A. For other noise requirements, please contact the factory.



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I_{IB}	Input bias current	vs Common-mode input voltage	6
		vs Free-air temperature	7
V_{OM}	Maximum peak output voltage	vs Output current	8,9
		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 Current	13
		vs Free-air temperature	14
V_{OL}	Low-level output voltage	vs 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, 22
I_{DD}	Supply current	vs Supply voltage	23
		vs Free-air temperature	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
		vs Free-air temperature	34
ϕ_m	Phase margin	vs Supply voltage	35
		vs Free-air temperature	36
	Phase shift	vs Frequency	17



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TYPICAL CHARACTERISTICS†

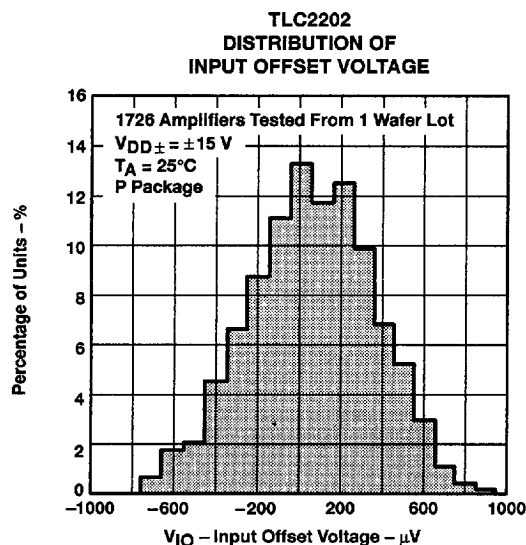


Figure 5

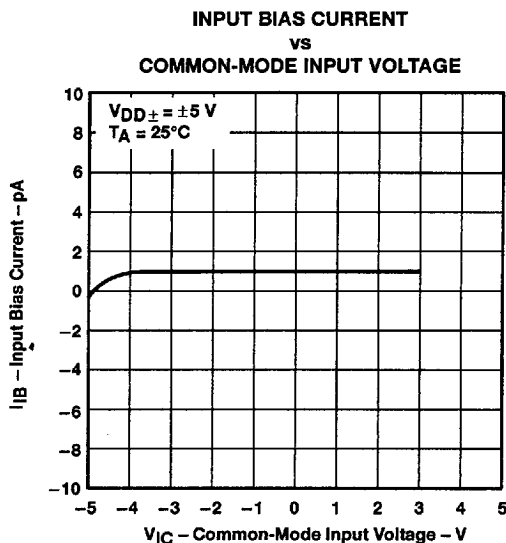


Figure 6

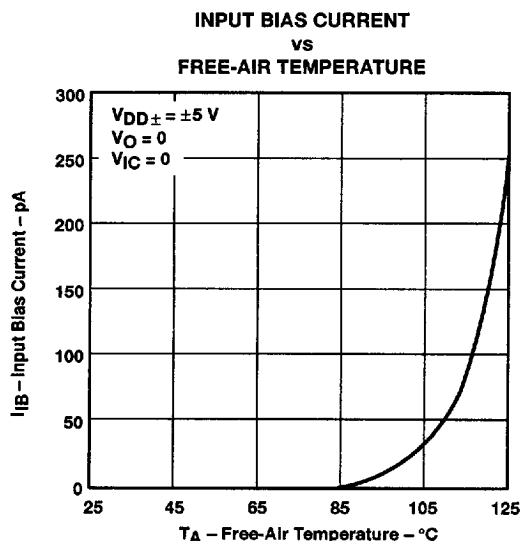


Figure 7

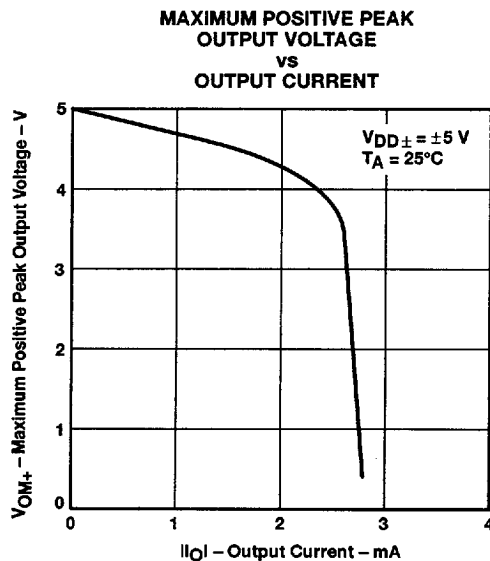


Figure 8

