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## 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.

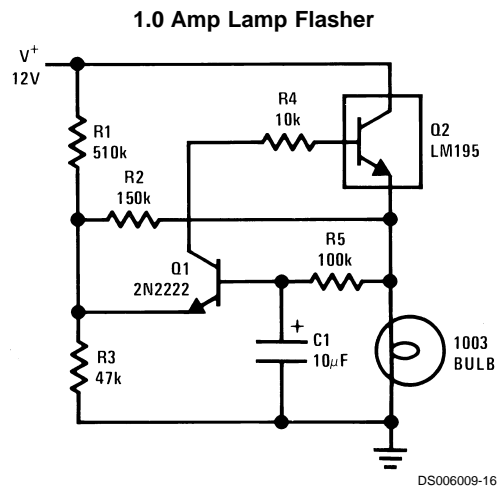
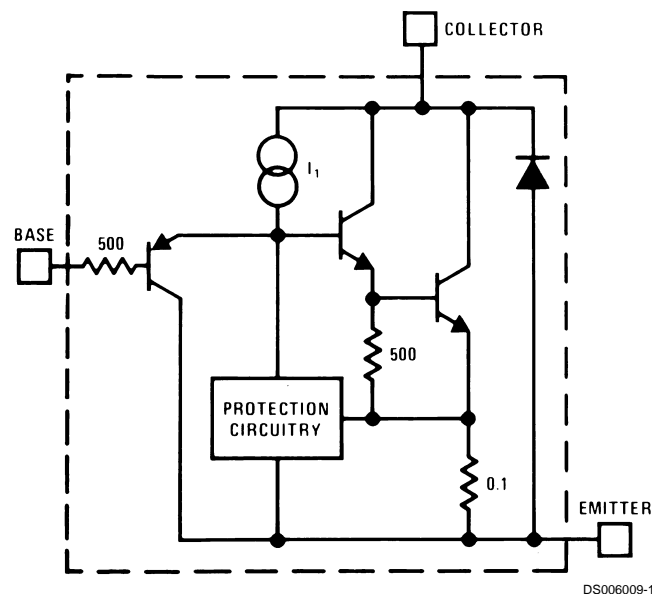
For low-power applications (under 100 mA), refer to the LP395 Ultra Reliable Power Transistor.

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

### Features

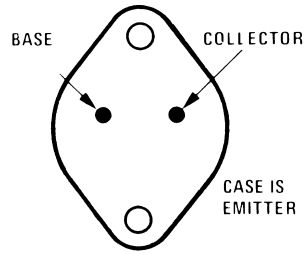
- Internal thermal limiting
- Greater than 1.0A output current
- 3.0  $\mu\text{A}$  typical base current
- 500 ns switching time
- 2.0V saturation
- Base can be driven up to 40V without damage
- Directly interfaces with CMOS or TTL
- 100% electrical burn-in

### Simplified Circuit



# Connection Diagrams

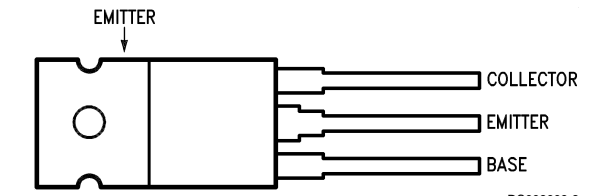
**TO-3 Metal Can Package**



DS006009-2

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

**TO-220 Plastic Package**

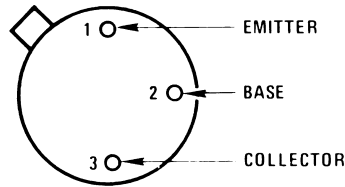


DS006009-3

Case is Emitter

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

**TO-5 Metal Can Package**



CASE IS EMITTER

DS006009-4

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

## 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	$\mu A$
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.

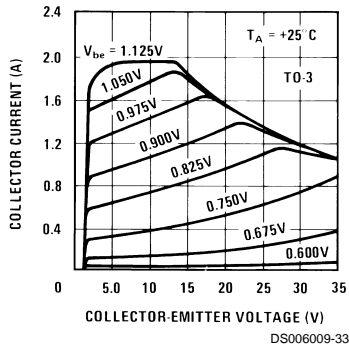
**Note 3:** Without a heat sink, the thermal resistance of the TO-5 package is about  $+150^\circ C/W$ , while that of the TO-3 package is  $+35^\circ C/W$ .

**Note 4:** Selected devices with higher breakdown available.

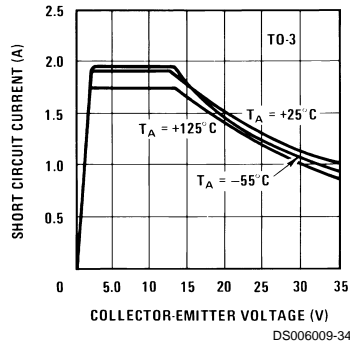
**Note 5:** Refer to RETS195H and RETS195K drawings of military LM195H and LM195K versions for specifications.

