# TIGER ELECTRONIC CO.,LTD

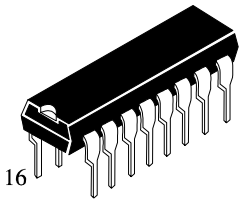
## ULN2003AN/ADR

RoHS COMPLIANT

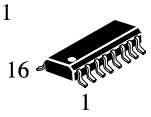
# SEVEN DARLINGTON ARRAYS

The ULN2003A are monolithic high-voltage, high-current Darlington transistor arrays. Each consists of seven n-p-n 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 ULN2003A has a 2.7-k series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.




N SUFFIX
PLASTIC



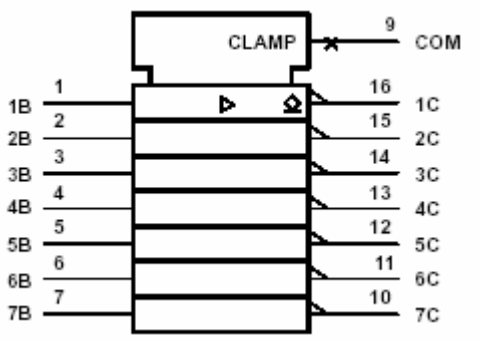

D SUFFIX
SOIC

**ORDERING INFORMATION**

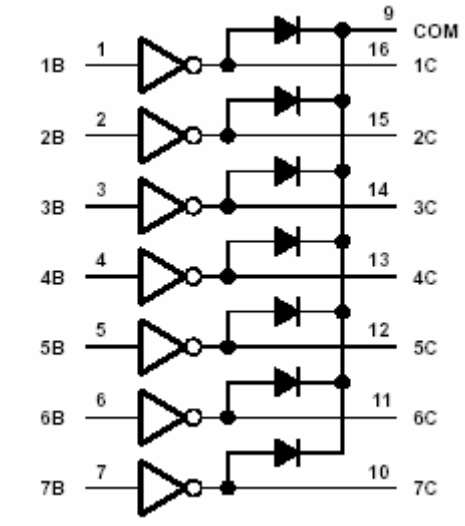
ULN2003AN Plastic
ULN2003ADR SOIC
$T_A$ = -20°C to 85° C for all packages

- 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

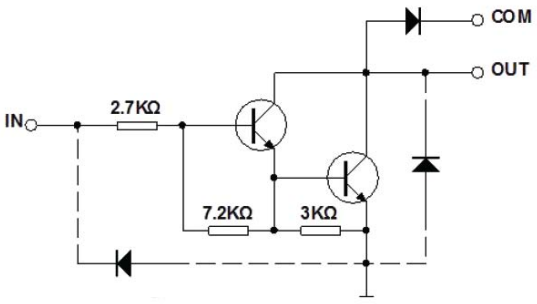
### LOGIC SYSBOL




### LOGIC DIAGRAM




SCHEMATICS (each Darlington Pair)




All resistor values shown are nominal.

**ULN2003A: $R_B$ = 2.7 kW**

**Absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)**

| | |
|---|---|
| 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°C to 85°C |
| Storage temperature range, Tstg | –65°C to 150°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C |

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 | 950 mW | 7.6 mW/°C | 494 mW |
| N | 1150 mW | 9.2 mW/°C | 598 mW |

