- B Grade Is 100% Tested for Noise 30 nV/ $\sqrt{\text{Hz}}$  Max at f = 10 Hz 12 nV/ $\sqrt{\text{Hz}}$  Max at f = 1 kHz
- Low Input Offset Voltage . . . 500 µV Max
- **Excellent Offset Voltage Stability** With Temperature . . . 0.5 μV/°C Typ
- Rail-to-Rail Output Swing

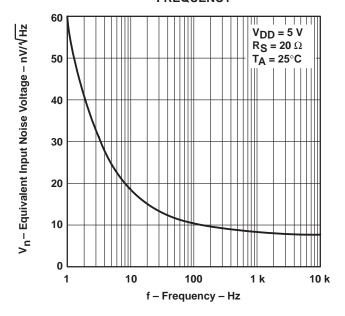
#### description

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

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

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

TYPICAL EQUIVALENT INPUT NOISE VOLTAGE vs **FREQUENCY** 



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

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



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

Advanced LinCMOS is a trademark of Texas Instruments Incorporated.



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#### **TLC2201 AVAILABLE OPTIONS**

		V may	V mov		PACKAGE	DEVICES		CHIP
TA	V <sub>IO</sub> max AT 25°C	V <sub>n</sub> max f = 10 Hz AT 25°C	V <sub>n</sub> max f = 1 kHz AT 25°C	SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	FORM <sup>‡</sup> (Y)
0°C to 70°C	200 μV 200 μV 500 μV	35 nV/√Hz 30 nV/√Hz —	15 nV/√ <u>Hz</u> 12 nV/√Hz —	TLC2201ACD TLC2201BCD TLC2201CD	_	_	TLC2201ACP TLC2201BCP TLC2201CP	TLC2201Y
-40°C to 85°C	200 μV 200 μV 500 μV	35 nV/√ <u>Hz</u> 30 nV/√Hz —	15 nV/√ <u>Hz</u> 12 nV/√Hz —	TLC2201AID TLC2201BID TLC2201ID	_	_	TLC2201AIP TLC2201BIP TLC2201IP	_
-55°C to 125°C	200 μV 200 μV 500 μV	35 nV/√Hz 30 nV/√Hz —	15 nV/√ <u>Hz</u> 12 nV/√Hz —	TLC2201AMD TLC2201BMD TLC2201MD	TLC2201AMFK TLC2201BMFK TLC2201MFK	TLC2201AMJG TLC2201BMJG TLC2201MJG	TLC2201AMP TLC2201BMP TLC2201MP	_

<sup>†</sup> The D packages are available taped and reeled. Add R suffix to device type (e.g. TLC220xBCDR).

#### **TLC2202 AVAILABLE OPTIONS**

					PACKAGE	D DEVICES		CHIP
TA	V <sub>IO</sub> max AT 25°C	V <sub>n</sub> max f = 10 Hz AT 25°C	V <sub>n</sub> max f = 1 kHz AT 25°C	SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	FORM‡ (Y)
0°C to 70°C	500 μV 500 μV 1 mV	30 nV/√ <u>Hz</u> 35 nV/√Hz —	12 nV/√ <u>Hz</u> 15 nV/√Hz —	TLC2202BCD TLC2202ACD TLC2202CD	_ _ _	_ _ _	TLC2202BCP TLC2202ACP TLC2202CP	TLC2202Y
-40°C to 85°C	500 μV 500 μV 1 mV	30 nV/√Hz 35 nV/√Hz —	12 nV/√Hz 15 nV/√Hz —	TLC2202BID TLC2202AID TLC2202ID	_ _ _	_ _ _	TLC2202BIP TLC2202AIP TLC2202IP	_
-55°C to 125°C	500 μV 500 μV 1 mV	30 nV/√Hz 35 nV/√Hz —	12 nV/√Hz 15 nV/√Hz —	TLC2202BMD TLC2202AMD TLC2202MD	TLC2202BMFK TLC2202AMFK TLC2202MFK	TLC2202BMJG TLC2202AMJG TLC2202MJG	TLC2202BMP TLC2202AMP TLC2202MP	_

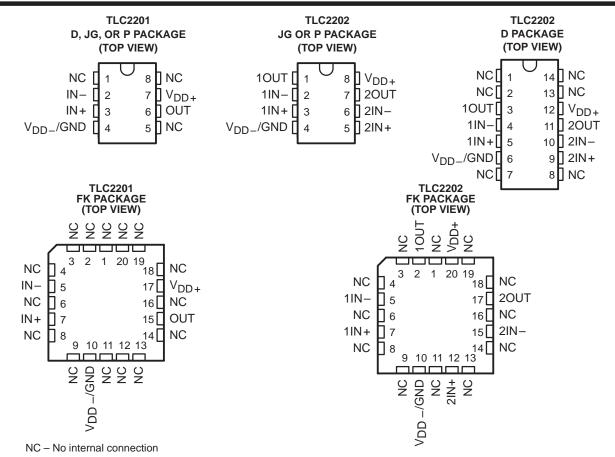
<sup>†</sup> The D packages are available taped and reeled. Add R suffix to device type (e.g. TLC220xBCDR).



<sup>&</sup>lt;sup>‡</sup>Chip forms are tested at 25°C only.

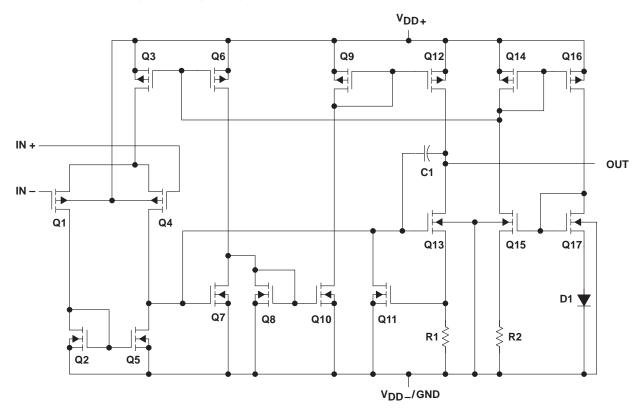
<sup>&</sup>lt;sup>‡</sup>Chip forms are tested at 25°C only.

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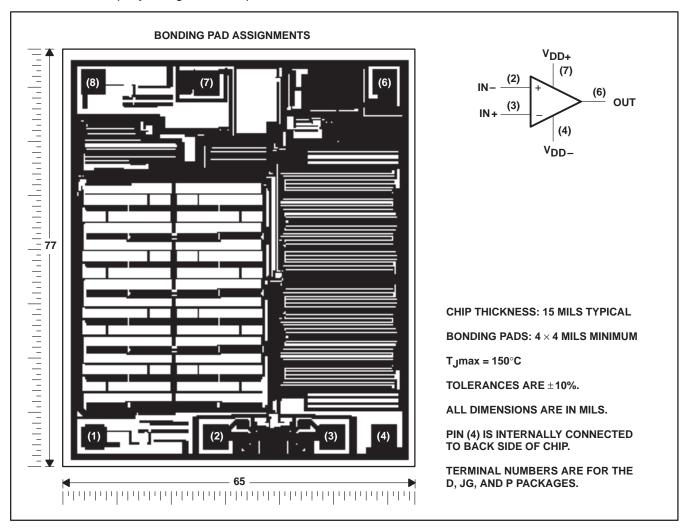
#### equivalent schematic (each amplifier)



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

#### **TLC2201Y chip information**

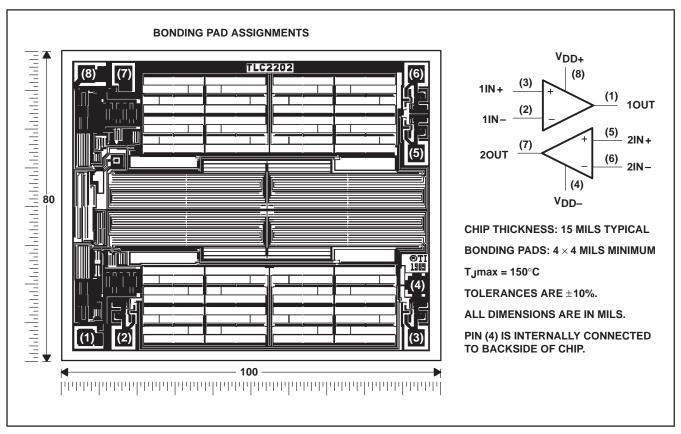
This chip, when properly assembled, displays characteristics similar to the TLC2201C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding path. Chips may be mounted with conductive epoxy or a gold-silicon preform.



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#### TLC2202Y chip formation

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



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

Supply voltage, V <sub>DD+</sub> (see Note 1)	
Supply voltage, V <sub>DD</sub>	8 V
Differential input voltage, V <sub>ID</sub> (see Note 2)	
Input voltage, V <sub>I</sub> (any input)	
Input current, I <sub>I</sub> (each input)	±5 mA
Output current, IO (each output)	
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	. See Dissipation Rating Table
Operating free-air temperature range, T <sub>A</sub> : C suffix	0°C to 70°C
I suffix	40°C to 85°C
M suffix	
Storage temperature range	–65°C to 150°C
Case temperature for 60 seconds: FK package	
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P pack	age 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package	9 300°C

<sup>†</sup> 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 VDD+ and VDD-.
  - 2. Differential voltages are at IN+ with respect to IN-.
  - 3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating in not exceeded.

#### **DISSIPATION RATING TABLE**

PACKAGE	$T_{\mbox{$A$}} \leq 25^{\circ}\mbox{$C$}$ POWER RATING	DERATING FACTOR ABOVE T <sub>A</sub> = 25°C	T <sub>A</sub> = 70°C POWER RATING	T <sub>A</sub> = 85°C POWER RATING	T <sub>A</sub> = 125°C POWER RATING
D-8	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
D-14	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
Р	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	UNIT
Supply voltage, V <sub>DD</sub> ±	±2.3	±8	±2.3	±8	±2.3	±8	V
Common-mode input voltage, V <sub>IC</sub>	$V_{DD-}$	V <sub>DD+</sub> -2.3	$V_{DD-}$	V <sub>DD+</sub> -2.3	$V_{DD-}$	V <sub>DD+</sub> -2.3	V
Operating free-air temperature, T <sub>A</sub>	0	70	-40	85	-55	125	°C



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

	DADAMETED	TEST COM	IDITIONS	<b>-</b> +	Т	LC22010	С	LINUT	
	PARAMETER	TEST CON	DITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT	
\/.0	Input offset voltege			25°C		100	500	μV	
VIO	Input offset voltage			Full range			600	μν	
αVIO	Temperature coefficient of input offset voltage	1		Full range		0.5		μV/°C	
	Input offset voltage long-term drift (see Note 4)	V <sub>IC</sub> = 0,	$R_S = 50 \Omega$	25°C		0.001	0.005	μV/mo	
l. a	lanut offeet europe	VIC = 0,	KS = 50 12	25°C		0.5		A	
IIO	Input offset current			Full range			100	pΑ	
1	Input bias current	1		25°C		1		- Α	
IB	input bias current	Full		Full range			100	pА	
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	-5 to 2.7			٧	
.,	Mandana and the second and and and the second and			25°C	4.7	4.8		.,	
VOM+	Maximum positive peak output voltage swing	D. 401-0		Full range	4.7			V	
\/	Maximum ponetive pools sustaint voltage suring	$R_L = 10 \text{ k}\Omega$		25°C	-4.7	-4.9			
VOM-	Maximum negative peak output voltage swing			Full range	-4.7			٧	
		$V_O = \pm 4 \text{ V},$	R <sub>1</sub> = 500 kΩ	25°C	400	560			
AVD	Large-signal differential voltage amplification	VO = ±4 V,	KL = 300 K22	Full range	300			\//m\/	
AVD	Large-signal differential voltage amplification	$V_0 = \pm 4 \text{ V},$	$R_{\parallel} = 10 \text{ k}\Omega$	25°C	90	100		V/mV	
		VO = ± + v,	NC = 10 K22	Full range	70				
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$	$V_{O} = 0,$	Full range	85			dB	
kove	Cumply voltage rejection ratio (AVI) - (AVI)	V== : -+2 2 V	to ±0.\/	25°C	90	110		dB	
ksvr	Supply voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	$V_{DD\pm} = \pm 2.3 \text{ V to } \pm 8 \text{ V}$		Full range	85			UD	
loo	Supply current	$V_{O} = 0$ ,	No load	25°C		1.1	1.5	mA	
IDD	очрру очнени	1 *0 = 0,	140 luau	Full range			1.5	111/	

<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  $T_A = 150$  °C extrapolated to  $T_A = 25$  °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. +	TL	UNIT		
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
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		V/μs
J Six	Siew rate at unity gain	C <sub>L</sub> = 100 pF	Full range	1.5			ν/μ5
\ <u></u>	Equivalent input noise voltage	f = 10 Hz	25°C		18		nV/√ <del>Hz</del>
V <sub>n</sub>	Equivalent input hoise voltage	f = 1 kHz	25°C		8		nv/∀HZ
V	Dook to pook aguivalent input poice veltage	f = 0.1 to 1 Hz	25°C		0.5		\/
VN(PP)	Peak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μV
In	Equivalent input noise current		25°C		0.6		fA/√Hz
	Gain-bandwidth product	$f = 10 \text{ kHz}, \qquad R_L = 10 \text{ k}\Omega,$ $C_L = 100 \text{ pF}$	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L$ = 10 kΩ, $C_L$ = 100 pF	25°C		48°		

<sup>†</sup> Full range is 0°C to 70°C.



