# LM317L

# 100 mA 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.

### Features

- Pb−Free Packages are Available
- 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



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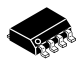
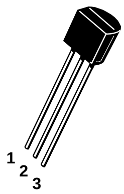
## LOW CURRENT THREE−TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATOR

SOIC−8
D SUFFIX
CASE 751




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

TO−92
Z SUFFIX
CASE 29

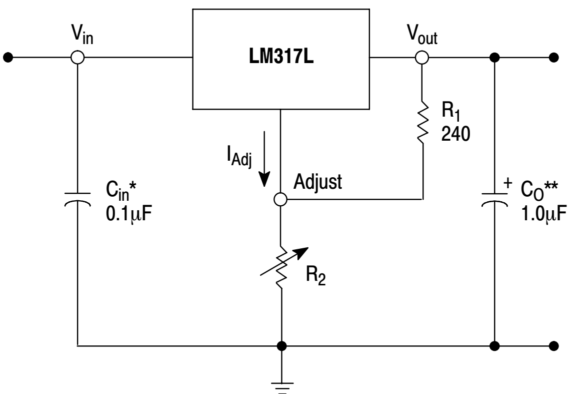



Pin 1. Adjust
2. $V_{out}$
3. $V_{in}$

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

### Simplified Application




* $C_{in}$ 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.

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

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

## MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Input−Output Voltage Differential | $V_I-V_O$ | 40 | Vdc |
| Power Dissipation<br>Case 29 (TO−92)<br>$T_A$ = 25°C<br>Thermal Resistance, Junction−to−Ambient<br>Thermal Resistance, Junction−to−Case | <br><br>$P_D$<br>$R_{\theta JA}$<br>$R_{\theta JC}$ | <br><br>Internally Limited<br>160<br>83 | <br><br>W<br>°C/W<br>°C/W |
| Case 751 (SOIC−8) (Note 1)<br>$T_A$ = 25°C<br>Thermal Resistance, Junction−to−Ambient<br>Thermal Resistance, Junction−to−Case | <br>$P_D$<br>$R_{\theta JA}$<br>$R_{\theta JC}$ | <br>Internally Limited<br>180<br>45 | <br>W<br>°C/W<br>°C/W |
| Operating Junction Temperature Range | $T_J$ | −40 to +125 | °C |
| Storage Temperature Range | $T_{stg}$ | −65 to +150 | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. SOIC−8 Junction−to−Ambient Thermal Resistance is for minimum recommended pad size. Refer to Figure 23 for Thermal Resistance variation versus pad size.
2. This device series contains ESD protection and exceeds the following tests:
   Human Body Model, 2000 V per MIL STD 883, Method 3015.
   Machine Model Method, 200 V.

**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 Min | LM317L, LB Typ | LM317L, LB Max | Unit |
|---|---|---|---|---|---|---|
| Line Regulation (Note 3)<br>$T_A$ = 25°C, 3.0 V ≤ $V_I - V_O$ ≤ 40 V | 1 | $Reg_{line}$ | – | 0.01 | 0.04 | %/V |
| Load Regulation (Note 3), $T_A$ = 25°C<br>10 mA ≤ $I_O$ ≤ $I_{max}$ – LM317L<br>$V_O$ ≤ 5.0 V<br>$V_O$ ≥ 5.0 V | 2 | $Reg_{load}$ | <br><br>–<br>– | <br><br>5.0<br>0.1 | <br><br>25<br>0.5 | <br><br>mV<br>% $V_O$ |
| Adjustment Pin Current | 3 | $I_{Adj}$ | – | 50 | 100 | μA |
| Adjustment Pin Current Change<br>2.5 V ≤ $V_I - V_O$ ≤ 40 V, $P_D$ ≤ $P_{max}$<br>10 mA ≤ $I_O$ ≤ $I_{max}$ – LM317L | 1, 2 | $\Delta I_{Adj}$ | – | 0.2 | 5.0 | μA |
| Reference Voltage<br>3.0 V ≤ $V_I - V_O$ ≤ 40 V, $P_D$ ≤ $P_{max}$<br>10 mA ≤ $I_O$ ≤ $I_{max}$ – LM317L | 3 | $V_{ref}$ | 1.20 | 1.25 | 1.30 | V |
| Line Regulation (Note 3), 3.0 V ≤ $V_I - V_O$ ≤ 40 V | 1 | $Reg_{line}$ | – | 0.02 | 0.07 | %/V |
| Load Regulation (Note 3)<br>10 mA ≤ $I_O$ ≤ $I_{max}$ – LM317L<br>$V_O$ ≤ 5.0 V<br>$V_O$ ≥ 5.0 V | 2 | $Reg_{load}$ | <br><br>–<br>– | <br><br>20<br>0.3 | <br><br>70<br>1.5 | <br><br>mV<br>% $V_O$ |
| Temperature Stability ($T_{low}$ ≤ $T_J$ ≤ $T_{high}$) | 3 | $T_S$ | – | 0.7 | – | % $V_O$ |
| Minimum Load Current to Maintain Regulation ($V_I - V_O$ = 40 V) | 3 | $I_{Lmin}$ | – | 3.5 | 10 | mA |
| Maximum Output Current<br>$V_I - V_O$ ≤ 6.25 V, $P_D$ ≤ $P_{max}$, Z Package<br>$V_I - V_O$ ≤ 40 V, $P_D$ ≤ $P_{max}$, $T_A$ = 25°C, Z Package | 3 | $I_{max}$ | <br>100<br>– | <br>200<br>20 | <br>–<br>– | mA |
| RMS Noise, % of $V_O$<br>$T_A$ = 25°C, 10 Hz ≤ f ≤ 10 kHz | | N | – | 0.00<br>3 | – | % $V_O$ |
| Ripple Rejection (Note 4)<br>$V_O$ = 1.2 V, f = 120 Hz<br>$C_{Adj}$ = 10 μF, $V_O$ = 10.0 V | 4 | RR | <br>60<br>– | <br>80<br>80 | <br>–<br>– | dB |
| Long Term Stability, $T_J = T_{high}$ (Note 5)<br>$T_A$ = 25°C for Endpoint Measurements | 3 | S | – | 0.3 | 1.0 | %/1.0 k Hrs. |

