National Semiconductor Corporation

LM195/LM295/LM395 Ultra Reliable Power Transistors

General Description

The LM195/LM295/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 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.

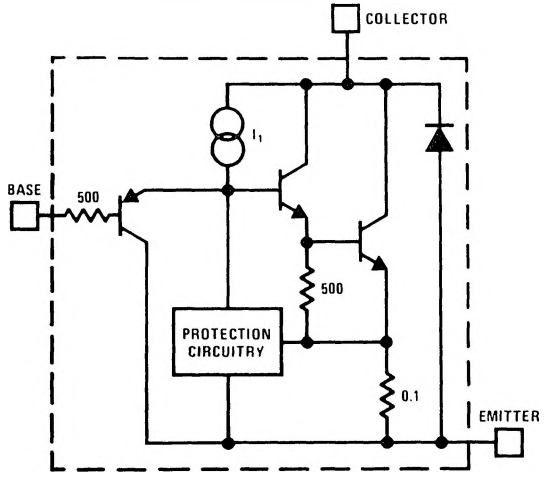
The LM195/LM295/LM395 are available in standard TO-3 power packages and solid Kovar TO-5. The LM195 is rated for operation from −55°C to +150°C, the LM295 from −25°C to +150°C and the LM395 from 0°C to +125°C.

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 of the LM195



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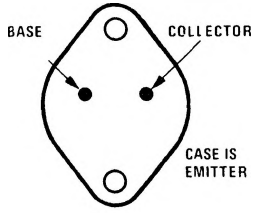
Connection Diagrams

TO-3 Metal Can Package



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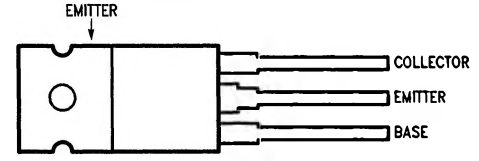
Bottom View

**Order Number LM195K,
LM295K or LM395K
See NS Package Number K02A**

TO-220 Plastic Package



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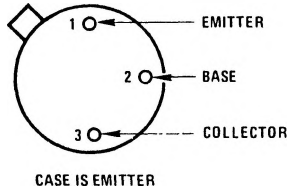
Case is Emitter

Top View

**Order Number LM395T
See NS Package Number T03B**

TO-5 Metal Can Package



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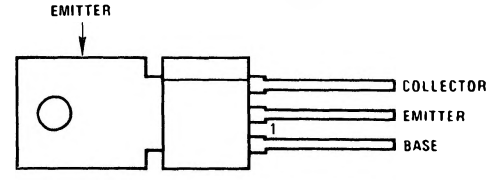
Bottom View

**Order Number LM195H,
LM295H or LM395H
See NS Package Number H03B**

TO-202 Plastic Package



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Top View

**Order Number LM395P
See NS Package Number P03A**

Absolute Maximum Ratings

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

Collector to Emitter Voltage
- LM195, LM295 — 42V
- LM395 — 36V

Collector to Base Voltage
- LM195, LM295 — 42V
- LM395 — 36V

Base to Emitter Voltage (Forward)
- LM195, LM295 — 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
- LM295 — −25°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 1)

Parameter	Conditions	LM195, LM295			LM395			Units
		Min	Typ	Max	Min	Typ	Max	
Collector-Emitter Operating Voltage (Note 3)	$I_Q \le I_C \le I_{MAX}$			42			36	V
Base to Emitter Breakdown Voltage	$0 \le V_{CE} \le V_{CEMAX}$	42			36	60		V
Collector Current								
TO-3, TO-220	$V_{CE} \le 15V$	1.2	2.2		1.0	2.2		A
TO-5, TO-202	$V_{CE} \le 7.0V$	1.2	1.8		1.0	1.8		A
Saturation Voltage	$I_C \le 1.0A$, $T_A = 25°C$		1.8	2.0		1.8	2.2	V
Base Current	$0 \le I_C \le I_{MAX}$ $0 \le V_{CE} \le V_{CEMAX}$		3.0	5.0		3.0	10	μA
Quiescent Current (I_Q)	$V_{be} = 0$ $0 \le V_{CE} \le V_{CEMAX}$		2.0	5.0		2.0	10	mA
Base to Emitter Voltage	$I_C = 1.0A$, $T_A = +25°C$		0.9			0.9		V
Switching Time	$V_{CE} = 36V$, $R_L = 36\Omega$, $T_A = 25°C$		500			500		ns
Thermal Resistance Junction to Case (Note 2)	TO-3 Package (K)		2.3	3.0		2.3	3.0	°C/W
	TO-5 Package (H)		12	15		12	15	°C/W
	TO-220 Package (T)					4	6	°C/W
	TO-202 Package (P)					12	15	°C/W

