- **Output Swing Includes Both Supply Rails**
- Low Noise . . . 9 nV/ $\sqrt{\text{Hz}}$  Typ at f = 1 kHz
- Low Input Bias Current . . . 1 pA Typ
- Fully Specified for Both Single-Supply and **Split-Supply Operation**
- **Common-Mode Input Voltage Range Includes Negative Rail**
- High-Gain Bandwidth . . . 2.2 MHz Typ
- High Slew Rate . . . 3.6 V/µs Typ

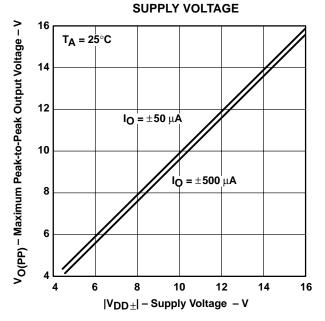
#### description

The TLC2272 and TLC2274 are dual and quadruple operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLC227x family offers 2 MHz of bandwidth and 3 V/µs of slew rate for higher speed applications. These devices offer comparable ac performance while having better noise, input offset voltage, and dissipation than existing operational amplifiers. The TLC227x has a noise voltage of 9 nV/ $\sqrt{Hz}$ , two times lower than competitive solutions.

The TLC227x, exhibiting high input impedance and low noise, is excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature, with single- or split-supplies, makes this

- **Low Input Offset Voltage** 950  $\mu$ V Max at T<sub>A</sub> = 25°C
- **Macromodel Included**
- Performance Upgrades for the TS272, TS274, TLC272, and TLC274
- **Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards**

## **MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE**



family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLC227xA family is available with a maximum input offset voltage of 950 μV. This family is fully characterized at 5 V and  $\pm$ 5 V.

The TLC2272/4 also makes great upgrades to the TLC272/4 or TS272/4 in standard designs. They offer increased output dynamic range, lower noise voltage, and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage range, see the TLV2432 and TLV2442 devices.

If the design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.



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



#### **TLC2272 AVAILABLE OPTIONS**

			PACKAGED DEVICE	s
TA	V <sub>IO</sub> max At 25°C	SMALL OUTLINE† (D)	PLASTIC DIP (P)	TSSOP <sup>‡</sup> (PW)
0°C to 70°C	950 μV 2.5 mV	TLC2272ACD TLC2272CD	TLC2272ACP TLC2272CP	TLC2272ACPW TLC2272CPW
-40°C to 125°C	950 μV 2.5 mV	TLC2272AID TLC2272ID	TLC2272AIP TLC2272IP	— TLC2272IPW
-40 C to 123 C	950 μV 2.5 mV	TLC2272AQD TLC2272QD	_	TLC2272AQPW TLC2272QPW
-55°C to 125°C	950 μV 2.5 mV	TLC2272AMD TLC2272MD	TLC2272AMP TLC2272MP	_

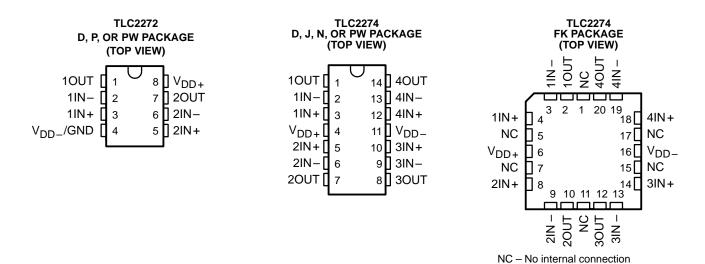
<sup>†</sup>The D packages are available taped and reeled. Add R suffix to the device type (e.g., TLC2272CDR).

#### **TLC2274 AVAILABLE OPTIONS**

			PA	CKAGED DEVICES	3	
TA	V <sub>IO</sub> max AT 25°C	SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP‡ (PW)
0°C to 70°C	950 μV 2.5 mV	TLC2274ACD TLC2274CD	_	_	TLC2274ACN TLC2274CN	TLC2274ACPW TLC2274CPW
40°C to 405°C	950 μV 2.5 mV	TLC2274AID TLC2274ID	_	_	TLC2274AIN TLC2274IN	TLC2274AIPW TLC2274IPW
-40°C to 125°C 950 μV TLC2274AQD 2.5 mV TLC2274QD		_	_	_	_	
-55°C to 125°C 950 μV TLC2274AMD TLC2274AMFK TLC2274MFK		TLC2274AMJ TLC2274MJ	TLC2274AMN TLC2274MN	_		

<sup>&</sup>lt;sup>†</sup> The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2274CDR).

<sup>§</sup> Chips are tested at 25°C.



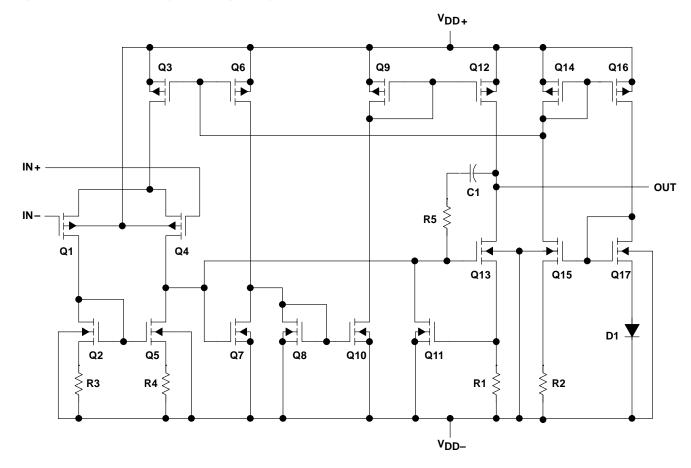


<sup>&</sup>lt;sup>‡</sup> The PW package is available taped and reeled. Add R suffix to the device type (e.g., TLC2272PWR).

<sup>§</sup> Chips are tested at 25°C.

<sup>‡</sup>The PW package is available taped and reeled.

#### equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT											
COMPONENT TLC2272 TLC2274											
Transistors 38 76											
Resistors	26	52									
Diodes	9	18									
Capacitors 3 6											

<sup>†</sup> Includes both amplifiers and all ESD, bias, and trim circuitry

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

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

Supply voltage, V <sub>DD+</sub> (see Note 1)		8 V
Supply voltage, V <sub>DD</sub> (see Note 1)		8 V
Differential input voltage, V <sub>ID</sub> (see Note 2)		±16 V
Input voltage range, VI (any input, see Not	te 1)	$\dots$ V <sub>DD</sub> $$ – 0.3 V to V <sub>DD+</sub>
Input current, I <sub>I</sub> (any input)		
Output current, IO		±50 mA
Total current into V <sub>DD+</sub>		
Total current out of V <sub>DD</sub>		±50 mA
Duration of short-circuit current at (or below	w) 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, Q suffix	40°C to 125°C
	M suffix	–55°C to 125°C
Storage temperature range		–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from		
Lead temperature 1,6 mm (1/16 inch) from	case for 60 seconds: J package .	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-. Excessive current will flow if input is brought below V<sub>DD-</sub> 0.3 V.
  - 3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

#### **DISSIPATION RATING TABLE**

PACKAGE	$T_{\mbox{A}} \le 25^{\circ}\mbox{C}$ 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	337 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
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW	230 mW
Р	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW
PW-8	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
PW-14	700 mW	5.6 mW/°C	448 mW	364 mW	_

#### recommended operating conditions

	С	SUFFIX	13	SUFFIX	Q	SUFFIX	М	UNIT	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	UNIT
Supply voltage, V <sub>DD±</sub>	±2.2	±8	±2.2	±8	±2.2	±8	±2.2	±8	V
Input voltage, V <sub>I</sub>	$V_{DD-}$	V <sub>DD+</sub> –1.5	$V_{DD-}$	V <sub>DD+</sub> -1.5	$V_{DD-}$	V <sub>DD+</sub> -1.5	$V_{DD-}$	V <sub>DD+</sub> -1.5	V
Common-mode input voltage, V <sub>IC</sub>	$V_{DD-}$	V <sub>DD+</sub> -1.5	V						
Operating free-air temperature, TA	0	70	-40	125	-40	125	-55	125	°C



# TLC2272C electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

	DADAMETED	TEST CON	IDITIONS	T. †	Т	LC22720	С	TL	.C2272A	C	
	PARAMETER	TEST CON	DITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
\/:o	Input offset voltage			25°C		300	2500		300	950	μV
VIO	Input offset voltage			Full range			3000			1500	μν
ανιο	Temperature coefficient of input offset voltage			25°C to 70°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0 \text{ V},$ $V_{DD} \pm = \pm 2.5 \text{ V},$ $V_{O} = 0 \text{ V},$ $R_{S} = 50 \Omega$		25°C		0.002			0.002		μV/mo
lio	Input offset current			25°C Full range		0.5	60 100		0.5	60 100	pА
		-		25°C	-	1	60		1	60	
lΒ	Input bias current					- '	100			100	pΑ
.,	Common-mode input	<b>D</b> 500	24 - 25 - 24	Full range 25°C	0 to 4	-0.3 to 4.2	100	0 to 4	-0.3 to 4.2	100	.,
VICR	voltage	$R_S = 50 \Omega$ ,	$ V_{IO}  \le 5 \text{ mV}$	Full range	0 to 3.5			0 to 3.5			V
		$I_{OH} = -20  \mu A$		25°C		4.99			4.99		
	High lovel output	I <sub>OH</sub> = -200 μA		25°C	4.85	4.93		4.85	4.93		
Vон	High-level output voltage	10Η = -200 μΑ		Full range	4.85			4.85			V
	renage	I <sub>OH</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		IOH = - I IIIA		Full range	4.25			4.25			
		$V_{IC} = 2.5 V,$	$I_{OL} = 50 \mu A$	25°C		0.01			0.01		
		V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 500 μA	25°C		0.09	0.15		0.09	0.15	
VOL	Low-level output voltage	V <sub>I</sub> C = 2.5 V,	ΙΟΓ = 200 μΑ	Full range			0.15			0.15	V
		V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 5 mA	25°C		0.9	1.5		0.9	1.5	
		VIC = 2.5 V,	IOC = 2 IIIA	Full range			1.5			1.5	
		V 05V	D. 40 lot	25°C	15	35		15	35		
AVD	Large-signal differential voltage amplification	$V_{IC} = 2.5 \text{ V},$ $V_{O} = 1 \text{ V to 4 V}$	$R_L = 10 \text{ k}\Omega^{\ddagger}$	Full range	15			15			V/mV
	voltage amplification	VO = 1 V 10 4 V	$R_L = 1 \text{ m}\Omega^{\ddagger}$	25°C		175			175		
<sup>r</sup> id	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
rį	Common-mode input resistance			25°C		1012			1012		Ω
Cį	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z <sub>O</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		140			140		Ω
CMRR	Common-mode	V <sub>IC</sub> = 0 V to 2.7 \		25°C	70	75		70	75		dB
	rejection ratio	$V_0 = 2.5 \text{ V},$	$R_S = 50 \Omega$	Full range	70			70			
ksvr	Supply-voltage rejection ratio	$V_{DD} = 4.4 \text{ V to 1}$ $V_{IC} = V_{DD}/2$ ,	6 V, No load	25°C	80	95		80	95		dB
	(ΔV <sub>DD</sub> /ΔV <sub>IO</sub> )	VIC - VDD/2,	140 1000	Full range	80			80			
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 2.5 V,	No load	25°C		2.2	3		2.2	3	mA
טט.		V 0 = 2.5 v,		Full range			3			3	

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

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



<sup>‡</sup>Referenced to 0 V

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

## TLC2272C operating characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$

	PARAMETER	TEST CONDITI	ONE	- +	7	TLC22720	;	TI	LC2272A	С	UNIT
ľ	PARAMETER	TEST CONDITI	ONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
	Slew rate at unity	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$	_	25°C	2.3	3.6		2.3	3.6		
SR	gain	$R_L = 10 \text{ k}\Omega^{\ddagger},  C_L = 10 \text{ k}\Omega^{\ddagger}$	= 100 pF∓	Full range	· 1 1.7			1.7			V/μs
V	Equivalent input	f = 10 Hz		25°C		50			50		nV/√Hz
V <sub>n</sub>	noise voltage	f = 1 kHz		25°C		9			9		IIV/VHZ
VAIDD	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
V <sub>NPP</sub>	noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>
		$V_{O} = 0.5 \text{ V to } 2.5 \text{ V},$	A <sub>V</sub> = 1			0.0013%			0.0013%		
THD + N	Total harmonic distortion plus noise	f = 20 kHz,	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	diotoratori pido fioloc	$R_L = 10 \text{ k}\Omega^{\ddagger}$	$A_{V} = 100$			0.03%			0.03%		
	Gain-bandwidth product	$f = 10 \text{ kHz}, R_L = 100 \text{ pF}^{\ddagger}$	= 10 kΩ <sup>‡</sup> ,	25°C		2.18			2.18		MHz
ВОМ	Maximum output-swing bandwidth	$V_{O(PP)} = 2 \text{ V}, \qquad A_{V} = R_{L} = 10 \text{ k}\Omega^{\ddagger}, \qquad C_{L} = 0$	= 1, = 100 pF‡	25°C		1			1		MHz
t-	Settling time	$A_V = -1$ , Step = 0.5 V to 2.5 V,	To 0.1%	25°C		1.5			1.5		μs
t <sub>S</sub>	Octaining time	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L = 100 \text{ pF}^{\ddagger}$	To 0.01%	25 0	2.6				2.6		μο
φm	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> :	= 100 pF‡	25°C		50°			50°		
	Gain margin	<u> </u>		25°C		10			10		dB

