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Simple automatic-shutoff circuit uses few components

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You often need to include a timed automatic-turn-off circuit in battery-powered equipment to extend battery life. Previously published Design Ideas for this function all involve many components (**references 1** through **7**). The circuit in **Figure 1** is a simple automatic-shutoff add-on circuit featuring no quiescent current.

When you press the pushbutton switch, C_1 charges rapidly through the low-value R_2 to the zener voltage of diode D_1, and P-channel MOSFET Q_1 immediately conducts. After the pushbutton is released, C_1 discharges slowly through the high-value R_1 with a time constant of R_1C_1 seconds. During this time, C_1 loses 63% of its initial voltage—from 9V to 3V after the delay. **Reference 8** shows the on-resistance versus the gate-to-source voltage of a Vishay Siliconix Si4435. As long as the gate-to-source voltage is greater than approximately 3V, the device's on-resistance remains lower than 0.1**Ω**, yielding a dropout voltage of less than 0.1V for a load sinking as much as 1A.

The 9.1V zener diode, D_1, keeps the shutoff time delay independent of the battery voltage and ensures that the gate-to-source voltage does not exceed Q_1's rated maximum of 20V. Thus, you can use this circuit with a choice of battery voltages; only the maximum drain-to-source voltage of transistor Q_1 limits the choice. With 3.6 to 9V batteries, D_1 and R_1 are useless (remove D_1 and short-circuit R_2), and you must compute the time delay with the classic **equation** $T=-R_1C_1\log_e(3/V_{BAT})$, as **Table 1** shows. With battery voltages as low as 1.5V, instead use a bipolar transistor with a low saturation voltage as well as a modified circuit scheme.

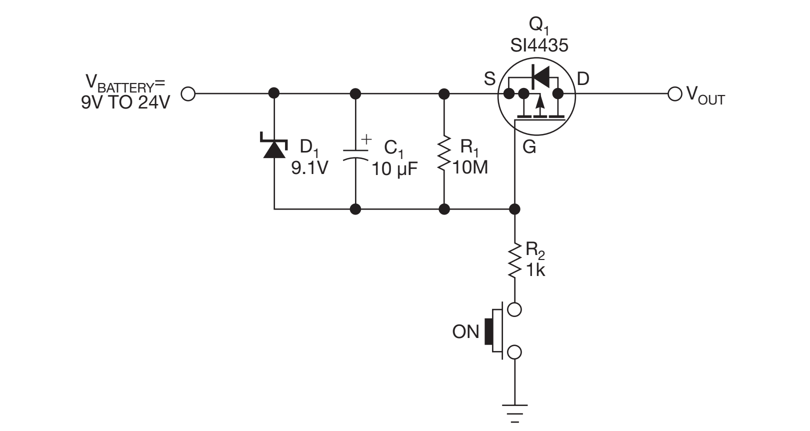

Figure 1 This simple automatic-shutoff circuit uses a P-channel MOSFET.

TABLE 1 TIME DELAY (SECONDS) WITH 10-MΩ R_1

Battery voltage (V)	LN ($3/V_{BAT}$)	C_1=10 µF	C_1=100 µF
7.5	–0.916	92	916
6	–0.693	69	693
4.5	–0.405	41	405
3.6	–0.182	18	182

Editor's note: With no feedback for rapid shutoff, as C_1 slowly discharges below 3V, Q_1 goes through a period of gradually increasing the on-resistance, which temporarily increases its power dissipation and heating during the shutoff action. Be sure to consider this effect, size Q_1 adequately for the load current, and use adequately sized heat sinks. **EDN**

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