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



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TYPICAL CHARACTERISTICS†

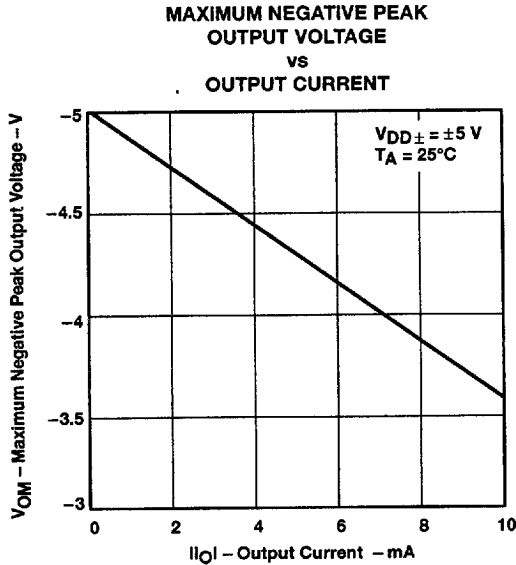


Figure 9

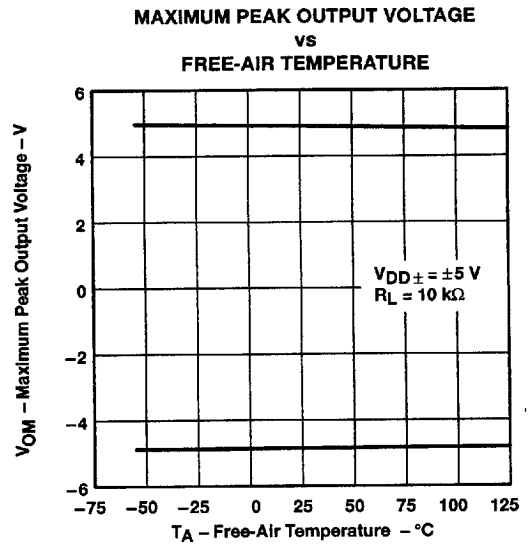


Figure 10

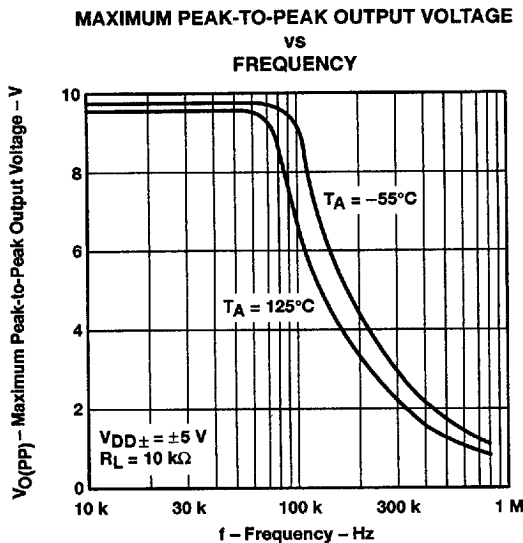


Figure 11

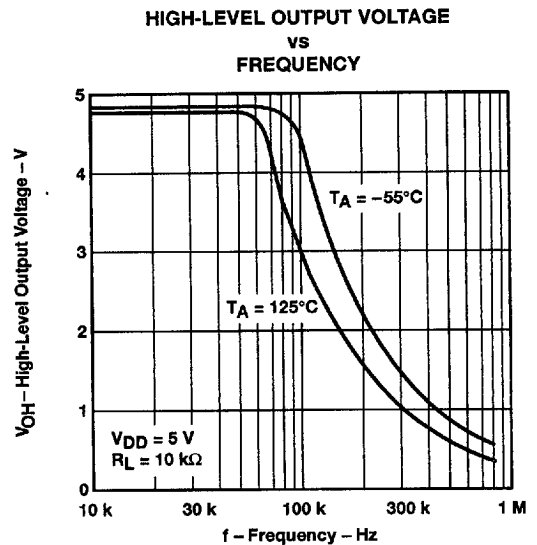


Figure 12

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



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TYPICAL CHARACTERISTICS†

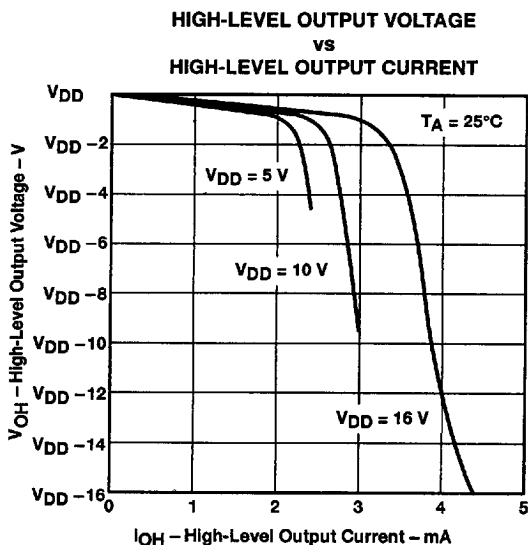


