

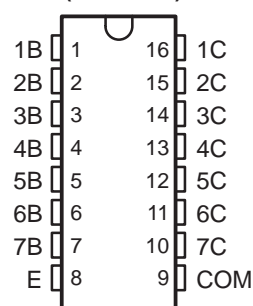
# ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, ULQ2004A HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SLRS027G – DECEMBER 1976 – REVISED JUNE 2004

The ULN2001A is obsolete  
and is no longer supplied.

- 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

ULN2001A . . . D OR N PACKAGE  
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/ordering information

The ULN2001A, ULN2002A, ULN2003A, 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.

## ORDERING INFORMATION

T <sub>A</sub>	PACKAGE†		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	ULN2004AD	ULN2004A
			ULN2004ADR	
	SOP (NS)	Reel of 2000	ULN2003ANSR	ULN2003A
			ULN2004ANSR	ULN2004A
	TSSOP (PW)	Tube of 90	ULN2003APW	UN2003A
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	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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

# ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, ULQ2004A HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

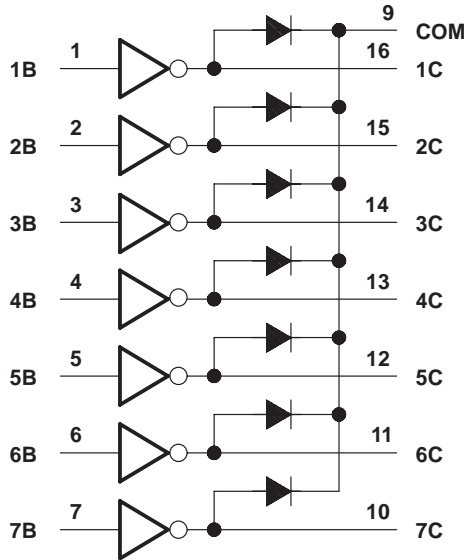
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The ULN2001A is obsolete  
and is no longer supplied.

## description/ordering information (continued)

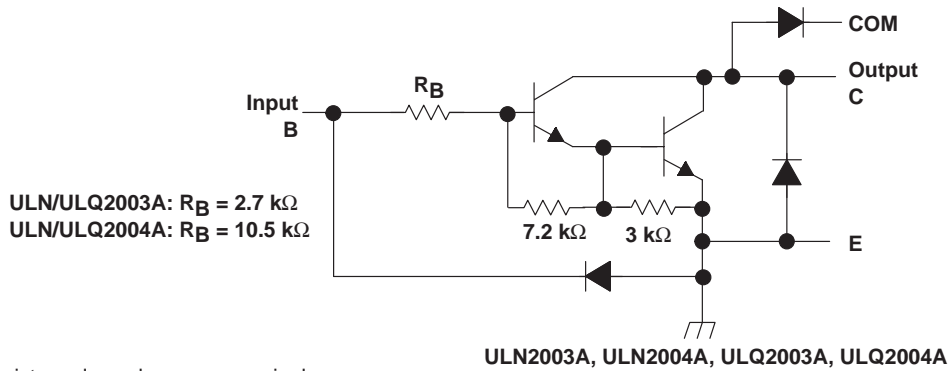
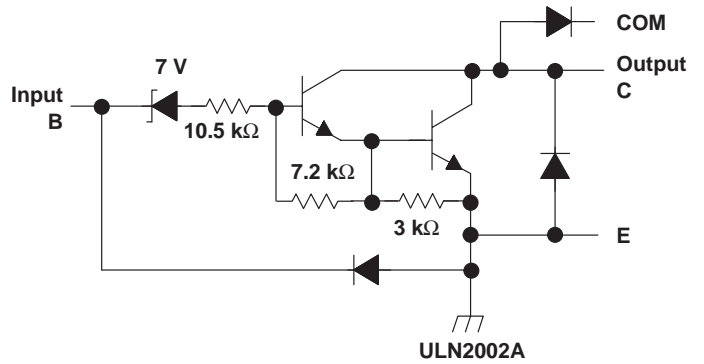
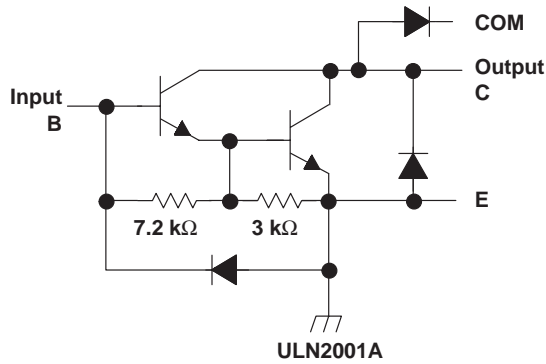
The ULN2001A is a general-purpose array and can be used with TTL and CMOS technologies. The ULN2002A is designed specifically for use with 14-V to 25-V PMOS devices. Each input of this device has a Zener diode and resistor in series to control the input current to a safe limit. The ULN2003A and ULQ2003A 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.

