- **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)

1B	1	16	1C
2B	2	15	2C
3B	3	14	3C
4B	4	13	4C
5B	5	12	5C
6B	6	11	6C
7B	7	10	7C
E	8	9	COM
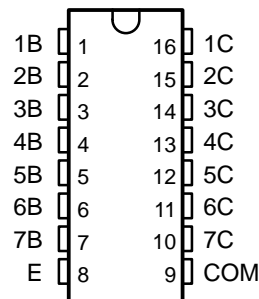
description

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-kΩ series base resistor for each Darlington pair, for operation directly with TTL or 5-V CMOS devices. The ULQ2004A-Q1 has a 10.5-kΩ 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$_A$	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.

TEXAS INSTRUMENTS

logic diagram

schematics (each Darlington pair)

ULQ2003A-Q1: R$_B$ = 2.7 kΩ
ULQ2004A-Q1: R$_B$ = 10.5 kΩ

7.2 kΩ   **3 kΩ**

ULQ2003A-Q1, ULQ2004A-Q1
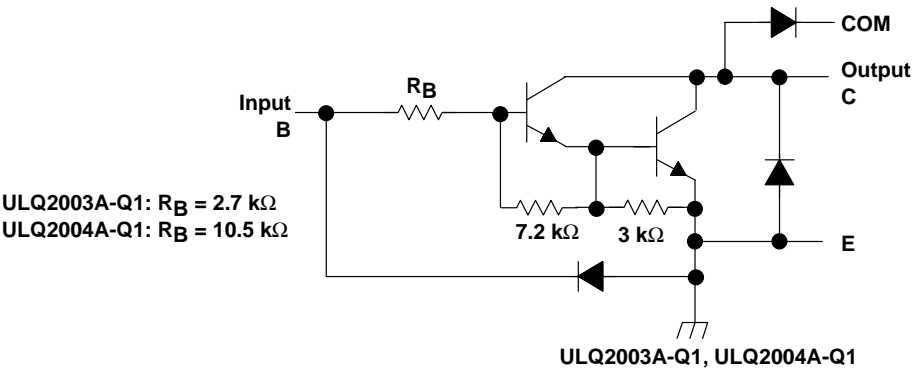
All resistor values shown are nominal.

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, θ$_{JA}$ (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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DISSIPATION RATING TABLE

PACKAGE	$T_A = 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING	$T_A = 105°C$ POWER RATING
D	950 mW	7.6 mW/°C	494 mW	342 mW

electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		ULQ2003A-Q1 MIN	TYP	MAX	ULQ2004A-Q1 MIN	TYP	MAX	UNIT
$V_{I(on)}$	On-state input voltage, See Figure 6	$V_{CE} = 2$ V	$I_C = 125$ mA						5	V
			$I_C = 200$ mA			2.7			6	
			$I_C = 250$ mA			2.9				
			$I_C = 275$ mA						7	
			$I_C = 300$ mA			3				
			$I_C = 350$ mA						8	
$V_{CE(sat)}$	Collector-emitter saturation voltage, See Figure 5	$I_I = 250$ µA,	$I_C = 100$ mA		0.9	1.2		0.9	1.1	V
		$I_I = 350$ µA,	$I_C = 200$ mA		1	1.4		1	1.3	
		$I_I = 500$ µA,	$I_C = 350$ mA		1.2	1.7		1.2	1.6	
I_{CEX}	Collector cutoff current	$V_{CE} = 50$ V, $I_I = 0$, See Figure 1				100			50	µA
		$V_{CE} = 50$ V, See Figure 2	$I_I = 0$						100	
			$V_I = 1$ V						500	
V_F	Clamp forward voltage, See Figure 8	$I_F = 350$ mA			1.7	2.2		1.7	2	V
$I_{I(off)}$	Off-state input current, See Figure 3	$V_{CE} = 50$ V,	$I_C = 500$ µA	30	65		50	65		µA
I_I	Input current, see Figure 4	$V_I = 3.85$ V			0.93	1.35				mA
		$V_I = 5$ V						0.35	0.5	
		$V_I = 12$ V						1	1.45	
I_R	Clamp reverse current, See Figure 7	$V_R = 50$ V,	$T_A = 25°C$			100			50	µA
		$V_R = 50$ V				100			100	
C_i	Input capacitance	$V_I = 0$,	$f = 1$ MHz		15	25		15	25	pF

switching characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	ULQ2003A-Q1, ULQ2004A-Q1 MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high level output	See Figure 9		1	10	µs
t_{PHL}	Propagation delay time, high-to-low level output	See Figure 9		1	10	µs
V_{OH}	High-level output voltage after switching	$V_S = 50$ V, $I_O ≈ 300$ mA, See Figure 10	$V_S–500$			mV

