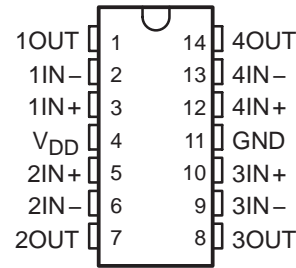


# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

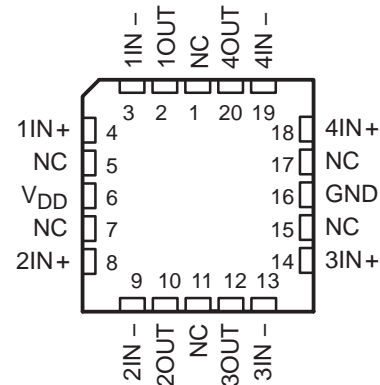
SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

- **Trimmed Offset Voltage:**  
TLC279 . . . 900  $\mu\text{V}$  Max at 25°C,  
 $V_{\text{DD}} = 5\text{ V}$
- **Input Offset Voltage Drift . . . Typically**  
0.1  $\mu\text{V}/\text{Month}$ , Including the First 30 Days
- **Wide Range of Supply Voltages Over Specified Temperature Range:**  
0°C to 70°C . . . 3 V to 16 V  
–40°C to 85°C . . . 4 V to 16 V  
–55°C to 125°C . . . 4 V to 16 V
- **Single-Supply Operation**
- **Common-Mode Input Voltage Range Extends Below the Negative Rail (C-Suffix and I-Suffix Versions)**
- **Low Noise . . . Typically 25 nV/ $\sqrt{\text{Hz}}$  at  $f = 1\text{ kHz}$**
- **Output Voltage Range Includes Negative Rail**
- **High Input Impedance . . .  $10^{12}\ \Omega$  Typ**
- **ESD-Protection Circuitry**
- **Small-Outline Package Option Also Available in Tape and Reel**
- **Designed-In Latch-Up Immunity**

D, J, N, OR PW PACKAGE  
(TOP VIEW)



FK PACKAGE  
(TOP VIEW)



NC – No internal connection

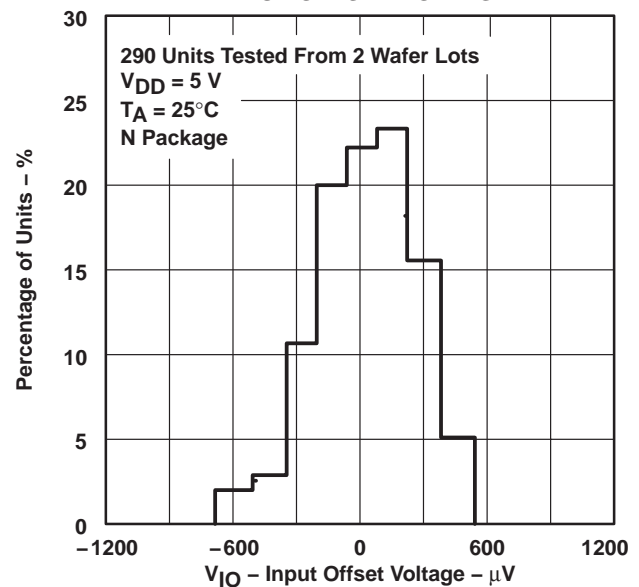
## description

The TLC274 and TLC279 quad operational amplifiers combine a wide range of input offset voltage grades with low offset voltage drift, high input impedance, low noise, and speeds approaching that of general-purpose BiFET devices.

These devices use Texas Instruments silicon-gate LinCMOS™ technology, which provides offset voltage stability far exceeding the stability available with conventional metal-gate processes.

The extremely high input impedance, low bias currents, and high slew rates make these cost-effective devices ideal for applications which have previously been reserved for BiFET and NFET products. Four offset voltage grades are available (C-suffix and I-suffix types), ranging from the low-cost TLC274 (10 mV) to the high-precision TLC279 (900  $\mu\text{V}$ ). These advantages, in combination with good common-mode rejection and supply voltage rejection, make these devices a good choice for new state-of-the-art designs as well as for upgrading existing designs.

DISTRIBUTION OF TLC279  
INPUT OFFSET VOLTAGE



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 © 2001, Texas Instruments Incorporated

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## description (continued)

In general, many features associated with bipolar technology are available on LinCMOS™ operational amplifiers, without the power penalties of bipolar technology. General applications such as transducer interfacing, analog calculations, amplifier blocks, active filters, and signal buffering are easily designed with the TLC274 and TLC279. The devices also exhibit low voltage single-supply operation, making them ideally suited for remote and inaccessible battery-powered applications. The common-mode input voltage range includes the negative rail.

A wide range of packaging options is available, including small-outline and chip-carrier versions for high-density system applications.

The device inputs and outputs are designed to withstand –100-mA surge currents without sustaining latch-up.

The TLC274 and TLC279 incorporate internal ESD-protection circuits that prevent functional failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.2; however, care should be exercised in handling these devices as exposure to ESD may result in the degradation of the device parametric performance.

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

### AVAILABLE OPTIONS

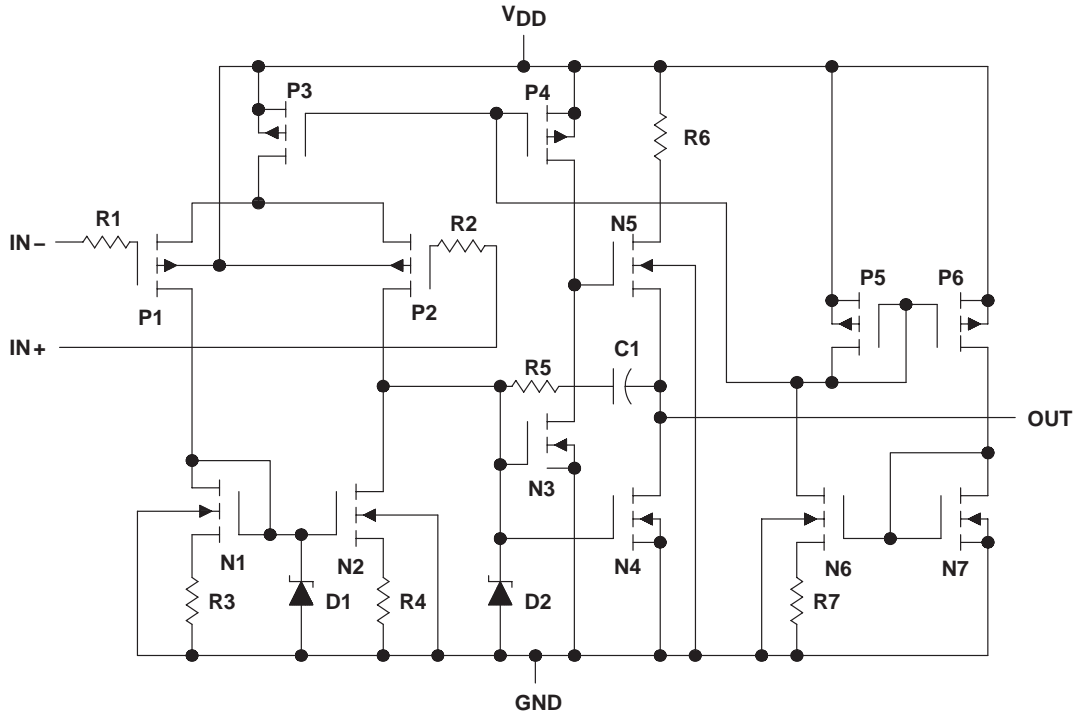
T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGED DEVICES					CHIP FORM (Y)
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP (PW)	
0°C to 70°C	900 μV	TLC279CD	—	—	TLC279CN	—	—
	2 mV	TLC274BCD	—	—	TLC274BCN	—	—
	5 mV	TLC274ACD	—	—	TLC274ACN	—	—
	10 mV	TLC274CD	—	—	TLC274CN	TLC274CPW	TLC274Y
–40°C to 85°C	900 μV	TLC279ID	—	—	TLC279IN	—	—
	2 mV	TLC274BID	—	—	TLC274BIN	—	—
	5 mV	TLC274AID	—	—	TLC274AIN	—	—
	10 mV	TLC274ID	—	—	TLC274IN	—	—
–55°C to 125°C	900 μV	TLC279MD	TLC279MFK	TLC279MJ	TLC279MN	—	—
	10 mV	TLC274MD	TLC274MFK	TLC274MJ	TLC274MN	—	—

The D package is available taped and reeled. Add R suffix to the device type (e.g., TLC279CDR).

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

equivalent schematic (each amplifier)

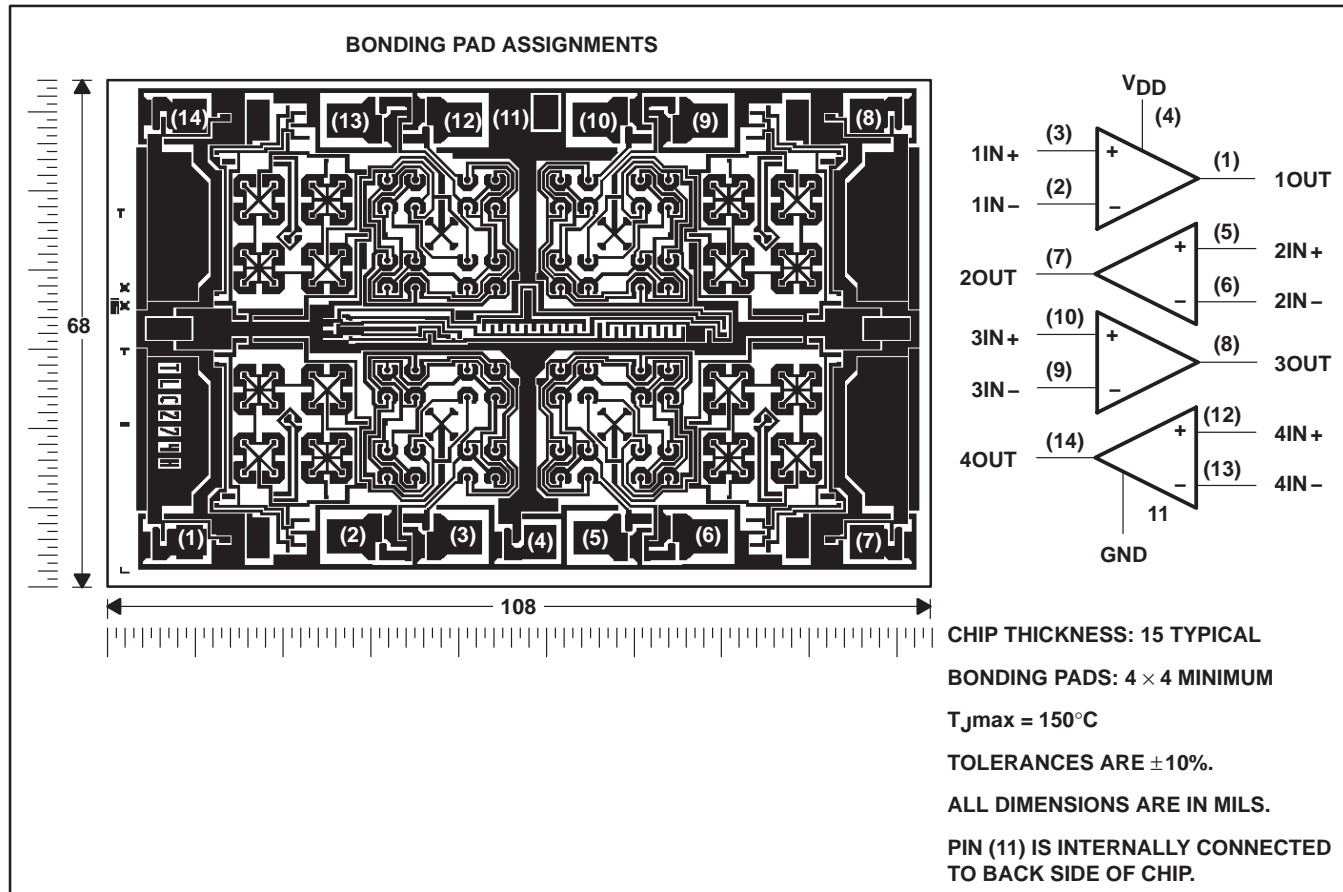


# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## TLC274Y chip information

These chips, when properly assembled, display characteristics similar to the TLC274C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

Supply voltage, $V_{DD}$ (see Note 1)	18 V
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm V_{DD}$
Input voltage range, $V_I$ (any input)	–0.3 V to $V_{DD}$
Input current, $I_I$	$\pm 5$ mA
Output current, $I_O$ (each output)	$\pm 30$ mA
Total current into $V_{DD}$	45 mA
Total current out of GND	45 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature, $T_A$ : C suffix	0°C to 70°C
I suffix	–40°C to 85°C
M suffix	–55°C to 125°C
Storage temperature range	–65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, or PW package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J 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 network ground.
  2. Differential voltages are at the noninverting input with respect to the inverting input.
  3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded (see application section).

