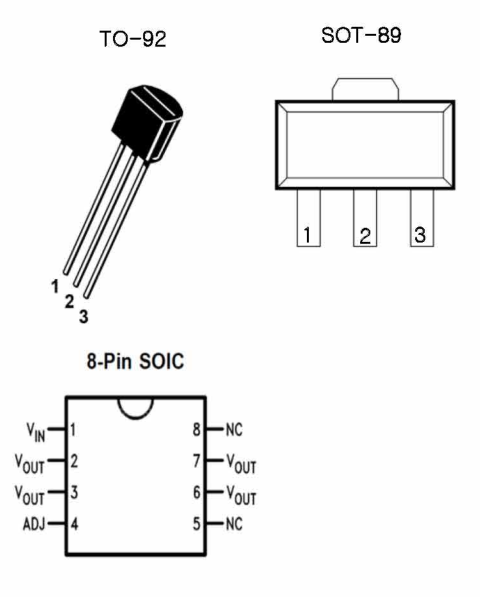
100mA 3-Terminal Adjustable Regulator

Description

The LM317L is adjustable 3-terminal positive voltage regulator capable of supplying in excess of 100mA over an output voltage range of 1.2 V to 37 V. These voltage regulator is exceptionally easy to use and require only two external resistors to set the output voltage. Further, it employ internal current limiting, thermal shutdown and safe area compensation, making them essentially blow-out proof.

The LM317L serve a wide variety of applications to make a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM317L series can be used as a precision current requlator.



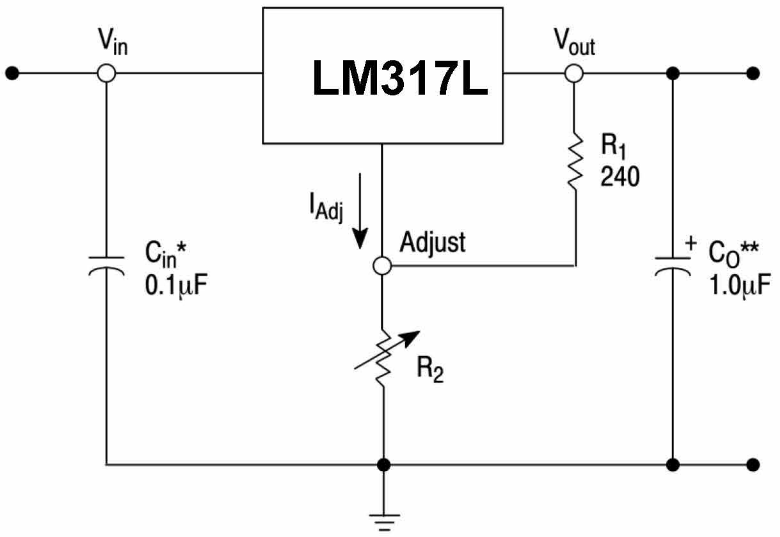
Features

- Output Current in Excess of 100mA
- Output Adjustable Between 1.2 V and 37 V
- Internal Shot Circuit Current Limiting
- Internal Thermal Overload Protection
- Output Transistor Safe-Area Compensation
- Floating Operation for High Voltage Applications
- Eliminates Stocking Many Fixed Voltages
- ESD Level (HBM) 4kV
- Minimum Load Current 1.5mA Type

Ordering Information

Part Number	Package	Packing	Temperature(TA)	Package Qty
LM317LIPK	SOT-89-3	Reel	-40°C ~ 125°C	1000
LM317LMX	SOIC-8	Reel	-40°C ~ 125°C	2500
LM317LZ	TO-92-3	Tube	-40°C ~ 125°C	2000

Typical Applications



* C_{in} is required if regulator is located an appreciable distance from power supply filter.
** C_O is not needed for stability, however, it does improve transient response.

$$V_{OUT} = 1.25\ V\ (1+R2/R1) + I_{ADJ}R2$$

Since I_{ADJ} is controlled to less than 100uA, the error associated with this term is negligible in most applications.

ABSOLUTE MAXIMUM RATINGS

Characteristics	Symbol	Value	Unit
Input - Output Voltage Differential	$V_{IN} – V_{OUT}$	40	V
Power Dissipation	P_D	Internally Limited	W
Operating Junction Temperature Range	T_J	0 ~ +125	℃
Storage Temperature Range	T_{STG}	-65 ~ +125	℃

* Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.
Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (Note 1)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Line Regulation	Reg_{line}	$3V \le (V_{IN} - V_{OUT}) \le 40V$, $I_L \le 20mA$ (Note 2)	$T_A = 25°C$	-	0.01	0.04	%/V
				-	0.02	0.07	%/V
Load Regulation	Reg_{load}	$V_{OUT} \le 5V$, $5mA \le I_{OUT} \le 100mA$ (Note 2)	$T_A = 25°C$	-	5	25	mV
				-	20	70	mV
		$V_{OUT} \ge 5V$, $5mA \le I_{OUT} \le 100mA$ (Note 2)	$T_A = 25°C$	-	0.1	0.5	%V_{OUT}
				-	0.3	1.5	%V_{OUT}
Thermal Regulation	-	TA= 25°C, 10 ms Pulse		-	0.04	0.2	%/W
Adjustment Pin Current	I_{ADJ}	-		-	50	100	µA
Adjustment Pin Current Change	ΔI_{ADJ}	$5mA \le I_L \le 100mA$, $3V \le (V_{IN} – V_{OUT}) \le 40V$, $P_D \le P_{MAX}$		-	0.2	5.0	µA
Reference Voltage	V_{REF}	$5mA \le I_{OUT} \le 100mA$, $3V \le (V_{IN} – V_{OUT}) \le 40V$, $P_D \le P_{MAX}$		1.20	1.25	1.30	V
Temperature Stability	Ts	$T_{MIN} \le T_J \le T_{MAX}$		-	0.65	-	%V_{OUT}
Minimum Load Current	$I_{L(MIN)}$	$(V_{IN} – V_{OUT}) \le 40V$		-	3.5	10	mA
Current Limit	I_{MAX}	$3V \le (V_{IN} – V_{OUT}) \le 13V$,		100	200	300	mA
		$(V_{IN} – V_{OUT}) = 40V$		25	50	150	mA
RMS Noise , % of V_{OUT}	N	$T_J = 25°C$, $10 Hz \le f \le 10 kHz$		-	0.003	-	%V_{OUT}
Ripple Rejection Ratio	RR	V_{OUT} = 10V, f = 120 Hz, C_{ADJ} = 0µF		-	65	-	dB
		C_{ADJ} = 10µF		66	80	-	dB
Long-Term Stability	ST	T_J=125°C, 1000 Hours		-	0.3	1	%/1.0k Hrs.

Notes: 1. These specifications apply: $0°C \le T_J \le 125°C$, $V_{IN} – V_{OUT}$ = 5.0 V, I_{OUT} = 40mA (unless otherwise noted). Although power dissipation is internally limited, these specifications are applicable for power dissipations up to P_{MAX}= 625mW (TO-92, SOP-8) and P_{MAX}= 500mW (SOT-89), I_{MAX} is 100mA.

2. Load and line regulation are specified at constant junction temperature. Changes in Vo due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

Application Hints

In operation, the LM317L 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 I_1 then flows through the output set resistor R2, giving an output voltage of

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R2)$$

Since the 100µA current from the adjustment terminal represents an error term, the LM317L 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.

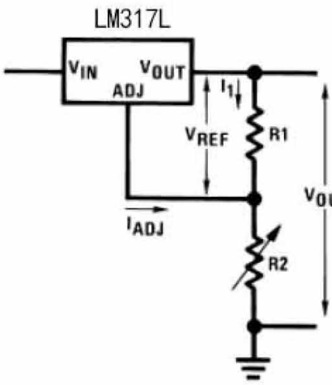


FIGURE 1.

External Capacitors

An input bypass capacitor is recommended in case the regulator is more than 6 inches away from the usual large filter capacitor. A 0.1µF disc or 1µF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used, but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the LM317L to improve ripple rejection and noise. This bypass capacitor prevents ripple and noise from being amplified as the output voltage is increased. With a 10µF bypass capacitor 80 dB ripple rejection is obtainable at any output level. Increases over 10µF do not appreciably improve the ripple rejection at frequencies above 120Hz. If the bypass capacitor is used, it is sometimes necessary to include protection diodes to prevent the capacitor from discharging through internal low current paths and damaging the device.

In general, the best type of capacitors to use is solid tantalum. *Solid tantalum capacitors have low impedance even at high frequencies*. Depending upon capacitor construction, it takes about 25µF in aluminum electrolytic to equal 1µF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies; but some types have a large decrease in capacitance at frequencies around 0.5MHz. For this reason, a 0.01µF disc may seem to work better than a 0.1µF disc as a bypass.

Although the LM317L is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1µF solid tantalum (or 25µF aluminum electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The LM317L is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240Ω) should be tied directly to the output of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 15V regulator with 0.05Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05Ω x I_L. If the set resistor is connected near the load the effective line resistance will be 0.05Ω (1 + R2/R1) or in this case, 11.5 times worse.

Figure 2 shows the effect of resistance between the regulator and 240Ω set resistor.

