



## 3-TERMINAL ADJUSTABLE REGULATOR

### LM317L / LM317LF

#### DESCRIPTION

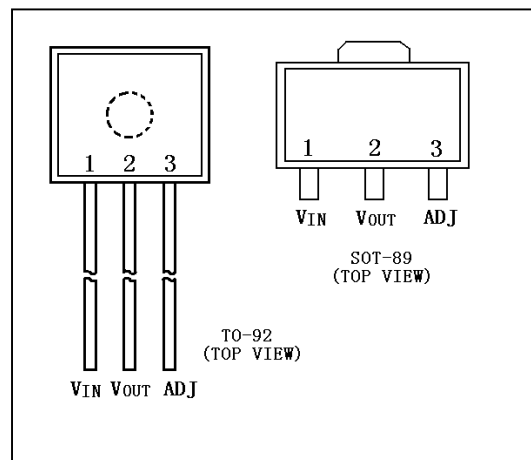
The LM317 is an adjustable 3-terminal positive voltage regulator capable of supplying 100mA over a 1.2V to 37V output range. It is exceptionally easy to use and requires only two external resistors to set the output voltage. Further, it employs internal current limiting, thermal shutdown and safe area compensation, making it essentially blow-out proof. Also, the LM317 is available packaged in a standard TO-92 transistor package which is easy to use.

The LM317 serves a wide variety of applications including local, on card regulation. This device can also be used to make a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM317 can be used as a precision current regulator.

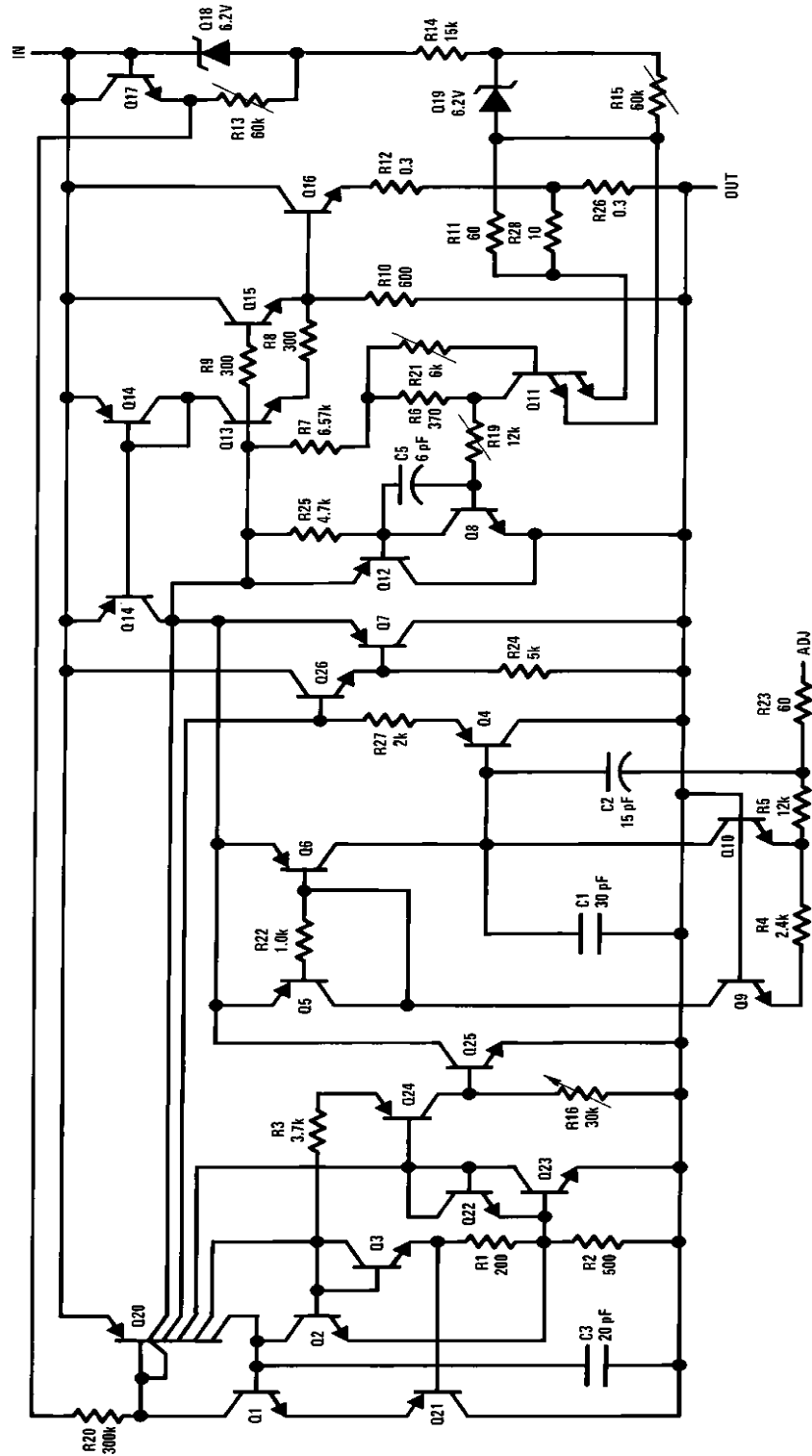
#### FEATURES

- Adjustable output down to 1.2V
- Guaranteed 100 mA output current
- Line regulation typically 0.01%/V
- Load regulation typically 0.1%
- Current limit constant with temperature
- Eliminates the need to stock many voltages
- 80 dB ripple rejection
- Output is short circuit protected

