LP395 Ultra Reliable Power Transistor

Check for Samples: LP395

FEATURES
- Internal Thermal Limiting
- Internal Current and Power Limiting
- Specified 100 mA Output Current
- 0.5 μA Typical Base Current
- Directly Interfaces with TTL or CMOS
- +36 Volts On Base Causes No Damage
- 2 μs Switching Time

DESCRIPTION
The LP395 is a fast monolithic transistor with complete overload protection. This very high gain transistor has included on the chip, current limiting, power limiting, and thermal overload protection, making it difficult to destroy from almost any type of overload. Available in an epoxy TO-92 transistor package this device is specified to deliver 100 mA.

Thermal limiting at the chip level, a feature not available in discrete designs, provides comprehensive protection against overload. Excessive power dissipation or inadequate heat sinking causes the thermal limiting circuitry to turn off the device preventing excessive die temperature.

The LP395 offers a significant increase in reliability while simplifying protection circuitry. It is especially attractive as a small incandescent lamp or solenoid driver because of its low drive requirements and blowout-proof design.

Connection Diagram

Typical Applications

Figure 1. TO-92 Package
See NS Package LP0003A

Figure 2. Fully Protected Lamp Driver

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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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Tested Limit</th>
<th>Design Limit</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector to Emitter Voltage</td>
<td>0.5 mA ≤ IC ≤ 100 mA</td>
<td>36</td>
<td>36 (3)</td>
<td>V(Max)</td>
</tr>
<tr>
<td>Collector to Base Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base to Emitter Voltage (Forward)</td>
<td>VN= 2V, VC= 36V</td>
<td>45</td>
<td>25</td>
<td>mA(Min)</td>
</tr>
<tr>
<td>Base to Emitter Voltage (Reverse)</td>
<td>VN= 2V, VC= 15V</td>
<td>90</td>
<td>60</td>
<td>mA(Min)</td>
</tr>
<tr>
<td>Base to Emitter Current (Reverse)</td>
<td>VN= 2V, 2V ≤ VC ≤ 6V</td>
<td>130</td>
<td>100</td>
<td>mA(Min)</td>
</tr>
<tr>
<td>Collector Current Limit</td>
<td>0 ≤ IC ≤ 100 mA</td>
<td>-0.3</td>
<td>-2.0</td>
<td>μA(Max)</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>Internally Limited</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-40°C to +125°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-65°C to +150°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Temp. (Soldering, 10 seconds)</td>
<td>260°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits.

**ELECTRICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Typical</th>
<th>Tested Limit</th>
<th>Design Limit</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCE</td>
<td>Collector to Emitter Voltage</td>
<td>0.5 mA ≤ IC ≤ 100 mA</td>
<td></td>
<td>36</td>
<td>36 (3)</td>
<td>V(Max)</td>
</tr>
<tr>
<td>ICL</td>
<td>Collector Current Limit</td>
<td>VN= 2V, VC= 36V</td>
<td>45</td>
<td>25</td>
<td>20</td>
<td>mA(Min)</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>VN= 2V, VC= 15V</td>
<td>90</td>
<td>60</td>
<td>50</td>
<td>mA(Min)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VN= 2V, 2V ≤ VC ≤ 6V</td>
<td>130</td>
<td>100</td>
<td>100</td>
<td>mA(Min)</td>
</tr>
<tr>
<td>IB</td>
<td>Base Current</td>
<td>0 ≤ IC ≤ 100 mA</td>
<td>-0.3</td>
<td>-2.0</td>
<td>-2.5</td>
<td>μA(Max)</td>
</tr>
<tr>
<td>IQ</td>
<td>Quiescent Current</td>
<td>VN= 0V, 0 ≤ VC ≤ 36V</td>
<td>0.24</td>
<td>0.50</td>
<td>0.60</td>
<td>mA(Max)</td>
</tr>
<tr>
<td>VCESAT</td>
<td>Saturation Voltage</td>
<td>VN= 2V, IC= 100 mA</td>
<td>1.82</td>
<td>2.00</td>
<td>2.10</td>
<td>V(Max)</td>
</tr>
<tr>
<td>BVBE</td>
<td>Base to Emitter Breakdown Voltage</td>
<td>0 ≤ VC ≤ 36V, IB = 2 μA</td>
<td>36</td>
<td>36</td>
<td>V(Min)</td>
<td></td>
</tr>
<tr>
<td>VBE</td>
<td>Base to Emitter Voltage</td>
<td>IC= 5 mA</td>
<td>0.69</td>
<td>0.79</td>
<td>0.90</td>
<td>V(Max)</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>IC= 100 mA (4)</td>
<td>1.02</td>
<td>1.40</td>
<td>V(Max)</td>
<td></td>
</tr>
<tr>
<td>IS</td>
<td>Switching Time</td>
<td>VC= 20V, RL= 200Ω</td>
<td>2</td>
<td></td>
<td>μs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VC= 0V, +2V, 0V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>θJA</td>
<td>Thermal Resistance Junction to Ambient</td>
<td>0.4° leads soldered to printed circuit board</td>
<td>150</td>
<td>180</td>
<td>°C/W (Max)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.125° leads soldered to printed circuit board</td>
<td>130</td>
<td>160</td>
<td>°C/W (Max)</td>
<td></td>
</tr>
</tbody>
</table>