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

	DADAMETED	TEST OF	NIDITIONS	- +	TL	C2201	/C	TL	C2201E	3C	
	PARAMETER	I IEST CC	ONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V/10	Input offset voltage			25°C		80	200		80	200	μV
VIO	Input offset voltage			Full range			300			300	μν
ανιο	Temperature coefficient of input offset voltage			Full range		0.5			0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	V <sub>IC</sub> = 0,	$R_S = 50 \Omega$	25°C		0.001	0.005		0.001	0.005	μV/mo
li o	Input offset current		25			0.5			0.5		pА
lio	input onset current			Full range			100			100	PΑ
I <sub>IB</sub>	Input bias current			25°C		1			1		pА
'IB	input bias current			Full range			100			100	PΛ
VICR	Common-mode input voltage range	$R_S = 50 \Omega$		Full range	-5 to 2.7			-5 to 2.7			V
V <sub>OM+</sub>	Maximum positive peak output			25°C	4.7	4.8		4.7	4.8		V
VOM+	voltage swing	$R_{\rm I} = 10  \rm k\Omega$		Full range	4.7			4.7			V
VOM-	Maximum negative peak output	110 10 10		25°C	-4.7	-4.9		-4.7	-4.9		V
VOIVI-	voltage swing			Full range	-4.7			-4.7			,
		V0 = +4 V	$R_1 = 500 \text{ k}\Omega$	25°C	400	560		400	560		
A <sub>VD</sub>	Large-signal differential voltage	VO - ± + v,	11 = 000 132	Full range	300			300			V/mV
1,00	amplification	V0 = +4 V	$R_I = 10 \text{ k}\Omega$	25°C	90	100		90	100		*/!!!*
		VO - = 1 V,	11 - 10 1122	Full range	70			70			
CMRR	Common-mode rejection ratio	VIC = VICRI	min,	25°C	90	115		90	115		dB
Ommark.	- Common mode rejection ratio	$V_{O} = 0$ ,	$R_S = 50 \Omega$	Full range	85			85			<u> </u>
ksvr	Supply voltage rejection ratio	VDD+=+2	.3 V to +8 V	25°C	90	110		90	110		dB
SVK	$(\Delta V_{DD\pm}/\Delta V_{IO})$	. DD ± - ±2.	$DD\pm = \pm 2.3 \text{ V to } \pm 8 \text{ V}$ Full r		85			85			<u> </u>
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0,	No load	25°C		1.1	1.5		1.1	1.5	mA
טט.		.0 = 0,		Full range			1.5			1.5	1117 (

<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  $T_A = 150$  °C extrapolated to  $T_A = 25$  °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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

PARAMETER		TEST CONDITIONS	T. †	TL	C2201A	C	TL	C2210B	C	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = \pm 2.3 \text{ V},  R_L = 10 \text{ k}\Omega,$	25°C	2	2.7		2	2.7		V/us
SIX	Siew rate at unity gain	C <sub>L</sub> = 100 pF	Full range	1.5			1.5			ν/μ5
\ <u></u>	Equivalent input noise volt-	f = 10 Hz	25°C		18	35		18	30	nV/√ <del>Hz</del>
V <sub>n</sub>	age (see Note 5)	f = 1 kHz	25°C		8	15		8	12 nv/vH	
\/\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	$ f = 10 \text{ kHz}, \qquad R_L = 10 \text{ k}\Omega, $ $C_L = 100 \text{ pF} $	25°C		1.9			1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°			48°		

<sup>†</sup> Full range is 0°C to 70°C.

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



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

	DADAMETED	TEST COME	NTIONS	- t	T	LC22010	С	LINUT
	PARAMETER	TEST COND	OHIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
V/10	Input offset voltege			25°C		100	500	\/
VIO	Input offset voltage			Full range			600	μV
ανιο	Temperature coefficient of input offset voltage	1		Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	\\ 0	D- 50.0	25°C		0.001	0.005	μV/mo
l	lanut offeet current	$V_{IC} = 0$ ,	$R_S = 50 \Omega$	25°C		0.5		<b>π</b> Λ
IO	Input offset current			Full range			100	pΑ
1	land big a support			25°C		1		^
ΙΒ	Input bias current			Full range			100	pΑ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	0 to 2.7			V
\/ <b>-</b>	Manipular high lavel autout valtage	D. 40 l-0		25°C	4.7	4.8		V
VOH	Maximum high-level output voltage	R <sub>L</sub> = 10 kΩ		Full range	4.7			V
V/	Manipular lavel autout valta as	1- 0		25°C		0	50	\/
VOL	Maximum low-level output voltage	IO = 0		Full range			50	mV
		$V_{O} = 1 \text{ V to 4 V},$		25°C	150	315		
Δ	Large cianal differential valte as emplification	$R_L = 500 \text{ k}\Omega$		Full range	100			V/mV
AVD	Large-signal differential voltage amplification	$V_0 = 1 \text{ V to 4 V},$		25°C	25	55		V/IIIV
		$R_L = 10 \text{ k}\Omega$		Full range	15			
CMDD		V <sub>IC</sub> = V <sub>ICR</sub> min,	$V_{\Omega} = 0$ ,	25°C	90	110		40
CMRR	Common-mode rejection ratio	$R_S = 50 \Omega$		Full range	85			dB
1	Complementary residents retire (AVI = - /AVI = )	V= - 4 C V to 4	0.17	25°C	90	110		40
ksvr	Supply voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	V <sub>DD</sub> = 4.6 V to 16 V		Full range	85			dB
1	Cumhi current	V- 25V	Nolood	25°C		1	1.5	A
IDD	Supply current	$V_0 = 2.5 V$ ,	No load	Full range			1.5	mA

<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  $T_A = 150$  °C extrapolated to  $T_A = 25$  °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. +	TL	UNIT		
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
SR	Slew rate at unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.8	2.5		V/µs
J S K	Siew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.3			ν/μ5
V	Equivalent input noise voltage	f = 10 Hz	25°C		18		nV/√ <del>Hz</del>
Vn	Equivalent input noise voltage	f = 1 kHz	25°C	8			IIV/VHZ
V	Dook to pook aguivalent input poice veltage	f = 0.1 to 1 Hz	25°C		0.5		\/
VN(PP)	Peak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μV
In	Equivalent input noise current		25°C		0.6		fA/√Hz
	Gain-bandwidth product		25°C		1.8		MHz
φm	Phase margin at unity gain	$R_L$ = 10 kΩ, $C_L$ = 100 pF	25°C		45°		

<sup>†</sup> Full range is 0°C to 70°C.



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

	DADAMETED	TEST CONDITIONS	<b></b> +	TL	C2201	/C	TL	C2201E	3C	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V <sub>IO</sub>	Input offset voltage		25°C		80	200		80	200	μV
V10	input onset voltage		Full range			300			300	μν
αVIO	Temperature coefficient of input offset voltage		Full range		0.5			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		0.001	0.005	μV/mo
lio	Input offset current	]	25°C		0.5			0.5		pА
liO	input onset current		Full range			100			100	PΛ
I <sub>IB</sub>	Input bias current		25°C		1			1		pА
IIB	input bias current		Full range			100			100	PA
VICR	Common-mode input voltage range	$R_S = 50 \Omega$	Full range	0 to 2.7			0 to 2.7			V
Vон	Maximum high-level output	R <sub>L</sub> = 10 kΩ	25°C	4.7	4.8		4.7	4.8		V
VOH	voltage		Full range	4.7			4.7			V
VOL	Maximum low-level output	I <sub>O</sub> = 0	25°C		0	50		0	50	m∨
, OL	voltage	10 - °	Full range			50			50	
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		150	315		
A <sub>VD</sub>	Large-signal differential	$R_L = 500 \text{ k}\Omega$	Full range	100			100			V/mV
1,00	voltage amplification	$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	25	55		25	55		*/*****
		$R_L = 10 \text{ k}\Omega$	Full range	15			15			
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICR</sub> min,	25°C	90	110		90	110		dB
Owner		$V_0 = 0$ , $R_S = 50 \Omega$	Full range	85			85			
ksvr	Supply voltage rejection ratio	V <sub>DD</sub> = 4.6 V to 16 V	25°C	90	110		90	110		dB
-SVK	$(\Delta V_{DD\pm}/\Delta V_{IO})$		Full range	85			85			
IDD	Supply current	$V_O = 2.5 \text{ V}$ , No load	25°C		1	1.5		1	1.5	mA
טט.		1.0 2.0 1, 1.0 .500	Full range			1.5			1.5	

<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  $T_A = 150$  °C extrapolated to  $T_A = 25$  °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	т.†	TL	C2201A	C	TL	C2210B	C	LINUT
	PARAIVIETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.8	2.5		1.8	2.5		V/us
Jok	Siew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.3			1.3			ν/μ5
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√ <del>Hz</del>
Vn	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	nv/∀HZ
V2.455	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√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
φm	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.

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 or nontesting of other parameters.



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

	PARAMETER	TEST C	CONDITIONS	т. †	Т	LC22020	2	UNIT
	PARAMETER	IEST	CNDITIONS	TΑ <sup>†</sup>	MIN	TYP	MAX	UNII
V	lanut offeet voltege			25°C		100	1000	/
VIO	Input offset voltage	\/ 0	D- 50.0	Full range			1150	μV
ανιο	Temperature coefficient of input offset voltage	$V_{IC} = 0,$	$R_S = 50 \Omega$	Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	1		25°C		0.001	0.005	μV/mo
L -	lanut offeet europt			25°C		0.5		
IO	Input offset current	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	D 50.0	Full range			100	^
I	land bing sument	$V_{IC} = 0$ ,	$R_S = 50 \Omega$	25°C		1		pΑ
ΙΒ	Input bias current			Full range			100	
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	-5 to 2.7			V
				25°C	4.7	4.8		
VOM+	Maximum positive peak output voltage swing			Full range	4.7			V
		$R_L = 10 \text{ k}\Omega$		25°C	-4.7	-4.9		
VOM-	Maximum negative peak output voltage swing			Full range	-4.7			V
			D 50010	25°C	300	560		
^	Lanca di sala la Mana di albanta sa ang Pilanda	$V_0 = \pm 4 V$	$R_L = 500 \text{ k}\Omega$	Full range	200			\//\/
AVD	Large-signal differential voltage amplification		D 4010	25°C	50	100		V/mV
		$V_0 = \pm 4 V$	$R_L = 10 \text{ k}\Omega$	Full range	25			
01400		$V_{\Omega} = 0$ ,	V <sub>IC</sub> = V <sub>ICR</sub> min,	25°C	80	115		i.
CMRR	Common-mode rejection ratio	$R_S = 50 \Omega$	10 1010	Full range	80			dB
I.	Ourselve and resident and the COVID-100	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	0.)//	25°C	80	110		-JD
ksvr	Supply-voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	$V_{DD\pm} = \pm 2.3$	3 V t0 ±8 V	Full range	80			dB
	Complex suggests	V 0	Noteed	25°C		1.8	2.7	A
IDD	Supply current	$V_O = 0$ ,	No load	Full range			2.7	mA

<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  $T_A = 150$  °C extrapolated to  $T_A = 25$  °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CON	IDITIONS	т.†	TL	C22020	;	UNIT
	PARAMETER	TEST CON	IDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = \pm 2.3 V$ ,	$R_L = 10 \text{ k}\Omega$ ,	25°C	1.8	2.7		V/us
Join Toring	Siew rate at unity gain	$C_L = 100  pF$		Full range	1.3			ν/μ3
\/	Equivalent input noise voltage	f = 10 Hz		25°C		18		nV/√ <del>Hz</del>
V <sub>n</sub>	Equivalent input hoise voltage	f = 1 kHz		25°C		8		11V/ \\ \\ \\ \
\\\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		25°C		0.5		μV
VN(PP)	reak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz		25°C		0.7		μν
In	Equivalent input noise current			25°C		0.6		fA/√Hz
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	$R_L = 10 \text{ k}\Omega$ ,	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF	25°C		48°		

TFull range is 0°C to 70°C.



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

	DADAMETED	TEOT OF	NIDITIONS	- +	TL	C2202/	AC	TL	.C2202E	3C	
	PARAMETER	I IEST CC	NDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage			25°C		80	500		80	500	μV
VIO	input onset voltage			Full range			650			650	μν
ανιο	Temperature coefficient of input offset voltage	$V_{IC} = 0$ ,	$R_S = 50 \Omega$	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
li o	Input offset current			25°C		0.5			0.5		ρA
lio	input onset current	V <sub>IC</sub> = 0,	$R_S = 50 \Omega$	Full range			100			100	рΑ
Iв	Input bias current	V[C] = 0	KS = 50 22	25°C		1			1		Aq
LIB	input bias current			Full range			100			100	PΑ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	-5 to 2.7			-5 to 2.7			٧
\/	Maximum positive peak			25°C	4.7	4.8		4.7	4.8		V
VOM+	output voltage swing	$R_{I} = 10 \text{ k}\Omega$		Full range	4.7			4.7			V
V <sub>OM</sub> -	Maximum negative peak	INC = 10 K22		25°C	-4.7	-4.9		-4.7	-4.9		V
VOM-	output voltage swing			Full range	-4.7			-4.7			V
		V0 = +4 V	$R_1 = 500 \text{ k}\Omega$	25°C	300	560		300	560		
A <sub>VD</sub>	Large-signal differential	VO = = 1 V,		Full range	200			200			V/mV
1.00	voltage amplification	V0 = +4 V	$R_I = 10 \text{ k}\Omega$	25°C	50	100		50	100		.,
		10 = 11,		Full range	25			25			
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICR</sub> r		25°C	80	115		80	115		dB
		$V_{O} = 0,$	$R_S = 50 \Omega$	Full range	80			80			
ksvr	Supply-voltage rejection ratio	V <sub>DD+</sub> = ±2.5	3 V to ±8 V	25°C	80	110		80	110		dB
UVIN	$(\Delta V_{DD\pm}/\Delta V_{IO})$	55:		Full range	80			80			
IDD	Supply current	$V_{\Omega} = 0$ ,	No load	25°C		1.8	2.7		1.8	2.7	mA
	7000 to 7000			Full range			2.7			2.7	

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. †	TL	C2202A	C	TL	C2202E	C	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
SR	Clay rate at unity cain	$V_0 = \pm 2.3 \text{ V},$	25°C	1.8	2.7		1.8	2.7		\//a
SK	Slew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.3			1.3			V/μs
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√Hz
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	110/10
\/\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√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
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°			48°		

<sup>†</sup>Full range is 0°C to 70°C.

