# LM117JAN 3-Terminal Adjustable Regulator

**Check for Samples: LM117JAN**

## FEATURES

- **Specified 0.5A or 1.5A Output Current**
- **Adjustable Output Down to 1.2V**
- **Current Limit Constant with Temperature**
- **80 dB Ripple Rejection**
- **Output is Short-circuit Protected**

## DESCRIPTION

The LM117 adjustable 3-terminal positive voltage regulator is capable of supplying either 0.5A or 1.5A over a 1.2V to 37V output range. It is exceptionally easy to use and requires only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators.

In addition to higher performance than fixed regulators, the LM117 series offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejection ratios which are difficult to achieve with standard 3-terminal regulators.

Besides replacing fixed regulators, the LM117 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, i.e., avoid short-circuiting the output.

Also, it makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment pin and output, the LM117 can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.
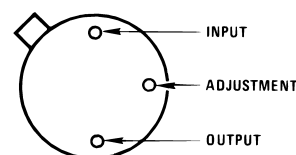
For the negative complement, see LM137 series data sheet.

## Connection Diagrams
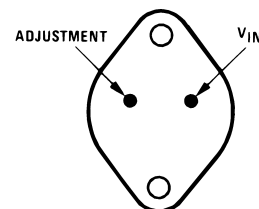


CASE IS OUTPUT

**Figure 1. (TO-3)**
**Metal Can Package**
**Bottom View**
**Steel Package**
**Package Number K0002C**



CASE IS OUTPUT

**Figure 2. (TO)**
**Metal Can Package**
**Bottom View**
**Package Number NDT0003A**

**Table 1. LM117 Series Packages**
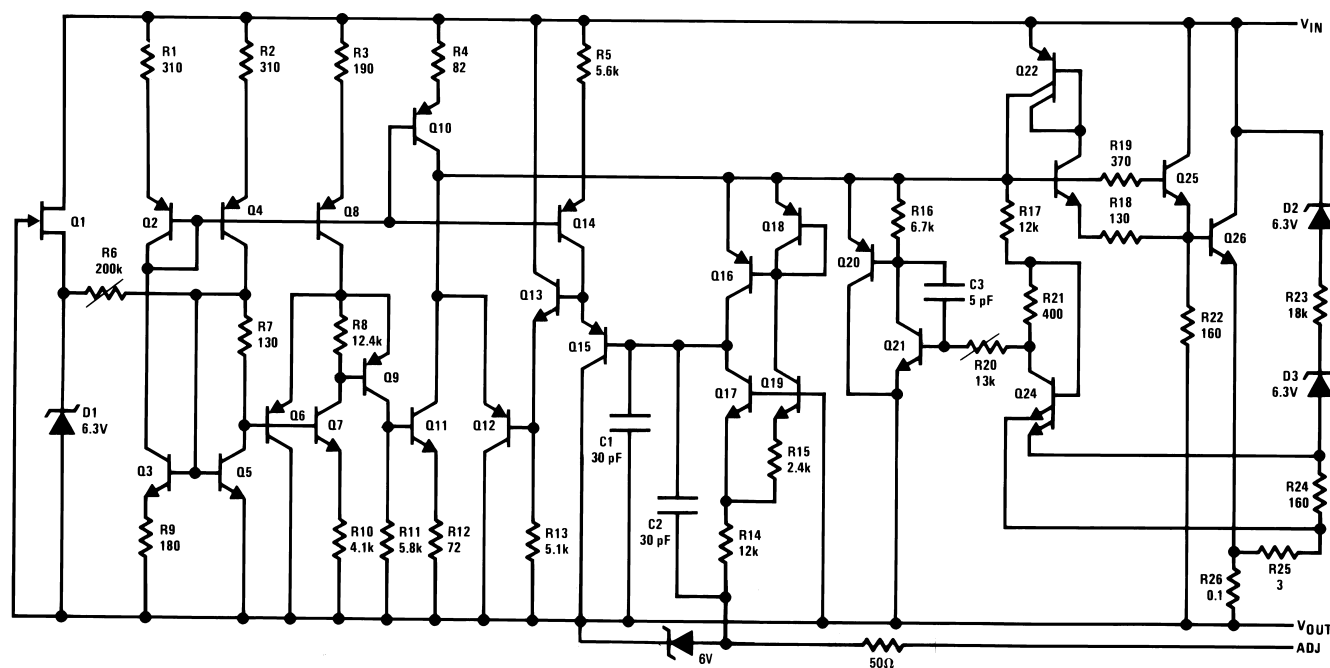
| Part Number Suffix | Package | Design Load Current |
|---|---|---|
| K | TO-3 | 1.5A |
| NDT | TO | 0.5A |

## Schematic Diagram

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings[1]

| Power Dissipation [2] | | Internally Limited |
|---|---|---|
| Input-Output Voltage Differential | | +40V, −0.3V |
| Storage Temperature | | −65°C ≤ $T_A$ ≤ +150°C |
| Maximum Junction Temperature ($T_{Jmax}$) | | +150°C |
| Lead Temperature   Metal Package | | 300°C |
| Thermal Resistance | | |
| $\theta_{JA}$ | TO–3 Still Air | 39°C/W |
| | TO–3 500LF/Min Air flow | 14°C/W |
| | TO Still Air | 186°C/W |
| | TO 500LF/Min Air flow | 64°C/W |
| $\theta_{JC}$ | TO–3 | 1.9°C/W |
| | TO Metal Can | 21°C/W |
| ESD Tolerance [3] | | 3KV |

(1)   Absolute Maximum Ratings indicate 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. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(2)   The maximum power dissipation must be derated at elevated temperatures and is dictated by $T_{Jmax}$ (maximum junction temperature), $\theta_{JA}$ (package junction to ambient thermal resistance), and $T_A$ (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower. "Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO package and 20W for the TO-3 package."

(3)   Human body model, 100 pF discharged through a 1.5 kΩ resistor.

## Recommended Operating Conditions

| Operating Temperature Range | −55°C ≤ $T_A$ ≤ +125°C |
|---|---|
| Input Voltage Range | 4.25V to 41.25V |

## Quality Conformance Inspection

MIL-STD-883, Method 5005 - Group A

| Subgroup | Description | Temp °C |
|---|---|---|
| 1 | Static tests at | 25 |
| 2 | Static tests at | 125 |
| 3 | Static tests at | -55 |
| 4 | Dynamic tests at | 25 |
| 5 | Dynamic tests at | 125 |
| 6 | Dynamic tests at | -55 |
| 7 | Functional tests at | 25 |
| 8A | Functional tests at | 125 |
| 8B | Functional tests at | -55 |
| 9 | Switching tests at | 25 |
| 10 | Switching tests at | 125 |
| 11 | Switching tests at | -55 |
| 12 | Settling time at | 25 |
| 13 | Settling time at | 125 |
| 14 | Settling time at | -55 |

