National Semiconductor

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 500ns.

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 cause 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.

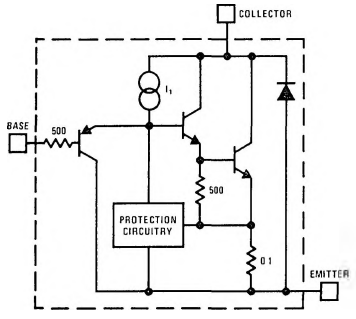
The LM195 is easy to use and only a few precautions need be observed. Excessive collector to emitter voltage can destroy the LM195 as with any power transistor. When the device is used as an emitter follower with low source impedance, it is necessary to insert a 5.0k resistor in series with the base 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

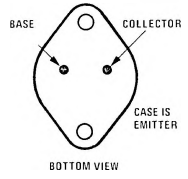
- Internal thermal limiting
- Greater than 1.0A output current
- 3.0μA typical base current
- 500ns switching time
- 2.0V saturation
- Base can be driven up to 40V without damage
- Directly interfaces with CMOS or TTL

Simplified Circuit and Connection Diagrams



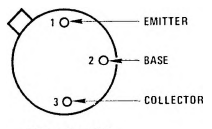
Simplified Circuit of the LM195

TO-3 Metal Can Package



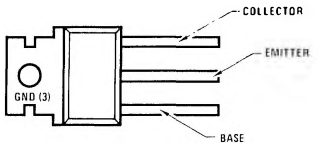
BOTTOM VIEW

TO-5 Metal Can Package



CASE IS EMITTER
BOTTOM VIEW

TO-220 Power Package



TOP VIEW

Absolute Maximum Ratings

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 seconds)	300°C

Electrical Characteristics (Note 1)

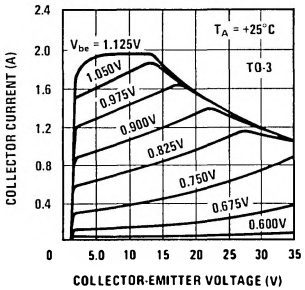
PARAMETER	CONDITIONS	LM195, LM295			LM395			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Collector-Emitter Operating Voltage	$I_O < I_C \leq I_{MAX}$			42			36	V
Base to Emitter Breakdown Voltage	$0 < V_{CE} \leq V_{CE\,MAX}$	42			36	60		V
Collector Current								
TO-3	$V_{CE} < 15V$	1.2	2.0		1.0	2.0		A
TO-5	$V_{CE} \leq 7.0V$	1.2	2.0		1.0	2.0		A
TO-220	$V_{CE} \leq 15V$				1.0	2.0		A
Saturation Voltage	$I_C \leq 1.0A$		1.8	2.0		1.8	2.2	V
Base Current	$0 < I_C \leq I_{MAX}$ $0 \leq V_{CE} < V_{CE\,MAX}$		3.0	5.0		3.0	10	μA
Quiescent Current	$V_{be} = 0$ $0 \leq V_{CE} \leq V_{CE\,MAX}$		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		2.3	3.0		2.3	3.0	°C/W
	TO-5 Package		12	15		12	15	°C/W

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

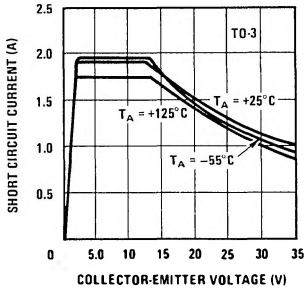
Note 2: Without a heat sink, the thermal resistance of the TO-5 package is about +150°C/W, while that of the TO-3 package is +35°C/W.

