

# TLC227x, TLC227xA Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

- Output Swing Includes Both Supply Rails
- Low Noise . . . 9 nV/√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
- Low Input Offset Voltage  
950 μV 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

## description

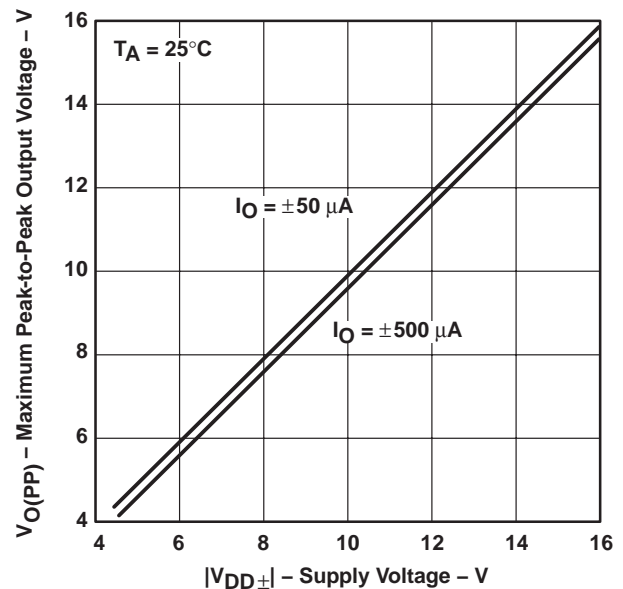
The TLC2272 and TLC2274 are dual and quaduple operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLC227x family offers 2 MHz of bandwidth and 3 V/μs of slew rate for higher speed applications. These devices offer comparable ac performance while having better noise, input offset voltage, and power dissipation than existing CMOS operational amplifiers. The TLC227x has a noise voltage of 9 nV/√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 micro-power 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 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 ±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, 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.

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE  
vs  
SUPPLY VOLTAGE



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.

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



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2004, Texas Instruments Incorporated  
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

#### TLC2272 AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max At 25°C	PACKAGED DEVICES					
		SMALL OUTLINE† (D)	CERAMIC LCC (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP‡ (PW)	CERAMIC FLAT PACK (U)
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	— —
	950 µV 2.5 mV	TLC2272AQD TLC2272QD	— —	— —	—	TLC2272AQPW TLC2272QPW	— —
–55°C to 125°C	950 µV 2.5 mV	TLC2272AMD TLC2272MD	TLC2272AMFK TLC2272MFK	TLC2272AMJG TLC2272MJG	TLC2272AMP TLC2272MP	—	TLC2272AMU TLC2272MU

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

‡ The PW package is available taped and reeled. Add R suffix to the device type (e.g., TLC2272PWR).

§ Chips are tested at 25°C.

#### TLC2274 AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGED DEVICES					
		SMALL OUTLINE† (D)	CERAMIC LCC (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP‡ (PW)	CERAMIC FLAT PACK (W)
0°C to 70°C	950 µV 2.5 mV	TLC2274ACD TLC2274CD	—	—	TLC2274ACN TLC2274CN	TLC2274ACPW TLC2274CPW	—
–40°C to 125°C	950 µV 2.5 mV	TLC2274AID TLC2274ID	—	—	TLC2274AIN TLC2274IN	TLC2274AIPW TLC2274IPW	—
	950 µV 2.5 mV	TLC2274AQD TLC2274QD	—	—	—	—	—
–55°C to 125°C	950 µV 2.5 mV	TLC2274AMD TLC2274MD	TLC2274AMFK TLC2274MFK	TLC2274AMJ TLC2274MJ	TLC2274AMN TLC2274MN	—	TLC2274AMW TLC2274MW

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLC2274CDR).

‡ The PW package is available taped and reeled.

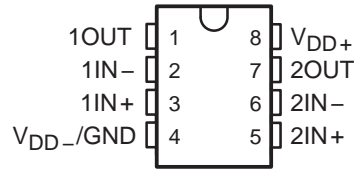
§ Chips are tested at 25°C.

# TLC227x, TLC227xA

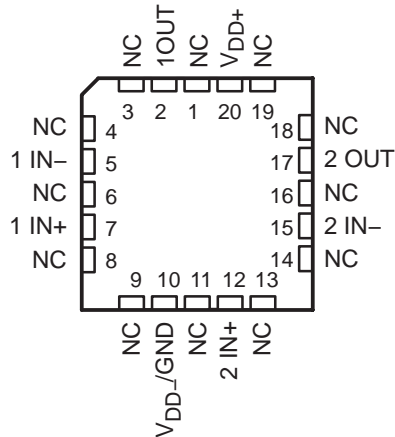
## Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

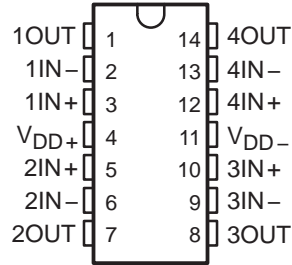
**TLC2272**  
D, JG, P, OR PW PACKAGE  
(TOP VIEW)



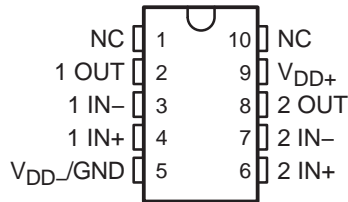
**TLC2272**  
FK PACKAGE  
(TOP VIEW)



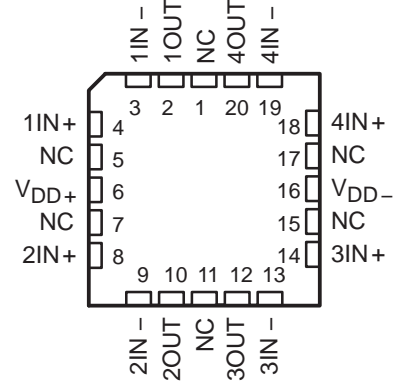
**TLC2274**  
D, J, N, PW, OR W PACKAGE  
(TOP VIEW)



**TLC2272**  
U PACKAGE  
(TOP VIEW)



**TLC2274**  
FK PACKAGE  
(TOP VIEW)



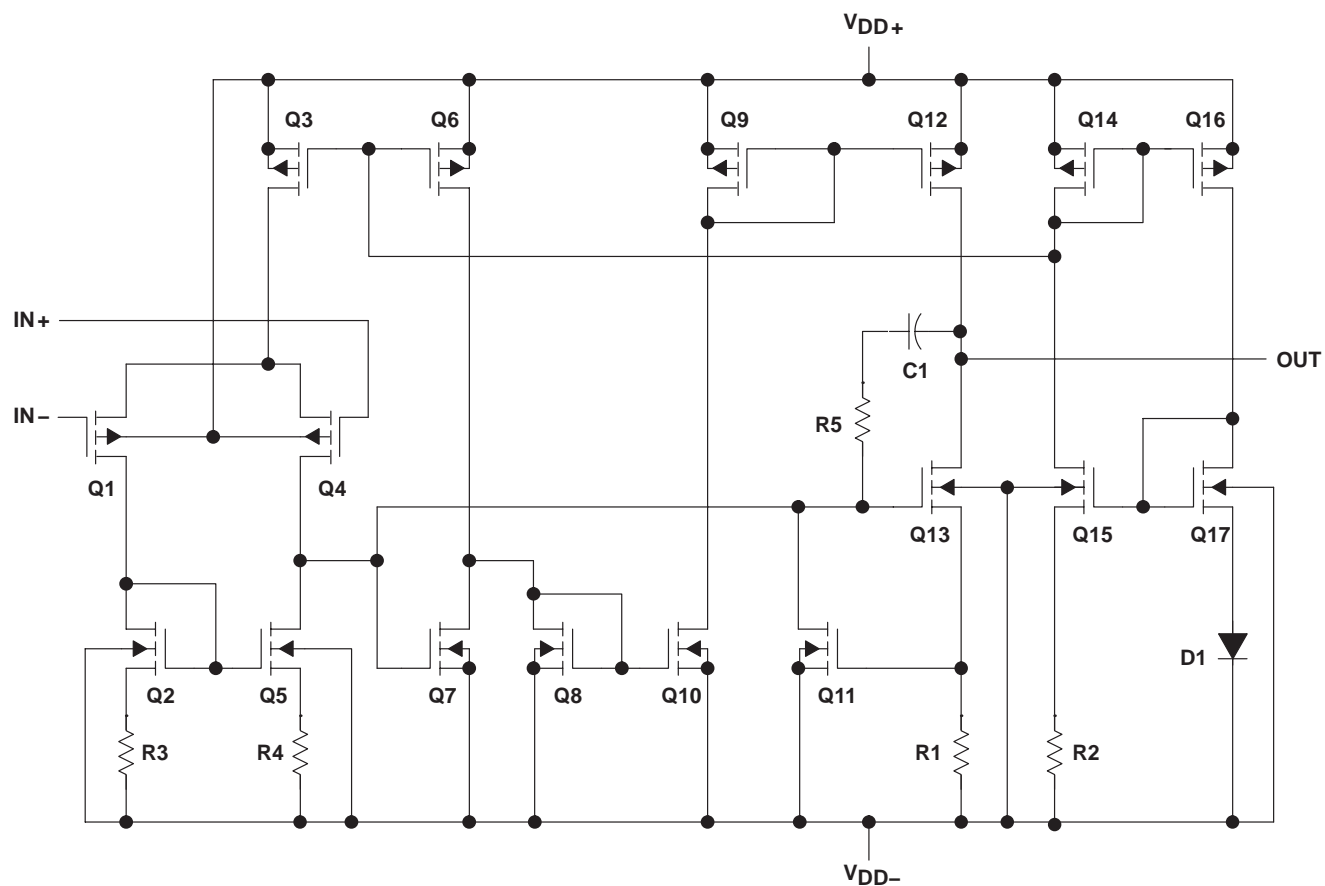
NC – No internal connection

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

equivalent schematic (each amplifier)



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

† Includes both amplifiers and all ESD, bias, and trim circuitry

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

Supply voltage, $V_{DD+}$ (see Note 1)	8 V
Supply voltage, $V_{DD-}$ (see Note 1)	–8 V
Differential input voltage, $V_{ID}$ (see Note 2)	±16 V
Input voltage range, $V_I$ (any input, see Note 1)	$V_{DD-} - 0.3 \text{ V}$ to $V_{DD+}$
Input current, $I_I$ (any input)	±5 mA
Output current, $I_O$	±50 mA
Total current into $V_{DD+}$	±50 mA
Total current out of $V_{DD-}$	±50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5):	
D package (8 pin)	97.1°C/W
D package (14 pin)	86.2°C/W
N package	79.7°C/W
P package	84.6°C/W
PW package (8 pin)	149°C/W
PW package (14 pin)	113°C/W
Package thermal impedance, $\theta_{JC}$ (see Notes 4 and 5):	
FK package	5.6°C/W
J package	15.1°C/W
U package	14.7°C/W
Operating free-air temperature range, $T_A$ :	
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 case for 10 seconds: D, N, P or PW package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J or U package	300°C

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

- NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{DD+}$  and  $V_{DD-}$ .
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ . Excessive current will flow if input is brought below  $V_{DD-} - 0.3 \text{ V}$ .
  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.
  4. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  5. The package thermal impedance is calculated in accordance with JESD 51-7 (plastic) or MIL-STD-883 Method 1012 (ceramic).

**recommended operating conditions**

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD\pm}$	±2.2	±8	±2.2	±8	±2.2	±8	±2.2	±8	V
Input voltage, $V_I$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	V
Common-mode input voltage, $V_{IC}$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	$V_{DD-}$	$V_{DD+} - 1.5$	V
Operating free-air temperature, $T_A$	0	70	–40	125	–40	125	–55	125	°C

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC2272C			TLC2272AC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0\text{ V}$ , $V_{DD} \pm \pm 2.5\text{ V}$ , $V_O = 0\text{ V}$ , $R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 70°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5	60		0.5	60		pA
		Full range		100			100		
$I_{IB}$ Input bias current		25°C	1	60		1	60		pA
		Full range		100			100		
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega$ , $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V
		Full range	0 to 3.5			0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99		V
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.85			4.85			
	$I_{OH} = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65		
		Full range	4.25			4.25			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 50\ \mu\text{A}$	25°C		0.01			0.01		V
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 500\ \mu\text{A}$	25°C	0.09	0.15		0.09	0.15		
		Full range		0.15			0.15		
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 5\text{ mA}$	25°C	0.9	1.5		0.9	1.5		
		Full range		1.5			1.5		
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$	25°C	15	35		15	35		V/mV
		Full range	15			15			
		25°C		175			175		
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$c_i$ Common-mode input capacitance	$f = 10\text{ kHz}$ , P package	25°C		8			8		pF
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz}$ , $A_V = 10$	25°C		140			140		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	75		70	75		dB
		Full range	70			70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95		80	95		dB
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}$ , No load	25°C	2.2	3		2.2	3		mA
		Full range		3			3		

† Full range is 0°C to 70°C.

‡ Referenced to 0 V

NOTE 6: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2272C			TLC2272AC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR      Slew rate at unity gain	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $R_L = 10\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	25°C	2.3	3.6		2.3	3.6		V/ $\mu\text{s}$
		Full range	1.7			1.7			
$V_n$ Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		50			50		nV/ $\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$	25°C		9			9		
$V_{NPP}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		1			1		$\mu\text{V}$
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.4			1.4		
$I_n$ Equivalent input noise current		25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
THD + N      Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $f = 20\text{ kHz}$ , $R_L = 10\text{ k}\Omega^\ddagger$	$A_V = 1$		0.0013%			0.0013%		
		$A_V = 10$		0.004%			0.004%		
		$A_V = 100$		0.03%			0.03%		
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $R_L = 10\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	25°C		2.18		2.18		MHz
BOM      Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V}$ , $A_V = 1$ , $R_L = 10\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	25°C		1			1		MHz
$t_s$ Settling time	$A_V = -1$ , Step = $0.5\text{ V to }2.5\text{ V}$ , $R_L = 10\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	To 0.1%	25°C		1.5		1.5		$\mu\text{s}$
		To 0.01%	25°C		2.6		2.6		
$\phi_m$ 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

$^\dagger$  Full range is 0°C to 70°C.

$^\ddagger$  Referenced to 0 V

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2272C			TLC2272AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>IC</sub> = 0 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	300	2500		300	950	μV	
	Full range				3000		1500				
αV <sub>IO</sub>	Temperature coefficient of input offset voltage			25°C to 70°C	2		2		μV/°C		
	Input offset voltage long-term drift (see Note 4)			25°C	0.002		0.002		μV/mo		
I <sub>IO</sub>	Input offset current			25°C	0.5	60		0.5	60	pA	
				Full range		100		100			
I <sub>IB</sub>	Input bias current			25°C	1	60		1	60	pA	
				Full range		100		100			
V <sub>ICR</sub>	Common-mode input voltage	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	
				Full range	–5 to 3.5		–5 to 3.5				
V <sub>OM+</sub>	Maximum positive peak output voltage	I <sub>O</sub> = –20 μA		25°C	4.99			4.99		V	
		I <sub>O</sub> = –200 μA		25°C	4.85	4.93		4.85	4.93		
				Full range	4.85			4.85			
		I <sub>O</sub> = –1 mA		25°C	4.25	4.65		4.25	4.65		
				Full range	4.25			4.25			
V <sub>OM–</sub>	Maximum negative peak output voltage	V <sub>IC</sub> = 0 V, I <sub>O</sub> = 50 μA		25°C	–4.99			–4.99		V	
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 500 μA		25°C	–4.85	–4.91		–4.85	–4.91		
				Full range	–4.85			–4.85			
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 5 mA		25°C	–3.5	–4.1		–3.5	–4.1		
				Full range	–3.5			–3.5			
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>O</sub> = ±4 V	R <sub>L</sub> = 10 kΩ	25°C	25	50		25	50	V/mV	
			R <sub>L</sub> = 1 mΩ	Full range	25			25			
				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,	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 ratio	V <sub>IC</sub> = –5 V to 2.7 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	75	80		75	80	dB	
				Full range	75			75			
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	V <sub>DD±</sub> = 2.2 V to ±8 V, V <sub>IC</sub> = 0 V, No load		25°C	80	95		80	95	dB	
				Full range	80			80			
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0 V No load		25°C	2.4	3		2.4	3	mA	
				Full range	3			3			

† Full range is 0°C to 70°C.

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





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

PARAMETER		TEST CONDITIONS		$T_A^\dagger$	TLC2272C			TLC2272AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 2.3\text{ V}$ , $C_L = 100\text{ pF}$	$R_L = 10\text{ k}\Omega$	25°C	2.3	3.6		2.3	3.6		V/ $\mu\text{s}$
				Full range	1.7			1.7			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$		25°C		50			50		nV/ $\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$		25°C		9			9		
$V_{NPP}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$		25°C		1			1		$\mu\text{V}$
		$f = 0.1\text{ Hz to }10\text{ Hz}$		25°C		1.4			1.4		
$I_n$	Equivalent input noise current			25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion pulse duration	$V_O = \pm 2.3\text{ V}$ , $f = 20\text{ kHz}$ , $R_L = 10\text{ k}\Omega$	$A_V = 1$	25°C		0.0011%			0.0011%		
			$A_V = 10$			0.004%			0.004%		
			$A_V = 100$			0.03%			0.03%		
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 10\text{ k}\Omega$	25°C		2.25			2.25		MHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 10\text{ k}\Omega$	$A_V = 1$ , $C_L = 100\text{ pF}$	25°C		0.54			0.54		MHz
$t_s$	Settling time	$A_V = -1$ , Step = $-2.3\text{ V to }2.3\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	To 0.1%	25°C		1.5			1.5		$\mu\text{s}$
			To 0.01%			3.2			3.2		
$\phi_m$	Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$		25°C		52°			52°		
	Gain margin			25°C		10			10		dB

$^\dagger$  Full range is 0°C to 70°C.

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2274C			TLC2274AC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD\pm} = \pm 2.5\text{ V}$ , $V_{IC} = 0\text{ V}$ , $V_O = 0\text{ V}$ , $R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 70°C		2			2		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.002			0.002		$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C		0.5	60		0.5	60	pA
		Full range			100			100	
$I_{IB}$ Input bias current		25°C		1	60		1	60	pA
		Full range			100			100	
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega$ , $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	–0.3 to 4.2		0 to 4	–0.3 to 4.2		V
		Full range	0 to 3.5			0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99		V
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
	$I_{OH} = -1\text{ mA}$	Full range	4.85			4.85			
		25°C	4.25	4.65		4.25	4.65		
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 50\ \mu\text{A}$	25°C		0.01			0.01		V
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 500\ \mu\text{A}$	25°C	0.09	0.15		0.09	0.15		
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 5\text{ mA}$	Full range		0.15			0.15		
		25°C	0.9	1.5		0.9	1.5		
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to } 4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	15	35	15	35		V/mV
		$R_L = 1\text{ m}\Omega^\ddagger$	25°C	175		175			
			Full range	15		15			
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$c_i$ Common-mode input capacitance	$f = 10\text{ kHz}$ , N package	25°C		8			8		pF
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz}$ , $A_V = 10$	25°C		140			140		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to } 2.7\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	75		70	75		dB
		Full range	70			70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to } 16\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95		80	95		dB
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}$ , No load	25°C		4.4	6		4.4	6	mA
		Full range			6			6	

$^\dagger$  Full range is 0°C to 70°C.

$^\ddagger$  Referenced to 0 V

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



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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274C			TLC2274AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ‡, C <sub>L</sub> = 100 pF‡		25°C	2.3	3.6		2.3	3.6		V/μs
				Full range	1.7			1.7			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV/√Hz
		f = 1 kHz		25°C	9			9			
V <sub>N(PP)</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA/√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = 0.5 V to 2.5 V, f = 20 kHz, R <sub>L</sub> = 10 kΩ‡	A <sub>V</sub> = 1	25°C	0.0013%			0.0013%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF‡	R <sub>L</sub> = 10 kΩ‡,	25°C	2.18			2.18			MHz
BOM	Maximum output-swing bandwidth	V <sub>O(PP)</sub> = 2 V, R <sub>L</sub> = 10 kΩ‡,	A <sub>V</sub> = 1, C <sub>L</sub> = 100 pF‡	25°C	1			1			MHz
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ‡, C <sub>L</sub> = 100 pF‡	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		2.6			2.6			
φ <sub>m</sub>	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ‡, C <sub>L</sub> = 100 pF‡		25°C	50°			50°			
	Gain margin			25°C	10			10			dB

$^\dagger$  Full range is 0°C to 70°C.

