

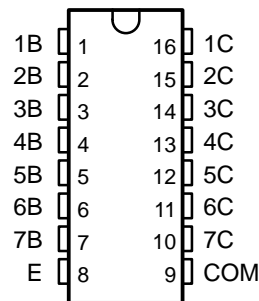
# ULQ2003A-Q1, ULQ2004A-Q1, HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SGLS148 – DECEMBER 2002

- Qualification in Accordance With AEC-Q100†
- Qualified for Automotive Applications
- Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval
- ESD Protection Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- 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

† Contact factory for details. Q100 qualification data available on request.

D PACKAGE  
(TOP VIEW)



## description

The ULQ2003A-Q1 and ULQ2004A-Q1 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.

The ULQ2003A-Q1 has a 2.7-k $\Omega$  series base resistor for each Darlington pair, for operation directly with TTL or 5-V CMOS devices. The ULQ2004A-Q1 has 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 ULQ2004A-Q1 is below that of the ULQ2003A-Q1.

### AVAILABLE OPTIONS

T <sub>A</sub>	D PACKAGES†
	SMALL OUTLINE
-40°C to 105°C	ULQ2003ATDQ1 ULQ2003ATDRQ1
	ULQ2004ATDQ1‡ ULQ2004ATDRQ1‡

† The D package is available taped and reeled. Add the suffix R to device type (e.g., ULQ2003TDADRQ1).

‡ ULQ2004ATDQ1 and ULQ2004ATDRQ1 are Product Preview only.



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.

This document contains information on products in more than one phase of development. The status of each device is indicated on the page(s) specifying its electrical characteristics.

 **TEXAS  
INSTRUMENTS**

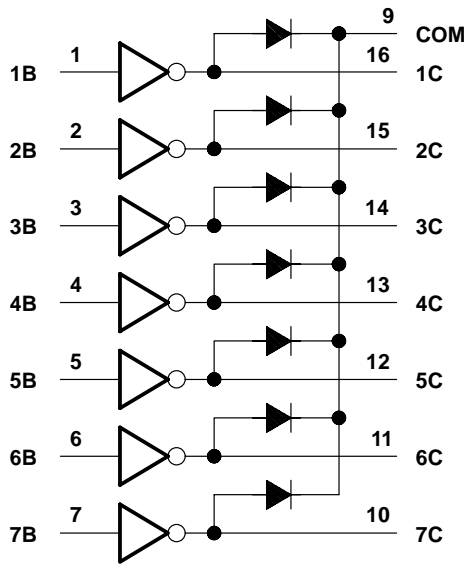
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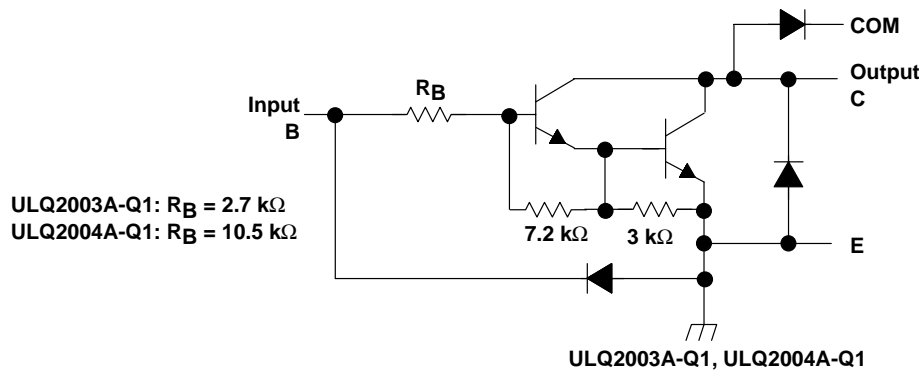
# ULQ2003A-Q1, ULQ2004A-Q1, HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SGLS148 – DECEMBER 2002

## logic diagram



## schematics (each Darlington pair)



All resistor values shown are nominal.

