TS317L

3-Terminal Adjustable Output Positive Voltage Regulator

SOP-8

Pin assignment:
1. Input
2. Output
3. Output
4. Adjust
5. N/C
6. Output
7. Output
8. N/C

TO-92

Pin assignment:
1. Adjustable
2. Output
3. Input

Output Voltage Range From 1.25V to 37V
Output Current up to 100mA

General Description

The TS317L is adjustable 3-terminal positive voltage regulator capable of supplying in excess of 100mA over an output voltage range of 1.25 V to 37 V. This voltage regulator is exceptionally easy to use and require 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.

Besides replacing fixed regulators, the TS317L is useful in a wide variety of other applications. Since the regulator is "floating " and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input-to-output differential is not exceeded.

Also, it makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the TS317L can be used as a precision current regulator. Supplyies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.25V where most loads draw little current.

The TS317L is offered in 3-pin TO-92 and SOP-8 package.

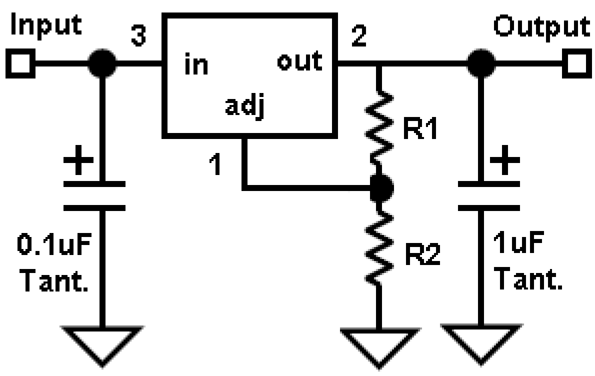
Features

- ✧ Output current up to 100mA
- ✧ Output Adjustable between 1.25 V and 37 V
- ✧ Internal Thermal Overload Protection
- ✧ Internal Short-Circuit Current Limiting Constant with Temperature
- ✧ Output Transistor Safe-Area Compensation
- ✧ Floating Operation for High Voltage Applications
- ✧ Eliminates Stocking Many Fixed Voltages
- ✧ Output voltage offered in 4% tolerance

Ordering Information

Part No.	Operating Temp.	Package
TS317LCS	-20 ~ +125°C	SOP-8
TS317LCT		TO-92

Standard Application



$Vout = 1.25\ V * (1 + R2 / R1) + Iadj_j * R2$

Since I_{Adj} is controlled to less than 100 μA, the error associated with this term is negligible in most applications A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0V above the output voltage even during the low point on the Input ripple voltage.

* = Cin is required if regulator is located an appreciable distance from power supply filter.

** = Co is not needed for stability; however, it does improve transient response.

TSC

Absolute Maximum Rating

Input Voltage	Vin	40	V
Power Dissipation	Pd	Internal Limited	W
Operating Junction Temperature Range	T_J	-20 ~ +125	^oC
Storage Temperature Range	T_{STG}	-55 ~ +150	^oC
Lead Temperature (soldering 4 sec.)	T_{LEAD}	+260	^oC

Note: "Absolute maximum rating" indicated 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.

Electrical Characteristics

(Tj =T_{LOW} to T_{HIGH} see [Note 1], Vin-Vout= 5V, Io=40mA; Pmax per [Note 2]; unless otherwise specified.)

CHARACTERISTIC	CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Reference voltage (Note 4)	5mA ≤ Io ≤ 100mA 3V ≤ Vi - Vo ≤ 40V	Vref	1.20	1.25	1.30	V
Line regulation (Note 3)	Tj = 25 ^oC, 3V ≤ Vi -Vo ≤ 40V, Io=20mA	REGline	--	0.01	0.07	%/V
Load regulation (Note 3)	Tj = 25 ^oC, 5mA ≤ I_O ≤ Imax,	REGload	--	0.1	1.5	%
Thermal regulation	Tj = 25 ^oC, 10 ms Pulse	--	--	0.03	0.2	%/W
Adjustment pin current		Iadj	--	50	100	uA
Adjustment pin current change	Pd ≤ Pmax, 5mA ≤ Io ≤ Imax, 3V ≤ V_I - V_O ≤ 40V	ΔIadj	--	0.2	5.0	uA
Current limit	3V ≤ V_I - V_O ≤ 13V V_I - V_O = 40V	I_{LIMIT}	-- --	200 50	-- --	mA
Temperature stability	T_{LOW} ≤ Tj ≤ T_{HIGH}	T_S	--	0.65	--	%
Minimum load current	V_I - V_O ≤ 40V	Imin	--	3.5	5	mA
RMS Noise, % of V_O	Ta =25 ^oC, 10H_Z ≤ f ≤ 10KH_Z	N	--	0.003	--	%
Ripple rejection ratio	Vout= 10V, f= 120Hz, Cadj= 0	--	--	65	--	dB
Long-term stability (Note 5)	Tj = 125 ^oC, 1000hrs	S	--	0.3	1.0	%
Thermal resistance Junction to Ambient	CT package 0.4" leads CS package	Rθja	-- --	180 165	-- --	^oC/W

