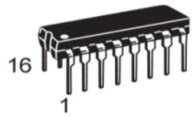
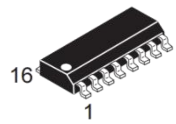
HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

Features

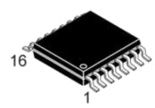
- 500-mA Rated Collector Current (Single Output)
- High-Voltage Outputs . . . 50 V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic
- Relay Driver Applications



DIP-16



SOP-16



TSSOP-16

Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing Qty
ULN2003N	DIP-16	ULN2003	TUBE	1000pcs/Box
ULN2004N	DIP-16	ULN2004	TUBE	1000pcs/Box
ULN2003M/TR	SOP-16	ULN2003	REEL	2500pcs/Reel
ULN2004M/TR	SOP-16	ULN2004	REEL	2500pcs/Reel
ULN2003MT/TR	TSSOP-16	ULN2003	REEL	2500pcs/Reel
ULN2004MT/TR	TSSOP-16	ULN2004	REEL	2500pcs/Reel

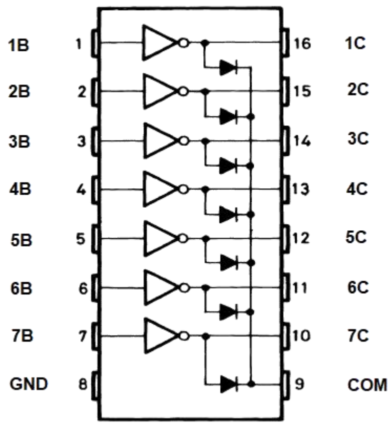
Description

The ULN2003 and ULN2004 are monolithic 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 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.

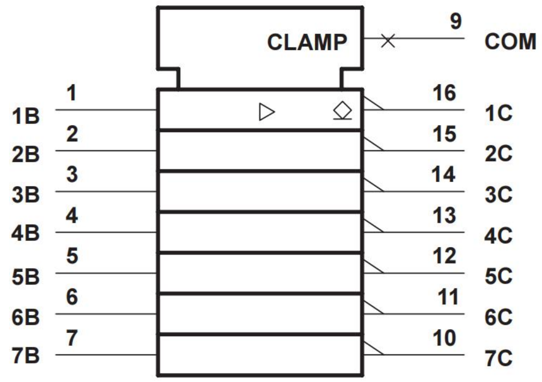
Each input of this device has a zener diode and resistor in series to control the input current to a safe limit. The ULN2003 has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices. The ULN2004 has a 10.5-kΩ series base resistor to allow its operation directly from CMOS devices that use supply voltages of 6 to 15 V. The required input current of the ULN2004 is below that of the ULN2003.