With the TO-92 package, it is easy to minimize the resistance from the case to the set resistor, by using two separate leads to the output pin. The ground of R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

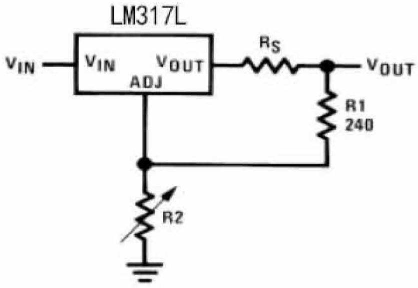


FIGURE 2. Regulator with Line Resistance in Output Lead

Thermal Regulation

When power is dissipated in an IC, a temperature gradient occurs across the IC chip affecting the individual IC circuit components. With an IC regulator, this gradient can be especially severe since power dissipation is large. Thermal regulation is the effect of these temperature gradients on output voltage (in percentage output change) per watt of power change in a specified time. Thermal regulation error is independent of electrical regulation or temperature coefficient, and occurs within 5ms to 50ms after a change in power dissipation. Thermal regulation depends on IC layout as well as electrical design. The thermal regulation of a voltage regulator is defined as the percentage change of V_{OUT}, per watt, within the first 10ms after a step of power is applied. The LM317L specification is 0.2%/W, maximum.

In the Thermal Regulation curve at the bottom of the Typical Performance Characteristics page, a typical LM317L's output changes only 7mV (or 0.07% of V_{OUT} = −10V) when a 1W pulse is applied for 10 ms. This performance is thus well inside the specification limit of 0.2%/W x 1W = 0.2% maximum. When the 1W pulse is ended, the thermal regulation again shows a 7 mV change as the gradients across the LM317L chip die out. Note that the load regulation error of about 14 mV (0.14%) is additional to the thermal regulation error.

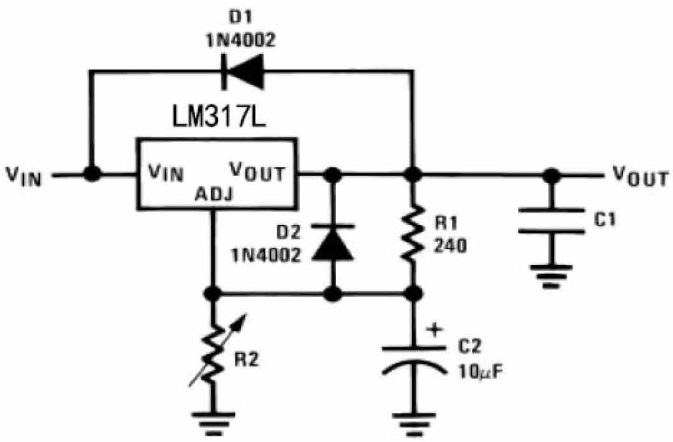
Application Hints (Continued)

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 10µF 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 LM317L, 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 µF or less, the LM317L'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 LM317L is a 50 Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10µF capacitance. *Figure 3* shows an LM317L with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



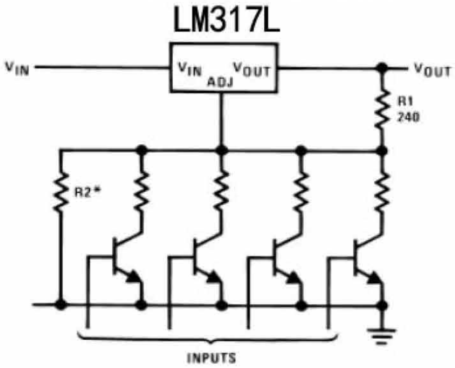
$$V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right) I_{ADJ}\,R2$$

