

## DS2003

### High Current/Voltage Darlington Drivers

#### General Description

The DS2003 is comprised of seven high voltage, high current NPN Darlington transistor pairs. All units feature common emitter, open collector outputs. To maximize their effectiveness, these units contain suppression diodes for inductive loads and appropriate emitter base resistors for leakage.

The DS2003 has a series base resistor to each Darlington pair, thus allowing operation directly with TTL or CMOS operating at supply voltages of 5.0V.

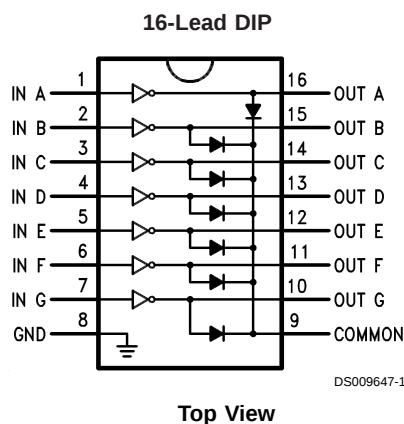
The DS2003 offers solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and

LEDs. Applications requiring sink currents beyond the capability of a single output may be accommodated by paralleling the outputs.

#### Features

- Seven high gain Darlington pairs
- High output voltage ( $V_{CE} = 50V$ )
- High output current ( $I_C = 350\text{ mA}$ )
- TTL, PMOS, CMOS compatible
- Suppression diodes for inductive loads
- Extended temperature range

#### Connection Diagram



#### Order Numbers

| N Package<br>Number<br>N16E | M Package<br>Number<br>M16A |
|-----------------------------|-----------------------------|
| DS2003TN                    | DS2003TM                    |
| DS2003CN                    | DS2003CM                    |

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

|                             |                 |
|-----------------------------|-----------------|
| Storage Temperature Range   | -65°C to +150°C |
| Operating Temperature Range |                 |
| DS2003TN, DS2003TM          | -40°C to +105°C |
| DS2003CN, DS2003CM          | 0°C to +85°C    |
| Lead Temperature            |                 |
| Soldering, 10 seconds       | 265°C           |

|                              |         |
|------------------------------|---------|
| N16E Package                 | 1330 mW |
| M16A Package                 | 770 mW  |
| Input Voltage                | 30V     |
| Output Voltage               | 55V     |
| Emitter-Base Voltage         | 6.0V    |
| Continuous Collector Current | 500 mA  |
| Continuous Base Current      | 25 mA   |

**Note:** \*Derate N16E package 13.3 mW/°C for  $T_A$  above 25°C. Derate M16A package 7.7 mW/°C for  $T_A$  above 25°C.

Maximum Power Dissipation\* at  $T_A = 25^\circ\text{C}$

## Electrical Characteristics

$T_A = 25^\circ\text{C}$ , unless otherwise specified (Note 2)