## logic diagram



The ULN2001A is obsolete  
and is no longer supplied.

schematics (each Darlington pair)



All resistor values shown are nominal.

# ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, ULQ2004A HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

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## absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)†

Collector-emitter voltage	50 V
Clamp diode reverse voltage (see Note 1)	50 V
Input voltage, $V_I$ (see Note 1)	30 V
Peak collector current (see Figures 14 and 15)	500 mA
Output clamp current, $I_{OK}$	500 mA
Total emitter-terminal current	-2.5 A
Operating free-air temperature range, $T_A$ , ULN200xA	-20°C to 70°C
ULQ200xA	-40°C to 85°C
ULQ200xAT	-40°C to 105°C
Package thermal impedance, $\theta_{JA}$ (see Notes 2 and 3): D package	73°C/W
N package	67°C/W
NS package	64°C/W
PW package	108°C/W
Package thermal impedance, $\theta_{JC}$ (see Notes 4 and 5): D package	36°C/W
N package	54°C/W
Operating virtual junction temperature, $T_J$	150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
Storage temperature range, $T_{stg}$	-65°C to 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.

- NOTES:
- All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.
  - Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  - The package thermal impedance is calculated in accordance with JESD 51-7.
  - Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JC}$ , and  $T_C$ . The maximum allowable power dissipation at any allowable case temperature is  $P_D = (T_J(\text{max}) - T_C)/\theta_{JC}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  - The package thermal impedance is calculated in accordance with MIL-STD-883.

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

PARAMETER	TEST FIGURE	TEST CONDITIONS	ULN2001A			ULN2002A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{I(\text{on})}$ On-state input voltage	6	$V_{CE} = 2 \text{ V}$ , $I_C = 300 \text{ mA}$						13	V
$V_{CE(\text{sat})}$ Collector-emitter saturation voltage	5	$I_I = 250 \mu\text{A}$ , $I_C = 100 \text{ mA}$		0.9	1.1		0.9	1.1	V
		$I_I = 350 \mu\text{A}$ , $I_C = 200 \text{ mA}$		1	1.3		1	1.3	
		$I_I = 500 \mu\text{A}$ , $I_C = 350 \text{ mA}$		1.2	1.6		1.2	1.6	
$V_F$ Clamp forward voltage	8	$I_F = 350 \text{ mA}$		1.7	2		1.7	2	V
$I_{CEX}$ Collector cutoff current	1	$V_{CE} = 50 \text{ V}$ , $I_I = 0$			50			50	$\mu\text{A}$
	2	$V_{CE} = 50 \text{ V}$ , $T_A = 70^\circ\text{C}$ , $I_I = 0$ , $V_I = 6 \text{ V}$			100			100	
								500	
$I_{I(\text{off})}$ Off-state input current	3	$V_{CE} = 50 \text{ V}$ , $T_A = 70^\circ\text{C}$ , $I_C = 500 \mu\text{A}$	50	65		50	65		$\mu\text{A}$
$I_I$ Input current	4	$V_I = 17 \text{ V}$					0.82	1.25	mA
$I_R$ Clamp reverse current	7	$V_R = 50 \text{ V}$ , $T_A = 70^\circ\text{C}$			100			100	$\mu\text{A}$
		$V_R = 50 \text{ V}$			50			50	
$h_{FE}$ Static forward-current transfer ratio	5	$V_{CE} = 2 \text{ V}$ , $I_C = 350 \text{ mA}$	1000						
$C_i$ Input capacitance		$V_I = 0$ , $f = 1 \text{ MHz}$		15	25		15	25	pF