D1 protects against C1
D2 protects against C2

FIGURE 3. Regulator with Protection Diodes

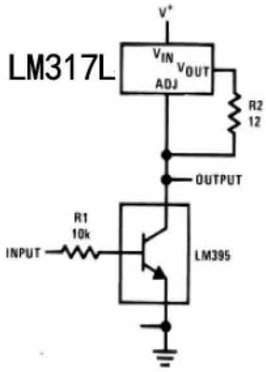
Typical Applications

Digitally Selected Outputs

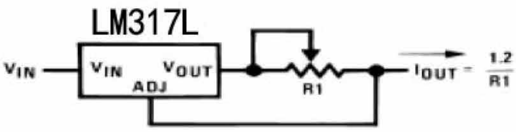


*Sets maximum V_{OUT}

High Gain Amplifier

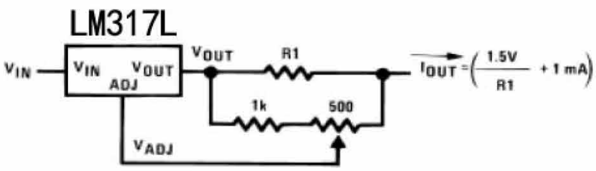


Adjustable Current Limiter

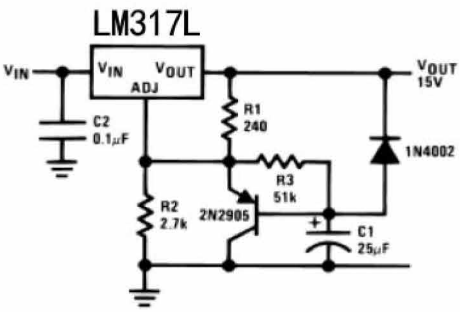


12 ≤ R1 ≤ 240

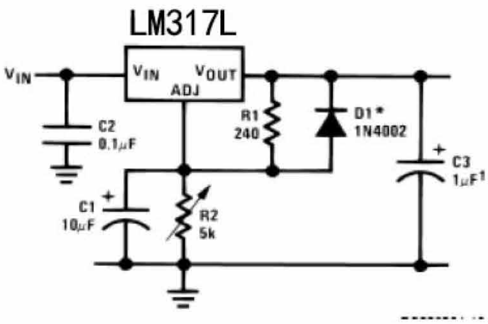
Precision Current Limiter



Slow Turn-On 15V Regulator



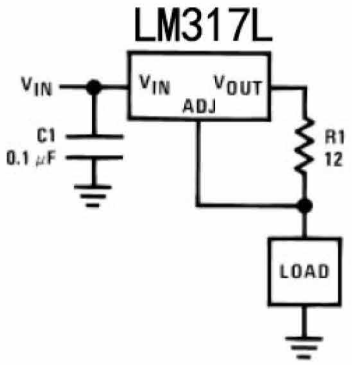
Adjustable Regulator with
Improved Ripple Rejection



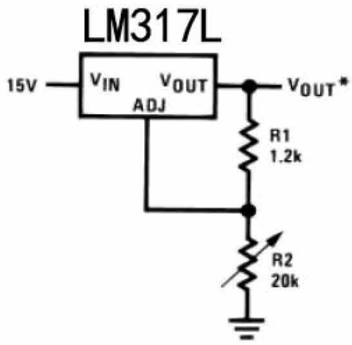
†Solid tantalum
*Discharges C1 if output is shorted to ground

Typical Applications (Continued)