# Typical Performance Characteristics (for K and T Packages)

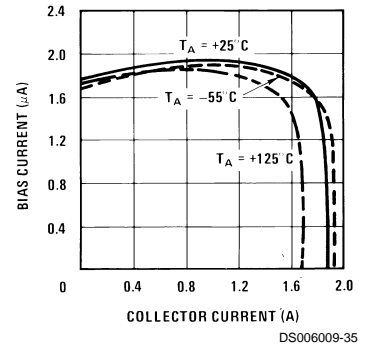
**Collector Characteristics**



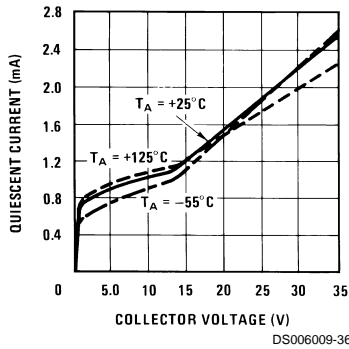
**Short Circuit Current**



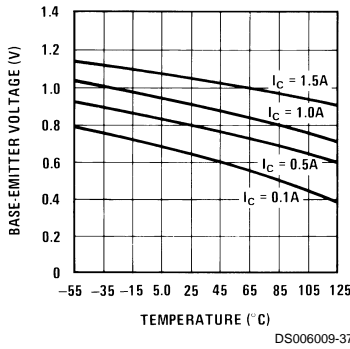
**Bias Current**



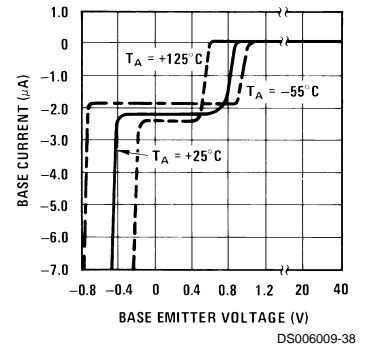
**Quiescent Current**



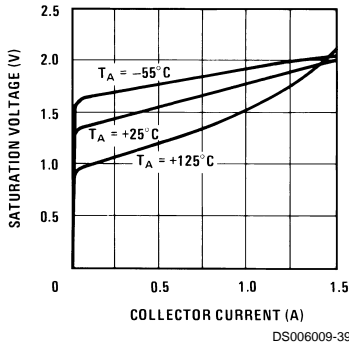
**Base Emitter Voltage**



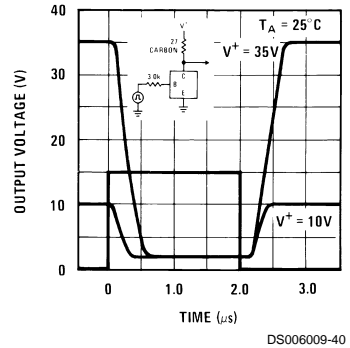
**Base Current**



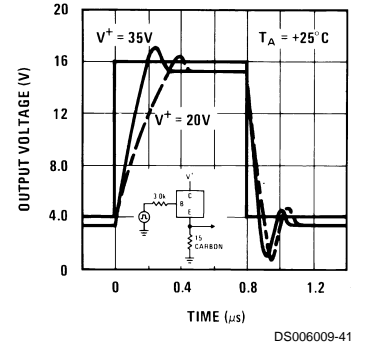
