

**NOTICE**  
SEE ORDER OF DATA FOR ERRATA INFORMATION

- **TLC2201B Is 100% Tested for Noise:**  
25 nV/Hz Max at  $f = 10$  Hz  
12 nV/Hz Max at  $f = 1$  kHz
- **Low Input Offset Voltage ... 200  $\mu$ V Max**
- **Excellent Offset Voltage Stability with Temperature ... 0.5  $\mu$ V/ $^{\circ}$ C Typ**

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

T-79-08

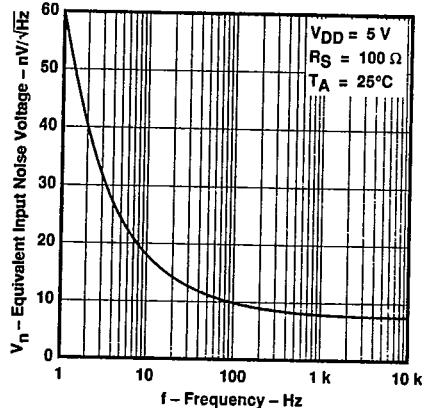
**description**

The TLC2201, TLC2201A, and TLC2201B 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 latchup. 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

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## Operational Amplifiers

## AVAILABLE OPTIONS

$T_A$	$V_{IO}$ max AT $25^{\circ}$ C	$V_n$ max $f = 10$ Hz AT $25^{\circ}$ C	$V_n$ max $f = 1$ kHz AT $25^{\circ}$ C	PACKAGE				
				SMALL-OUTLINE (D)	PLASTIC DIP (P)	CERAMIC DIP (JG)	CHIP CARRIER (FK)	METAL CAN (L)
0°C to 70°C	200 $\mu$ V	25 nV/Hz	12 nV/Hz	TLC2201BCD	TLC2201BCP	TLC2201BCJG	—	TLC2201BCL
	200 $\mu$ V	35 nV/Hz	15 nV/Hz	TLC2201ACD	TLC2201ACP	TLC2201ACJG	—	TLC2201ACL
	500 $\mu$ V	—	—	TLC2201CD	TLC2201CP	TLC2201CJG	—	TLC2201CL
-40°C to 85°C	200 $\mu$ V	25 nV/Hz	12 nV/Hz	TLC2201BID	TLC2201BIP	TLC2201BIJG	—	TLC2201BIL
	200 $\mu$ V	35 nV/Hz	15 nV/Hz	TLC2201AID	TLC2201AIP	TLC2201AJG	—	TLC2201AIL
	500 $\mu$ V	—	—	TLC2201ID	TLC2201IP	TLC2201JG	—	TLC2201IL
-55°C to 125°C	200 $\mu$ V	25 nV/Hz	12 nV/Hz	TLC2201BMD	TLC2201BMP	TLC2201BMJG	TLC2201BMFK	TLC2201BML
	200 $\mu$ V	35 nV/Hz	15 nV/Hz	TLC2201AMD	TLC2201AMP	TLC2201AMJG	TLC2201AMFK	TLC2201AML
	500 $\mu$ V	—	—	TLC2201MD	TLC2201MP	TLC2201MJG	TLC2201MFK	TLC2201ML

D packages are available taped-and-reeled. Add "R" suffix to device type when ordering (e.g., TLC2201BCDR). Advanced LinCMOS is a trademark of Texas Instruments Incorporated.

PRODUCTION DATA documents contain information 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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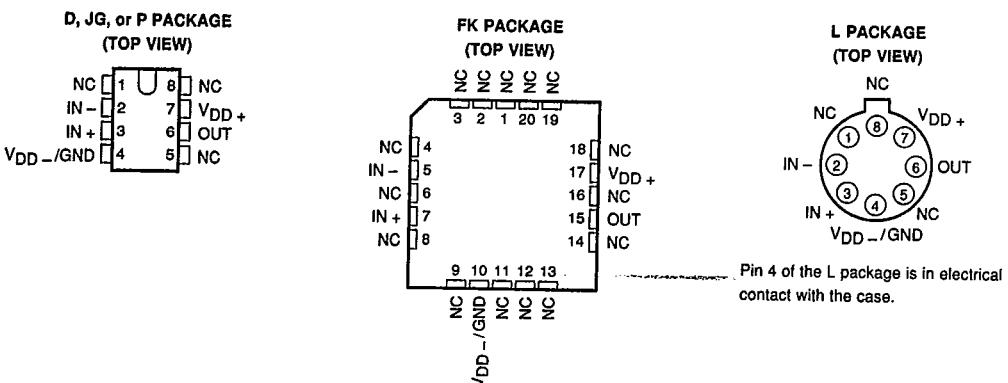
TLC2201, TLC2201A, TLC2201B

Advanced LinCMOS™ LOW-NOISE PRECISION  
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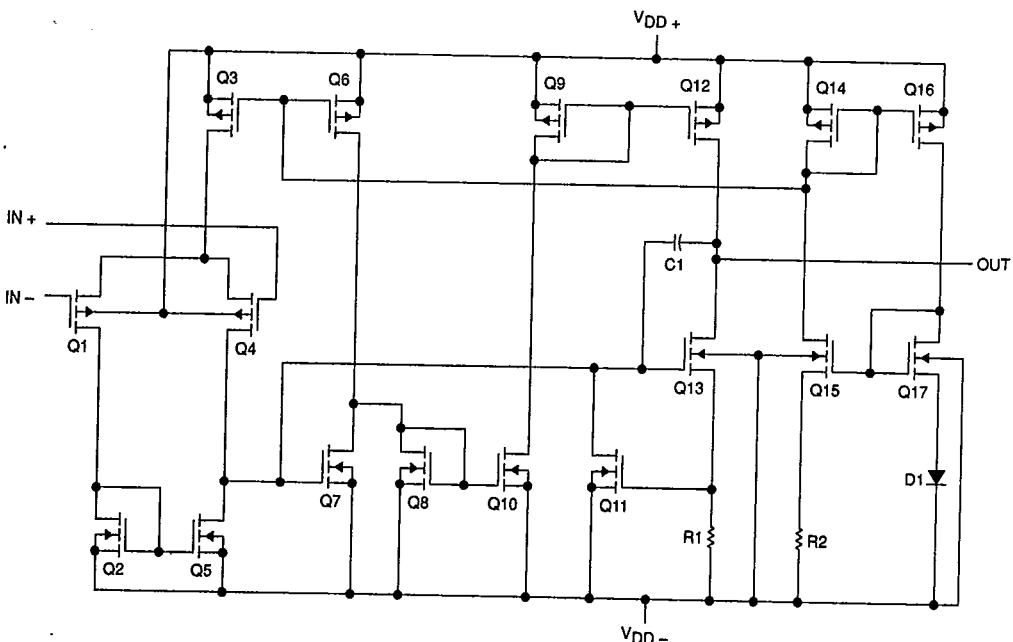
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**description (continued)**

The M-suffix devices are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The I-suffix devices are characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The C-suffix devices are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .



