

## DS2003 High Current/Voltage Darlington Drivers

Check for Samples: [DS2003](#)

### 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

### DESCRIPTION

The DS2003 comprises seven high voltage, high current NPN Darlington transistor pairs. All units feature a common emitter and 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.

### Connection Diagram

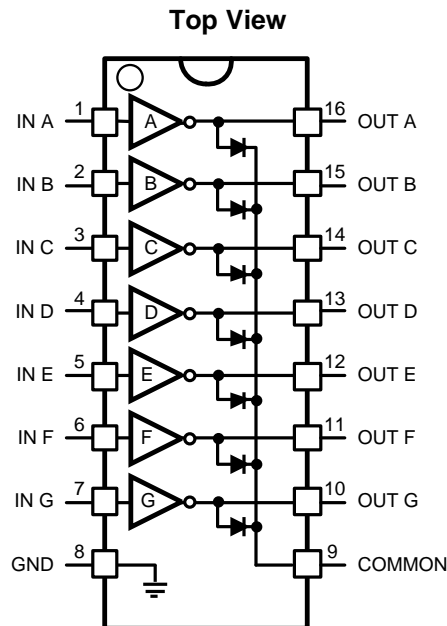


Figure 1.



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings<sup>(1)(2)</sup>

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	
NFG0016E Package $\theta_{JA}$	88°C/W
D0016A 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

- (1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be specified. They are not meant to imply that the devices should be operated at these limits. The [Electrical Characteristics](#) provide conditions for actual device operation.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.

## Electrical Characteristics

$T_A = 25^\circ\text{C}$ , unless otherwise specified <sup>(1)</sup>

Parameter		Test Conditions	Min	Typ	Max	Units
$I_{CEX}$	Output Leakage Current	$T_A = 25^\circ\text{C}$ , $V_{CE} = 50\text{V}$ ( <a href="#">Figure 6</a> )			20	$\mu\text{A}$
		$T_A = 85^\circ\text{C}$ , $V_{CE} = 50\text{V}$ ( <a href="#">Figure 6</a> )			100	
		$T_A = 125^\circ\text{C}$ , $V_{CE} = 50\text{V}$ ( <a href="#">Figure 6</a> ) for DS2003T			150	
$V_{CE(Sat)}$	Collector-Emitter Saturation Voltage	$I_C = 350\text{mA}$ , $I_B = 500\mu\text{A}$ ( <a href="#">Figure 8</a> ) <sup>(2)</sup>		1.25	1.6	V
		$I_C = 200\text{mA}$ , $I_B = 350\mu\text{A}$ ( <a href="#">Figure 8</a> )		1.1	1.3	
		$I_C = 100\text{mA}$ , $I_B = 250\mu\text{A}$ ( <a href="#">Figure 8</a> )		0.9	1.1	
$I_{I(ON)}$	Input Current	$V_I = 3.85\text{V}$ ( <a href="#">Figure 9</a> )		0.93	1.35	mA
$I_{I(OFF)}$	Input Current <sup>(3)</sup>	$I_C = 500\mu\text{A}$ ( <a href="#">Figure 10</a> )	50	100		$\mu\text{A}$
		$T_A = +25^\circ\text{C}$	50	100		
		$T_A = +85^\circ\text{C}$	25	50		
		$T_A = +125^\circ\text{C}$ for DS2003T	10	25		
$V_{I(ON)}$	Input Voltage <sup>(4)</sup>	$V_{CE} = 2.0\text{V}$ , $I_C = 200\text{mA}$ ( <a href="#">Figure 11</a> )			2.4	V
		$V_{CE} = 2.0\text{V}$ , $I_C = 250\text{mA}$ ( <a href="#">Figure 11</a> )			2.7	
		$V_{CE} = 2.0\text{V}$ , $I_C = 300\text{mA}$ ( <a href="#">Figure 11</a> )			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	$\mu\text{s}$

- (1) All limits apply to the complete Darlington series except as specified for a single device type.
- (2) 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%.
- (3) The  $I_{I(OFF)}$  current limit ensured against partial turn-on of the output.
- (4) The  $V_{I(ON)}$  voltage limit ensures a minimum output sink current per the specified test conditions.