Pin configuration

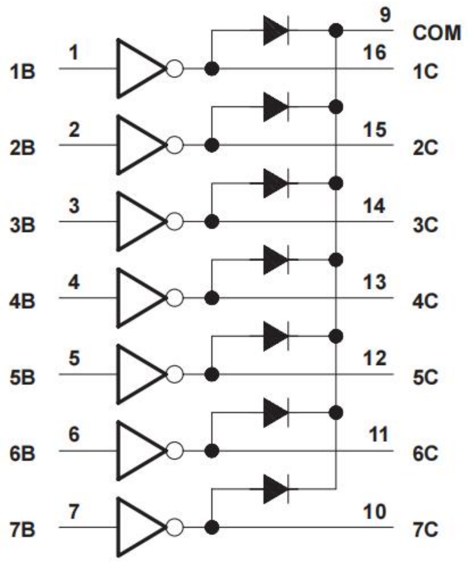
DIP-16/SOP-16/TSSOP-16



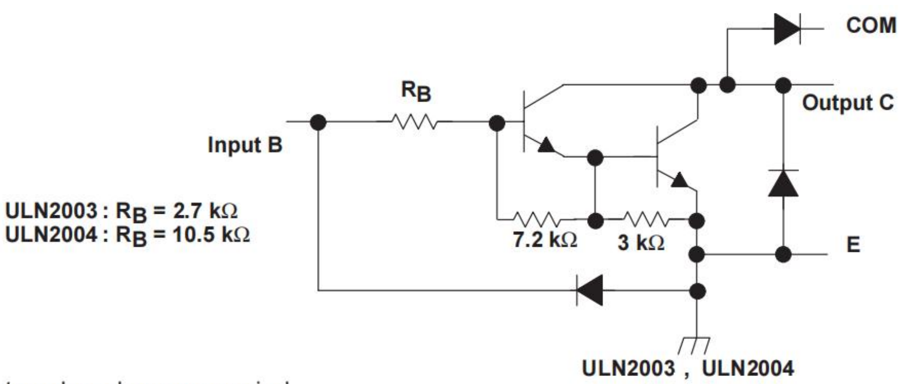
logic symbol



logic diagram



schematics



All resistor values shown are nominal.

Absolute maximum ratings

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

Parameter	Value	Unit
Collector-emitter voltage	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
Continuous total power dissipation	See Dissipation Rating Table	
Operating free-air temperature range, T_A	- 20 to85	°C
Storage temperature range, T_{stg}	- 65 to150	°C
Lead Temperature (Soldering, 10 seconds)	245	°C

Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured.

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

Dissipation Rating Table

PACKAGE	T_A = 25°C POWER RATING	DERATING FACTOR ABOVE T_A = 25°C	T_A = 85°C POWER RATING
SOP	950 mW	7.6 mW/°C	494 mW
DIP	1150 mW	9.2 mW/°C	598 mW

Electrical Characteristics, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST FIGURE	TEST CONDITIONS		ULN2003 MIN	ULN2003 TYP	ULN2003 MAX	ULN2004 MIN	ULN2004 TYP	ULN2004 MAX	UNIT
$V_{I(on)}$	On-state input voltage	6	V_{CE}=2V	I_C= 125mA						5	V
				I_C=200mA			2.4			6	
				I_C=250mA			2.7				
				I_C=275mA						7	
				I_C=300mA			3				
				I_C=350mA						8	
$V_{CE(at)}$	Collector-emitter saturation voltage	5	I_I=250μA,I_C=100mA			0.9	1.1		0.9	1.1	V
			I_I=350μA,I_C=200mA			1	1.3		1	1.3	
			I_I=500μA,I_C=350mA			1.2	1.6		1.2	1.6	
I_{CEX}	Collector cutoff current	1	V_{CE}=50V,I_I=0				50			50	μA
		2	V_{CE}=50V, T_A=70°C	I_I = 0			100			100	
				VI = 1 V						500	
V_F	Clamp forward voltage	8	I_F = 350 mA			1.7	2		1.7	2	V
$I_{I(off)}$	Off-state input current	3	V_{CE}=50V,I_C=500μA,T_A=70°C		50	65		50	65		μA
I_I	Input current	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	7	V_R = 50 V				50			50	μA
			V_R = 50 V,	T_A = 70°C			100			100	
C_i	Input capacitance		V_I = 0,	f = 1 MHz		15	25		15	25	pF

Switching Characteristics, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	See Figure 9		0.25	1	μs
t_{PHL}	Propagation delay time, high-to-low-level output			0.25	1	μs
V_{OH}	High-level output voltage after switching	V_S = 50 V,I_O ≈ 300 mA, SeeFigure10	V_S –20			V