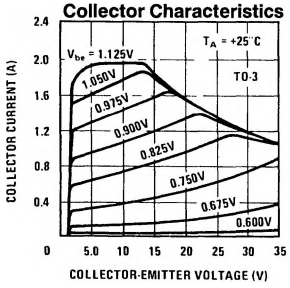
Note 1: Unless otherwise specified, these specifications apply for $-55°C \le T_j \le +150°C$ for the LM195, $-25°C \le T_j \le +150°C$ for the LM295 and $0°C \le +125°C$ for the LM395.

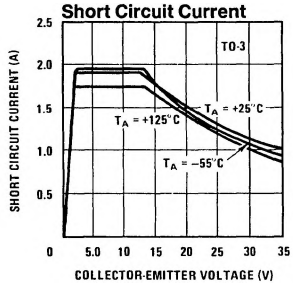
Note 2: Without a heat sink, the thermal resistance of the TO-5 package is about +150°C/W, while that of the TO-3 package is +35°C/W.

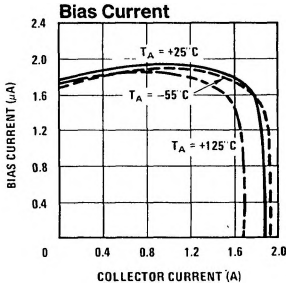
Note 3: Selected devices with higher breakdown available.

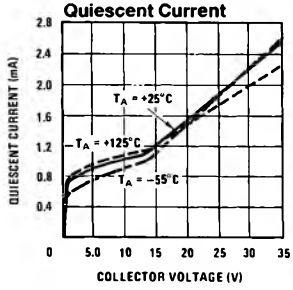
Note 4: Refer to RETS195H and RETS195K drawings of military LM195H and LM195K versions for specifications.

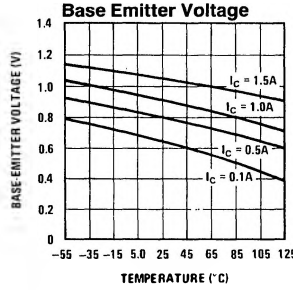
Typical Performance Characteristics (for K and T Packages)

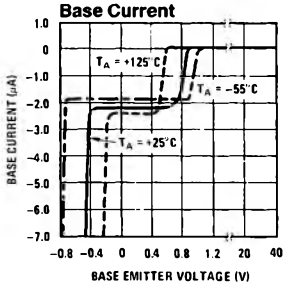


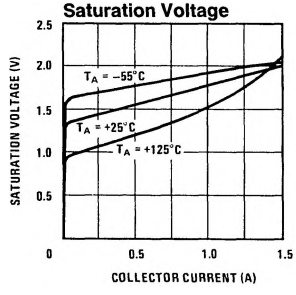


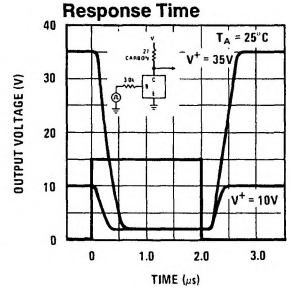


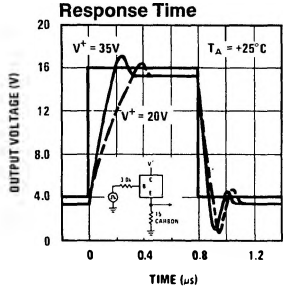












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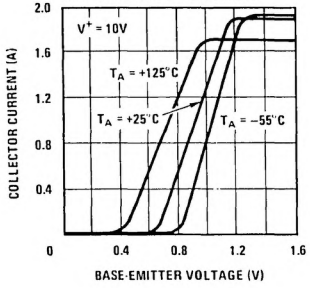
Typical Performance Characteristics (for K and T Packages) (Continued)