Notes:

1. T_{LOW} = -20 ^oC, T_{HIGH} = + 125 ^oC
2. Pmax: CS package=0.5W, CT package=0.625W,
3. Load and line regulation are specified at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.
4. Selected devices with tightened tolerance reference voltage available.
5. Since Long-Term Stability cannot be measured on each device before shipment, this specification is an engineering estimate of average stability from lot to lot.

Application Information

Basic Circuit Operation

The TS317L is a 3-terminal floating regulator. In operation, the TS317L develops and maintains a nominal 1.25V reference (Vref) between its output and adjustment terminals. This reference voltage is converted to a programming current (Iprog.) by R_1 (see Figure 17), and this constant current flows through R_2 to ground. The regulated output voltage is given by:

Vout = Vref (1 + R2 / R1) + Iadj * R2

Since the current from the adjustment terminal (Iadj) represents an error term in the equation, the TS317L was designed to control Iadj to less than 100uA and keep it constant. To do this, all quiescent operating current is returned to the output terminal. This imposes the requirement for a minimum load current. If the load current is less than this minimum, the output voltage will rise.

Since the TS317L is a floating regulator, it is only the voltage differential across the circuit which is important to performance, and operation at high voltages with respect to ground is possible.

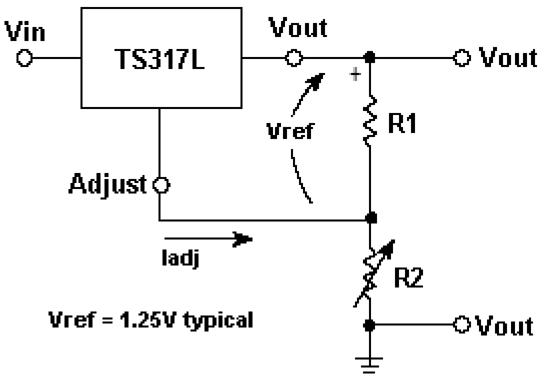


Figure 1. basic circuit configuration

Load Regulation

The TS317L 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 therminal 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 Io.

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 6 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 of 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.

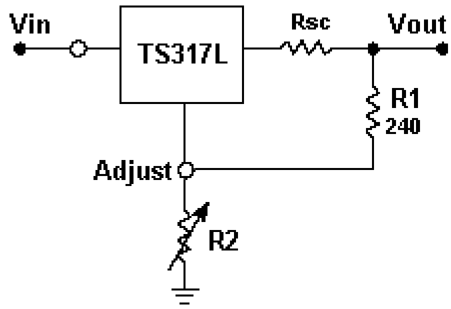


Figure 2. Regulator with line resistance in output lead

External Capacitor

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 tantalum input bypass capacitor (Cin) is recommended to reduce the sensitivity to input line impedance.

The adjustment terminal may be bypassed to ground to improve ripple rejection and noice. This capacitor (Cadj) prevents ripple from being amplified as the output voltage is increased. With a 10uF bypass capacitor 80dB ripple rejection is obtainable at any output level. Increased over 10uF 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 25uF in aluminum electrolytic to equal 1uF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies; but some types have a large

Application Information (continued)

decrease in capacitance at frequencies around 0.5MHz. for this reason, a 0.01uF disc may seem to work better than a 0.1uF disc as a bypass.

Although the TS317L is stable with no output capacitance, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 50pF and 5000pF. A 1uμF solid tantalum (or 25uF aluminum electrolytic) on the output swamps this effect and insures stability.

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 of 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 Vout, per watt, within the first 10ms after a step of power is applied. The TS317L specification is 0.2%/W, maximum.

