

Plastic-Encapsulate Darlington Transistors

ULN2003 DARLINGTON TRANSISTOR (NPN)

Description

ULN2003 is high voltage, high current darlington arrays each containing seven open collector darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. The ULN2003 device has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

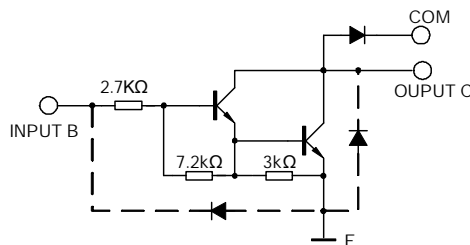
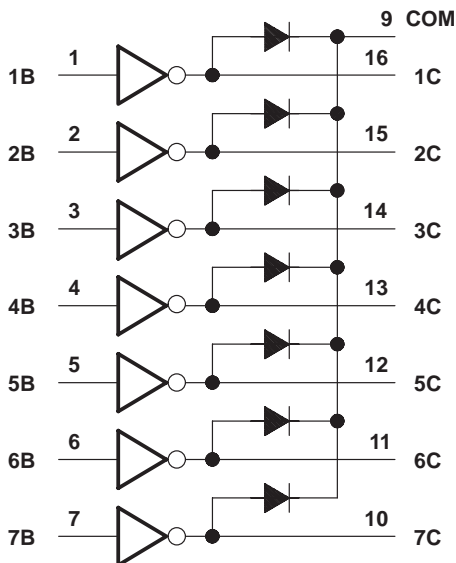
Features

- 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

Applications

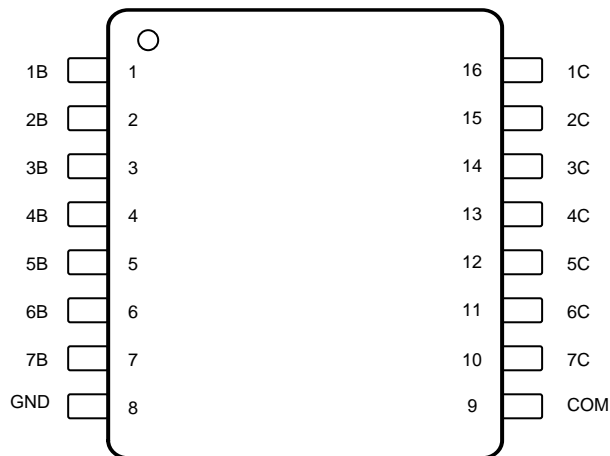
- Relay Drivers
- Hammer Drivers
- Lamp Drivers
- Line Drivers
- Logic Buffers
- Stepper Motors
- IP Camera
- HVAC Valve and LED Dot Matrix

Logic Diagram



Pin Configuration and Functions

Top View



Not to scale

Pin Functions

| PIN | | TYPE | DESCRIPTION |
|------|-----|------|---|
| NAME | NO. | | |
| 1B | 1 | I | Channel 1 through 7 Darlington base input |
| 2B | 2 | | |
| 3B | 3 | | |
| 4B | 4 | | |
| 5B | 5 | | |
| 6B | 6 | | |
| 7B | 7 | | |
| 1C | 16 | O | Channel 1 through 7 Darlington collector output |
| 2C | 15 | | |
| 3C | 14 | | |
| 4C | 13 | | |
| 5C | 12 | | |
| 6C | 11 | | |
| 7C | 10 | | |
| GND | 8 | — | Common emitter shared by all channels (typically tied to ground) |
| COM | 9 | I/O | Common cathode node for flyback diodes (required for inductive loads) |

Typical Characteristics

ABSOLUTE MAXIMUM RATING

| PARAMETER | SYMBOL | ULN2003 | | | UNIT |
|---------------------------------------|-----------|---------|-----|-----|------|
| | | MIN | TYP | MAX | |
| Output voltage | V_O | | | 50 | V |
| Input voltage | V_I | | | 30 | V |
| Collector current(continuous current) | I_C | | | 500 | mA |
| Base current(continuous current) | I_B | | | 25 | mA |
| Operating Ambient Temperature | T_A | -20 | | 85 | °C |
| Operating Junction Temperature | T_J | | | 150 | °C |
| Storage Temperature | T_{stg} | -55 | | 150 | °C |

ELECTRICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$ unless otherwise specified)

| PARAMETER | | TEST CONDITIONS | ULN2003 | | | UNIT |
|--------------|--------------------------------------|---|-------------------------|------|-------|---------------|
| | | | MIN | TYP | MAX | |
| I_{CEX} | Collector cutoff current | $V_{CE} = 40\text{ V}, T_{amb}=+85^\circ\text{C}$ | | | 100.0 | μA |
| | | $V_{CE} = 40\text{ V}, T_{amb}=+25^\circ\text{C}$ | | | 50.0 | μA |
| V_{CES} | Collector-emitter saturation voltage | $I_C = 350\text{ mA}, I_B=500\mu\text{A}$ | | 1.1 | 1.6 | V |
| | | $I_C = 200\text{ mA}, I_B=350\mu\text{A}$ | | 0.95 | 1.3 | |
| | | $I_C = 100\text{ mA}, I_B=250\mu\text{A}$ | | 0.85 | 1.1 | |
| $I_{I(ON)}$ | Input current(ON) | $V_I = 3.85\text{ V}$ | | 0.93 | 1.35 | mA |
| $V_{I(ON)}$ | Input voltage(ON) | $V_{CE} = 2.0\text{ V}, I_C=200\text{mA}$ | | | 2.4 | V |
| | | $V_{CE} = 2.0\text{ V}, I_C=250\text{mA}$ | | | 2.7 | |
| | | $V_{CE} = 2.0\text{ V}, I_C=300\text{mA}$ | | | 3.0 | |
| $I_{I(OFF)}$ | Input current(OFF) | $V_{CE} = 2.0\text{ V}, I_C=350\text{mA}$ | 50 | 100 | | μA |
| C_I | Input capacitance | | | 15 | 30 | pF |
| t_{ON} | On delay time | 50%EI to 50%EO | | 0.25 | 1.0 | μs |
| t_{OFF} | Off delay time | 50%EI to 50%EO | | 0.25 | 1.0 | μs |
| I_R | Clamp reverse current | $V_R = 50\text{ V}$ | $T_A=+25^\circ\text{C}$ | | 50.0 | μA |
| | | | $T_A=+85^\circ\text{C}$ | | 100.0 | |
| V_F | Clamp forward voltage | $I_F=350\text{mA}$ | | 1.5 | 2.0 | V |

Typical Characteristics Measurement

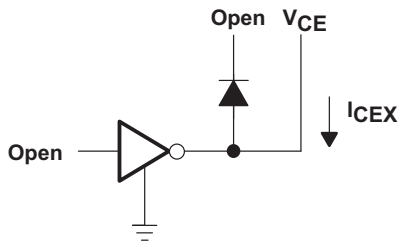


Figure 1. I_{CEX} Test Circuit

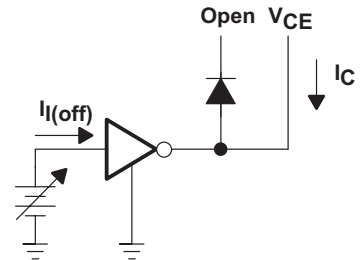


Figure 2. $I_{I(off)}$ Test Circuit

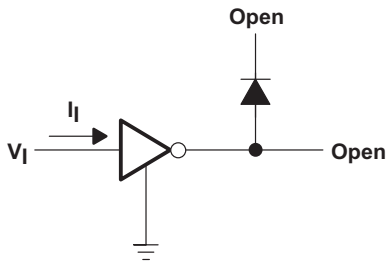


Figure 3. $I_{I(on)}$ Test Circuit

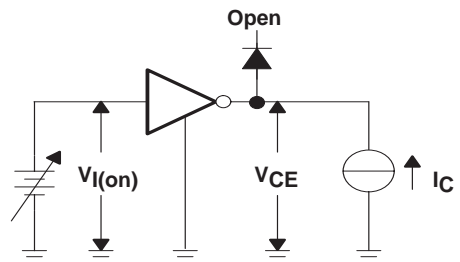
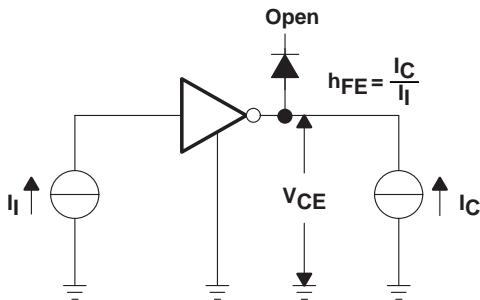