## LM117H    JAN Electrical Characteristics DC Parameters

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-group |
|---|---|---|---|---|---|---|---|
| $V_O$ | Output Voltage | $V_I$ = 4.25V, $I_L$ = -5mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 4.25V, $I_L$ = -500mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 41.25V, $I_L$ = -50mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| $V_{RLine}$ | Line Regulation | 4.25V ≤ $V_I$ ≤ 41.25V, $I_L$ = -5mA | | -9.0 | 9.0 | mV | 1 |
| | | | | -23 | 23 | mV | 2, 3 |
| $V_{RLoad}$ | Load Regulation | $V_I$ = 6.25V, -500mA ≤ $I_L$ ≤ -5mA | | -12 | 12 | mV | 1, 2, 3 |
| | | $V_I$ = 41.25V, -50mA ≤ $I_L$ ≤ -5mA | | -12 | 12 | mV | 1, 2, 3 |
| $\theta_R$ | Thermal Regulation | $V_I$ = 14.6V, $I_L$ = -500mA | | -12 | 12 | mV | 1 |
| $I_{Adj}$ | Adjust Pin Current | $V_I$ = 4.25V, $I_L$ = -5mA | | -100 | -15 | µA | 1, 2, 3 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | -100 | -15 | µA | 1, 2, 3 |
| $\Delta I_{Adj}$ / Line | Adjust Pin Current Change | 4.25V ≤ $V_I$ ≤ 41.25V, $I_L$ = -5mA | | -5.0 | 5.0 | µA | 1, 2, 3 |
| $\Delta I_{Adj}$ / Load | Adjust Pin Current Change | $V_I$ = 6.25V, -500mA ≤ $I_L$ ≤ -5mA | | -5.0 | 5.0 | µA | 1, 2, 3 |
| $I_{OS}$ | Output Short Circuit Current | $V_I$ = 4.25V | | -1.8 | -0.5 | A | 1, 2, 3 |
| | | $V_I$ = 40V | | -0.5 | -0.05 | A | 1, 2, 3 |
| $V_O$ Recov | Output Voltage Recovery | $V_I$ = 4.25V, $R_L$ = 2.5Ω, $C_L$ = 20µF | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 40V, $R_L$ = 250Ω | | 1.2 | 1.3 | V | 1, 2, 3 |
| $I_Q$ | Minimum Load Current | $V_I$ = 4.25V, Forced $V_O$ = 1.4V | | -3.0 | -0.5 | mA | 1, 2, 3 |
| | | $V_I$ = 14.25V, Forced $V_O$ = 1.4V | | -3.0 | -0.5 | mA | 1, 2, 3 |
| | | $V_I$ = 41.25V, Forced $V_O$ = 1.4V | | -5.0 | -1.0 | mA | 1, 2, 3 |
| $V_{Start}$ | Voltage Start-Up | $V_I$ = 4.25V, $R_L$ = 2.5Ω, $C_L$=20µF, $I_L$ = -500mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| $V_O$ | Output Voltage | $V_I$ = 6.25V, $I_L$ = -5mA | [1] | 1.2 | 1.3 | V | 2 |

(1)   Tested @ $T_A$ = 125°C, correlated to $T_A$ = 150°C

## LM117H    JAN Electrical Characteristics AC Parameters

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-group |
|---|---|---|---|---|---|---|---|
| $V_{NO}$ | Output Noise Voltage | $V_I$ = 6.25V, $I_L$ = -50mA | | | 120 | µV$_{RMS}$ | 7 |
| $\Delta V_O$ / $\Delta V_I$ | Line Transient Response | $V_I$ = 6.25V, $\Delta V_I$ = 3V, $I_L$ = -10mA | | | 6 | mV/V | 7 |
| $\Delta V_O$ / $\Delta I_L$ | Load Transient Response | $V_I$ = 6.25V, $\Delta I_L$ = -200mA, $I_L$ = -50mA | | | 0.6 | mV/mA | 7 |
| $\Delta V_I$ / $\Delta V_O$ | Ripple Rejection | $V_I$ = 6.25V, $I_L$ = -125mA $e_I$ = 1V$_{RMS}$ at $f$ = 2400Hz, | | 65 | | dB | 4 |

## LM117H    JAN Electrical Characteristics DC Drift Parameters

Deltas performed on JAN S devices at Group B, Subgroup 5, only.

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-group |
|---|---|---|---|---|---|---|---|
| $V_O$ | Output Voltage | $V_I$ = 4.25V, $I_L$ = -5mA | | -0.01 | 0.01 | V | 1 |
| | | $V_I$ = 4.25V, $I_L$ = -500mA | | -0.01 | 0.01 | V | 1 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | -0.01 | 0.01 | V | 1 |
| | | $V_I$ = 41.25V, $I_L$ = -50mA | | -0.01 | 0.01 | V | 1 |
| $V_{RLine}$ | Line Regulation | 4.25V ≤ $V_I$ ≤ 41.25V, $I_L$ = -5mA | | -4.0 | 4.0 | mV | 1 |
| $I_{Adj}$ | Adjust Pin Current | $V_I$ = 4.25V, $I_L$ = -5mA | | -10 | 10 | µA | 1 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | -10 | 10 | µA | 1 |

## LM117K    JAN Electrical Characteristics DC Parameters

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-group |
|---|---|---|---|---|---|---|---|
| $V_O$ | Output Voltage | $V_I$ = 4.25V, $I_L$ = -5mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 4.25V, $I_L$ = -1.5A | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 41.25V, $I_L$ = -200mA | | 1.2 | 1.3 | V | 1, 2, 3 |
| $V_{RLine}$ | Line Regulation | 4.25V ≤ $V_I$ ≤ 41.25V, $I_L$ = -5mA | | -9.0 | 9.0 | mV | 1 |
| | | | | -23 | 23 | mV | 2, 3 |
| $V_{RLoad}$ | Load Regulation | $V_I$ = 6.25V, -1.5A ≤ $I_L$ ≤ -5mA | | -3.5 | 3.5 | mV | 1 |
| | | | | -12 | 12 | mV | 2, 3 |
| | | $V_I$ = 41.25V, -200mA ≤ $I_L$ ≤ -5mA | | -3.5 | 3.5 | mV | 1 |
| | | | | -12 | 12 | mV | 2, 3 |
| $\theta_R$ | Thermal Regulation | $V_I$ = 14.6V, $I_L$ = -1.5A | | -12 | 12 | mV | 1 |
| $I_{Adj}$ | Adjust Pin Current | $V_I$ = 4.25V, $I_L$ = -5mA | | -100 | -15 | µA | 1, 2, 3 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | -100 | -15 | µA | 1, 2, 3 |
| $\Delta I_{Adj}$ / Line | Adjust Pin Current Change | 4.25V ≤ $V_I$ ≤ 41.25V, $I_L$ = -5mA | | -5.0 | 5.0 | µA | 1, 2, 3 |
| $\Delta I_{Adj}$ / Load | Adjust Pin Current Change | $V_I$ = 6.25V, -1.5A ≤ $I_L$ ≤ -5mA | | -5.0 | 5.0 | µA | 1, 2, 3 |
| $I_{OS}$ | Output Short Circuit Current | $V_I$ = 4.25V | | -3.5 | -1.5 | A | 1, 2, 3 |
| | | $V_I$ = 40V | | -1.0 | -0.18 | A | 1, 2, 3 |
| $V_O$ Recov | Output Voltage Recovery | $V_I$ = 4.25V, $R_L$ = 0.833Ω, $C_L$ = 20µF | | 1.2 | 1.3 | V | 1, 2, 3 |
| | | $V_I$ = 40V, $R_L$ = 250Ω | | 1.2 | 1.3 | V | 1, 2, 3 |
| $I_Q$ | Minimum Load Current | $V_I$ = 4.25V, Forced $V_O$ = 1.4V | | -3.0 | -0.2 | mA | 1, 2, 3 |
| | | $V_I$ = 14.25V, Forced $V_O$ = 1.4V | | -3.0 | -0.2 | mA | 1, 2, 3 |
| | | $V_I$ = 41.25V, Forced $V_O$ = 1.4V | | -5.0 | -0.2 | mA | 1, 2, 3 |
| $V_{Start}$ | Voltage Start-Up | $V_I$ = 4.25V, $R_L$ = 0.833Ω, $C_L$=20µF, $I_L$ = -1.5A | | 1.2 | 1.3 | V | 1, 2, 3 |
| $V_O$ | Output Voltage | $V_I$ = 6.25V, $I_L$ = -5mA | (1) | 1.2 | 1.3 | V | 2 |

