

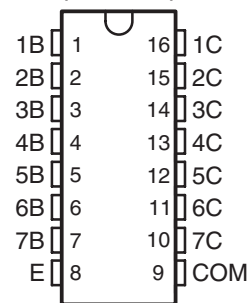
## HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

 Check for Samples: [ULN2002A](#), [ULN2003A](#), [ULN2003AI](#), [ULN2004A](#), [ULQ2003A](#), [ULQ2004A](#)

### FEATURES

- 500-mA-Rated Collector Current (Single Output)
- High-Voltage Outputs: 50 V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic
- Relay-Driver Applications

ULN2002A . . . N PACKAGE  
 ULN2003A . . . D, N, NS, OR PW PACKAGE  
 ULN2004A . . . D, N, OR NS PACKAGE  
 ULQ2003A, ULQ2004A . . . D OR N PACKAGE  
 (TOP VIEW)



### DESCRIPTION

The ULN2002A, ULN2003A, ULN2003AI, ULN2004A, ULQ2003A, and ULQ2004A are high-voltage high-current Darlington transistor arrays. Each consists of seven npn Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of a single Darlington pair is 500 mA. The Darlington pairs can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. For 100-V (otherwise interchangeable) versions of the ULN2003A and ULN2004A, see the [SN75468](#) and [SN75469](#), respectively.

The ULN2001A is a general-purpose array and can be used with TTL and CMOS technologies. The ULN2002A is designed specifically for use with 14-V to 25-V PMOS devices. Each input of this device has a Zener diode and resistor in series to control the input current to a safe limit. The ULN2003A and ULQ2003A have a 2.7-k $\Omega$  series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices. The ULN2004A and ULQ2004A have a 10.5-k $\Omega$  series base resistor to allow operation directly from CMOS devices that use supply voltages of 6 V to 15 V. The required input current of the ULN/ULQ2004A is below that of the ULN/ULQ2003A, and the required voltage is less than that required by the ULN2002A.



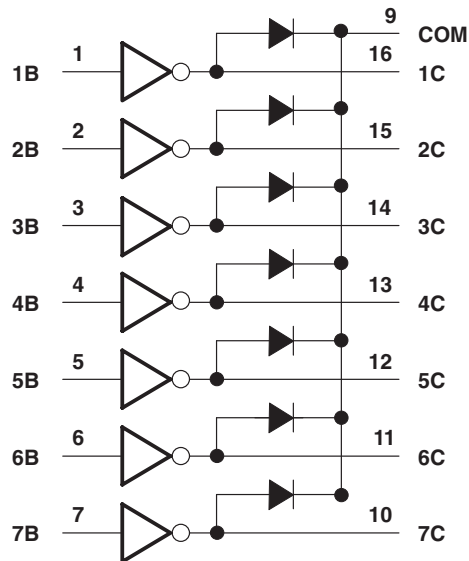
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**ORDERING INFORMATION<sup>(1)</sup>**

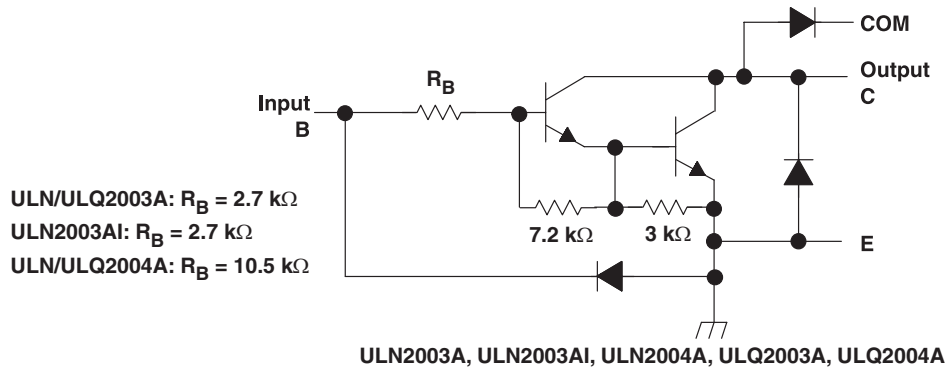
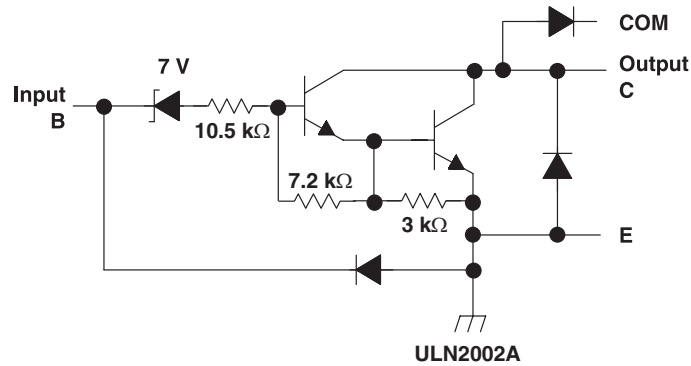
T <sub>A</sub>	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-20°C to 70°C	PDIP – N	Tube of 25	ULN2002AN	ULN2002AN
			ULN2003AN	ULN2003AN
			ULN2004AN	ULN2004AN
	SOIC – D	Tube of 40	ULN2003AD	ULN2003A
			ULN2003ADR	
		Reel of 2500	ULN2003ADRG3	ULN2004A
			ULN2004AD	
		Reel of 2500	ULN2004ADRG3	
	SOP – NS	Reel of 2000	ULN2003ANSR	ULN2003A
			ULN2004ANSR	ULN2004A
TSSOP – PW	Tube of 90	ULN2003APW	UN2003A	
	Reel of 2000	ULN2003APWR		
-40°C to 85°C	PDIP – N	Tube of 25	ULQ2003AN	ULQ2003A
			ULQ2004AN	ULQ2004AN
	SOIC – D	Tube of 40	ULQ2003AD	ULQ2003A
			ULQ2003ADR	
		Reel of 2500	ULQ2004AD	ULQ2004A
			ULQ2004ADR	
	SOP – NS	Reel of 2000	ULN2003AINSR	ULN2003AI
-40°C to 105°C	PDIP – N	Tube of 425	ULN2003AIN	ULN2003AIN
	SOIC – D	Tube of 40	ULN2003AID	ULN2003AI
		Reel of 2500	ULN2003AIDR	
	TSSOP – PW	Reel of 2500	ULN2003AIPWR	UN2003AI

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).  
 (2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

**LOGIC DIAGRAM**



**SCHEMATICS (EACH DARLINGTON PAIR)**



ULN/ULQ2003A:  $R_B = 2.7 \text{ k}\Omega$   
 ULN2003AI:  $R_B = 2.7 \text{ k}\Omega$   
 ULN/ULQ2004A:  $R_B = 10.5 \text{ k}\Omega$

All resistor values shown are nominal.