TEXAS
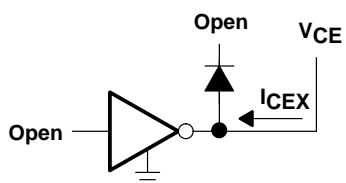**INSTRUMENTS**

PARAMETER MEASUREMENT INFORMATION

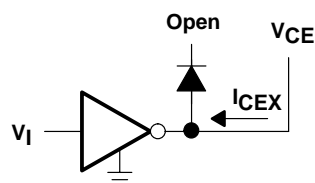**Figure 1. I_{CEX} Test Circuit**

Figure 2. I_{CEX} Test Circuit
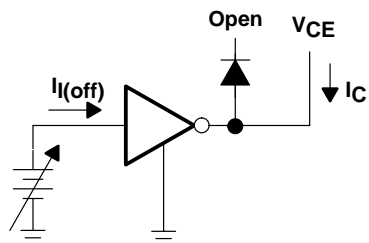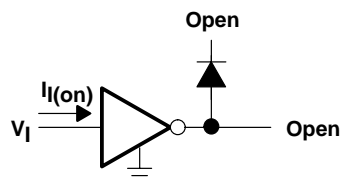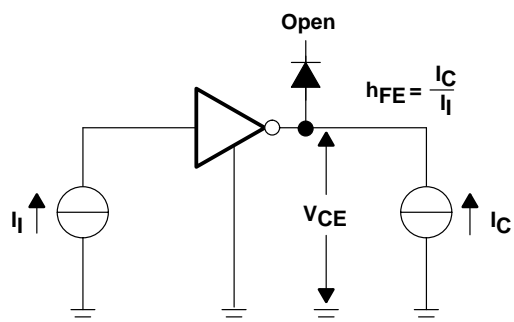
Figure 3. $I_{I(off)}$ Test Circuit

Figure 4. I_I Test Circuit

$$h_{FE} = \frac{I_C}{I_I}$$

NOTE: I_I is fixed for measuring $V_{CE(sat)}$, variable for measuring h_{FE}.
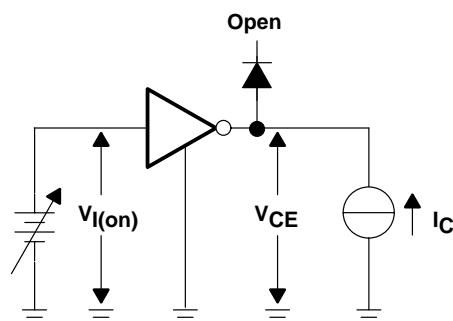
Figure 5. h_{FE}, $V_{CE(sat)}$ Test Circuit
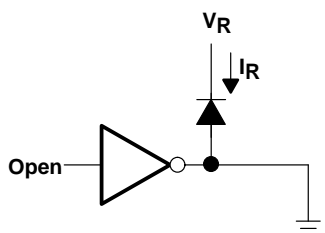
Figure 6. $V_{I(on)}$ Test Circuit
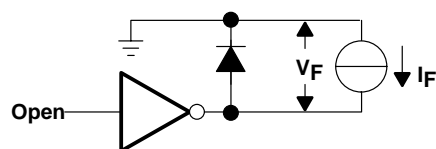
Figure 7. I_R Test Circuit

Figure 8. V_F Test Circuit

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PARAMETER MEASUREMENT INFORMATION

VOLTAGE WAVEFORMS
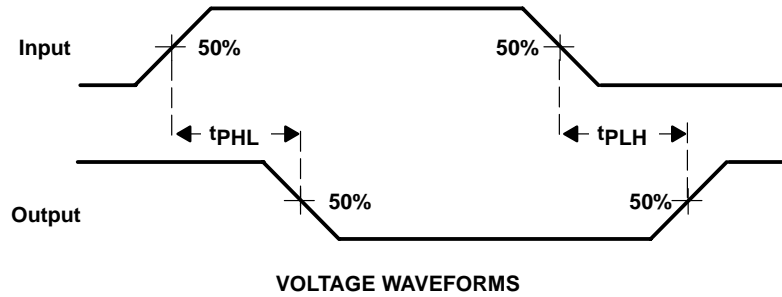
Figure 9. Propagation Delay-Time Waveforms