**Saturation Voltage**



**Response Time**

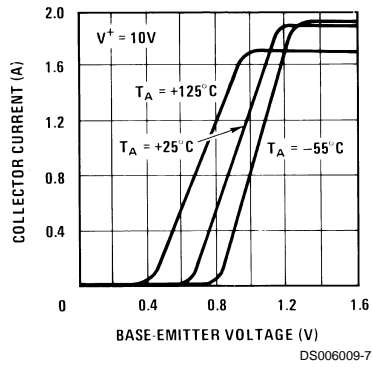


**Response Time**

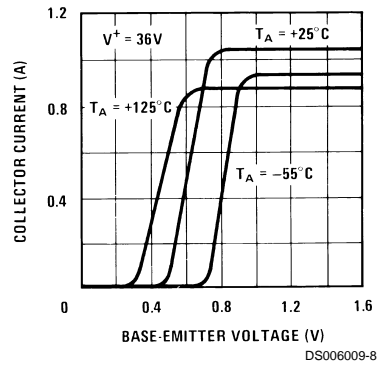


# Typical Performance Characteristics (for K and T Packages) (Continued)

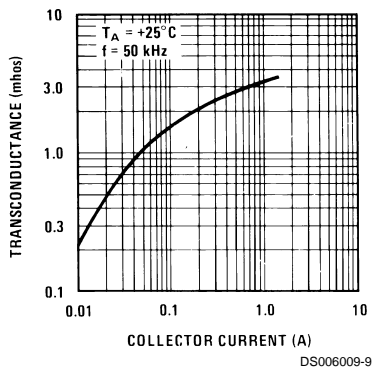
10V Transfer Function



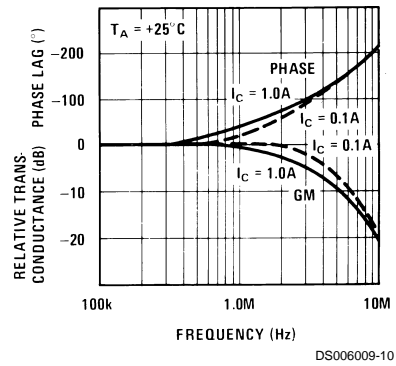
36V Transfer Function



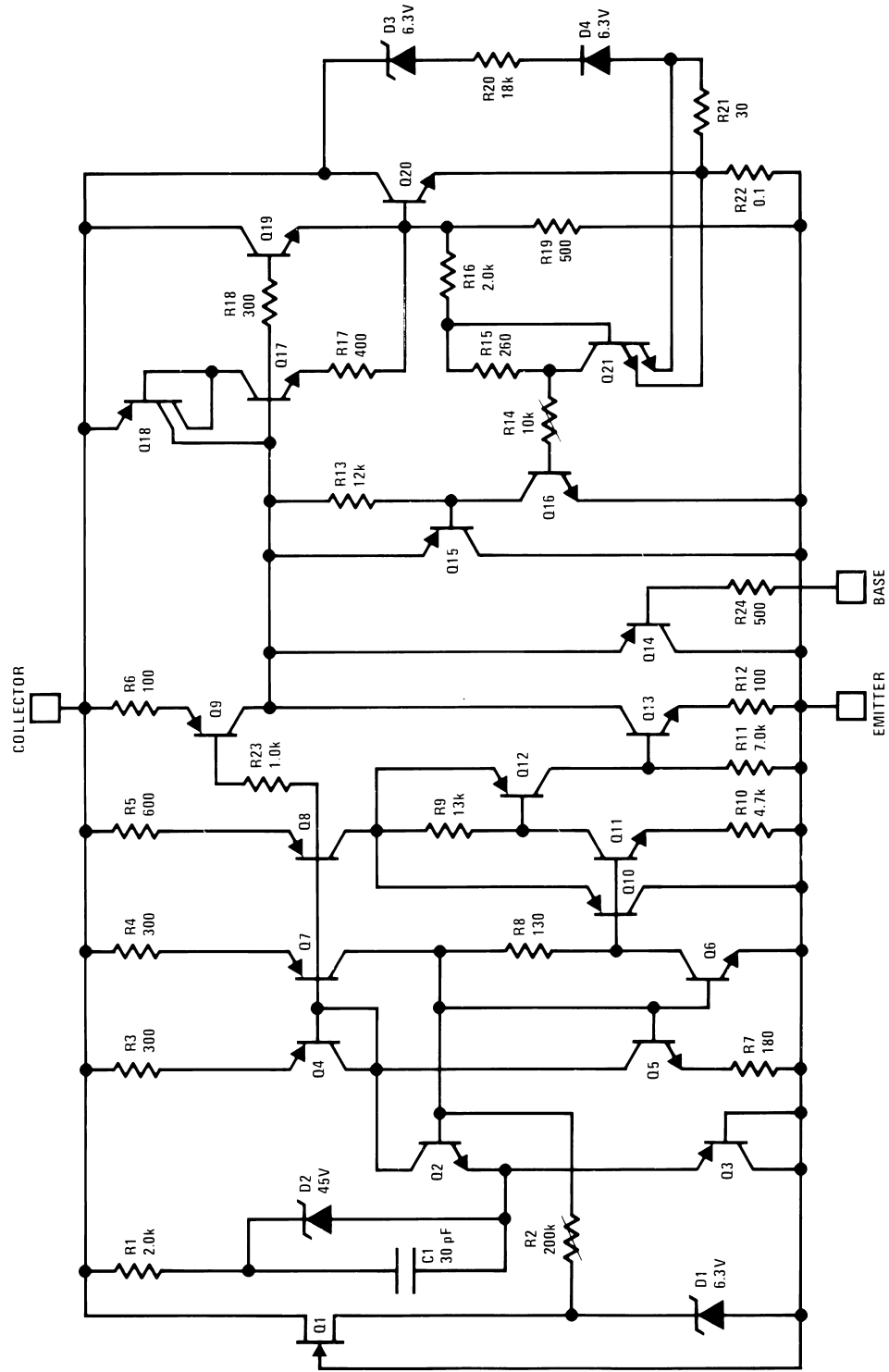
Transconductance



Small Signal Frequency Response

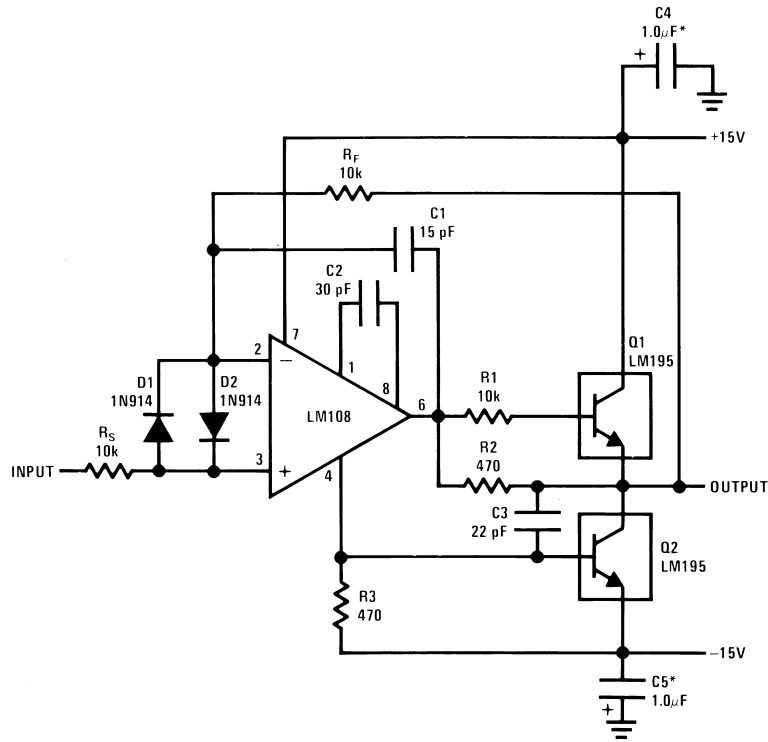