NC – No Internal connection

**equivalent schematic**

**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 (see Note 2) . . . . .	$\pm 16$ V
Input voltage range, $V_I$ (any input, see Note 1) . . . . .	$\pm 8$ V
Input current, $I_I$ (each input) . . . . .	$\pm 5$ mA
Output current, $I_O$ . . . . .	$\pm 50$ 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, $T_A$ : M-suffix . . . . .	-55°C to 125°C
I-suffix . . . . .	-40°C to 85°C
C-suffix . . . . .	0°C to 70°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 or L package . . . . .	300°C

- 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 the noninverting input with respect to the inverting input.  
 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 $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$		$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
			POWER RATING	POWER RATING		
D	725 mW	5.8 mW/ $^\circ\text{C}$	464 mW	377 mW	145 mW	
FK	1375 mW	11.0 mW/ $^\circ\text{C}$	880 mW	715 mW	275 mW	
JG	1050 mW	8.4 mW/ $^\circ\text{C}$	672 mW	546 mW	210 mW	
L	650 mW	5.2 mW/ $^\circ\text{C}$	416 mW	338 mW	130 mW	
P	1000 mW	8.0 mW/ $^\circ\text{C}$	640 mW	520 mW	200 mW	

**recommended operating conditions**

	M-SUFFIX		I-SUFFIX		C-SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD}$	$\pm 2.3$	$\pm 8$	$\pm 2.3$	$\pm 8$	$\pm 2.3$	$\pm 8$	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, $T_A$	-65	125	-40	85	0	70	$^\circ\text{C}$

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201M			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage		25°C	100	500	µV
		Full range		700	
$\alpha V_{IO}$ Temperature coefficient of input offset voltage		-55°C to 125°C	0.5		µV/°C
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	0.001	0.005	µV/mo
		25°C	0.5		
$I_{IO}$ Input offset current		Full range		500	pA
		25°C	1		
$I_{IB}$ Input bias current		Full range		500	pA
		25°C			
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\Omega$	Full range	-5 to 2.7		V
		25°C	4.7	4.8	
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\text{ k}\Omega$	Full range	4.7		V
		25°C	-4.7	-4.9	
$V_{OM-}$ Maximum negative peak output voltage swing		Full range	-4.7		V
		25°C	400	560	
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4$ V, $R_L = 500\text{ k}\Omega$	Full range	200		
	$V_O = \pm 4$ V, $R_L = 10\text{ k}\Omega$	25°C	90	100	V/mV
		Full range	45		
$CMRR$ Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50\Omega$	25°C	90	115	dB
		Full range	85		
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD} \pm / \Delta V_{IO}$ )	$V_{DD} \pm = \pm 2.3$ V to $\pm 8$ V	25°C	90	110	dB
		Full range	85		
$I_{DD}$ Supply current	$V_O = 0$ , No load	25°C	1.1	1.5	mA
		Full range		1.5	

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201M			UNIT
		MIN	TYP	MAX	
$SR$ Slew rate at unity gain	$V_O = \pm 2.3$ V, $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2	2.7	V/µs
		Full range	1.3		
$V_n$ Equivalent input noise voltage	$f = 10$ Hz	25°C	18		nV/√Hz
	$f = 1$ kHz	25°C	8		
$V_{NPP}$ 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/√Hz
Gain-bandwidth product	$f = 10$ kHz, $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.9		MHz
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	48°		

<sup>†</sup>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 <sup>†</sup>	TLC2201AM			TLC2201BM			UNIT	
		MIN	TYP	MAX	MIN	TYP	MAX		
$V_{IO}$	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	80	200	80	200	400	μV	
$\alpha V_{IO}$		Full range					400	μV/°C	
		-55°C to 125°C		0.5		0.5			
$I_{IO}$		25°C	0.001	0.005	0.001	0.005	0.005	μA/mo	
		25°C	0.5		0.5				
		Full range		500		500		pA	
$I_B$		25°C	1		1			pA	
		Full range		500		500			
$V_{ICR}$	$R_S = 50\Omega$	Full range	-5		-5			V	
$V_{OM+}$			to			to			
$R_L = 10 k\Omega$	25°C	2.7		2.7					
	$V_{OM-}$		Full range	4.7	4.8	4.7	4.8	4.7	V
			25°C	4.7		4.7			
	$A_{VD}$		Full range	-4.7	-4.9	-4.7	-4.9	-4.7	V
$V_O = \pm 4$ V, $R_L = 500 k\Omega$	25°C	400	560	400	560	400	V/mV		
	Full range	200		200					
	$CMRR$		25°C	90	100	90	100	90	dB
$V_O = 0$ , $V_{IC} = V_{ICR}$ min., $R_S = 50\Omega$	Full range	45		45					
	25°C	90	115	90	115	90			
$k_{SVR}$	$V_{DD} \pm = \pm 2.3$ V to $\pm 8$ V	Full range	85		85				
$I_{DD}$		25°C	90	110	90	110	90		
$V_O = 0$ , No load	Full range	85		85					
			25°C	1.1	1.5	1.1	1.5	1.1	
			Full range			1.5		1.5	mA

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AM			TLC2201BM			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$SR$	$V_O = \pm 2.3$ V, $R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	2	2.7	2	2.7	2	V/μs
		Full range	1.3		1.3			
$V_n$	$f = 10$ Hz	25°C	18	35	18	25	18	nV/√Hz
		25°C	8	15	8	12	8	
$V_{NPP}$	$f = 0.1$ to $1$ Hz	25°C	0.5		0.5		0.5	μV
		25°C	0.7		0.7		0.7	
$I_n$	$f = 0.1$ to $10$ Hz	25°C	0.6		0.6		0.6	fA/√Hz
		25°C	0.6		0.6		0.6	
$G$	$f = 10$ kHz, $R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	1.9		1.9		1.9	MHz
		25°C						
$\phi_m$	$R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	48°		48°		48°	

<sup>†</sup>Full range is -55°C to 125°C.NOTES: 4. Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150$  °C extrapolated to  $T_A = 25$  °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.

## Operational Amplifiers

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TLC2201M

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OPERATIONAL AMPLIFIERS

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201M			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage		25°C	100	500	μV
		Full range		700	
$\alpha V_{IO}$ Temperature coefficient of input offset voltage		-55°C to 125°C	0.5		μV/°C
Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	0.001	0.005	μV/mo
$I_{IO}$ Input offset current		25°C	0.5		pA
		Full range		500	
$I_B$ Input bias current		25°C	1		pA
		Full range		500	
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\Omega$		0		V
		Full range	to		
			2.7		
$V_{OH}$ 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	
$AVD$ Large-signal differential voltage amplification	$V_O = 1$ V to 4 V, $R_L = 500\text{ k}\Omega$ ,	25°C	150	315	
	$R_L = 10\text{ k}\Omega$	Full range	75		V/mV
	$V_O = 1$ V to 4 V,	25°C	25	55	
	$R_L = 10\text{ k}\Omega$	Full range	10		
$CMRR$ Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50\Omega$	25°C	90	110	dB
		Full range	85		
$kSVR$ Supply-voltage rejection ratio ( $\Delta V_{DD} \pm \Delta V_{IO}$ )	$V_{DD} = 4.6$ V to 16 V	25°C	90	110	dB
		Full range	85		
$I_{DD}$ Supply current	$V_O = 2.5$ V, No load	25°C	1	1.5	mA
		Full range		1.5	

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201M			UNIT
		MIN	TYP	MAX	
$SR$ Slew rate at unity gain	$V_O = 0.5$ V to 2.5 V, $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8	2.5	V/μs
		Full range	1.1		
$V_n$ Equivalent input noise voltage	$f = 10$ Hz	25°C	18		nV/√Hz
	$f = 1$ kHz	25°C	8		
$V_{NPP}$ 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/√Hz
Gain-bandwidth product	$f = 10$ kHz, $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8		MHz
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	45°		

<sup>†</sup>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,  $V_{DD} = 5$  V (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AM			TLC2201BM			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	25°C	80	200	80	200	80	$\mu$ V
		Full range		400		400		
$\alpha V_{IO}$	Temperature coefficient of input offset voltage	-55°C to 125°C		0.5		0.5		$\mu$ V/°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 $\mu$ V/mo
			25°C	0.5		0.5		
$I_{IO}$	Input offset current	Full range	500		500		500	pA
		25°C	1		1		500	pA
$I_{IB}$	Input bias current	Full range	500		500		500	pA
$V_{ICR}$	Common-mode input voltage range	$R_S = 50 \Omega$	0		0			V
		Full range	to	2.7	to	2.7		
$V_{OH}$	Maximum high-level output voltage	$R_L = 10 k\Omega$	25°C	4.7	4.8	4.7	4.8	V
		Full range	4.7		4.7			
$V_{OL}$	Maximum low-level output voltage	$I_O = 0$	25°C	0	50	0	50	mV
		Full range		50		50		
$AVD$	Large-signal differential voltage amplification	$V_O = 1$ V to 4 V, $R_L = 500 k\Omega$	25°C	150	315	150	315	V/mV
		Full range	75		75			
	$V_O = 1$ V to 4 V, $R_L = 10 k\Omega$	25°C	25	55	25	55		
		Full range	10		10			
CMRR	Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$	25°C	90	110	90	110	dB
		Full range	85		85			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD} \pm \Delta V_{IO}$ )	$V_{DD} = 4.6$ V to 16 V	25°C	90	110	90	110	dB
		Full range	85		85			
$I_{DD}$	Supply current	$V_O = 2.5$ V, No load	25°C	1	1.5	1	1.5	mA
		Full range		1.5		1.5		

