

# LM317L, NCV317LB

## 100 mA Adjustable Output, Positive Voltage Regulator

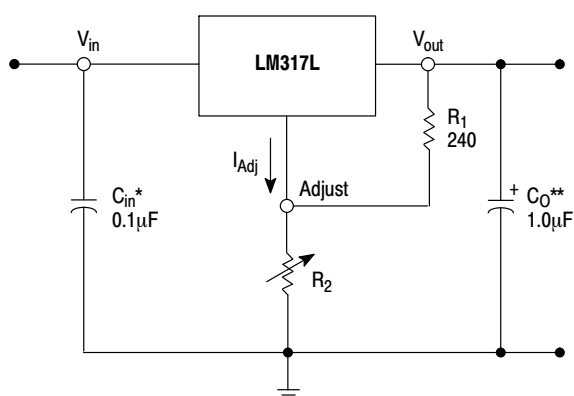
The LM317L is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 100 mA over an output voltage range of 1.2 V to 37 V. This voltage regulator is exceptionally easy to use and requires only two external resistors to set the output voltage. Further, it employs internal 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

- 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
- Pb-Free Packages are Available
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes

### 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  $\mu A$ , the error associated with this term is negligible in most applications.



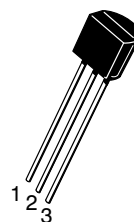
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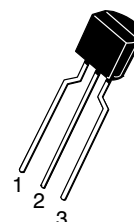
## LOW CURRENT THREE-TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATOR



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



STRAIGHT LEAD  
BULK PACK



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

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

# LM317L, NCV317LB

## MAXIMUM RATINGS

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

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

- SOIC-8 Junction-to-Ambient Thermal Resistance is for minimum recommended pad size. Refer to Figure 24 for Thermal Resistance variation versus pad size.
- 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.

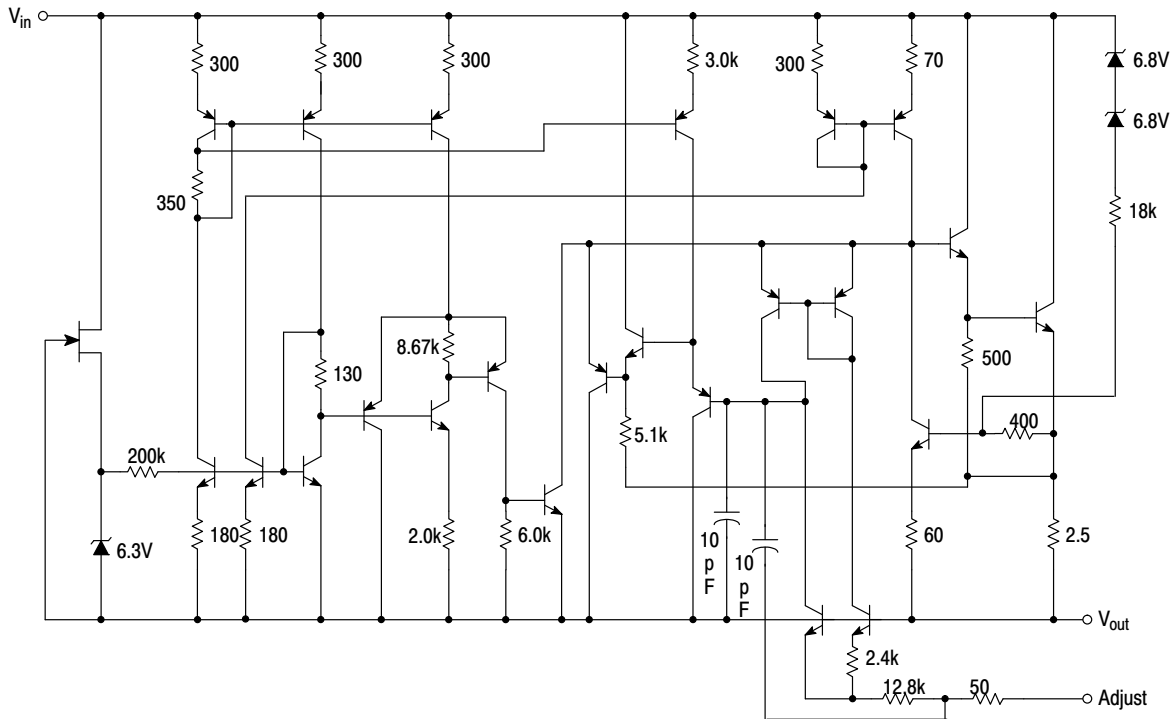


Figure 1. Representative Schematic Diagram

## LM317L, NCV317LB

**ELECTRICAL CHARACTERISTICS** ( $V_I - V_O = 5.0\text{ V}$ ;  $I_O = 40\text{ mA}$ ;  $T_J = T_{\text{low}}$  to  $T_{\text{high}}$  (Note 3);  $I_{\text{max}}$  and  $P_{\text{max}}$  (Note 4); unless otherwise noted.)