Parameter Measurement Information

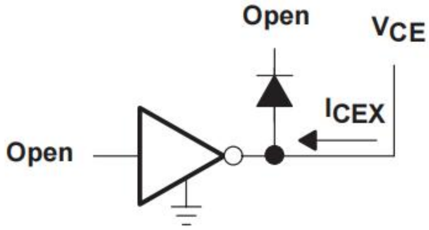


Figure 1. I_{CEX} Test Circuit

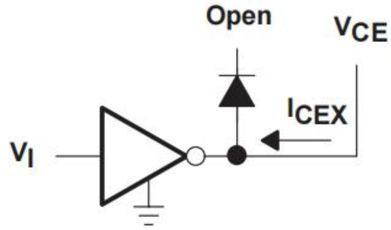


Figure 2. I_{CEX} Test Circuit

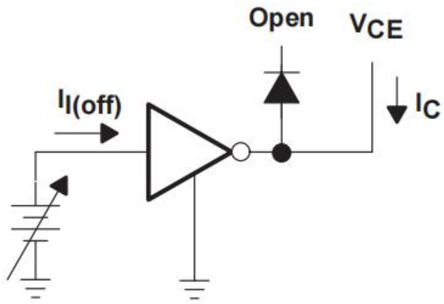


Figure 3. $I_{I(off)}$ Test Circuit

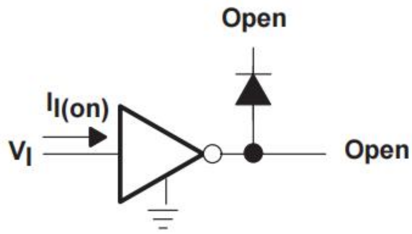
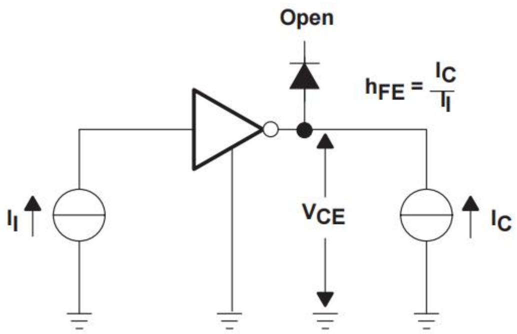


