

LM317L

Three-Terminal Adjustable Output Positive Voltage Regulator

The LM317L is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 100 mA over an output voltage range of 1.2 V to 37 V. This voltage regulator 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 them essentially blow-out proof.

The LM317L 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 LM317L can be used as a precision current regulator.

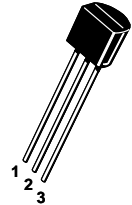
- Output Current in Excess of 100 mA
- Output Adjustable Between 1.2 V and 37 V
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe-Area Compensation
- Floating Operation for High Voltage Applications
- Standard 3-Lead Transistor Package
- Eliminates Stocking Many Fixed Voltages

LOW CURRENT THREE-TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATOR

SEMICONDUCTOR TECHNICAL DATA

Z SUFFIX PLASTIC PACKAGE CASE 29

- Pin 1. Adjust
2. V_{out}
3. V_{in}



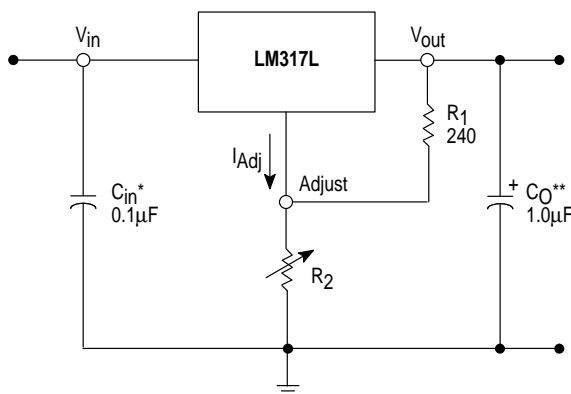
D SUFFIX PLASTIC PACKAGE CASE 751 (SOP-8*)

- Pin 1. V_{in}
2. V_{out}
3. V_{out}
4. Adjust
5. N.C.
6. V_{out}
7. V_{out}
8. N.C.



* SOP-8 is an internally modified SO-8 package. Pins 2, 3, 6 and 7 are electrically common to the die attach flag. This internal lead frame modification decreases package thermal resistance and increases power dissipation capability when appropriately mounted on a printed circuit board. SOP-8 conforms to all external dimensions of the standard SO-8 package.

Simplified Application



* C_{in} is required if regulator is located an appreciable distance from power supply filter.

** C_0 is not needed for stability, however, it does improve transient response.

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

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

ORDERING INFORMATION

Device	Operating Temperature Range	Package
LM317LD	$T_J = 0^\circ \text{ to } +125^\circ \text{C}$	SOP-8
LM317LZ		Plastic
LM317LBD	$T_J = -40^\circ \text{ to } +125^\circ \text{C}$	SOP-8
LM317LBZ		Plastic

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input–Output Voltage Differential	$V_I - V_O$	40	Vdc
Power Dissipation	P_D	Internally Limited	W
Operating Junction Temperature Range	T_J	–40 to +125	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS ($V_I - V_O = 5.0$ V; $I_O = 40$ mA; $T_J = T_{low}$ to T_{high} [Note 1]; I_{max} and P_{max} [Note 2]; unless otherwise noted.)

Characteristics	Figure	Symbol	LM317L, LB			Unit
			Min	Typ	Max	
Line Regulation (Note 3) $T_A = 25^\circ\text{C}$, $3.0\text{ V} \leq V_I - V_O \leq 40\text{ V}$	1	Regline	–	0.01	0.04	%/V
Load Regulation (Note 3), $T_A = 25^\circ\text{C}$ $10\text{ mA} \leq I_O \leq I_{max}$ – LM317L $V_O \leq 5.0\text{ V}$ $V_O \geq 5.0\text{ V}$	2	Regload	– –	5.0 0.1	25 0.5	mV % V_O
Adjustment Pin Current	3	I_{Adj}	–	50	100	μA
Adjustment Pin Current Change $2.5\text{ V} \leq V_I - V_O \leq 40\text{ V}$, $P_D \leq P_{max}$ $10\text{ mA} \leq I_O \leq I_{max}$ – LM317L	1, 2	ΔI_{Adj}	–	0.2	5.0	μA
Reference Voltage $3.0\text{ V} \leq V_I - V_O \leq 40\text{ V}$, $P_D \leq P_{max}$ $10\text{ mA} \leq I_O \leq I_{max}$ – LM317L	3	V_{ref}	1.20	1.25	1.30	V
Line Regulation (Note 3) $3.0\text{ V} \leq V_I - V_O \leq 40\text{ V}$	1	Regline	–	0.02	0.07	%/V
Load Regulation (Note 3) $10\text{ mA} \leq I_O \leq I_{max}$ – LM317L $V_O \leq 5.0\text{ V}$ $V_O \geq 5.0\text{ V}$	2	Regload	– –	20 0.3	70 1.5	mV % V_O
Temperature Stability ($T_{low} \leq T_J \leq T_{high}$)	3	T_S	–	0.7	–	% V_O
Minimum Load Current to Maintain Regulation ($V_I - V_O = 40\text{ V}$)	3	I_{Lmin}	–	3.5	10	mA
Maximum Output Current $V_I - V_O \leq 6.25\text{ V}$, $P_D \leq P_{max}$, Z Package $V_I - V_O \leq 40\text{ V}$, $P_D \leq P_{max}$, $T_A = 25^\circ\text{C}$, Z Package	3	I_{max}	100 –	200 20	– –	mA
RMS Noise, % of V_O $T_A = 25^\circ\text{C}$, $10\text{ Hz} \leq f \leq 10\text{ kHz}$		N	–	0.003	–	% V_O
Ripple Rejection (Note 4) $V_O = 1.2\text{ V}$, $f = 120\text{ Hz}$ $C_{Adj} = 10\text{ }\mu\text{F}$, $V_O = 10.0\text{ V}$	4	RR	60 –	80 80	– –	dB
Long Term Stability, $T_J = T_{high}$ (Note 5) $T_A = 25^\circ\text{C}$ for Endpoint Measurements	3	S	–	0.3	1.0	%/1.0 k Hrs.
Thermal Resistance, Junction–to–Case Z Package		$R_{\theta JC}$	–	83	–	°C/W
Thermal Resistance, Junction–to–Air Z Package		$R_{\theta JA}$	–	160	–	°C/W