$^\ddagger$  Referenced to 0 V

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274C			TLC2274AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>IC</sub> = 0 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	300	2500		300	950	μV	
	Full range			3000			1500				
αV <sub>IO</sub>	Temperature coefficient of input offset voltage			25°C to 70°C	2			2			μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C	0.002			0.002			μV/mo
I <sub>IO</sub>	Input offset current			25°C	0.5	60		0.5	60	pA	
				Full range	100			100			
I <sub>IB</sub>	Input bias current			25°C	1	60		1	60	pA	
				Full range	100			100			
V <sub>ICR</sub>	Common-mode input voltage	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	
				Full range	-5 to 3.5			-5 to 3.5			
V <sub>OM+</sub>	Maximum positive peak output voltage	I <sub>O</sub> = -20 μA		25°C	4.99			4.99			V
		I <sub>O</sub> = -200 μA		25°C	4.85	4.93		4.85	4.93		
				Full range	4.85			4.85			
				I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	
				Full range	4.25			4.25			
V <sub>OM-</sub>	Maximum negative peak output voltage	V <sub>IC</sub> = 0 V, I <sub>O</sub> = 50 μA		25°C	-4.99			-4.99			V
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 500 μA		25°C	-4.85	-4.91		-4.85	-4.91		
				Full range	-4.85			-4.85			
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = -5 mA		25°C	-3.5	-4.1		-3.5	-4.1		
				Full range	-3.5			-3.5			
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>O</sub> = ±4 V	R <sub>L</sub> = 10 kΩ	25°C	25	50		25	50	V/mV	
				Full range	25			25			
			R <sub>L</sub> = 1 MΩ	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
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = -5 V to 2.7 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	75	80		75	80	dB	
				Full range	75			75			
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	V <sub>DD±</sub> = ±2.2 V to ±8 V, V <sub>IC</sub> = 0 V, No load		25°C	80	95		80	95	dB	
				Full range	80			80			
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0 V, No load		25°C	4.8	6		4.8	6	mA	
				Full range	6			6			

$^\dagger$  Full range is 0°C to 70°C.

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



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

PARAMETER		TEST CONDITIONS		$T_A^\dagger$	TLC2274C			TLC2274AC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 2.3\text{ V}$ , $C_L = 100\text{ pF}$	$R_L = 10\text{ k}\Omega$	25°C	2.3	3.6		2.3	3.6		V/ $\mu\text{s}$
				Full range	1.7			1.7			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$		25°C		50			50		nV/ $\sqrt{\text{Hz}}$
		$f = 1\text{ Hz}$		25°C		9			9		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$		25°C		1			1		$\mu\text{V}$
		$f = 0.1\text{ Hz to }10\text{ Hz}$		25°C		1.4			1.4		
$I_n$	Equivalent input noise current			25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3\text{ V}$ , $f = 20\text{ kHz}$ , $R_L = 10\text{ k}\Omega$	$A_V = 1$	25°C		0.0011%			0.0011%		
			$A_V = 10$			0.004%			0.004%		
			$A_V = 100$			0.03%			0.03%		
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 10\text{ k}\Omega$	25°C		2.25			2.25		MHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 10\text{ k}\Omega$	$A_V = 1$ , $C_L = 100\text{ pF}$	25°C		0.54			0.54		MHz
$t_s$	Settling time	$A_V = -1$ , Step = $-2.3\text{ V to }2.3\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	To 0.1%	25°C		1.5			1.5		$\mu\text{s}$
			To 0.01%			3.2			3.2		
$\phi_m$	Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$		25°C		52°			52°		
	Gain margin			25°C		10			10		dB

$^\dagger$  Full range is 0°C to 70°C.

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2272I			TLC2272AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0\text{ V},$ $V_O = 0\text{ V},$ $V_{DD\pm} = \pm 2.5\text{ V}$ $R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 85°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5	60		0.5	60		pA
		–40°C to 85°C		150			150		
		Full range		800			800		
$I_{IB}$ Input bias current		25°C	1	60		1	60		pA
		–40°C to 85°C		150			150		
		Full range		800			800		
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega,$ $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	–0.3 to 4.2		0 to 4	–0.3 to 4.2		V
		Full range	0 to 3.5			0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99		V
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.85			4.85			
	$I_{OH} = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65		
		Full range	4.25			4.25			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 50\ \mu\text{A}$	25°C		0.01			0.01		V
		25°C	0.09	0.15		0.09	0.15		
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	Full range		0.15			0.15		
		25°C	0.9	1.5		0.9	1.5		
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 5\text{ mA}$	Full range		1.5			1.5		
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	15	35		15	35	V/mV
			Full range	15			15		
		$R_L = 1\text{ m}\Omega^\ddagger$	25°C	175			175		
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$C_i$ Common-mode input capacitance	$f = 10\text{ kHz},$ P package	25°C		8			8		pF
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz},$ $A_V = 10$	25°C		140			140		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	75		70	75		dB
		Full range	70			70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	25°C	80	95		80	95		dB
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V},$ No load	25°C		2.2	3		2.2	3	mA
		Full range			3			3	

$^\dagger$  Full range is –40°C to 125°C.

$^\ddagger$  Referenced to 0 V

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



**TLC227x, TLC227xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**OPERATIONAL AMPLIFIERS**

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> <sup>†</sup>	TLC2272I			TLC2272AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	2.3	3.6		2.3	3.6		V/μs
				Full range	1.7			1.7			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV√Hz
		f = 1 kHz		25°C	9			9			
V <sub>NPP</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = 0.5 V to 2.5 V, f = 20 kHz, R <sub>L</sub> = 10 kΩ <sup>‡</sup>	A <sub>V</sub> = 1	25°C	0.0013%			0.0013%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF <sup>‡</sup>	R <sub>L</sub> = 10 kΩ <sup>‡</sup> ,	25°C	2.18			2.18			MHz
BOM	Maximum output-swing bandwidth	V <sub>O</sub> (PP) = 2 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> ,	A <sub>V</sub> = 1, C <sub>L</sub> = 100 pF <sup>‡</sup>	25°C	1			1			MHz
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		2.6			2.6			
φ <sub>m</sub>	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	50°			50°			
	Gain margin			25°C	10			10			dB

$^\dagger$  Full range is – 40°C to 125°C.

$^\ddagger$  Referenced to 0 V

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2272I			TLC2272AI			UNIT		
					MIN	TYP	MAX	MIN	TYP	MAX			
V <sub>IO</sub>	Input offset voltage	V <sub>IC</sub> = 0 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	300		2500	300		950	μV		
				Full range			3000			1500			
α <sub>VIO</sub>	Temperature coefficient of input offset voltage			25°C to 85°C	2				2				μV/°C
				25°C	0.002				0.002				μV/mo
I <sub>IO</sub>	Input offset current			25°C	0.5		60		0.5		60		pA
				–40°C to 85°C		150		150					
				Full range		800		800					
I <sub>IB</sub>	Input bias current			25°C	1		60		1		60		pA
				–40°C to 85°C		150		150					
				Full range		800		800					
V <sub>ICR</sub>	Common-mode input voltage	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			
				Full range	–5 to 3.5		–5 to 3.5						
V <sub>OM+</sub>	Maximum positive peak output voltage	I <sub>O</sub> = –20 μA		25°C	4.99		4.99				V		
		I <sub>O</sub> = –200 μA		25°C	4.85	4.93	4.85		4.93				
				Full range	4.85		4.85						
		I <sub>O</sub> = –1 mA		25°C	4.25	4.65	4.25		4.65				
				Full range	4.25		4.25						
V <sub>OM–</sub>	Maximum negative peak output voltage	V <sub>IC</sub> = 0 V, I <sub>O</sub> = 50 μA		25°C	–4.99		–4.99				V		
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 500 μA		25°C	–4.85	–4.91	–4.85		–4.91				
				Full range	–4.85		–4.85						
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 5 mA		25°C	–3.5	–4.1	–3.5		–4.1				
				Full range	–3.5		–3.5						
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>O</sub> = ±4 V	R <sub>L</sub> = 10 kΩ	25°C	25	50	25		50	V/mV			
			Full range		25		25						
			R <sub>L</sub> = 1 mΩ	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,	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 ratio	V <sub>IC</sub> = –5 V to 2.7 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	75	80	75		80	dB			
				Full range		75		75					
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>DD</sub> ±/ΔV <sub>IO</sub> )	V <sub>DD</sub> = 4.4 V to 16 V, V <sub>IC</sub> = V <sub>DD</sub> /2, No load		25°C	80	95	80		95	dB			
				Full range		80		80					
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0 V, No load		25°C	2.4		3	2.4		3	mA		
				Full range		3		3					

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





**TLC227x, TLC227xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**OPERATIONAL AMPLIFIERS**

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		$T_A^\dagger$	TLC2272I			TLC2272AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = \pm 2.3\text{ V}$ , $C_L = 100\text{ pF}$	$R_L = 10\text{ k}\Omega$ ,	25°C	2.3	3.6		2.3	3.6		V/ $\mu\text{s}$
				Full range	1.7			1.7			
$V_n$	Equivalent input noise voltage	$f = 10\text{ Hz}$		25°C		50			50		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$		25°C		9			9		
$V_{NPP}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$		25°C		1			1		$\mu\text{V}$
		$f = 0.1\text{ Hz to }10\text{ Hz}$		25°C		1.4			1.4		
$I_n$	Equivalent input noise current			25°C		0.6			0.6		$\text{fA}/\sqrt{\text{Hz}}$
THD + N	Total harmonic distortion plus noise	$V_O = \pm 2.3\text{ V}$ $R_L = 10\text{ k}\Omega$ , $f = 20\text{ kHz}$	$A_V = 1$	25°C		0.0011%			0.0011%		
			$A_V = 10$			0.004%			0.004%		
			$A_V = 100$			0.03%			0.03%		
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}$	$R_L = 10\text{ k}\Omega$ ,	25°C		2.25			2.25		MHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 4.6\text{ V}$ , $R_L = 10\text{ k}\Omega$ ,	$A_V = 1$ , $C_L = 100\text{ pF}$	25°C		0.54			0.54		MHz
$t_s$	Settling time	$A_V = -1$ , Step = $-2.3\text{ V to }2.3\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	To 0.1%	25°C		1.5			1.5		$\mu\text{s}$
			To 0.01%			3.2			3.2		
$\phi_m$	Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$		25°C		52°			52°		
	Gain margin			25°C		10			10		dB

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2274I			TLC2274AI			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD} = \pm 2.5\text{ V}, V_{IC} = 0\text{ V}, V_O = 0\text{ V}, R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 85°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5	60		0.5	60		pA
		–40°C to 85°C		150			150		
		Full range		800			800		
$I_{IB}$ Input bias current		25°C	1	60		1	60		pA
		–40°C to 85°C		150			150		
		Full range		800			800		
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega,  V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	–0.3 to 4.2		0 to 4	–0.3 to 4.2		V
		Full range	0 to 3.5			0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99		V
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.85			4.85			
	$I_{OH} = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65		
		Full range	4.25			4.25			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}, I_{OL} = 50\ \mu\text{A}$	25°C		0.01			0.01		V
	$V_{IC} = 2.5\text{ V}, I_{OL} = 500\ \mu\text{A}$	25°C		0.09 0.15			0.09 0.15		
		Full range		0.15			0.15		
	$V_{IC} = 2.5\text{ V}, I_{OL} = 5\text{ mA}$	25°C		0.9 1.5			0.9 1.5		
		Full range		1.5			1.5		
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}, V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	15	35	15	35		V/mV
			Full range	15		15			
		$R_L = 1\text{ M}\Omega^\ddagger$	25°C	175		175			
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$C_i$ Common-mode input capacitance	$f = 10\text{ kHz}, \text{ N package}$	25°C		8			8		pF
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz}, A_V = 10$	25°C		140			140		$\Omega$
$CMRR$ Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V}, V_O = 2.5\text{ V}, R_S = 50\ \Omega$	25°C	70	75		70	75		dB
		Full range	70			70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}, V_{IC} = V_{DD}/2, \text{ No load}$	25°C	80	95		80	95		dB
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}, \text{ No load}$	25°C		4.4 6			4.4 6		mA
		Full range		6			6		

$^\dagger$  Full range is –40°C to 125°C.

$^\ddagger$  Referenced to 0 V

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



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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> <sup>†</sup>	TLC2274I			TLC2274AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	2.3	3.6		2.3	3.6		V/μs
				Full range	1.7			1.7			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV/√Hz
		f = 1 kHz		25°C	9			9			
V <sub>N(PP)</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA/√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = 0.5 V to 2.5 V, f = 20 kHz, R <sub>L</sub> = 10 kΩ <sup>‡</sup>	A <sub>V</sub> = 1	25°C	0.0013%			0.0013%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	2.18			2.18			MHz
BOM	Maximum output-swing bandwidth	V <sub>O(PP)</sub> = 2 V, A <sub>V</sub> = 1, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	1			1			MHz
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		2.6			2.6			
φ <sub>m</sub>	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	50°			50°			
	Gain margin			25°C	10			10			dB

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

$^\ddagger$  Referenced to 0 V

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274I			TLC2274AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>IC</sub> = 0 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	300	2500	300	950	μV		
	Full range			3000			1500				
α <sub>VIO</sub>	Temperature coefficient of input offset voltage			25°C to 85°C	2			2		μV/°C	
	Input offset voltage long-term drift (see Note 4)			25°C	0.002			0.002		μV/mo	
I <sub>IO</sub>	Input offset current			25°C	0.5	60	0.5	60	pA		
				–40°C to 85°C	150			150			
				Full range	800			800			
I <sub>IB</sub>	Input bias current			25°C	1	60	1	60	pA		
				–40°C to 85°C	150			150			
				Full range	800			800			
V <sub>ICR</sub>	Common-mode input voltage	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		
				Full range	–5 to 3.5		–5 to 3.5				
V <sub>OM+</sub>	Maximum positive peak output voltage	I <sub>O</sub> = –20 μA		25°C	4.99		4.99		V		
				25°C	4.85	4.93	4.85	4.93			
				Full range	4.85		4.85				
				25°C	4.25	4.65	4.25	4.65			
				Full range	4.25		4.25				
V <sub>OM–</sub>	Maximum negative peak output voltage	V <sub>IC</sub> = 0 V, I <sub>O</sub> = 50 μA		25°C	–4.99		–4.99		V		
				25°C	–4.85	–4.91	–4.85	–4.91			
				Full range	–4.85		–4.85				
				25°C	–3.5	–4.1	–3.5	–4.1			
				Full range	–3.5		–3.5				
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>O</sub> = ±4 V	R <sub>L</sub> = 10 kΩ	25°C	25	50	25	50	V/mV		
				Full range	25		25				
			R <sub>L</sub> = 1 MΩ	25°C	300		300				
r <sub>id</sub>	Differential input resistance			25°C	10 <sup>12</sup>			Ω			
r <sub>i</sub>	Common-mode input resistance			25°C	10 <sup>12</sup>			Ω			
c <sub>i</sub>	Common-mode input capacitance	f = 10 kHz, N package		25°C	8			pF			
z <sub>o</sub>	Closed-loop output impedance	f = 1 MHz, A <sub>V</sub> = 10		25°C	130			Ω			
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = –5 V to 2.7 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	75	80	75	80	dB		
				Full range	75		75				
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	V <sub>DD±</sub> = ±2.2 V to ±8 V, V <sub>IC</sub> = 0 V, No load		25°C	80	95	80	95	dB		
				Full range	80		80				
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0 V, No load		25°C	4.8	6	4.8	6	mA		
				Full range	6		6				

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



**TLC227x, TLC227xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**OPERATIONAL AMPLIFIERS**

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274I			TLC2274AI			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = ±2.3 V, C <sub>L</sub> = 100 pF  R <sub>L</sub> = 10 kΩ,		25°C	2.3	3.6		2.3	3.6		V/μs
				Full range	1.7			1.7			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV/√Hz
		f = 1 kHz		25°C	9			9			
V <sub>N(PP)</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA/√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = ±2.3 V, R <sub>L</sub> = 10 kΩ, f = 20 kHz	A <sub>V</sub> = 1	25°C	0.0011%			0.0011%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF  R <sub>L</sub> = 10 kΩ,		25°C	2.25			2.25			MHz
B <sub>OM</sub>	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
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = −2.3 V to 2.3 V, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		3.2			3.2			
φ <sub>m</sub>	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

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2272Q, TLC2272M			TLC2272AQ, TLC2272AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0\text{ V},$ $V_O = 0\text{ V},$ $V_{DD\pm} = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5	60		0.5	60		$\text{pA}$
		Full range		800			800		
$I_{IB}$ Input bias current		25°C	1	60		1	60		$\text{pA}$
		Full range		800			800		
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega,$ $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	–0.3 to 4.2		0 to 4	–0.3 to 4.2		$\text{V}$
		Full range	0 to 3.5			0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99		$\text{V}$
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
	$I_{OH} = -1\text{ mA}$	Full range	4.85			4.85			
		25°C	4.25	4.65		4.25	4.65		
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 50\ \mu\text{A}$	25°C	0.01			0.01			$\text{V}$
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$	25°C	0.09	0.15		0.09	0.15		
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 5\text{ mA}$	Full range		0.15			0.15		
		25°C	0.9	1.5		0.9	1.5		
		Full range		1.5			1.5		
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	10	35	10	35		$\text{V/mV}$
		$R_L = 1\text{ m}\Omega^\ddagger$	25°C	175		175			
		Full range	10			10			
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$C_i$ Common-mode input capacitance	$f = 10\text{ kHz},$ P package	25°C		8			8		$\text{pF}$
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz},$ $A_V = 10$	25°C		140			140		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$	25°C	70	75		70	75		$\text{dB}$
		Full range	70			70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	25°C	80	95		80	95		$\text{dB}$
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V},$ No load	25°C	2.2	3		2.2	3		$\text{mA}$
		Full range		3			3		

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

$^\ddagger$  Referenced to 2.5 V

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



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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2272Q, TLC2272M			TLC2272AQ, TLC2272AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR      Slew rate at unity gain	$V_O = 1.25\text{ V to }2.75\text{ V}$ , $R_L = 10\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	25°C	2.3	3.6		2.3	3.6		V/ $\mu\text{s}$
		Full range	1.7			1.7			
$V_n$ Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		50			50		nV/ $\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$	25°C		9			9		
$V_{NPP}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		1			1		$\mu\text{V}$
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.4			1.4		
$I_n$ Equivalent input noise current		25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
THD + N      Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V}$ , $f = 20\text{ kHz}$ , $R_L = 10\text{ k}\Omega^\ddagger$	$A_V = 1$		0.0013%			0.0013%		
		$A_V = 10$		0.004%			0.004%		
		$A_V = 100$		0.03%			0.03%		
	Gain-bandwidth product	$f = 10\text{ kHz}$ , $C_L = 100\text{ pF}^\ddagger$		2.18			2.18		MHz
BOM      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
$t_s$ Settling time	$A_V = -1$ , Step = 0.5 V to 2.5 V, $R_L = 10\text{ k}\Omega^\ddagger$ , $C_L = 100\text{ pF}^\ddagger$	To 0.1%	25°C	1.5			1.5		$\mu\text{s}$
		To 0.01%		2.6			2.6		
$\phi_m$ 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

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

$^\ddagger$  Referenced to 2.5 V

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2272Q, TLC2272M			TLC2272AQ, TLC2272AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0\text{ V}, V_O = 0\text{ V}, R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5	60		0.5	60		$\text{pA}$
		Full range		800			800		
$I_{IB}$ Input bias current		25°C	1	60		1	60		$\text{pA}$
		Full range		800			800		
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega,  V_{IO}  \leq 5\text{ mV}$	25°C	-5 to 4	-5.3 to 4.2		-5 to 4	-5.3 to 4.2		$\text{V}$
		Full range	-5 to 3.5			-5 to 3.5			
$V_{OM+}$ Maximum positive peak output voltage	$I_O = -20\ \mu\text{A}$	25°C		4.99			4.99		$\text{V}$
	$I_O = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.85			4.85			
	$I_O = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65		
		Full range	4.25			4.25			
$V_{OM-}$ Maximum negative peak output voltage	$V_{IC} = 0\text{ V}, I_O = 50\ \mu\text{A}$	25°C		-4.99			-4.99		$\text{V}$
	$V_{IC} = 0\text{ V}, I_O = 500\ \mu\text{A}$	25°C	-4.85	-4.91		-4.85	-4.91		
		Full range	-4.85			-4.85			
	$V_{IC} = 0\text{ V}, I_O = 5\text{ mA}$	25°C	-3.5	-4.1		-3.5	-4.1		
		Full range	-3.5			-3.5			
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 4\text{ V}$	$R_L = 10\text{ k}\Omega$	25°C	20	50	20	50		$\text{V/mV}$
			Full range	20		20			
		$R_L = 1\text{ m}\Omega$	25°C	300		300			
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$c_i$ Common-mode input capacitance	$f = 10\text{ kHz}, \text{ P package}$	25°C		8			8		$\text{pF}$
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz}, A_V = 10$	25°C		130			130		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = -5\text{ V to } 2.7\text{ V}, V_O = 0\text{ V}, R_S = 50\ \Omega$	25°C	75	80		75	80		$\text{dB}$
		Full range	75			75			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD\pm}/\Delta V_{IO}$ )	$V_{DD} = \pm 2.2\text{ V to } \pm 8\text{ V}, V_{IC} = 0\text{ V}, \text{ No load}$	25°C	80	95		80	95		$\text{dB}$
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}, \text{ No load}$	25°C	2.4	3		2.4	3		$\text{mA}$
		Full range		3			3		

