

# High Voltage Adjustable Power Supplies

National Semiconductor  
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## 7.4.4 HIGH VOLTAGE ADJUSTABLE POWER SUPPLIES

The floating-mode operation of adjustable three-terminal regulators such as the LM117 family make them ideal for high voltage operation. The regulator has no ground pin; instead, all the quiescent current (about 5 mA) flows to the output terminal. Since the regulator sees only the input-output differential, its voltage rating — 40V for the standard LM117 series and 60V for the high voltage LM117HV series — will not be exceeded for outputs of hundreds of volts. However, the IC may break down when the output is shorted unless special design approaches are used to protect against it.

Figure 1 shows how it's done. Zener diode D1 ensures that the LM317H sees only a 5V input-output differential over the entire range of output voltage from 1.2V to 160V. Since

high-voltage transistors by necessity have a low  $\beta$ , a Darlington is used to stand off the high voltage. The zener impedance is low enough that no bypass capacitor is required directly at the LM317 input. (In fact, no capacitor should be used here if the circuit is to survive an output short!) R3 limits short circuit current to 50 mA. The RC network on the output improves transient response as does bypassing the ADJUST pin, while R4 and D2 protect the ADJUST pin during shorts.

Since Q2 may dissipate up to 5W normally or 10W during a short circuit, it should be well heat sunk. For higher output currents substitute a pass device in a TO-3 or TO-220 package in place of the TO-202 NSD134 and reduce R3. Of course, if the required output current is less than 25 mA, R3 can be increased to reduce the size of the heat sink needed.

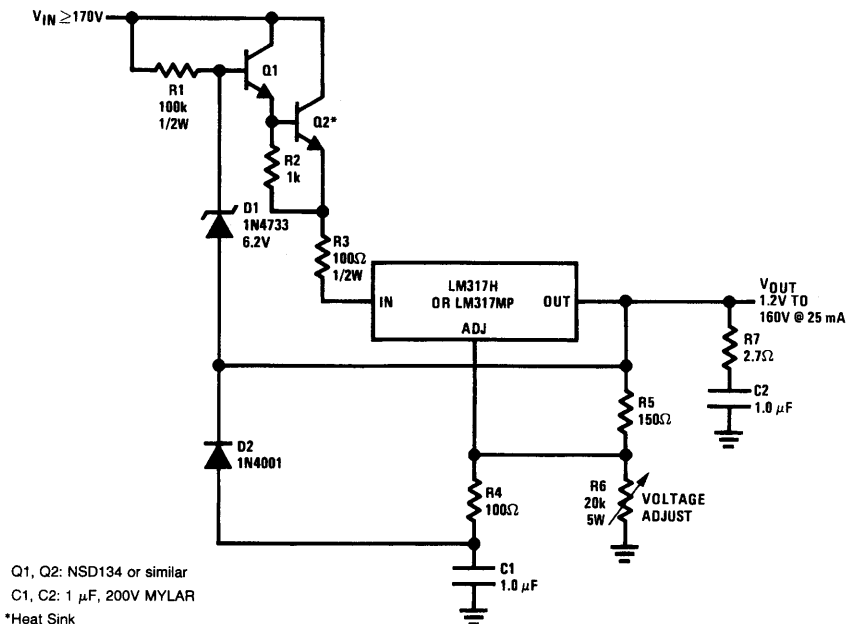


FIGURE 1. Basic High Voltage Regulator

TL/H/7335-1

An improved approach is shown in *Figure 2*. Here an LM329B 6.9V zener reference has been stacked in series with the LM317's internal reference. This both improves temperature stability, since the LM329B has a guaranteed TC of  $\pm 20$  ppm/ $^{\circ}$ C, and improves regulation, because more loop gain is available from the LM317.

These techniques can be extended for higher output voltages and/or currents by either using better high voltage transistors or cascoding or paralleling (with appropriate emitter ballasting resistors) several transistors. The output short circuit current, determined by R3, must be within Q2's safe area of operation so that secondary breakdown cannot occur.

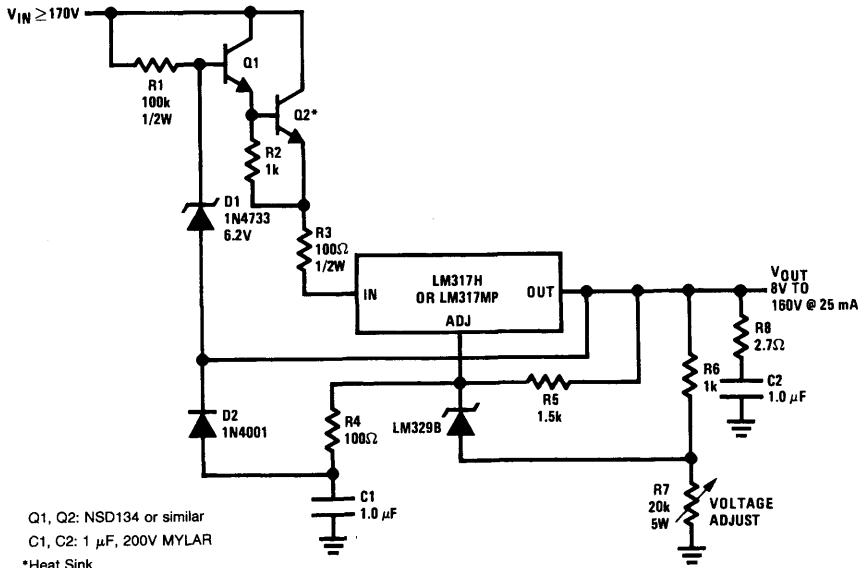


FIGURE 2. Precision High Voltage Regulator

TL/H/7335-2