

TLC2201, TLC2201A, TLC2201B, TLC2201Y Advanced LinCMOS™ LOW-NOISE PRECISION OPERATIONAL AMPLIFIERS

SLOS021A – NOVEMBER 1988 – REVISED AUGUST 1994

- **TLC2201B 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 . . . 200 μ V Max**
- **Excellent Offset Voltage Stability**
With Temperature . . . 0.5 μ V/°C Typ

- **Low Input Bias Current**
1 pA at $T_A = 25^\circ\text{C}$
- **Fully Specified for Both Single-Supply and Split-Supply Operation**
- **Common-Mode Input Voltage Range**
Includes the Negative Rail

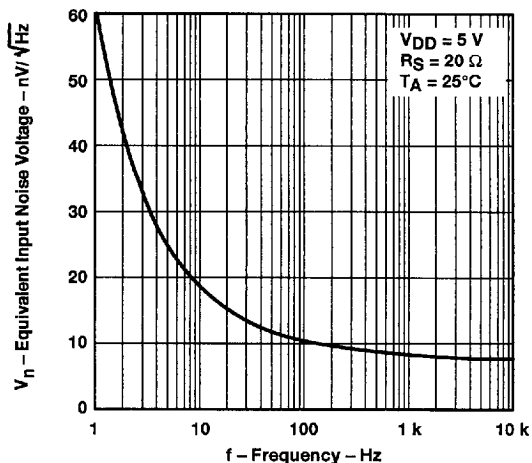
description

The TLC2201, TLC2201A, TLC2201B, and TLC2201Y 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 device parametric performance.

**TYPICAL EQUIVALENT
INPUT NOISE VOLTAGE
vs
FREQUENCY**



AVAILABLE OPTIONS

T_A	V_{IOmax} AT 25°C	V_nmax $f = 10$ Hz AT 25°C	V_nmax $f = 1$ 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 μ V 200 μ V 500 μ V	35 nV/√Hz 30 nV/√Hz —	15 nV/√Hz 12 nV/√Hz —	TLC2201ACD TLC2201BCD TLC2201CD	—	—	TLC2201ACP TLC2201BCP TLC2201CP	TLC2201Y
-40°C to 85°C	200 μ V 200 μ V 500 μ V	35 nV/√Hz 30 nV/√Hz —	15 nV/√Hz 12 nV/√Hz —	TLC2201AID TLC2201BID TLC2201ID	—	—	TLC2201AIP TLC2201BIP TLC2201IP	—
-55°C to 125°C	200 μ V 200 μ V 500 μ V	35 nV/√Hz 30 nV/√Hz —	15 nV/√Hz 12 nV/√Hz —	TLC2201AMD TLC2201BMD TLC2201MD	TLC2201AMFK TLC2201BMFK TLC2201MFK	TLC2201AMJG TLC2201BMJG TLC2201MJG	TLC2201AMP TLC2201BMP TLC2201MP	—

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2201BCDR). Chip-form versions are tested at 25°C only.

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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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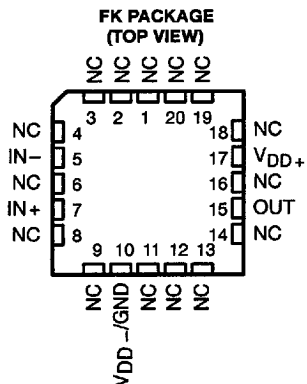
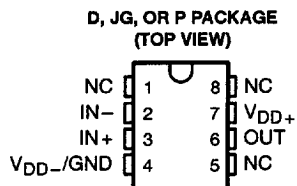
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description (continued)

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



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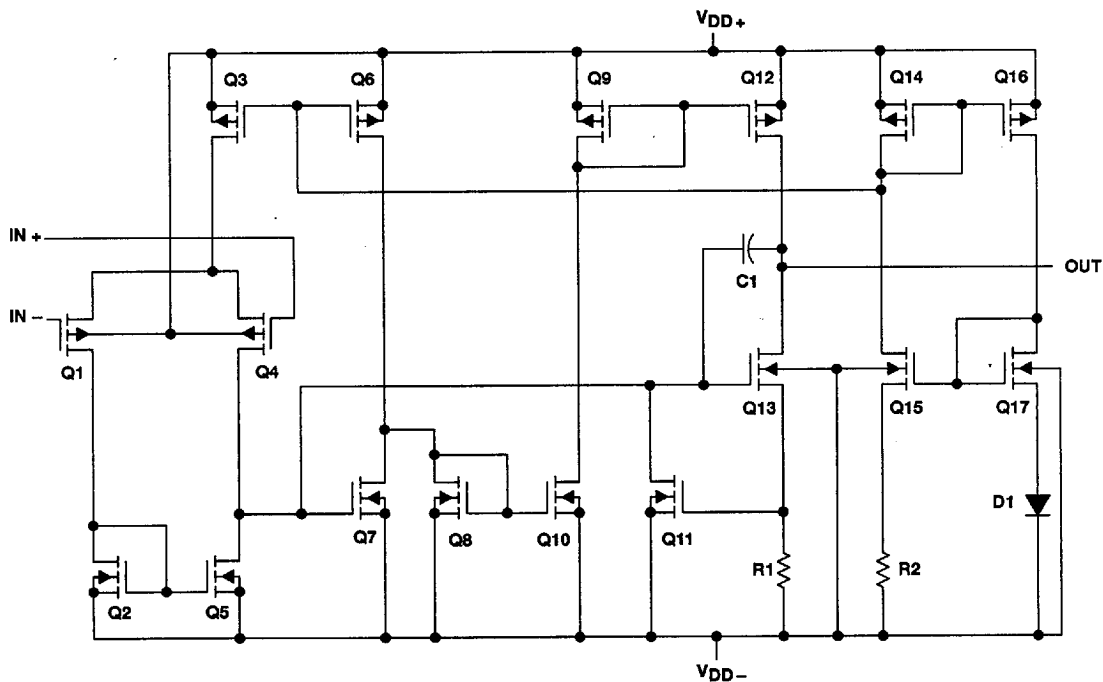
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equivalent schematic (each amplifier)



