

LM195/LM395 Ultra Reliable Power Transistors

General Description

The LM195/LM395 are fast, monolithic power transistors 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 imped-

ance, 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.

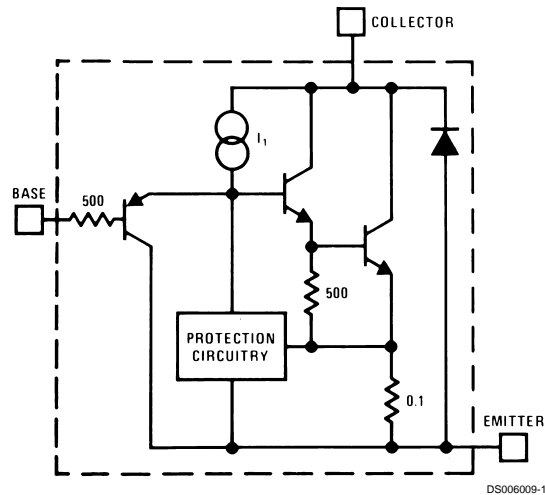
For low-power applications (under 100 mA), refer to the LP395 Ultra Reliable Power Transistor.

The LM195/LM395 are available in standard TO-3 power packages and solid Kovar TO-5. The LM195 is rated for operation from -55°C to $+150^{\circ}\text{C}$ and the LM395 from 0°C to $+125^{\circ}\text{C}$.

Features

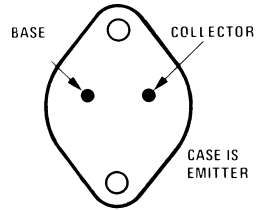
- Internal thermal limiting
- Greater than 1.0A output current
- 3.0 μA typical base current
- 500 ns switching time
- 2.0V saturation
- Base can be driven up to 40V without damage
- Directly interfaces with CMOS or TTL
- 100% electrical burn-in

Simplified Circuit



Connection Diagrams

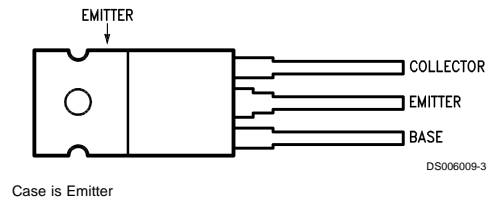
TO-3 Metal Can Package



DS006009-2

Bottom View
Order Number LM195K/883
See NS Package Number K02A

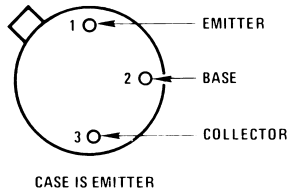
TO-220 Plastic Package



DS006009-3

Top View
Order Number LM395T
See NS Package Number T03B

TO-5 Metal Can Package



DS006009-4

Bottom View
Order Number LM195H/883
See NS Package Number H03B

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

Collector Current

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)

| Parameter | Conditions | LM195 | | | LM395 | | | Units |
|---|--|------------|------------|-----|------------|------------|-----|--------------|
| | | Min | Typ | Max | Min | Typ | Max | |
| Collector-Emitter Operating Voltage (Note 4) | $I_C \leq I_{C \max}$ | | | 42 | | | 36 | V |
| Base to Emitter Breakdown Voltage | $0 \leq V_{CE} \leq V_{CEMAX}$ | 42 | | | 36 | 60 | | V |
| Collector Current TO-3, TO-220 TO-5 | $V_{CE} \leq 15V$ $V_{CE} \leq 7.0V$ | 1.2 1.2 | 2.2 1.8 | | 1.0 1.0 | 2.2 1.8 | | A A |
| Saturation Voltage | $I_C \leq 1.0A, T_A = 25^\circ C$ | | 1.8 | 2.0 | | 1.8 | 2.2 | V |
| Base Current | $0 \leq I_C \leq I_{C \max}$ $0 \leq V_{CE} \leq V_{CEMAX}$ | | 3.0 | 5.0 | | 3.0 | 10 | μA |
| Quiescent Current (I_Q) | $V_{be} = 0$ $0 \leq V_{CE} \leq V_{CEMAX}$ | | 2.0 | 5.0 | | 2.0 | 10 | mA |
| Base to Emitter Voltage | $I_C = 1.0A, T_A = +25^\circ C$ | | 0.9 | | | 0.9 | | V |
| Switching Time | $V_{CE} = 36V, R_L = 36\Omega,$ $T_A = 25^\circ C$ | | 500 | | | 500 | | ns |
| Thermal Resistance Junction to Case (Note 3) | TO-3 Package (K) | | 2.3 | 3.0 | | 2.3 | 3.0 | $^\circ C/W$ |
| | TO-5 Package (H) | | 12 | 15 | | 12 | 15 | $^\circ C/W$ |
| | TO-220 Package (T) | | | | | 4 | 6 | $^\circ C/W$ |

