

## 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.

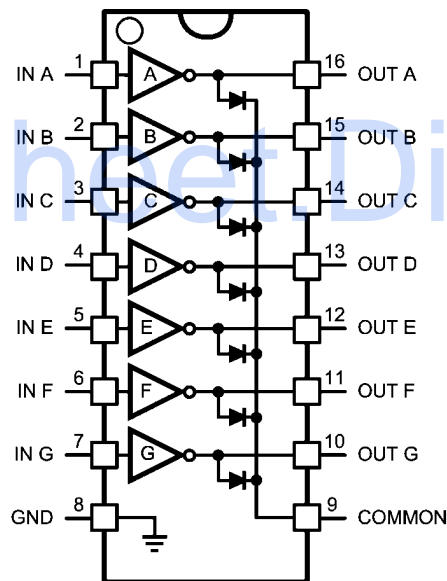
The DS2003 offers solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and LEDs. Applications requiring sink currents beyond the capability of

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



Top View

964701

## Ordering Information

Operating Temperature Range	Package Number	Order Number	Shipped As
-40°C to +125°C	M16A	DS2003TM	Rail of 48
		DS2003TMX	Reel of 2500
-40°C to +85°C	M16A	DS2003CM	Rail of 48
		DS2003CMX	Reel of 2500
	N16E	DS2003CN	Rail of 25

## 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	
N16E Package $\theta_{JA}$	88°C/W
M16A Package $\theta_{JA}$	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	$T_A = 25^\circ\text{C}$ , $V_{CE} = 50\text{V}$ <i>(Figure 1)</i>			20	$\mu\text{A}$
		$T_A = 85^\circ\text{C}$ , $V_{CE} = 50\text{V}$ <i>(Figure 1)</i>			100	
		$T_A = 125^\circ\text{C}$ , $V_{CE} = 50\text{V}$ <i>(Figure 1)</i> for DS2003T			150	
$V_{CE(Sat)}$	Collector-Emitter Saturation Voltage	$I_C = 350\text{mA}$ , $I_B = 500\mu\text{A}$ <i>(Figure 3)</i> <i>(Note 3)</i>		1.25	1.6	V
		$I_C = 200\text{mA}$ , $I_B = 350\mu\text{A}$ <i>(Figure 3)</i>		1.1	1.3	
		$I_C = 100\text{mA}$ , $I_B = 250\mu\text{A}$ <i>(Figure 3)</i>		0.9	1.1	
$I_{I(ON)}$	Input Current	$V_I = 3.85\text{V}$ <i>(Figure 4)</i>		0.93	1.35	mA
$I_{I(OFF)}$	Input Current <i>(Note 4)</i>	$I_C = 500\mu\text{A}$ <i>(Figure 5)</i>	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 <i>(Note 5)</i>	$V_{CE} = 2.0\text{V}$ , $I_C = 200\text{mA}$ <i>(Figure 6)</i>			2.4	V
		$V_{CE} = 2.0\text{V}$ , $I_C = 250\text{mA}$ <i>(Figure 6)</i>			2.7	
		$V_{CE} = 2.0\text{V}$ , $I_C = 300\text{mA}$ <i>(Figure 6)</i>			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	$V_R = 50\text{V}$ <i>(Figure 7)</i>				
		$T_A = 25^\circ\text{C}$		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	$I_F = 350\text{mA}$ <i>(Figure 8)</i>		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.

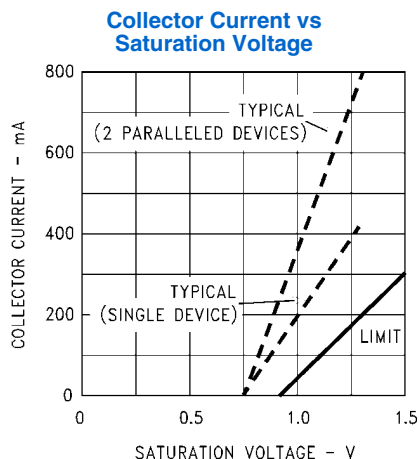
**Note 2:** All limits apply to the complete Darlington series except as specified for a single device type.