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



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

	DADAMETED	TEST	CANDITIONS	T. †	Т	LC22020	2	LINUT
	PARAMETER	IESTO	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
\/.0	Input offeet voltage			25°C		100	1000	μV
VIO	Input offset voltage	\/.a = 0	$R_S = 50 \Omega$	Full range			1150	μν
ανιο	Temperature coefficient of input offset voltage	VIC = 0,	KS = 50 22	Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.001	0.005	μV/mo
lιΟ	Input offset current			Full range			100	
lin	Input bias current	$V_{IC} = 0$ ,	$R_S = 50 \Omega$	25°C		1		рА
ΙΒ	input bias current			Full range			100	
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	0 to 2.7			٧
Vон	Maximum high-level output voltage	$R_{\parallel} = 10 \text{ k}\Omega$		25°C	4.7	4.8		V
VОН	waxiinum nigri-iever output voitage	INC = 10 K32		Full range	4.7			V
VOL	Maximum low-level output voltage	IO = 0		25°C		0	50	mV
VOL	waximum low level output voltage	10 = 0		Full range			50	111.0
		V <sub>O</sub> =1 V to 4		25°C	150	315		
AVD	Large-signal differential voltage amplification	$R_L = 500 \text{ k}\Omega$		Full range	100			V/mV
AVD	Large signal differential voltage amplification	V <sub>O</sub> = 1 V to 4	1 V,	25°C	25	55		V/111V
		$R_L = 10 \text{ k}\Omega$		Full range	15			
CMRR	Common-mode rejection ratio	$V_{O} = 0$ ,	$V_{IC} = V_{ICR}min$	25°C	75	110		dB
OWNER	Common mode rejection ratio	$R_S = 50 \Omega$		Full range	75			uВ
kovo	Supply-voltage rejection ratio (ΔV <sub>DD+</sub> /ΔV <sub>IO</sub> )	V <sub>DD</sub> = 4.6 V t	to 16 V	25°C	80	110		dB
ksvr	- σαρριγ-voitage rejection ratio (Δν DD±/Δν IO)	4.0 V I		Full range	80			ub
Inn	Supply current	V <sub>O</sub> = 0,	No load	25°C		1.7	2.6	mA
IDD	очрріў сипепі	v <sub>O</sub> = 0,	INU IUAU	Full range			2.6	111/4

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CON	DITIONS	T <sub>A</sub> †	TL	C22020	;	UNIT
	PARAMETER	TEST CON	DITIONS		MIN	TYP	MAX	UNII
SR	Slew rate at unity gain	$V_0 = 0.5 \text{ V to } 2.5$	5 V,	25°C	1.6	2.5		V/μs
SIX	Siew rate at unity gain	$R_L = 10 \text{ k}\Omega$ ,	$C_L = 100 pF$	Full range	1.1			ν/μ5
\ <u>'</u>	Equivalent input noise voltage	f = 10 Hz		25°C		18		nV/√ <del>Hz</del>
Vn	Equivalent input noise voltage	f = 1 kHz		25°C		8		11V/ \\ \\ \\ \
\/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		25°C		0.5		μV
VN(PP)	reak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz		25°C		0.7		μν
In	Equivalent input noise current			25°C		0.6		fA/√Hz
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	$R_L = 10 \text{ k}\Omega$ ,	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF	25°C		47°		

<sup>†</sup> Full range is 0°C to 70°C.



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

	DADAMETED	TEGT CONDITIONS	- +	TL	C2202/	AC OA	TL	.C2202E	3C	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage		25°C		80	500		80	500	μV
V10	input onset voltage		Full range			650			650	μν
ανιο	Temperature coefficient of input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	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
lio	Input offset current		25°C		0.5			0.5		pА
טוי	input onset current	$V_{IC} = 0$ , $R_S = 50 \Omega$	Full range			100			100	РΛ
lup.	Input bias current	V <sub>1</sub> C = 0, K <sub>S</sub> = 30 22	25°C		1			1		pА
IB	input bias current		Full range			100			100	PΛ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			0 to 2.7			V
V/0	Maximum high-level	$R_{\rm I} = 10 \text{ k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
VOH	output voltage	K[ = 10 K22	Full range	4.7			4.7			V
VOL	Maximum low-level	IO = 0	25°C		0	50		0	50	mV
*OL	output voltage	10 = 0	Full range			50			50	111.
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		150	315		
A <sub>VD</sub>	Large-signal differential	$R_L = 500 \text{ k}\Omega$	Full range	100			100			V/mV
1.00	voltage amplification	$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	25	55		25	55		.,
		$R_L = 10 \text{ k}\Omega$	Full range	15			15			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min,$	25°C	75	110		75	110		dB
		$V_{O} = 0$ , $R_{S} = 50 \Omega$	Full range	75			75			
ksvr	Supply-voltage rejection ratio	V <sub>DD</sub> = 4.6 V to 16 V	25°C	80	110		80	110		dB
371	$(\Delta V_{DD\pm}/\Delta V_{IO})$	DD	Full range	80			80			
I <sub>DD</sub>	Supply current	$V_O = 2.5 \text{ V}$ , No load	25°C		1.7	2.6		1.7	2.6	mA
			Full range			2.6			2.6	

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. †	TL	C2202A	C	TL	C2202B	C	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
SR	Class rate at units gain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.6	2.5		1.6	2.5		1////
SK	Slew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.1			1.1			V/μs
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√ <del>Hz</del>
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	110/10
VALCED	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
V <sub>N(PP)</sub>	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	$f = 10 \text{ kHz}, R_L = 10 \text{ k}Ω,$ $C_L = 100 \text{ pF}$	25°C		1.9			1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		47°			47°		

<sup>†</sup>Full range is 0°C to 70°C.

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



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

	DARAMETER	TEGT	CNDITIONS	- +	Т	LC2201	ı	UNIT
	PARAMETER	IEST C	ONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
1/	lanut effect voltage			25°C		100	500	/
VIO	Input offset voltage			Full range			650	μV
αVIO	Temperature coefficient of input offset voltage	]		Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	V <sub>IC</sub> = 0,	$R_S = 50 \Omega$	25°C		0.001	0.005	μV/mo
l. a	land affect ourset	$V_{1C} = 0$	NS = 30 12	25°C		0.5		
lio	Input offset current			Full range			150	pА
l.n	Input bias current	]		25°C		1		рА
ΙΒ	input bias current			Full range			150	PA
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	-5 to 2.7			V
.,				25°C	4.7	4.8		
VOM+	Maximum positive peak output voltage swing	D. 401-0		Full range	4.7			V
V	Maximum pagativa pagk autout valtage auting	$R_L = 10 \text{ k}\Omega$		25°C	-4.7	-4.9		V
VOM-	Maximum negative peak output voltage swing			Full range	-4.7			V
		\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	R <sub>L</sub> = 500 kΩ	25°C	400	560		
Δ, τ	Large-signal differential voltage amplification	VO = ±4 V,	KL = 300 K22	Full range	250			V/mV
AVD	Large-signal differential voltage amplification	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	$R_L = 10 \text{ k}\Omega$	25°C	90	100		V/IIIV
		VO = ±4 v,	NL = 10 K22	Full range	65			
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICR</sub> n	nin,	25°C	90	115		dB
OWNTRIC	Common mode rejection ratio	$V_{O} = 0$ ,	$R_S = 50 \Omega$	Full range	85			ub.
ksvr	Supply voltage rejection ratio (ΔV <sub>DD+</sub> /ΔV <sub>IO</sub> )	V <sub>DD±</sub> = ±2.3		25°C	90	110		dB
2vk	Cappi, Tollago Tojoollon Tallo (AVDD±/AVIO)	* DD ± - ±2.0		Full range	85			<u> </u>
lDD	Supply current	V <sub>O</sub> = 0,	No load	25°C		1.1	1.5	mA
-טט				Full range			1.5	

<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  $T_A = 150$  °C extrapolated to  $T_{A=2}$  25 °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	- +	TI	_C2201I		UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
SR	Slew rate at unity gain	$V_0 = \pm 2.3 \text{ V},  R_L = 10 \text{ k}\Omega,$	25°C	2	2.7		V/μs
SK	Siew rate at unity gain	C <sub>L</sub> = 100 pF	Full range	1.4			ν/μδ
V	Equivalent input noise voltage	f = 10 Hz	25°C		18		nV/√Hz
V <sub>n</sub>	Equivalent input noise voltage	f = 1 kHz	25°C		8		nv/∀HZ
V	Dock to peak aguivalent input paige valtage	f = 0.1 to 1 Hz	25°C		0.5		μV
VN(PP)	Peak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μν
In	Equivalent input noise current		25°C		0.6		fA/√Hz
	Gain-bandwidth product	$f = 10 \text{ kHz}, \qquad R_L = 10 \text{ k}\Omega,$ $C_L = 100 \text{ pF}$	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°		

<sup>†</sup>Full range is -40°C to 85°C.



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

	DADAMETED	TEST CO	NDITIONS	- +	TL	C2201	Al	TL	C2210	BI	UNIT
	PARAMETER	I IESI CO	NDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
VIO	Input offset voltage			25°C		80	200		80	200	μV
V10	mput onset voltage			Full range			350			350	μν
ανιο	Temperature coefficient of input offset voltage			Full range		0.5			0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	V <sub>IC</sub> = 0,	$R_S = 50 \Omega$	25°C		0.001	0.005		0.001	0.005	μV/mo
li o	Input offset current	1		25°C		0.5			0.5		pА
ΙΟ	input onset current			Full range			150			150	PΑ
1.0	Input bias current			25°C		1			1		pА
IВ	input bias current			Full range			150			150	PΛ
VICR	Common-mode input voltage range	$R_S = 50 \Omega$		Full range	-5 to 2.7			-5 to 2.7			V
V	Maximum positive peak output			25°C	4.7	4.8		4.7	4.8		V
VOM+	voltage swing	R <sub>I</sub> = 10 kΩ		Full range	4.7			4.7			V
V <sub>OM</sub> -	Maximum negative peak output	KL = 10 K22		25°C	-4.7	-4.9		-4.7	-4.9		V
VOM-	voltage swing			Full range	-4.7			-4.7			V
		\/o = +4 \/	R <sub>1</sub> = 500 kΩ	25°C	400	560		400	560		
AVD	Large-signal differential voltage	VO = ± + v,	11 = 000 122	Full range	250			250			V/mV
\\U	amplification	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	$R_1 = 10 \text{ k}\Omega$	25°C	90	100		90	100		V/111V
		VO - ±+ v,	11 - 10 1022	Full range	65			65			
CMRR	Common-mode rejection ratio	VIC = VICR	min,	25°C	90	115		90	115		dB
Om ar		$V_{O} = 0$ ,	$R_S = 50 \Omega$	Full range	85			85			45
ksvr	Supply voltage rejection ratio	$V_{DD \pm} = \pm 2.$	3 V to +8 V	25°C	90	110		90	110		dB
ovk	$(\Delta V_{DD\pm}/\Delta V_{IO})$	· UU ± - ±2.		Full range	85			85			
lDD	Supply current	VO = 0,	No load	25°C		1.1	1.5		1.1	1.5	mA
טט.	Capp., canon	1.0 = 0,		Full range			1.5			1.5	'''' \

<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  $T_A = 150$  °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	<b>-</b> .+	TL	.C2201	ΑI	TL	.C2210E	31	UNIT
	PARAIVIETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = \pm 2.3 \text{ V},$	25°C	2	2.7		2	2.7		V/us
SIX	Siew rate at utility gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.4			1.4			ν/μ5
\ <u>'</u>	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√ <del>Hz</del>
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	IIV/VIIZ
V2.455	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	$f = 10 \text{ kHz}, \qquad R_L = 10 \text{ k}\Omega,$ $C_L = 100 \text{ pF}$	25°C		1.9			1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°			48°	·	

<sup>†</sup>Full range is -40°C to 85°C.

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



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

	DADAMETED	TEST COMPITIONS	- +	Т	LC2201	I	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
V/10	Input offset voltage		25°C		100	500	μV
VIO	input oilset voitage		Full range			650	μν
ανιο	Temperature coefficient of input offset voltage	]	Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	V- 0 D- 50.0	25°C		0.001	0.005	μV/mo
	land offer a company	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C		0.5		A
10	Input offset current		Full range			150	pΑ
I	land bing sument	1	25°C		1		- A
ΙΒ	Input bias current		Full range			150	pА
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			V
			25°C	4.7	4.8		
VOH	Maximum high-level output voltage	$R_L = 10 \text{ k}\Omega$	Full range	4.7			V
			25°C		0	50	
VOL	Maximum low-level output voltage	IO = 0	Full range			50	mV
		$V_{O} = 1 \text{ V to 4 V},$	25°C	150	315		
	Lanca di sala differenzia la la collega di sala di sal	$R_L = 500 \text{ k}\Omega$	Full range	100			\
AVD	Large-signal differential voltage amplification	V <sub>O</sub> = 1 V to 4 V,	25°C	25	55		V/mV
		$R_L = 10 \text{ k}\Omega$	Full range	15			
OMBB	On the second se	V <sub>IC</sub> = V <sub>ICR</sub> min,	25°C	90	110		-ID
CMRR	Common-mode rejection ratio	$V_O = 0$ , $R_S = 50 \Omega$	Full range	85			dB
	Complementation matic (AVIII)	V 4 C V to 4C V	25°C	90	110		40
ksvr	Supply voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	$V_{DD} = 4.6 \text{ V to } 16 \text{ V}$	Full range	85			dB
1	Cumply oursent	V- 25V No lood	25°C		1	1.5	A
<sup>ו</sup> סס	Supply current	$V_O = 2.5 \text{ V}$ , No load	Full range			1.5	mA

<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  $T_A = 150^{\circ}C$  extrapolated to  $T_A = 25^{\circ}C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. †	Т	LC2201I		UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
SR	Slew rate at unity gain	V <sub>O</sub> = 0.5 V to 2.5 V,	25°C	1.8	2.5		V/µs
J SK	Siew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.2			ν/μδ
\ /	Equivalent input noise voltage	f = 10 Hz	25°C		18		nV/√ <del>Hz</del>
V <sub>n</sub>	Equivalent input noise voltage	f = 1 kHz	25°C		8		nv/√Hz
\/=\	Dook to pook aguivalent input poice veltage	f = 0.1 to 1 Hz	25°C		0.5		\/
VN(PP)	Peak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μV
In	Equivalent input noise current		25°C		0.6		fA/√ <del>Hz</del>
	Gain-bandwidth product		25°C		1.8		MHz
φm	Phase margin at unity gain	$R_L$ = 10 kΩ, $C_L$ = 100 pF	25°C		45°		

<sup>†</sup> Full range is -40°C to 85°C.