Figure 4. I_I Test Circuit



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

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

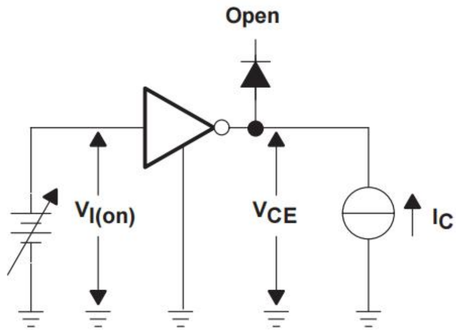


Figure 6. $V_{I(on)}$ Test Circuit

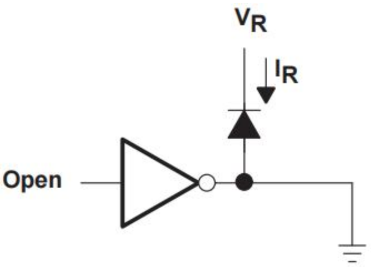


Figure 7. I_R Test Circuit

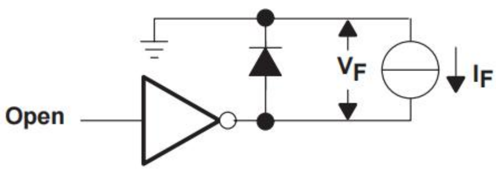


Figure 8. V_F Test Circuit

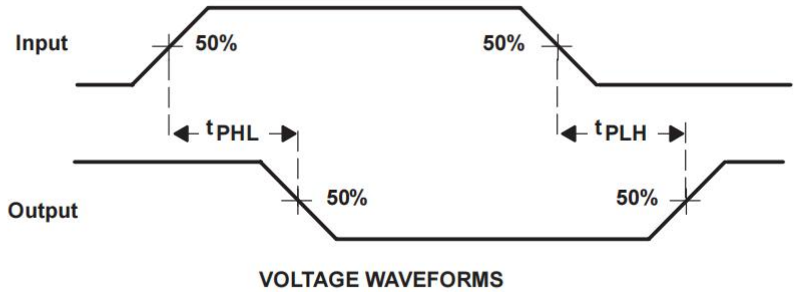
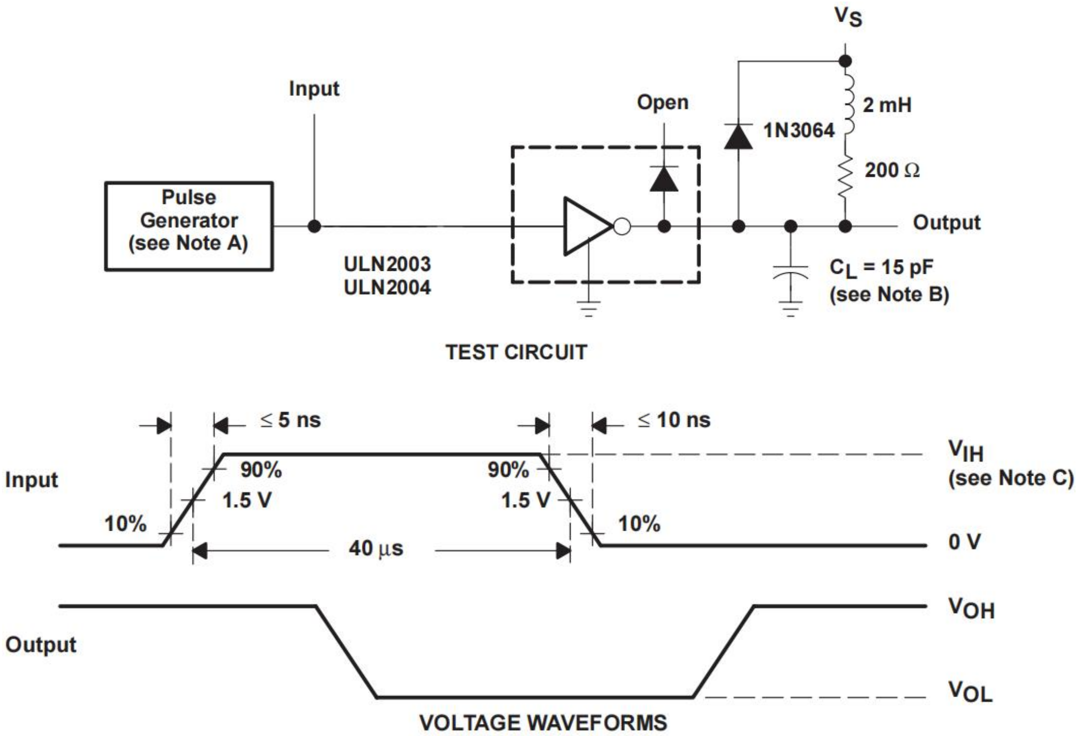


Figure 9. Propagation Delay Time Waveforms



NOTES: A. The pulse generator has the following characteristics: PRR = 12.5 kHz, Z_O = 50 Ω.

B. CL includes probe and jig capacitance.

C. For testing the ULN2003A, V_{IH} = 3 V

for the ULN2004A, V_{IH} = 8 V.