TEST CIRCUIT
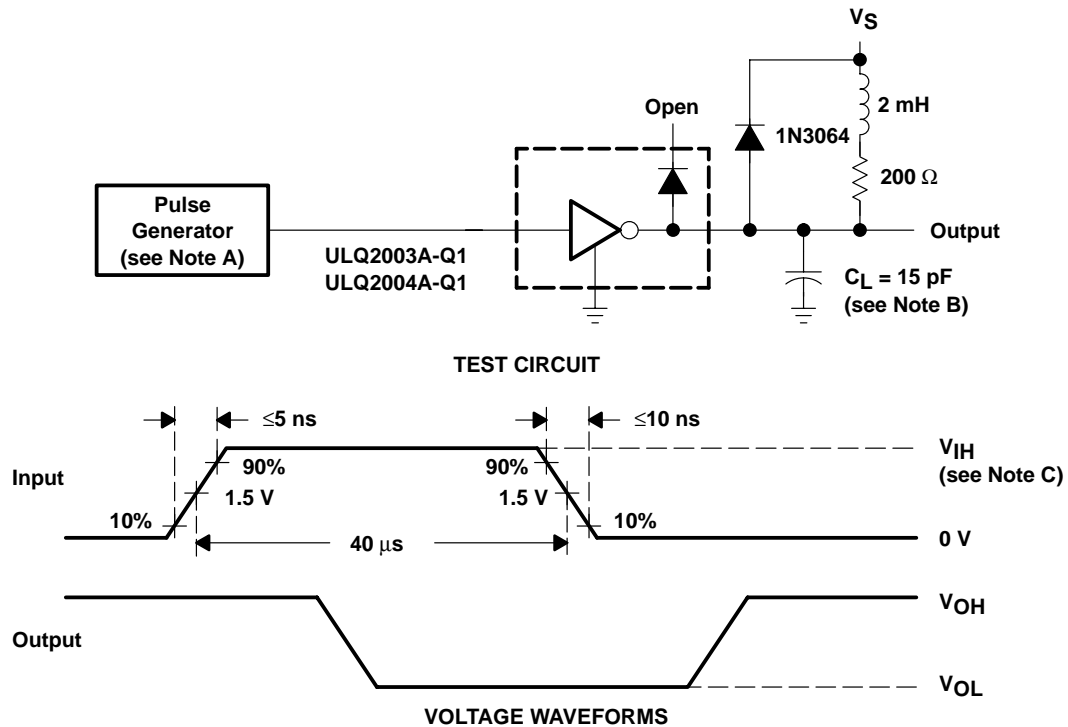
VOLTAGE WAVEFORMS

NOTES: A. The pulse generator has the following characteristics: PRR = 12.5 kHz, Z_O = 50 Ω.
B. C_L includes probe and jig capacitance.
C. For testing the ULQ2003A-Q1, V_{IH} = 3 V; for the ULQ2004A-Q1, V_{IH} = 8 V.

Figure 10. Latch-Up Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

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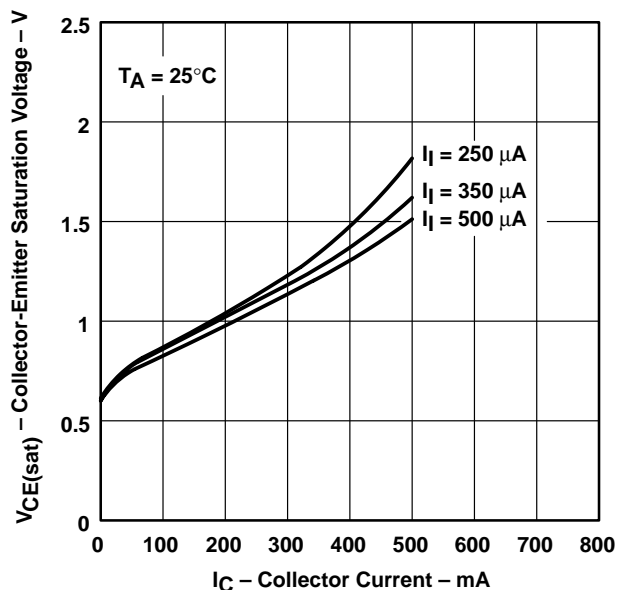vs
COLLECTOR CURRENT
(ONE DARLINGTON)