The collector-emitter diode is a parasitic structure and should not be used to conduct current. If the collector(s) go below ground an external Schottky diode should be added to clamp negative undershoots.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

at 25°C free-air temperature (unless otherwise noted)

		MIN	MAX	UNIT	
V <sub>CC</sub>	Collector-emitter voltage		50	V	
	Clamp diode reverse voltage <sup>(2)</sup>		50	V	
V <sub>I</sub>	Input voltage <sup>(2)</sup>		30	V	
	Peak collector current	See Figure 14 and Figure 15		500 mA	
I <sub>OK</sub>	Output clamp current		500	mA	
	Total emitter-terminal current		–2.5	A	
T <sub>A</sub>	Operating free-air temperature range	ULN200xA	–20	70	°C
		ULN200xAI	–40	105	
		ULQ200xA	–40	85	
		ULQ200xAI	–40	105	
θ <sub>JA</sub>	Package thermal impedance <sup>(3) (4)</sup>	D package		73	°C/W
		N package		67	
		NS package		64	
		PW package		108	
θ <sub>JC</sub>	Package thermal impedance <sup>(5) (6)</sup>	D package		36	°C/W
		N package		54	
T <sub>J</sub>	Operating virtual junction temperature		150	°C	
	Lead temperature for 1.6 mm (1/16 inch) from case for 10 seconds		260	°C	
T <sub>stg</sub>	Storage temperature range	–65	150	°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.
- All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.
- Maximum power dissipation is a function of T<sub>J</sub>(max), θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J</sub>(max) – T<sub>A</sub>)/θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- The package thermal impedance is calculated in accordance with JESD 51-7.
- Maximum power dissipation is a function of T<sub>J</sub>(max), θ<sub>JC</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J</sub>(max) – T<sub>A</sub>)/θ<sub>JC</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- The package thermal impedance is calculated in accordance with MIL-STD-883.

## ELECTRICAL CHARACTERISTICS

T<sub>A</sub> = 25°C

PARAMETER	TEST FIGURE	TEST CONDITIONS	ULN2002A			UNIT
			MIN	TYP	MAX	
V <sub>I(on)</sub>	Figure 6	V <sub>CE</sub> = 2 V, I <sub>C</sub> = 300 mA			13	V
V <sub>CE(sat)</sub>	Figure 4	I <sub>I</sub> = 250 μA, I <sub>C</sub> = 100 mA		0.9	1.1	V
		I <sub>I</sub> = 350 μA, I <sub>C</sub> = 200 mA		1	1.3	
		I <sub>I</sub> = 500 μA, I <sub>C</sub> = 350 mA		1.2	1.6	
V <sub>F</sub>	Figure 7	I <sub>F</sub> = 350 mA		1.7	2	V
I <sub>CEX</sub>	Figure 1	V <sub>CE</sub> = 50 V, I <sub>I</sub> = 0			50	μA
	Figure 2	V <sub>CE</sub> = 50 V, T <sub>A</sub> = 70°C, I <sub>I</sub> = 0, V <sub>I</sub> = 6 V			100 500	
I <sub>I(off)</sub>	Figure 2	V <sub>CE</sub> = 50 V, I <sub>C</sub> = 500 μA	50	65		μA
I <sub>I</sub>	Figure 3	V <sub>I</sub> = 17 V		0.82	1.25	mA
I <sub>R</sub>	Figure 6	V <sub>R</sub> = 50 V, T <sub>A</sub> = 70°C			100	μA
					50	
C <sub>i</sub>		V <sub>I</sub> = 0, f = 1 MHz			25	pF

**ELECTRICAL CHARACTERISTICS**
 $T_A = 25^\circ\text{C}$ 

PARAMETER	TEST FIGURE	TEST CONDITIONS		ULN2003A			ULN2004A			UNIT	
				MIN	TYP	MAX	MIN	TYP	MAX		
$V_{I(\text{on})}$ On-state input voltage	Figure 6	$V_{CE} = 2\text{ V}$	$I_C = 125\text{ mA}$						5	V	
			$I_C = 200\text{ mA}$					2.4	6		
			$I_C = 250\text{ mA}$					2.7			
			$I_C = 275\text{ mA}$								7
			$I_C = 300\text{ mA}$						3		
			$I_C = 350\text{ mA}$								
$V_{CE(\text{sat})}$ Collector-emitter saturation voltage	Figure 5	$I_I = 250\text{ }\mu\text{A}$ , $I_C = 100\text{ mA}$		0.9	1.1		0.9	1.1	V		
		$I_I = 350\text{ }\mu\text{A}$ , $I_C = 200\text{ mA}$		1	1.3		1	1.3			
		$I_I = 500\text{ }\mu\text{A}$ , $I_C = 350\text{ mA}$		1.2	1.6		1.2	1.6			
$I_{CEX}$ Collector cutoff current	Figure 1	$V_{CE} = 50\text{ V}$ , $I_I = 0$						50	$\mu\text{A}$		
	Figure 2	$V_{CE} = 50\text{ V}$ , $T_A = 70^\circ\text{C}$	$I_I = 0$					100			
$V_F$ Clamp forward voltage	Figure 8	$I_F = 350\text{ mA}$			1.7	2		1.7	2	V	
$I_{I(\text{off})}$ Off-state input current	Figure 3	$V_{CE} = 50\text{ V}$ , $T_A = 70^\circ\text{C}$	$I_C = 500\text{ }\mu\text{A}$	50	65		50	65		$\mu\text{A}$	
$I_I$ Input current	Figure 4	$V_I = 3.85\text{ V}$		0.93	1.35					mA	
		$V_I = 5\text{ V}$					0.35	0.5			
		$V_I = 12\text{ V}$					1	1.45			
$I_R$ Clamp reverse current	Figure 7	$V_R = 50\text{ V}$						50		$\mu\text{A}$	
			$T_A = 70^\circ\text{C}$						100		100
$C_i$ Input capacitance		$V_I = 0$ , $f = 1\text{ MHz}$		15	25		15	25		pF	

**ELECTRICAL CHARACTERISTICS**
 $T_A = 25^\circ\text{C}$ 

PARAMETER	TEST FIGURE	TEST CONDITIONS	ULN2003AI			UNIT	
			MIN	TYP	MAX		
$V_{I(\text{on})}$ On-state input voltage	Figure 6	$V_{CE} = 2\text{ V}$	$I_C = 200\text{ mA}$			2.4	V
			$I_C = 250\text{ mA}$			2.7	
			$I_C = 300\text{ mA}$			3	
$V_{CE(\text{sat})}$ Collector-emitter saturation voltage	Figure 5	$I_I = 250\text{ }\mu\text{A}$ , $I_C = 100\text{ mA}$		0.9	1.1	V	
		$I_I = 350\text{ }\mu\text{A}$ , $I_C = 200\text{ mA}$		1	1.3		
		$I_I = 500\text{ }\mu\text{A}$ , $I_C = 350\text{ mA}$		1.2	1.6		
$I_{CEX}$ Collector cutoff current	Figure 1	$V_{CE} = 50\text{ V}$ , $I_I = 0$				50	$\mu\text{A}$
$V_F$ Clamp forward voltage	Figure 8	$I_F = 350\text{ mA}$			1.7	2	V
$I_{I(\text{off})}$ Off-state input current	Figure 3	$V_{CE} = 50\text{ V}$ , $I_C = 500\text{ }\mu\text{A}$	50	65			$\mu\text{A}$
$I_I$ Input current	Figure 4	$V_I = 3.85\text{ V}$		0.93	1.35		mA
$I_R$ Clamp reverse current	Figure 7	$V_R = 50\text{ V}$				50	$\mu\text{A}$
$C_i$ Input capacitance		$V_I = 0$ , $f = 1\text{ MHz}$		15	25		pF

