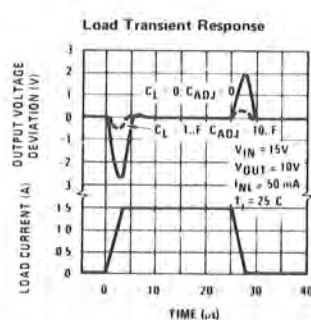
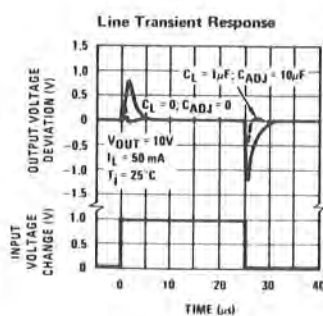
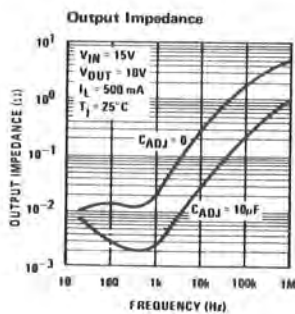
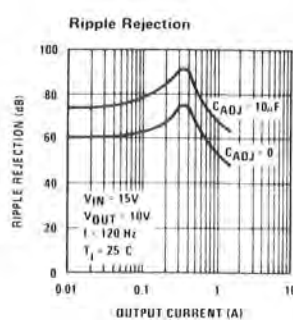
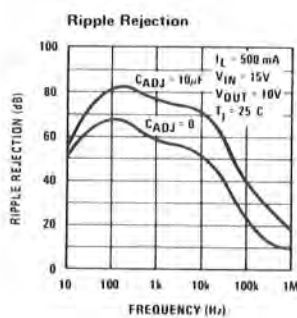
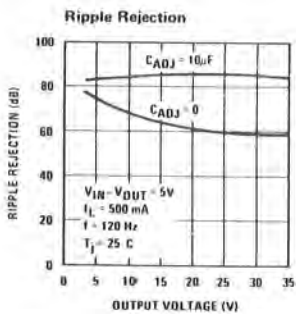
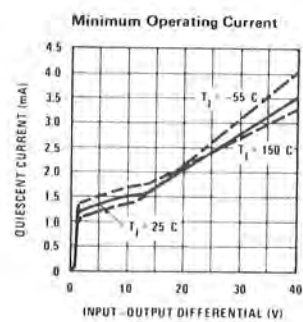
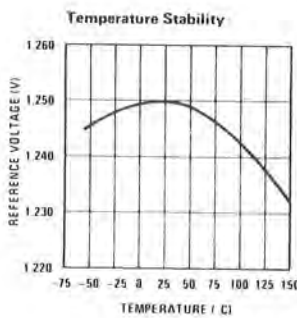
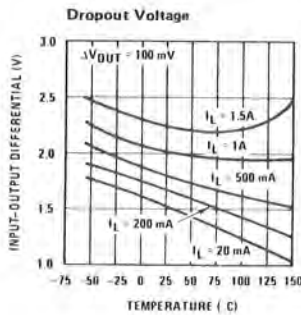
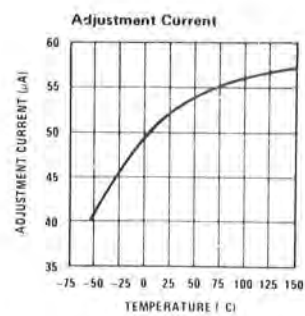
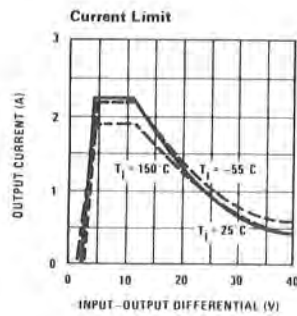
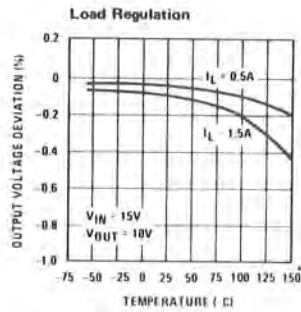


typical performance characteristics (K and T Packages)



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

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

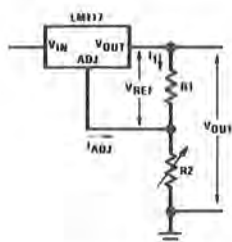


FIGURE 1.

