

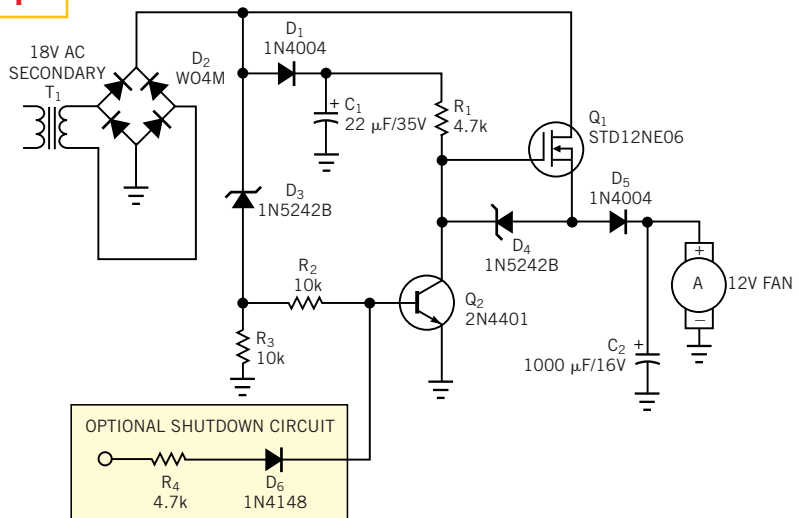
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## MOSFET switch provides efficient ac/dc conversion

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**O**CCASIONALLY, YOU HAVE access to a transformer for powering a dc circuit, but its output voltage is much higher than that required for the dc voltage. The full-wave-rectified and filtered output of an ac input voltage  $V_X$  is  $V_{DC} = 1.414V_X - 2V_F$ , where  $V_F$  is the forward drop in the rectifier (approximately 0.7V). For example, if you require 12V dc to power a small cooling fan drawing 100 mA and the ac voltage is 18V, a full-wave rectifier and filter results in a 24V-dc output. Although you can regulate the voltage down to 12V dc by using a simple three-terminal regulator (such a  $\mu$ A7812), the result is wasted power of approximately 1.3W. This waste means that you must provide for heat removal, somewhat defeating the purpose of including the cooling fan. If you use a typical 100 × 100-mm, 12V-dc fan rated at 0.45A, the typical heat loss is approximately 2.5W, increasing to 5W at full load. In many applications, this level of loss is unacceptable, so you'd have to use an extra transformer secondary, a dc/dc converter, or a switching regulator. The circuit in **Figure 1** uses a MOSFET switch

**Figure 1**



Using a MOSFET circuit, you can efficiently convert the too-high voltage of a leftover transformer to a lower dc level.

and diode to effectively draw current from the transformer when the voltage is close to the desired level of 12V dc.

The full-wave bridge,  $D_2$ , rectifies the 18V-ac signal. The diode,  $D_1$ , and  $C_1$  provide a gate bias voltage of approximately 24V dc. This voltage drives the gate of  $Q_1$  through  $R_1$ , shunted by  $D_4$ , which maintains the gate voltage at a maximum of 12V relative to the source, even during transient conditions. As the bridge-rectifier output increases from 0V to the peak of approximately 24V each half-cycle, the bias voltage holds the MOSFET on until the input voltage reaches the breakdown voltage of  $D_3$  (12V) plus the  $V_{BE(ON)}$  of  $Q_2$ , or approximately 12.7V. At that point,  $Q_2$  turns on, turning  $Q_1$  off. The output filter capacitor,  $C_2$ , charges through  $D_5$ . As the rectifier output voltage decreases

from 24 to 0V,  $Q_2$  again turns off at approximately 12.7V, allowing  $Q_1$  to turn on and provide another pulse of current to charge  $C_2$ .  $C_2$  provides power for the load between the pulses, which occur at 240 Hz with a 60-Hz input. Thus, power drain from the transformer occurs in short pulses, much in the manner of a typical bridge-rectifier/output-filter arrangement but at double the frequency. If you want to turn the fan off with a logic signal, you can add  $R_4$  and  $D_6$ . When you apply a logic-high signal to the input,  $Q_2$  conducts, turning the MOSFET off. (DI #2484)

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