(1)    Tested @ $T_A$ = 125°C, correlated to $T_A$ = 150°C

## LM117K   JAN Electrical Characteristics AC Parameters

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-group |
|--------|-----------|------------|-------|-----|-----|------|-----------|
| $V_{NO}$ | Output Noise Voltage | $V_I$ = 6.25V, $I_L$ = -100mA | | | 120 | $\mu V_{RMS}$ | 7 |
| $\Delta V_O / \Delta V_I$ | Line Transient Response | $V_I$ = 6.25V, $\Delta V_I$ = 3V, $I_L$ = -10mA | (1) | | 18 | mV | 7 |
| $\Delta V_O / \Delta I_L$ | Load Transient Response | $V_I$ = 6.25V, $\Delta I_L$ = -400mA, $I_L$ = -100mA | (2) | | 120 | mV | 7 |
| $\Delta V_I / \Delta V_O$ | Ripple Rejection | $V_I$ = 6.25V, $I_L$ = -500mA $e_I$ = 1$V_{RMS}$ at $f$ = 2400Hz, | | 65 | | dB | 4 |

(1)   SS limit of 6mV/V is equivalent to 18mV
(2)   SS limit of 0.3mV/V is equivalent to 120mV

## LM117K   JAN Electrical Characteristics DC Drift Parameters

Deltas performed on JAN S devices at Group B, Subgroup 5, only.

| Symbol | Parameter | Conditions | Notes | Min | Max | Unit | Sub-group |
|--------|-----------|------------|-------|-----|-----|------|-----------|
| $V_O$ | Output Voltage | $V_I$ = 4.25V, $I_L$ = -5mA | | -0.01 | 0.01 | V | 1 |
| | | $V_I$ = 4.25V, $I_L$ = -1.5A | | -0.01 | 0.01 | V | 1 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | -0.01 | 0.01 | V | 1 |
| | | $V_I$ = 41.25V, $I_L$ = -200mA | | -0.01 | 0.01 | V | 1 |
| $V_{RLine}$ | Line Regulation | 4.25V ≤ $V_I$ ≤ 41.25V, $I_L$ = -5mA | | -4.0 | 4.0 | mV | 1 |
| $I_{Adj}$ | Adjust Pin Current | $V_I$ = 4.25V, $I_L$ = -5mA | | -10 | 10 | $\mu$A | 1 |
| | | $V_I$ = 41.25V, $I_L$ = -5mA | | -10 | 10 | $\mu$A | 1 |

Product Folder Links: *LM117JAN*

## Typical Performance Characteristics
Output Capacitor = 0μF unless otherwise noted

**Load Regulation**



Figure 3.

**Current Limit**



Figure 4.

**Adjustment Current**



Figure 5.

**Dropout Voltage**



Figure 6.

**Temperature Stability**



Figure 7.

**Minimum Operating Current**



Figure 8.

Submit Documentation Feedback          7
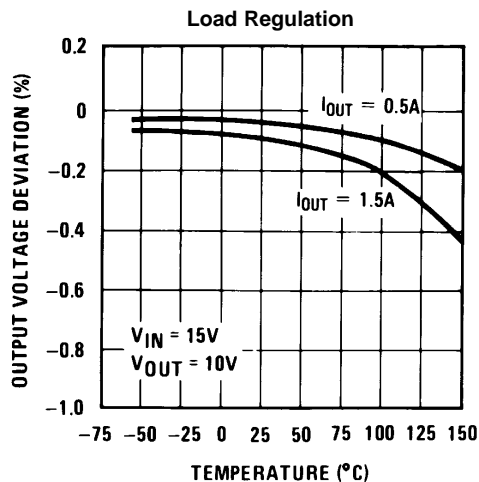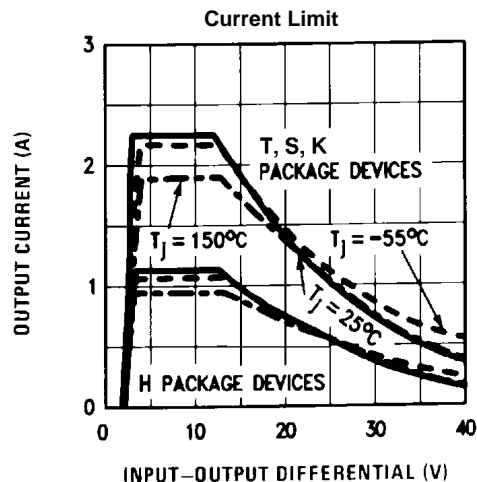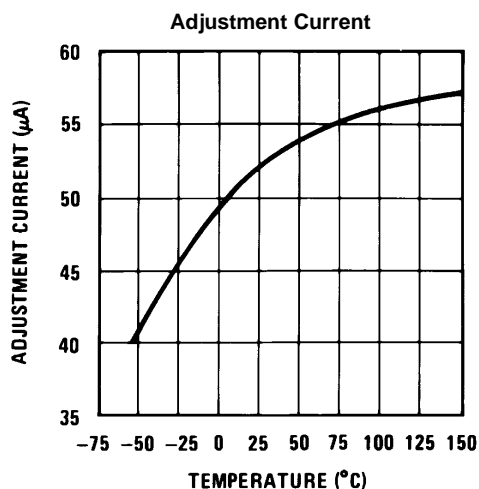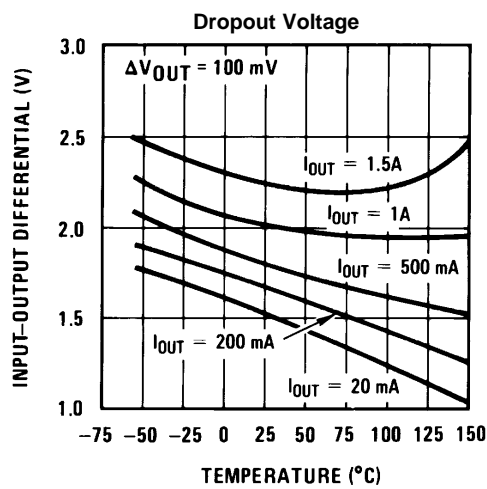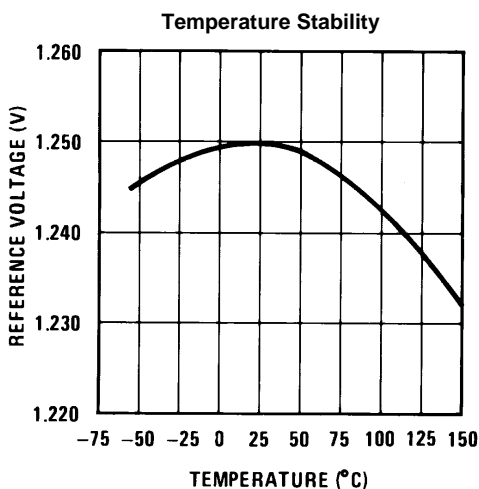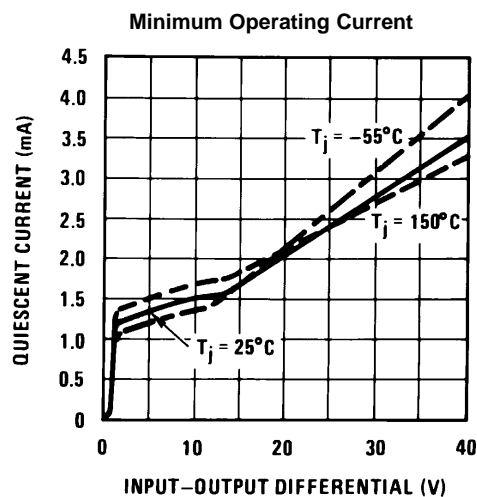
## Typical Performance Characteristics (continued)

Output Capacitor = 0µF unless otherwise noted

**Ripple Rejection**



Figure 9.