| Characteristics   | Figure | Symbol                     | LM317L, LB, NCV317LB |            |           | Unit             |
|---|--------|----------------------------|----------------------|------------|-----------|------------------|
|   |        |                            | Min                  | Typ        | Max       |                  |
| Line Regulation (Note 5)<br>$T_A = 25^\circ\text{C}$ , $3.0\text{ V} \leq V_I - V_O \leq 40\text{ V}$   | 1      | $\text{Reg}_{\text{line}}$ | -                    | 0.01       | 0.04      | %/V              |
| Load Regulation (Note 5), $T_A = 25^\circ\text{C}$<br>$10\text{ mA} \leq I_O \leq I_{\text{max}}$ - LM317L<br>$V_O \leq 5.0\text{ V}$<br>$V_O \geq 5.0\text{ V}$                                    | 2      | $\text{Reg}_{\text{load}}$ | -<br>-               | 5.0<br>0.1 | 25<br>0.5 | mV<br>% $V_O$    |
| Adjustment Pin Current  | 3      | $I_{\text{Adj}}$           | -                    | 50         | 100       | $\mu\text{A}$    |
| Adjustment Pin Current Change<br>$2.5\text{ V} \leq V_I - V_O \leq 40\text{ V}$ , $P_D \leq P_{\text{max}}$<br>$10\text{ mA} \leq I_O \leq I_{\text{max}}$ - LM317L                                 | 1, 2   | $\Delta I_{\text{Adj}}$    | -                    | 0.2        | 5.0       | $\mu\text{A}$    |
| Reference Voltage<br>$3.0\text{ V} \leq V_I - V_O \leq 40\text{ V}$ , $P_D \leq P_{\text{max}}$<br>$10\text{ mA} \leq I_O \leq I_{\text{max}}$ - LM317L   | 3      | $V_{\text{ref}}$           | 1.20                 | 1.25       | 1.30      | V                |
| Line Regulation (Note 5), $3.0\text{ V} \leq V_I - V_O \leq 40\text{ V}$  | 1      | $\text{Reg}_{\text{line}}$ | -                    | 0.02       | 0.07      | %/V              |
| Load Regulation (Note 5)<br>$10\text{ mA} \leq I_O \leq I_{\text{max}}$ - LM317L<br>$V_O \leq 5.0\text{ V}$<br>$V_O \geq 5.0\text{ V}$  | 2      | $\text{Reg}_{\text{load}}$ | -<br>-               | 20<br>0.3  | 70<br>1.5 | mV<br>% $V_O$    |
| Temperature Stability ( $T_{\text{low}} \leq T_J \leq T_{\text{high}}$ )  | 3      | $T_S$                      | -                    | 0.7        | -         | % $V_O$          |
| Minimum Load Current to Maintain Regulation ( $V_I - V_O = 40\text{ V}$ )   | 3      | $I_{\text{Lmin}}$          | -                    | 3.5        | 10        | mA               |
| Maximum Output Current<br>$V_I - V_O \leq 6.25\text{ V}$ , $P_D \leq P_{\text{max}}$ , Z Package<br>$V_I - V_O \leq 40\text{ V}$ , $P_D \leq P_{\text{max}}$ , $T_A = 25^\circ\text{C}$ , Z Package | 3      | $I_{\text{max}}$           | 100<br>-             | 200<br>20  | -<br>-    | mA               |
| RMS Noise, % of $V_O$<br>$T_A = 25^\circ\text{C}$ , $10\text{ Hz} \leq f \leq 10\text{ kHz}$  | -      | N                          | -                    | 0.003      | -         | % $V_O$          |
| Ripple Rejection (Note 6)<br>$V_O = 1.2\text{ V}$ , $f = 120\text{ Hz}$<br>$C_{\text{Adj}} = 10\text{ }\mu\text{F}$ , $V_O = 10.0\text{ V}$   | 4      | RR                         | 60<br>-              | 80<br>80   | -<br>-    | dB               |
| Thermal Shutdown (Note 7)   | -      | -                          | -                    | 180        | -         | $^\circ\text{C}$ |
| Long Term Stability, $T_J = T_{\text{high}}$ (Note 8)<br>$T_A = 25^\circ\text{C}$ for Endpoint Measurements   | 3      | S                          | -                    | 0.3        | 1.0       | %/1.0 k Hrs.     |

3.  $T_{\text{low}}$  to  $T_{\text{high}} = 0^\circ$  to  $+125^\circ\text{C}$  for LM317L  $-40^\circ$  to  $+125^\circ\text{C}$  for LM317LB, NCV317LB