## 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 Figure 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
Package thermal impedance, $\theta_{JA}$ (see Note 2)	73°C/W
Operating free-air temperature range, $T_A$	-40°C to 105°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: 1. All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.  
 2. The package thermal impedance is calculated in accordance with JESD 51-7.



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# ULQ2003A-Q1, ULQ2004A-Q1, HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SGLS148 – DECEMBER 2002

**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	$T_A = 105^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/ $^\circ\text{C}$	494 mW	342 mW

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

PARAMETER	TEST CONDITIONS	ULQ2003A-Q1			ULQ2004A-Q1			UNIT	
		MIN	TYP	MAX	MIN	TYP	MAX		
$V_{I(on)}$ On-state input voltage, See Figure 6	$V_{CE} = 2\text{ V}$	$I_C = 125\text{ mA}$					5	V	
		$I_C = 200\text{ mA}$			2.7		6		
		$I_C = 250\text{ mA}$			2.9				
		$I_C = 275\text{ mA}$					7		
		$I_C = 300\text{ mA}$			3				
		$I_C = 350\text{ mA}$					8		
$V_{CE(sat)}$ Collector-emitter saturation voltage, See Figure 5	$I_I = 250\ \mu\text{A}, I_C = 100\text{ mA}$ $I_I = 350\ \mu\text{A}, I_C = 200\text{ mA}$ $I_I = 500\ \mu\text{A}, I_C = 350\text{ mA}$		0.9	1.2		0.9	1.1	V	
				1	1.4		1		1.3
				1.2	1.7		1.2		1.6
$I_{CEX}$ Collector cutoff current	$V_{CE} = 50\text{ V}, I_I = 0,$ See Figure 1			100			50	$\mu\text{A}$	
							100		
	$V_{CE} = 50\text{ V},$ See Figure 2	$I_I = 0$ $V_I = 1\text{ V}$					500		
$V_F$ Clamp forward voltage, See Figure 8	$I_F = 350\text{ mA}$		1.7	2.2		1.7	2	V	
$I_{I(off)}$ Off-state input current, See Figure 3	$V_{CE} = 50\text{ V}, I_C = 500\ \mu\text{A}$	30	65		50	65		$\mu\text{A}$	
$I_I$ Input current, see 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, See Figure 7	$V_R = 50\text{ V}, T_A = 25^\circ\text{C}$			100			50	$\mu\text{A}$	
	$V_R = 50\text{ V}$			100			100		
$C_i$ Input capacitance	$V_I = 0, f = 1\text{ MHz}$		15	25		15	25	pF	

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

PARAMETER	TEST CONDITIONS	ULQ2003A-Q1, ULQ2004A-Q1			UNIT
		MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low-to-high level output	See Figure 9		1	10	$\mu\text{s}$
$t_{PHL}$ Propagation delay time, high-to-low level output	See Figure 9		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 Figure 10		$V_S - 500$		mV



