Water-leak detector uses 9V batteries

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A previously published Design Idea describes a practical gadget that has the potential to save a lot with little investment (Reference 1). However, the circuit uses 120V line voltage and, as such, it is not that convenient for many applications. This Design Idea describes a portable water-leak detector that uses a common 9V battery for power (Figure 1). The circuit consumes less than 10 μA during detection mode, and a 9V alkaline battery has greater-than-500-mAh capacitance. So one battery can last more than five years, which is equivalent to the battery's shelf life. When the battery voltage drops below 6.5V, the detector beeps to indicate that it is time to change the battery.

![Figure 1](image)

**Figure 1** IC\textsubscript{1A} and IC\textsubscript{1B} determine the conditions for sounding the buzzer, and IC\textsubscript{1C} oscillates to provide the trigger for IC\textsubscript{1D}.

The design uses Maxim Integrated Circuits’ MAX934, an ultra-low-power quad comparator with a built-in 1.2V reference. The chip uses about 6 μA. IC\textsubscript{1A}, R\textsubscript{1}, and R\textsubscript{2} provide water-leakage detection. R\textsubscript{1} is the water probe, which can be two bare copper wires wrapped in a sponge. R\textsubscript{1} has high impedance when the sponge is dry, so IC\textsubscript{1A}’s output stays high. Once the circuit detects the water leak, R\textsubscript{1}’s value decreases to less than a few hundred kilohms, which forces IC\textsubscript{1A}’s output low. Through D\textsubscript{1}, it makes the output of IC\textsubscript{1B} high.

IC\textsubscript{1B}, R\textsubscript{3}, and R\textsubscript{4} form a low-voltage detector. When the water probe is dry and the battery voltage becomes lower than 6.6V, the voltage on IC\textsubscript{1B}’s negative input is less than 1.2V. Because the reference voltage is 1.2V, IC\textsubscript{1B}’s output
changes from low to high. So when the probe is dry and the battery voltage is higher than 6.6V, IC\textsubscript{1B}'s output is low, which forces IC\textsubscript{1C}'s output high, and IC\textsubscript{1D}'s output stays low.

Either a wet probe or a low-voltage battery can force IC\textsubscript{1B}'s output high, freeing a narrow-duty-cycle oscillator comprising IC\textsubscript{1C}, C\textsubscript{2}, R\textsubscript{5}, R\textsubscript{8}, and D\textsubscript{3}. The oscillation period is approximately 7 seconds, and IC\textsubscript{1C}'s output is low for about 0.3 seconds. That low output allows a 2.4-kHz oscillator comprising IC\textsubscript{1D}, C\textsubscript{3}, and R\textsubscript{9} to operate. When the circuit detects a water leak or the battery's power is low, the buzzer sounds for a fraction of a second every 7 seconds. In this way, the warning sound can last for a long time before the battery gets too low.

Resistors R\textsubscript{6} and R\textsubscript{7} increase IC\textsubscript{1C}'s hysteresis, which lets you use a smaller value for C\textsubscript{2}. R\textsubscript{10} and R\textsubscript{11} increase IC\textsubscript{1D}'s hysteresis to improve the sound frequency's stability. All capacitors are ceramic, ensuring low leakage current.

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**Reference**