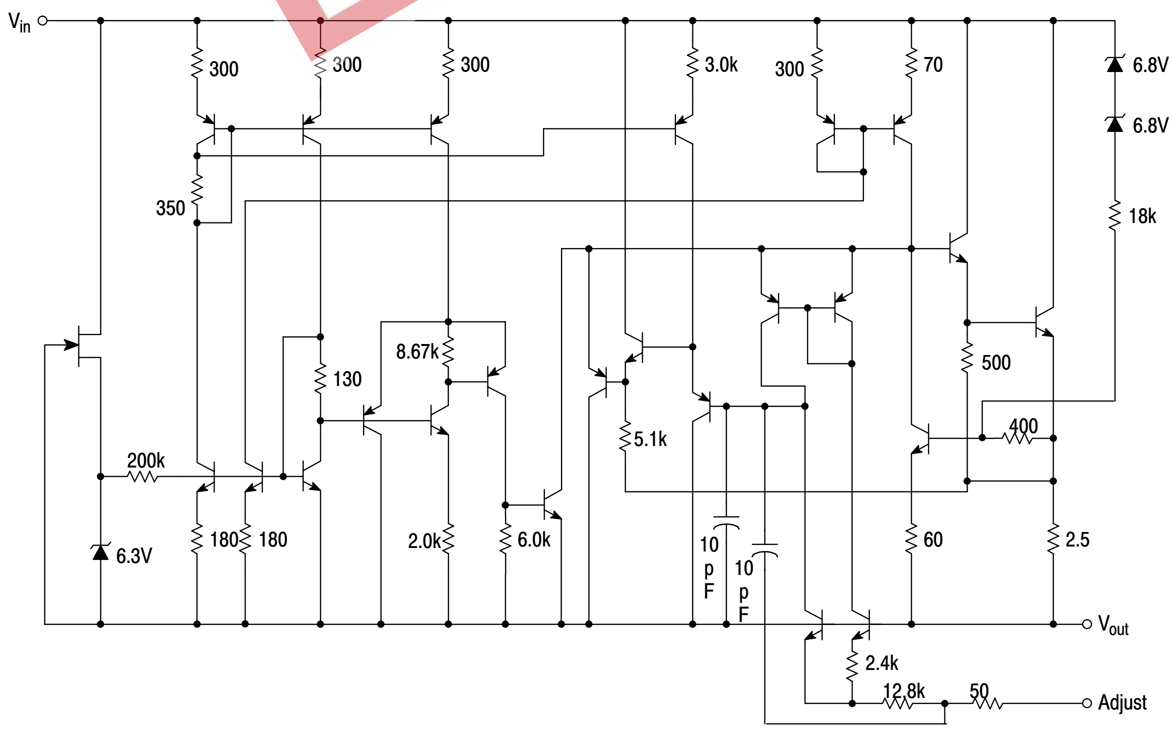
3. $T_{low}$ to $T_{high}$ = 0° to +125°C for LM317L −40° to +125°C for LM317LB
4. $I_{max}$ = 100 mA $P_{max}$ = 625 mW
5. Load and line regulation are specified at constant junction temperature. Changes in $V_O$ due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.
6. $C_{Adj}$, when used, is connected between the adjustment pin and ground.
7. 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.