# ULQ2003A-Q1, ULQ2004A-Q1, HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SGLS148 – DECEMBER 2002

## PARAMETER MEASUREMENT INFORMATION

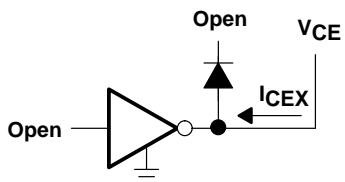


Figure 1.  $I_{CEX}$  Test Circuit

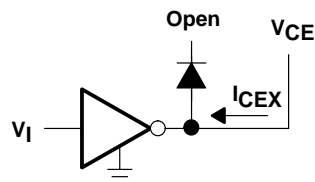


Figure 2.  $I_{CEX}$  Test Circuit

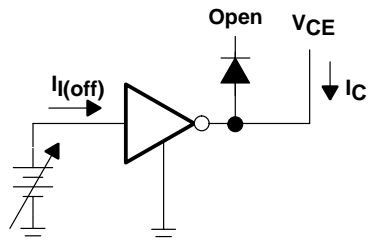


Figure 3.  $I_{1(off)}$  Test Circuit

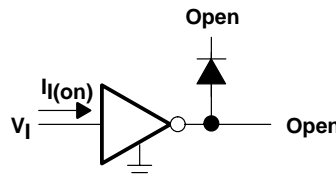
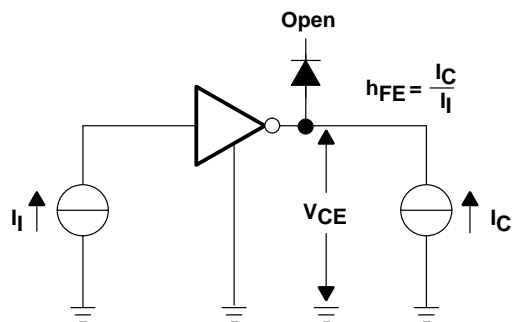


Figure 4.  $I_1$  Test Circuit



NOTE:  $I_1$  is fixed for measuring  $V_{CE(sat)}$ , variable for measuring  $h_{FE}$ .