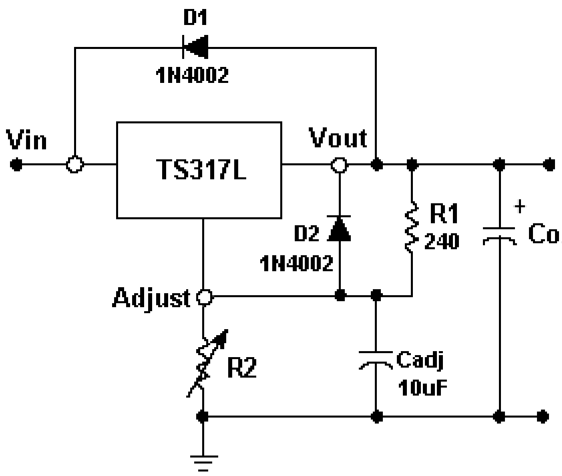
TS317L's output changes only 7mV (or 0.07% of Vout= -10V) when a 1W pulse is applied for 10ms. This performance is thus well inside the specification limit of 0.2%/W x 1W = 0.2% maximum. When the 1W pulse is ended, the thermal regulation again shows a 7mV change as the gradients across the TS317L chip die out. Note that the load regulation error of about 14mV (0.14%) is additional to the thermal regulation error.

Protection Diode

When external capacitors are used with any I.C. regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 10uF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short, these 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 Vin. In the TS317L, 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 25uF or less, the TS317L'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 TS317L is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10uF capacitance. Figure 3 shows an TS317L with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



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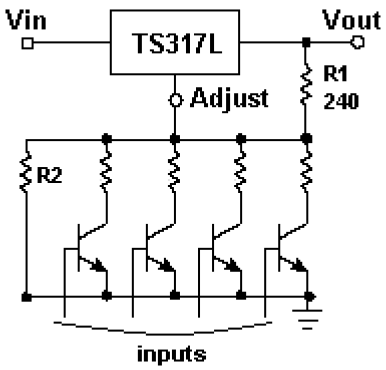
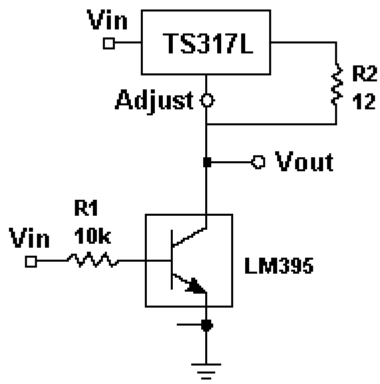
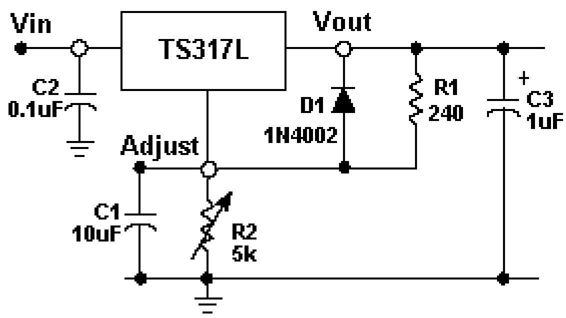
Typical Application



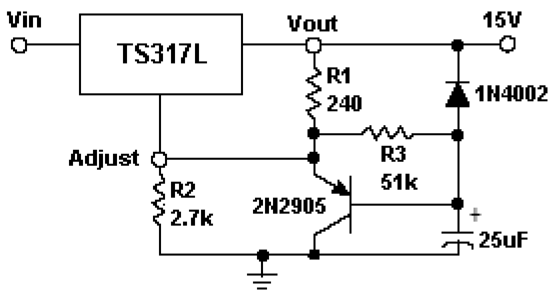
Digitally selected outputs



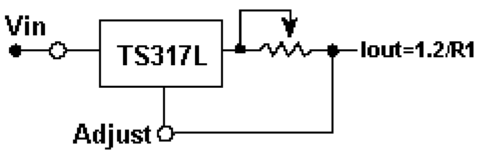
High gain amplifier



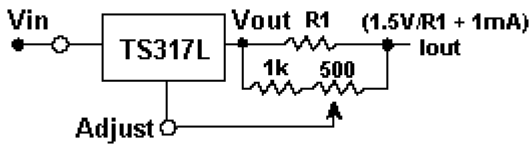
Adjustable regulator with improved
Ripple rejection