**Ripple Rejection**



Figure 10.

**Ripple Rejection**



Figure 11.

**Output Impedance**



Figure 12.

**Line Transient Response**



Figure 13.

**Load Transient Response**



Figure 14.

Product Folder Links: *LM117JAN*
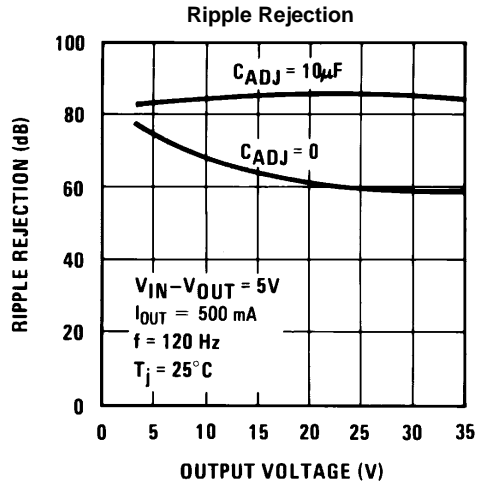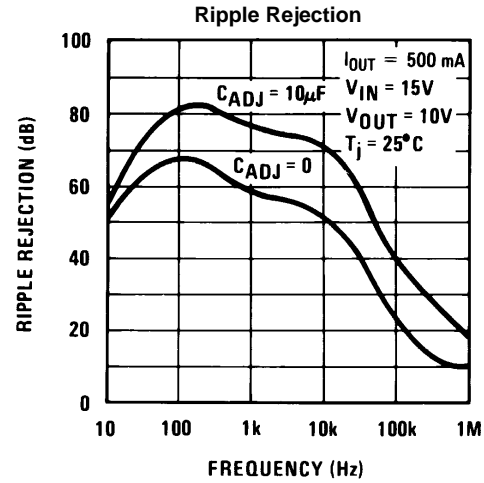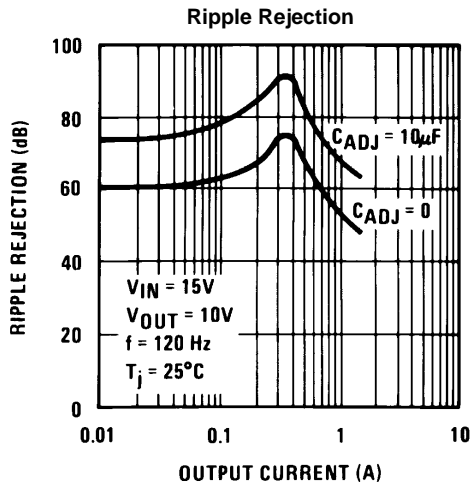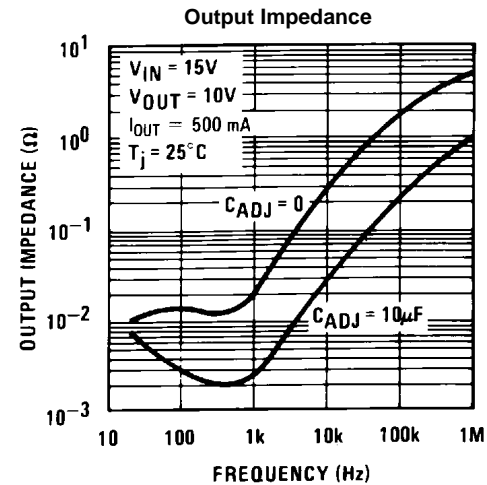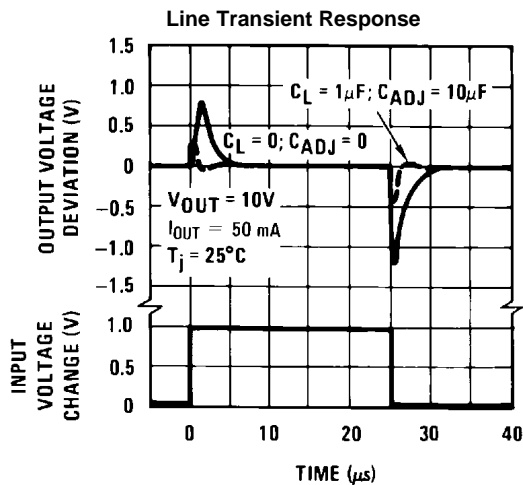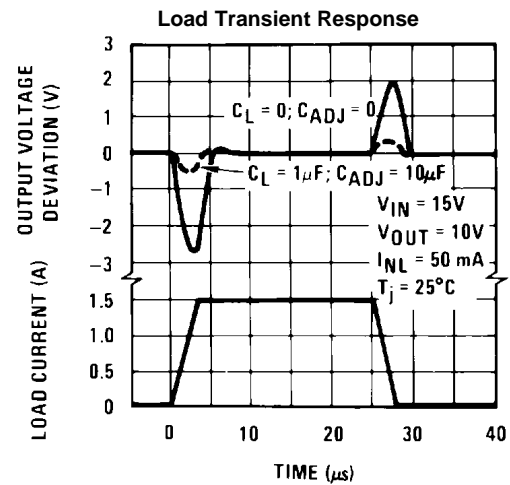
## APPLICATION HINTS

In operation, the LM117 develops a nominal 1.25V reference voltage, $V_{REF}$, between the output and adjustment terminal. The reference voltage is impressed across program resistor R1 and, since the voltage is constant, a constant current $I_1$ then flows through the output set resistor R2, giving an output voltage of

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$
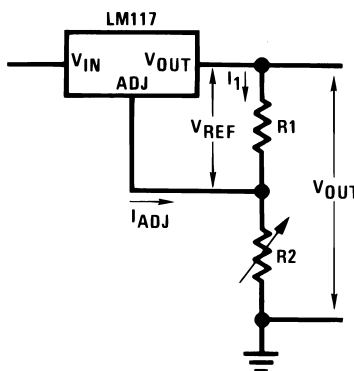


Since the 100µA current from the adjustment terminal represents an error term, the LM117 was designed to minimize $I_{ADJ}$ and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

## EXTERNAL CAPACITORS

An input bypass capacitor is recommended. A 0.1µF disc or 1µF solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the LM117 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10µF bypass capacitor 80dB ripple rejection is obtainable at any output level. Increases over 10µF 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 25µF in aluminum electrolytic to equal 1µF solid tantalum at high frequencies. Ceramic capacitors are also good at high frequencies; but some types have a large decrease in capacitance at frequencies around 0.5MHz. For this reason, 0.01µF disc may seem to work better than a 0.1µF disc as a bypass.

Although the LM117 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500 pF and 5000 pF. A 1µF solid tantalum (or 25µF aluminum electrolytic) on the output swamps this effect and insures stability. Any increase of the load capacitance larger than 10µF will merely improve the loop stability and output impedance.

## LOAD REGULATION

The LM117 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 terminal and the output terminal (usually 240Ω) should be tied directly to the output (case) 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 × $I_L$. 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.

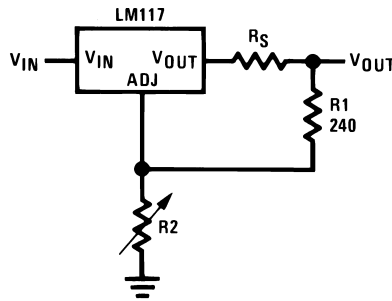Figure 15 shows the effect of resistance between the regulator and 240Ω set resistor.