## ORDERING INFORMATION

| Device | Operating Temperature Range | Package | Shipping† |
|---|---|---|---|
| LM317LBD | $T_J$ = −40°C to +125°C | SOIC−8 | 98 Units / Rail |
| LM317LBDG | | SOIC−8 (Pb−Free) | 98 Units / Rail |
| LM317LBDR2 | | SOIC−8 | 2500/Tape & Reel |
| LM317LBDR2G | | SOIC−8 (Pb−Free) | 2500/Tape & Reel |
| LM317LBZ | | TO−92 | 2000 Units / Bag |
| LM317LBZG | | TO−92 (Pb−Free) | 2000 Units / Bag |
| LM317LBZRA | | TO−92 | 2000 Tape & Reel |
| LM317LBZRAG | | TO−92 (Pb−Free) | 2000 Tape & Reel |
| LM317LBZRP | | TO−92 | 2000 Ammo Pack |
| LM317LBZRPG | | TO−92 (Pb−Free) | 2000 Ammo Pack |
| LM317LD | $T_J$ = 0°C to +125°C | SOIC−8 | 98 Units / Rail |
| LM317LDG | | SOIC−8 (Pb−Free) | 98 Units / Rail |
| LM317LDR2 | | SOIC−8 | 2500/Tape & Reel |
| LM317LDR2G | | SOIC−8 (Pb−Free) | 2500/Tape & Reel |
| LM317LZ | | TO−92 | 2000 Units / Bag |
| LM317LZG | | TO−92 (Pb−Free) | 2000 Units / Bag |
| LM317LZRA | | TO−92 | 2000 Tape & Reel |
| LM317LZRAG | | TO−92 (Pb−Free) | 2000 Tape & Reel |
| LM317LZRE | | TO−92 | 2000 Tape & Reel |
| LM317LZRM | | TO−92 | 2000 Ammo Pack |
| LM317LZRP | | TO−92 | 2000 Ammo Pack |
| LM317LZRPG | | TO−92 (Pb−Free) | 2000 Ammo Pack |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