# Schematic Diagram



# Typical Applications

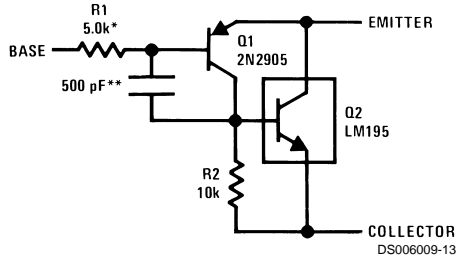
## 1.0 Amp Voltage Follower



DS006009-12

\*Solid Tantalum

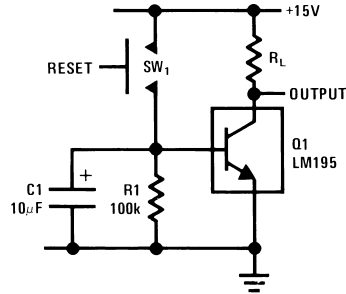
## Power PNP



DS006009-13

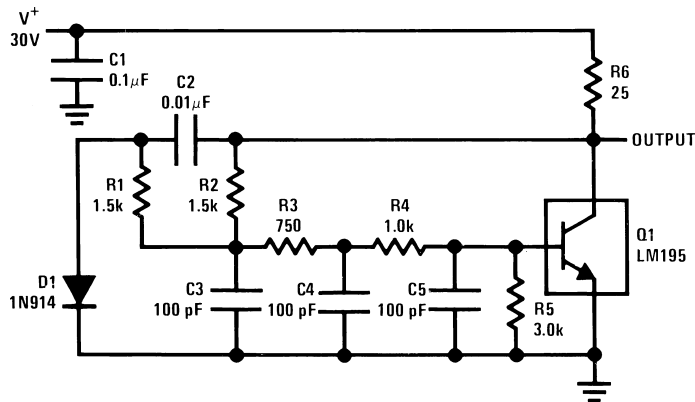
\*Protects against excessive base drive  
\*\*Needed for stability

## Time Delay



DS006009-14

## 1.0 MHz Oscillator

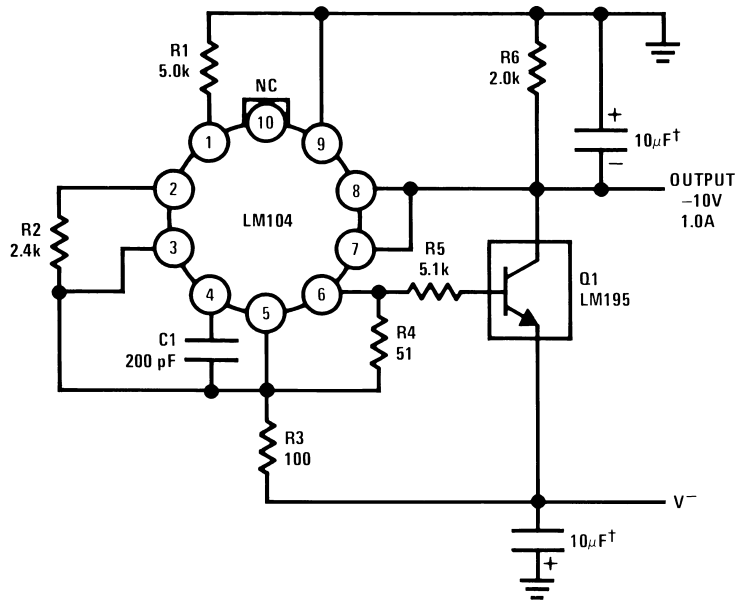


DS006009-15



Typical Applications (Continued)

