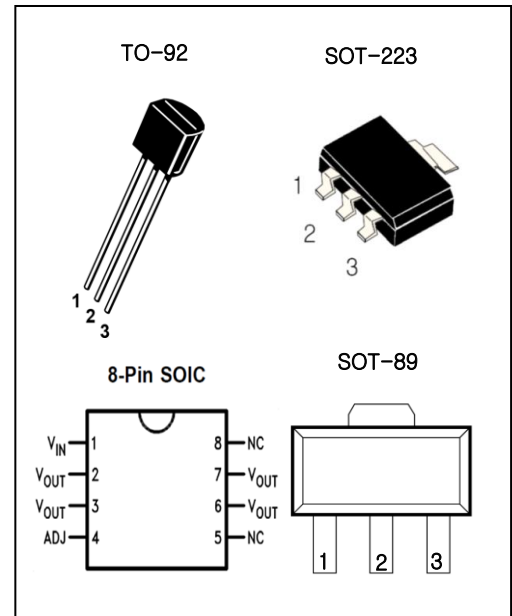


# 100mA ADJUSTABLE OUTPUT, POSITIVE VOLTAGE REGULATOR IC

**IL317L**

## Features

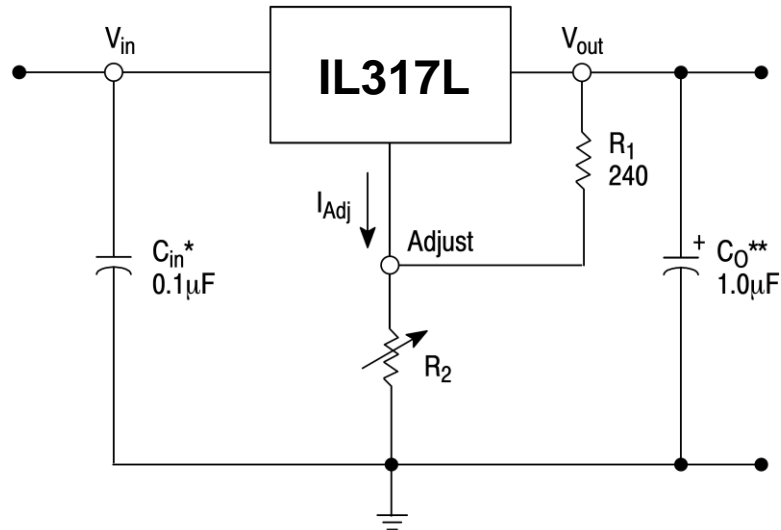
- Output Current in Excess of 100mA
- Output Adjustable Between 1.2 V and 37 V
- Internal Shot Circuit Current Limiting
- Internal Thermal Overload Protection
- Output Transistor Safe-Area Compensation
- Floating Operation for High Voltage Applications
- Eliminates Stocking Many Fixed Voltages



## Ordering Information

Device	Package	Pin#1	Pin#2	Pin#3	Packing
IL317LALF	TO-92	Adjust	Output	Input	Tape
IL317LAPT	SOT-89				Tape & Reel
IL317LAET	SOT-223				Tape & Reel
IL317LLF	TO-92	Input	Output	Adjust	Tape
IL317LPT	SOT-89				Tape & Reel
IL317LET	SOT-223				Tape & Reel
IL317LDT	SOP-8	-	-	-	Tape & Reel

## 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.

$$V_{OUT} = 1.25 \text{ V} (1 + R_2/R_1) + I_{ADJ}R_2$$

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	°C
Storage Temperature Range	$T_{STG}$	-65 ~ +125	°C

\* 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.

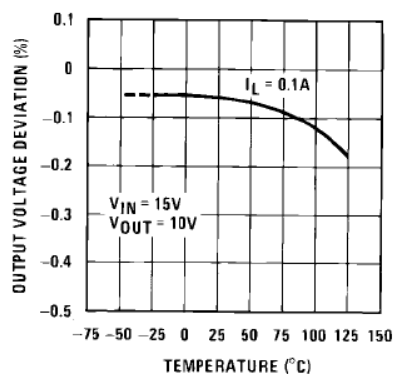
## ELECTRICAL CHARACTERISTICS (Note 1)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Line Regulation	Reg <sub>line</sub>	3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 40V I <sub>L</sub> ≤ 20mA (Note 2)	T <sub>A</sub> = 25°C	-	0.01	0.04	%V
				-	0.02	0.07	
Load Regulation	Reg <sub>load</sub>	V <sub>OUT</sub> ≤ 5V, 5mA ≤ I <sub>OUT</sub> ≤ 100mA (Note 2)	T <sub>A</sub> = 25°C	-	5	25	mV
				-	20	70	
		V <sub>OUT</sub> ≥ 5V, 5mA ≤ I <sub>OUT</sub> ≤ 100mA (Note 2)	T <sub>A</sub> = 25°C	-	0.1	0.5	%V <sub>OUT</sub>
				-	0.3	1.5	
Thermal Regulation	-	TA= 25°C, 10 ms Pulse		-	0.04	0.2	%/W
Adjustment Pin Current	I <sub>ADJ</sub>	-		-	50	100	μA
Adjustment Pin Current Change	ΔI <sub>ADJ</sub>	5mA ≤ I <sub>L</sub> ≤ 100mA, 3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 40V P <sub>D</sub> ≤ P <sub>MAX</sub>		-	0.2	5.0	μA
Reference Voltage	V <sub>REF</sub>	5mA ≤ I <sub>OUT</sub> ≤ 100mA, 3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 40V P <sub>D</sub> ≤ P <sub>MAX</sub>		1.20	1.25	1.30	V
Temperature Stability	T <sub>s</sub>	T <sub>MIN</sub> ≤ T <sub>J</sub> ≤ T <sub>MAX</sub>		-	0.65	-	%V <sub>OUT</sub>
Minimum Load Current	I <sub>L(MIN)</sub>	(V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 40V		-	3.5	10	mA
Current Limit	I <sub>MAX</sub>	3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 13V,		100	200	300	mA
		(V <sub>IN</sub> - V <sub>OUT</sub> ) = 40V		25	50	150	
RMS Noise , % of V <sub>OUT</sub>	N	T <sub>J</sub> = 25°C, 10 Hz ≤ f ≤ 10 kHz		-	0.003	-	%V <sub>OUT</sub>
Ripple Rejection Ratio	RR	V <sub>OUT</sub> = 10V, f = 120 Hz, C <sub>ADJ</sub> = 0μF		-	65	-	dB
		C <sub>ADJ</sub> = 10μF		66	80	-	
Long-Term Stability	ST	T <sub>J</sub> =125°C, 1000 Hours		-	0.3	1	%/1.0k Hrs.