Figure 13

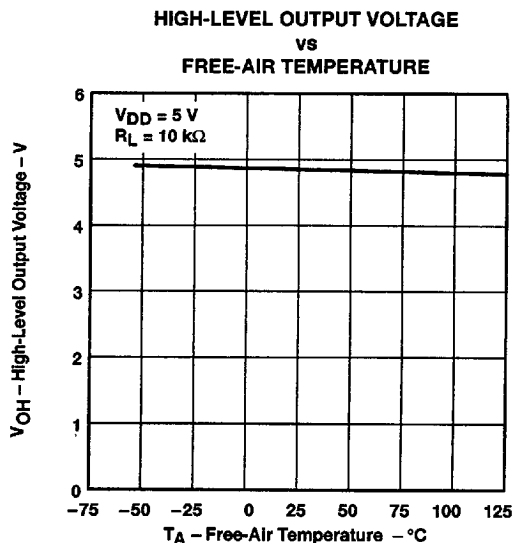


Figure 14

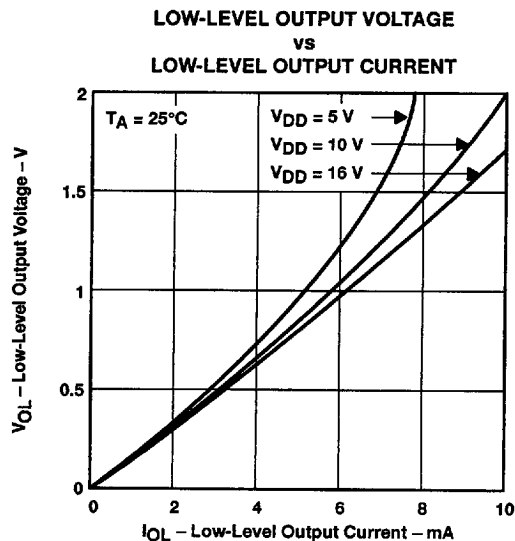


Figure 15

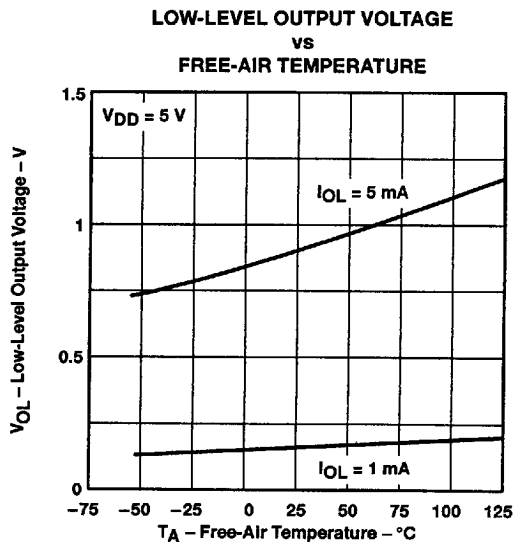


Figure 16

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



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TYPICAL CHARACTERISTICS†

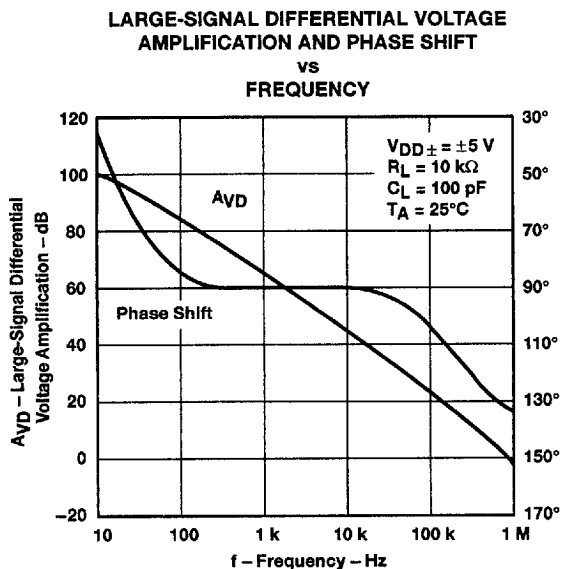


Figure 17

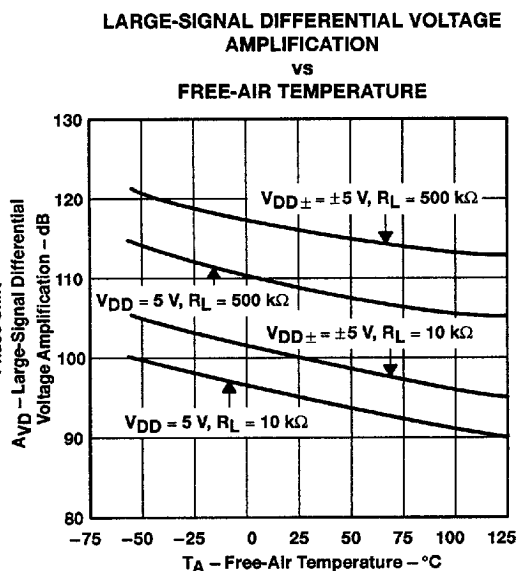


Figure 18

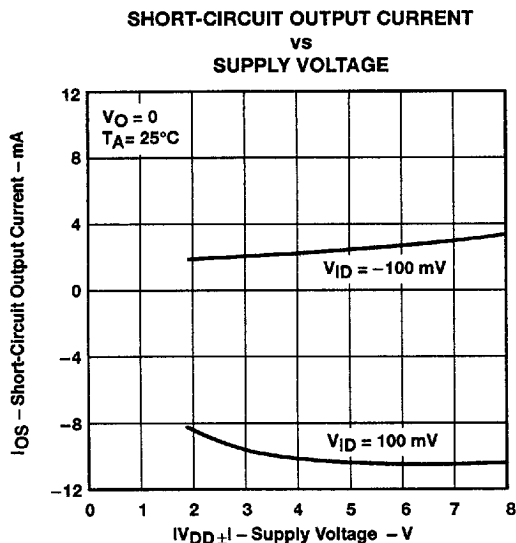


Figure 19

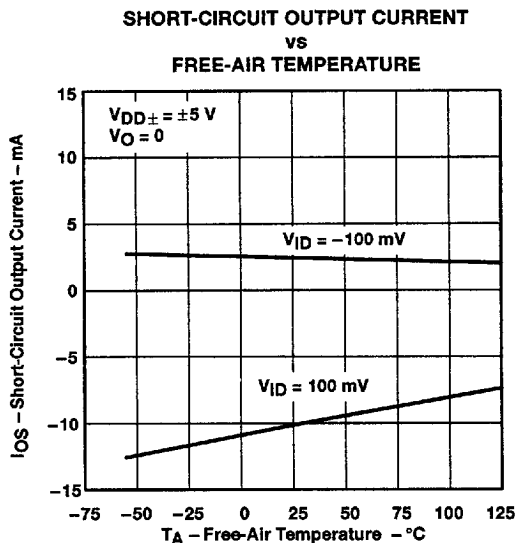