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

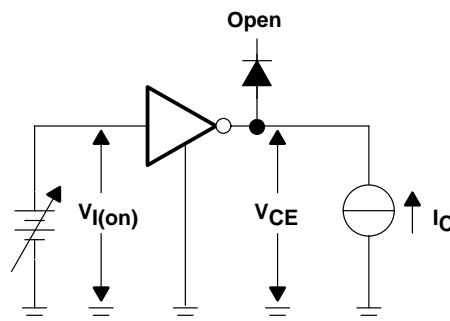


Figure 6.  $V_{1(on)}$  Test Circuit

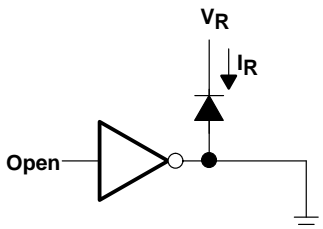


Figure 7.  $I_R$  Test Circuit

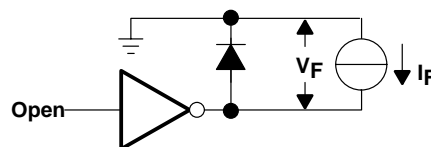


Figure 8.  $V_F$  Test Circuit

PARAMETER MEASUREMENT INFORMATION

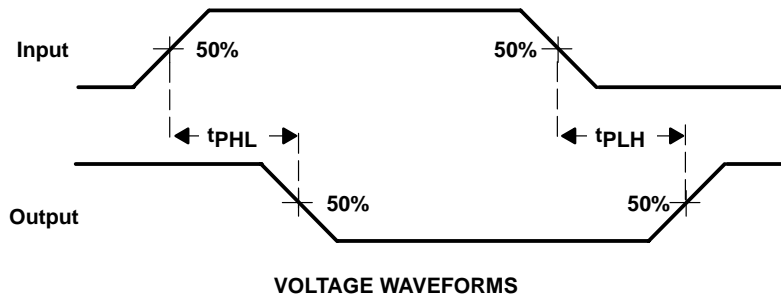
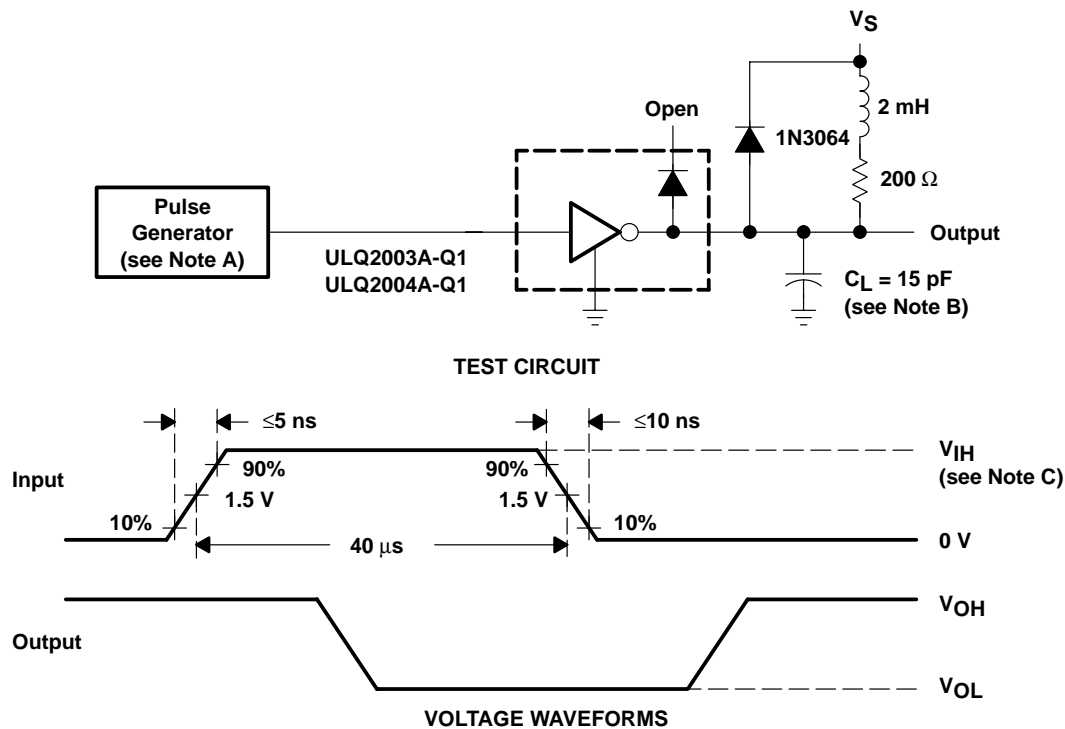


Figure 9. Propagation Delay-Time Waveforms



- 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 ULQ2003A-Q1,  $V_{IH} = 3 \text{ V}$ ; for the ULQ2004A-Q1,  $V_{IH} = 8 \text{ V}$ .