Figure 10. Latch-Up Test Circuit and Voltage Waveforms

Typical Characteristics

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

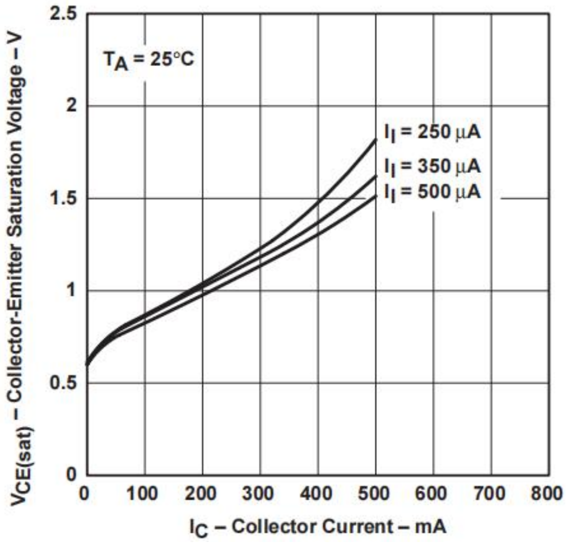


Figure 11

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

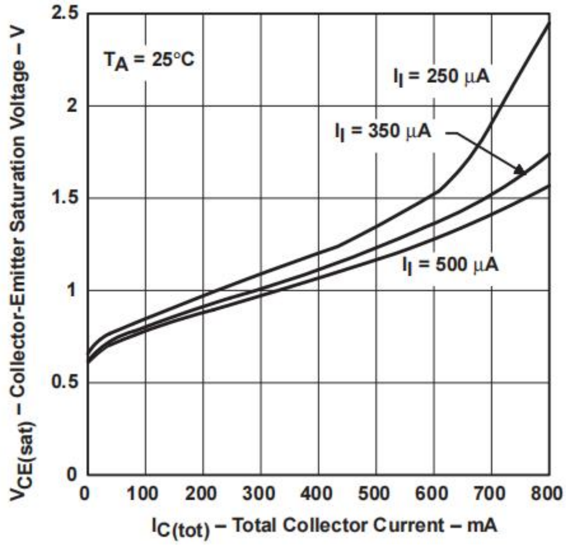


Figure 12

COLLECTOR CURRENT
vs
INPUT CURRENT

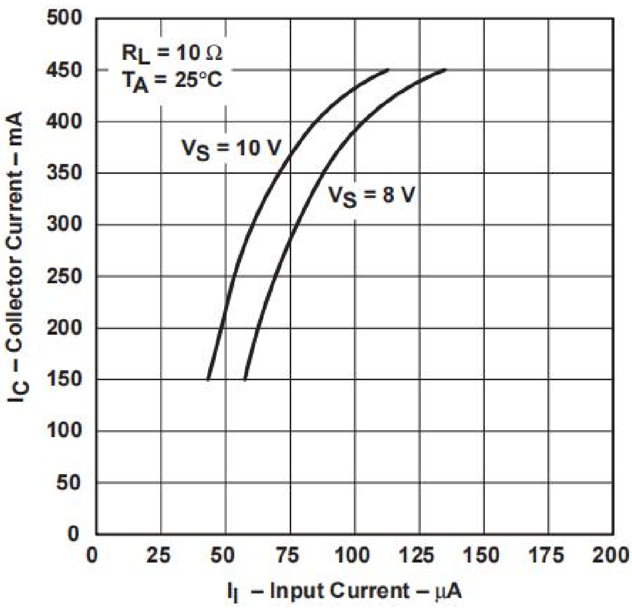


Figure 13

Thermal Information

SOP PACKAGE
MAXIMUM COLLECTOR CURRENT