#### PIN CONNECTION



SCHEMATIC DIAGRAM



**ABSOLUTE MAXIMUM RATINGS** ( $T_a=25^\circ\text{C}$ )

Characteristic	Symbol	Min.	Max.	Unit
Input-Output Voltage Differential	$V_i/A_o$	-0.3	40	V
Power Dissipation	$P_D$	-	Internally Limited	W
Operating Junction Temperature Range	$T_j$	-25	125	$^\circ\text{C}$
Lead Temperature (Soldering, 4 seconds)	$T_L$	-	250	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-55	150	$^\circ\text{C}$

**ELECTRICAL CHARACTERISTICS** (unless otherwise specified:  $V_i-V_o=5.0\text{V}$ ;  
 $I_o=40\text{mA}$ ;  $T_j=0\sim 125^\circ\text{C}$ ;  $I_{max}=100\text{mA}$  and  $P_{max}=625\text{mW}$  )

Characteristics	Test conditions	Symbol	Min.	Typ.	Max.	Unit
Line Regulation	$T_j=25^\circ\text{C}$ , $I_L \leq 20\text{mA}$ $3\text{V} \leq (V_{IN}-V_{OUT}) \leq 40\text{V}$	Regline	-	0.01	0.05	% /V
Load Regulation	$T_j=25^\circ\text{C}$ , $5\text{mA} \leq I_{OUT} \leq I_{MAX}$	Regload	-	0.1	0.5	%
Adjustment Pin Current	-	$I_{adj}$	-	50	100	$\mu\text{A}$
Adjustment Pin Current Change	$5\text{mA} \leq I_L \leq 100\text{mA}$ $3\text{V} \leq (V_{IN}-V_{OUT}) \leq 40\text{V}$ , $P \leq 625\text{mW}$	$\Delta I_{adj}$	-	0.2	6	$\mu\text{A}$
Reference Voltage	$3\text{V} \leq (V_{IN}-V_{OUT}) \leq 40\text{V}$ , $5\text{mA} \leq I_{OUT} \leq 100\text{mA}$ , $P \leq 625\text{mW}$	$V_{ref}$	1.15	1.25	1.35	V
Line Regulation	$3\text{V} \leq (V_{IN}-V_{OUT}) \leq 40\text{V}$ , $I \leq 20\text{mA}$	Regline	-	0.02	0.05	%/V
Load Regulation	$5\text{mA} \leq I_{OUT} \leq 100\text{mA}$	Regload	-	0.3	1.2	%
Temperature Stability	$T_{MIN} \leq T_j \leq T_{MAX}$	$T_s$	-	0.65	-	%
Minimum Load Current	$(V_{IN}-V_{OUT}) \leq 40\text{V}$	$I_{Lmin}$	-	3.5	17	mA
	$3\text{V} \leq (V_{IN}-V_{OUT}) \leq 15\text{V}$			1.5	6	
Current Limit	$3\text{V} \leq (V_{IN}-V_{OUT}) \leq 13\text{V}$	$I_{max}$	40	200	260	mA
	$(V_{IN}-V_{OUT}) = 40\text{V}$			25	50	70
Rms Noise % of $V_o$	$T_j=25^\circ\text{C}$ , $10\text{Hz} \leq f \leq 10\text{KHz}$	N	-	0.003	0.008	%
Ripple Rejection	$V_{OUT}=10\text{V}$ , $f=120\text{Hz}$ , $C_{ADJ}=0$	RR		65	80	dB
	$C_{ADJ}=10\mu\text{F}$			66	80	
Long-Term Stability	$T_j=125^\circ\text{C}$ , 1000Hours	S	-	0.3	1	%

## APPLICATION INFORMATION

### 1. Basic circuit operation

In operation, the LM317 develops a nominal 1.25V reference voltage,  $V_{ref}$ , between the output and adjustment terminal. The reference voltage is impressed across program resistor  $R1$  and, since the voltage is constant, a constant current  $I1$  then flows through the output set resistor  $R2$ , giving an output voltage of

$$V_{out} = V_{ref}(1 + R2/R1) + I_{adj} * (R2)$$

Since the  $100\mu A$  current from the adjustment terminal represents an error term, the LM317 was designed to minimize  $I_{adj}$  and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

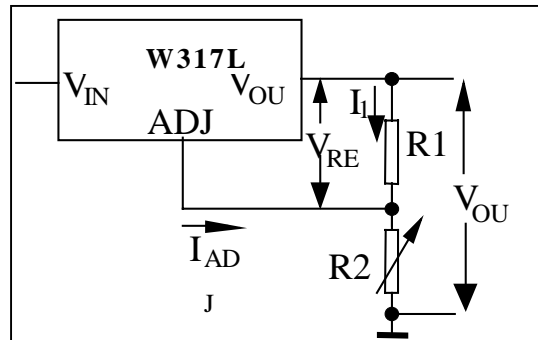
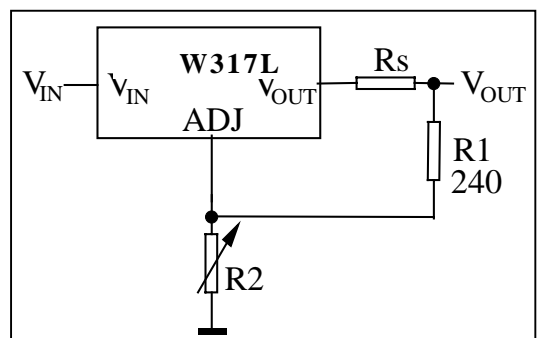


Figure: Basic circuit configuration

### 2. Load Regulation

The LM317 is capable of providing extremely good load regulation, but a few precautions are needed to obtain maximum performance. For best performance, the programming resistor ( $R1$ ) should be connected as close to the regulator as possible to minimize line drops which effectively appear in series with the reference, thereby degrading regulation. The ground end of  $R2$  can be returned near the load ground to provide remote ground sensing and improve load regulation in output lead



Regulator with line resistance

### 3. External capacitors

A  $0.1\mu F$  disc or  $1.0\mu F$  tantalum input bypass capacitor ( $C_{in}$ ) is recommended to reduce the sensitivity to input line impedance.

