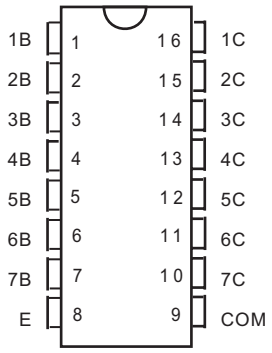
HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAY

DESCRIPTION

The ULN2003A is 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 500mA. 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 ULN2003A has a 2.7kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

PIN CONFIGURATION



(Top View)

FEATURES

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

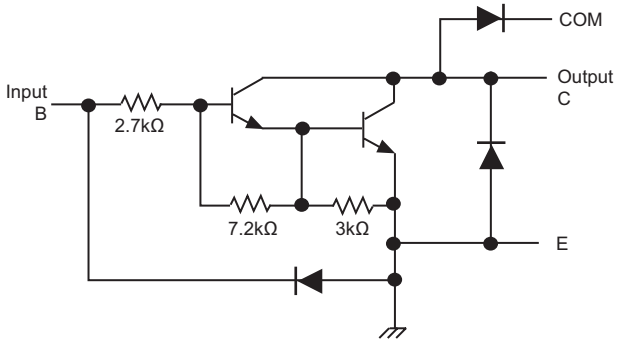
APPLICATIONS

- Display Driver
- Relay Driver
- Lamp Driver

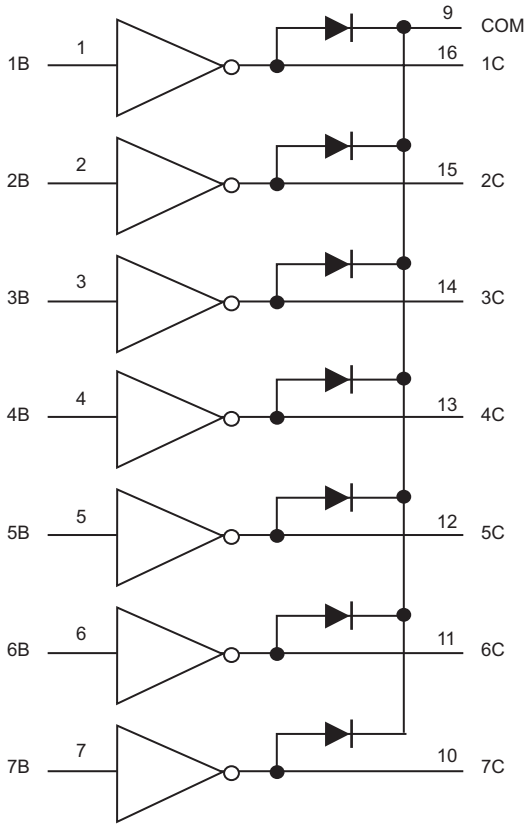
ORDERING INFORMATION

Temperature Range	Package		Orderable Device	Package Qty
-20°C to +85°C	DIP16L	Pb-Free	ULN2003AN	25Units/Tube
	SOP16L		ULN2003AD	50Units/Tube
			ULN2003ADR	3000Units/Tape

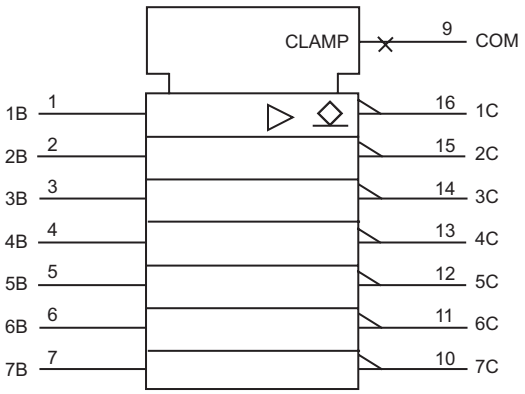
SCHEMATICS (EACH DARLINGTON PAIR)



