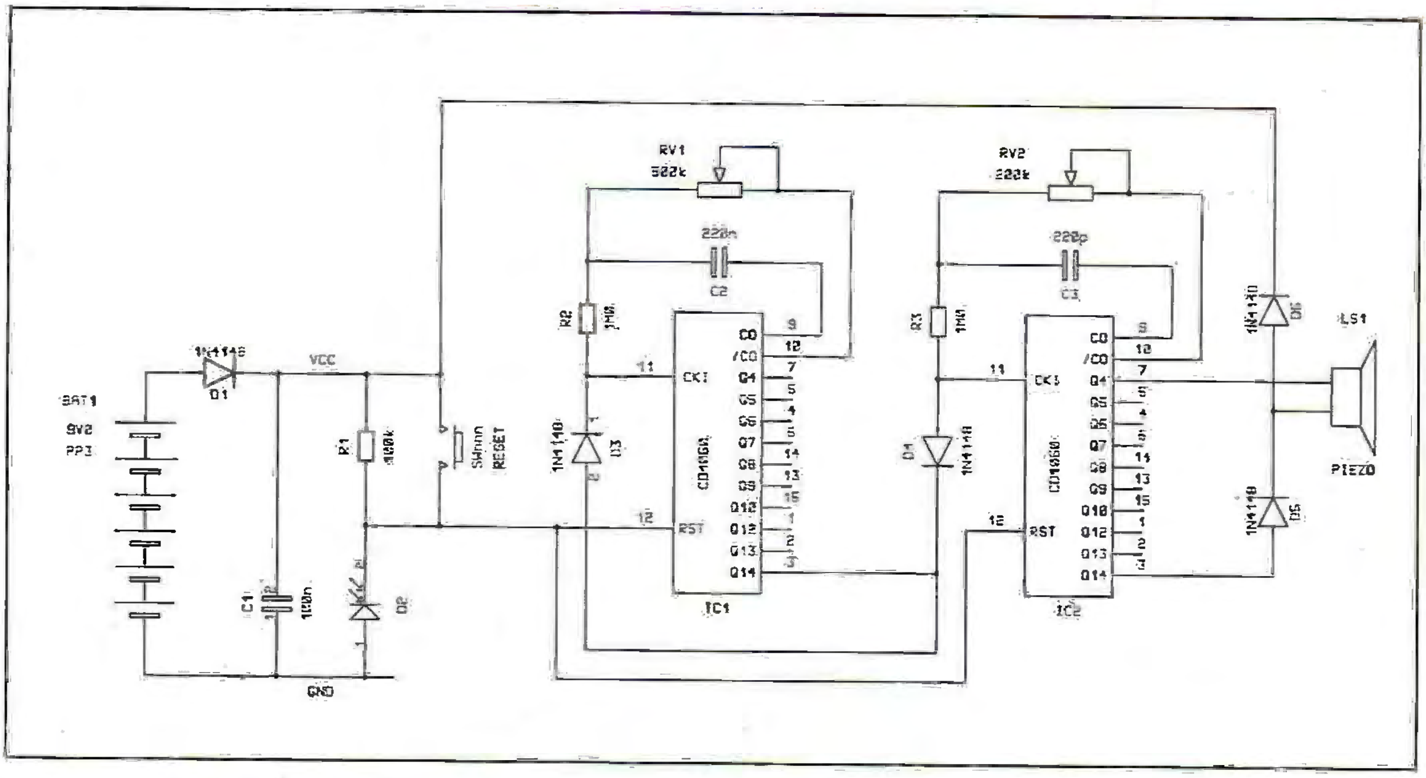
Delayed ALARM

by John Edwards



THIS IS A DELAYED ACTION ALARM WITH A LEVEL-SENSITIVE TRIGGER CONDITION. IT WILL NOT SOUND UNTIL THE TRIGGER CONDITION HAS BEEN PRESENT FOR SOME TIME, AND WILL THEN ONLY CONTINUE TO SOUND WHILST THIS CONDITION IS HELD.

As soon as the condition is removed the alarm is immediately reset, and the delay will again operate if the condition returns. Originally, it was intended to warn me about leaving the 'fridge door ajar, which is a bit of a habit. To do this it uses light as the trigger condition, and allows me a few minutes before it complains that the door is still open. Temperature could be used instead, of course.

