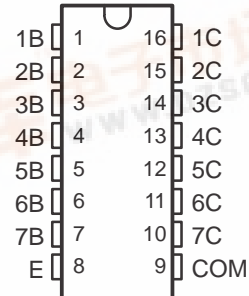


- **500-mA Rated Collector Current (Single Output)**
- **High-Voltage Outputs . . . 50 V**
- **Output Clamp Diodes**
- **Inputs Compatible With Various Types of Logic**
- **Interchangeable With ULN2001A Series**

**D OR N PACKAGE  
(TOP VIEW)**

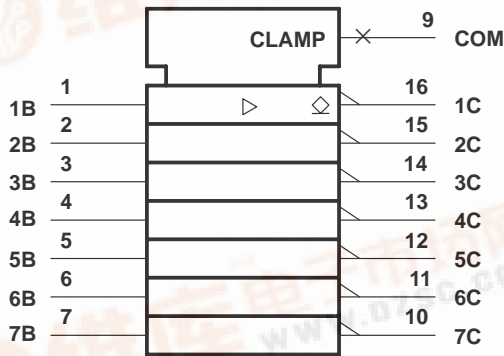


**description**

The ULQ2003A is a monolithic high-voltage, high-current Darlington transistor array. The device 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 may 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. The ULQ2003A has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

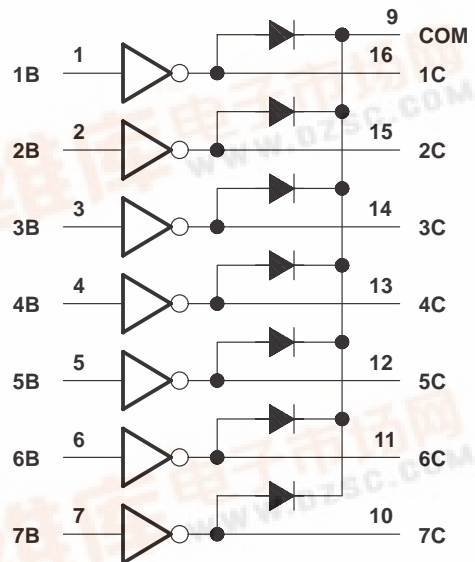
The ULQ2003A is offered in standard 16-pin dual in-line (N) and surface-mount (D) packaging. The device is characterized for operation over the junction temperature range of -40°C to 105°C.

**logic symbol†**

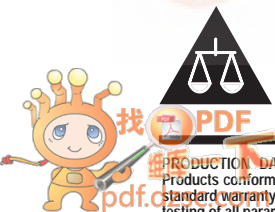


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

**logic diagram (positive logic)**



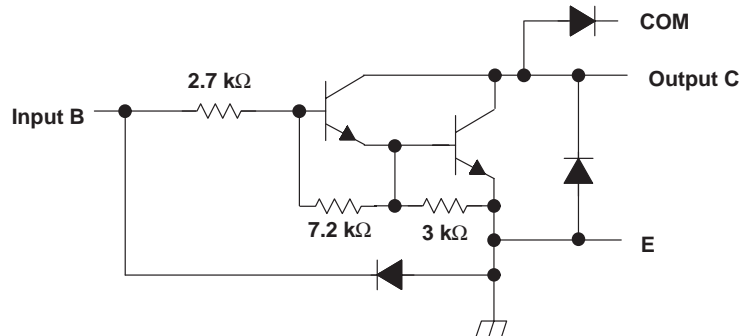
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



# ULQ2003A DARLINGTON TRANSISTOR ARRAY

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## schematics (each Darlington pair)



All resistor values shown are nominal.

## absolute maximum ratings over operating temperature range (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 13 and 14)	500 mA
Output clamp current, $I_{OK}$	500 mA
Total emitter-terminal current	-2.5 A
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$	-40°C to 85°C
Operating junction temperature range, $T_J$	-40°C to 105°C
Storage temperature range, $T_{stg}$	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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.

NOTE 1: All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.