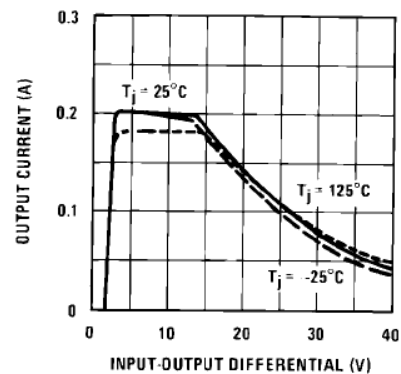
- Notes: 1. These specifications apply:  $0^\circ C \leq T_J \leq 125^\circ C$ ,  $V_{IN} - V_{OUT} = 5.0 V$ ,  $I_{OUT} = 40mA$  (unless otherwise noted). Although power dissipation is internally limited, these specifications are applicable for power dissipations up to  $P_{MAX} = 625mW$  (TO-92, SOP-8) and  $P_{MAX} = 500mW$  (SOT-89),  $I_{MAX}$  is 100mA.
2. Load and line regulation are specified at constant junction temperature. Changes in  $V_o$  due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

## Typical Performance Characteristics (Output capacitor = 0 $\mu$ F unless otherwise noted.)

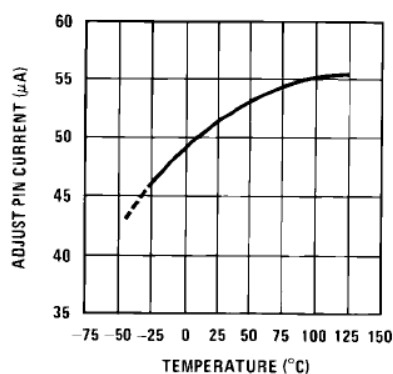
Load Regulation



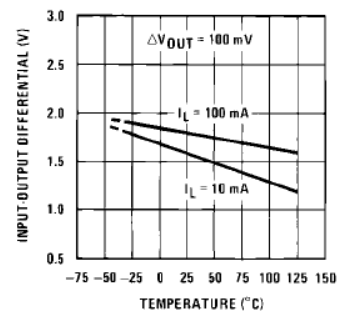
Current Limit



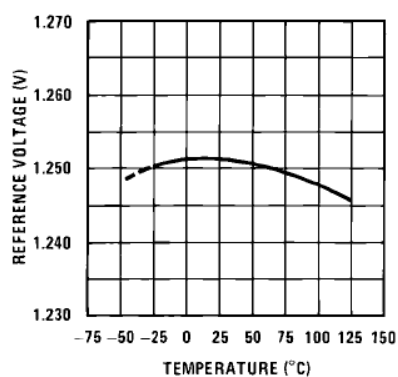
Adjustment Current



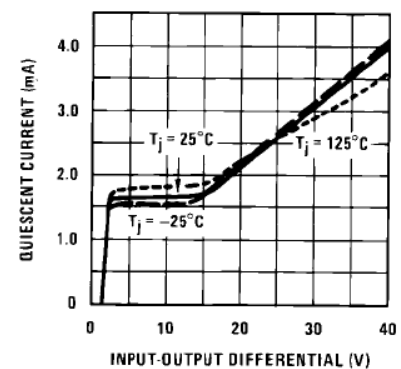
Dropout Voltage



Reference Voltage  
Temperature Stability

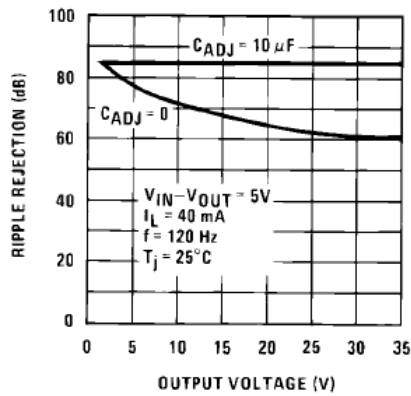


Minimum Operating Current

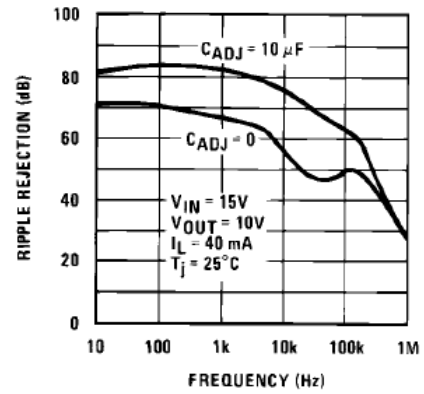


# Typical Performance Characteristics (Output capacitor = 0 $\mu$ F unless otherwise noted.) (Continued)

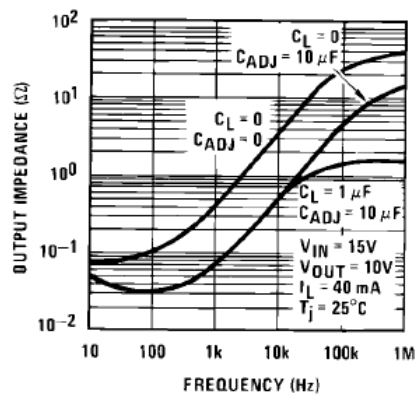
Ripple Rejection



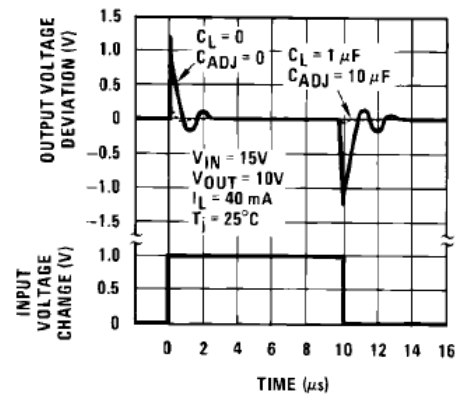
Ripple Rejection



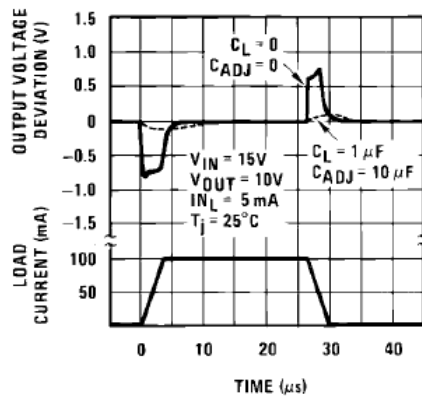
Output Impedance



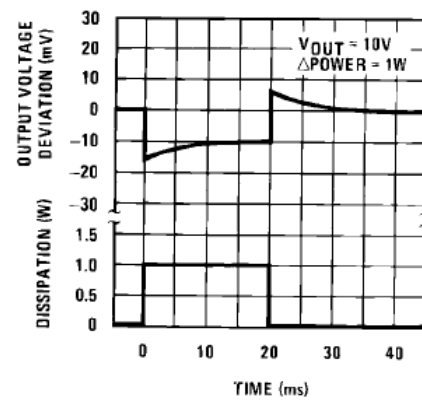
Line Transient Response



Load Transient Response



Thermal Regulation



## Application Hints

In operation, the IL317L 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 100 $\mu$ A current from the adjustment terminal represents an error term, the IL317L 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.

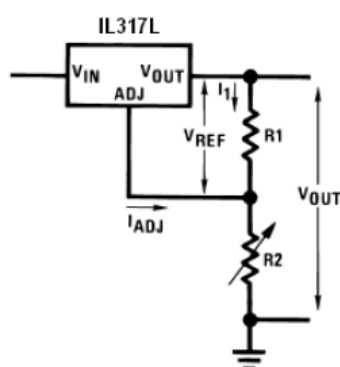


FIGURE 1.

## 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 0.1 $\mu$ F disc or 1 $\mu$ F 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 IL317L to improve ripple rejection and noise. This bypass capacitor prevents ripple and noise from being amplified as the output voltage is increased. With a 10 $\mu$ F bypass capacitor 80 dB ripple rejection is obtainable at any output level. Increases over 10 $\mu$ F 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 25 $\mu$ F in aluminum electrolytic to equal 1 $\mu$ F 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 0.01 $\mu$ F disc may seem to work better than a 0.1 $\mu$ F disc as a bypass.