COMPONENT COUNT	
Transistors	17
Diodes	1
Resistors	2
Capacitors	1



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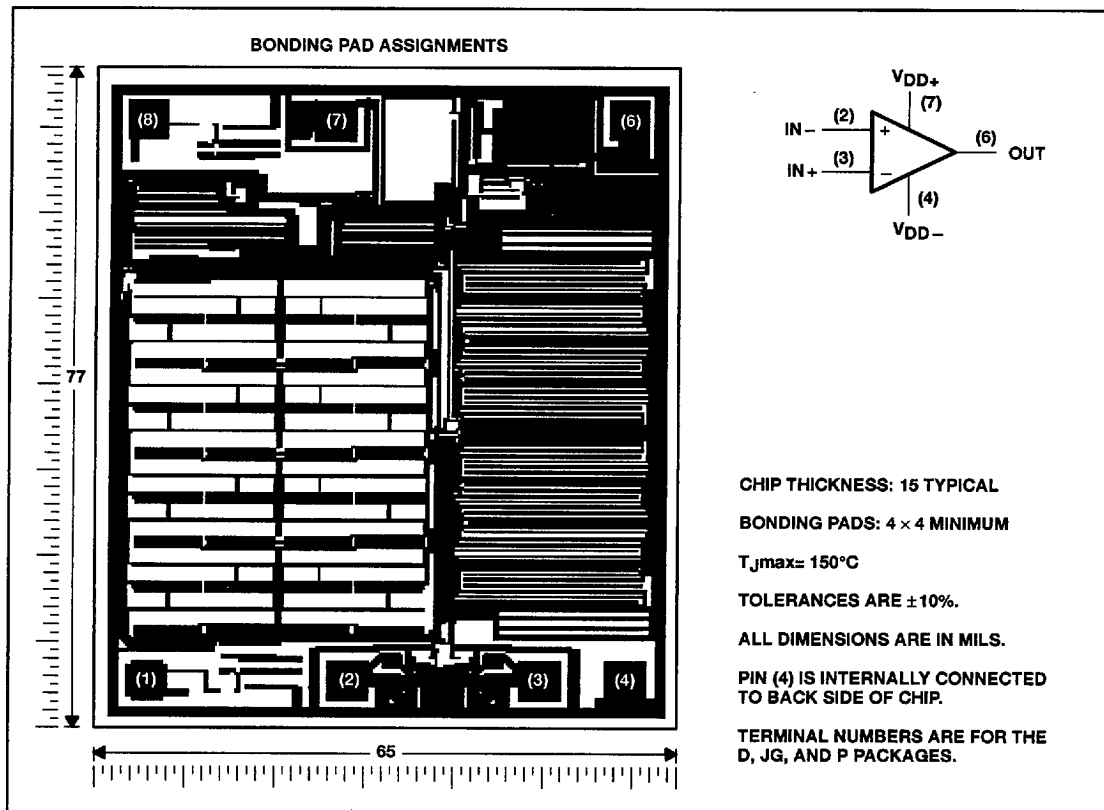
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TLC2201Y chip information

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



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

Supply voltage, V_{DD+} (see Note 1)	8 V
Supply voltage, V_{DD-} (see Note 1)	–8 V
Differential input voltage, V_{ID} (see Note 2)	±16 V
Input voltage, V_I (any input) (see Note 1)	±8 V
Input current, I_I (each input)	±5 mA
Output current, I_O	±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, 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 can 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	725 mW	5.8 mW/°C	464 mW	377 mW	145 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, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201C			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	μV
		Full range			600	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			100	
I_{IB} Input bias current		25°C		1		pA
		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	-4.7	-4.9		V
		Full range	-4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}, \quad R_L = 500\ \text{k}\Omega$	25°C	400	580		V/mV
		Full range	300			
	$V_O = \pm 4\text{ V}, \quad R_L = 10\ \text{k}\Omega$	25°C	90	100		
		Full range	70			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, \quad V_O = 0, \quad R_S = 50\ \Omega$	25°C	90	115		dB
		Full range	85			
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	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	

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

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

† Full range is 0°C to 70°C.

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, $V_{DD} \pm = \pm 5$ V (unless otherwise noted)

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

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

PARAMETER	TEST CONDITIONS	$T_A \uparrow$	TLC2201AC			TLC2201BC			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	2	2.7		2	2.7		V/ μs
		Full range	1.5			1.5			
V_n Equivalent input noise voltage (see Note 5)	$f = 10$ 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 TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



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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		pA
		Full range			100	
I_{IB} Input bias current		25°C		1		pA
		Full range			100	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range		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	

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	$V_O = 0.5\text{ V to }2.5\text{ V},$ $R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	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	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$	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.

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

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

† Full range is 0°C to 70°C.

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 TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



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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		
		Full range			150	pA
I_{IB} Input bias current		25°C		1		
		Full range			150	pA
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			
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	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	

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

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

† Full range is -40°C to 85°C .

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, $V_{DD} \pm = \pm 5$ V (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201AI			TLC2210BI			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	
αV_{IO} Temperature coefficient of input offset voltage		Full range		0.5			0.5		$\mu V/^\circ C$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005		0.001	0.005	$\mu V/mo$
I_{IO} Input offset current		25°C		0.5			0.5		pA
		Full range			150			150	
I_{IB} Input bias current	$R_S = 50 \Omega$	25°C		1			1		pA
		Full range			150			150	
V_{ICR} Common-mode input voltage range		Full range	-5 to 2.7			-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10 k\Omega$	25°C		4.7	4.8		4.7	4.8	V
		Full range		4.7			4.7		
V_{OM-} Maximum negative peak output voltage swing		25°C		-4.7	-4.9		-4.7	-4.9	V
		Full range		-4.7			-4.7		
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4$ V, $R_L = 500 k\Omega$	25°C		400	560		400	560	V/mV
		Full range		250			250		
	$V_O = \pm 4$ V, $R_L = 10 k\Omega$	25°C		90	100		90	100	
		Full range		65			65		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50 \Omega$	25°C		90	115		90	115	dB
		Full range		85			85		
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$)	$V_{DD} \pm = \pm 2.3$ V to ± 8 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	

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

PARAMETER		TEST CONDITIONS	T _A †	TLC2201AI			TLC2210BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V _O = ±2.3 V, R _L = 10 kΩ, C _L = 100 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 Hz	25°C		18	35		18	30	nV/√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/√Hz
Gain-bandwidth product		f = 10 kHz, R _L = 10 kΩ, C _L = 100 pF	25°C		1.9			1.9		MHz
φ _m	Phase margin at unity gain	R _L = 10 kΩ, C _L = 100 pF	25°C		48°			48°		

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

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 assuming an activation energy of 0.96 eV.