## ELECTRICAL CHARACTERISTICS

T<sub>A</sub> = -40°C to 105°C

PARAMETER	TEST FIGURE	TEST CONDITIONS	ULN2003AI			UNIT
			MIN	TYP	MAX	
V <sub>I(on)</sub> On-state input voltage	Figure 6	V <sub>CE</sub> = 2 V	I <sub>C</sub> = 200 mA		2.7	V
			I <sub>C</sub> = 250 mA		2.9	
			I <sub>C</sub> = 300 mA		3	
V <sub>CE(sat)</sub> Collector-emitter saturation voltage	Figure 5	I <sub>I</sub> = 250 μA, I <sub>C</sub> = 100 mA		0.9	1.2	V
		I <sub>I</sub> = 350 μA, I <sub>C</sub> = 200 mA		1	1.4	
		I <sub>I</sub> = 500 μA, I <sub>C</sub> = 350 mA		1.2	1.7	
I <sub>CEX</sub> Collector cutoff current	Figure 1	V <sub>CE</sub> = 50 V, I <sub>I</sub> = 0			100	μA
V <sub>F</sub> Clamp forward voltage	Figure 8	I <sub>F</sub> = 350 mA		1.7	2.2	V
I <sub>I(off)</sub> Off-state input current	Figure 3	V <sub>CE</sub> = 50 V, I <sub>C</sub> = 500 μA	30	65		μA
I <sub>I</sub> Input current	Figure 4	V <sub>I</sub> = 3.85 V		0.93	1.35	mA
I <sub>R</sub> Clamp reverse current	Figure 7	V <sub>R</sub> = 50 V			100	μA
C <sub>i</sub> Input capacitance		V <sub>I</sub> = 0, f = 1 MHz		15	25	pF

## ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER	TEST FIGURE	TEST CONDITIONS	ULQ2003A			ULQ2004A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>I(on)</sub> On-state input voltage	Figure 6	V <sub>CE</sub> = 2 V	I <sub>C</sub> = 125 mA					5	V
			I <sub>C</sub> = 200 mA			2.7		6	
			I <sub>C</sub> = 250 mA			2.9			
			I <sub>C</sub> = 275 mA					7	
			I <sub>C</sub> = 300 mA			3			
			I <sub>C</sub> = 350 mA					8	
V <sub>CE(sat)</sub> Collector-emitter saturation voltage	Figure 5	I <sub>I</sub> = 250 μA, I <sub>C</sub> = 100 mA		0.9	1.2	0.9	1.1	V	
		I <sub>I</sub> = 350 μA, I <sub>C</sub> = 200 mA		1	1.4	1	1.3		
		I <sub>I</sub> = 500 μA, I <sub>C</sub> = 350 mA		1.2	1.7	1.2	1.6		
I <sub>CEX</sub> Collector cutoff current	Figure 1	V <sub>CE</sub> = 50 V, I <sub>I</sub> = 0			100			μA	
	Figure 2	V <sub>CE</sub> = 50 V, T <sub>A</sub> = 70°C, V <sub>I</sub> = 6 V					100 500		
V <sub>F</sub> Clamp forward voltage	Figure 8	I <sub>F</sub> = 350 mA		1.7	2.3	1.7	2	V	
I <sub>I(off)</sub> Off-state input current	Figure 3	V <sub>CE</sub> = 50 V, T <sub>A</sub> = 70°C, I <sub>C</sub> = 500 μA		65		50	65	μA	
I <sub>I</sub> Input current	Figure 4	V <sub>I</sub> = 3.85 V		0.93	1.35			mA	
		V <sub>I</sub> = 5 V				0.35	0.5		
		V <sub>I</sub> = 12 V				1	1.45		
I <sub>R</sub> Clamp reverse current	Figure 7	V <sub>R</sub> = 50 V	T <sub>A</sub> = 25°C		100		50	μA	
					100		100		
C <sub>i</sub> Input capacitance		V <sub>I</sub> = 0, f = 1 MHz		15	25	15	25	pF	

## SWITCHING CHARACTERISTICS

 $T_A = 25^\circ\text{C}$ 

PARAMETER	TEST CONDITIONS	ULN2002A, ULN2003A, ULN2004A			UNIT
		MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low- to high-level output	See <a href="#">Figure 9</a>		0.25	1	$\mu\text{s}$
$t_{PHL}$ Propagation delay time, high- to low-level output	See <a href="#">Figure 9</a>		0.25	1	$\mu\text{s}$
$V_{OH}$ High-level output voltage after switching	$V_S = 50\text{ V}$ , $I_O = 300\text{ mA}$ , See <a href="#">Figure 10</a>	$V_S - 20$			mV

## SWITCHING CHARACTERISTICS

 $T_A = 25^\circ\text{C}$ 

PARAMETER	TEST CONDITIONS	ULN2003AI			UNIT
		MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low- to high-level output	See <a href="#">Figure 9</a>		0.25	1	$\mu\text{s}$
$t_{PHL}$ Propagation delay time, high- to low-level output	See <a href="#">Figure 9</a>		0.25	1	$\mu\text{s}$
$V_{OH}$ High-level output voltage after switching	$V_S = 50\text{ V}$ , $I_O \approx 300\text{ mA}$ , See <a href="#">Figure 10</a>	$V_S - 20$			mV

## SWITCHING CHARACTERISTICS

 $T_A = -40^\circ\text{C}$  to  $105^\circ\text{C}$ 

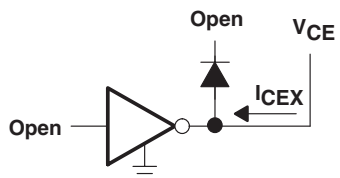
PARAMETER	TEST CONDITIONS	ULN2003AI			UNIT
		MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low- to high-level output	See <a href="#">Figure 9</a>		1	10	$\mu\text{s}$
$t_{PHL}$ Propagation delay time, high- to low-level output	See <a href="#">Figure 9</a>		1	10	$\mu\text{s}$
$V_{OH}$ High-level output voltage after switching	$V_S = 50\text{ V}$ , $I_O \approx 300\text{ mA}$ , See <a href="#">Figure 10</a>	$V_S - 50$			mV

## SWITCHING CHARACTERISTICS

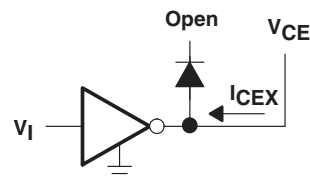
over recommended operating conditions (unless otherwise noted)

PARAMETER	TEST CONDITIONS	ULQ2003A, ULQ2004A			UNIT
		MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low- to high-level output	See <a href="#">Figure 9</a>		1	10	$\mu\text{s}$
$t_{PHL}$ Propagation delay time, high- to low-level output	See <a href="#">Figure 9</a>		1	10	$\mu\text{s}$
$V_{OH}$ High-level output voltage after switching	$V_S = 50\text{ V}$ , $I_O = 300\text{ mA}$ , See <a href="#">Figure 10</a>	$V_S - 20$			mV