DISSIPATION RATING TABLE

PACKAGE	$T_A = 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 85^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	494 mW
N	1150 mW	9.2 mW/°C	598 mW

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## electrical characteristics over operating junction temperature range, $T_J = -40^\circ\text{C}$ to $105^\circ\text{C}$

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{I(\text{on})}$	On-state input voltage	$V_{CE} = 2\text{ V}$ , See Figure 5	$I_C = 200\text{ mA}$			2.7	V
			$I_C = 250\text{ mA}$			2.9	
			$I_C = 300\text{ mA}$			3	
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage		$I_I = 250\text{ }\mu\text{A}$ , See Figure 4	$I_C = 100\text{ mA}$ ,	0.9	1.2	V
			$I_I = 350\text{ }\mu\text{A}$ , See Figure 4	$I_C = 200\text{ mA}$ ,	1	1.4	
			$I_I = 500\text{ }\mu\text{A}$ , See Figure 4	$I_C = 350\text{ mA}$ ,	1.2	1.7	
$I_{CEX}$	Collector cutoff current	$V_{CE} = 50\text{ V}$ , See Figure 1	$I_I = 0$ ,			100	$\mu\text{A}$
$V_F$	Clamp forward voltage	$I_F = 350\text{ mA}$ ,	See Figure 7		1.7	2.2	V
$I_{I(\text{off})}$	Off-state input current	$V_{CE} = 50\text{ V}$ , See Figure 2	$I_C = 500\text{ }\mu\text{A}$ ,	30	65		$\mu\text{A}$
$I_I$	Input current	$V_I = 3.85\text{ V}$ ,	See Figure 3		0.93	1.35	mA
$I_R$	Clamp reverse current	$V_R = 50\text{ V}$ ,	See Figure 6			100	$\mu\text{A}$
$C_i$	Input capacitance	$V_I = 0$ ,	$f = 1\text{ MHz}$		15	25	pF

## switching characteristics over operating junction temperature, $T_J = -40^\circ\text{C}$ to $105^\circ\text{C}$

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{PLH}$	Propagation delay time, low-to-high-level output	See Figure 8			1	10	$\mu\text{s}$
$t_{PHL}$	Propagation delay time, high-to-low-level output				1	10	$\mu\text{s}$
$V_{OH}$	High-level output voltage after switching	$V_S = 50\text{ V}$ , See Figure 9	$I_O \approx 300\text{ mA}$ ,	$V_S - 500$			mV

### PARAMETER MEASUREMENT INFORMATION

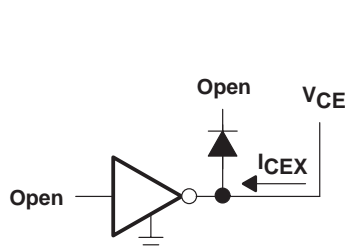


Figure 1.  $I_{CEX}$  Test Circuit

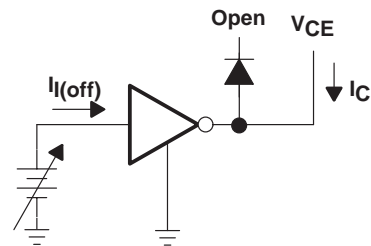
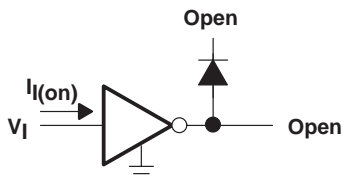


Figure 2.  $I_{I(\text{off})}$  Test Circuit

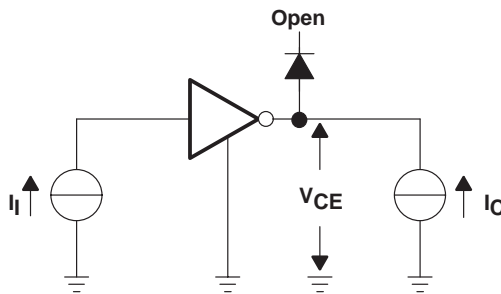
**ULQ2003A  
DARLINGTON TRANSISTOR ARRAY**

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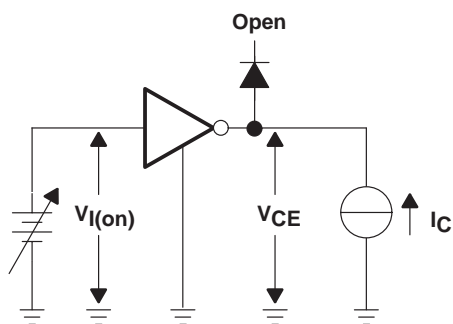
**PARAMETER MEASUREMENT INFORMATION**



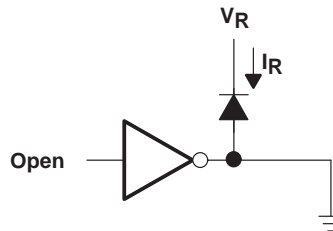
**Figure 3.  $I_I$  Test Circuit**



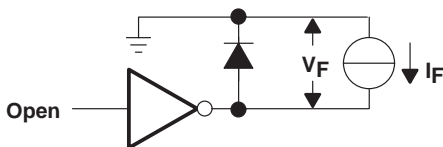
**Figure 4.  $V_{CE(sat)}$  Test Circuit**