The adjustment terminal may be bypassed to ground to improve ripple rejection. This capacitor ( $C_{adj}$ ) prevents ripple from being amplified as the output voltage is increased. A  $10\mu F$  capacitor should improve ripple rejection about 15dB at 120Hz in a

10V application.

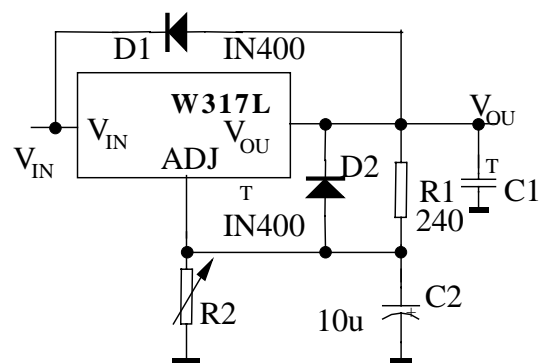
Although the LM317 is stable with no output capacitance, like any feedback circuit, certain values of external capacitance can cause excessive ringing. An output capacitance ( $C_o$ ) in the form of a  $1.0\mu\text{F}$  tantalum or  $25\mu\text{F}$  aluminum electrolytic capacitor on the output swamps this effect and insures stability.

#### 4. Protection Diodes

When external capacitors are used with any IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most  $10\mu\text{F}$  capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short, there is enough energy to damage parts of the IC.

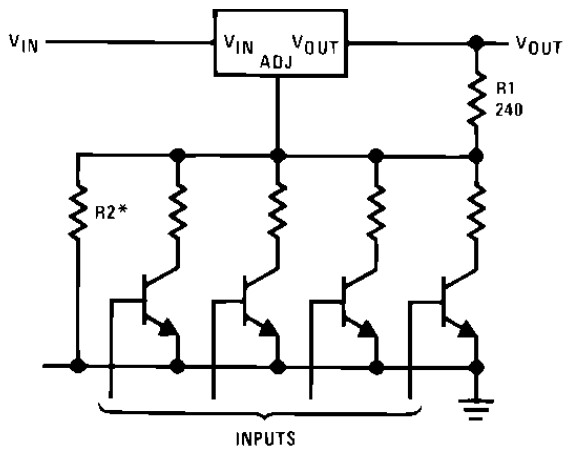
When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of  $V_{in}$ . In the LM317, this discharge path is through a large junction that is able to sustain a 2A surge with no problem. This is not true of other types of positive regulators. For output capacitors of  $25\mu\text{F}$  or less, the LM317's ballast resistors and output structure limit the peak current to a low enough level so that there is no need to use a protection diode.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when either the input or output is shorted. Internal to the LM317 is a  $50\Omega$  resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and  $10\mu\text{F}$  capacitance. Figure in right shows an LM317 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