**Electrical characteristics, TA = 25°C (unless otherwise noted)**

| PARAMETER | | TEST FIGURE | TEST CONDITIONS | | ULN2003A MIN | ULN2003A TYP | ULN2003A MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{I(on)}$ | On-state input voltage | 6 | $V_{CE}$ = 2 V | $I_C$ = 125 mA | | | | V |
| | | | | $I_C$ = 200 mA | | | 2.4 | |
| | | | | $I_C$ = 250 mA | | | 2.7 | |
| | | | | $I_C$ = 275 mA | | | | |
| | | | | $I_C$ = 300 mA | | | 3 | |
| | | | | $I_C$ = 350 mA | | | | |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | 5 | $I_I$ = 250 µA, | $I_C$ = 100 mA | | 0.9 | 1.1 | V |
| | | | $I_I$ = 350 µA, | $I_C$ = 200 mA | | 1 | 1.3 | |
| | | | $I_I$ = 500 µA, | $I_C$ = 350 mA | | 1.2 | 1.6 | |
| $I_{CEX}$ | Collector cutoff current | 1 | $V_{CE}$ = 50 V, | $I_I$ = 0 | | | 50 | µA |
| | | 2 | $V_{CE}$ = 50 V, $T_A$ = 70°C | $I_I$ = 0 | | | 100 | |
| | | | | $V_I$ = 1 V | | | | |
| $V_F$ | Clamp forward voltage | 8 | $I_F$ = 350 mA | | | 1.7 | 2 | V |
| $I_{I(off)}$ | Off-state input current | 3 | $V_{CE}$ = 50 V, $T_A$ = 70°C | $I_C$ = 500 µA, | 50 | 65 | | µA |
| $I_I$ | Input current | 4 | $V_I$ = 3.85 V | | | 0.93 | 1.35 | mA |
| | | | $V_I$ = 5 V | | | | | |
| | | | $V_I$ = 12 V | | | | | |
| $I_R$ | Clamp reverse current | 7 | $V_R$ = 50 V | | | | 50 | µA |
| | | | $V_R$ = 50 V, | $T_A$ = 70°C | | | 100 | |
| $C_i$ | Input capacitance | | $V_I$ = 0, | f = 1 MHz | | 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, See Figure 10 | $V_S$–20 | | | mV |

## PARAMETER MEASUREMENT INFORMATION

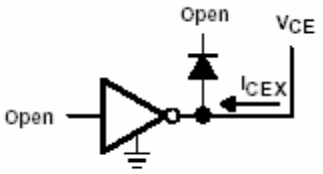


Figure 1. $I_{CEX}$ Test Circuit

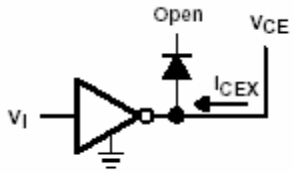


Figure 2. $I_{CEX}$ Test Circuit

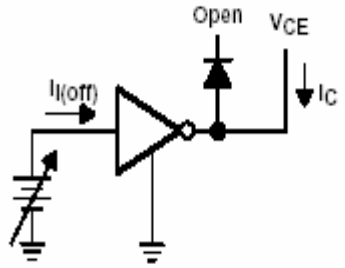


Figure 3. $I_{I(off)}$ Test Circuit

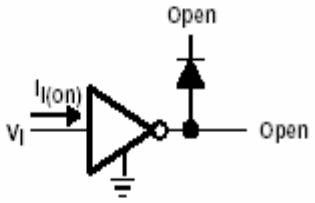
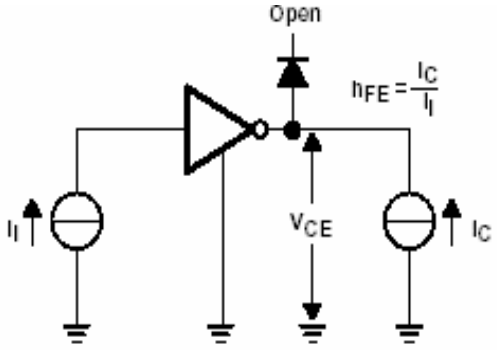