100mA Current Regulator

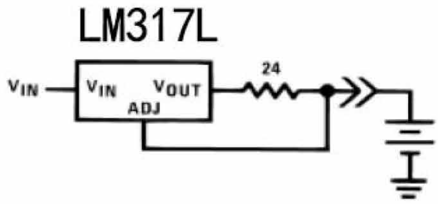


1.2V–12V Regulator with Minimum Program Current

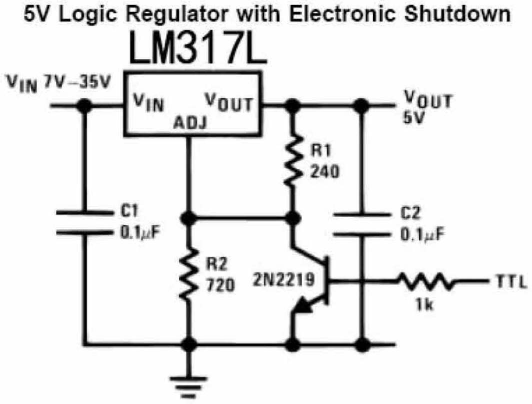


*Minimum load current ≈ 2 mA

50mA Constant Current Battery Charger for Nickel-Cadmium Batteries

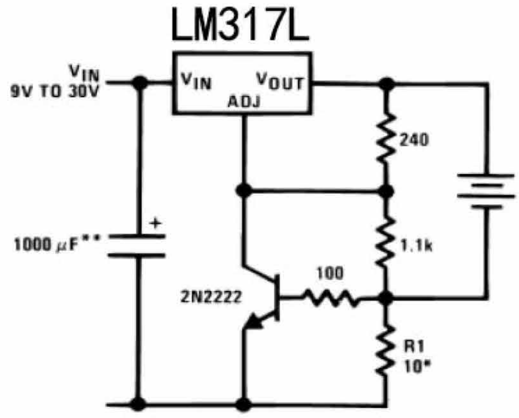


5V Logic Regulator with Electronic Shutdown



*Minimum output ≈ 1.2V

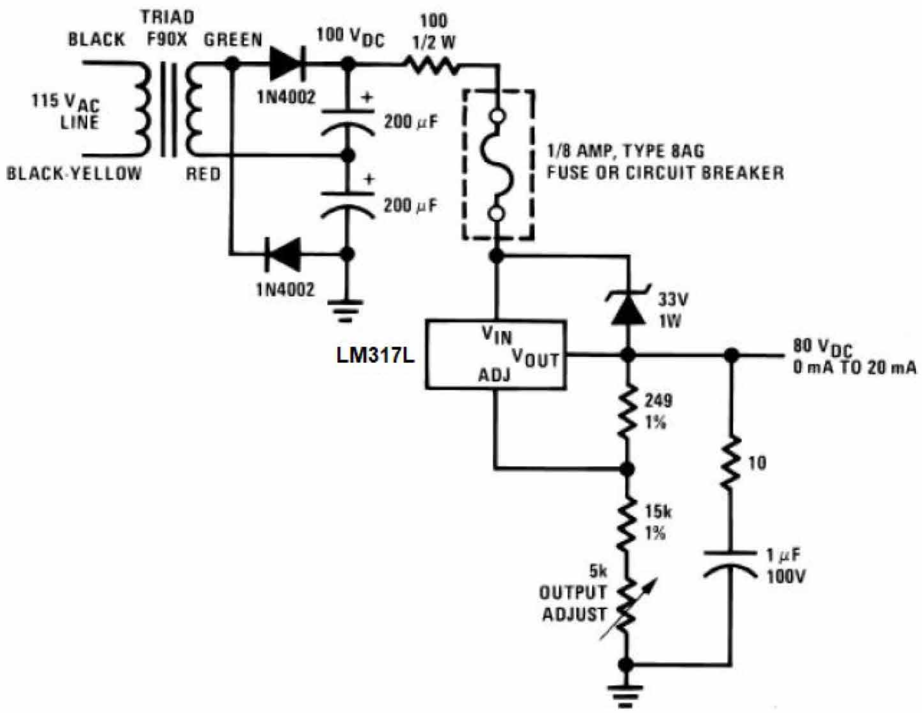
Current Limited 6V Charger



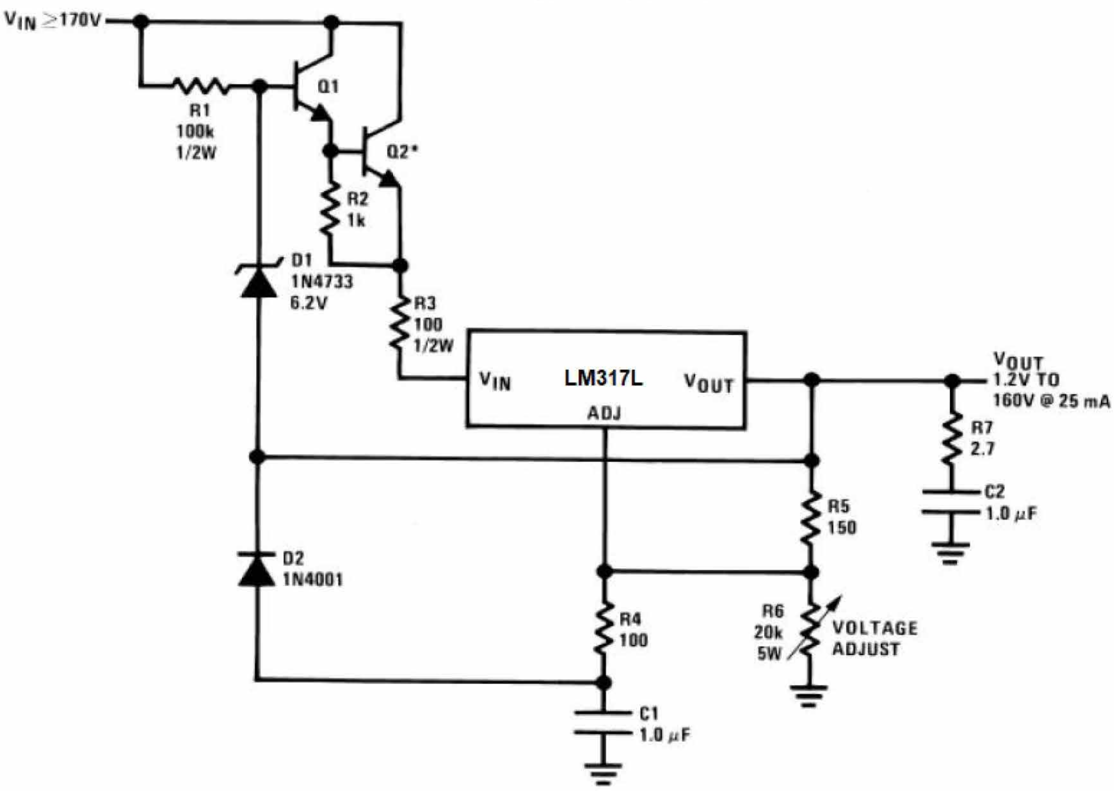
*Sets peak current, I_{PEAK} = 0.6V/R1
**1000µF is recommended to filter out any input transients.

Typical Applications (Continued)

