

# 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.

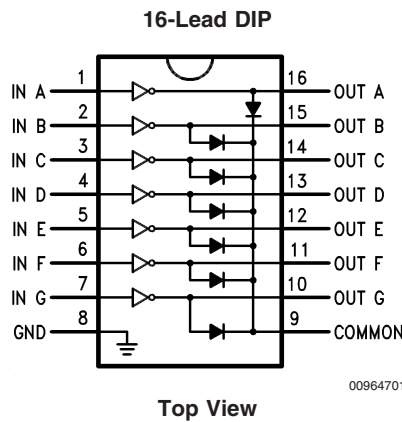
The DS2003 offers solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and

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

Operating Temperature Range	N Package Number N16E	SOIC Package Number M16A	TSSOP Package Number MT16
-40°C to +125°C	DS2003TN	DS2003TM	DS2003TMT
-40°C to +85°C	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, $T_A$	
DS2003T	-40°C to +125°C
DS2003C	-40°C to +85°C
Junction Temperature Range, $T_J$	-40°C to +150°C
Lead Temperature	
Soldering, 10 seconds	265°C

## ESD Ratings

Human Body Model	+/-2000V
Machine Model	+/- 200V

## Package Thermal Dissipation Ratings

MT16 Package $\theta_{J-A}$	130°C/W
N16E Package $\theta_{J-A}$	88°C/W
M16A Package $\theta_{J-A}$	115°C/W

Input Voltage	-0.3V to 30V
Output Voltage	55V
Emitter-Base Voltage	6.0V
Continuous Collector Current	500 mA
Continuous Base Current	25 mA

**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)			100	
		$T_A = 125^\circ\text{C}$ , $V_{CE} = 50\text{V}$ (Figure 1) for DS2003T			150	
$V_{CE(Sat)}$	Collector-Emitter Saturation Voltage	$I_C = 350\text{mA}$ , $I_B = 500\mu\text{A}$ (Figure 3) (Note 3)		1.25	1.6	V
		$I_C = 200\text{mA}$ , $I_B = 350\mu\text{A}$ (Figure 3)		1.1	1.3	
		$I_C = 100\text{mA}$ , $I_B = 250\mu\text{A}$ (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)	$I_C = 500\mu\text{A}$ (Figure 5)	50	100		$\mu\text{A}$
		$T_A = +25^\circ\text{C}$	50	100		$\mu\text{A}$
		$T_A = +85^\circ\text{C}$	25	50		$\mu\text{A}$
		$T_A = +125^\circ\text{C}$ for DS2003T	10	25		$\mu\text{A}$
$V_{I(ON)}$	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)				
		$T_A = 25^\circ\text{C}$		5	10	$\mu\text{A}$
		$T_A = 85^\circ\text{C}$		10	50	$\mu\text{A}$
		$T_A = 125^\circ\text{C}$ for DS2003T		20	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.

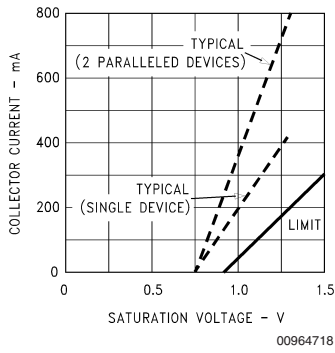
**Note 3:** Under normal operating conditions these units will sustain 350 mA per output with  $V_{CE(Sat)} = 1.6\text{V}$  at  $70^\circ\text{C}$  with a pulse width of 20 ms and a duty cycle of 30%.

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

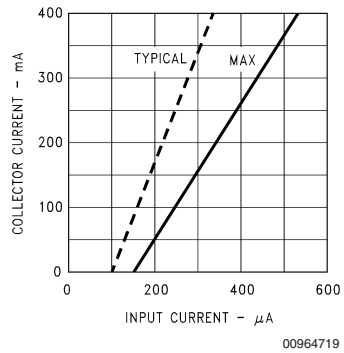
**Note 5:** The  $V_{I(ON)}$  voltage limit guarantees a minimum output sink current per the specified test conditions.

# Typical Performance Characteristics

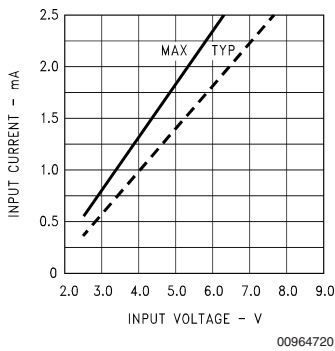
**Collector Current vs Saturation Voltage**