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



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2201I			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0, \quad R_S = 50\ \Omega$	25°C		100	500	μV
		Full range			650	
α_{VIO} Temperature coefficient of input offset voltage		Full range		0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			150	
I_{IB} Input bias current		25°C		1		pA
		Full range			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$	Full range	0 to 2.7			V
V_{OH} Maximum high-level output voltage	$R_L = 10\ \text{k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OL} Maximum low-level output voltage	$I_O = 0$	25°C		0	50	mV
		Full range			50	
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 500\ \text{k}\Omega$	25°C	150	315		V/mV
		Full range	100			
	$V_O = 1\text{ V to }4\text{ V},$ $R_L = 10\ \text{k}\Omega$	25°C	25	55		
		Full range	15			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin},$ $V_O = 0, \quad R_S = 50\ \Omega$	25°C	90	110		dB
		Full range	85			
kSVR 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	

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		V/ μs
		Full range	1.2			
V_n Equivalent input noise voltage	$f = 10\ \text{Hz}$	25°C		18		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$	25°C		8		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\ \text{Hz}$	25°C		0.5		μV
	$f = 0.1\text{ to }10\ \text{Hz}$	25°C		0.7		
I_n Equivalent input noise current		25°C		0.6		$\text{fA}/\sqrt{\text{Hz}}$
Gain-bandwidth product	$f = 10\ \text{kHz}, \quad R_L = 10\ \text{k}\Omega,$ $C_L = 100\ \text{pF}$	25°C		1.8		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		45°		

† Full range is -40°C to 85°C .

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

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	$V_O = 0.5\text{ V to }2.5\text{ V}, \quad R_L = 10\text{ k}\Omega, \quad C_L = 100\text{ pF}$	25°C	1.8	2.5		1.8	2.5		$\text{V}/\mu\text{s}$
		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		1.8			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°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 TLC2201A and on all devices for the TLC2201B. For other test requirements, please contact the factory. This statement has no bearing on testing or nontesting of other parameters.



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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	
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)		25°C		0.001	0.005	$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5		pA
		Full range			500	
I_{IB} Input bias current		25°C		1		pA
		Full range			500	
V_{ICR} Common-mode input voltage range	$R_S = 50 \Omega$	Full range	-5 to 2.7			V
V_{OM+} Maximum positive peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	4.7	4.8		V
		Full range	4.7			
V_{OM-} Maximum negative peak output voltage swing		25°C	-4.7	-4.9		V
		Full range	-4.7			
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 4 \text{ V}, \quad R_L = 500 \text{ k}\Omega$	25°C	400	580		V/mV
		Full range	200			
	$V_O = \pm 4 \text{ V}, \quad R_L = 10 \text{ k}\Omega$	25°C	90	100		
		Full range	45			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin},$ $V_O = 0, \quad R_S = 50 \Omega$	25°C	90	115		dB
		Full range	85			
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	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	

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

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

† Full range is -55°C to 125°C.

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, $V_{DD} \pm \pm 5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T _A †	TLC2201AM			TLC2210BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C		80	200		80	200	μV
			Full range			400			400	
α _{VIO}	Temperature coefficient of input offset voltage		Full range		0.5			0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005		0.001	0.005	μV/mo
I _{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			500			500	
I _{IB}	Input bias current		25°C		1			1		pA
			Full range			500			500	
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	–5 to 2.7			–5 to 2.7		V	
V _{OM+}	Maximum positive peak output voltage swing	R _L = 10 kΩ	25°C	4.7	4.8		4.7	4.8	V	
			Full range	4.7			4.7			
V _{OM–}	Maximum negative peak output voltage swing		25°C	–4.7	–4.9		–4.7	–4.9	V	
			Full range	–4.7			–4.7			
A _{VD}	Large-signal differential voltage amplification	V _O = ±4 V, R _L = 500 kΩ	25°C	400	560		400	560	V/mV	
			Full range	200			200			
		V _O = ±4 V, R _L = 10 kΩ	25°C	90	100		90	100		
			Full range	45			45			
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin} , V _O = 0, R _S = 50 Ω	25°C	90	115		90	115	dB	
			Full range	85			85			
k _{SVR}	Supply voltage rejection ratio (ΔV _{DD} ±/ΔV _{IO})	V _{DD} ± = ±2.3 V to ±8 V	25°C	90	110		90	110	dB	
			Full range	85			85			
I _{DD}	Supply current	V _O = 0, No load	25°C		1.1	1.5		1.1	1.5	mA
			Full range			1.5			1.5	

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

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



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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)	$f = 10\text{ Hz}$	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 -55°C to 125°C .

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



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

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		V/ μs
		Full range	1.1			
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		1.8		MHz
ϕ_m Phase margin at unity gain	$R_L = 10\ \text{k}\Omega, \quad C_L = 100\ \text{pF}$	25°C		45°		

*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 †	TLC2201AM		TLC2210BM		UNIT		
				MIN	TYP	MAX	MIN		TYP	MAX
V _{IO}	Input offset voltage	V _{IC} = 0, R _S = 50 Ω	25°C		80	200		80	200	μV
			Full range			400			400	
α _{VIO}	Temperature coefficient of input offset voltage		Full range		0.5			0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.001	0.005		0.001	0.005	μV/mo
I _{IO}	Input offset current		25°C		0.5			0.5		pA
			Full range			500			500	
I _{IB}	Input bias current		25°C		1			1		pA
			Full range			500			500	
V _{ICR}	Common-mode input voltage range	R _S = 50 Ω	Full range	0 to 2.7			0 to 2.7		V	
V _{OH}	Maximum high-level output voltage	R _L = 10 kΩ	25°C	4.7	4.8		4.7	4.8	V	
			Full range	4.7			4.7			
V _{OL}	Maximum low-level output voltage	I _O = 0	25°C		0	50		0	50	V
			Full range			50			50	
A _{VD}	Large-signal differential voltage amplification	V _O = 1 V to 4 V, R _L = 500 kΩ	25°C	150	315		150	315	V/mV	
			Full range	75			75			
		V _O = 1 V to 4 V, R _L = 10 kΩ	25°C	25	55		25	55		
			Full range	10			10			
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICRmin} , V _O = 0, R _S = 50 Ω	25°C	90	110		90	110	dB	
			Full range	85			85			
K _{SVR}	Supply voltage rejection ratio (ΔV _{DD} ± ΔV _{IO})	V _{DD} = 4.6 V to 16 V	25°C	90	110		90	110	dB	
			Full range	85			85			
I _{DD}	Supply current	V _O = 2.5 V, No load	25°C		1.1	1.5		1.1	1.5	mA
			Full range			1.5			1.5	

† Full range is -55°C to 125°C .