10V Transfer Function



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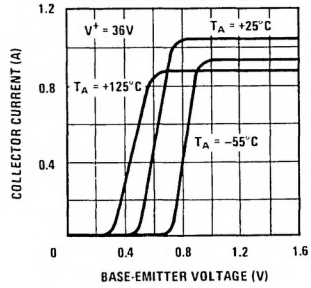
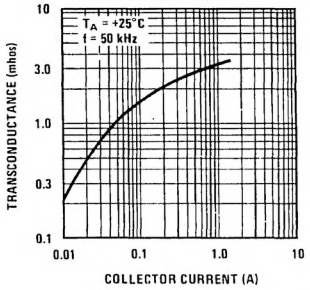
36V Transfer Function



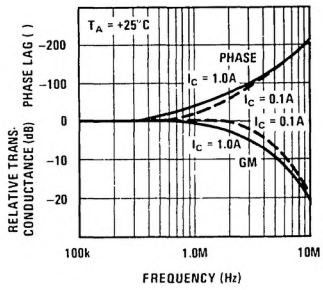
TL/H/6009–8

Transconductance



TL/H/6009–9

Small Signal Frequency Response



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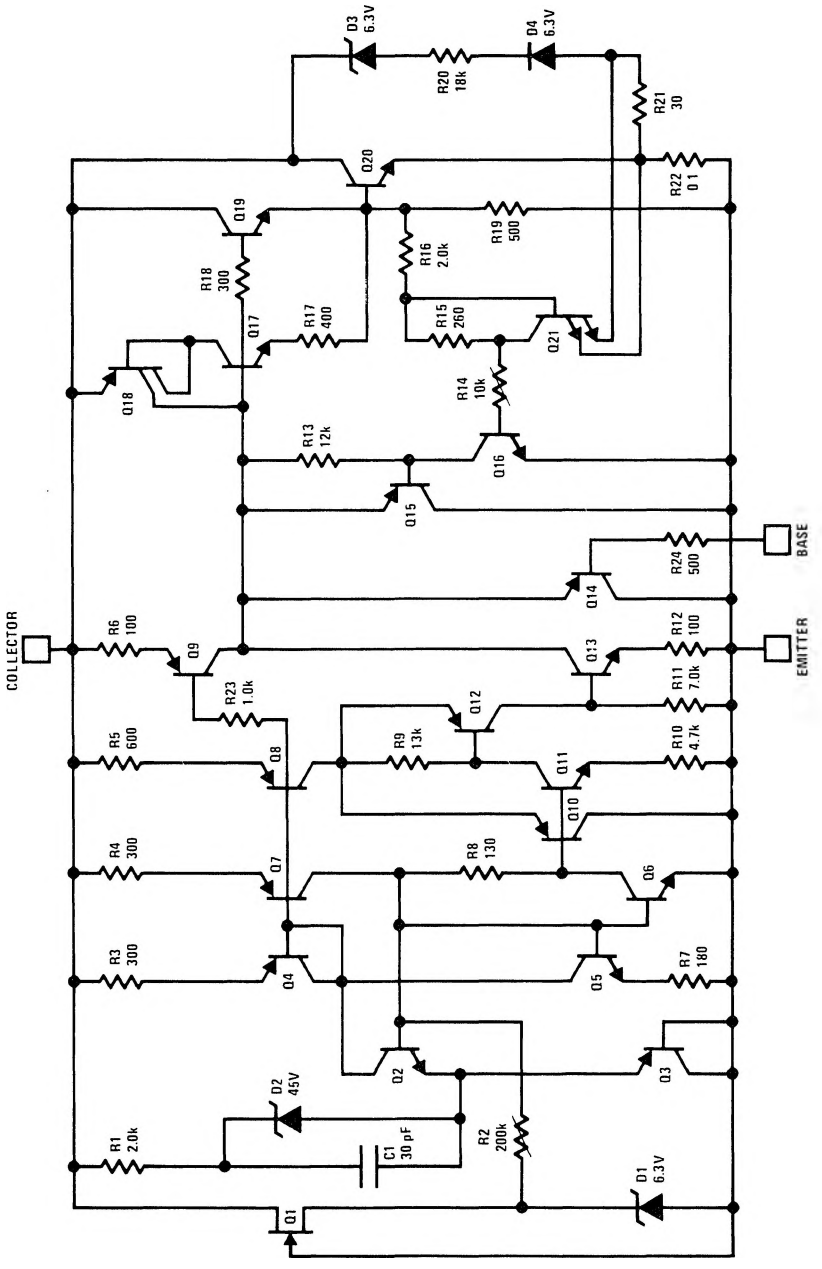
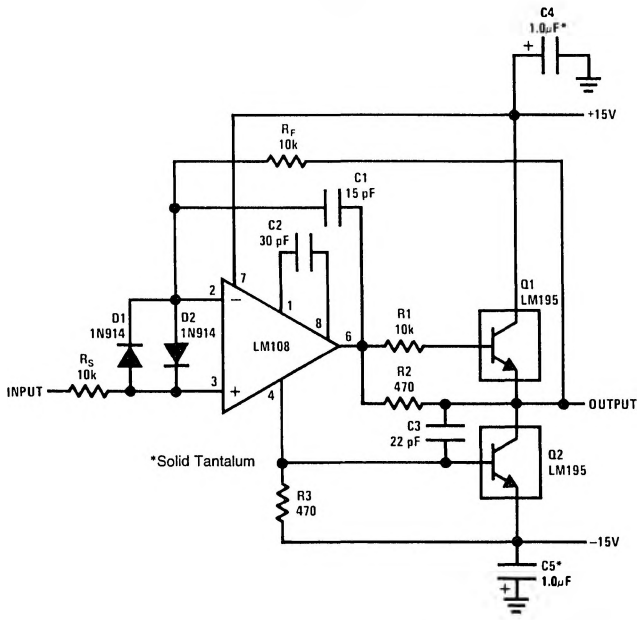
Schematic Diagram