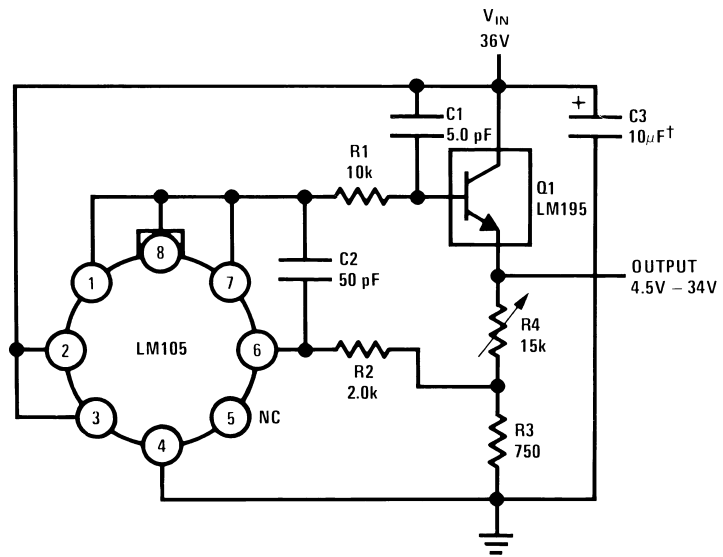
1.0 Amp Negative Regulator



DS006009-17

†Solid Tantalum

1.0 Amp Positive Voltage Regulator

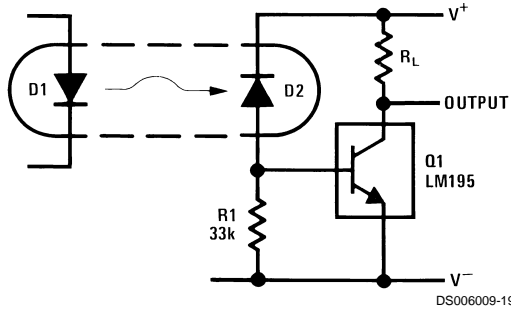


DS006009-18

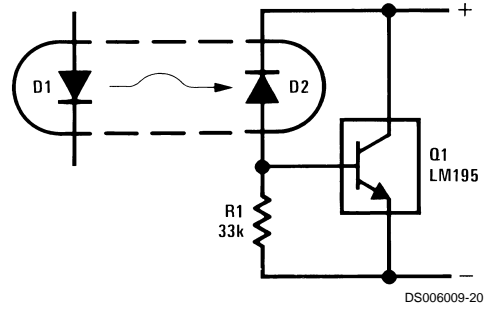
†Solid Tantalum

# Typical Applications (Continued)

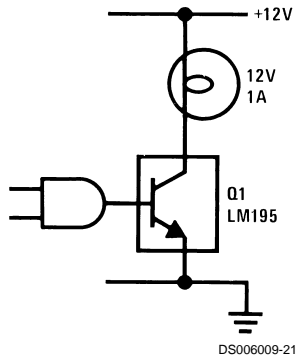
**Fast Optically Isolated Switch**



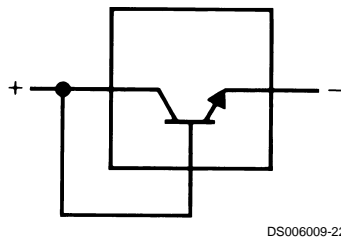
**Optically Isolated Power Transistor**



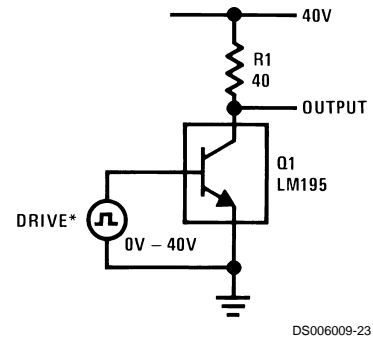
**CMOS or TTL Lamp Interface**



**Two Terminal Current Limiter**

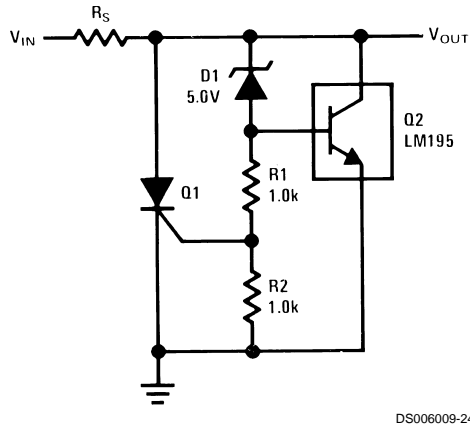


**40V Switch**

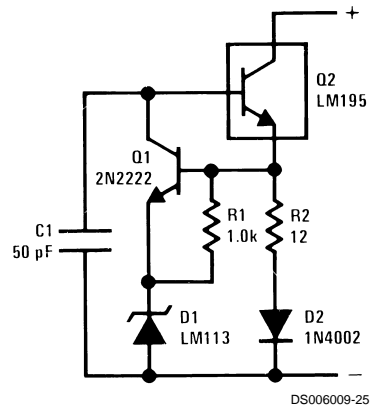


\*Drive Voltage 0V to  $\geq 10V \leq 42V$

**6.0V Shunt Regulator with Crowbar**

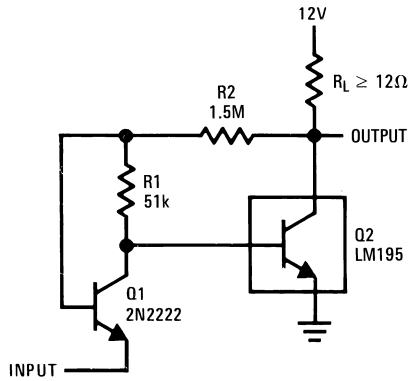


