3-Terminal Adjustable Output Positive Voltage Regulators

**Description**

The LM317 is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 1.5A over an output voltage range of 1.2V to 37V. 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 it essentially blow-out proof.

**Features**

- Output current in excess of 1.5 ampere
- Output adjustable between 1.2V and 37V
- 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

**Mechanical Data**

**Case:** TO-220 and TO-263 packages  
**Weight:** approx. 1.35g

Case outlines are on the back page.

**Notes:**

- 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.
- \( V_{out} = 1.25V \left(1 + \frac{R_2}{R_1}\right) + I_{adj} R_2 \)
- Since \( I_{adj} \) is controlled to less than 100\( \mu \)A, the error associated with this term is negligible in most applications.
## Electrical Characteristics – LM317

Vi - Vo = 5V, Io = 0.5A, TJ = Tlow to Thigh (see Note 1), Imax and Pmax per Note 2, unless otherwise noted.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Regulation (Fig. 1) (^{(3)})</td>
<td>REGline</td>
<td>TA = 25°C</td>
<td>–</td>
<td>0.01</td>
<td>0.04</td>
<td>%Vo/V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TJ = 0°C thru 125°C</td>
<td>–</td>
<td>0.02</td>
<td>0.07</td>
<td>%Vo/V</td>
</tr>
<tr>
<td>Load Regulation (Fig. 2) (^{(3)})</td>
<td>REGload</td>
<td>V0 ≤ 5.0</td>
<td>–</td>
<td>5</td>
<td>25</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V0 ≥ 5.0</td>
<td>–</td>
<td>0.1</td>
<td>0.5</td>
<td>%Vo</td>
</tr>
<tr>
<td>Load Regulation (Fig. 2) (^{(3)})</td>
<td>REGload</td>
<td>V0 ≤ 5.0</td>
<td>–</td>
<td>20</td>
<td>70</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V0 ≥ 5.0</td>
<td>–</td>
<td>0.3</td>
<td>1.5</td>
<td>%Vo</td>
</tr>
<tr>
<td>Thermal Regulation</td>
<td>REGtherm</td>
<td>TJ = 25°C, 20ms Pulse</td>
<td>–</td>
<td>0.03</td>
<td>0.07</td>
<td>%Vo/W</td>
</tr>
<tr>
<td>Adjustment Pin Current (Fig. 3)</td>
<td>IAdj</td>
<td>–</td>
<td>50</td>
<td>100</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Adjustment Pin Current Change</td>
<td>∆IAdj</td>
<td>10mA ≤ IL ≤ 1.5A</td>
<td>–</td>
<td>0.2</td>
<td>5</td>
<td>µA</td>
</tr>
<tr>
<td>Reference Voltage (Fig. 3) (^{(4)})</td>
<td>Vref</td>
<td>10mA ≤ IO ≤ 1.5A</td>
<td>1.225</td>
<td>1.25</td>
<td>1.275</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5V ≤ VI – VO ≤ 40V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Stability (Fig. 3)</td>
<td>TS</td>
<td>Tlow ≤ TJ ≤ Thigh</td>
<td>–</td>
<td>1</td>
<td>–</td>
<td>%Vo</td>
</tr>
<tr>
<td>Min. Load Current to Maintain Regulation (Fig. 3)</td>
<td>Imin</td>
<td>VI – VO = 40V</td>
<td>–</td>
<td>3.5</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>Maximum Output Current (Fig. 3)</td>
<td>Imax</td>
<td>VI – VO ≤ 15V</td>
<td>1.5</td>
<td>2.2</td>
<td>–</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VI – VO = 40V, TJ = 25°C</td>
<td>0.15</td>
<td>0.4</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>RMS Noise, % of Vo</td>
<td>N</td>
<td>TJ = 25°C, 10Hz ≤ f ≤ 10KHz</td>
<td>–</td>
<td>0.003</td>
<td>–</td>
<td>%Vo</td>
</tr>
<tr>
<td>Ripple Rejection (Fig. 4)</td>
<td>RR</td>
<td>V0 = 10V, f = 120Hz (^{(5)})</td>
<td>65</td>
<td>80</td>
<td>–</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CAdj = 10µF</td>
<td>66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-Term Stability (after 1000 hr) Fig. 3</td>
<td>S</td>
<td>TJ = 125°C (^{(6)}), TJ = 25°C for Endpoint Measurements</td>
<td>–</td>
<td>0.3</td>
<td>1.0</td>
<td>%</td>
</tr>
</tbody>
</table>

### Notes:

1. Tlow = 0°C, Thigh = 125°C
2. Imax = 1.5A, Pmax : TO-220 = 2W, TO-263 = 2W
3. Load and line regulation are specified at constant junction temperature. Changes in Vo 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. CAdj, when used, is connected between the adjustment pin and ground.
6. 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.
Fig. 1 – Line Regulation Test Circuit

Line Regulation (\%V) = \frac{V_{OH} - V_{OL}}{V_{OL}} \times 100

Pulse Testing Required:
1% Duty Cycle is Suggested

Fig. 2 – Load Regulation and \( \Delta I_{adj}/\text{Load} \) Test Circuit

\[
\text{Load Regulator (mV)} = \frac{V_0(\text{min. Load}) - V_0(\text{max. Load})}{V_0(\text{min. Load}) - V_0(\text{max. Load})} \times 100
\]

Pulse Testing Required:
1% Duty Cycle is Suggested

Fig. 3 – Standard Test Circuit

Pulse Testing Required:
1% Duty Cycle is Suggested

To Calculate R2:
\( V_o = I_{SET} \times R_2 + 1.250V \)
Assume \( I_{SET} = 5.25mA \)

Fig. 4 – Ripple Rejection Test Circuit

*D1 Discharges \( C_{ADJ} \) if Output is Shorted to Ground
Ratings and Characteristic Curves \((T_A = 25^\circ C\text{ unless otherwise noted})\)

**Fig. 5 – Load Regulation**

\[ \Delta V_o = \text{Output Voltage Change (\%)} \]

\[ V_I = 15V \quad V_O = 10V \]

\[ T_J = \text{Junction Temperature (\°C)} \]

**Fig. 6 – Current Limit**

\[ I_O = \text{Output Current (A)} \]

\[ V_I - V_O = \text{Input - Output Voltage Differential (Vdc)} \]

**Fig. 7 – Adjustment Pin Current**

\[ I_{ADJ} = \text{Adjustment Pin Current (\(\mu\)A)} \]

**Fig. 8 – Dropout Voltage**

\[ V_I - V_O = \text{Input - Output Voltage Differential (Vdc)} \]

**Fig. 9 – Temperature Stability**

\[ V_{\text{ref}} = \text{Reference Voltage (V)} \]

**Fig. 10 – Minimum Operating Current**

\[ I_O = \text{Quiescent Current (mA)} \]

\[ V_I - V_O = \text{Input - Output Voltage Differential (Vdc)} \]
Fig. 11 – Ripple Rejection vs. Output Voltage

Fig. 12 – Ripple Rejection vs. Output Current

Fig. 13 – Ripple Rejection vs. Frequency

Fig. 14 – Output Impedance

Fig. 15 – Line Transient Response

Fig. 16 – Load Transient Response