Since the 100 μ A 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 0.1 μ F disc or 1 μ F 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 10 μ F bypass capacitor 80 dB ripple rejection is obtainable at any output level. Increases over 10 μ F do not appreciably improve the ripple rejection at frequencies above 120 Hz. 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 are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25 μ F in aluminum electrolytic to equal 1 μ F 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 0.5 MHz. For this reason, 0.01 μ F disc may seem to work better than a 0.1 μ F 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 1 μ F solid tantalum (or 25 μ F aluminum electrolytic) on the output swamps this effect and insures stability.

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 240 Ω) should be tied directly to the output 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 0.05 Ω resistance between the regulator and load will have a load regulation due to line resistance of 0.05 $\Omega \times I_L$. If the set resistor is connected near the load the effective line resistance will be 0.05 $\Omega (1 + R2/R1)$ or in this case, 11.5 times worse.

Figure 2 shows the effect of resistance between the regulator and 240 Ω set resistor.

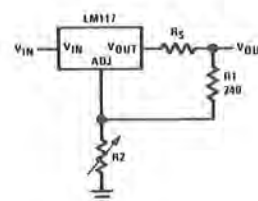


FIGURE 2. Regulator with Line Resistance in Output Lead

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-5 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 10 μ F 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 25 μ F 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 50 Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10 μ F capacitance. Figure 3 shows an LM117 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.

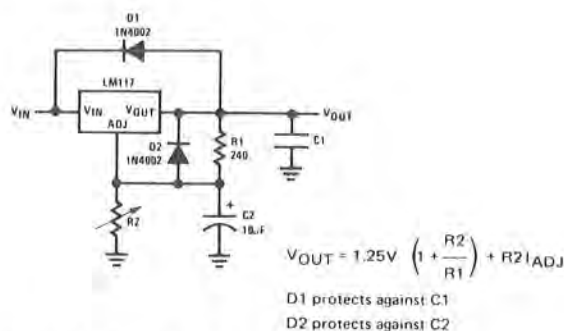
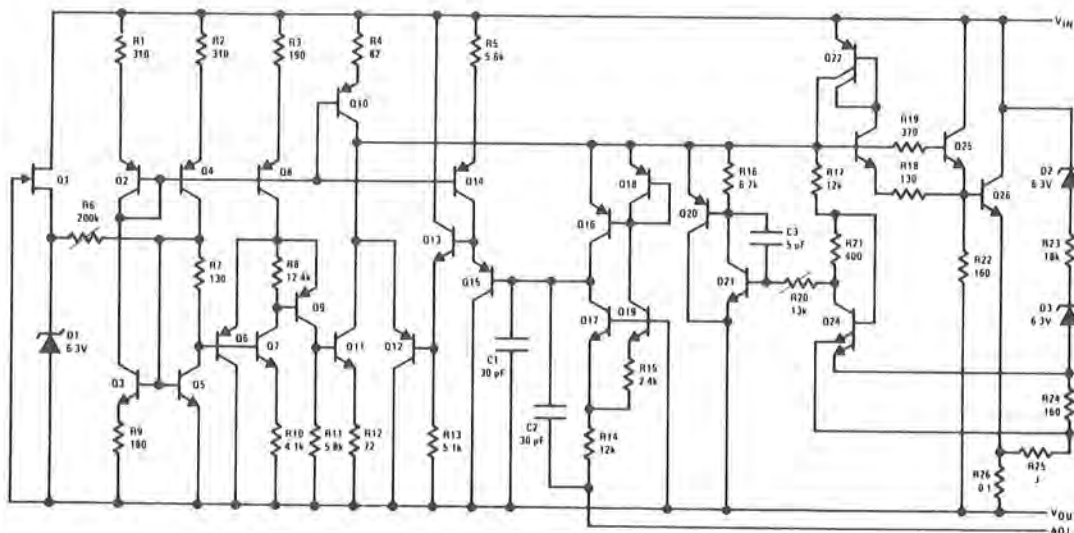