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



<sup>‡</sup>Referenced to 0 V

# TLC2272C electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V (unless otherwise specified)

	DADAMETED	TEST CO.	NDITIONS	- +	Т	LC22720	2	TL	C2272A	С	
	PARAMETER	l lesi co	NDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
\/\c	Input offeet voltage			25°C		300	2500		300	950	μV
VIO	Input offset voltage			Full range			3000			1500	μν
ανιο	Temperature coefficient of input offset voltage			25°C to 70°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0 V,$ RS = 50 $\Omega$	$V_O = 0 V$ ,	25°C		0.002			0.002		μV/mo
Ιο	Input offset current			25°C		0.5	60		0.5	60	pА
10	mpat onoot ourront			Full range			100			100	Ρ''.
IIB	Input bias current			25°C		1	60		1	60	pА
-ID				Full range			100			100	Pr.
Vion	Common-mode input	Po = 50 O	V <sub> O</sub>   ≤5 mV	25°C	-5 to 4	-5.3 to 4.2		–5 to 4	-5.3 to 4.2		V
VICR	voltage	NS = 30 sz,	IAIO   Z2 IIIA	Full range	-5 to 3.5			-5 to 3.5			V
		$I_{O} = -20 \mu A$		25°C		4.99			4.99		
	Mandania and Stransia at	Ja - 200 uA		25°C	4.85	4.93		4.85	4.93		V
VOM+	Maximum positive peak output voltage	$I_{O} = -200 \mu A$		Full range	4.85			4.85			
	output voltago	I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		IO = -1 IIIA		Full range	4.25			4.25			
		$V_{IC} = 0 V$ ,	$I_O = 50 \mu\text{A}$	25°C		-4.99			-4.99		
	Maximum negative peak	V <sub>IC</sub> = 0 V,	I <sub>O</sub> = 500 μA	25°C	-4.85	-4.91		-4.85	-4.91		
VOM-	output voltage	VIC = 0 V,	.0 = 000 ft. t	Full range	-4.85			-4.85			V
	, ,	V <sub>IC</sub> = 0 V,	$I_O = 5 \text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
		10 0 1,	•	Full range	-3.5			-3.5			
	Large-signal differential		R <sub>L</sub> = 10 kΩ	25°C	25	50		25	50		
AVD	voltage amplification	$V_O = \pm 4 V$	_	Full range	25			25			V/mV
			$R_L = 1 \text{ m}\Omega$	25°C		300			300		
<sup>r</sup> id	Differential input resistance			25°C		1012			1012		Ω
rį	Common-mode input resistance			25°C		1012			1012		Ω
cį	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z <sub>O</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		130			130		Ω
CMRR	Common-mode rejection	$V_{IC} = -5 V to$		25°C	75	80		75	80		dB
OWINK	ratio	$V_O = 0 V$ ,	$R_S = 50 \Omega$	Full range	75			75			ub
ksvr	Supply-voltage rejection	$V_{DD\pm} = 2.2$	/ to ±8 V,	25°C	80	95		80	95		dB
ovk	ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	$V_{IC} = 0 V$	No load	Full range	80			80			<u> </u>
IDD	Supply current	VO = 0 V	No load	25°C		2.4	3		2.4	3	mA
00	117 ** * **	<u> </u>		Full range			3			3	

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

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



SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

## TLC2272C operating characteristics at specified free-air temperature, $\rm V_{DD\pm}$ = $\pm 5~V$

	ARAMETER	TEST CONDITION	)NC	<b>-</b> .+		TLC2272C	;	Т	LC2272A	С	UNIT
"	ARAWETER	TEST CONDITIO	JNS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
	Claur rate at	V- 122V B	. 40160	25°C	2.3	3.6		2.3	3.6		
SR	Slew rate at unity gain	$V_O = \pm 2.3 \text{ V},$ R C <sub>L</sub> = 100 pF	L = 10 kΩ,	Full range	1.7			1.7			V/μs
V	Equivalent input	f = 10 Hz		25°C		50			50		nV/√ <del>Hz</del>
V <sub>n</sub>	noise voltage	f = 1 kHz		25°C		9			9		NV/∀HZ
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
VNPP	noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>
	Total harmonic	$V_0 = \pm 2.3 \text{ V},$	A <sub>V</sub> = 1			0.0011%			0.0011%		
THD + N	distortion pulse	f = 20 kHz,	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	duration	$R_L = 10 \text{ k}\Omega$	$A_{V} = 100$			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R C <sub>L</sub> = 100 pF	L = 10 kΩ,	25°C		2.25			2.25		MHz
Вом	Maximum output- swing bandwidth		v = 1, L = 100 pF	25°C		0.54			0.54		MHz
+_	Settling time	$A_V = -1$ , Step = -2.3 V to 2.3 V,	To 0.1%	25°C		1.5			1.5		μs
t <sub>S</sub>	Columny affic	$R_L$ = 10 kΩ, $C_L$ = 100 pF	To 0.01%	25 0		3.2			3.2		μο
φm	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ, C	L = 100 pF	25°C		52°			52°		
	Gain margin	_		25°C		10			10		dB

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



# TLC2274C electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

	PARAMETER	TEST CON	IDITIONS	<b>T.</b> +	Т	LC2274	С	TL	C2274A	C	
	PARAMETER	TEST COI	ADITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage			25°C		300	2500		300	950	μV
110		1		Full range			3000			1500	μι
αVIO	Temperature coefficient of input offset voltage			25°C to 70°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 2.5 \text{ V},$ $V_{O} = 0 \text{ V},$	$V_{IC} = 0 V$ , $R_S = 50 \Omega$	25°C		0.002			0.002		μV/mo
IIO	Input offset current			25°C		0.5	60		0.5	60	pА
10				Full range 25°C			100			100	F
IIB	Input bias current					1	60		1	60	pА
							100			100	<u>'</u>
VICR	Common-mode input	R <sub>S</sub> = 50 Ω,	V <sub>IO</sub>   ≤ 5 mV,	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V
VICK	voltage	175 - 50 52,	V O  = 0 IIIV,	Full range	0 to 3.5			0 to 3.5			ľ
		I <sub>OH</sub> = -20 μA		25°C		4.99			4.99		
		I <sub>OH</sub> = -200 μA		25°C	4.85	4.93		4.85	4.93		
Vон	High-level output voltage	ΙΟΗ = -200 μΑ		Full range	4.85			4.85			V
		lou - 1 mA		25°C	4.25	4.65		4.25	4.65		
		$I_{OH} = -1 \text{ mA}$		Full range	4.25			4.25			
		$V_{IC} = 2.5 V,$	$I_{OL} = 50 \mu A$	25°C		0.01			0.01		
	Low lovel output voltage	output voltage $V_{IC} = 2.5 \text{ V}, \qquad I_{OL} = 500 \mu\text{A}$	lou = 500 uA	25°C		0.09	0.15		0.09	0.15	
VOL	Low-level output voltage		Full range			0.15		_	0.15	V	
		V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 5 mA	25°C		0.9	1.5		0.9	1.5	
		110 =10 1,		Full range			1.5			1.5	
	Large-signal differential	V <sub>IC</sub> = 2.5 V,	$R_L = 10 \text{ k}\Omega^{\ddagger}$	25°C	15	35		15	35		
$A_{VD}$	voltage amplification	$V_0 = 1 \text{ V to 4 V}$		Full range	15			15	-		V/mV
			$R_L = 1 \text{ m}\Omega^{\ddagger}$	25°C		175			175		
<sup>r</sup> id	Differential input resistance			25°C		1012			1012		Ω
rį	Common-mode input resistance			25°C		1012			1012		Ω
Cį	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z <sub>O</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		140			140		Ω
OME	Common-mode rejection	V <sub>IC</sub> = 0 V to 2.7 V	V,	25°C	70	75		70	75		.15
CMRR	ratio	$V_0 = 2.5 \text{ V},$	$R_S = 50 \Omega$	Full range	70			70			dB
la	Supply-voltage rejection	$V_{DD} = 4.4 \text{ V to } 1$	6 V,	25°C	80	95		80	95		40
ksvr	ratio (ΔV <sub>DD</sub> /ΔV <sub>IO</sub> )	$V_{IC} = V_{DD}/2$ ,	No load	Full range	80			80			dB
la a	Cumply ourrest	Va = 2.5.V		25°C		4.4	6		4.4	6	m ^
IDD	Supply current	$V_0 = 2.5 V$ ,	No load	Full range			6			6	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  $T_A = 150^{\circ}C$  extrapolated to  $T_A = 25^{\circ}C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



<sup>‡</sup>Referenced to 0 V

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

### TLC2274C operating characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$

DA.	DAMETED	TEST CONDI	TIONS	- +	7	TLC22740	;	TI	_C2274A	С	UNIT	
PA	RAMETER	TEST CONDI	IIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII	
	Class rate at	V 05V4-05V		25°C	2.3	3.6		2.3	3.6			
SR	Slew rate at unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$ $R_L = 10 \text{ k}\Omega^{\ddagger},$	C <sub>L</sub> = 100 pF <sup>‡</sup>	Full range	1.7			1.7			V/μs	
V	Equivalent input	f = 10 Hz		25°C		50			50		->441	
Vn	noise voltage	f = 1 kHz		25°C		9			9		nV/√Hz	
Verre	Peak-to-peak	f = 0.1 Hz to 1 Hz		25°C		1			1		\/	
V <sub>N(PP)</sub>	equivalent input noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μV	
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>	
	Total harmonic	$V_{O} = 0.5 \text{ V to } 2.5 \text{ V},$	A <sub>V</sub> = 1		0.0013%				0.0013%			
THD + N	distortion plus	distortion plus $f = 20 \text{ kHz}$	f = 20 kHz,	A <sub>V</sub> = 10	25°C		0.004%		0.004%			
	noise	$R_L = 10 \text{ k}\Omega^{\ddagger}$	A <sub>V</sub> = 100			0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF‡	$R_L = 10 \text{ k}\Omega^{\ddagger}$ ,	25°C		2.18			2.18		MHz	
ВОМ	Maximum output-swing bandwidth	$V_{O(PP)} = 2 \text{ V},$ $R_{L} = 10 \text{ k}\Omega^{\ddagger},$	$A_V = 1$ , $C_L = 100 \text{ pF}^{\ddagger}$	25°C		1			1		MHz	
	Sattling time	$A_V = -1$ , Step = 0.5 V to 2.5 V,	To 0.1%	25°C		1.5			1.5		: 6	
t <sub>S</sub>	Settling time	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L = 100 \text{ pF}^{\ddagger}$	To 0.01%	25 0		2.6			2.6		μs	
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega^{\ddagger}$ ,	C <sub>L</sub> = 100 pF <sup>‡</sup>	25°C		50°			50°			
	Gain margin			25°C		10			10		dB	

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



<sup>‡</sup>Referenced to 0 V

# TLC2274C electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V (unless otherwise noted)

	DADAMETED	TEST CO	MOITIONS	- +	Т	LC2274	С	TL	.C2274A	C	
	PARAMETER	IESI CO	NDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
\/10	Input offset voltage			25°C		300	2500		300	950	μV
VIO	input onset voltage			Full range			3000			1500	μν
αVIO	Temperature coefficient of input offset voltage			25°C to 70°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0 V$ , $R_S = 50 \Omega$	$V_O = 0 V$ ,	25°C		0.002			0.002		μV/mo
lio	Input offset current			25°C		0.5	60		0.5	60	pА
טוי	input onset current			Full range			100			100	PΑ
I <sub>IB</sub>	Input bias current			25°C		1	60		1	60	pА
чь	mpat blad darront			Full range			100			100	Ρ, .
VICR	Common-mode input	Ro = 50 O	V <sub>IO</sub>   ≤ 5 mV	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2		V
VICR	voltage	10 22,	IAIO I = 2 IIIA	Full range	-5 to 3.5			-5 to 3.5			V
		$I_0 = -20 \mu A$		25°C		4.99			4.99		
	Mandanan and War and broadens	Ja - 200 III	۸	25°C	4.85	4.93		4.85	4.93		
V <sub>OM+</sub>	Maximum positive peak output voltage	$I_{O} = -200 \mu$	٦	Full range	4.85			4.85			V
		I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		10 = -1 1114		Full range	4.25			4.25			
		$V_{IC} = 0 V$	$I_O = 50 \mu\text{A}$	25°C		-4.99			-4.99		
	Maximum nanativa naali	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	lo - 500 u A	25°C	-4.8 5	-4.91		-4.85	-4.91		
V <sub>OM</sub> -	Maximum negative peak output voltage	vIC = 0 v,	IO = 500 μA	Full range	-4.8 5			-4.85			V
		V 0.V	1 5 ··· A	25°C	-3.5	-4.1		-3.5	-4.1		
		VIC = 0 V	$I_O = -5 \text{ mA}$	Full range	-3.5			-3.5			
			D: 40 kg	25°C	25	50		25	50		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 4 V$	$R_L = 10 \text{ k}\Omega$	Full range	25			25			V/mV
	Tonago ampinioanon		$R_L = 1 M\Omega$	25°C		300			300		
<sup>r</sup> id	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
rį	Common-mode input resistance			25°C		1012			1012		Ω
ci	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z <sub>O</sub>	Closed-loop output impedance	f = 1 MHz,	Ay = 10	25°C		130			130		Ω
CMDD	Common mode rejection ratio	$V_{IC} = -5 V t$		25°C	75	80		75	80		dВ
CMRR	Common-mode rejection ratio	$V_O = 0 V$	$R_S = 50 \Omega$	Full range	75			75			dB
ko:-	Supply-voltage rejection ratio	$V_{DD\pm} = \pm 2.2$	2 V to ±8 V,	25°C	80	95		80	95		4D
ksvr	$(\Delta V_{DD\pm}/\Delta V_{IO})$	$V_{IC} = 0 V$	No load	Full range	80			80			dB
la a	Supply current	Vo = 0.V	No load	25°C		4.8	6		4.8	6	m ^
IDD	Supply current	$V_O = 0 V$	INU IUAU	Full range			6			6	mA

† Full range is 0°C to 70°C.