Figure 20

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



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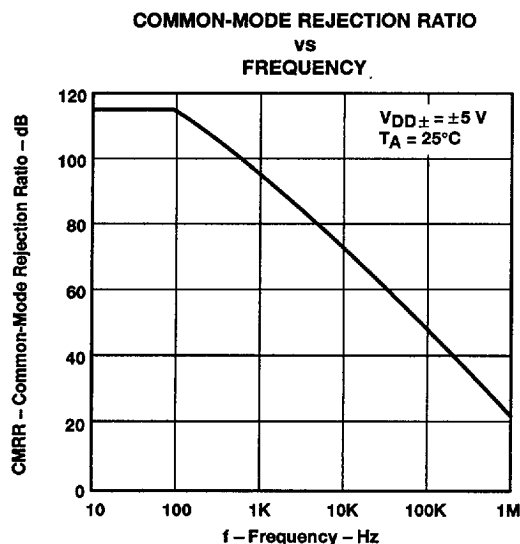


Figure 21

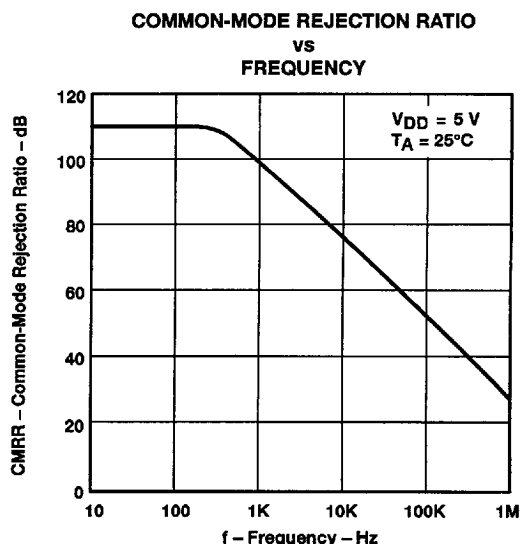


Figure 22

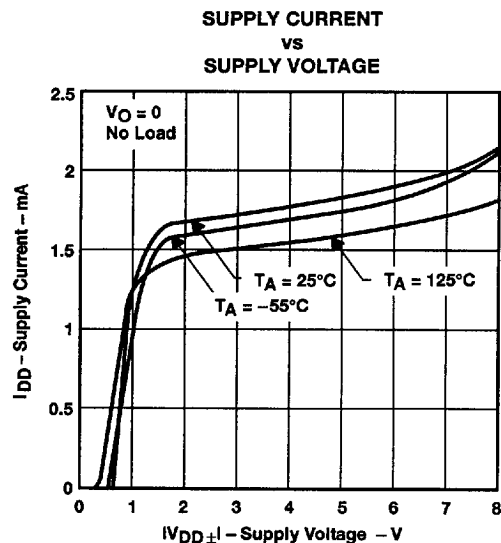


Figure 23

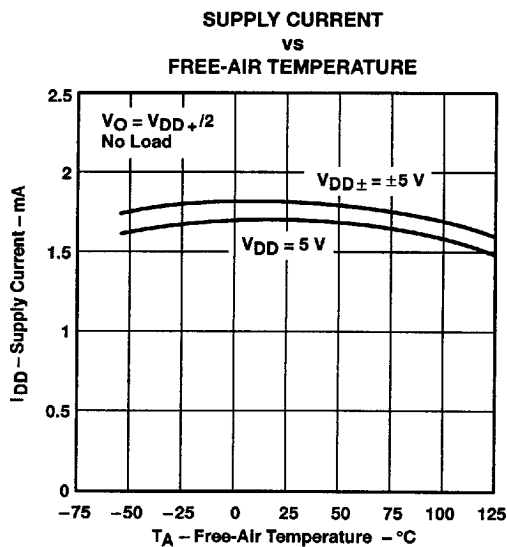


Figure 24

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



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TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