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



**TLC227x, TLC227xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**OPERATIONAL AMPLIFIERS**

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> <sup>†</sup>	TLC2272Q, TLC2272M			TLC2272AQ, TLC2272AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = ±1 V, C <sub>L</sub> = 100 pF		R <sub>L</sub> = 10 kΩ,	25°C	2.3	3.6		2.3	3.6	V/μs
					Full range	1.7			1.7		
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV/√Hz
		f = 1 kHz		25°C	9			9			
V <sub>NPP</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA/√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = ±2.3 V R <sub>L</sub> = 10 kΩ, f = 20 kHz	A <sub>V</sub> = 1	25°C	0.0011%			0.0011%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	R <sub>L</sub> = 10 kΩ,	25°C	2.25			2.25			MHz
BOM	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
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = −2.3 V to 2.3 V, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		3.2			3.2			
φ <sub>m</sub>	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

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLC2274Q, TLC2274M			TLC2274AQ, TLC2274AM			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{DD\pm} = \pm 2.5\text{ V}$ , $V_O = 0\text{ V}$ , $V_{IC} = 0\text{ V}$ , $R_S = 50\ \Omega$	25°C	300	2500		300	950		$\mu\text{V}$
		Full range		3000			1500		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage		25°C to 125°C	2			2			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C	0.002			0.002			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	0.5	60		0.5	60		pA
		Full range		800			800		
$I_{IB}$ Input bias current		25°C	1	60		1	60		pA
		Full range		800			800		
$V_{ICR}$ Common-mode input voltage	$R_S = 50\ \Omega$ , $ V_{IO}  \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V
		Full range	0 to 3.5			0 to 3.5			
$V_{OH}$ High-level output voltage	$I_{OH} = -20\ \mu\text{A}$	25°C		4.99			4.99		V
	$I_{OH} = -200\ \mu\text{A}$	25°C	4.85	4.93		4.85	4.93		
		Full range	4.85			4.85			
	$I_{OH} = -1\text{ mA}$	25°C	4.25	4.65		4.25	4.65		
		Full range	4.25			4.25			
$V_{OL}$ Low-level output voltage	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 50\ \mu\text{A}$	25°C		0.01			0.01		V
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 500\ \mu\text{A}$	25°C		0.09	0.15		0.09	0.15	
		Full range			0.15			0.15	
	$V_{IC} = 2.5\text{ V}$ , $I_{OL} = 5\text{ mA}$	25°C		0.9	1.5		0.9	1.5	
		Full range			1.5			1.5	
$A_{VD}$ Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	25°C	10	35		10	35	V/mV
			Full range	10			10		
		$R_L = 1\text{ M}\Omega^\ddagger$	25°C		175			175	
$r_{id}$ Differential input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$r_i$ Common-mode input resistance		25°C		$10^{12}$			$10^{12}$		$\Omega$
$c_i$ Common-mode input capacitance	$f = 10\text{ kHz}$ , N package	25°C		8			8		pF
$z_o$ Closed-loop output impedance	$f = 1\text{ MHz}$ , $A_V = 10$	25°C		140			140		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ V to }2.7\text{ V}$ , $V_O = 2.5\text{ V}$ , $R_S = 50\ \Omega$	25°C	70	75		70	75		dB
		Full range	70			70			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 4.4\text{ V to }16\text{ V}$ , $V_{IC} = V_{DD}/2$ , No load	25°C	80	95		80	95		dB
		Full range	80			80			
$I_{DD}$ Supply current	$V_O = 2.5\text{ V}$ , No load	25°C		4.4	6		4.4	6	mA
		Full range			6			6	

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

$^\ddagger$  Referenced to 2.5 V

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



**TLC227x, TLC227xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**OPERATIONAL AMPLIFIERS**

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> <sup>†</sup>	TLC2274Q, TLC2274M			TLC2274AQ, TLC2274AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	2.3	3.6		2.3	3.6		V/μs
				Full range	1.7			1.7			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV/√Hz
		f = 1 kHz		25°C	9			9			
V <sub>N(PP)</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA/√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = 0.5 V to 2.5 V, f = 20 kHz, R <sub>L</sub> = 10 kΩ <sup>‡</sup>	A <sub>V</sub> = 1	25°C	0.0013%			0.0013%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF <sup>‡</sup> , R <sub>L</sub> = 10 kΩ <sup>‡</sup>		25°C	2.18			2.18			MHz
B <sub>OM</sub>	Maximum output-swing bandwidth	V <sub>O(PP)</sub> = 2 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , A <sub>V</sub> = 1, C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	1			1			MHz
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = 0.5 V to 2.5 V, R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		2.6			2.6			
φ <sub>m</sub>	Phase margin at unity gain	R <sub>L</sub> = 10 kΩ <sup>‡</sup> , C <sub>L</sub> = 100 pF <sup>‡</sup>		25°C	50°			50°			
	Gain margin			25°C	10			10			dB

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

$^\ddagger$  Referenced to 2.5 V

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274Q, TLC2274M			TLC2274AQ, TLC2274AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>IC</sub> = 0 V, V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	300	2500		300	950	μV	
	Full range			3000			1500				
αV <sub>IO</sub>	Temperature coefficient of input offset voltage			25°C to 125°C	2			2			μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C	0.002			0.002			μV/mo
I <sub>IO</sub>	Input offset current			25°C	0.5	60		0.5	60	pA	
				Full range	800			800			
I <sub>IB</sub>	Input bias current			25°C	1	60		1	60	pA	
				Full range	800			800			
V <sub>ICR</sub>	Common-mode input voltage	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	
				Full range	-5 to 3.5			-5 to 3.5			
V <sub>OM+</sub>	Maximum positive peak output voltage	I <sub>O</sub> = -20 μA		25°C	4.99			4.99			V
		I <sub>O</sub> = -200 μA		25°C	4.85	4.93		4.85	4.93		
				Full range	4.85			4.85			
		I <sub>O</sub> = -1 mA		25°C	4.25	4.65		4.25	4.65		
				Full range	4.25			4.25			
V <sub>OM-</sub>	Maximum negative peak output voltage	V <sub>IC</sub> = 0 V, I <sub>O</sub> = 50 μA		25°C	-4.99			-4.99			V
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 500 μA		25°C	-4.85	-4.91		-4.85	-4.91		
				Full range	-4.85			-4.85			
		V <sub>IC</sub> = 0 V, I <sub>O</sub> = 5 mA		25°C	-3.5	-4.1		-3.5	-4.1		
				Full range	-3.5			-3.5			
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>O</sub> = ±4 V	R <sub>L</sub> = 10 kΩ	25°C	20	50		20	50	V/mV	
				Full range	20			20			
			R <sub>L</sub> = 1 MΩ	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
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = -5 V to 2.7 V V <sub>O</sub> = 0 V, R <sub>S</sub> = 50 Ω		25°C	75	80		75	80	dB	
				Full range	75			75			
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>DD±</sub> /ΔV <sub>IO</sub> )	V <sub>DD±</sub> = ± 2.2 V to ±8 V, V <sub>IC</sub> = 0 V, No load		25°C	80	95		80	95	dB	
				Full range	80			80			
I <sub>DD</sub>	Supply current	V <sub>O</sub> = 0 V, No load		25°C	4.8	6		4.8	6	mA	
				Full range	6			6			

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



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

PARAMETER		TEST CONDITIONS		T <sub>A</sub> †	TLC2274Q, TLC2274M			TLC2274AQ, TLC2274AM			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V <sub>O</sub> = ±2.3 V, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF		25°C	2.3	3.6		2.3	3.6		V/μs
				Full range	1.7			1.7			
V <sub>n</sub>	Equivalent input noise voltage	f = 10 Hz		25°C	50			50			nV/√Hz
		f = 1 kHz		25°C	9			9			
V <sub>N(PP)</sub>	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1			1			μV
		f = 0.1 Hz to 10 Hz		25°C	1.4			1.4			
I <sub>n</sub>	Equivalent input noise current			25°C	0.6			0.6			fA/√Hz
THD + N	Total harmonic distortion plus noise	V <sub>O</sub> = ±2.3 V, R <sub>L</sub> = 10 kΩ, f = 20 kHz	A <sub>V</sub> = 1	25°C	0.0011%			0.0011%			
			A <sub>V</sub> = 10		0.004%			0.004%			
			A <sub>V</sub> = 100		0.03%			0.03%			
	Gain-bandwidth product	f = 10 kHz, C <sub>L</sub> = 100 pF	R <sub>L</sub> = 10 kΩ,	25°C	2.25			2.25			MHz
BOM	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
t <sub>s</sub>	Settling time	A <sub>V</sub> = −1, Step = −2.3 V to 2.3 V, R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF	To 0.1%	25°C	1.5			1.5			μs
			To 0.01%		3.2			3.2			
φ <sub>m</sub>	Phase margin at unit gain	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF		25°C	52°			52°			
	Gain margin			25°C	10			10			dB

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

**TLC227x, TLC227xA**  
**Advanced LinCMOS™ RAIL-TO-RAIL**  
**OPERATIONAL AMPLIFIERS**

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

**TYPICAL CHARACTERISTICS**

**Table of Graphs**

			<b>FIGURE</b>
$V_{IO}$	Input offset voltage	Distribution vs Common-mode voltage	1 – 4 5, 6
$\alpha V_{IO}$	Input offset voltage temperature coefficient	Distribution	7 – 10
$I_{IB}/I_{IO}$	Input bias and input offset current	vs Free-air temperature	11
$V_I$	Input voltage	vs Supply voltage vs Free-air temperature	12 13
$V_{OH}$	High-level output voltage	vs High-level output current	14
$V_{OL}$	Low-level output voltage	vs Low-level output current	15, 16
$V_{OM+}$	Maximum positive peak output voltage	vs Output current	17
$V_{OM-}$	Maximum negative peak output voltage	vs Output current	18
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	19
$I_{OS}$	Short-circuit output current	vs Supply voltage vs Free-air temperature	20 21
$V_O$	Output voltage	vs Differential input voltage	22, 23
$A_{VD}$	Large-signal differential voltage amplification	vs Load resistance	24
	Large-signal differential voltage amplification and phase margin	vs Frequency	25, 26
	Large-signal differential voltage amplification	vs Free-air temperature	27, 28
$z_o$	Output impedance	vs Frequency	29, 30
CMRR	Common-mode rejection ratio	vs Frequency	31
		vs Free-air temperature	32
kSVR	Supply-voltage rejection ratio	vs Frequency	33, 34
		vs Free-air temperature	35
$I_{DD}$	Supply current	vs Supply voltage	36, 37
		vs Free-air temperature	38, 39
SR	Slew rate	vs Load capacitance	40
		vs Free-air temperature	41
$V_O$	Inverting large-signal pulse response		42, 43
	Voltage-follower large-signal pulse response		44, 45
	Inverting small-signal pulse response		46, 47
	Voltage-follower small-signal pulse response		48, 49
$V_n$	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
$\phi_m$	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.



## TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLC2272  
INPUT OFFSET VOLTAGE**

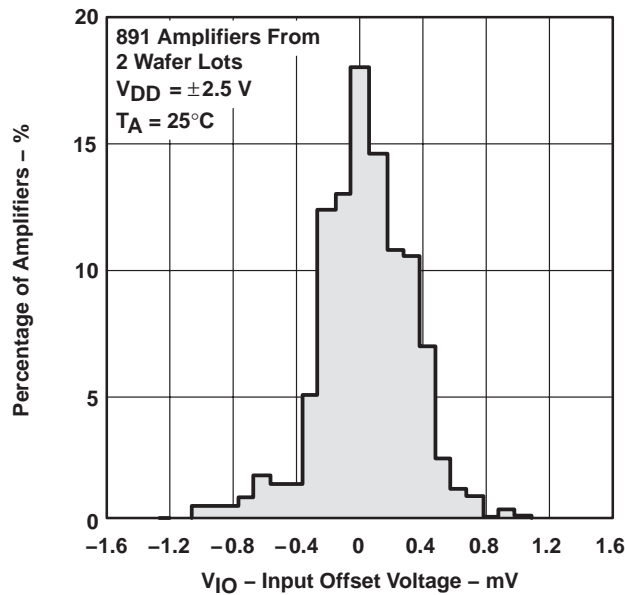


Figure 1

**DISTRIBUTION OF TLC2272  
INPUT OFFSET VOLTAGE**

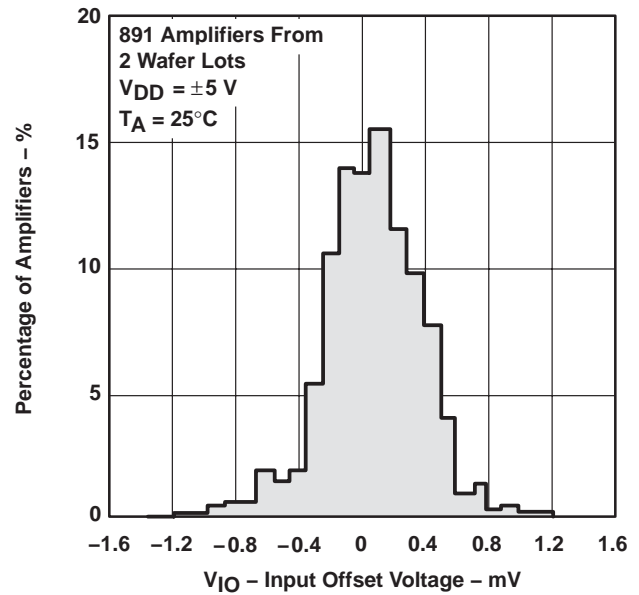


Figure 2

**DISTRIBUTION OF TLC2274  
INPUT OFFSET VOLTAGE**

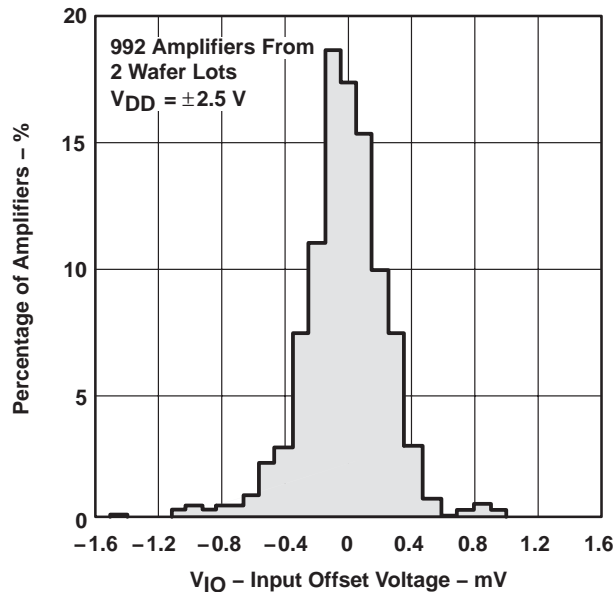


Figure 3

**DISTRIBUTION OF TLC2274  
INPUT OFFSET VOLTAGE**

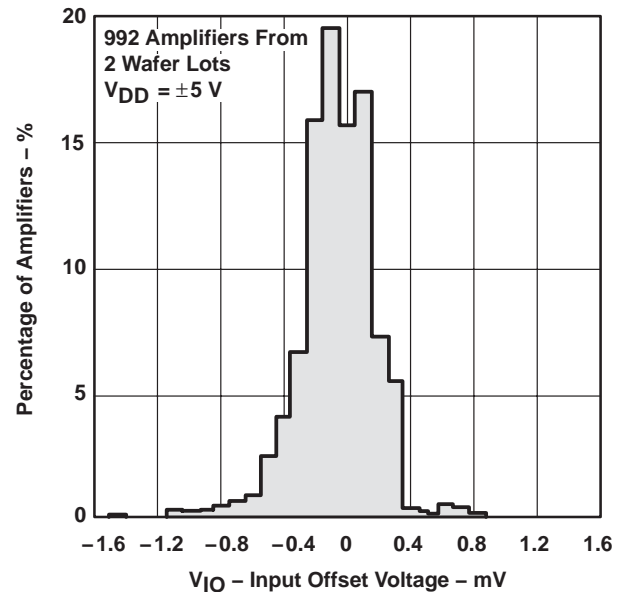


Figure 4

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

#### TYPICAL CHARACTERISTICS

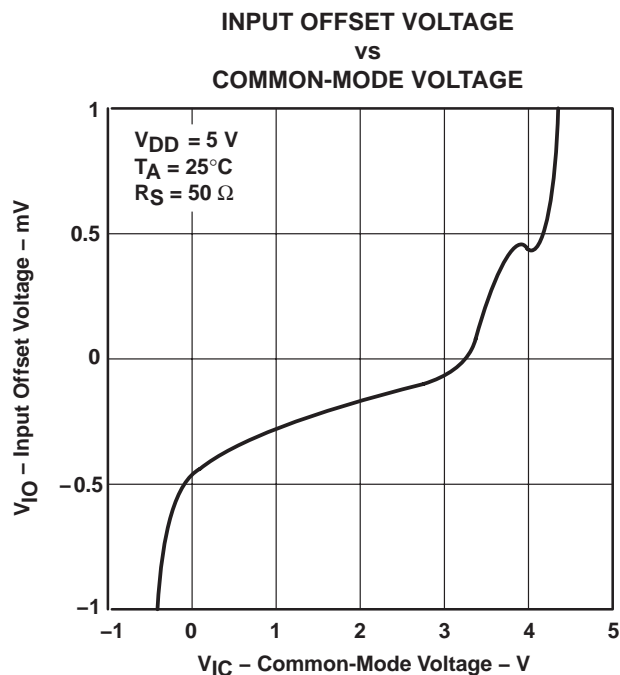


Figure 5

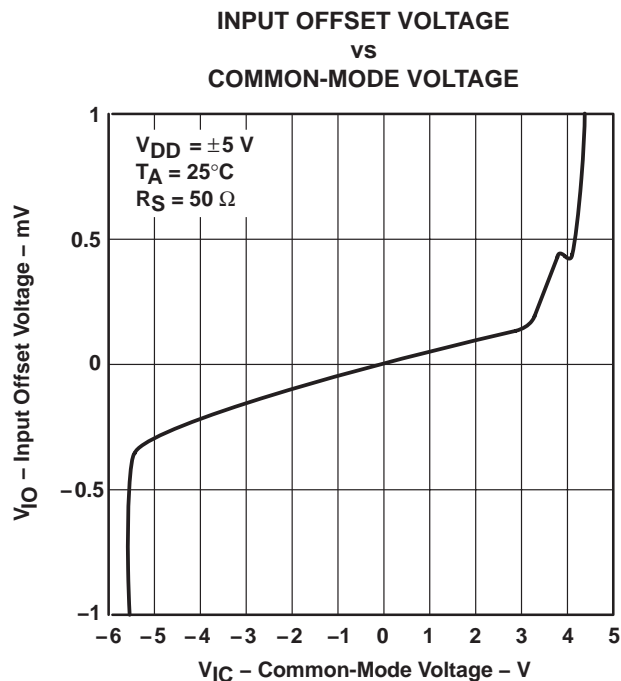


Figure 6

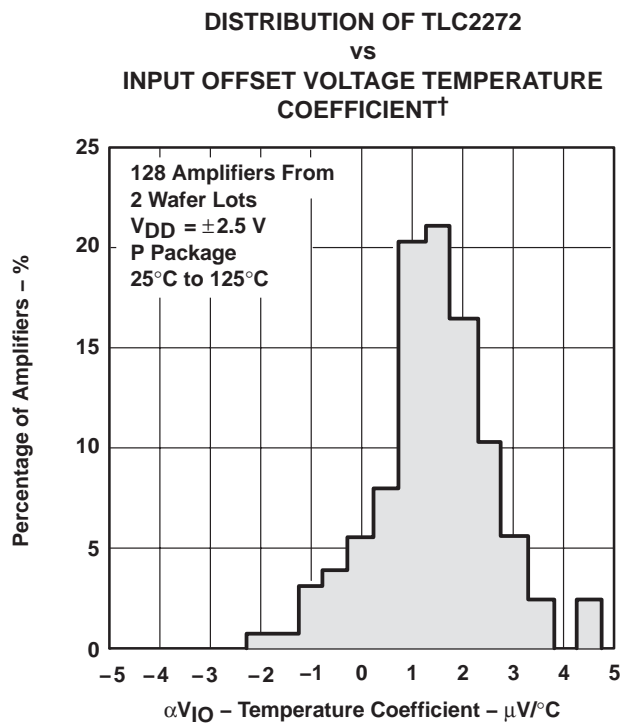


Figure 7

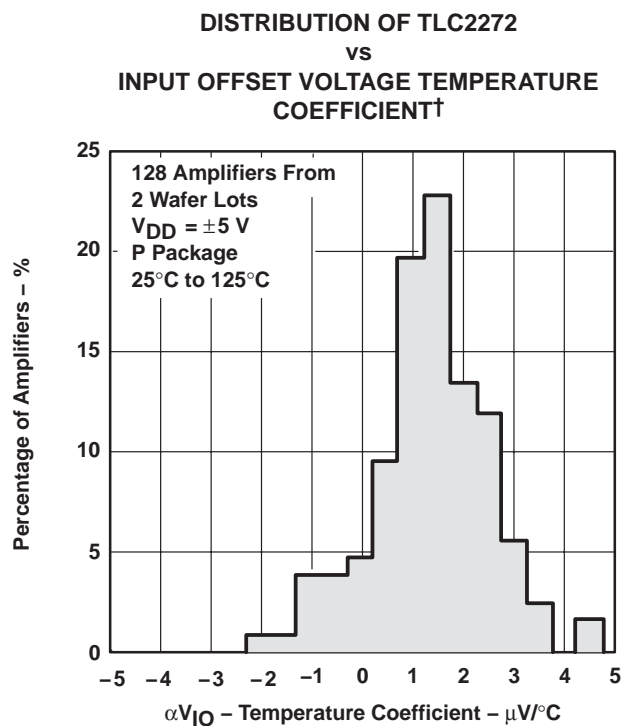


Figure 8

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



## TYPICAL CHARACTERISTICS

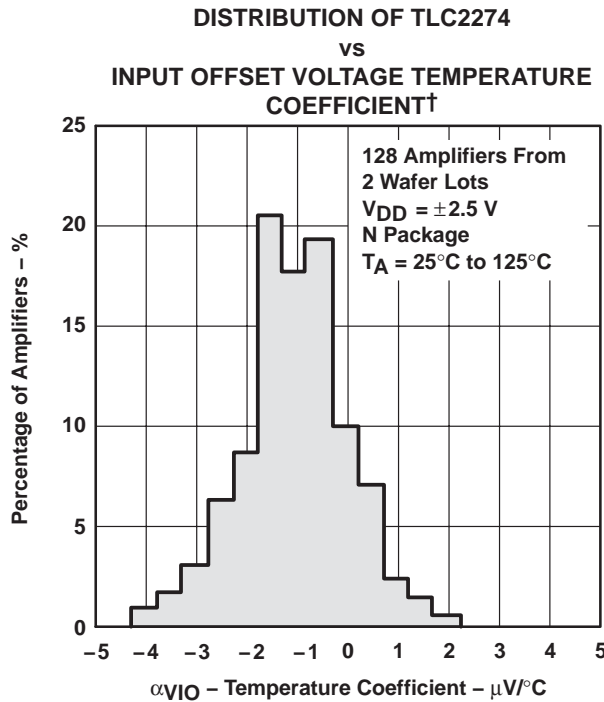


Figure 9

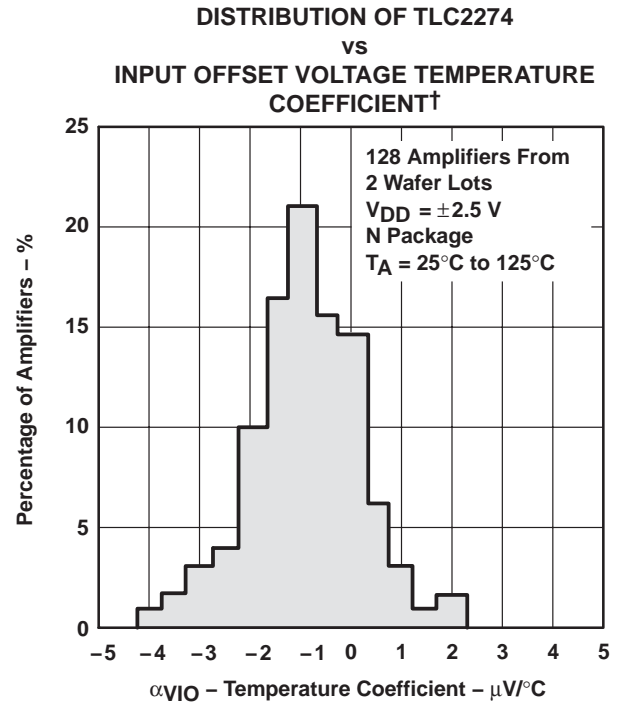


Figure 10

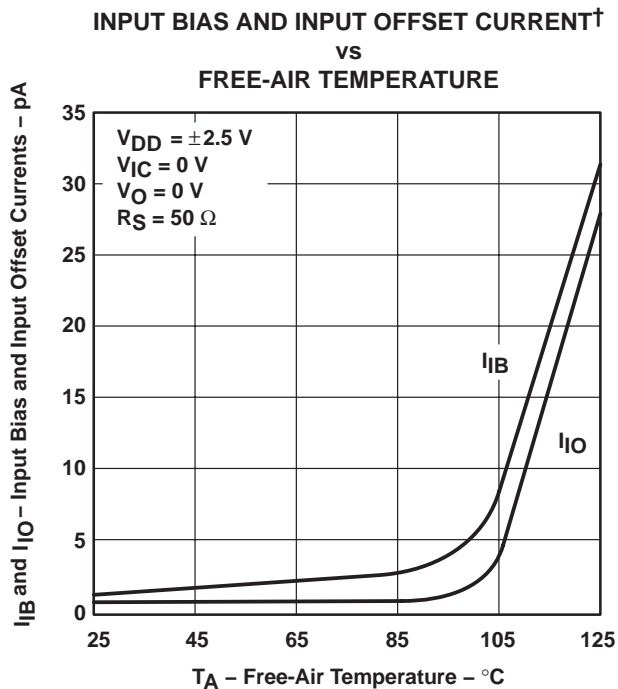


Figure 11

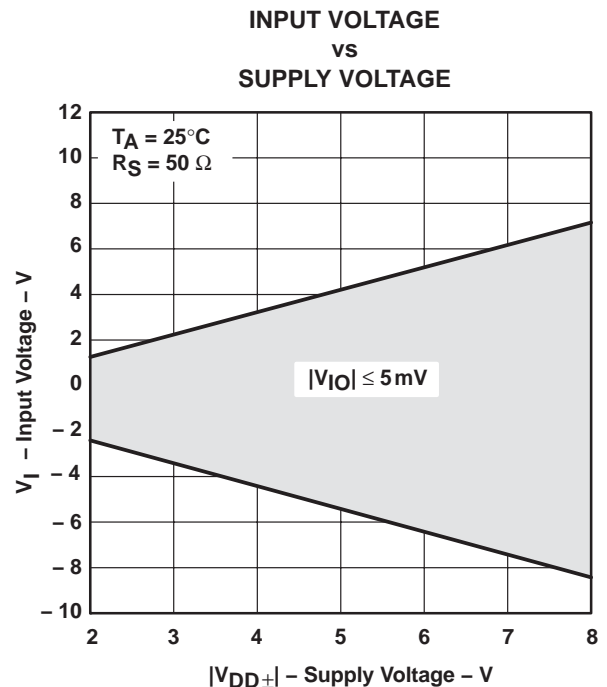


Figure 12

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

## TYPICAL CHARACTERISTICS

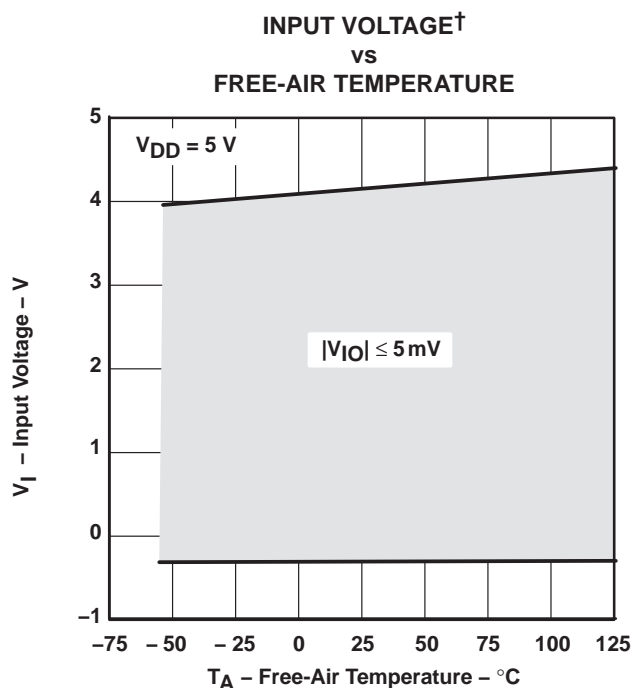


Figure 13

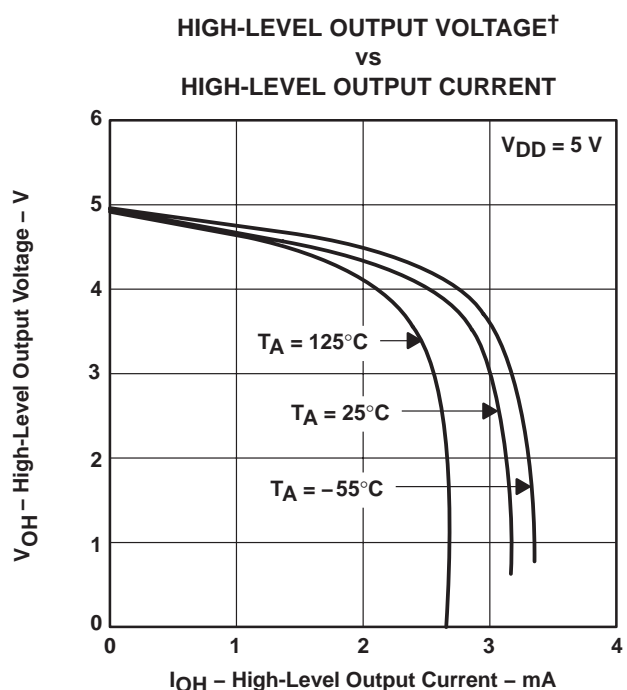


Figure 14

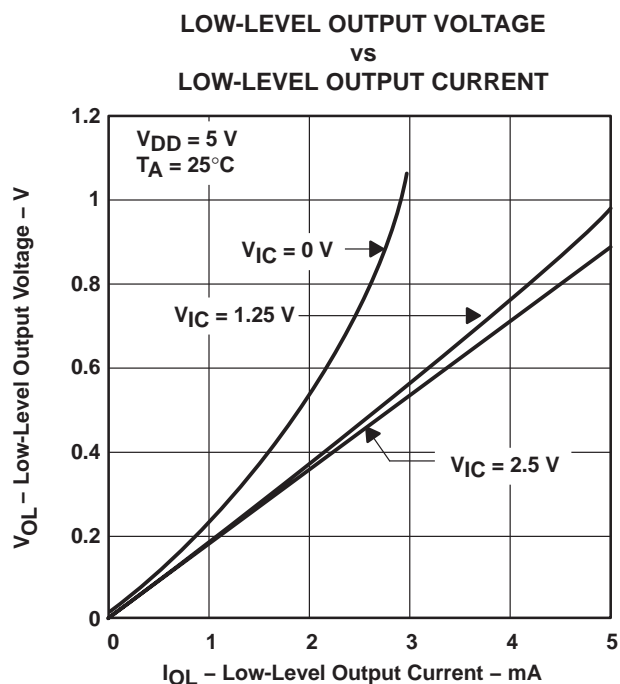


Figure 15

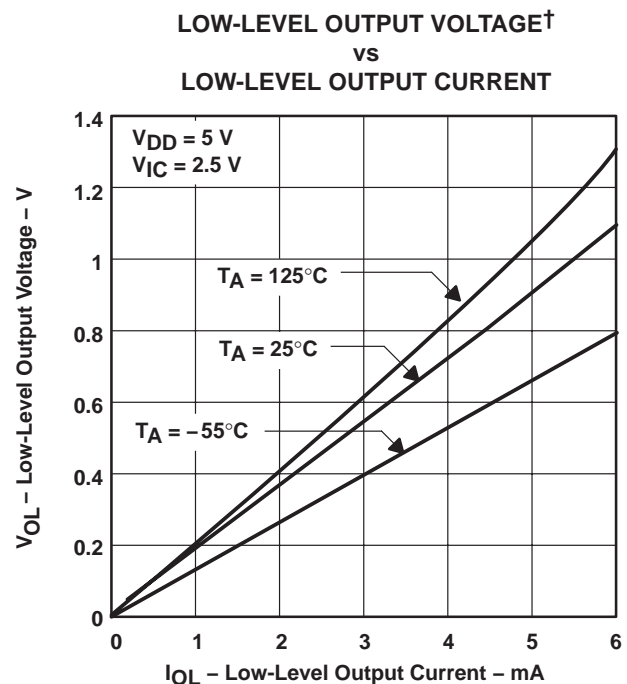
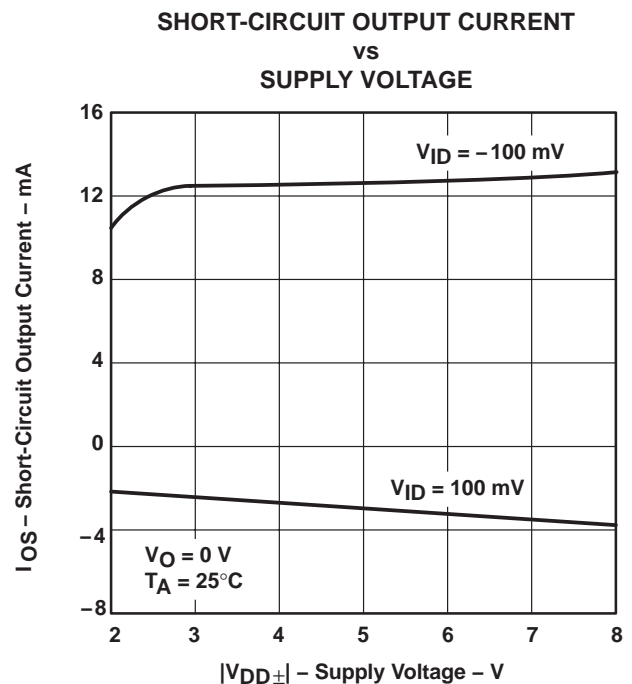
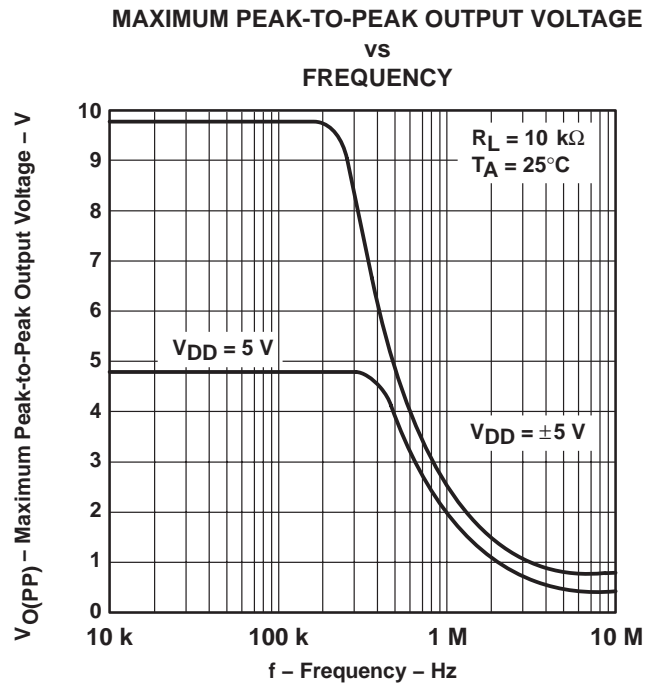
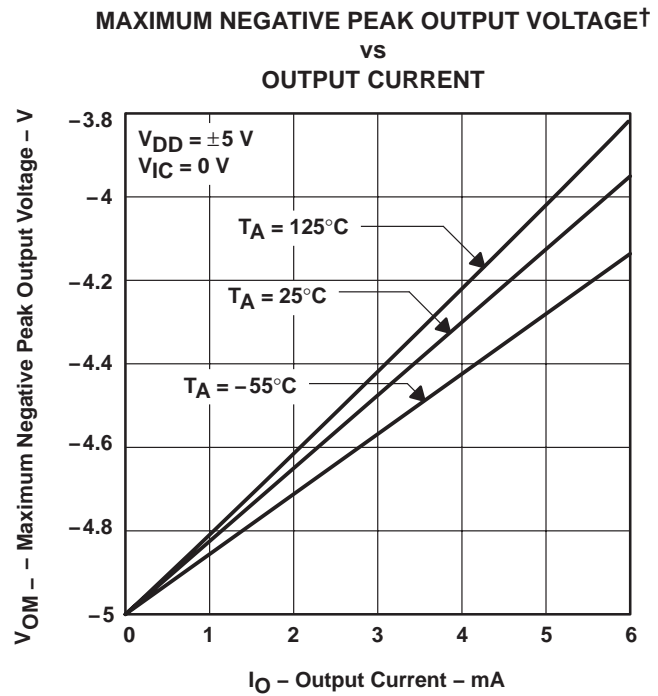
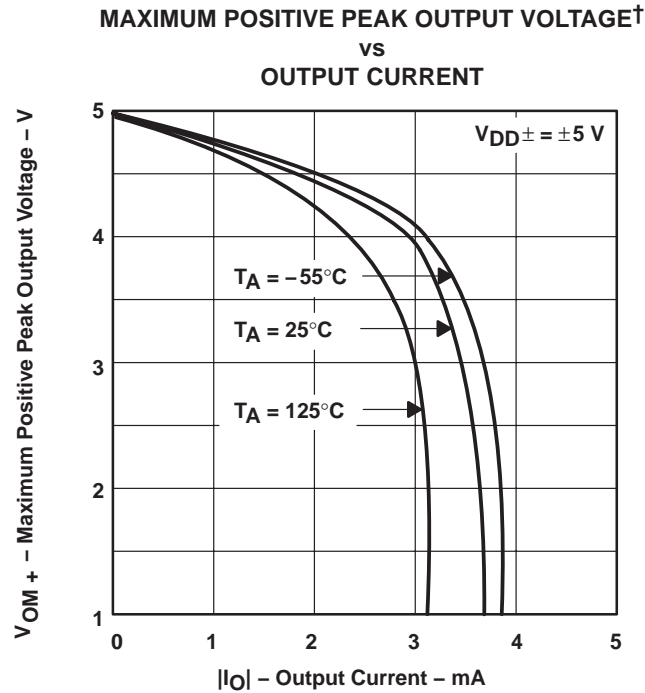