The ULN2001A is obsolete  
and is no longer supplied.

electrical characteristics,  $T_A = 25^\circ\text{C}$  (unless otherwise noted) (continued)

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

**ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, ULQ2004A**  
**HIGH-VOLTAGE HIGH-CURRENT**  
**DARLINGTON TRANSISTOR ARRAY**

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The ULN2001A is obsolete  
and is no longer supplied.

**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	6	V <sub>CE</sub> = 2 V	I <sub>C</sub> = 125 mA						5	V
			I <sub>C</sub> = 200 mA						6	
			I <sub>C</sub> = 250 mA						2.7	
			I <sub>C</sub> = 275 mA						2.9	
			I <sub>C</sub> = 300 mA						3	
			I <sub>C</sub> = 350 mA						7	
V <sub>CE(sat)</sub> Collector-emitter saturation voltage	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	1	V <sub>CE</sub> = 50 V, I <sub>I</sub> = 0						100	μA	
	2	V <sub>CE</sub> = 50 V, I <sub>I</sub> = 0 V <sub>I</sub> = 1 V						500		
V <sub>F</sub> Clamp forward voltage	8	I <sub>F</sub> = 350 mA		1.7	2.3		1.7	2	V	
I <sub>I(off)</sub> Off-state input current	3	V <sub>CE</sub> = 50 V, I <sub>C</sub> = 500 μA		65		50	65		μA	
I <sub>I</sub> Input current	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	7	V <sub>R</sub> = 50 V, T <sub>A</sub> = 25°C			100			50	μA	
		V <sub>R</sub> = 50 V			100			100		
C <sub>i</sub> Input capacitance		V <sub>I</sub> = 0, f = 1 MHz		15	25		15	25	pF	

**switching characteristics, T<sub>A</sub> = 25°C**

PARAMETER	TEST CONDITIONS	ULN2001A, ULN2002A, ULN2003A, ULN2004A			UNIT
		MIN	TYP	MAX	
t <sub>PLH</sub> Propagation delay time, low- to high-level output	See Figure 9		0.25	1	μs
t <sub>PHL</sub> Propagation delay time, high- to low-level output	See Figure 9		0.25	1	μs
V <sub>OH</sub> High-level output voltage after switching	V <sub>S</sub> = 50 V, I <sub>O</sub> ≈ 300 mA, See Figure 10		V <sub>S</sub> -20		mV

**switching characteristics over recommended operating conditions (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	ULQ2003A, ULQ2004A			UNIT
		MIN	TYP	MAX	
t <sub>PLH</sub> Propagation delay time, low- to high-level output	See Figure 9		1	10	μs
t <sub>PHL</sub> Propagation delay time, high- to low-level output	See Figure 9		1	10	μs
V <sub>OH</sub> High-level output voltage after switching	V <sub>S</sub> = 50 V, I <sub>O</sub> ≈ 300 mA, See Figure 10		V <sub>S</sub> -500		mV



The ULN2001A is obsolete and is no longer supplied.