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### TLC2201I electrical characteristics at specified free-air temperature, V<sub>DD</sub> = 5 V (unless otherwise

	DADAMETED	TEST COMPITIONS	- +	Τl	C2201	AI	TI	LC2201	BI	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage		25°C		80	200		80	200	μΑ
V10	input onset voltage		Full range			350			350	μΑ
αVIO	Temperature coefficient of input offset voltage		Full range		0.5			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		0.001	0.005	μV/mo
lio	Input offset current	]	25°C		0.5			0.5		рA
10	input onset current		Full range			150			150	PΛ
I <sub>IB</sub>	Input bias current	]	25°C		1			1		рA
,IR	input bias current		Full range			150			150	PΛ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			0 to 2.7			V
Vон	Maximum high-level output	$R_1 = 10 \text{ k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
VOH	voltage	KL = 10 K22	Full range	4.7			4.7			V
VOL	Maximum low-level output	I <sub>O</sub> = 0	25°C		0	50		0	50	mV
VOL	voltage	10 = 0	Full range			50			50	111.0
		$V_0 = 1 \text{ V to 4 V},$	25°C	150	315		150	315		
AVD	Large-signal differential	$R_L = 500 \text{ k}\Omega$	Full range	100			100			V/mV
1,00	voltage amplification	$V_O = 1 V \text{ to } 4 V,$	25°C	25	55		25	55		V/1111
		$R_L = 10 \text{ k}\Omega$	Full range	15			15			
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICR</sub> min,	25°C	90	110		90	110		dB
Jimar	Common mode rejection ratio	$V_O = 0$ , $R_S = 50 \Omega$	Full range	85			85			GD.
ksvr	Supply voltage rejection ratio	V <sub>DD</sub> = 4.6 V to 16 V	25°C	90	110		90	110		dB
SVK	$(\Delta V_{DD\pm}/\Delta V_{IO})$	- 10 - 10 10 10 1	Full range	85			85			45
IDD	Supply current	V <sub>O</sub> = 2.5 V, No load	25°C		1	1.5		1	1.5	mA
+ =		2.5 1, 1.5 1544	Full range			1.5			1.5	

<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<sub>A</sub> = 150°C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. †	TL	.C2201	ΑI	TL	.C2210E	31	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.8	2.5		1.8	2.5		V/us
Jok	Siew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.2			1.2			ν/μ5
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Equivalent input noise	f = 10 Hz	25°C		18	35		18	30	nV/√ <del>Hz</del>
Vn	voltage (see Note 5)	f = 1 kHz	25°C		8	15		8	12	nv/∀HZ
V	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product		25°C		1.8			1.8		MHz
φm	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 -40°C to 85°C.

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



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

	DADAMETED	TEST	CAUDITIONS	T. †	Т	LC2202	I	LIAUT
	PARAMETER	1551 C	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
V. 0	Input offset voltage			25°C		100	1000	\/
VIO	Input offset voltage	\/\a_ = 0	$R_S = 50 \Omega$	Full range			1200	μV
ανιο	Temperature coefficient of input offset voltage	$V_{IC} = 0,$	KS = 50.22	Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.001	0.005	μV/mo
I <sub>IO</sub>	Input offset current			Full range			150	
lin.	Input bias current	$V_{IC} = 0$ ,	$R_S = 50 \Omega$	25°C		1		pА
ΙΒ	input bias current			Full range			150	
					-5			
VICR	Common-mode input voltage range	$R_S = 50 \Omega$		Full range	to 2.7			V
				0500		4.0		
VoM+	Maximum positive peak output voltage swing			25°C	4.7	4.8		V
		$R_L = 10 \text{ k}\Omega$		Full range	4.7	-4.9		V
VOM-	Maximum negative peak output voltage swing			25°C	-4.7 -4.7	-4.9		V
				Full range		500		V
		$V_0 = \pm 4 V$ ,	$R_L = 500 \text{ k}\Omega$	25°C	300	560		
AVD	Large-signal differential voltage amplification			Full range	150	400		V/mV
-		$V_0 = \pm 4 V$	$R_L = 10 \text{ k}\Omega$	25°C	50	100		
		,		Full range	25			
CMRR	Common-mode rejection ratio	$V_{O} = 0$ ,	$V_{IC} = V_{ICR}min,$	25°C	80	115		dB
Owner	Common mode rejection ratio	$R_S = 50 \Omega$		Full range	80			ub
kova	Supply-voltage rejection ratio (ΔV <sub>DD+</sub> /ΔV <sub>IO</sub> )	\/nn - +2 2 \	/ +o ± 9 \/	25°C	80	110		dB
ksvr	anbhiλ-λοιταθε relection ματίο (πλDD ∓\πλΙΟ)	$V_{DD} = \pm 2.3 $	ν ιο ⊥ο ν	Full range	80			uБ
	Supply current	Vo = 0	No load	25°C		1.8	2.7	mΛ
IDD	Supply current	$V_O = 0$ ,	INU IUAU	Full range			2.7	mA

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	DADAMETED	TEST CON	IDITIONS	T. †	TI	LC2202I		LINUT
	PARAMETER	1EST CON	IDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = \pm 2.3 V$ ,	$R_L = 10 \text{ k}\Omega$ ,	25°C	1.8	2.7		V/µs
SIX	Siew rate at unity gain	C <sub>L</sub> = 100 pF		Full range	1.2			ν/μ5
\/	Equivalent input noise voltage	f = 10 Hz		25°C		18		nV/√ <del>Hz</del>
Vn	Equivalent input hoise voltage	f = 1 kHz		25°C		8		IIV/ VIIZ
\/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		25°C		0.5		μV
VN(PP)	reak-to-peak equivalent input hoise voltage	f = 0.1 to 10 Hz		25°C		0.7		μν
In	Equivalent input noise current			25°C		0.6		fA/√ <del>Hz</del>
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	$R_L = 10 \text{ k}\Omega$ ,	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF	25°C		48°		

<sup>†</sup> Full range is -40°C to 85°C.



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

	DADAMETED	TEGT CONDITIONS	- +	TI	C2202	Al	TI	C2202	BI	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage		25°C		80	500		80	500	μV
V10	input onset voltage		Full range			700			700	μν
ανιο	Temperature coefficient of input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	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
lio	Input offset current		25°C		0.5			0.5		pА
10	input onset current	$V_{IC} = 0$ , $R_S = 50 \Omega$	Full range			150			150	рΑ
I <sub>IB</sub>	Input bias current	VIC = 0, 115 = 30 12	25°C		1			1		pА
מוי	input bias current		Full range			150			150	рΑ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	-5 to 2.7			-5 to 2.7			V
V/011	Maximum positive peak		25°C	4.7	4.8		4.7	4.8		V
VOM+	output voltage swing	R <sub>I</sub> = 10 kΩ	Full range	4.7			4.7			V
V <sub>OM</sub> -	Maximum negative peak	IVE = 10 K22	25°C	-4.7	-4.9		-4.7	-4.9		V
VOIVI—	output voltage swing		Full range	-4.7			-4.7			·
		$V_O = \pm 4 V$ ,	25°C	300	560		300	560		
A <sub>VD</sub>	Large-signal differential	$R_L = 500 \text{ k}\Omega$	Full range	150			150			V/mV
1.00	voltage amplification	$V_O = \pm 4 V$ ,	25°C	50	100		50	100		.,
		$R_L = 10 \text{ k}\Omega$	Full range	25			25			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min,$	25°C	80	115		80	115		dB
		$V_{O} = 0$ , $R_{S} = 50 \Omega$	Full range	80			80			
ksvr	Supply-voltage rejection ratio	V <sub>DD±</sub> ±2.3 V to ±8 V	25°C	80	110		80	110		dB
3/1	$(\Delta V_{DD\pm}/\Delta V_{IO})$	-DD1 == 0 + 10 = 0 +	Full range	80			80			
I <sub>DD</sub>	Supply current	$V_{O} = 0$ , No load	25°C		1.8	2.7		1.8	2.7	mA
	117		Full range			2.7			2.7	

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. †	TL	.C2202/	٩I	TL	.C2202E	31	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Clay rate at unity gain	$V_O = \pm 2.3 \text{ V, R}_L = 10 \text{ k}\Omega,$	25°C	1.8	2.7		1.8	2.7		1////
SK	Slew rate at unity gain	C <sub>L</sub> = 100 pF	Full range	1.2			1.2			V/μs
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√Hz
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	110/1012
VALCED	Peak-to-peak equivalent	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
V <sub>N(PP)</sub>	input noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√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
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°			48°		

<sup>†</sup>Full range is -40°C to 85°C.

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



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

	DADAMETED	TEST CONDITIONS		T. †	T	LC2202	I	LIAUT
	PARAMETER	TEST CONDITIONS		T <sub>A</sub> †	MIN	TYP	MAX	UNIT
V10	Input offset voltage			25°C		100	1000	μV
VIO	input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$		Full range			1200	μν
αVIO	Temperature coefficient of input offset voltage	$V_{1}C = 0, \qquad KS = 30.22$		Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.001	0.005	μV/mo
lιO	Input offset current			Full range			150	
l.s	Input bias current	$V_{IC} = 0$ , $R_S = 50 \Omega$		25°C		1		рА
lΒ	input bias current			Full range			150	
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	0 to 2.7			V
VOH	Maximum high-level output voltage	$R_{I} = 10 \text{ k}\Omega$		25°C	4.7	4.8		V
VОН	waximum nigh-level output voltage			Full range	4.7			V
VOL	Maximum low-level output voltage	I <sub>O</sub> = 0		25°C		0	50	mV
VOL	waximum low-level output voltage	10 = 0		Full range			50	111.0
		$V_O = 1 V \text{ to } 4 V$		25°C	150	315		
AVD	Large-signal differential voltage amplification	$R_L = 500 \text{ k}\Omega$		Full range	100			V/mV
700	Large-signal differential voltage amplification	$V_0 = 1 \ V \text{ to } 4 \ V,$		25°C	25	55		V/IIIV
		$R_L = 10 \text{ k}\Omega$		Full range	15			
CMRR	Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$	min,	25°C	75	110		dB
OWINT	Common mode rejection ratio	$R_S = 50 \Omega$		Full range	75			uБ
kovp	Supply-voltage rejection ratio (ΔV <sub>DD+</sub> /ΔV <sub>IO</sub> )	V <sub>DD</sub> = 4.6 V to 16 V		25°C	80	110		dB
ksvr	- σαρριγ-voltage rejection ratio (Δν DD±/Δν IO)	VDD- 4.0 V to 10 V		Full range	80			uБ
IDD	Supply current	V <sub>O</sub> = 2.5 V, No load		25°C		1.7	2.6	mA
IDD	очррту синен	VO = 2.5 V, NO 10au		Full range			2.6	111/1

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDI	TIONS	т.†	TI	_C2202I		UNIT
	PARAMETER	TEST CONDI	IIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V}$	,	25°C	1.6	2.5		V/µs
SK	Siew rate at unity gain		L = 100 pF	Full range	1			ν/μ5
V	Equivalent input noise voltage	f = 10 Hz		25°C		18		-> //s/I-I=
Vn	Equivalent input noise voltage	f = 1 kHz		25°C		8		nV/√Hz
V	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		25°C		0.5		μV
V <sub>N(PP)</sub>	reak-to-peak equivalent input hoise voltage	f = 0.1 to 10 Hz		25°C		0.7		μν
In	Equivalent input noise current			25°C		0.6		fA/√Hz
	Gain-bandwidth product	$f = 10 \text{ kHz},  ext{R}$ $C_L = 100 \text{ pF}$	L = 10 kΩ,	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C$	L = 100 pF	25°C		47°		

<sup>†</sup>Full range is -40°C to 85°C.



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

	DADAMETER	TEST COMPITIONS	T. T	TL	C2202	Al	TI	C2202	ВІ	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
VIO	Input offset voltage		25°C		80	500		80	500	μV
10	par ender verage	]	Full range			700			700	μν
αVIO	Temperature coefficient of input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	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
lio	Input offset current		25°C		0.5			0.5		pА
10	input onset current	$V_{IC} = 0$ , $R_S = 50 \Omega$	Full range			150			150	рΑ
I <sub>IB</sub>	Input bias current	1 10 - 0, 115 - 30 22	25°C		1			1		рA
'ID	input blue outront		Full range			150			150	ρ'n
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			0 to 2.7			V
V/011	Maximum high-level output	$R_{I} = 10 \text{ k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
VOH	voltage	K[ = 10 K22	Full range	4.7			4.7			V
VOL	Maximum low-level output	I <sub>O</sub> = 0	25°C		0	50		0	50	mV
, OL	voltage	1.0 - 0	Full range			50			50	
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		150	315		
A <sub>VD</sub>	Large-signal differential	R <sub>L</sub> = 500 kΩ	Full range	100			100			V/mV
1.40	voltage amplification	$V_O = 1 V \text{ to } 4 V,$	25°C	25	55		25	55		.,
		$R_L = 10 \text{ k}\Omega$	Full range	15			15			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min,$	25°C	75	110		75	110		dB
		$V_{O} = 0$ , $R_{S} = 50 \Omega$	Full range	75			75			
ksvr	Supply-voltage rejection ratio	V <sub>DD</sub> = 4.6 V to 16 V	25°C	80	110		80	110		dB
UVIN	$(\Delta V_{DD\pm}/\Delta V_{IO})$		Full range	80			80			·
IDD	Supply current	$V_{\Omega} = 2.5 \text{ V}$ , No load	25°C		1.7	2.6		1.7	2.6	mA
+ = "			Full range			2.6			2.6	

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. †	TL	C2202	ΑI	TL	.C2202I	31	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
SR	Clay rate at unity cain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.6	2.5		1.6	2.5		\//v.c
SK	Slew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1			1			V/μs
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√Hz
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	110/10
VALCED	Peak-to-peak equivalent	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)	input noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μν
In	Equivalent input noise current		25°C		0.6			0.6		fA/√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
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		47°			47°		