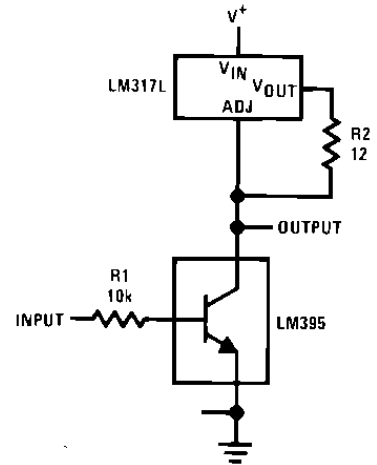
Regulator with protection diodes

APPLICATION CIRCUIT



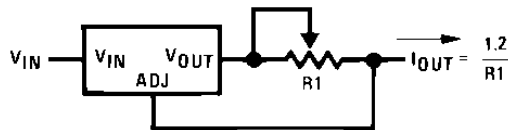
\*Sets maximum Vout

Digitally Selected Outputs



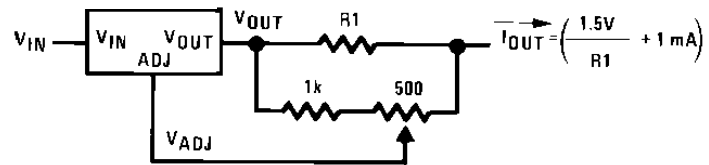
High Gain Amplifier

Adjustable Current Limiter

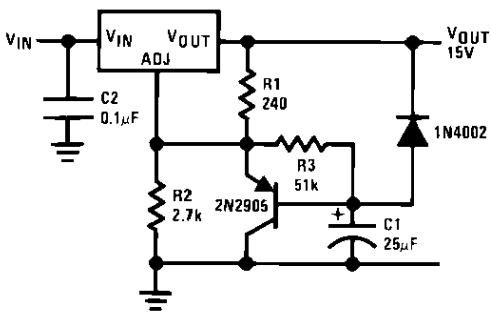


$$12 \leq R1 \leq 240$$

Precision Current Limiter

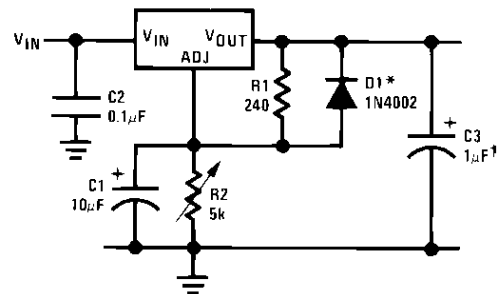


Adjustable Current Limiter



Slow Turn-on 15V Regulator  
Improved Ripple Rejection

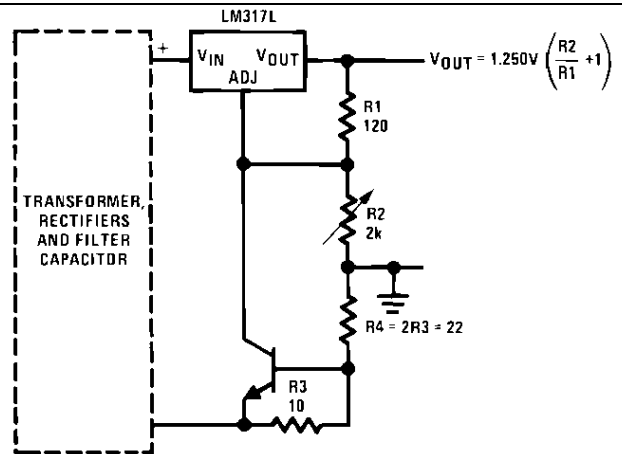
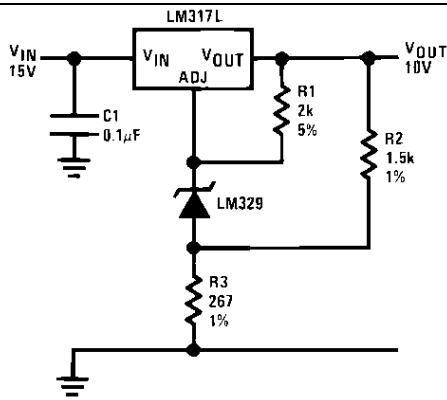
Precision Current Limiter  
Improved Ripple Rejection



+Sold tantalum

\*Discharges C1 if output is shorted to ground

Adjustable Regulator with

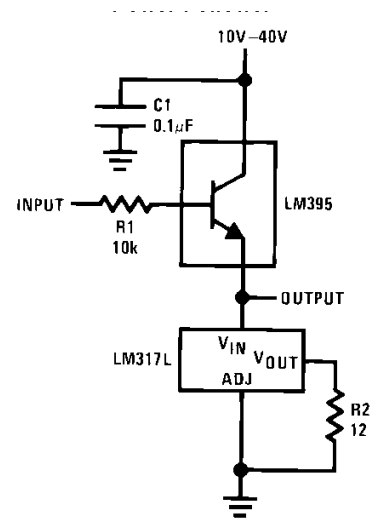
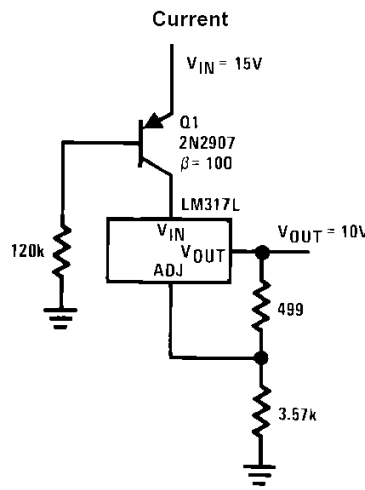
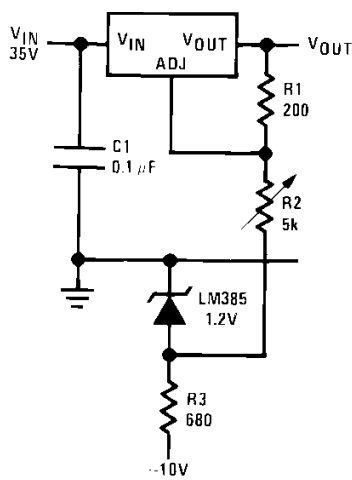


Short circuit current is approximately  $600\text{mV}/R3$ ,

At 25mA output only 3/4V of drop occurs in R3 and R4

High Stability 10V Regulator

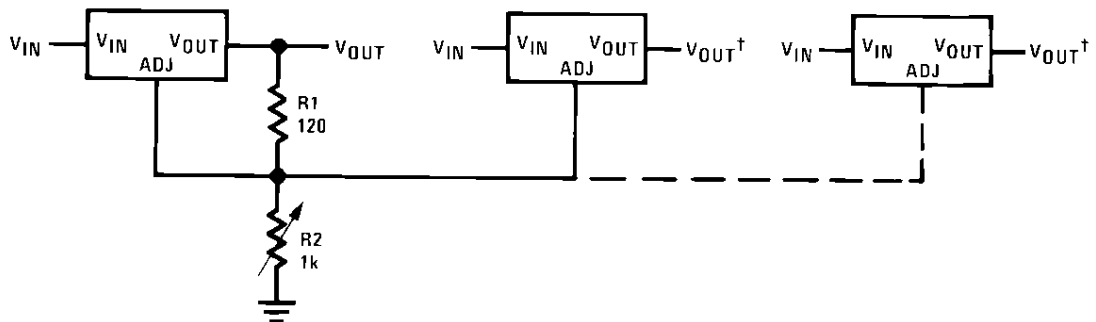
Adjustable Regulator with Current Limiter



