

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 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.

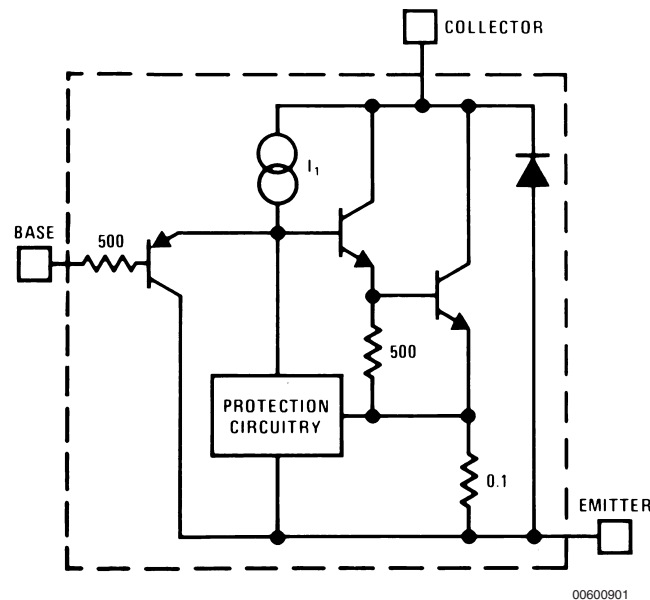
For low-power applications (under 100 mA), refer to the LP395 Ultra Reliable Power Transistor.

The LM195/LM395 are available in the standard TO-3, Kovar TO-5, and TO-220 packages. The LM195 is rated for operation from -55°C to $+150^{\circ}\text{C}$ and the LM395 from 0°C to $+125^{\circ}\text{C}$.

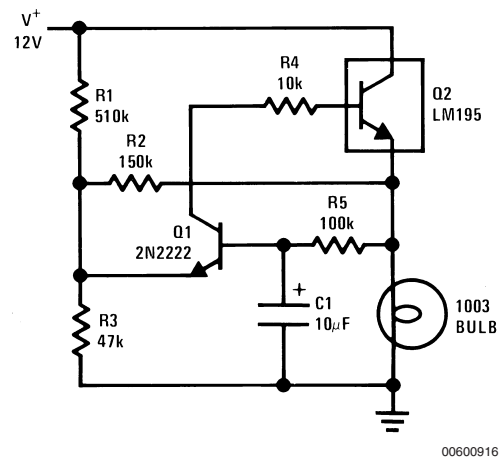
Features

- 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

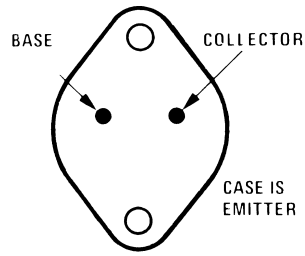


1.0 Amp Lamp Flasher



Connection Diagrams

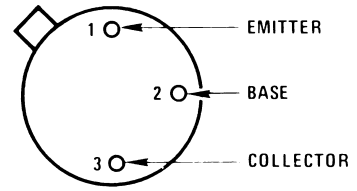
TO-3 Metal Can Package



00600902

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

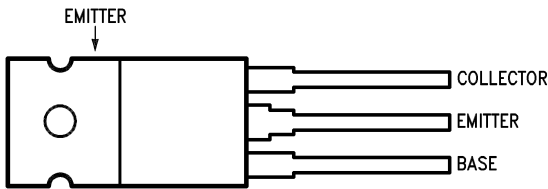
TO-5 Metal Can Package



00600904

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

TO-220 Plastic Package



00600903

Case is Emitter

Top View
Order Number LM395T
See NS Package Number T03B

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)	$I_Q \leq I_C \leq I_{MAX}$			42			36	V
Base to Emitter Breakdown Voltage	$0 \leq V_{CE} \leq V_{CEMAX}$	42			36	60		V
Collector Current								A
TO-3, TO-220	$V_{CE} \leq 15V$	1.2	2.2		1.0	2.2		A
TO-5	$V_{CE} \leq 7.0V$	1.2	1.8		1.0	1.8		A
Saturation Voltage	$I_C \leq 1.0A, T_A = 25^\circ C$		1.8	2.0		1.8	2.2	V
Base Current	$0 \leq I_C \leq I_{MAX}$ $0 \leq V_{CE} \leq V_{CEMAX}$		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 $+35^\circ C/W$.

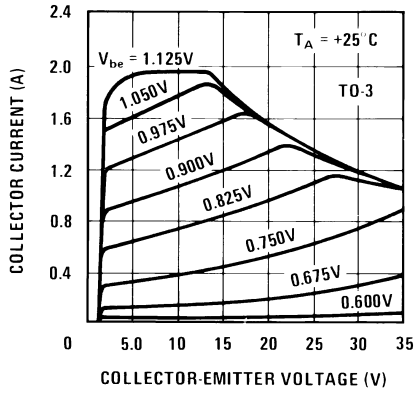
Note 4: Selected devices with higher breakdown available.