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



SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

### TLC2274C operating characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5~\text{V}$

	ARAMETER	TEST CONDITION	NC	_ +	1	LC22740	;	Τl	_C2274A	С	UNIT
"	AKAWETEK	TEST CONDITIO	ONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
	Claus rate at units	V- 122V D	1010	25°C	2.3	3.6		2.3	3.6		
SR	Slew rate at unity gain	$V_O = \pm 2.3 \text{ V}, \qquad R_L = C_L = 100 \text{ pF}$	10 kΩ,	Full range	1.7			1.7			V/μs
V	Equivalent input	f = 10 Hz		25°C		50			50		->4//11-
Vn	noise voltage	f = 1 Hz		25°C		9			9		nV/√Hz
V4.455)	Peak-to-peak	f = 0.1 Hz to 1 Hz		25°C		1			1		\/
V <sub>N(PP)</sub>	equivalent input noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μV
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>
	Total harmonic	$V_{O} = \pm 2.3 \text{ V},$	A <sub>V</sub> = 1			0.0011%			0.0011%		
THD + N	distortion plus	f = 20 kHz,	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	noise	$R_L = 10 \text{ k}\Omega$	$A_{V} = 100$			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R <sub>L</sub> = 100 pF	10 kΩ,	25°C		2.25			2.25		MHz
ВОМ	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6 \text{ V},  A_{V} = R_{L} = 10 \text{ k}\Omega,  C_{L} = 0.0 \text{ C}$	1, 100 pF	25°C		0.54			0.54		MHz
t -	Settling time	$A_V = -1$ , Step = -2.3 V to 2.3 V,	To 0.1%	25°C		1.5			1.5		μs
t <sub>S</sub>	Octaining time	$R_L = 10 \text{ k}\Omega,$ $C_L = 100 \text{ pF}$	To 0.01%	23 0		3.2			3.2		μο
φm	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> =	100 pF	25°C		52°			52°		
	Gain margin			25°C		10			10		dB

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

# TLC2272I electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

	PARAMETER	TEST CO	NDITIONS	T +		ΓLC2272		Т	LC2272A	NI	UNIT
	PARAMETER	l lesi coi	NDITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
\/	Input offeet voltege			25°C		300	2500		300	950	μV
V <sub>IO</sub>	Input offset voltage			Full range			3000			1500	μν
$\alpha_{VIO}$	Temperature coefficient of input offset voltage			25°C to 85°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	V <sub>IC</sub> = 0 V,	$V_{DD\pm} = \pm 2.5 \text{ V}$	25°C		0.002			0.002		μV/mo
		$V_O = 0 V$ ,	$R_S = 50 \Omega$	25°C		0.5	60		0.5	60	
I <sub>IO</sub>	Input offset current			–40°C to 85°C			150			150	pА
				Full range			800			800	
				25°C		1	60		1	60	
$I_{IB}$	Input bias current			–40°C to 85°C			150			150	pА
				Full range			800			800	
M	Common-mode input	D 50.0	N/ 1 < 5 \	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		<b>V</b>
V <sub>ICR</sub>	voltage	$R_S = 50 \Omega$ ,	$ V_{IO}  \le 5 \text{ mV}$	Full range	0 to 3.5			0 to 3.5			V
		$I_{OH} = -20 \mu A$		25°C		4.99			4.99		
	High laval autaut	I <sub>OH</sub> = -200 μA		25°C	4.85	4.93		4.85	4.93		
$V_{OH}$	High-level output voltage	10H = -200 μΑ		Full range	4.85			4.85			V
	· -····g-	I <sub>OH</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		IOH = - I IIIA		Full range	4.25			4.25			
		$V_{IC} = 2.5 V$ ,	$I_{OL} = 50 \mu\text{A}$	25°C		0.01			0.01		
	Low-level output	V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 500 μA	25°C		0.09	0.15		0.09	0.15	
$V_{OL}$	voltage	V <sub>1</sub> C = 2.0 V,	10L = 000 μ/τ	Full range			0.15			0.15	V
	· ·	V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 5 mA	25°C		0.9	1.5		0.9	1.5	
		V <sub>1</sub> C = 2.0 V,	10L = 0 11/1/	Full range			1.5			1.5	
	Lorgo signal differential	V 25V	$R_L = 10 \text{ k}\Omega^{\ddagger}$	25°C	15	35		15	35		
$A_{VD}$	Large-signal differential voltage amplification	$V_{IC} = 2.5 \text{ V},$ $V_{O} = 1 \text{ V to 4 V}$		Full range	15			15	_		V/m\
		Ů	$R_L = 1 \text{ m}\Omega^{\ddagger}$	25°C		175			175		
r <sub>id</sub>	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
r <sub>i</sub>	Common-mode input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
c <sub>i</sub>	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z <sub>o</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		140			140		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0 \text{ V to } 2.7 \text{ V}$ $V_{O} = 2.5 \text{ V}$	V, $R_S = 50 \Omega$	25°C Full range	70 70	75		70 70	75		dB
ı.	Supply-voltage	V <sub>DD</sub> = 4.4 V to 1	16 V,	25°C	80	95		80	95		i,
k <sub>SVR</sub>	rejection ratio $(\Delta V_{DD}/\Delta V_{IO})$	$V_{IC} = V_{DD}/2$ ,	No load	Full range	80			80			dB
		.,		25°C		2.2	3		2.2	3	
$I_{DD}$	Supply current	$V_0 = 2.5 V$ ,	No load	Full range			3			3	mA

<sup>†</sup> Full range is – 40°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.



<sup>‡</sup>Referenced to 0 V

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

### TLC2272I operating characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$

	ARAMETER	TEST CONDITIO	NC	T. †		TLC2272I		Т	LC2272AI		UNIT
F*	ARAMETER	TEST CONDITIO	NS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
	Slew rate at	Vo - 0.5 V to 2.5 V		25°C	2.3	3.6		2.3	3.6		
SR	unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$ $R_L = 10 \text{ k}\Omega^{\ddagger},$ $C_L$	= 100 pF‡	Full range	1.7			1.7			V/μs
V	Equivalent input	f = 10 Hz		25°C		50			50		-> /+/ <del>    -</del>
Vn	noise voltage	f = 1 kHz		25°C		9			9		nV√Hz
VALDE	Peak-to-peak	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
VNPP	equivalent input noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA√Hz
	Total harmonic	$V_{O} = 0.5 \text{ V to } 2.5 \text{ V},$	A <sub>V</sub> = 1			0.0013%			0.0013%		
THD + N	distortion plus	f = 20 kHz,	$A_{V} = 10$	25°C		0.004%			0.004%		
	noise	$R_L = 10 \text{ k}\Omega^{\ddagger}$	$A_{V} = 100$			0.03%			0.03%		
	Gain-bandwidth product	$f = 10 \text{ kHz}, \\ C_L = 100 \text{ pF}^{\ddagger}$	= 10 kΩ <sup>‡</sup> ,	25°C		2.18			2.18		MHz
ВОМ	Maximum output- swing bandwidth	$V_{O(PP)} = 2 \text{ V},$ Av $R_L = 10 \text{ k}\Omega^{\ddagger},$ CL	= 1, = 100 pF‡	25°C		1			1		MHz
	Ostilla actions	$A_V = -1$ , Step = 0.5 V to 2.5 V,	To 0.1%	0500		1.5			1.5		_
t <sub>s</sub>	Settling time	$R_L = 10 \text{ k}\Omega^{\ddagger},$ $C_L = 100 \text{ pF}^{\ddagger}$	To 0.01%	25°C		2.6			2.6	•	μs
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L$	= 100 pF‡	25°C		50°			50°		
	Gain margin			25°C		10			10		dB

<sup>†</sup> Full range is – 40°C to 125°C.



<sup>‡</sup>Referenced to 0 V

# TLC2272I electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V (unless otherwise noted)

	DADAMETED	TEST 001	IDITIONS		1	LC2272I		TI	LC2272A	I	
	PARAMETER	TEST CON	NULTIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V	land offers welleng			25°C		300	2500		300	950	\/
V <sub>IO</sub>	Input offset voltage			Full range			3000			1500	μV
$\alpha_{\text{VIO}}$	Temperature coefficient of input offset voltage			25°C to 85°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0 V$ , $R_S = 50 \Omega$	V <sub>O</sub> = 0 V,	25°C		0.002			0.002		μV/mo
		]		25°C		0.5	60		0.5	60	
I <sub>IO</sub>	Input offset current			–40°C to 85°C			150			150	pА
				Full range			800			800	
		1		25°C		1	60		1	60	
I <sub>IB</sub>	Input bias current			–40°C to 85°C			150			150	pА
				Full range			800			800	
V	Common-mode	$R_S = 50 \Omega$ ,	$ V_{IO}  \le 5 \text{ mV}$	25°C	−5 to 4	-5.3 to 4.2		–5 to 4	-5.3 to 4.2		V
V <sub>ICR</sub>	input voltage	KS = 50 12,	v  0   ≥ 3 111v	Full range	–5 to 3.5			–5 to 3.5			V
		$I_{O} = -20 \mu\text{A}$		25°C		4.99			4.99		
		J 200 A		25°C	4.85	4.93		4.85	4.93		
V <sub>OM+</sub>	Maximum positive peak output voltage	$I_{O} = -200 \mu\text{A}$		Full range	4.85			4.85			V
	pour output voltage	1 1		25°C	4.25	4.65		4.25	4.65		
		$I_O = -1 \text{ mA}$		Full range	4.25			4.25			
		$V_{IC} = 0 V$ ,	I <sub>O</sub> = 50 μA	25°C		-4.99			-4.99		
	N.A	V <sub>IC</sub> = 0 V,	I <sub>O</sub> = 500 μA	25°C	-4.85	-4.91		-4.85	-4.91		
$V_{OM-}$	Maximum negative peak output voltage	VIC = 0 V,	10 = 300 μΑ	Full range	-4.85			-4.85			V
	pour output vollage	V <sub>IC</sub> = 0 V,	I <sub>O</sub> = 5 mA	25°C	-3.5	-4.1		-3.5	-4.1		
		VIC = 0 V,	10 = 2 IIIA	Full range	-3.5			-3.5			
	Large-signal		R <sub>L</sub> = 10 kΩ	25°C	25	50		25	50		
$A_{VD}$	differential voltage	$V_O = \pm 4 V$	K[ = 10 K22	Full range	25			25			V/mV
	amplification		$R_L = 1 \text{ m}\Omega$	25°C		300			300		
r <sub>id</sub>	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
r <sub>i</sub>	Common-mode input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
Cį	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z <sub>o</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		130			130		Ω
OMES	Common-mode	$V_{IC} = -5 \text{ V to } 2.7$	V,	25°C	75	80		75	80		45
CMRR	rejection ratio		$R_S = 50 \Omega$	Full range	75			75			dB
k <sub>SVR</sub>	Supply-voltage rejection ratio	V <sub>DD</sub> = 4.4 V to 1	6 V,	25°C	80	95		80	95		dB
	$(\Delta V_{DD\pm}/\Delta V_{IO})$	$V_{IC} = V_{DD}/2$ ,	No load	Full range	80			80			
Inn	Supply current	V <sub>O</sub> = 0 V,	No load	25°C		2.4	3		2.4	3	mA
I <sub>DD</sub>	Cupply Culterit	VO = 0 V,	No loau	Full range			3			3	111/5

<sup>†</sup> Full range is – 40°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.



SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

## TLC2272I operating characteristics at specified free-air temperature, $\rm V_{DD\pm}$ = $\pm5~V$

	ARAMETER	TEST CONDITIO	MC	- +		TLC2272I		7	LC2272A	I	UNIT
"	ARAMETER	TEST CONDITION	ONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
	Slew rate at	$V_{O} = \pm 2.3 \text{ V}, R_{I}$	= 10 kΩ,	25°C	2.3	3.6		2.3	3.6		
SR	unity gain	C <sub>L</sub> = 100 pF		Full range	1.7			1.7			V/μs
V <sub>n</sub>	Equivalent input	f = 10 Hz		25°C		50			50		nV√Hz
٧n	noise voltage	f = 1 kHz		25°C		9			9		ΠV∀ΠZ
V <sub>NPP</sub>	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
VNPP	noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA√ <del>Hz</del>
	Total harmonic	V <sub>O</sub> = ±2.3 V	A <sub>V</sub> = 1			0.0011%			0.0011%		
THD + N	distortion plus	$R_L = 10 \text{ k}\Omega,$	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	noise	f = 20 kHz	$A_{V} = 100$			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R <sub>I</sub> C <sub>L</sub> = 100 pF	_ = 10 kΩ,	25°C		2.25			2.25		MHz
ВОМ	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6 \text{ V}, \qquad A_{V}$ $R_{L} = 10 \text{ k}\Omega, \qquad C_{I}$	/ = 1, _ = 100 pF	25°C		0.54			0.54		MHz
to	Settling time	$A_V = -1$ , Step = -2.3 V to 2.3 V,	To 0.1%	25°C		1.5			1.5		μs
t <sub>S</sub>	Octaining tillie	$R_L = 10 \text{ k}\Omega,$ $C_L = 100 \text{ pF}$	To 0.01%	200		3.2			3.2		μο
φm	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ, C <sub>I</sub>	_ = 100 pF	25°C		52°			52°		
	Gain margin			25°C		10			10		dB

<sup>†</sup> Full range is –40°C to 125°C.



# TLC2274I electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 V (unless otherwise noted)

	PARAMETER	TEST CON	IDITIONS	<b>-</b> +	Т	LC2274	ı	T	LC2274 <i>F</i>	AI .	
	PARAMETER	TEST CON	DITIONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V <sub>IO</sub>	Input offset voltage			25°C		300	2500		300	950	μV
*10				Full range			3000			1500	μ,
$\alpha_{\text{VIO}}$	Temperature coefficient of input offset voltage			25°C to 85°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 2.5 \text{ V},$	V:== 0 V	25°C		0.002			0.002		μV/mo
		$V_{OD} \pm = \pm 2.5 \text{ V},$ $V_{O} = 0 \text{ V},$		25°C		0.5	60		0.5	60	
I <sub>IO</sub>	Input offset current			-40°C to 85°C			150			150	pА
				Full range			800			800	
		1		25°C		1	60		1	60	
I <sub>IB</sub>	Input bias current			–40°C to 85°C			150			150	рА
				Full range			800			800	
V	Common-mode input	D 50.0	N/ 1 < 5 == 1/	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		
V <sub>ICR</sub>	voltage	$R_S = 50 \Omega$ ,	$ V_{IO}  \le 5 \text{ mV}$	Full range	0 to 3.5			0 to 3.5			V
		I <sub>OH</sub> = -20 μA		25°C		4.99			4.99		
				25°C	4.85	4.93		4.85	4.93		
V <sub>OH</sub>	High-level output voltage	$I_{OH} = -200 \mu A$		Full range	4.85			4.85			V
				25°C	4.25	4.65		4.25	4.65		
		$I_{OH} = -1 \text{ mA}$		Full range	4.25			4.25	•		
		V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 50 μA	25°C		0.01			0.01		
		V 05V		25°C		0.09	0.15		0.09	0.15	
$V_{OL}$	Low-level output voltage	$V_{IC} = 2.5 V,$	$I_{OL} = 500 \mu\text{A}$	Full range			0.15			0.15	V
		V 25V		25°C		0.9	1.5		0.9	1.5	
		$V_{IC} = 2.5 V,$	$I_{OL} = 5 \text{ mA}$	Full range			1.5			1.5	
			B 40 kOt	25°C	15	35		15	35		
$A_{VD}$	Large-signal differential voltage amplification	$V_{IC} = 2.5 \text{ V},$ $V_{O} = 1 \text{ V to 4 V}$	$R_L = 10 \text{ k}\Omega^{\ddagger}$	Full range	15			15			V/mV
	· · · · · · · · · · · · · · · · · · ·		$R_L = 1 M\Omega^{\ddagger}$	25°C		175			175		
r <sub>id</sub>	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
rį	Common-mode input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
c <sub>i</sub>	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z <sub>o</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		140			140		Ω
CMRR	Common-mode rejection	V <sub>IC</sub> = 0 V to 2.7	V,	25°C	70	75		70	75		dB
CIVIRR	ratio	$V_0 = 2.5 \text{ V},$	$R_S = 50 \Omega$	Full range	70			70			ub
k	Supply-voltage rejection	$V_{DD} = 4.4 \text{ V to 1}$		25°C	80	95		80	95		dB
k <sub>SVR</sub>	ratio ( $\Delta V_{DD} / \Delta V_{IO}$ )	$V_{IC} = V_{DD}/2,$	No load	Full range	80			80			ub
loo	Supply current	V <sub>O</sub> = 2.5 V,	No load	25°C		4.4	6		4.4	6	mA
I <sub>DD</sub>	Сарріу сапені	V() = 2.5 V,	140 1000	Full range			6			6	111/5

<sup>†</sup> Full range is – 40°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.