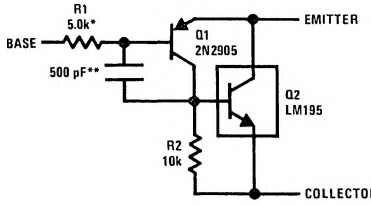
Typical Applications

1.0 Amp Voltage Follower



TL/H/6009–12

Power PNP

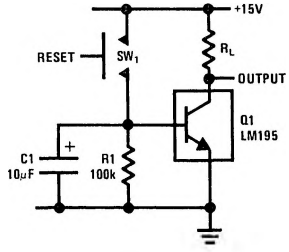


TL/H/6009–13

*Protects against excessive base drive

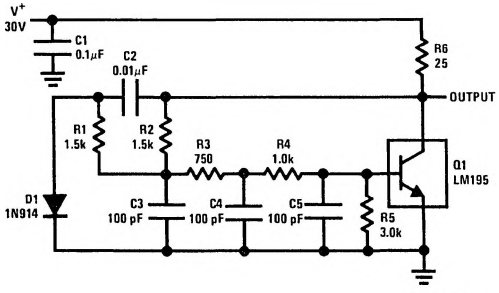
**Needed for stability

Time Delay



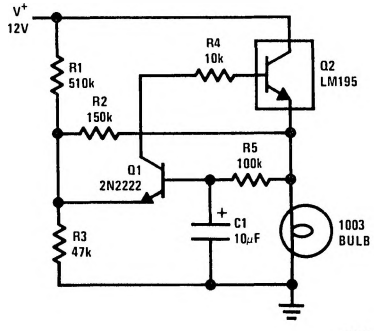
TL/H/6009–14

1.0 MHz Oscillator



TL/H/6009–15

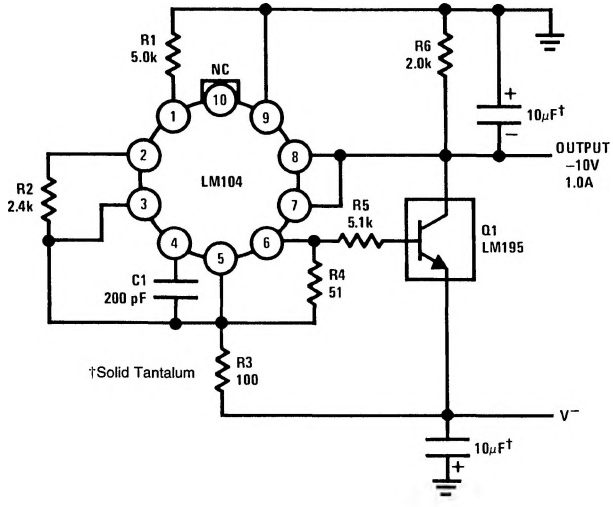
1.0 Amp Lamp Flasher



TL/H/6009–16

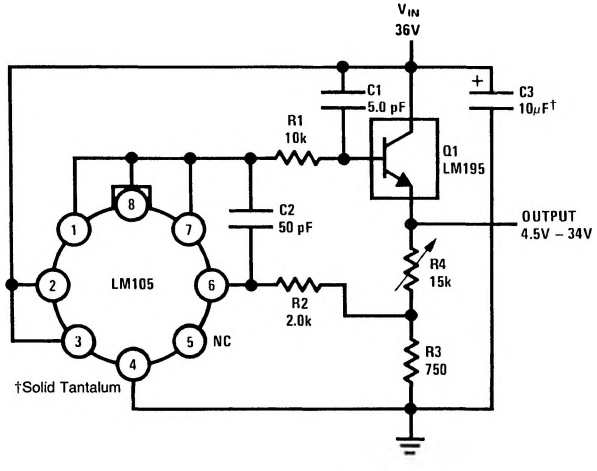
Typical Applications (Continued)

1.0 Amp Negative Regulator



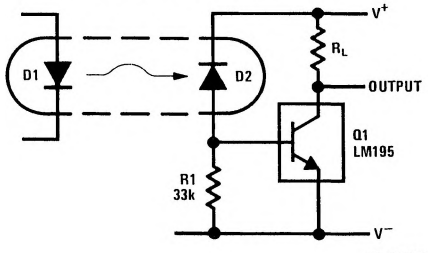
TL/H/6009–17

1.0 Amp Positive Voltage Regulator



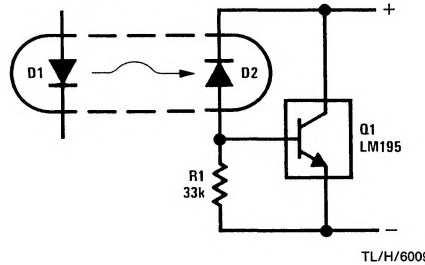
TL/H/6009–18

Fast Optically Isolated Switch



TL/H/6009–19

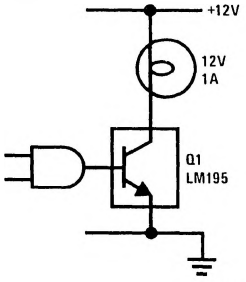
Optically Isolated Power Transistor



TL/H/6009–20

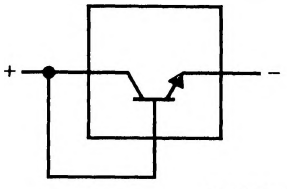
Typical Applications (Continued)