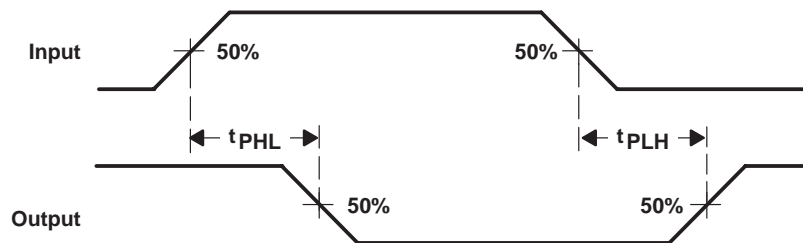
**Figure 5.  $V_{I(on)}$  Test Circuit**



**Figure 6.  $I_R$  Test Circuit**



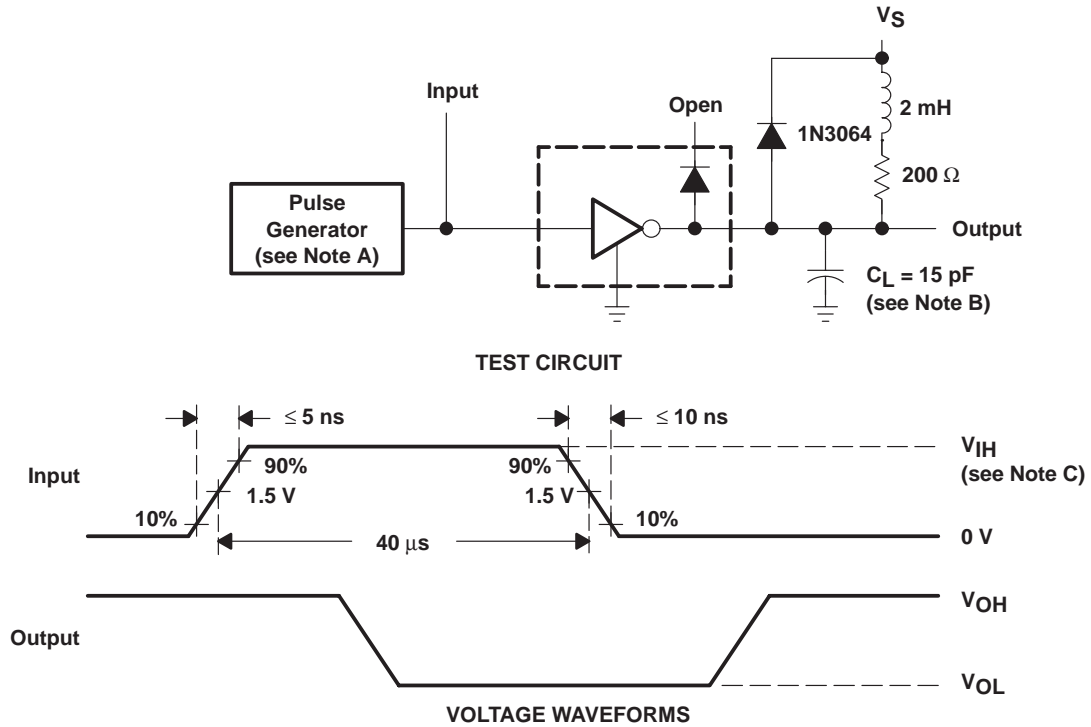
**Figure 7.  $V_F$  Test Circuit**



**VOLTAGE WAVEFORMS**

**Figure 8. Propagation Delay Time Waveforms**

PARAMETER MEASUREMENT INFORMATION



- 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.  $V_{IH} = 3$  V

Figure 9. Latch-Up Test Circuit and Voltage Waveforms

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## TYPICAL CHARACTERISTICS

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

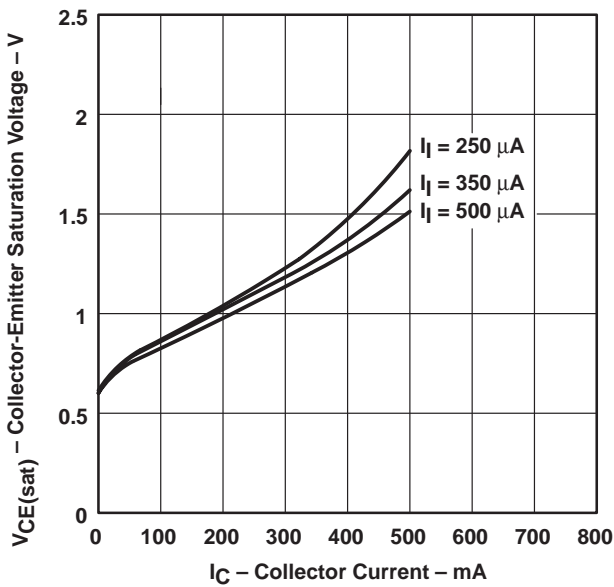


Figure 10

COLLECTOR-EMITTER SATURATION VOLTAGE  
vs  
TOTAL COLLECTOR CURRENT  
(TWO DARLINGTONS PARALLELED)