<sup>‡</sup>Referenced to 0 V

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

## TLC2274I operating characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$

	PARAMETER	TEST CONDITION	ONE	+ +	•	TLC22741		Т	LC2274A	I	UNIT
'	PARAMETER	TEST CONDITION	ONS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNII
	Class rate at units	V- 05 V+- 05 V		25°C	2.3	3.6		2.3	3.6		
SR	Slew rate at unity gain	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$ $R_L = 10 \text{ k}\Omega^{\ddagger},  C_L =$	100 pF‡	Full range	1.7			1.7			V/μs
V	Equivalent input	f = 10 Hz		25°C		50			50		nV/√ <del>Hz</del>
٧ <sub>n</sub>	noise voltage	f = 1 kHz		25°C		9			9		nv/√Hz
V4.455	Peak-to-peak	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
V <sub>N(PP)</sub>	equivalent input noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>
	Tatalliania and	$V_O = 0.5 \text{ V to } 2.5 \text{ V},$	A <sub>V</sub> = 1			0.0013%			0.0013%		
THD + N	Total harmonic distortion plus noise	f = 20 kHz,	$A_{V} = 10$	25°C		0.004%			0.004%		
		$R_L = 10 \text{ k}\Omega^{\ddagger}$	$A_{V} = 100$			0.03%			0.03%		
	Gain-bandwidth product	$f = 10 \text{ kHz}, R_L = C_L = 100 \text{ pF}^{\ddagger}$	10 kΩ <sup>‡</sup> ,	25°C		2.18			2.18		MHz
ВОМ	Maximum output-swing bandwidth	$V_{O(PP)} = 2 \text{ V},  A_{V} = R_{L} = 10 \text{ k}\Omega^{\ddagger},  C_{L} = 0$	1, 100 pF‡	25°C		1			1		MHz
<b>+</b> -	Settling time	$A_V = -1$ , Step = 0.5 V to 2.5 V,	To 0.1%	25°C		1.5			1.5		μs
t <sub>S</sub>	Setting time	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L = 100 \text{ pF}^{\ddagger}$	To 0.01%	25 0		2.6			2.6		μδ
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L = 100 \text{ pF}^{\ddagger}$		25°C	50°			50°			
	Gain margin	]	•	25°C		10			10		dB

<sup>†</sup> Full range is – 40°C to 125°C.



<sup>‡</sup>Referenced to 0 V

# TLC2274I electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V (unless otherwise noted)

	PARAMETER	TEST C	ONDITIONS	- +	7	LC2274I		T	LC2274A	I	
	PARAWIETER	1231 C	CHOITIUNS	T <sub>A</sub> †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V	Input offset voltage			25°C		300	2500		300	950	/
V <sub>IO</sub>	Input offset voltage			Full range			3000			1500	μV
$\alpha_{\text{VIO}}$	Temperature coefficient of input offset voltage	]		25°C to 85°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	V 0V	V 0V	25°C		0.002			0.002		μV/mo
		$V_{IC} = 0 \text{ V},$ $R_S = 50 \Omega$	ν <sub>O</sub> = υ ν,	25°C		0.5	60		0.5	60	
I <sub>IO</sub>	Input offset current			–40°C to 85°C			150			150	рА
				Full range			800			800	
		1		25°C		1	60		1	60	
$I_{IB}$	Input bias current			–40°C to 85°C			150			150	pА
				Full range			800			800	
V <sub>ICR</sub>	Common-mode input	Po = 50 O	V <sub>IO</sub>  ≤ 5 mV	25°C	–5 to 4	-5.3 to 4.2		–5 to 4	-5.3 to 4.2		V
VICR	voltage	NS = 50 22,	1 4 10 1 = 3 111 A	Full range	–5 to 3.5			–5 to 3.5			V
		$I_{O} = -20 \mu A$		25°C		4.99			4.99		
		$I_0 = -200 \mu$	۸	25°C	4.85	4.93		4.85	4.93		
V <sub>OM+</sub>	Maximum positive peak output voltage	10 = -200 μ	^	Full range	4.85			4.85			V
		I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		10 - 11170		Full range	4.25			4.25			
		$V_{IC} = 0 V$ ,	$I_O = 50 \mu\text{A}$	25°C		-4.99			-4.99		
	Maximum pagativa paak	V <sub>10</sub> = 0 V	I <sub>O</sub> = 500 μA	25°C	-4.85	-4.91		-4.85	-4.91		
$V_{OM-}$	Maximum negative peak output voltage	V <sub>1</sub> C = 0 V,		Full range	-4.85			-4.85			V
		V <sub>IC</sub> = 0 V,	I <sub>O</sub> = 5 mA	25°C	-3.5	-4.1		-3.5	-4.1		
		10 0 1,	•	Full range	-3.5			-3.5			
	Large-signal differential		$R_L = 10 \text{ k}\Omega$	25°C	25	50		25	50		
$A_{VD}$	voltage amplification	$V_O = \pm 4 V$		Full range	25			25	-		V/mV
			$R_L = 1 M\Omega$	25°C		300			300		
r <sub>id</sub>	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
r <sub>i</sub>	Common-mode input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
c <sub>i</sub>	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
Z <sub>O</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		130			130		Ω
OMBD	Common-mode rejection	$V_{IC} = -5 V t$	o 2.7 V,	25°C	75	80		75	80		-10
CMRR	ratio	$V_O = 0 V$ ,	$R_S = 50 \Omega$	Full range	75			75			dB
kov-	Supply-voltage rejection	$V_{DD\pm} = \pm 2.2$		25°C	80	95		80	95		dB
k <sub>SVR</sub>	ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{IC} = 0 V$ ,	No load	Full range	80			80			uБ
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0 V,	No load	25°C		4.8	6		4.8	6	mA
טטי	Сарріу сапені	1 VO = 0 V,	140 1000	Full range			6			6	111/4

<sup>†</sup> Full range is – 40°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.



SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

## TLC2274I operating characteristics at specified free-air temperature, $\rm V_{DD\pm}$ = $\pm5~V$

$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	JNIT		LC2274A	Т		_C2274I	7	_ +	NC	TEST CONDITIO	ADAMETED	
SR Slew rate at unity gain $V_{O} = \pm 2.3 \text{ V}$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$ $R_{L} = 10 \text{ k}\Omega$ , $C_{L} = 100 \text{ pF}$	וואנ	MAX	TYP	MIN	MAX	TYP	MIN	T <sub>A</sub> †	ONS	LEST CONDITIO	ARAMEIER	"
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			3.6	2.3		3.6	2.3	25°C	1010	V- 122V D	Claurate et unitu	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	V/μs			1.7			1.7		_ = 10 K22,		•	SR
Peak-to-peak $V_{N(PP)}$ equivalent input noise voltage $V_{N(PP)}$ Equivalent input noise current $V_{N(PP)}$ Equivalent $V_{N(PP)}$ Equivalent $V_{N(PP)}$ Equivalent $V_{N(PP)}$ Equivalent input noise current $V_{N(PP)}$ Equivalent $V_{N(PP)}$ Equivalen	<del></del>		50			50		25°C		f = 10 Hz	Equivalent input	V
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	J/√HZ		9			9		25°C		f = 1 kHz	noise voltage	٧n
noise voltage $f = 0.1 \text{ Hz}$ to 10 Hz $25^{\circ}\text{C}$ 1.4 1.4 1.4 $I_{\text{noise current}}$ Equivalent input noise current $25^{\circ}\text{C}$ 0.6 0.6 $fA/$	\/		1			1		25°C		f = 0.1 Hz to 1 Hz	•	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
In noise current 25°C 0.6 0.6 fA/v	μν		1.4			1.4		25°C		f = 0.1 Hz to 10 Hz	•	VN(PP)
0.0040/	√√Hz		0.6			0.6		25°C				In
Total harmonic $V_{Q} = \pm 2.3 \text{ V},$ $A_{V} = 1$ 0.0011% 0.0011%			0.0011%			.0011%			A <sub>V</sub> = 1	Vo = ±2.3 V.	Total harmonic	
THD + N distortion plus $R_L = 10 \text{ k}\Omega$ , $A_V = 10$ 25°C 0.004% 0.004%			0.004%			0.004%		25°C	A <sub>V</sub> = 10	$R_L = 10 \text{ k}\Omega$ ,		THD + N
noise $f = 20 \text{ kHz}$ $A_V = 100$ 0.03% 0.03%			0.03%			0.03%			$A_{V} = 100$	f = 20 kHz	noise	
Gain-bandwidth product $f = 10 \text{ kHz}, C_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$ $R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$ $2.25$	MHz		2.25			2.25		25°C	= 10 kΩ,			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	MHz		0.54			0.54		25°C			•	ВОМ
	μs		1.5			1.5		25°€	To 0.1%	Step = $-2.3 \text{ V}$ to $2.3 \text{ V}$ ,	Sattling time	•-
ts Settling time $R_L = 10 \text{ k}\Omega$ , $R_L = 100 \text{ pF}$ To $0.01\%$ $R_L = 100 \text{ pF}$ $R_L = 100 \text{ pF}$ $R_L = 100 \text{ pF}$	μ5		3.2			3.2		23 0	To 0.01%		Setting time	ıs
$\phi_{\text{m}}$ Phase margin at unity gain $R_{\text{L}} = 10 \text{ k}\Omega$ , $C_{\text{L}} = 100 \text{ pF}$ $25^{\circ}\text{C}$ $52^{\circ}$ $52^{\circ}$			52°			52°		25°C	= 100 pF	R <sub>L</sub> = 10 kΩ, C <sub>L</sub>	•	φm
Gain margin         25°C         10         10         dE	dB		10			10		25°C			Gain margin	

<sup>†</sup> Full range is -40°C to 125°C.



# TLC2272Q and TLC2272M electrical characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$ (unless otherwise noted)

PARAM	METER	TEST CONDITIONS	NDITIONS	T <sub>A</sub> †	TLC2272Q, TLC2272M				C2272A .C2272A	,	UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub> Input off	fset voltage			25°C		300	2500		300	950	μV
V <sub>IO</sub> Input on				Full range			3000			1500	μν
	ature coefficient offset voltage			25°C to 125°C		2			2		μV/°C
	fset voltage long- ft (see Note 4)	V <sub>IC</sub> = 0 V, V <sub>O</sub> = 0 V,	$V_{DD\pm} = \pm 2.5 \text{ V},$ R <sub>S</sub> = 50 $\Omega$	25°C		0.002			0.002		μV/mo
I <sub>IO</sub> Input off	set current	1		25°C		0.5	60		0.5	60	pА
III) III)put on	Set Current			Full range			800			800	PΛ
I <sub>IB</sub> Input bia	as current			25°C		1	60		1	60	pА
IIB IIIPULDI	as current			Full range			800			800	PA
1 1/100	n-mode input	$R_S = 50 \Omega$	$ V_{IO}  \le 5 \text{ mV}$	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V
VICR voltage		113 = 30 22,	IAIO I = 2 IIIA	Full range	0 to 3.5			0 to 3.5			V
		$I_{OH} = -20  \mu A$		25°C		4.99			4.99		
l ligh lo	ral autaut	I <sub>OH</sub> = -200 μA		25°C	4.85	4.93		4.85	4.93		
VOH voltage	el output	10H = -200 μΛ		Full range	4.85			4.85			V
l		I <sub>OH</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		IOH = - I IIIA		Full range	4.25			4.25			
		$V_{IC} = 2.5 V,$	$I_{OL} = 50 \mu A$	25°C		0.01			0.01		
		V <sub>IC</sub> = 2.5 V,	I <sub>OL</sub> = 500 μA	25°C		0.09	0.15		0.09	0.15	
VOL Low-lev	el output voltage	V <sub>1</sub> C = 2.5 V,		Full range			0.15			0.15	V
		V <sub>IC</sub> = 2.5 V,	IOL = 5 mA	25°C		0.9	1.5		0.9	1.5	
		10 =:0 1,	.OL 0	Full range			1.5			1.5	
Large-si	•	V <sub>IC</sub> = 2.5 V,	$R_L = 10 \text{ k}\Omega^{\ddagger}$	25°C	10	35		10	35		
10	tial voltage	$V_0 = 1 \text{ V to 4 V}$		Full range	10			10			V/mV
amplific			$R_L = 1 \text{ m}\Omega^{\ddagger}$	25°C		175			175		
rid Differen resistan	tial input ce			25°C		10 <sup>12</sup>			1012		Ω
r <sub>i</sub> Commo resistan	n-mode input ce			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
Commo capacita	n-mode input ance	f = 10 kHz,	P package	25°C		8			8		pF
Z <sub>O</sub> Closed- impedar	loop output nce	f = 1 MHz,	A <sub>V</sub> = 10	25°C		140			140		Ω
CMDD Commo	n-mode rejection	$V_{IC} = 0 \ V \text{ to } 2.7$	V,	25°C	70	75		70	75		45
CMRR ratio		$V_0 = 2.5 V$ ,	$R_S = 50 \Omega$	Full range	70			70			dB
	voltage rejection	$V_{DD} = 4.4 \text{ V to}$		25°C	80	95		80	95		40
kSVR ratio (Δ\	<sup>/</sup> DD/∆VIO)	$V_{IC} = V_{DD}/2$	No load	Full range	80			80			dB
I <sub>DD</sub> Supply	current	V <sub>O</sub> = 2.5 V,	No load	25°C		2.2	3		2.2	3	mA
I <sub>DD</sub> Supply		VO = 2.5 V,	1 NO IOAU	Full range			3			3	111/4

Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

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.