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AM			TLC2201BM			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 0.5$ V to 2.5 V, $R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	1.8	2.5	1.8	2.5	V/ $\mu$ s
		Full range		1.1		1.1		
$V_n$	Equivalent input noise voltage (see Note 5)	$f = 10$ Hz	25°C	18	35	18	25	nV/ $\sqrt{\text{Hz}}$
		$f = 1$ kHz	25°C	8	15	6	12	
$V_{NPP}$	Peak-to-peak equivalent input noise voltage	$f = 0.1$ to 1 Hz	25°C	0.5		0.5		$\mu$ V
		$f = 0.1$ to 10 Hz	25°C	0.7		0.7		
$I_n$	Equivalent input noise current		25°C	0.6		0.6		$\text{fA}/\sqrt{\text{Hz}}$
		$f = 10$ kHz, $R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	1.8		1.8		MHz
$\phi_m$	Phase margin at unity gain	$R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	45°		45°		

<sup>†</sup>Full range is -55°C to 125°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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Operational Amplifiers

TEXAS INSTR (LIN/INTFC) 25E D ■ 8961724 0080531 4 ■  
**TLC2201I**  
**Advanced LinCMOS™ LOW-NOISE PRECISION TEXAS INSTR (LIN/INTFC)**  
**OPERATIONAL AMPLIFIERS**

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201I			UNIT
		MIN	TYP	MAX	
$V_{IO}$	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C	100	500	$\mu\text{V}$
$\Delta V_{IO}$		Full range		650	
Input offset voltage long-term drift (see Note 4)		-40°C to 85°C	0.5		$\mu\text{V}/^\circ\text{C}$
$I_{IO}$		25°C	0.001	0.005	$\mu\text{A}/\text{mo}$
$I_{IB}$		25°C	0.5		$\text{pA}$
		Full range		150	
		25°C	1		
		Full range		150	
$V_{ICR}$		$R_S = 50 \Omega$	-5 to 2.7		$\text{V}$
$V_{OM+}$		25°C	4.7	4.8	
$V_{OM-}$		Full range	4.7		
		25°C	-4.7	-4.9	
		Full range	-4.7		$\text{V}$
AVD Large-signal differential voltage amplification	$V_O = \pm 4$ V, $R_L = 500 \text{ k}\Omega$ ,	25°C	400	560	$\text{V}/\text{mV}$
		Full range	250		
		$V_O = \pm 4$ V, $R_L = 10 \text{ k}\Omega$	25°C	90	
		Full range	65		
CMRR Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$	25°C	90	115	$\text{dB}$
		Full range	85		
kSVR Supply-voltage rejection ratio ( $\Delta V_{DD \pm} / \Delta V_{IO}$ )	$V_{DD \pm} = \pm 2.3$ V to $\pm 8$ V	25°C	90	110	$\text{dB}$
		Full range	85		
$I_{DD}$ Supply current	$V_O = 0$ , No load	25°C	1.1	1.5	$\text{mA}$
		Full range		1.5	

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

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

<sup>†</sup>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 <sup>†</sup>	TLC2201AI			TLC2201BI			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	80	200	80	200	80	μV
$\alpha V_{IO}$		Full range		350		350		μV/°C
Input offset voltage long-term drift (see Note 4)		-40°C to 85°C	0.5		0.5		0.5	μV/mo
$I_{IO}$		25°C	0.001	0.005	0.001	0.005	0.001	μA
		25°C	0.5		0.5		0.5	
		Full range		150		150		pA
$I_{IB}$		25°C	1		1		1	
		Full range		150		150		pA
$V_{ICR}$		$R_S = 50\Omega$	-5 to 2.7		-5 to 2.7		-5 to 2.7	V
$V_{OM+}$		25°C	4.7	4.8	4.7	4.8	4.7	V
$V_{OM-}$	$R_L = 10\text{ k}\Omega$	Full range	4.7		4.7		4.7	V
Maximum negative peak output voltage swing		25°C	-4.7	-4.9	-4.7	-4.9	-4.7	V
AVD		Full range	-4.7		-4.7		-4.7	V/mV
Large-signal differential voltage amplification		$V_O = \pm 4$ V, $R_L = 500\text{ k}\Omega$	25°C	400	560	400	560	
CMRR	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50\Omega$	Full range	250		250		250	
Common-mode rejection ratio		$V_O = \pm 4$ V, $R_L = 10\text{ k}\Omega$	25°C	90	100	90	100	V/mV
		Full range	65		65		65	
$k_{SVR}$	$V_{DD} \pm = \pm 2.3$ V to $\pm 8$ V	25°C	90	110	90	110	90	dB
Supply-voltage rejection ratio ( $\Delta V_{DD} \pm / \Delta V_{IO}$ )		Full range	85		85		85	dB
$I_{DD}$	$V_O = 0$ , No load	25°C	1.1	1.5	1.1	1.5	1.1	mA
		Full range		1.5		1.5		

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AI			TLC2201BI			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR	$V_O = \pm 2.3$ V, $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2	2.7	2	2.7	2	V/μs
		Full range	1.4		1.4		1.4	
$V_n$	$f = 10$ Hz	25°C	18	35	18	25	18	nV/Hz
Equivalent input noise voltage (see Note 5)		25°C	8	15	8	12	8	
$V_{NPP}$	$f = 0.1$ to $1$ Hz	25°C	0.5		0.5		0.5	μV
Peak-to-peak equivalent input noise voltage		25°C	0.7		0.7		0.7	
$I_n$	$f = 0.1$ to $10$ Hz	25°C	0.6		0.6		0.6	fA/√Hz
Equivalent input noise current		25°C	0.6		0.6		0.6	
	$f = 10$ kHz, $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.9		1.9		1.9	MHz
$\phi_m$	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	48°		48°		48°	

<sup>†</sup>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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Operational Amplifiers

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TLC2201

Advanced LinCMOS™ LOW-NOISE PRECISION  
OPERATIONAL AMPLIFIERS

TEXAS INSTR (LIN/INTFC)

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201I			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C	100	500	μV
$\alpha V_{IO}$ Temperature coefficient of input offset voltage		Full range		650	
Input offset voltage long-term drift (see Note 4)		-40°C to 85°C		0.5	μV/°C
$I_{IO}$ Input offset current		25°C	0.001	0.005	μV/mo
$I_{IB}$ Input bias current		25°C	0.5		pA
$V_{ICR}$ Common-mode input voltage range		Full range		150	
$V_{OH}$ Maximum high-level output voltage	$R_L = 10 \text{ k}\Omega$	25°C	4.7	4.8	V
$V_{OL}$ Maximum low-level output voltage	$I_O = 0$	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	0	50	V/mV
$V_O = 1 \text{ V to } 4 \text{ V}$ , $R_L = 10 \text{ k}\Omega$		Full range	100		
$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$		25°C	25	55	
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD} \pm / \Delta V_{IO}$ )	$V_{DD} = 4.6 \text{ V to } 16 \text{ V}$	Full range	15		
$I_{DD}$ Supply current	$V_O = 2.5 \text{ V}$ , No load	25°C	1	1.5	mA
		Full range		1.5	

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201I			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V}$ , $R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	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		nV/√Hz
		25°C	8		
$V_{NPP}$ Peak-to-peak equivalent input noise voltage	$f = 0.1 \text{ to } 1 \text{ Hz}$	25°C	0.5		μV
		25°C	0.7		
$I_n$ Equivalent input noise current	$f = 10 \text{ kHz}$ , $R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C	0.6		fA/√Hz
		25°C	1.8		
$\phi_m$ Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C	45°		MHz
		25°C			