Figure 16

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

## TYPICAL CHARACTERISTICS



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

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

### TYPICAL CHARACTERISTICS

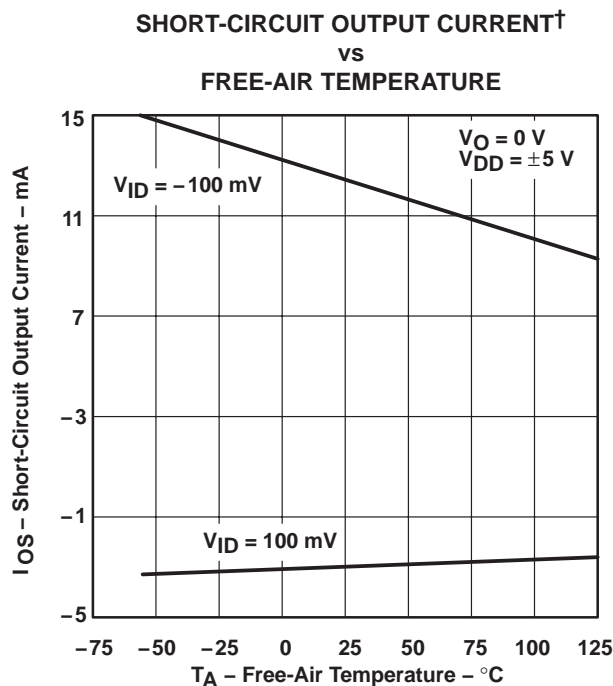


Figure 21

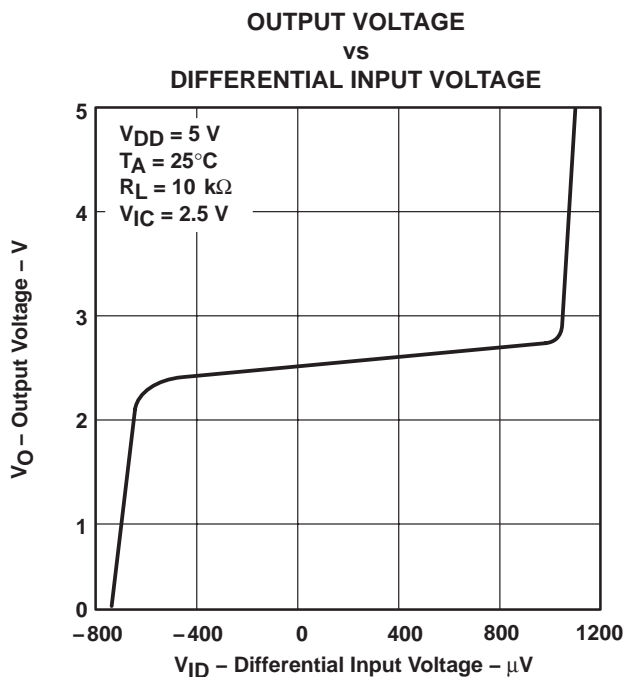


Figure 22

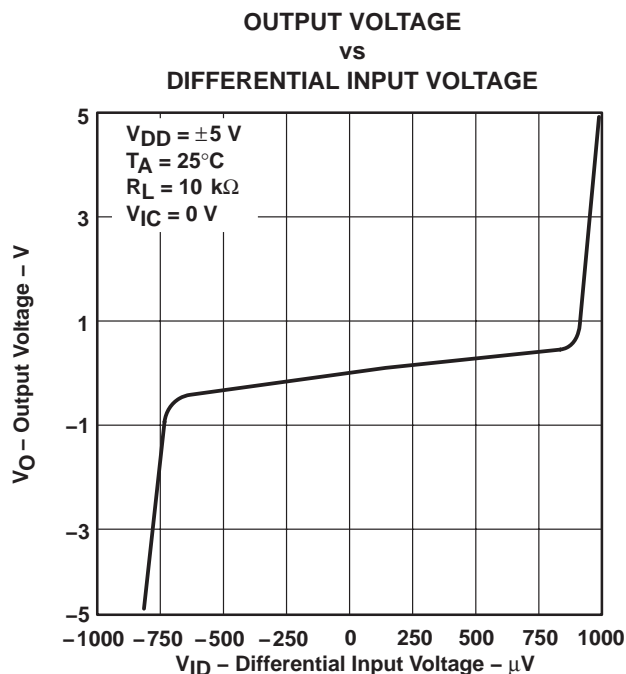


Figure 23

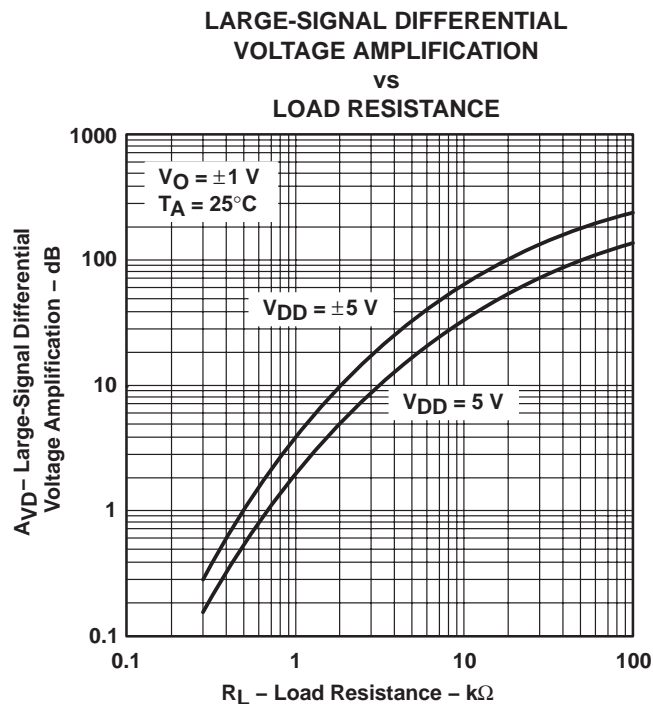


Figure 24

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

## TYPICAL CHARACTERISTICS

### LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN

vs  
FREQUENCY

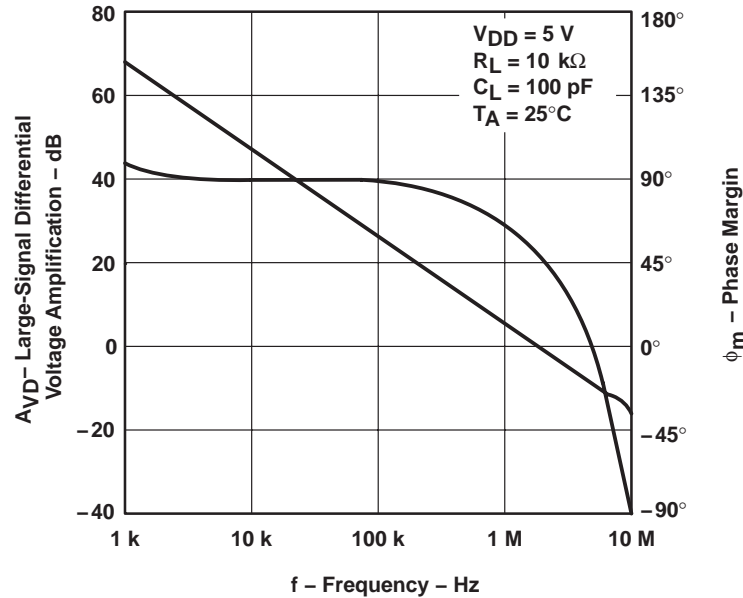


Figure 25

### LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN

vs  
FREQUENCY

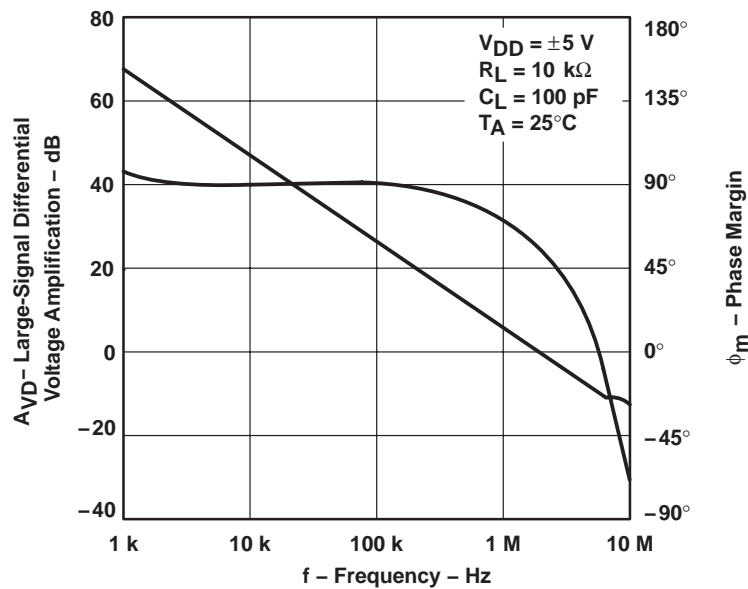


Figure 26

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

### TYPICAL CHARACTERISTICS

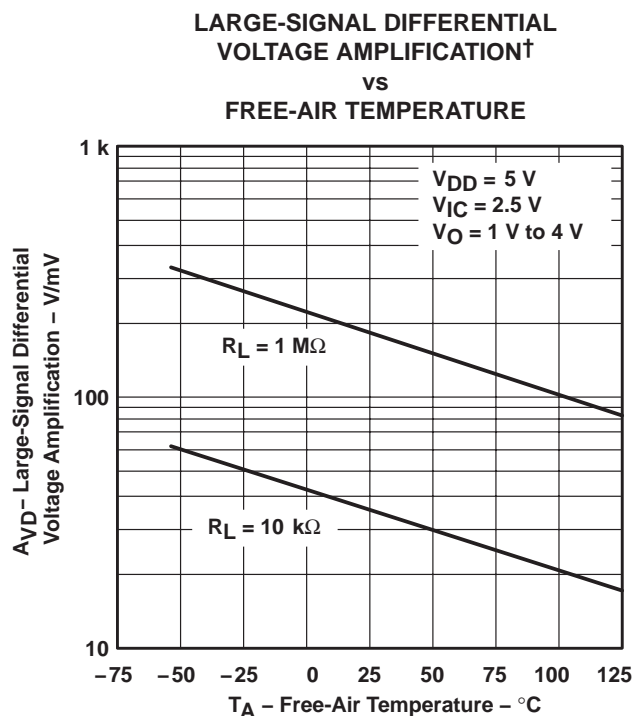


Figure 27

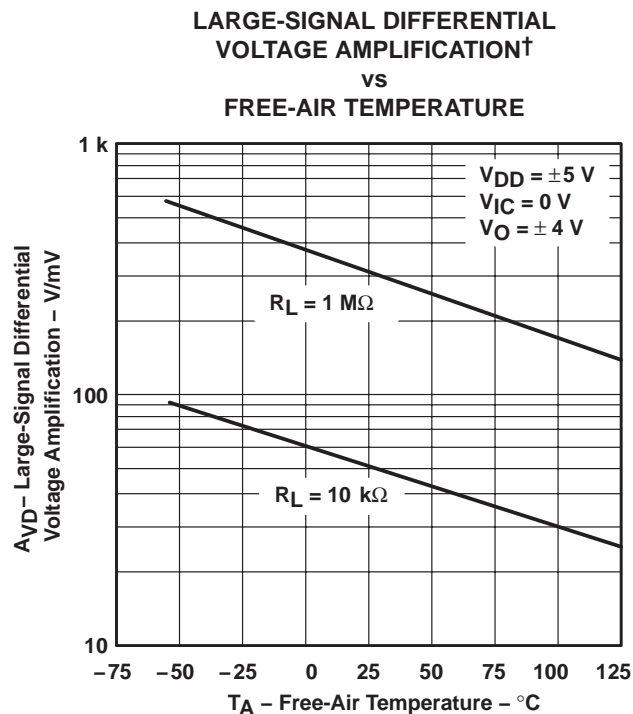


Figure 28

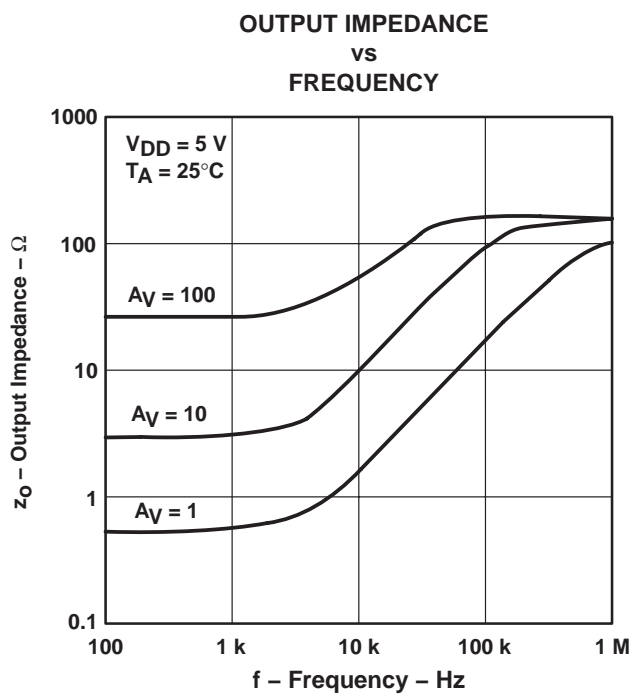


Figure 29

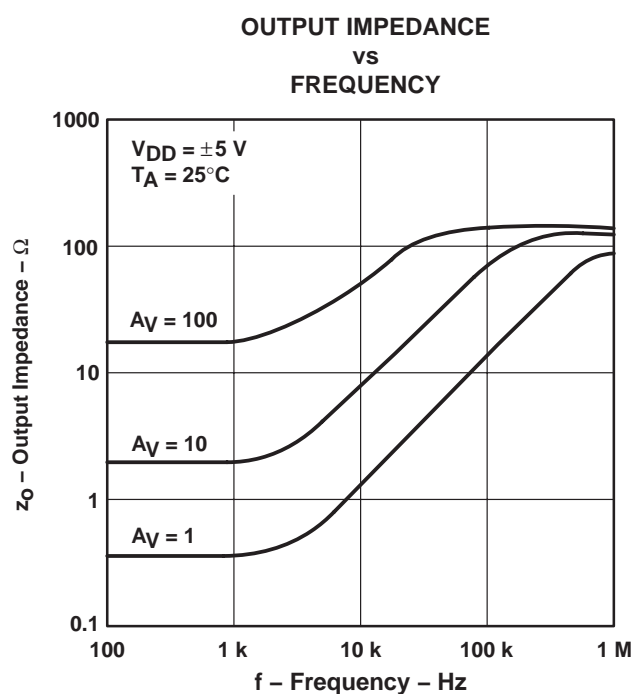


Figure 30

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

## TYPICAL CHARACTERISTICS

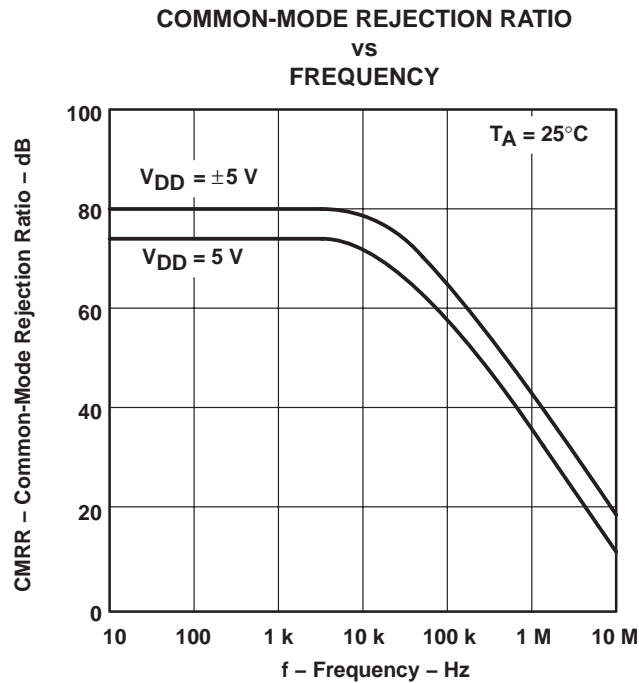


Figure 31

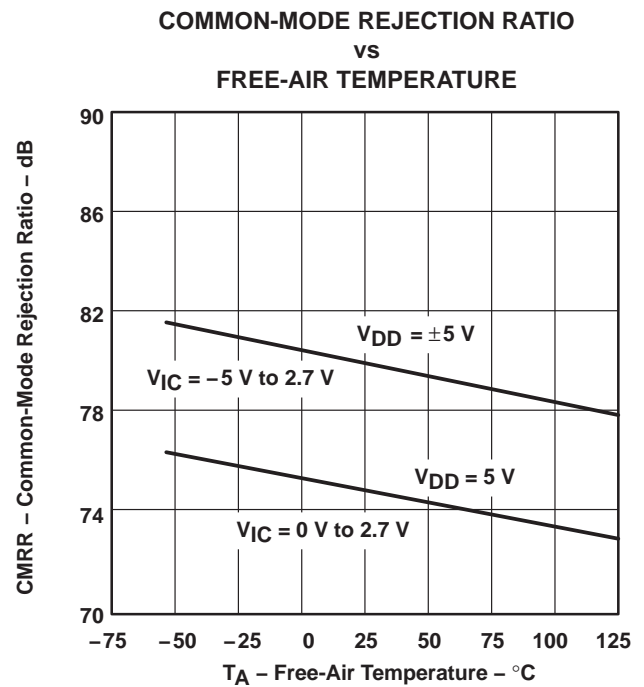


Figure 32

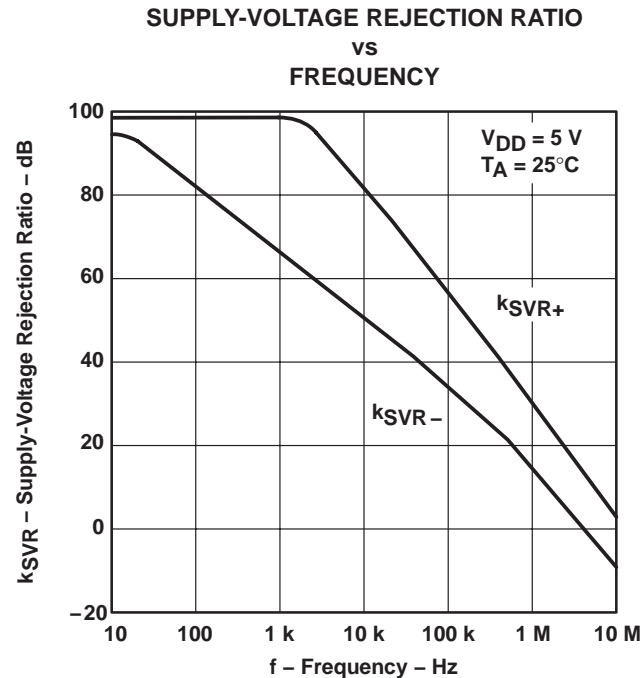


Figure 33

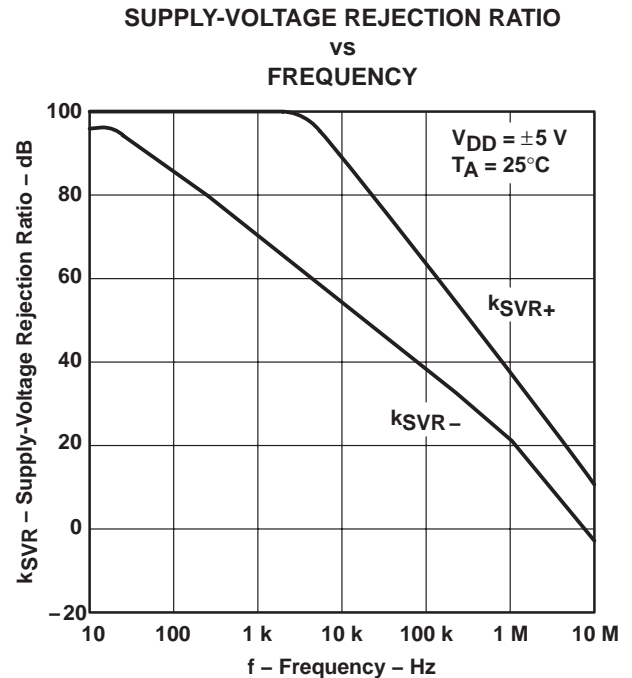


Figure 34

## TYPICAL CHARACTERISTICS

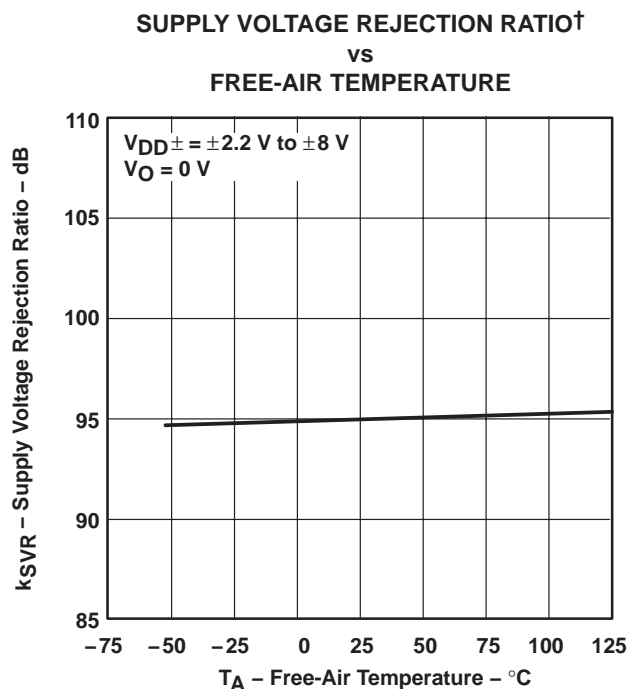


Figure 35

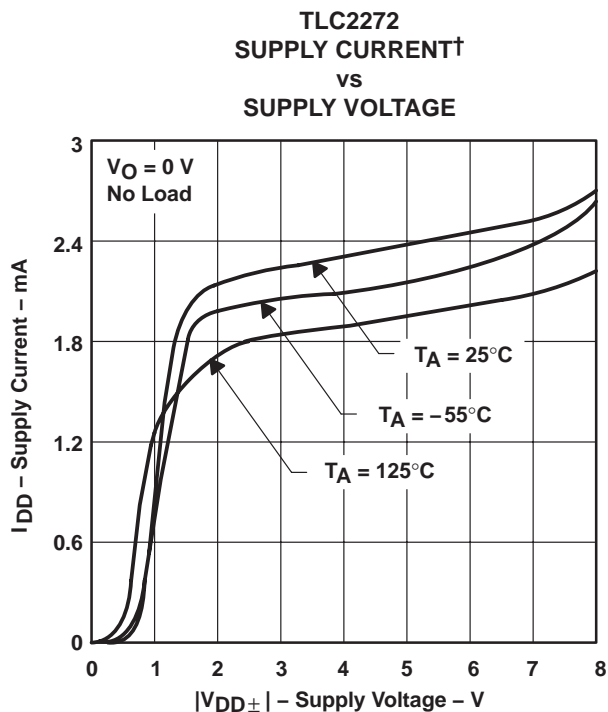


Figure 36

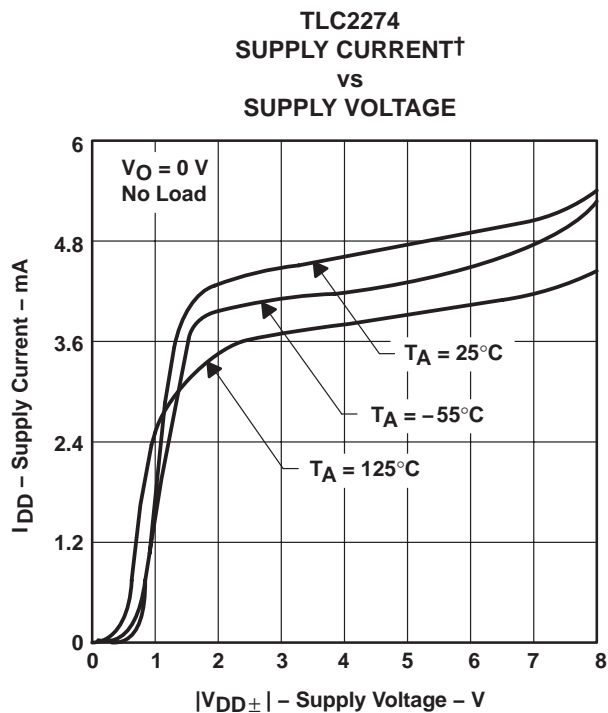


Figure 37

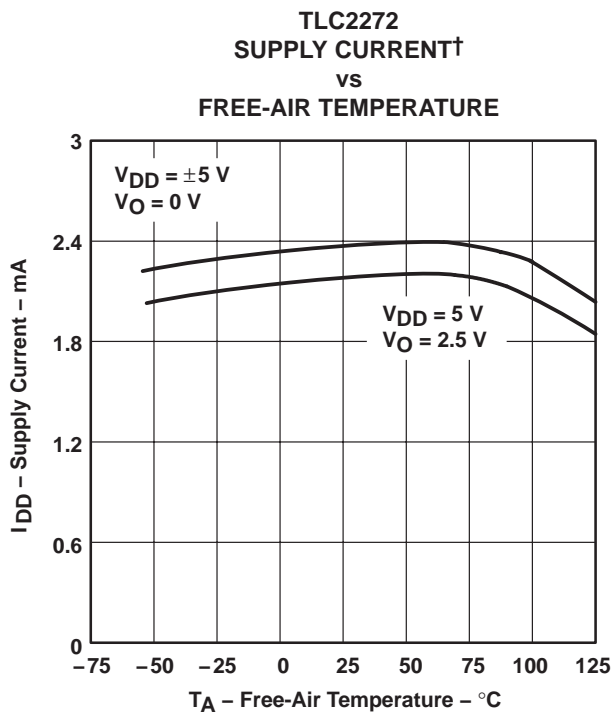


Figure 38

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



## TYPICAL CHARACTERISTICS

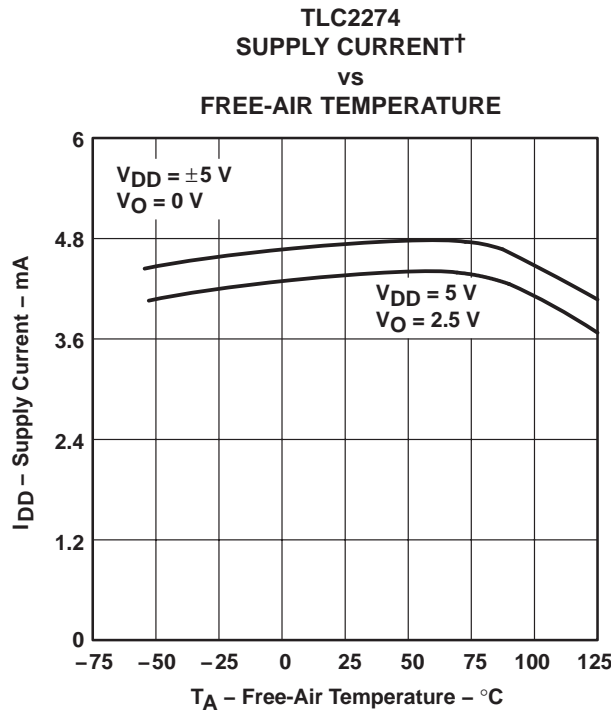


Figure 39

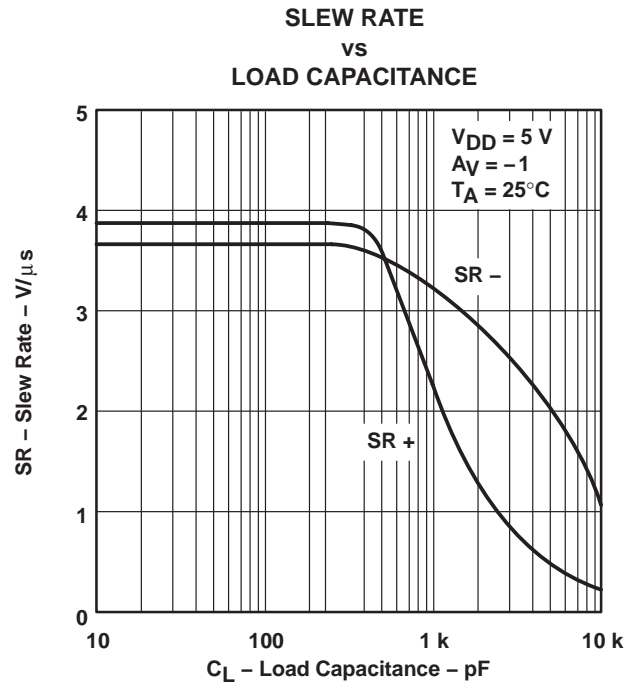


Figure 40

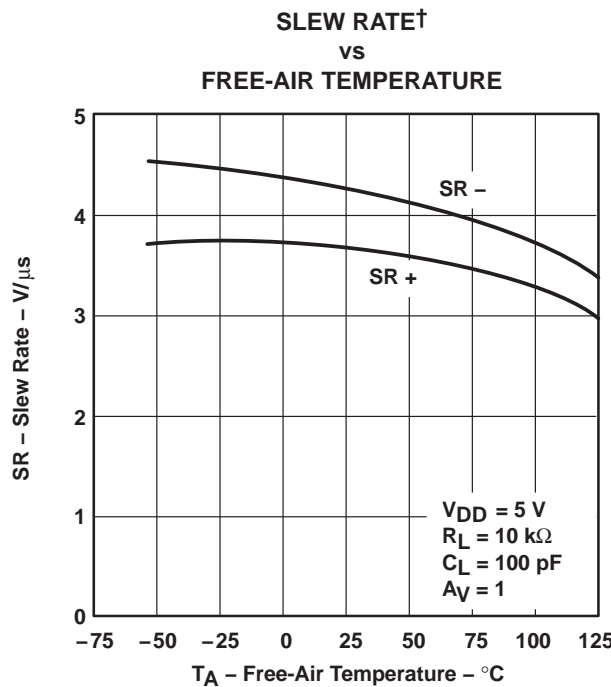


Figure 41

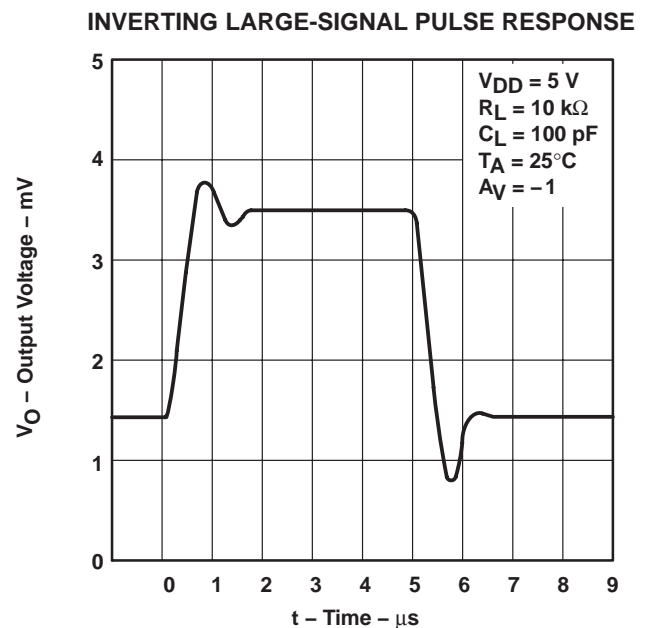
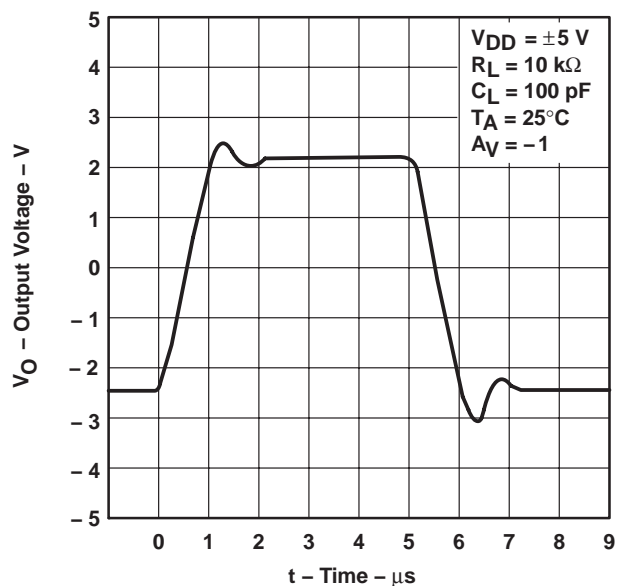