- NOTES:** 1. T_{low} to $T_{high} = 0^\circ$ to $+125^\circ\text{C}$ for LM317L -40° to $+125^\circ\text{C}$ for LM317LB
2. $I_{max} = 100\text{ mA}$ $P_{max} = 625\text{ mW}$
3. 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.
4. C_{Adj} , when used, is connected between the adjustment pin and ground.
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.

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Representative Schematic Diagram

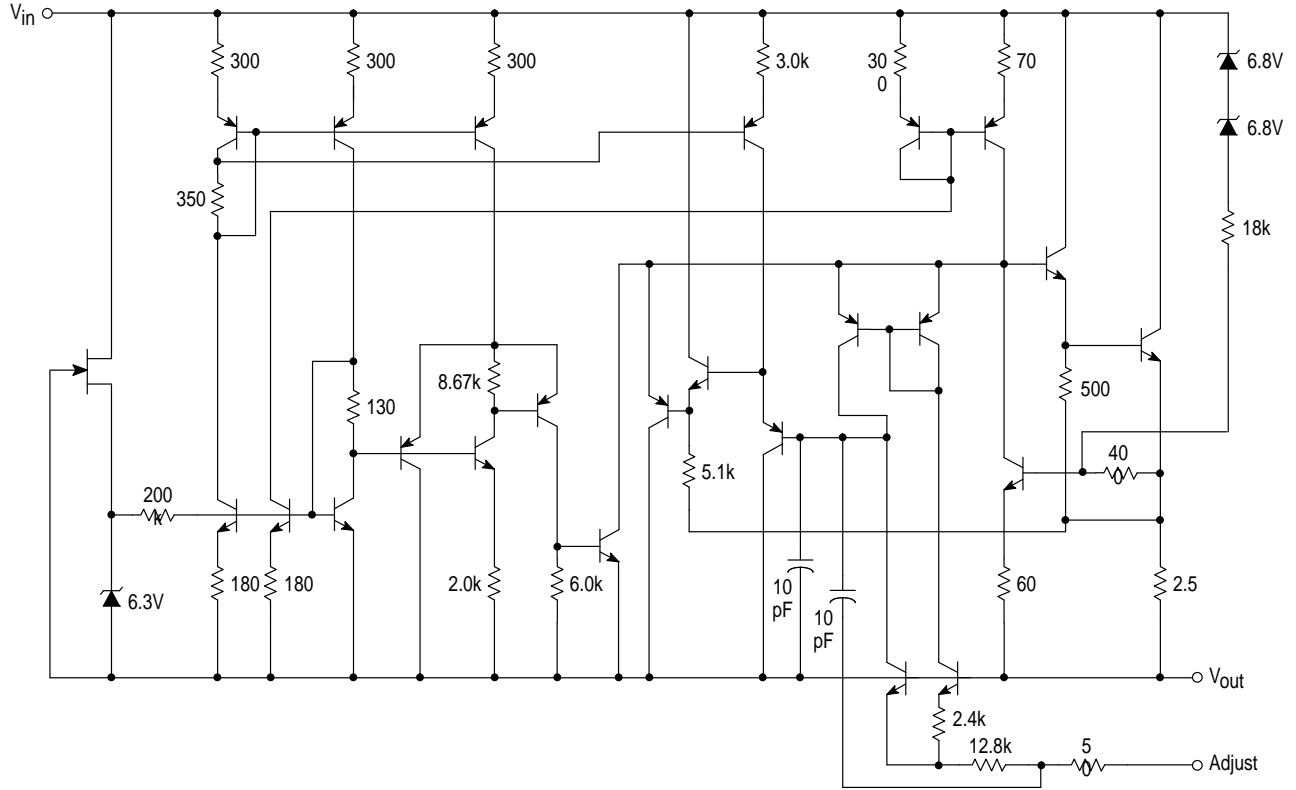
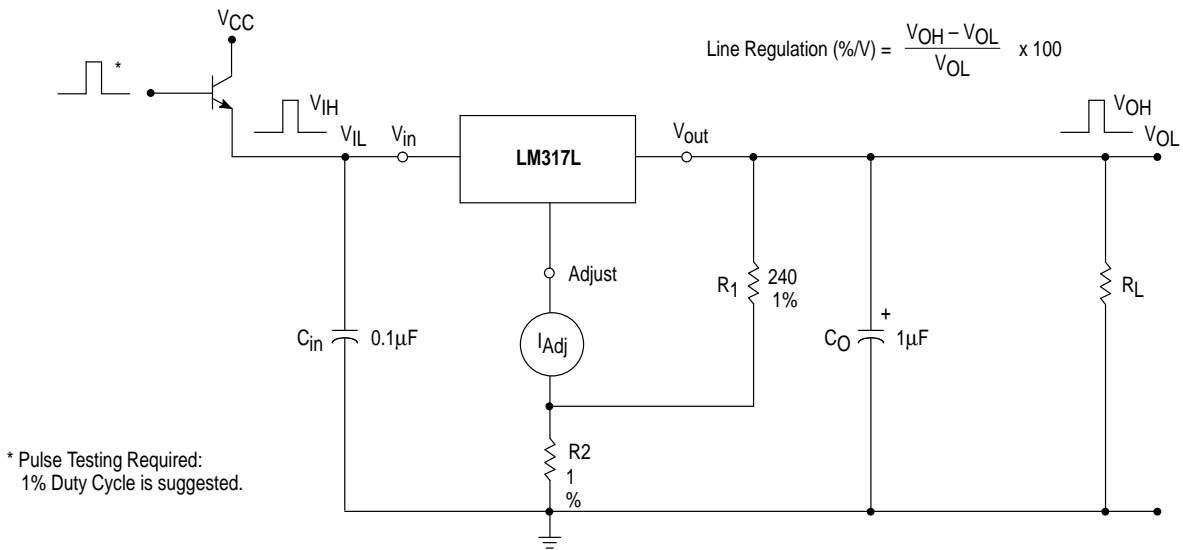