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 $-55^\circ C \leq T_J \leq +150^\circ C$ for the LM195 and $0^\circ C \leq +125^\circ C$ for the LM395.

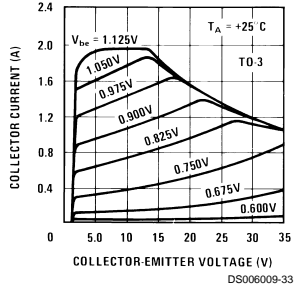
Note 3: Without a heat sink, the thermal resistance of the TO-5 package is about $+150^\circ C/W$, while that of the TO-3 package is $+35^\circ C/W$.

Note 4: Selected devices with higher breakdown available.

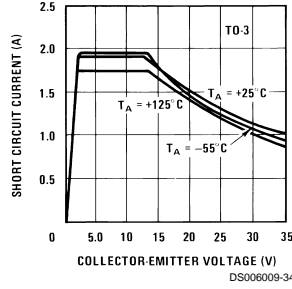
Note 5: Refer to RETS195H and RETS195K drawings of military LM195H and LM195K versions for specifications.

Typical Performance Characteristics (for K and T Packages)

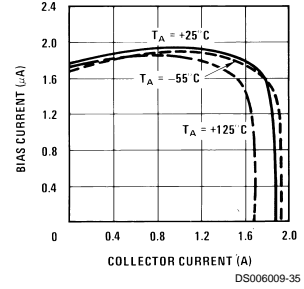
Collector Characteristics



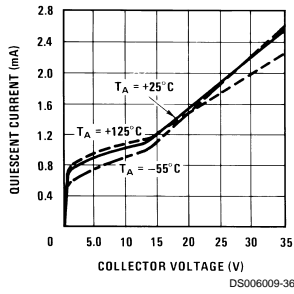
Short Circuit Current



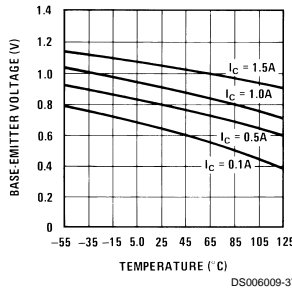
Bias Current



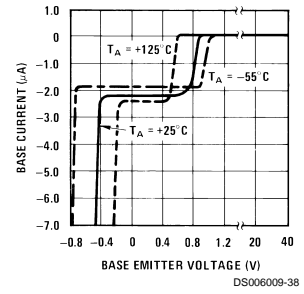
Quiescent Current



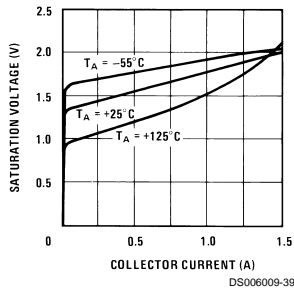
Base Emitter Voltage



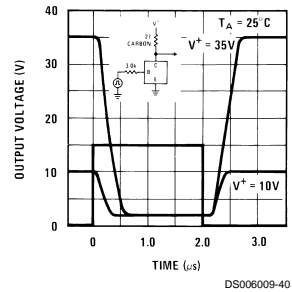
Base Current



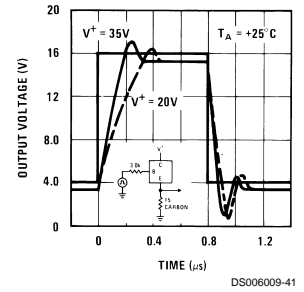
Saturation Voltage



Response Time

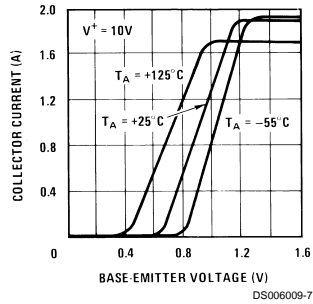


Response Time

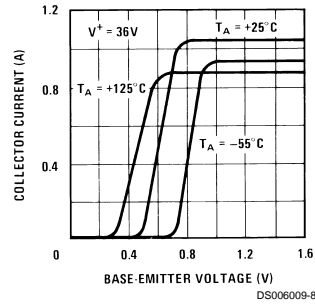


Typical Performance Characteristics (for K and T Packages) (Continued)