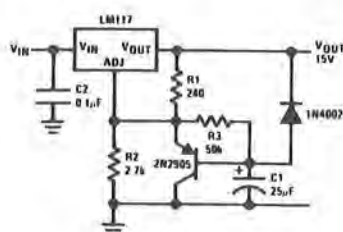
FIGURE 3. Regulator with Protection Diodes

schematic diagram

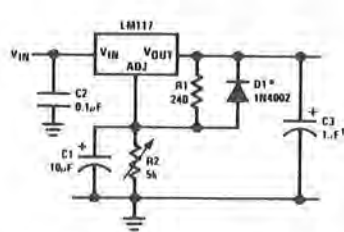


typical applications (con't)

Slow Turn-On 15V Regulator

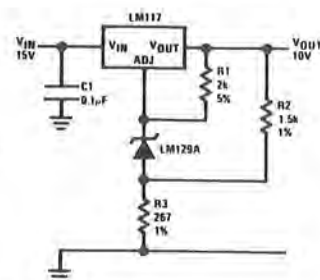


Adjustable Regulator with Improved Ripple Rejection

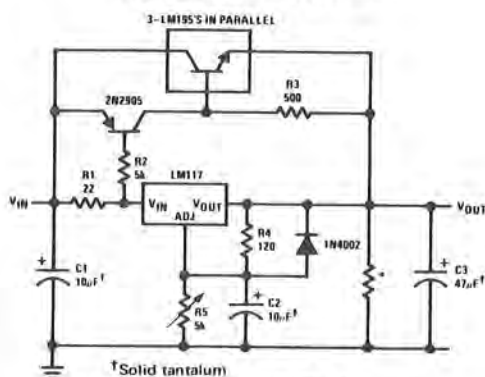


† Solid tantalum
* Discharges C1 if output is shorted to ground

High Stability 10V Regulator

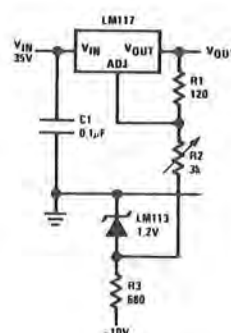


High Current Adjustable Regulator

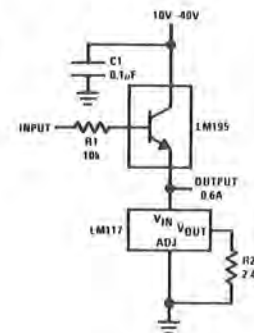


† Solid tantalum
* Minimum load current = 30 mA
‡ Optional—improves ripple rejection