4.  $I_{\text{max}} = 100\text{ mA}$   $P_{\text{max}} = 625\text{ mW}$

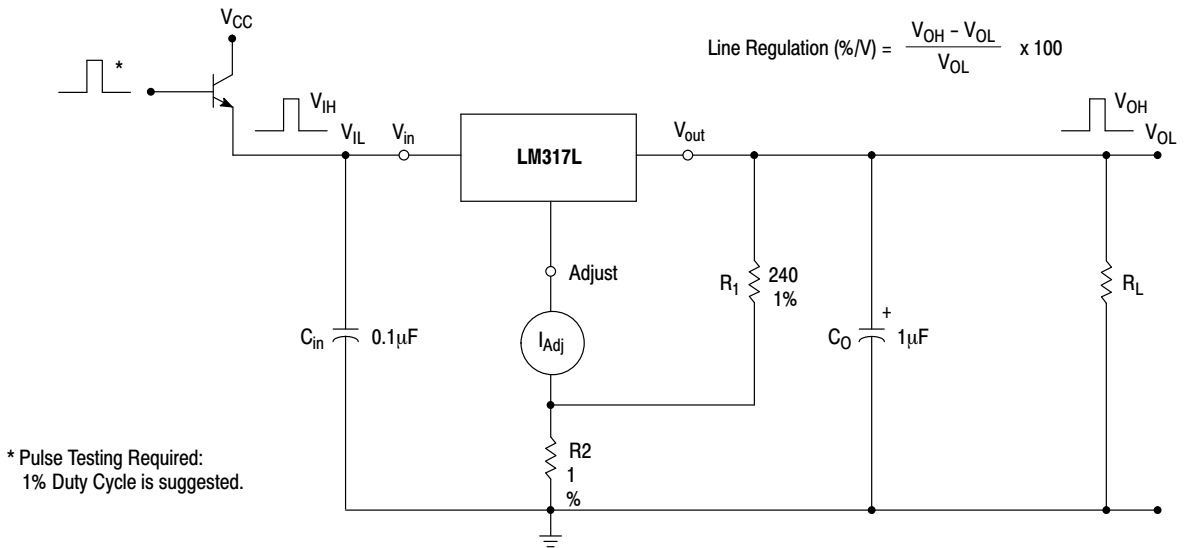
5. Load and line regulation are specified at constant junction temperature. Changes in  $V_O$  due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

6.  $C_{\text{Adj}}$ , when used, is connected between the adjustment pin and ground.

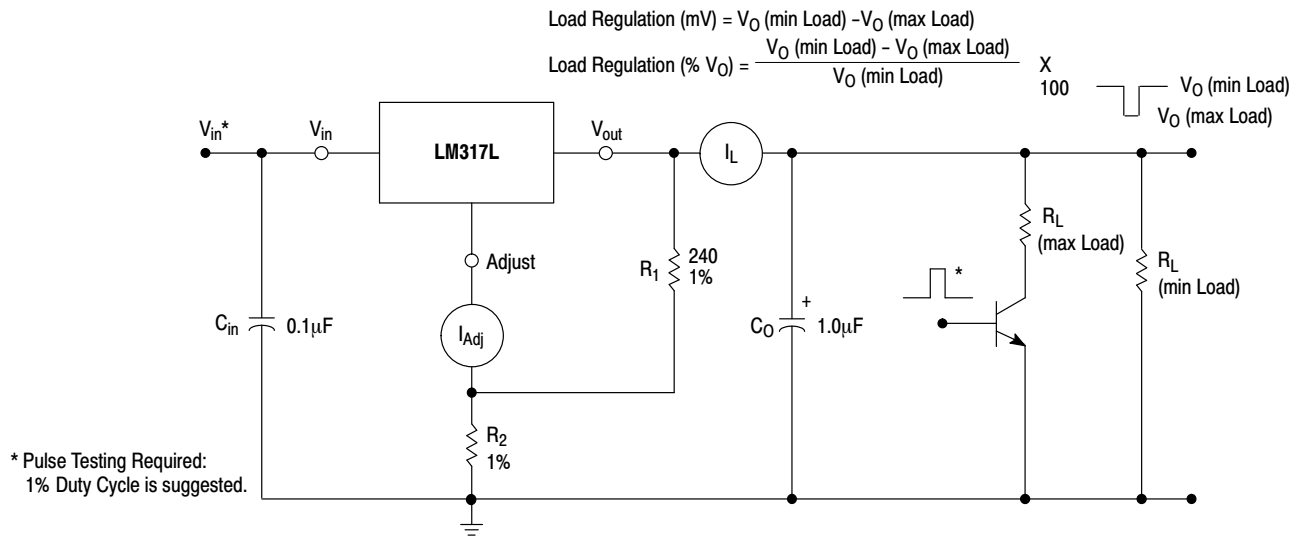
7. Thermal characteristics are not subject to production test.

8. 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.