Figure 1. Line Regulation and $\Delta I_{Adj}/Line$ Test Circuit



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Figure 2. Load Regulation and ΔI_{Adj} /Load Test Circuit

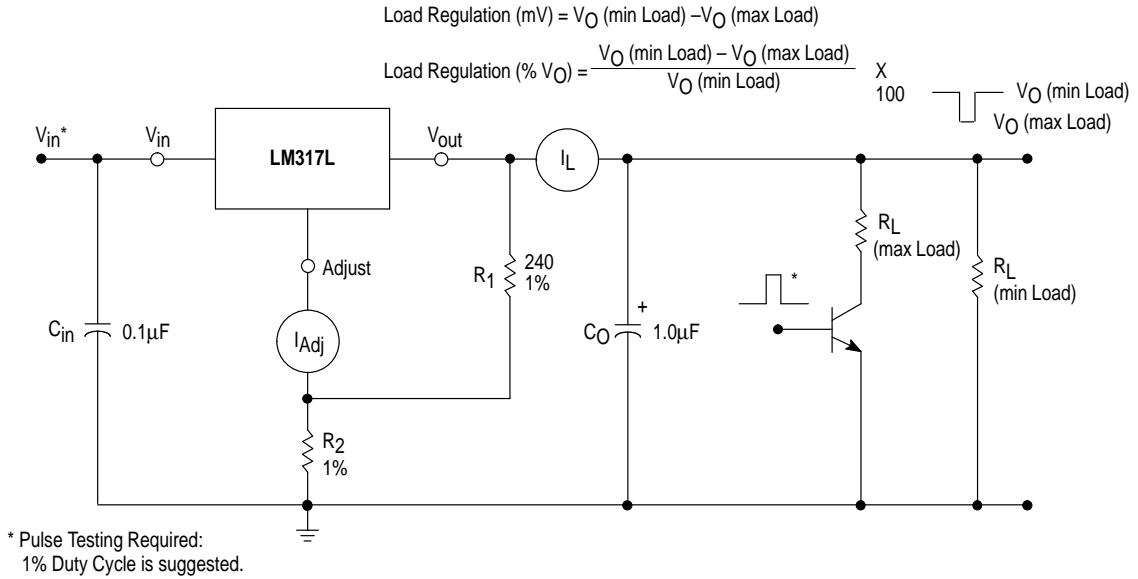


Figure 3. Standard Test Circuit

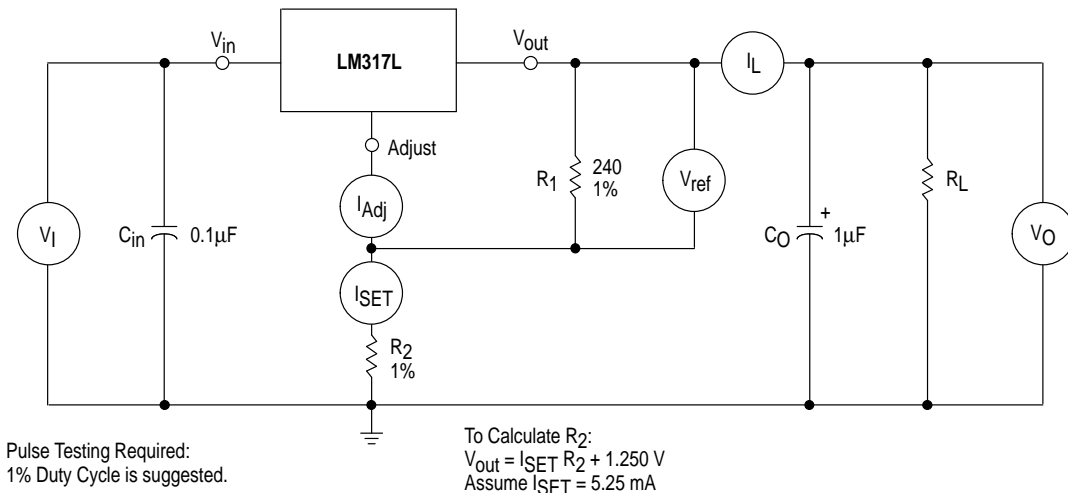


Figure 4. Ripple Rejection Test Circuit

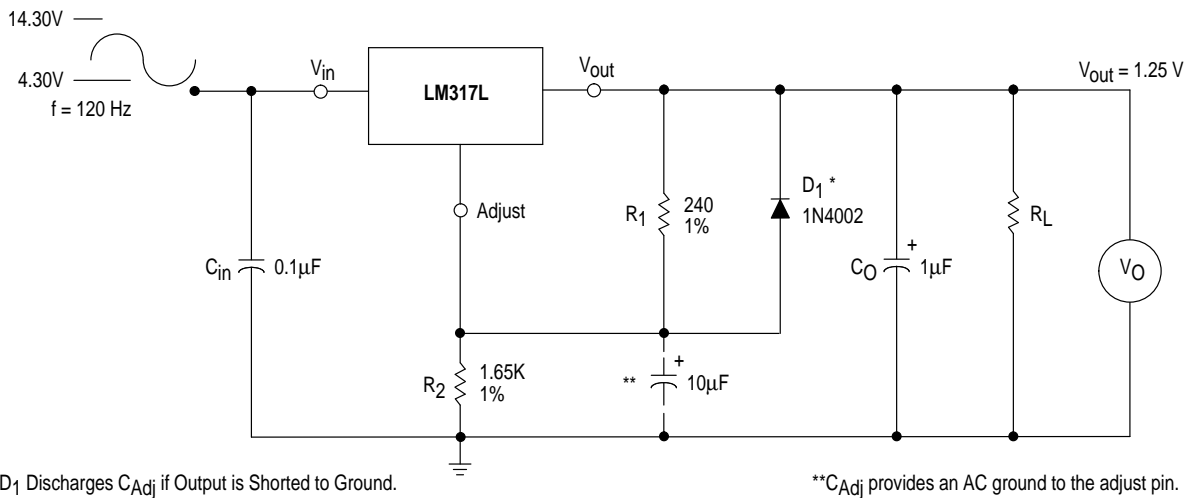


Figure 5. Load Regulation

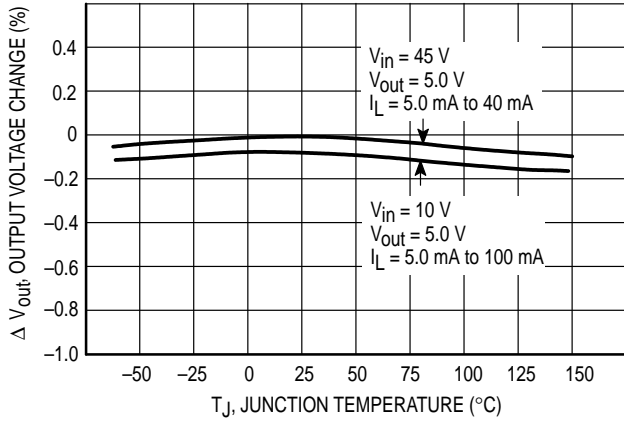


Figure 6. Ripple Rejection

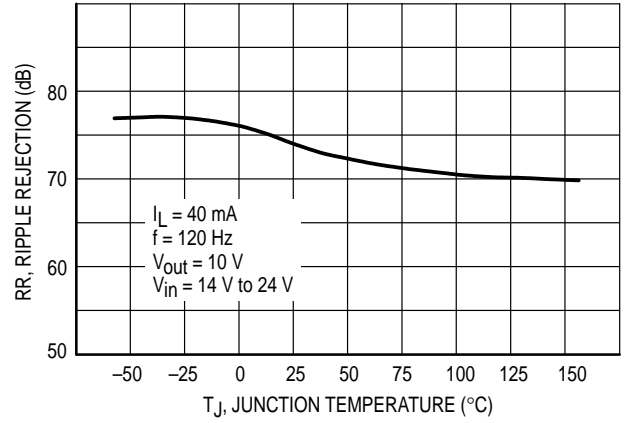


Figure 7. Current Limit

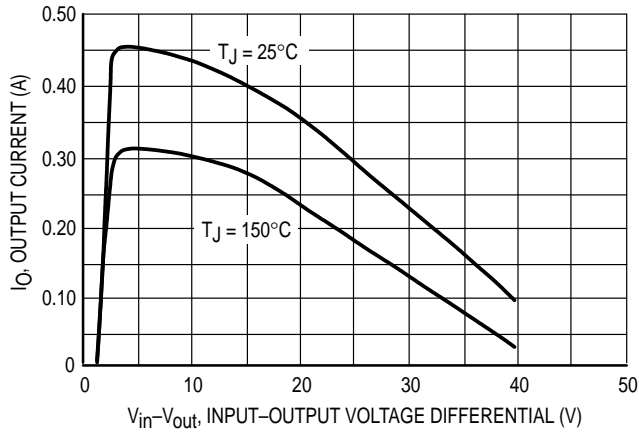


Figure 8. Dropout Voltage

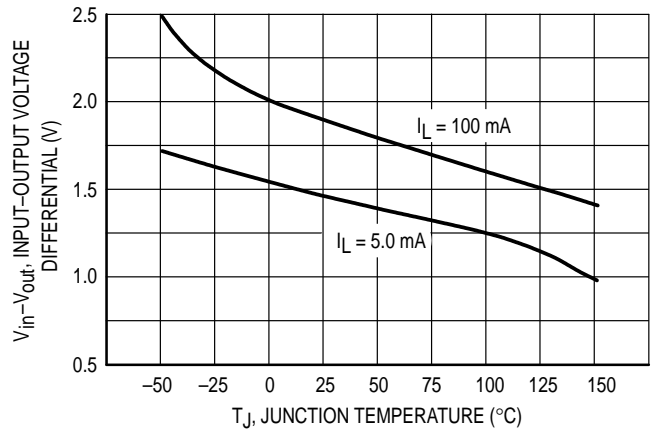


Figure 9. Minimum Operating Current