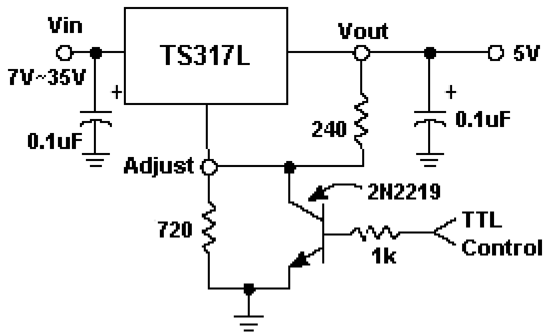
Slow turn-on 15V regulator



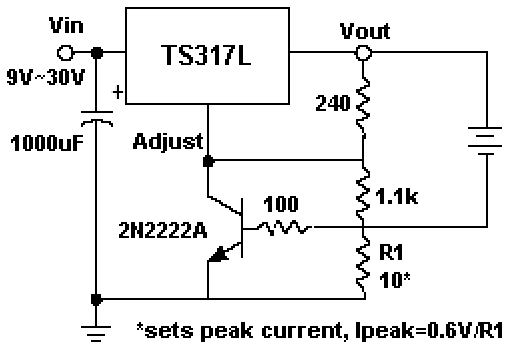
Adjustable current limiter



Precision current limiter

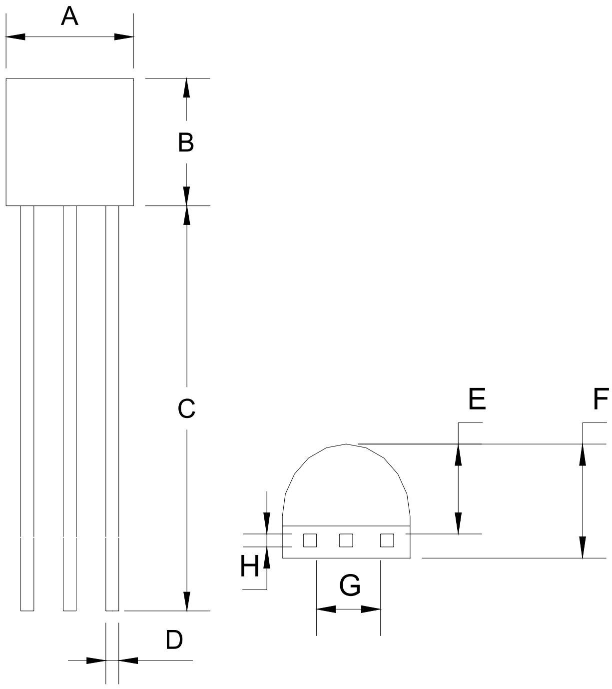


5V logic regulator with electronic shutdown



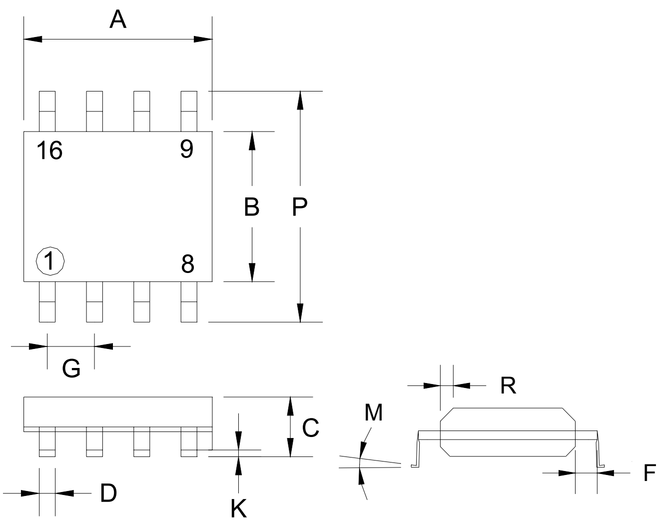
Current limited 6V charger

TO-92 Mechanical Drawing



TO-92 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.70	0.169	0.185
B	4.30	4.70	0.169	0.185
C	14.30(typ)		0.563(typ)	
D	0.43	0.49	0.017	0.019
E	2.19	2.81	0.086	0.111
F	3.30	3.70	0.130	0.146
G	2.42	2.66	0.095	0.105
H	0.37	0.43	0.015	0.017

SOP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 (typ)		0.05 (typ)	
K	0.10	0.25	0.004	0.009
M	0^{o}	7^{o}	0^{o}	7^{o}
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019