Although the IL317L is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values be-

tween 500 pF and 5000 pF. A 1 $\mu$ F solid tantalum (or 25 $\mu$ F aluminum electrolytic) on the output swamps this effect and insures stability.

## Load Regulation

The IL317L 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 240 $\Omega$ ) 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 0.05 $\Omega$  resistance between the regulator and load will have a load regulation due to line resistance of 0.05 $\Omega$   $\times$   $I_L$ . If the set resistor is connected near the load the effective line resistance will be 0.05 $\Omega$  (1 +  $R2/R1$ ) or in this case, 11.5 times worse.

Figure 2 shows the effect of resistance between the regulator and 240 $\Omega$  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.

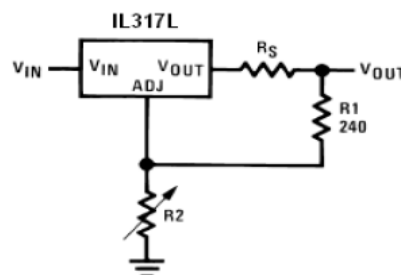


FIGURE 2. Regulator with Line Resistance in Output Lead

## 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 IL317L specification is 0.2%/W, maximum.

In the Thermal Regulation curve at the bottom of the Typical Performance Characteristics page, a typical IL317'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  $\times$  1W = 0.2% maximum. When the 1W pulse is ended, the thermal regulation again shows a 7 mV change as the gradients across the IL317L 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)

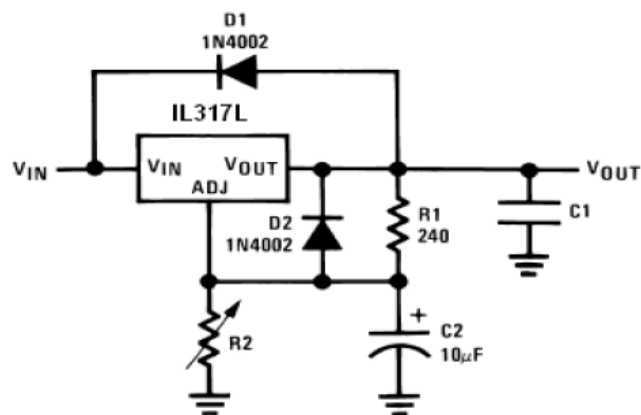
### Protection Diodes

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 IL317L, this dis-

charge 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 IL317L'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 IL317L 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 IL317L with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



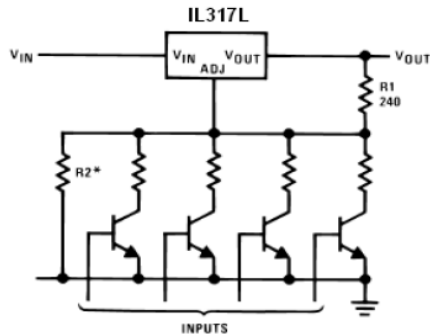
$$V_{OUT} = 1.25V \left( 1 + \frac{R_2}{R_1} \right) I_{ADJ} R_2$$