<sup>†</sup>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,  $V_{DD} = 5$  V (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AI			TLC2201BI			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	80	200	80	200	80	$\mu$ V
		Full range		350		350		
		-40°C to 85°C		0.5		0.5		$\mu$ V/ $^{\circ}$ C
		25°C	0.001	0.005	0.001	0.005	0.001	$\mu$ V/mo
		25°C	0.5		0.5		0.5	pA
		Full range		150		150		
$I_{IB}$ Input bias current		25°C	1		1		1	pA
		Full range		150		150		
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\Omega$	Full range	0 to 2.7		0 to 2.7		0 to 2.7	V
		25°C	4.7	4.8	4.7	4.8	4.7	
$V_{OH}$ Maximum high-level output voltage	$R_L = 10\text{ k}\Omega$	Full range	4.7		4.7		4.7	V
		25°C	0	50	0	50	0	
$V_{OL}$ Maximum low-level output voltage	$I_O = 0$	Full range		50		50	50	mV
		25°C	90	110	90	110	90	
$A_{VD}$ Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}$ , $R_L = 500\text{ k}\Omega$	Full range	100		100		100	V/mV
		25°C	25	55	25	55	25	
		Full range	15		15		15	
$CMRR$ Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min., $R_S = 50\Omega$	25°C	85		85		85	dB
		25°C	90	110	90	110	90	
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD} \pm / \Delta V_{IO}$ )	$V_{DD} = 4.6\text{ V to }16\text{ V}$	Full range	85		85		85	dB
		25°C	90	110	90	110	90	
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}$ , No load	25°C	1	1.5	1	1.5	1	mA
		Full range		1.5		1.5	1.5	

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AI			TLC2201BI			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8	2.5	1.8	2.5	1.8	$\text{V}/\mu\text{s}$
		Full range	1.2		1.2		1.2	
$V_n$ Equivalent input noise voltage (see Note 5)	$f = 10\text{ Hz}$	25°C	18	35	18	25	18	$\text{nV}/\sqrt{\text{Hz}}$
		25°C	8	15	8	12	8	
$V_{NPP}$ Peak-to-peak equivalent input noise voltage	$f = 0.1$ to $1\text{ Hz}$	25°C	0.5		0.5		0.5	$\mu\text{V}$
		25°C	0.7		0.7		0.7	
$I_n$ Equivalent input noise current	$f = 10\text{ kHz}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	0.6		0.6		0.6	$\text{fA}/\sqrt{\text{Hz}}$
		25°C	1.8		1.8		1.8	
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	45°		45°		45°	MHz
		25°C		45°		45°		

<sup>†</sup>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.

## Operational Amplifiers

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201C			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C	100	500	$\mu\text{V}$
		Full range		600	
$\alpha V_{IO}$ Temperature coefficient of input offset voltage		0°C to 70°C		0.5	$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5		$\text{pA}$
		Full range		100	
$I_{IB}$ Input bias current	$R_L = 10 \text{ k}\Omega$	25°C	1		$\text{pA}$
		Full range		100	
$V_{ICR}$ Common-mode input voltage range		Full range	-5 to 2.7		$\text{V}$
$V_{OM+}$ Maximum positive peak output voltage swing		25°C	4.7	4.8	$\text{V}$
$V_{OM-}$ Maximum negative peak output voltage swing		Full range	4.7		
		25°C	-4.7	-4.9	$\text{V}$
		Full range	-4.7		
AVD Large-signal differential voltage amplification	$V_O = \pm 4 \text{ V}$ , $R_L = 500 \text{ k}\Omega$ ,	25°C	400	560	$\text{V}/\text{mV}$
		Full range	300		
		25°C	90	100	
CMRR Common-mode rejection ratio	$V_O = \pm 4 \text{ V}$ , $R_L = 10 \text{ k}\Omega$	Full range	70		$\text{dB}$
		25°C	90	115	
		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	$\text{dB}$
		Full range	85		
I <sub>DD</sub> Supply current	$V_O = 0$ , No load	25°C		1.1	$\text{mA}$
		Full range		1.5	

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201C			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = \pm 2.3 \text{ V}$ , $R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C	2	2.7	$\text{V}/\mu\text{s}$
		Full range		1.5	
$V_n$ Equivalent input noise voltage	$f = 10 \text{ Hz}$	25°C		18	$\text{nV}/\sqrt{\text{Hz}}$
		25°C		8	
$V_{NPP}$ Peak-to-peak equivalent input noise voltage	$f = 0.1 \text{ to } 1 \text{ Hz}$	25°C		0.5	$\mu\text{V}$
		25°C		0.7	
$I_n$ Equivalent input noise current	$f = 10 \text{ kHz}$ , $R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		0.6	$\text{fA}/\sqrt{\text{Hz}}$
		25°C		1.9	
$\phi_m$ Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°	$\text{MHz}$
		25°C			

<sup>†</sup>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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TLC2201AC, TLC2201BC  
Advanced LinCMOS™ LOW-NOISE PRECISION  
OPERATIONAL AMPLIFIERS

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AC			TLC2201BC			UNIT	
		MIN	TYP	MAX	MIN	TYP	MAX		
$V_{IO}$	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	80	200	80	200	300	$\mu$ V	
$\alpha V_{IO}$		Full range							
Temperature coefficient of input offset voltage		0°C to 70°C		0.5		0.5		$\mu$ V/°C	
Input offset voltage long-term drift (see Note 4)		25°C	0.001	0.005	0.001	0.005		$\mu$ V/mo	
$I_{IO}$	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	0.5		0.5			pA	
Input offset current		Full range		100		100			
		25°C	1		1			pA	
		Full range		100		100			
$I_B$	$V_{IC} = 0$ , $R_S = 50\Omega$	25°C	-5	to	-5	to	2.7	V	
Common-mode Input voltage range		Full range	2.7		2.7				
$V_{OM+}$	$R_L = 10 k\Omega$	25°C	4.7	4.8	4.7	4.8		V	
Maximum positive peak output voltage swing		Full range	4.7		4.7				
$V_{OM-}$	$R_L = 10 k\Omega$	25°C	-4.7	-4.9	-4.7	-4.9		V	
Maximum negative peak output voltage swing		Full range	-4.7		-4.7				
AVD	$V_O = \pm 4$ 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	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50\Omega$	25°C	90	115	90	115		dB	
		Full range	85		85				
	$V_{DD} \pm = \pm 2.3$ V to $\pm 8$ V	25°C	90	110	90	110			
		Full range	85		85				
$k_{SVR}$	$V_{DD} \pm = \pm 2.3$ V to $\pm 8$ V	25°C	1.1	1.5	1.1	1.5		mA	
		Full range		1.5		1.5			
$I_{DD}$	Supply current	$V_O = 0$ , No load							

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## Operational Amplifiers

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201AC			TLC2201BC			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR	$V_O = \pm 2.3$ V, $R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	2	2.7	2	2.7		$V/\mu$ s
		Full range	1.5		1.5			
$V_n$	$f = 10$ Hz	25°C	18	35	18	25		$nV/\sqrt{Hz}$
		25°C	8	15	8	12		
$V_{NPP}$	$f = 0.1$ to $1$ Hz	25°C	0.5		0.5			$\mu$ V
		25°C	0.7		0.7			
$I_n$	Equivalent input noise current	25°C	0.6		0.6			$fA/\sqrt{Hz}$
	$f = 10$ kHz, $R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	1.9		1.9			MHz
		25°C						
$\phi_m$	Phase margin at unity gain	$R_L = 10 k\Omega$ , $C_L = 100 pF$	25°C	48°		48°		

<sup>†</sup>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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## TLC2201C

