Single pin controls relay, intermittent buzzer, and status LED

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Switching applications involving controlling devices or appliances using digital-I/O lines through a relay often need to indicate the change of state of the I/O line and, hence, the connected device. This indication could be in the form of a buzzer that turns on for a few seconds every time the line changes state. Designers generally employ an additional I/O pin to trigger the buzzer whenever the state of the primary I/O line changes. This Design Idea discusses a circuit that controls a device through a relay and an intermittent buzzer with only one digital-I/O pin.

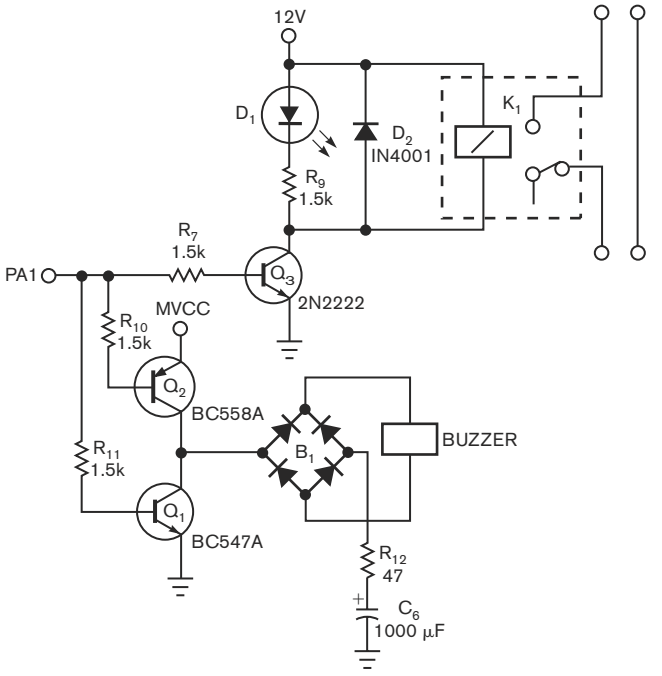

Figure 1 This circuit controls a device through a relay and an intermittent buzzer with only one digital-I/O pin.

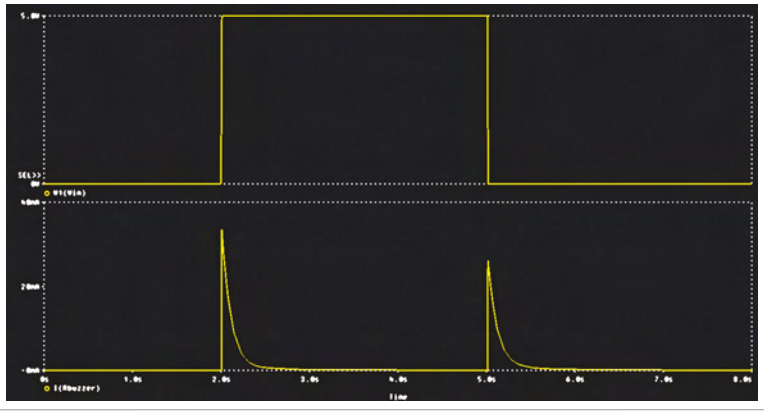

Figure 2 A Spice simulation of the buzzer circuit replaces the buzzer with 50Ω resistance and plots the current through the buzzer and the status of the I/O line.

Pin PA1 of the digital device controls a relay, which switches an appliance on and off (**Figure 1**). NPN transistor Q_3 activates the relay coil when the I/O line is in the high state. Status LED D_1 connects in parallel to the relay coil and turns on when the I/O line is high and off when the line is low.

The buzzer remains on for a small amount of time when the relay changes state. You accomplish this task by employing a push-pull-inverter topology using complementary BJTs (bipolar-junction transistors) NPN Q_1 and PNP Q_2. The output of this stage connects to a bridge rectifier with a buzzer as a load because buzzers usually are unidirectional. The bridge rectifier connects in series both with resistor R_{12} to regulate the maximum current through the buzzer and with capacitor C_1 to ensure that the buzzer "fades off." When the line is low, transistor Q_2 is on, the capacitor charges to a positive voltage, and the buzzer operates until the current through it is sufficient. When the line goes high, transistor Q_1 switches on, the capacitor discharges to approximately 0V, and the buzzer operates again for a short duration. The on-time of the buzzer depends on the values of R_{EQ}, the series combination of R_{12} and the buzzer resistance, and C_6. To change the time constant and hence the on-time of the buzzer, you should change the value of the capacitor rather than that of the resistor. You can also design this circuit using only one BJT instead of two, but the transistor would always draw some current at steady state.

This topology is useful when no separate I/O lines are available for controlling the buzzer. You can also employ this topology to indicate the change of state of any input stage directly by connecting it to the given circuit or through a buffer. **Figure 2** shows a Spice simulation of the buzzer circuit. This simulation replaces the buzzer with 50Ω resistance and plots the current through the buzzer along with the status of the I/O line. EDN