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$	$T_A = 85^\circ\text{C}$	$T_A = 125^\circ\text{C}$
	POWER RATING		POWER RATING	POWER RATING	POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW	—
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
N	1575 mW	12.6 mW/°C	1008 mW	819 mW	—
PW	700 mW	5.6 mW/°C	448 mW	—	—

## recommended operating conditions

		C SUFFIX		I SUFFIX		M SUFFIX		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{DD}$		3	16	4	16	4	16	V
Common-mode input voltage, $V_{IC}$	$V_{DD} = 5$ V	–0.2	3.5	–0.2	3.5	0	3.5	V
	$V_{DD} = 10$ V	–0.2	8.5	–0.2	8.5	0	8.5	
Operating free-air temperature, $T_A$		0	70	–40	85	–55	125	°C



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

PARAMETER		TEST CONDITIONS		$T_A$ †	TLC274C, TLC274AC, TLC274BC, TLC279C			UNIT
					MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	TLC274C	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ ,	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV
					Full range		12	
		TLC274AC	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ ,	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	0.9	5	
					Full range		6.5	
TLC274BC	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ ,	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	340	2000	$\mu\text{V}$		
			Full range		3000			
TLC279C	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ ,	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	320	900			
			Full range		1500			
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage			25°C to 70°C	1.8		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input offset current (see Note 4)	$V_O = 2.5\text{ V}$ ,	$V_{IC} = 2.5\text{ V}$	25°C	0.1	60	pA	
$I_{IB}$	Input bias current (see Note 4)			70°C	7	300		
				25°C	0.6	60	pA	
70°C	40			600				
$V_{ICR}$	Common-mode input voltage range (see Note 5)			25°C	-0.2 to 4	-0.3 to 4.2	V	
				Full range	-0.2 to 3.5		V	
$V_{OH}$	High-level output voltage	$V_{ID} = 100\text{ mV}$ ,	$R_L = 10\text{ k}\Omega$	25°C	3.2	3.8	V	
				0°C	3	3.8		
				70°C	3	3.8		
$V_{OL}$	Low-level output voltage	$V_{ID} = -100\text{ mV}$ ,	$I_{OL} = 0$	25°C	0	50	mV	
				0°C	0	50		
				70°C	0	50		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 0.25\text{ V to }2\text{ V}$ ,	$R_L = 10\text{ k}\Omega$	25°C	5	23	V/mV	
				0°C	4	27		
				70°C	4	20		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$		25°C	65	80	dB	
				0°C	60	84		
				70°C	60	85		
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V}$ ,	$V_O = 1.4\text{ V}$	25°C	65	95	dB	
				0°C	60	94		
				70°C	60	96		
$I_{DD}$	Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	$V_{IC} = 2.5\text{ V}$	25°C	2.7	6.4	mA	
				0°C	3.1	7.2		
				70°C	2.3	5.2		

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.

5. This range also applies to each input individually.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

**electrical characteristics at specified free-air temperature,  $V_{DD} = 10\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLC274C, TLC274AC, TLC274BC, TLC279C			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	TLC274C	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$ $V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV
				Full range		12	
		TLC274AC	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$ $V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	0.9	5	mV
				Full range		6.5	
		TLC274BC	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$ $V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	390	2000	$\mu\text{V}$
				Full range		3000	
		TLC279C	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$ $V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	370	1200	$\mu\text{V}$
				Full range		1900	
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage		25°C to 70°C	2		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input offset current (see Note 4)	$V_O = 5\text{ V},$ $V_{IC} = 5\text{ V}$	25°C	0.1	60	pA	
$I_{IB}$	Input bias current (see Note 4)		70°C	7	300		
			25°C	0.7	60	pA	
70°C	50		600				
$V_{ICR}$	Common-mode input voltage range (see Note 5)		25°C	-0.2 to 9	-0.3 to 9.2	V	
			Full range	-0.2 to 8.5		V	
$V_{OH}$	High-level output voltage	$V_{ID} = 100\text{ mV},$ $R_L = 10\text{ k}\Omega$	25°C	8	8.5	V	
			0°C	7.8	8.5		
			70°C	7.8	8.4		
$V_{OL}$	Low-level output voltage	$V_{ID} = -100\text{ mV},$ $I_{OL} = 0$	25°C	0	50	mV	
			0°C	0	50		
			70°C	0	50		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V},$ $R_L = 10\text{ k}\Omega$	25°C	10	36	V/mV	
			0°C	7.5	42		
			70°C	7.5	32		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	65	85	dB	
			0°C	60	88		
			70°C	60	88		
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V},$ $V_O = 1.4\text{ V}$	25°C	65	95	dB	
			0°C	60	94		
			70°C	60	96		
$I_{DD}$	Supply current (four amplifiers)	$V_O = 5\text{ V},$ No load	$V_{IC} = 5\text{ V},$	25°C	3.8	8	mA
				0°C	4.5	8.8	
				70°C	3.2	6.8	

† Full range is 0°C to 70°C.

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.  
5. This range also applies to each input individually.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

PARAMETER		TEST CONDITIONS	$T_A$ †	TLC274I, TLC274AI, TLC274BI, TLC279I			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ , $V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV	
			Full range		13		
			25°C	0.9	5	mV	
			Full range		7		
		TLC274BI	25°C	340	2000	$\mu\text{V}$	
			Full range		3500		
		TLC279I	25°C	320	900	$\mu\text{V}$	
			Full range		2000		
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage		25°C to 85°C	1.8		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input offset current (see Note 4)	$V_O = 2.5\text{ V}$ , $V_{IC} = 2.5\text{ V}$	25°C	0.1	60	pA	
			85°C	24	1000		
$I_{IB}$	Input bias current (see Note 4)		25°C	0.6	60	pA	
			85°C	200	2000		
$V_{ICR}$	Common-mode input voltage range (see Note 5)			25°C	-0.2 to 4	-0.3 to 4.2	V
				Full range	-0.2 to 3.5		V
$V_{OH}$	High-level output voltage	25°C		3.2	3.8	V	
		-40°C		3	3.8		
		85°C	3	3.8			
$V_{OL}$	Low-level output voltage	$V_{ID} = -100\text{ mV}$ , $I_{OL} = 0$	25°C	0	50	mV	
		-40°C	0	50			
		85°C	0	50			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 0.25\text{ V to } 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C	5	23	V/mV	
			-40°C	3.5	32		
			85°C	3.5	19		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	65	80	dB	
			-40°C	60	81		
			85°C	60	86		
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to } 10\text{ V}$ , $V_O = 1.4\text{ V}$	25°C	65	95	dB	
			-40°C	60	92		
			85°C	60	96		
$I_{DD}$	Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	25°C	2.7	6.4	mA	
			-40°C	3.8	8.8		
			85°C	2.1	4.8		

† Full range is -40°C to 85°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.

5. This range also applies to each input individually.





# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

**electrical characteristics at specified free-air temperature,  $V_{DD} = 10\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLC274I, TLC274AI, TLC274BI, TLC279I			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	TLC274I $V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ , $V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV	
			Full range		13		
			25°C	0.9	5	mV	
			Full range		7		
		TLC274BI $V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ , $V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	390	2000	$\mu\text{V}$	
			Full range		3500		
		TLC279I $V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ , $V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	370	1200	$\mu\text{V}$	
			Full range		2900		
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage		25°C to 85°C	2		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input offset current (see Note 4)	$V_O = 5\text{ V}$ , $V_{IC} = 5\text{ V}$	25°C	0.1	60	pA	
$I_{IB}$	Input bias current (see Note 4)		85°C	26	1000		
			25°C	0.7	60	pA	
85°C	220		2000				
$V_{ICR}$	Common-mode input voltage range (see Note 5)		25°C	-0.2 to 9	-0.3 to 9.2	V	
			Full range	-0.2 to 8.5		V	
$V_{OH}$	High-level output voltage	$V_{ID} = 100\text{ mV}$ , $R_L = 10\text{ k}\Omega$	25°C	8	8.5	V	
			-40°C	7.8	8.5		
			85°C	7.8	8.5		
$V_{OL}$	Low-level output voltage	$V_{ID} = -100\text{ mV}$ , $I_{OL} = 0$	25°C	0	50	mV	
			-40°C	0	50		
			85°C	0	50		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C	10	36	V/mV	
			-40°C	7	47		
			85°C	7	31		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	65	85	dB	
			-40°C	60	87		
			85°C	60	88		
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V}$ , $V_O = 1.4\text{ V}$	25°C	65	95	dB	
			-40°C	60	92		
			85°C	60	96		
$I_{DD}$	Supply current (four amplifiers)	$V_O = 5\text{ V}$ , No load $V_{IC} = 5\text{ V}$	25°C	3.8	8	mA	
			-40°C	5.5	10		
			85°C	2.9	6.4		

† Full range is -40°C to 85°C.

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.  
5. This range also applies to each input individually.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

PARAMETER		TEST CONDITIONS		$T_A^\dagger$	TLC274M, TLC279M			UNIT
					MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	TLC274M	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV
					Full range		12	
	TLC279M	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	320	900	$\mu\text{V}$	
				Full range		3750		
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage			25°C to 125°C	2.1		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input offset current (see Note 4)	$V_O = 2.5\text{ V}$ , $V_{IC} = 2.5\text{ V}$		25°C	0.1	60	pA	
$I_{IB}$	Input bias current (see Note 4)			125°C	1.4	15	nA	
				25°C	0.6	60	pA	
				125°C	9	35	nA	
$V_{ICR}$	Common-mode input voltage range (see Note 5)			25°C	0 to 4	-0.3 to 4.2	V	
				Full range	0 to 3.5		V	
$V_{OH}$	High-level output voltage	$V_{ID} = 100\text{ mV}$ , $R_L = 10\text{ k}\Omega$		25°C	3.2	3.8	V	
				-55°C	3	3.8		
				125°C	3	3.8		
$V_{OL}$	Low-level output voltage	$V_{ID} = -100\text{ mV}$ , $I_{OL} = 0$		25°C		0 50	mV	
				-55°C		0 50		
				125°C		0 50		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 0.25\text{ V to }2\text{ V}$ , $R_L = 10\text{ k}\Omega$		25°C	5	23	V/mV	
				-55°C	3.5	35		
				125°C	3.5	16		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$		25°C	65	80	dB	
				-55°C	60	81		
				125°C	60	84		
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V}$ , $V_O = 1.4\text{ V}$		25°C	65	95	dB	
				-55°C	60	90		
				125°C	60	97		
$I_{DD}$	Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load	$V_{IC} = 2.5\text{ V}$	25°C	2.7	6.4	mA	
				-55°C		4 10		
				125°C	1.9	4.4		

$^\dagger$  Full range is -55°C to 125°C.

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.  
5. This range also applies to each input individually.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

**electrical characteristics at specified free-air temperature,  $V_{DD} = 10\text{ V}$  (unless) otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLC274M, TLC279M			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ ,	$V_{IC} = 0$ , $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV
				Full range		12	
				25°C	370	1200	$\mu\text{V}$
				Full range		4300	
$\alpha_{VIO}$	Average temperature coefficient of input offset voltage		25°C to 125°C	2.2		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input offset current (see Note 4)	$V_O = 5\text{ V}$ ,	$V_{IC} = 5\text{ V}$	25°C	0.1	60	pA
$I_{IB}$	Input bias current (see Note 4)			125°C	1.8	15	nA
				25°C	0.7	60	pA
				125°C	10	35	nA
$V_{ICR}$	Common-mode input voltage range (see Note 5)			25°C	0 to 9	-0.3 to 9.2	V
				Full range	0 to 8.5		V
$V_{OH}$	High-level output voltage	$V_{ID} = 100\text{ mV}$ ,	$R_L = 10\text{ k}\Omega$	25°C	8	8.5	V
				-55°C	7.8	8.5	
				125°C	7.8	8.4	
$V_{OL}$	Low-level output voltage	$V_{ID} = -100\text{ mV}$ ,	$I_{OL} = 0$	25°C	0	50	mV
				-55°C	0	50	
				125°C	0	50	
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V}$ ,	$R_L = 10\text{ k}\Omega$	25°C	10	36	V/mV
				-55°C	7	50	
				125°C	7	27	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$		25°C	65	85	dB
				-55°C	60	87	
				125°C	60	86	
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V}$ ,	$V_O = 1.4\text{ V}$	25°C	65	95	dB
				-55°C	60	90	
				125°C	60	97	
$I_{DD}$	Supply current (four amplifiers)	$V_O = 5\text{ V}$ , No load	$V_{IC} = 5\text{ V}$ ,	25°C	3.8	8	mA
				-55°C	6.0	12	
				125°C	2.5	5.6	

† Full range is -55°C to 125°C.

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.  
5. This range also applies to each input individually.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS	$T_A$	TLC274C, TLC274AC, TLC274BC, TLC279C			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\ \Omega$ , $C_L = 20\ \text{pF}$ , See Figure 1	$V_{I\text{PP}} = 1\ \text{V}$	25°C	3.6		V/ $\mu\text{s}$
			0°C	4		
			70°C	3		
		$V_{I\text{PP}} = 2.5\ \text{V}$	25°C	2.9		
			0°C	3.1		
			70°C	2.5		
$V_n$ Equivalent input noise voltage	$f = 1\ \text{kHz}$ , See Figure 2	$R_S = 20\ \Omega$ ,	25°C	25		nV/ $\sqrt{\text{Hz}}$
BOM Maximum output-swing bandwidth	$V_O = V_{OH}$ , $R_L = 10\ \text{k}\Omega$ ,	$C_L = 20\ \text{pF}$ , See Figure 1	25°C	320		kHz
			0°C	340		
			70°C	260		
B <sub>1</sub> Unity-gain bandwidth	$V_I = 10\ \text{mV}$ , See Figure 3	$C_L = 20\ \text{pF}$ ,	25°C	1.7		MHz
			0°C	2		
			70°C	1.3		
$\phi_m$ Phase margin	$V_I = 10\ \text{mV}$ , $C_L = 20\ \text{pF}$ ,	$f = B_1$ ,	25°C	46°		
			0°C	47°		
			70°C	44°		

## operating characteristics at specified free-air temperature, $V_{DD} = 10\ \text{V}$

PARAMETER	TEST CONDITIONS	$T_A$	TLC274C, TLC274AC, TLC274BC, TLC279C			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\ \Omega$ , $C_L = 20\ \text{pF}$ , See Figure 1	$V_{I\text{PP}} = 1\ \text{V}$	25°C	5.3		V/ $\mu\text{s}$
			0°C	5.9		
			70°C	4.3		
		$V_{I\text{PP}} = 5.5\ \text{V}$	25°C	4.6		
			0°C	5.1		
			70°C	3.8		
$V_n$ Equivalent input noise voltage	$f = 1\ \text{kHz}$ , See Figure 2	$R_S = 20\ \Omega$ ,	25°C	25		nV/ $\sqrt{\text{Hz}}$
BOM Maximum output-swing bandwidth	$V_O = V_{OH}$ , $R_L = 10\ \text{k}\Omega$ ,	$C_L = 20\ \text{pF}$ , See Figure 1	25°C	200		kHz
			0°C	220		
			70°C	140		
B <sub>1</sub> Unity-gain bandwidth	$V_I = 10\ \text{mV}$ , See Figure 3	$C_L = 20\ \text{pF}$ ,	25°C	2.2		MHz
			0°C	2.5		
			70°C	1.8		
$\phi_m$ Phase margin	$V_I = 10\ \text{mV}$ , $C_L = 20\ \text{pF}$ ,	$f = B_1$ , See Figure 3	25°C	49°		
			0°C	50°		
			70°C	46°		