**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%.

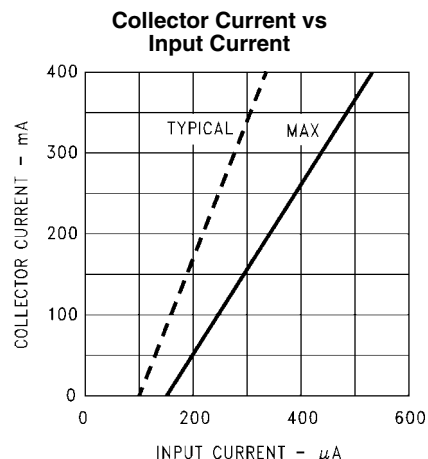
**Note 4:** The  $I_{I(OFF)}$  current limit guaranteed against partial turn-on of the output.

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

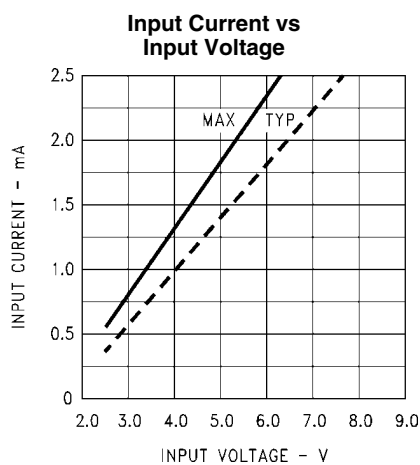
## Typical Performance Characteristics



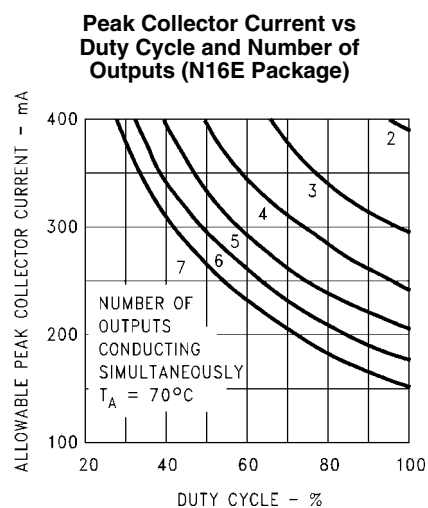
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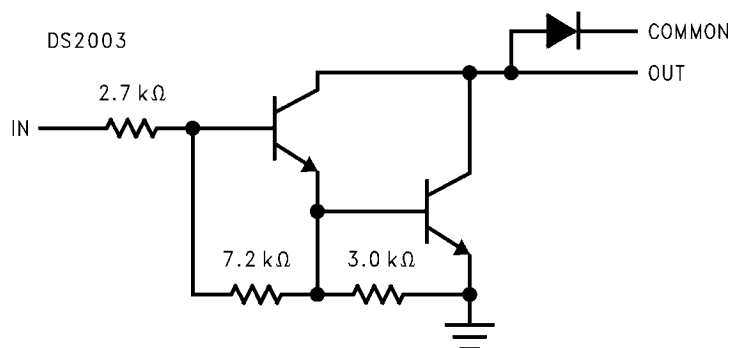


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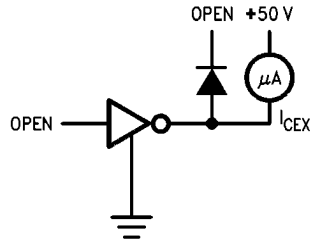
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## Equivalent Circuits



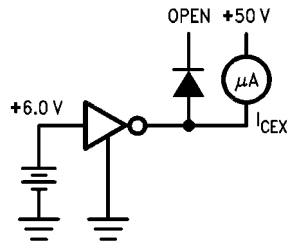
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## Test Circuits



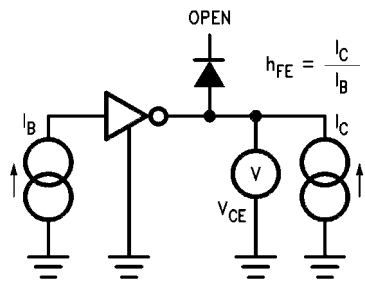
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FIGURE 1.