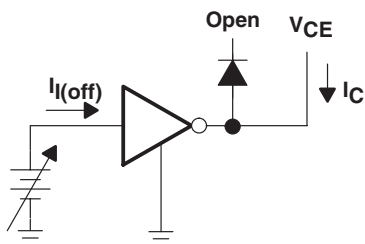
**PARAMETER MEASUREMENT INFORMATION**



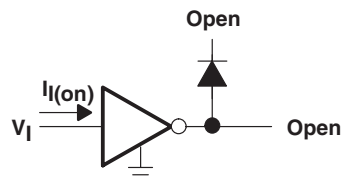
**Figure 1.  $I_{CEX}$  Test Circuit**



**Figure 2.  $I_{CEX}$  Test Circuit**

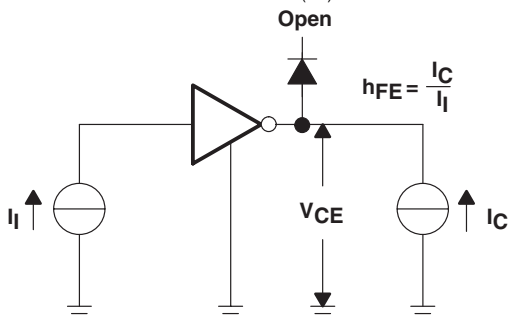


**Figure 3.  $I_{I(off)}$  Test Circuit**

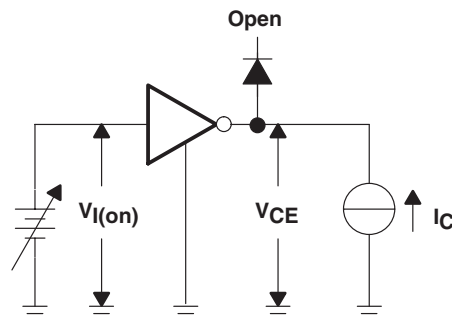


**Figure 4.  $I_I$  Test Circuit**

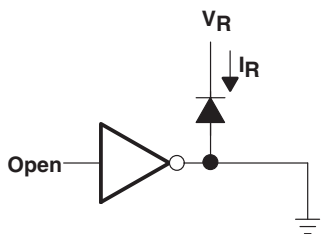
A.  $I_I$  is fixed for measuring  $V_{CE(sat)}$ , variable for measuring  $h_{FE}$ .



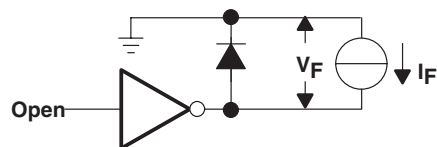
**Figure 5.  $h_{FE}$ ,  $V_{CE(sat)}$  Test Circuit**



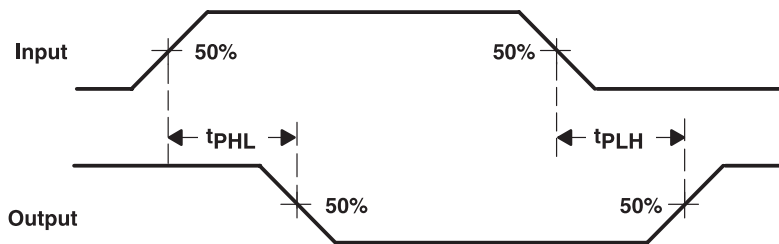
**Figure 6.  $V_{I(on)}$  Test Circuit**



**Figure 7.  $I_R$  Test Circuit**



**Figure 8.  $V_F$  Test Circuit**

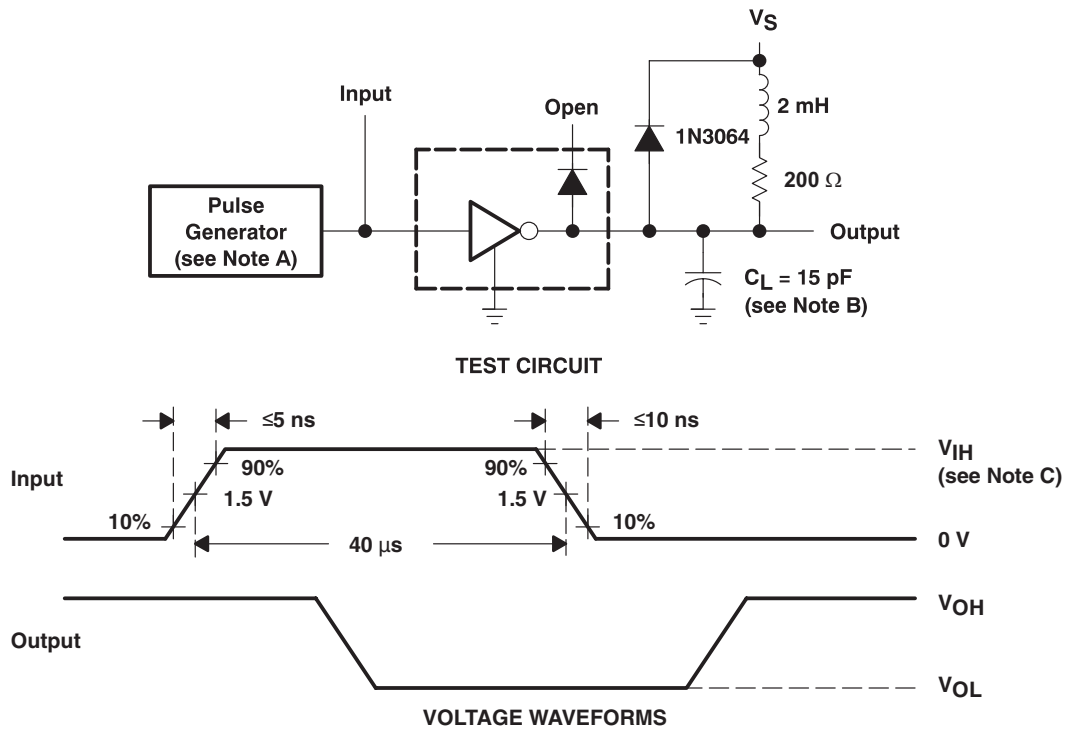


**VOLTAGE WAVEFORMS**

**Figure 9. Propagation Delay-Time Waveforms**



PARAMETER MEASUREMENT INFORMATION (continued)



- A. The pulse generator has the following characteristics: PRR = 12.5 kHz,  $Z_O = 50 \Omega$ .
- B.  $C_L$  includes probe and jig capacitance.
- C. For testing the ULN2003A, ULN2003AI, and ULQ2003A,  $V_{IH} = 3 \text{ V}$ ; for the ULN2002A,  $V_{IH} = 13 \text{ V}$ ; for the ULN2004A and the ULQ2004A,  $V_{IH} = 8 \text{ V}$ .

Figure 10. Latch-Up Test Circuit and Voltage Waveforms

**TYPICAL CHARACTERISTICS**

**COLLECTOR-EMITTER SATURATION VOLTAGE  
 vs  
 COLLECTOR CURRENT (ONE DARLINGTON)**

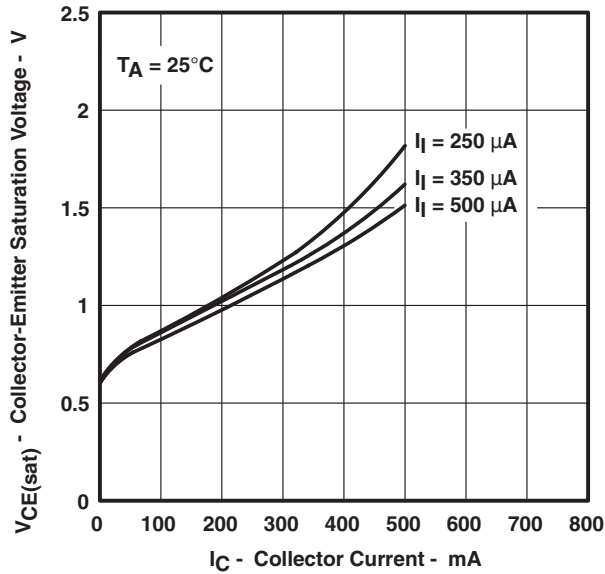


Figure 11.