D1 protects against C1  
D2 protects against C2

FIGURE 3. Regulator with Protection Diodes

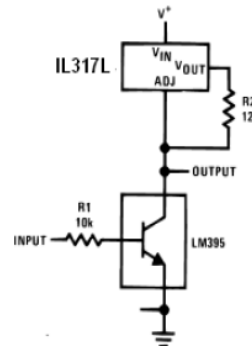
## Typical Applications

Digitally Selected Outputs

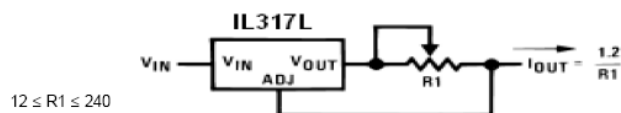


\*Sets maximum  $V_{OUT}$

High Gain Amplifier

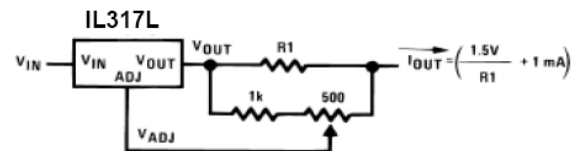


Adjustable Current Limiter

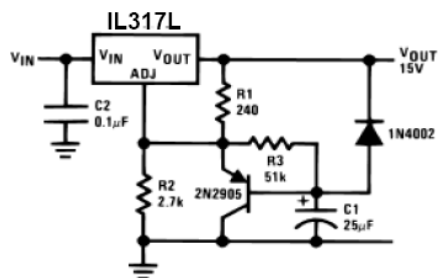


$12 \leq R1 \leq 240$

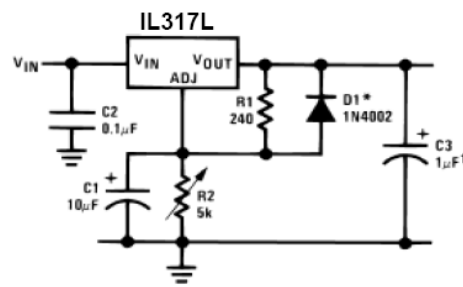
Precision Current Limiter



Slow Turn-On 15V Regulator



Adjustable Regulator with Improved Ripple Rejection



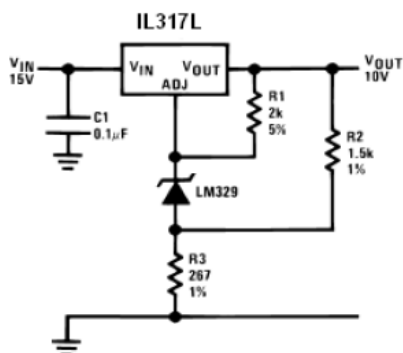
†Solid tantalum

\*Discharges C1 if output is shorted to ground

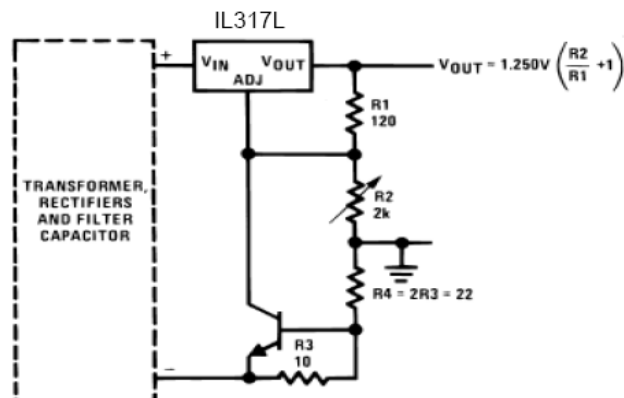


## Typical Applications (Continued)

High Stability 10V Regulator

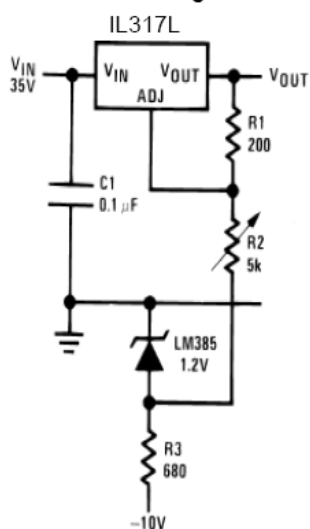


Adjustable Regulator with Current Limiter



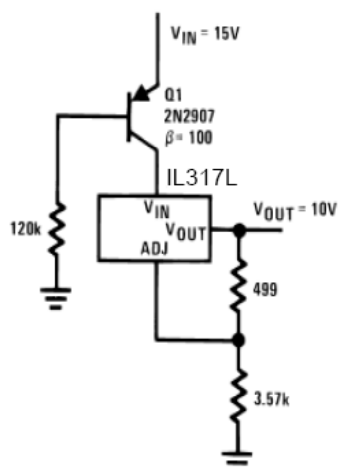
Short circuit current is approximately  $600 \text{ mV}/R_3$ , or 60mA  
At 25mA output only 3/4V of drop occurs in R3 and R4.

0V–30V Regulator

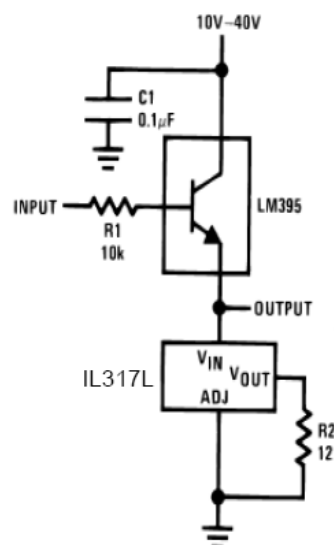


Full output current not available at high input-output voltages

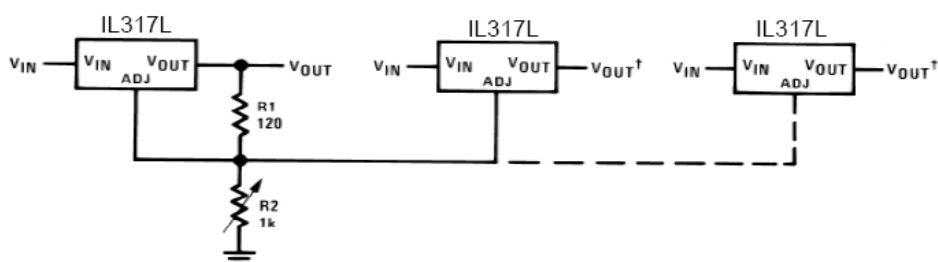
Regulator With 15mA Short Circuit Current