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS		$T_A$	TLC274I, TLC274AI, TLC274BI, TLC279I			UNIT
				MIN	TYP	MAX	
SR    Slew rate at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 20\text{ pF}$ , See Figure 1	$V_{I\text{PP}} = 1\text{ V}$	25°C	3.6		V/ $\mu\text{s}$	
			-40°C	4.5			
			85°C	2.8			
		$V_{I\text{PP}} = 2.5\text{ V}$	25°C	2.9			
			-40°C	3.5			
			85°C	2.3			
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , See Figure 2	$R_S = 20\ \Omega$	25°C	25		nV/ $\sqrt{\text{Hz}}$	
$B_{\text{OM}}$ Maximum output-swing bandwidth	$V_O = V_{\text{OH}}$ , $R_L = 10\text{ k}\Omega$ , See Figure 1	$C_L = 20\text{ pF}$ , See Figure 1	25°C	320		kHz	
			-40°C	380			
			85°C	250			
$B_1$ Unity-gain bandwidth	$V_I = 10\text{ mV}$ , See Figure 3	$C_L = 20\text{ pF}$	25°C	1.7		MHz	
			-40°C	2.6			
			85°C	1.2			
$\phi_m$ Phase margin	$V_I = 10\text{ mV}$ , $C_L = 20\text{ pF}$ ,	$f = B_1$ , See Figure 3	25°C	46°			
			-40°C	49°			
			85°C	43°			

## operating characteristics at specified free-air temperature, $V_{DD} = 10\text{ V}$

PARAMETER	TEST CONDITIONS		$T_A$	TLC274I, TLC274AI, TLC274BI, TLC279I			UNIT
				MIN	TYP	MAX	
SR    Slew rate at unity gain	$R_L = 10\ \Omega$ , $C_L = 20\text{ pF}$ , See Figure 1	$V_{I\text{PP}} = 1\text{ V}$	25°C	5.3		V/ $\mu\text{s}$	
			-40°C	6.7			
			85°C	4			
		$V_{I\text{PP}} = 5.5\text{ V}$	25°C	4.6			
			-40°C	5.8			
			85°C	3.5			
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , See Figure 2	$R_S = 20\ \Omega$	25°C	25		nV/ $\sqrt{\text{Hz}}$	
$B_{\text{OM}}$ Maximum output-swing bandwidth	$V_O = V_{\text{OH}}$ , $R_L = 10\text{ k}\Omega$ , See Figure 1	$C_L = 20\text{ pF}$ , See Figure 1	25°C	200		kHz	
			-40°C	260			
			85°C	130			
$B_1$ Unity-gain bandwidth	$V_I = 10\text{ mV}$ , See Figure 3	$C_L = 20\text{ pF}$	25°C	2.2		MHz	
			-40°C	3.1			
			85°C	1.7			
$\phi_m$ Phase margin	$V_I = 10\text{ mV}$ , $C_L = 20\text{ pF}$ ,	$f = B_1$ , See Figure 3	25°C	49°			
			-40°C	52°			
			85°C	46°			



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS	$T_A$	TLC274M, TLC279M			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\text{ k}\Omega$ , $C_L = 20\text{ pF}$ , See Figure 1	$V_{I\text{PP}} = 1\text{ V}$	25°C	3.6		V/ $\mu\text{s}$
			-55°C	4.7		
			125°C	2.3		
		$V_{I\text{PP}} = 2.5\text{ V}$	25°C	2.9		
			-55°C	3.7		
			125°C	2		
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , See Figure 2	$R_S = 20\ \Omega$	25°C	25		nV/ $\sqrt{\text{Hz}}$
$B_{\text{OM}}$ Maximum output-swing bandwidth	$V_O = V_{\text{OH}}$ , $R_L = 10\text{ k}\Omega$	$C_L = 20\text{ pF}$ , See Figure 1	25°C	320		kHz
			-55°C	400		
			125°C	230		
$B_1$ Unity-gain bandwidth	$V_I = 10\text{ mV}$ , See Figure 3	$C_L = 20\text{ pF}$	25°C	1.7		MHz
			-55°C	2.9		
			125°C	1.1		
$\phi_m$ Phase margin	$V_I = 10\text{ mV}$ , $C_L = 20\text{ pF}$	$f = B_1$ , See Figure 3	25°C	46°		
			-55°C	49°		
			125°C	41°		

## operating characteristics at specified free-air temperature, $V_{DD} = 10\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A$	TLC274M, TLC279M			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\ \Omega$ , $C_L = 20\text{ pF}$ , See Figure 1	$V_{I\text{PP}} = 1\text{ V}$	25°C	5.3		V/ $\mu\text{s}$
			-55°C	7.1		
			125°C	3.1		
		$V_{I\text{PP}} = 5.5\text{ V}$	25°C	4.6		
			-55°C	6.1		
			125°C	2.7		
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , See Figure 2	$R_S = 20\ \Omega$	25°C	25		nV/ $\sqrt{\text{Hz}}$
$B_{\text{OM}}$ Maximum output-swing bandwidth	$V_O = V_{\text{OH}}$ , $R_L = 10\text{ k}\Omega$	$C_L = 20\text{ pF}$ , See Figure 1	25°C	200		kHz
			-55°C	280		
			125°C	110		
$B_1$ Unity-gain bandwidth	$V_I = 10\text{ mV}$ , See Figure 3	$C_L = 20\text{ pF}$	25°C	2.2		MHz
			-55°C	3.4		
			125°C	1.6		
$\phi_m$ Phase margin	$V_I = 10\text{ mV}$ , $C_L = 20\text{ pF}$	$f = B_1$ , See Figure 3	25°C	49°		
			-55°C	52°		
			125°C	44°		



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## electrical characteristics, $V_{DD} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLC274Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ , $V_{IC} = 0$ , $R_L = 10\ \text{k}\Omega$		1.1	10	mV
$I_{IO}$ Input offset current (see Note 4)	$V_O = 2.5\text{ V}$ , $V_{IC} = 2.5\text{ V}$		0.1		pA
$I_{IB}$ Input bias current (see Note 4)			0.6		pA
$V_{ICR}$ Common-mode input voltage range (see Note 5)		-0.2 to 4	-0.3 to 4.2		V
$V_{OH}$ High-level output voltage	$V_{ID} = 100\text{ mV}$ , $R_L = 10\ \text{k}\Omega$	3.2	3.8		V
$V_{OL}$ Low-level output voltage	$V_{ID} = -100\text{ mV}$ , $I_{OL} = 0$		0	50	mV
$A_{VD}$ Large-signal differential voltage amplification	$V_O = 0.25\text{ V to }2\text{ V}$ , $R_L = 10\ \text{k}\Omega$	5	23		V/mV
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	65	80		dB
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V}$ , $V_O = 1.4\text{ V}$	65	95		dB
$I_{DD}$ Supply current (four amplifiers)	$V_O = 2.5\text{ V}$ , No load $V_{IC} = 2.5\text{ V}$		2.7	6.4	mA

## electrical characteristics, $V_{DD} = 10\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLC274Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 1.4\text{ V}$ , $R_S = 50\ \Omega$ , $V_{IC} = 0$ , $R_L = 10\ \text{k}\Omega$		1.1	10	mV
$I_{IO}$ Input offset current (see Note 4)	$V_O = 5\text{ V}$ , $V_{IC} = 5\text{ V}$		0.1		pA
$I_{IB}$ Input bias current (see Note 4)			0.7		pA
$V_{ICR}$ Common-mode input voltage range (see Note 5)		-0.2 to 9	-0.3 to 9.2		V
$V_{OH}$ High-level output voltage	$V_{ID} = 100\text{ mV}$ , $R_L = 10\ \text{k}\Omega$	8	8.5		V
$V_{OL}$ Low-level output voltage	$V_{ID} = -100\text{ mV}$ , $I_{OL} = 0$		0	50	mV
$A_{VD}$ Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V}$ , $R_L = 10\ \text{k}\Omega$	10	36		V/mV
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	65	85		dB
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ )	$V_{DD} = 5\text{ V to }10\text{ V}$ , $V_O = 1.4\text{ V}$	65	95		dB
$I_{DD}$ Supply current (four amplifiers)	$V_O = 5\text{ V}$ , No load $V_{IC} = 5\text{ V}$		3.8	8	mA

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.  
5. This range also applies to each input individually.



# TLC274, TLC274A, TLC274B, TLC274Y, TLC279

## LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

### operating characteristics, $V_{DD} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLC274Y			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\text{ k}\Omega$ , See Figure 1 $C_L = 20\text{ pF}$	$V_{IPP} = 1\text{ V}$	3.6		$\text{V}/\mu\text{s}$
		$V_{IPP} = 2.5\text{ V}$	2.9		
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$ , See Figure 2	25			$\text{nV}/\sqrt{\text{Hz}}$
$B_{OM}$ Maximum output-swing bandwidth	$V_O = V_{OH}$ , See Figure 1 $C_L = 20\text{ pF}$ , $R_L = 10\text{ k}\Omega$ ,	320			kHz
$B_1$ Unity-gain bandwidth	$V_I = 10\text{ mV}$ , $C_L = 20\text{ pF}$ , See Figure 3	1.7			MHz
$\phi_m$ Phase margin	$V_I = 10\text{ mV}$ , See Figure 3 $f = B_1$ , $C_L = 20\text{ pF}$ ,	46°			

### operating characteristics, $V_{DD} = 10\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLC274Y			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\text{ k}\Omega$ , See Figure 1 $C_L = 20\text{ pF}$	$V_{IPP} = 1\text{ V}$	5.3		$\text{V}/\mu\text{s}$
		$V_{IPP} = 5.5\text{ V}$	4.6		
$V_n$ Equivalent input noise voltage	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$ , See Figure 2	25			$\text{nV}/\sqrt{\text{Hz}}$
$B_{OM}$ Maximum output-swing bandwidth	$V_O = V_{OH}$ , See Figure 1 $C_L = 20\text{ pF}$ , $R_L = 10\text{ k}\Omega$ ,	200			kHz
$B_1$ Unity-gain bandwidth	$V_I = 10\text{ mV}$ , $C_L = 20\text{ pF}$ , See Figure 3	2.2			MHz
$\phi_m$ Phase margin	$V_I = 10\text{ mV}$ , See Figure 3 $f = B_1$ , $C_L = 20\text{ pF}$ ,	49°			



PARAMETER MEASUREMENT INFORMATION

single-supply versus split-supply test circuits

Because the TLC274 and TLC279 are optimized for single-supply operation, circuit configurations used for the various tests often present some inconvenience since the input signal, in many cases, must be offset from ground. This inconvenience can be avoided by testing the device with split supplies and the output load tied to the negative rail. A comparison of single-supply versus split-supply test circuits is shown below. The use of either circuit gives the same result.

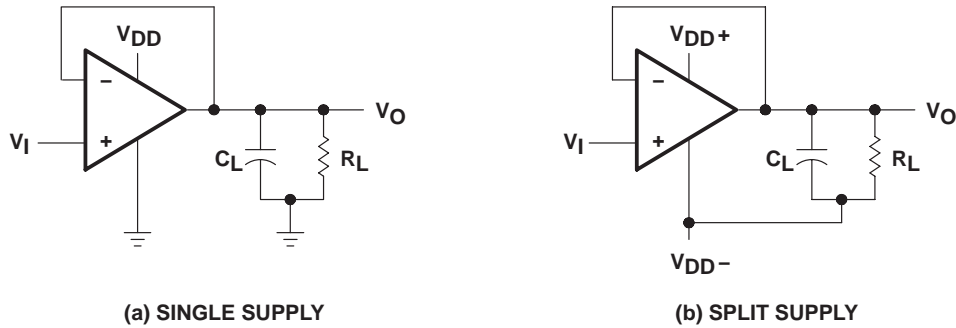


Figure 1. Unity-Gain Amplifier

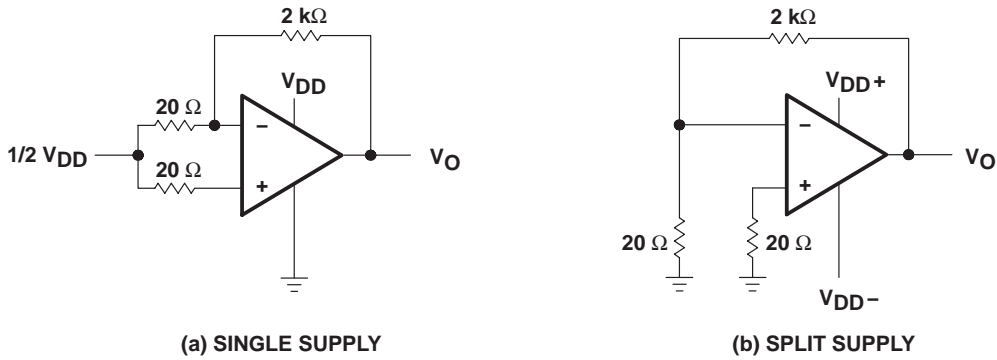


Figure 2. Noise-Test Circuit



Figure 3. Gain-of-100 Inverting Amplifier

**PARAMETER MEASUREMENT INFORMATION**

**input bias current**

Because of the high input impedance of the TLC274 and TLC279 operational amplifiers, attempts to measure the input bias current can result in erroneous readings. The bias current at normal room ambient temperature is typically less than 1 pA, a value that is easily exceeded by leakages on the test socket. Two suggestions are offered to avoid erroneous measurements:

1. Isolate the device from other potential leakage sources. Use a grounded shield around and between the device inputs (see Figure 4). Leakages that would otherwise flow to the inputs are shunted away.
2. Compensate for the leakage of the test socket by actually performing an input bias current test (using a picoammeter) with no device in the test socket. The actual input bias current can then be calculated by subtracting the open-socket leakage readings from the readings obtained with a device in the test socket.