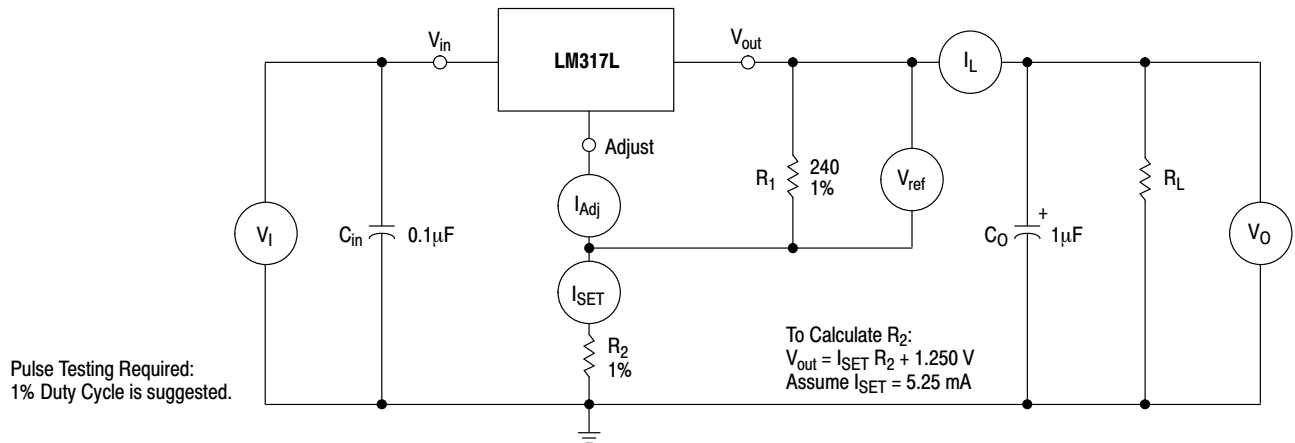
# LM317L, NCV317LB



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

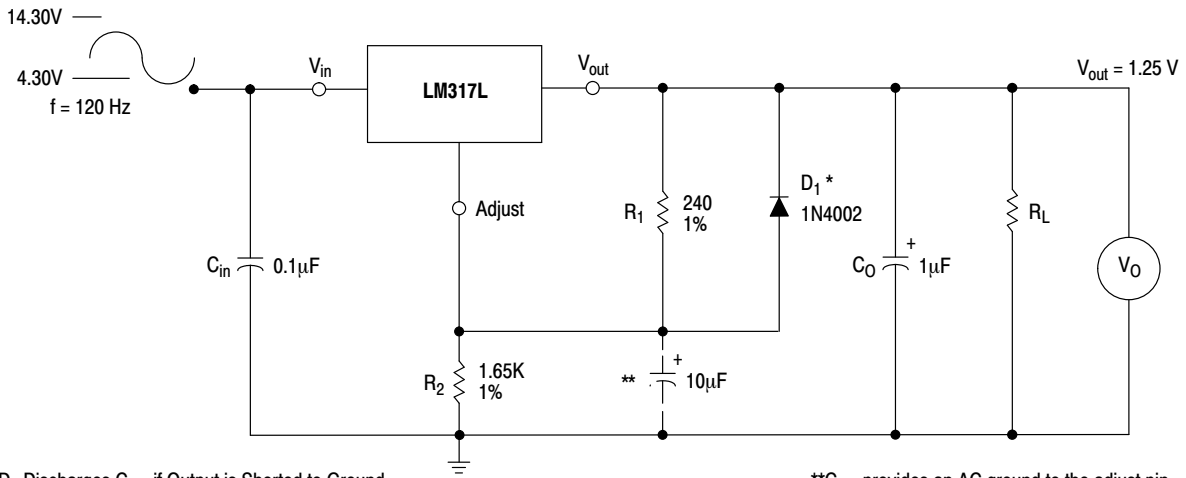


**Figure 3. Load Regulation and  $\Delta I_{Adj}$ /Load Test Circuit**

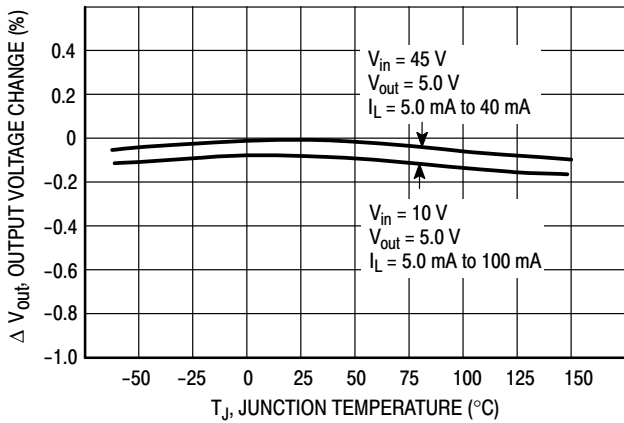


**Figure 4. Standard Test Circuit**

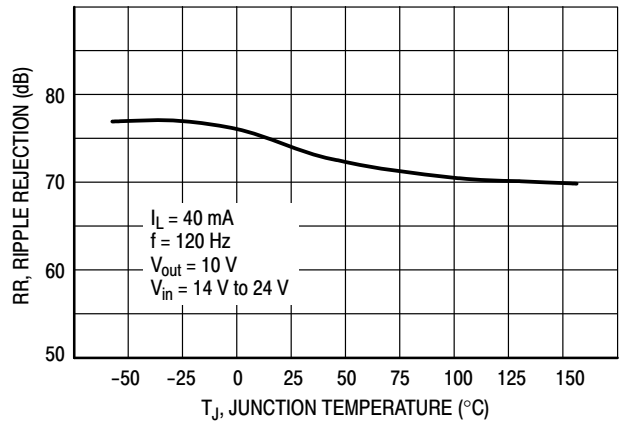
# LM317L, NCV317LB



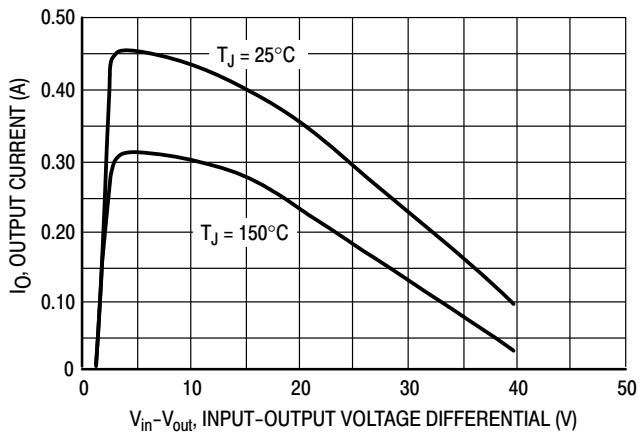
**Figure 5. Ripple Rejection Test Circuit**