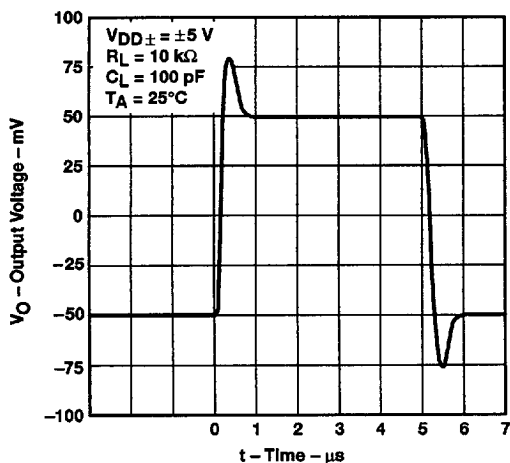


Figure 25

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

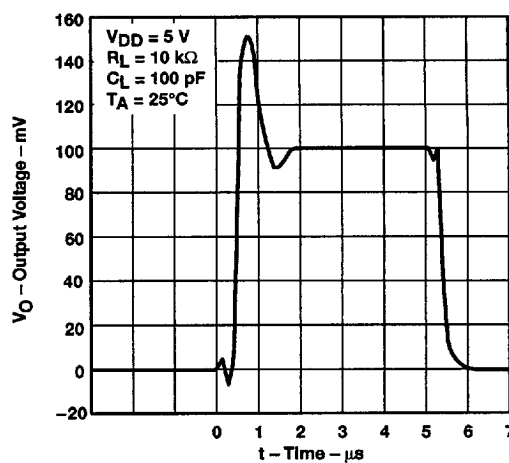


Figure 26

VOLTAGE-FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

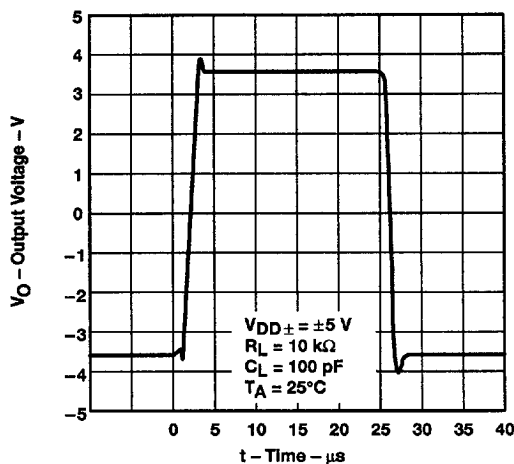


Figure 27

VOLTAGE-FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

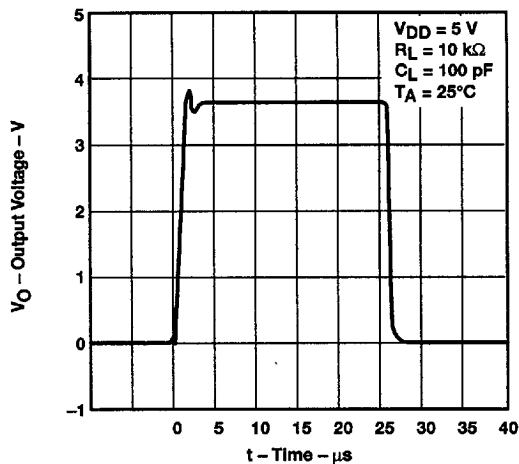


Figure 28



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TLC2202, TLC2202A, TLC2202B, TLC2202Y
Advanced LinCMOS™ LOW-NOISE PRECISION
DUAL OPERATIONAL AMPLIFIERS
 SLOS056A – MAY 1990 – REVISED AUGUST 1994