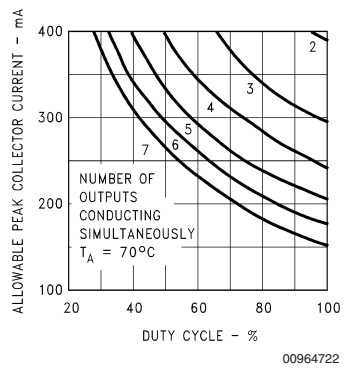
**Collector Current vs Input Current**



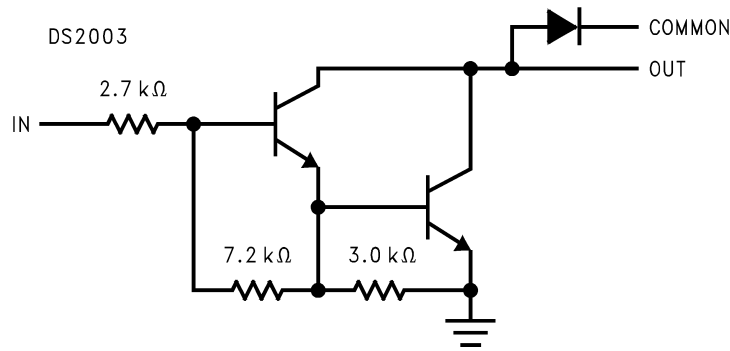
**Input Current vs Input Voltage**



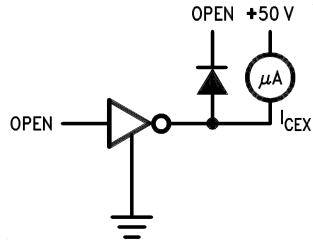
**Peak Collector Current vs Duty Cycle and Number of Outputs (N16E Package)**



## Equivalent Circuits

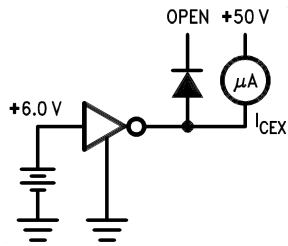


# Test Circuits



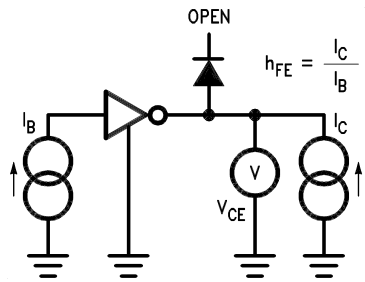
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FIGURE 1.



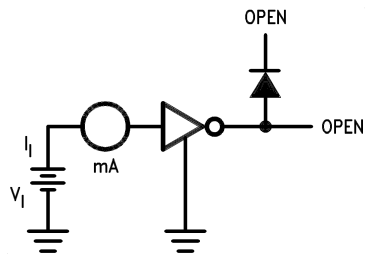
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FIGURE 2.



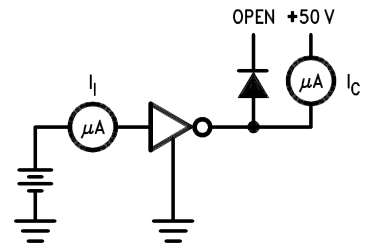
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FIGURE 3.



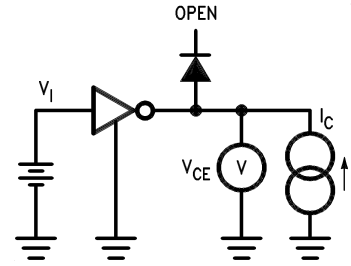
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FIGURE 4.



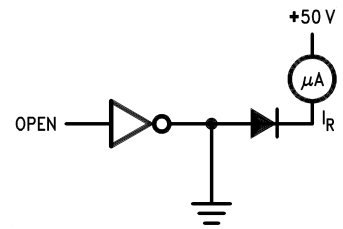
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FIGURE 5.



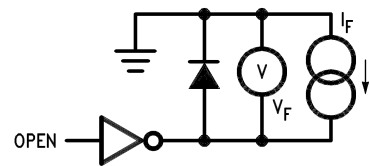
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FIGURE 6.



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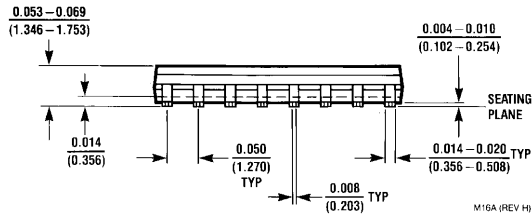
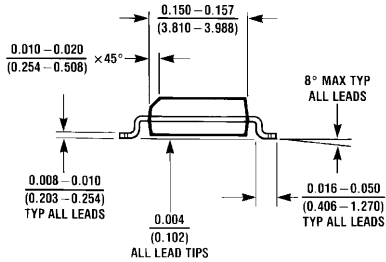
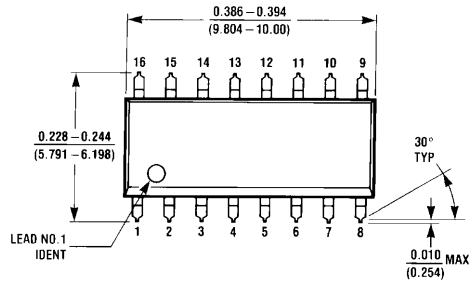
FIGURE 7.