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

Typical Performance Characteristics

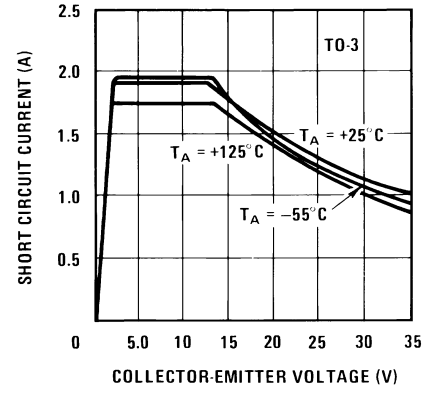
(for K and T Packages)

Collector Characteristics



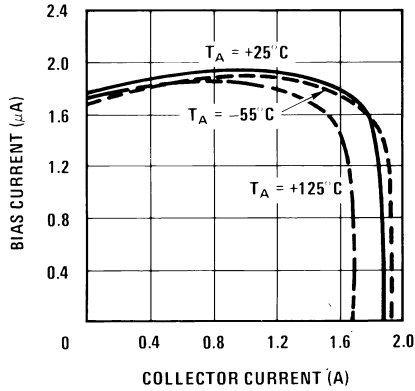
00600933

Short Circuit Current



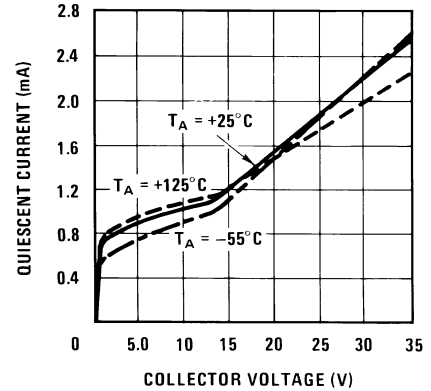
00600934

Bias Current



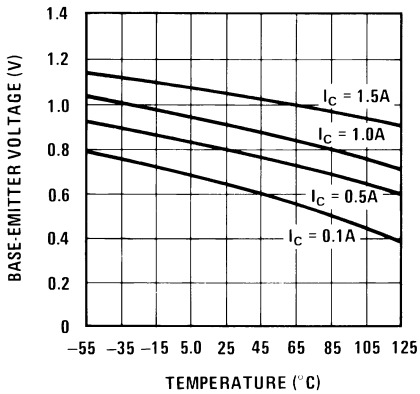
00600935

Quiescent Current



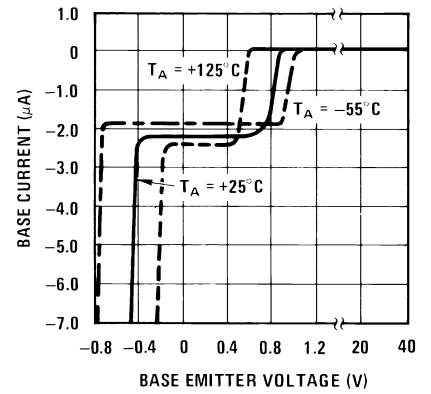
00600936

Base Emitter Voltage



00600937

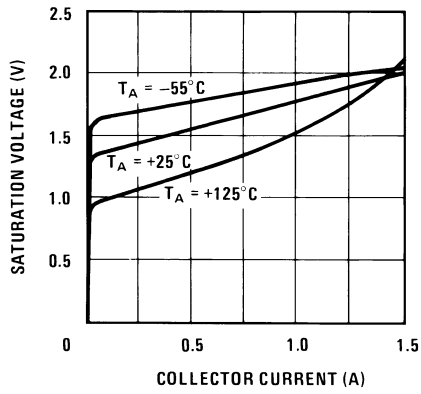
Base Current



00600938

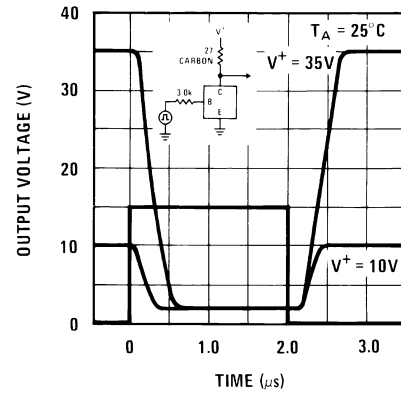
Typical Performance Characteristics (for K and T Packages) (Continued)