CMOS or TTL Lamp Interface



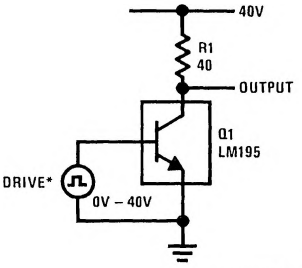
TL/H/6009–21

Two Terminal Current Limiter



TL/H/6009–22

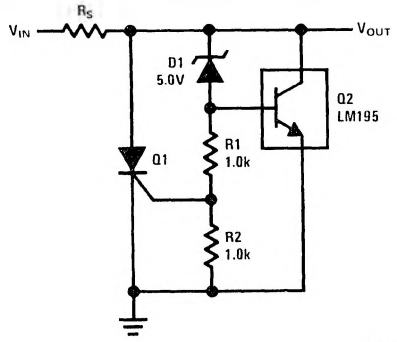
40V Switch



TL/H/6009–23

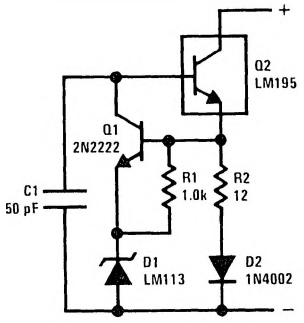
*Drive Voltage 0V to ≥ 10V ≤ 42V

6.0V Shunt Regulator with Crowbar



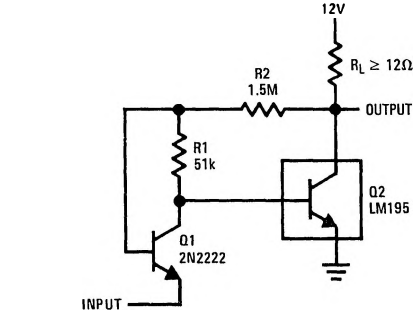
TL/H/6009–24

Two Terminal 100 mA Current Regulator



TL/H/6009–25

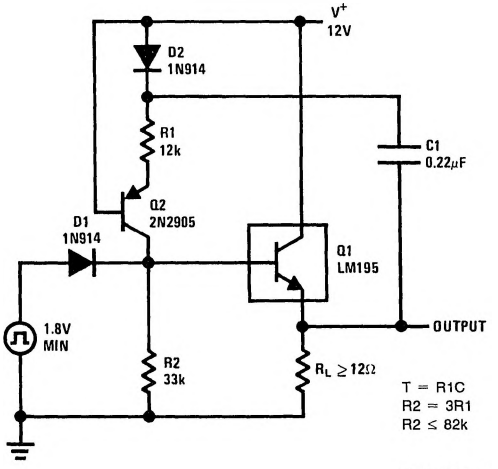
Low Level Power Switch



Turn ON = 350 mV
Turn OFF = 200 mV

TL/H/6009–26

Power One-Shot

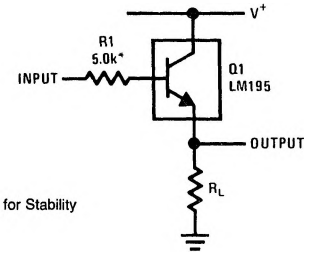


T = R1C
R2 = 3R1
R2 ≤ 82k

TL/H/6009–27

Typical Applications (Continued)

