Water Alarm

Timely warning against flooding

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Water is vital for humans, but too much of it has an undesirable effect, particularly when it turns up in the wrong places. This is what two Elektor designers discovered after a blocked drain of a combination boiler and a leaking filter of an aquarium. This will quickly suggest the idea of designing a small circuit that will give a clear signal when this type of flooding occurs, in this case with a loud alarm.

It is not always possible to prevent a water leak, of course. But in this case it is essential to discover it as quickly as possible. That is the purpose of this circuit: a clear warning when water appears somewhere where it doesn't belong.

What are the most important design criteria to keep in mind when designing a flood alarm? Seeing that it could be years, or hopefully never, before there is a leak, the circuit has to be always ready and should not rely on the mains voltage. If the circuit is powered from batteries it is very important that the circuit has very low or no power consumption when everything is dry. To detect the water we make use the fact that (non distilled) water is conductive to an extent.

The Design

Water is a poor conductor then and consequently we should be able to measure a relatively large resistance between the two electrodes. The best way to do this is to make the gate of a MOSFET the input of our circuit. We prefer to measure with respect to ground, so we use a P-channel version for T1, in the form of a BS250. This FET switches the oscillator that follows. When it is dry, T1 has to stay off. This is achieved with R1. C1 prevents the circuit reacting to noise. With a value of 10 MΩ the circuit is sensitive enough and the current that flows is less than one micro-ampère (1 μA). R2 protects the gate from high voltages (when the electrode it touched, for example) and forms in combination with C1 a low-pass filter, so that any AC (noise) voltages are filtered out and the oscillator that follows is switched cleanly. R3 ensures that this oscillator is completely off (no current consumption at all).

To minimise the power consumption when water is detected the (active) buzzer is intermittently turned on. The buzzer is activated for about 1 to 1.5 seconds every 10 seconds. The oscillator that makes this happen is implemented with discrete parts. For this we chose an astable multivibrator with two transistors. The advantage of this is that one of these two transistors (T3) switches the buzzer and the buzzer also functions as the collector resistor. C4 is necessary because most active buzzers (the version with a built-in oscillator that generates the bleeping noise) are a very noisy load. The buzzer that is used here, without a parallel capacitor, prevented the operation of the oscillator (the buzzer remained on).

The component values of the circuit around T2 and T3 have been designed with the specific requirements of this application in mind (highly asymmetric square wave) so that these values are quite different from the standard implementation. This is also why the off-time deviates from the value resulting from the standard formula that is normally used to calculate the component values for this AMV.

T3 is a Darlington device so that the base resistor R6 can be as large as possible. This ensures that C3 has a reasonable value. When the buzzer is not activated the collector resistor of T2 determines the largest share of the current consumption. During the time when the buzzer is activated, C3 has to be charged again. Since the time (R4×C3) required to recharge C3 is longer than the time set by R5×C2, the expected time of R6×C3 is therefore shorter. The theoretical times in an optimal case may be calculated from

$$\ln 2 \times R5 \times C2$$

and

$$\ln 2 \times R6 \times C3.$$

The expected time would have been 15 seconds, but has been reduced to 10 seconds by the combination of values chosen for these components. Increasing the value of C3 to lengthen the off-time does not work. R4 would have to be reduced by the same ratio and that would increase the current consumption.

You could experiment with the value of R6, but make sure that T3 still switches on properly. The voltage drop will be around 0.8 V.

For the 'sensor' for this water alarm you can use two short wires with the insulation stripped off. The circuit is sensitive enough to sense a drop of tap water on a table with the ends of the sensor wires.

To prevent the circuit from drowning in a large pool of water and therefore won't work properly any more, you can build it into an enclosure that floats. Alternatively you could mount the PCB, buzzer and battery on a block of polystyrene. The wires for the sensor can be pushed through the block and bent over on the underside. The block of polystyrene has to be big enough to carry the weight of the circuit, of course. A third possibility is to mount the circuit sufficiently high up in the room. The sensor can be connected to the circuit with twisted wires, preventing them from picking up noise.