| Symbol        | Parameter                            | Conditions                                                                                   | Min | Typ  | Max  | Units         |
|---------------|--------------------------------------|----------------------------------------------------------------------------------------------|-----|------|------|---------------|
| $I_{CEX}$     | Output Leakage Current               | $T_A = 25^\circ\text{C}$ , $V_{CE} = 50\text{V}$ (Figure 1)                                  |     |      | 20   | $\mu\text{A}$ |
|               |                                      | $T_A = 85^\circ\text{C}$ , $V_{CE} = 50\text{V}$ (Figure 1) for DS2003CN, DS2003CM           |     |      | 100  |               |
|               |                                      | $T_A = 105^\circ\text{C}$ , $V_{CE} = 50\text{V}$ (Figure 1) for DS2003TN, DS2003TM          |     |      | 150  |               |
| $V_{CE(Sat)}$ | Collector-Emitter Saturation Voltage | $I_C = 350\text{ mA}$ , $I_B = 500\text{ }\mu\text{A}$ (Figure 3) (Note 3)                   |     | 1.25 | 1.6  | V             |
|               |                                      | $I_C = 200\text{ mA}$ , $I_B = 350\text{ }\mu\text{A}$ (Figure 3)                            |     | 1.1  | 1.3  |               |
|               |                                      | $I_C = 100\text{ mA}$ , $I_B = 250\text{ }\mu\text{A}$ (Figure 3)                            |     | 0.9  | 1.1  |               |
| $I_{I(ON)}$   | Input Current                        | $V_I = 3.85\text{V}$ (Figure 4)                                                              |     | 0.93 | 1.35 | mA            |
| $I_{I(OFF)}$  | Input Current (Note 4)               | $T_A = 85^\circ\text{C}$ for DS2003CN, DS2003CM<br>$I_C = 500\text{ }\mu\text{A}$ (Figure 5) | 50  | 100  |      | $\mu\text{A}$ |
| $V_{I(ON)}$   | Input Voltage (Note 5)               | $V_{CE} = 2.0\text{V}$ , $I_C = 200\text{ mA}$ (Figure 6)                                    |     |      | 2.4  | V             |
|               |                                      | $V_{CE} = 2.0\text{V}$ , $I_C = 250\text{ mA}$ (Figure 6)                                    |     |      | 2.7  |               |
|               |                                      | $V_{CE} = 2.0\text{V}$ , $I_C = 300\text{ mA}$ (Figure 6)                                    |     |      | 3.0  |               |
| $C_I$         | Input Capacitance                    |                                                                                              |     | 15   | 30   | pF            |
| $t_{PLH}$     | Turn-On Delay                        | $0.5 V_I$ to $0.5 V_O$                                                                       |     |      | 1.0  | $\mu\text{s}$ |
| $t_{PHL}$     | Turn-Off Delay                       | $0.5 V_I$ to $0.5 V_O$                                                                       |     |      | 1.0  | $\mu\text{s}$ |
| $I_R$         | Clamp Diode Leakage Current          | $V_R = 50\text{V}$ (Figure 7) $T_A = 25^\circ\text{C}$                                       |     |      | 50   | $\mu\text{A}$ |
|               |                                      | $T_A = 85^\circ\text{C}$                                                                     |     |      | 100  | $\mu\text{A}$ |
| $V_F$         | Clamp Diode Forward Voltage          | $I_F = 350\text{ mA}$ (Figure 8)                                                             |     | 1.7  | 2.0  | V             |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.

**Note 2:** All limits apply to the complete Darlington series except as specified for a single device type.

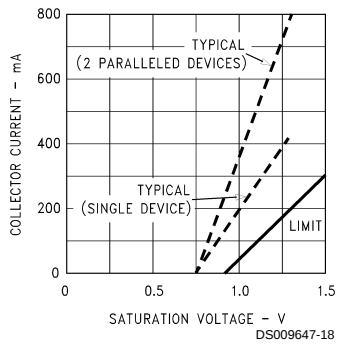
**Note 3:** Under normal operating conditions these units will sustain 350 mA per output with  $V_{CE(Sat)} = 1.6\text{V}$  at  $70^\circ\text{C}$  with a pulse width of 20 ms and a duty cycle of 30%.

**Note 4:** The  $I_{I(OFF)}$  current limit guaranteed against partial turn-on of the output.

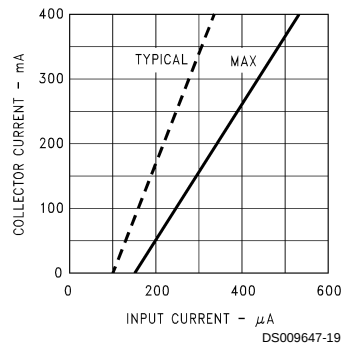
**Note 5:** The  $V_{I(ON)}$  voltage limit guarantees a minimum output sink current per the specified test conditions.