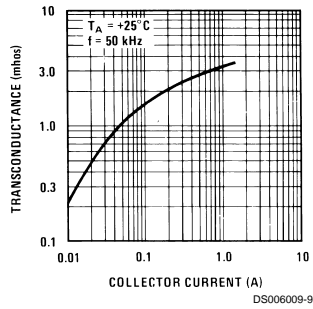
10V Transfer Function



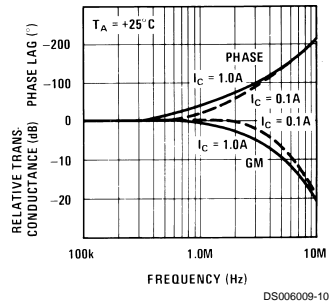
36V Transfer Function



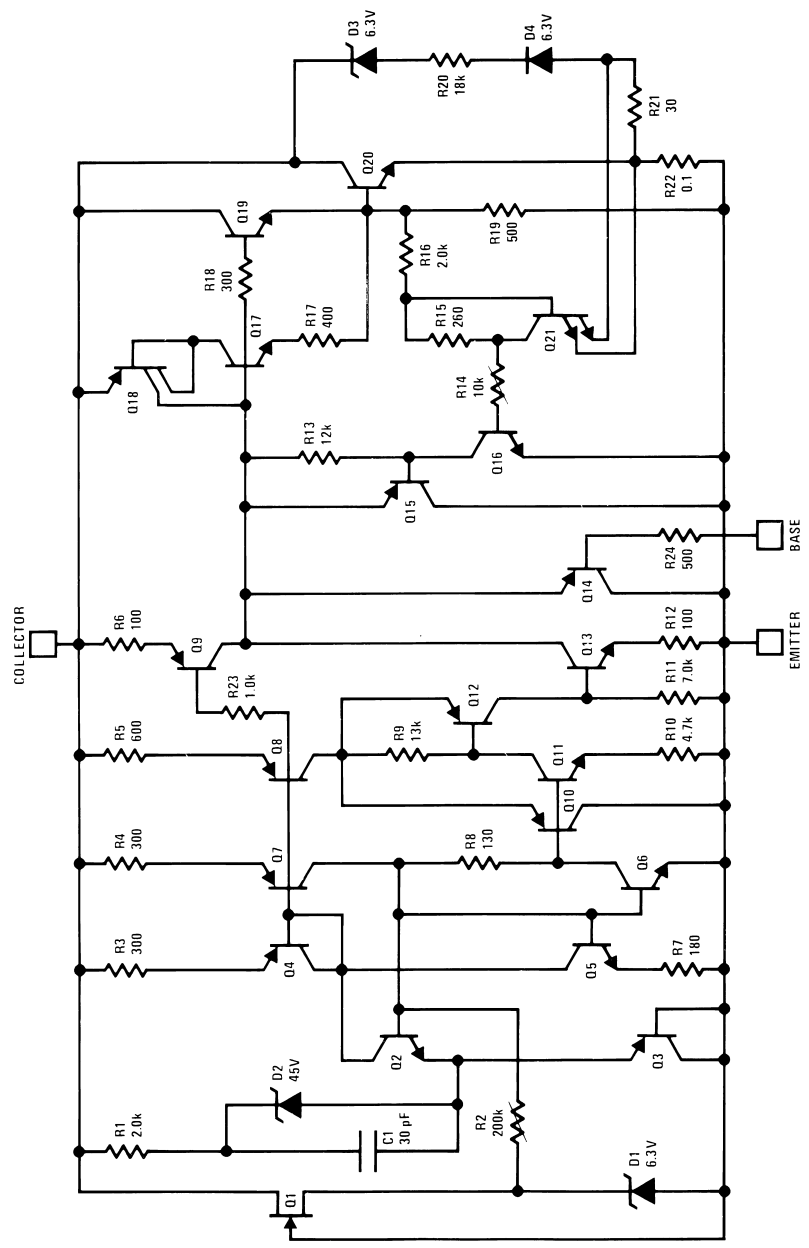
Transconductance



Small Signal Frequency Response



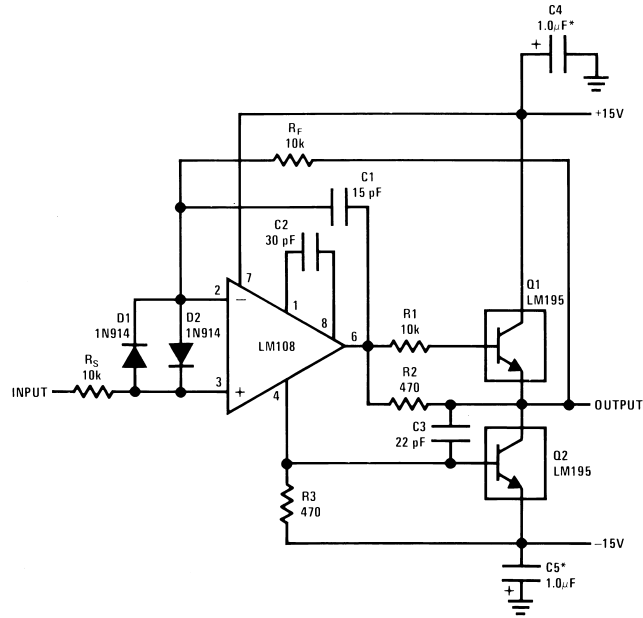
Schematic Diagram



DS006006-11