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



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

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

† Full range is -55°C to 125°C .

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



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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	500	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	$V_O = 1 \text{ V to } 4 \text{ V}$, $R_L = 500 \Omega$	25	55		V/mV
	$V_O = 1 \text{ V to } 4 \text{ V}$, $R_L = 10 \Omega$	25	55		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$, $R_S = 50 \Omega$, $V_O = 0$	90	110		dB
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} \pm / \Delta V_{IO}$)	$V_{DD} = 4.6 \text{ to } 16 \text{ V}$	90	110		dB
I_{DD} Supply current per amplifier	$V_O = 2.5 \text{ V}$, No load		1	1.5	mA

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	$V_O = \pm 0.5 \text{ to } 2.5 \text{ V}$, $R_L = 10 \text{ k}\Omega$, $C_L = 100 \text{ pF}$	1.8	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°		

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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PARAMETER MEASUREMENT INFORMATION

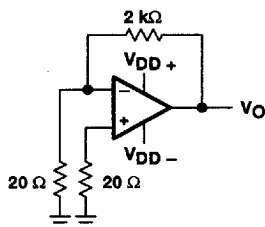
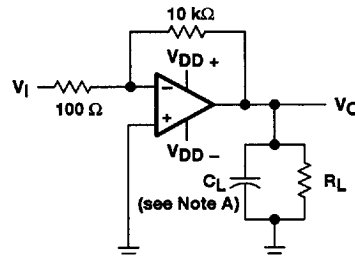
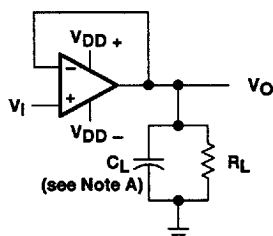


Figure 1. Noise-Voltage Test Circuit



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

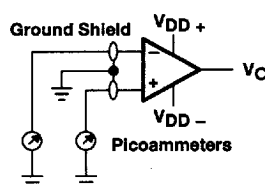


Figure 4. Input-Bias and Offset-Current Test Circuit

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 typical of the TLC2201, TLC2201A, and TLC2201B, 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 applications 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 TLC2201A. For other noise requirements, please contact the factory.



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TYPICAL CHARACTERISTICS

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I_{IB}	Input bias current	vs Common-mode voltage	6
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CMRR	Common-mode rejection ratio	vs Frequency	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
I_{DD}	Supply current	vs Supply voltage	21
		vs Free-air temperature	22
SR	Slew rate	vs Supply voltage	23
		vs Free-air temperature	24
	Pulse response	Small signal	25, 26
		Large signal	27, 28
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	0.1 to 1 Hz	29
		0.1 to 10 Hz	30
	Gain-bandwidth product	vs Supply voltage	31
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ϕ_m	Phase margin	vs Supply voltage	33
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	Phase shift	vs Frequency	17