<sup>†</sup>Full range is -40°C to 85°C

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



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

	DADAMETED	TEOT 0	ONDITIONS	_ +	Т	LC2201	/I	
	PARAMETER	IESIC	ONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
\/	lanut offeet voltege			25°C		100	500	\/
VIO	Input offset voltage			Full range			700	μV
ανιο	Temperature coefficient of input offset voltage	]		Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	1	D- 50.0	25°C		0.001	0.005	μV/mo
	land offers coment	$V_{IC} = 0,$	$R_S = 50 \Omega$	25°C		0.5		Λ
IO	Input offset current			Full range			500	pΑ
	Lawrence Community	1		25°C		1		A
IB	Input bias current			Full range			500	pΑ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω		Full range	-5 to 2.7			V
\/	Maximum positive pook output voltage aving			25°C	4.7	4.8		V
VOM+	Maximum positive peak output voltage swing	D. 40 kg		Full range	4.7			V
\/	Maximum nagativa naak autaut valtaga auting	$R_L = 10 \text{ k}\Omega$		25°C	-4.7	-4.9		V
VOM-	Maximum negative peak output voltage swing			Full range	-4.7			V
		\/- \	D. 500 kg	25°C	400	560		
۸	Large-signal differential voltage amplification	$V_0 = \pm 4 V$ ,	$R_L = 500 \text{ k}\Omega$	Full range	200			V/mV
AVD	Large-signal differential voltage amplification	\/- \	D: 40 kO	25°C	90	100		V/IIIV
		$V_0 = \pm 4 V$	$R_L = 10 \text{ k}\Omega$	Full range	45			
OMBB	On any and any in order order	V <sub>IC</sub> = V <sub>ICR</sub> n	nin,	25°C	90	115		-ID
CMRR	Common-mode rejection ratio	$V_{O} = 0$ ,	$R_S = 50 \Omega$	Full range	85			dB
l	Complexed to a pointing ratio (AV)	\/ +0.4	2.1/45 + 0.1/	25°C	90	110		40
ksvr	Supply voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	$V_{DD\pm} = \pm 2.3$	3 V 10 ±8 V	Full range	85			dB
	Complete company	\/ O	Natard	25°C		1.1	1.5	A
IDD	Supply current	$V_O = 0$ ,	No load	Full range			1.5	mA

<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  $T_A = 150^{\circ}C$  extrapolated to  $T_A = 25^{\circ}C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	T. +	TL	.C2201N	1	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
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		V/μs
J Six	Siew rate at unity gain	C <sub>L</sub> = 100 pF	Full range	1.3			ν/μ5
\ <u></u>	Equivalent input noise voltage	f = 10 Hz	25°C		18		->1/6/I-I=
V <sub>n</sub>	Equivalent input hoise voltage	f = 1 kHz	25°C		8		nV/√Hz
V	Dook to neek equivalent input poice voltage	f = 0.1 to 1 Hz	25°C		0.5		\/
VN(PP)	Peak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μV
In	Equivalent input noise current		25°C		0.6		fA/√Hz
	Gain-bandwidth product		25°C		1.9		MHz
φm	Phase margin	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°		

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



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

	DADAMETED	TEST CONDIT	TIONS	- t	TL	C2201A	M	TL	C2210B	M	
	PARAMETER	TEST CONDIT	IIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V	Input offset voltage			25°C		80	200		80	200	μV
VIO	Input offset voltage			Full range			400			400	μν
ανιο	Temperature coefficient of input offset voltage			Full range		0.5			0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	V <sub>IC</sub> = 0, R <sub>S</sub>	$S = 50 \Omega$	25°C		0.001	0.005		0.001	0.005	μV/mo
li o	Input offset current	]		25°C		0.5			0.5		pА
ΙΟ	input onset current			Full range			500			500	PΑ
	Input bias current			25°C		1			1		рA
IB	input bias current			Full range			500			500	PΛ
VICR	Common-mode input voltage range	$R_S = 50 \Omega$		Full range	-5 to 2.7			-5 to 2.7			V
\/	Maximum positive peak			25°C	4.7	4.8		4.7	4.8		V
V <sub>OM+</sub>	output voltage swing	R <sub>I</sub> = 10 kΩ		Full range	4.7			4.7			V
V <sub>OM</sub> -	Maximum negative peak	KL = 10 K22		25°C	-4.7	-4.9		-4.7	-4.9		V
VOM-	output voltage swing			Full range	-4.7			-4.7			V
		$V_0 = \pm 4 V$ ,		25°C	400	560		400	560		
AVD	Large-signal differential	$R_L = 500 \text{ k}\Omega$		Full range	200			200			V/mV
\^VD	voltage amplification	$V_0 = \pm 4 V$ ,		25°C	90	100		90	100		V/IIIV
		$R_L = 10 \text{ k}\Omega$		Full range	45			45			
CMRR	Common-mode rejection	$V_{IC} = V_{ICR}min,$		25°C	90	115		90	115		dB
CIVILLY	ratio	$V_O = 0$ , Rs	$S = 50 \Omega$	Full range	85			85			UD
ksvr	Supply voltage rejection	$V_{DD \pm} = \pm 2.3 \text{ V to}$	n +8 V	25°C	90	110		90	110		dB
2VK	ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	100±-±2.0 V to	· · · ·	Full range	85			85			QD
IDD	Supply current	$V_{\Omega} = 0$ , No	oload	25°C		1.1	1.5		1.1	1.5	mA
טט.	Cappiy current	1,0 = 0,	7 1344	Full range			1.5			1.5	1117 (

<sup>†</sup> 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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST	T. †	TL	C2201A	М	TLO	C2201B	М	LINUT
	PARAMETER	CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Claus rate at unity main	$V_0 = \pm 2.3 \text{ V},$ $R_1 = 10 \text{ k}\Omega,$	25°C	2	2.7		2	2.7		\//v.a
SK	Slew rate at unity gain	$C_L = 100 \text{ pF}$	Full range	1.3			1.3			V/μs
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	nV/√ <del>Hz</del>
Vn	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	NV/VHZ
V	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		/
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μV
In	Equivalent input noise current		25°C		0.6			0.6		fA/√ <del>Hz</del>
	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
фm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°			48°		

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

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



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

	DADAMETED	TEST SOMBITIONS	- +	Т	LC2201	М	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
V. 0	Input offeet voltage		25°C		100	500	μV
VIO	Input offset voltage		Full range			700	μν
ανιο	Temperature coefficient of input offset voltage		Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	)/.a 0	25°C		0.001	0.005*	μV/mo
li o	Input offset current	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C		0.5		рA
lo	input onset current		Full range			500	PΑ
1	Input bigg current		25°C		1		pА
IB	Input bias current		Full range			500	PΑ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			V
\/ - · ·	Marian as bish lavel autout valtage	D: 40 kg	25°C	4.7	4.8		V
VOH	Maximum high-level output voltage	$R_L = 10 \text{ k}\Omega$	Full range	4.7			V
V	Maximum lave lavel autout valtage	10 0	25°C		0	50	mV
VOL	Maximum low-level output voltage	IO = 0	Full range			50	IIIV
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		
۸–	Large-signal differential voltage amplification	$R_L = 500 \text{ k}\Omega$	Full range	75			V/mV
AVD	Large-signal differential voltage amplification	$V_O = 1 V \text{ to } 4 V,$	25°C	25	55		V/IIIV
		$R_L = 10 \text{ k}\Omega$	Full range	10			
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICR</sub> min,	25°C	90	110		dB
CIVIKK	Common-mode rejection ratio	$V_O = 0$ , $R_S = 50 \Omega$	Full range	85			иь
kovo	Supply voltage rejection ratio (AVDD : /AVDD	Vpp = 4.6 V to 16 V	25°C	90	110		dB
ksvr	Supply voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	V <sub>DD</sub> = 4.6 V to 16 V	Full range	85			ub
laa	Supply current	V <sub>O</sub> = 2.5 V, No load	25°C		1	1.5	mA
IDD	очрріу синені	VO - 2.5 V, NO load	Full range			1.5	111/4

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

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

	PARAMETER	TEST CONDITIONS	t	TL	.C2201N	1	UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
SR	Slew rate at unity gain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.8	2.5		V/μs
SK	Siew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.1			ν/μ5
V	Equivalent input noise voltage	f = 10 Hz	25°C		18		nV/√ <del>Hz</del>
Vn	Equivalent input hoise voltage	f = 1 kHz	25°C		8		nv/∀HZ
V	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.5		μV
VN(PP)	reak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μν
In	Equivalent input noise current		25°C		0.6		fA/√Hz
	Gain-bandwidth product		25°C		1.8		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		45°		
	Gain-bandwidth product	C <sub>L</sub> = 100 pF	25°C		1.8		Н

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



<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  $T_A = 150^{\circ}C$  extrapolated to  $T_A = 25^{\circ}C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	DADAMETED	TEST CONDITIONS	- +	TL	.C2201A	M	TL	.C2210B	М	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V	Input offset voltage		25°C		80	200		80	200	μV
VIO	input onset voltage		Full range			400			400	μν
αΛΙΟ	Temperature coefficient of input offset voltage		Full range		0.5			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		0.001	0.005	μV/mo
lio.	Input offset current		25°C		0.5			0.5		pА
IIO	input onset current		Full range			500			500	PΑ
lin	Input bias current		25°C		1			1		pА
<sup>I</sup> IB	input bias current		Full range			500			500	PΑ
V <sub>ICR</sub>	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			0 to 2.7			V
V	Maximum high-level output	$R_{I} = 10 \text{ k}\Omega$	25°C	4.7	4.8		4.7	4.8		V
VOH	voltage	K[ = 10 K22	Full range	4.7			4.7			V
VOL	Maximum low-level output	I <sub>O</sub> = 0	25°C		0	50		0	50	V
VOL	voltage	10 = 0	Full range			50			50	V
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		150	315		
AVD	Large-signal differential	$R_L = 500 \text{ k}\Omega$	Full range	75			75			V/mV
<b>~</b> VD	voltage amplification	$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	25	55		25	55		V/IIIV
		$R_L = 10 \text{ k}\Omega$	Full range	10			10			
CMRR	Common-mode rejection	$V_{IC} = V_{ICR}min,$	25°C	90	110		90	110		dB
CIVILLIA	ratio	$V_0 = 0$ , $R_S = 50 \Omega$	Full range	85			85			ub
kevp	Supply voltage rejection	V <sub>DD</sub> = 4.6 V to 16 V	25°C	90	110		90	110		dB
ksvr	ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	VDD = 4.0 V to 10 V	Full range	85			85			ub
lDD	Supply current	V <sub>O</sub> = 2.5 V, No load	25°C		1.1	1.5		1.1	1.5	mA
טטי	очрріў сипепі	VO = 2.5 V, NO 10au	Full range			1.5			1.5	ША

<sup>†</sup> 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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	PARAMETER	TEST CONDITIONS	<b>-</b> .+	TL	C2201A	М	TL	C2201B	M	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Claw rate of unity gain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.8	2.5		1.8	2.5		V/µs
SK .	Slew rate at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	Full range	1.1			1.1			ν/μδ
	Equivalent input noise voltage	f = 10 Hz	25°C		18	35		18	30	->4/ <del>  -</del>
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15		8	12	nV/√Hz
V	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		\/
V <sub>N(PP)</sub>	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μV
In	Equivalent input noise current		25°C		0.6			0.6		fA/√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
фm	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 –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 or nontesting of other parameters.



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

	DADAMETED	TEOT 0	CNETTONS	- +	TI	C2202	M	UNIT
	PARAMETER	IESI C	ONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
V/10	Input offset voltage			25°C		100	1000	μV
VIO	Input offset voltage	\/\o0	$R_S = 50 \Omega$	Full range			1250	μν
ανιο	Temperature coefficient of input offset voltage	$V_{IC} = 0,$	KS = 30.22	Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.001	0.005*	μV/mo
IIO	Input offset current			Full range			500	
lin	Input bias current	$V_{IC} = 0$ ,	$R_S = 50 \Omega$	25°C		1		pА
lΒ	input bias current			Full range			500	
					-5			
VICR	Common-mode input voltage range	$R_S = 50 \Omega$		Full range	to 2.7			V
				25°C	4.7	4.8		
V <sub>OM+</sub>	Maximum positive peak output voltage swing			Full range	4.7	4.0		V
		$R_L = 10 \text{ k}\Omega$		25°C	-4.7	-4.9		V
VOM-	Maximum negative peak output voltage swing			Full range	-4.7	-4.9		V
			.,	25°C	300	560		V
		$V_O = 1 \text{ V to } 4$ $R_L = 500 \text{ k}\Omega$	V,	Full range	100	300		
AVD	Large-signal differential voltage amplification		.,	25°C	50	100		V/mV
		$V_O = 1 \text{ V to 4}$ $R_L = 10 \text{ k}\Omega$	V,		25	100		
		<del>-</del> -		Full range 25°C	80	115		
CMRR	Common-mode rejection ratio	$V_O = 0$ , $R_S = 50 \Omega$	$V_{IC} = V_{ICR}$ min,			115		dB
		NS = 50 22		Full range	80	440		
ksvr	Supply-voltage rejection ratio $(\Delta V_{DD\pm}/\Delta V_{IO})$	V <sub>DD</sub> = ±2.3 V	to ±8 V	25°C	80	110		dB
				Full range	80			
IDD	Supply current	$V_{O} = 0$ ,	No load	25°C		1.8	2.7	mA
				Full range			2.7	

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

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

	DADAMETED	TEST CON	IDITIONS	т.†	TL	.C2202N	1	UNIT
	PARAMETER	TEST CON	IDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_0 = \pm 2.3 \text{ V},$	$R_L = 10 \text{ k}\Omega$ ,	25°C	1.8	2.7		V/μs
OIX.	Siew rate at unity gain	C <sub>L</sub> = 100 pF		Full range	1.1			ν/μ3
\/	Equivalent input noise voltage	f = 10 Hz		25°C		18		nV/√ <del>Hz</del>
Vn	Equivalent input hoise voltage	f = 1 kHz		25°C		8		IIV/∀⊓Z
\/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		25°C		0.5		μV
VN(PP)	reak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz		25°C		0.7		μν
In	Equivalent input noise current			25°C		0.6		fA/√Hz
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	$R_L = 10 \text{ k}\Omega$ ,	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF	25°C		48°		

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



<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using Arrhenius equation and assuming an activation energy of 0.96 eV.