Saturation Voltage



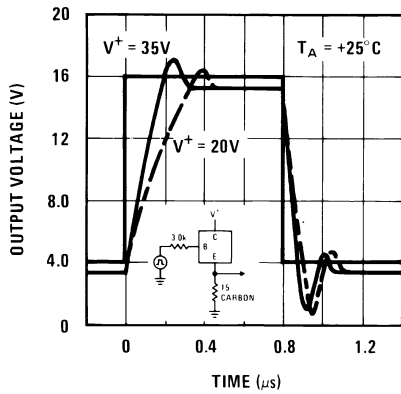
00600939

Response Time



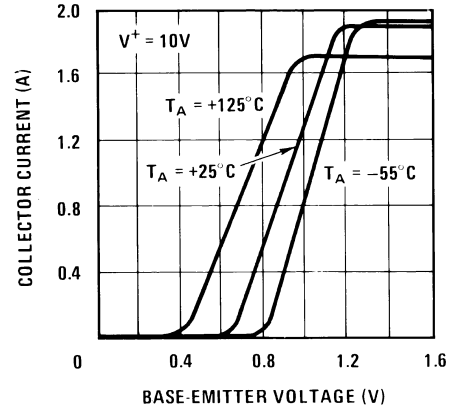
00600940

Response Time



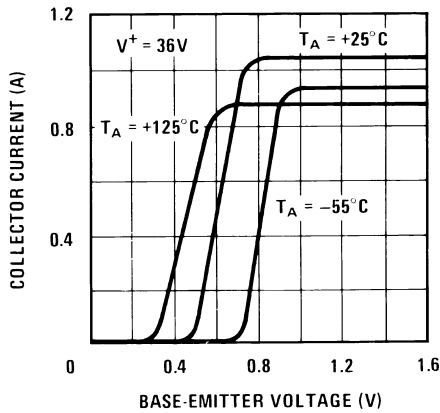
00600941

10V Transfer Function



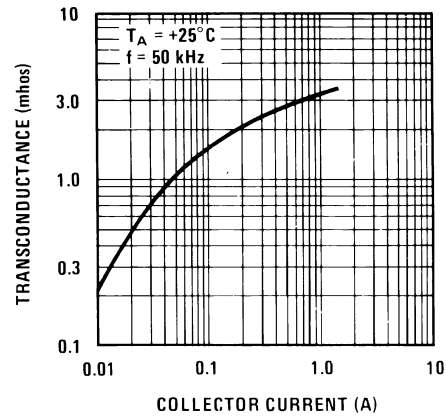
00600907

36V Transfer Function



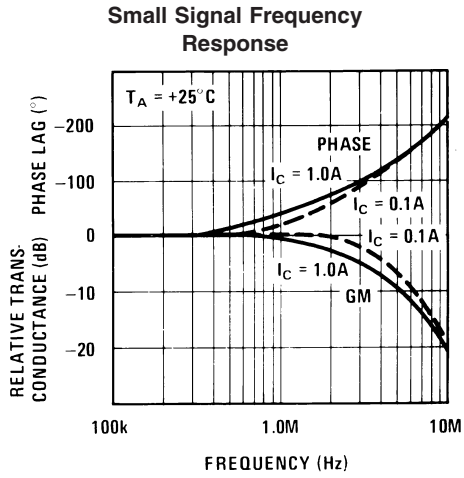
00600908

Transconductance



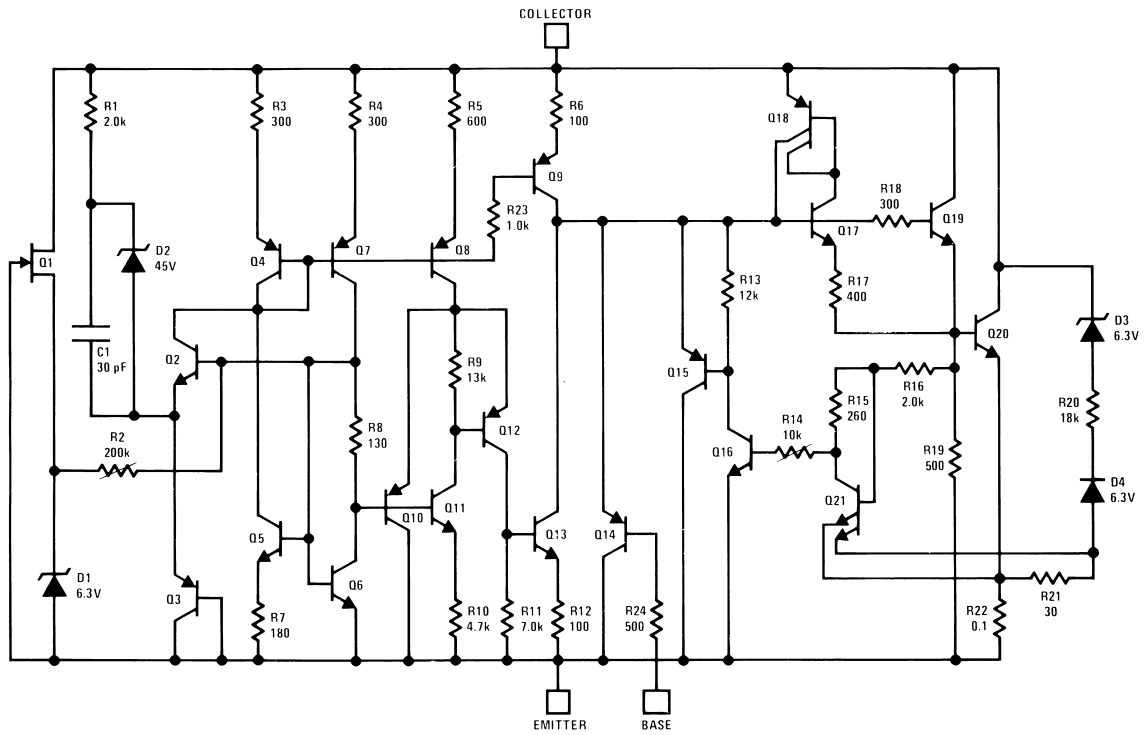
00600909

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



00600910