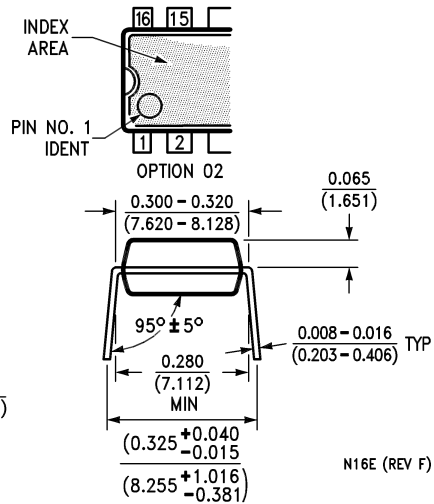
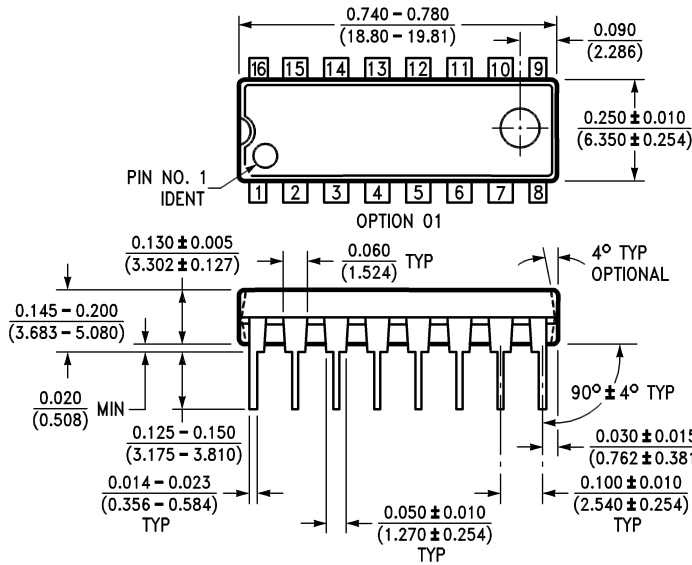
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FIGURE 8.

**Physical Dimensions** inches (millimeters) unless otherwise noted

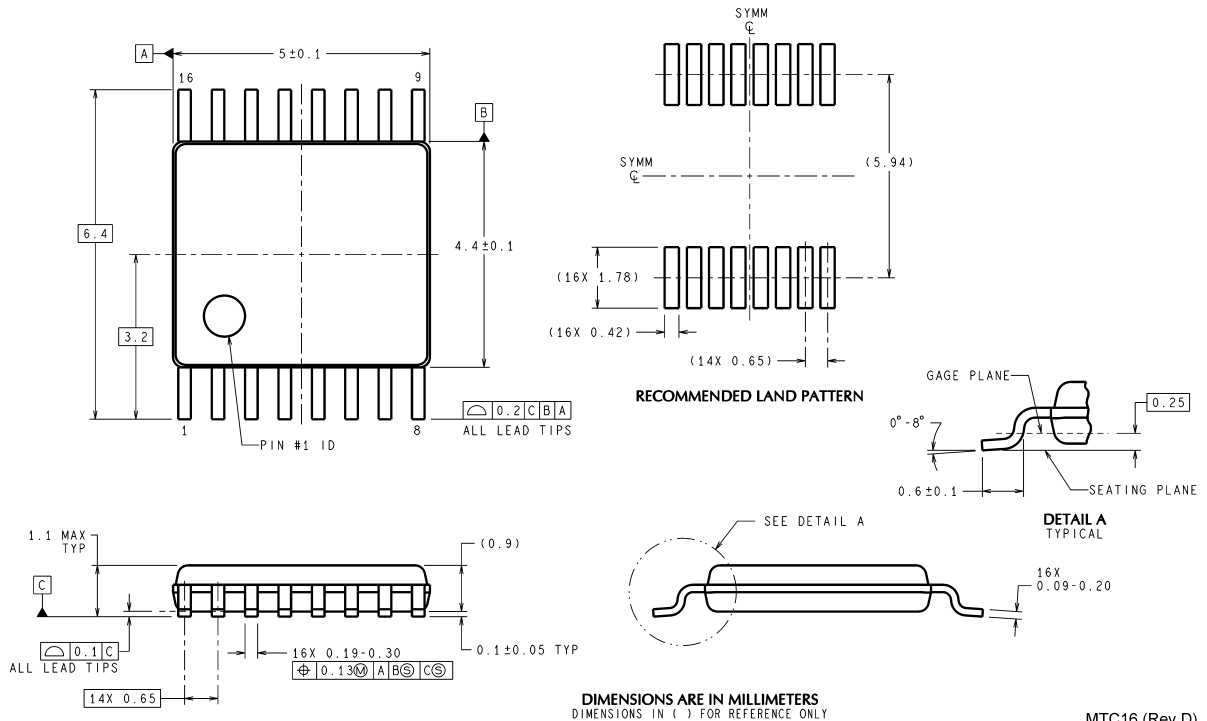


**SOIC Package (M)**  
**Order Number DS2003CM, DS2003TM**  
**NS Package Number M16A**



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

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**TSSOP Package (MT)**  
**Order Number DS2003TMT**  
**NS Package Number MTC16**

MTC16 (Rev D)

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