### Representative Schematic Diagram



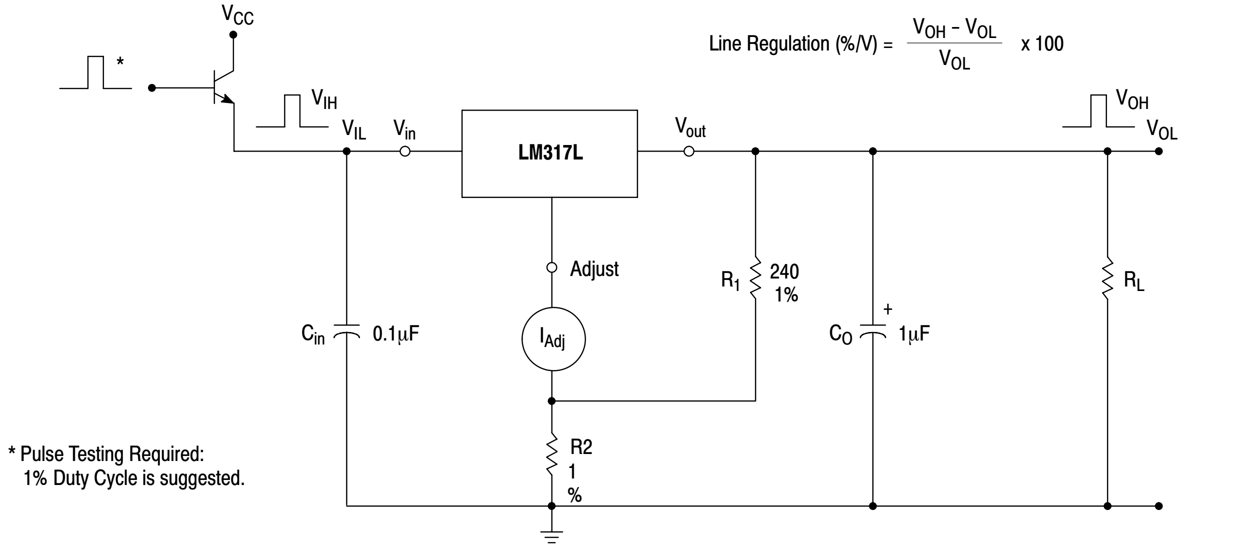



**Figure 1. Line Regulation and $\Delta I_{Adj}$/Line Test Circuit**

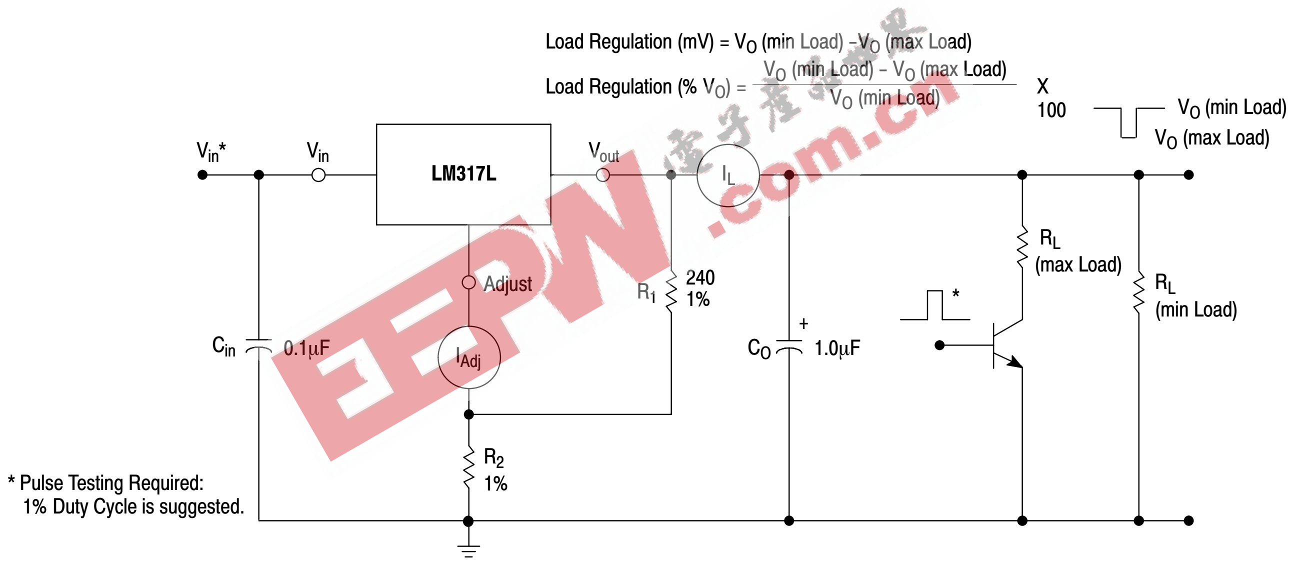