## Electrical Characteristics (continued)

 $T_A = 25^{\circ}\text{C}$ , unless otherwise specified <sup>(1)</sup>

Parameter		Test Conditions	Min	Typ	Max	Units
$I_R$	Clamp Diode Leakage Current	$V_R = 50\text{V}$ ( <a href="#">Figure 12</a> )				$\mu\text{A}$
		$T_A = 25^{\circ}\text{C}$		5	10	
		$T_A = 85^{\circ}\text{C}$		10	50	
		$T_A = 125^{\circ}\text{C}$ for DS2003T		20	100	
$V_F$	Clamp Diode Forward Voltage	$I_F = 350\text{mA}$ ( <a href="#">Figure 13</a> )		1.7	2.0	V

## Typical Performance Characteristics

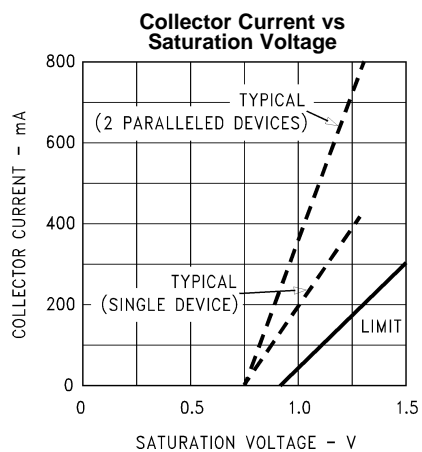


Figure 2.

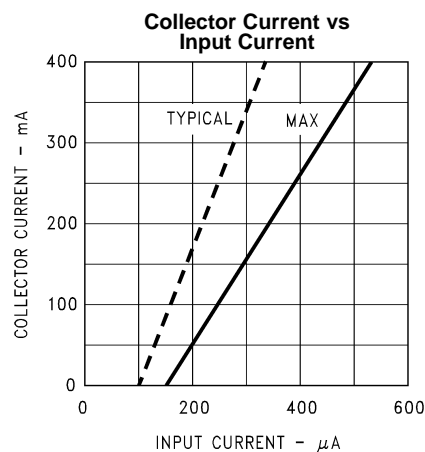


Figure 3.

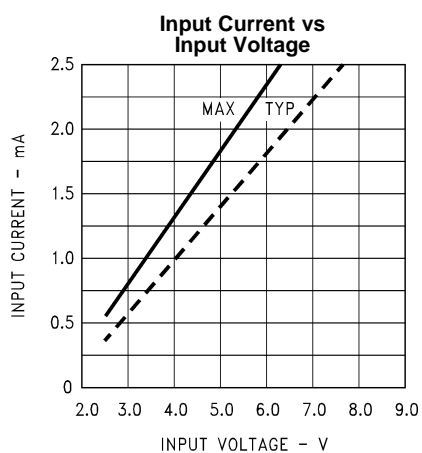


Figure 4.

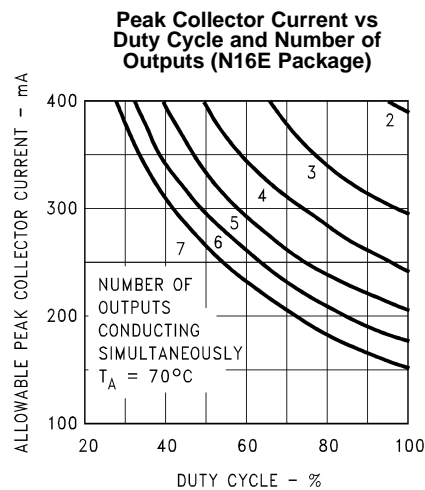
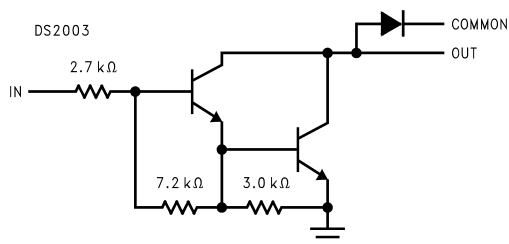
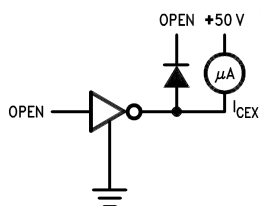


Figure 5.