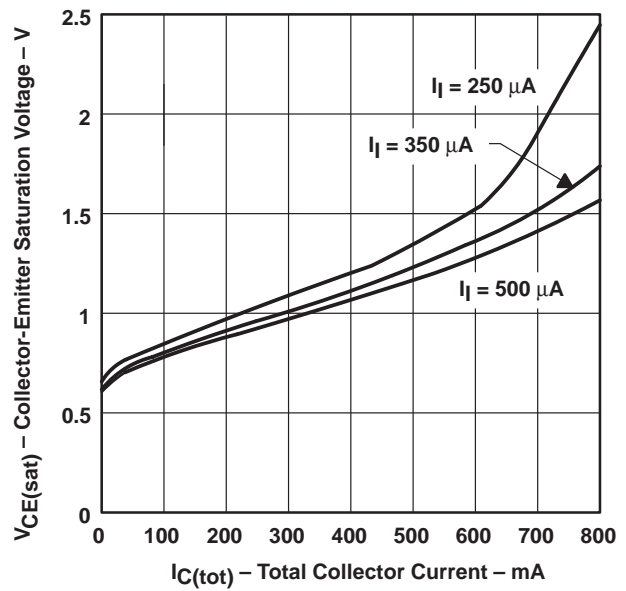


Figure 11

COLLECTOR CURRENT  
vs  
INPUT CURRENT

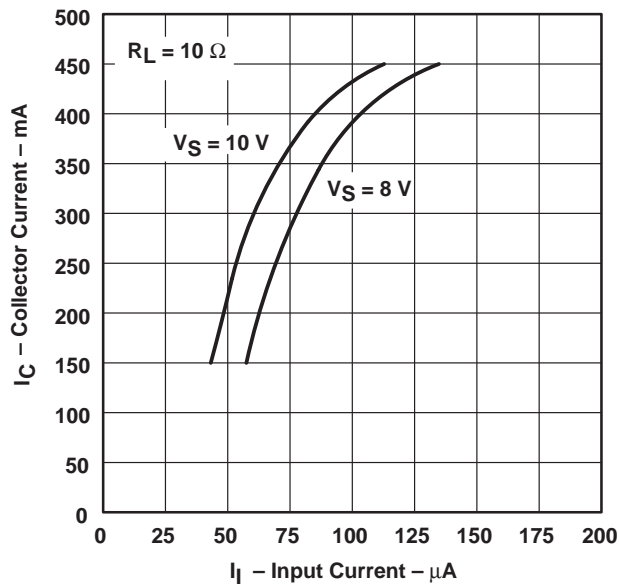


Figure 12

THERMAL INFORMATION

D PACKAGE  
 MAXIMUM COLLECTOR CURRENT  
 VS  
 DUTY CYCLE

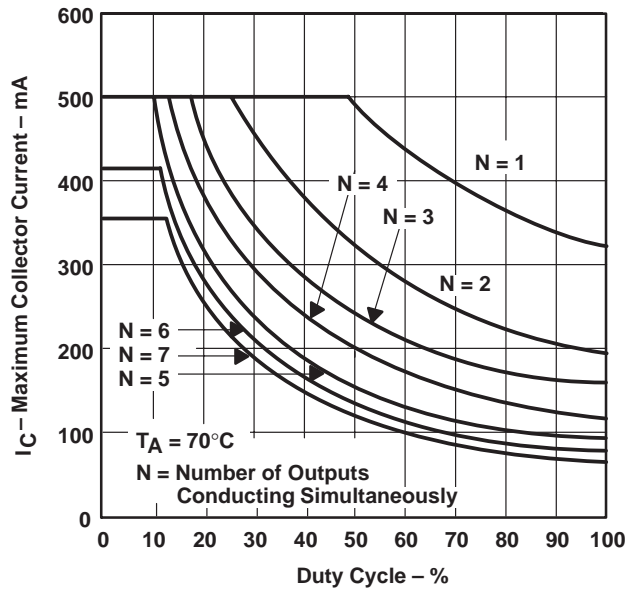


Figure 13

N PACKAGE  
 MAXIMUM COLLECTOR CURRENT  
 VS  
 DUTY CYCLE

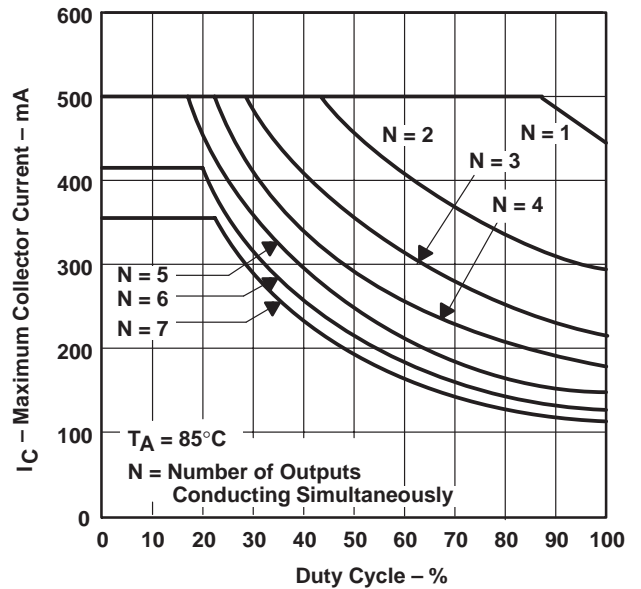