One word of caution: many automatic testers as well as some bench-top operational amplifier testers use the servo-loop technique with a resistor in series with the device input to measure the input bias current (the voltage drop across the series resistor is measured and the bias current is calculated). This method requires that a device be inserted into the test socket to obtain a correct reading; therefore, an open-socket reading is not feasible using this method.



**Figure 4. Isolation Metal Around Device Inputs (J and N packages)**

**low-level output voltage**

To obtain low-supply-voltage operation, some compromise was necessary in the input stage. This compromise results in the device low-level output being dependent on both the common-mode input voltage level as well as the differential input voltage level. When attempting to correlate low-level output readings with those quoted in the electrical specifications, these two conditions should be observed. If conditions other than these are to be used, please refer to Figures 14 through 19 in the Typical Characteristics of this data sheet.

**input offset voltage temperature coefficient**

Erroneous readings often result from attempts to measure temperature coefficient of input offset voltage. This parameter is actually a calculation using input offset voltage measurements obtained at two different temperatures. When one (or both) of the temperatures is below freezing, moisture can collect on both the device and the test socket. This moisture results in leakage and contact resistance, which can cause erroneous input offset voltage readings. The isolation techniques previously mentioned have no effect on the leakage since the moisture also covers the isolation metal itself, thereby rendering it useless. It is suggested that these measurements be performed at temperatures above freezing to minimize error.

PARAMETER MEASUREMENT INFORMATION

full-power response

Full-power response, the frequency above which the operational amplifier slew rate limits the output voltage swing, is often specified two ways: full-linear response and full-peak response. The full-linear response is generally measured by monitoring the distortion level of the output while increasing the frequency of a sinusoidal input signal until the maximum frequency is found above which the output contains significant distortion. The full-peak response is defined as the maximum output frequency, without regard to distortion, above which full peak-to-peak output swing cannot be maintained.

Because there is no industry-wide accepted value for significant distortion, the full-peak response is specified in this data sheet and is measured using the circuit of Figure 1. The initial setup involves the use of a sinusoidal input to determine the maximum peak-to-peak output of the device (the amplitude of the sinusoidal wave is increased until clipping occurs). The sinusoidal wave is then replaced with a square wave of the same amplitude. The frequency is then increased until the maximum peak-to-peak output can no longer be maintained (Figure 5). A square wave is used to allow a more accurate determination of the point at which the maximum peak-to-peak output is reached.

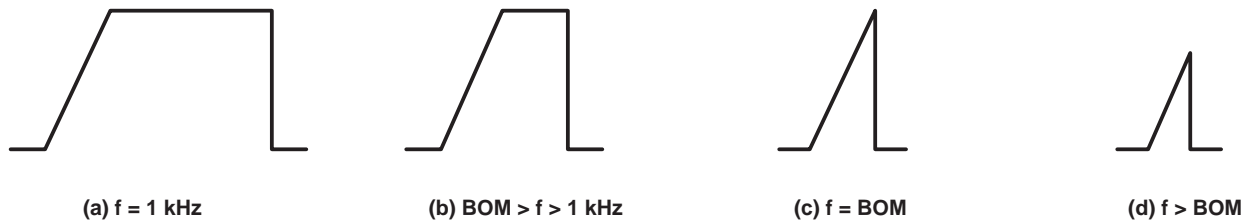


Figure 5. Full-Power-Response Output Signal

test time

Inadequate test time is a frequent problem, especially when testing CMOS devices in a high-volume, short-test-time environment. Internal capacitances are inherently higher in CMOS than in bipolar and BiFET devices and require longer test times than their bipolar and BiFET counterparts. The problem becomes more pronounced with reduced supply levels and lower temperatures.

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
$V_{IO}$	Input offset voltage	Distribution	6, 7
$\alpha V_{IO}$	Temperature coefficient of input offset voltage	Distribution	8, 9
$V_{OH}$	High-level output voltage	vs High-level output current vs Supply voltage vs Free-air temperature	10, 11 12 13
$V_{OL}$	Low-level output voltage	vs Common-mode input voltage vs Differential input voltage vs Free-air temperature vs Low-level output current	14, 15 16 17 18, 19
$A_{VD}$	Large-signal differential voltage amplification	vs Supply voltage vs Free-air temperature vs Frequency	20 21 32, 33
$I_{IB}$	Input bias current	vs Free-air temperature	22
$I_{IQ}$	Input offset current	vs Free-air temperature	22
$V_{IC}$	Common-mode input voltage	vs Supply voltage	23
$I_{DD}$	Supply current	vs Supply voltage vs Free-air temperature	24 25
$SR$	Slew rate	vs Supply voltage vs Free-air temperature	26 27
	Normalized slew rate	vs Free-air temperature	28
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	29
$B_1$	Unity-gain bandwidth	vs Free-air temperature vs Supply voltage	30 31
$\phi_m$	Phase margin	vs Supply voltage vs Free-air temperature vs Load capacitance	34 35 36
$V_n$	Equivalent input noise voltage	vs Frequency	37
	Phase shift	vs Frequency	32, 33



TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLC274  
 INPUT OFFSET VOLTAGE



