The Wheel of Fortune

A solid-state design using 20 LEDs

There can't be many television networks worldwide that aren't running some version of the 'Wheel of Fortune' game show. You know the one where contestants spin the wheel and then wait with growing excitement to find out if they have won a fortune or lost everything. The wheels are also popular at fund-raising events and fairs. This electronic version is a lot handier and hasn't got any mechanical components to go wrong.

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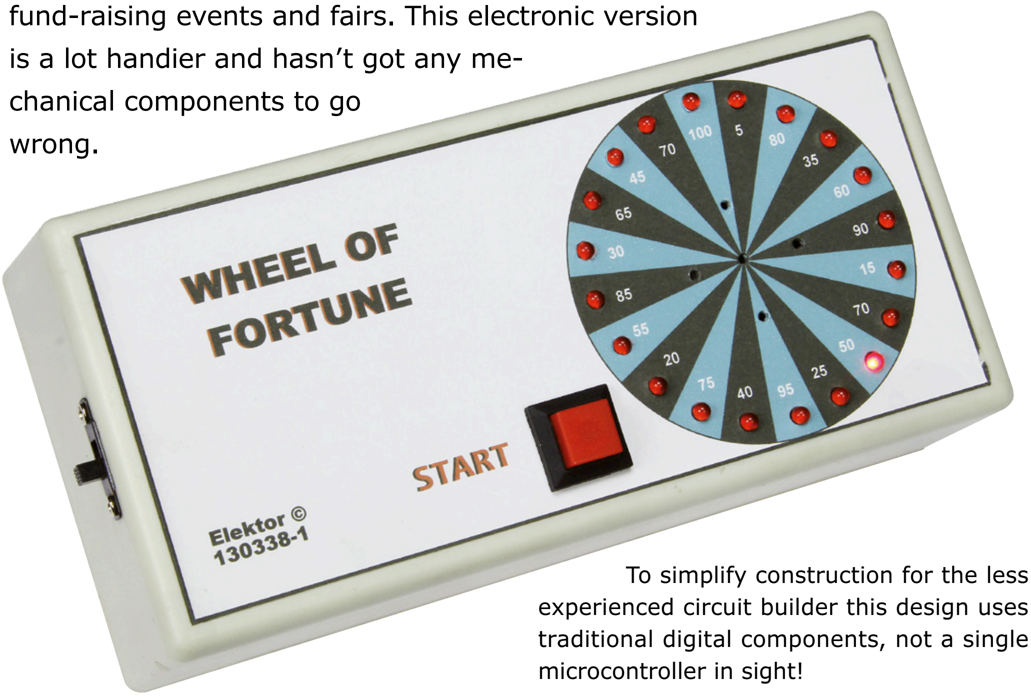

To simplify construction for the less experienced circuit builder this design uses traditional digital components, not a single microcontroller in sight!

The 'Wheel of Fortune' has been a popular game show format for many years, it introduces an element of chance and excitement as the wheel slows and we try to predict where it will stop. In case you have missed the program there are many variants on the theme, some use a big wheel divided into compartments with prizes or tokens inside and the contestant takes a turn at spinning the wheel, waiting in anticipation as it clatters to a halt with a pointer indicating which compartment to open to discover if they have won.
This project shows how you can make an electronic equivalent of the wheel of fortune using a circle of 20 LEDs that light up one after another. Just like the original mechanical version the rotating light pulse is accompanied by a clattering sound which gradually slows until the rotating light chaser stops.

The schematic

The circuit diagram is given in **Figure 1,** for a change we will begin by describing its function starting, not at the source of the circuit's signals but at its output i.e. the LEDs and ring counter. This part of the circuit is made up of IC3 and IC4.A. IC3 is a 4017 CMOS 5-stage Johnson counter. The clock signal connects to the counter's clock input (pin 14) and the reset and enable inputs (pins 15 and 13 respectively) are tied to ground so that the IC counts when it receives clock signals. At each rising edge of the clock the ten output pins Q0 to Q9 will sequentially be toggled to a high state one after another. After Q9 is high the counter cycles the high state around to Q0 at the next rising clock edge. The IC output stage can drive sufficient current to light the LEDs without the need for a buffer. Each of the LEDs anodes are connected directly to a Q output of the counter and the cathode of the ten LEDs are connected together via a series resistor to ground to make what is effectively a ten-LED light-chaser circuit.

A Wheel of Fortune with just ten LEDs is a little bit mean so we use a trick here so that we can double the number to twenty. The carry out (CO) signal (pin12) is used to alternately switch between two banks of ten LEDs. This output is intended to be used as a control signal when counters are cascaded; it goes high when output Q0 goes high and low when Q5 output goes high. The CO signal is used here to clock a D-type flip flop type 4013 (IC4.A). A rising edge on the CLK input is active and the $\overline{Q}$ output (pin 2) is wired to the D input (pin 5) to form a toggle or divide-by-two configuration. At each rising edge of the CLK input the two outputs Q and $\overline{Q}$ swap state. It can be seen from the circuit diagram that these two outputs are used to switch transistors T4 and T5 so that they alternately enable a bank of ten LEDs by switching their common cathode to ground. The effect is that one bank of ten LEDs display the light-chasing effect generated by the outputs of IC3 then the effect is continued on the other bank when the CO output causes the flip flop to switch state.