LOGIC DIAGRAM



LOGIC SYMBOL



ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	50	V
Input Voltage (See Note 1)	V_I	30	V
Peak collector current (see Figures 14 and 15)	I_{CP}	500	mA
Output clamp current	I_{OK}	500	mA
Total emitter-terminal current	I_{ET}	-2.5	A
Continuous total power dissipation	P	See Dissipation Rating Table	
Operating temperature range	T_A	-20 to +85	°C
Storage temperature range	T_{stg}	-65 to 150	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	T_L	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°C Power Rating	Derating Factor Above T_A=25°C	T_A=85°C Power Rating
D	950mW	7.6mW/°C	494mW
N	1150mW	9.2mW/°C	598mW

ELECTRICAL CHARACTERISTICS, T_A = 25°C (unless otherwise noted)

Parameter	Symbol	Figure	Test Conditions		Min	Typ	Max	Unit
On-state Input Voltage	$V_{I\ (ON)}$	6	V_{CE}=2V	I_C=200mA			2.4	V
				I_C=250mA			2.7	
				I_C=300mA			3	
Collector-emitter saturation voltage	$V_{CE\ (SAT)}$	5	I_I=250μA	I_C=100mA		0.9	1.1	V
			I_I=350μA	I_C=200mA		1	1.3	
			I_I=500μA	I_C=350mA		1.2	1.6	
Collector cutoff current	I_{CEX}	1	V_{CE}=50V	I_I=0			50	μA
		2	V_{CE}=50V, T_A=70°C	I_I=0			100	
Clamp forward voltage	V_F	8	I_F=350mA			1.7	2	V
Off-state input current	$I_{I\ (OFF)}$	3	V_{CE}=50V, T_A=70°C	I_I=500μA	50	65		μA
Input current	I_I	4	V_I=3.85V			0.93	1.35	mA
Clamp reverse current	I_R	7	V_R=50V				50	μA
			V_R=50V	T_A=70°C			100	
Input capacitance	C_I		V_I=0, f=1MHz			15	25	pF

SWITCHING CHARACTERISTICS, T_A = 25°C

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Propagation delay time, low- to high-level output	t_{PLH}	See Figure 9		0.25	1	μs
Propagation delay time, high- to low-level output	t_{PHL}	See Figure 9		0.25	1	μs
High-level output voltage after switching	V_{OH}	V_S=50V, I_O≈300mA, See Figure 10	V_S-20			mV

PARAMETER MEASUREMENT INFORMATION

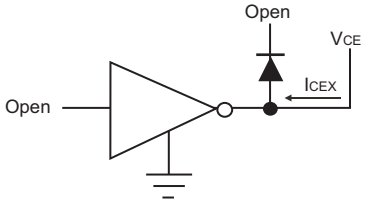


Figure 1. I_{CEX} Test Circuit

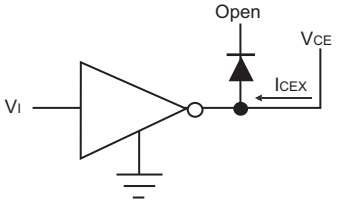


Figure 2. I_{CEX} Test Circuit

PARAMETER MEASUREMENT INFORMATION(CONTINUED)

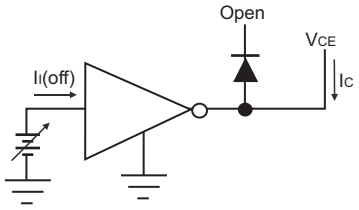


Figure 3. $I_{I(off)}$ Test Circuit

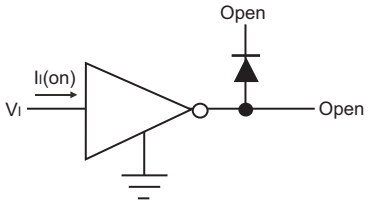
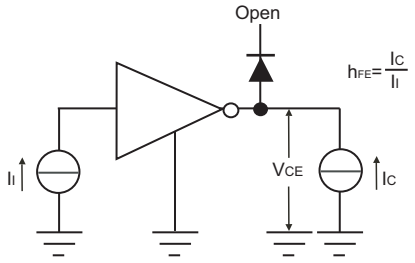