Power Follower



Adjusting Multiple On-Card Regulators with Single Control\*

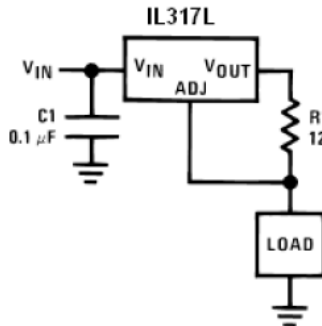


\*All outputs within  $\pm 100\text{mV}$

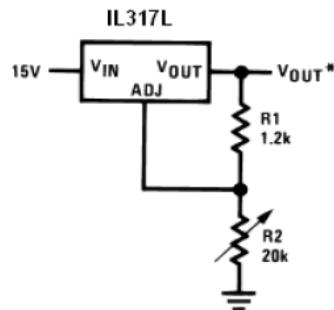
†Minimum load –5mA

## Typical Applications (Continued)

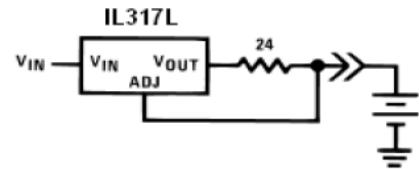
100mA Current Regulator



1.2V–12V Regulator with Minimum Program Current

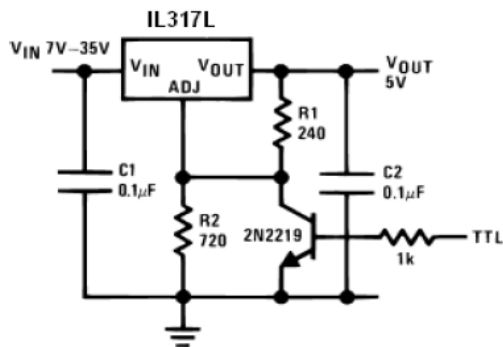


50mA Constant Current Battery Charger for Nickel-Cadmium Batteries



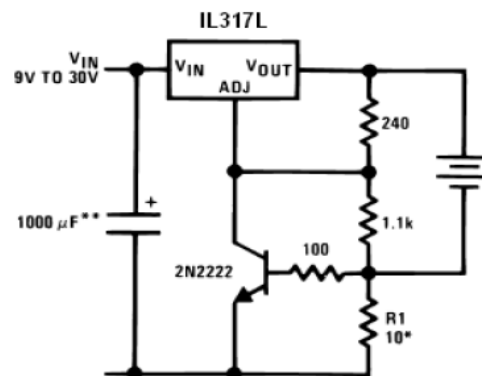
\*Minimum load current ≈ 2 mA

5V Logic Regulator with Electronic Shutdown



\*Minimum output ≈ 1.2V

Current Limited 6V Charger

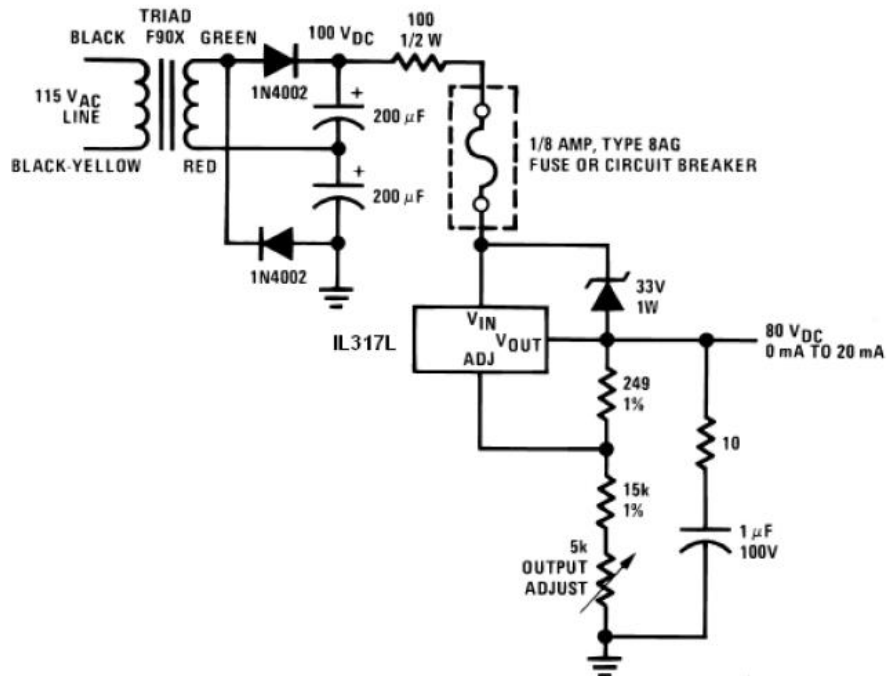


\*Sets peak current,  $I_{PEAK} = 0.6V/R1$

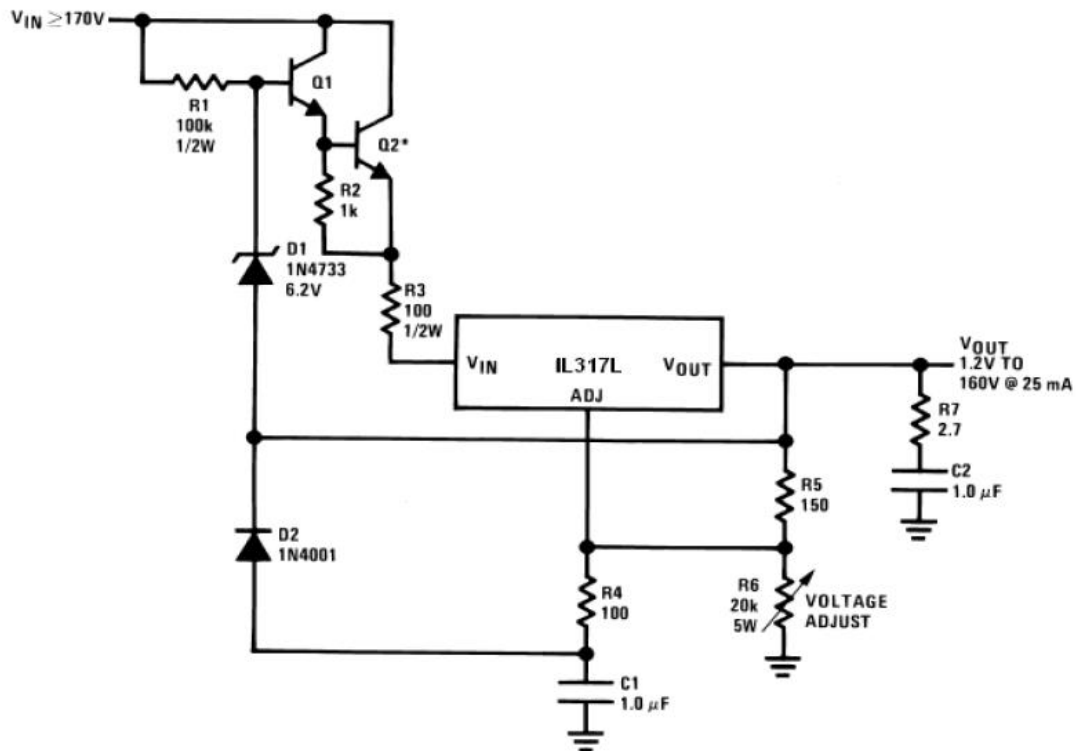
\*\*1000μF is recommended to filter out any input transients.