Typical Applications

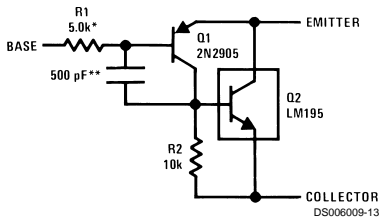
1.0 Amp Voltage Follower



DS006009-12

*Solid Tantalum

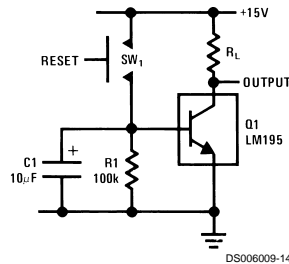
Power PNP



DS006009-13

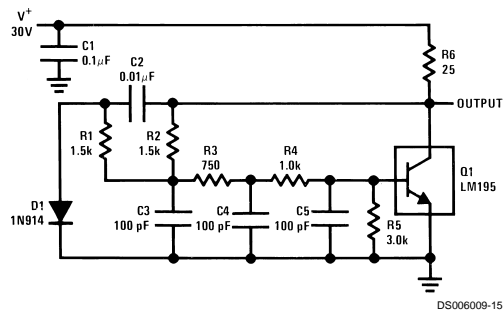
*Protects against excessive base drive
**Needed for stability