PARAMETER MEASUREMENT INFORMATION

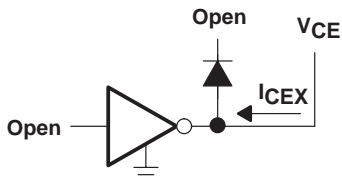


Figure 1.  $I_{CEX}$  Test Circuit

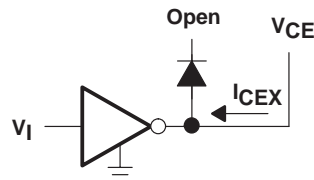


Figure 2.  $I_{CEX}$  Test Circuit

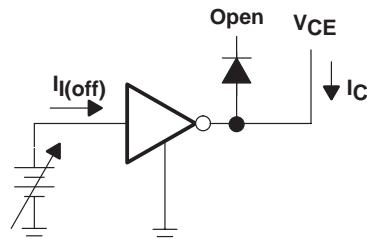


Figure 3.  $I_{I(off)}$  Test Circuit

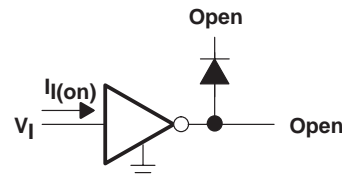
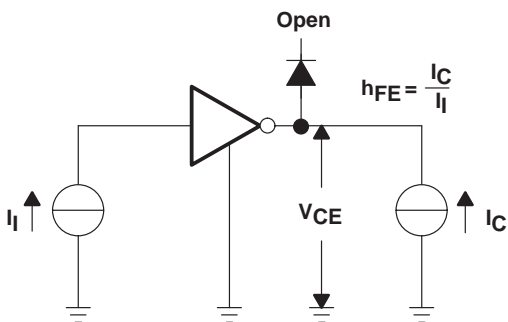


Figure 4.  $I_I$  Test Circuit



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

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

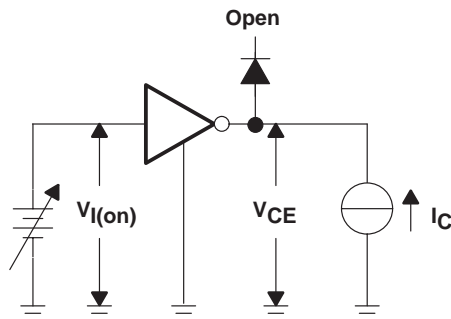


Figure 6.  $V_{I(on)}$  Test Circuit

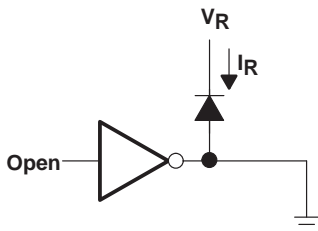


Figure 7.  $I_R$  Test Circuit

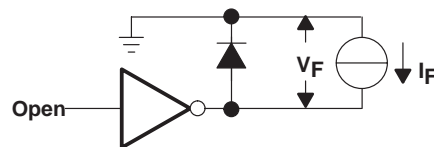


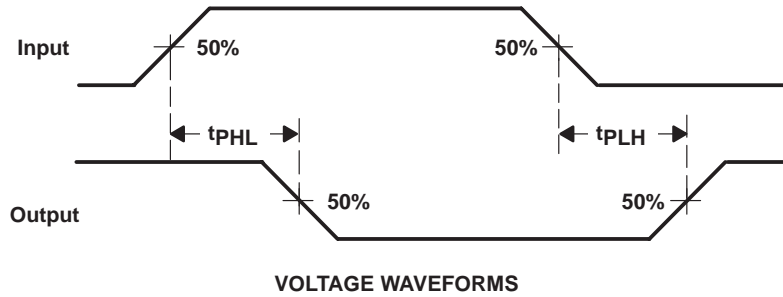
Figure 8.  $V_F$  Test Circuit

**ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, ULQ2004A**  
**HIGH-VOLTAGE HIGH-CURRENT**  
**DARLINGTON TRANSISTOR ARRAY**