## Typical Performance Characteristics

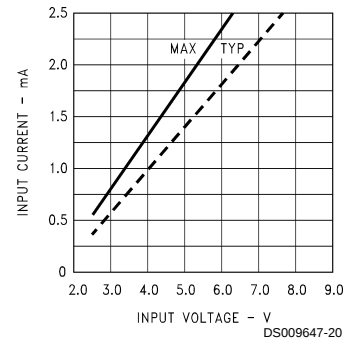
**Collector Current vs Saturation Voltage**



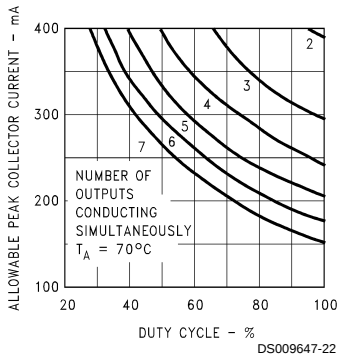
**Collector Current vs Input Current**



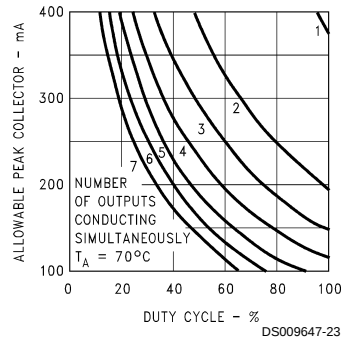
**Input Current vs Input Voltage**



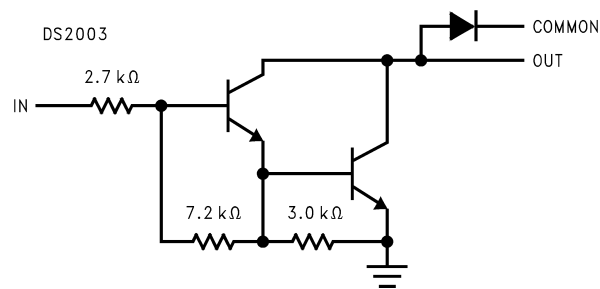
**Peak Collector Current vs Duty Cycle and Number of Outputs (Molded Package)**



**Peak Collector Current vs Duty Cycle and Number of Outputs (Ceramic Package)**



## Equivalent Circuits



DS009647-3

# Test Circuits

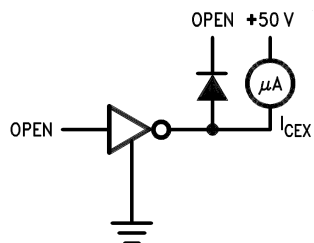


FIGURE 1.

DS009647-7

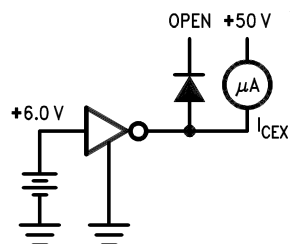


FIGURE 2.

DS009647-8

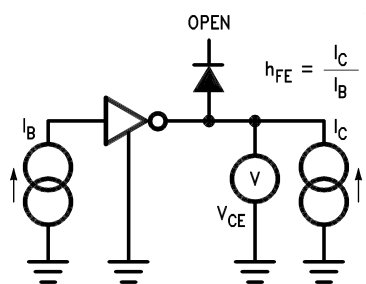


FIGURE 3.

DS009647-9

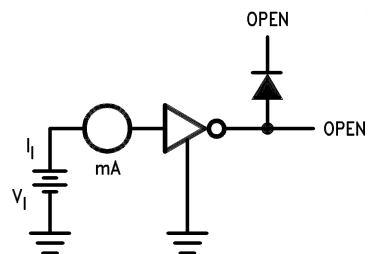


FIGURE 4.

DS009647-10

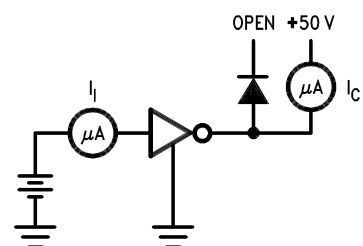


FIGURE 5.

DS009647-11

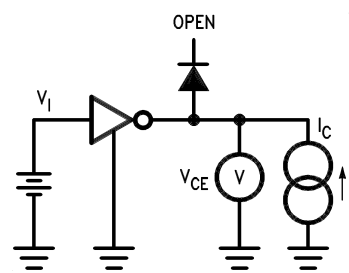


FIGURE 6.

DS009647-12

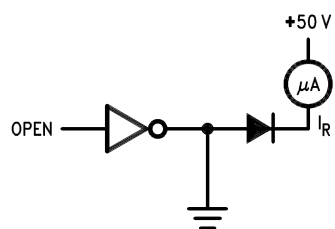


FIGURE 7.

