

## 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.

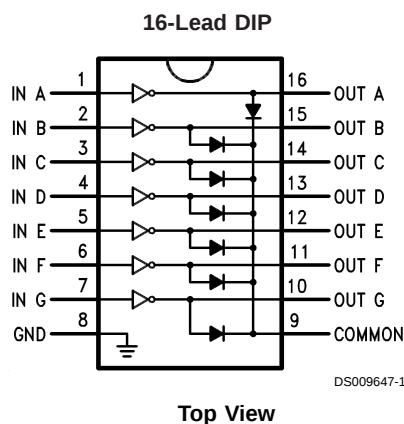
The DS2003 offers solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and

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.

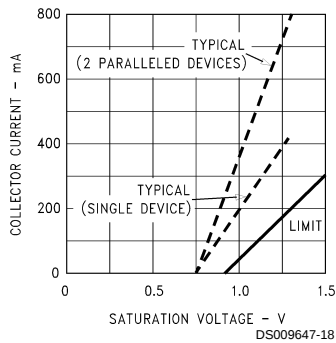
**Note 3:** Under normal operating conditions these units will sustain 350 mA per output with  $V_{CE(Sat)} = 1.6\text{V}$  at  $70^\circ\text{C}$  with a pulse width of 20 ms and a duty cycle of 30%.

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

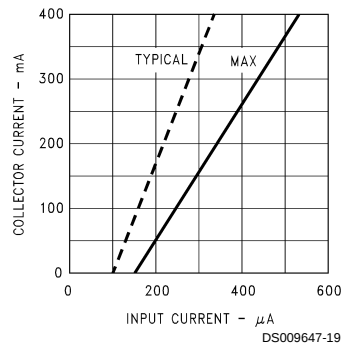
**Note 5:** The  $V_{I(ON)}$  voltage limit guarantees a minimum output sink current per the specified test conditions.

## Typical Performance Characteristics

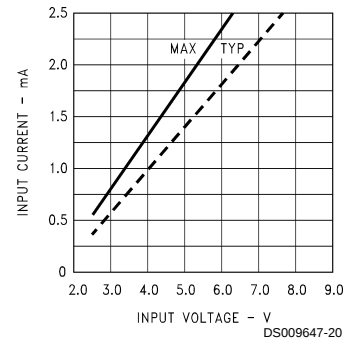
**Collector Current vs Saturation Voltage**



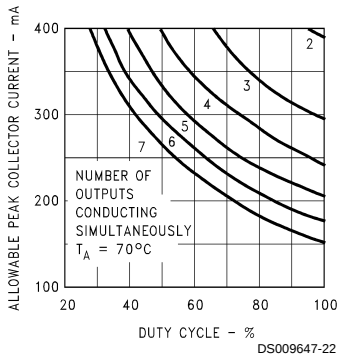
**Collector Current vs Input Current**



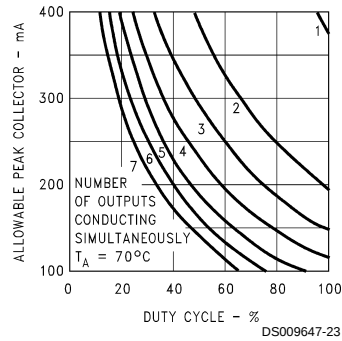
**Input Current vs Input Voltage**



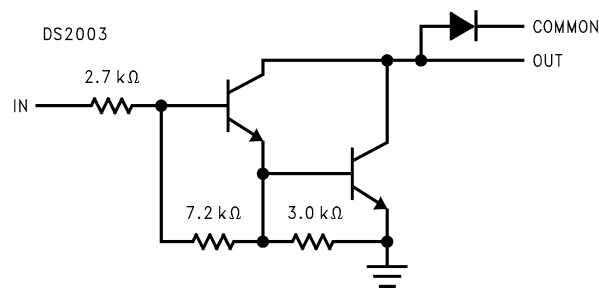
**Peak Collector Current vs Duty Cycle and Number of Outputs (Molded Package)**



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

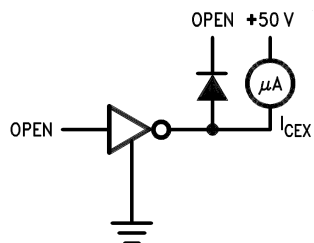


## Equivalent Circuits



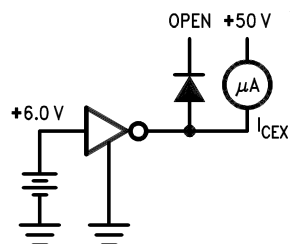
DS009647-3

# Test Circuits



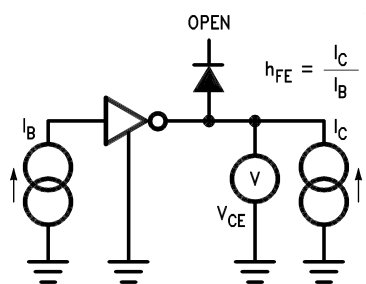
DS009647-7

FIGURE 1.



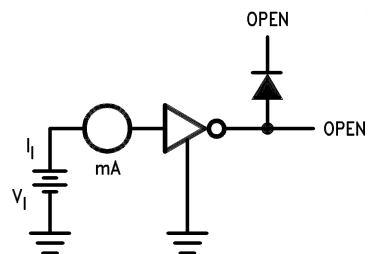
DS009647-8

FIGURE 2.