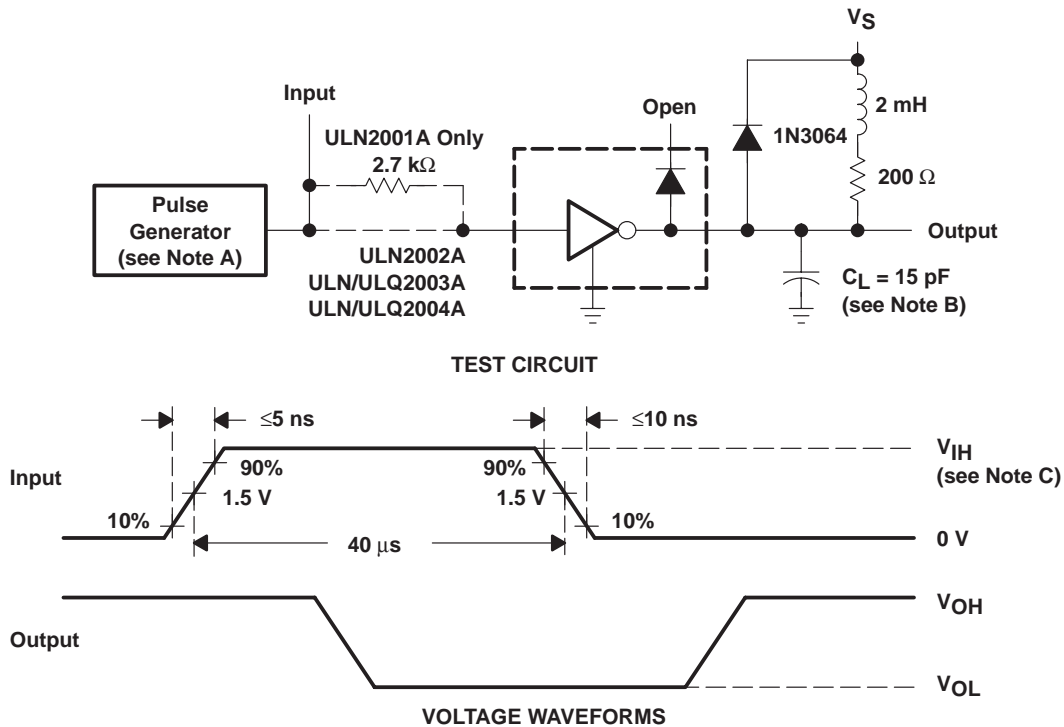
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The ULN2001A is obsolete  
 and is no longer supplied.

**PARAMETER MEASUREMENT INFORMATION**



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



- NOTES: 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 ULN2001A, the ULN2003A, and the 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**



The ULN2001A is obsolete and is no longer supplied.