Time Delay



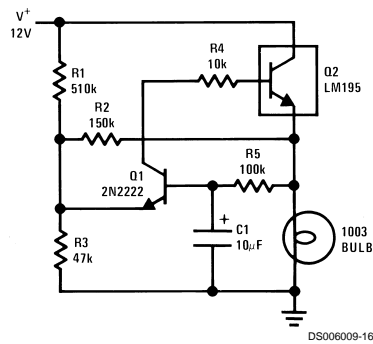
DS006009-14

1.0 MHz Oscillator



DS006009-15

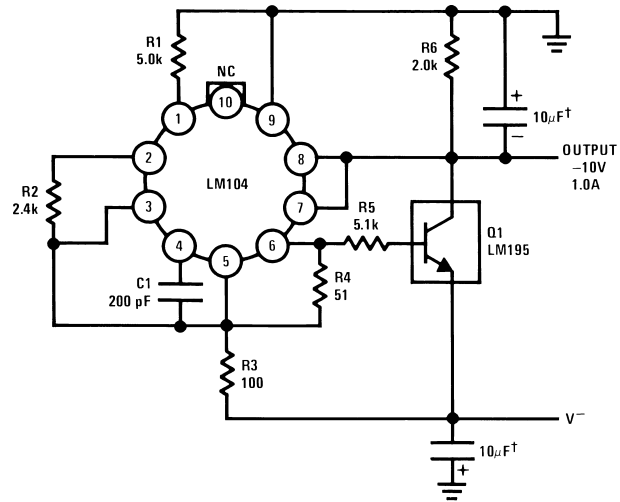
1.0 Amp Lamp Flasher



DS006009-16

Typical Applications (Continued)

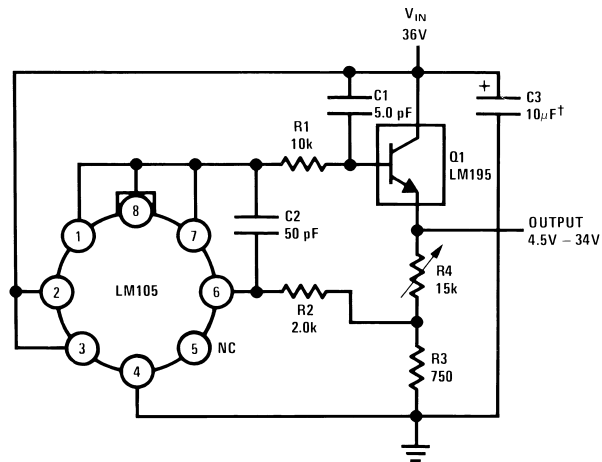
1.0 Amp Negative Regulator



DS006009-17

†Solid Tantalum

1.0 Amp Positive Voltage Regulator

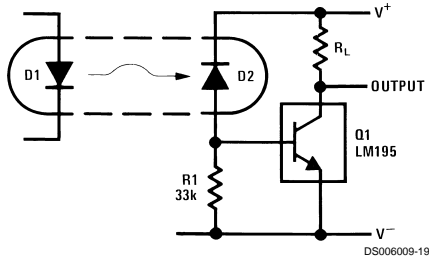


DS006009-18

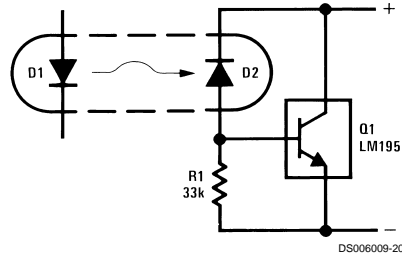
†Solid Tantalum

Typical Applications (Continued)

