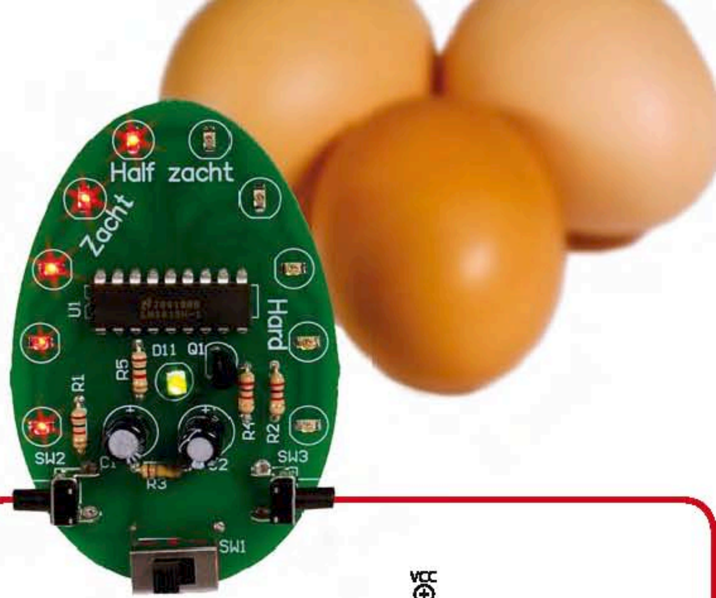
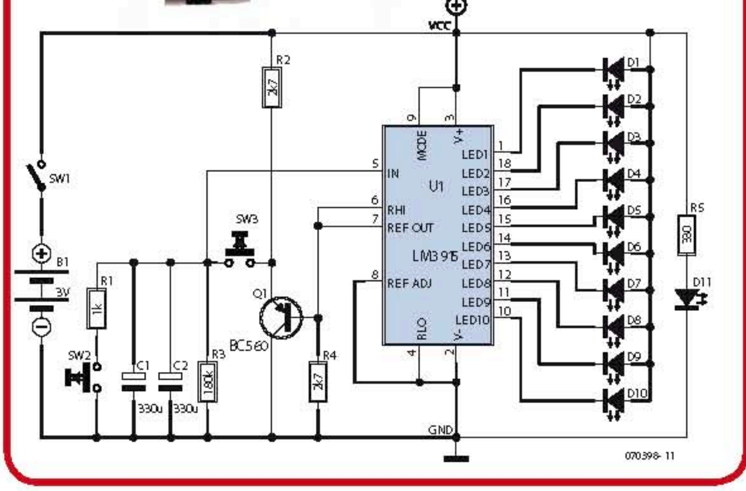
Schrödinger's egg

Design: Rob Reilink (The Netherlands)



Boiling an egg to give the correct yoke consistency is clearly a very serious business. Everyone has their own preference and it's a sure indicator of a bad day ahead when your breakfast egg turns out to be over or under cooked. Empires have crumbled, marriages failed and banking institutions brought to their knees all for the want of a perfectly cooked egg. OK so maybe we are guilty of over-egging the pudding slightly but the 'doneness' of a boiled egg is difficult to gauge, other foodstuffs are not so secretive; they change colour or yield to the prodding of a knife when they are cooked but a boiled egg just sits there in the pan gently bouncing up and down... A bit like Schrödinger's cat experiment we cannot know the state of the contents until the box/shell is cracked open. Unlike the fate of Schrödinger's cat we can predict the outcome by measuring cooking time. Providing the other variables (egg size, initial egg temperature) are constant measuring the cooking time should produce consistent results.

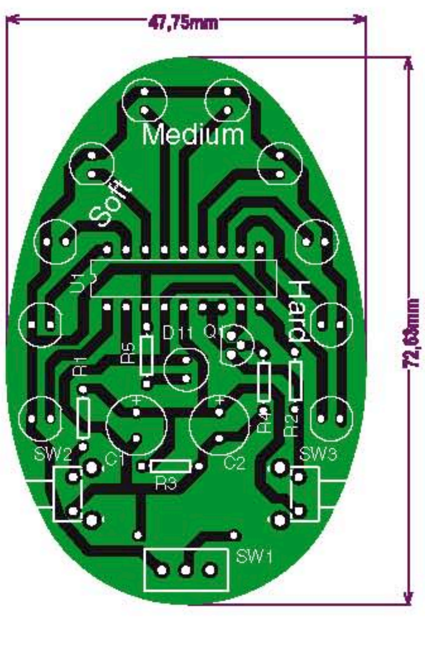


Kitchen timers come in all shapes and sizes the design here emulates the old clockwork wind-up versions with a pointer indicating the time left. Two pushbuttons are used to set the timed period, indicated by the number of LEDs illuminated. As the timer progresses fewer LEDs are illuminated until at the end of the timed period they all go out, indicating that the egg is perfectly cooked.

Thinking about how the circuit could be implemented you would probably begin with some digital timer/counter to provide an accurate time base and then add a few gates and drivers for the LEDs. You may even want to simplify the hardware more by using a microcontroller. Over the years we have seen many similar designs that have gone down this route but maybe there is an alternative solution?

As demonstrated here and using very few components we can also approach the problem from an analogue direction. A repeatable time base is produced by measuring the time it takes for the voltage in an RC network to decay.

The graph plot illustrates what happens when a charged capacitor C is discharged through a resistor R. The voltage does not fall linearly with time but instead traces a curve corresponding to the exponential function. If we were to set voltage thresholds every 0.5 V and measure how long it takes for the voltage to fall 0.5 V it is clear that in the first time period would be shorter than the second which in turn would be shorter than the third etc, not exactly ideal for a time base. The answer to this problem of non linearity is to use an LM3915 IC. This device is a dot/bar display driver for 10 LEDs. The input voltage level is connected internally to 10 comparators each with a different threshold voltage. The thresholds in the LM3915 are related exponentially so that they compensate for the discharge curve. The time period between each LED going out is now equal.



The RC network is made up from C1/C2 in parallel and R3. Two small capacitors in parallel are used here because they take up less space than a single larger capacity capacitor. Pushbuttons SW2 and SW3 are used for setting the time; a press on SW3 extends the time while a press on SW2 reduces the time. Once the desired number of LEDs are lit the buttons are released and the timer runs.

Transistor Q1 limits the voltage on C1/C2, without this measure the capacitor would charge up to the supply voltage and the first time period would be very long. Q1 limits the voltage to approximately 0.6 V above the internal reference voltage (Pin 7 of U1). R4 reduces the current drawn from the reference to 0.5 mA. The LED brightness is also defined by the current drawn from the reference voltage.

Using the layout diagrams given here it is possible to make your own PCB. The images can be transferred to a transparent film ensuring that the finished PCB outline measures 72.6 x 47.8 mm. A .pdf file for the layout can also be downloaded from the corresponding page of the Elektor website, just click on 'Layout' to open the file in Adobe Reader. Armed with a copy of the layout on film you should be able to get the PCB made up in an electronic workshop or PCB manufacturers assuming you do not want the bother of making it yourself. Construction can begin by first fitting the resistors then the capacitors followed by the LEDs and transistor. An 18-way socket can now be mounted to take the IC and lastly fit the pushbuttons and then on the back of the PCB fit the battery holder for the two AAA cells.

You can experiment with the values of C1/C2 and R3 to alter the maximum timing period.