Figure 4. $I_{I(on)}$ Test Circuit



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

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

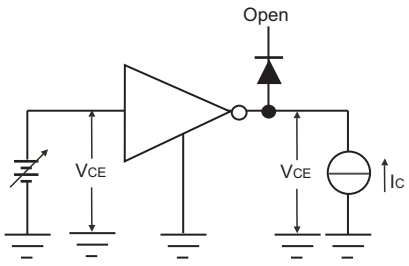


Figure 6. $V_{I(on)}$ Test Circuit

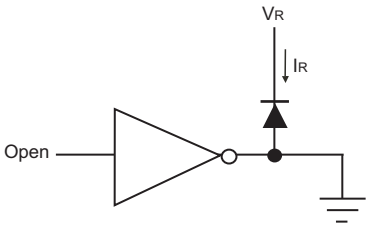


Figure 7. I_R Test Circuit

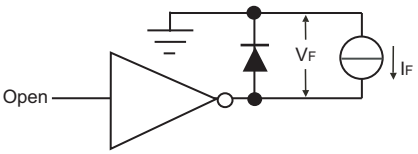
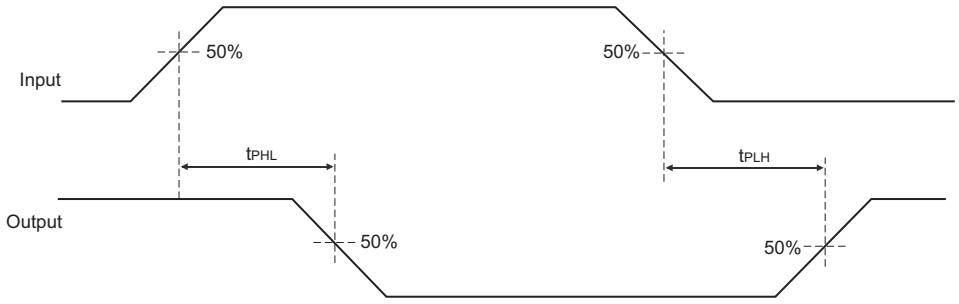


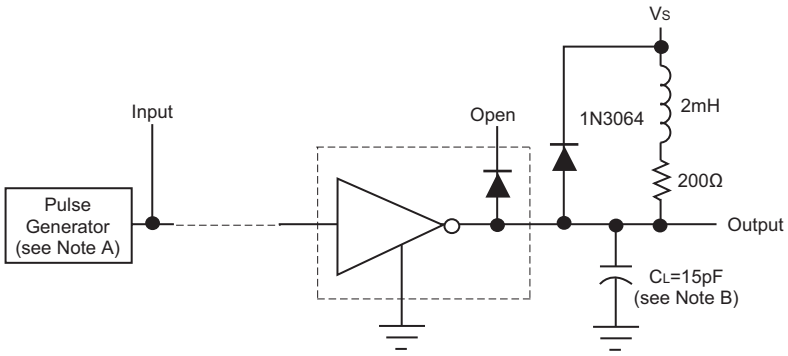
Figure 8. V_F Test Circuit



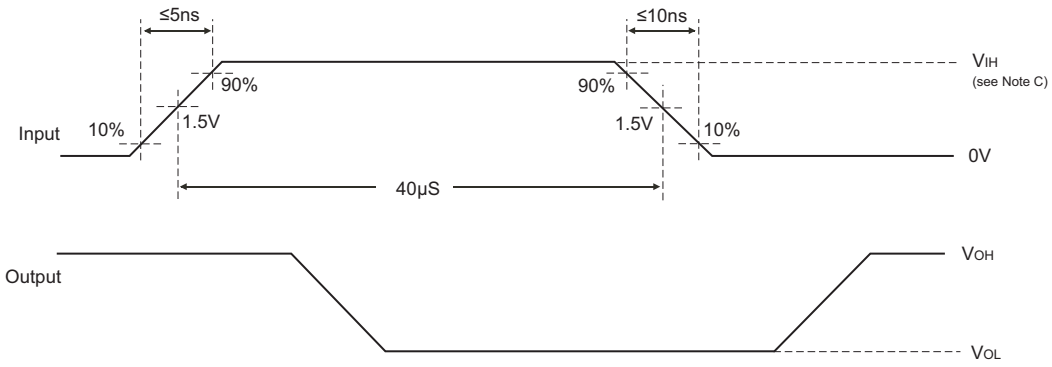
VOLTAGE WAVEFORMS

Figure 9. Propagation Delay-Time Waveforms

PARAMETER MEASUREMENT INFORMATION(CONTINUED)



TEST CIRCUIT



VOLTAGE WAVEFORMS

Notes: **A**. The pulse generator has the following characteristics: PRR = 12.5 kHz, Z_O = 50Ω.
B. C_L includes probe and jig capacitance.
C. V_{IH}=3V.