Short Circuit Protected 80V Supply



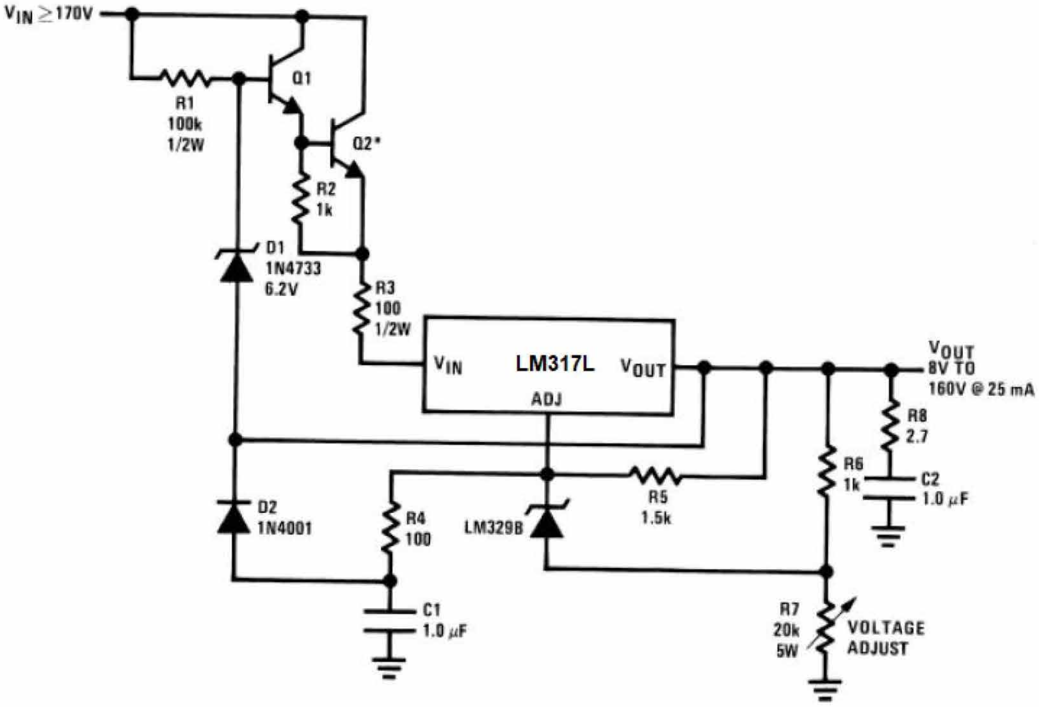
Basic High Voltage Regulator



Q1, Q2: NSD134 or similar
C1, C2: 1μF, 200V mylar**
*Heat sink

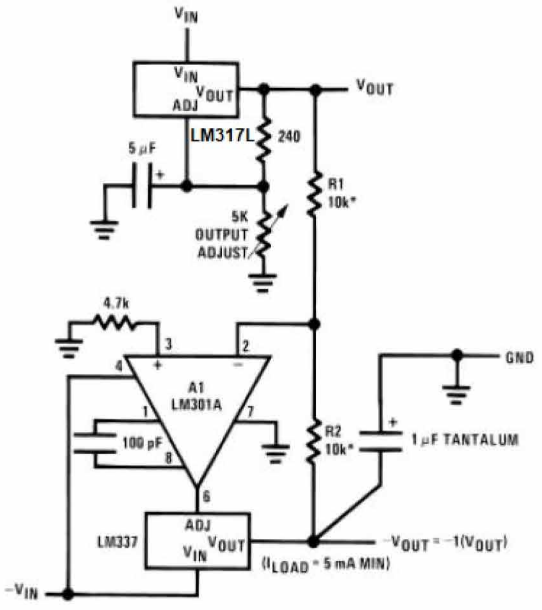
Typical Applications (Continued)

Precision High Voltage Regulator



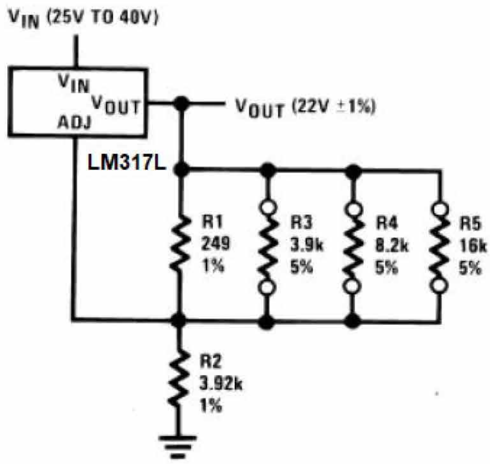
Q1, Q2: NSD134 or similar
C1, C2: 1µF, 200V mylar**
*Heat sink
**Mylar is a registered trademark of DuPont Co.

Tracking Regulator



A1 = LM301A, LM307, or LF13741 only
R1, R2 = matched resistors with good TC tracking