Figure 42

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

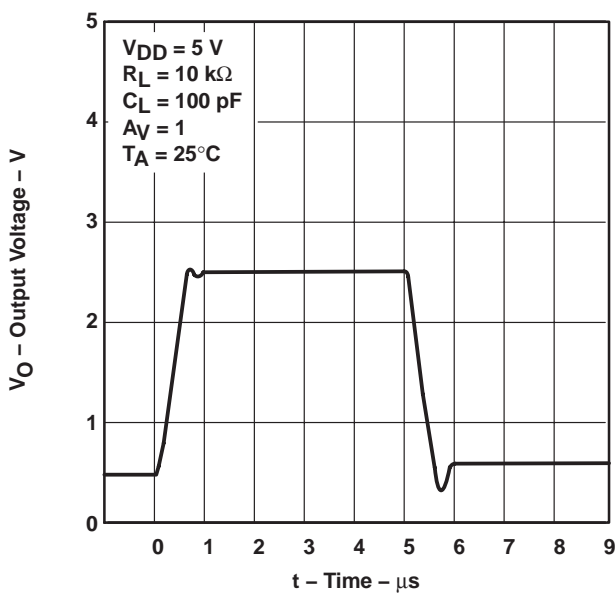
## TYPICAL CHARACTERISTICS

**INVERTING LARGE-SIGNAL PULSE RESPONSE**



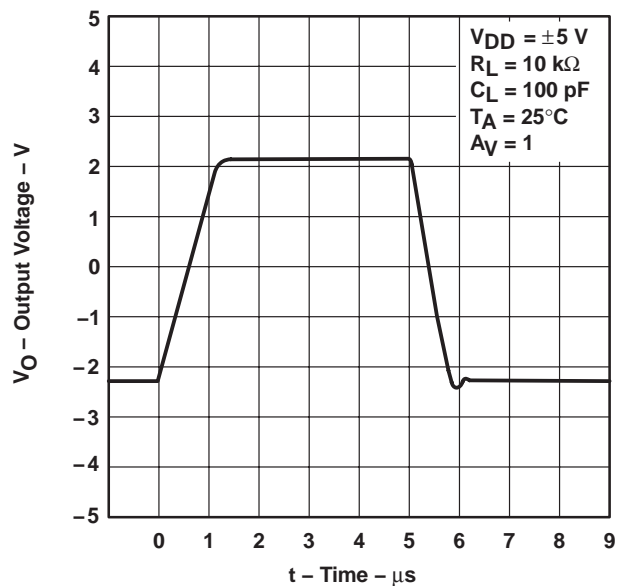
**Figure 43**

**VOLTAGE-FOLLOWER  
LARGE-SIGNAL PULSE RESPONSE**



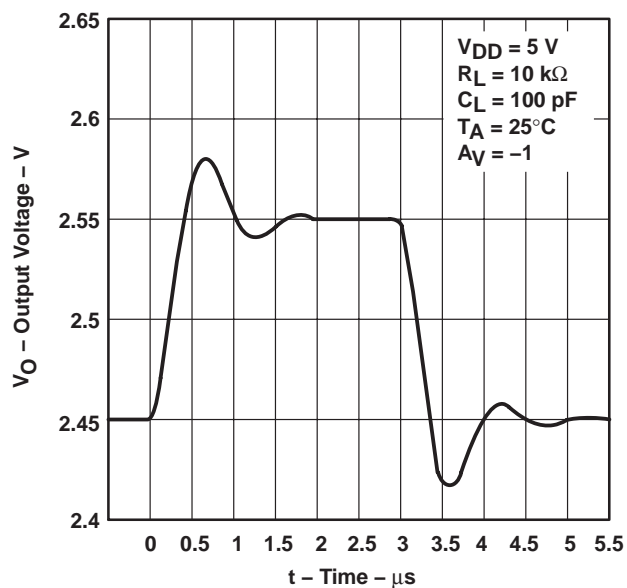
**Figure 44**

**VOLTAGE-FOLLOWER  
LARGE-SIGNAL PULSE RESPONSE**



**Figure 45**

**INVERTING SMALL-SIGNAL PULSE RESPONSE**



**Figure 46**

## TYPICAL CHARACTERISTICS

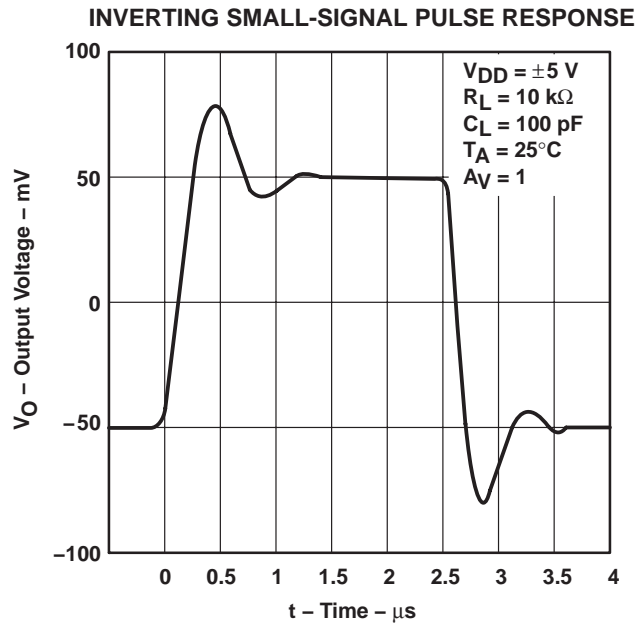


Figure 47

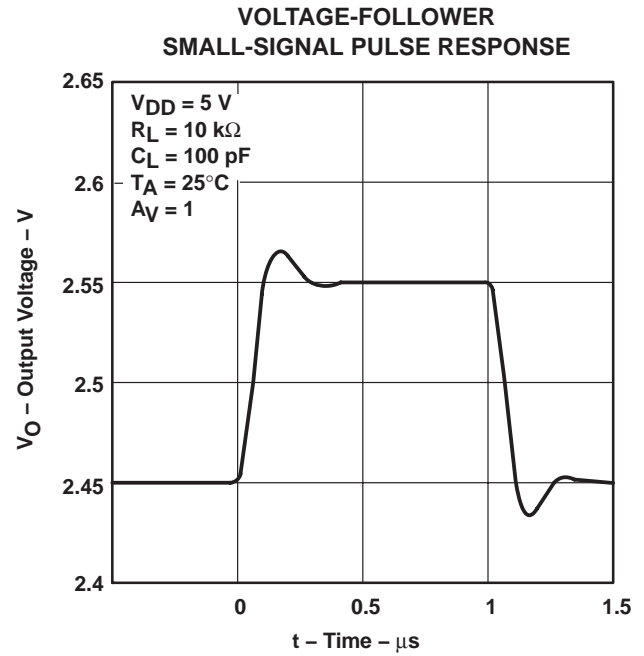


Figure 48

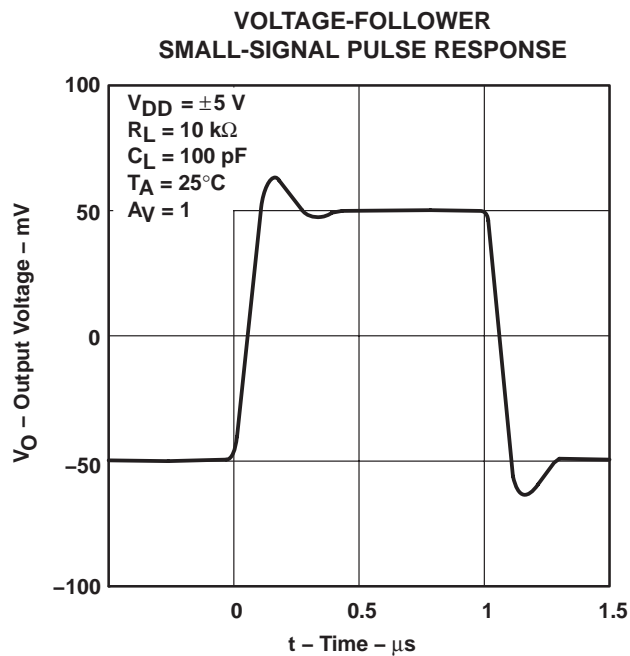


Figure 49

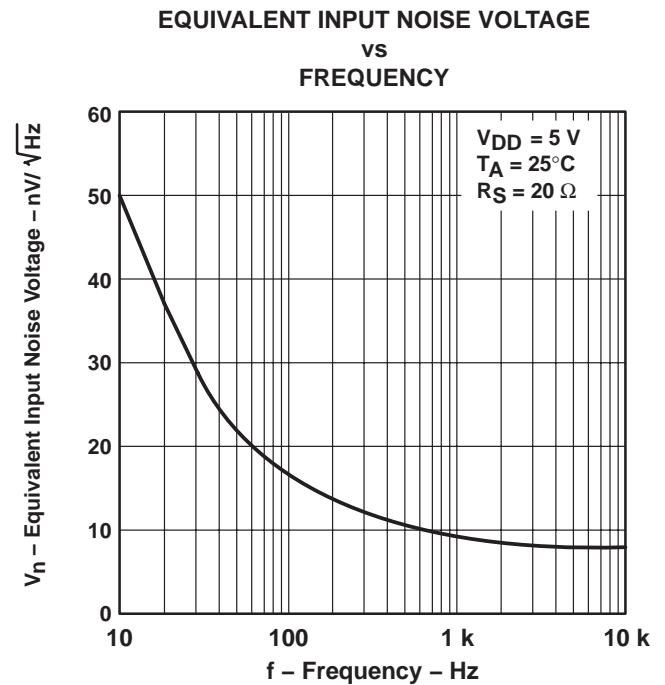


Figure 50

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

### TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE  
vs  
FREQUENCY

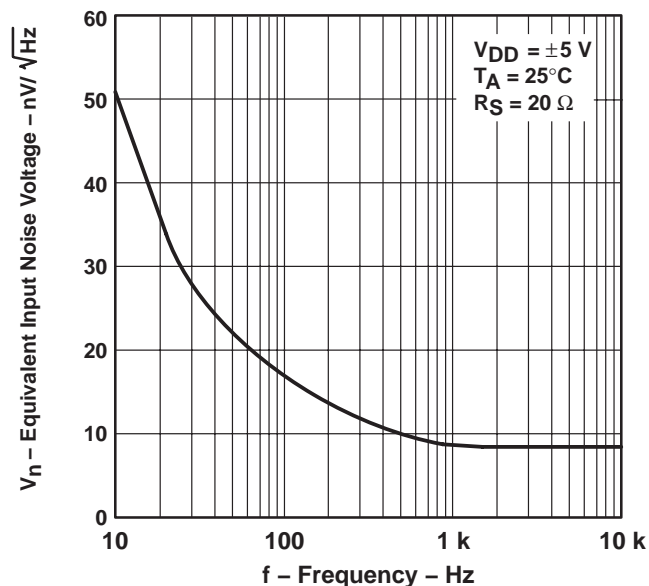


Figure 51

NOISE VOLTAGE  
OVER A 10 SECOND PERIOD

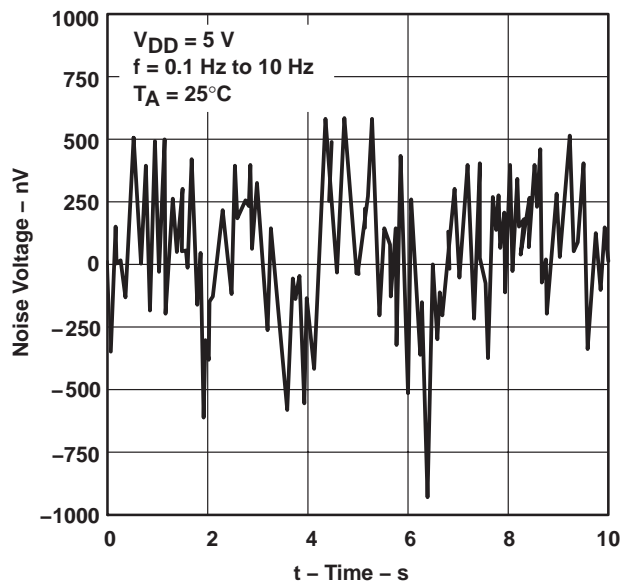


Figure 52

INTEGRATED NOISE VOLTAGE  
vs  
FREQUENCY

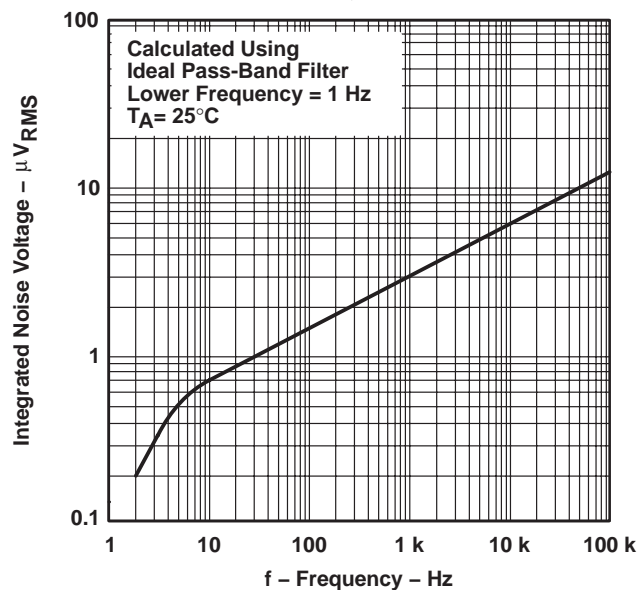


Figure 53

TOTAL HARMONIC DISTORTION PLUS NOISE  
vs  
FREQUENCY

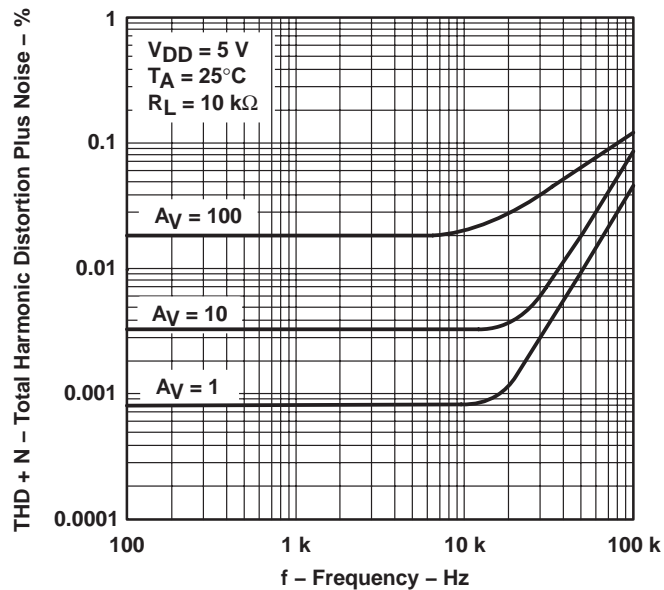
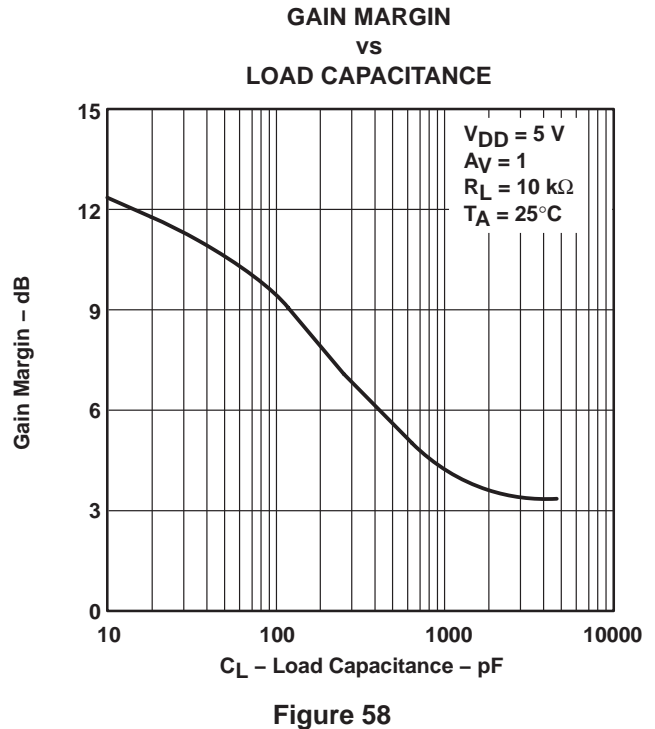
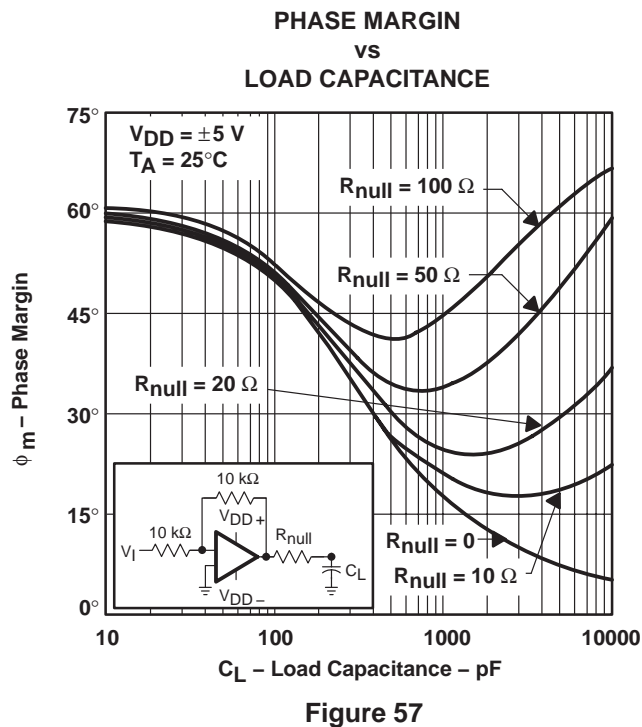
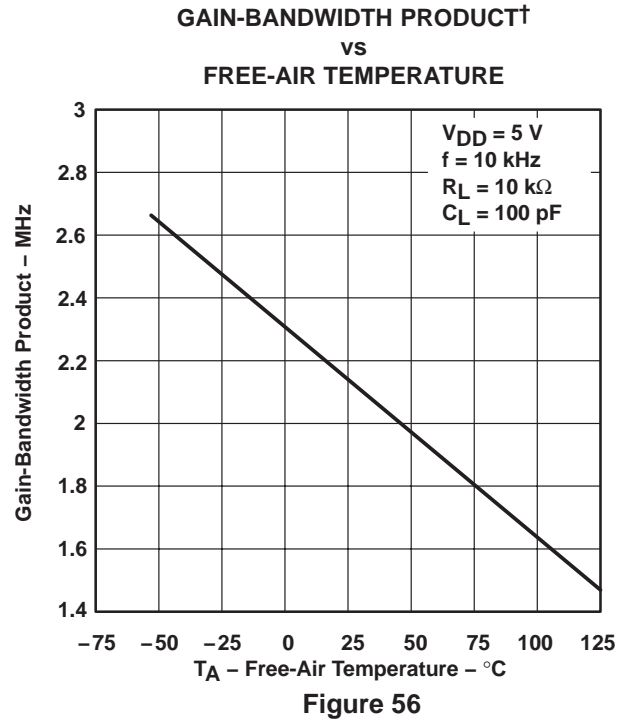
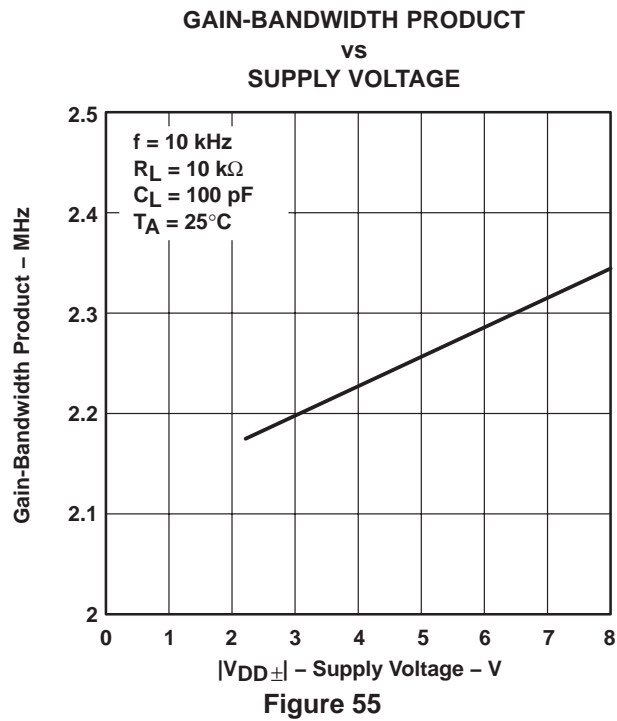


Figure 54

## TYPICAL CHARACTERISTICS



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

# TLC227x, TLC227xA

## Advanced LinCMOS™ RAIL-TO-RAIL

### OPERATIONAL AMPLIFIERS

SLOS190G – FEBRUARY 1997 – REVISED MAY 2004

## APPLICATION INFORMATION

### macromodel information

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

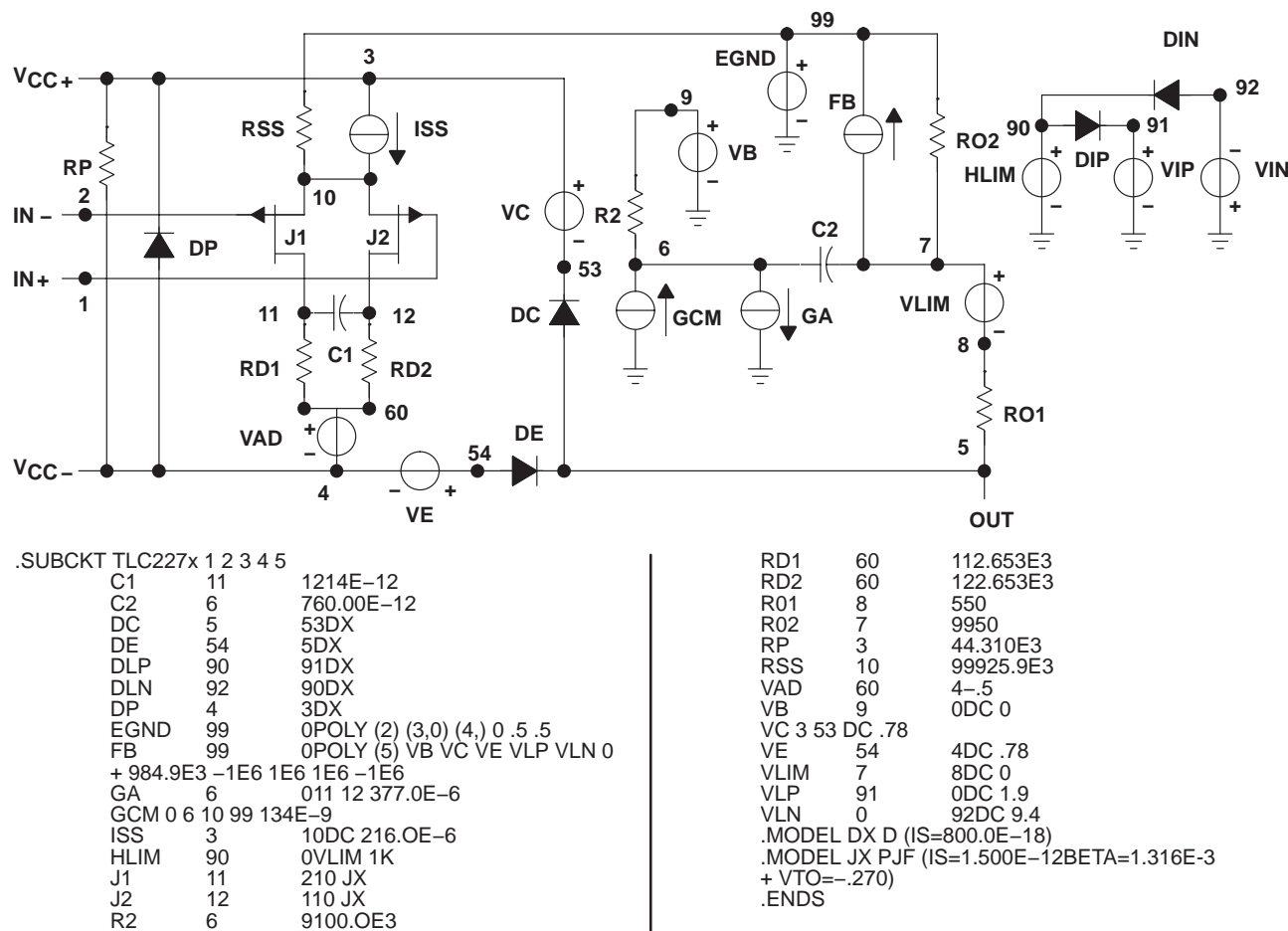


Figure 59. Boyle Macromodel and Subcircuit

*PSpice* and *Parts* are trademarks of MicroSim Corporation.

Macromodels, simulation models, or other models provided by TI, directly or indirectly, are not warranted by TI as fully representing all of the specification and operating characteristics of the semiconductor product to which the model relates.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
5962-9318201M2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
5962-9318201MCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9318201QDA	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9318202Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
5962-9318202QCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9318202QDA	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9555201NXDR	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
5962-9555201Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
5962-9555201QHA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9555201QPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9555202Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
5962-9555202QHA	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-9555202QPA	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2272ACD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272ACDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272ACDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272ACDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272ACP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272ACPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272ACPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272ACPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TLC2272ACPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272AIP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272AIPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272AMD	ACTIVE	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272AMDR	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
TLC2272AMJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	Level-NC-NC-NC