Figure 4. $I_I$ Test Circuit



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

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

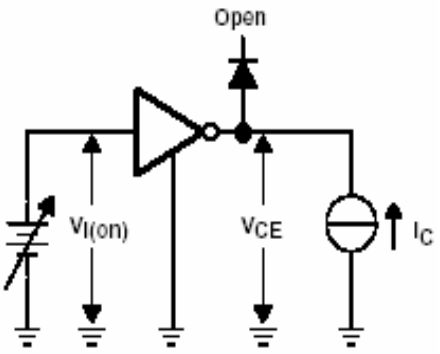


Figure 6. $V_{I(on)}$ Test Circuit

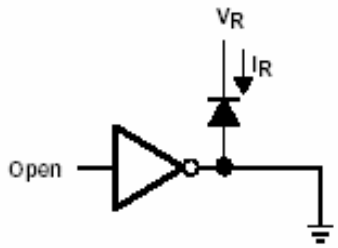



Figure 7. $I_R$ Test Circuit

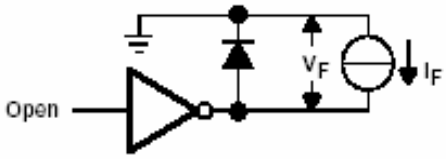



Figure 8. $V_F$ Test Circuit

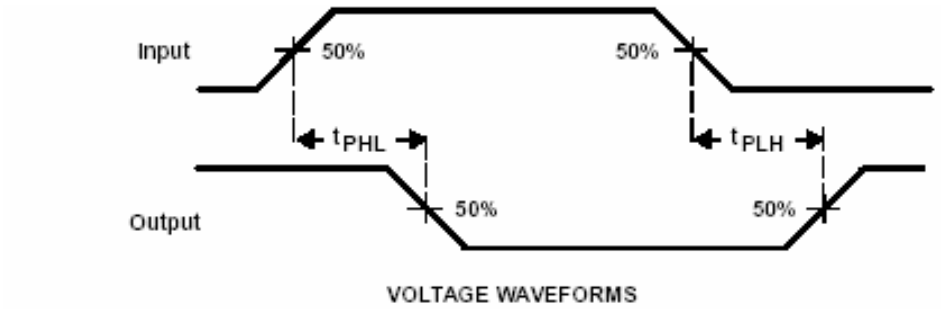
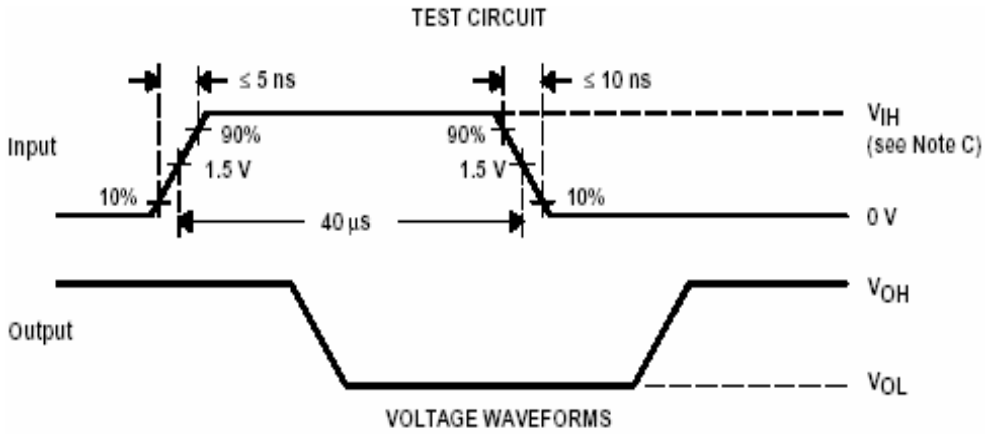