Figure 10. Latch-Up Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

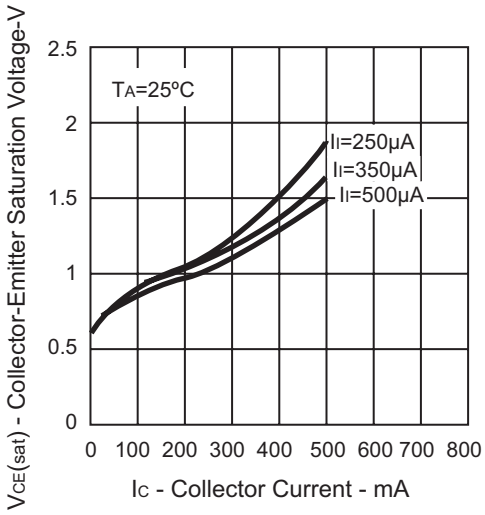


Figure 11. COLLECTOR-EMITTER SATURATION VOLTAGE vs. COLLECTOR CURRENT (ONE DARLINGTON)

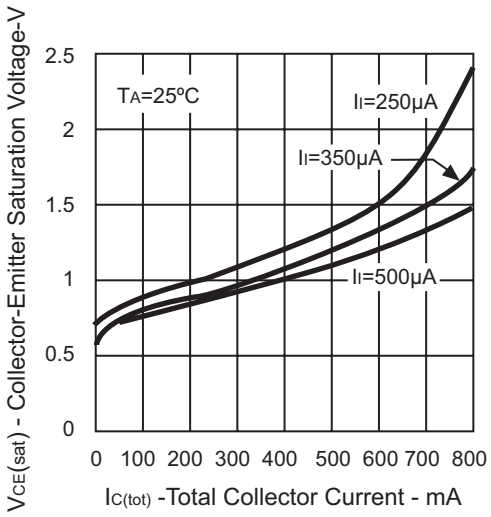


Figure 12. COLLECTOR-EMITTER SATURATION VOLTAGE vs. TOTAL COLLECTOR CURRENT (TWO DARLINGTONS IN PARALLEL)