**Figure 2. Load Regulation and $\Delta I_{Adj}$/Load Test Circuit**

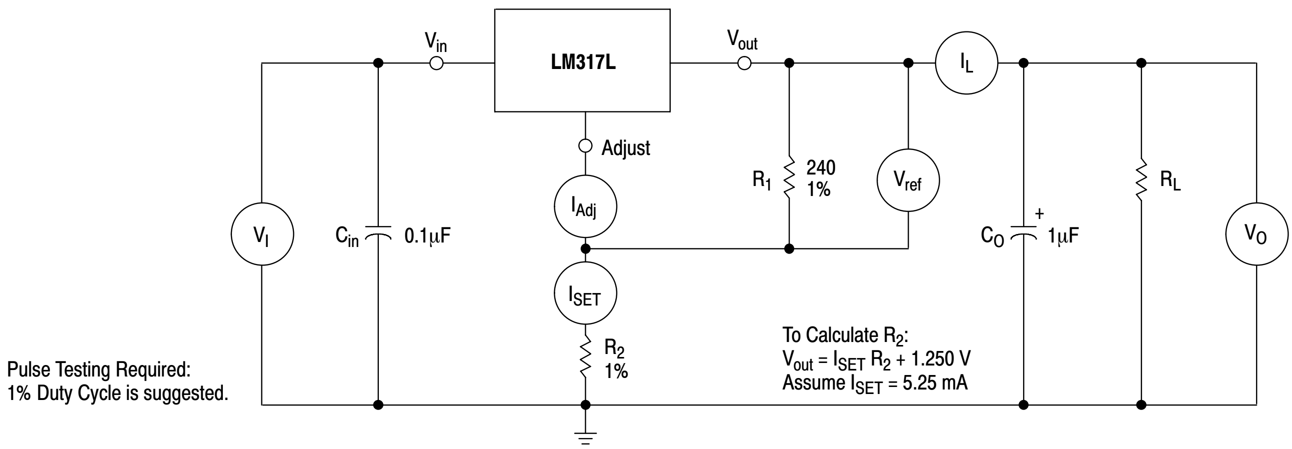
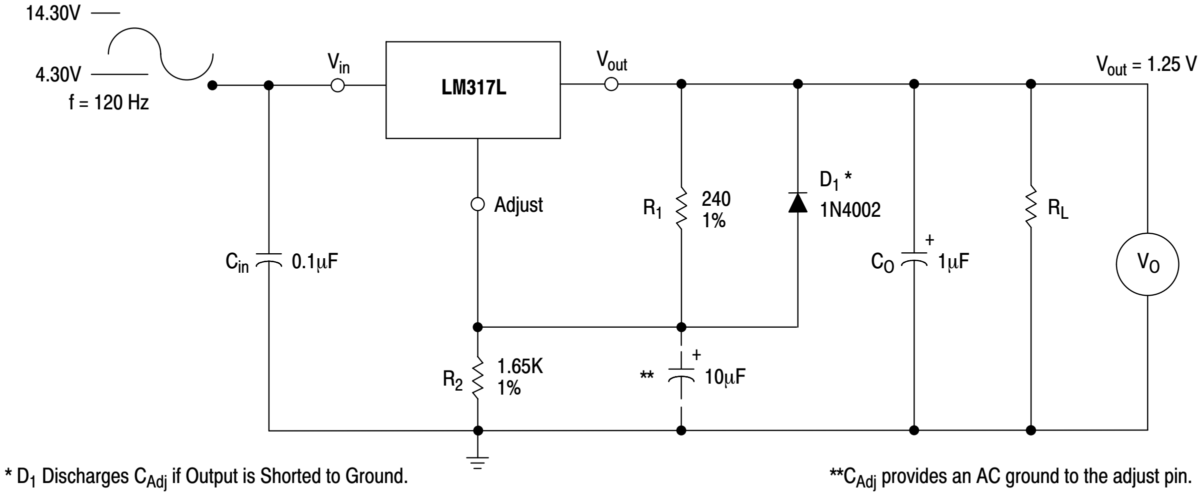



**Figure 3. Standard Test Circuit**




* $D_1$ Discharges $C_{Adj}$ if Output is Shorted to Ground.