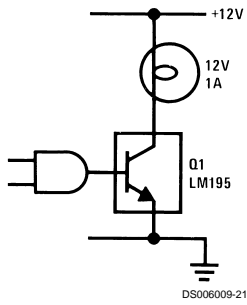
Fast Optically Isolated Switch



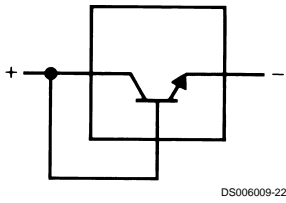
Optically Isolated Power Transistor



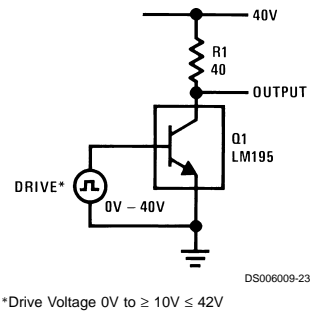
CMOS or TTL Lamp Interface



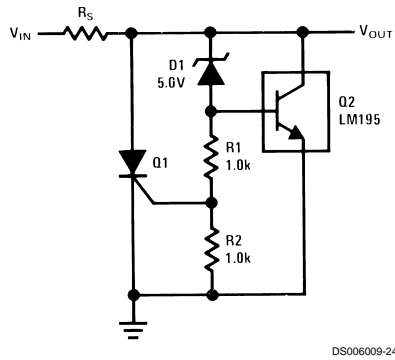
Two Terminal Current Limiter



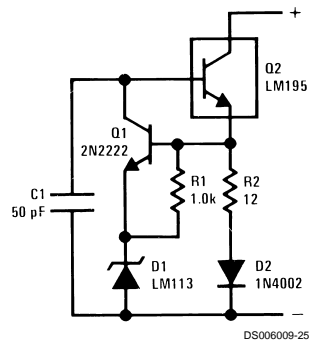
40V Switch



6.0V Shunt Regulator with Crowbar

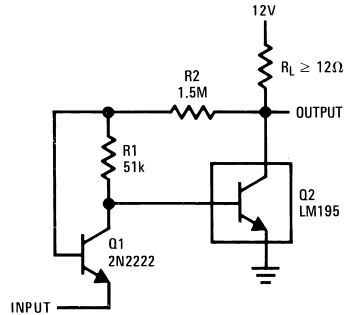


Two Terminal 100 mA Current Regulator



Typical Applications (Continued)