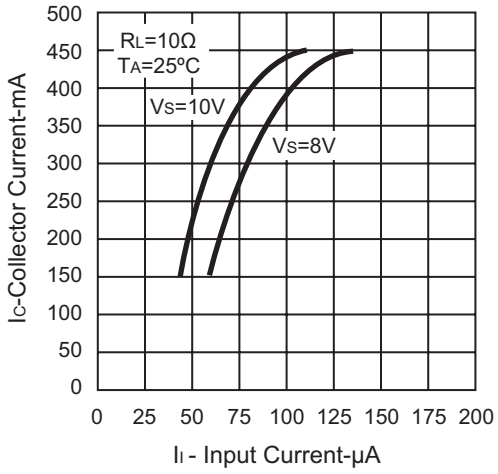


Figure 13. COLLECTOR CURRENT vs. INPUT CURRENT

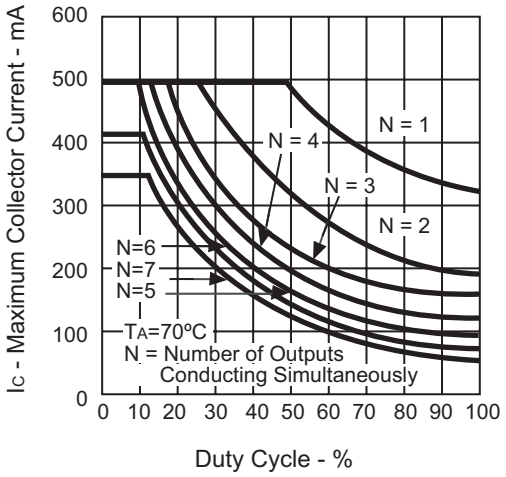


Figure 14. D PACKAGE MAXIMUM COLLECTOR CURRENT vs. DUTY CYCLE

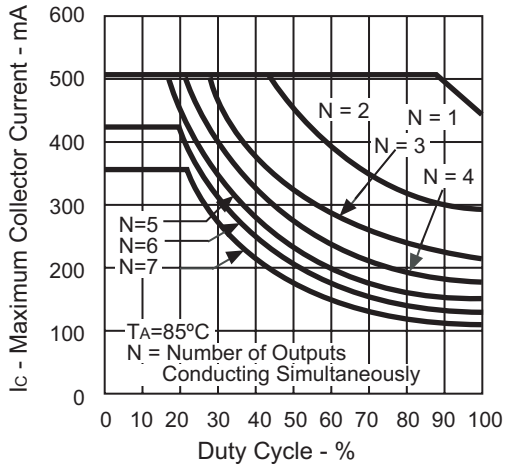


Figure 15. N PACKAGE MAXIMUM COLLECTOR CURRENT vs. DUTY CYCLE

APPLICATION INFORMATION

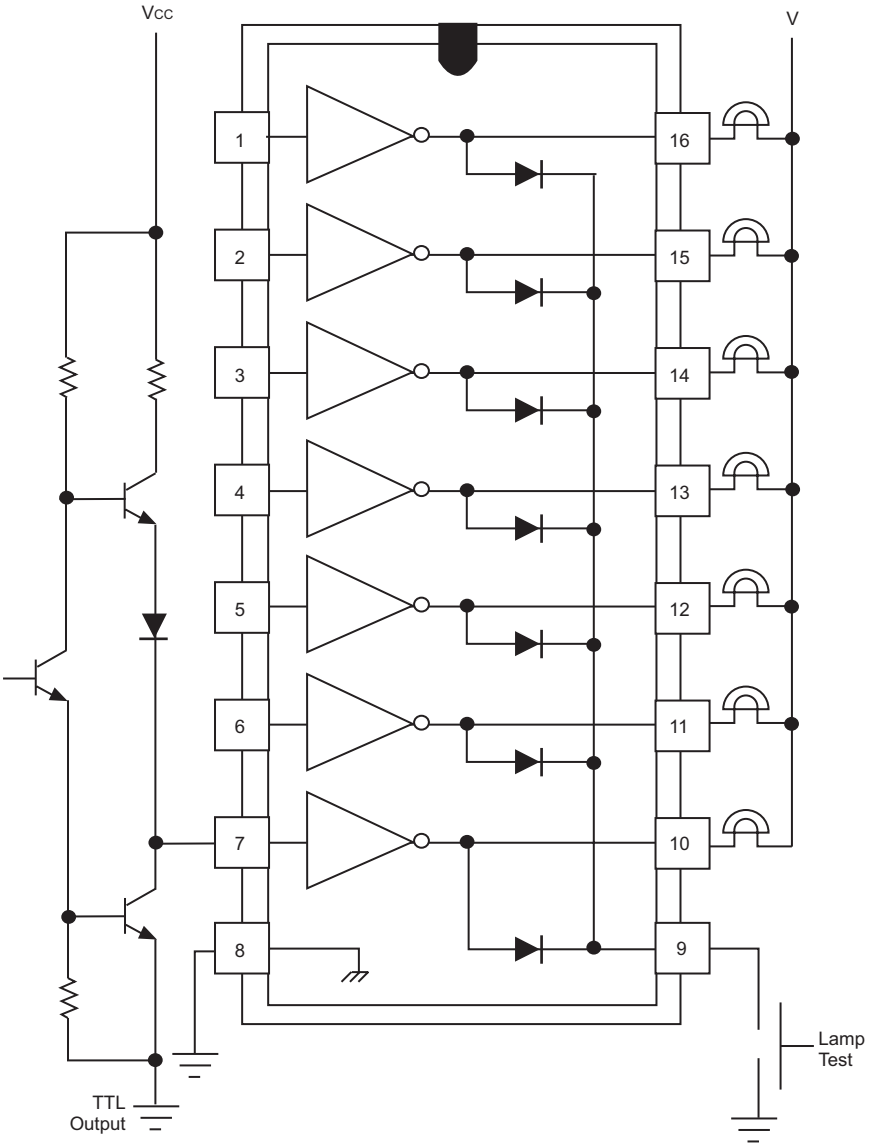


Figure 16. TTL to Load

APPLICATION INFORMATION(CONTINUED)