Figure 6

DISTRIBUTION OF TLC274  
 INPUT OFFSET VOLTAGE

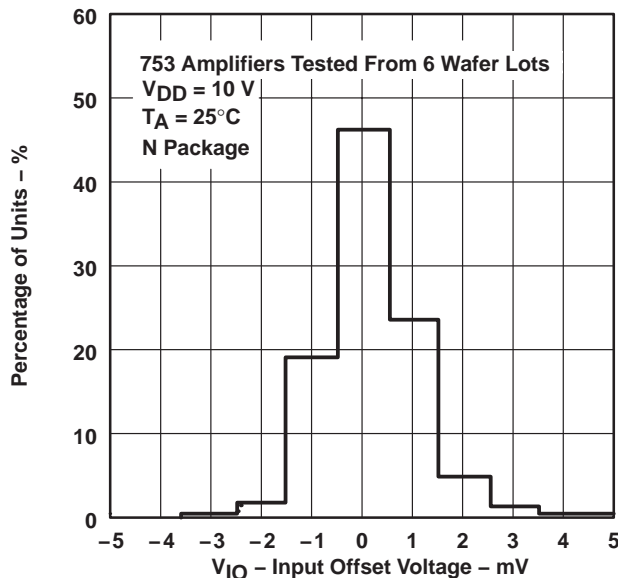


Figure 7

DISTRIBUTION OF TLC274 AND TLC279  
 INPUT OFFSET VOLTAGE  
 TEMPERATURE COEFFICIENT

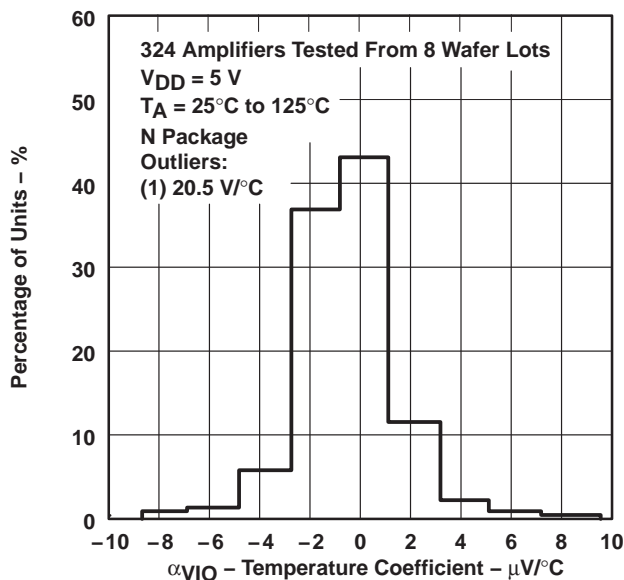


Figure 8

DISTRIBUTION OF TLC274 AND TLC279  
 INPUT OFFSET VOLTAGE  
 TEMPERATURE COEFFICIENT

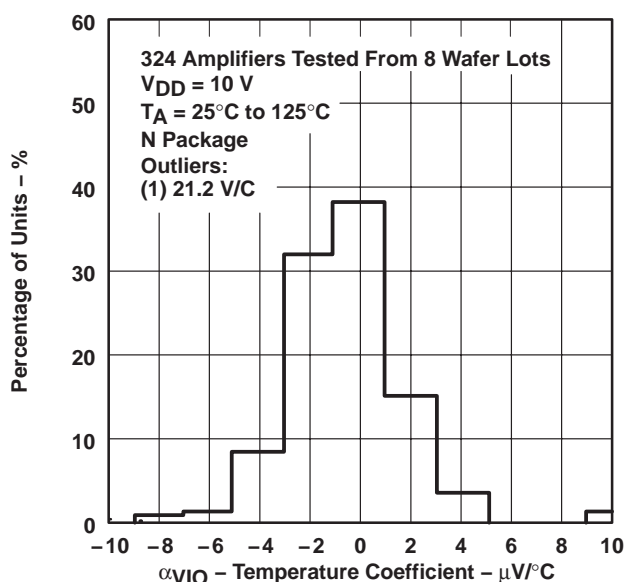


Figure 9

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## TYPICAL CHARACTERISTICS†

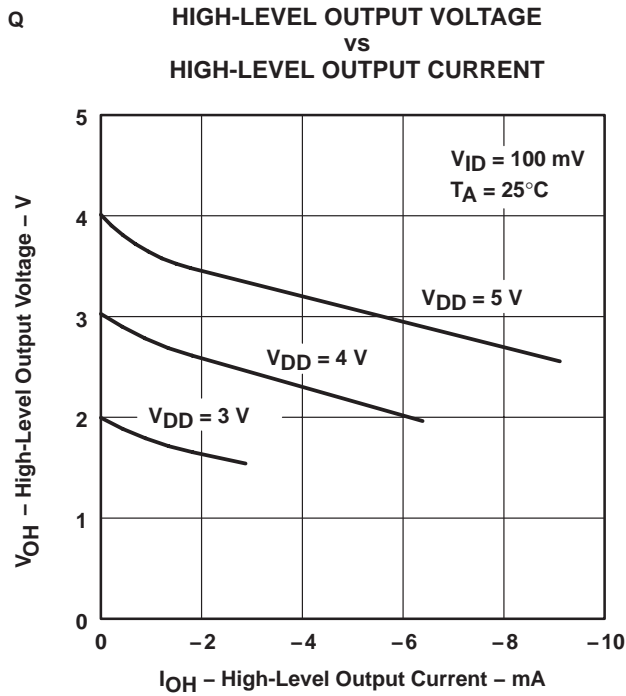


Figure 10

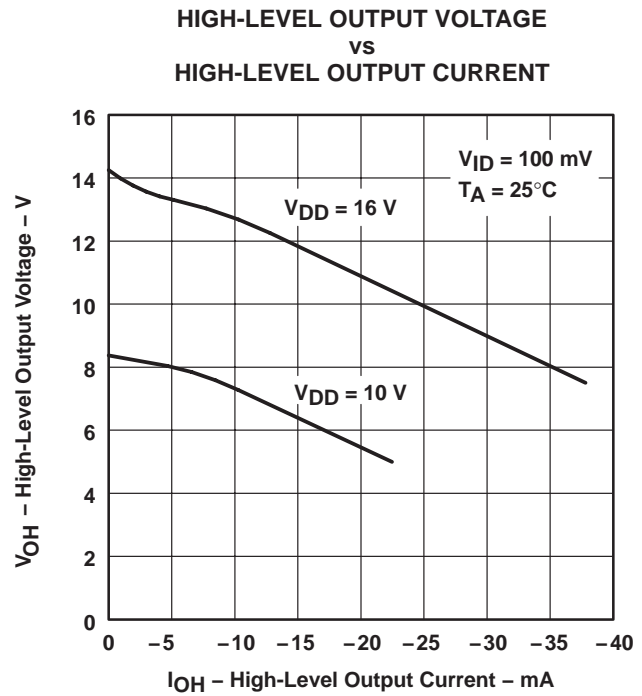


Figure 11

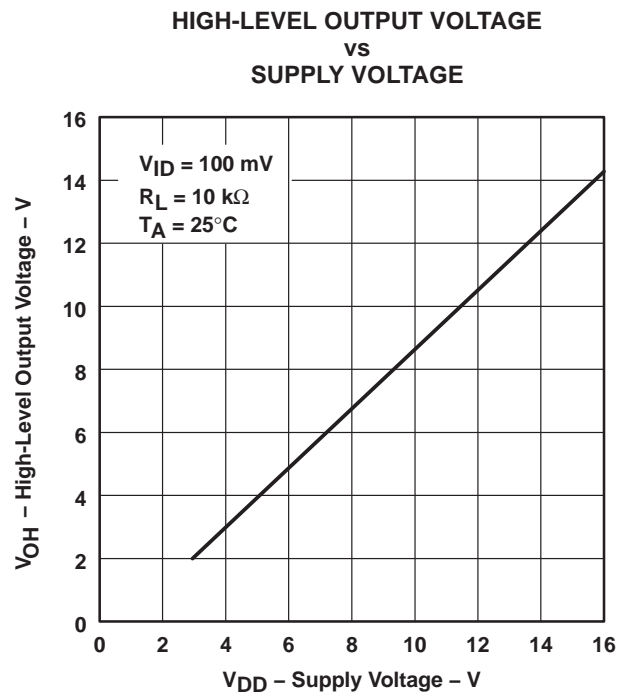


Figure 12

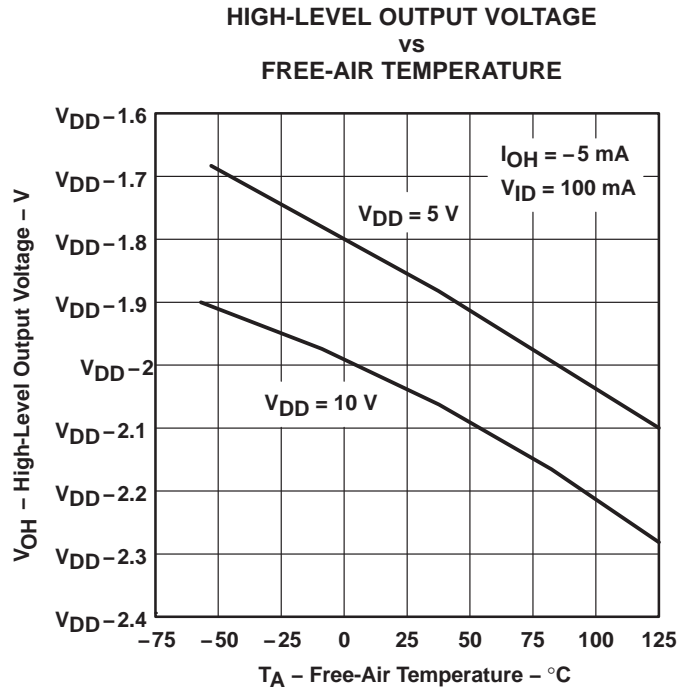


Figure 13

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

TYPICAL CHARACTERISTICS†

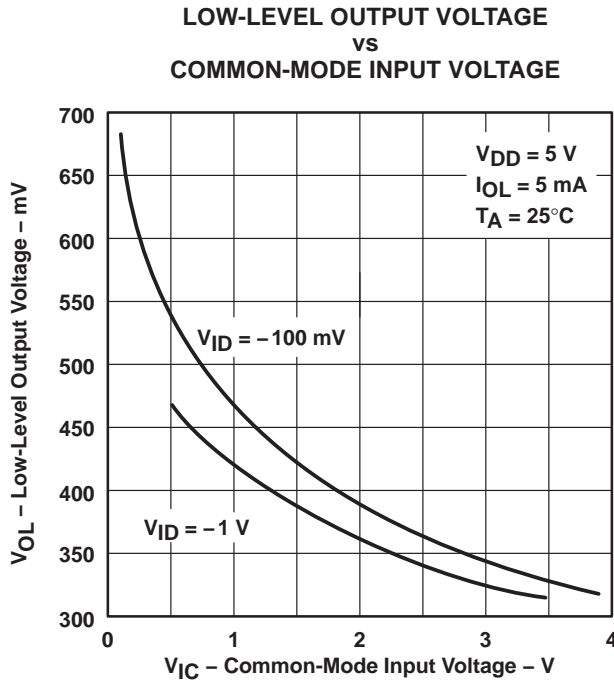


Figure 14

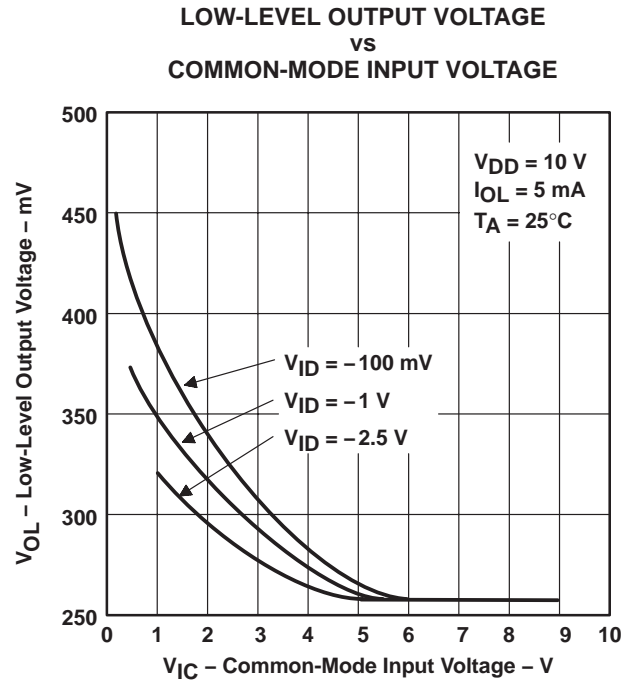


Figure 15

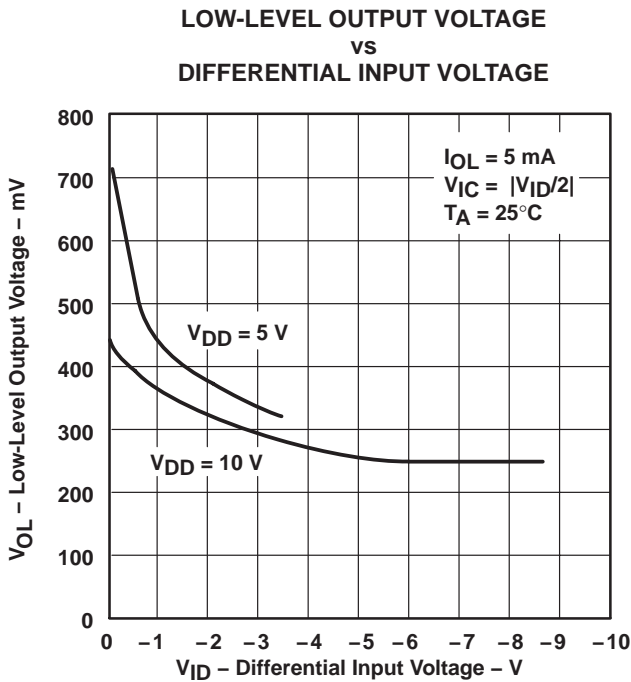


Figure 16

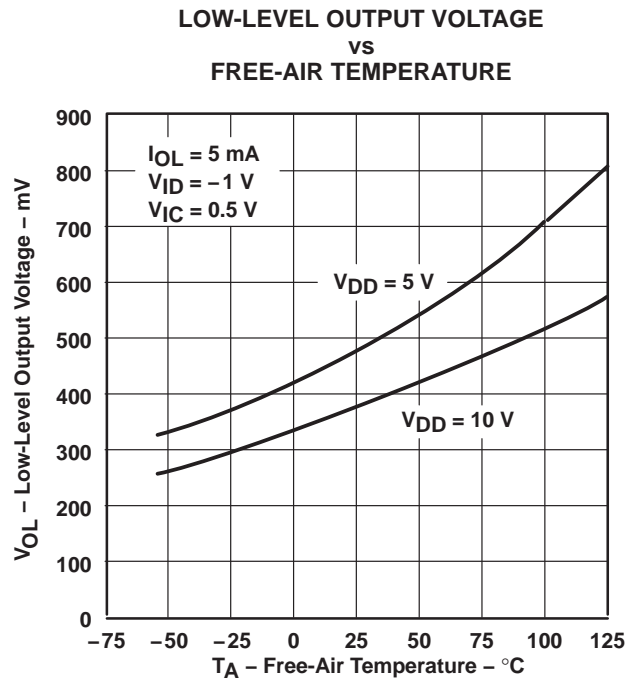


Figure 17

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

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## TYPICAL CHARACTERISTICS†

LOW-LEVEL OUTPUT VOLTAGE  
vs  
LOW-LEVEL OUTPUT CURRENT



Figure 18

LOW-LEVEL OUTPUT VOLTAGE  
vs  
LOW-LEVEL OUTPUT CURRENT



Figure 19

LARGE-SIGNAL  
DIFFERENTIAL VOLTAGE AMPLIFICATION  
vs  
SUPPLY VOLTAGE



Figure 20

LARGE-SIGNAL  
DIFFERENTIAL VOLTAGE AMPLIFICATION  
vs  
FREE-AIR TEMPERATURE

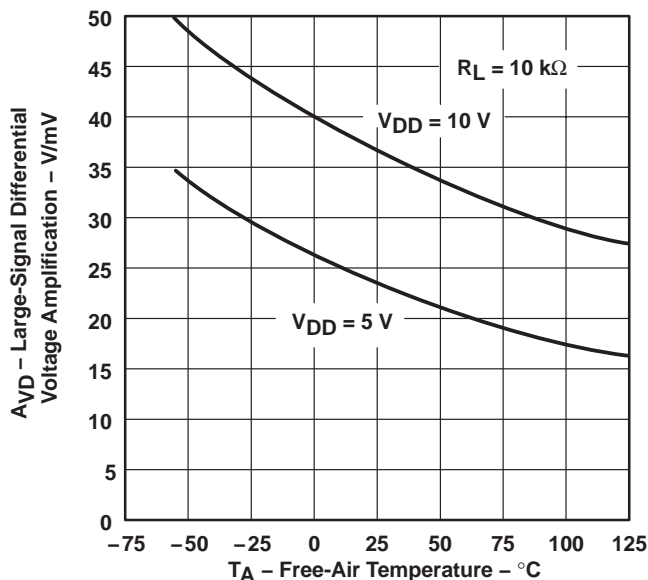


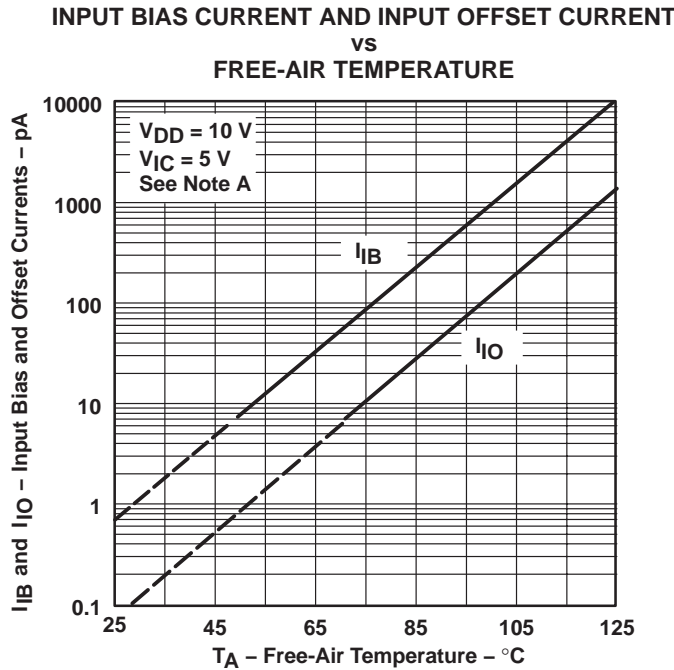
Figure 21

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





TYPICAL CHARACTERISTICS†



NOTE A: The typical values of input bias current and input offset current below 5 pA were determined mathematically.