Figure 10. Latch-Up Test Circuit and Voltage Waveforms

# ULQ2003A-Q1, ULQ2004A-Q1, HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SGLS148 – DECEMBER 2002

## TYPICAL CHARACTERISTICS

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

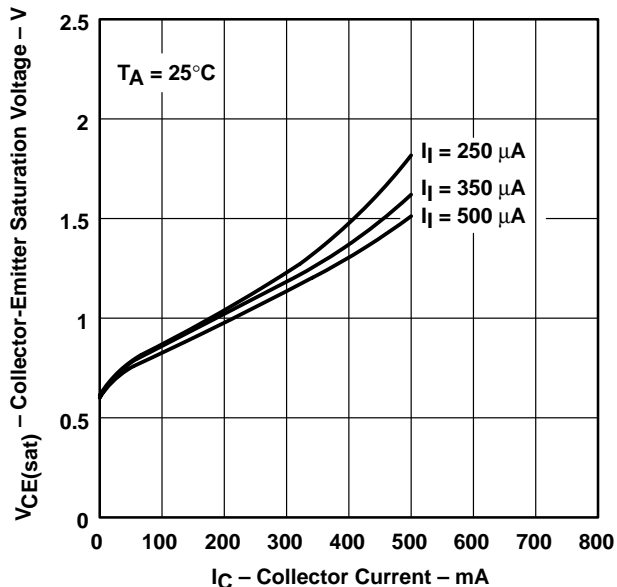


Figure 11

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

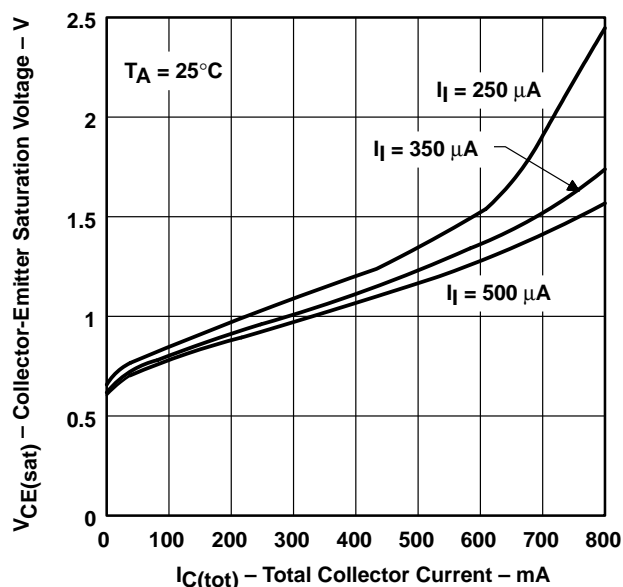


Figure 12