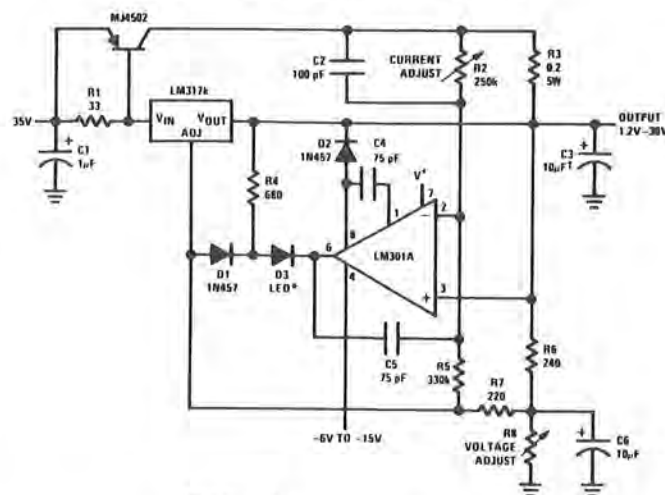
0 to 30V Regulator



Power Follower

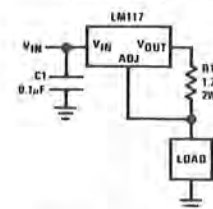


5A Constant Voltage/Constant Current Regulator

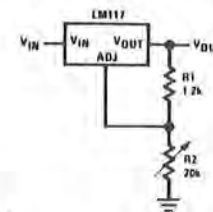


† Solid tantalum
* Lights in constant current mode

1A Current Regulator



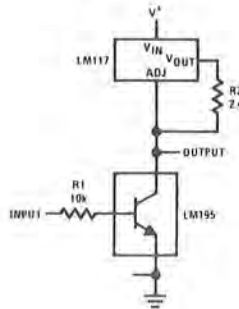
1.2V-20V Regulator with Minimum Program Current



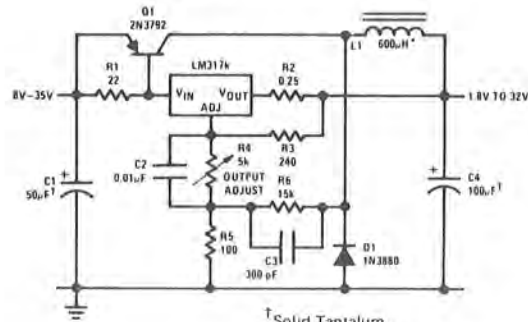
* Minimum load current = 4 mA

typical applications (con't)

High Gain Amplifier



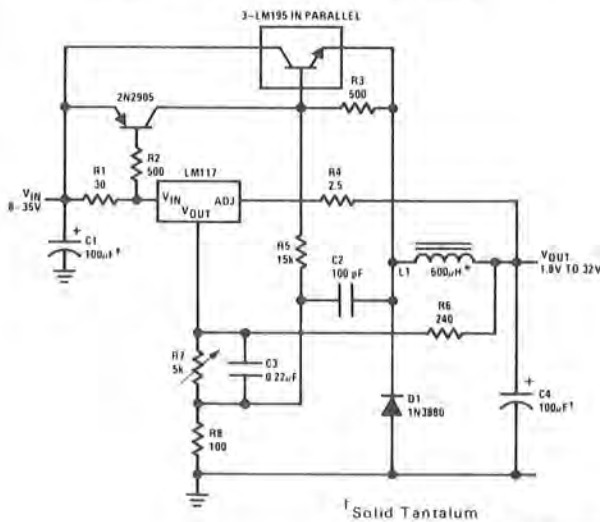
Low Cost 3A Switching Regulator



† Solid Tantalum

* Core—Arnold A-254168-2 60 turns

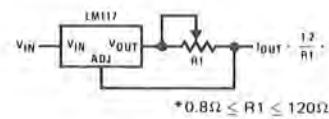
4A Switching Regulator with Overload Protection