Figure 11

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
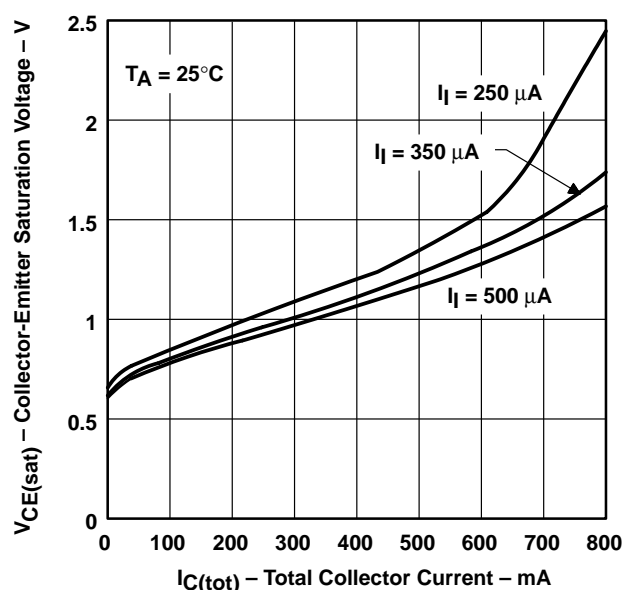TOTAL COLLECTOR CURRENT
(TWO DARLINGTONS IN PARALLEL)
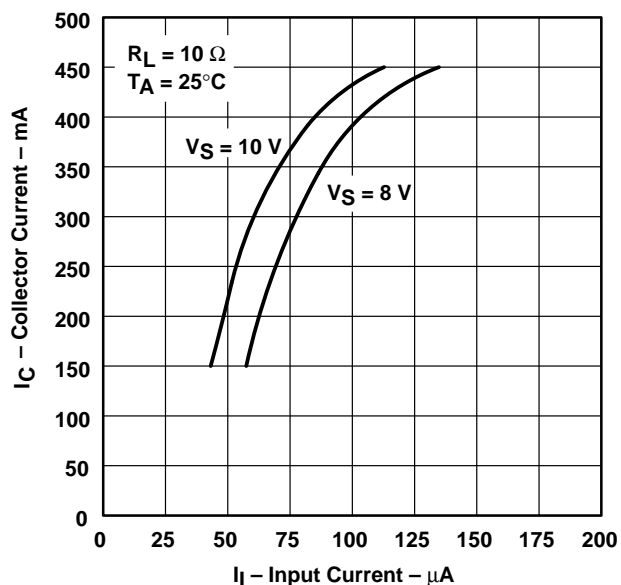
Figure 12

COLLECTOR CURRENT
vs
INPUT CURRENT

Figure 13

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THERMAL INFORMATION
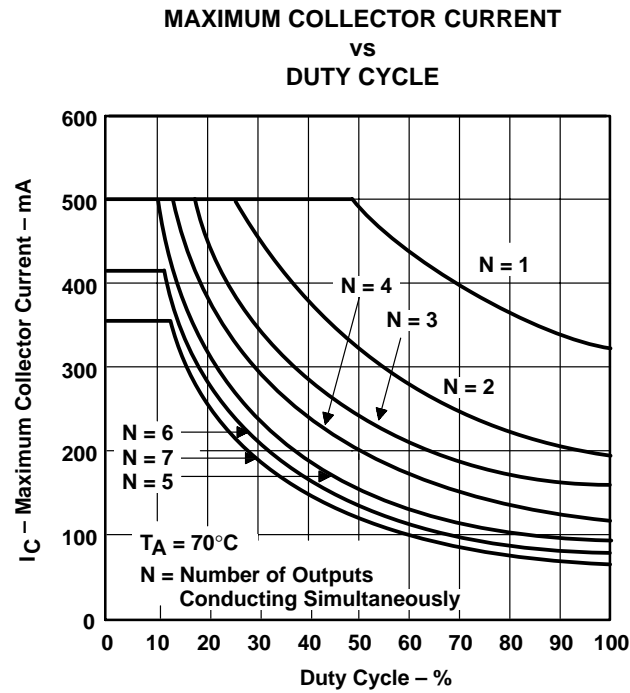
MAXIMUM COLLECTOR CURRENT
vs
DUTY CYCLE