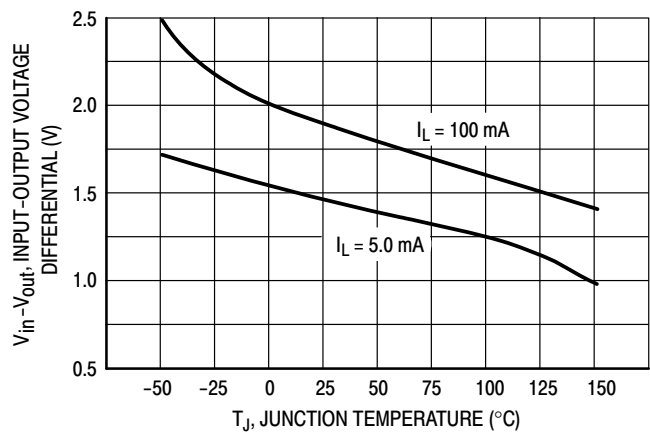
**Figure 6. Load Regulation**



**Figure 7. Ripple Rejection**



**Figure 8. Current Limit**



**Figure 9. Dropout Voltage**

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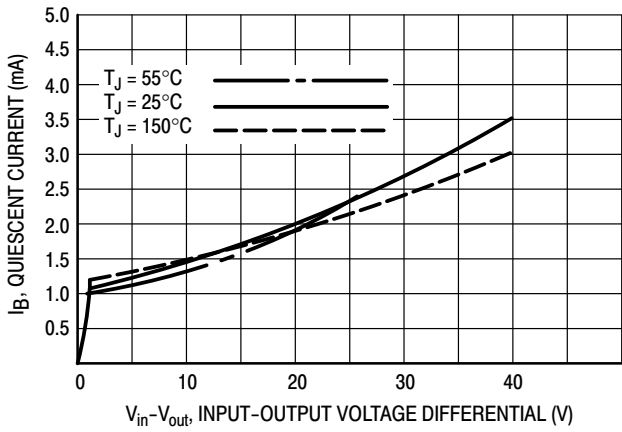