**$C_{Adj}$ provides an AC ground to the adjust pin.

Figure 4. Ripple Rejection Test Circuit

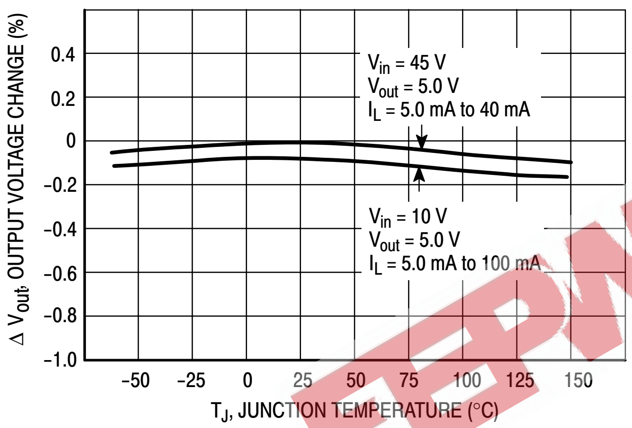



Figure 5. Load Regulation

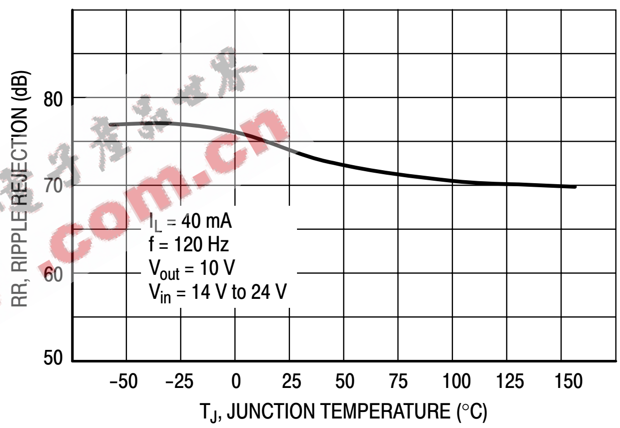



Figure 6. Ripple Rejection

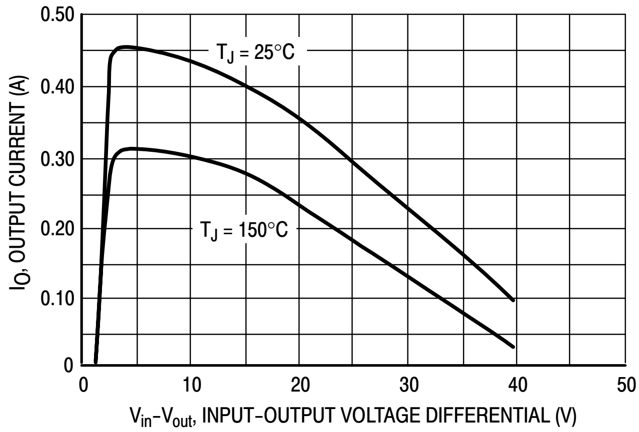



Figure 7. Current Limit

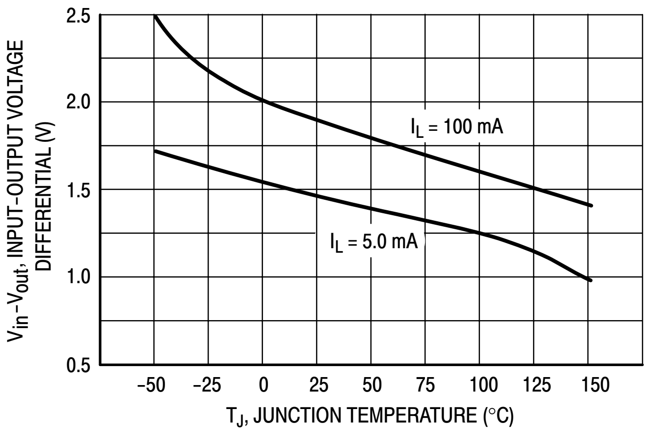



Figure 8. Dropout Voltage

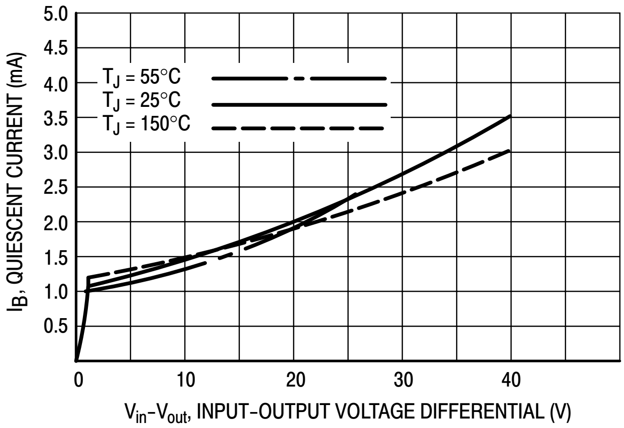



**Figure 9. Minimum Operating Current**

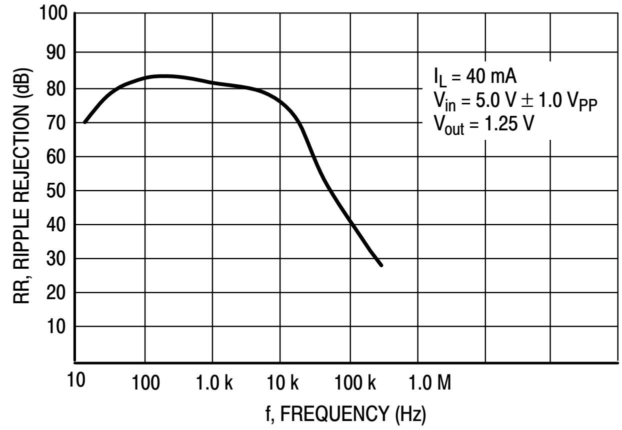



**Figure 10. Ripple Rejection versus Frequency**

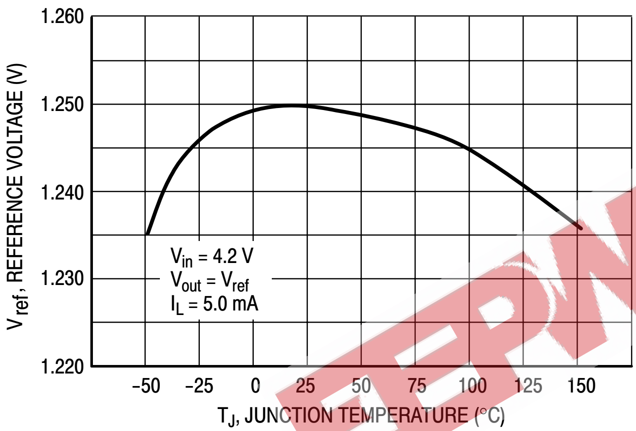



**Figure 11. Temperature Stability**

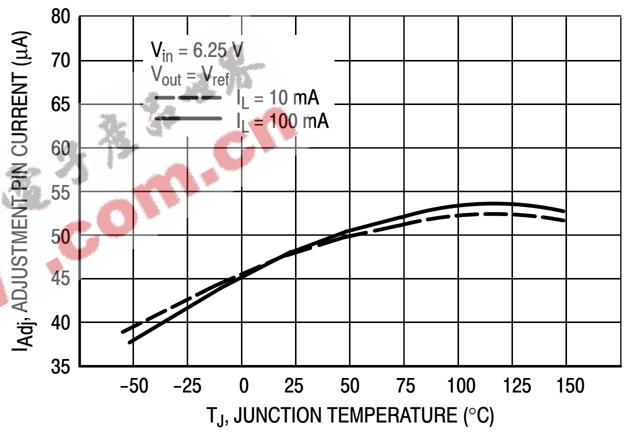



**Figure 12. Adjustment Pin Current**

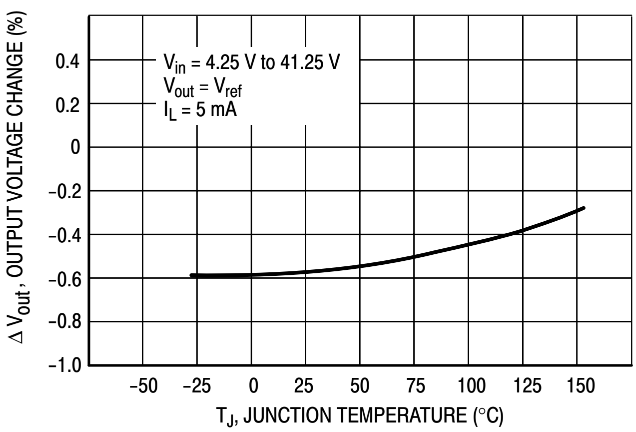