Current consumption

For the buzzer we used a type that can be found at Digi-Key, the CEP-2260A. This buzzer, at a power supply voltage of 9 V, uses less than 5 mA. The actual buzzer that we have, used even less, only 4 mA. There are however 12-V buzzers that use 20 mA or more. Using one of these would considerably reduce the amount of time that the alarm can remain active.

The current consumption of our prototype averaged less than 0.5 mA, so with a standard 9-V PP3 battery rated at 500 mAh it will run continuously for 1,000 hours. If nobody has taken any action after the alarm has been going for 40 days, well then...

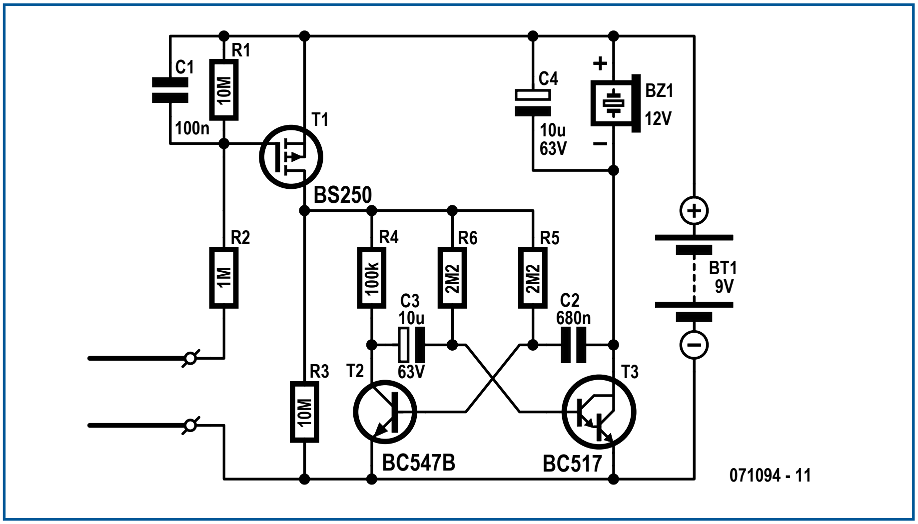
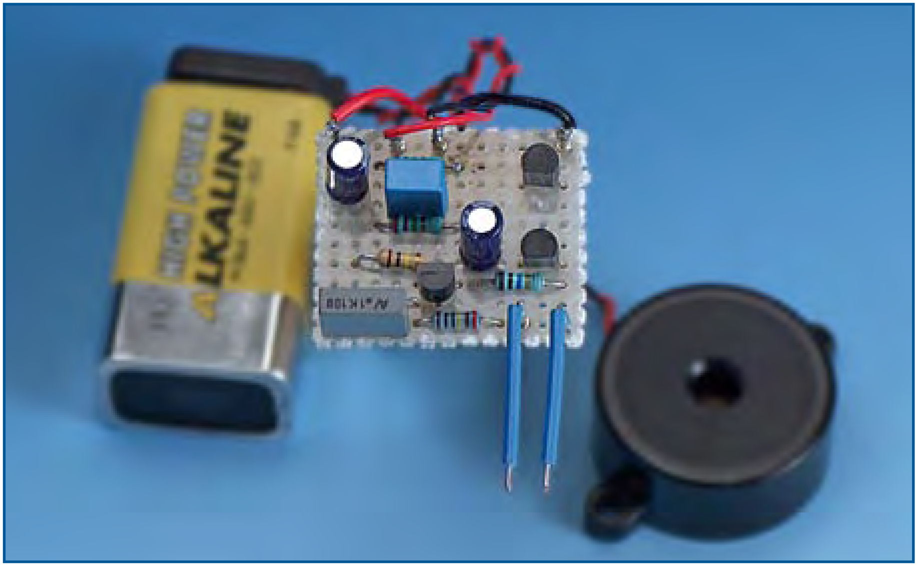


Figure 1. The circuit comprises a detector section with a MOSFET and an astable multivibrator with two transistors.



Since the current consumption in the idle state is negligible (<1 μA), there is a risk that the battery may leak after a few years. So keep an eye on the life expectancy of the battery and make sure it is mounted in the separate compartment or a plastic bag, so should the battery leak, it cannot cause any damage.

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