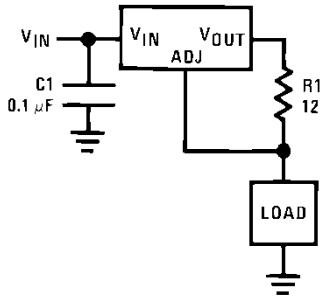
0V~30V Regulator

Current

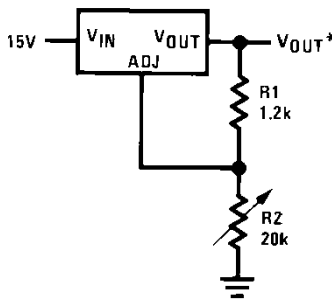
Power Follower



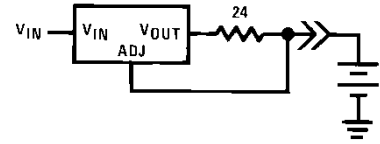
Adjusting Multiple on-Card Regulators with Single Control



100mA Current Regulator

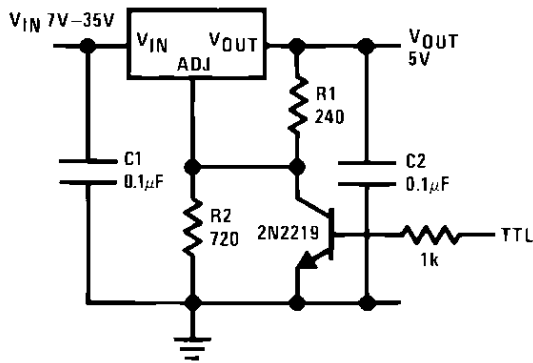


1.2V~12V Regulator with Minimum Program Current



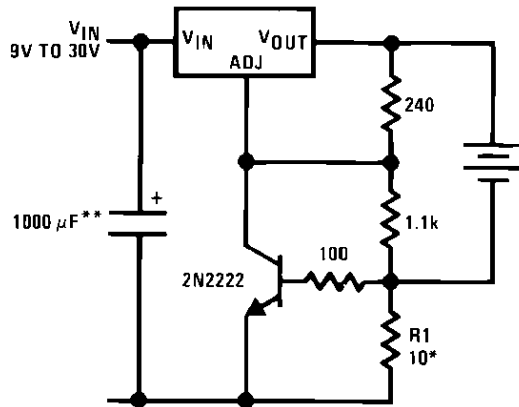
50mA constant Current Battery Charger for Nickel-Cadmium Batteries

\*Minimum load current=2mA



\*Minimum output=1.2V

5V Logic Regulator with Electronic Shutdown

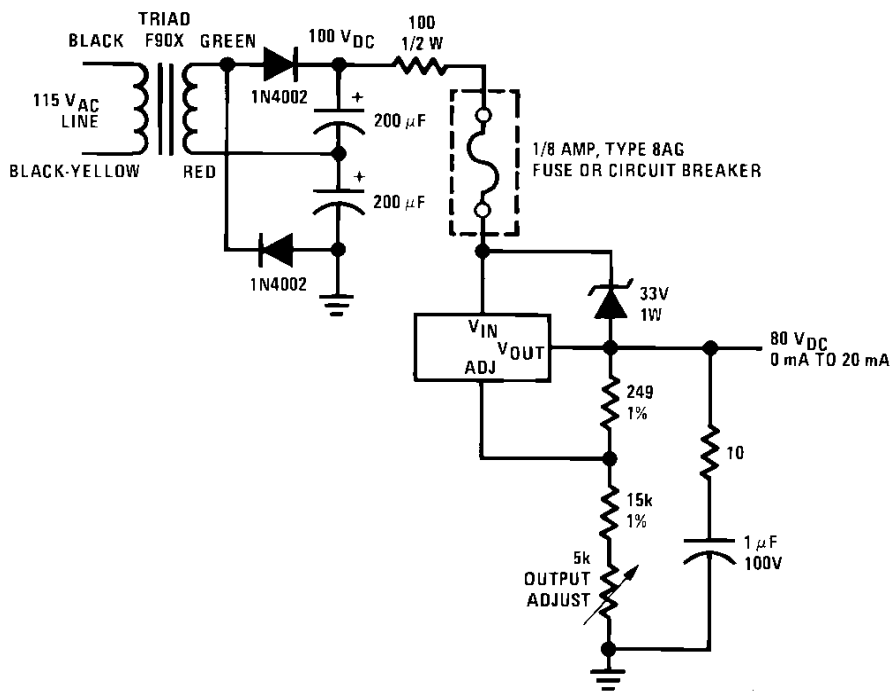


\*Sets peak current,  $I_{peak} = 0.6V/R1$

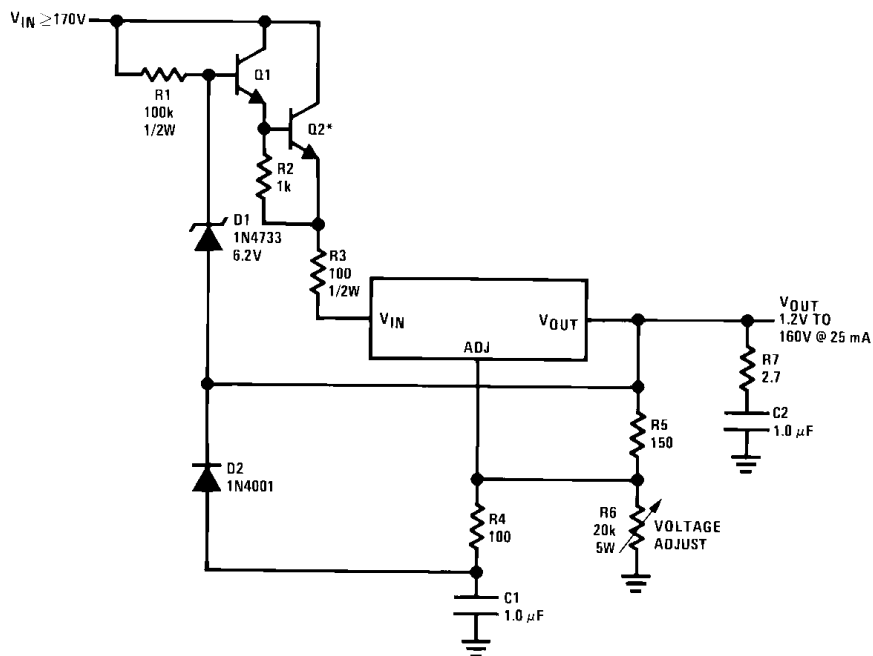
\*\*1000µF is recommended to filter out any input transients