**COLLECTOR-EMITTER SATURATION VOLTAGE  
 vs  
 TOTAL COLLECTOR CURRENT (TWO DARLINGTONS IN PARALLEL)**

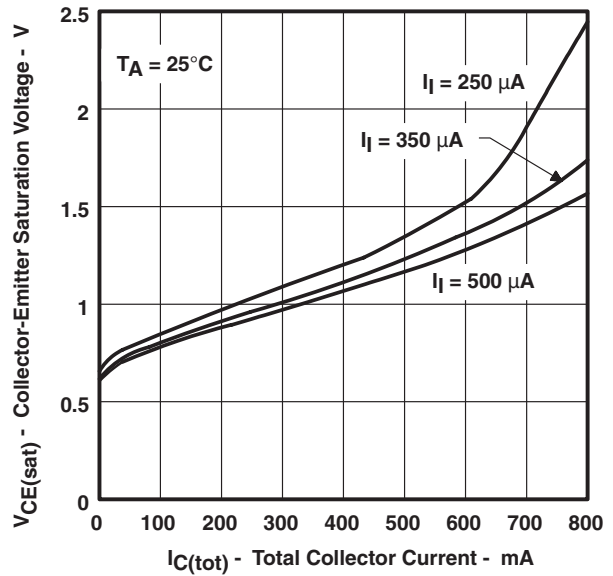


Figure 12.

**COLLECTOR CURRENT  
 vs  
 INPUT CURRENT**

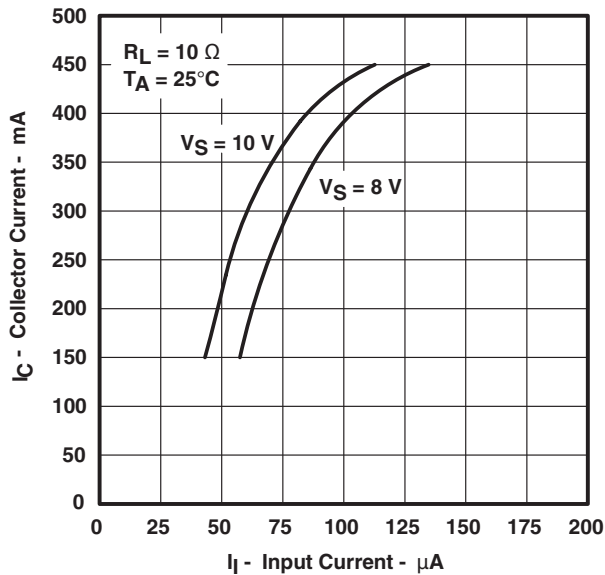


Figure 13.

**D PACKAGE  
 MAXIMUM COLLECTOR CURRENT  
 vs  
 DUTY CYCLE**

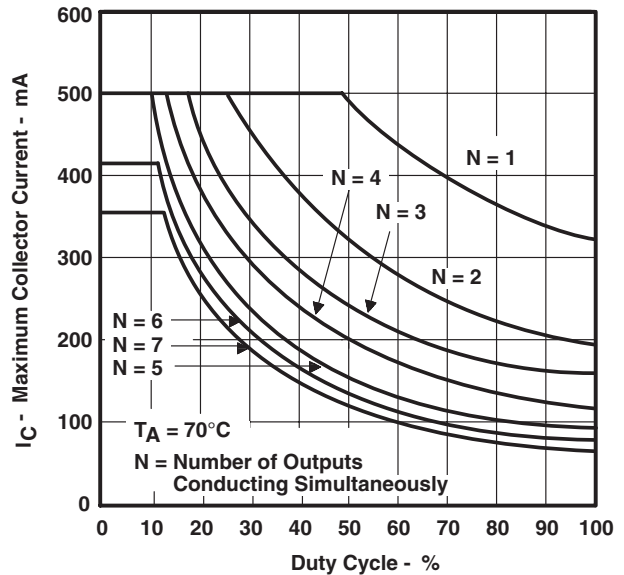


Figure 14.

TYPICAL CHARACTERISTICS (continued)

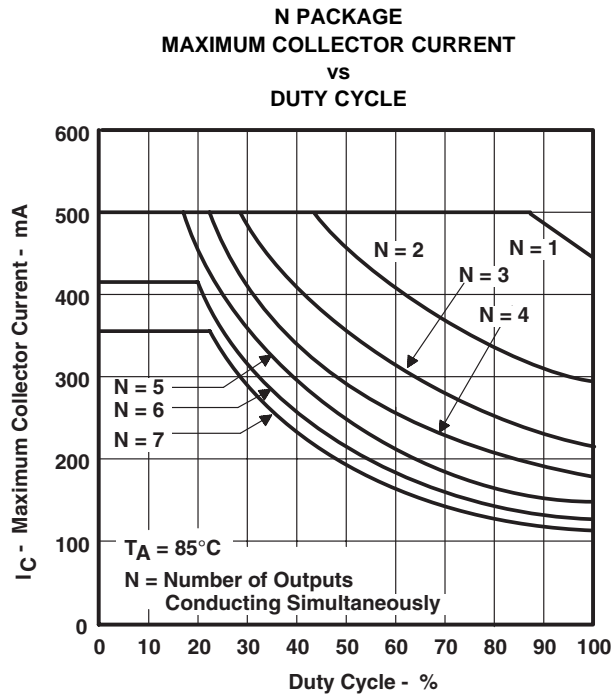


Figure 15.

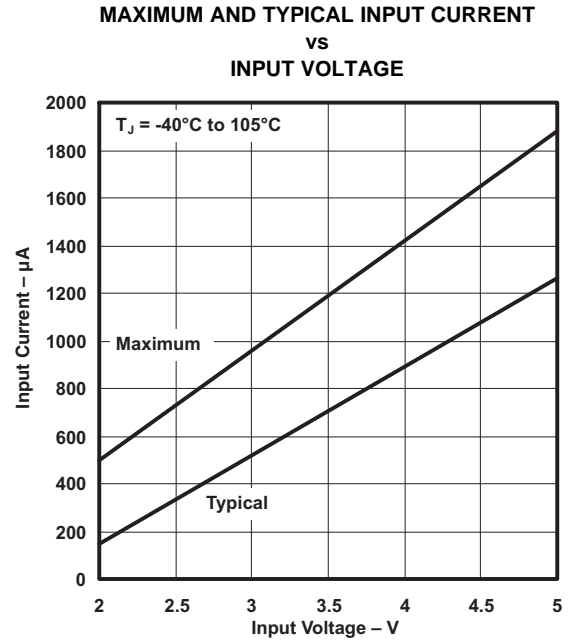


Figure 16.

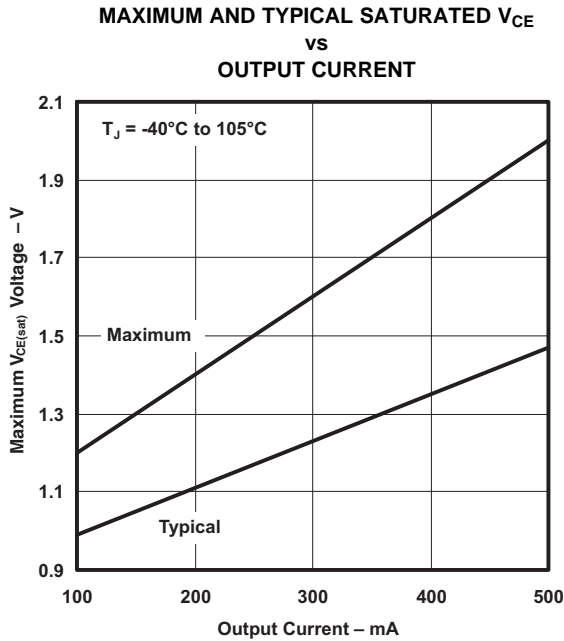


Figure 17.