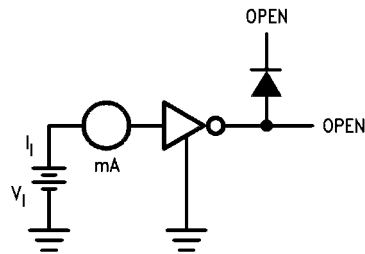
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FIGURE 2.



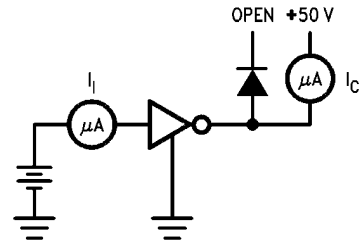
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FIGURE 3.



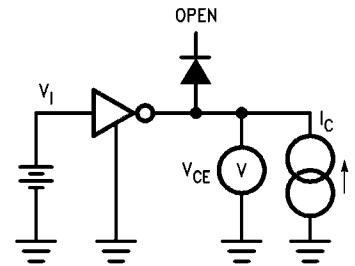
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FIGURE 4.



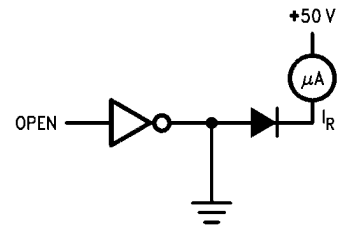
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FIGURE 5.



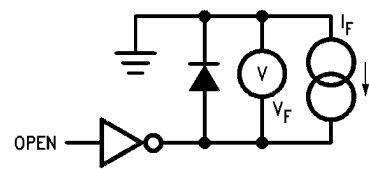
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FIGURE 6.



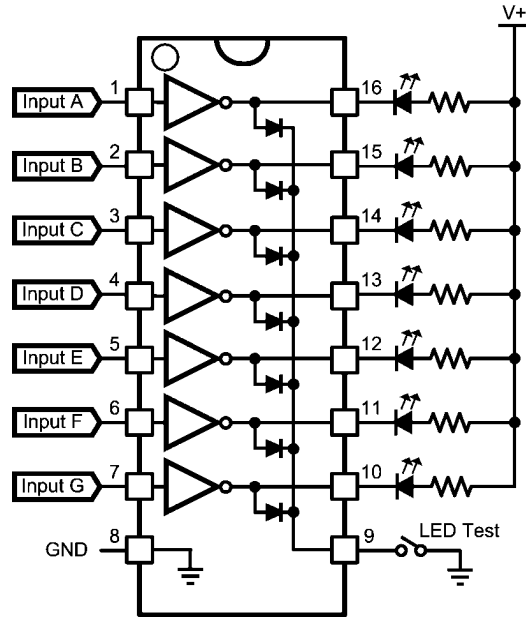
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FIGURE 7.



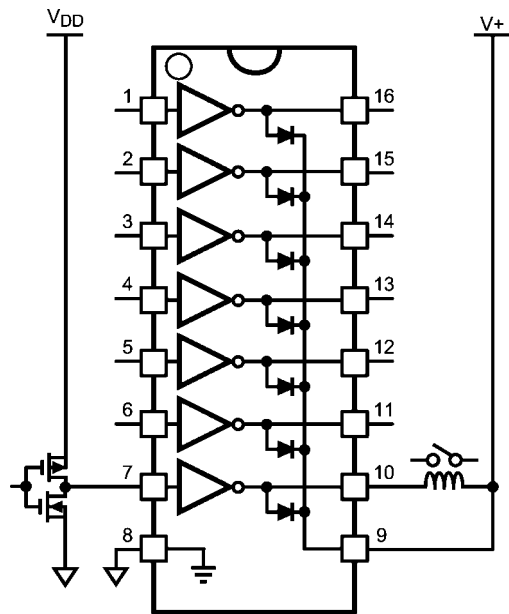
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FIGURE 8.