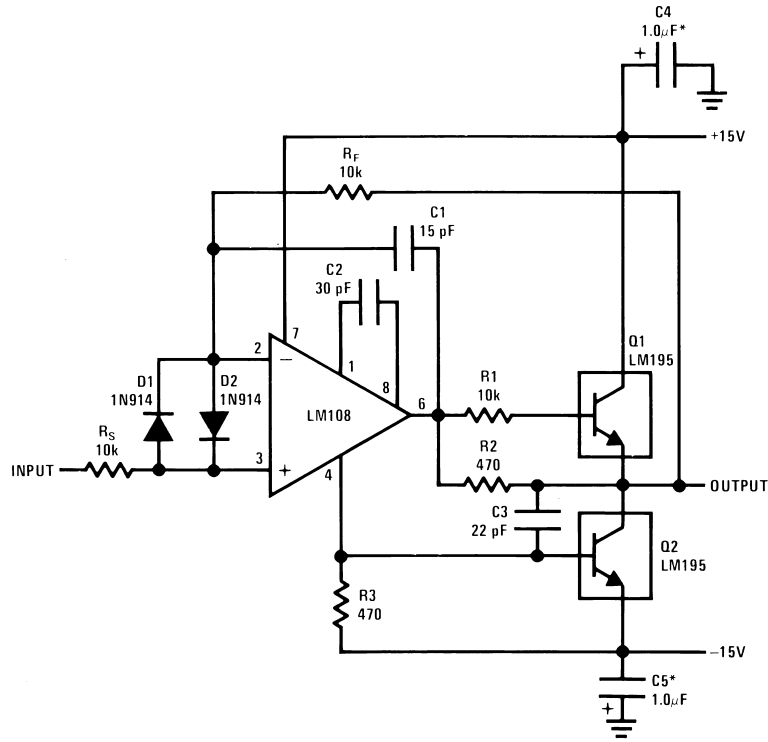
Schematic Diagram



00600911

Typical Applications

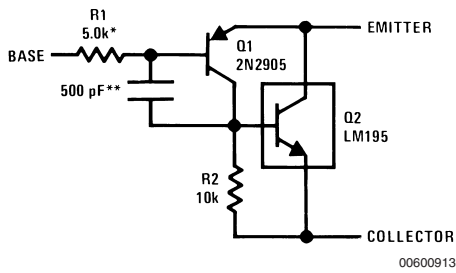
1.0 Amp Voltage Follower



00600912

*Solid Tantalum

Power PNP

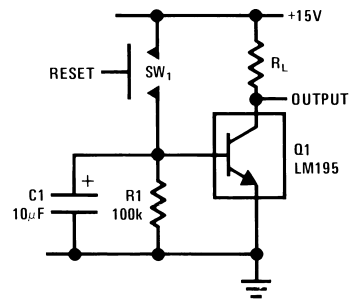


00600913

*Protects against excessive base drive

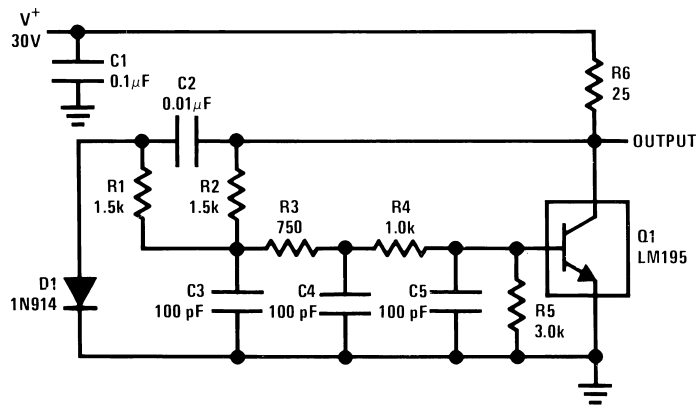
**Needed for stability

Time Delay



00600914

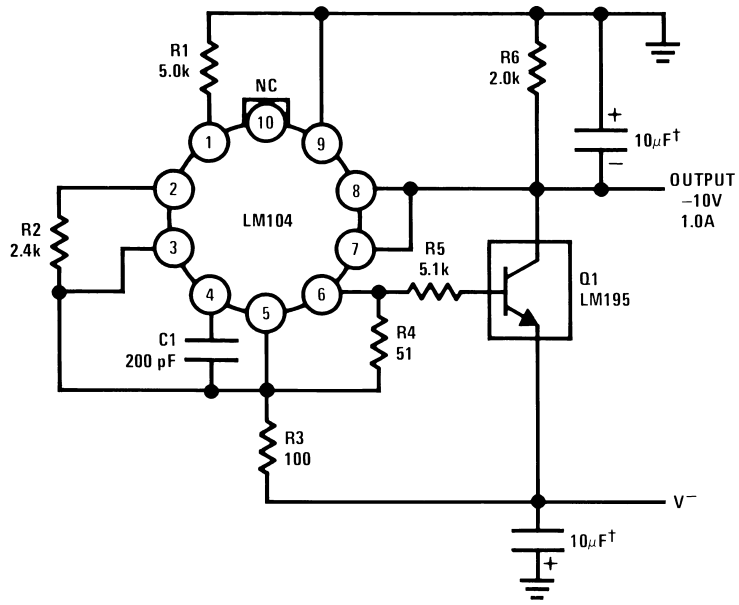
1.0 MHz Oscillator



00600915

Typical Applications (Continued)