Regulator With Trimmable Output Voltage



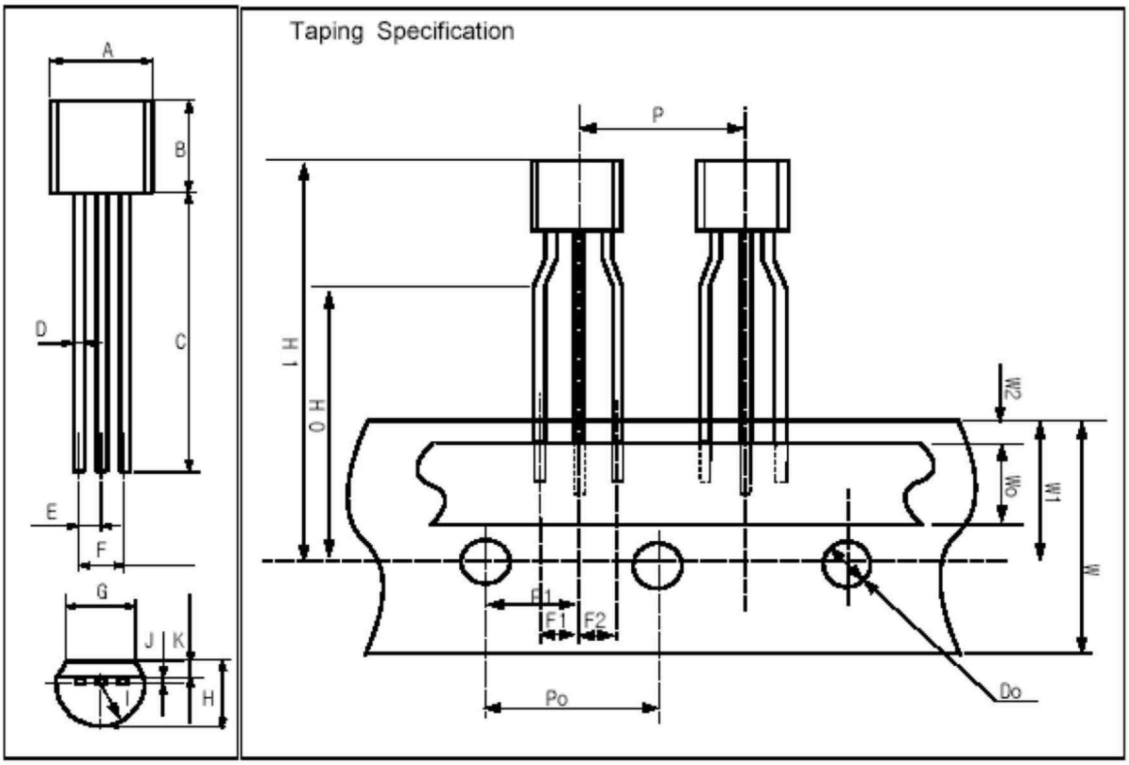
Trim Procedure:

—If V_{OUT} is 23.08V or higher, cut out R3 (if lower, don't cut it out).
—Then if V_{OUT} is 22.47V or higher, cut out R4 (if lower, don't).
—Then if V_{OUT} is 22.16V or higher, cut out R5 (if lower, don't).

This will trim the output to well within ±1% of 22.00 V_{DC}, without any of the expense or uncertainty of a trim pot (see LB-46). Of course, this technique can be used at any output voltage level.

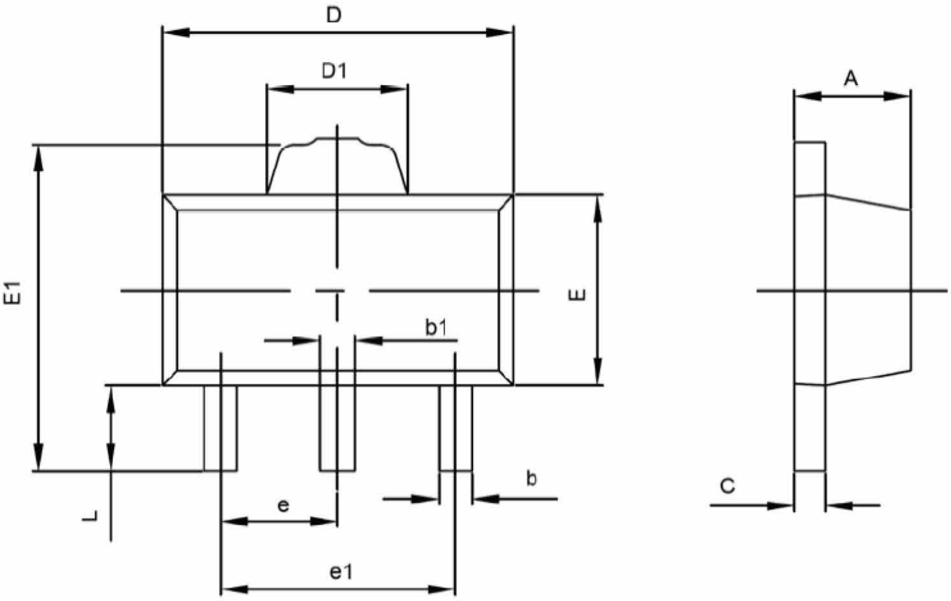
PACKAGE OUTLINE

[TO-92]