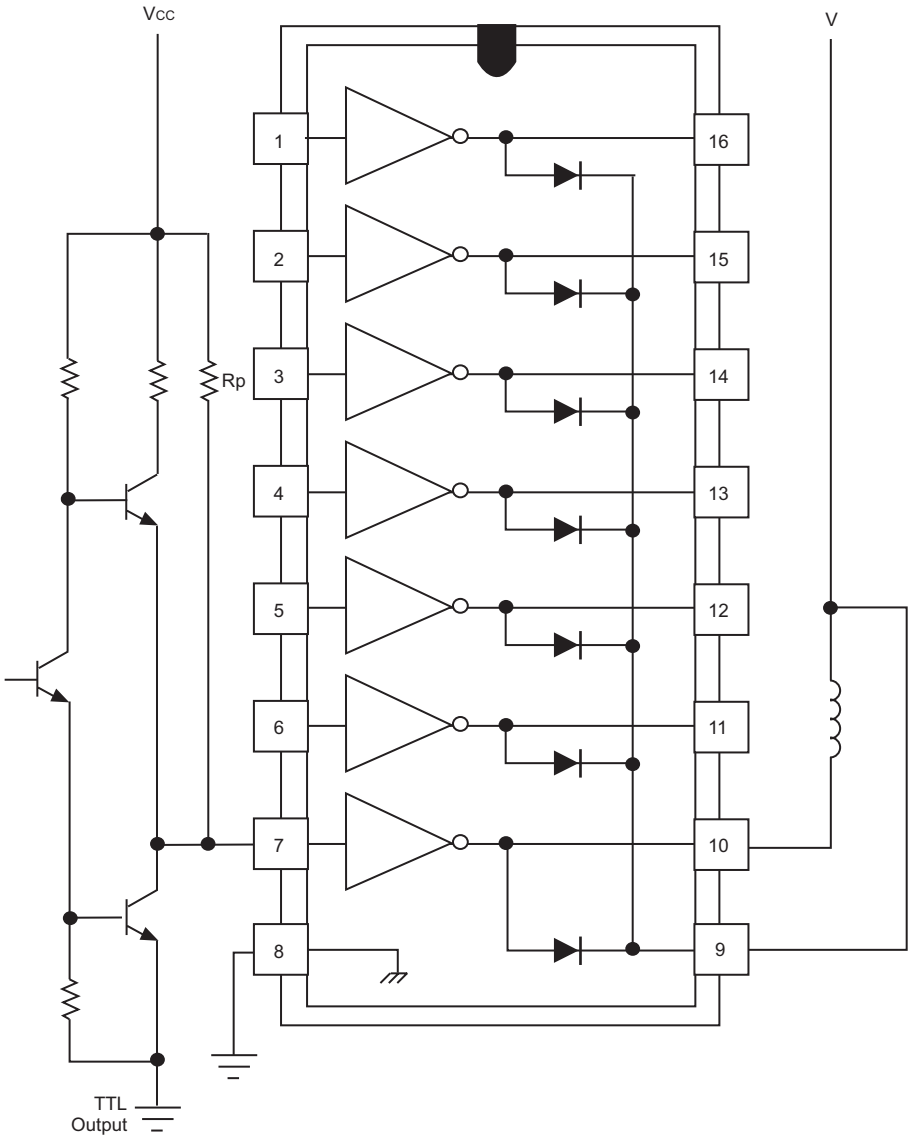
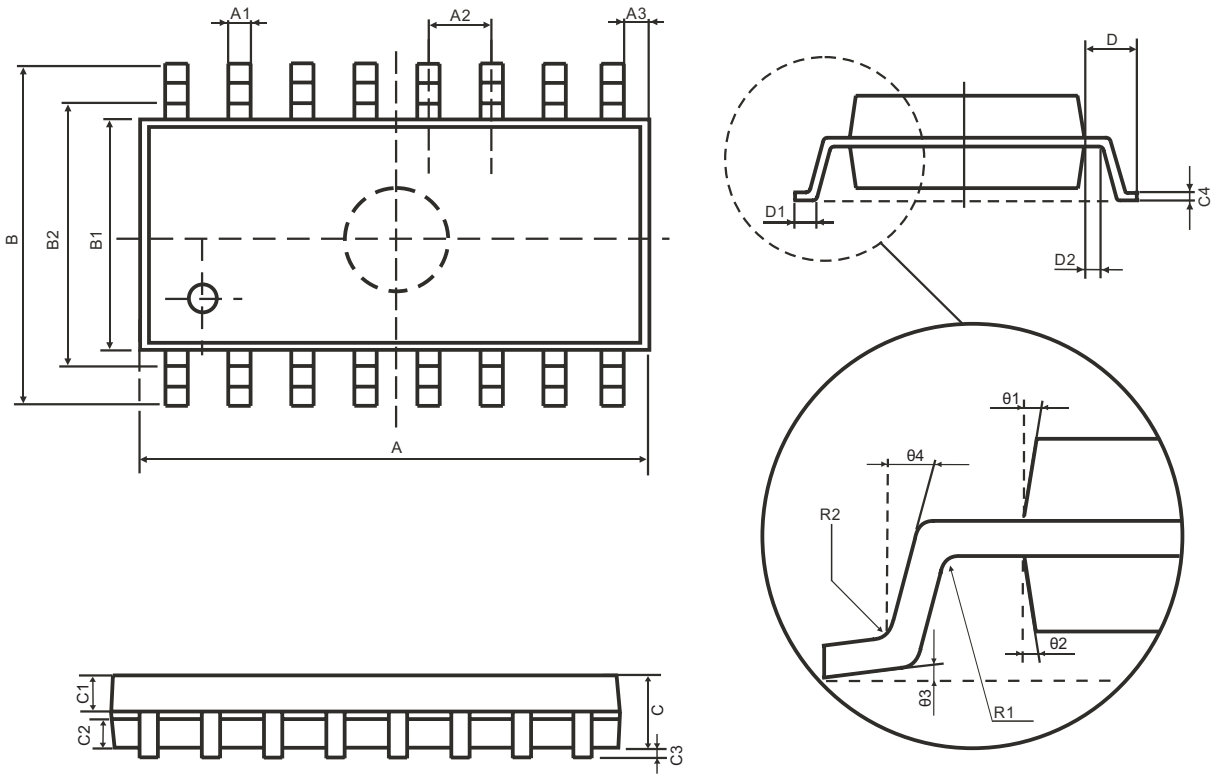