Current Limited 6V Charger





Short Circuit Protected 80V Supply

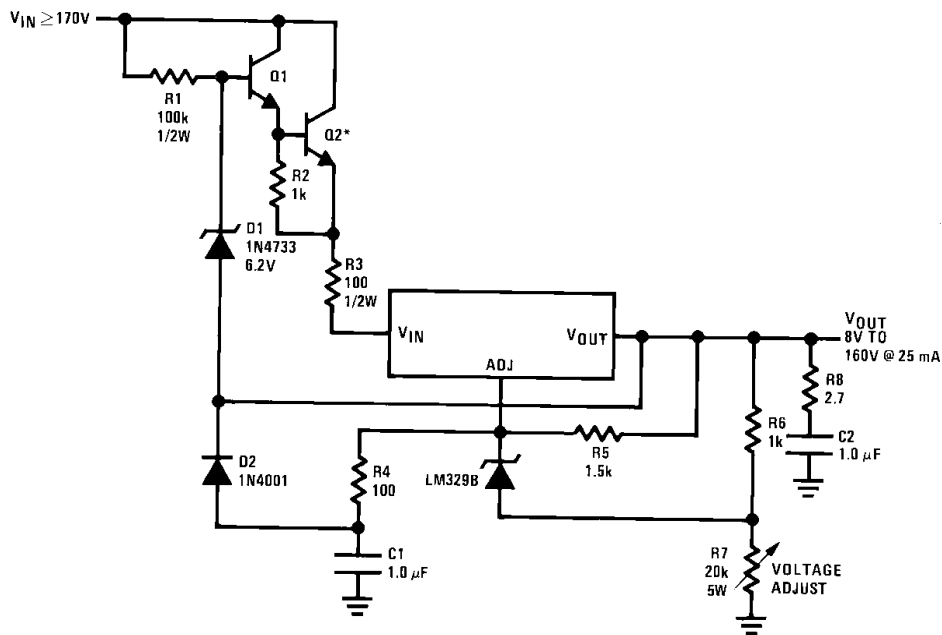


Q1,Q2: NSD134 or similar

C1,C2: 1μF, 200V mylar\*\*

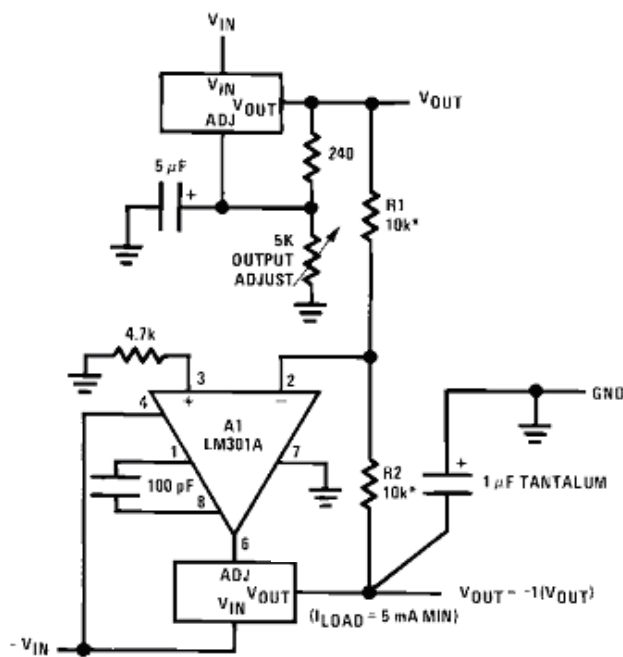
\*Heat sink

Basic High Voltage Regulator

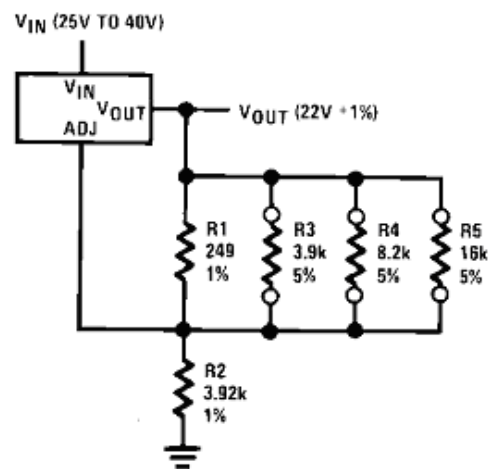


Q1,Q2: NSD134 or similar C1,C2: 1μF, 200V mylar\*\* \*Heat sink \*\* Mylar is a registered trademark of DuPont Co.