(1) Specified and 100% production tested.
(2) Specified (but not 100% production tested) over the operating temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.
(3) Parameters identified with **boldface type** apply at temp. extremes. All other numbers, unless noted apply at +25°C.
(4) These numbers apply for pulse testing with a low duty cycle.
(5) Base positive with respect to emitter.
One failure mode incandescent lamps may experience is one in which the filament resistance drops to a very low value before it actually blows out. This is especially rough on most solid-state lamp drivers and in most cases a lamp failure of this type will also cause the lamp driver to fail. Because of its high gain and blowout-proof design, the LP395 is an ideal candidate for reliably driving small incandescent lamps. Additionally, the current limiting characteristics of the LP395 are advantageous as it serves to limit the cold filament inrush current, thus increasing lamp life.
TYPICAL PERFORMANCE CHARACTERISTICS

5 Volt Transfer Function

![5 Volt Transfer Function Graph](image)

36 Volt Transfer Function

![36 Volt Transfer Function Graph](image)

Collector Characteristics

![Collector Characteristics Graph](image)

Available Collector Current

![Available Collector Current Graph](image)

Quiescent Collector Current

![Quiescent Collector Current Graph](image)

Saturation Voltage

![Saturation Voltage Graph](image)
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Collector Current Threshold

$V_C = +5V$

$125^\circ C$

$25^\circ C$

$-40^\circ C$

$+3\sigma$

$-3\sigma$

- Collector Current (mA)

- Base-Emitter Voltage (V)

Figure 9.
TYPICAL APPLICATIONS

Figure 10. Lamp Flasher (Short Circuit Proof)

Figure 11. Optically Isolated Switch

Figure 12. Two Terminal Current Limiter

Figure 13. Composite PNP
## REVISION HISTORY

**Changes from Revision B (March 2013) to Revision C**

<table>
<thead>
<tr>
<th>Change Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changed layout of National Data Sheet to TI format</td>
<td>6</td>
</tr>
</tbody>
</table>
PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>PINS</th>
<th>Package Qty</th>
<th>Eco Plan</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp</th>
<th>Op Temp (°C)</th>
<th>Device Marking</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP395Z/LFT1</td>
<td>ACTIVE</td>
<td>TO-92</td>
<td>LP</td>
<td>3</td>
<td>2000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>SN</td>
<td>N / A for Pkg Type</td>
<td></td>
<td></td>
<td>LP 395Z</td>
</tr>
<tr>
<td>LP395Z/NOPB</td>
<td>ACTIVE</td>
<td>TO-92</td>
<td>LP</td>
<td>3</td>
<td>1800</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>SN</td>
<td>N / A for Pkg Type</td>
<td>-40 to 125</td>
<td></td>
<td>LP 395Z</td>
</tr>
</tbody>
</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".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
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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2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
   a. Straight lead option available in bulk pack only.
   b. Formed lead option available in tape and reel or ammo pack.
   c. Specific products can be offered in limited combinations of shipping medium and lead options.
   d. Consult product folder for more information on available options.
TAPE SPECIFICATIONS

LP0003A
TO-92 - 5.34 mm max height

FOR FORMED LEAD OPTION PACKAGE
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