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TYPICAL CHARACTERISTICS†

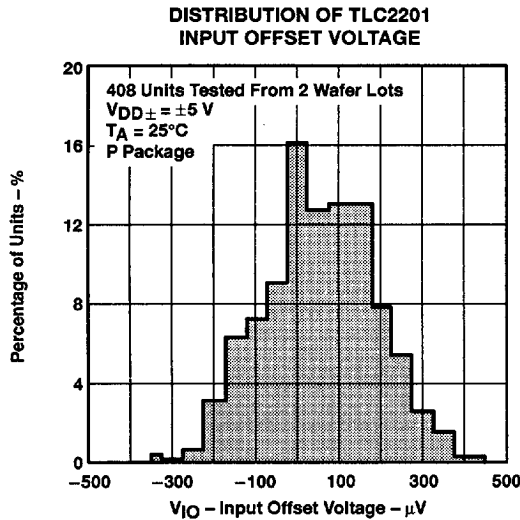


Figure 5

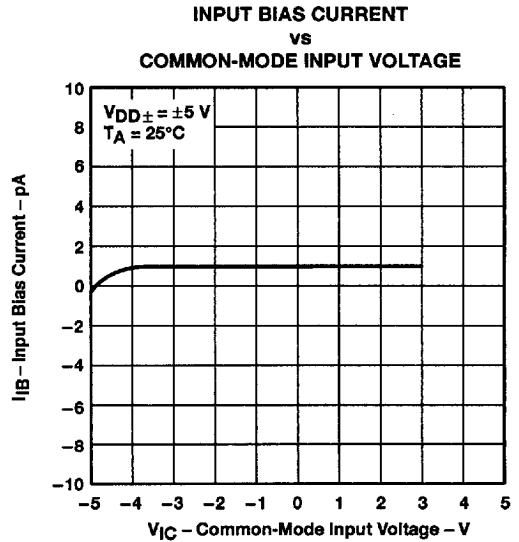


Figure 6

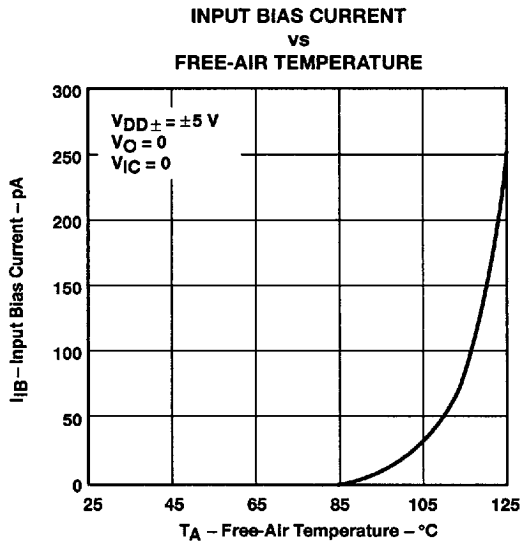


Figure 7

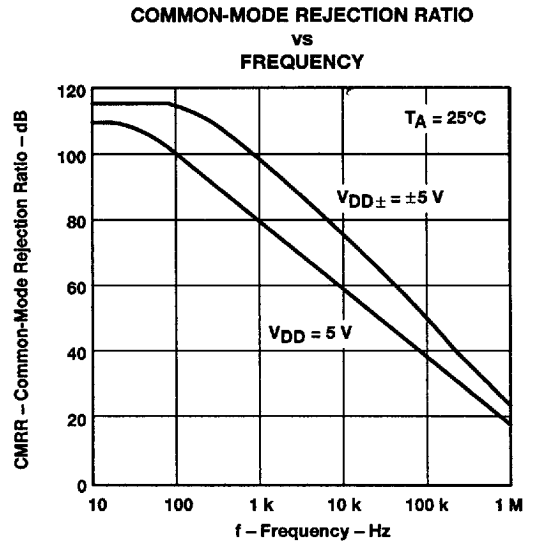


Figure 8

† 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†

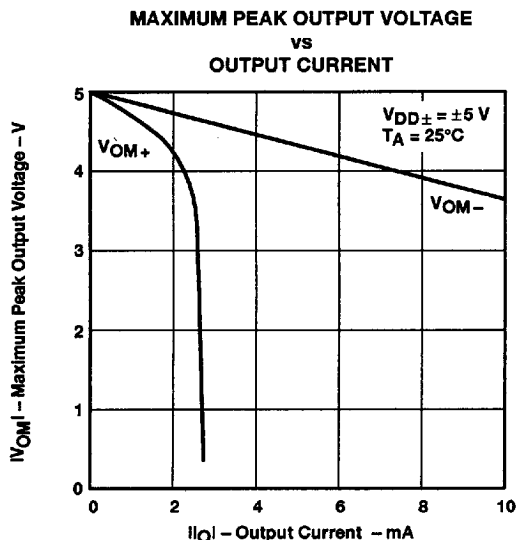


Figure 9

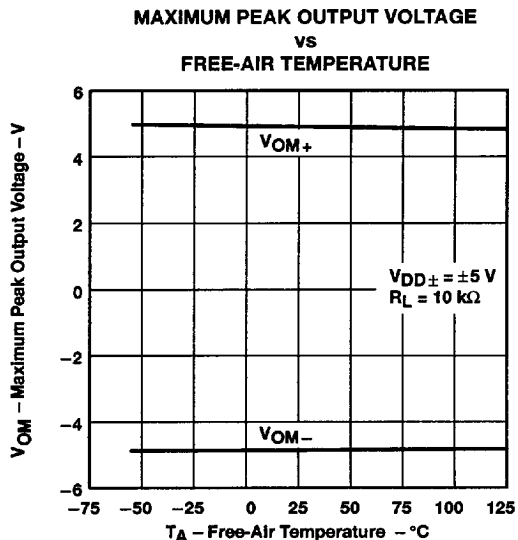


Figure 10

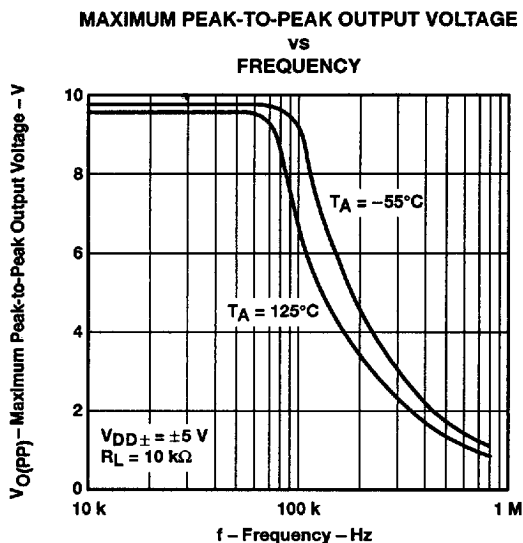


Figure 11

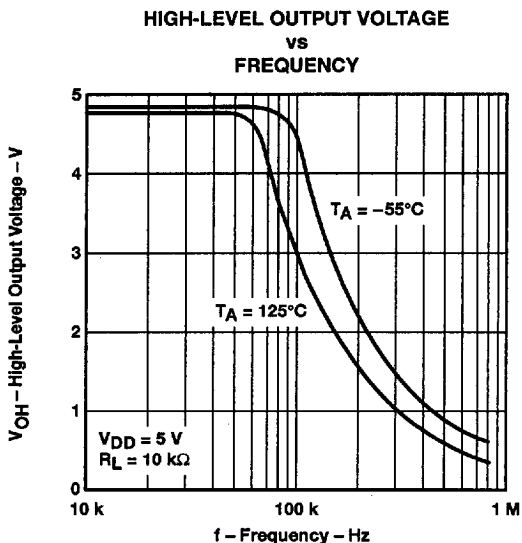


Figure 12

† 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†

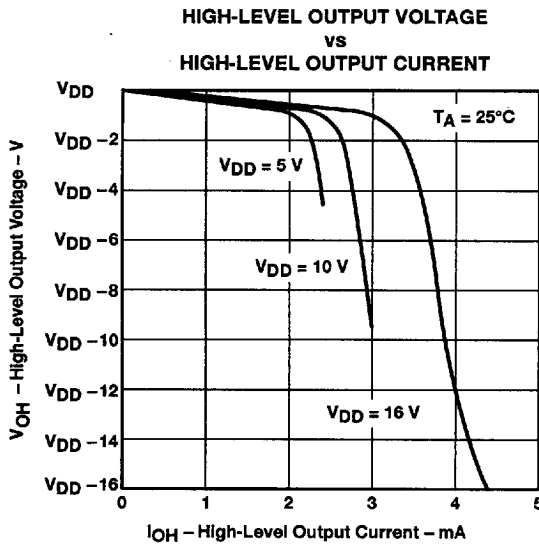


Figure 13

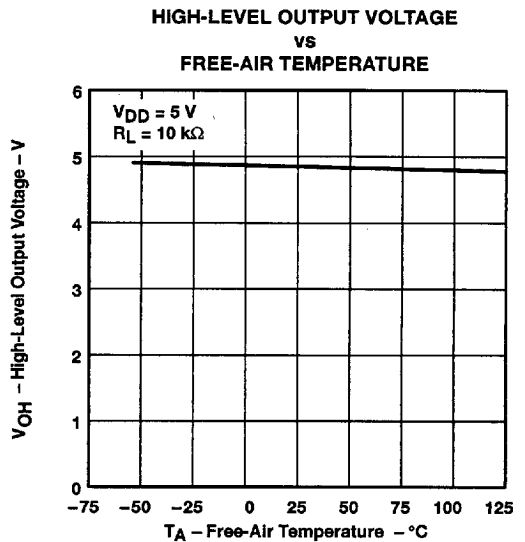


Figure 14

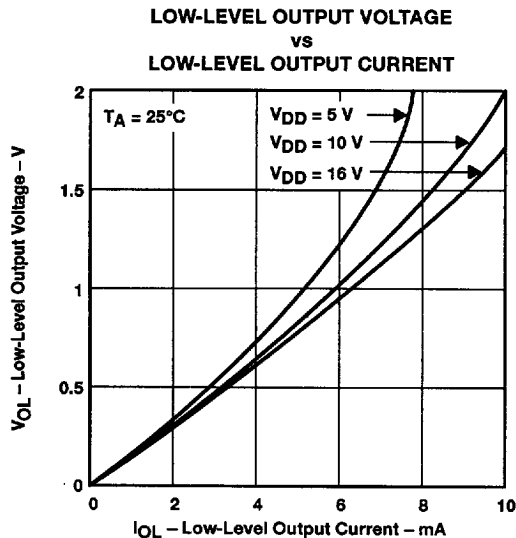


Figure 15