Advanced LinCMOS™ LOW-NOISE PRECISION TEXAS INSTR (LIN/INTFC)  
OPERATIONAL AMPLIFIERST - 79 - 08electrical characteristics at specified free-air temperature,  $V_{DD} = 5$  V (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201C			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage		25°C	100	500	μV
		Full range		600	
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		0°C to 70°C		0.5	μV/°C
		25°C	0.001	0.005	μV/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		pA
		Full range		100	
$V_{ICR}$ Common-mode input voltage range	$R_S = 50\Omega$	Full range	0 to 2.7		V
		25°C	4.7	4.8	
$V_{OH}$ Maximum high-level output voltage	$R_L = 10\text{ k}\Omega$	Full range	4.7		V
		25°C	0	50	mV
$V_{OL}$ Maximum low-level output voltage	$I_O = 0$	Full range	50		
		25°C	150	315	
AVD Large-signal differential voltage amplification	$V_O = 1\text{ V to }4\text{ V}$ , $R_L = 500\text{ k}\Omega$ , $R_I = 10\text{ k}\Omega$	Full range	100		V/mV
		25°C	25	55	
CMRR Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50\Omega$	Full range	15		dB
		25°C	90	110	
kSVR Supply-voltage rejection ratio ( $\Delta V_{DD} \pm / \Delta V_{IO}$ )	$V_{DD} = 4.6\text{ V to }16\text{ V}$	Full range	85		dB
		25°C	90	110	
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}$ , No load	25°C	1	1.5	mA
		Full range		1.5	

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

PARAMETER	TEST CONDITIONS <sup>†</sup>	TLC2201C			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8	2.5	V/μs
		Full range		1.3	
$V_n$ Equivalent input noise voltage	$f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	18		nV/√Hz
		25°C	8		
$V_{NPP}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ to }1\text{ Hz}$ $f = 0.1\text{ to }10\text{ Hz}$	25°C	0.5		μV
		25°C	0.7		
$I_n$ Equivalent input noise current	$f = 10\text{ kHz}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	0.6		fA/√Hz
		25°C	1.8		
$\phi_m$ Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		45°	
		25°C			

<sup>†</sup>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,  $V_{DD} = 5$  V (unless otherwise noted)

PARAMETER		TEST CONDITIONS <sup>†</sup>	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
$\alpha V_{IO}$	Temperature coefficient of input offset voltage		Full range		300		300		
	Input offset voltage long-term drift (see Note 4)		0°C to 70°C		0.5		0.5		μV/°C
	$I_{IO}$		25°C	0.001	0.005	0.001	0.005		μV/mo
$I_{IB}$	Input offset current		25°C	0.5		0.5			pA
	Input bias current		Full range		100		100		
			25°C	1		1			pA
$V_{ICR}$	Common-mode input voltage range		Full range	0		0			V
	Maximum high-level output voltage		Full range	to 2.7		to 2.7			
	Maximum low-level output voltage		25°C	4.7	4.8	4.7	4.8		V
$A_{VD}$	Large-signal differential voltage amplification		Full range	4.7		4.7			
	$V_O = 1$ V to 4 V, $R_L = 500 \text{ k}\Omega$		25°C	150	315	150	315		
	$V_O = 1$ V to 4 V, $R_L = 10 \text{ k}\Omega$		Full range	100		100			V/mV
CMRR	Common-mode rejection ratio		25°C	25	55	25	55		
	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$		Full range	15		15			dB
	$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD} \pm / \Delta V_{IO}$ )	$V_{DD} = 4.6$ V to 16 V	25°C	90	110	90	110		dB
$I_{DD}$	Supply current	$V_O = 2.5$ V, No load	25°C	1	1.5	1	1.5		mA
			Full range		1.5		1.5		

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

PARAMETER		TEST CONDITIONS <sup>†</sup>	TLC2201AC			TLC2201BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 0.5$ V to 2.5 V, $R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C	1.8	2.5	1.8	2.5		V/μs
			Full range	1.3		1.3			
$V_n$	Equivalent input noise voltage (see Note 5)	$f = 10$ Hz	25°C	18	35	18	25		nV/Hz
		$f = 1$ kHz	25°C	8	15	8	12		
$V_{NPP}$	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, $R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C	1.8		1.8			MHz
	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C	45°		45°			

<sup>†</sup>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.

## Operational Amplifiers

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## PARAMETER MEASUREMENT INFORMATION

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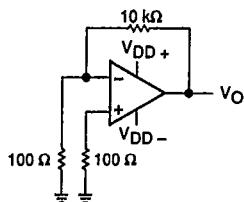


FIGURE 1. NOISE VOLTAGE TEST CIRCUIT

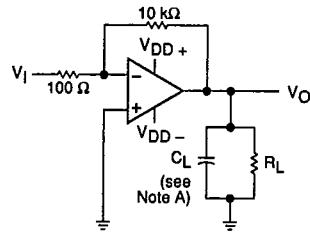
NOTE A:  $C_L$  includes fixture capacitance.

FIGURE 2. PHASE MARGIN TEST CIRCUIT

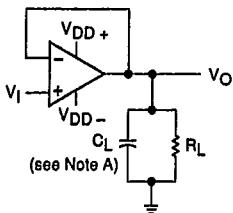
NOTE A:  $C_L$  includes fixture capacitance.

FIGURE 3. SLEW RATE TEST CIRCUIT

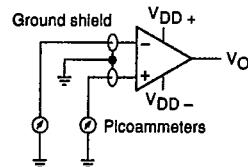


FIGURE 4. INPUT BIAS AND OFFSET CURRENT TEST CIRCUIT

## typical values

Typical values as 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 test requirements, please contact the factory.

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**TYPICAL CHARACTERISTICS****T-79-08****table of graphs**

			<b>FIGURE</b>
V <sub>IO</sub>	Input offset voltage	Distribution	5
I <sub>IB</sub>	Input bias current	vs Common-mode voltage	6
		vs Temperature	7
CMRR	Common-mode rejection ratio	vs Frequency	8
V <sub>OM</sub>	Maximum peak output voltage	vs Output current	9
		vs Temperature	10
V <sub>OPP</sub>	Maximum peak-to-peak output voltage	vs Frequency	11
		vs Frequency	12
V <sub>OH</sub>	High-level output voltage	vs Current	13
		vs Temperature	14
V <sub>OL</sub>	Low-level output voltage	vs Output current	15
		vs Temperature	16
A <sub>VD</sub>	Differential voltage amplification	vs Frequency	17
		vs Temperature	18
I <sub>OS</sub>	Short-circuit output current	vs Supply voltage	19
		vs Temperature	20
I <sub>DD</sub>	Supply current	vs Supply voltage	21
		vs Temperature	22
SR	Slew rate	vs Supply voltage	23
		vs Temperature	24
	Pulse response	Small-signal	25, 26
		Large-signal	27, 28
V <sub>NPP</sub>	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
		vs Temperature	32
φ <sub>m</sub>	Phase margin	vs Supply voltage	33
		vs Temperature	34
	Phase shift	vs Frequency	17

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**TYPICAL CHARACTERISTICS<sup>†</sup>**