**Figure 15. Regulator with Line Resistance in Output Lead**

With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor, by using two separate leads to the case. However, with the TO package, care should be taken to minimize the wire length of the output lead. The ground of R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

## 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. Most 10μF capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short, there 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 $V_{IN}$. In the LM117, this discharge path is through a large junction that is able to sustain 15A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 25μF or less, there is no need to use diodes.

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 LM117 is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10μF capacitance. Figure 16 shows an LM117 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.
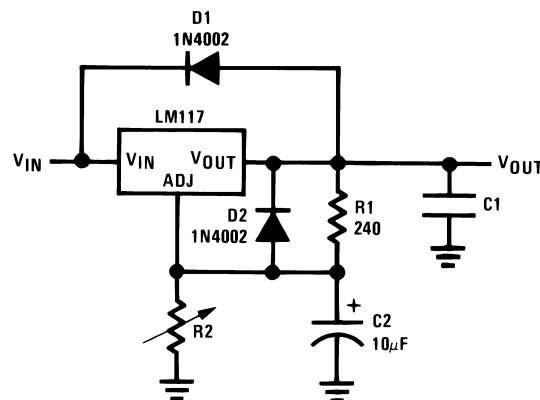


$$V_{OUT} = 1.25V \left( 1 + \frac{R2}{R1} \right) + I_{ADJ}R2$$

D1 protects against C1
D2 protects against C2

**Figure 16. Regulator with Protection Diodes**

When a value for θ$_{(H–A)}$ is found using the equation shown, *a heatsink must be selected that has a value that is less than or equal to this number.*

θ$_{(H–A)}$ is specified numerically by the heatsink manufacturer in the catalog, or shown in a curve that plots temperature rise vs power dissipation for the heatsink.

## Typical Applications
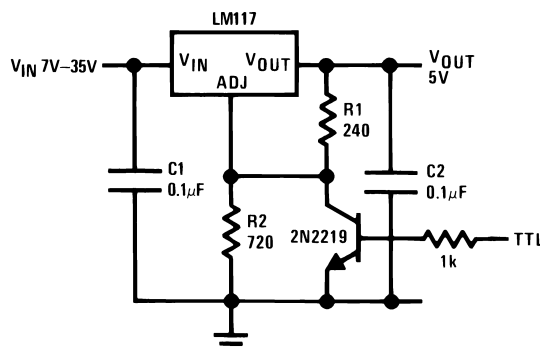


*Min. output ≅ 1.2V
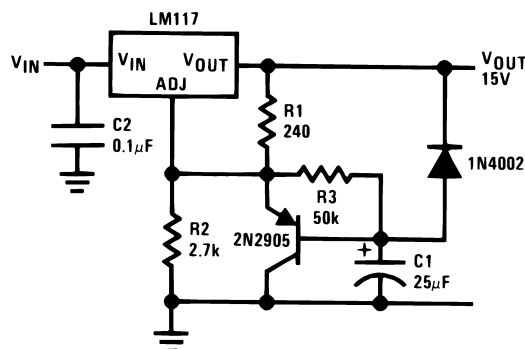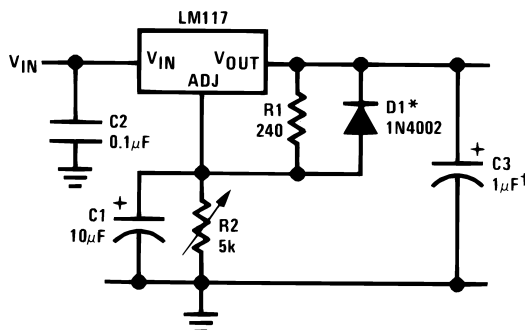
**Figure 17. 5V Logic Regulator with Electronic Shutdown***



**Figure 18. Slow Turn-On 15V Regulator**



†Solid tantalum
*Discharges C1 if output is shorted to ground

**Figure 19. Adjustable Regulator with Improved Ripple Rejection**
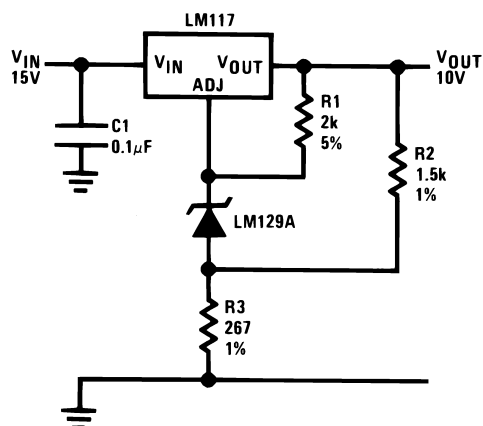
**Figure 20. High Stability 10V Regulator**
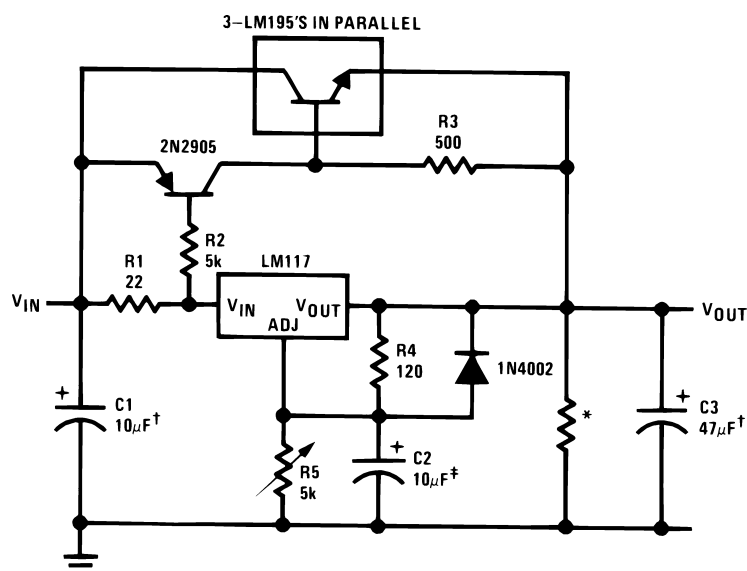


‡Optional—improves ripple rejection
†Solid tantalum
*Minimum load current = 30 mA

**Figure 21. High Current Adjustable Regulator**
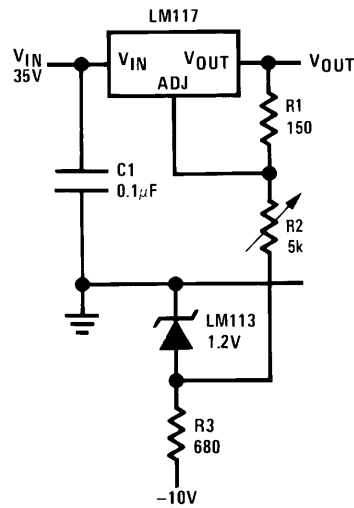
Full output current not available at high input-output voltages