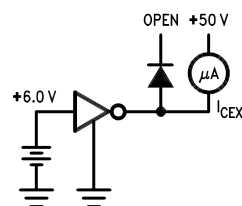
## EQUIVALENT CIRCUITS



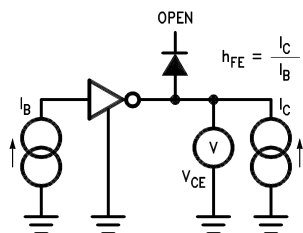
## Test Circuits



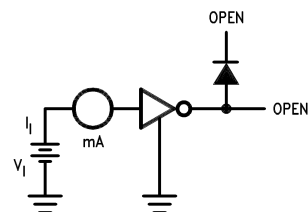
**Figure 6.**



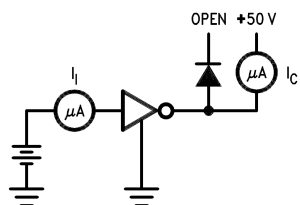
**Figure 7.**



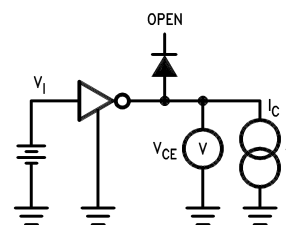
**Figure 8.**



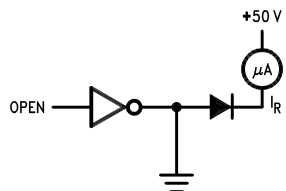
**Figure 9.**



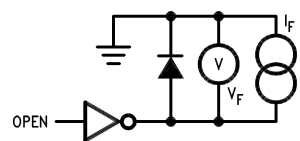
**Figure 10.**



**Figure 11.**



**Figure 12.**



**Figure 13.**

## Typical Applications

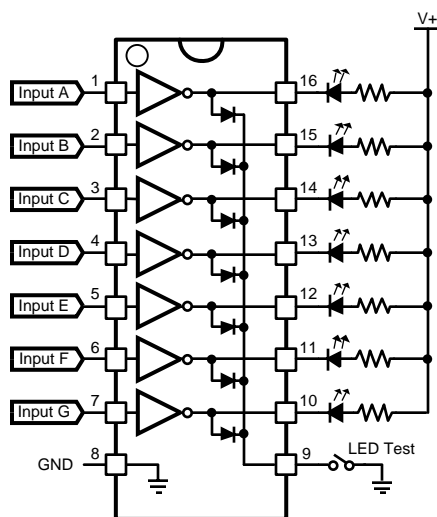


Figure 14. Typical LED Driver

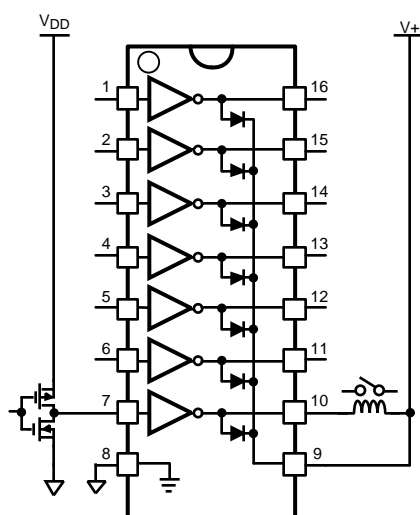


Figure 15. Typical Relay Driver

## REVISION HISTORY

Changes from Revision I (April 2013) to Revision J	Page
<ul style="list-style-type: none"><li>Changed layout of National Data Sheet to TI format .....</li></ul>	<a href="#">6</a>

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DS2003CM	ACTIVE	SOIC	D	16	48	TBD	Call TI	Call TI	-40 to 125	DS2003CM	<a href="#">Samples</a>
DS2003CM/NOPB	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	DS2003CM	<a href="#">Samples</a>
DS2003CMX/NOPB	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	DS2003CM	<a href="#">Samples</a>
DS2003TM	ACTIVE	SOIC	D	16	48	TBD	Call TI	Call TI	-40 to 125	DS2003TM	<a href="#">Samples</a>
DS2003TM/NOPB	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	DS2003TM	<a href="#">Samples</a>
DS2003TMX	ACTIVE	SOIC	D	16	2500	TBD	Call TI	Call TI	-40 to 125	DS2003TM	<a href="#">Samples</a>
DS2003TMX/NOPB	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	DS2003TM	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS2003CMX/NOPB	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.3	8.0	16.0	Q1
DS2003TMX	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.3	8.0	16.0	Q1
DS2003TMX/NOPB	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.3	8.0	16.0	Q1