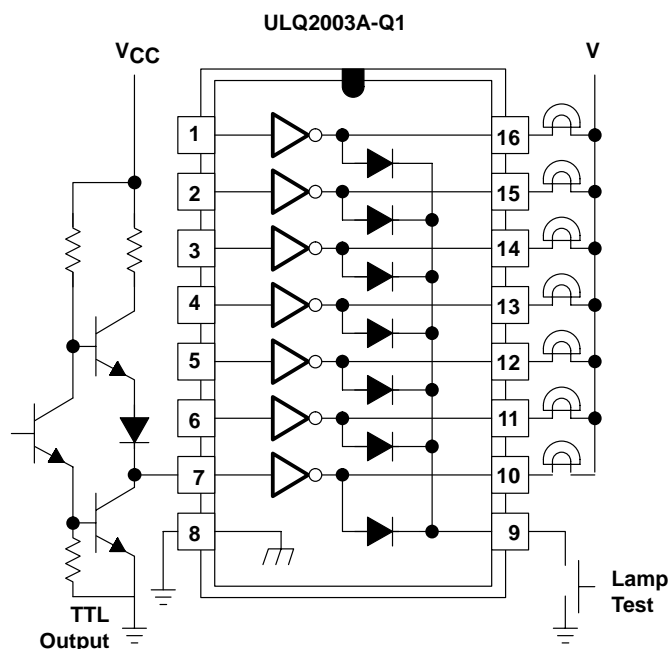**Figure 14**

APPLICATION INFORMATION

Figure 15. TTL to Load
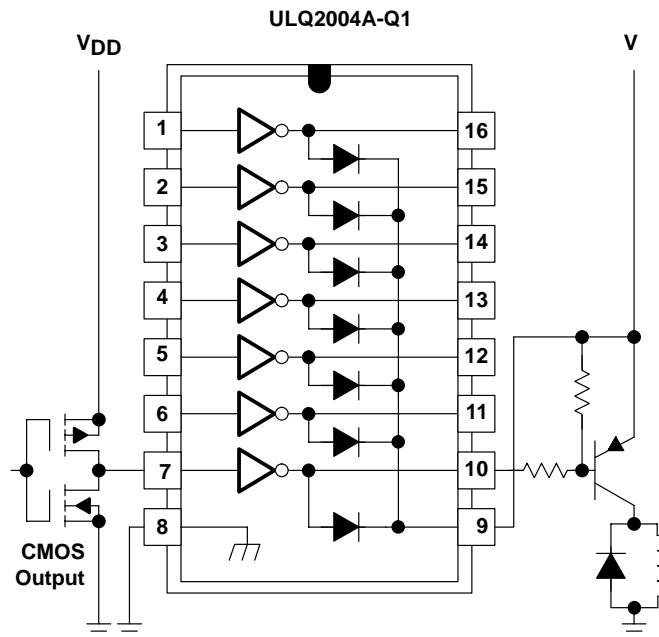

Figure 16. Buffer for Higher Current Loads
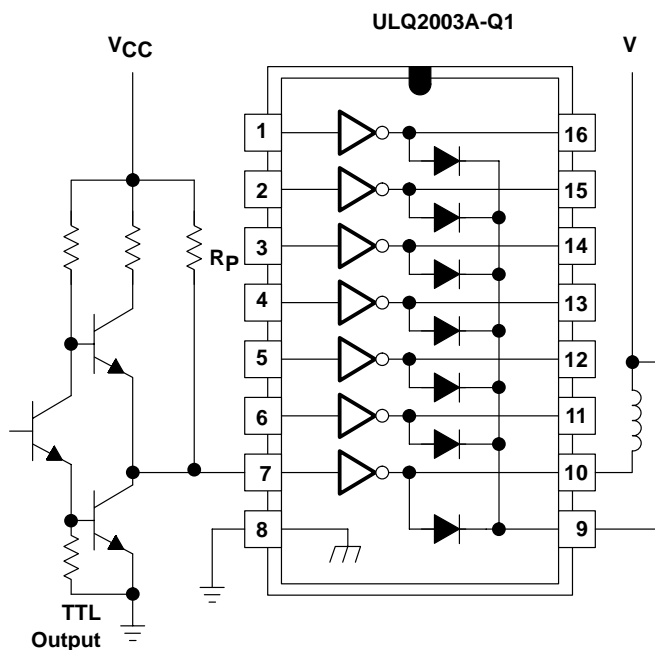
**Figure 17. Use of Pullup Resistors
to Increase Drive Current**