TYPICAL CHARACTERISTICS†

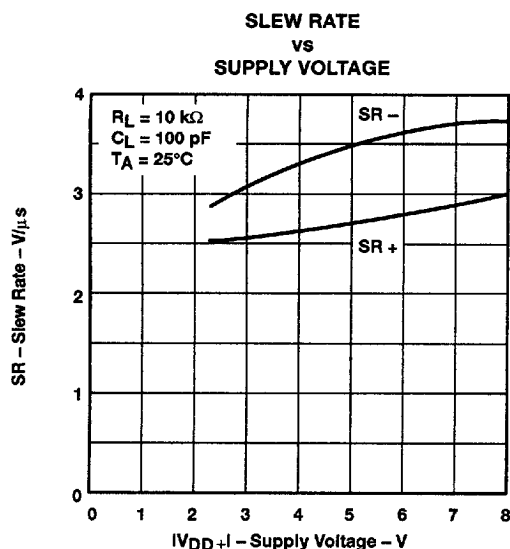


Figure 29

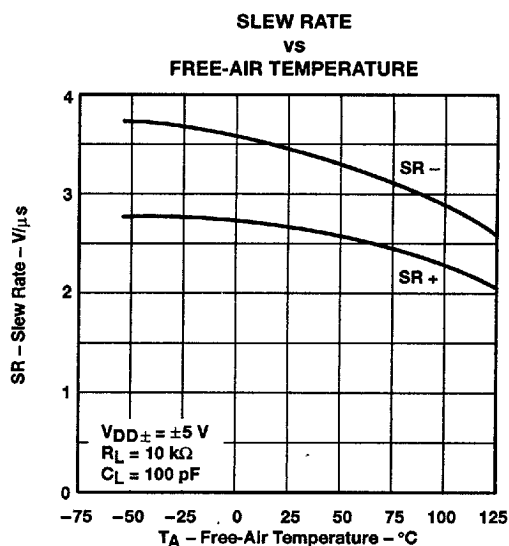


Figure 30

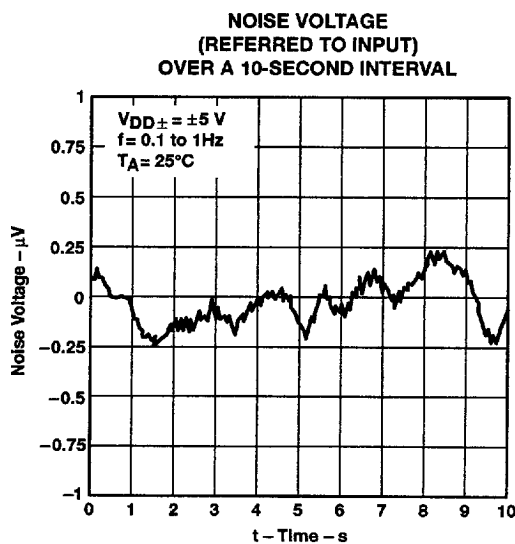


Figure 31

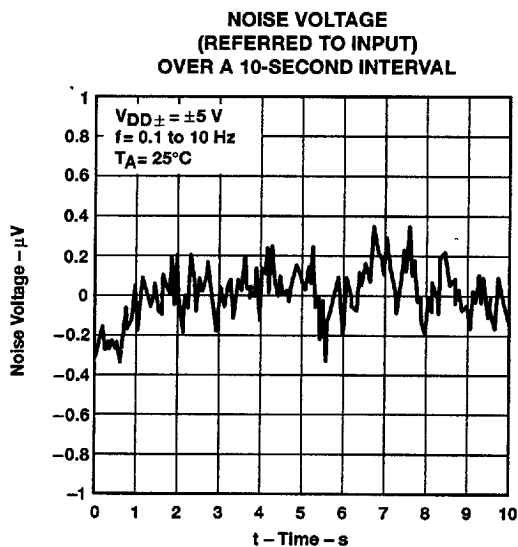


Figure 32

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



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2-852

8961724 0093534 519

TYPICAL CHARACTERISTICS†

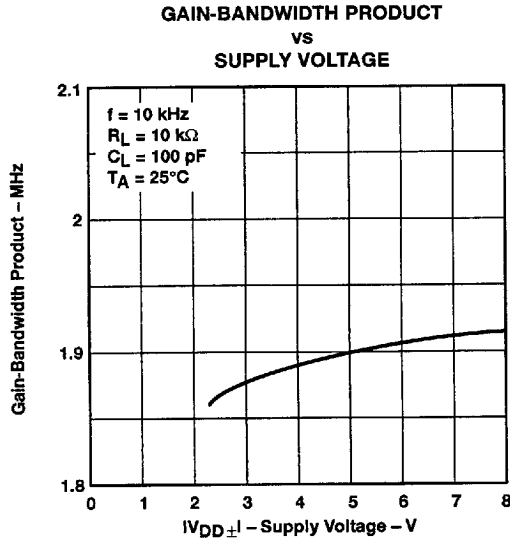


Figure 33

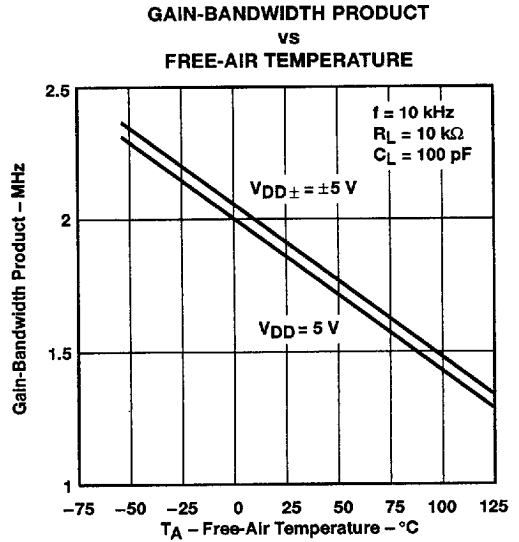


Figure 34

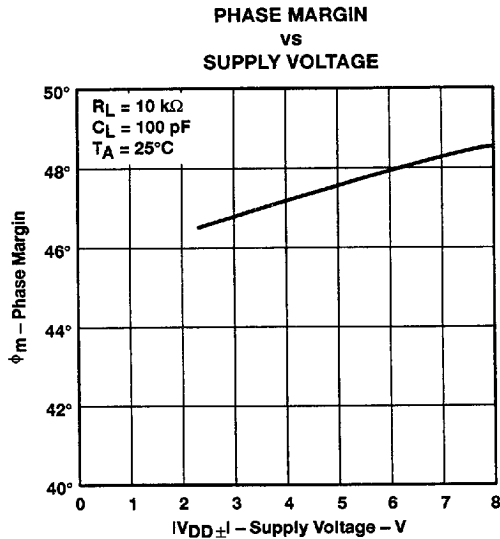


Figure 35

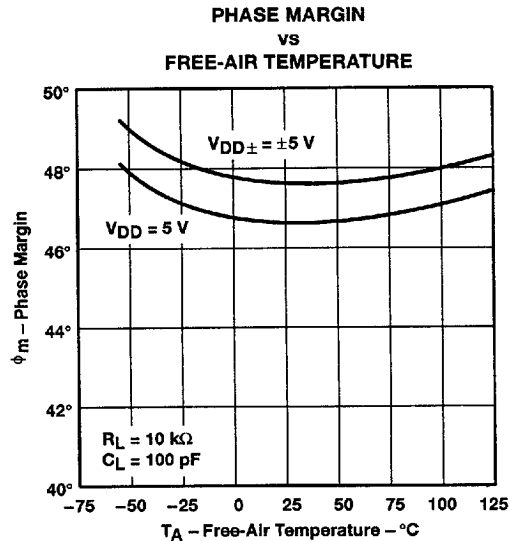


Figure 36

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



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TLC2202, TLC2202A, TLC2202B, TLC2202Y
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DUAL OPERATIONAL AMPLIFIERS

SLOS056A – MAY 1990 – REVISED AUGUST 1994

APPLICATION INFORMATION

latch-up avoidance

Because CMOS devices are susceptible to latch-up due to their inherent parasitic thyristors, the TLC2202, TLC2202A, and TLC2202B 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.



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