Figure 22



Figure 23

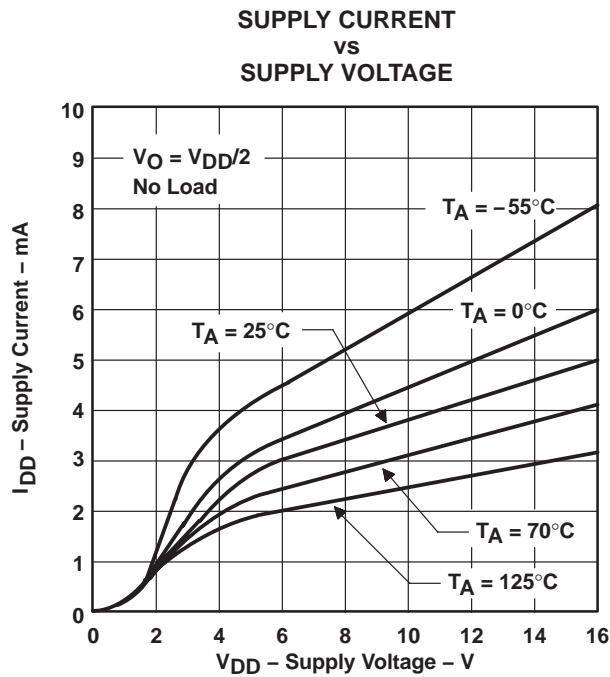


Figure 24

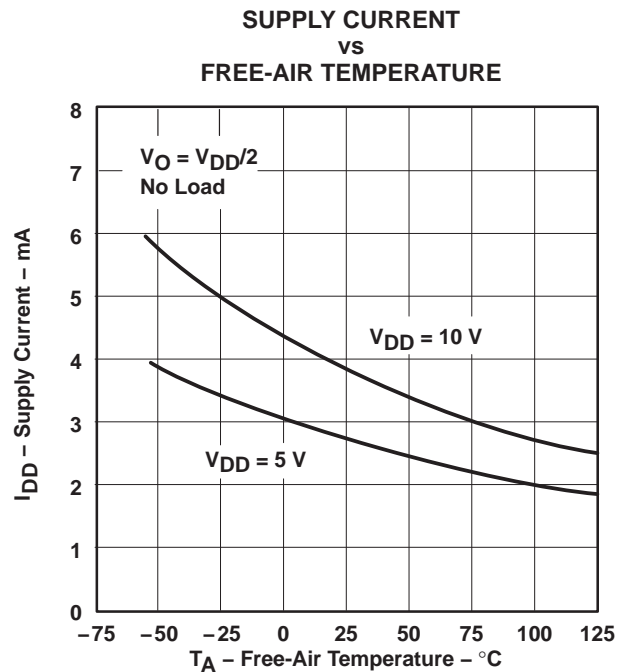


Figure 25

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

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## TYPICAL CHARACTERISTICS†

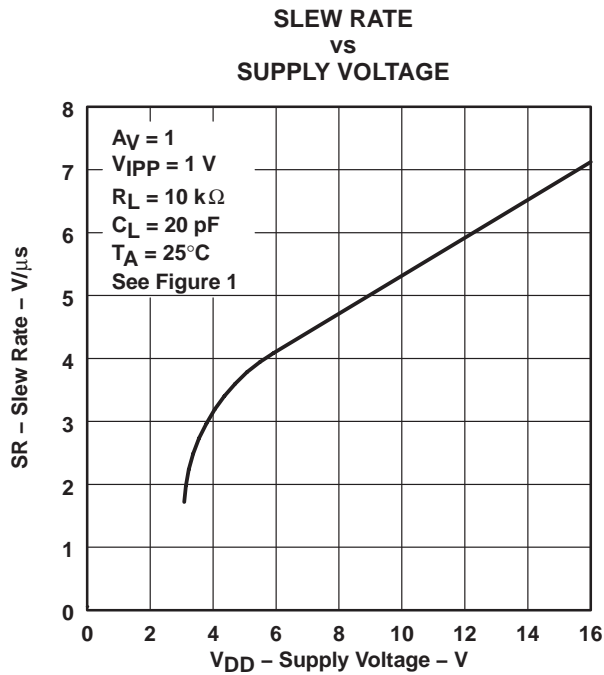


Figure 26

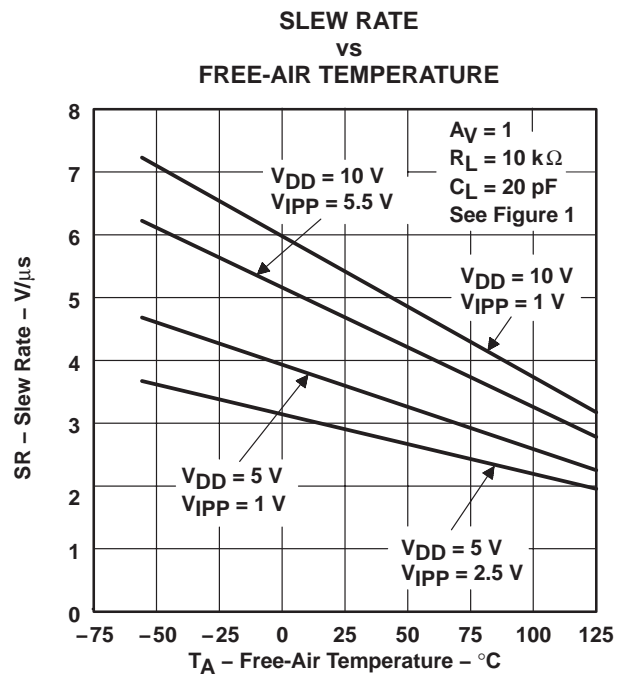


Figure 27

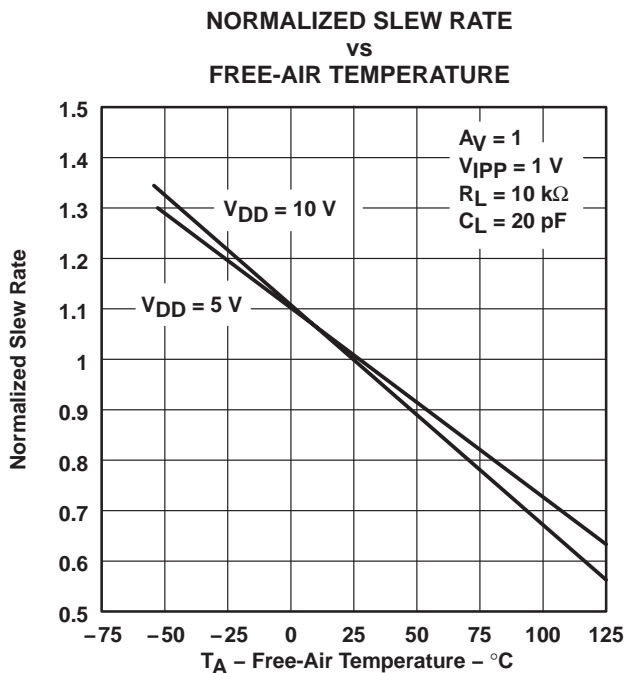


Figure 28

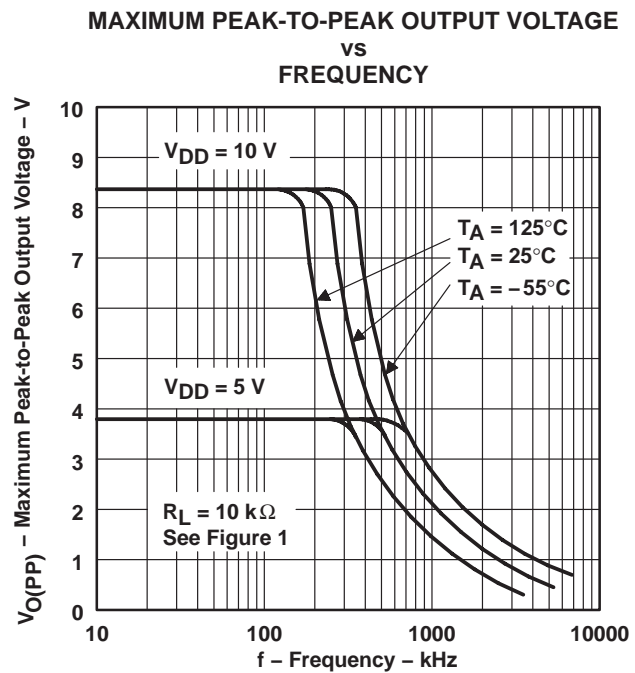
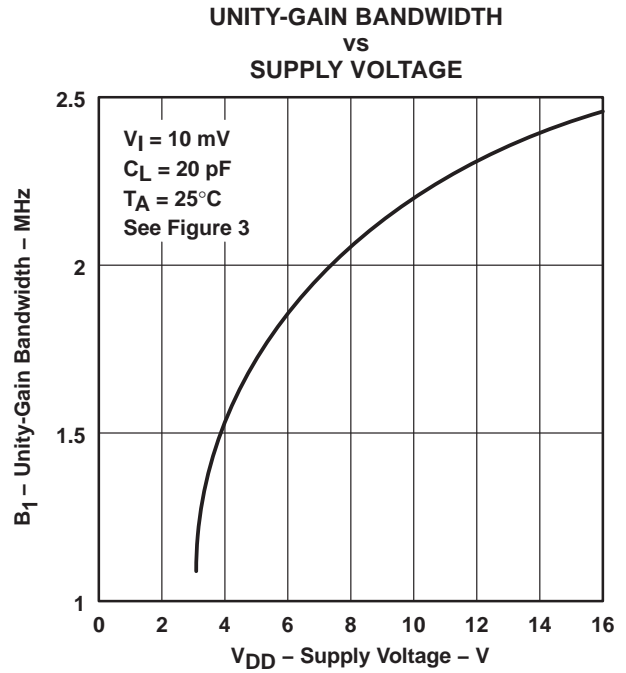


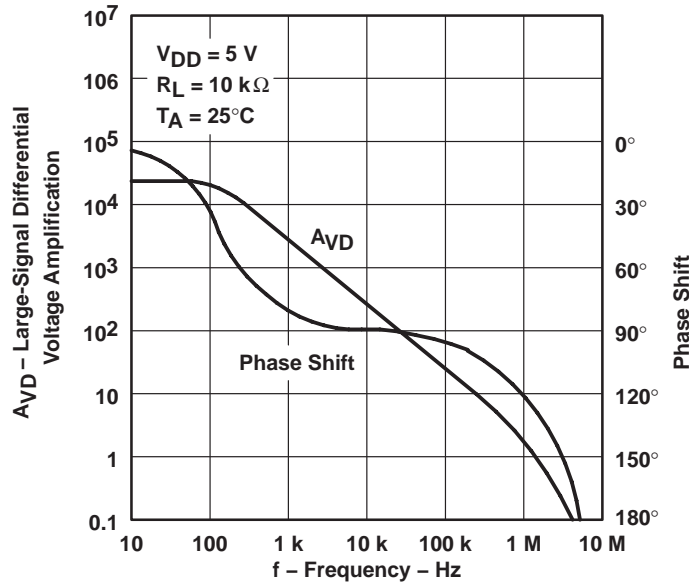
Figure 29

† 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 SHIFT  
 vs  
 FREQUENCY**



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

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## TYPICAL CHARACTERISTICS†

### LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VS FREQUENCY



Figure 33

### PHASE MARGIN VS SUPPLY VOLTAGE

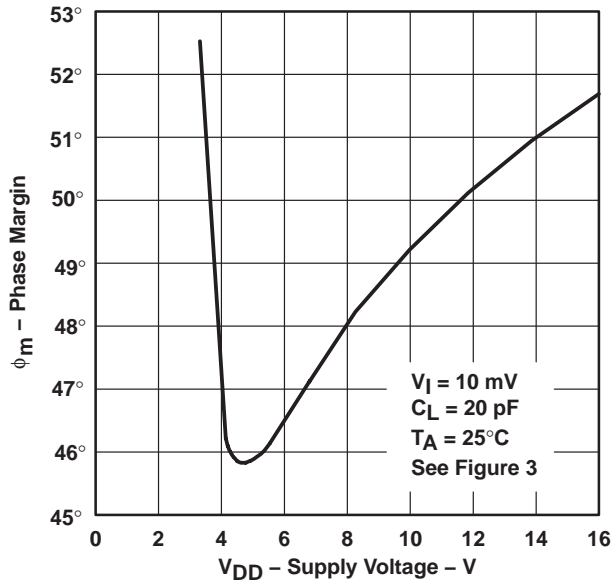


Figure 34

### PHASE MARGIN VS FREE-AIR TEMPERATURE



Figure 35

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

TYPICAL CHARACTERISTICS

PHASE MARGIN  
 vs  
 LOAD CAPACITANCE

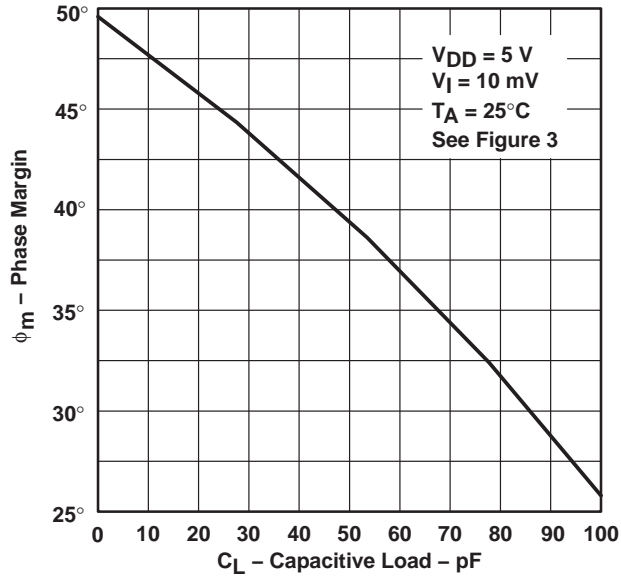


Figure 36

EQUIVALENT INPUT NOISE VOLTAGE  
 vs  
 FREQUENCY



Figure 37

**APPLICATION INFORMATION**

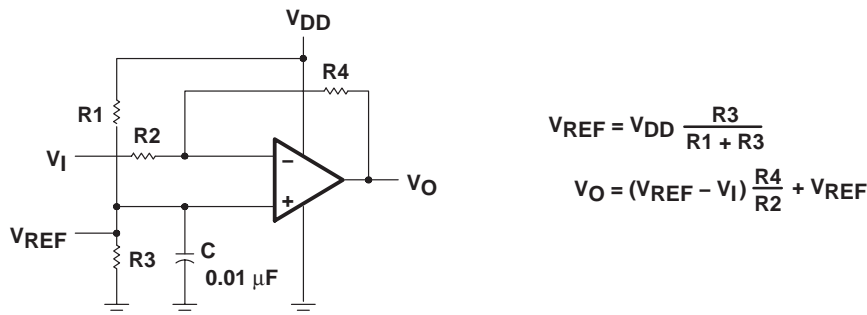
**single-supply operation**

While the TLC274 and TLC279 perform well using dual power supplies (also called balanced or split supplies), the design is optimized for single-supply operation. This design includes an input common-mode voltage range that encompasses ground as well as an output voltage range that pulls down to ground. The supply voltage range extends down to 3 V (C-suffix types), thus allowing operation with supply levels commonly available for TTL and HCMOS; however, for maximum dynamic range, 16-V single-supply operation is recommended.

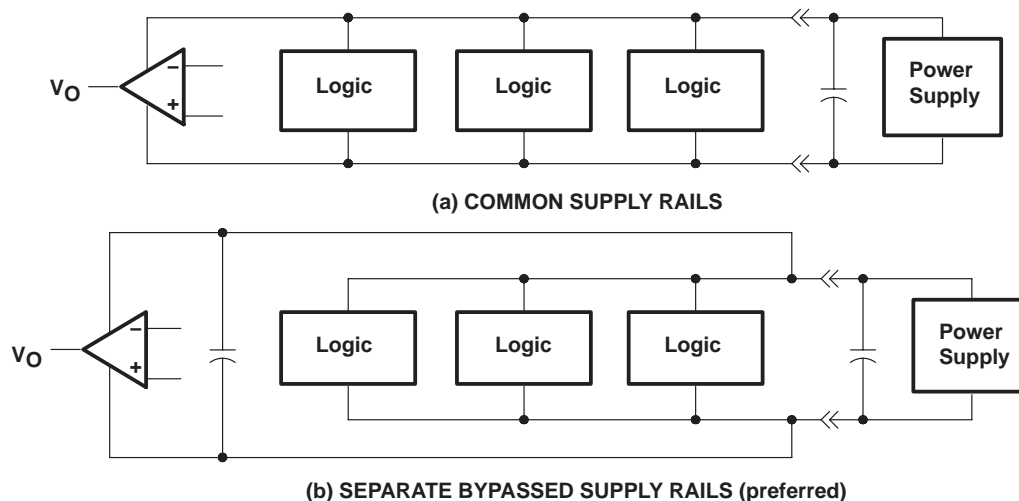
Many single-supply applications require that a voltage be applied to one input to establish a reference level that is above ground. A resistive voltage divider is usually sufficient to establish this reference level (see Figure 38). The low input bias current of the TLC274 and TLC279 permits the use of very large resistive values to implement the voltage divider, thus minimizing power consumption.

The TLC274 and TLC279 work well in conjunction with digital logic; however, when powering both linear devices and digital logic from the same power supply, the following precautions are recommended:

1. Power the linear devices from separate bypassed supply lines (see Figure 39); otherwise the linear device supply rails can fluctuate due to voltage drops caused by high switching currents in the digital logic.
2. Use proper bypass techniques to reduce the probability of noise-induced errors. Single capacitive decoupling is often adequate; however, high-frequency applications may require  $R_C$  decoupling.