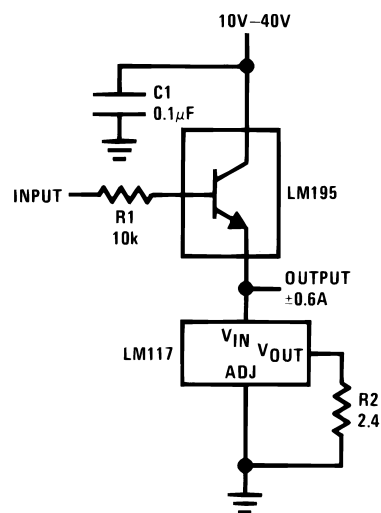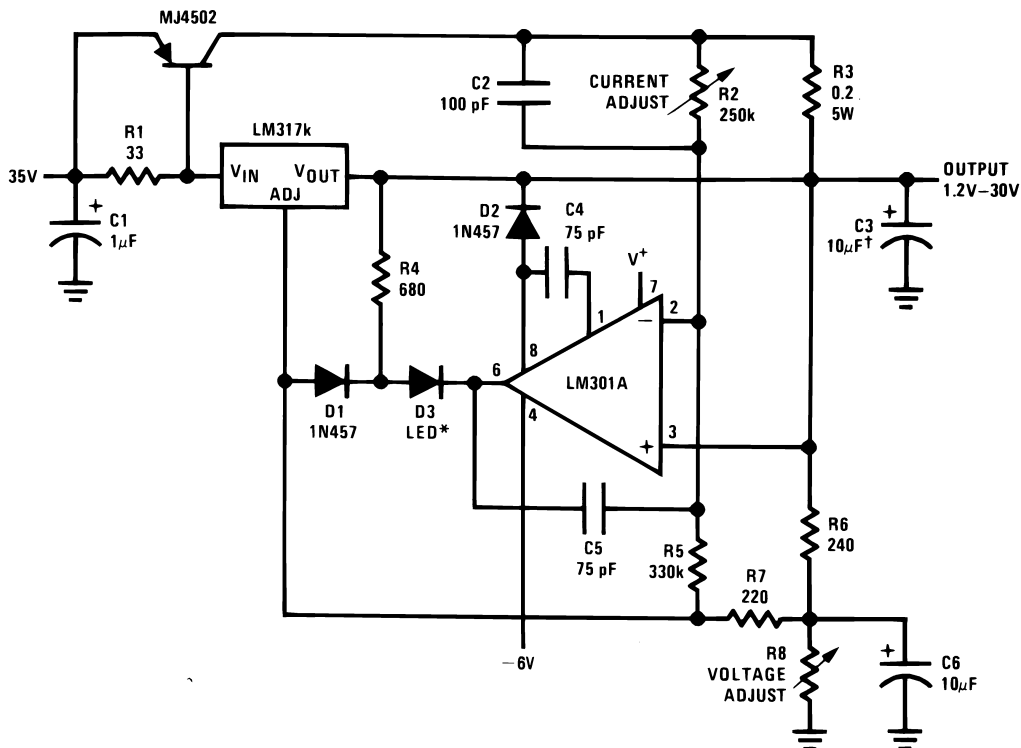**Figure 22. 0 to 30V Regulator**



**Figure 23. Power Follower**

†Solid tantalum
*Lights in constant current mode

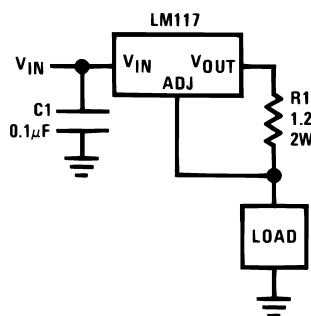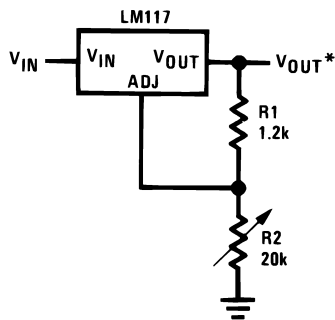**Figure 24. 5A Constant Voltage/Constant Current Regulator**



**Figure 25. 1A Current Regulator**



*Minimum load current ≅ 4 mA

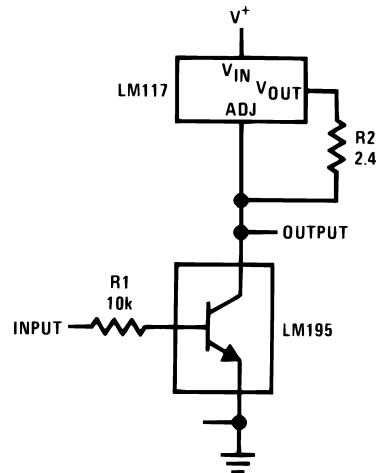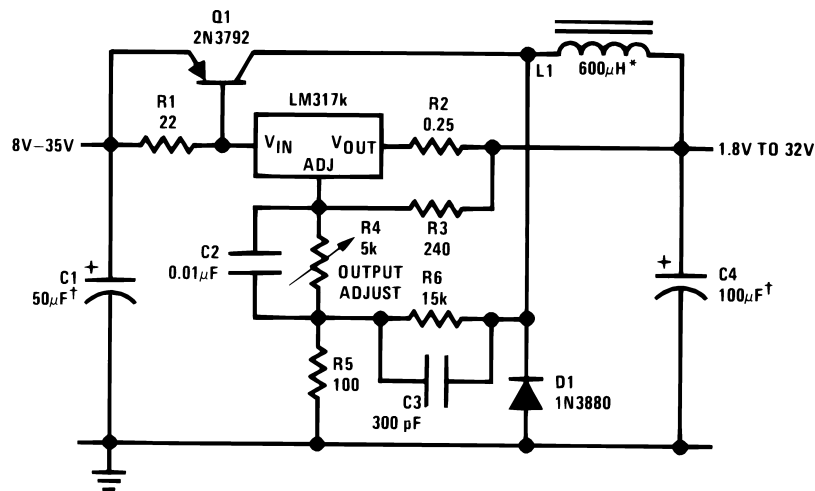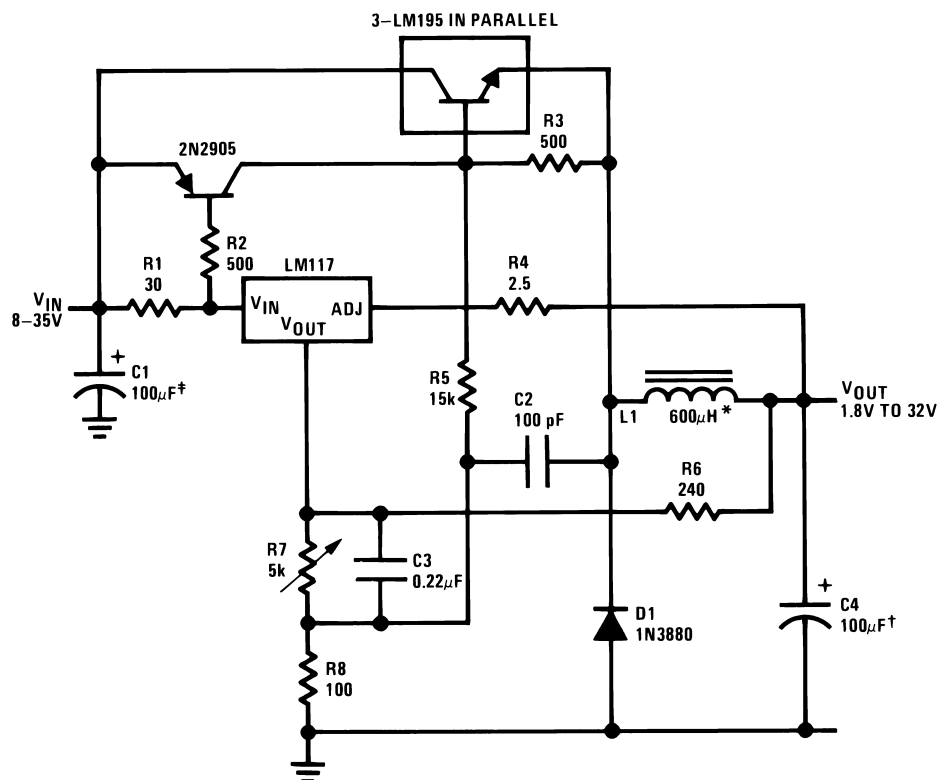**Figure 26. 1.2V–20V Regulator with Minimum Program Current**