**Two Terminal 100 mA Current Regulator**



# Typical Applications (Continued)

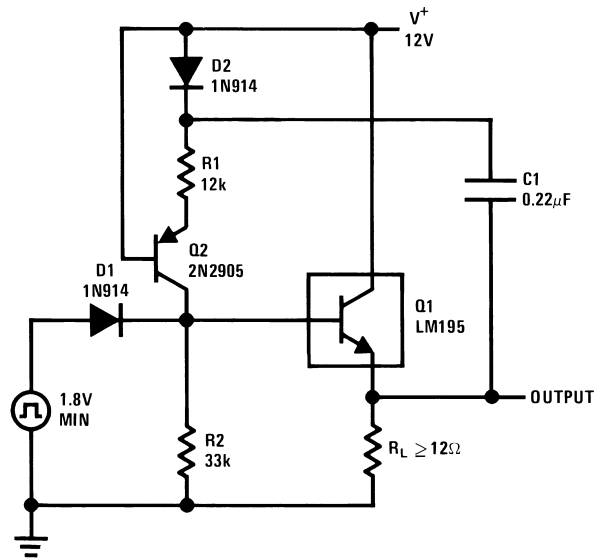
**Low Level Power Switch**



DS006009-26

Turn ON = 350 mV  
Turn OFF = 200 mV

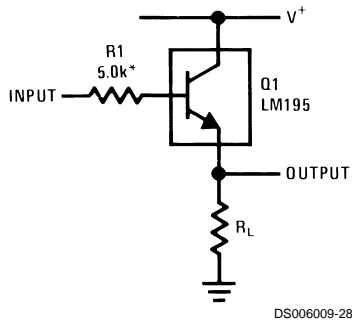
**Power One-Shot**



DS006009-27

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

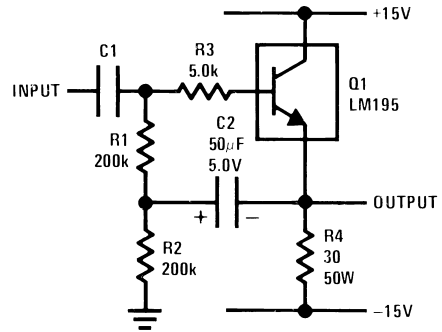
**Emitter Follower**



DS006009-28

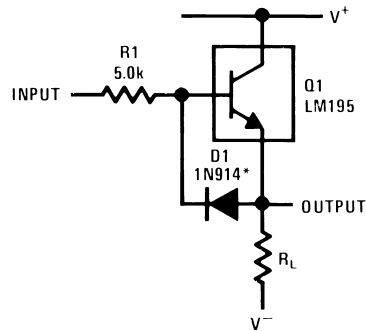
\*Need for Stability

**High Input Impedance AC Emitter Follower**



DS006009-29

**Fast Follower**

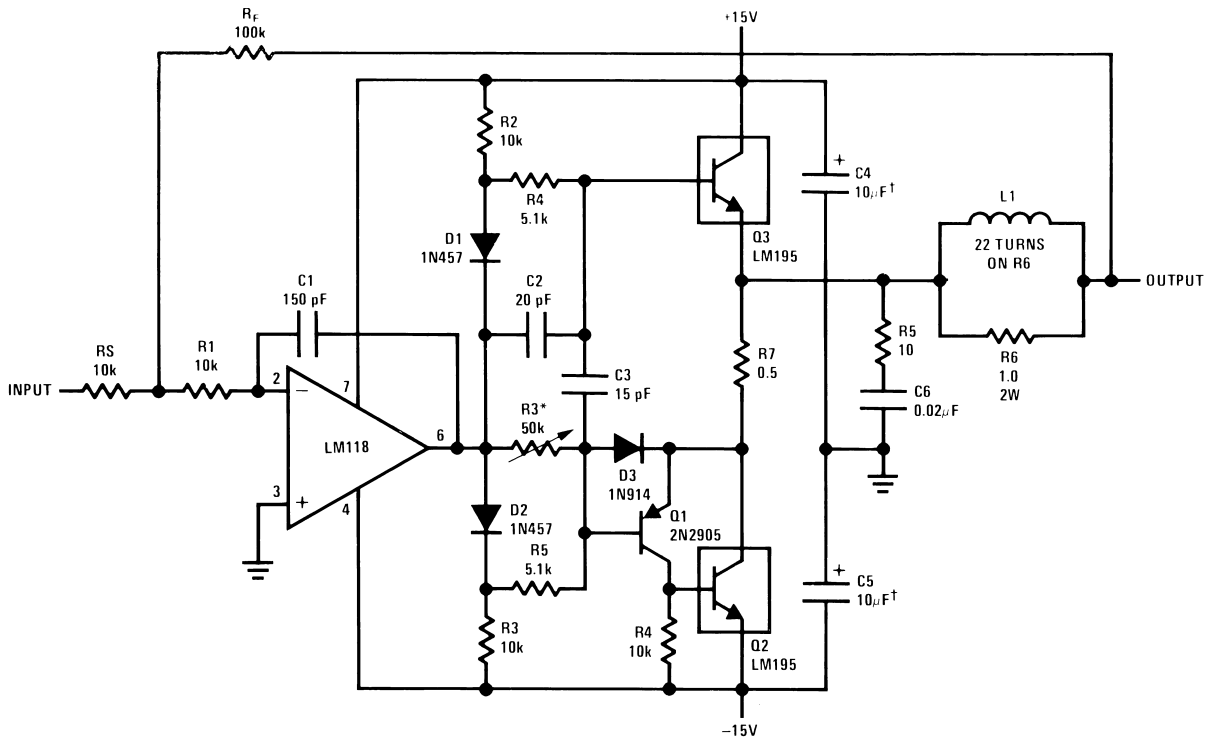


DS006009-30

\*Prevents storage with fast fall time square wave drive

Typical Applications (Continued)

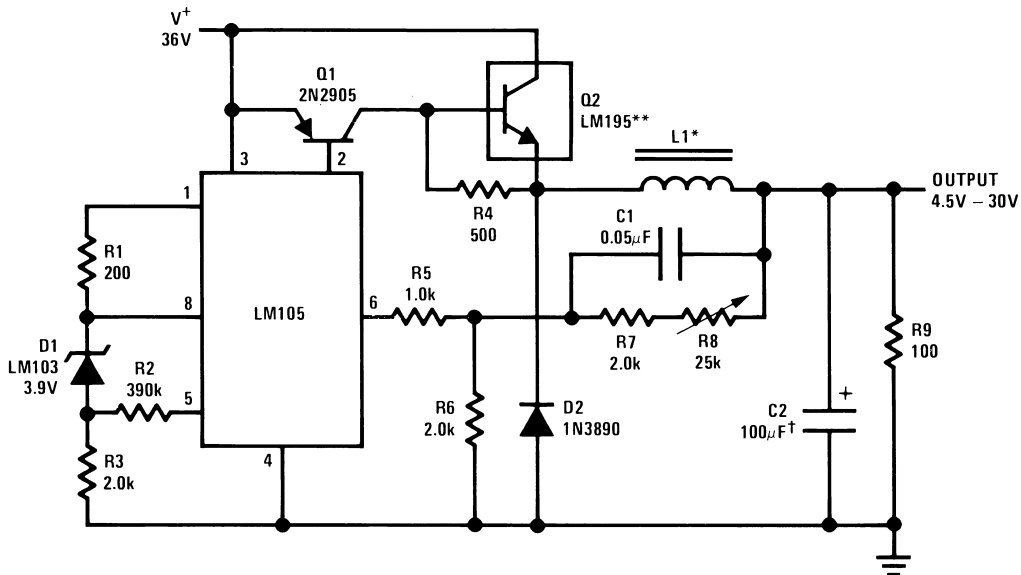