<sup>‡</sup>Referenced to 2.5 V

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

### TLC2272Q and TLC2272M operating characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$

PA	ARAMETER	TEST CONDITION	)NS	T <sub>A</sub> †		LC2272Q LC2272N	•		C2272A C2272A		UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
	Slew rate at	V <sub>O</sub> = 1.25 V to 2.75 V,		25°C	2.3	3.6		2.3	3.6		
SR	unity gain	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L =$	: 100 pF‡	Full range	1.7			1.7			V/μs
V	Equivalent input	f = 10 Hz		25°C		50			50		nV/√Hz
V <sub>n</sub>	noise voltage	f = 1 kHz		25°C		9			9		IIV/VHZ
V4.155	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz f = 0.1 Hz to 10 Hz		25°C		1			1		μV
V <sub>NPP</sub>	noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current		25°C 0.6					fA/√ <del>Hz</del>			
	Total harmonic	$V_{\Omega} = 0.5 \text{ V to } 2.5 \text{ V},$	A <sub>V</sub> = 1			0.0013%			0.0013%		
THD + N	distortion plus	f = 20 kHz,	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	noise	$R_L = 10 \text{ k}\Omega^{\ddagger}$ ,	A <sub>V</sub> = 100			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R <sub>L</sub> C <sub>L</sub> = 100 pF‡	_ = 10 kΩ <sup>‡</sup> ,	25°C		2.18			2.18		MHz
ВОМ	Maximum output- swing bandwidth		/ = 1, _ = 100 pF‡	25°C		1			1		MHz
t <sub>S</sub>	Settling time	$A_V = -1$ , Step = 0.5 V to 2.5 V,	To 0.1%	25°C		1.5			1.5		μs
'S		$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L = 100 \text{ pF}^{\ddagger}$	To 0.01%	20 0		2.6			2.6		μο
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega^{\ddagger}, \qquad C_L$	_ = 100 pF‡	25°C		50°			50°		
	Gain margin			25°C		10			10		dB

<sup>†</sup> Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.



<sup>‡</sup>Referenced to 2.5 V

# TLC2272Q and TLC2272M electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V (unless otherwise noted)

	PARAMETER	TEST CONDITIONS		T <sub>A</sub> †		LC22720 LC22721		TLC2272AQ, TLC2272AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
VIO	Input offset voltage			25°C		300	2500		300	950	μV
VIO	input onset voltage			Full range			3000			1500	μν
ανιο	Temperature coefficient of input offset voltage			25°C to 125°C		2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{IC} = 0 V,$ RS = 50 $\Omega$	V <sub>O</sub> = 0 V,	25°C		0.002			0.002		μV/mo
ΙΙΟ	Input offset current	25°C		0.5	60		0.5	60	pА		
10	input onset current			Full range			800			800	- μΛ
Iв	Input bias current			25°C		1	60		1	60	pА
,ID				Full range			800			800	P' ·
VICR	Common-mode input	R <sub>S</sub> = 50 Ω,	V <sub>IO</sub>   ≤ 5 mV	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2		V
VICK	voltage	11.5 = 00 22,	14101 = 01114	Full range	-5 to 3.5			-5 to 3.5			•
		$I_{O} = -20 \mu\text{A}$		25°C		4.99			4.99		
	Maximum positive peak	I <sub>O</sub> = -200 μΑ		25°C	4.85	4.93		4.85	4.93		
VOM+	output voltage	10 = 200 μΛ		Full range	4.85			4.85			V
	ou.put romago	I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
		10 = -1 IIIA		Full range	4.25			4.25			
		$V_{IC} = 0 V$	$I_O = 50 \mu\text{A}$	25°C		-4.99			-4.99		
	Maximum negative peak	V <sub>IC</sub> = 0 V,	I <sub>O</sub> = 500 μA	25°C	-4.85	-4.91		-4.85	-4.91		
VOM-	output voltage	10 0 1,		υ = 000 μπ	Full range	-4.85			-4.85		
		V <sub>IC</sub> = 0 V,	$I_0 = 5 \text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
		10 ,	•	Full range	-3.5			-3.5			
١.	Large-signal differential		$R_L = 10 \text{ k}\Omega$	25°C	20	50		20	50		
AVD	voltage amplification	$V_O = \pm 4 V$		Full range	20			20			V/mV
			$R_L = 1 \text{ m}\Omega$	25°C		300			300		
<sup>r</sup> id	Differential input resistance			25°C		1012			1012		Ω
rį	Common-mode input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
c <sub>i</sub>	Common-mode input capacitance	f = 10 kHz,	P package	25°C		8			8		pF
z <sub>0</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		130			130		Ω
CMDD	Common-mode rejection	$V_{IC} = -5 V to$	2.7 V,	25°C	75	80		75	80		40
CMRR	ratio	$V_O = 0 V$	$R_S = 50 \Omega$	Full range	75			75			dB
ko:-	Supply-voltage rejection	$V_{DD} = \pm 2.2$	√ to ±8 V,	25°C	80	95		80	95		4D
ksvr	ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{IC} = 0 V$	No load	Full range	80			80			dB
Inc	Supply current	V <sub>O</sub> = 2.5 V,	No load	25°C		2.4	3		2.4	3	mA
IDD	ouppiy current	ν() = 2.5 v,	INU IUAU	Full range			3			3	IIIA

<sup>†</sup> Full range is –40°C to 125°C for Q level part, –55°C to 125°C for M level part.

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.



SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

# TLC2272Q and TLC2272M operating characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V

PA	RAMETER	TEST CONDITIONS  TA <sup>†</sup> TLC2272Q, TLC2272M		,		C2272A	,	UNIT			
					MIN	TYP	MAX	MIN	TYP	MAX	
	Slew rate at	V <sub>O</sub> = ±1 V, R <sub>I</sub> =	: 10 kΩ,	25°C	2.3	3.6		2.3	3.6		
SR	unity gain	C <sub>L</sub> = 100 pF	- 10 KS2,	Full range	1.7			1.7			V/μs
V <sub>n</sub>	Equivalent input	f = 10 Hz		25°C		50			50		nV/√ <del>Hz</del>
٧n	noise voltage	f = 1 kHz		25°C		9			9		IIV/√⊓Z
V4.17.7	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
VNPP	noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
	Total harmonic	V <sub>O</sub> = ±2.3 V	A <sub>V</sub> = 1			0.0011%			0.0011%		
THD + N	distortion plus	$R_L = 10 \text{ k}\Omega$	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	noise	f = 20 kHz	A <sub>V</sub> = 100			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	$R_L = 10 \text{ k}\Omega$ ,	25°C		2.25			2.25		MHz
ВОМ	Maximum output-swing bandwidth	V <sub>O(PP)</sub> = 4.6 V, R <sub>L</sub> = 10 kΩ,	A <sub>V</sub> = 1, C <sub>L</sub> = 100 pF	25°C		0.54			0.54		MHz
	Settling time	$A_V = -1$ , Step = -2.3 V to 2.3 V,	To 0.1%	25°C		1.5		1.5			:
t <sub>S</sub>	Setting time	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	To 0.01%	20 0		3.2			3.2		μ\$
φт	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ,	C <sub>L</sub> = 100 pF	25°C		52°			52°		
	Gain margin			25°C		10			10		dB

<sup>†</sup> Full range is –40°C to 125°C for Q level part, –55°C to 125°C for M level part.



# TLC2274Q and TLC2274M electrical characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$ (unless otherwise noted)

	PARAMETER	RAMETER TEST CONDITIONS		T <sub>A</sub> †	TLC2274Q, TLC2274M			TLC2274AQ, TLC2274AM			UNIT	
				^	MIN	TYP	MAX	MIN	TYP	MAX		
V	land offert college			25°C		300	2500		300	950	\/	
VIO	Input offset voltage			Full range			3000			1500	μV	
ανιο	Temperature coefficient of input offset voltage			25°C to 125°C		2			2		μV/°C	
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 2.5 \text{ V},$ $V_{O} = 0 \text{ V},$	$V_{IC} = 0 V$ , $R_S = 50 \Omega$	25°C		0.002			0.002		μV/mo	
110	Input offset current			25°C		0.5	60		0.5	60	pА	
10	input onset current			Full range			800			800	PΛ	
Iв	Input bias current			25°C		1	60		1	60	pА	
'IB	input bias current			Full range			800			800	PA	
\/10D	Common-mode input	Po = 50 O	V <sub>IO</sub>   ≤ 5 mV	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V	
VICR	voltage	$R_S = 50 \Omega,$	V O  ≥ 3 111V	Full range	0 to 3.5			0 to 3.5			V	
		$I_{OH} = -20  \mu A$		25°C		4.99			4.99			
	LPak lavel extend	Jan. 200 A		25°C	4.85	4.93		4.85	4.93		V	
VOH	High-level output voltage	I <sub>OH</sub> = -200 μA		Full range	4.85			4.85				
		I <sub>OH</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65			
				Full range	4.25			4.25				
		$V_{IC} = 2.5 V$ ,	$I_{OL} = 50 \mu A$	25°C		0.01			0.01			
	Low-level output	$V_{IC} = 2.5 V$ ,		25°C		0.09	0.15		0.09	0.15		
VOL	voltage	I <sub>OL</sub> = 500 μA		Full range			0.15			0.15	1	
	<b>g</b> .	V <sub>IC</sub> = 2.5 V,	IOL = 5 mA	25°C		0.9	1.5		0.9	1.5		
		VIC - 2.0 V,	10L = 011//	Full range			1.5			1.5		
	Large-signal differential	V <sub>IC</sub> = 2.5 V,	R <sub>L</sub> = 10 kه	25°C	10	35		10	35			
AVD	voltage amplification	$V_0 = 1 \text{ V to 4 V}$	11 - 10 1221	Full range	10			10			V/mV	
			$R_L = 1 M\Omega^{\ddagger}$	25°C		175			175			
<sup>r</sup> id	Differential input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω	
rį	Common-mode input resistance			25°C		1012			1012		Ω	
ci	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF	
z <sub>0</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		140			140		Ω	
CMRR	Common-mode	V <sub>IC</sub> = 0 V to 2.7 \		25°C	70	75		70	75		٩D	
CIVIRR	rejection ratio	$V_0 = 2.5 \text{ V},$	$R_S = 50 \Omega$	Full range	70			70			dB	
kovis	Supply-voltage rejection	$V_{DD} = 4.4 \text{ V to 1}$		25°C	80	95		80	95		dР	
ksvr	ratio (ΔV <sub>DD</sub> /ΔV <sub>IO</sub> )	$V_{IC} = V_{DD}/2$ ,	No load	Full range	80			80			dB	
Inc	Supply current	V <sub>O</sub> = 2.5 V,	No load	25°C		4.4	6		4.4	6	mA	
lDD	Сирріу бинені	VO = 2.5 V,	140 1000	Full range			6			6		

Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

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.



<sup>‡</sup>Referenced to 2.5 V

SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

### TLC2274Q and TLC2274M operating characteristics at specified free-air temperature, $V_{DD} = 5 \text{ V}$

PA	RAMETER	TEST CONDITIONS TAT TLC2274M		<i>'</i>		C2274A0 .C2274A	,	UNIT			
					MIN	TYP	MAX	MIN	TYP	MAX	
	Slew rate at unity	$V_0 = 0.5 \text{ V to } 2.5 \text{ V},$	C <sub>L</sub> = 100 pF <sup>‡</sup>	25°C	2.3	3.6		2.3	3.6		
SR	gain	$R_L = 10 \text{ k}\Omega^{\ddagger}$	CL = 100 pr+	Full range	1.7			1.7			V/μs
V <sub>n</sub>	Equivalent input	f = 10 Hz		25°C		50			50		nV/√ <del>Hz</del>
٧n	noise voltage	f = 1 kHz		25°C		9			9		NV/VHZ
VALCED	Peak-to-peak	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
V <sub>N(PP)</sub>	equivalent input noise voltage	f = 0.1 Hz to 10 Hz		25°C	C 1.4				1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>
	Total harmonic	$V_{O} = 0.5 \text{ V to } 2.5 \text{ V},$	A <sub>V</sub> = 1			0.0013%			0.0013%		
THD + N	distortion plus	f = 20 kHz,	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	noise	$R_L = 10 \text{ k}\Omega^{\ddagger}$	A <sub>V</sub> = 100			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF <sup>‡</sup>	$R_L = 10 \text{ k}\Omega^{\ddagger}$ ,	25°C		2.18			2.18		MHz
ВОМ	Maximum out- put-swing band- width	$V_{O(PP)} = 2 V,$ $R_{L} = 10 \text{ k}\Omega^{\ddagger},$	A <sub>V</sub> = 1, C <sub>L</sub> = 100 pF‡	25°C		1			1		MHz
<b>+</b> -	Settling time	$A_V = -1$ , Step = 0.5 V to 2.5 V,	To 0.1%	25°C		1.5			1.5		μs
t <sub>S</sub>	Octaing time	$R_L = 10 \text{ k}\Omega^{\ddagger}$ , $C_L = 100 \text{ pF}^{\ddagger}$	To 0.01%	25 0		2.6			2.6		μο
φm	Phase margin at unity gain	$R_L = 10 \text{ k}\Omega^{\ddagger}$ ,	C <sub>L</sub> = 100 pF‡	25°C		50°			50°		
	Gain margin			25°C		10			10		dB

<sup>†</sup> Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.