Figure 4. $V_{I(on)}$ Test Circuit



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

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

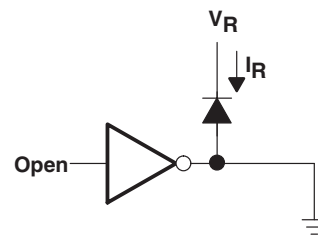


Figure 6. I_R Test Circuit

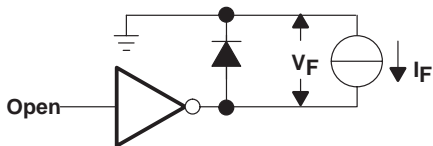


Figure 7. V_F Test Circuit

Typical Application

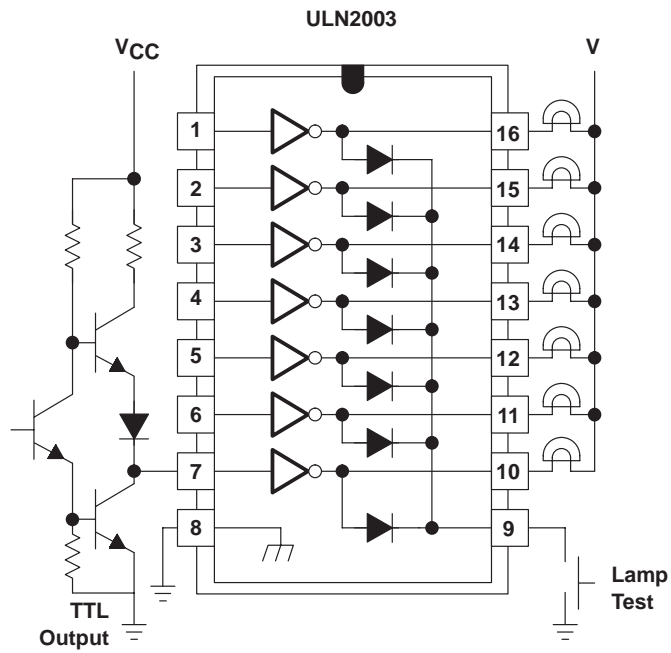


Figure 8. TTL to Load

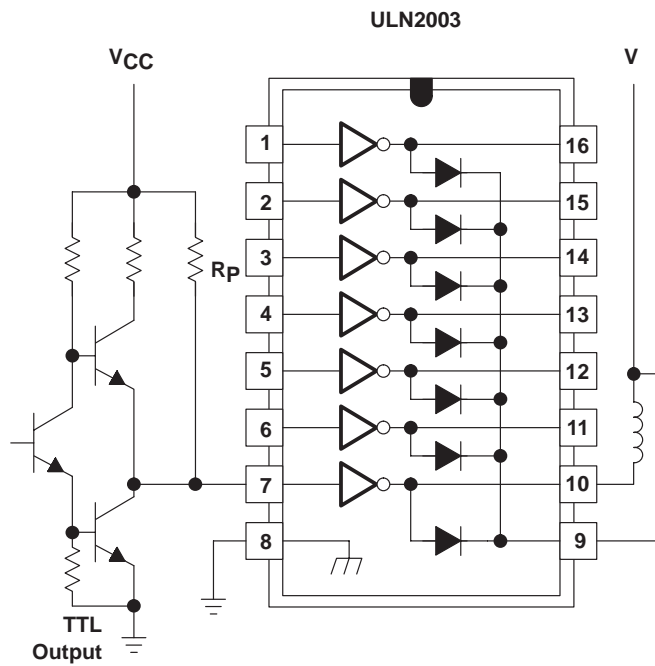
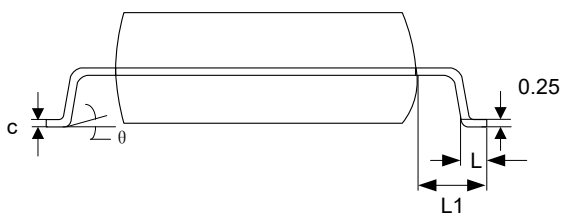
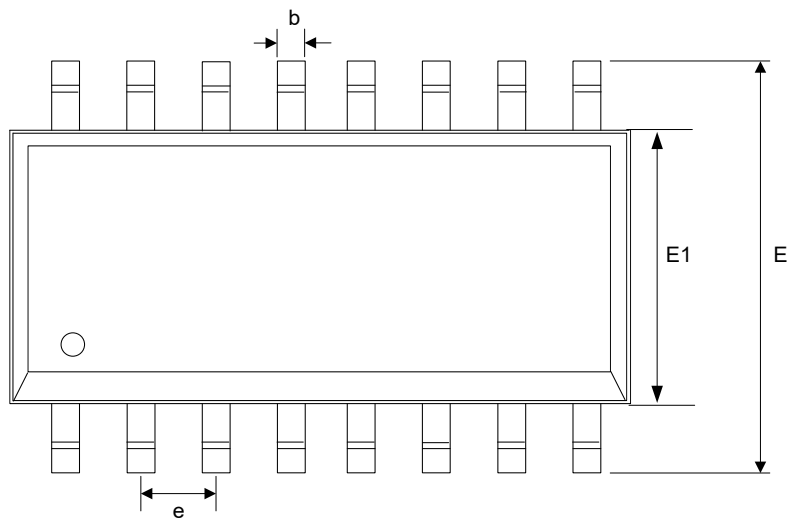
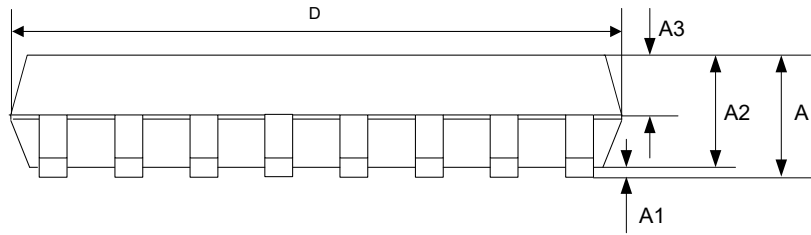