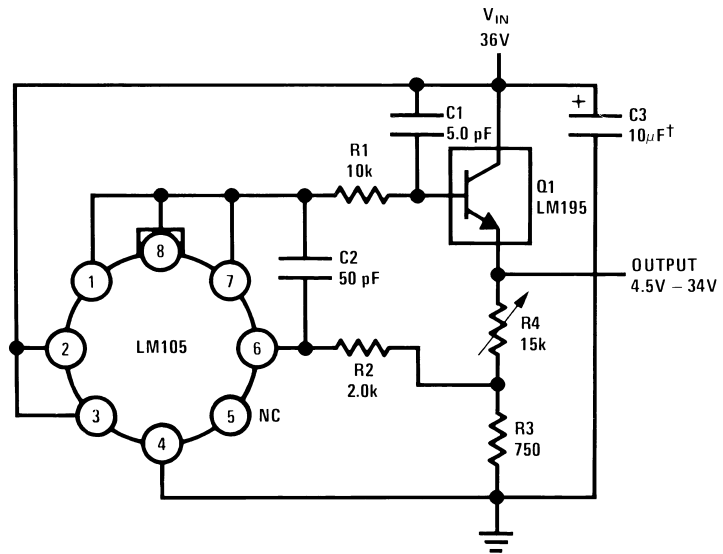
1.0 Amp Negative Regulator



00600917

†Solid Tantalum

1.0 Amp Positive Voltage Regulator

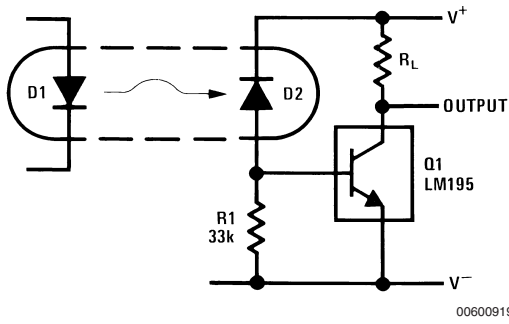


00600918

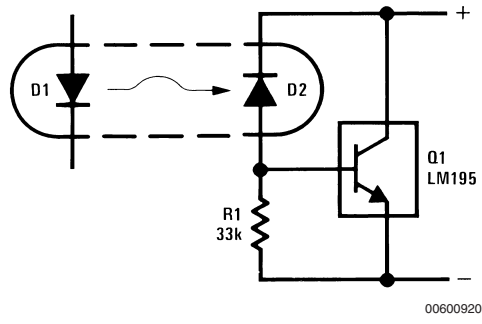
†Solid Tantalum

Typical Applications (Continued)