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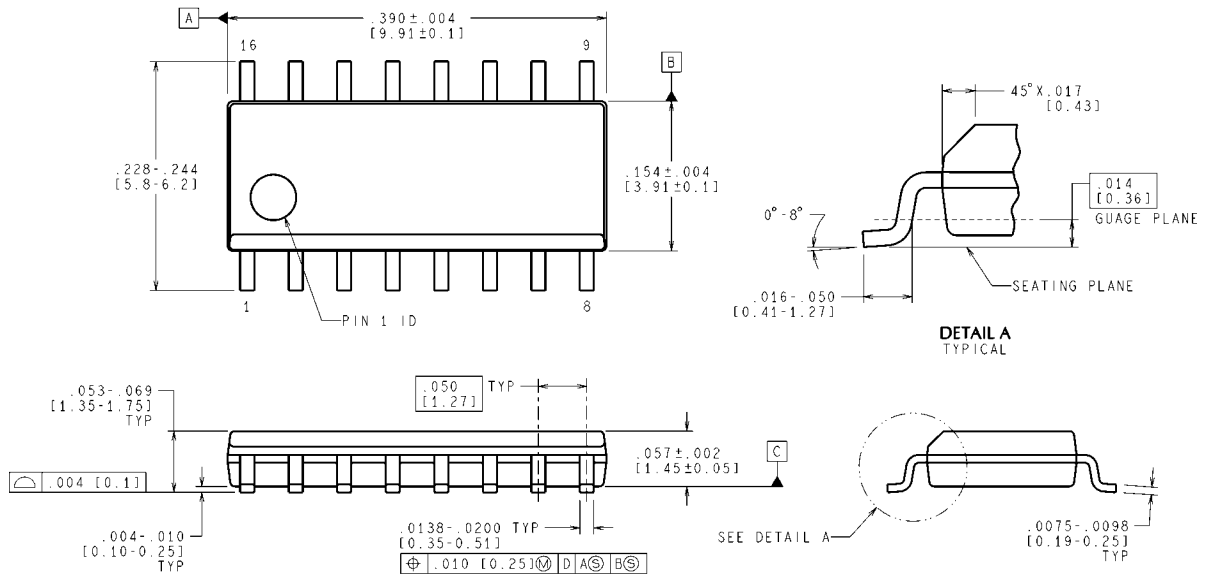
FIGURE 9. Typical LED Driver



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FIGURE 10. Typical Relay Driver

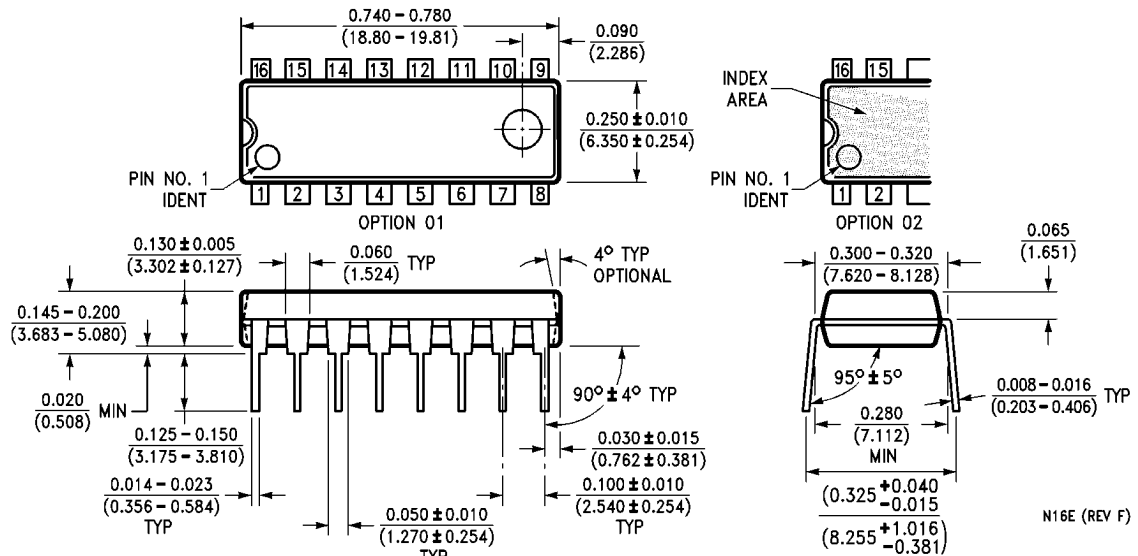
# Physical Dimensions inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

M16A (Rev J)

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



N16E (REV F)

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

## Notes

## Notes

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Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage Reference	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Solutions	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
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