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 ($I_C = 350 mA$)
- 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.
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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Temperature Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range, $T_A$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS2003T</td>
<td>$-65^\circ C$ to $+150^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS2003C</td>
<td>$-40^\circ C$ to $+125^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Temperature Range, $T_J$</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soldering, 10 seconds</td>
<td></td>
<td></td>
<td></td>
<td>$265^\circ C$</td>
<td></td>
</tr>
<tr>
<td>Lead Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Body Model</td>
<td></td>
<td></td>
<td></td>
<td>+/-2000V</td>
<td></td>
</tr>
<tr>
<td>Machine Model</td>
<td></td>
<td></td>
<td></td>
<td>+/-2000V</td>
<td></td>
</tr>
<tr>
<td>Package Thermal Dissipation Ratings</td>
<td></td>
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<td></td>
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<tr>
<td>NFG0016E Package $\theta_{JA}$</td>
<td></td>
<td></td>
<td></td>
<td>$88^\circ C/W$</td>
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<tr>
<td>D0016A Package $\theta_{JA}$</td>
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<td></td>
<td></td>
<td>$115^\circ C/W$</td>
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<tr>
<td>Input Voltage</td>
<td></td>
<td>$-0.3V$ to $30V$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td></td>
<td></td>
<td></td>
<td>$55V$</td>
<td></td>
</tr>
<tr>
<td>ESD Ratings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Body Model</td>
<td></td>
<td></td>
<td></td>
<td>+/-2000V</td>
<td></td>
</tr>
<tr>
<td>Machine Model</td>
<td></td>
<td></td>
<td></td>
<td>+/-2000V</td>
<td></td>
</tr>
<tr>
<td>Electrical Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(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**

$T_A = 25^\circ C$, unless otherwise specified \(^{(1)}\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{CEX}$ Output Leakage Current</td>
<td>$T_A = 25^\circ C$, $V_{CE} = 50V$ (Figure 6)</td>
<td>20</td>
<td></td>
<td></td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td>$T_A = 85^\circ C$, $V_{CE} = 50V$ (Figure 6)</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_A = 125^\circ C$, $V_{CE} = 50V$ (Figure 6) for DS2003T</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$V_{CE(Sat)}$ Collector-Emitter Saturation Voltage</td>
<td>$I_C = 350mA$, $I_B = 500\mu A$ (Figure 8)(^{(2)})</td>
<td>1.25</td>
<td>1.6</td>
<td></td>
<td>$V$</td>
</tr>
<tr>
<td></td>
<td>$I_C = 200mA$, $I_B = 350\mu A$ (Figure 8)</td>
<td>1.1</td>
<td>1.3</td>
<td></td>
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<tr>
<td></td>
<td>$I_C = 100mA$, $I_B = 250\mu A$ (Figure 8)</td>
<td>0.9</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{I(ON)}$ Input Current</td>
<td>$V_I = 3.85V$ (Figure 9)</td>
<td>0.93</td>
<td>1.35</td>
<td>$mA$</td>
<td></td>
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<tr>
<td>$I_{I(OFF)}$ Input Current (^{(3)})</td>
<td>$I_C = 500\mu A$ (Figure 10)</td>
<td>50</td>
<td>100</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_A = +25^\circ C$</td>
<td>50</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_A = +85^\circ C$</td>
<td>25</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_A = +125^\circ C$ for DS2003T</td>
<td>10</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{I(ON)}$ Input Voltage (^{(4)})</td>
<td>$V_{CE} = 2.0V$, $I_C = 200mA$ (Figure 11)</td>
<td>2.4</td>
<td></td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{CE} = 2.0V$, $I_C = 250mA$ (Figure 11)</td>
<td>2.7</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>$V_{CE} = 2.0V$, $I_C = 300mA$ (Figure 11)</td>
<td>3.0</td>
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<tr>
<td>$C_I$ Input Capacitance</td>
<td></td>
<td>15</td>
<td>30</td>
<td>$pF$</td>
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<tr>
<td>$I_{PLH}$ Turn-On Delay</td>
<td>$0.5V_I$ to $0.5V_O$</td>
<td>1.0</td>
<td></td>
<td>$\mu s$</td>
<td></td>
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<tr>
<td>$I_{PHL}$ Turn-Off Delay</td>
<td>$0.5V_I$ to $0.5V_O$</td>
<td>1.0</td>
<td></td>
<td>$\mu s$</td>
<td></td>
</tr>
</tbody>
</table>

(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 $V_{CE(Sat)} = 1.6V$ at $70^\circ C$ 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)

$T_A = 25^\circ C$, unless otherwise specified \(^{(1)}\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
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<tr>
<td>$I_R$</td>
<td>Clamp Diode</td>
<td></td>
<td></td>
<td></td>
<td>µA</td>
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<tr>
<td></td>
<td>Leakage Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_R = 50V$ (Figure 12)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>$T_A = 25^\circ C$</td>
<td>5</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_A = 85^\circ C$</td>
<td>10</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_A = 125^\circ C$ for DS2003T</td>
<td>20</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_F$</td>
<td>Clamp Diode</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Forward Voltage</td>
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<tr>
<td></td>
<td>$I_F = 350mA$ (Figure 13)</td>
<td>1.7</td>
<td>2.0</td>
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</table>
Typical Performance Characteristics

**Figure 2.** Collector Current vs Saturation Voltage

**Figure 3.** Collector Current vs Input Current

**Figure 4.** Input Current vs Input Voltage

**Figure 5.** Peak Collector Current vs Duty Cycle and Number of Outputs (N16E Package)
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

<table>
<thead>
<tr>
<th>Changes from Revision I (April 2013) to Revision J</th>
<th>Page</th>
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<tbody>
<tr>
<td>• Changed layout of National Data Sheet to TI format</td>
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## PACKAGING INFORMATION

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<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish (3)</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
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<tr>
<td>DS2003CM</td>
<td>LIFEBUY</td>
<td>SOIC D</td>
<td>16</td>
<td>48</td>
<td>TBD</td>
<td>Call TI</td>
<td>Call TI</td>
<td>-40 to 85</td>
<td>DS2003CM</td>
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<tr>
<td>DS2003CM/NOPB</td>
<td>LIFEBUY</td>
<td>SOIC D</td>
<td>16</td>
<td>48</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU SN</td>
<td>Level-1-260C-UNLIM</td>
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<td>DS2003CM</td>
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<td>DS2003CMX/NOPB</td>
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<td>SOIC D</td>
<td>16</td>
<td>48</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU SN</td>
<td>Level-1-260C-UNLIM</td>
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<td>DS2003CM</td>
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<tr>
<td>DS2003TM</td>
<td>LIFEBUY</td>
<td>SOIC D</td>
<td>16</td>
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<td>TBD</td>
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<td>-40 to 125</td>
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<td>DS2003TM/NOPB</td>
<td>LIFEBUY</td>
<td>SOIC D</td>
<td>16</td>
<td>48</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU SN</td>
<td>Level-1-260C-UNLIM</td>
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<td>DS2003TM</td>
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<td>DS2003TMX</td>
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<td>Green (RoHS &amp; no Sb/Br)</td>
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<td>-40 to 125</td>
<td>DS2003TM</td>
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</table>

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
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- **Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

(5) 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.

(6) **Lead/Ball Finish** - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.
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B. This drawing is subject to change without notice.
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.
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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