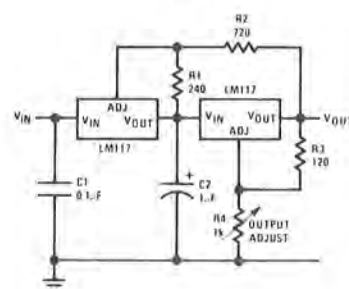
† Solid Tantalum

* Core Arnold A-254168-2 60 turns

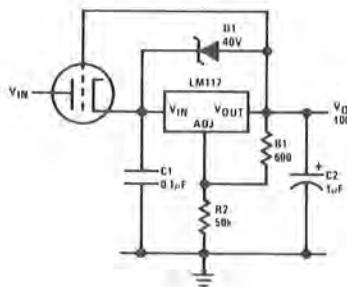
Precision Current Limiter



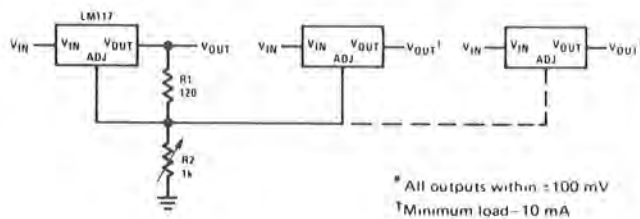
Tracking Preregulator



High Voltage Regulator



Adjusting Multiple On-Card Regulators with Single Control*

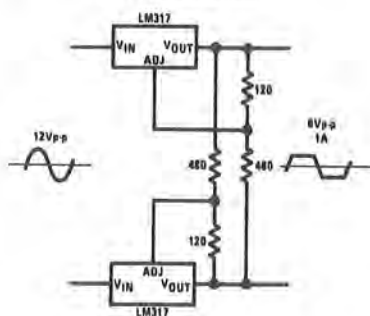


* All outputs within ±100 mV

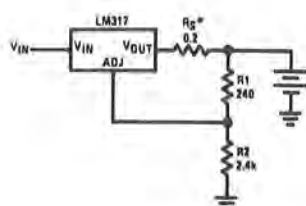
† Minimum load—10 mA

typical applications (con't)

AC Voltage Regulator

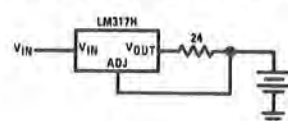


12V Battery Charger

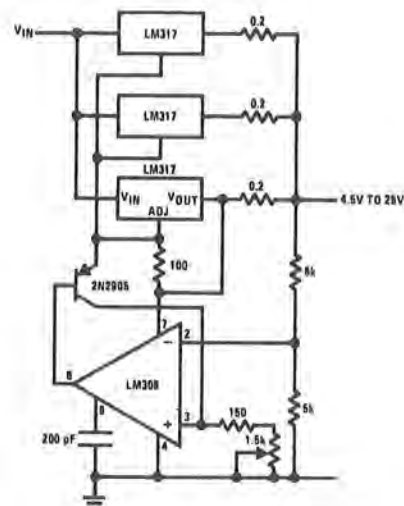


*RS—sets output impedance of charger $Z_{OUT} = R_S \left(1 + \frac{R_2}{R_1} \right)$
Use of RS allows low charging rates with fully charged battery.

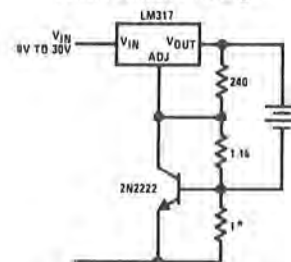
50 mA Constant Current Battery Charger



Adjustable 4A Regulator



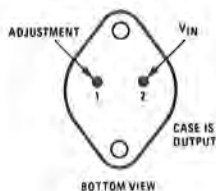
Current Limited 6V Charger



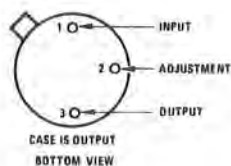
*Sets peak current (0.6A for 1Ω)

connection diagrams

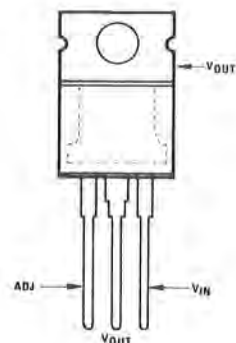
Metal Can Package



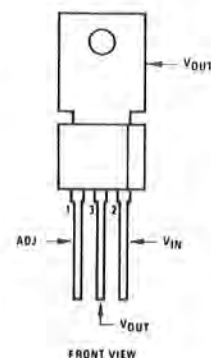
Metal Can Package



Plastic Package



Plastic Package



Order Number LM117K, LM217K
or LM317K
See Package 18

Order Number LM117H, LM217H
or LM317H
See Package 9

Order Number LM317T
See Package 26

Order Number LM317P
See Package 37

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440496, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.
National does not assume any responsibility for use of any circuitry described; no circuit patent licenses are implied; and National reserves the right, at any time without notice, to change said circuitry.

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