<sup>‡</sup>Referenced to 2.5 V

# TLC2274Q and TLC2274M electrical characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274Q, TLC2274M			TLC2274AQ, TLC2274AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V. 0	Input offeet voltege			25°C		300	2500		300	950	\/
VIO	Input offset voltage			Full range			3000			1500	μV
ανιο	Temperature coefficient of input offset voltage			25°C to 125°C		2			2		μV/°C
	Input offset voltage long- term drift (see Note 4)	V <sub>IC</sub> = 0 V, R <sub>S</sub> = 50 Ω	$V_O = 0 V$ ,	25°C		0.002			0.002		μV/mo
1	Input offeet ourrent	1		25°C		0.5	60		0.5	60	pА
ΙO	Input offset current			Full range			800			800	рА
	Innut bigg gurrant	]		25°C		1	60		1	60	- A
ΙΒ	Input bias current			Full range			800			800	pА
VICR	Common-mode input	Rs = 50 Ω.	V <sub>IO</sub>   ≤ 5 mV	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2		V
·ICK	voltage	115 - 50 22,	101=0	Full range	-5 to 3.5			-5 to 3.5			•
		$I_{O} = -20 \mu$ A	<b>L</b>	25°C		4.99			4.99		
		I <sub>O</sub> = -200 μ	^	25°C	4.85	4.93		4.85	4.93		
VOM+	VOM+ Maximum positive peak output voltage	10 = 200 μΑ		Full range	4.85			4.85			V
		I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
				Full range	4.25			4.25			
		$V_{IC} = 0 V$ ,	$I_O = 50 \mu\text{A}$	25°C		-4.99			-4.99		
		\/10 = 0 \/	I <sub>O</sub> = 500 μA	25°C	-4.85	-4.91		-4.85	-4.91		
VOM-	Maximum negative peak output voltage	VIC = 0 V,		Full range	-4.85			-4.85			V
	output rollago	\/10 = 0 \/	I <sub>O</sub> = 5 mA	25°C	-3.5	-4.1		-3.5	-4.1		
		$V_{1C} = 0 V_{1}$	10 = 3111A	Full range	-3.5			-3.5			
			R <sub>L</sub> = 10 kΩ	25°C	20	50		20	50		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 4 V$	KL = 10 K22	Full range	20			20			V/mV
	Totage ampinioation		$R_L = 1 M\Omega$	25°C		300			300		
r <sub>id</sub>	Differential input resistance			25°C		10 <sup>12</sup>			1012		Ω
rį	Common-mode input resistance			25°C		10 <sup>12</sup>			10 <sup>12</sup>		Ω
ci	Common-mode input capacitance	f = 10 kHz,	N package	25°C		8			8		pF
z <sub>o</sub>	Closed-loop output impedance	f = 1 MHz,	A <sub>V</sub> = 10	25°C		130			130		Ω
CMRR	Common-mode rejection	V <sub>IC</sub> = -5 V	to 2.7 V	25°C	75	80		75	80		dB
CIVIKK	ratio	$V_O = 0 V$	$R_S = 50 \Omega$	Full range	75			75			ub
kovis	Supply-voltage rejection	$V_{DD\pm}=\pm 2$	.2 V to ±8 V,	25°C	80	95		80	95		4B
ksvr	ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{IC} = 0 V$	No load	Full range	80			80			dB
IDE	Supply current	V <sub>O</sub> = 0 V,	No load	25°C		4.8	6		4.8	6	mA
IDD		νυ – υ ν,		Full range			6			6	

<sup>†</sup> Full range is –40°C to 125°C for Q level part, –55°C to 125°C for M level part.

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.



SLOS190F - FEBRUARY 1997 - REVISED MAY 2001

# TLC2274Q and TLC2274M operating characteristics at specified free-air temperature, $V_{DD\pm}$ = $\pm 5$ V

PARAMETER		TEST CONDITION	T <sub>A</sub> †		LC22740 LC2274N	,	TLC2274AQ, TLC2274AM			UNIT	
					MIN	TYP	MAX	MIN TYP MAX		MAX	
	Slew rate at unity	Va = +2.2 V B.	= 10 kΩ,	25°C	2.3	3.6		2.3	3.6		
SR	gain	$V_O = \pm 2.3 \text{ V}, \qquad R_L = 100 \text{ pF}$	= 10 KS2,	Full range	1.7			1.7			V/µs
V	Equivalent input	f = 10 Hz		25°C		50			50		nV/√ <del>Hz</del>
Vn	noise voltage	f = 1 kHz		25°C		9			9		nv/√Hz
VALCES.	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz		25°C		1			1		μV
VN(PP)	noise voltage	f = 0.1 Hz to 10 Hz		25°C		1.4			1.4		μν
In	Equivalent input noise current			25°C		0.6			0.6		fA/√ <del>Hz</del>
	Total harmonic	$V_{O} = \pm 2.3 \text{ V},$	A <sub>V</sub> = 1			0.0011%			0.0011%		
THD + N	distortion plus	$R_L = 10 \text{ k}\Omega$	A <sub>V</sub> = 10	25°C		0.004%			0.004%		
	noise	f = 20 kHz	A <sub>V</sub> = 100			0.03%			0.03%		
	Gain-bandwidth product	f = 10 kHz, R <sub>L</sub> : C <sub>L</sub> = 100 pF	= 10 kΩ,	25°C		2.25			2.25		MHz
ВОМ	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6 \text{ V},  A_{V} = R_{L} = 10 \text{ k}\Omega,  C_{L} = 0.0 \text{ C}$	= 1, = 100 pF	25°C		0.54			0.54		MHz
	Cattling time	$A_V = -1$ , Step = -2.3 V to 2.3 V,	To 0.1%	25°C		1.5			1.5		
t <sub>S</sub>	Settling time	$R_L = 10 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$	To 0.01%	20 C		3.2			3.2		μs
φm	Phase margin at unit gain	$R_L = 10 \text{ k}\Omega$ , $C_L = 10 \text{ k}\Omega$	= 100 pF	25°C		52°			52°		
	Gain margin	]		25°C		10			10		dB

<sup>†</sup> Full range is –40°C to 125°C for Q level part, –55°C to 125°C for M level part.



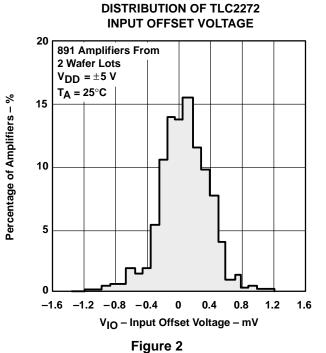
#### **Table of Graphs**

			FIGURE
VIO	Input offset voltage	Distribution vs Common-mode voltage	1 – 4 5, 6
ανιο	Input offset voltage temperature coefficient	Distribution	7 – 10
I <sub>IB</sub> /I <sub>IO</sub>	Input bias and input offset current	vs Free-air temperature	11
VI	Input voltage	vs Supply voltage vs Free-air temperature	12 13
Vон	High-level output voltage	vs High-level output current	14
VOL	Low-level output voltage	vs Low-level output current	15, 16
V <sub>OM+</sub>	Maximum positive peak output voltage	vs Output current	17
V <sub>OM</sub> -	Maximum negative peak output voltage	vs Output current	18
VO(PP)	Maximum peak-to-peak output voltage	vs Frequency	19
los	Short-circuit output current	vs Supply voltage vs Free-air temperature	20 21
Vo	Output voltage	vs Differential input voltage	22, 23
	Large-signal differential voltage amplification	vs Load resistance	24
A <sub>VD</sub>	Large-signal differential voltage amplification and phase margin	vs Frequency	25, 26
	Large-signal differential voltage amplification	vs Free-air temperature	27, 28
z <sub>O</sub>	Output impedance	vs Frequency	29, 30
CMRR	Common-mode rejection ratio	vs Frequency vs Free-air temperature	31 32
ksvr	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature	33, 34 35
I <sub>DD</sub>	Supply current	vs Supply voltage vs Free-air temperature	36, 37 38, 39
SR	Slew rate	vs Load capacitance vs Free-air temperature	40 41
	Inverting large-signal pulse response		42, 43
\/ -	Voltage-follower large-signal pulse response		44, 45
VO	Inverting small-signal pulse response		46, 47
	Voltage-follower small-signal pulse response		48, 49
Vn	Equivalent input noise voltage	vs Frequency	50, 51
	Noise voltage over a 10-second period		52
	Integrated noise voltage	vs Frequency	53
THD + N	Total harmonic distortion plus noise	vs Frequency	54
	Gain-bandwidth product	vs Supply voltage vs Free-air temperature	55 56
φm	Phase margin	vs Load capacitance	57
	Gain margin	vs Load capacitance	58

NOTE: For all graphs where  $V_{DD} = 5 \text{ V}$ , all loads are referenced to 2.5 V.

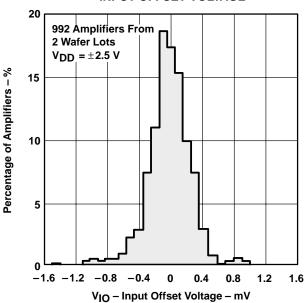


#### **DISTRIBUTION OF TLC2272 INPUT OFFSET VOLTAGE** 20 891 Amplifiers From 2 Wafer Lots $V_{DD} = \pm 2.5 \text{ V}$ T<sub>A</sub> = 25°C Percentage of Amplifiers – % 15 10 5 -1.6 -1.2 -0.8 -0.4 0 0.4 0.8 1.2 1.6 VIO - Input Offset Voltage - mV



## DISTRIBUTION OF TLC2274 INPUT OFFSET VOLTAGE

Figure 1



DISTRIBUTION OF TLC2274 INPUT OFFSET VOLTAGE

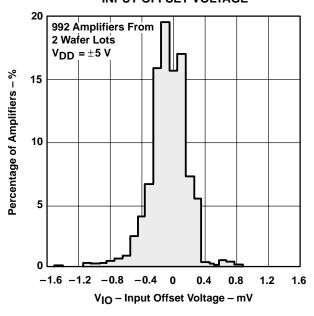
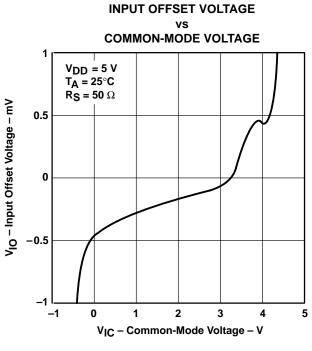


Figure 3

Figure 4





# Figure 5 **DISTRIBUTION OF TLC2272** VS INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT<sup>†</sup> 25 128 Amplifiers From 2 Wafer Lots $V_{DD} = \pm 2.5 V$ 20 P Package Percentage of Amplifiers – %

25°C to 125°C

15

10

5

-5 -4 -3

-2

-1 0 1  $\alpha$ V<sub>IO</sub> – Temperature Coefficient –  $\mu$ V/°C Figure 7

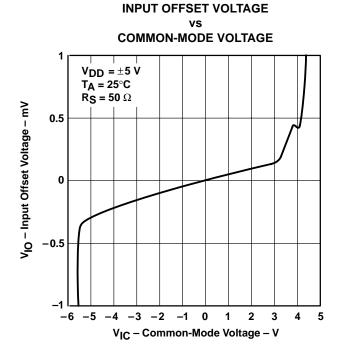


Figure 6

### **DISTRIBUTION OF TLC2272 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT**†

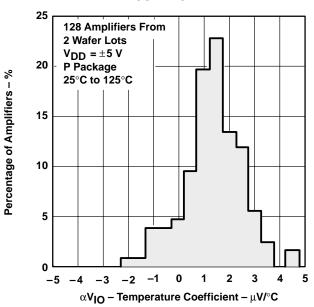


Figure 8

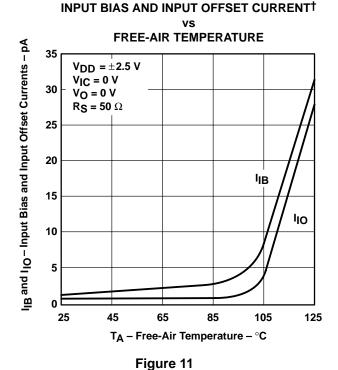
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

5



#### **DISTRIBUTION OF TLC2274** INPUT OFFSET VOLTAGE TEMPERATURE **COEFFICIENT**† 25 128 Amplifiers From 2 Wafer Lots $V_{DD} = \pm 2.5 V$ 20 N Package Percentage of Amplifiers – % $T_A = 25^{\circ}C$ to $125^{\circ}C$ 15 10 5 0 2 -5 -2 -1 $\alpha_{VIO}$ - Temperature Coefficient - $\mu V/^{\circ}C$





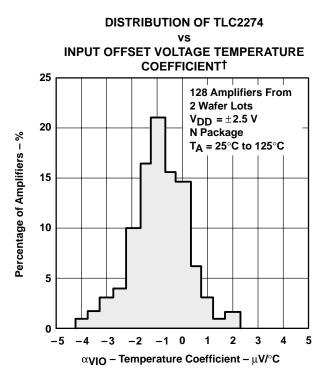
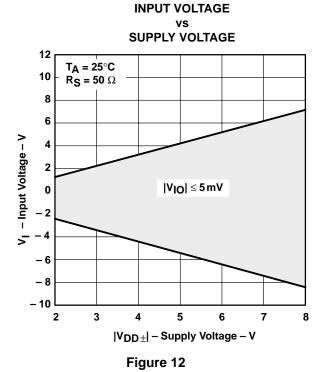
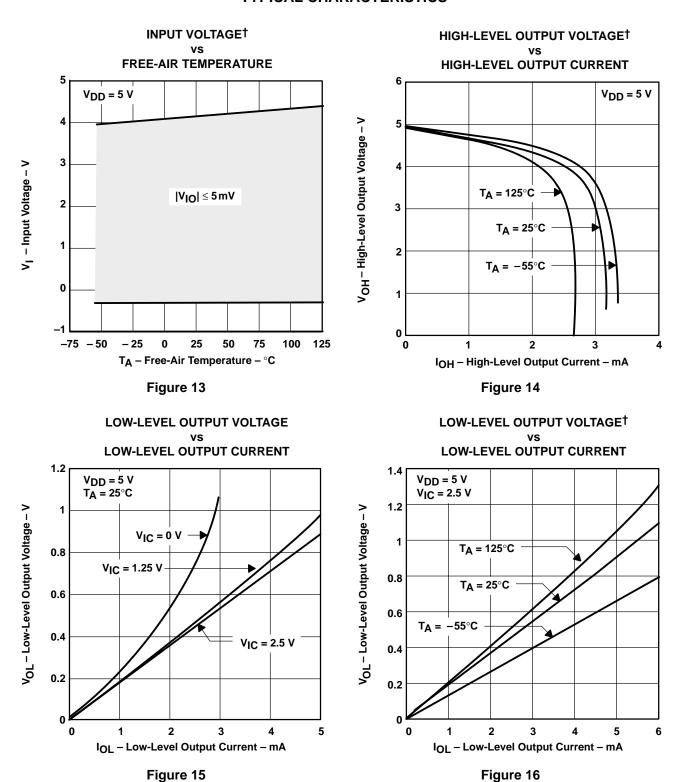


Figure 10



<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.



# MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE<sup>†</sup> **OUTPUT CURRENT** V<sub>OM +</sub> - Maximum Positive Peak Output Voltage - V $V_{DD} \pm = \pm 5 V$ $T_A = -55^{\circ}C$ $T_A = 25^{\circ}C$ $T_A = 125^{\circ}C$ 2 0 3 |IO| - Output Current - mA

MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE<sup>†</sup>

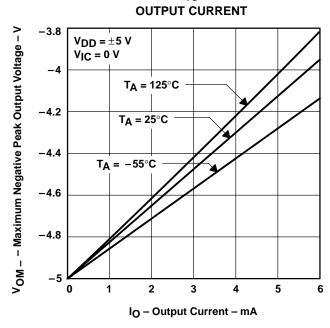
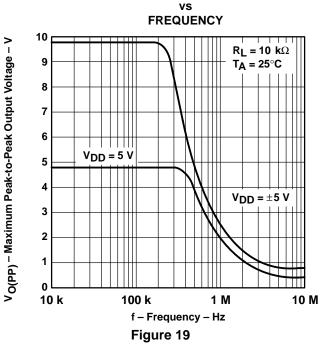


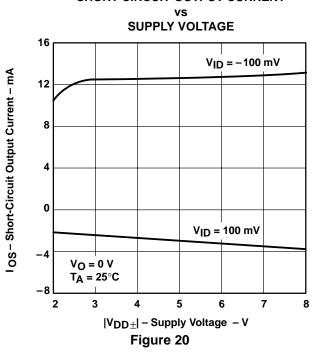
Figure 18

Figure 17





#### SHORT-CIRCUIT OUTPUT CURRENT



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



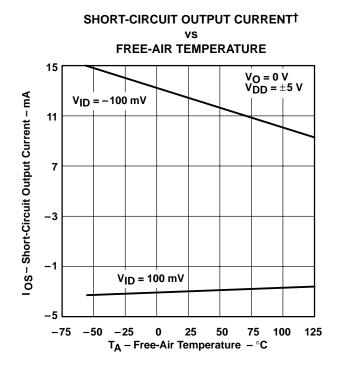


Figure 21

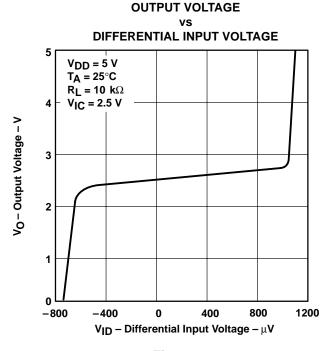
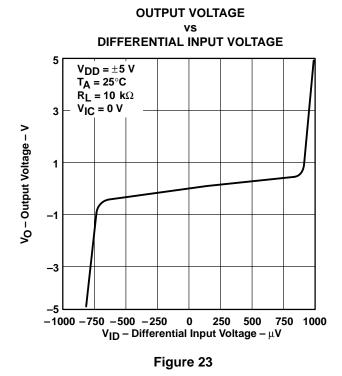
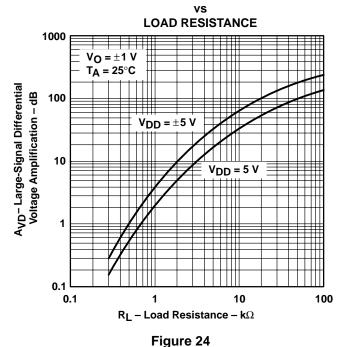


Figure 22

LARGE-SIGNAL DIFFERENTIAL

**VOLTAGE AMPLIFICATION** 





† 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 AMPLIFICATION AND PHASE MARGIN

vs **FREQUENCY** 80 180°  $V_{DD} = 5 V$  $R_L = 10 \text{ k}\Omega$ C<sub>L</sub> = 100 pF T<sub>A</sub> = 25°C 135° 60 A<sub>VD</sub>- Large-Signal Differential Voltage Amplification - dB <sup>0</sup>m − Phase Margin 40 90° 45° 20 0 0° -20 45° -90° -40 10 k 100 k 1 k 1 M 10 M f - Frequency - Hz

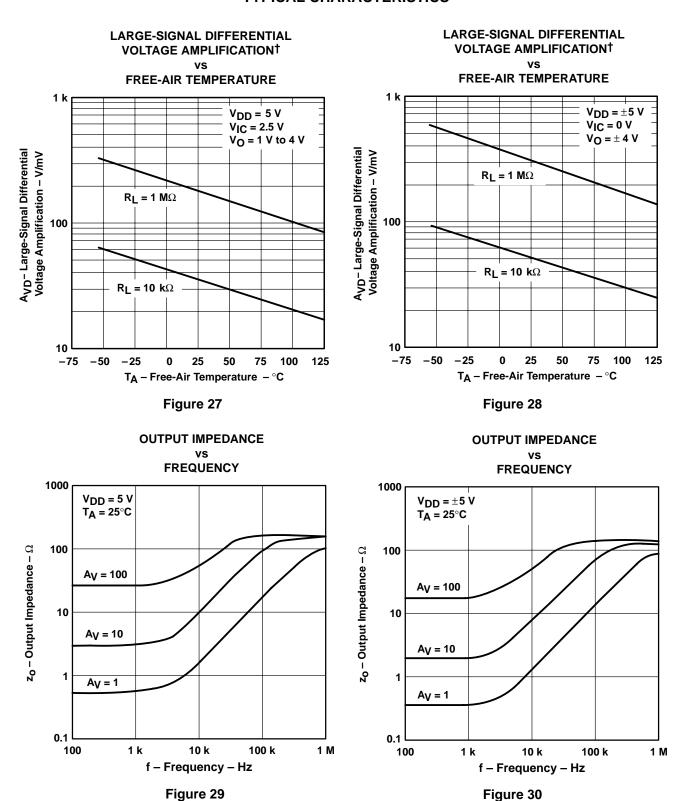
Figure 25

## LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN

**FREQUENCY** 80 180°  $V_{DD} = \pm 5 V$  $R_L = 10 \text{ k}\Omega$  $C_{L}^{-} = 100 \text{ pF}$ 135° 60 T<sub>A</sub> = 25°C A<sub>VD</sub>- Large-Signal Differential Voltage Amplification - dB <sup>o</sup>m − Phase Margin 90° 40 45° 20 **0**° 0 -20 -45° -40 -90° 1 k 10 k 100 k 1 M 10 M f - Frequency - Hz

Figure 26



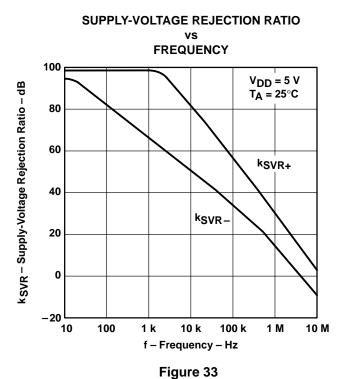


<sup>†</sup> Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



## **COMMON-MODE REJECTION RATIO FREQUENCY** 100 T<sub>A</sub> = 25°C CMRR - Common-Mode Rejection Ratio - dB $V_{DD} = \pm 5 V$ 80 $V_{DD} = 5 V$ 60 40 20 100 10 M 10 1 k 10 k 100 k 1 M f - Frequency - Hz

Figure 31



COMMON-MODE REJECTION RATIO

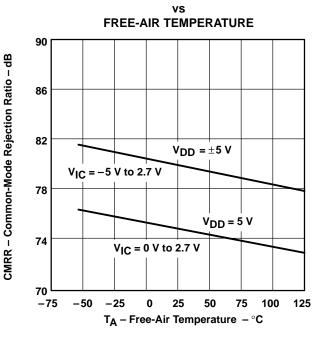


Figure 32

## SUPPLY-VOLTAGE REJECTION RATIO

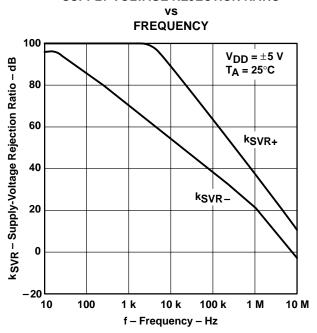


Figure 34



2.4

0

1

I DD - Supply Current - mA

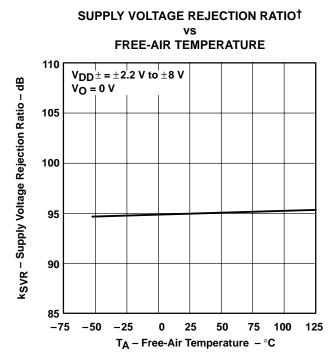
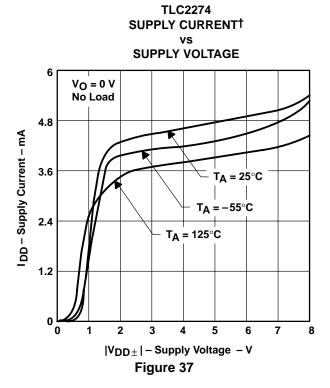


Figure 35



**TLC2272** SUPPLY CURRENT<sup>†</sup> **SUPPLY VOLTAGE**  $V_O = 0 V$ No Load 1.8 T<sub>A</sub> = 25°C  $T_A = -55^{\circ}C$ 1.2 T<sub>A</sub> = 125°C 0.6

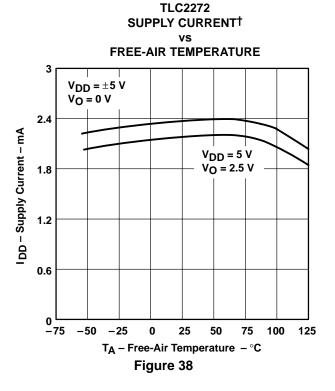
Figure 36

4

 $|V_{DD\pm}|$  – Supply Voltage – V

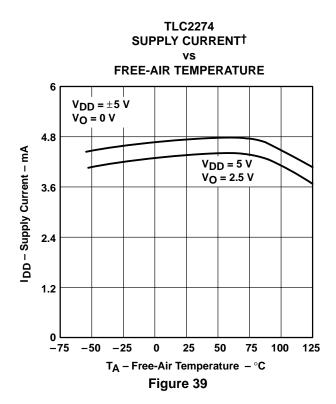
7

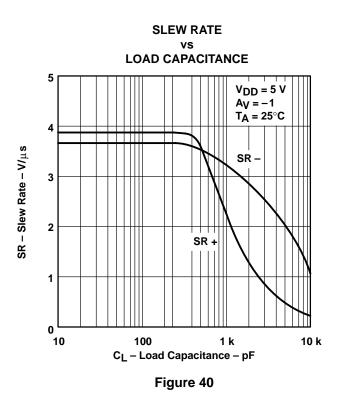
8

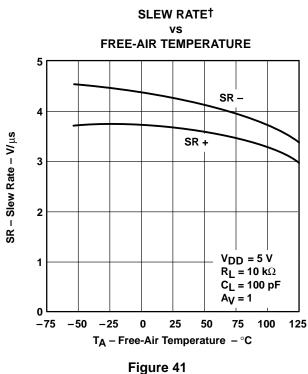


† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.