**Figure 13. Line Regulation**

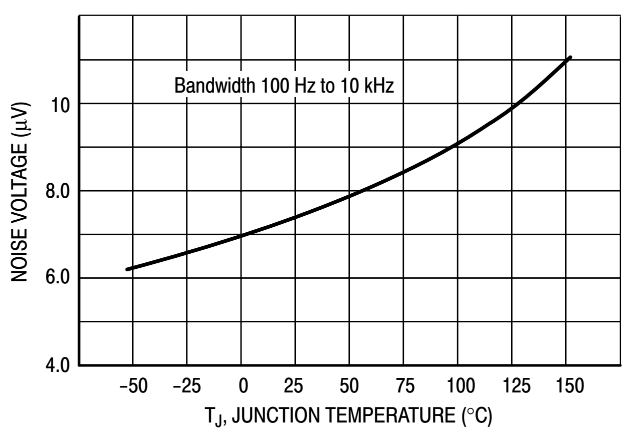



**Figure 14. Output Noise**

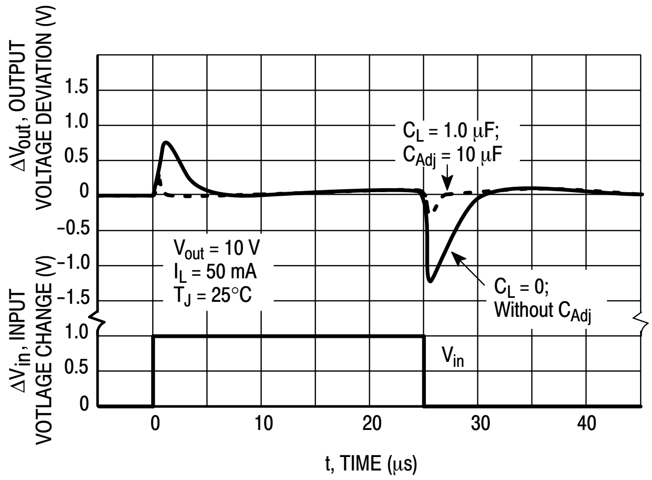



**Figure 15. Line Transient Response**

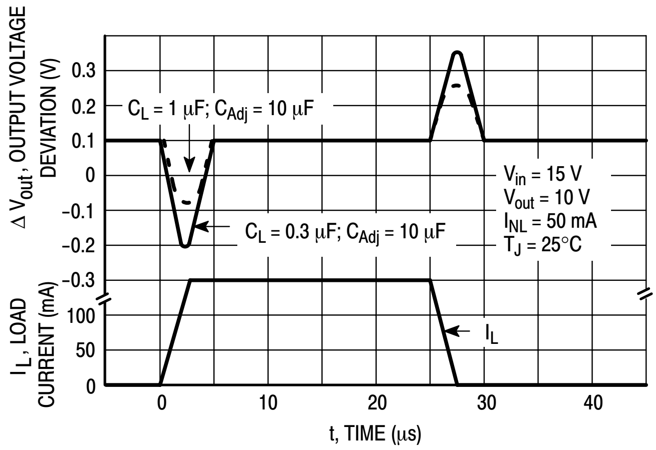



**Figure 16. Load Transient Response**

## 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.

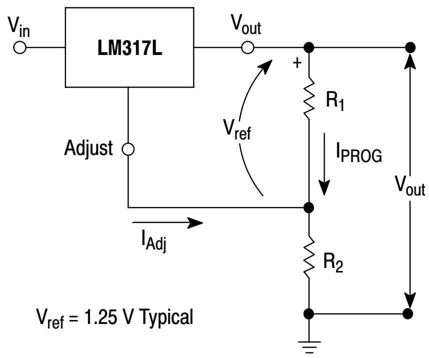



**Figure 17. Basic Circuit Configuration**

### 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 (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.

### 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 ($C_O > 10$ μF, $C_{Adj} > 5.0$ μF). 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.

