LM195/LM395
Ultra Reliable Power Transistors

General Description

The LM195/LM395 are fast, monolithic power integrated circuits with complete overload protection. These devices, which act as high gain power transistors, have included on the chip, current limiting, power limiting, and thermal overload protection making them virtually impossible to destroy from any type of overload. In the standard TO-3 transistor power package, the LM195 will deliver load currents in excess of 1.0A and can switch 40V in 500 ns.

The inclusion of thermal limiting, a feature not easily available in discrete designs, provides virtually absolute protection against overload. Excessive power dissipation or inadequate heat sinking causes the thermal limiting circuitry to turn off the device preventing excessive heating.

The LM195 offers a significant increase in reliability as well as simplifying power circuitry. In some applications, where protection is unusually difficult, such as switching regulators, lamp or solenoid drivers where normal power dissipation is low, the LM195 is especially advantageous.

The LM195 is easy to use and only a few precautions need be observed. Excessive collector to emitter voltage can destroy the LM195 as with any power transistor. When the device is used as an emitter follower with low source impedance, it is necessary to insert a 5.0k resistor in series with the base lead to prevent possible emitter follower oscillations. Although the device is usually stable as an emitter follower, the resistor eliminates the possibility of trouble without degrading performance. Finally, since it has good high frequency response, supply bypassing is recommended.

For low-power applications (under 100 mA), refer to the LP395 Ultra Reliable Power Transistor.

The LM195/LM395 are available in the standard TO-3, Kovar TO-5, and TO-220 packages. The LM195 is rated for operation from −55˚C to +150˚C and the LM395 from 0˚C to +125˚C.

Features

- Internal thermal limiting
- Greater than 1.0A output current
- 3.0 µA typical base current
- 500 ns switching time
- 2.0V saturation
- Base can be driven up to 40V without damage
- Directly interfaces with CMOS or TTL
- 100% electrical burn-in

Simplified Circuit

1.0 Amp Lamp Flasher

- R1: 510k
- R2: 150k
- R3: 47k
- R4: 10k
- R5: 100k
- Q1: 2N2222
- Q2: LM195
- C1: 10µF
- D: 1003 BULB
- V+: 12V

Connection Diagrams

TO-3 Metal Can Package

Bottom View
Order Number LM195K/883
See NS Package Number K02A
(Note 5)

TO-220 Plastic Package

Top View
Order Number LM395T
See NS Package Number T03B

TO-5 Metal Can Package

Bottom View
Order Number LM195H/883
See NS Package Number H03B
(Note 5)
### Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LM195</th>
<th>LM395</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector to Emitter Voltage</td>
<td>42V</td>
<td>36V</td>
</tr>
<tr>
<td>Collector to Base Voltage</td>
<td>42V</td>
<td>36V</td>
</tr>
<tr>
<td>Base to Emitter Voltage (Forward)</td>
<td>42V</td>
<td>36V</td>
</tr>
</tbody>
</table>