It consists of two sections, both timers based on the CD4060 device, from the standard 3..15V '4000' series CMOS. The first section is the delay, the second is the alarm. The CD4060 is a 14 stage binary counter with a built-in two-inverter oscillator section, so by adding two resistors and a capacitor it can generate its own clock. Not all the counter stages are available as outputs, due to pin count limitations: we cannot use the first 3 stages (Q1..Q3) and the 11th (Q11). There is a RESET input, which is active high and stops the oscillator as well as clears the count to zero.

Power is provided by BAT1, a 9v PP3. Since the chip can operate over a wide voltage range, this could be replaced by whatever else is convenient. No stabilisation is needed as the power drain is very low, and diode D1 is there only to protect against reverse battery connection. C1 provides decoupling for the chips, and should be mounted close to them. Only one chip is clocked at a time, which will reduce VCC noise.

R1 and D2 form the trigger circuit, with switch SW1 providing a manual reset. The switch can be left off if a manual reset is not needed. The diode D2 is a photodiode, and R1 should be set to a value which will allow IC1.12 to go high when the diode is in the dark, and low when there is a little light available. This will depend on the diode, but 100k will be a good starting point. The diode could be replaced by a selenium photoresistor, and 100k will be fine for that too. In the dark, then, IC1.12 and IC2.12 will be high, and both oscillators will be halted. All IC1 and IC2 outputs will be low. Nothing is happening, except a slight drain on the battery through D4+R3+RV2.

As soon as there is sufficient light, the D2/R1 takes both RST pins low, and IC1 oscillator starts up. IC2 oscillator continues to be held off via D4 by IC1.3 (Q14), which remains low, so there is nothing happening in the IC2 stage at the start. After 8192 IC1 clock periods, Q14 goes high, and this does two things: D4 ceases to lock up the IC2 clock, which now starts to run, and D3 locks up the IC1 oscillator instead, so the count in IC1 is frozen with Q14 high.

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Piezo sounder LS1 is driven on one connection with a continuous signal from IC2 Q4, but rather than ground the other LS1 connection, it is taken to the junction of diodes D5 and D6. This allows the sound to be gated off and on by IC2 output Q14. When Q14 is high, the attached terminal of LS1 is clamped to the range 0.6V above and below VCC by diodes D5 and D6, as D5 is effectively connected in reverse across D6. This allows the full VCC swing of Q4, less 1.2V, to appear across LS1. When Q14 is low,the attached LS1 terminal is free to swing across the whole range of VCC, so once clamped to VCC by D6 on the next upswing, no effective signal appears between the terminals of LS1. Both terminals rise and fall in unison, with LS1 being effectively a charged capacitor with one driven and one free terminal. So the sound from LS1 will be modulated on/off at a rate 1/1024 of the LS1 drive.

The basic equation for the IC1 oscillator frequency is 1/(2.2*VR1*C2), and for IC2 the frequency is 1/(2.2*VR1*C3). (Strictly, this equation applies only when R2 and R3 are big enough to ignore - at least 5 times the VR1/VR2 settings. But it is close enough for this application). With VR1 at mid point (100kohm) and C2 of 100nF, the IC1 oscillator will run at about 45Hz, so the delay will be around 8192/45 seconds befor Q14 goes high and stops the clock. This gives a neat 180 seconds delay before the alarm sounds. This can easily be changed by scaling the values accordingly, but note that though the capacitor can have quite a large value it must be a non-polarised type. Current leakage though the oscillator input pin 11 limits the maximum resistor value, as it results in an offset voltage across the resistors. With VR2 at its mid point (100kohm again) and with C3 of 220p IC2 oscillator will produce about 21kHz, so the drive for LS1 from IC2 Q4 will be around 1290Hz. This will be divided down by 1024 to modulate the tone at around 1.26Hz.

The trimpots VR1 and VR2 can be replaced by fixed resistors, if no adjustments are needed when in use. This will make the circuit physically rather smaller, and the whole thing should then be no larger than the PP3 itself. Of the two, VR2 is the main candidate for a fixed value. It is given here as a variable because different piezo transducers have different resonant frequencies, and tend to have quite a narrow response bandwidth. The small ones prefer to be driven with something around1.5kHz to 2kHz. Of course, the modulation frequency changes directly with the audio frequency. When you know what value works best, replace VR2 with that fixed resistor. The switch allows you to silence the alarm manually. Use a momentary switch for just temporary silence, or a slide or toggle switch for a long term disable. To use temperature as the trigger rather than light, replace photodiode D2 with a NTC thermistor, and R1 with a value equal to the thermistor when it is at the alarm temperature. Note, though, that the smaller the values of these components the higher the standing power drain on the battery.