## Typical Applications (Continued)

### Short Circuit Protected 80V Supply



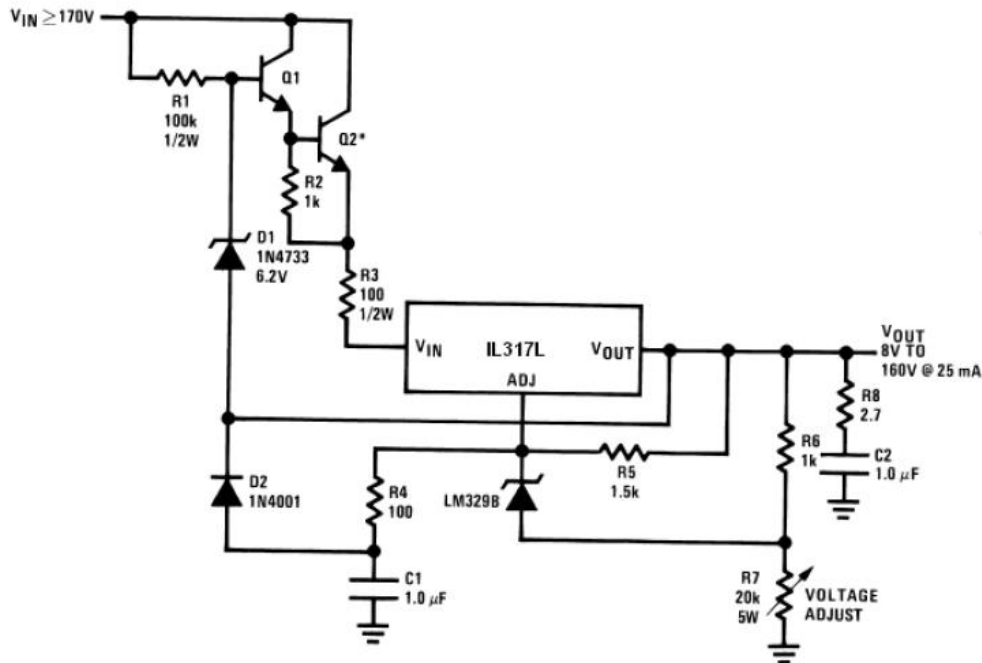
### Basic High Voltage Regulator



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

## Typical Applications (Continued)

### Precision High Voltage Regulator



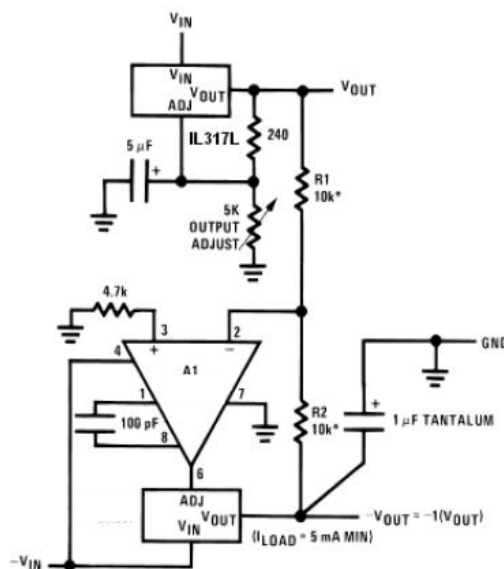
Q1, Q2: NSD134 or similar

C1, C2: 1μF, 200V mylar\*\*

\*Heat sink

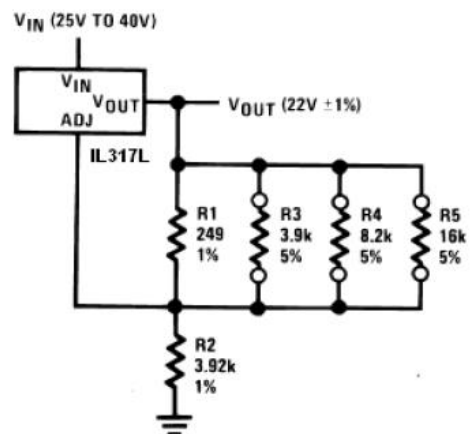
\*\*Mylar is a registered trademark of DuPont Co.

### Tracking Regulator



R1, R2 = matched resistors with good TC tracking

### Regulator With Trimmable Output Voltage



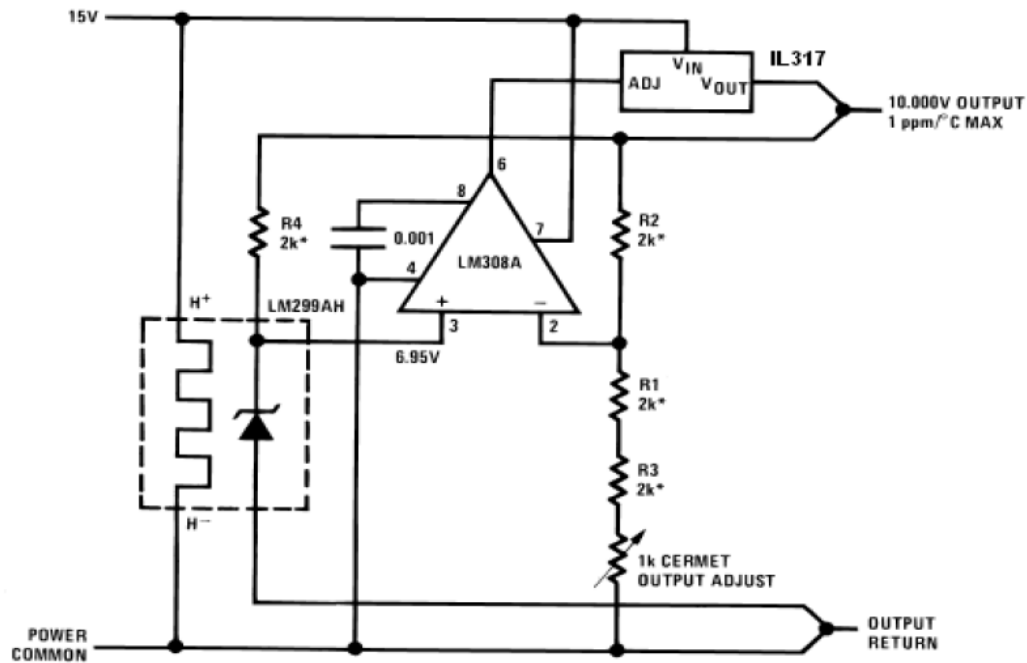
#### Trim Procedure:

- 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  $\pm 1\%$  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.