Typical Performance Characteristics

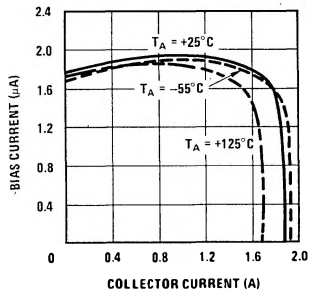
Collector Characteristics



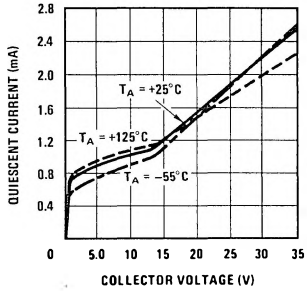
Short Circuit Current



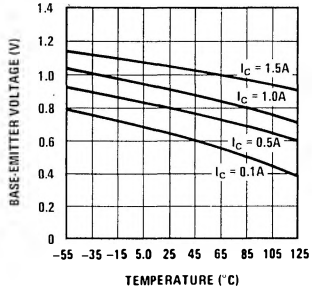
Bias Current



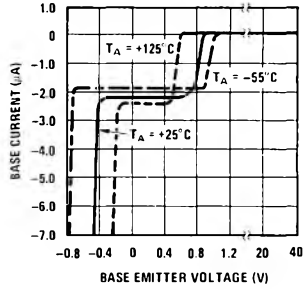
Quiescent Current



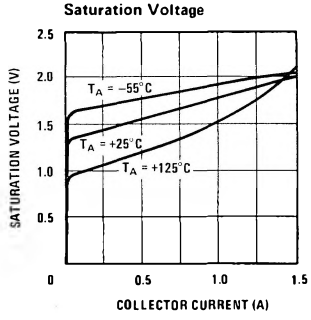
Base Emitter Voltage



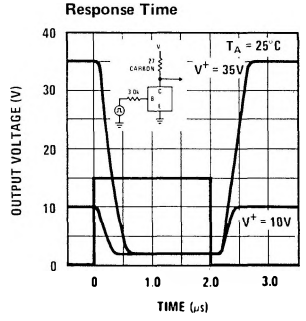
Base Current



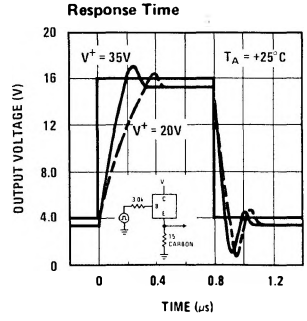
Saturation Voltage



Response Time

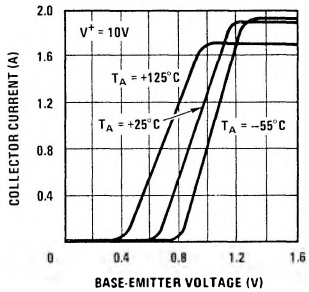


Response Time

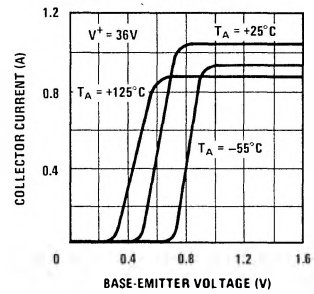


Typical Performance Characteristics (Cont'd.)