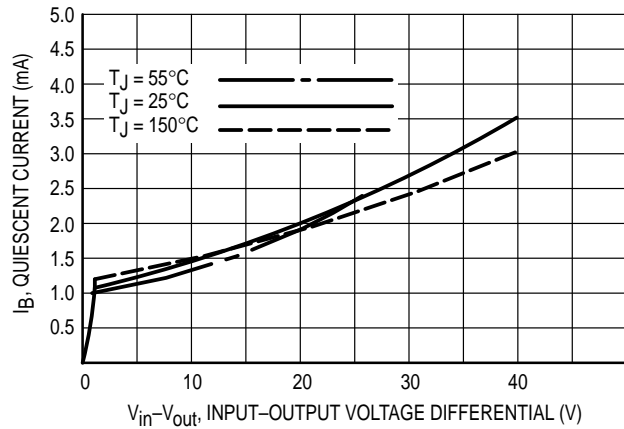


Figure 10. Ripple Rejection versus Frequency

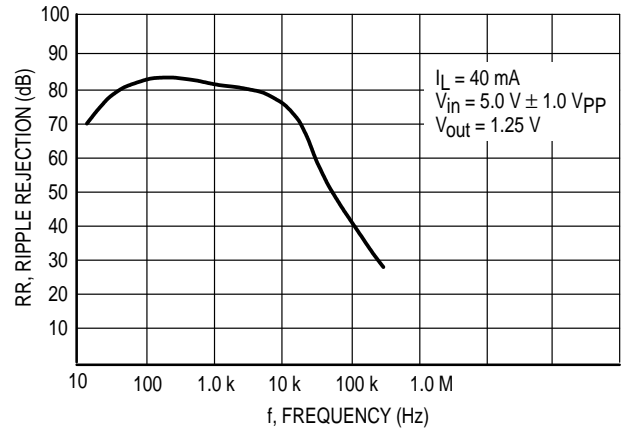


Figure 11. Temperature Stability

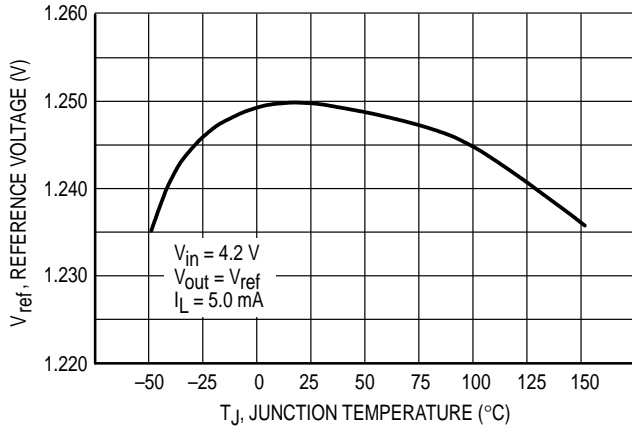


Figure 12. Adjustment Pin Current

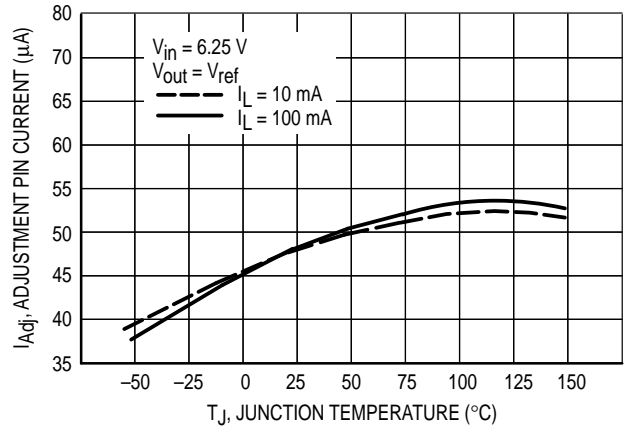


Figure 13. Line Regulation

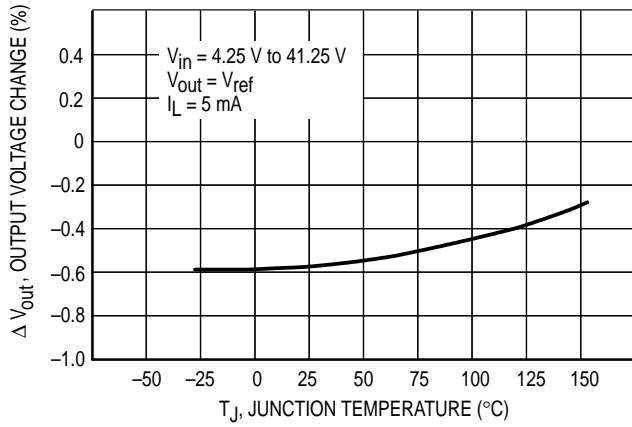


Figure 14. Output Noise

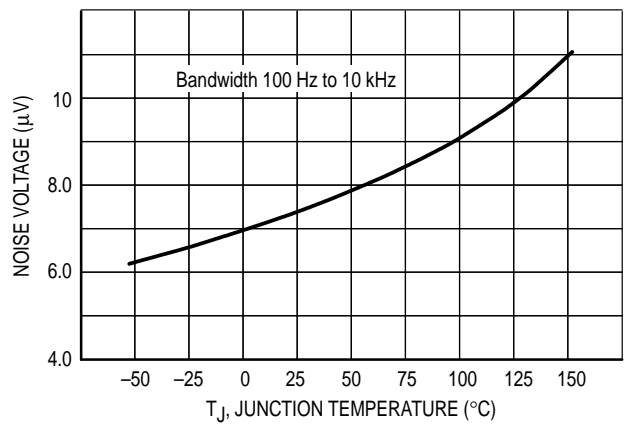


Figure 15. Line Transient Response

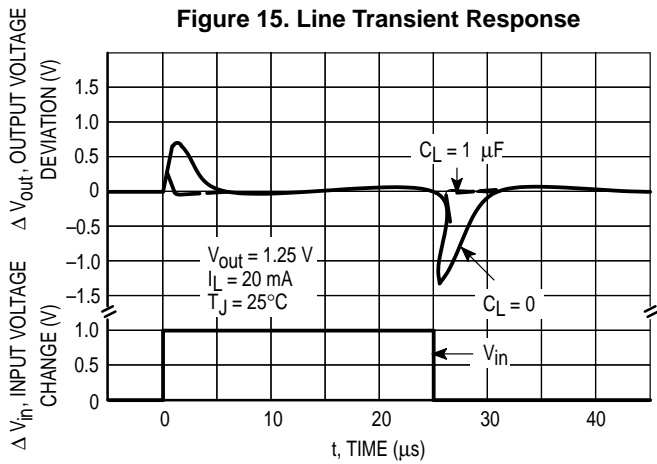
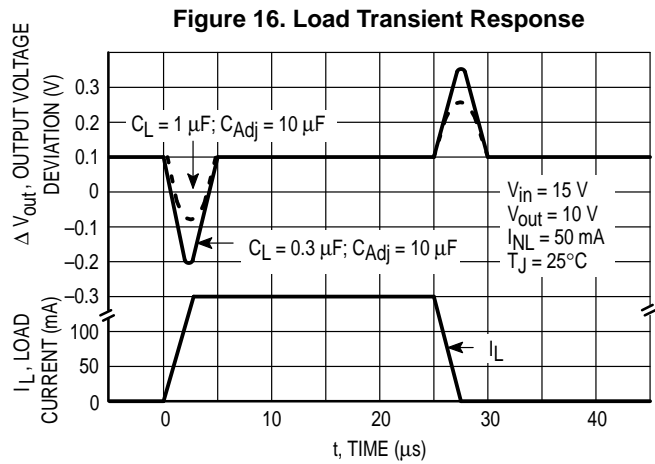


Figure 16. Load Transient Response



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APPLICATIONS INFORMATION

Basic Circuit Operation

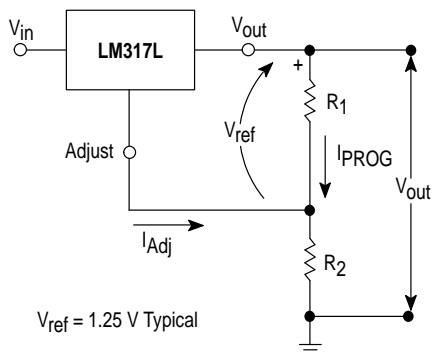