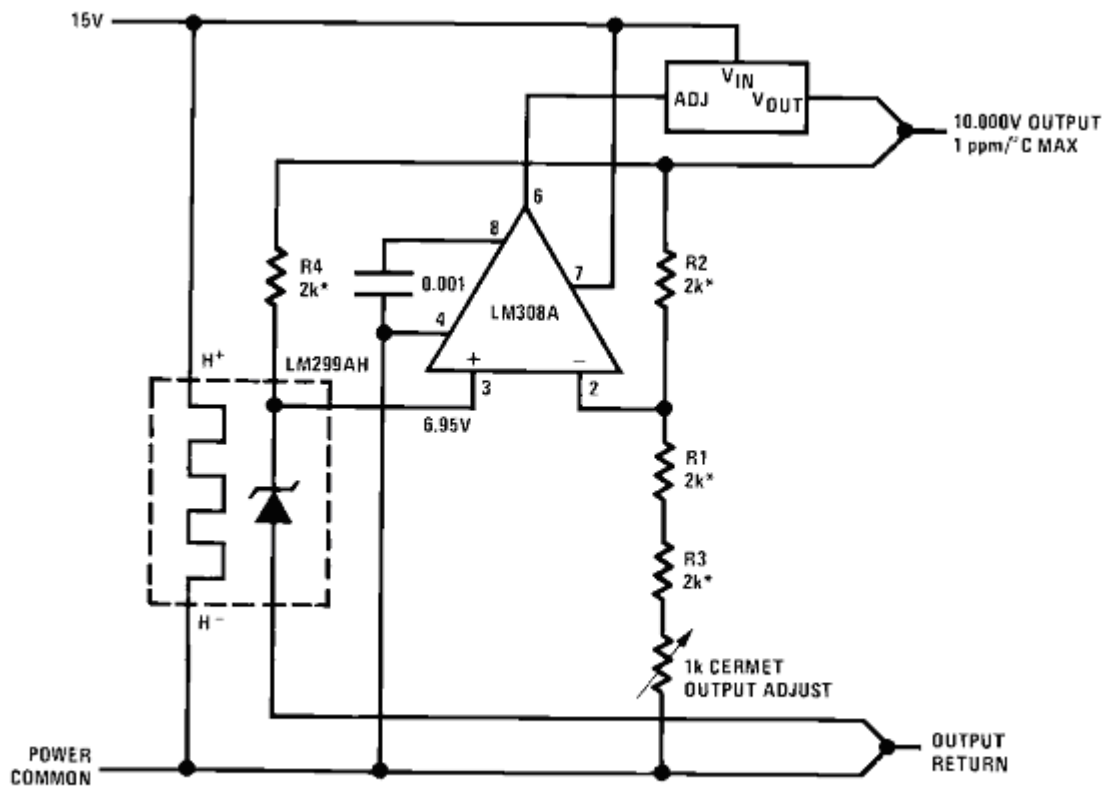
Precision High Voltage Regulator



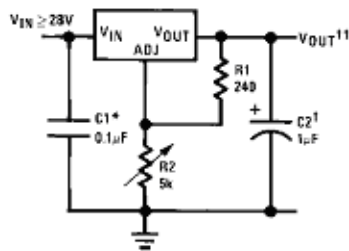
Tracking Regulator



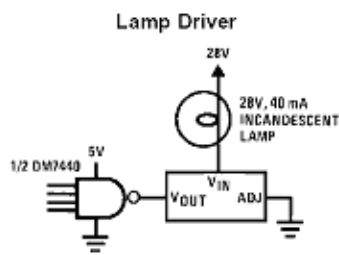
Regulator with Trimmable output Voltage



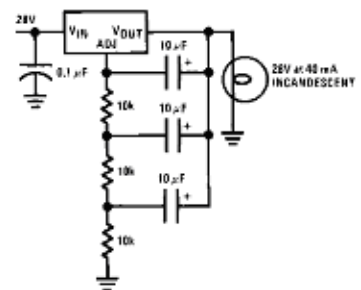
Precision Reference with Short-Circuit Proof Output