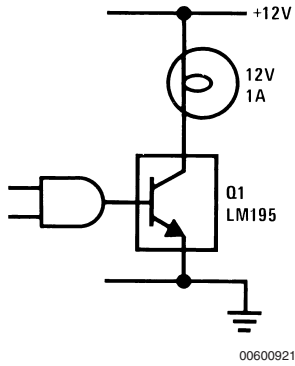
Fast Optically Isolated Switch



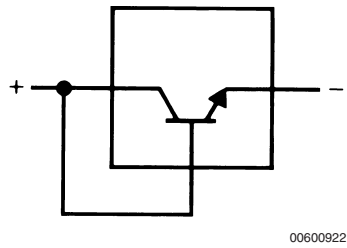
Optically Isolated Power Transistor



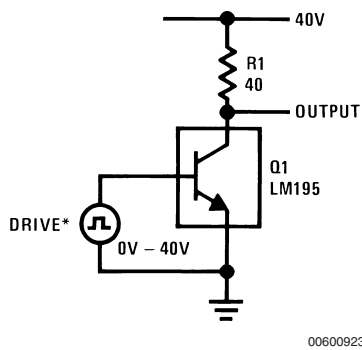
CMOS or TTL Lamp Interface



Two Terminal Current Limiter

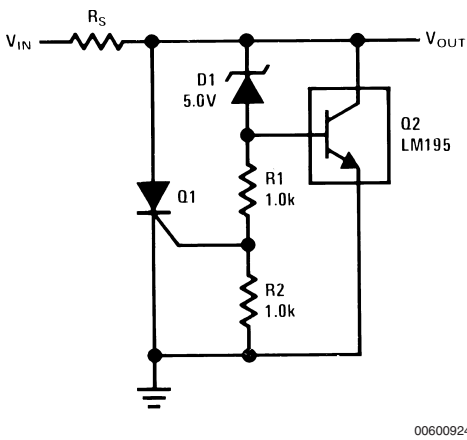


40V Switch

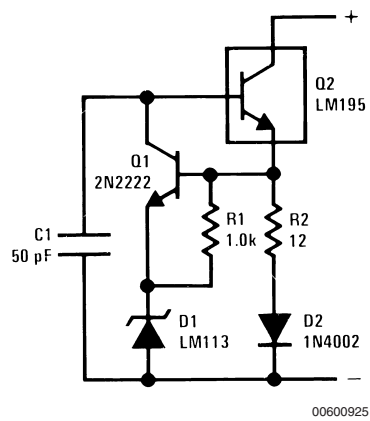


*Drive Voltage 0V to $\geq 10V \leq 42V$

6.0V Shunt Regulator with Crowbar

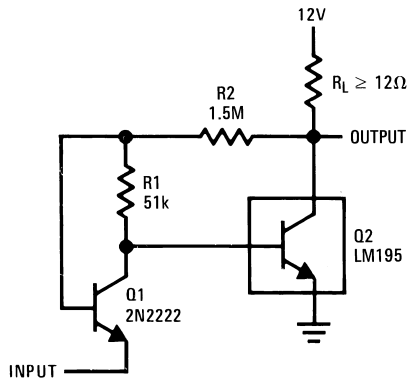


Two Terminal 100 mA Current Regulator



Typical Applications (Continued)