The LM317L is a 3-terminal floating regulator. In operation, the LM317L develops and maintains a nominal 1.25 V reference (V_{ref}) between its output and adjustment terminals. This reference voltage is converted to a programming current (I_{PROG}) by R_1 (see Figure 13), and this constant current flows through R_2 to ground. The regulated output voltage is given by:

$$V_{out} = V_{ref} \left(1 + \frac{R_2}{R_1} \right) + I_{Adj} R_2$$

Since the current from the adjustment terminal (I_{Adj}) represents an error term in the equation, the LM317L was designed to control I_{Adj} to less than 100 μA 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 LM317L 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 17. Basic Circuit Configuration



Load Regulation

The LM317L is capable of providing extremely good load regulation, but a few precautions are needed to obtain maximum performance. For best performance, the programming resistor (R_1) 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 R_2 can be returned near the load ground to provide remote ground sensing and improve load regulation.

External Capacitors

A 0.1 μF disc or 1.0 μF 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 μF capacitor should improve ripple rejection about 15 dB at 120 Hz in a 10 V application.

Although the LM317L 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 μF tantalum or 25 μF aluminum electrolytic capacitor on the output swamps this effect and insures stability.

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.

Figure 14 shows the LM317L with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values ($C_O > 10 \mu F$, $C_{Adj} > 5.0 \mu F$). Diode D_1 prevents C_O from discharging thru the IC during an input short circuit. Diode D_2 protects against capacitor C_{Adj} discharging through the IC during an output short circuit. The combination of diodes D_1 and D_2 prevents C_{Adj} from discharging through the IC during an input short circuit.

Figure 18. Voltage Regulator with Protection Diodes

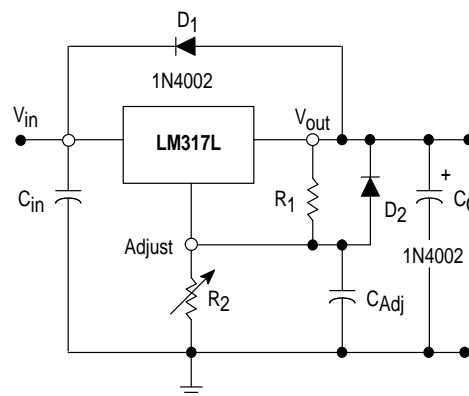
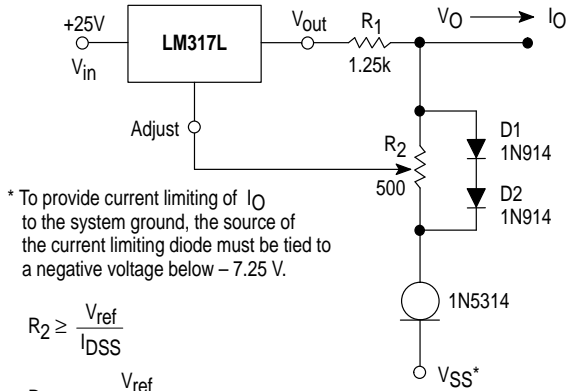