Figure 10. Minimum Operating Current

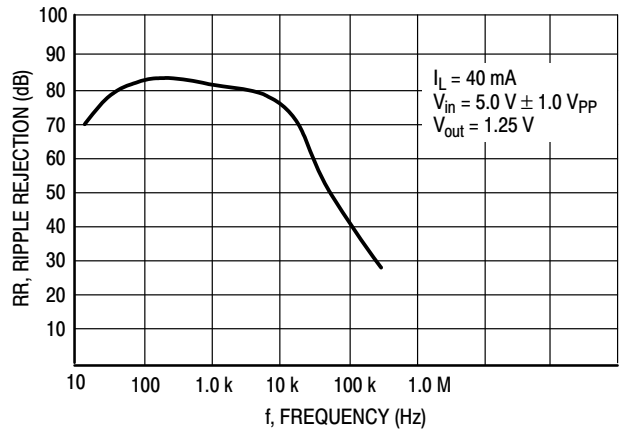


Figure 11. Ripple Rejection versus Frequency

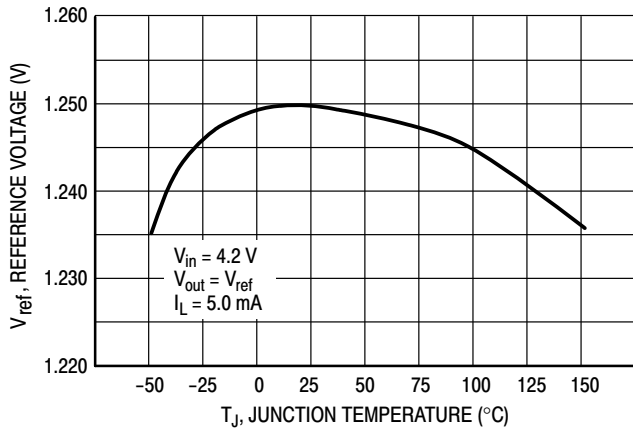


Figure 12. Temperature Stability

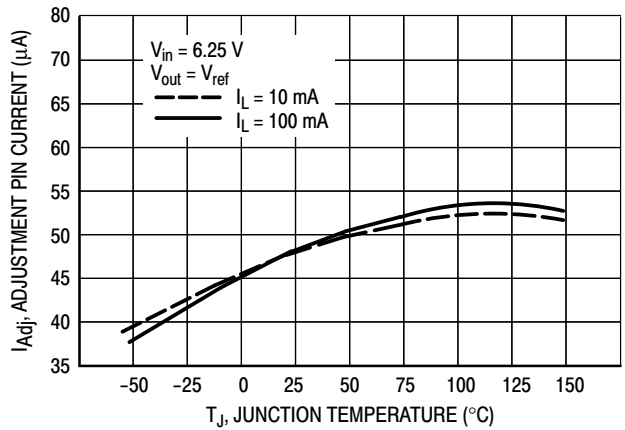


Figure 13. Adjustment Pin Current

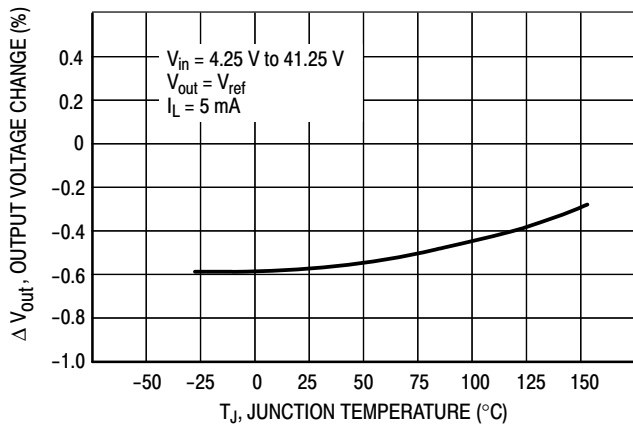


Figure 14. Line Regulation

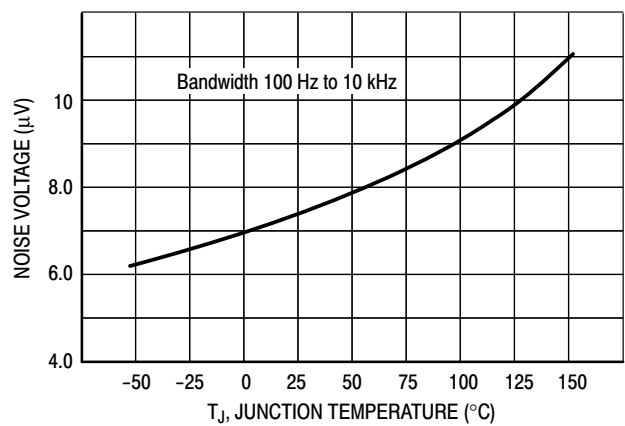


Figure 15. Output Noise

## LM317L, NCV317LB

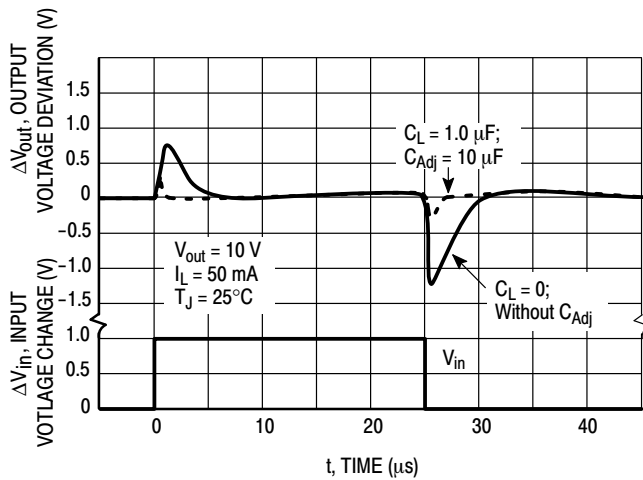


Figure 16. Line Transient Response

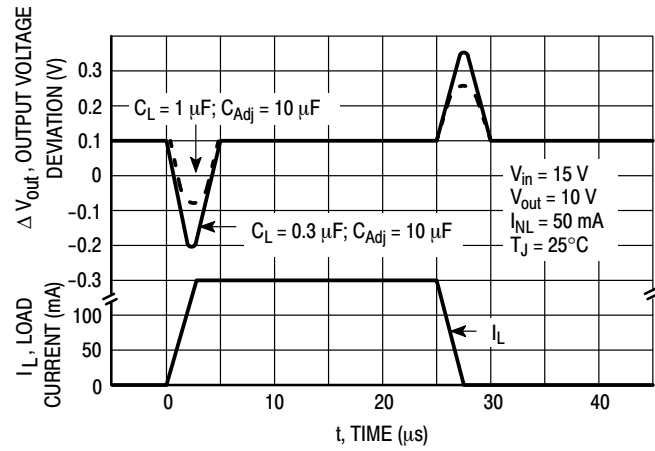


Figure 17. Load Transient Response

## 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  $\mu$ A 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.

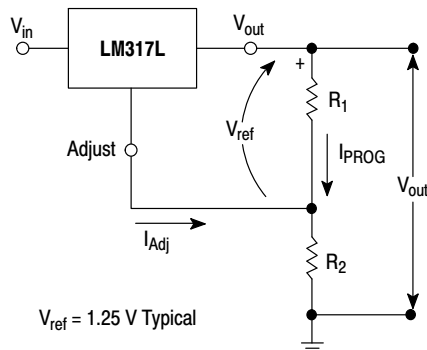


Figure 18. Basic Circuit Configuration

### 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  $\mu$ F disc or 1.0  $\mu$ F 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  $\mu$ F 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  $\mu$ F tantalum or 25  $\mu$ F aluminum electrolytic capacitor on the output swamps this effect and insures stability.

# LM317L, NCV317LB

## 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 ( $C_O > 10 \mu\text{F}$ ,  $C_{\text{Adj}} > 5.0 \mu\text{F}$ ). Diode  $D_1$  prevents  $C_O$  from discharging thru the IC during an input short circuit. Diode  $D_2$  protects against capacitor  $C_{\text{Adj}}$  discharging through the IC during an output short circuit. The combination of diodes  $D_1$  and  $D_2$  prevents  $C_{\text{Adj}}$  from discharging through the IC during an input short circuit.