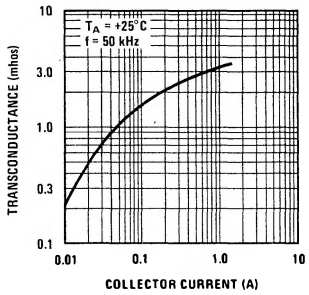
10V Transfer Function



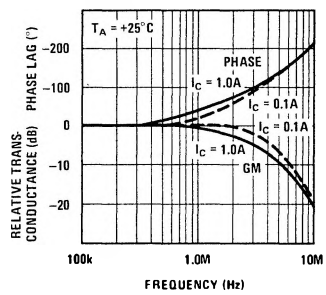
36V Transfer Function



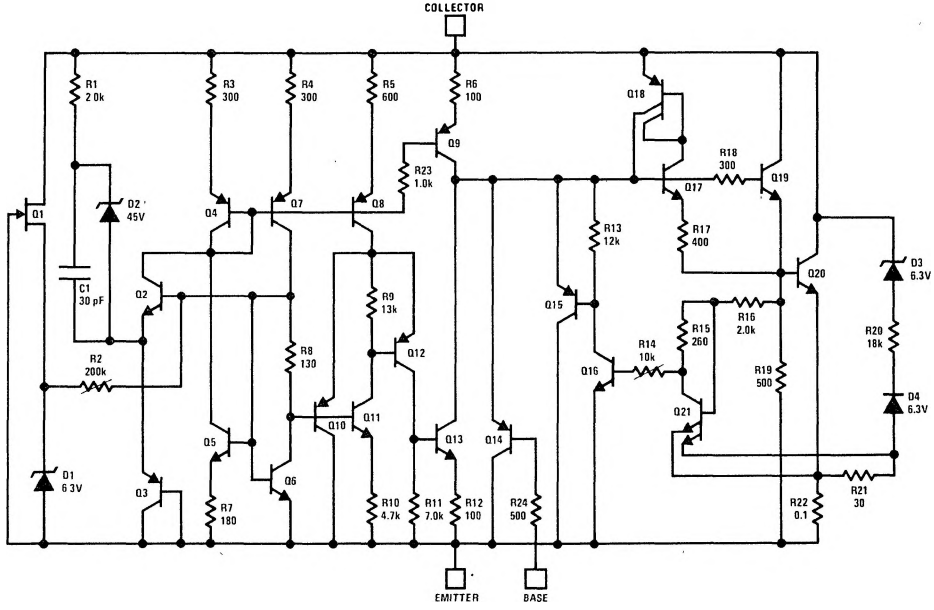
Transconductance



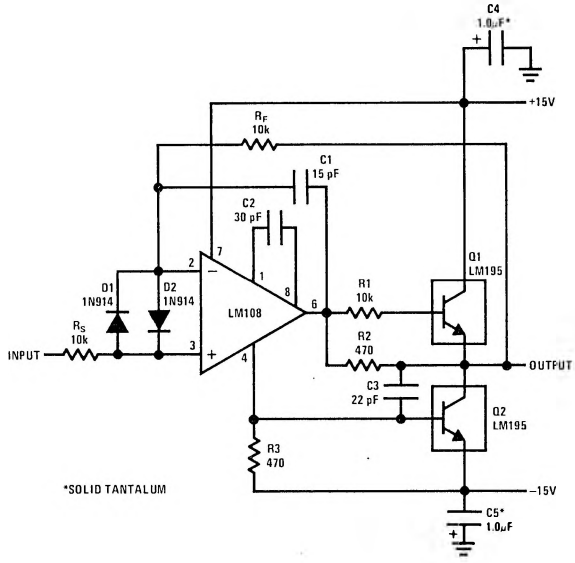
Small Signal Frequency Response



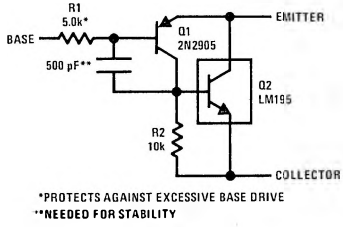
Schematic Diagram



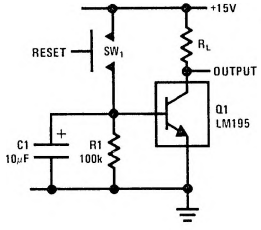
Typical Applications



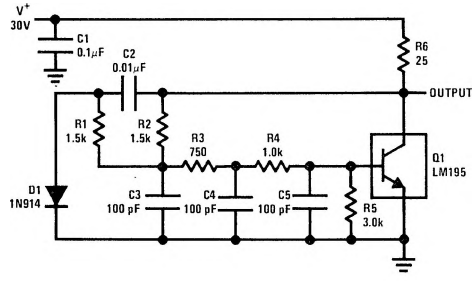
1.0 Amp Voltage Follower



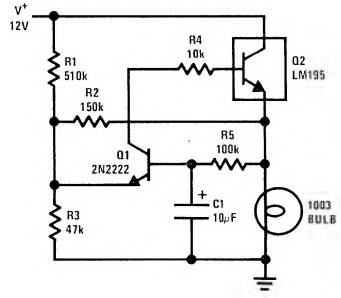
Power PNP



Time Delay

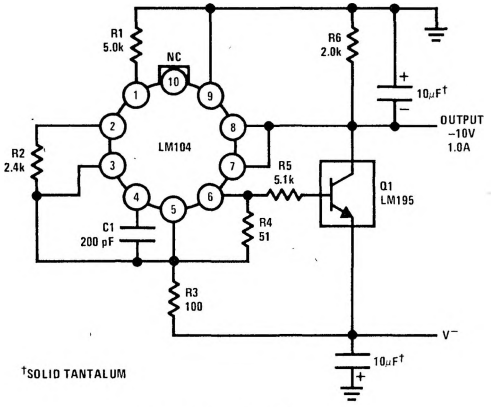


1.0 MHz Oscillator

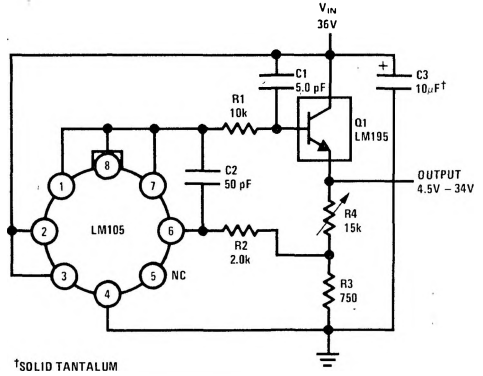


1.0 Amp Lamp Flasher

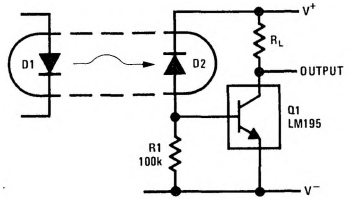
Typical Applications (Cont'd.)