**Figure 38. Inverting Amplifier With Voltage Reference**



**Figure 39. Common Versus Separate Supply Rails**

## APPLICATION INFORMATION

### input characteristics

The TLC274 and TLC279 are specified with a minimum and a maximum input voltage that, if exceeded at either input, could cause the device to malfunction. Exceeding this specified range is a common problem, especially in single-supply operation. Note that the lower range limit includes the negative rail, while the upper range limit is specified at  $V_{DD} - 1\text{ V}$  at  $T_A = 25^\circ\text{C}$  and at  $V_{DD} - 1.5\text{ V}$  at all other temperatures.

The use of the polysilicon-gate process and the careful input circuit design gives the TLC274 and TLC279 very good input offset voltage drift characteristics relative to conventional metal-gate processes. Offset voltage drift in CMOS devices is highly influenced by threshold voltage shifts caused by polarization of the phosphorus dopant implanted in the oxide. Placing the phosphorus dopant in a conductor (such as a polysilicon gate) alleviates the polarization problem, thus reducing threshold voltage shifts by more than an order of magnitude. The offset voltage drift with time has been calculated to be typically  $0.1\ \mu\text{V}/\text{month}$ , including the first month of operation.

Because of the extremely high input impedance and resulting low bias current requirements, the TLC274 and TLC279 are well suited for low-level signal processing; however, leakage currents on printed-circuit boards and sockets can easily exceed bias current requirements and cause a degradation in device performance. It is good practice to include guard rings around inputs (similar to those of Figure 4 in the Parameter Measurement Information section). These guards should be driven from a low-impedance source at the same voltage level as the common-mode input (see Figure 40).

Unused amplifiers should be connected as grounded unity-gain followers to avoid possible oscillation.

### noise performance

The noise specifications in operational amplifier circuits are greatly dependent on the current in the first-stage differential amplifier. The low input bias current requirements of the TLC274 and TLC279 result in a very low noise current, which is insignificant in most applications. This feature makes the devices especially favorable over bipolar devices when using values of circuit impedance greater than  $50\ \text{k}\Omega$ , since bipolar devices exhibit greater noise currents.



Figure 40. Guard-Ring Schemes

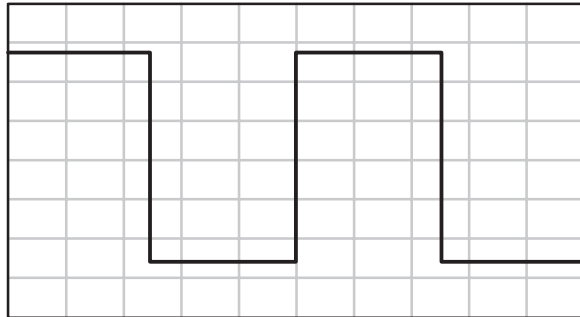
### output characteristics

The output stage of the TLC274 and TLC279 is designed to sink and source relatively high amounts of current (see typical characteristics). If the output is subjected to a short-circuit condition, this high current capability can cause device damage under certain conditions. Output current capability increases with supply voltage.

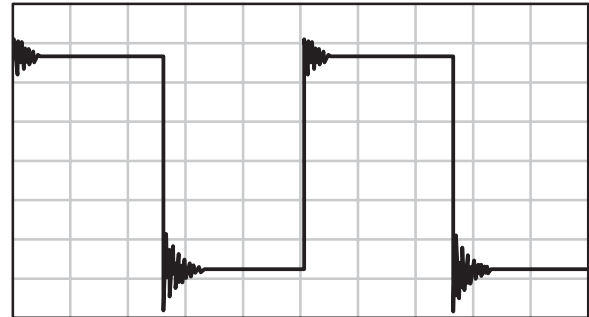
All operating characteristics of the TLC274 and TLC279 were measured using a  $20\text{-pF}$  load. The devices drive higher capacitive loads; however, as output load capacitance increases, the resulting response pole occurs at lower frequencies, thereby causing ringing, peaking, or even oscillation (see Figure 41). In many cases, adding a small amount of resistance in series with the load capacitance alleviates the problem.

APPLICATION INFORMATION

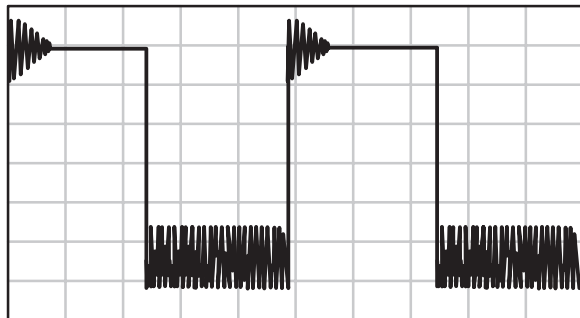
output characteristics (continued)



(a)  $C_L = 20 \text{ pF}$ ,  $R_L = \text{NO LOAD}$



(b)  $C_L = 130 \text{ pF}$ ,  $R_L = \text{NO LOAD}$



(c)  $C_L = 150 \text{ pF}$ ,  $R_L = \text{NO LOAD}$

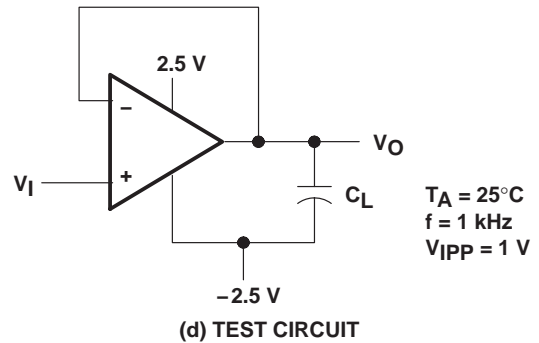


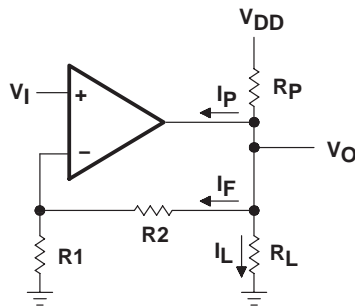
Figure 41. Effect of Capacitive Loads and Test Circuit

Although the TLC274 and TLC279 possess excellent high-level output voltage and current capability, methods for boosting this capability are available, if needed. The simplest method involves the use of a pullup resistor ( $R_P$ ) connected from the output to the positive supply rail (see Figure 42). There are two disadvantages to the use of this circuit. First, the NMOS pulldown transistor N4 (see equivalent schematic) must sink a comparatively large amount of current. In this circuit, N4 behaves like a linear resistor with an on-resistance between approximately  $60 \Omega$  and  $180 \Omega$ , depending on how hard the op amp input is driven. With very low values of  $R_P$ , a voltage offset from 0 V at the output occurs. Second, pullup resistor  $R_P$  acts as a drain load to N4 and the gain of the operational amplifier is reduced at output voltage levels where N5 is not supplying the output current.



APPLICATION INFORMATION

output characteristics (continued)



$$R_p = \frac{V_{DD} - V_O}{I_F + I_L + I_p}$$

$I_p$  = Pullup current required  
 by the operational amplifier  
 (typically 500  $\mu$ A)

Figure 42. Resistive Pullup to Increase  $V_{OH}$

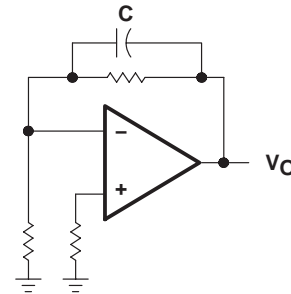


Figure 43. Compensation for Input Capacitance

feedback

Operational amplifier circuits nearly always employ feedback, and since feedback is the first prerequisite for oscillation, some caution is appropriate. Most oscillation problems result from driving capacitive loads (discussed previously) and ignoring stray input capacitance. A small-value capacitor connected in parallel with the feedback resistor is an effective remedy (see Figure 43). The value of this capacitor is optimized empirically.

electrostatic discharge protection

The TLC274 and TLC279 incorporate an internal electrostatic discharge (ESD) protection circuit that prevents functional failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.2. Care should be exercised, however, when handling these devices as exposure to ESD may result in the degradation of the device parametric performance. The protection circuit also causes the input bias currents to be temperature-dependent and have the characteristics of a reverse-biased diode.

latch-up

Because CMOS devices are susceptible to latch-up due to their inherent parasitic thyristors, the TLC274 and TLC279 inputs and outputs were designed to withstand –100-mA surge currents without sustaining latch-up; however, techniques should be used to reduce the chance of latch-up whenever possible. Internal protection diodes should not, by design, be forward biased. Applied input and output voltage should not exceed the supply voltage by more than 300 mV. Care should be exercised when using capacitive coupling on pulse generators. Supply transients should be shunted by the use of decoupling capacitors (0.1  $\mu$ F typical) located across the supply rails as close to the device as possible.

The current path established if latch-up occurs is usually between the positive supply rail and ground and can be triggered by surges on the supply lines and/or voltages on either the output or inputs that exceed the supply voltage. Once latch-up occurs, the current flow is limited only by the impedance of the power supply and the forward resistance of the parasitic thyristor and usually results in the destruction of the device. The chance of latch-up occurring increases with increasing temperature and supply voltages.

# TLC274, TLC274A, TLC274B, TLC274Y, TLC279 LinCMOS™ PRECISION QUAD OPERATIONAL AMPLIFIERS

SLOS092D – SEPTEMBER 1987 – REVISED MARCH 2001

## APPLICATION INFORMATION



NOTE A:  $d = \text{damping factor, } 1/Q$

Figure 44. State-Variable Filter

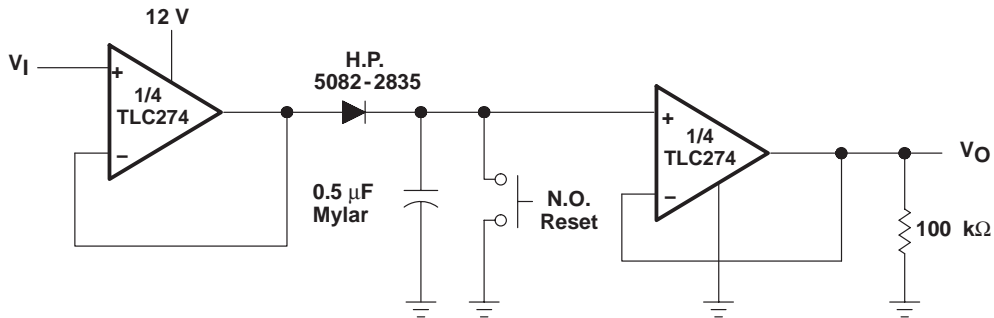
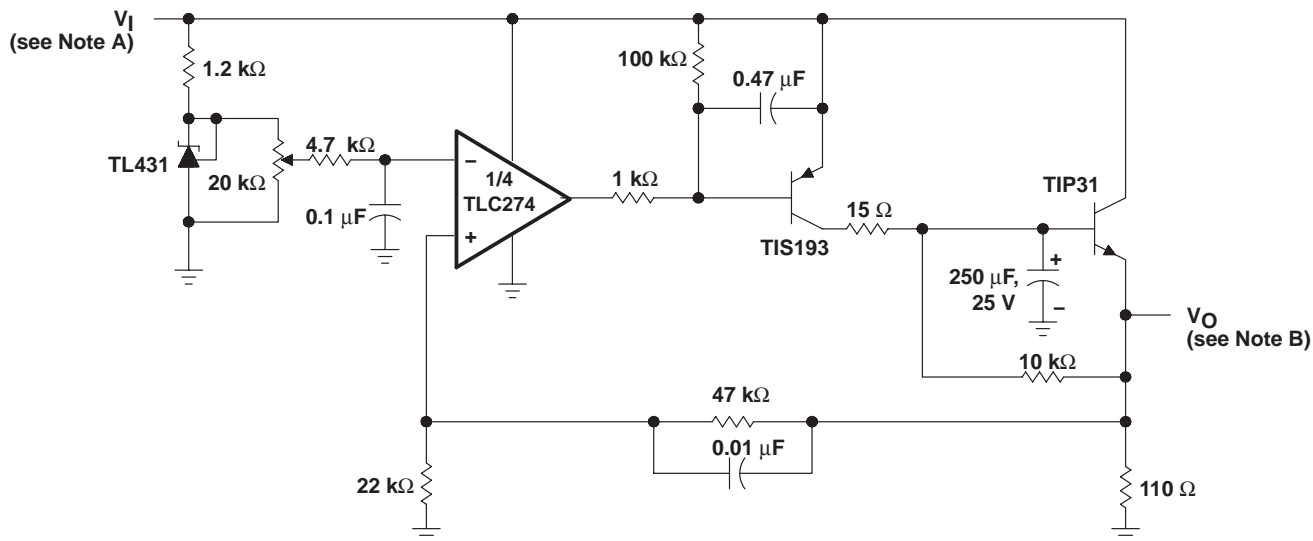


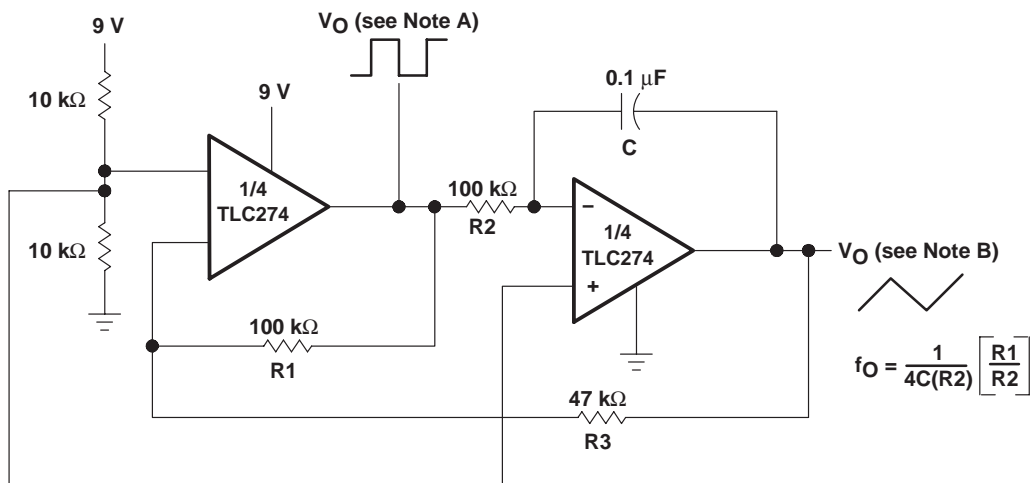
Figure 45. Positive-Peak Detector

APPLICATION INFORMATION



NOTES: B.  $V_I = 3.5 \text{ V to } 15 \text{ V}$   
 C.  $V_O = 2 \text{ V, } 0 \text{ to } 1 \text{ A}$