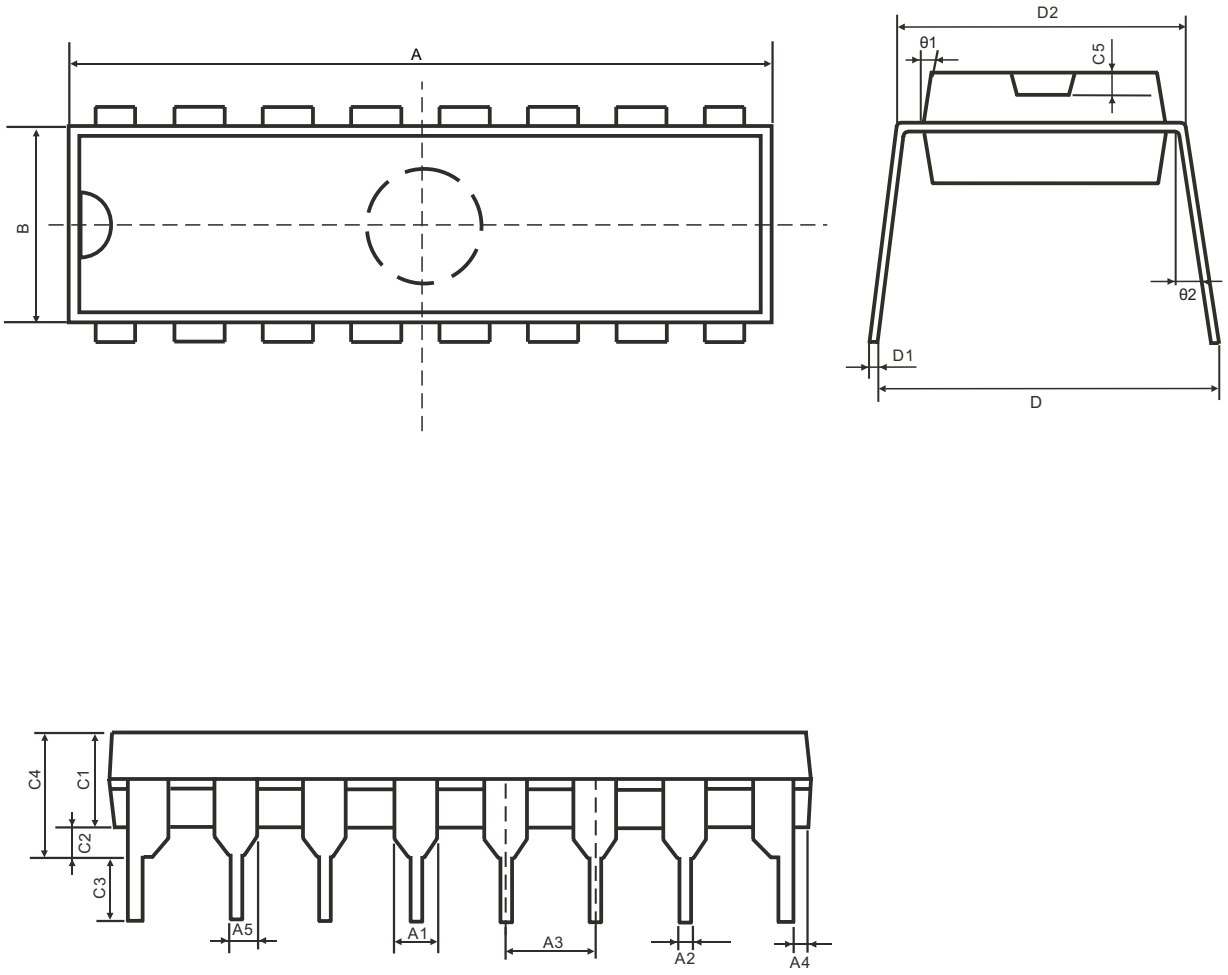
Figure 17. Use of Pull-up Resistors to Increase Drive Current