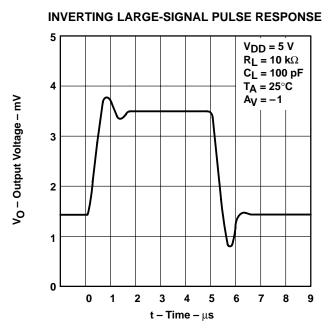


Figure 42

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



#### **INVERTING LARGE-SIGNAL PULSE RESPONSE**

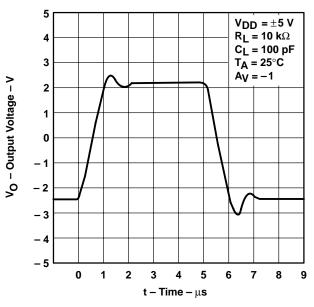


Figure 43

# VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

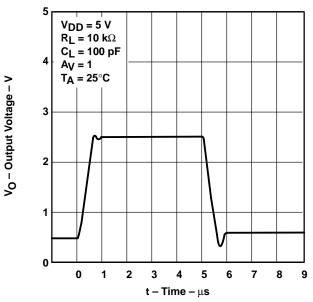


Figure 44

# VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

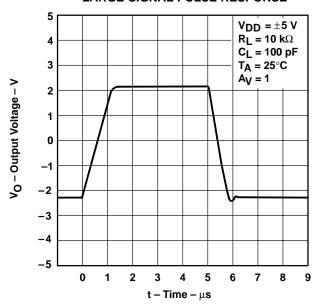


Figure 45

## **INVERTING SMALL-SIGNAL PULSE RESPONSE**

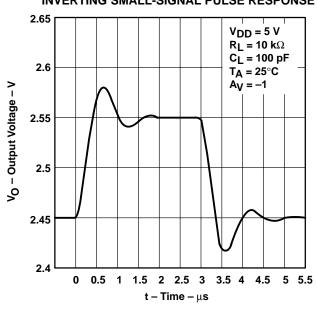


Figure 46

## **INVERTING SMALL-SIGNAL PULSE RESPONSE**

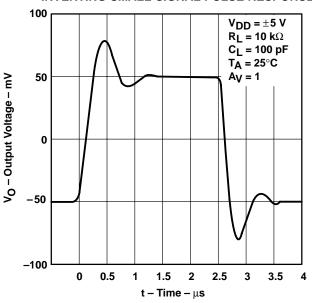


Figure 47

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

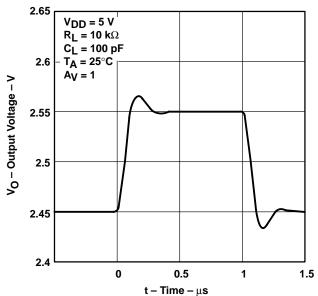


Figure 48

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

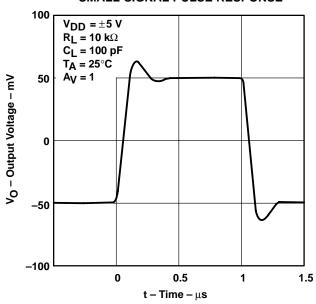


Figure 49

## **EQUIVALENT INPUT NOISE VOLTAGE**

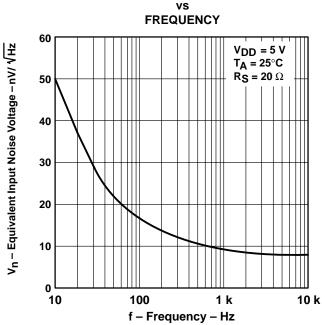


Figure 50



### **EQUIVALENT INPUT NOISE VOLTAGE**

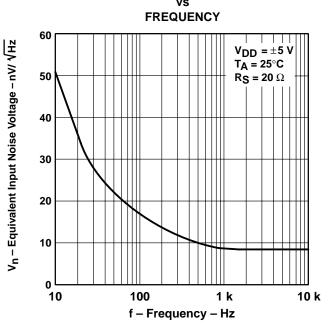


Figure 51

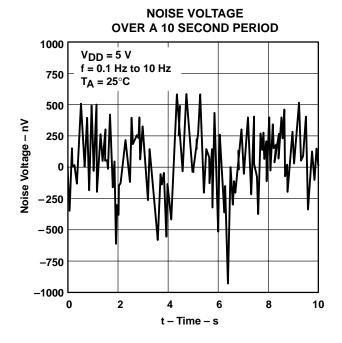


Figure 52

# INTEGRATED NOISE VOLTAGE vs

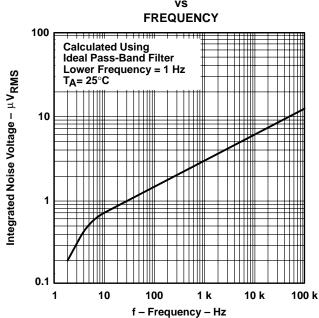


Figure 53

#### TOTAL HARMONIC DISTORTION PLUS NOISE

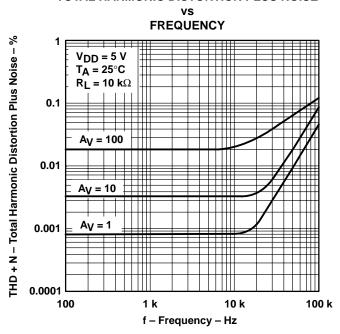
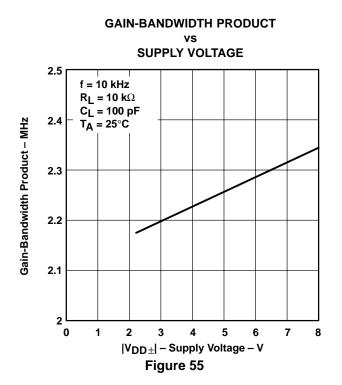
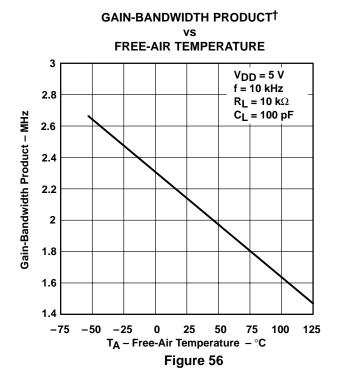
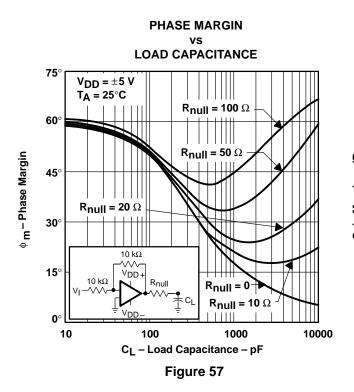


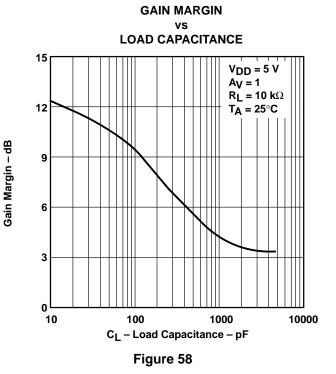
Figure 54











<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

#### macromodel information

Macromodel information provided was derived using Microsim  $Parts^{TM}$ , the model generation software used with Microsim  $PSpice^{TM}$ . The Boyle macromodel (see Note 5) and subcircuit in Figure 59 were generated using the TLC227x typical electrical and operating characteristics at  $T_A = 25$ °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).

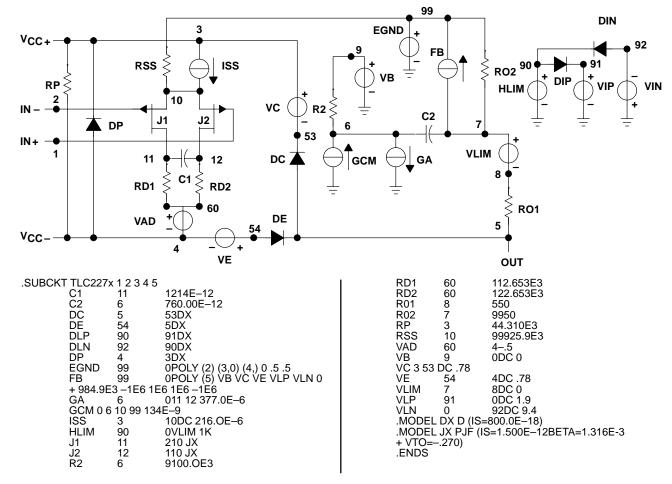


Figure 59. Boyle Macromodel and Subcircuit

PSpice and Parts are trademarks of MicroSim Corporation.

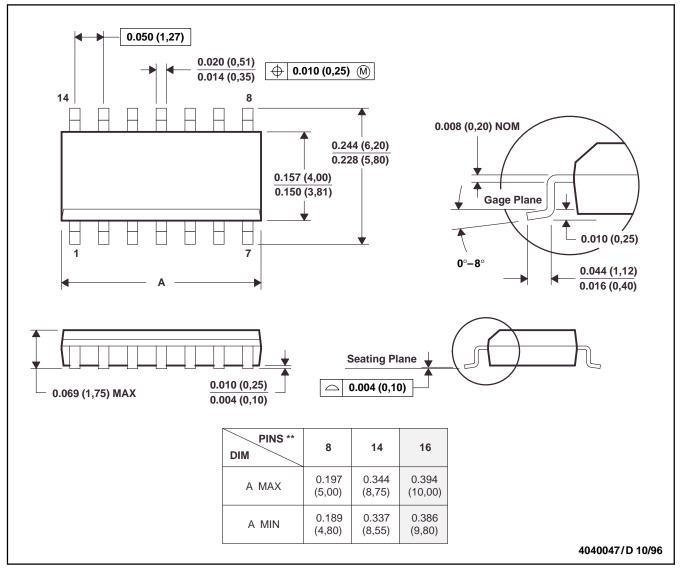


## **MECHANICAL DATA**

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

#### 14 PIN SHOWN

## PLASTIC SMALL-OUTLINE PACKAGE



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

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. Falls within JEDEC MS-012

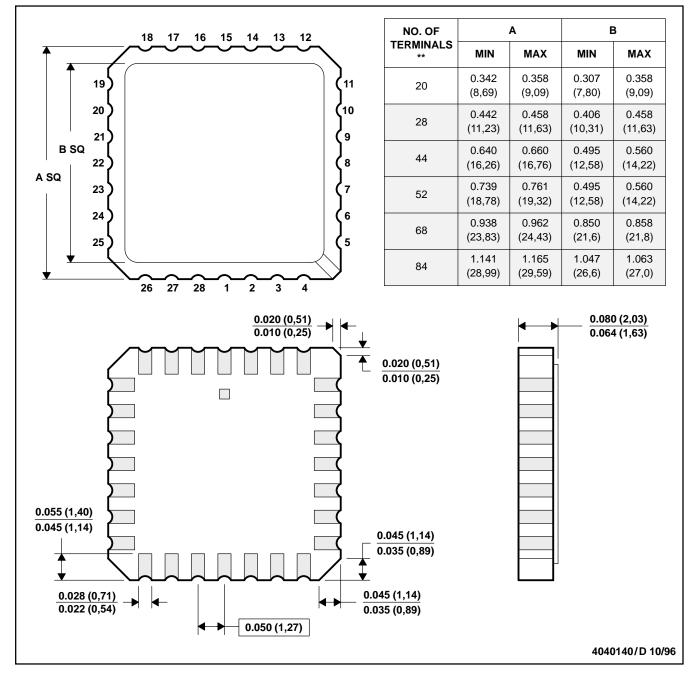


#### **MECHANICAL DATA**

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

#### 28 TERMINAL SHOWN

#### **LEADLESS CERAMIC CHIP CARRIER**



- 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

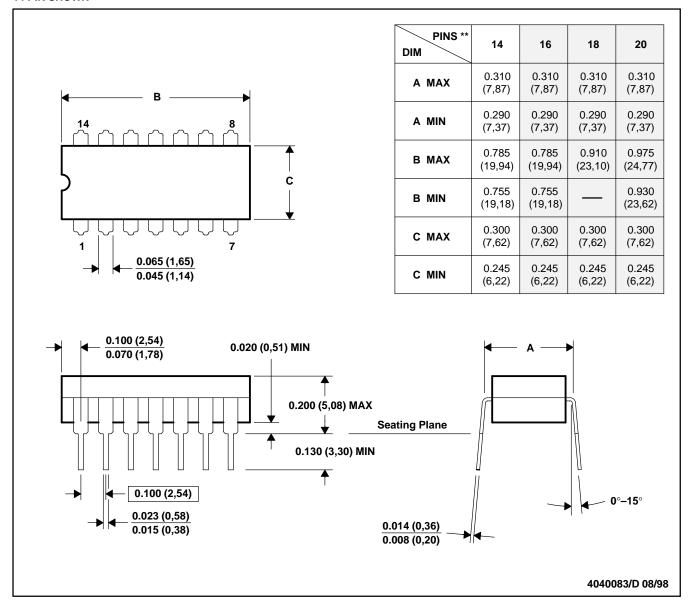


#### **MECHANICAL DATA**

## J (R-GDIP-T\*\*)

## 14 PIN SHOWN

#### **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 on press ceramic glass frit seal.
- E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, GDIP1-T20, and GDIP1-T22.

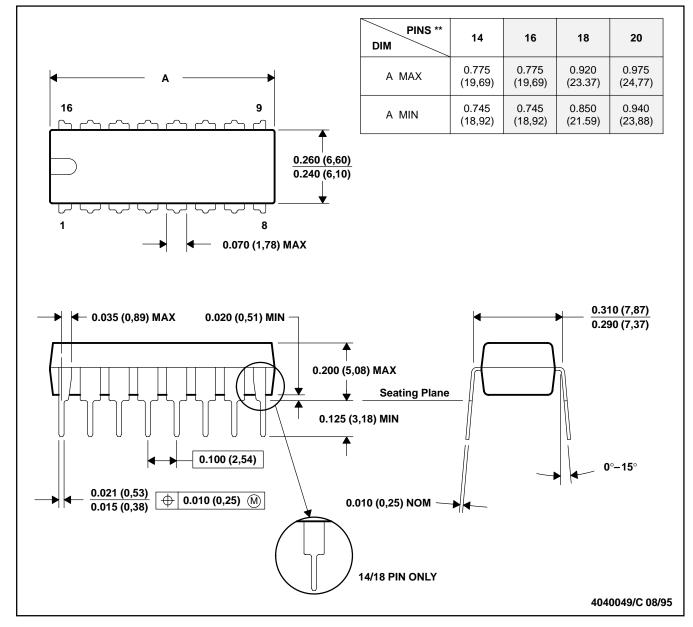


#### **MECHANICAL DATA**

## N (R-PDIP-T\*\*)

#### **16 PIN SHOWN**

#### PLASTIC DUAL-IN-LINE PACKAGE



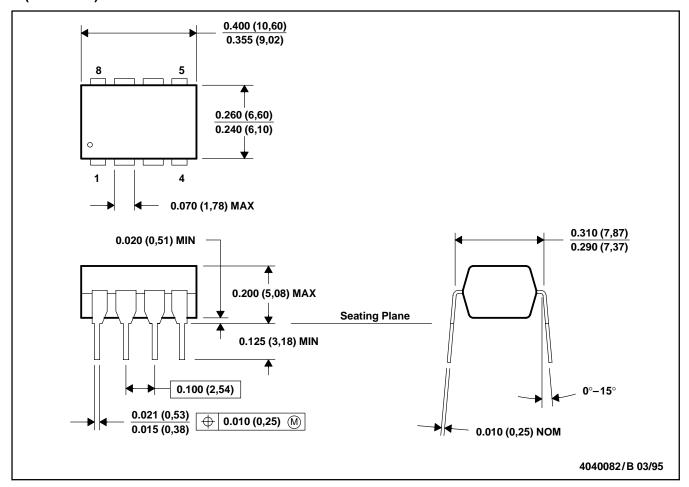
- B. This drawing is subject to change without notice.
- C. Falls within JEDEC MS-001 (20 pin package is shorter then MS-001.)



#### **MECHANICAL DATA**

## P (R-PDIP-T8)

#### PLASTIC DUAL-IN-LINE PACKAGE



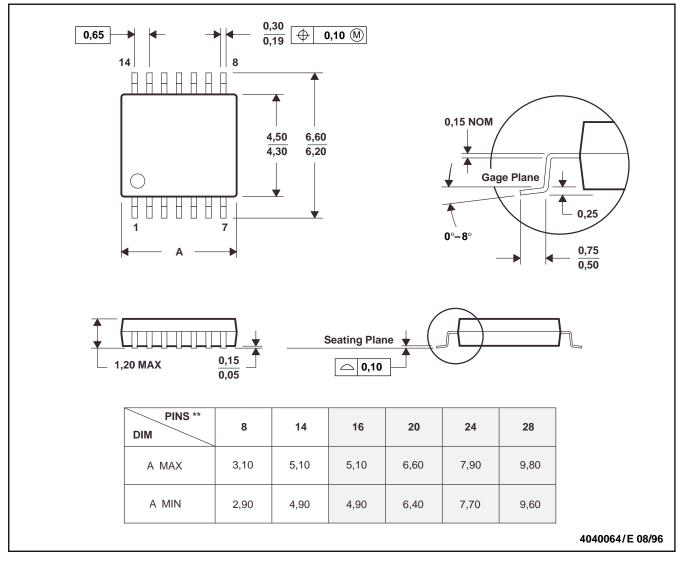
- B. This drawing is subject to change without notice.
- C. Falls within JEDEC MS-001

#### **MECHANICAL DATA**

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

#### 14 PIN SHOWN

## PLASTIC SMALL-OUTLINE PACKAGE



NOTES: A. All linear dimensions are in millimeters.

B. This drawing is subject to change without notice.

C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.

D. Falls within JEDEC MO-153

#### **IMPORTANT NOTICE**

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, license, warranty or endorsement thereof.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations and notices. Representation or reproduction of this information with alteration voids all warranties provided for an associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Resale of TI's products or services with <u>statements different from or beyond the parameters</u> stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service, is an unfair and deceptive business practice, and TI is not responsible nor liable for any such use.

Also see: Standard Terms and Conditions of Sale for Semiconductor Products, www.ti.com/sc/docs/stdterms.htm

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265