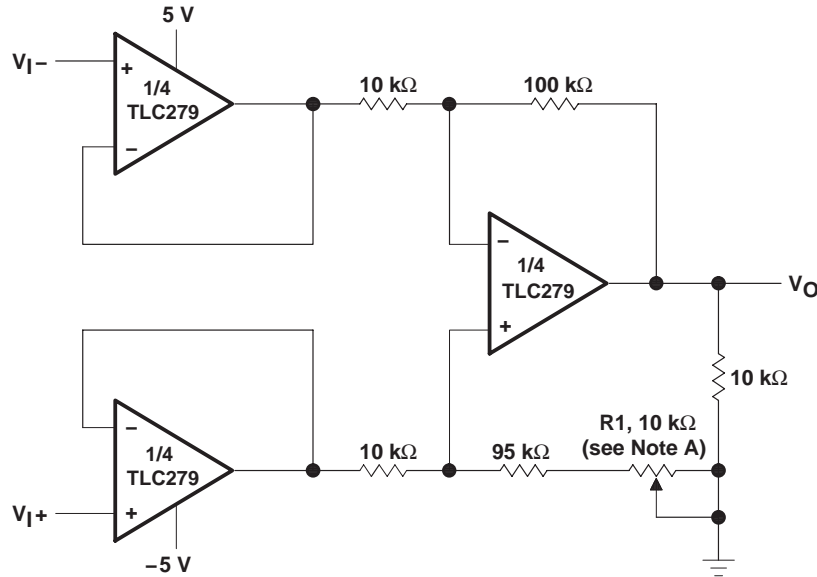
Figure 46. Logic-Array Power Supply



NOTES: A.  $V_{O(PP)} = 8 \text{ V}$   
 B.  $V_{O(PP)} = 4 \text{ V}$

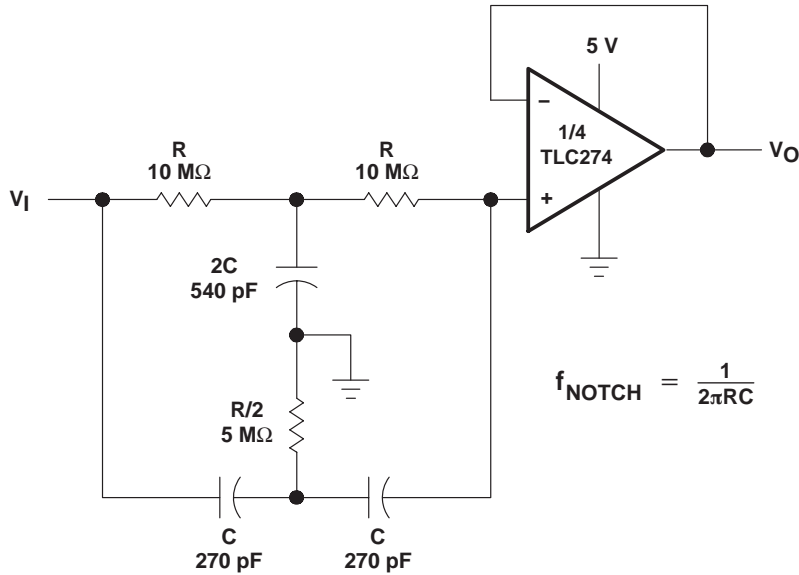
Figure 47. Single-Supply Function Generator

**APPLICATION INFORMATION**



NOTE C: CMRR adjustment must be noninductive.

**Figure 48. Low-Power Instrumentation Amplifier**



$$f_{\text{NOTCH}} = \frac{1}{2\pi RC}$$

**Figure 49. Single-Supply Twin-T Notch Filter**

**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>	Samples (Requires Login)
TLC274ACD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274ACDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274ACDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274ACDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274ACN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274ACNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274AIDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274AIDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274AIN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274AINE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274BCD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274BCDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274BCDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274BCDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	
TLC274BCN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274BCNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274BID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-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>	Samples (Requires Login)
TLC274BIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274BIDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274BIDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274BIN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274BINE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDB	ACTIVE	SSOP	DB	14	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDBG4	ACTIVE	SSOP	DB	14	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDBR	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDBRG4	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274CNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274CNSLE	OBSOLETE	SO	NS	14		TBD	Call TI	Call TI	
TLC274CNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CNSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-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>	Samples (Requires Login)
TLC274CPWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI	
TLC274CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274CPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC274IPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274IPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274MD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274MDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274MDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274MDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC274MFKB	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI	
TLC274MJ	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI	
TLC274MJB	OBSOLETE	CDIP	J	14		TBD	Call TI	Call TI	

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>	Samples (Requires Login)
TLC279CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279CN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC279CNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC279ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
TLC279IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC279INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
TLC279MFKB	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI	
TLC279MJB	OBSOLETE	CDIP	J	14		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), Pb-Free (RoHS Exempt), 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.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.



---

**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.

**TAPE AND REEL INFORMATION**
**REEL DIMENSIONS**

**TAPE DIMENSIONS**


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

**TAPE AND REEL INFORMATION**

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLC274ACDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274AIDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274BCDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274BIDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274CDBR	SSOP	DB	14	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TLC274CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274CNSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TLC274CPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TLC274IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC274IPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TLC274MDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC279CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC279IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLC274ACDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC274AIDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC274BCDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC274BIDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC274CDBR	SSOP	DB	14	2000	346.0	346.0	33.0
TLC274CDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC274CDR	SOIC	D	14	2500	333.2	345.9	28.6
TLC274CNSR	SO	NS	14	2000	346.0	346.0	33.0
TLC274CPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
TLC274IDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC274IPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
TLC274MDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC279CDR	SOIC	D	14	2500	346.0	346.0	33.0
TLC279IDR	SOIC	D	14	2500	346.0	346.0	33.0

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

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	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:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package is hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

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

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004

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

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- 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)

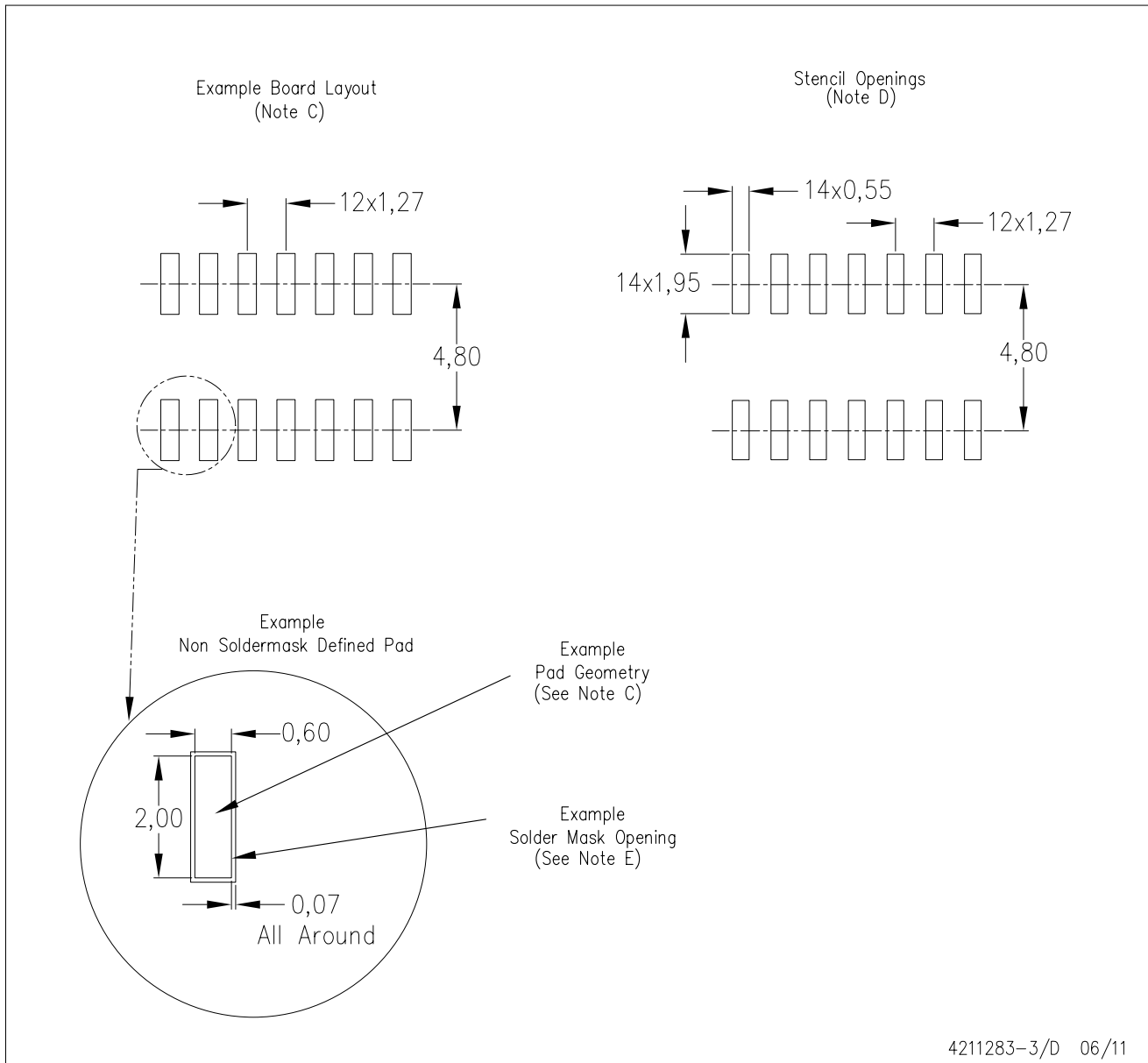
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



PW (R-PDSO-G14)

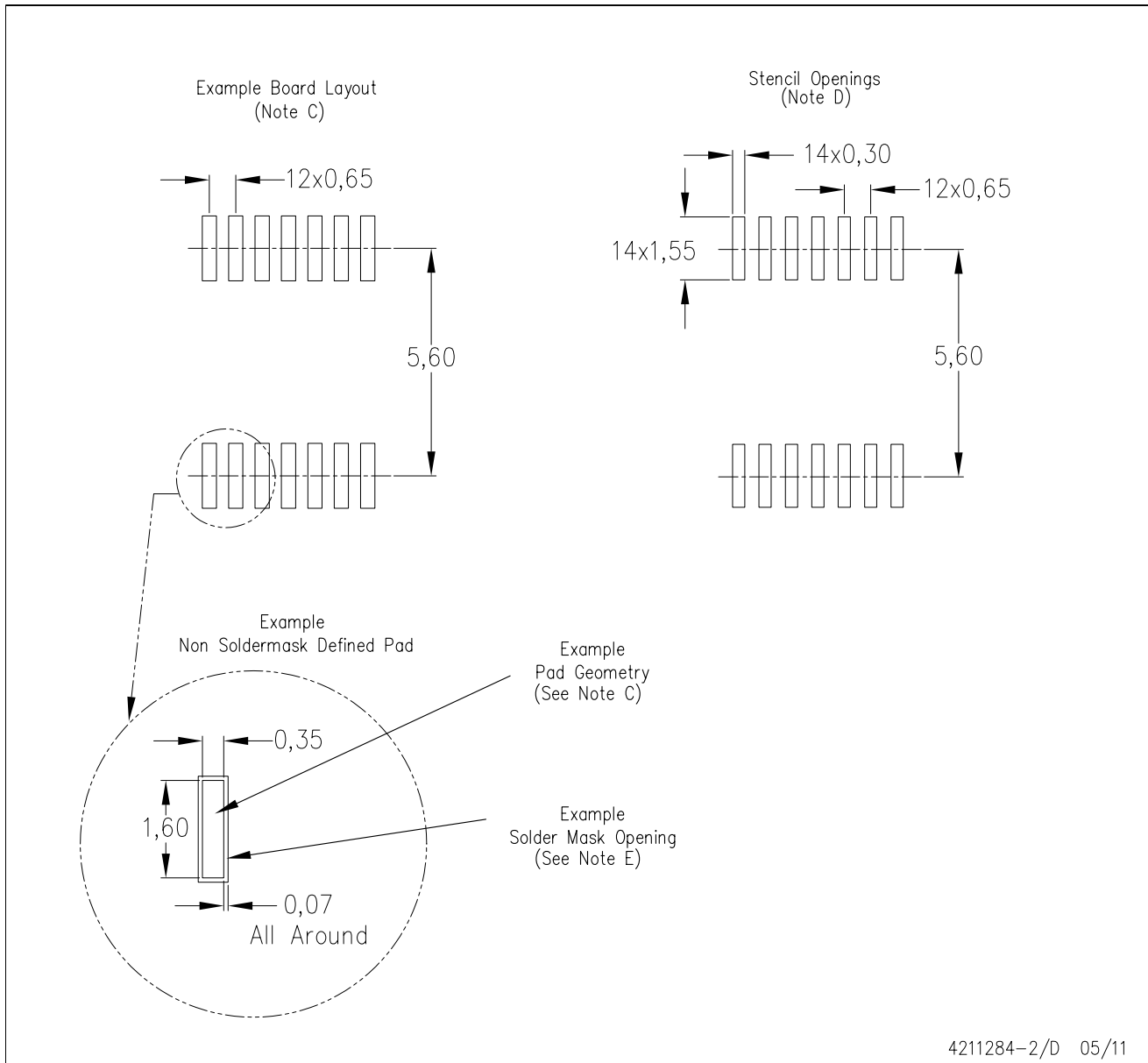
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

# 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.

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

PLASTIC SMALL-OUTLINE

28 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-150

## 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 TI 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. Information of third parties may be subject to additional restrictions.

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.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2012, Texas Instruments Incorporated