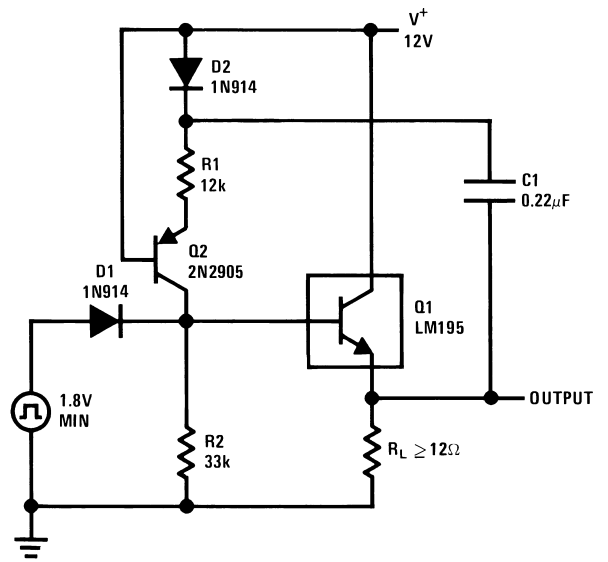
Low Level Power Switch



Turn ON = 350 mV
Turn OFF = 200 mV

00600926

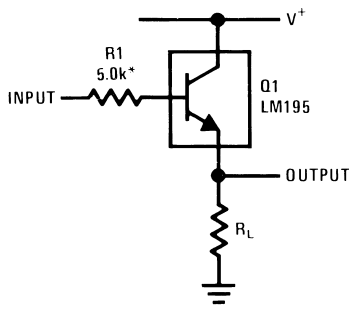
Power One-Shot



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

00600927

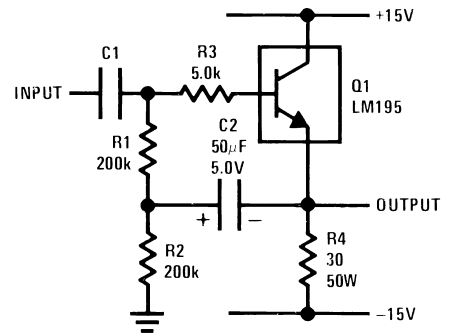
Emitter Follower



*Need for Stability

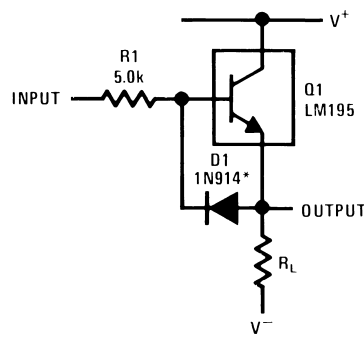
00600928

High Input Impedance AC Emitter Follower



00600929

Fast Follower

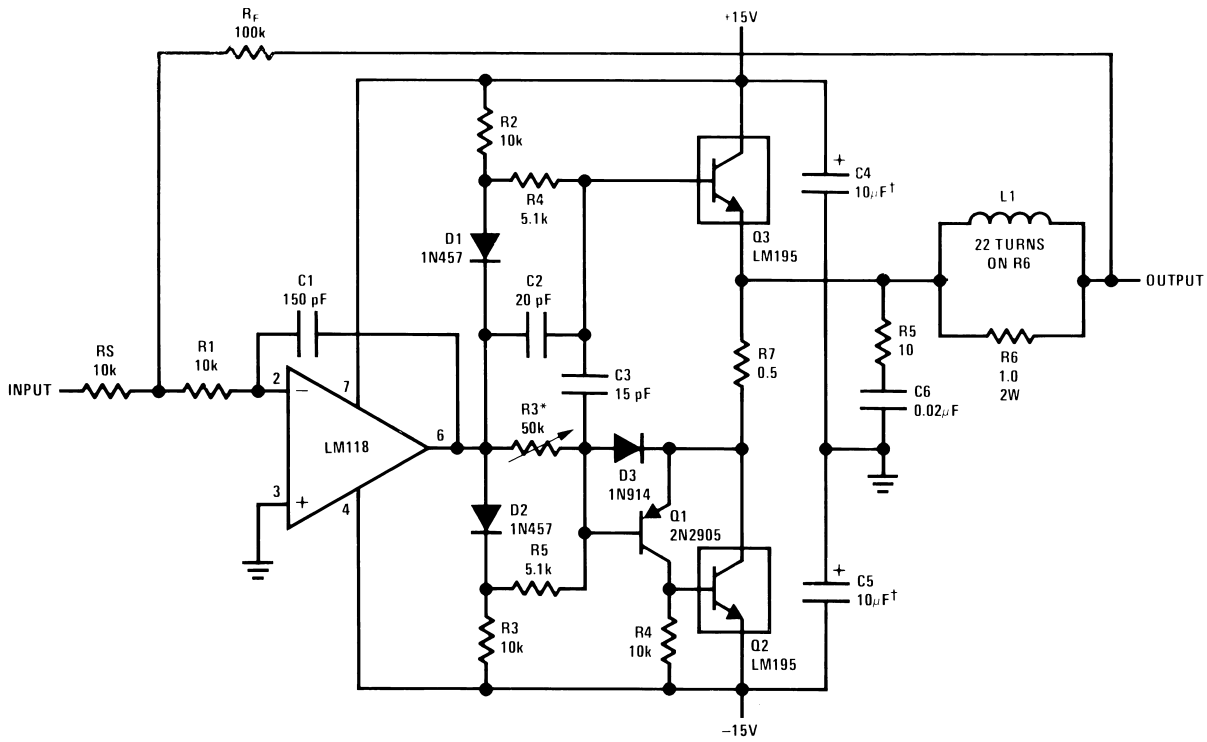


*Prevents storage with fast fall time square wave drive

00600930

Typical Applications (Continued)

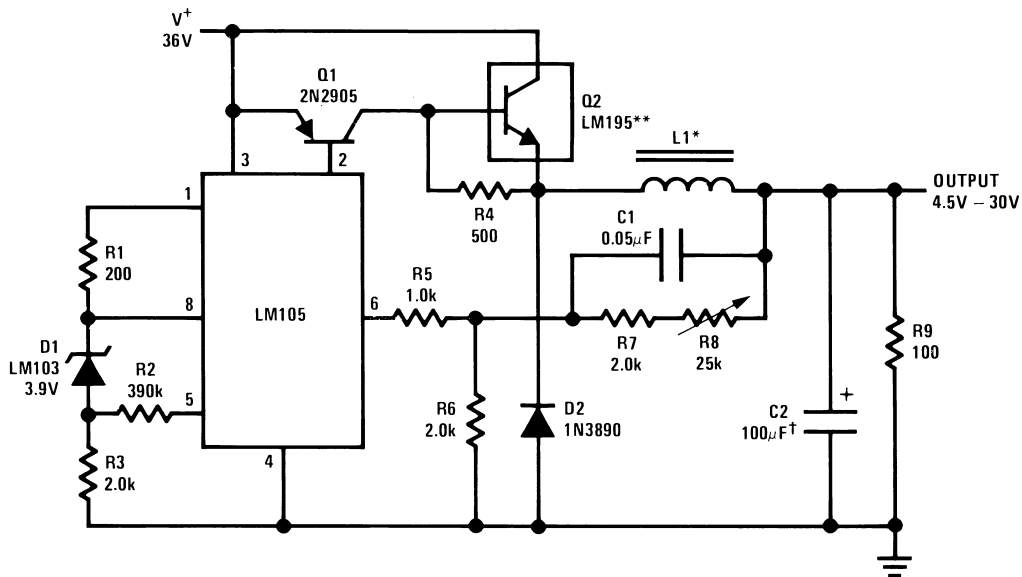
Power Op Amp



*Adjust for 50 mA quiescent current
 †Solid Tantalum

00600931

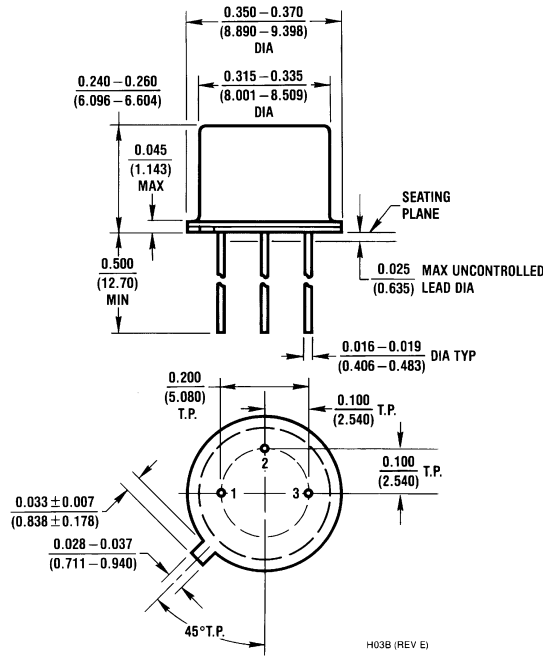
6.0 Amp Variable Output Switching Regulator