Power Op Amp



DS006009-31

\*Adjust for 50 mA quiescent current  
 †Solid Tantalum

6.0 Amp Variable Output Switching Regulator

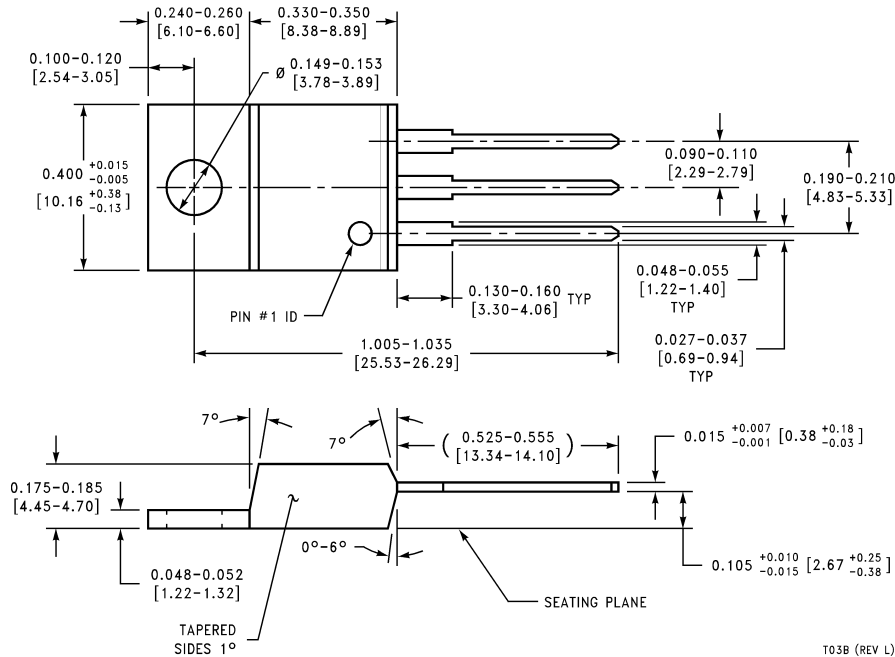


DS006009-32

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



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



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

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# LM395 Product Folder

## Ultra Reliable Power Transistor

<a href="#">General Description</a>	<a href="#">Features</a>	<a href="#">Datasheet</a>	<a href="#">Package &amp; Models</a>	<a href="#">Samples &amp; Pricing</a>	<a href="#">Application Notes</a>
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### Parametric Table