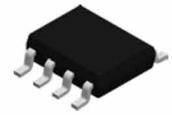
Package Dimension(unit:mm)				Taping Dimension(unit:mm)			
Symbol	Min	Typ	Max	Symbol	Min	Typ	Max
A	4.43	4.58	4.83	P	12.2	12.7	13.2
B	4.38	4.58	4.78	PO	12.5	12.7	12.9
C	14.07	14.47	14.87	P1	5.85	6.35	6.85
D	0.36	0.46	0.56	F1,F2	2.4	2.5	2.9
E	1.07	1.27	1.47	W	17.5	18.0	19.0
F	2.34	2.54	2.74	WO	5.5	6.0	6.5
G	3.40	3.60	3.80	W1	8.5	9.0	9.5
H	-	-	3.86	W2	-	-	1.0
I	-	[R2.29]	-	HO	15.5	16.0	16.5
J	0.33	0.38	0.39	H1	-	-	27.0
K	0.92	1.02	1.12	DO	3.8	4.0	4.2

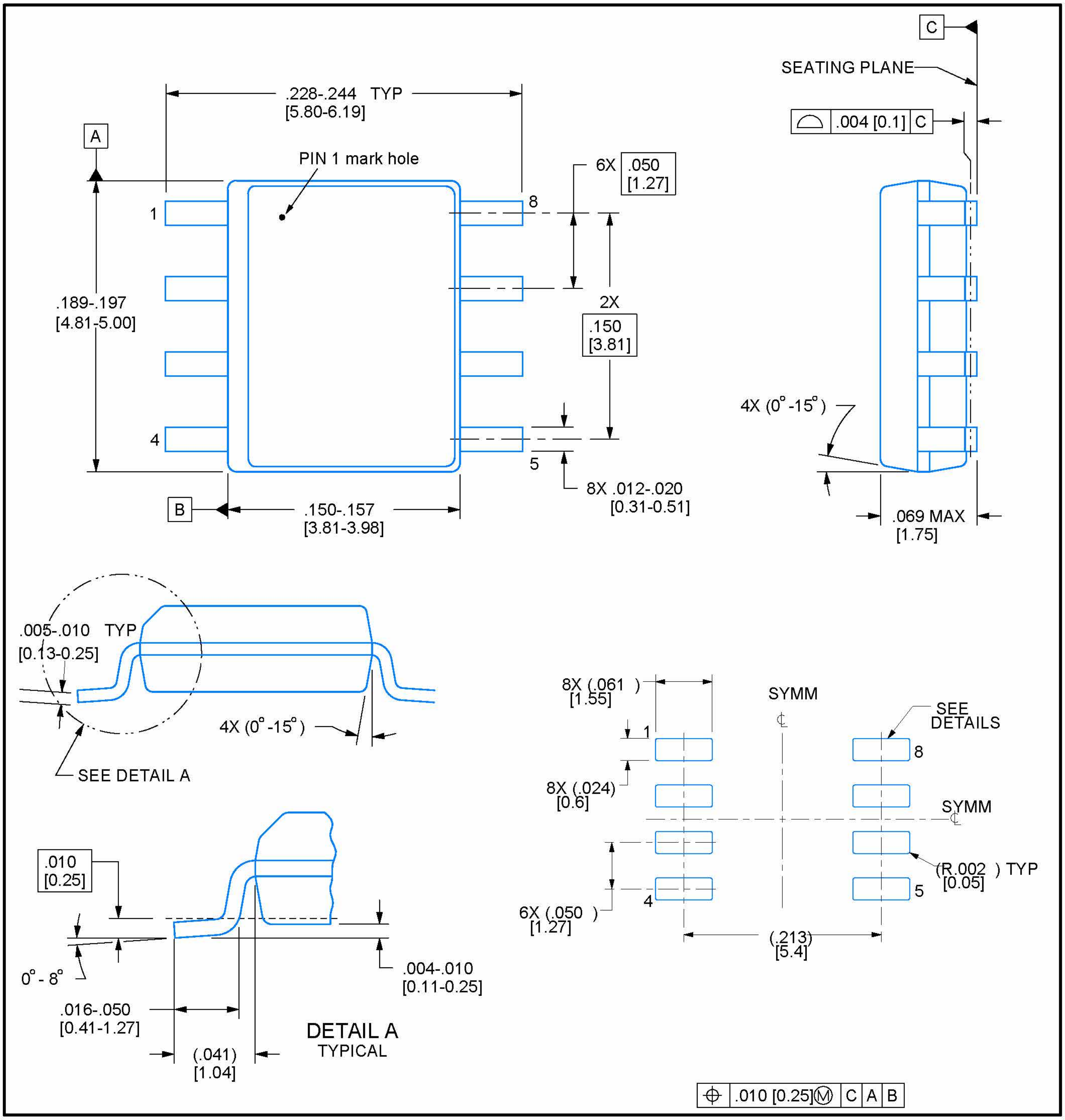
SOT-89-3L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.360	0.560	0.014	0.022
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.400	1.800	0.055	0.071
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500TYP		0.060TYP	
e1	2.900	3.100	0.114	0.122
L	0.900	1.100	0.035	0.043

PACKAGE OUTLINE SOIC - 8,1.75 mm max height





NOTES: Linear dimensions are in inches [millimeters]. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.