DS009647-13

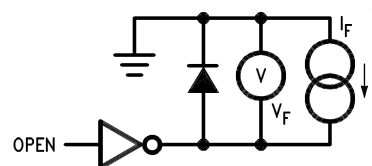
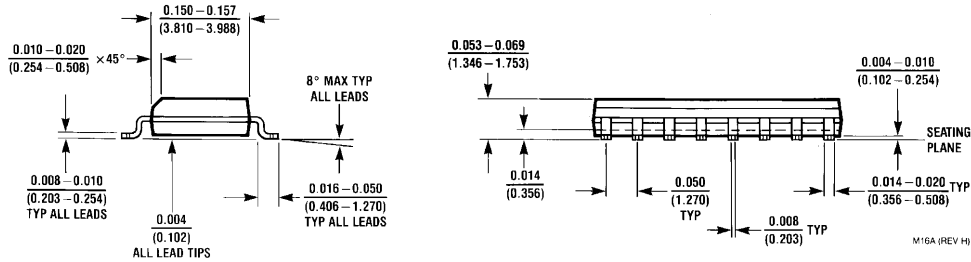
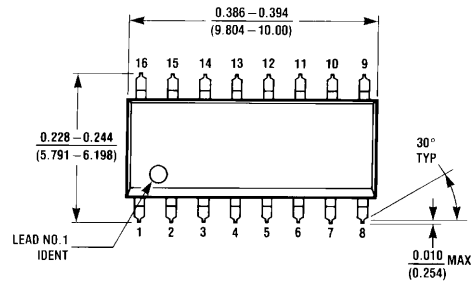


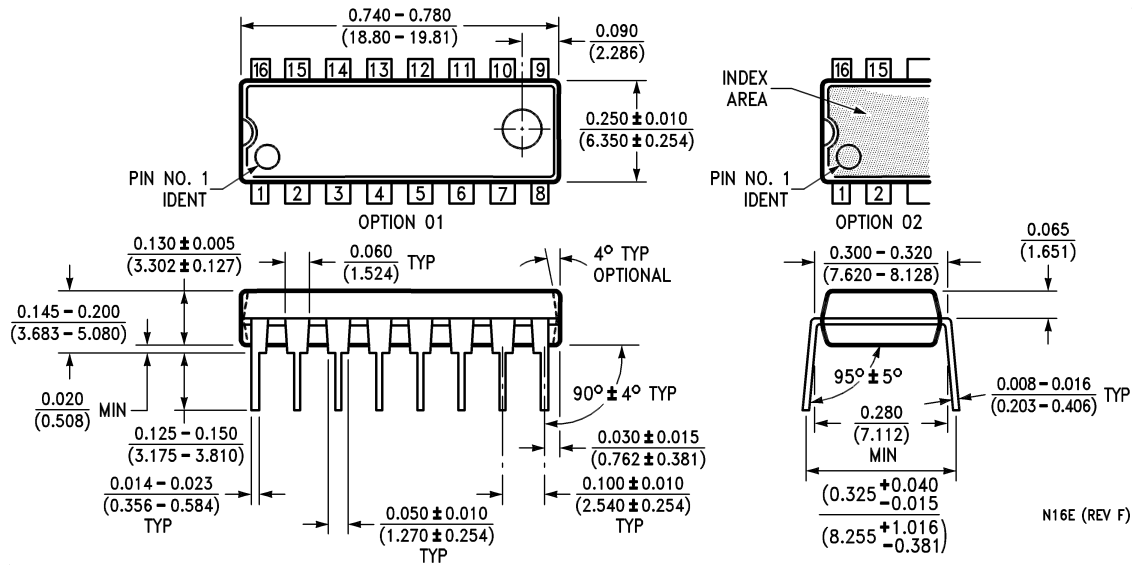
FIGURE 8.

DS009647-14

# Physical Dimensions inches (millimeters) unless otherwise noted



**Surface Mount Package (M)**  
**Order Number DS2003CM, DS2003TM**  
**NS Package Number M16A**



**Molded Dual-In-Line Package (N)**  
**Order Number DS2003CN, DS2003TN**  
**NS Package Number N16E**

## Notes

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