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLC2272AMP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TLC2272AMUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2272AQD	ACTIVE	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272AQDR	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272CPSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CPSRG4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TLC2272CPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272CPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC2272IPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272IPWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI
TLC2272IPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2272MD	ACTIVE	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272MDR	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
TLC2272MJG	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2272MJGB	ACTIVE	CDIP	JG	8	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2272MP	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TLC2272MUB	ACTIVE	CFP	U	10	1	TBD	A42 SNPB	Level-NC-NC-NC



Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLC2272QD	ACTIVE	SOIC	D	8	75	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272QDR	ACTIVE	SOIC	D	8	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2272QPWR	ACTIVE	TSSOP	PW	8	2000	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274ACD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274ACNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274ACPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ACPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274AINE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274AIPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
TLC2274AIPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AIPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274AMD	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274AMDR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274AMFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
TLC2274AMJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2274AMWB	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2274AQD	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLC2274AQDR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274CNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274CNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CNSR-A	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CNSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
TLC2274CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274CPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274IPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274IPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
TLC2274IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274IPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC2274MD	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274MDR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLC2274MJ	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2274MJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2274MN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPD	Level-NC-NC-NC
TLC2274MWB	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
TLC2274QD	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274QDR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-1-220C-UNLIM
TLC2274Y	PREVIEW	XCEPT	Y	0		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

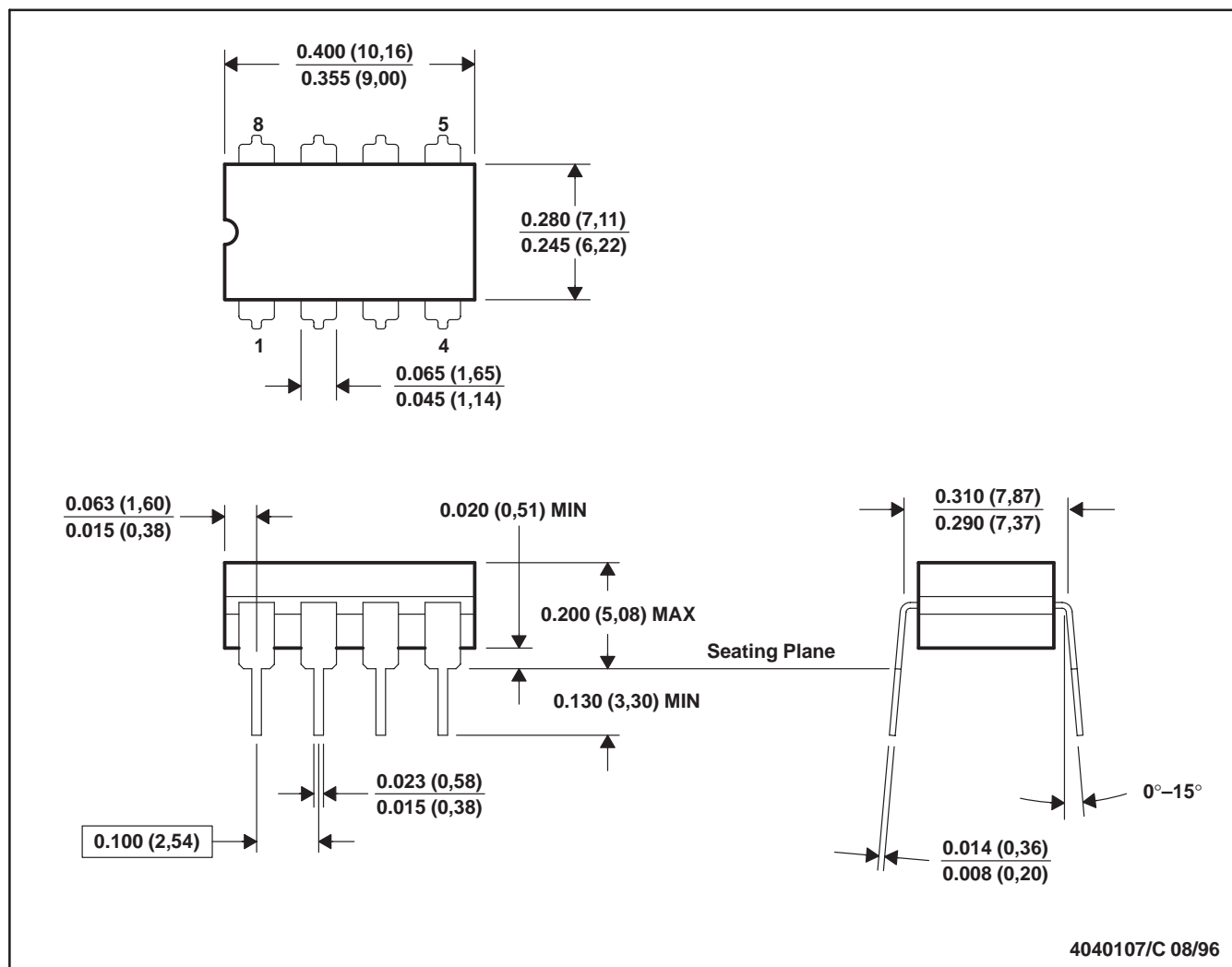
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## JG (R-GDIP-T8)

## CERAMIC DUAL-IN-LINE

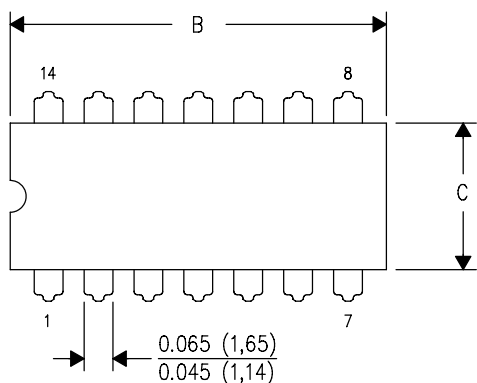


- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification.
  - Falls within MIL STD 1835 GDIP1-T8

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

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)

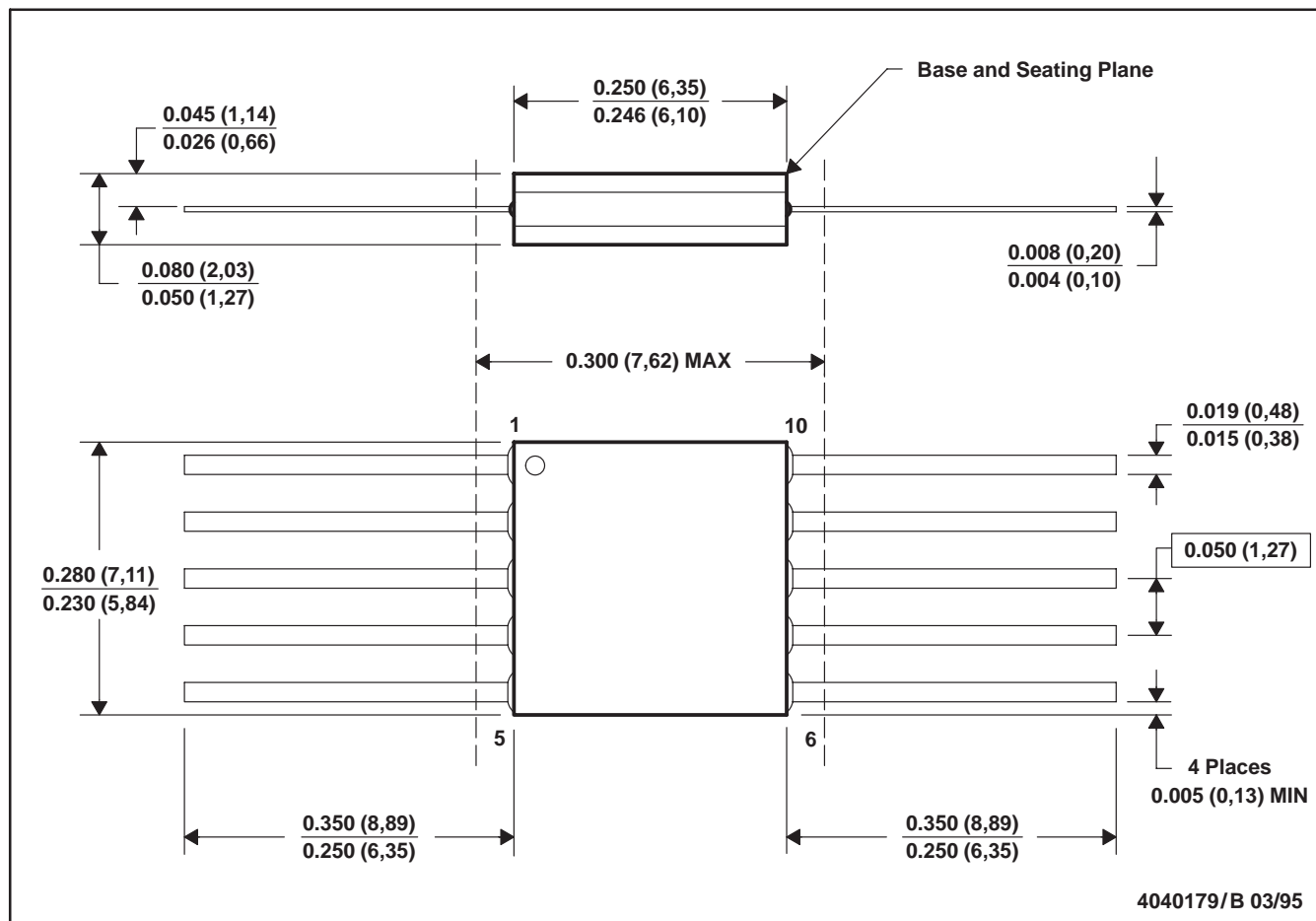


4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is 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-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