**Figure 27. High Gain Amplifier**



†Solid tantalum
*Core—Arnold A-254168-2 60 turns

**Figure 28. Low Cost 3A Switching Regulator**

†Solid tantalum
*Core—Arnold A-254168-2 60 turns

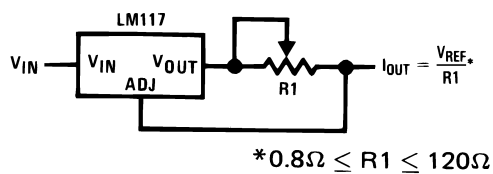**Figure 29. 4A Switching Regulator with Overload Protection**



$$I_{OUT} = \frac{V_{REF}}{R1} *$$

$$*0.8\Omega \leq R1 \leq 120\Omega$$

**Figure 30. Precision Current Limiter**



**Figure 31. Tracking Preregulator**

$$V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right) + I_{ADJ}\,R_2$$
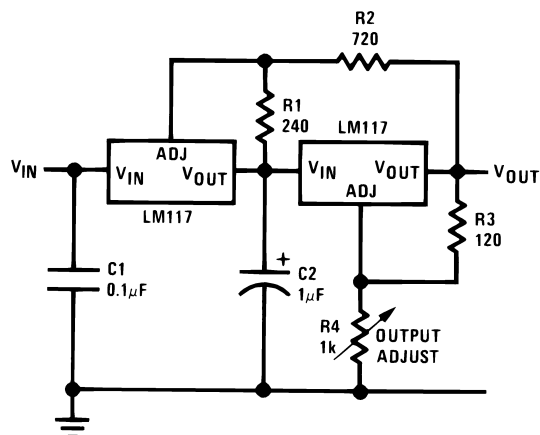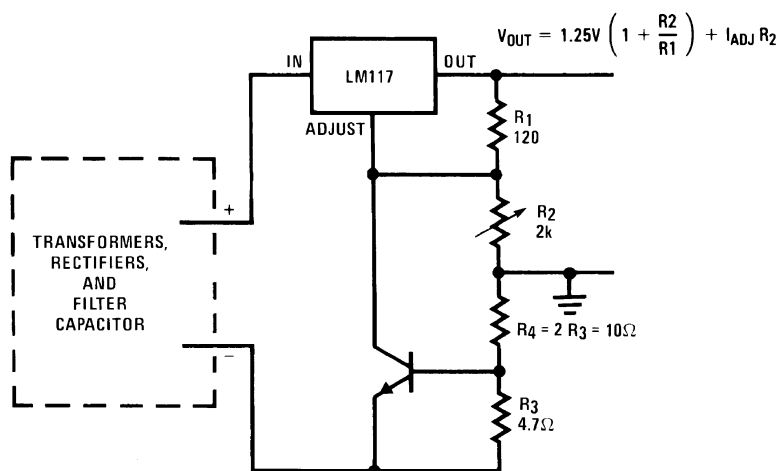
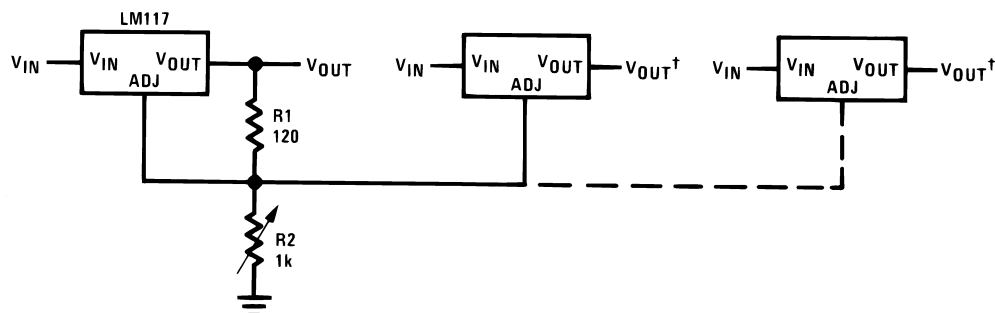— Short circuit current is approximately $\frac{600\text{ mV}}{R3}$, or 120 mA

(Compared to LM117's higher current limit)

— At 50 mA output only ¾ volt of drop occurs in $R_3$ and $R_4$

**Figure 32.  Current Limited Voltage Regulator**



*All outputs within ±100 mV

†Minimum load—10 mA

**Figure 33.  Adjusting Multiple On-Card Regulators with Single Control***
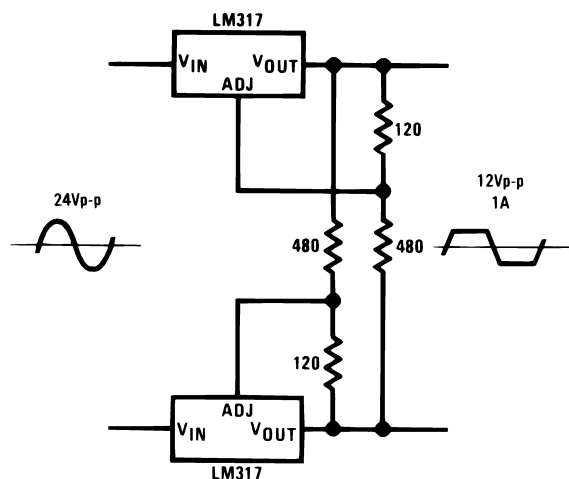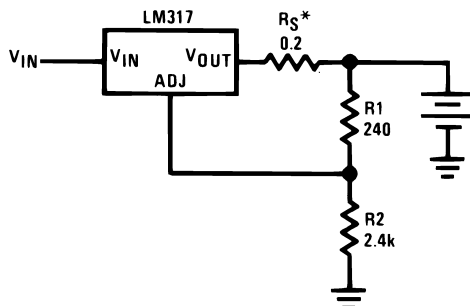


**Figure 34.  AC Voltage Regulator**

*$R_S$—sets output impedance of charger: $Z_{OUT} = R_S \left( 1 + \dfrac{R2}{R1} \right)$

Use of $R_S$ allows low charging rates with fully charged battery.

**Figure 35.  12V Battery Charger**
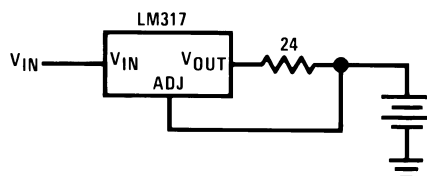


**Figure 36.  50mA Constant Current Battery Charger**
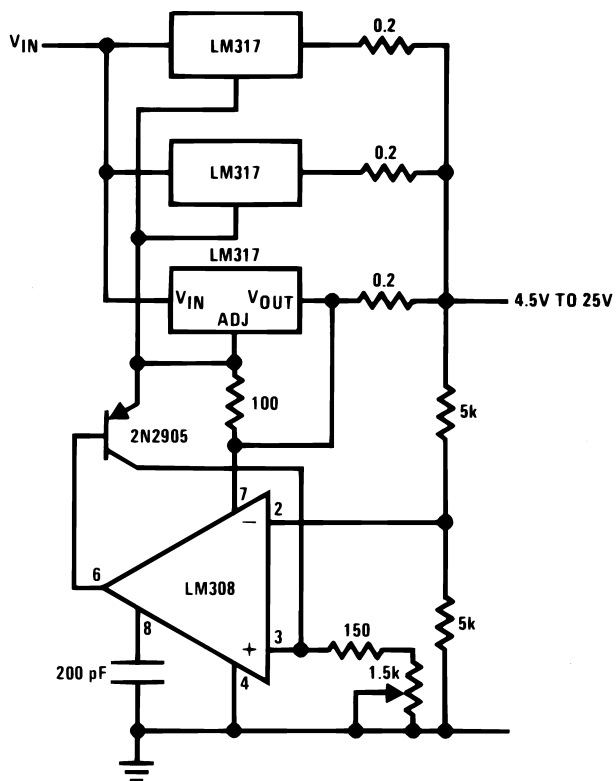


**Figure 37.  Adjustable 4A Regulator**

Product Folder Links: *LM117JAN*
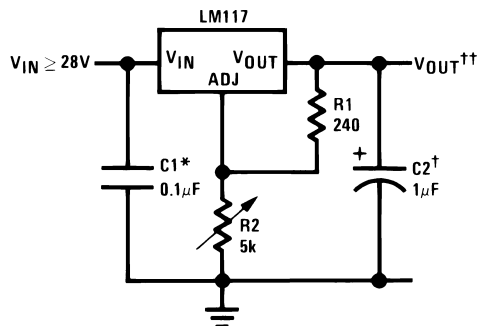
Full output current not available at high input-output voltages

   *Needed if device is more than 6 inches from filter capacitors.