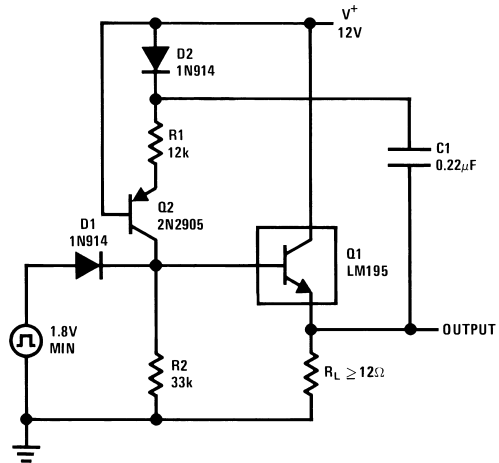
Low Level Power Switch



DS006009-26

Turn ON = 350 mV
Turn OFF = 200 mV

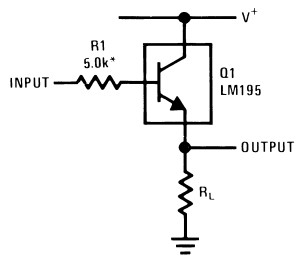
Power One-Shot



DS006009-27

$T = R1C$
 $R2 = 3R1$
 $R2 \leq 82k$

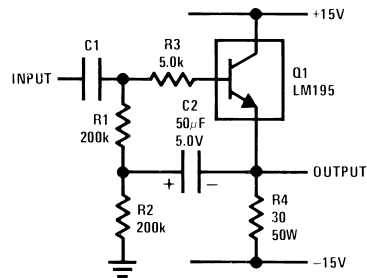
Emitter Follower



DS006009-28

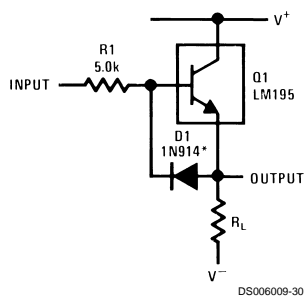
*Need for Stability

High Input Impedance AC Emitter Follower



DS006009-29

Fast Follower

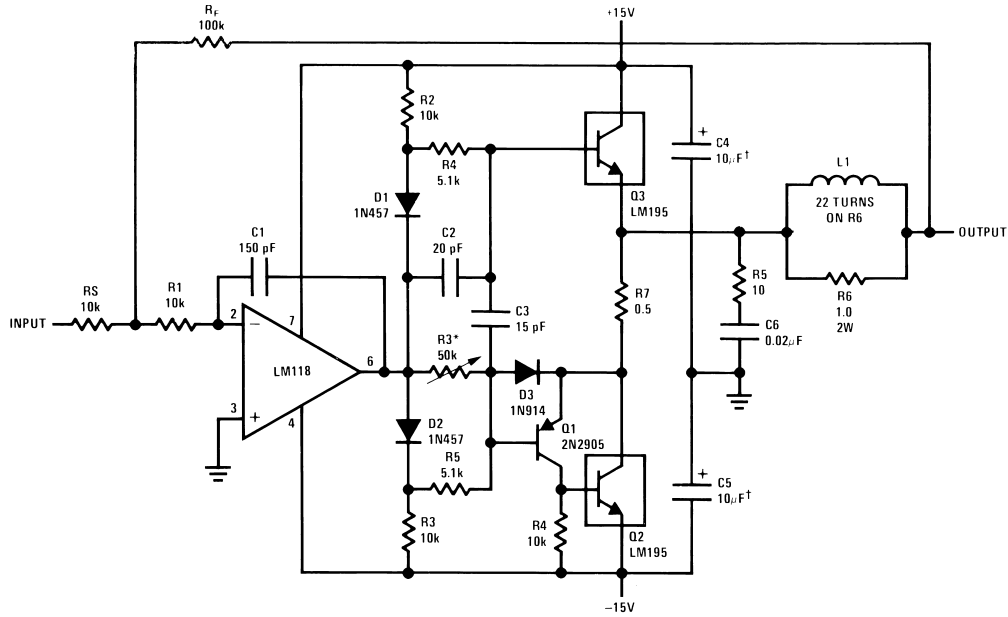


DS006009-30

*Prevents storage with fast fall time square wave drive

Typical Applications (Continued)

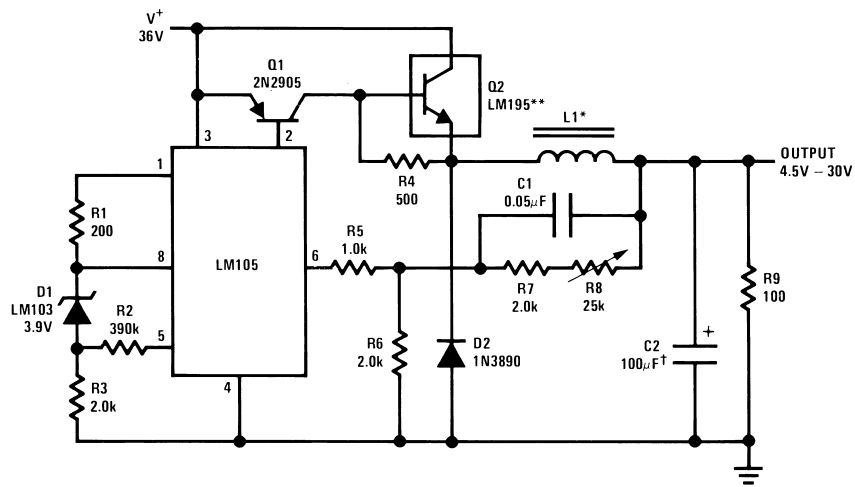
Power Op Amp



DS006009-31

*Adjust for 50 mA quiescent current
†Solid Tantalum

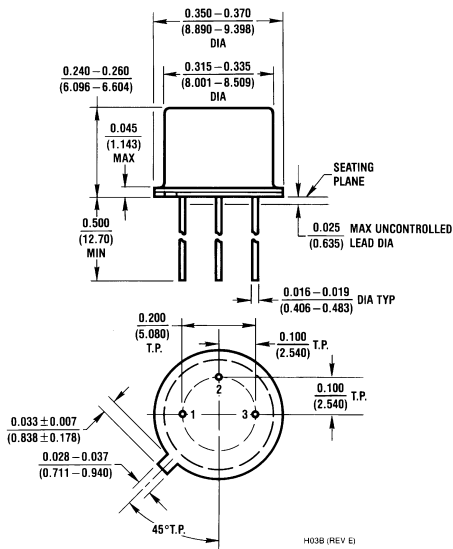
6.0 Amp Variable Output Switching Regulator