**TYPICAL CHARACTERISTICS**

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

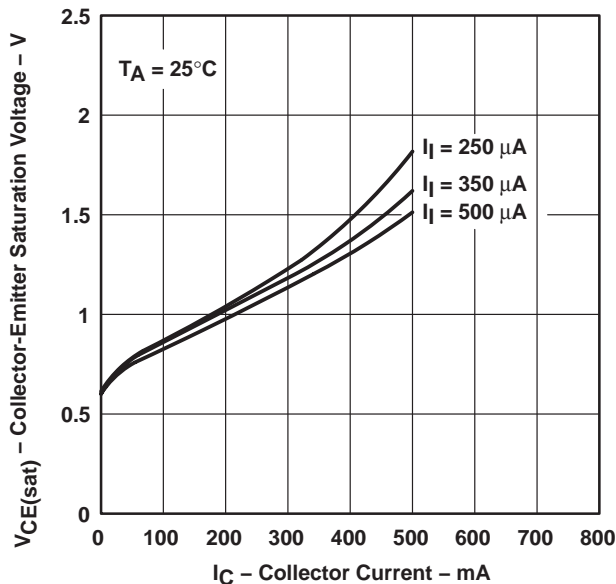


Figure 11

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

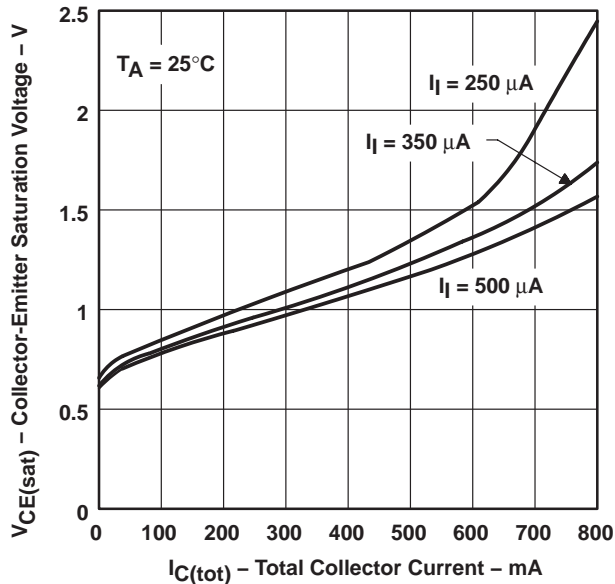


Figure 12

**COLLECTOR CURRENT  
vs  
INPUT CURRENT**

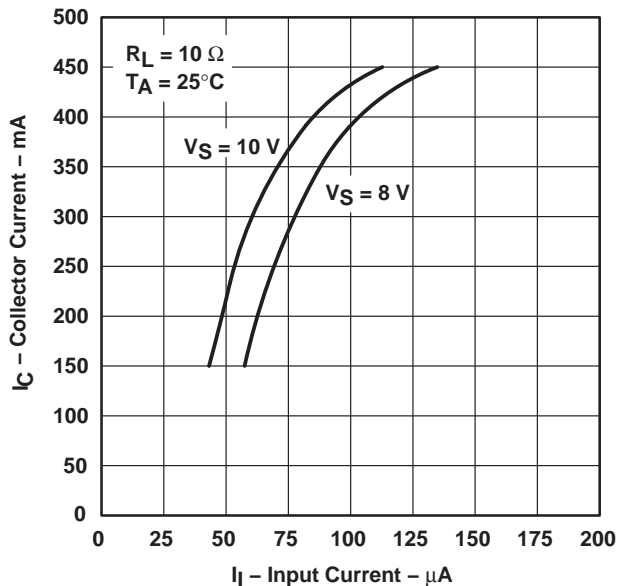


Figure 13

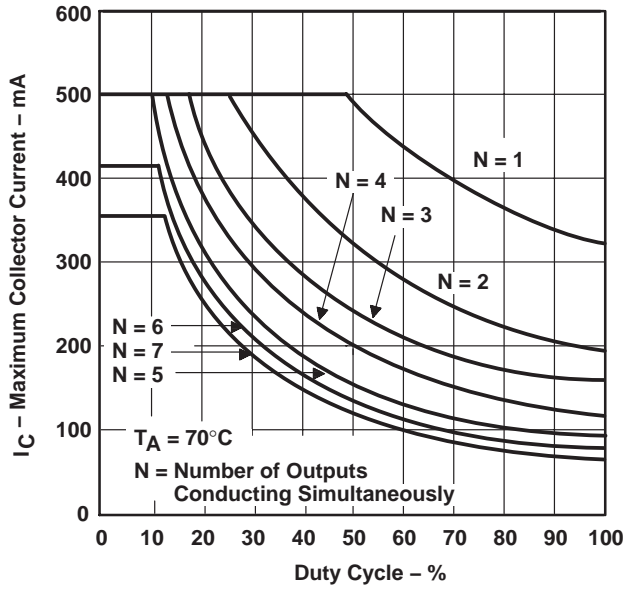
**ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, ULQ2004A**  
**HIGH-VOLTAGE HIGH-CURRENT**  
**DARLINGTON TRANSISTOR ARRAY**