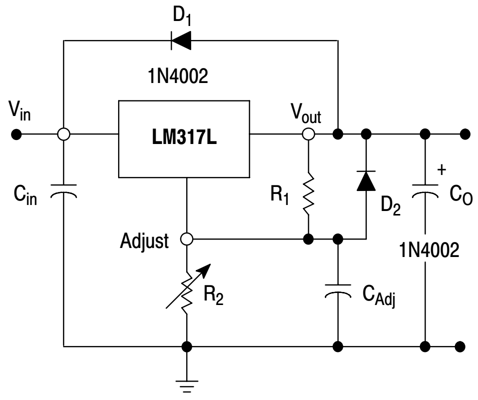



**Figure 18. Voltage Regulator with Protection Diodes**

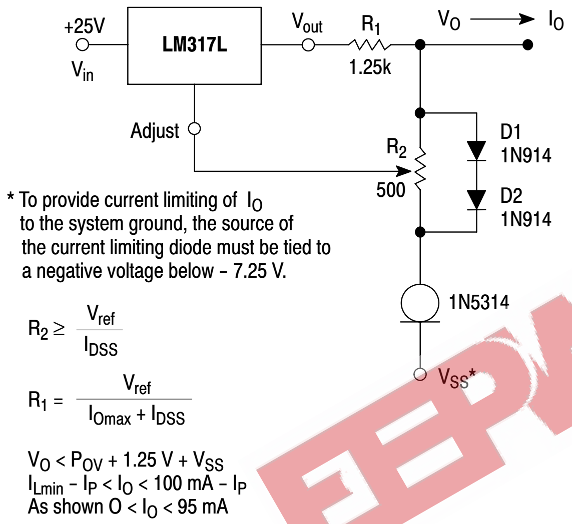



**Figure 19. Adjustable Current Limiter**

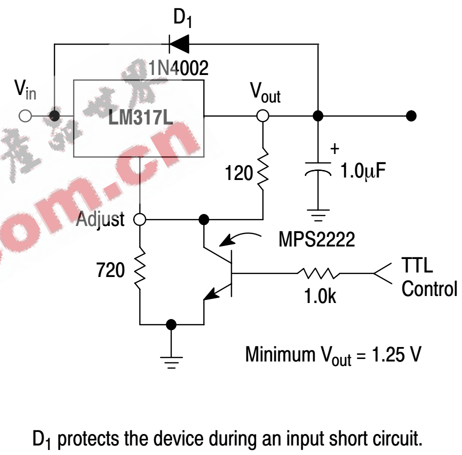



**Figure 20. 5.0 V Electronic Shutdown Regulator**



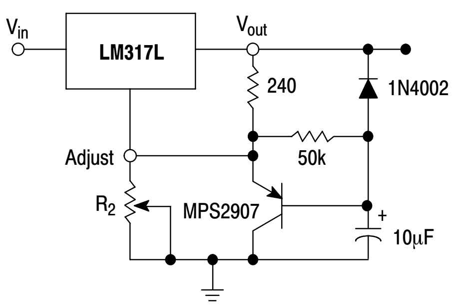



**Figure 21. Slow Turn−On Regulator**

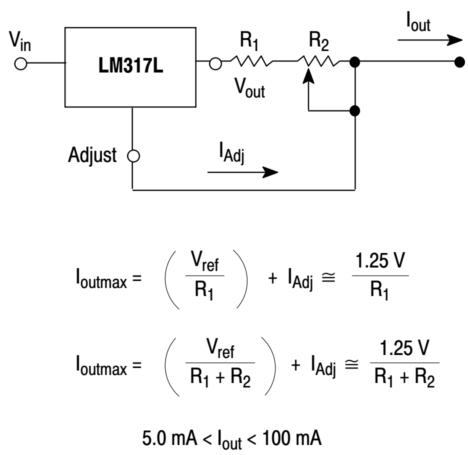



**Figure 22. Current Regulator**

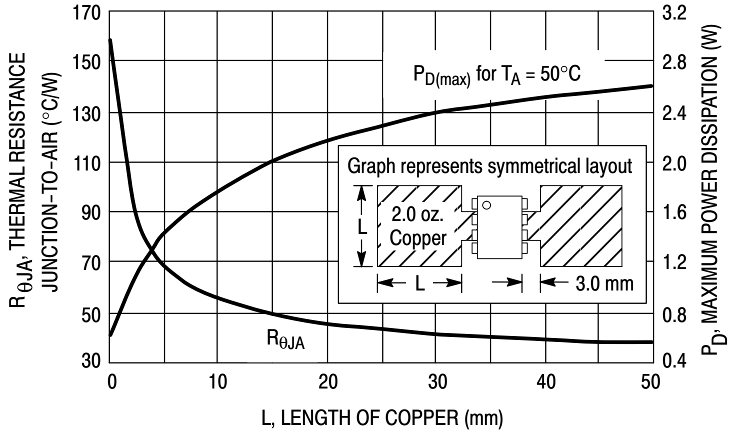
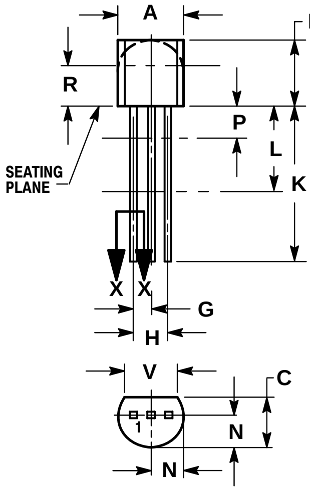
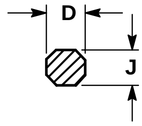



**Figure 23. SOP−8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length**

## PACKAGE DIMENSIONS

**TO−92**
**Z SUFFIX**
CASE 29−11
ISSUE AL



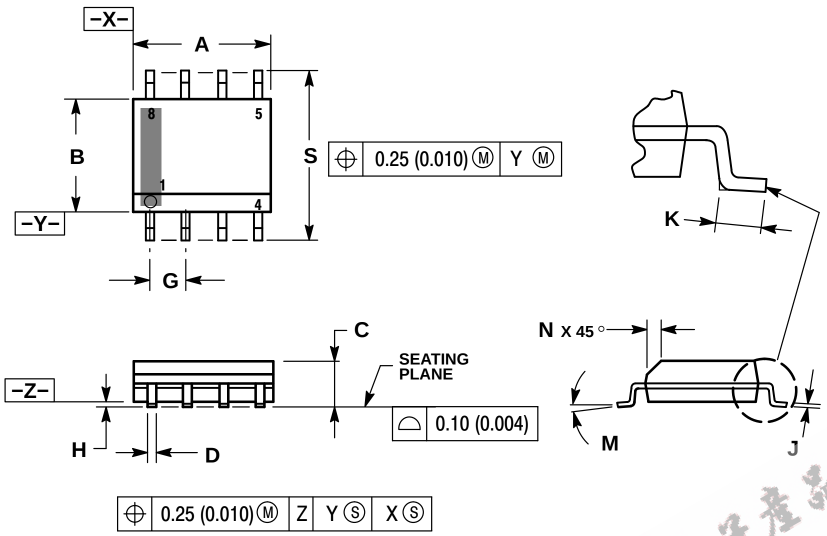

**SECTION X−X**

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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 | 0.021 | 0.407 | 0.533 |
| 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 | --- |

## PACKAGE DIMENSIONS

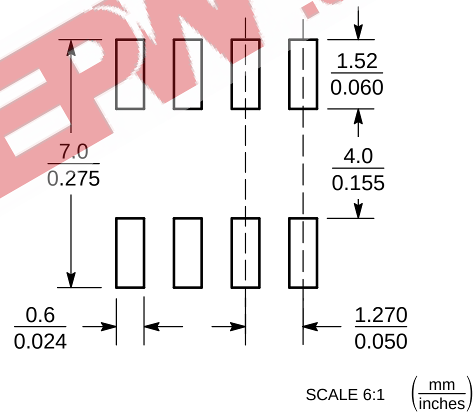
**SOIC−8**
**D SUFFIX**
CASE 751−07
ISSUE AG




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC | | 0.050 BSC | |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 0.19 | 0.25 | 0.007 | 0.010 |
| K | 0.40 | 1.27 | 0.016 | 0.050 |
| M | 0 ° | 8 ° | 0 ° | 8 ° |
| N | 0.25 | 0.50 | 0.010 | 0.020 |
| S | 5.80 | 6.20 | 0.228 | 0.244 |

### SOLDERING FOOTPRINT*




*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



**PUBLICATION ORDERING INFORMATION**

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