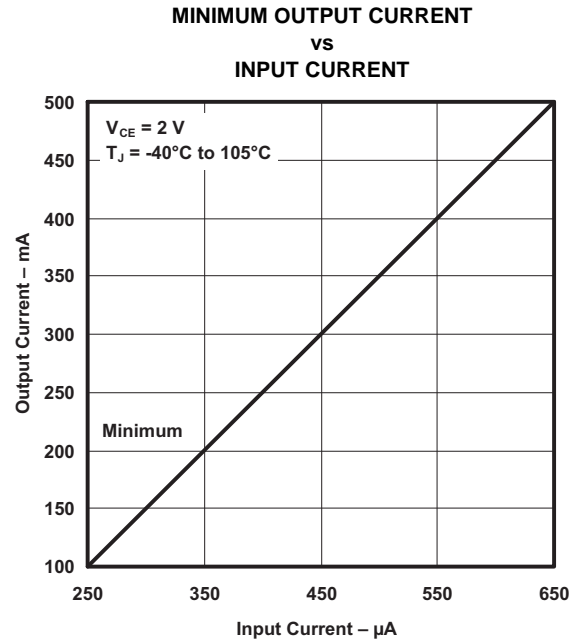


Figure 18.

APPLICATION INFORMATION

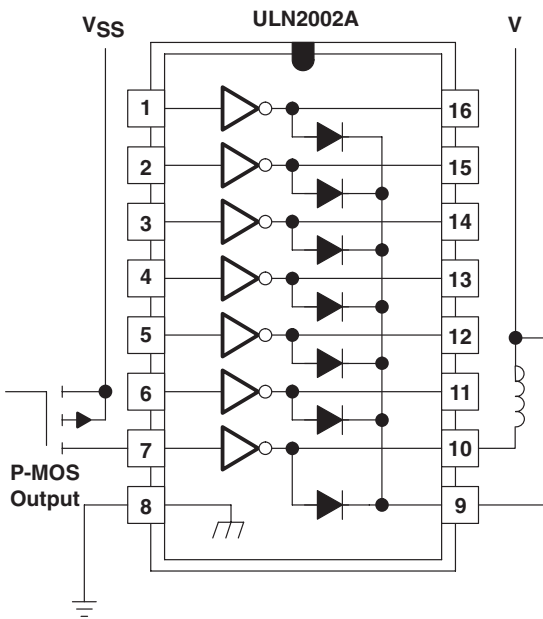


Figure 19. P-MOS to Load

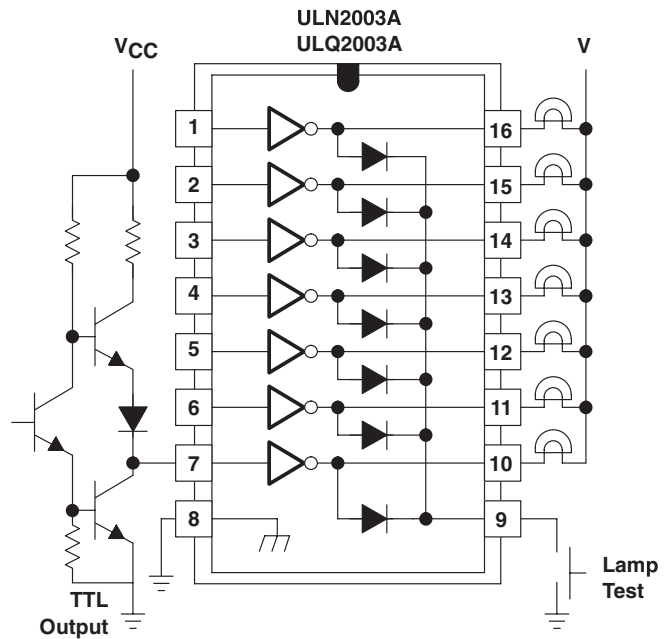


Figure 20. TTL to Load

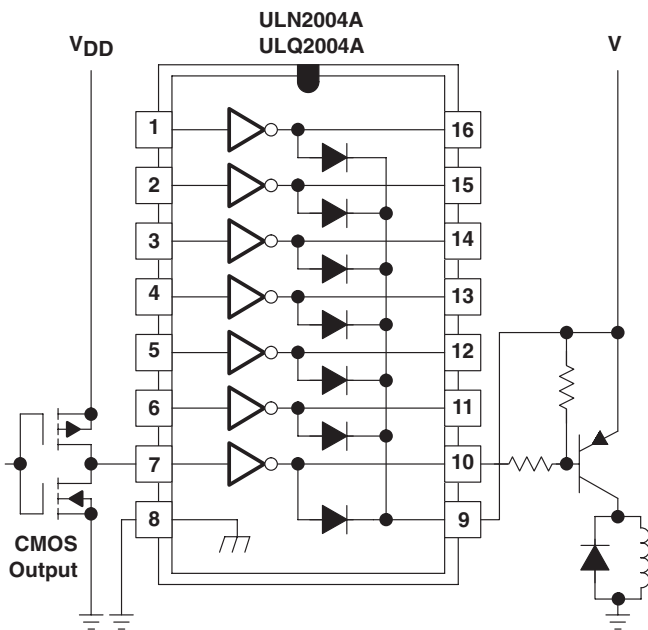


Figure 21. Buffer for Higher Current Loads

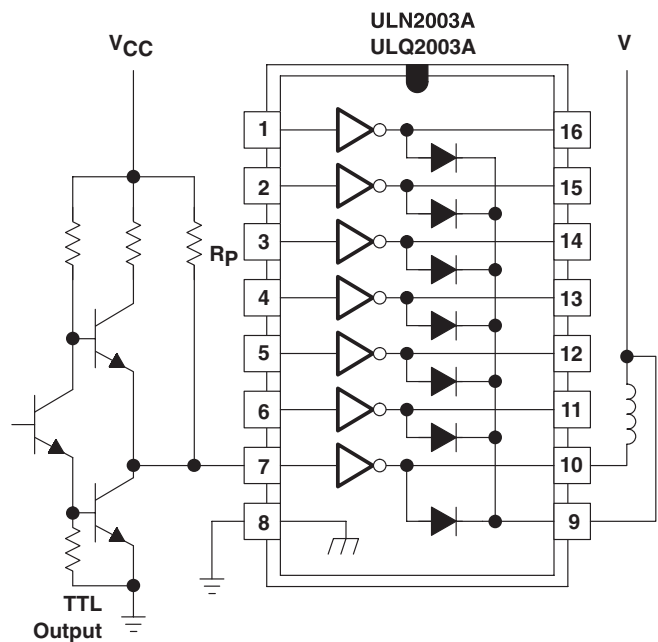


Figure 22. Use of Pullup Resistors to Increase Drive Current

## REVISION HISTORY

<b>Changes from Revision J (September 2010) to Revision K</b>	<b>Page</b>
• Added SOP – NS Package to the $-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$ $T_A$ range in the Ordering Information table. ....	<b>2</b>
• Added Input Current ( $I_i$ ) parameters .....	<b>5</b>
• Added Input Current ( $I_i$ ) parameters .....	<b>6</b>