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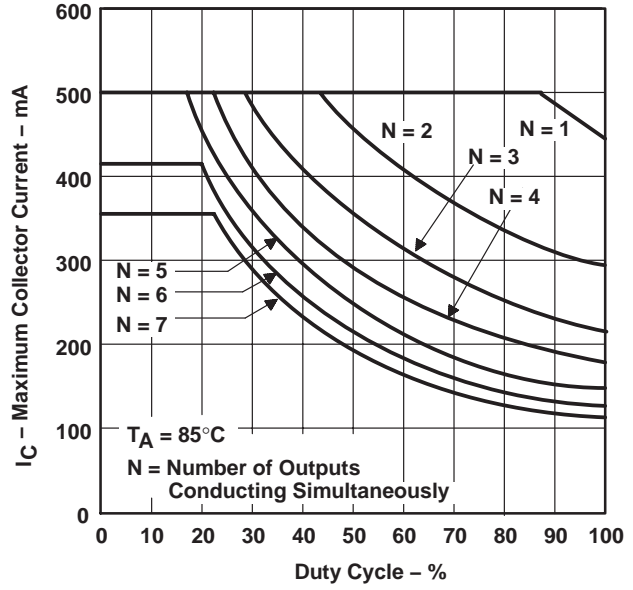
**THERMAL INFORMATION**

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



**Figure 14**

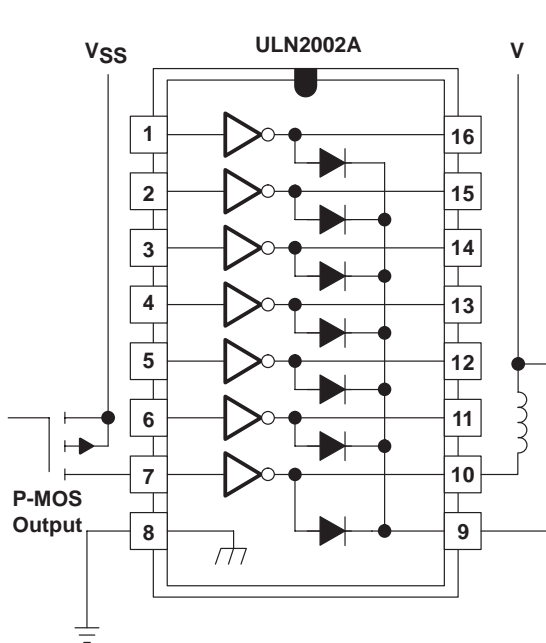
**N PACKAGE**  
**MAXIMUM COLLECTOR CURRENT**  
**vs**  
**DUTY CYCLE**



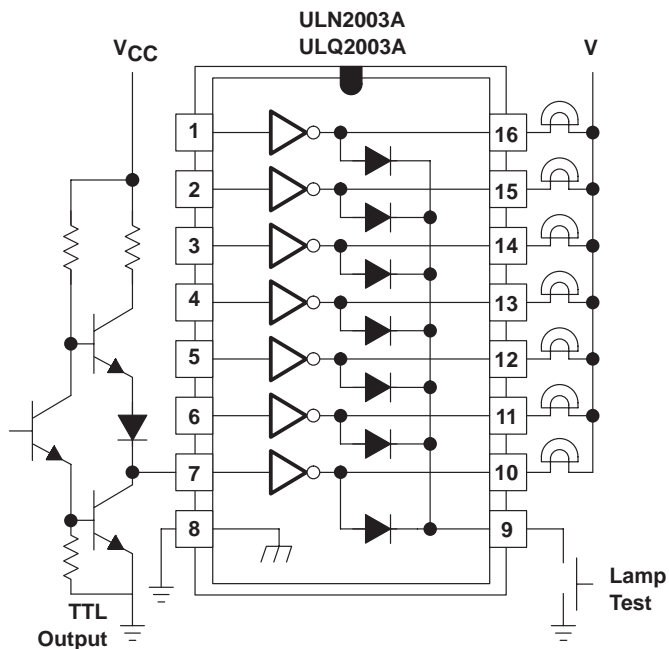
**Figure 15**

The ULN2001A is obsolete  
and is no longer supplied.