**Base to Emitter Voltage (Reverse)**: 20V

**Collector Current (Reverse)**: Internally Limited

**Power Dissipation**: Internally Limited

**Operating Temperature Range**
- LM195: −55°C to +150°C
- LM395: 0°C to +125°C

**Storage Temperature Range**: −65°C to +150°C

**Lead Temperature**:
- (Soldering, 10 sec.): 260°C

### Preconditioning

100% Burn-In In Thermal Limit

### Electrical Characteristics (Note 2)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>CM</th>
<th>CM</th>
<th>CM</th>
<th>CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-Emitter Operating Voltage</td>
<td>( I_C \leq I_C \leq I_{MAX} )</td>
<td>42</td>
<td></td>
<td>36</td>
<td>V</td>
</tr>
<tr>
<td>Base to Emitter Breakdown Voltage</td>
<td>( 0 \leq V_{CE} \leq V_{CEMAX} )</td>
<td>42</td>
<td>36</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>Collector Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO-3, TO-220</td>
<td>( V_{CE} \leq 15V )</td>
<td>1.2</td>
<td>2.2</td>
<td>1.0</td>
<td>2.2</td>
</tr>
<tr>
<td>TO-5</td>
<td>( V_{CE} \leq 7.0V )</td>
<td>1.2</td>
<td>1.8</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>( I_C \leq 1.0A, T_A = 25°C )</td>
<td>1.8</td>
<td>2.0</td>
<td>1.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Base Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 0 \leq I_C \leq I_{MAX} )</td>
<td>( 0 \leq V_{CE} \leq V_{CEMAX} )</td>
<td>3.0</td>
<td>5.0</td>
<td>3.0</td>
<td>10</td>
</tr>
<tr>
<td>Quiescent Current ( (I_Q) )</td>
<td>( V_{BE} = 0 )</td>
<td>2.0</td>
<td>5.0</td>
<td>2.0</td>
<td>10</td>
</tr>
<tr>
<td>( 0 \leq V_{CE} \leq V_{CEMAX} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base to Emitter Voltage</td>
<td>( I_C = 1.0A, T_A = +25°C )</td>
<td>0.9</td>
<td></td>
<td>0.9</td>
<td></td>
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<tr>
<td>Switching Time</td>
<td>( V_{CE} = 36V, R_L = 36Ω, T_A = 25°C )</td>
<td>500</td>
<td></td>
<td>500</td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- **Note 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 guarantee specific performance limits.
- **Note 2**: Unless otherwise specified, these specifications apply for −55°C ≤ T_J ≤ +150°C for the LM195 and 0°C ≤ +125°C for the LM395.
- **Note 3**: Without a heat sink, the thermal resistance of the TO-5 package is about +150°C/W, while that of the TO-3 package is +35°C/W.
- **Note 4**: Selected devices with higher breakdown available.
- **Note 5**: Refer to RETS195H and RETS195K drawings of military LM195H and LM195K versions for specifications.
Typical Performance Characteristics (for K and T Packages)

Collector Characteristics

Short Circuit Current

Bias Current

Quiescent Current

Base Emitter Voltage

Base Current

Saturation Voltage

Response Time

Response Time
Typical Performance Characteristics (for K and T Packages) (Continued)

10V Transfer Function

![10V Transfer Function Graph](DS006009-7)

36V Transfer Function

![36V Transfer Function Graph](DS006009-8)

Transconductance

![Transconductance Graph](DS006009-9)

Small Signal Frequency Response

![Small Signal Frequency Response Graph](DS006009-10)
Typical Applications

1.0 Amp Voltage Follower

*Solid Tantalum

Power PNP

*Protects against excessive base drive
**Needed for stability

Time Delay

1.0 MHz Oscillator
Typical Applications (Continued)

1.0 Amp Negative Regulator

1.0 Amp Positive Voltage Regulator

†Solid Tantalum
Typical Applications (Continued)

Fast Optically Isolated Switch

Optically Isolated Power Transistor

CMOS or TTL Lamp Interface

Two Terminal Current Limiter

40V Switch

*Drive Voltage 0V to ≥ 10V ≤ 42V

6.0V Shunt Regulator with Crowbar

Two Terminal 100 mA Current Regulator

DS006009-19

DS006009-20

DS006009-21

DS006009-22

DS006009-23

DS006009-24

DS006009-25
Typical Applications (Continued)

Low Level Power Switch

- Turn ON = 350 mV
- Turn OFF = 200 mV

Power One-Shot

- $R_2 \leq 82k$
- $T = R_1C$
- $R_2 = 3R_1$

Emitter Follower

- $R_1 = 5.0k^*$

High Input Impedance AC Emitter Follower

- $R_1 = 200k$

Fast Follower

- $R_1 = 5.0k^*$

*Need for Stability

*Prevents storage with fast fall time square wave drive
Typical Applications (Continued)

Power Op Amp

*Adjust for 50 mA quiescent current
†Solid Tantalum

6.0 Amp Variable Output Switching Regulator

*Sixty turns wound on Arnold Type A-083081-2 core.
**Four devices in parallel
†Solid tantalum

*DS006009-31
**DS006009-32
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