**Figure 9. Propagation Delay-Time Waveforms**




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

**Figure 10. Latch-Up Test Circuit and Voltage Waveforms**

## TYPICAL CHARACTERISTICS

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

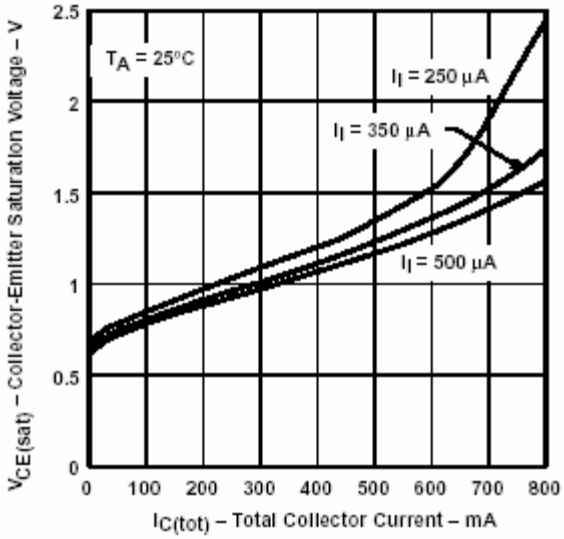



Figure 12

**COLLECTOR-EMITTER SATURATION VOLTAGE vs TOTAL COLLECTOR CURRENT**

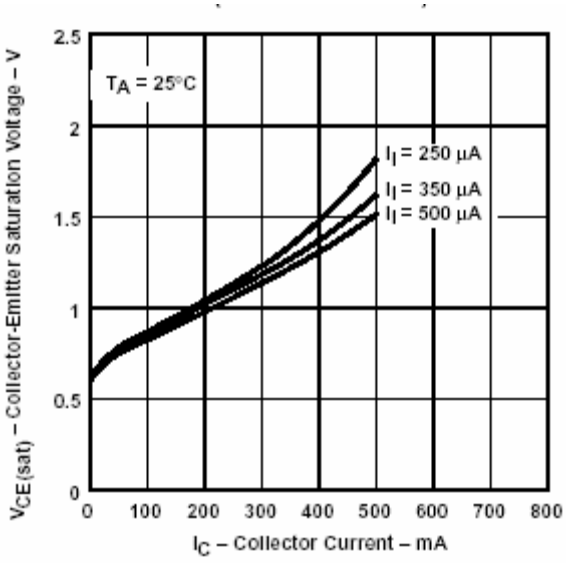



Figure 11

**COLLECTOR CURRENT vs INPUT CURRENT**

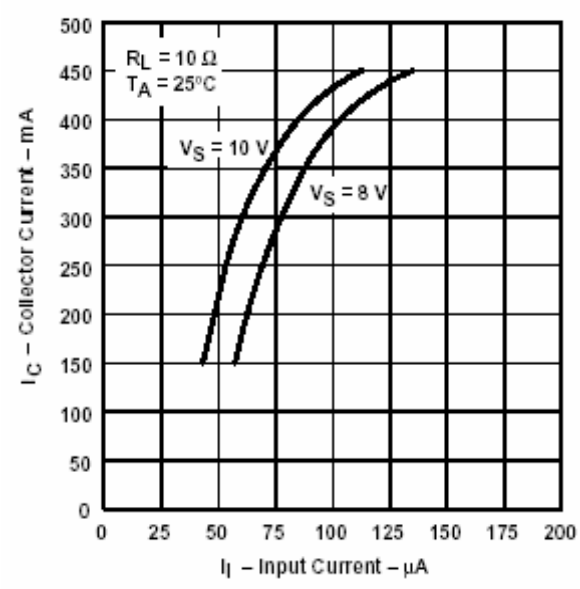



Figure 13

## THERMAL INFORMATION

**D PACKAGE**
**MAXIMUM COLLECTOR CURRENT**
**Vs**
**DUTY CYCLE**

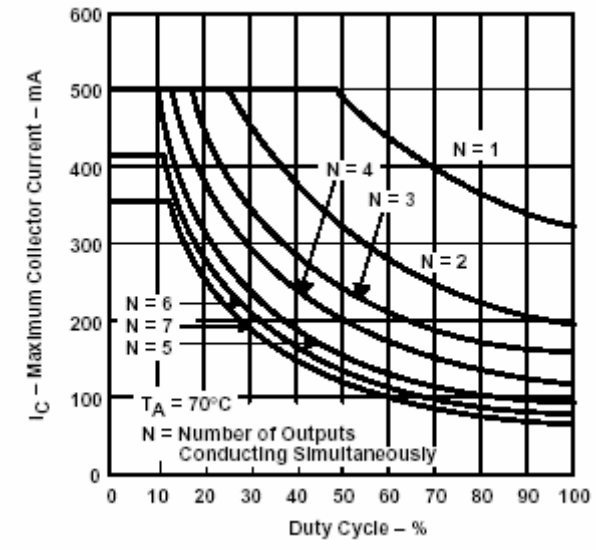