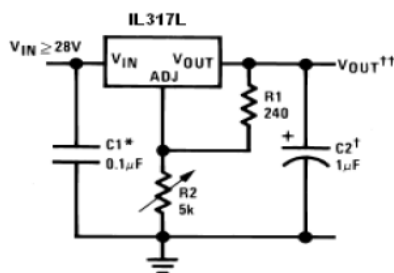
## Typical Applications (Continued)

### Precision Reference with Short-Circuit Proof Output

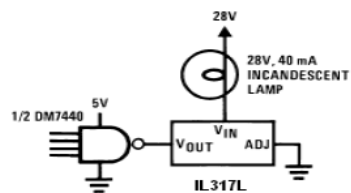


\*R1–R4 from thin-film network,  
Beckman 694-3-R2K-D or similar

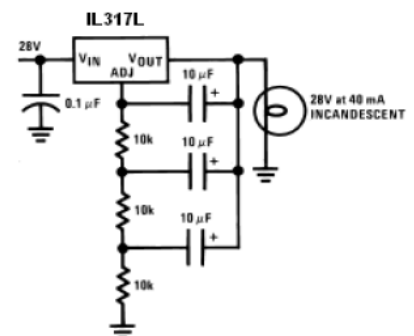
### 1.2V-25 Adjustable Regulator



### Fully Protected (Bulletproof) Lamp Driver



### Lamp Flasher



Full output current not available at high  
input-output voltages

†Optional—improves transient response

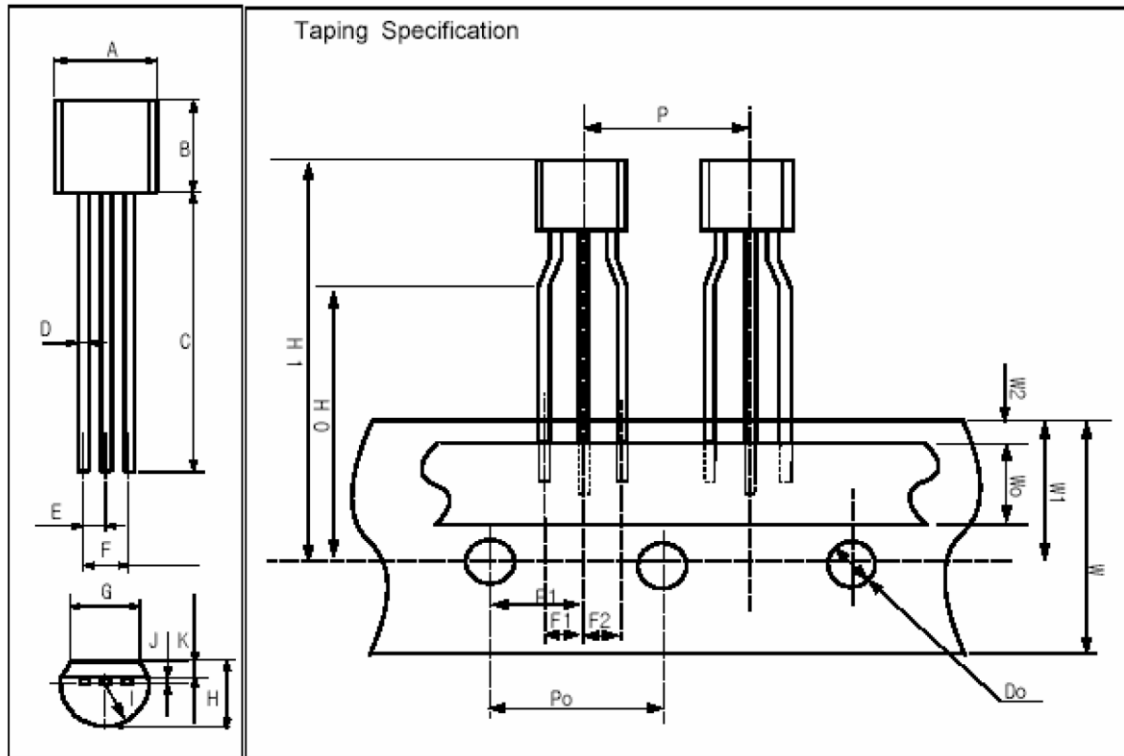
\*Needed if device is more than 6 inches from  
filter capacitors

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

Output rate—4 flashes per second at 10% duty  
cycle

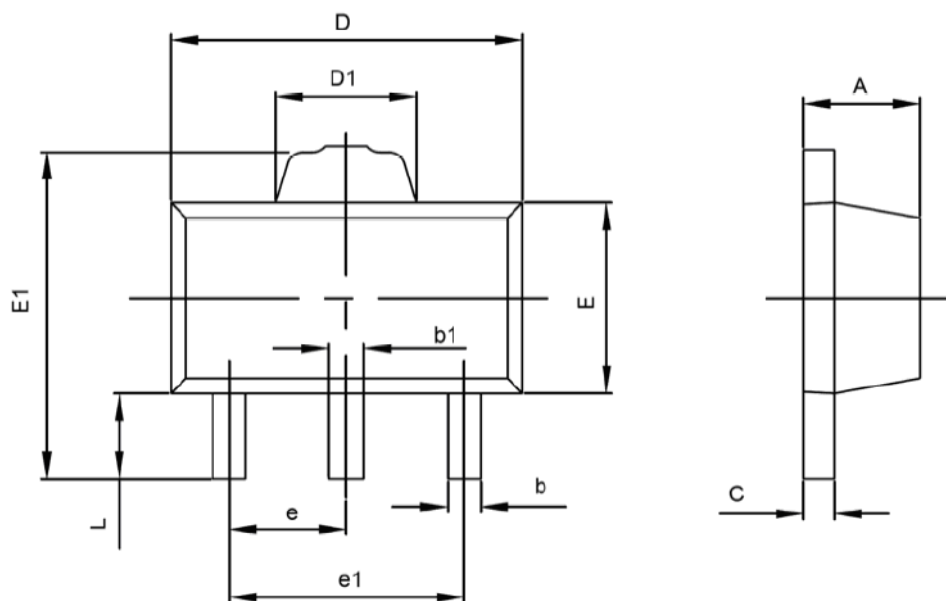
## PACKAGE OUTLINE

[TO-92]