Adjustable Regulator



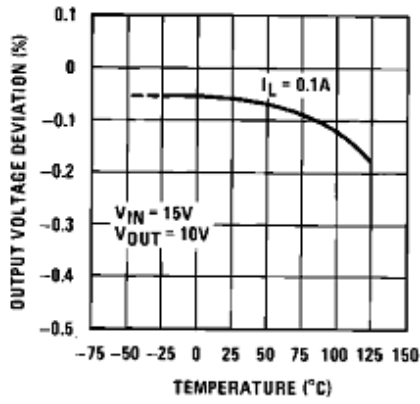
Protected (Bulletproof)  
Lamp Driver



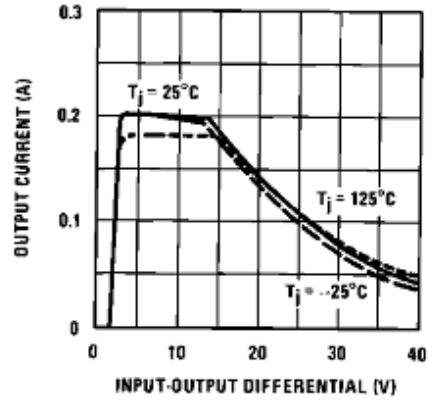
Lamp Flasher

CHARACTERISTICS CURVES

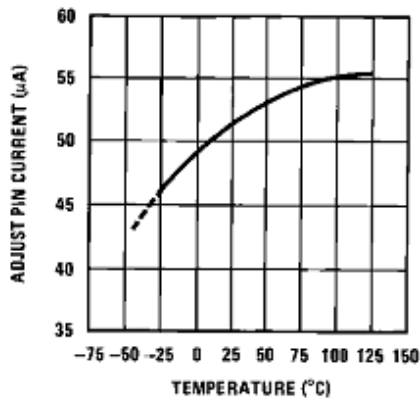
Load Regulation



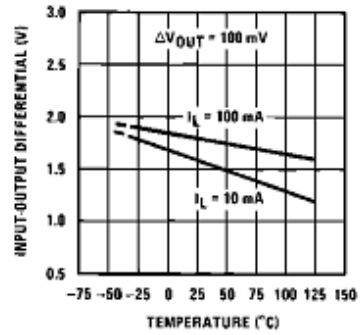
Current Limit



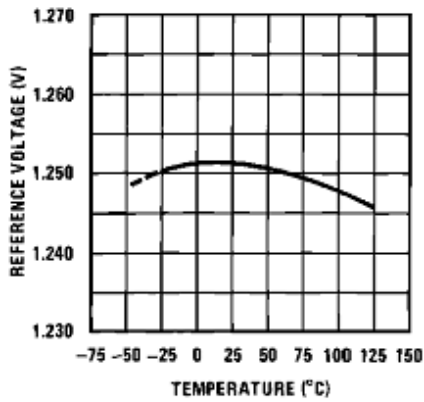
Adjustment Current



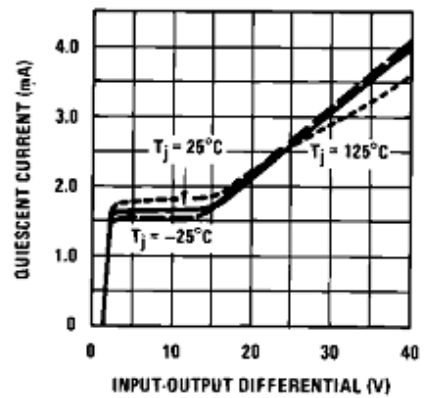
Dropout Voltage

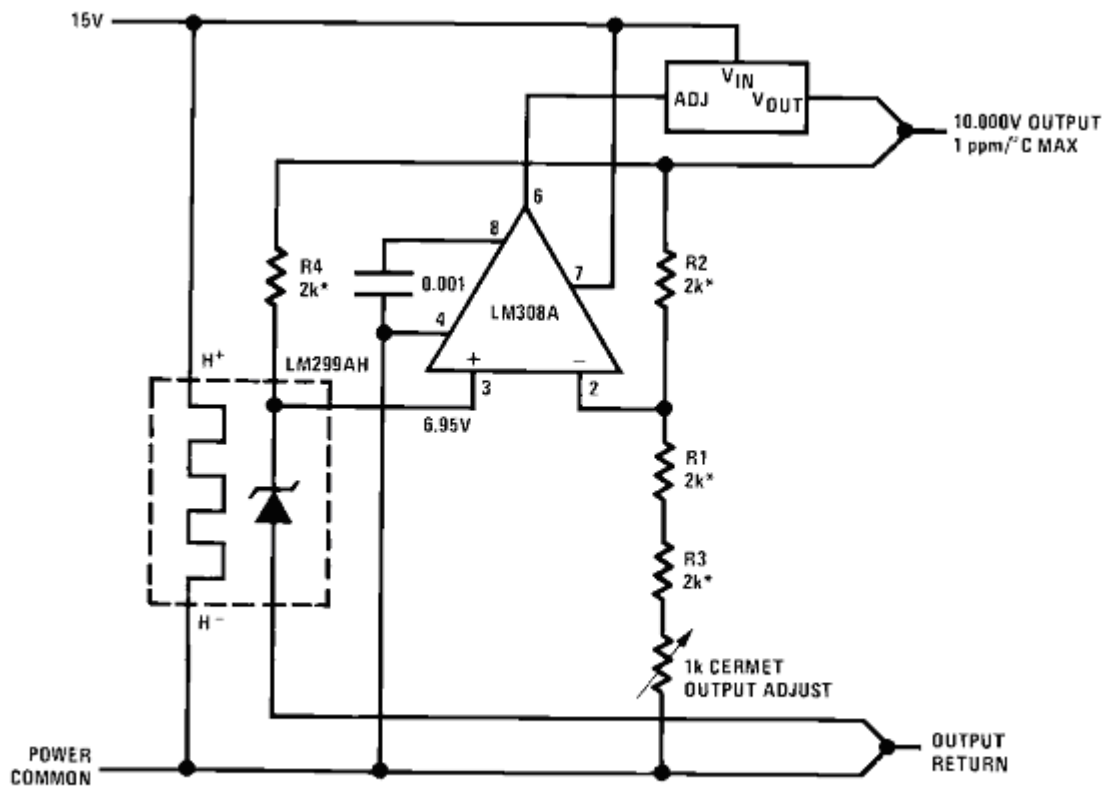


Reference Voltage Temperature Stability

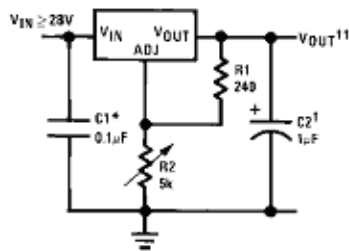


Minimum Operating Current

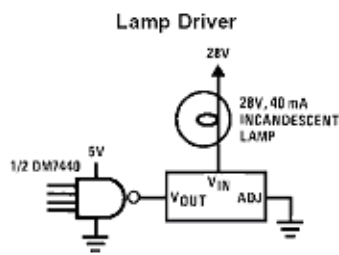




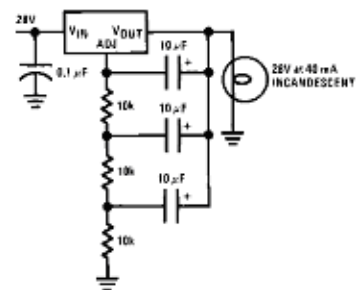
Precision Reference with Short-Circuit Proof Output



Adjustable Regulator



Protected (Bulletproof)  
Lamp Driver



Lamp Flasher

OUTLINE DRAWING