PHYSICAL DIMENSIONS
SOP16L



Symbol	Dimension(mm)		Symbol	Dimension(mm)	
	Min	Max		Min	Max
A	9.90	10.10	C4	0.20(TYP)	
A1	0.36	0.46	D	1.05(TYP)	
A2	1.27(TYP)		D1	0.40	0.70
A3	0.35(TYP)		D2	0.22	0.42
B	5.84	6.24	R1	0.15(TYP)	
B1	3.84	4.04	R2	0.15(TYP)	
B2	5.00(TYP)		θ1	8˚(TYP)	
C	1.35	1.55	θ2	8˚(TYP)	
C1	0.61	0.71	θ3	4˚(TYP)	
C2	0.54	0.64	θ4	15˚(TYP)	
C3	0.10	0.25			

DIP16L



Symbol	Dimension(mm)		Symbol	Dimension(mm)	
	Min	Max		Min	Max
A	19.05	19.45	C3	3.00	3.60
A1	1.52(TYP)		C4	3.85	4.45
A2	0.46(TYP)		C5	0.80(TYP)	
A3	2.54(TYP)		D	8.10	8.60
A4	0.51(TYP)		D1	0.20	0.35
A5	0.99(TYP)		D2	7.62(TYP)	
B	6.20	6.60	θ1	8°(TYP)	
C1	3.30	3.70	θ2	5°(TYP)	
C2	0.51(TYP)				