VS
DUTY CYCLE

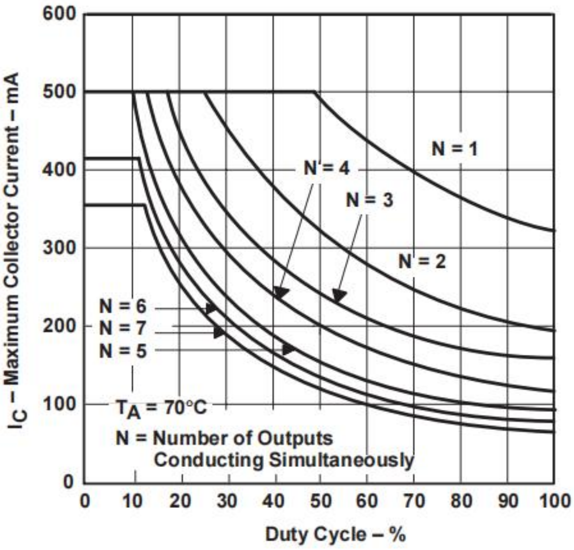


Figure 14

DIP PACKAGE
MAXIMUM COLLECTOR CURRENT
VS
DUTY CYCLE

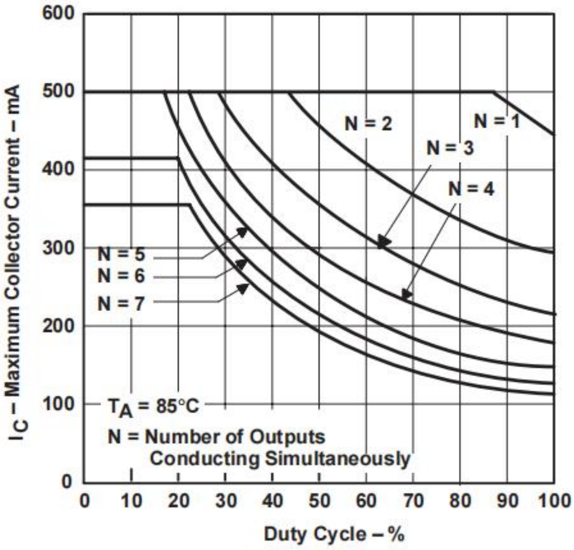


Figure 15

Application Information

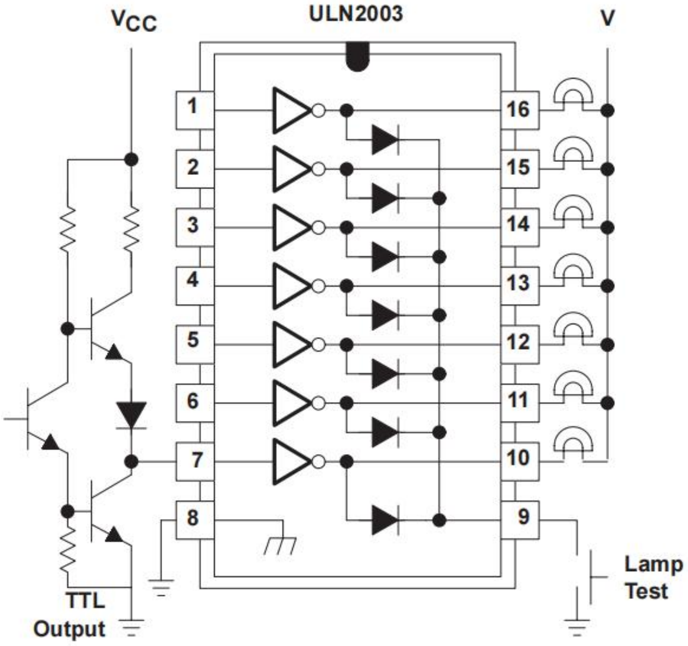


Figure 17. TTL to Load

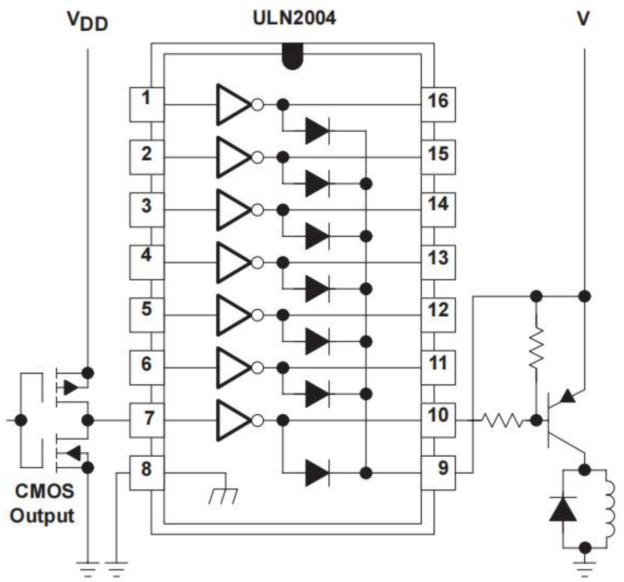


Figure 18. Buffer for Higher Current Loads

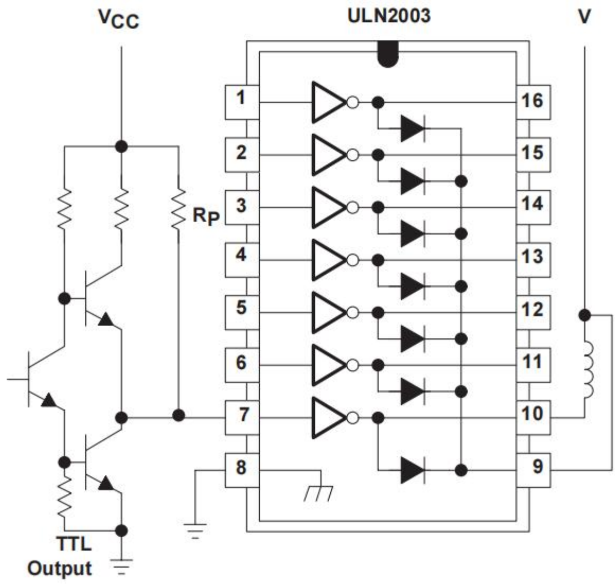
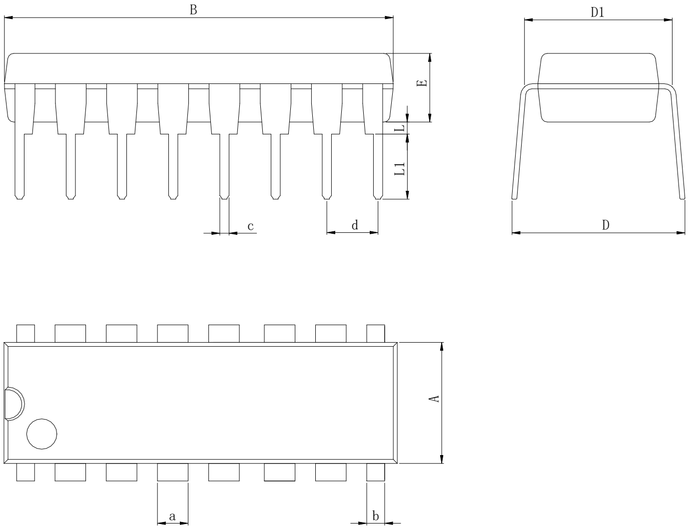