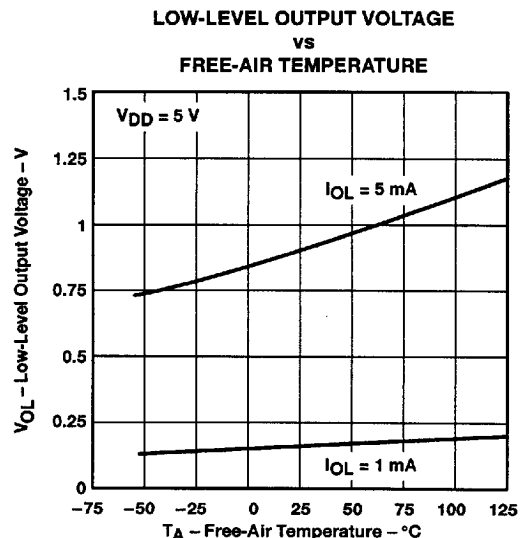


Figure 16

† 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†

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE
AMPLIFICATION AND PHASE SHIFT**

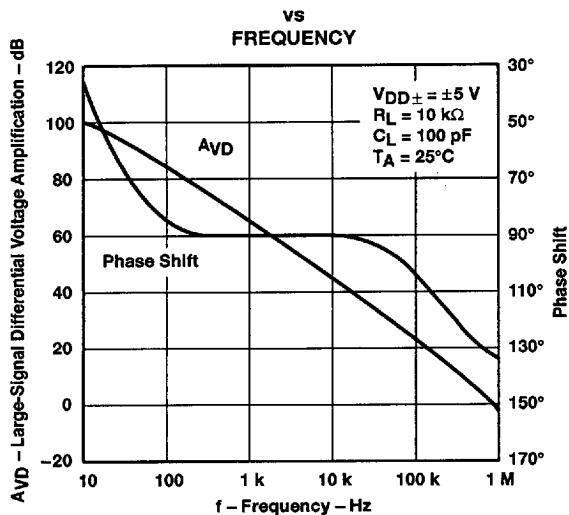


Figure 17

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE
AMPLIFICATION**

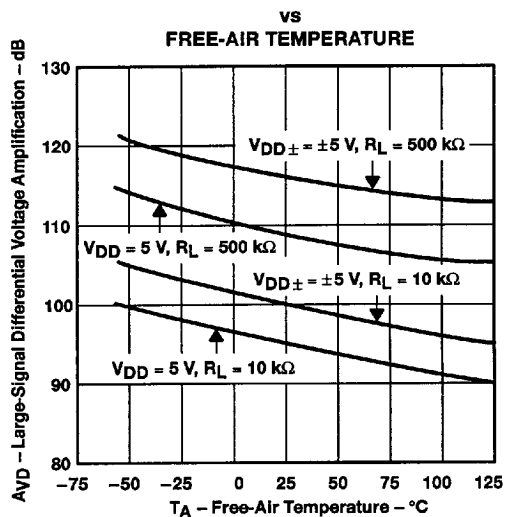


Figure 18

**SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE**

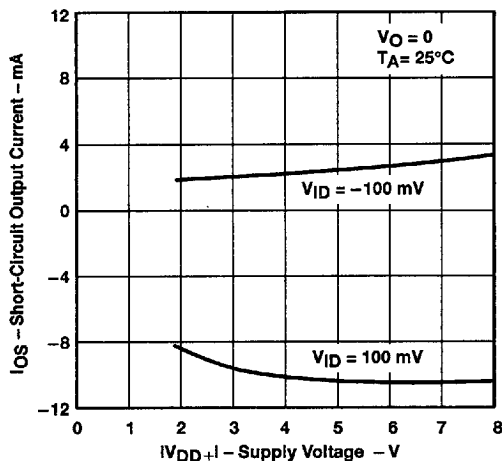


Figure 19

**SHORT-CIRCUIT OUTPUT CURRENT
vs
FREE-AIR TEMPERATURE**

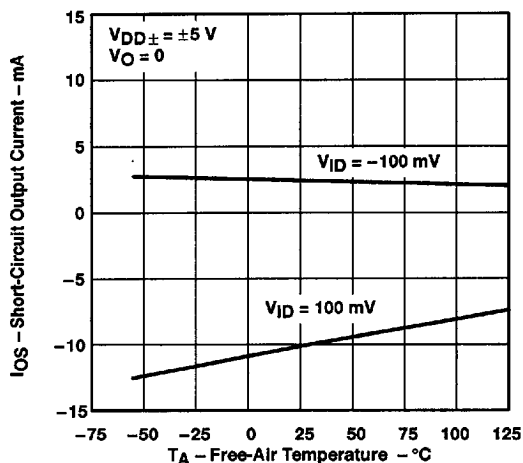


Figure 20

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



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TLC2201, TLC2201A, TLC2201B, TLC2201Y
Advanced LinCMOS™ LOW-NOISE PRECISION
OPERATIONAL AMPLIFIERS