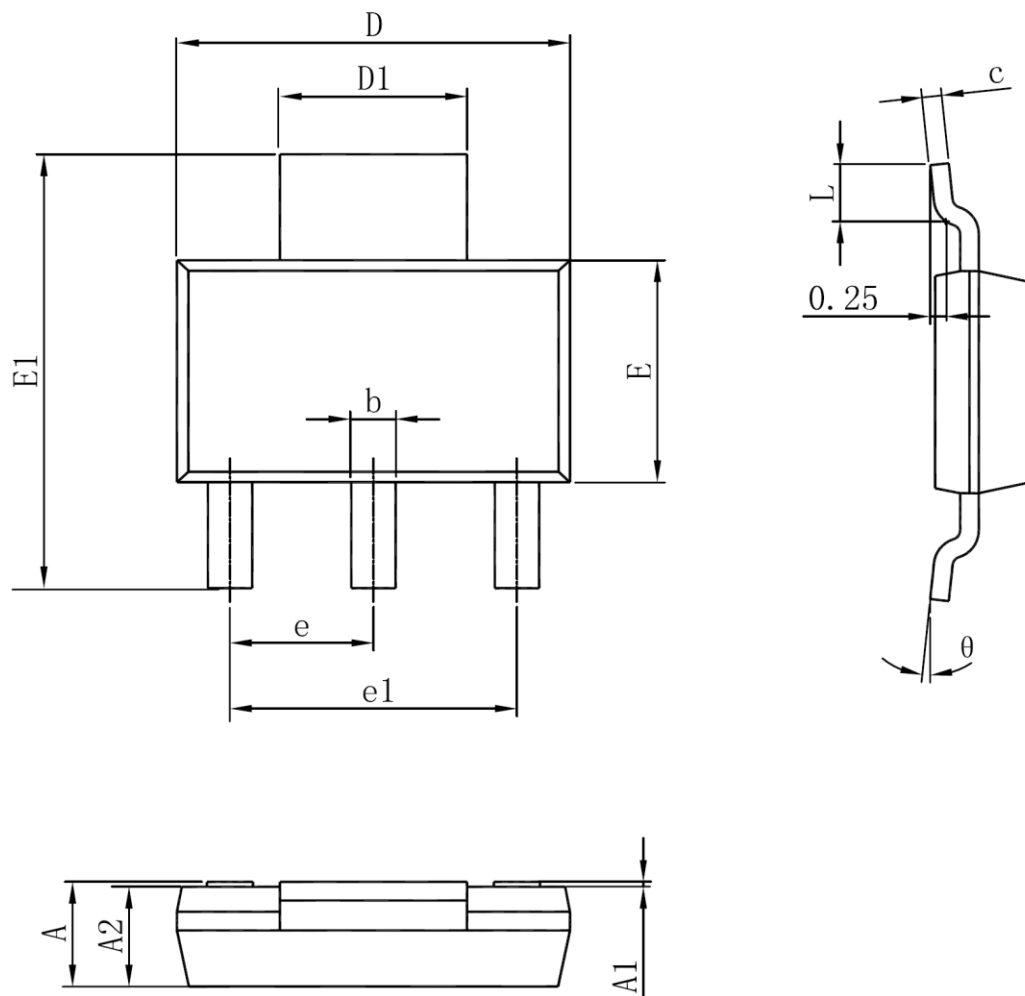
Package Dimension(unit:mm)				Taping Dimension(unit:mm)			
Symbol	Min	Typ	Max	Symbol	Min	Typ	Max
A	4.43	4.58	4.83	P	12.2	12.7	13.2
B	4.38	4.58	4.78	PO	12.5	12.7	12.9
C	14.07	14.47	14.87	P1	5.85	6.35	6.85
D	0.36	0.46	0.56	F1,F2	2.4	2.5	2.9
E	1.07	1.27	1.47	W	17.5	18.0	19.0
F	2.34	2.54	2.74	WO	5.5	6.0	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

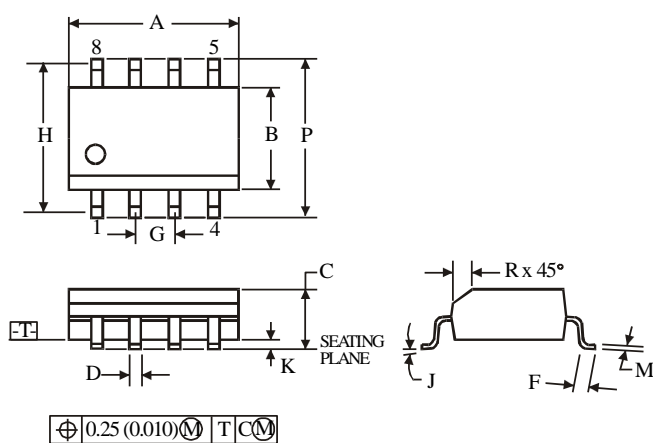
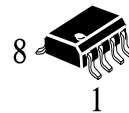
## SOT-223 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.520	1.800	0.060	0.071
A1	0.000	0.100	0.000	0.004
A2	1.500	1.700	0.059	0.067
b	0.660	0.820	0.026	0.032
c	0.250	0.350	0.010	0.014
D	6.200	6.400	0.244	0.252
D1	2.900	3.100	0.114	0.122
E	3.300	3.700	0.130	0.146
E1	6.830	7.070	0.269	0.278
e	2.300(BSC)		0.091(BSC)	
e1	4.500	4.700	0.177	0.185
L	0.900	1.150	0.035	0.045
θ	0°	10°	0°	10°



**D SUFFIX SOIC  
(MS - 012AA)**



Symbol	Dimension, mm	
	MIN	MAX
A	4.8	5
B	3.8	4
C	1.35	1.75
D	0.33	0.51
F	0.4	1.27
G	1.27	
H	5.72	
J	0°	8°
K	0.1	0.25
M	0.19	0.25
P	5.8	6.2
R	0.25	0.5

**NOTES:**

1. Dimensions A and B do not include mold flash or protrusion.
2. Maximum mold flash or protrusion 0.15 mm (0.006) per side for A; for B - 0.25 mm (0.010) per side.