Figure 19. Use of Pullup Resistors to Increase Drive Current

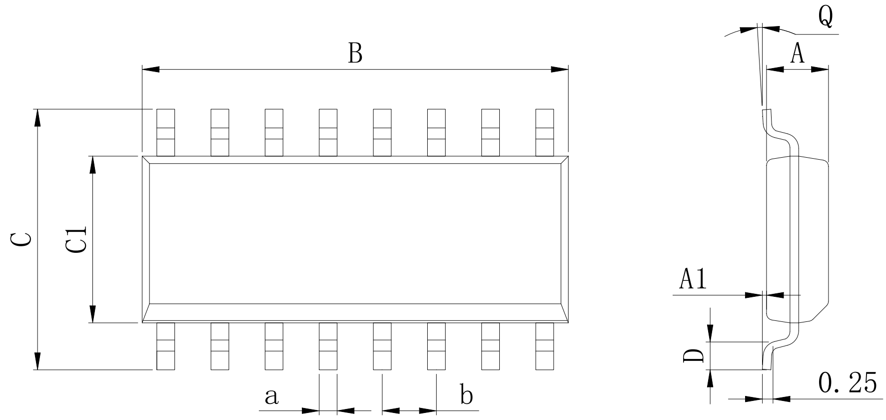
Physical Dimensions

DIP-16



Dimensions In Millimeters(DIP-16)											
Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	18.94	8.10	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	19.56	10.9	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

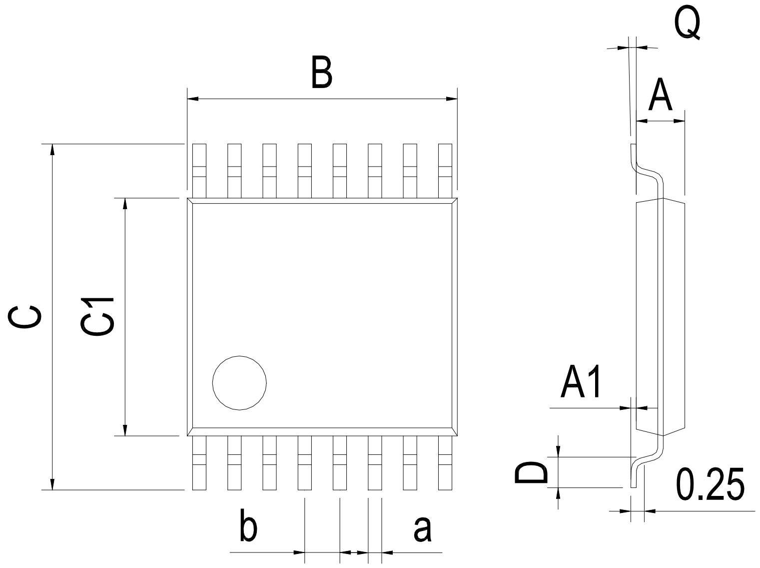
SOP-16



Dimensions In Millimeters(SOP16)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	9.80	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	10.0	6.20	4.00	0.80	8°	0.45	

Physical Dimensions

TSSOP-16



Dimensions In Millimeters(TSSOP-16)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.85	0.05	4.90	6.20	4.30	0.40	0°	0.20	0.65 BSC
Max:	0.95	0.20	5.10	6.60	4.50	0.80	8°	0.25	

Revision History

DATE	REVISION	PAGE
2019-11-18	New	1-14
2023-9-24		1-14

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