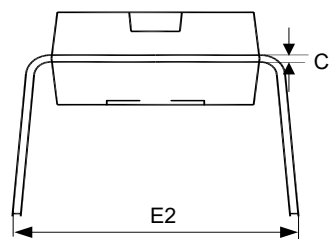
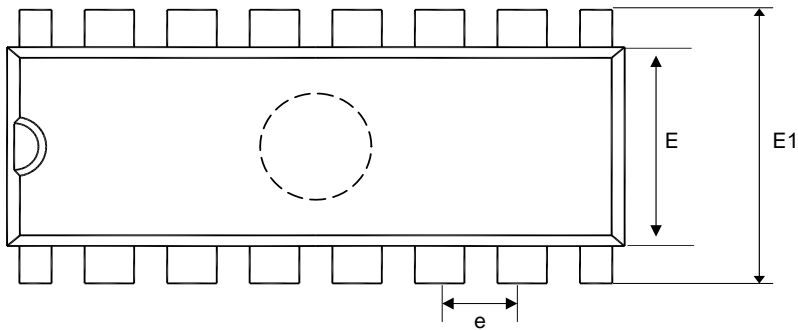
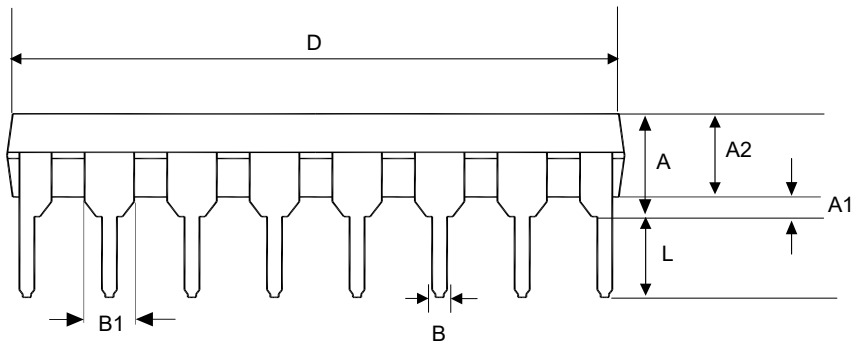
Figure 9. Use of Pullup Resistors to Increase Drive Current

SOP-16 Package Outline Dimensions



| SYMBOL | MILLIMETER | | |
|----------|------------|------|------|
| | MIN | NOM | MAX |
| A | - | - | 1.75 |
| A1 | 0.10 | - | 0.25 |
| A2 | | | 1.60 |
| A3 | 0.97 | 1.02 | 1.07 |
| b | 0.35 | - | 0.46 |
| c | 0.19 | - | 0.25 |
| D | 9.80 | | 10.0 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.80 | | 4.00 |
| e | 1.27BSC | | |
| L | 0.70 | 0.5 | 1.00 |
| L1 | 1.40BSC | | |
| θ | 0 | - | 8° |

DIP-16 Package Outline Dimensions



| SYMBOL | MILLIMETER | |
|--------|------------|--------|
| | Min | Max |
| A | 3.710 | 4.310 |
| A1 | 0.510 | |
| A2 | 3.200 | 3.600 |
| B | 0.380 | 0.570 |
| B1 | 1.524(BSC) | |
| C | 0.204 | 0.360 |
| D | 18.800 | 19.200 |
| E | 6.200 | 6.600 |
| E1 | 7.320 | 7.920 |
| e | 2.540(BSC) | |
| L | 3.000 | 3.600 |
| E2 | 8.400 | 9.0070 |

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