SLOS021A – NOVEMBER 1988 – REVISED AUGUST 1994

TYPICAL CHARACTERISTICS†

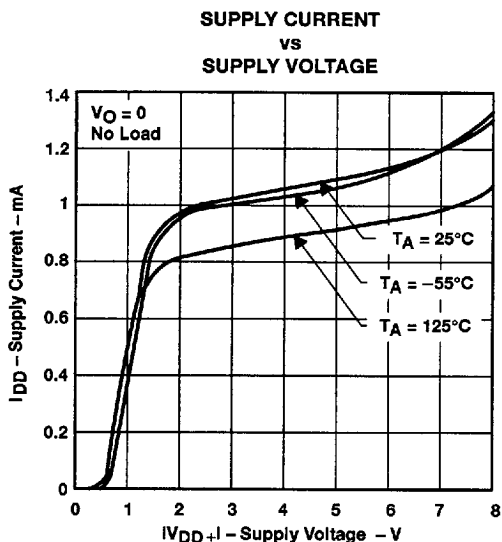


Figure 21

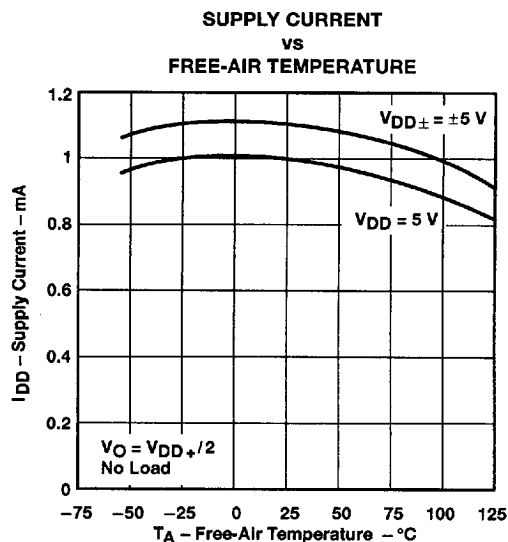


Figure 22

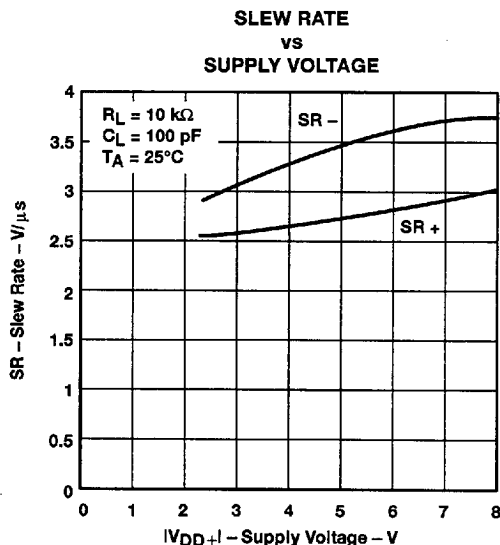


Figure 23

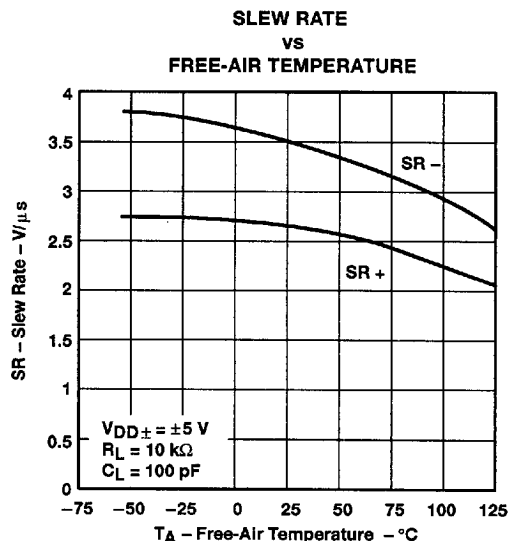


Figure 24

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



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TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