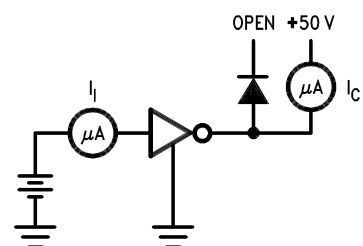
DS009647-9

FIGURE 3.



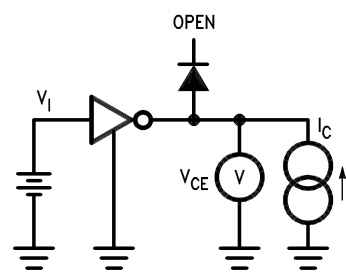
DS009647-10

FIGURE 4.



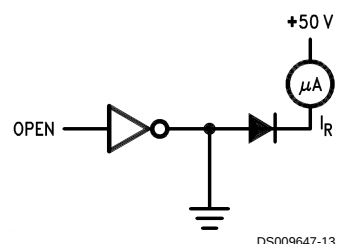
DS009647-11

FIGURE 5.



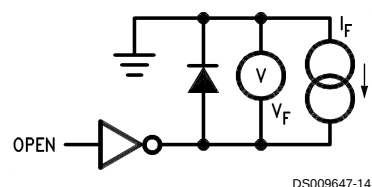
DS009647-12

FIGURE 6.



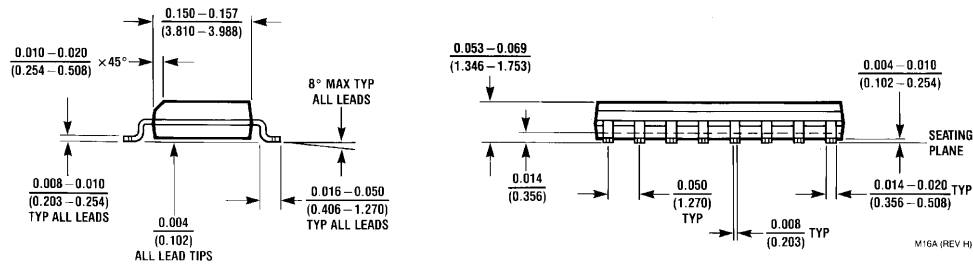
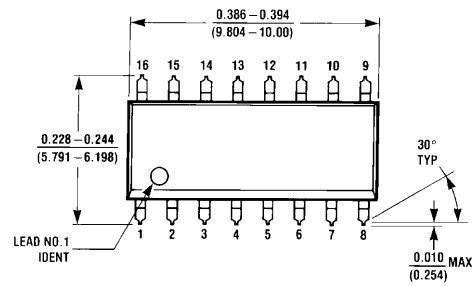
DS009647-13

FIGURE 7.

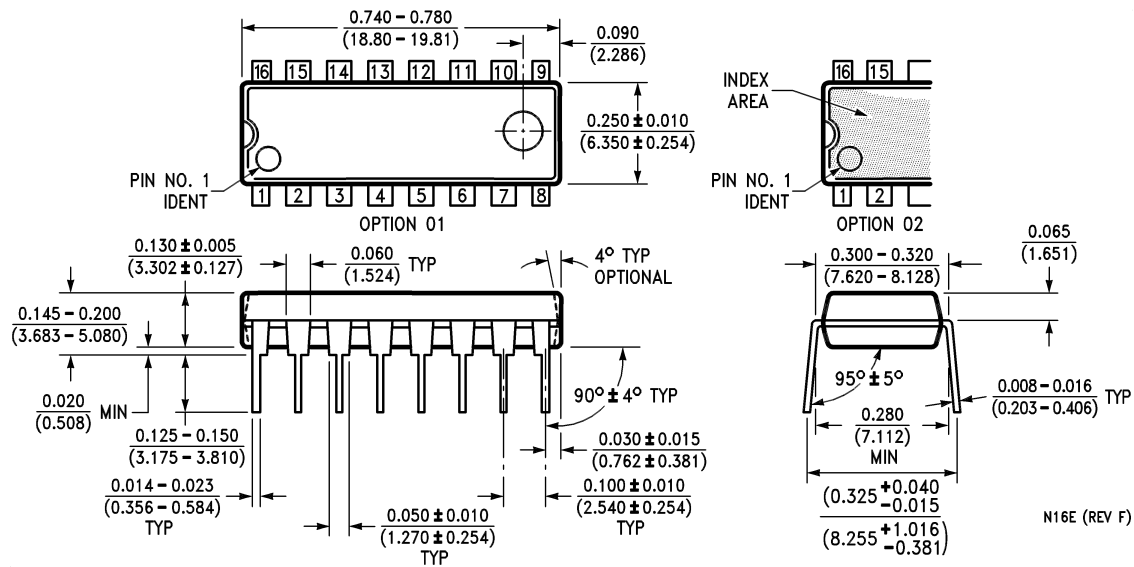


DS009647-14

FIGURE 8.



**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

### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com

www.national.com

**National Semiconductor Europe**  
Fax: +49 (0) 1 80-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 1 80-530 85 85  
English Tel: +49 (0) 1 80-532 78 32  
Français Tel: +49 (0) 1 80-532 93 58  
Italiano Tel: +49 (0) 1 80-534 16 80

**National Semiconductor Asia Pacific Customer Response Group**  
Tel: 65-2544466  
Fax: 65-2504466  
Email: sea.support@nsc.com

**National Semiconductor Japan Ltd.**  
Tel: 81-3-5639-7560  
Fax: 81-3-5639-7507