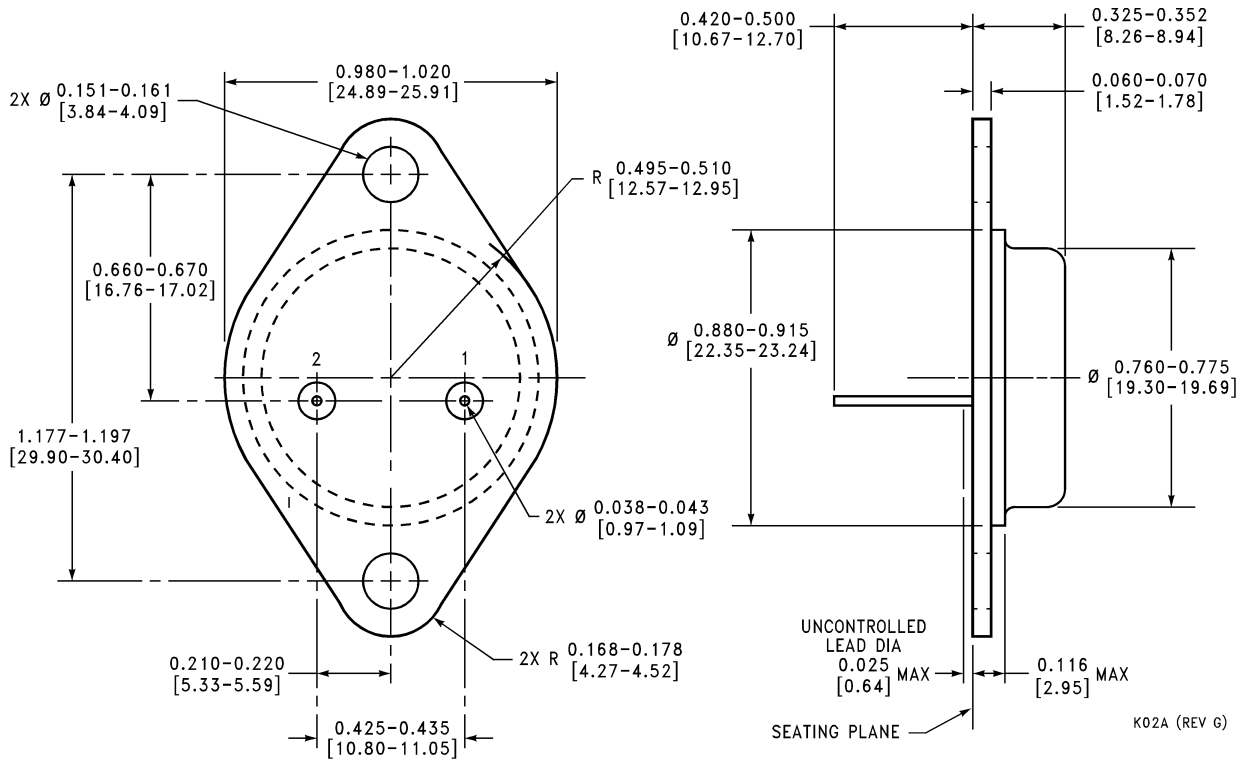
*Sixty turns wound on Arnold Type A-083081-2 core.
 **Four devices in parallel
 †Solid tantalum

00600932

Physical Dimensions inches (millimeters) unless otherwise noted

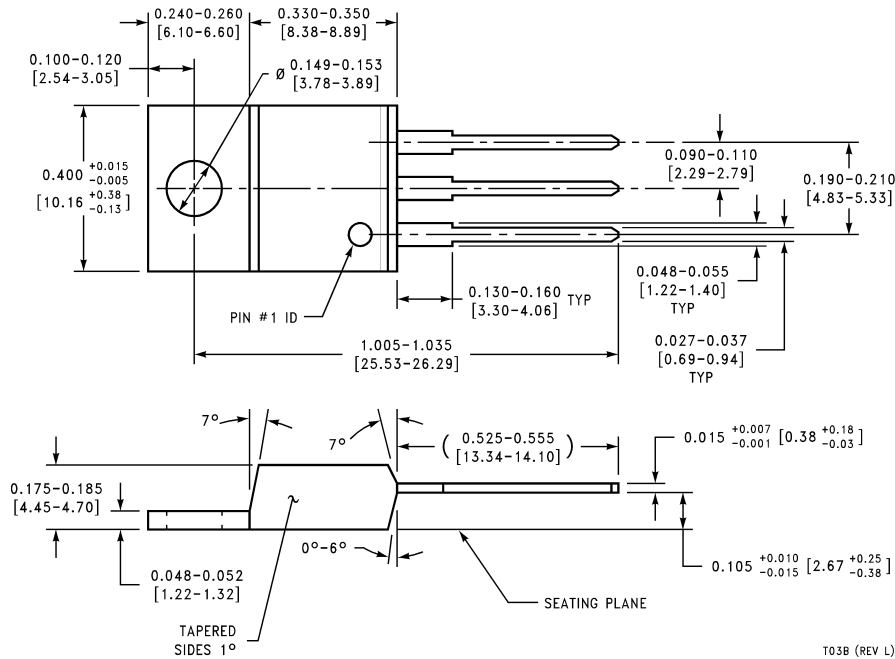


TO-5 Metal Can Package
Order Number LM195H/883
NS Package Number H03B



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**

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.



National Semiconductor
Americas Customer
Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

National Semiconductor
Europe Customer Support Center
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor
Asia Pacific Customer
Support Center
Email: ap.support@nsc.com

National Semiconductor
Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560