## TAPE AND REEL BOX DIMENSIONS

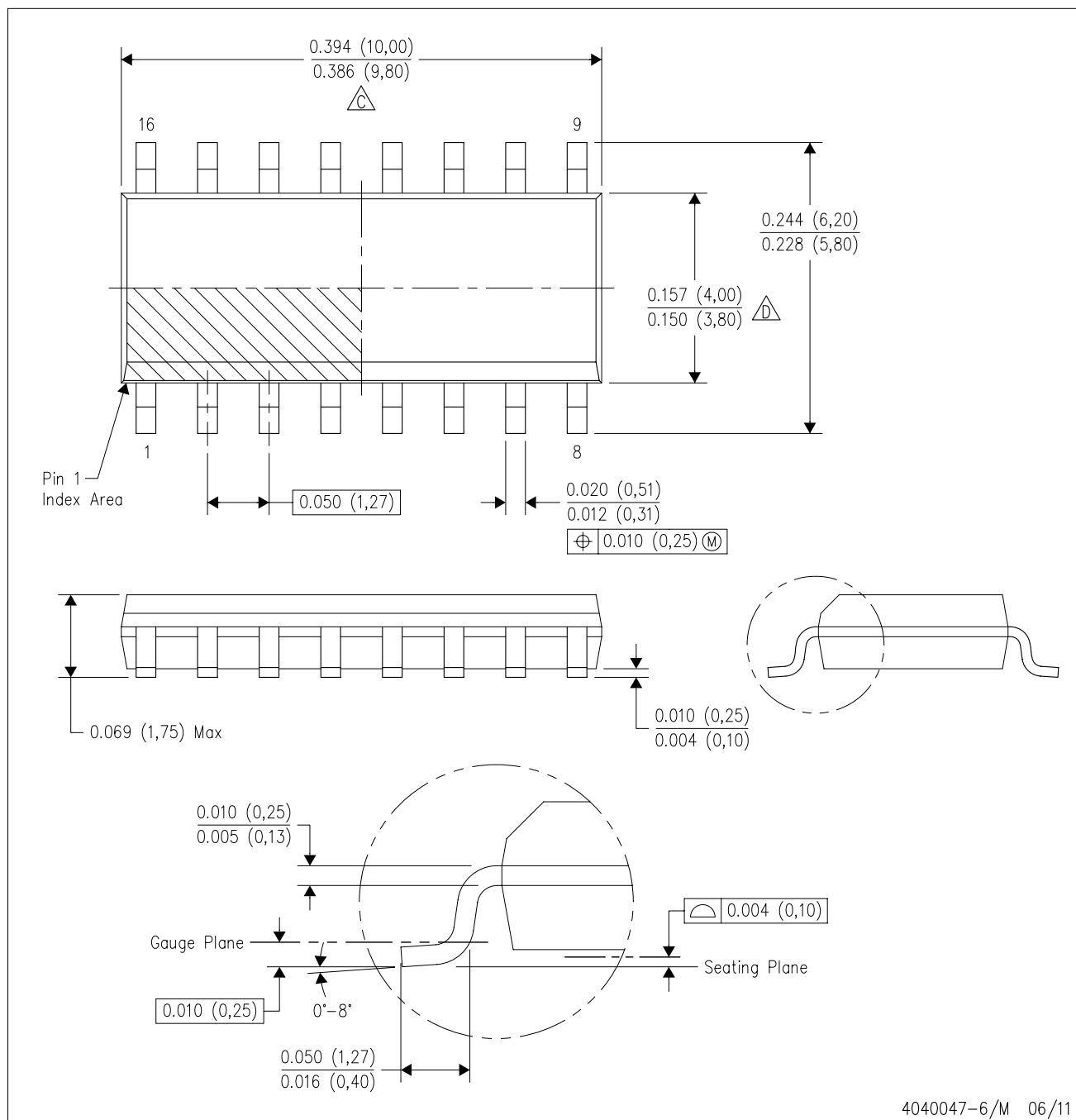


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS2003CMX/NOPB	SOIC	D	16	2500	367.0	367.0	35.0
DS2003TMX	SOIC	D	16	2500	367.0	367.0	35.0
DS2003TMX/NOPB	SOIC	D	16	2500	367.0	367.0	35.0

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.

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