COLLECTOR CURRENT  
vs  
INPUT CURRENT

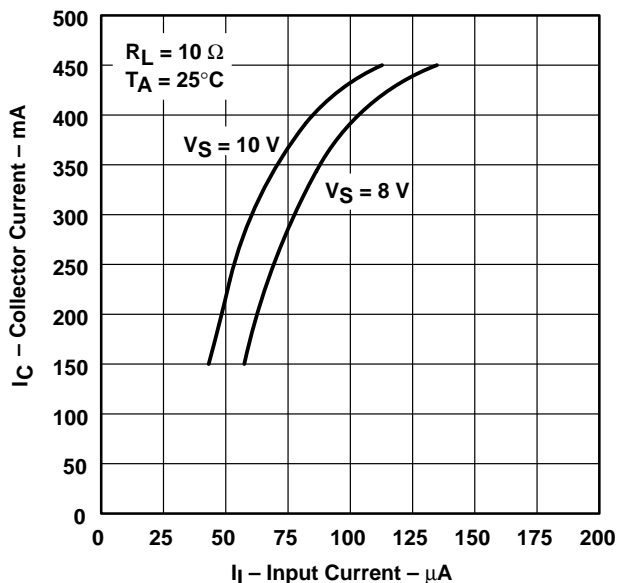


Figure 13



THERMAL INFORMATION

MAXIMUM COLLECTOR CURRENT  
vs  
DUTY CYCLE

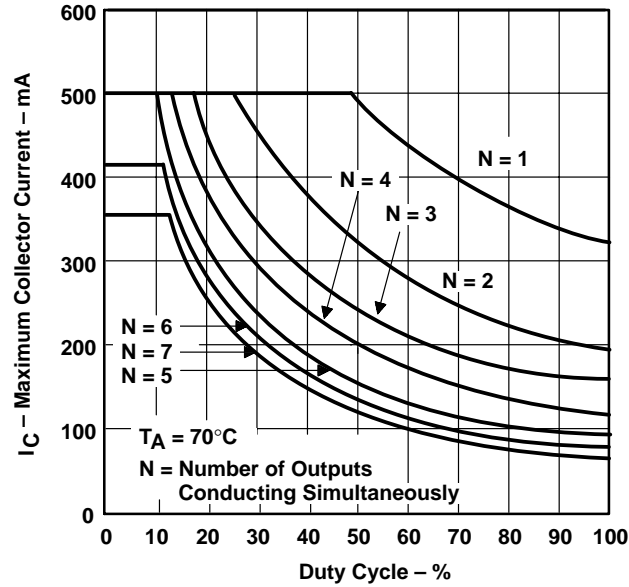


Figure 14

# ULQ2003A-Q1, ULQ2004A-Q1, HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

SGLS148 – DECEMBER 2002

## APPLICATION INFORMATION

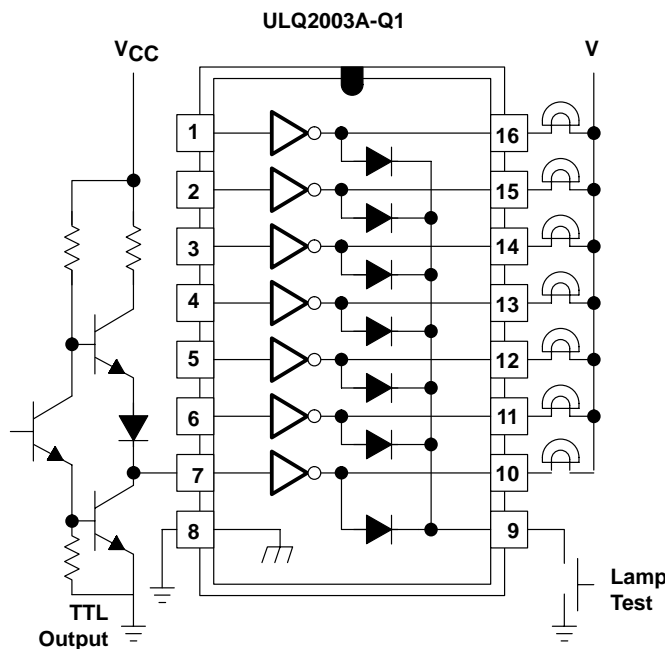


Figure 15. TTL to Load