MECHANICAL DATA

D (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**
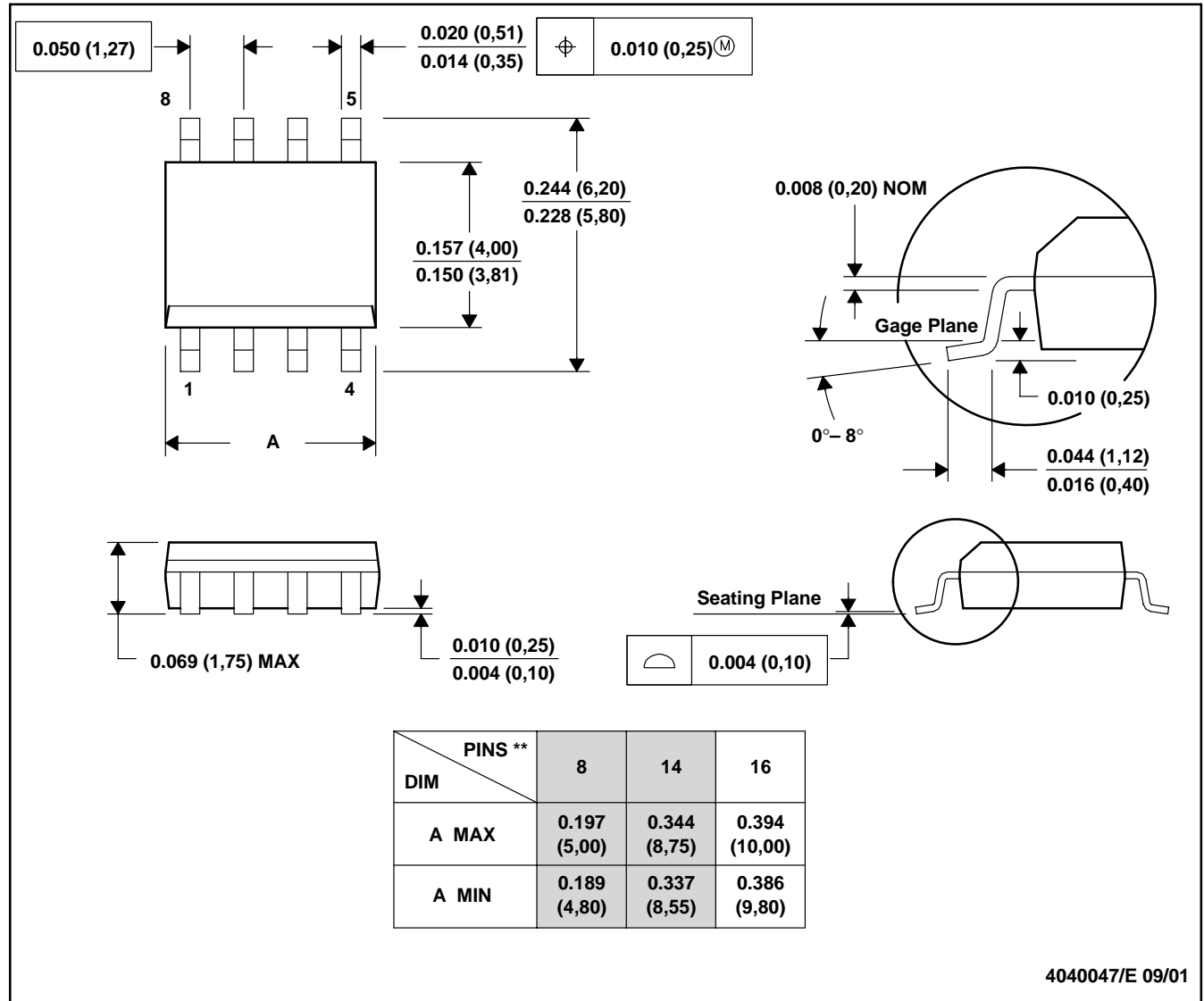
8 PINS SHOWN