**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)
ULN2001AD	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	
ULN2001ADR	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	
ULN2001AN	OBSOLETE	PDIP	N	16		TBD	Call TI	Call TI	
ULN2002AD	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	
ULN2002AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2002ANE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2003AD	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ADE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ADG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ADR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ADRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ADRG3	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	
ULN2003ADRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIDE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIDG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIDRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIDRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	

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)
ULN2003AINE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2003AINSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AIPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003AJ	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI	
ULN2003AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2003ANE3	PREVIEW	PDIP	N	16	25	TBD	Call TI	Call TI	
ULN2003ANE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2003ANSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ANSRE4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003ANSRG4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003APW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003APWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003APWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003APWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2003APWRE4	ACTIVE	TSSOP	PW	16	2000	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)
ULN2003APWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004AD	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004ADE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004ADG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004ADR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004ADRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004ADRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2004ANE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULN2004ANSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULN2004ANSRG4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2003AD	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2003ADG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2003ADR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2003ADRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2003AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	
ULQ2004AD	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2004ADG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2004ADR	ACTIVE	SOIC	D	16	2500	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)
ULQ2004ADRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
ULQ2004AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	

<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.

**OBSELETE:** 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.

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#### OTHER QUALIFIED VERSIONS OF ULQ2003A, ULQ2004A :

- Automotive: [ULQ2003A-Q1](#), [ULQ2004A-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**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
ULN2003ADR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
ULN2003ADR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
ULN2003AIDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
ULN2003AINSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
ULN2003AIPWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
ULN2003AIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
ULN2003ANSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
ULN2003APWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
ULN2003APWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
ULN2004ADR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
ULN2004ANSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
ULQ2003ADR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	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)
ULN2003ADR	SOIC	D	16	2500	346.0	346.0	33.0
ULN2003ADR	SOIC	D	16	2500	333.2	345.9	28.6
ULN2003AIDR	SOIC	D	16	2500	333.2	345.9	28.6
ULN2003AINSR	SO	NS	16	2000	346.0	346.0	33.0
ULN2003AIPWR	TSSOP	PW	16	2000	364.0	364.0	27.0
ULN2003AIPWR	TSSOP	PW	16	2000	346.0	346.0	29.0
ULN2003ANSR	SO	NS	16	2000	346.0	346.0	33.0
ULN2003APWR	TSSOP	PW	16	2000	346.0	346.0	29.0
ULN2003APWR	TSSOP	PW	16	2000	364.0	364.0	27.0
ULN2004ADR	SOIC	D	16	2500	346.0	346.0	33.0
ULN2004ANSR	SO	NS	16	2000	346.0	346.0	33.0
ULQ2003ADR	SOIC	D	16	2500	333.2	345.9	28.6

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.

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

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



4040049/E 12/2002

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

D (R-PDSO-G16)

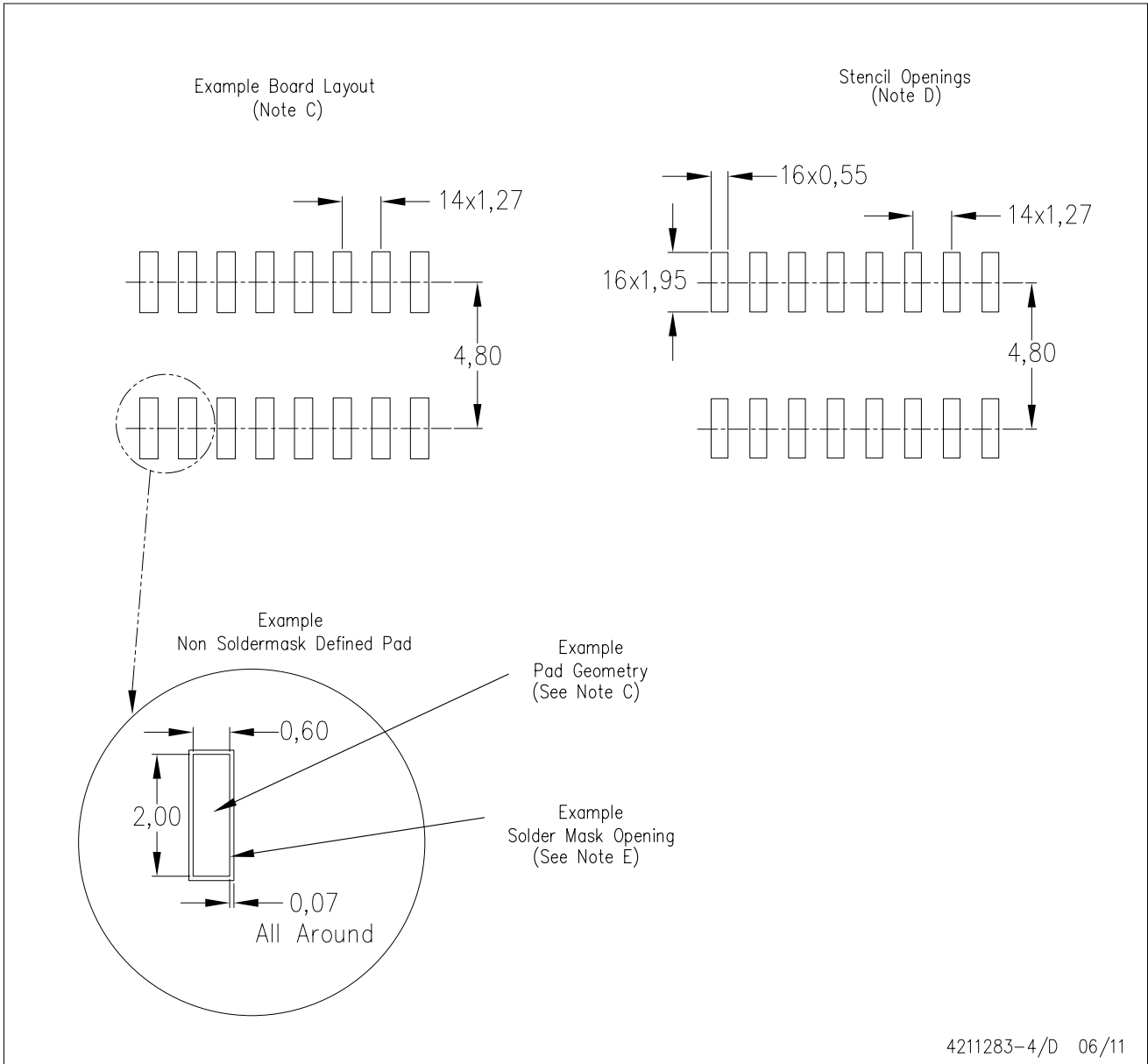
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - 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 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.