Figure 19. Adjustable Current Limiter



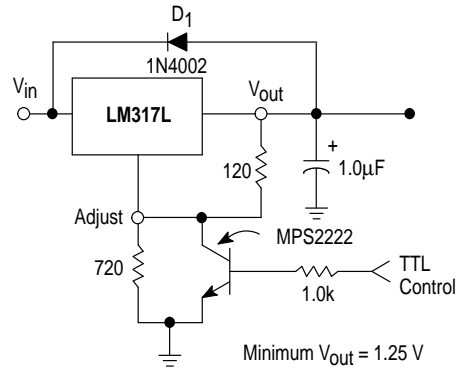
* To provide current limiting of I_O to the system ground, the source of the current limiting diode must be tied to a negative voltage below -7.25 V.

$$R_2 \geq \frac{V_{ref}}{I_{DSS}}$$

$$R_1 = \frac{V_{ref}}{I_{Omax} + I_{DSS}}$$

$V_O < P_{OV} + 1.25$ V + V_{SS}
 $I_{Lmin} - I_P < I_O < 100$ mA - I_P
 As shown $0 < I_O < 95$ mA

Figure 20. 5 V Electronic Shutdown Regulator



D1 protects the device during an input short circuit.

Figure 21. Slow Turn-On Regulator

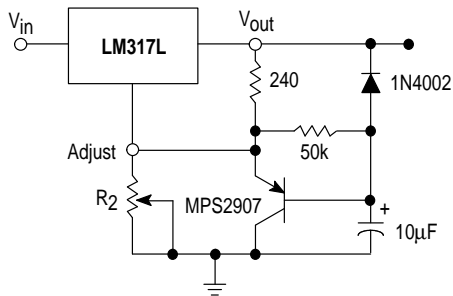
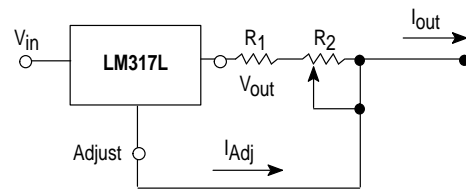


Figure 22. Current Regulator



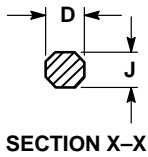
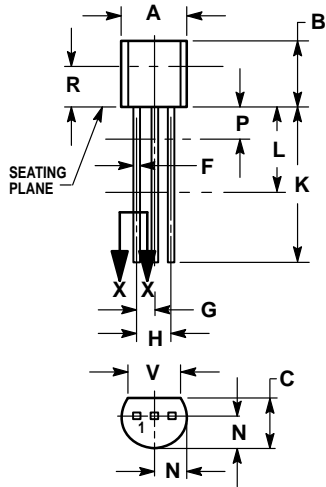
$$I_{outmax} = \left(\frac{V_{ref}}{R_1} \right) + I_{Adj} \cong \frac{1.25}{R_1}$$

$$I_{outmax} = \left(\frac{V_{ref}}{R_1 + R_2} \right) + I_{Adj} \cong \frac{1.25}{R_1 + R_2}$$

5.0 mA < I_{out} < 100 mA

LM317L OUTLINE DIMENSIONS

Z SUFFIX PLASTIC PACKAGE CASE 29-04 ISSUE AD

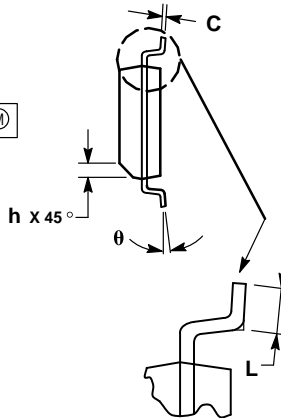
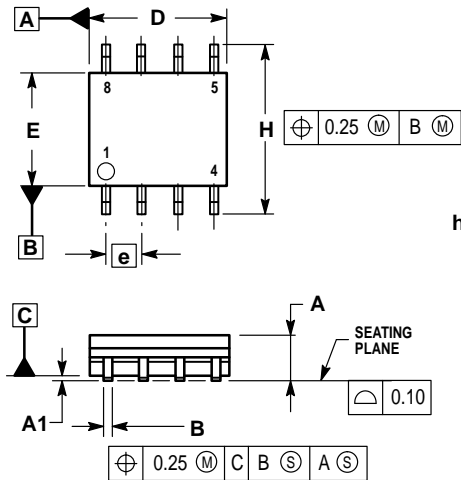


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSION D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.022	0.41	0.55
F	0.016	0.019	0.41	0.48
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	—	12.70	—
L	0.250	—	6.35	—
N	0.080	0.105	2.04	2.66
P	—	0.100	—	2.54
R	0.115	—	2.93	—
V	0.135	—	3.43	—

D SUFFIX PLASTIC PACKAGE CASE 751-05 (SOP-8) ISSUE R



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS	
	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.18	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.25
θ	0°	7°

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LM317L/D