DISTRIBUTION OF TLC2201  
 INPUT OFFSET VOLTAGE

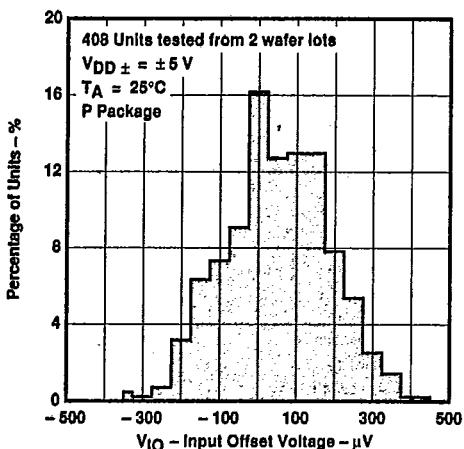


FIGURE 5

INPUT BIAS CURRENT  
 VS  
 COMMON-MODE INPUT VOLTAGE

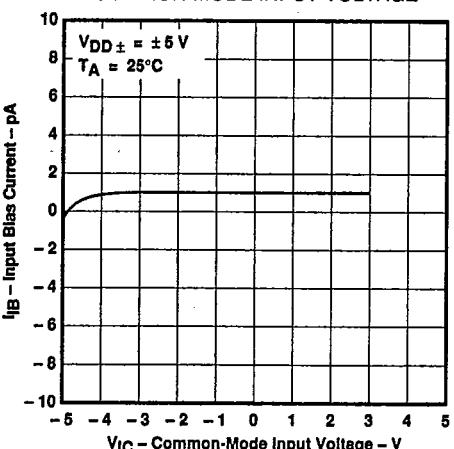


FIGURE 6

INPUT BIAS CURRENT  
 VS  
 FREE-AIR TEMPERATURE

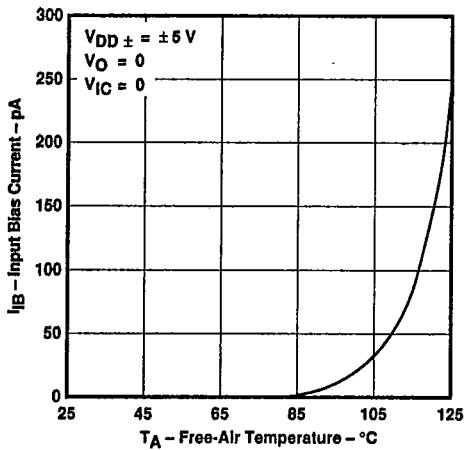


FIGURE 7

COMMON-MODE REJECTION RATIO  
 VS  
 FREQUENCY

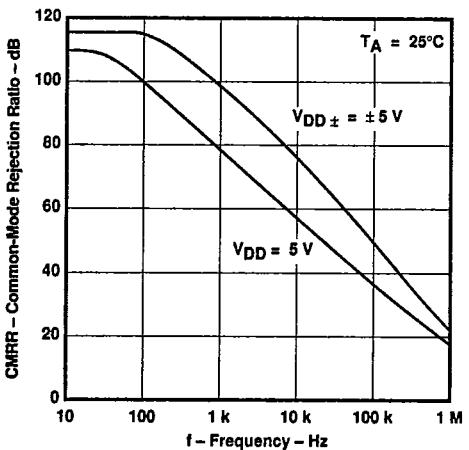


FIGURE 8

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

TYPICAL CHARACTERISTICS<sup>†</sup>

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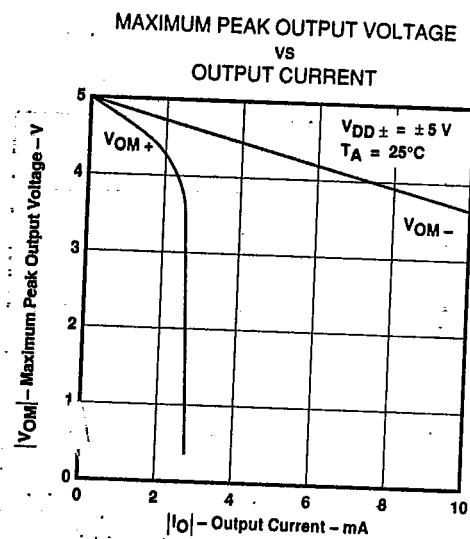


FIGURE 9

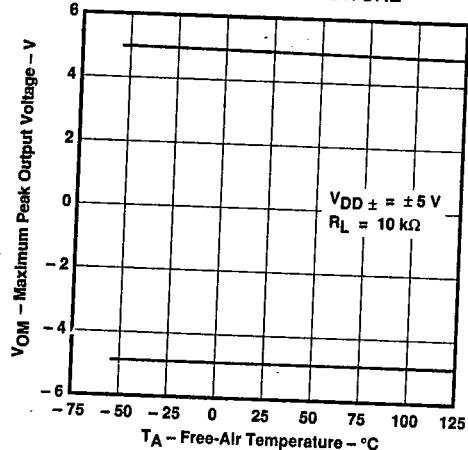
MAXIMUM PEAK OUTPUT VOLTAGE  
vs  
FREE-AIR TEMPERATURE

FIGURE 10

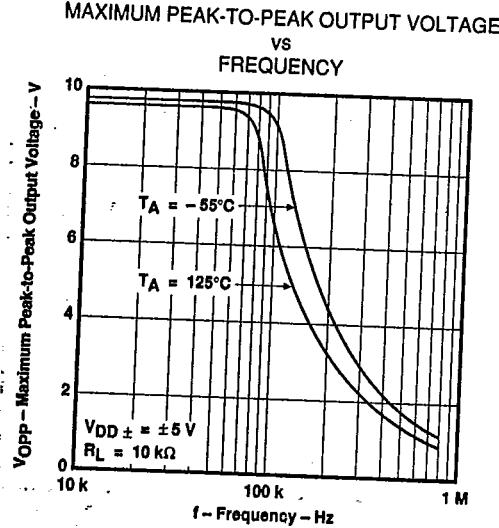


FIGURE 11

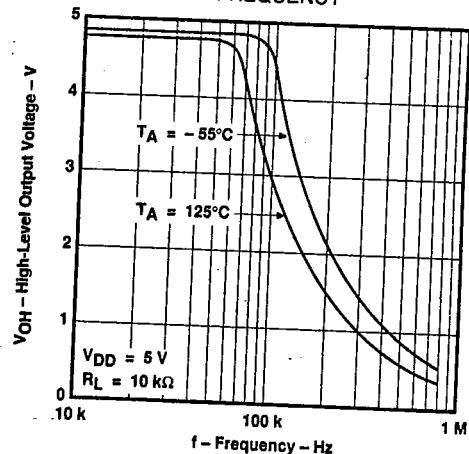
HIGH-LEVEL OUTPUT VOLTAGE  
vs  
FREQUENCY

FIGURE 12

<sup>†</sup>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

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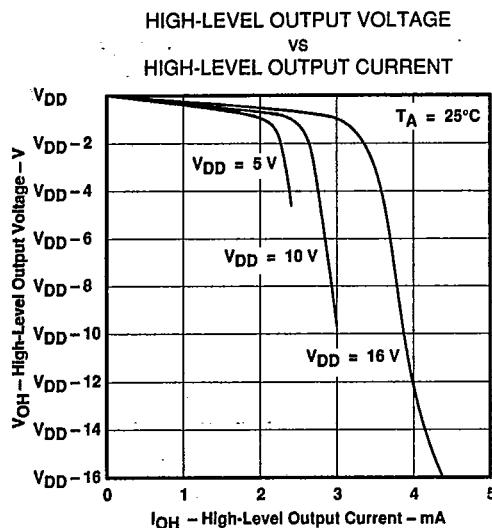
TYPICAL CHARACTERISTICS<sup>†</sup>