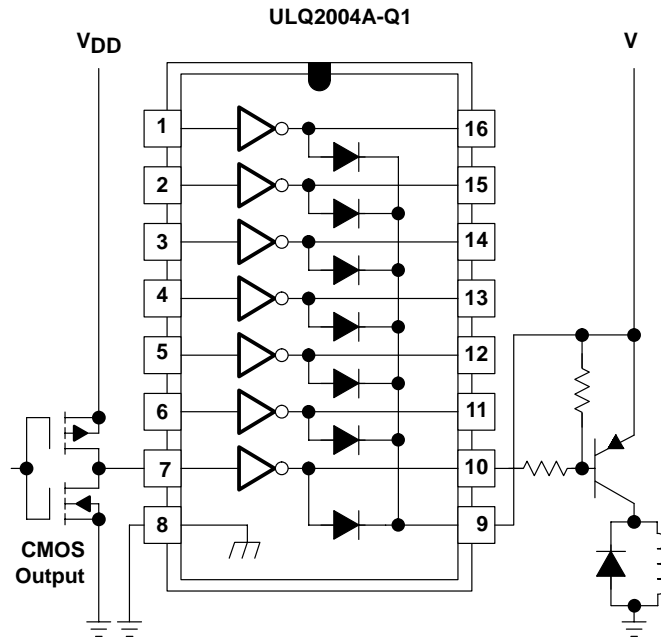


Figure 16. Buffer for Higher Current Loads

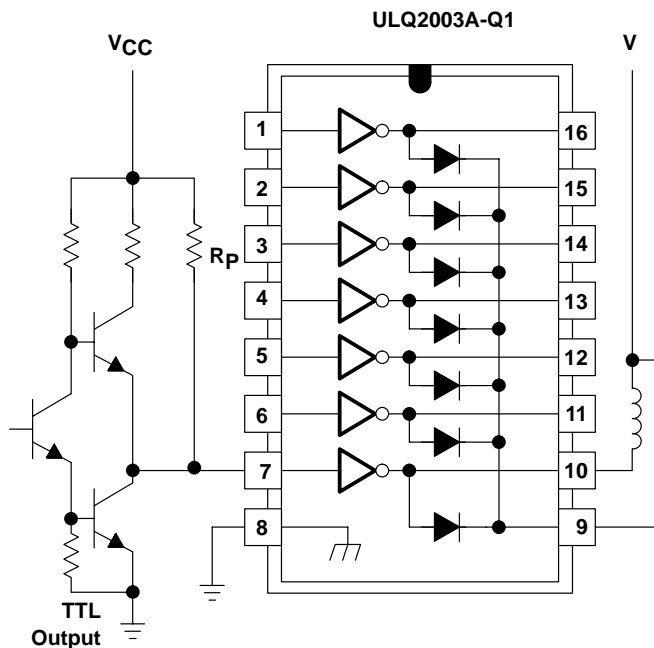


Figure 17. Use of Pullup Resistors  
to Increase Drive Current



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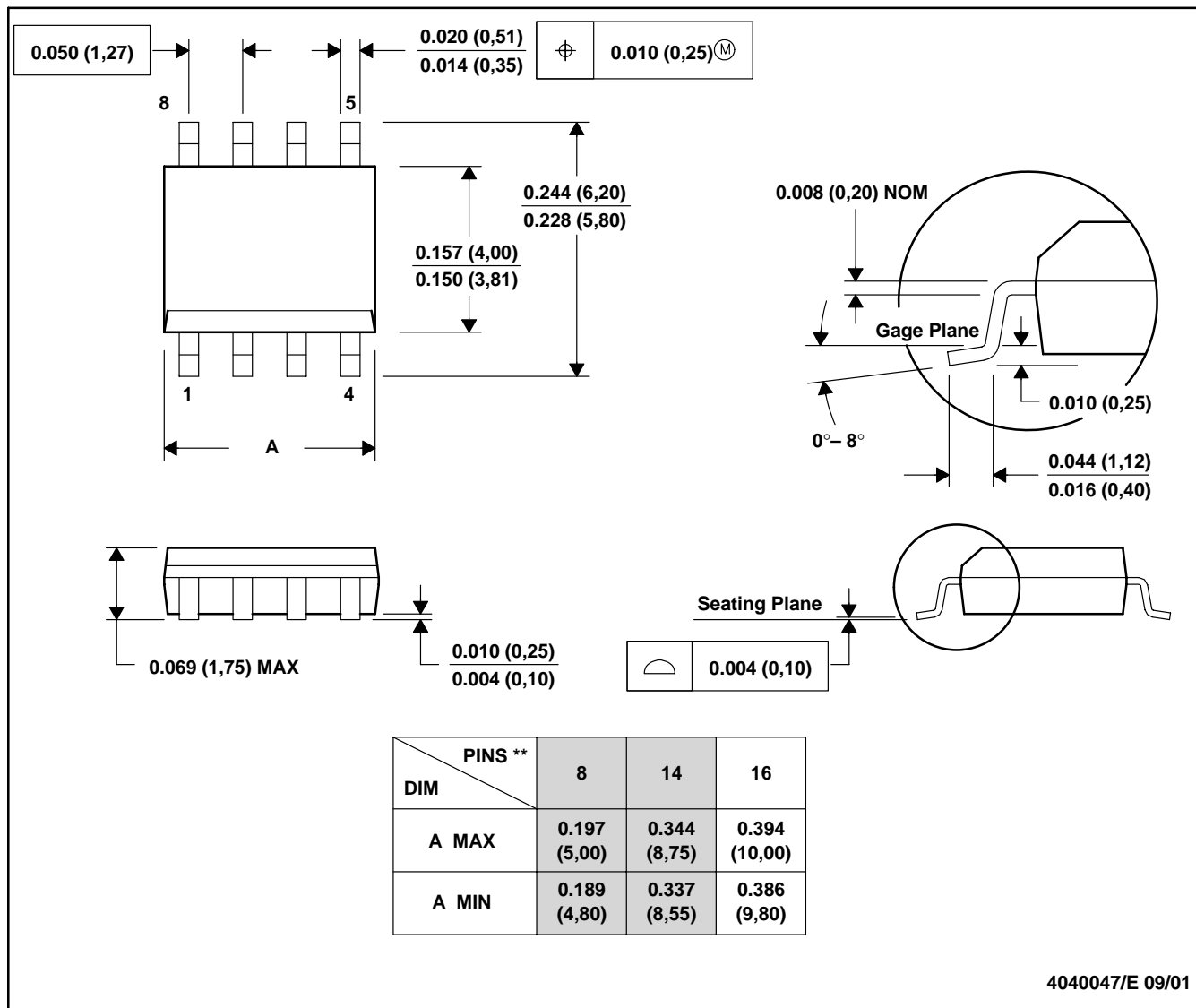
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## MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN

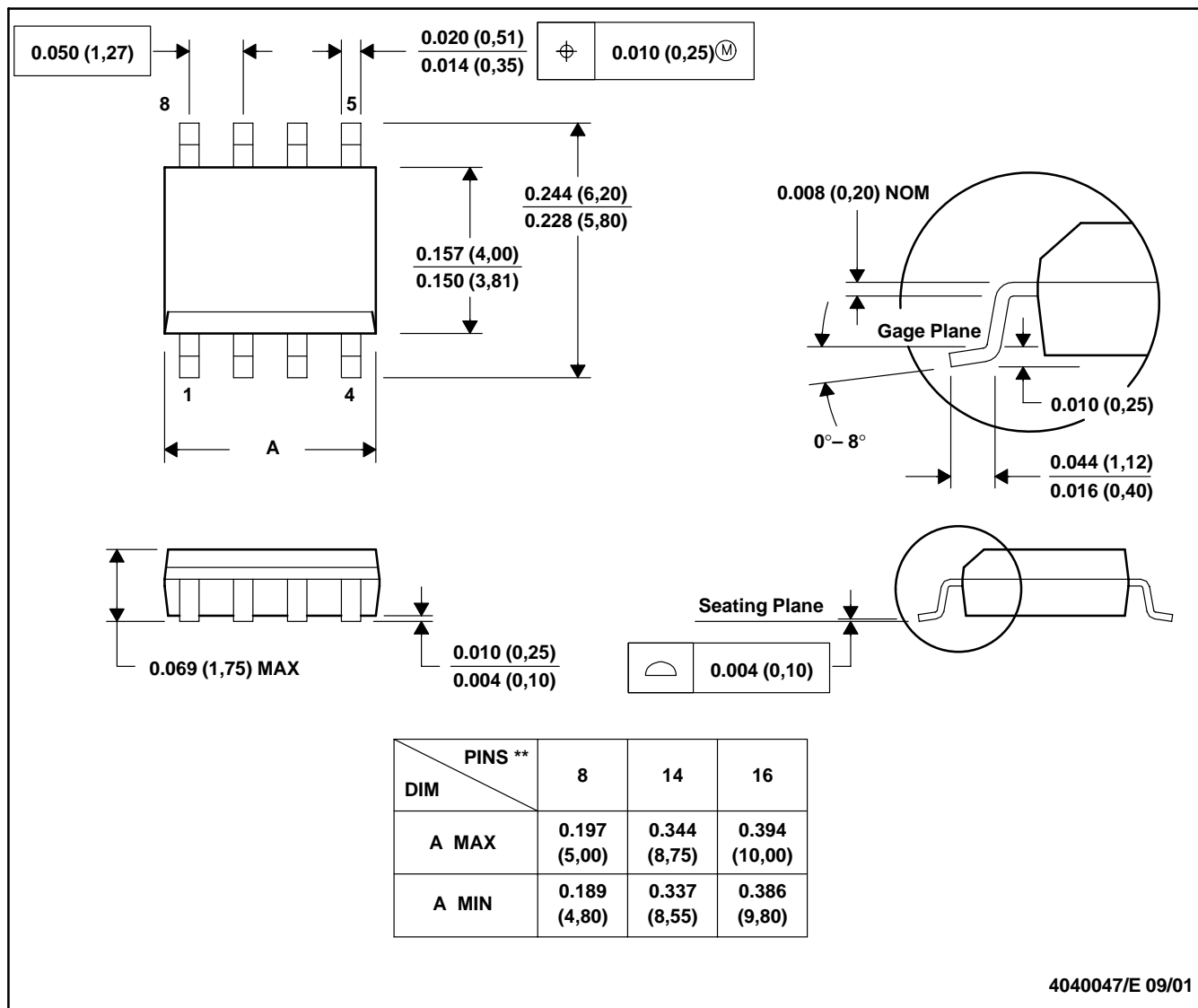


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

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

PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN



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