**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**

![Simplified Circuit Diagram](image)
Connection Diagrams

TO-3 Metal Can Package

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

TO-5 Metal Can Package

Bottom View
Order Number LM195H/883
See NS Package Number H03B
(Note 5)

TO-220 Plastic Package

Case is Emitter

Top View
Order Number LM395T
See NS Package Number T03B

www.national.com
Absolute Maximum Ratings (Note 1)

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

Collector to Emitter Voltage
- LM195: 42V
- LM395: 36V
Collector to Base Voltage
- LM195: 42V
- LM395: 36V
Base to Emitter Voltage (Forward)
- LM195: 42V
- LM395: 36V
Base to Emitter Voltage (Reverse): 20V

Preconditioning

100% Burn-In in Thermal Limit

Electrical Characteristics (Note 2)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM195</th>
<th>LM395</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-Emitter Operating Voltage</td>
<td>I_Q ≤ I_C ≤ I_MAX</td>
<td>42</td>
<td>36</td>
<td>V</td>
</tr>
<tr>
<td>Base to Emitter Breakdown Voltage</td>
<td>0 ≤ V_CE ≤ V_CEMAX</td>
<td>42</td>
<td>36</td>
<td>V</td>
</tr>
<tr>
<td>Collector Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO-3, TO-220</td>
<td>V_CE ≤ 15V</td>
<td>1.2</td>
<td>2.2</td>
<td>A</td>
</tr>
<tr>
<td>TO-5</td>
<td>V_CE ≤ 7.0V</td>
<td>1.2</td>
<td>1.8</td>
<td>A</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>I_C ≤ 1.0A, T_A = 25˚C</td>
<td>1.8</td>
<td>2.0</td>
<td>V</td>
</tr>
<tr>
<td>Base Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 ≤ I_C ≤ I_MAX</td>
<td>3.0</td>
<td>5.0</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td>0 ≤ V_CE ≤ V_CEMAX</td>
<td>3.0</td>
<td>10</td>
<td>µA</td>
</tr>
<tr>
<td>Quiescent Current (I_Q)</td>
<td>V_BE = 0</td>
<td>2.0</td>
<td>5.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>0 ≤ V_CE ≤ V_CEMAX</td>
<td>2.0</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>Base to Emitter Voltage</td>
<td>I_C = 1.0A, T_A = +25˚C</td>
<td>0.9</td>
<td>0.9</td>
<td>V</td>
</tr>
<tr>
<td>Switching Time</td>
<td>V_CE = 36V, R_L = 36Ω, T_A = 25˚C</td>
<td>500</td>
<td>500</td>
<td>ns</td>
</tr>
<tr>
<td>Thermal Resistance Junction to Case (Note 3)</td>
<td>TO-3 Package (K)</td>
<td>2.3</td>
<td>3.0</td>
<td>˚C/W</td>
</tr>
<tr>
<td></td>
<td>TO-5 Package (H)</td>
<td>12</td>
<td>15</td>
<td>˚C/W</td>
</tr>
<tr>
<td></td>
<td>TO-220 Package (T)</td>
<td>4</td>
<td>6</td>
<td>˚C/W</td>
</tr>
</tbody>
</table>

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

Saturation Voltage

Response Time

10V Transfer Function

36V Transfer Function

Transconductance
Typical Performance Characteristics (for K and T Packages) (Continued)

Small Signal Frequency Response

Schematic Diagram
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

*Solid Tantalum
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

6.0V Shunt Regulator with Crowbar

Two Terminal 100 mA Current Regulator

*Drive Voltage 0V to $\geq 10V \leq 42V$
**Typical Applications** (Continued)

**Low Level Power Switch**

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

**Power One-Shot**

- \( T = R_1 C \)
- \( R_2 = 3R_1 \)
- \( R_2 \leq 82k \)

**Emitter Follower**

- *Need for Stability*

**High Input Impedance AC Emitter Follower**

- *Prevents storage with fast fall time square wave drive*

[Diagrams of circuits for Low Level Power Switch, Power One-Shot, Emitter Follower, and High Input Impedance AC Emitter Follower]
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
Physical Dimensions  inches (millimeters) unless otherwise noted

TO-5 Metal Can Package
Order Number LM195H/883
NS Package Number H03B

TO-3 Metal Can Package
Order Number LM195K/883
NS Package Number K02A

www.national.com
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

TO-220 Plastic Package
Order Number LM395T
NS Package Number T03B

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

For the most current product information visit us at www.national.com.

LIFE SUPPORT POLICY

NATIONAL’S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

BANNED SUBSTANCE COMPLIANCE
National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no “Banned Substances” as defined in CSP-9-111S2.