FIGURE 13

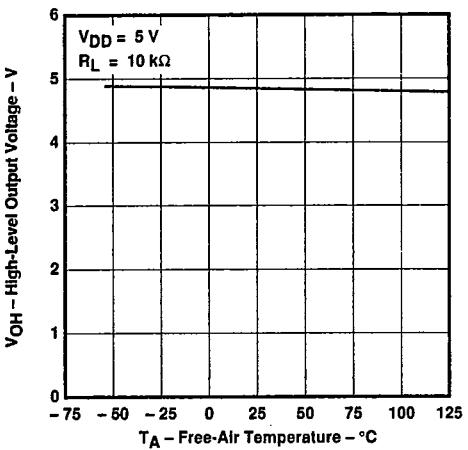
HIGH-LEVEL OUTPUT VOLTAGE  
vs  
FREE-AIR TEMPERATURE

FIGURE 14

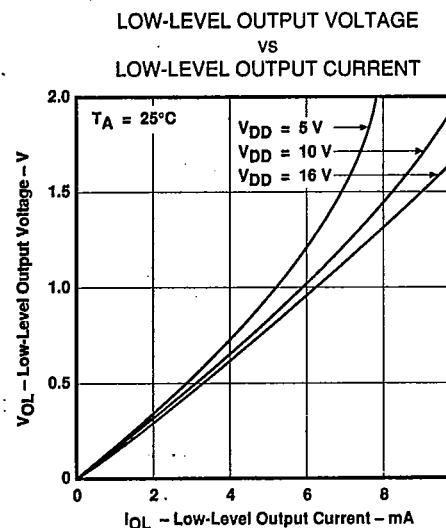


FIGURE 15

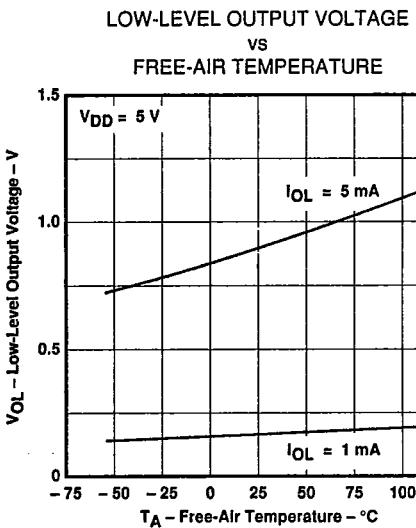


FIGURE 16

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

TYPICAL CHARACTERISTICS<sup>†</sup>

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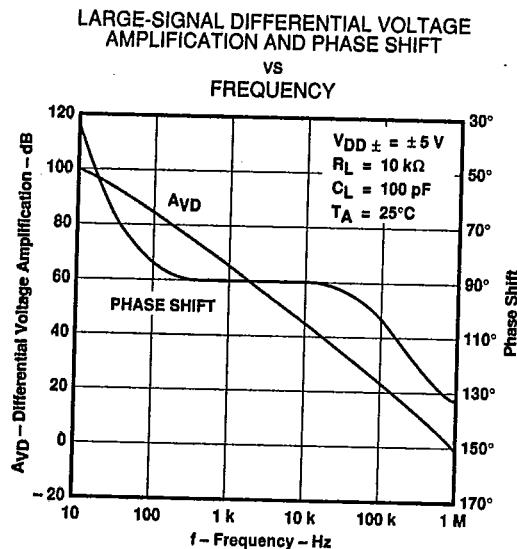
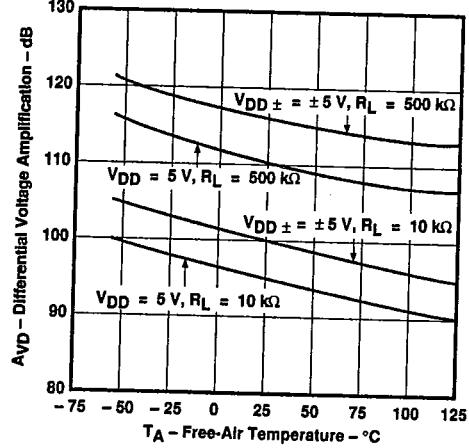


FIGURE 17

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION  
VS FREE-AIR TEMPERATURE



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## Operational Amplifiers

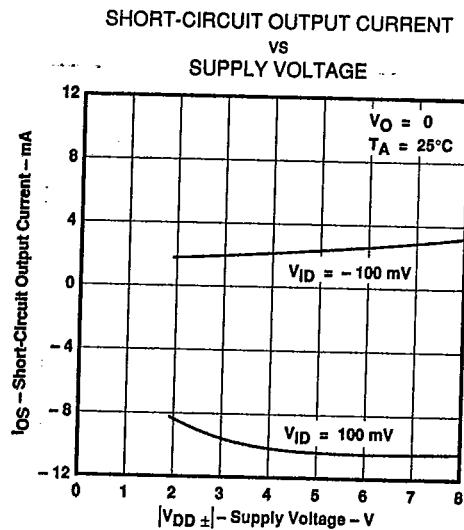


FIGURE 19

SHORT-CIRCUIT OUTPUT CURRENT VS FREE-AIR TEMPERATURE

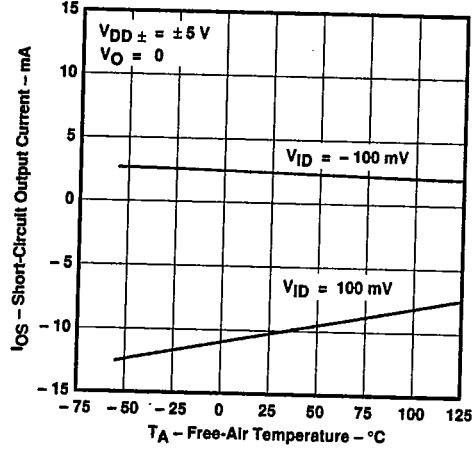


FIGURE 20

<sup>†</sup>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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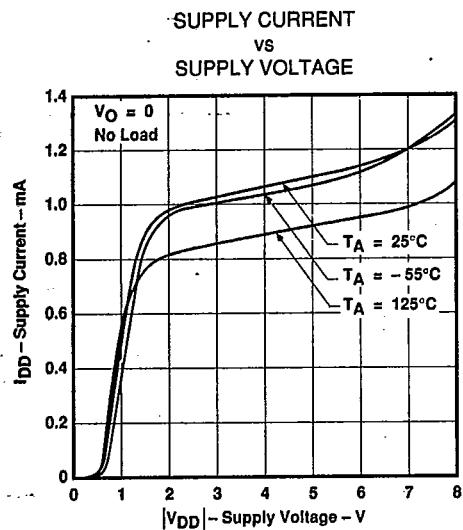
TYPICAL CHARACTERISTICS<sup>†</sup>

FIGURE 21

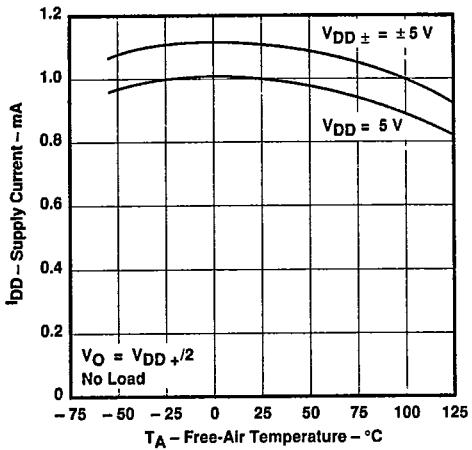
SUPPLY CURRENT  
VS  
FREE-AIR TEMPERATURE

FIGURE 22

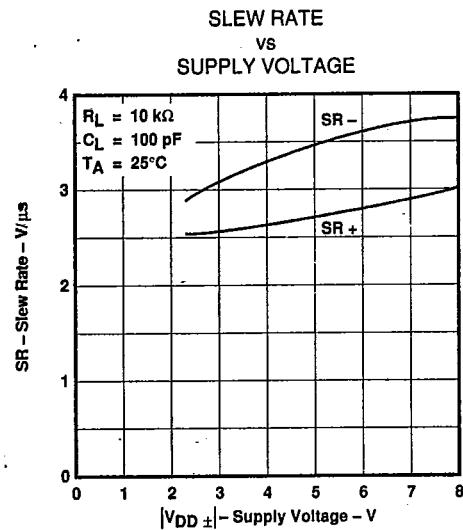


FIGURE 23

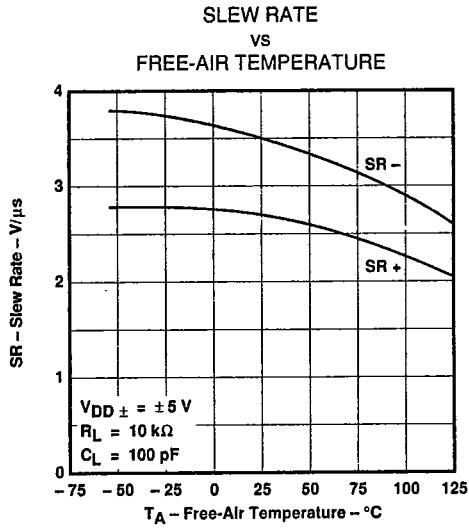


FIGURE 24

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

## TYPICAL CHARACTERISTICS

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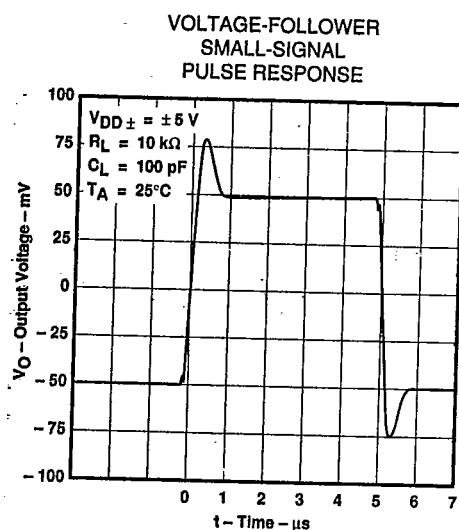