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

PARAMETER		TEST SOMBITIONS	- +	TLC2202AM			TLC2202BM			
		TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage	$V_{IC} = 0$ , $R_{S} = 50 \Omega$	25°C		80	500		80	500	μV
			Full range			750			750	
ανιο	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
l.o	Input offset current	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C		0.5			0.5		рА
lio			Full range			500			500	
I <sub>IB</sub>	Input bias current		25°C		1			1		рА
I JIB			Full range			500			500	
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	-5 to 2.7			-5 to 2.7			٧
\/	Maximum positive peak output voltage swing	R <sub>L</sub> = 10 kΩ	25°C	4.7	4.8		4.7	4.8		V
VOM+			Full range	4.7			4.7			
V <sub>OM</sub> -	Maximum negative peak		25°C	-4.7	-4.9		-4.7	-4.9		V
VOM-	output voltage swing		Full range	-4.7			-4.7			
AVD	Large-signal differential voltage amplification	$V_O = \pm 4 V$ , $R_L = 500 \text{ k}\Omega$	25°C	300	560		300	560		V/mV
			Full range	100			100			
		$V_O = \pm 4 \text{ V},$ $R_L = 10 \text{ k}\Omega$	25°C	50	100		50	100		
			Full range	25			25			
CMRR	Common-mode rejection ratio	$V_O = 0$ , $V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$	25°C	80	115		80	115		dB
			Full range	80			80			
ksvr	Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD\pm} = \pm 2.3 \text{ V to } \pm 8 \text{ V}$	25°C	80	110		80	110		dB
			Full range	80			80			
IDD	Supply current	V <sub>O</sub> = 0, No load	25°C		1.8	2.7		1.8	2.7	mA
			Full range			2.7			2.7	

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

<sup>†</sup> Full range is  $-55^{\circ}$ C to  $125^{\circ}$ C.

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

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

PARAMETER		TEST CONDITIONS	T <sub>A</sub> †	TLC2202AM			TLC2202BM			
				MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_O = \pm 2.3 \text{ V},$ $R_L = 10 \text{ k}\Omega,$ $C_L = 100 \text{ pF}$	25°C	1.8	2.7		1.8	2.7		V/μs
			Full range	1.1			1.1			
.,	Equivalent input noise voltage (see Note 5)	f = 10 Hz	25°C		18	35*		18	30*	nV/√ <del>Hz</del>
Vn		f = 1 kHz	25°C		8	15*		8	12*	
V	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.5			0.5		μV
VN(PP)		f = 0.1 to 10 Hz	25°C		0.7			0.7		
In	Equivalent input noise current		25°C		0.6			0.6		fA/√ <del>Hz</del>
	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
фm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	25°C		48°			48°		

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

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



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

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

	DARAMETER	TEGT COMPITIONS	- t	Т	LC2202	М	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNIT
V/10	Input offeet voltage		25°C		100	1000	\/
VIO	Input offset voltage	V <sub>1</sub> 0 Do 50 0	Full range			1250	μV
αVIO	Temperature coefficient of input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	Full range		0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	]	25°C		0.001	0.005*	μV/mo
lю	Input offset current		Full range			500	
l.=	Input bias current	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C		1		pА
IB	input bias current		Full range			500	
				0			
VICR	Common-mode input voltage range	$R_S = 50 \Omega$	Full range	to			V
				2.7			
VOH	Maximum high-level output voltage	$R_{I} = 10 \text{ k}\Omega$	25°C	4.7	4.8		V
тОн	waximam nigh lovel output voltage	TC = 10 Kd2	Full range	4.7			Ů
VOL	Maximum low-level output voltage	IO = 0	25°C		0	50	mV
VOL	waximum low level output voltage	10 = 0	Full range			50	111 V
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		
Δ	l anno cianol differential voltage annulfication	$R_L = 500 \text{ k}\Omega$	Full range	75			\//\/
AVD	Large-signal differential voltage amplification	V <sub>O</sub> = 1 V to 4 V,	25°C	25	55		V/mV
		R <sub>L</sub> = 10 kΩ	Full range	10			
OMBB	Occurred made misself as well-	V V D 50.0	25°C	75	110		JD
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min, R_S = 50 \Omega$	Full range	75			dB
l	Complementaries relies and the CANA	V= - 46 V to 46 V	25°C	80	110		40
ksvr	Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD} = 4.6 \text{ V to } 16 \text{ V}$	Full range	80			dB
1	Circular company	V- 05V Notes	25°C		1.7	2.6	A
IDD	Supply current	$V_O = 2.5 \text{ V}$ , No load	Full range			2.6	mA

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

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

	DADAMETED	TEST CONDITIONS	T. †	TLC2202M			UNIT
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	UNII
SR	Slow rate at unity gain	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.6	2.5		V/μs
J N	SR Slew rate at unity gain $R_L = 10 \text{ k}\Omega$ , $C_L = 100$		Full range	0.9			ν/μδ
V	Equivalent input noise voltage	f = 10 Hz	25°C		18		->1///II=
V <sub>n</sub>	Equivalent input noise voltage	f = 1 kHz	25°C		8		nV/√Hz
\/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Dock to peak aguivalent input paige veltage	f = 0.1 to 1 Hz	25°C		0.5		\/
VN(PP)	Peak-to-peak equivalent input noise voltage	f = 0.1 to 10 Hz	25°C		0.7		μV
In	Equivalent input noise current		25°C		0.6		fA/√Hz
	Gain-bandwidth product	$ f = 10 \text{ kHz}, \qquad \qquad R_L = 10 \text{ k}\Omega, $ $C_L = 100 \text{ pF} $	25°C		1.9		MHz
φm	Phase margin at unity gain	$R_L = 10 \text{ k}Ω$ , $C_L = 100 \text{ pF}$	25°C		47°		

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



<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  $T_A = 150^{\circ}C$  extrapolated to  $T_A = 25^{\circ}C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

	DADAMETED	TEST CONDITIONS	- +	TL	C2202/	MA	TL	.C2202E	зм	
	PARAMETER	TEST CONDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V10	Input offset voltage		25°C		80	500		80	500	μV
VIO	input onset voltage		Full range			750			750	μν
αVIO	Temperature coefficient of input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	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
li o	Input offset current		25°C		0.5			0.5		pА
ΙΟ	input onset current	$V_{IC} = 0$ , $R_S = 50 \Omega$	Full range			500			500	PA
lup.	Input bias current	V <sub>1</sub> C = 0, 1CS = 30 22	25°C		1			1		pА
lВ	input bias current		Full range			500			500	PΛ
VICR	Common-mode input voltage range	R <sub>S</sub> = 50 Ω	Full range	0 to 2.7			0 to 2.7			<b>&gt;</b>
V	Maximum high-level output	D. 4010	25°C	4.7	4.8		4.7	4.8		V
VOH	voltage	R <sub>L</sub> = 10 kΩ	Full range	4.7			4.7			V
Voi	Maximum low-level output	I <sub>O</sub> = 0	25°C		0	50		0	50	mV
VOL	voltage	10 = 0	Full range			50			50	IIIV
		$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	150	315		150	315		
Δ. σ	Large-signal differential	$R_L = 500 \text{ k}\Omega$	Full range	75			75			V/mV
AVD	voltage amplification	$V_0 = 1 \ V \text{ to } 4 \ V,$	25°C	25	55		25	55		V/111V
		$R_L = 10 \text{ k}\Omega$	Full range	10			10			
CMRR	Common-mode rejection	$V_O = 0$ , $V_{IC} = V_{ICR}min$ ,	25°C	75	110		75	110		dB
CIVIKK	ratio	$R_S = 50 \Omega$	Full range	75			75			uБ
keyp	Supply-voltage rejection	V <sub>DD</sub> = 4.6 V to 16 V	25°C	80	110		80	110		dB
ksvr	ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	VDD = 4.0 V to 10 V	Full range	80			80			ub
IDD	Supply current	V <sub>O</sub> = 2.5 V, No load	25°C		1.7	2.6		1.7	2.6	mA
טט.		VO = 2.0 V, No load	Full range			2.6			2.6	IIIA

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.

<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  $T_A = 150$ °C extrapolated to  $T_A = 25$ °C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

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

PARAMETER		TEST CONDITIONS	- +	TL	C2202A	M	TL	C2202B	М	
				MIN	TYP	MAX	MIN	TYP	MAX	UNIT
CD.	Claurete et unitu goin	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	25°C	1.6	2.5		1.6	2.5		1//
SR	Slew rate at unity gain	$R_L$ = 10 kΩ, $C_L$ = 100 pF	Full range	0.9			1.1			V/μs
V	Equivalent input noise voltage	f = 10 Hz	25°C		18	35*		18	30*	->4//
V <sub>n</sub>	(see Note 5)	f = 1 kHz	25°C		8	15*		8	12*	nV/√Hz
\\=\	Peak-to-peak equivalent input	f = 0.1 to 1 Hz	25°C		0.5			0.5		\/
VN(PP)	noise voltage	f = 0.1 to 10 Hz	25°C		0.7			0.7		μV
In	Equivalent input noise current		25°C		0.6			0.6		fA/√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
φm	Phase margin at unity gain	$R_L$ = 10 kΩ, $C_L$ = 100 pF	25°C		47°			47°		

<sup>\*</sup>On products compliant to MIL-PRF-38535, Class B, this parameter is not production tested.



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

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

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

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# TLC2201Y electrical characteristics at $V_{DD\pm}$ = $\pm 5$ V, $T_A$ = 25°C (unless otherwise noted)

	PARAMETER		OITIONS	Τι	_C2201Y	′	UNIT	
	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNII	
VIO	Input offset voltage				100		μV	
	Input offset voltage long-term drift (see Note 4)	\/.o = 0	= 0, $R_S = 50 \Omega$		0.001		μV/mo	
IIO	Input offset current	$\int_{0}^{\infty} dC = 0,$	$\int V  C = 0,$	$R_S = 50 \Omega$	0.5			pА
I <sub>IB</sub>	Input bias current				1		рА	
Vон	Maximum high-level output voltage	$R_L = 10 \text{ k}\Omega$			4.8		V	
VOL	Maximum low-level output voltage	IO = 0			0		mV	
Δ. σ	Large-signal differential voltage amplification	$V_0 = 1 V \text{ to } 4 V,$	$R_L = 500 \Omega$		55		V/mV	
AVD	Large-signal differential voltage amplification	$V_0 = 1 V \text{ to } 4 V,$	$R_L = 10 \Omega$		55		V/IIIV	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min,$ $R_S = 50 \Omega$	V <sub>O</sub> = 0,		110		dB	
ksvr	Supply voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD} = 4.6 \text{ to } 16$	V		110		dB	
$I_{DD}$	Supply current per amplifier	$V_0 = 2.5 V$ ,	No load		1		mA	

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

# TLC2201Y operating characteristics at V<sub>DD $\pm$ </sub> = $\pm$ 5 V, T<sub>A</sub> = 25°C

	PARAMETER	TEST	CONDITIONS		TLC2201Y		′	UNIT	
FANAMETER		1531	TEST CONDITIONS			TYP	MAX	UNIT	
SR	Positive slew rate at unity gain	$V_0 = \pm 0.5 \text{ to } 2.5 \text{ V},$	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF		2.5		V/μs	
V	Equivalent input poice veltage	f = 10 Hz 18		18		nV/√ <del>Hz</del>			
Vn	Equivalent input noise voltage	f = 1 kHz			8			NV/VHZ	
V	Peak-to-peak equivalent input noise	f = 0.1 to 1 Hz				0.5		μV	
VN(PP)	voltage	f = 0.1 to 10 Hz				0.7		μν	
In	Equivalent input noise current					0.6		pA/√ <del>Hz</del>	
	Gain-bandwidth product	f = 10 kHz,	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF		1.8		MHz	
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF			48°			

# TLC2202Y electrical characteristics, $V_{DD}$ = 5 V, $T_A$ = 25°C (unless otherwise noted)

	PARAMETER	TEST CONF	SITIONS	TLC2202Y			UNIT		
	PARAIVIETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT		
VIO	Input offset voltage				100		μV		
	Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0$ , $R_S = 50 \Omega$	V <sub>IC</sub> = 0,	V <sub>1</sub> = 0	Po = 50 O		0.001		μV/mo
IIO	Input offset current			KS = 50 22	KS = 50 12		0.5		pА
I <sub>IB</sub>	Input bias current				1		pА		
Vон	Maximum high-level output voltage	$R_L = 10 \text{ k}\Omega$			4.8		V		
VOL	Maximum low-level output voltage	I <sub>O</sub> = 0			0		mV		
Λ. σ	Large-signal differential voltage amplification	$V_0 = 1 V \text{ to } 4 V,$	R <sub>L</sub> = 500 Ω		315		V/mV		
AVD	Large-signal differential voltage amplification	$V_0 = 1 V \text{ to } 4 V,$	R <sub>L</sub> = 10 Ω		55		V/IIIV		
CMRR	Common-mode rejection ratio	$V_O = 0$ , $V_{ICR}$ min,	$R_S = 50 \Omega$		110		dB		
ksvr	Supply-voltage rejection ratio (ΔVDCC/ΔVIO)	V <sub>DD</sub> = 4.6 to 16 V			110		dB		
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 2.5 V,	No load		1.7		mA		

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

# TLC2202Y operating characteristics at $V_{DD}$ = 5 V, $T_A$ = 25°C

	PARAMETER	TEST CON	DITIONS	TLC2202Y			UNIT	
	FARAMETER	TEST CON	TEST CONDITIONS		TYP	MAX	UNIT	
SR	Positive slew rate at unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$ $C_L = 100 \text{ pF}$	$R_L = 10 \text{ k}\Omega$ ,		2.5		V/μs	
\ <u></u>	Fautivalent input paige valtage	f = 10 Hz		18			->4/1	
V <sub>n</sub> Equivalent input noise voltage		f = 10 kHz	8			nV/√Hz		
V	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz			0.5		μV	
V <sub>N(PP)</sub>	геак-то-реак equivalent input noise voitage	f = 0.1 to 10 Hz			0.7		μν	
In	Equivalent input noise current				0.6		pA/√Hz	
B <sub>1</sub>	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	$R_L = 10 \text{ k}\Omega$ ,		1.9		MHz	
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega$ ,	C <sub>L</sub> = 100 pF		47°			



#### PARAMETER MEASUREMENT INFORMATION

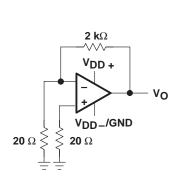
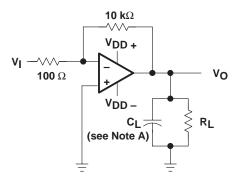
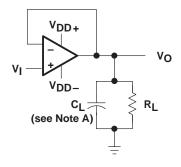


Figure 1. Noise-Voltage Test Circuit



NOTE A: C<sub>L</sub> includes fixture capacitance.