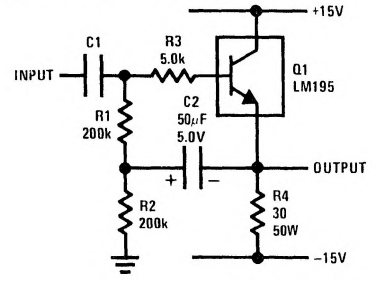
Emitter Follower



*Need for Stability

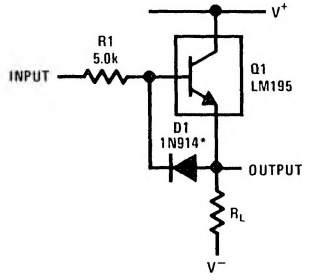
TL/H/6009-28

High Input Impedance AC Emitter Follower



TL/H/6009-29

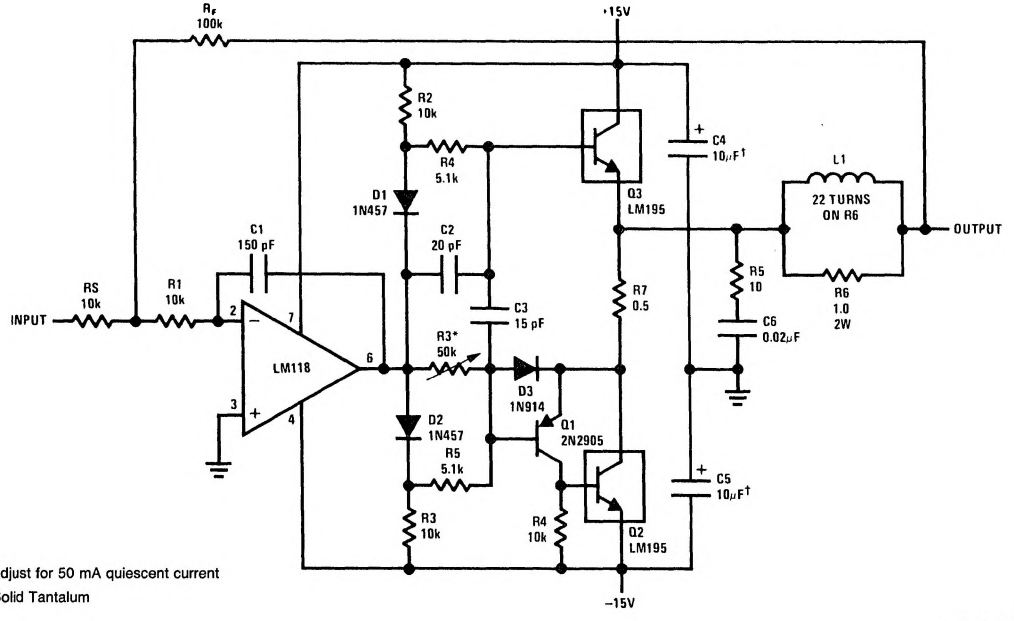
Fast Follower



TL/H/6009-30

*Prevents storage with fast fall time square wave drive

Power Op Amp



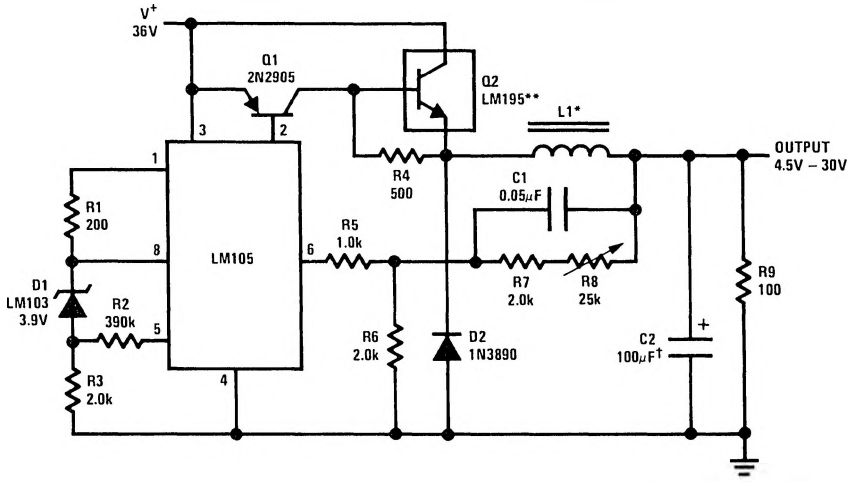
*Adjust for 50 mA quiescent current

†Solid Tantalum

TL/H/6009-31

Typical Applications (Continued)

6.0 Amp Variable Output Switching Regulator



TL/H/6009–32

*Sixty turns wound on Arnold Type A-083081-2 core.

**Four devices in parallel

†Solid tantalum