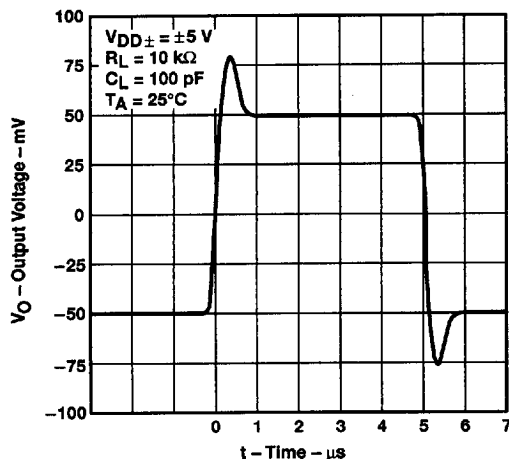


Figure 25

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

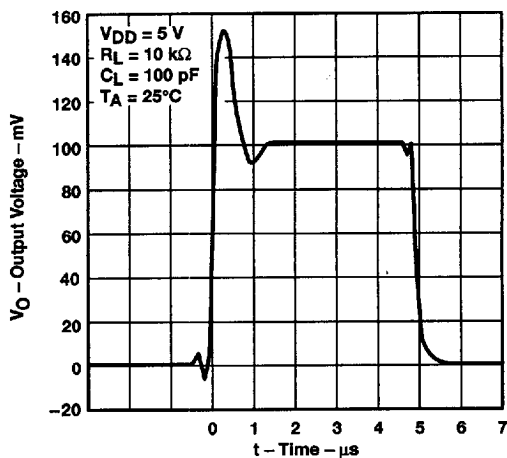


Figure 26

VOLTAGE-FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

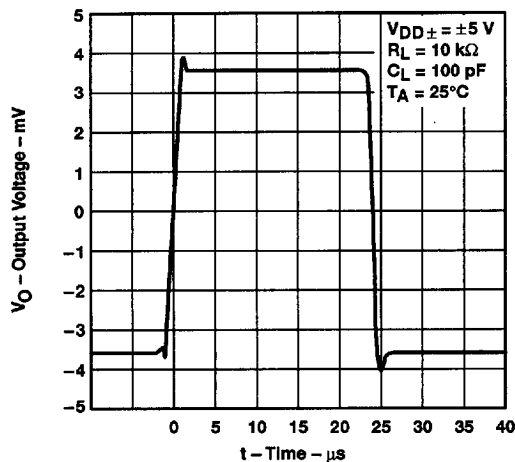


Figure 27

VOLTAGE-FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

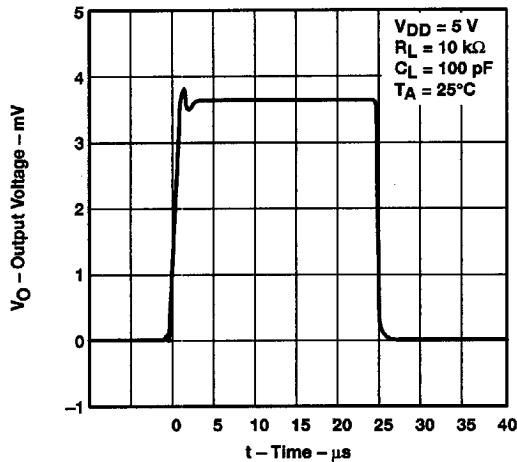


Figure 28



TYPICAL CHARACTERISTICS†

PEAK-TO-PEAK EQUIVALENT
INPUT NOISE VOLTAGE
0.1 TO 1 Hz

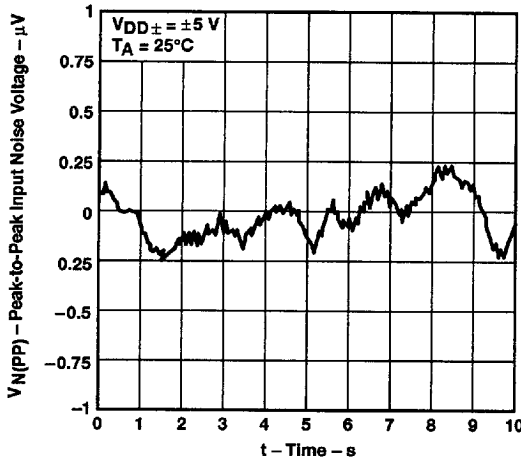


Figure 29

PEAK-TO-PEAK EQUIVALENT
INPUT NOISE VOLTAGE
0.1 TO 10 Hz

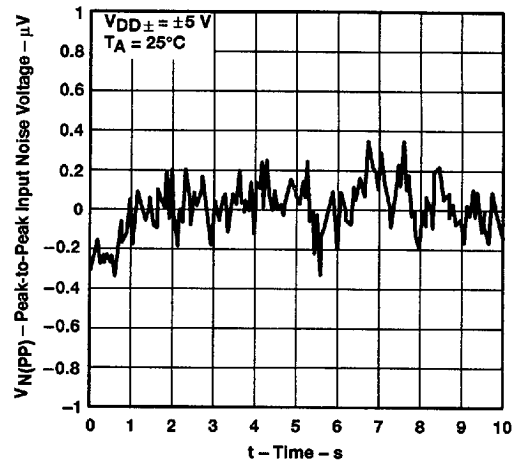


Figure 30

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

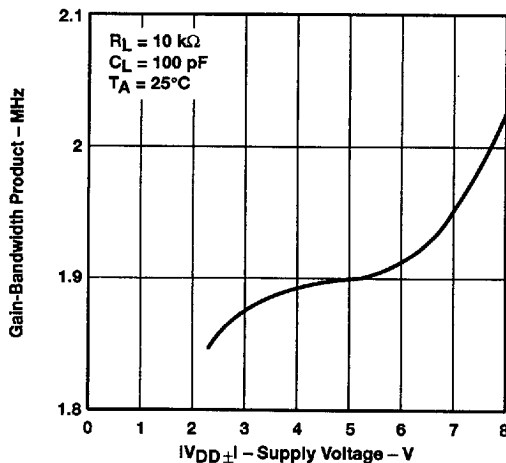


Figure 31

GAIN-BANDWIDTH PRODUCT
vs
FREE-AIR TEMPERATURE

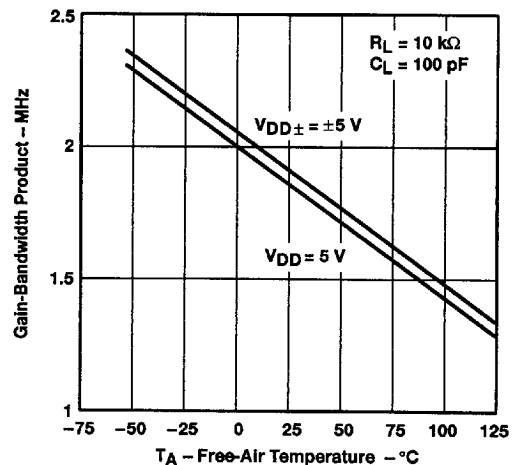


Figure 32

† 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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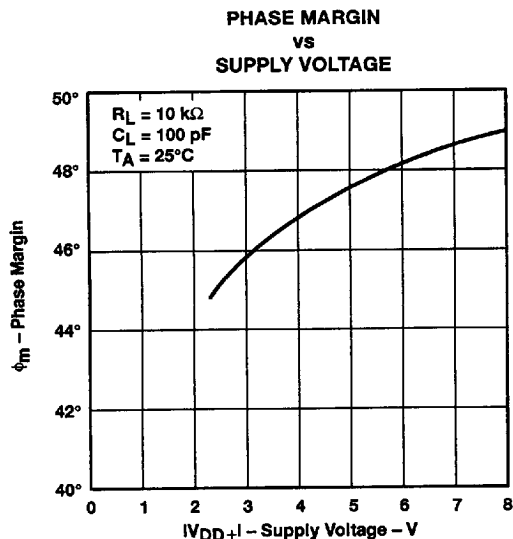


Figure 33

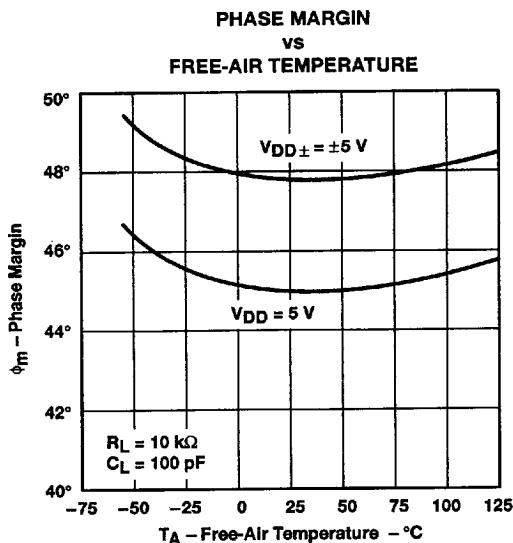


Figure 34

† 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 TLC2201, TLC2201A, and TLC2201B 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.