Figure 2. Phase-Margin Test Circuit



NOTE A: C<sub>1</sub> includes fixture capacitance.

Figure 3. Slew-Rate Test Circuit

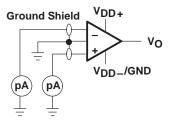


Figure 4. Input-Bias and Offset-Current Test Circuit

#### typical values

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

#### input bias and offset current

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

#### noise

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



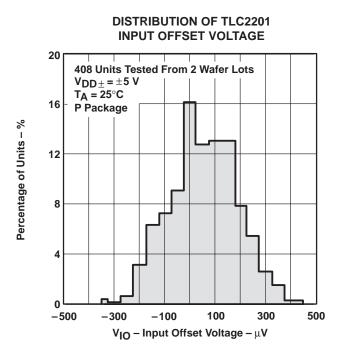
## **Table of Graphs**

			FIGURE
VIO	Input offset voltage	Distribution	5, 6
I <sub>IB</sub>	Input bias current	vs Common-mode input voltage vs Free-air temperature	7 8
V <sub>OM</sub>	Maximum peak output voltage	vs Output current vs Free-air temperature	9 10
VO(PP)	Maximum peak-to-peak output voltage	vs Frequency	11
Vон	High-level output voltage	vs Frequency vs High-level output current vs Free-air temperature	12 13 14
V <sub>OL</sub>	Low-level output voltage	vs Low-level output current vs Free-air temperature	15 16
AVD	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature	17 18
los	Short-circuit output current	vs Supply voltage vs Free-air temperature	19 20
CMRR	Common-mode rejection ratio	vs Frequency	21
I <sub>DD</sub>	Supply current	vs Supply voltage vs Free-air temperature	22 23, 24
	Pulse response	Small signal Large signal	25, 26 27, 28
SR	Slew rate	vs Supply voltage vs Free-air temperature	29 30
	Noise voltage (referred to input)	0.1 to 1 Hz 0.1 to 10 Hz	31 32
	Gain-bandwidth product	vs Supply voltage vs Free-air temperature	33, 34 35
фm	Phase margin	vs Supply voltage vs Free-air temperature	36, 37 38, 39
	Phase shift	vs Frequency	17

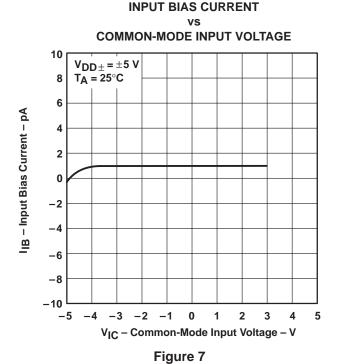


Percentage of Units – %

16







**TLC2202 DISTRIBUTION OF INPUT OFFSET VOLTAGE** 

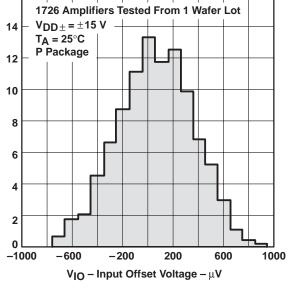


Figure 6

# **INPUT BIAS CURRENT<sup>†</sup>** FREE-AIR TEMPERATURE

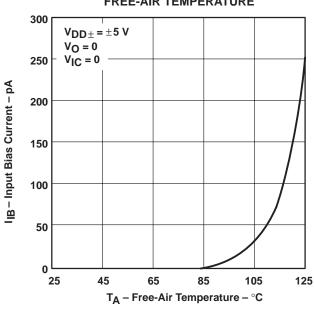
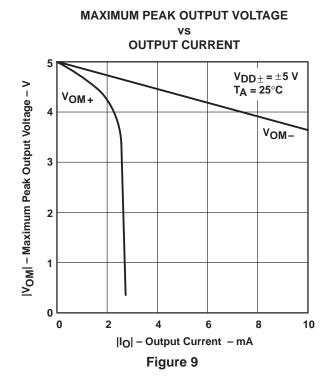


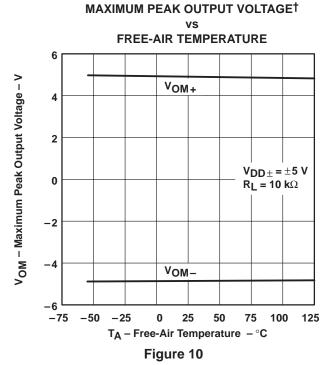
Figure 8

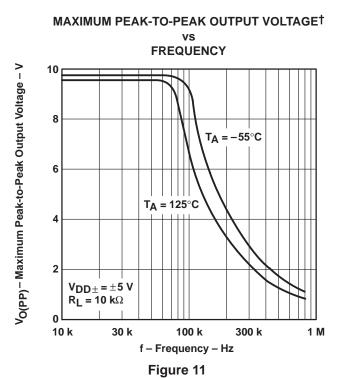
<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

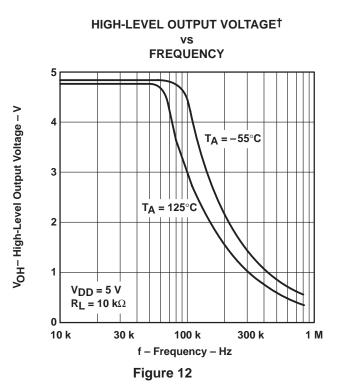


#### **TYPICAL CHARACTERISTICS**



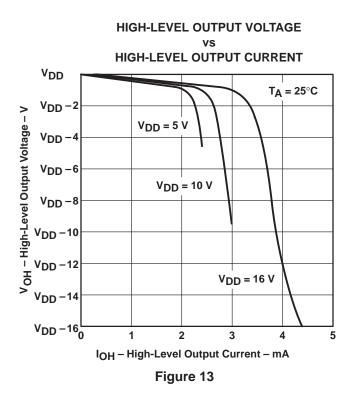


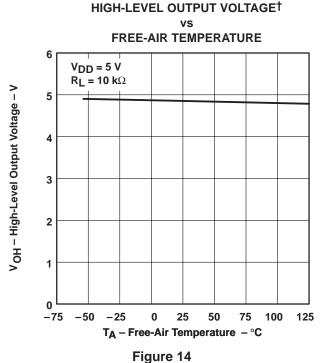


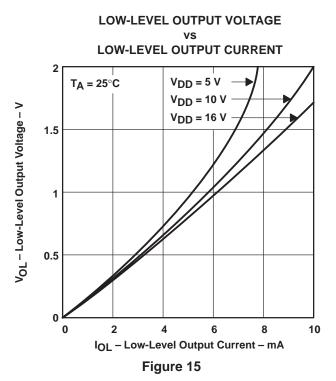


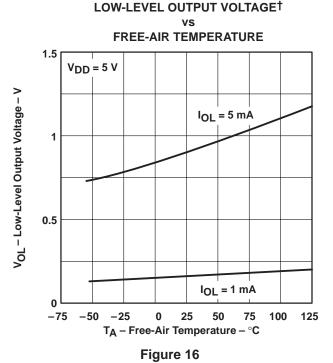
<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.











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



LARGE-SIGNAL DIFFERENTIAL VOLTAGE

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#### TYPICAL CHARACTERISTICS

#### LARGE-SIGNAL DIFFERENTIAL VOLTAGE **AMPLIFICATION AND PHASE SHIFT** vs **FREQUENCY** 120 $30^{\circ}$ $V_{DD\pm} = \pm 5 V$ $R_L = 10 \text{ k}\Omega$ 100 50° $C_{L}^{-} = 100 \text{ pF}$ A<sub>VD</sub>- Large-Signal Differential Voltage Amplification – dB Avd T<sub>A</sub> = 25°C 80 70° 60 90° Phase Shift **Phase Shift** 40 20 130° 150° 0 170° -20100 1 k 10 k 100 k 10 1 M f - Frequency - Hz

Figure 17

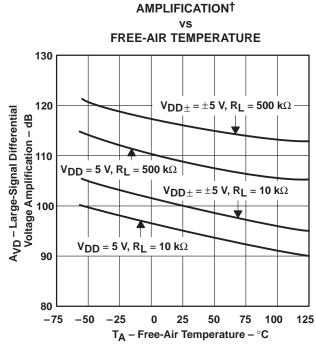
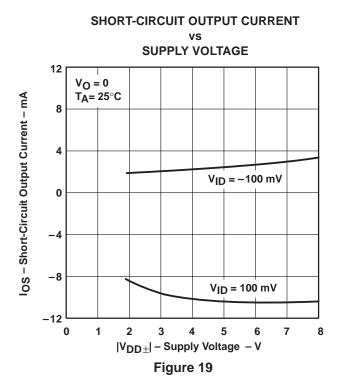
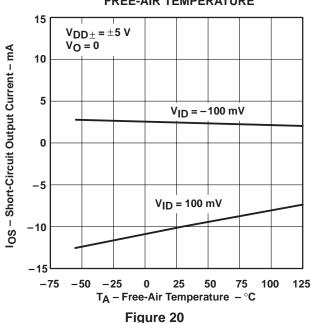


Figure 18

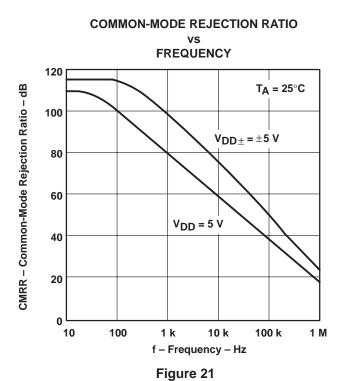


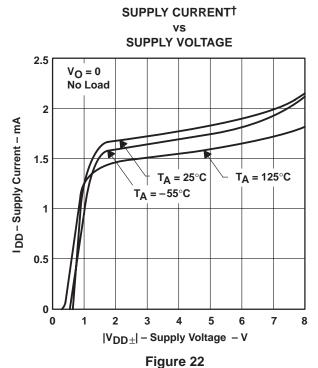
# SHORT-CIRCUIT OUTPUT CURRENT<sup>†</sup> vs FREE-AIR TEMPERATURE



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

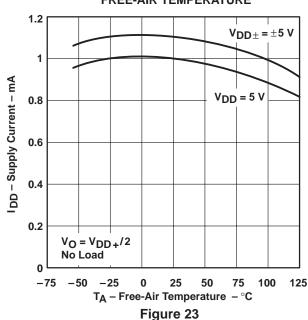




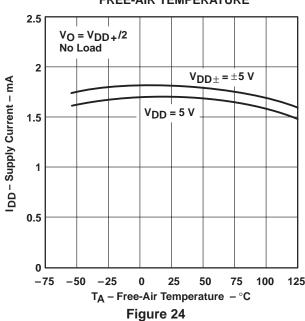


**TLC2201** SUPPLY CURRENT<sup>†</sup>





# **TLC2202** SUPPLY CURRENT<sup>†</sup> FREE-AIR TEMPERATURE



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



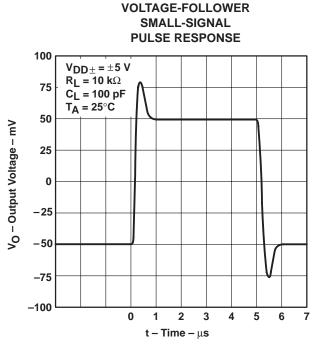
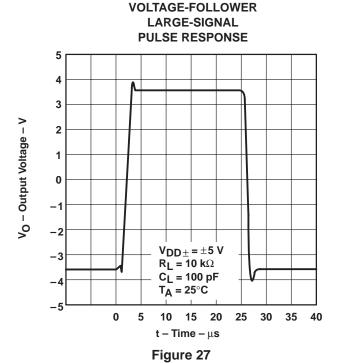


Figure 25



VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

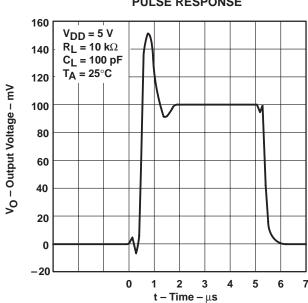


Figure 26

#### VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

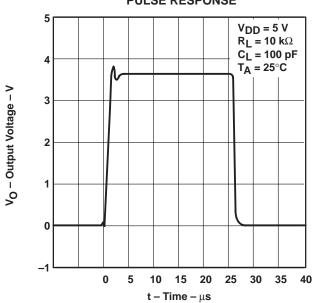
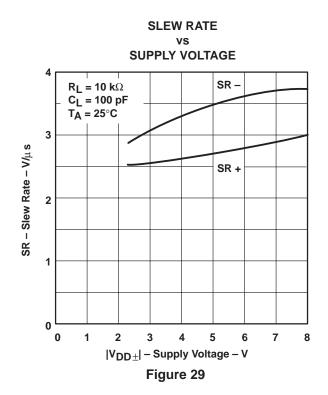


Figure 28



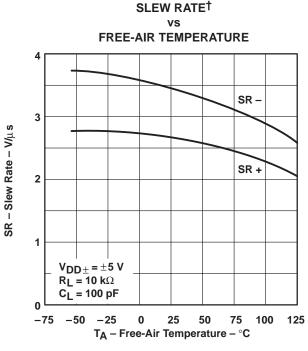
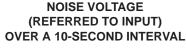
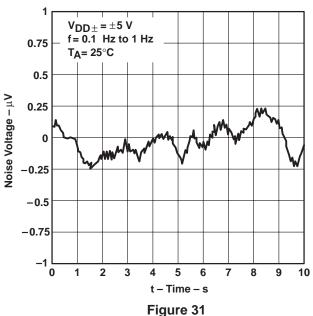
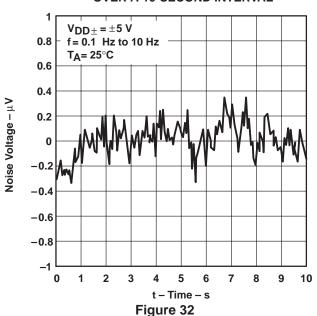