   †Optional—improves transient response. Output capacitors in the range of 1µF to 1000µF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

$$\dagger\dagger V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R_2)$$

**Figure 38. 1.2V–25V Adjustable Regulator**
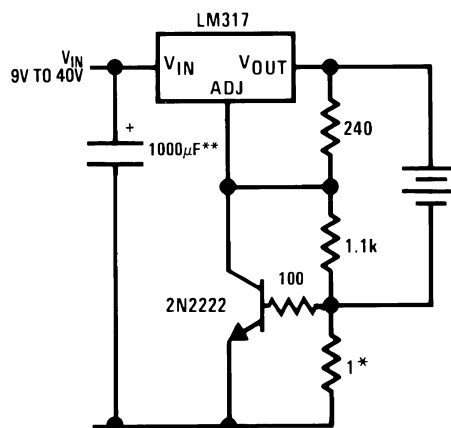


*Sets peak current (0.6A for 1Ω)

**The 1000µF is recommended to filter out input transients

**Figure 39. Current Limited 6V Charger**
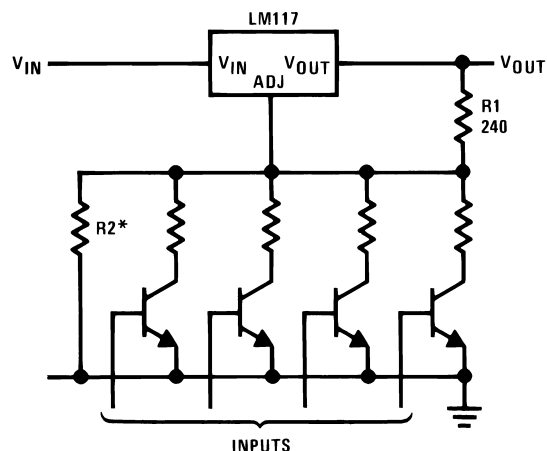


*Sets maximum $V_{OUT}$

**Figure 40. Digitally Selected Outputs**

## Revision History

| Date Released | Revision | Section | Originator | Changes |
|---|---|---|---|---|
| 03/14/06 | A | New Release to corporate format | L. Lytle | 2 MDS data sheets were consolidated into one corporate data sheet format. MJLM117–K Rev 0C1 and MJLM117–H Rev 1A1 will be archived. |
|  |  |  |  |  |

# PACKAGE OPTION ADDENDUM

## PACKAGING INFORMATION

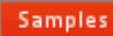| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JL117BXA | ACTIVE | TO | NDT | 3 | 20 | TBD | Call TI | Call TI | -55 to 125 | JL117BXA<br>JM38510/11703BXA Q ACO<br>JM38510/11703BXA Q >T | Samples |
| JM38510/11703BXA | ACTIVE | TO | NDT | 3 | 20 | TBD | Call TI | Call TI | -55 to 125 | JL117BXA<br>JM38510/11703BXA Q ACO<br>JM38510/11703BXA Q >T | Samples |
| M38510/11703BXA | ACTIVE | TO | NDT | 3 | 20 | TBD | Call TI | Call TI | -55 to 125 | JL117BXA<br>JM38510/11703BXA Q ACO<br>JM38510/11703BXA Q >T | Samples |

**(1)** The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

**(2)** Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

**(3)** MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**(4)** Only one of markings shown within the brackets will appear on the physical device.

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**OTHER QUALIFIED VERSIONS OF LM117JAN, LM117JAN-SP :**

● Military: LM117JAN

● Space: LM117JAN-SP

NOTE: Qualified Version Definitions:

    ● Military - QML certified for Military and Defense Applications

    ● Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

NDT0003A



SEATING PLANE

.500 MIN
[12.7]

.175±.010
[4.45±0.25]

Ø.360±.010
[9.14±0.25]

Ø.200
[5.08]

Ø.0175±.0015
[0.445±0.038]
TYP

Ø.325±.010
[8.26±0.25]

.035⁺·⁰⁰⁵₋·⁰⁰⁶
[0.89⁺⁰·¹²₋₀.₁₅]

45°

.050 MAX
[1.27]

.025 MAX
[0.63]
UNCONTROLLED
LEAD DIA

.031±.003
[0.79±0.07]
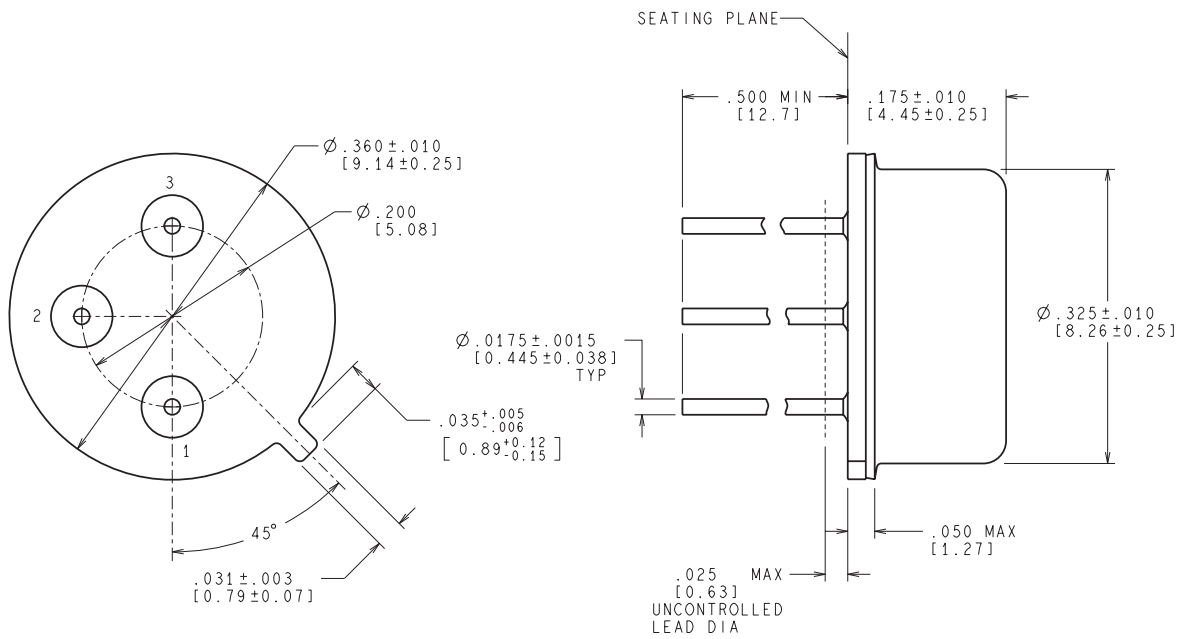
**CONTROLLING DIMENSION IS INCH**
VALUES IN [  ] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

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