PINS ** DIM	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/E 09/01

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

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D (R-PDSO-G)**   PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN

| DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/E 09/01

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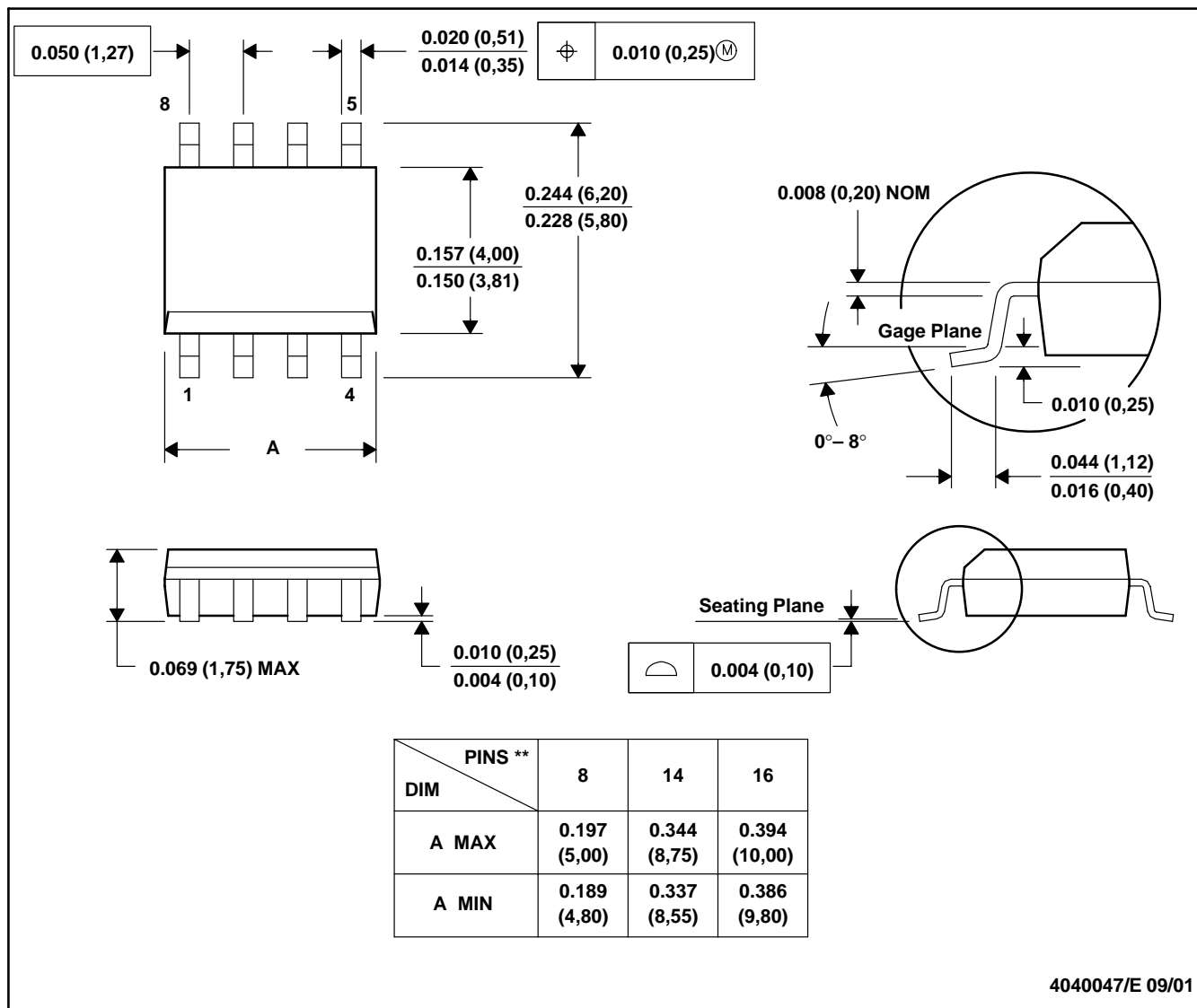
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Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265