Figure 30





#### NOISE VOLTAGE (REFERRED TO INPUT) OVER A 10-SECOND INTERVAL



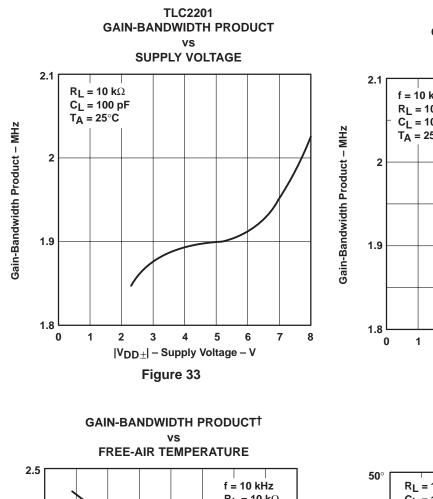
<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

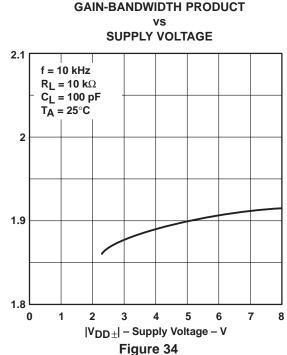


**TLC2202** 

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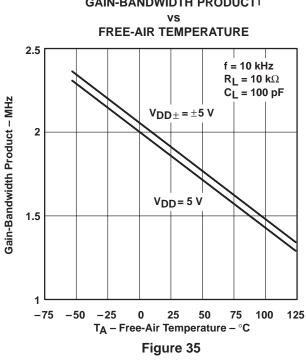
#### TYPICAL CHARACTERISTICS

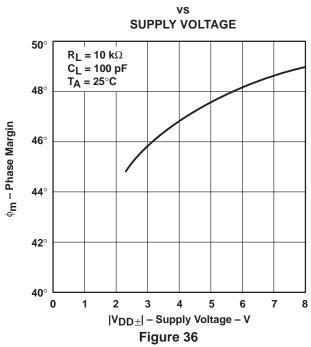




**TLC2201** 

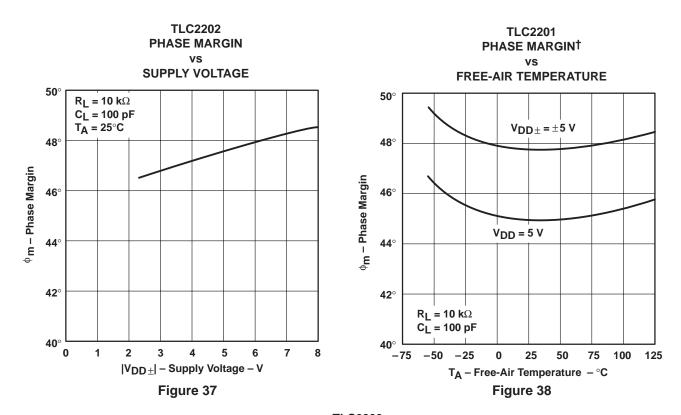
**PHASE MARGIN** 

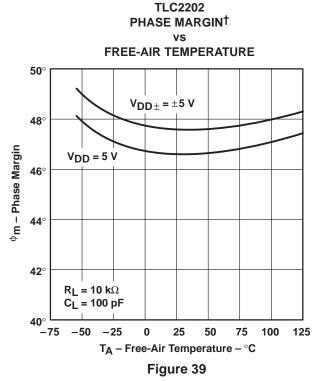




<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.







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



#### APPLICATION INFORMATION

#### latch-up avoidance

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

#### electrostatic discharge protection

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

#### macromodel information

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

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification

- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

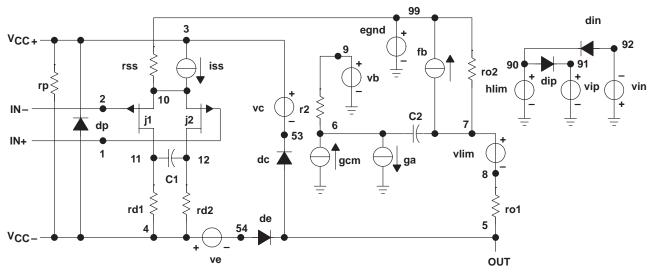
NOTE 5: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers", *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

PSpice and Parts are trademarks of MicroSim Corporation.



#### **APPLICATION INFORMATION**

## macromodel information (continued)



```
.subckt TLC220x 1 2 3 4 5
                                                                10 dc 135.0E-6
                                                            3
                                                       iss
                                                            2
                                                                0
                                                                   .5E-12
 c1
      1
         12 8.51E-12
                                                       i1
                                                            88
                                                                0
                                                                   1E-21
         7
 с2
      6
            50.00E-12
                                                        j1
                                                            11
                                                                89 10 jx
 cpsr 85 86 79.6E-9
                                                       j2
                                                            12
                                                                80 10 jx
         82 dx
 dcm+ 81
                                                                9
                                                                   100.0E3
                                                       r2
                                                            6
 dcm- 83
         81 dx
                                                       rcm
                                                            84
                                                                81
                                                                   1k
         53 dx
 dc
                                                       rn1
                                                            88
                                                                   1500
      54 5
            dx
                                                            8
 de
                                                       ro1
                                                                   188
 dlp 90
         91
            dx
                                                       ro2
                                                                99
                                                                   187
 dln 92
         90 dx
                                                            10
                                                                99 1.481E6
                                                       rss
 dр
      4
         3
            dx
                                                       vad
                                                            60
                                                                4 -.3v
 ecmr 84
         99
            (2,99) 1
                                                       vcm+
                                                            82
                                                                99 2.2
            poly(2) (3,0) (4,0) 0 .5 .5
 egnd 99
         0
                                                       vcm- 83
                                                                99 -4.5
 epsr 85
         0
            poly(1) (3,4) -200E-6 20E-6
                                                       vb
                                                            9
                                                                0 dc 0
            poly(1) (88,0) 100E-6 1
 ense 89
                                                            3
                                                                53 dc .9
                                                       VC
            poly(6) vb vc ve vlp vln
     7
         99
 fb
                                                            54
                                                                4 dc .8
                                                       ve
  vpsr 0 +
              895.9E3 -90E3 90E3 90E3 -90E3 895E3
                                                       vlim 7
                                                                8 dc 0
     6
         0
            11 12 314.2E-6
                                                       vlp 91 0
                                                                   dc 2.8
 qa
                                                       vln 0
                                                                92 dc 2.8
 gcm
      0
         6
            10 99 1.295E-9
                                                       vpsr 0
 gpsr 85 86 (85,86) 100E-6
                                                               86 dc 0
 grd1 60 11 (60,11) 3.141E-4
                                                      .model dx d(is=800.0E-18)
 grd2 60 12 (60,12) 3.141E-4
                                                      .model jx pjf(is=500.0E-15 beta=1.462E-3
 hlim 90 0 vlim 1k
                                                      + vto=-.155 kf=1E-17)
 hcmr 80 1
            poly(2) vcm+ vcm- 0 1E2 1E2
 irp 3
         4
            965E-6
```

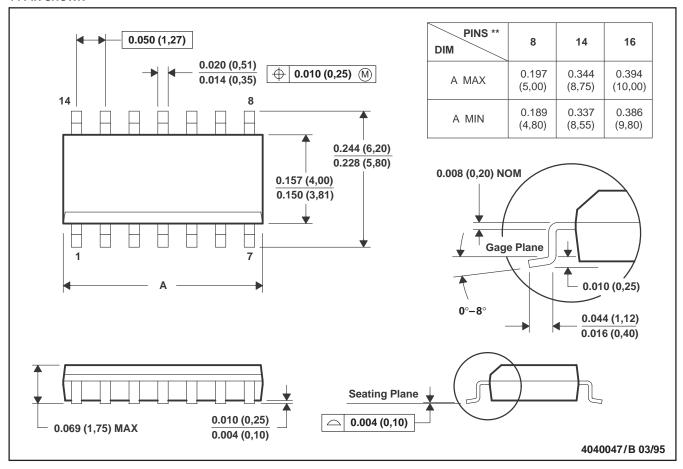
Figure 40. Boyle Macromodel and Subcircuit

#### **MECHANICAL INFORMATION**

#### D (R-PDSO-G\*\*)

#### PLASTIC SMALL-OUTLINE PACKAGE

#### 14 PIN SHOWN



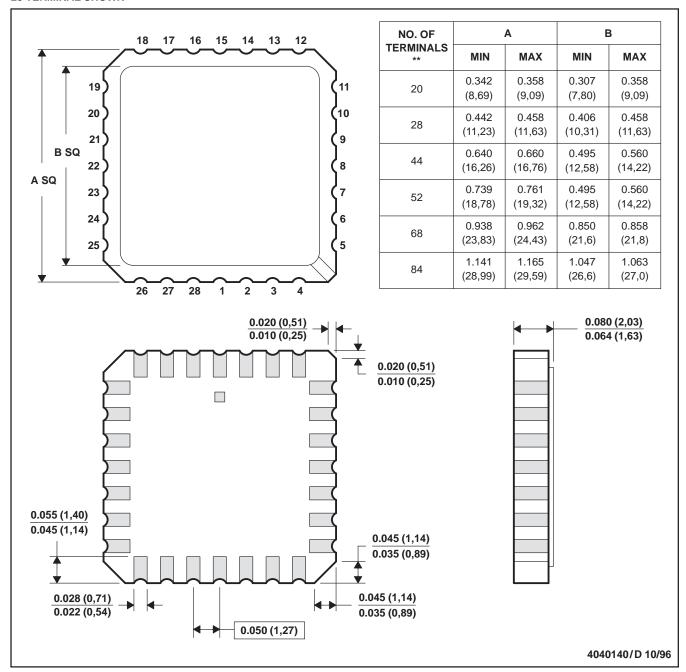
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
- D. Four center pins are connected to die mount pad.
- E. Falls within JEDEC MS-012

#### **MECHANICAL INFORMATION**

#### FK (S-CQCC-N\*\*)

#### LEADLESS CERAMIC CHIP CARRIER

#### 28 TERMINAL SHOWN



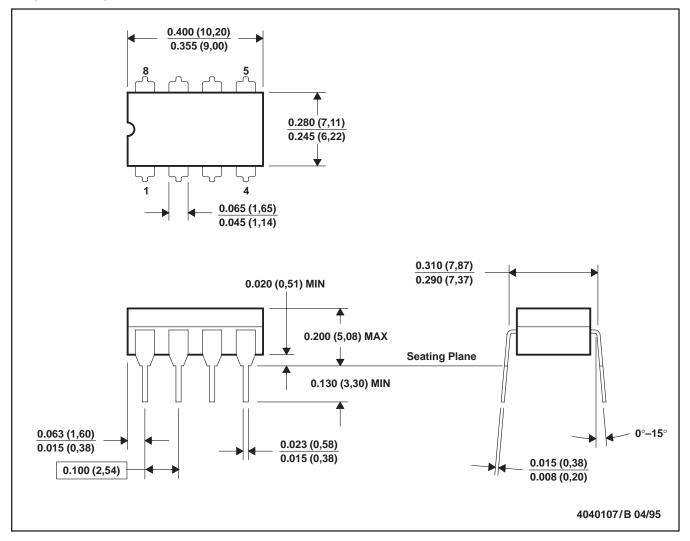
- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a metal lid.
- D. The terminals are gold plated.
- E. Falls within JEDEC MS-004



#### **MECHANICAL INFORMATION**

#### JG (R-GDIP-T8)

#### **CERAMIC DUAL-IN-LINE PACKAGE**

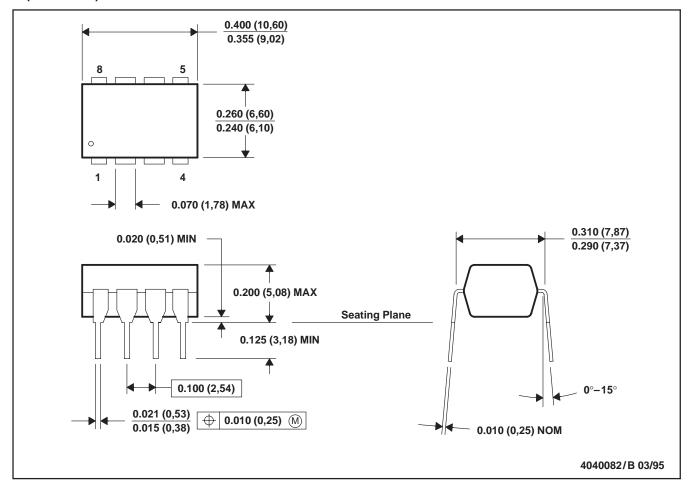


- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a ceramic lid using glass frit.
- D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only
- E. Falls within MIL-STD-1835 GDIP1-T8

#### **MECHANICAL INFORMATION**

#### P (R-PDIP-T8)

#### PLASTIC DUAL-IN-LINE PACKAGE



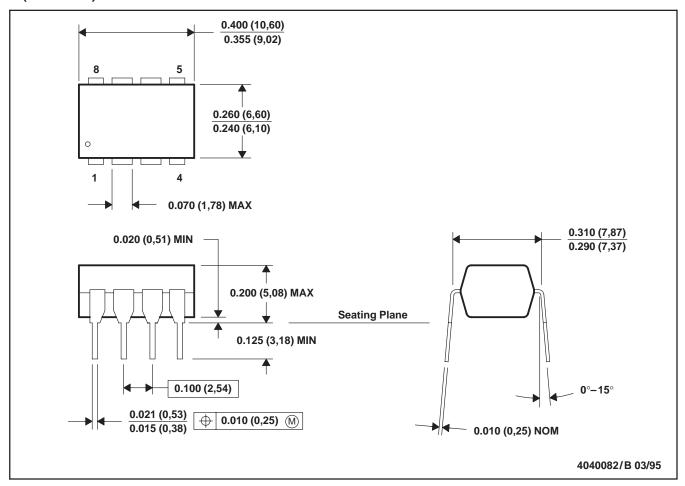
NOTES: A. All linear dimensions are in inches (millimeters).

B. This drawing is subject to change without notice.

C. Falls within JEDEC MS-001

#### P (R-PDIP-T8)

## PLASTIC DUAL-IN-LINE PACKAGE



- B. This drawing is subject to change without notice.
- C. Falls within JEDEC MS-001