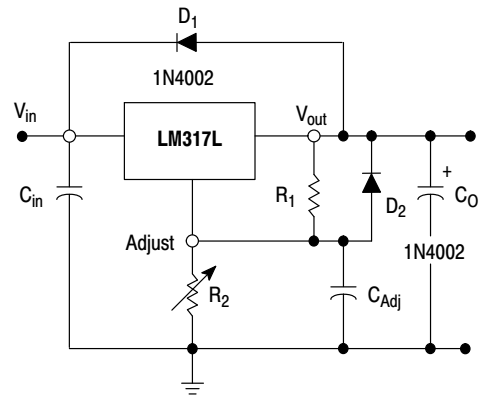


Figure 19. Voltage Regulator with Protection Diodes

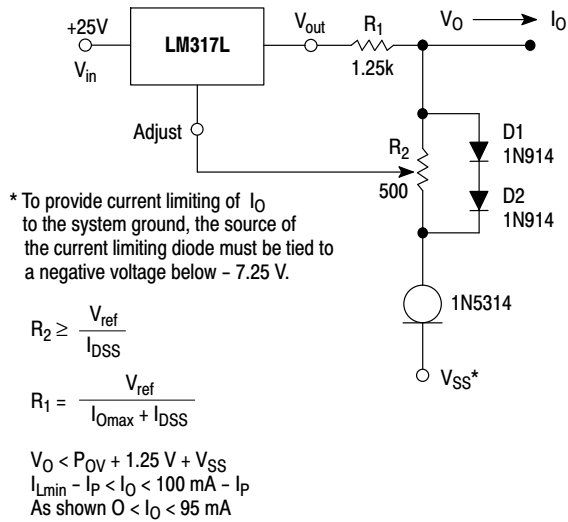
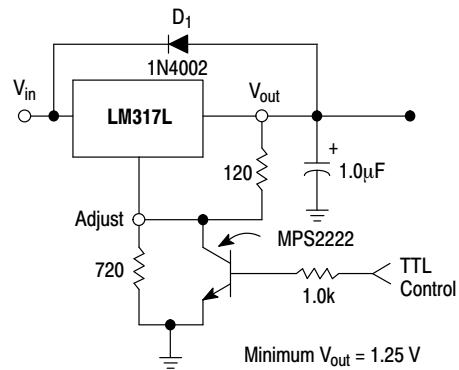


Figure 20. Adjustable Current Limiter



$D_1$  protects the device during an input short circuit.

Figure 21. 5.0 V Electronic Shutdown Regulator

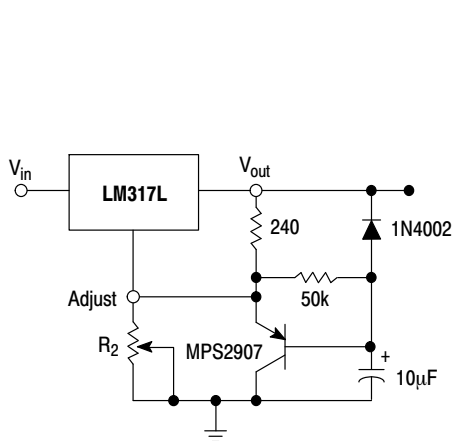
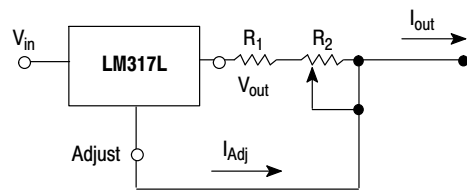


Figure 22. Slow Turn-On Regulator



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

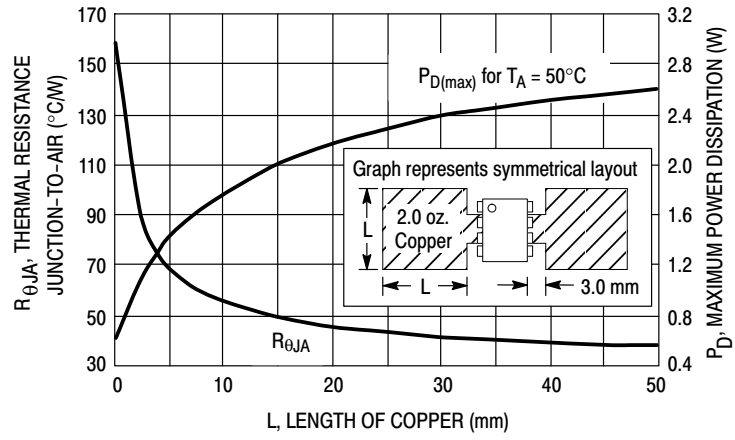
$$I_{\text{outmax}} = \left( \frac{V_{\text{ref}}}{R_1 + R_2} \right) + I_{\text{Adj}} \cong \frac{1.25 \text{ V}}{R_1 + R_2}$$

$5.0 \text{ mA} < I_{\text{out}} < 100 \text{ mA}$

Figure 23. Current Regulator



# LM317L, NCV317LB



**Figure 24. SOP-8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length**

# LM317L, NCV317LB

## ORDERING INFORMATION

| Device        | Operating Temperature Range      | Package                        | Shipping <sup>†</sup> |                 |
|---------------|----------------------------------|--------------------------------|-----------------------|-----------------|
| LM317LBD      | T <sub>J</sub> = -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        |                 |
| LM317LBZRPB   |                                  | TO-92 (Pb-Free)                | 2000 Ammo Pack        |                 |
| NCV317LBDG*   |                                  | SOIC-8 (Pb-Free)               | 98 Units / Rail       |                 |
| NCV317LBDR2*  |                                  | SOIC-8                         | 2500/Tape & Reel      |                 |
| NCV317LBDR2G* |                                  | SOIC-8 (Pb-Free)               | 2500/Tape & Reel      |                 |
| NCV317LBZG*   |                                  | TO-92 (Pb-Free)                | 2000 Units / Bag      |                 |
| NCV317LBZRAG* |                                  | TO-92 (Pb-Free)                | 2000 Tape & Reel      |                 |
| LM317LD       |                                  | T <sub>J</sub> = 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      |                 |
| LM317LZREG    | TO-92 (Pb-Free)                  |                                | 2000 Tape & Reel      |                 |
| LM317LZRM     | TO-92                            |                                | 2000 Ammo Pack        |                 |
| LM317LZRMG    | TO-92 (Pb-Free)                  |                                | 2000 Ammo Pack        |                 |
| LM317LZRP     | TO-92                            |                                | 2000 Ammo Pack        |                 |
| LM317LZRPB    | TO-92 (Pb-Free)                  |                                | 2000 Ammo Pack        |                 |