FIGURE 25

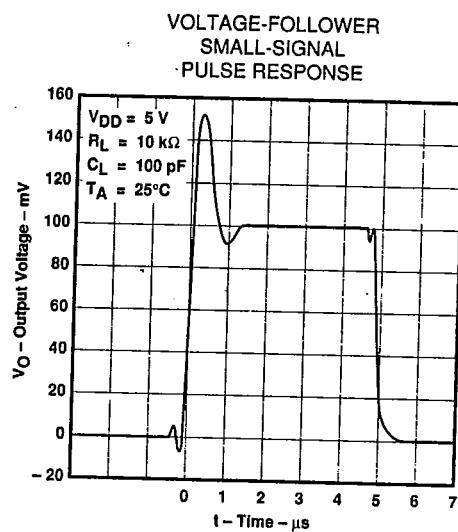


FIGURE 26

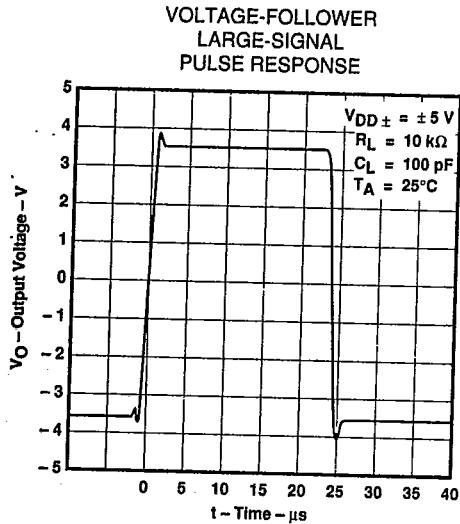


FIGURE 27

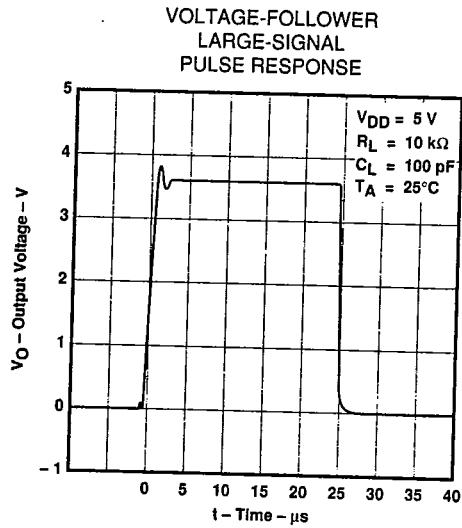


FIGURE 28

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**TYPICAL CHARACTERISTICS<sup>†</sup>**

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

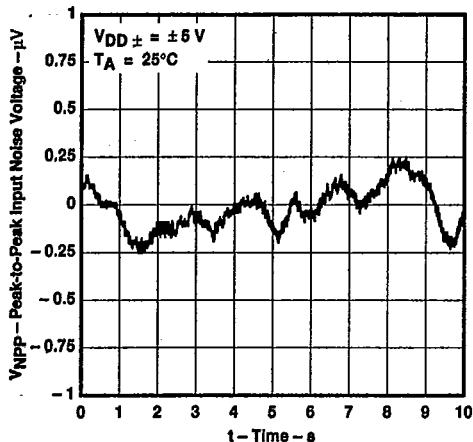


FIGURE 29

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

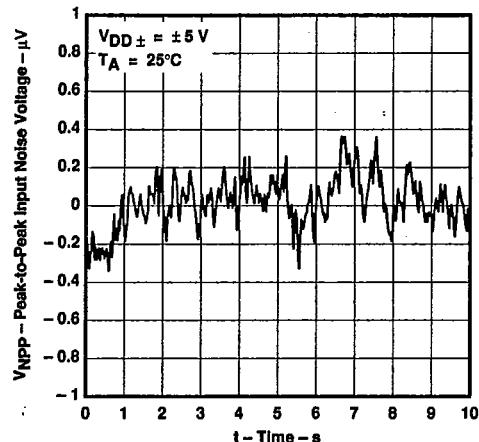


FIGURE 30

GAIN-BANDWIDTH PRODUCT  
VS  
SUPPLY VOLTAGE

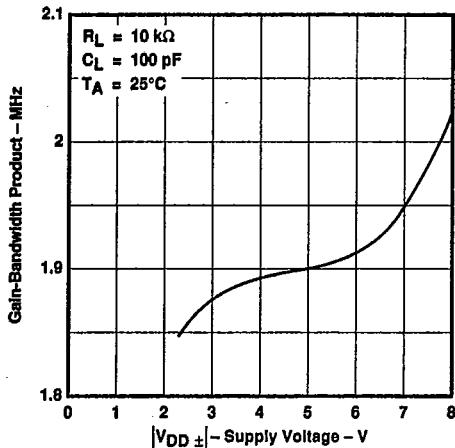


FIGURE 31

GAIN-BANDWIDTH PRODUCT  
VS  
FREE-AIR TEMPERATURE

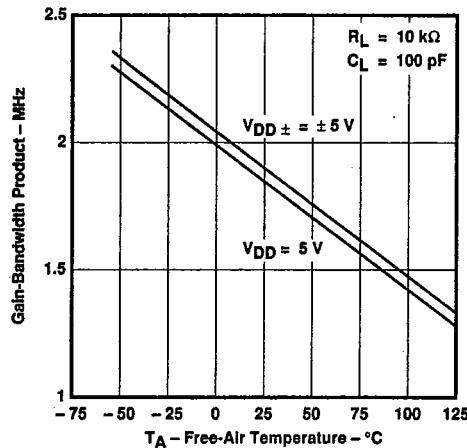


FIGURE 32

<sup>†</sup>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<sup>†</sup>

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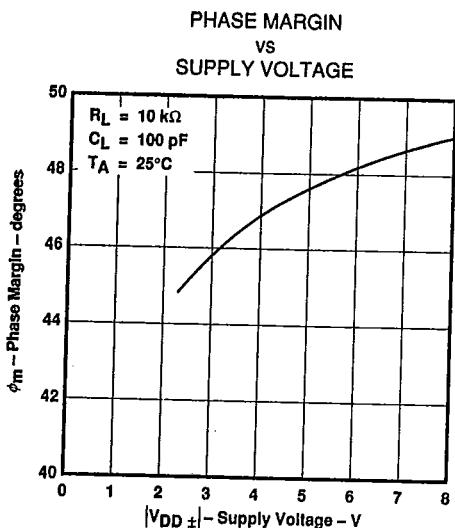


FIGURE 33

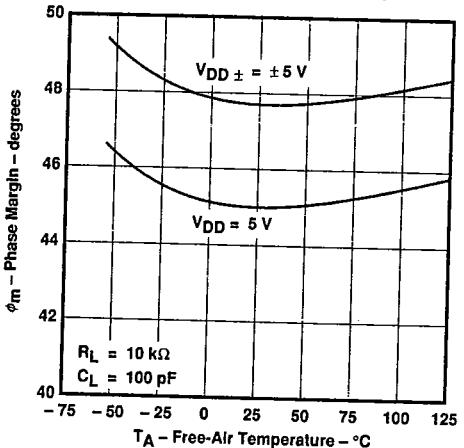
PHASE MARGIN  
VS  
FREE-AIR TEMPERATURE

FIGURE 34

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

## TYPICAL APPLICATION DATA

## latchup avoidance

Because CMOS devices are susceptible to latchup due to their inherent parasitic thyristors, the TLC2201, TLC2201A, and TLC2201B inputs and outputs are designed to withstand -100-mA surge currents without sustaining latchup; however, techniques reducing the chance of latchup should be used whenever possible. Internal protection diodes should not be forward biased in normal operation. Applied input and output voltages should not exceed the supply voltage by more than 300 mV. Care should be exercised when using capacitive coupling on pulse generators. Supply transients should be shunted by the use of decoupling capacitors (0.1  $\mu\text{F}$  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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