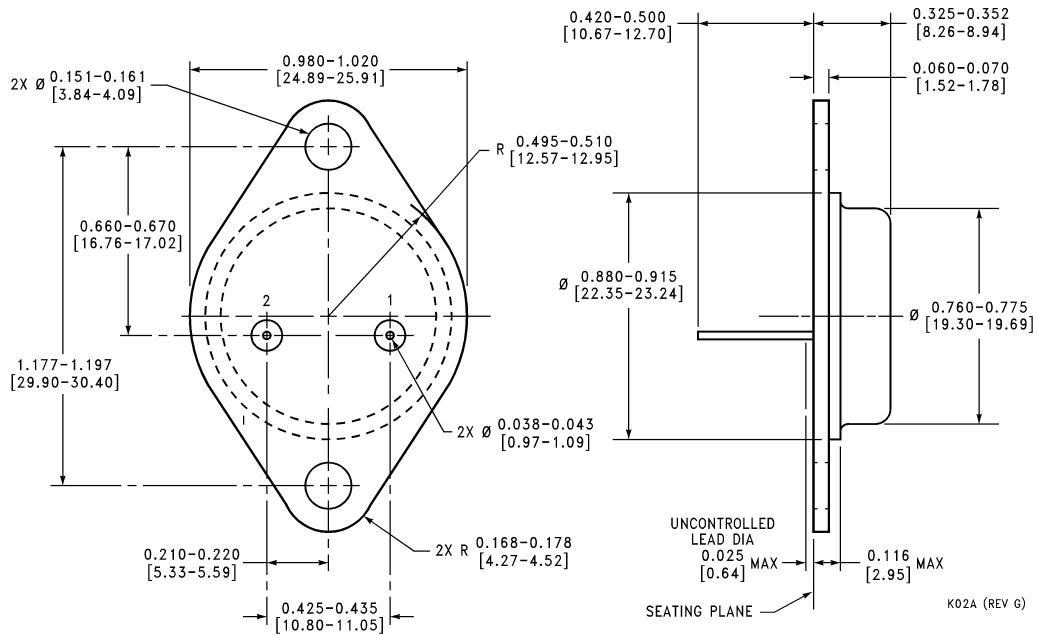
DS006009-32

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

Physical Dimensions inches (millimeters) unless otherwise noted

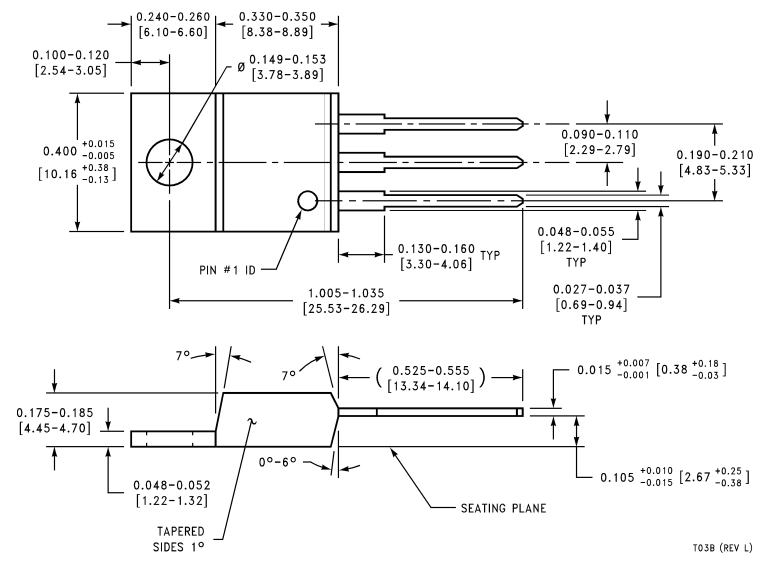


TO-5 Metal Can Package
Order Number LM195H/883
NS Package Number H03B



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

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




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

T03B (REV L)

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.

| | | | |
|--|---|--|---|
|  <p>National Semiconductor Corporation Americas Tel: 1-800-272-9959 Fax: 1-800-737-7018 Email: support@nsc.com www.national.com</p> | <p>National Semiconductor Europe Fax: +49 (0) 1 80-530 85 86 Email: europe.support@nsc.com Deutsch Tel: +49 (0) 1 80-530 85 85 English Tel: +49 (0) 1 80-532 78 32 Français Tel: +49 (0) 1 80-532 93 58 Italiano Tel: +49 (0) 1 80-534 16 80</p> | <p>National Semiconductor Asia Pacific Customer Response Group Tel: 65-2544466 Fax: 65-2504466 Email: sea.support@nsc.com</p> | <p>National Semiconductor Japan Ltd. Tel: 81-3-5639-7560 Fax: 81-3-5639-7507</p> |
|--|---|--|---|

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.