**Figure 14**

**N PACKAGE**
**MAXIMUM COLLECTOR CURRENT**
**vs**
**DUTY CYCLE**

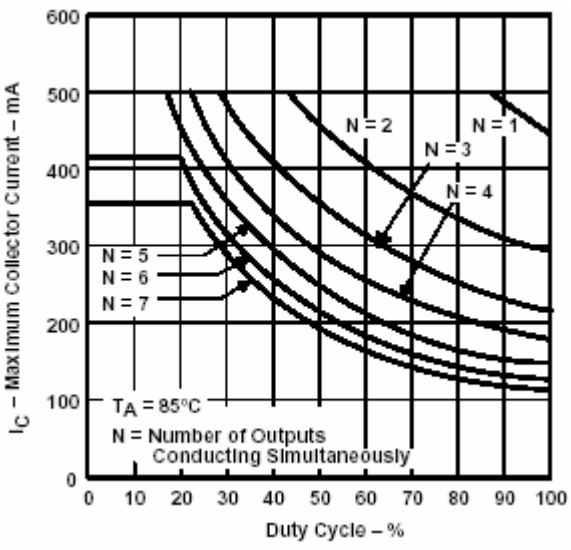



**Figure 15**

## APPLICATION INFORMATION

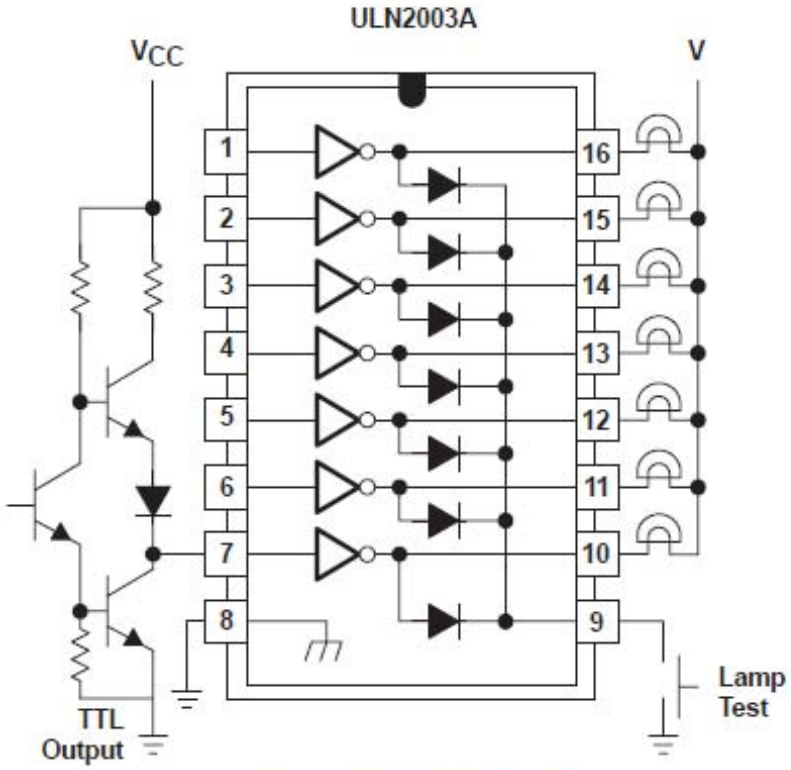



**Figure 16. TTL to Load**

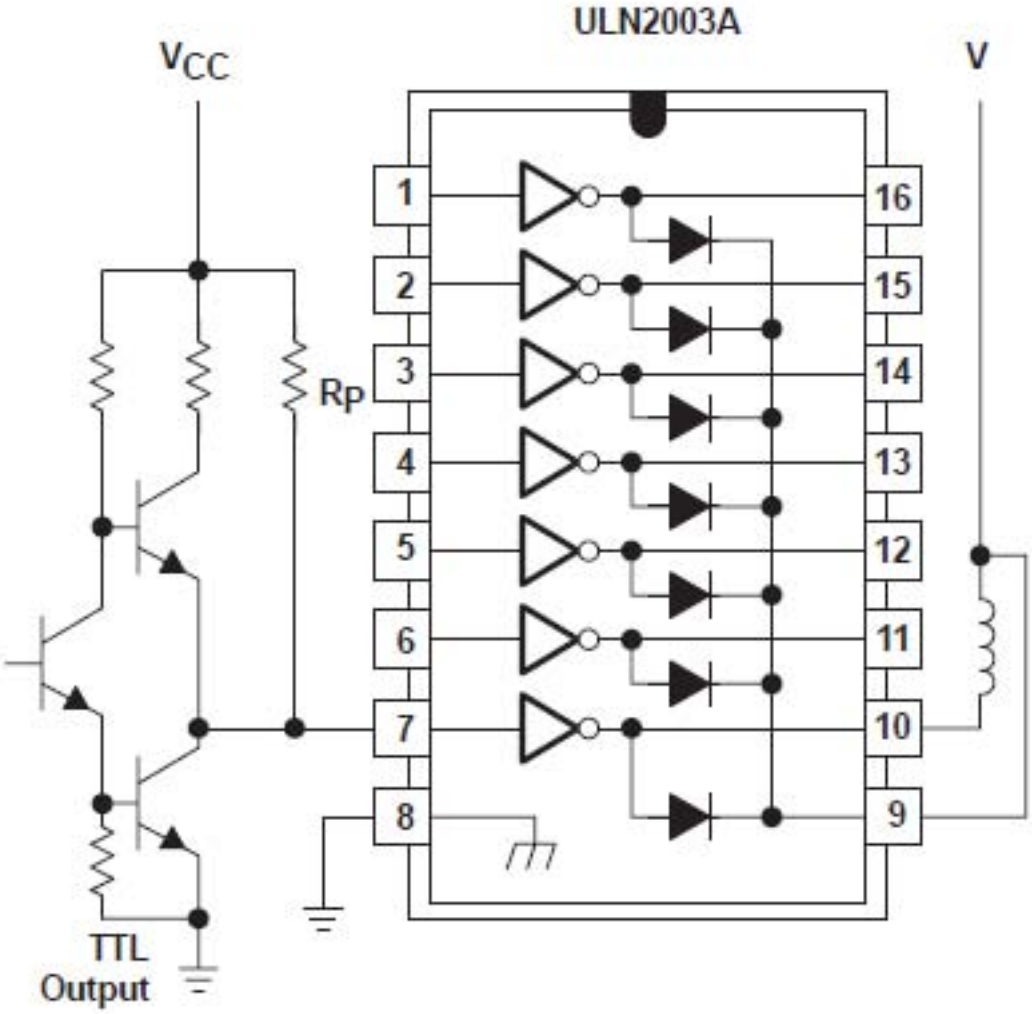
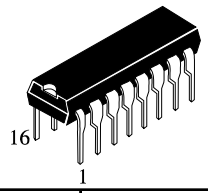
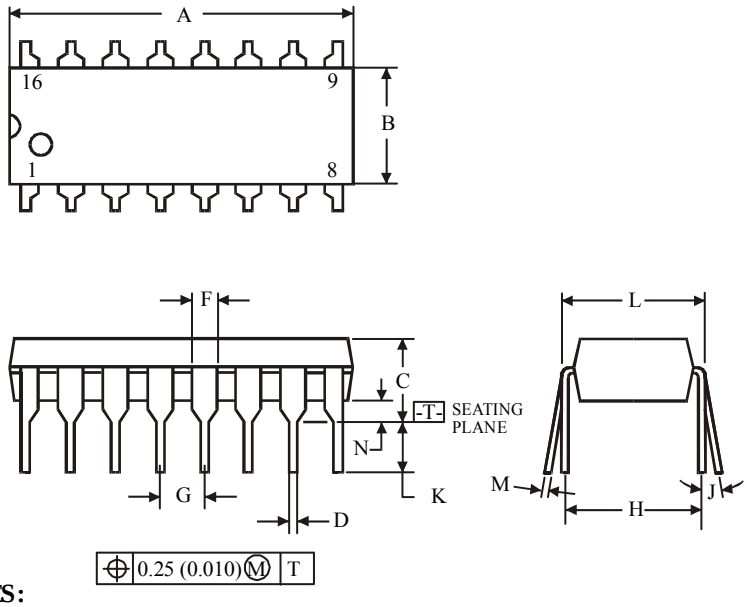