Figure 14

# ULQ2003A DARLINGTON TRANSISTOR ARRAY

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## APPLICATION INFORMATION

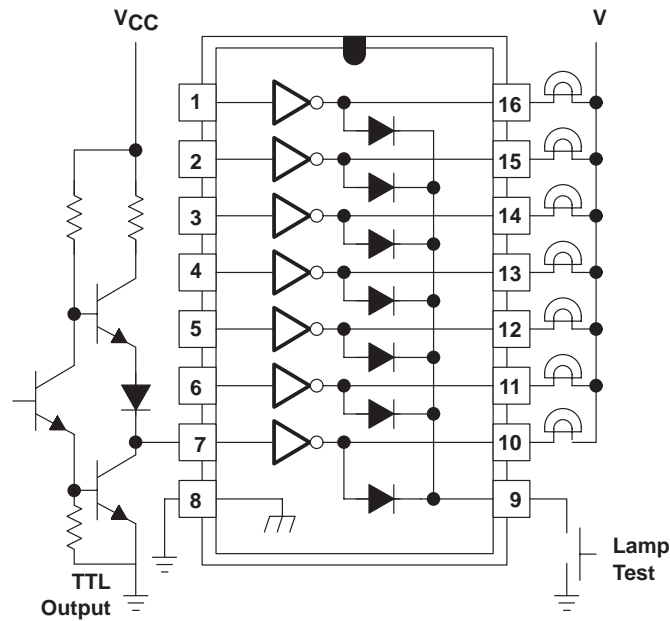


Figure 15. TTL to Load

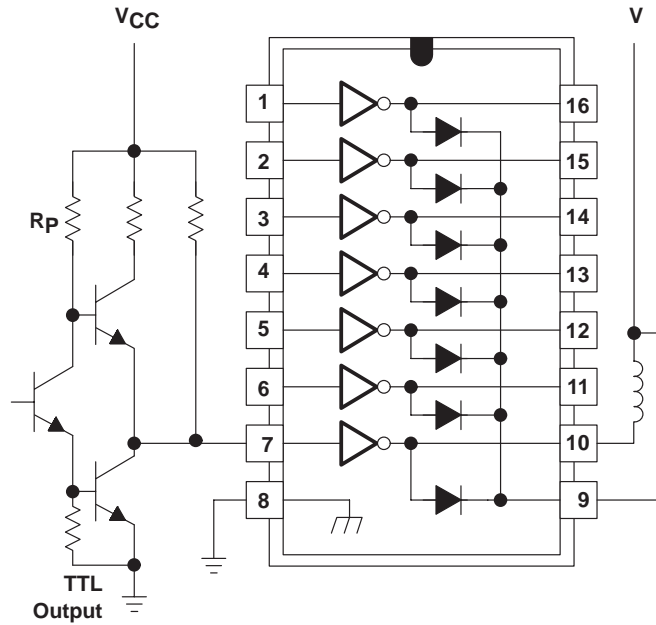


Figure 16. Use of Pullup Resistors to Increase Drive Current



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