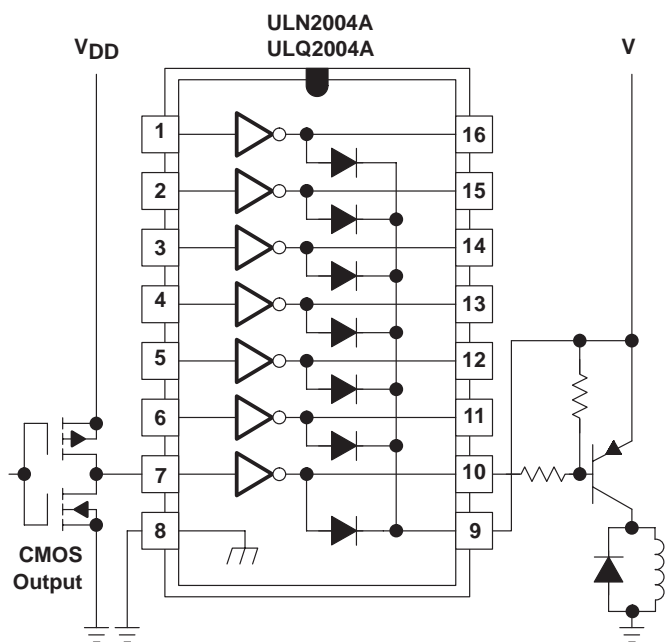
**APPLICATION INFORMATION**



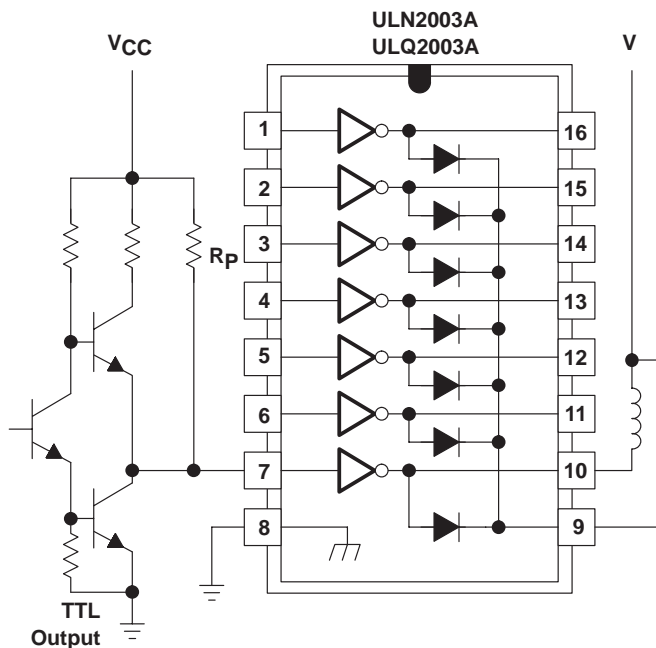
**Figure 16. P-MOS to Load**



**Figure 17. TTL to Load**



**Figure 18. Buffer for Higher Current Loads**



**Figure 19. Use of Pullup Resistors  
to Increase Drive Current**

**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>
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	Level-NC-NC-NC
ULN2002ANE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
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
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
ULN2003AJ	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
ULN2003AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
ULN2003ANE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
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	TBD	Call TI	Call TI
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
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
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
ULN2004AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
ULN2004ANE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
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	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
ULQ2003ADR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
ULQ2003AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
ULQ2004AD	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
ULQ2004ADR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
ULQ2004AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

<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) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

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

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

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

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

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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 PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-012 variation AC.



# MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



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

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

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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