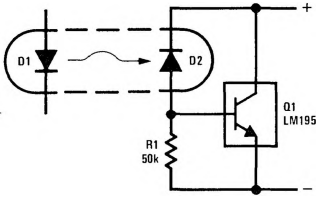
1.0 Amp Negative Regulator



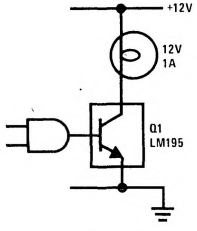
1.0 Amp Positive Voltage Regulator



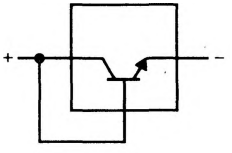
Fast Optically Isolated Switch



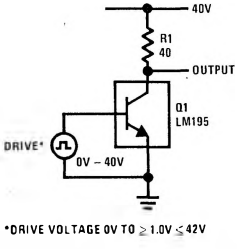
Optically Isolated Power Transistor



CMOS or TTL Lamp Interface



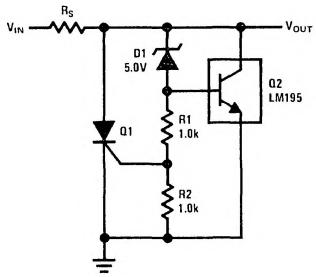
Two Terminal Current Limiter



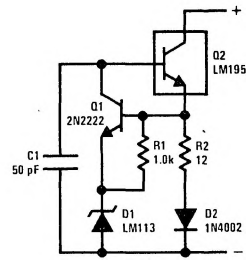
*DRIVE VOLTAGE 0V TO ≥ 1.0V ≤ 42V

40V Switch

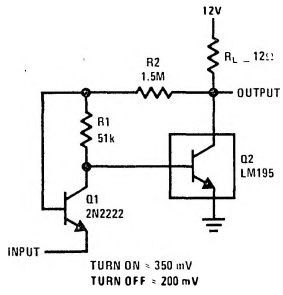
Typical Applications (Cont'd.)



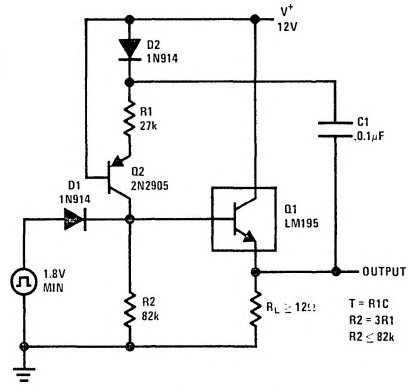
6.0V Shunt Regulator with Crowbar



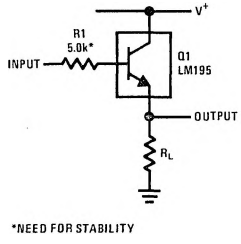
Two Terminal 100 mA Current Regulator



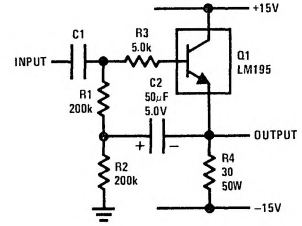
Low Level Power Switch



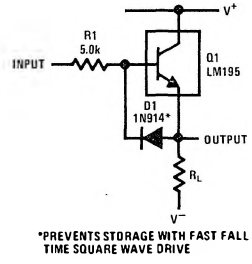
Power One-Shot



Emitter Follower

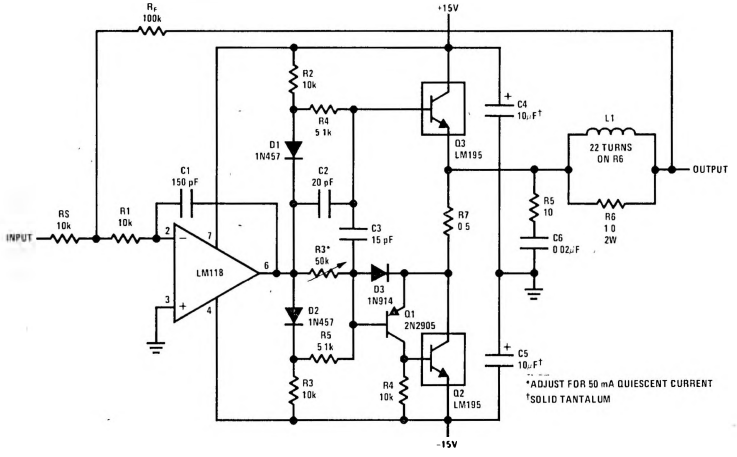


High Input Impedance AC Emitter Follower

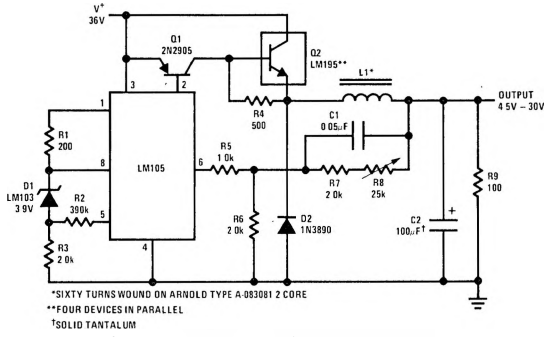


Fast Follower

Typical Applications (Cont'd.)



Power Op Amp



6.0 Amp Variable Output Switching Regulator