## U (S-GDFP-F10)

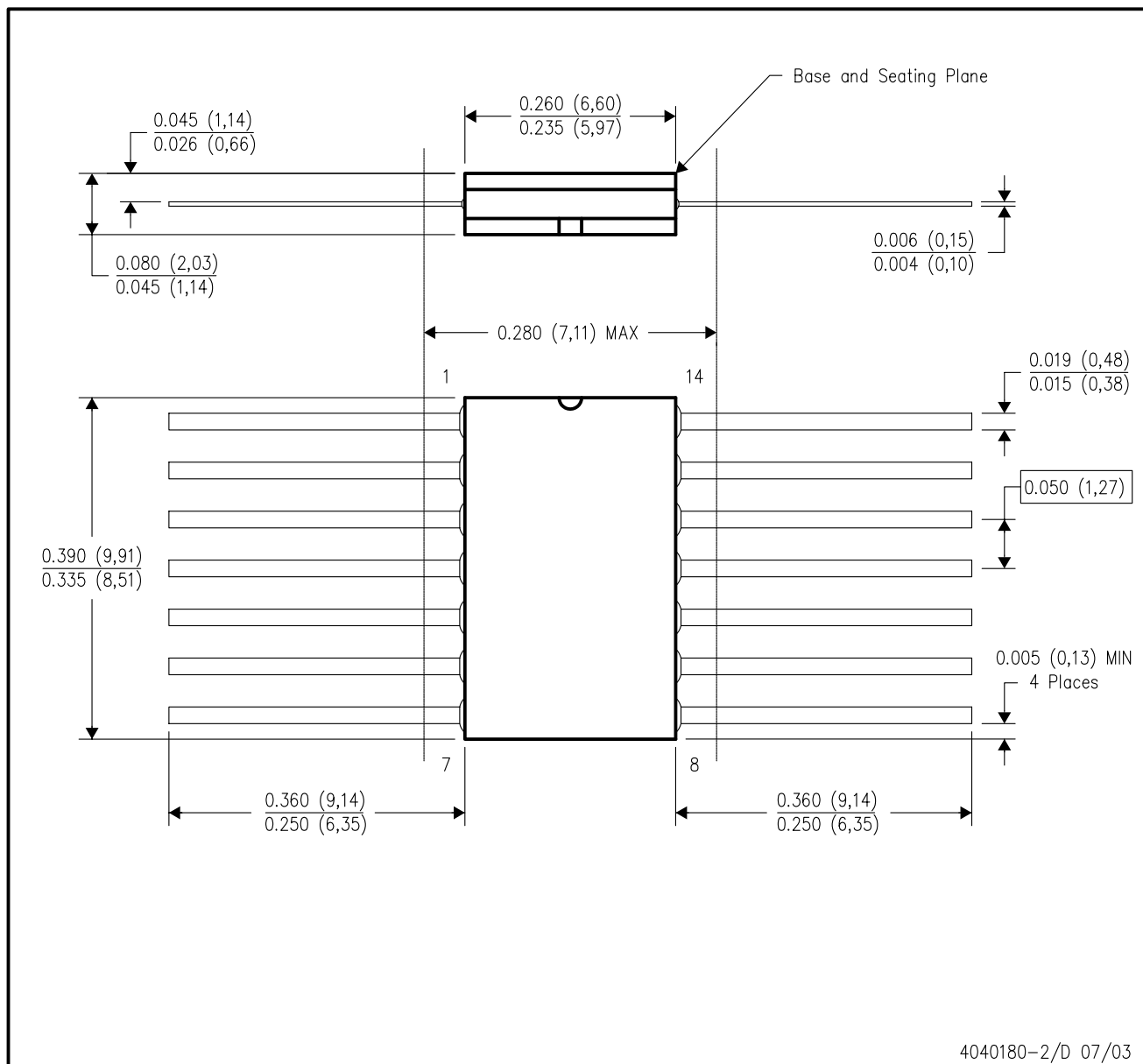
## CERAMIC DUAL FLATPACK



- NOTES: A. All linear dimensions are in inches (millimeters).  
 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.  
 E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA

W (R-GDFP-F14)

CERAMIC DUAL FLATPACK

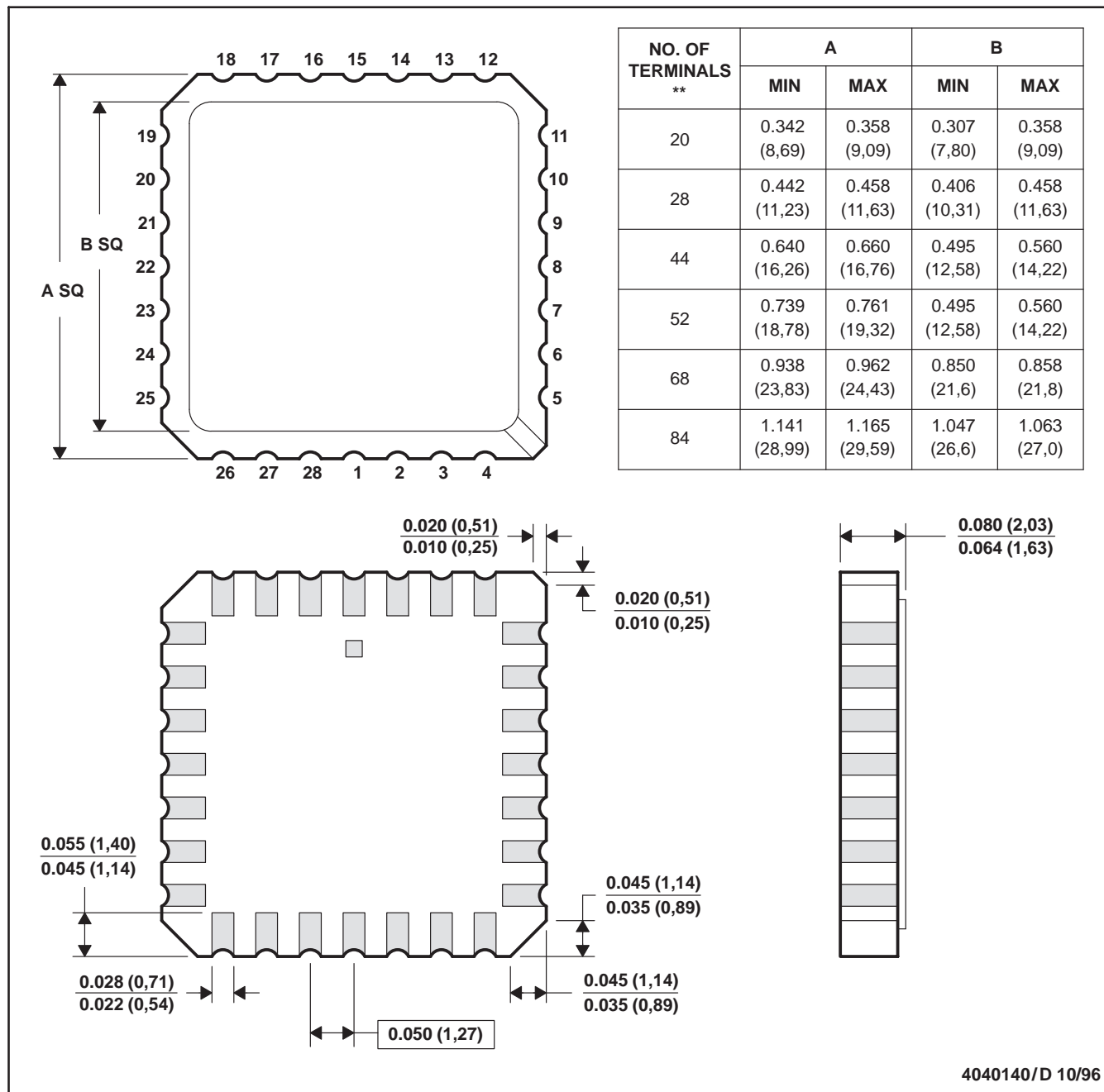


- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only.
  - Falls within MIL STD 1835 GDFP1-F14 and JEDEC MO-092AB

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

## LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

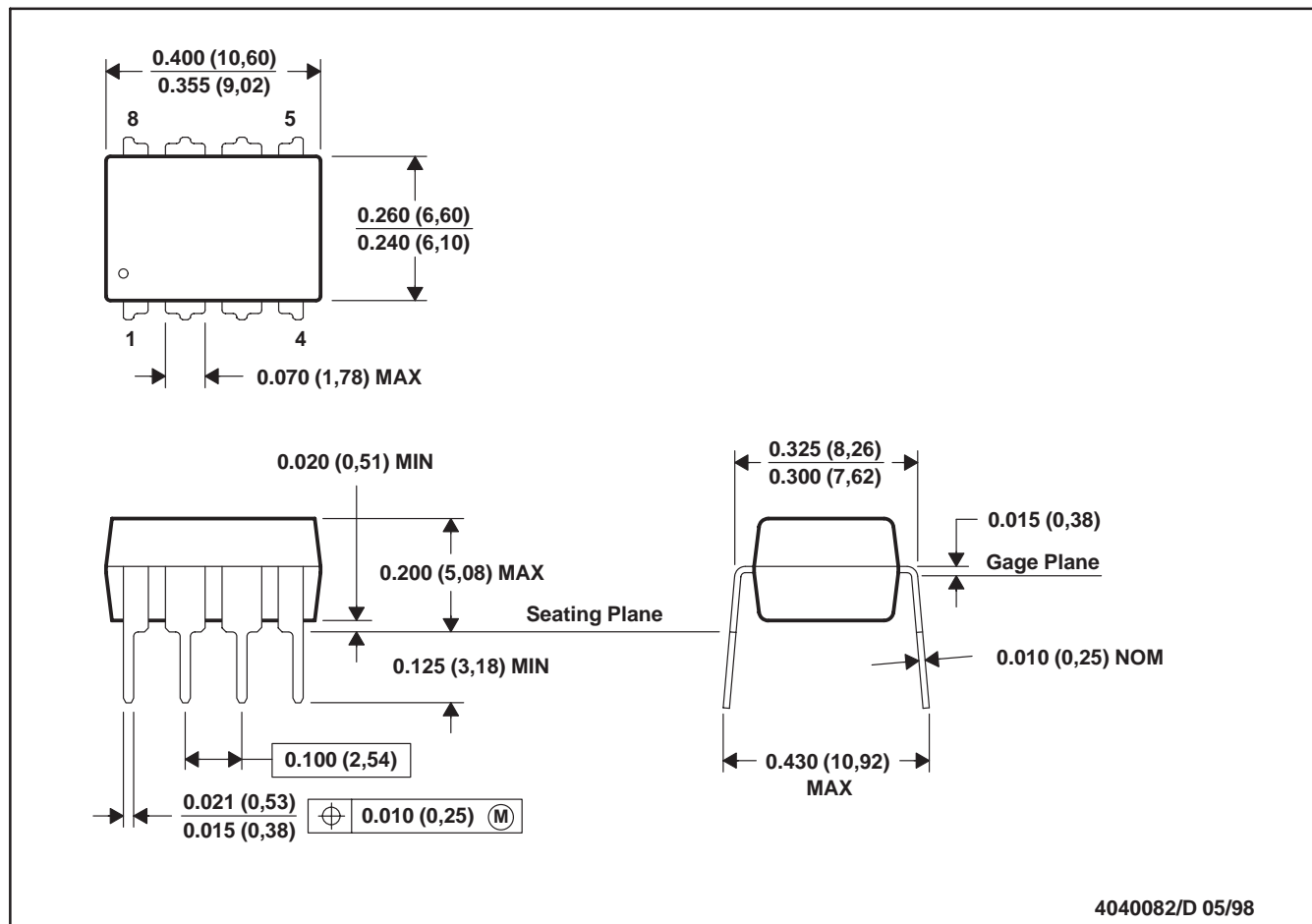


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a metal lid.
  - D. The terminals are gold plated.
  - E. Falls within JEDEC MS-004



## P (R-PDIP-T8)

## PLASTIC DUAL-IN-LINE



NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

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

16 PINS SHOWN

# PLASTIC DUAL-IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD



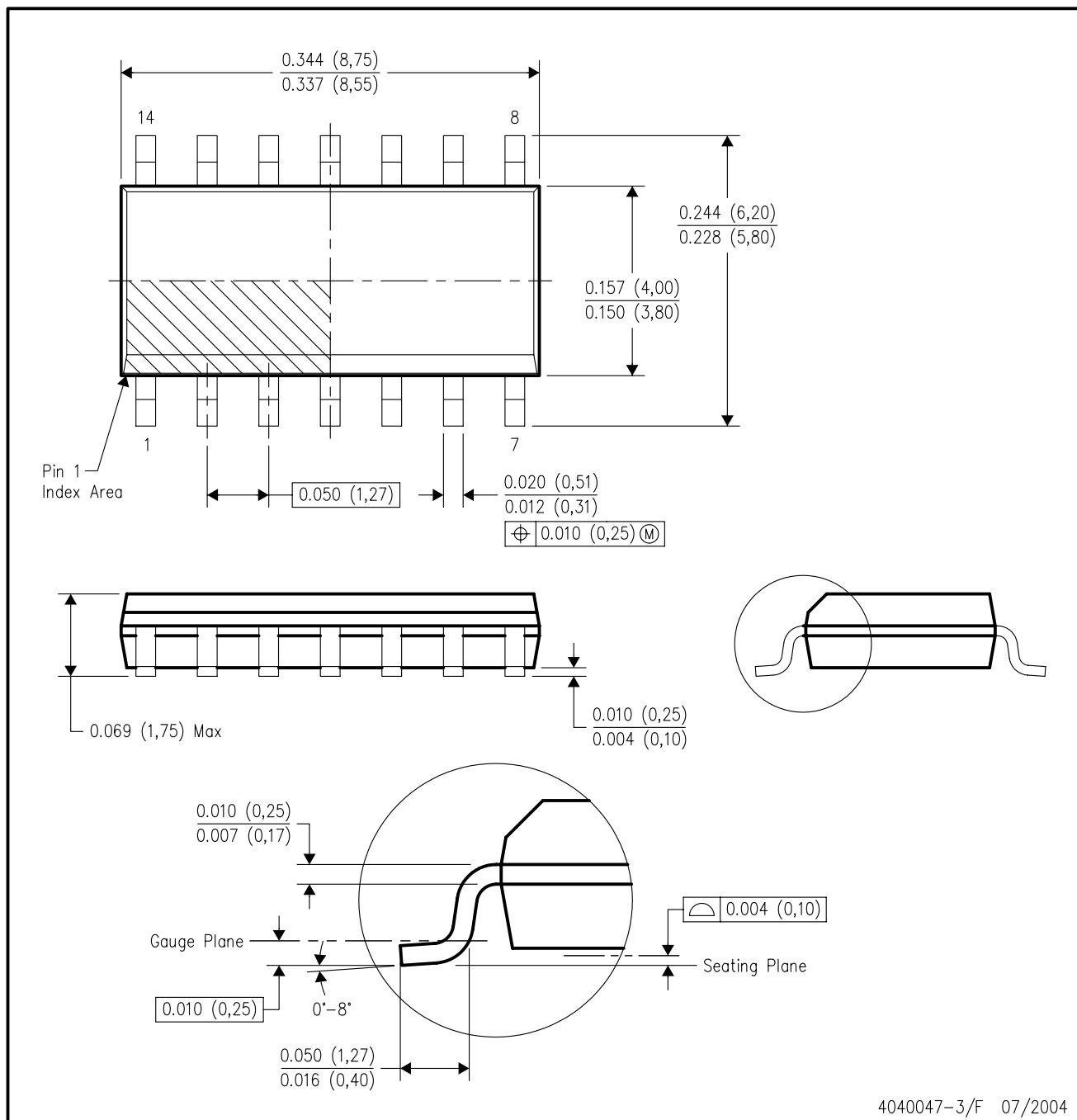
4040049/E 12/2002

NOTES:

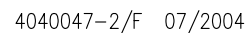
- A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).  
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

## D (R-PDSO-G14)

## PLASTIC SMALL-OUTLINE PACKAGE



4040047-3/F 07/2004



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 variation AA.

# MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



4040063/C 03/03

- 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.

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN

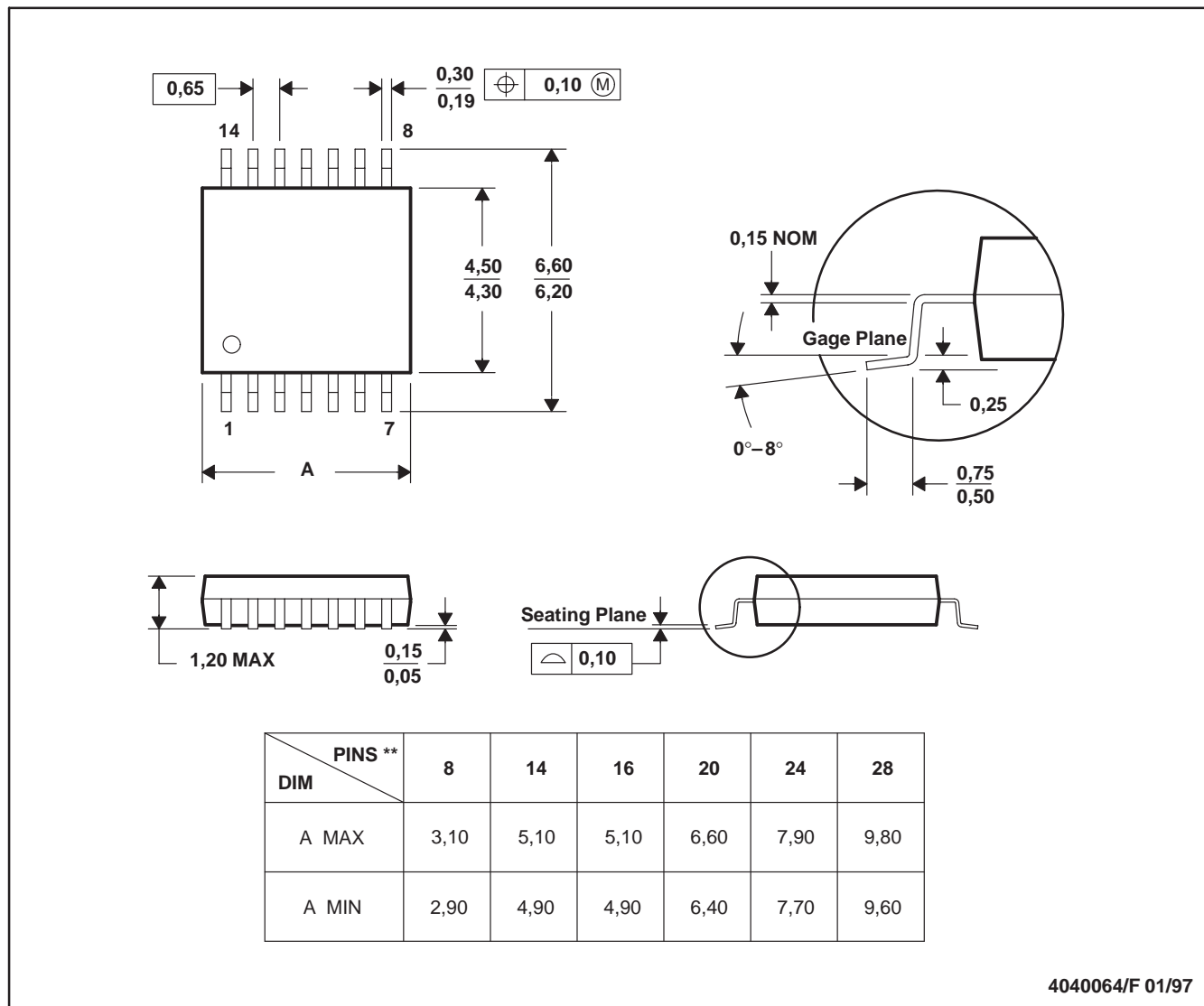


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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

## PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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 Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
		Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
		Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2005, Texas Instruments Incorporated