**Figure 17. Use of Pullup Resistors to Increase Drive Current**

## N SUFFIX PLASTIC DIP
## (MS - 001BB)



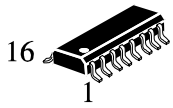



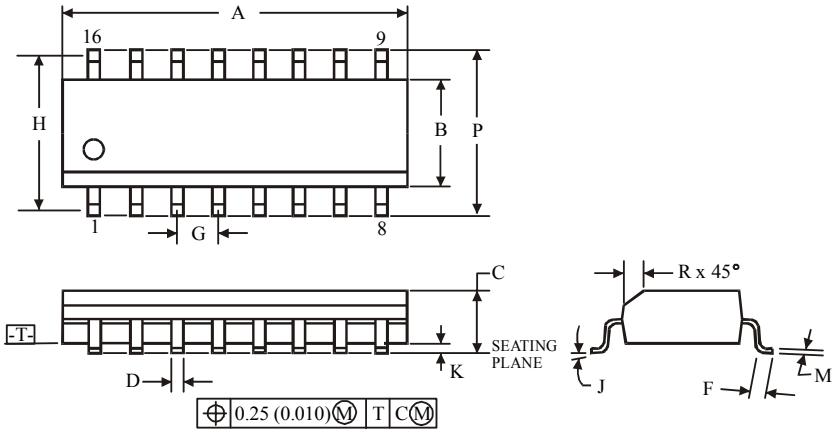

| | Dimension, mm | |
|---|---|---|
| **Symbol** | **MIN** | **MAX** |
| **A** | 18.67 | 19.69 |
| **B** | 6.10 | 7.11 |
| **C** | | 5.33 |
| **D** | 0.36 | 0.56 |
| **F** | 1.14 | 1.78 |
| **G** | 2.54 | |
| **H** | 7.62 | |
| **J** | 0° | 10° |
| **K** | 2.92 | 3.81 |
| **L** | 7.62 | 8.26 |
| **M** | 0.20 | 0.36 |
| **N** | 0.38 | |

**NOTES:**

1. Dimensions “A”, “B” do not include mold flash or protrusions.
   Maximum mold flash or protrusions 0.25 mm (0.010) per side.

## D SUFFIX SOIC
## (MS - 012AC)




| | Dimension, mm | |
|---|---|---|
| **Symbol** | **MIN** | **MAX** |
| **A** | 9.80 | 10.00 |
| **B** | 3.80 | 4.00 |
| **C** | 1.35 | 1.75 |
| **D** | 0.33 | 0.51 |
| **F** | 0.40 | 1.27 |
| **G** | 1.27 | |
| **H** | 5.72 | |
| **J** | 0° | 8° |
| **K** | 0.10 | 0.25 |
| **M** | 0.19 | 0.25 |
| **P** | 5.80 | 6.20 |
| **R** | 0.25 | 0.50 |

**NOTES:**

1. Dimensions A and B do not include mold flash or protrusion.
2. Maximum mold flash or protrusion 0.15 mm (0.006) per side
   for A; for B – 0.25 mm (0.010) per side.