### Parametric Table

Function	Ultra Reliable Power Transistor
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### Datasheet

Title	Size in Kbytes	Date	<input type="checkbox"/> View Online	<input type="checkbox"/> Download	<input type="checkbox"/> Receive via Email
LM195 LM395 Ultra Reliable Power Transistors	420 Kbytes	23-Aug-00	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>

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### Package Availability, Models, Samples & Pricing

Part Number	Package			Status	Models		Samples & Electronic Orders	Budgetary Pricing		Std Pack Size	Package Marking
	Type	Pins	MSL		SPICE	IBIS		Qty	\$US each		
LM395T	TO 220	3	<a href="#">MSL</a>	Full production	N/A	N/A	<input type="button" value="Buy Now"/>	1K+	\$1.4900	rail of 45	[logo]cUcZc2cT LM395T
LM395 MDC	<a href="#">Die</a>			Full production	N/A	N/A	<input type="button" value="Samples"/>			tray of N/A	-
LM395 MWC	<a href="#">Wafer</a>			Full production	N/A	N/A				wafer jar of N/A	-

### General Description

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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  $\mu$ A 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

## Application Notes

Title	Size in Kbytes	Date	<input type="checkbox"/> View Online	<input type="checkbox"/> Download	<input type="checkbox"/> Receive via Email
<b>AN-110:</b> Application Note 110 Fast IC Power Transistor with Thermal Protection	333 Kbytes	1-May-98	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
<b>AN-161:</b> IC Voltage Reference has 1 ppm per Degree Drift	133 Kbytes	4-Nov-95	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
<b>AN-173:</b> IC Zener Eases Reference Design	77 Kbytes	4-Nov-95	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
<b>AN-181:</b> Application Note 181 3-Terminal Regulator Is Adjustable	123 Kbytes	8-Nov-00	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>



<b>AN-262:</b> Applying Dual and Quad FET Op Amps	177 Kbytes	10-May-96	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
<b>AN-293:</b> Control Applications of CMOS DACs	178 Kbytes	4-Nov-95	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
<b>AN-460:</b> LM34/LM35 Precision Monolithic Temperature Sensors	190 Kbytes	4-Nov-95	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
LM34/LM35 Precision Monolithic Temperature Sensors <b>(JAPANESE)</b>	322 Kbytes		<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via</a>
<b>LB-28:</b> Linear Brief 28 General Purpose Power Supply	45 Kbytes	1-May-98	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>

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LM195

# LM195 Product Folder

## Ultra Reliable Power Transistor

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### Parametric Table

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### Datasheet

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LM195 LM395 Ultra Reliable Power Transistors	420 Kbytes	23-Aug-00	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
LM195 Mil-Aero Datasheet MNLM195-H	14 Kbytes		<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
LM195 Mil-Aero Datasheet MNLM195-K	9 Kbytes		<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>

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### Package Availability, Models, Samples & Pricing

Part Number	Package			Status	Models		Samples & Electronic Orders	Budgetary Pricing		Std Pack Size	<a href="#">Package Marking</a>
	Type	Pins	MSL		SPICE	IBIS		Qty	\$US each		
5962-8777801XA	<a href="#">TO-39</a>	3	<a href="#">MSL</a>	Full production	N/A	N/A	<a href="#">Buy Now</a>	50+	\$16.0000	tray of 20	[logo] cZcSc4cA LM195H/883QcM 5962-8777801XA SE
5962-8777801YA	<a href="#">TO-3</a>	2	<a href="#">MSL</a>	Full production	N/A	N/A	<a href="#">Buy Now</a>	50+	\$19.2000	tray of 50	[logo] cZcSc4cA LM195K/883 QcMSE5962-8777801YA
LM195K MD8	<a href="#">Die</a>			Full production	N/A	N/A	<a href="#">Samples</a>			tray of N/A	-
LM195H MD8	<a href="#">Wafer</a>			Full production	N/A	N/A				wafer jar of N/A	-

LM195H MW8	<a href="#">Wafer</a>	Full production	N/A	N/A				wafer jar of N/A	-
LM195K MW8	<a href="#">Wafer</a>	Full production	N/A	N/A				wafer jar of N/A	-

## 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  $\mu$ A 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

## Application Notes

Title	Size in Kbytes	Date	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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<b>AN-110:</b> Application Note 110 Fast IC Power Transistor with Thermal Protection	333 Kbytes	1-May-98	<a href="#">View Online</a>	<a href="#">Download</a>	<a href="#">Receive via Email</a>
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*[Information as of 5-Aug-2002]*

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