D (R-PDSO-G16)

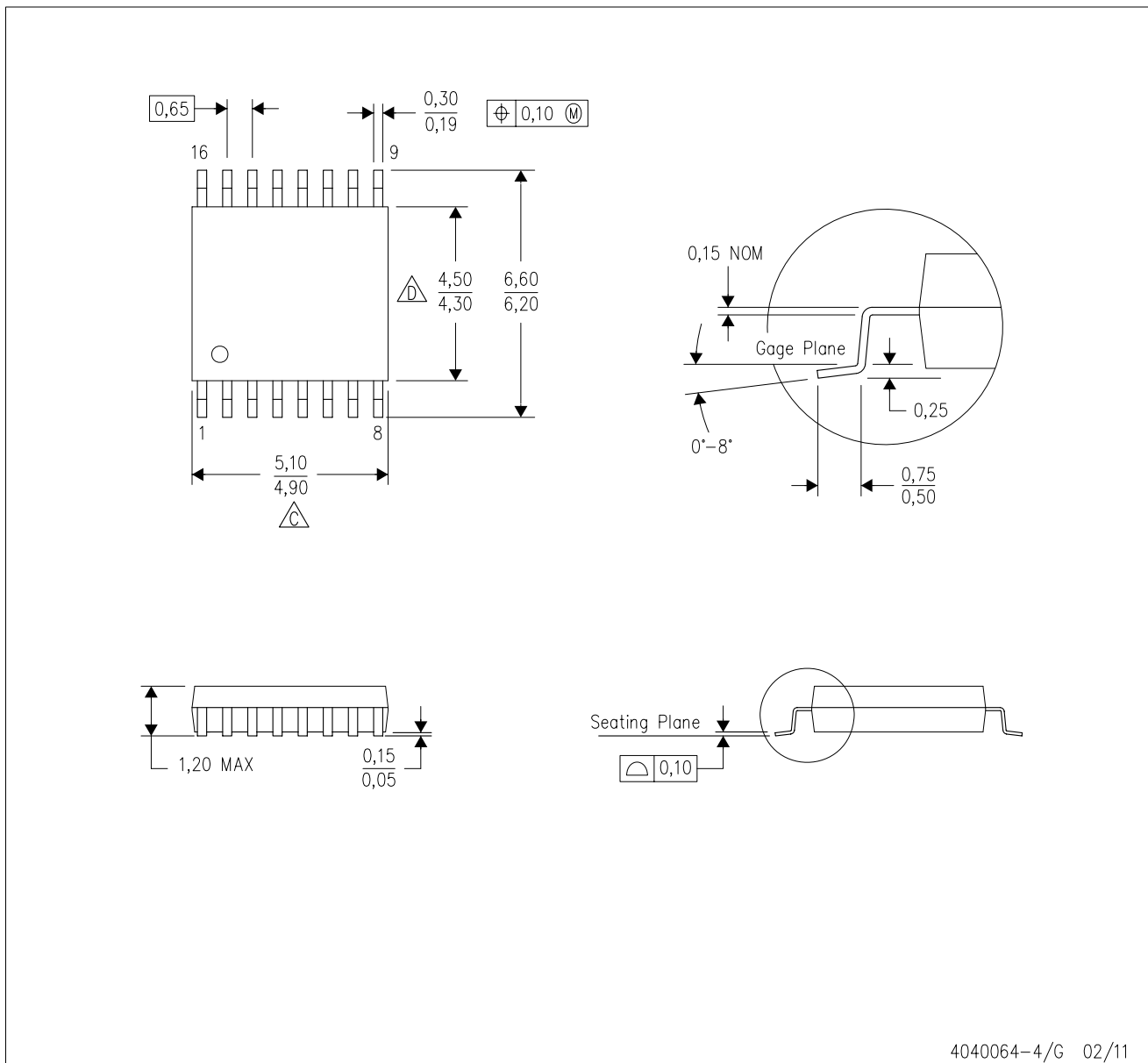
PLASTIC SMALL OUTLINE



- 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-G16)

PLASTIC SMALL OUTLINE



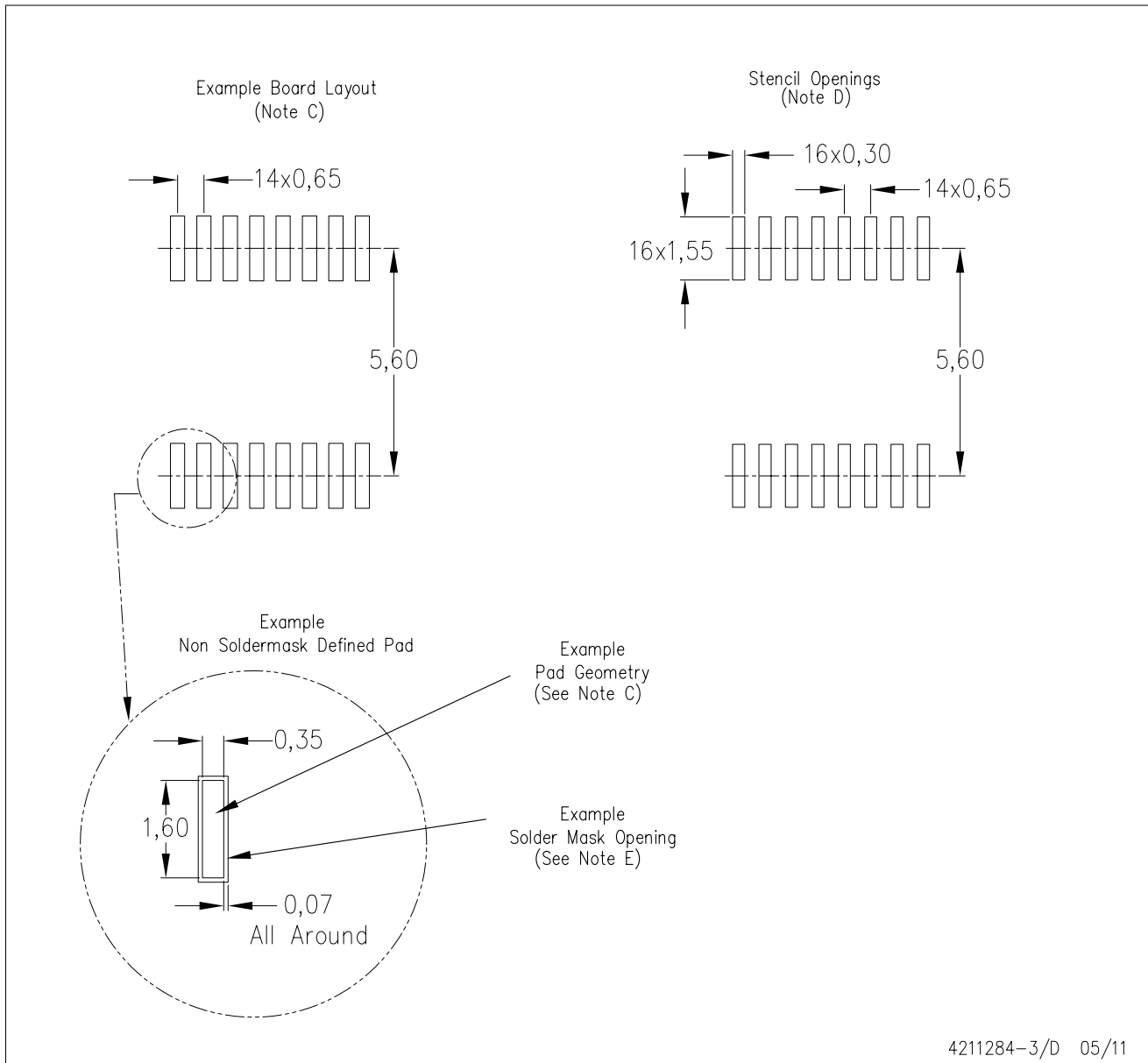
4040064-4/G 02/11

- 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.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  -  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-G16)

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.

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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)

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