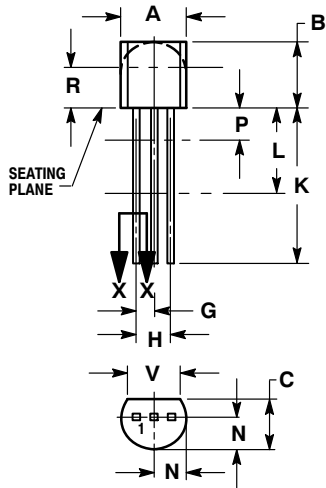
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\* NCV devices: T<sub>low</sub> = -40°C, T<sub>high</sub> = +125°C. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and control change.

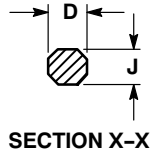
# LM317L, NCV317LB

## PACKAGE DIMENSIONS

TO-92 (TO-226)  
Z SUFFIX  
CASE 29-11  
ISSUE AM



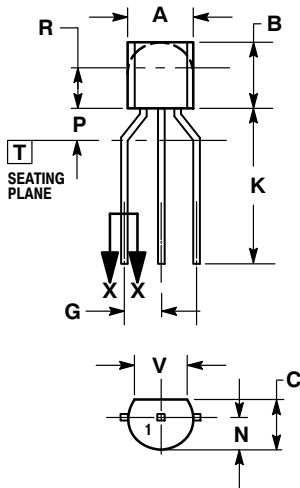
STRAIGHT LEAD  
BULK PACK



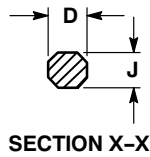
NOTES:

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.

| 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  | 0.021 | 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        | ---   |



BENT LEAD  
TAPE & REEL  
AMMO PACK



NOTES:

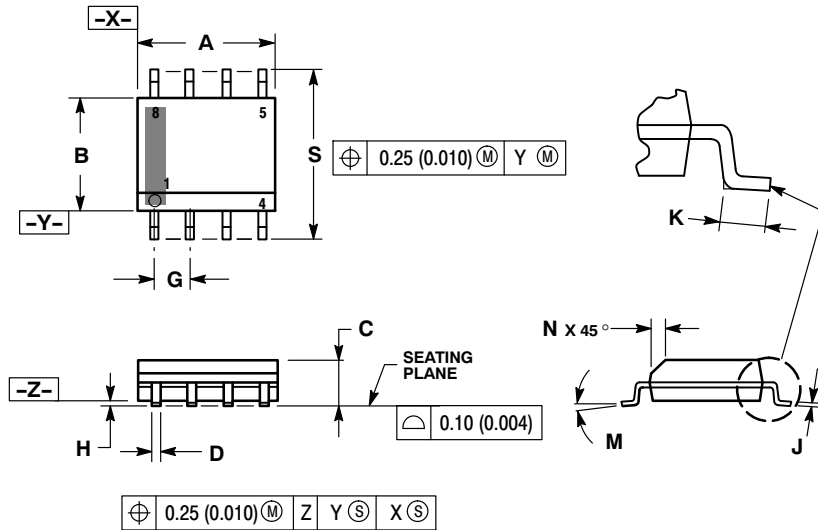
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 4.45        | 5.20 |
| B   | 4.32        | 5.33 |
| C   | 3.18        | 4.19 |
| D   | 0.40        | 0.54 |
| G   | 2.40        | 2.80 |
| J   | 0.39        | 0.50 |
| K   | 12.70       | ---  |
| N   | 2.04        | 2.66 |
| P   | 1.50        | 4.00 |
| R   | 2.93        | ---  |
| V   | 3.43        | ---  |

# LM317L, NCV317LB

## PACKAGE DIMENSIONS

SOIC-8  
D SUFFIX  
CASE 751-07  
ISSUE AJ

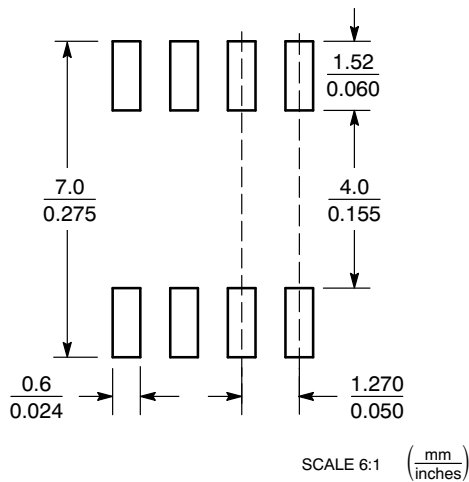


### NOTES:

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.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | 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.

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