Designer's casebook

Switching converter raises linear regulator's efficiency

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The low ripple and fast recovery of a series-pass voltage regulator can be attained at the high efficiency of a switching regulator if both are combined. In this circuit, the performance is achieved by using the switching circuit as a preregulator for the linear element.

As shown in the illustration of the general circuit, which is designed to transform the 35-volt raw input into a well-regulated output, heat dissipation across the LM317K series element can be reduced if it is made to handle a switched, rather than a continuous, input. Here, the switching regulator is formed by transistors Q_1–Q_4, D_1, and L_1. During power up, Q_1, driven through R_1–R_3, is brought into saturation. Q_2 remains off and Q_3 is turned on.

Switching occurs when V_d equals 3.6 volts, which is D_2's zener voltage. Q_4 then turns on, as does Q_2, and Q_3 is turned off.

As Q_2 turns on, Q_1 switches off, and because of the positive voltage spike created by L_1, load current is momentarily forced through D_1 as V_d decreases. When V_d reaches the lower hysteresis threshold of Q_3 as established by R_5 and R_6, Q_2 and Q_4 turn off, and Q_1 turns on, completing the switching cycle. With the supply's negative path restored, V_d rises until it reaches V_2, and the process is repeated.

The linear regulator can be of any type, including a three-terminal, nonadjustable device. Note that a switching current regulator can be formed if the regulator is replaced by a resistor. In that case, the switching current will be $Is = V_Z/R$. □

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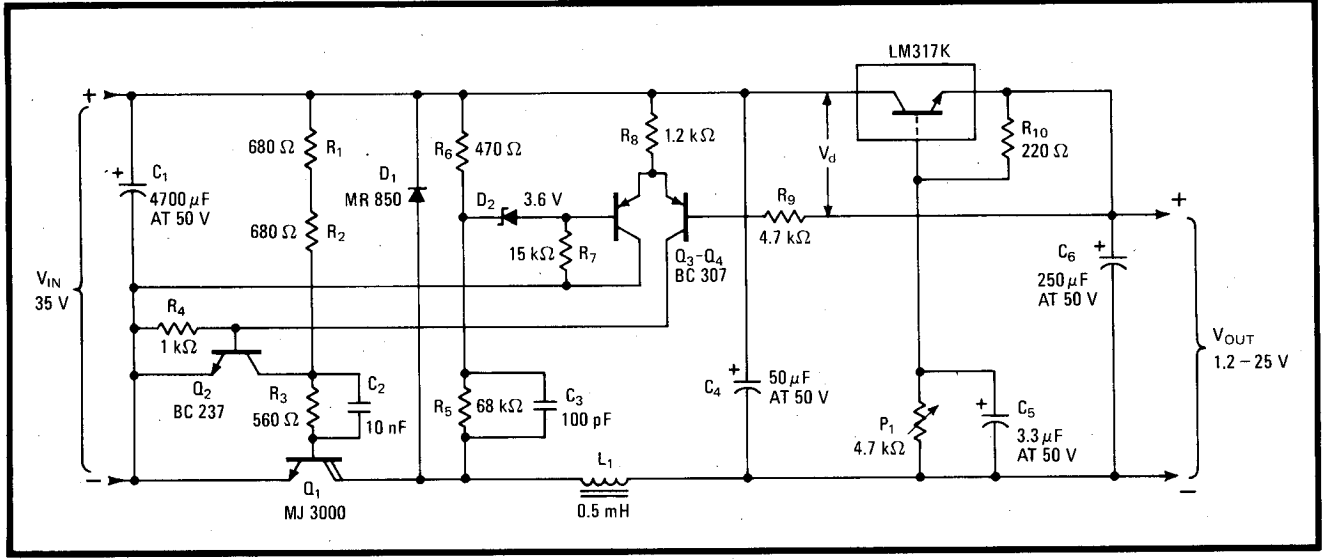

Mixed mode. Switched and linear regulators are combined to form a unit that has the advantages of both—low ripple, fast response, and high efficiency. Here a switched circuit serves as a preregulator for the linear series-pass element, the LM317K.