We now go back further to the clock generator source which drives the 4017. This consists of the familiar 4060 (IC1) 14-stage binary counter which includes a built-in oscillator

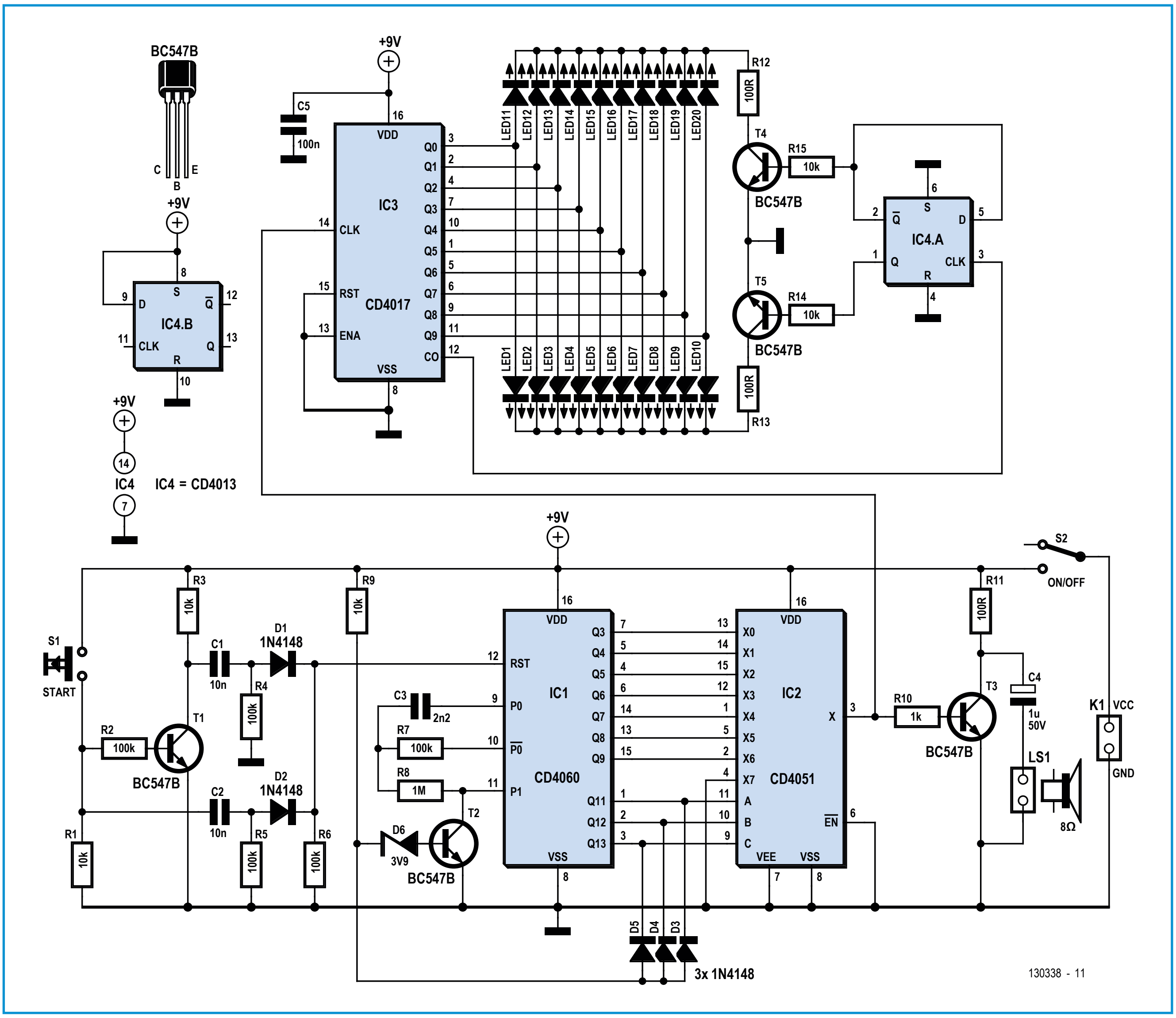

Figure 1.
The wheel of fortune goes electronic!

stage. Its oscillation frequency is governed the value of resistor R7 and capacitor C3 which with the values given produces a frequency of around 450 Hz. Not all of the divide-by-2 counter outputs are available at an output pin; we can only access Q3 to Q9 and Q11 to Q13. The signal output from Q3 (pin 7), is from the fourth divider in the chain so it outputs a signal of 450 / 16 = 28 Hz; while output Q4 (from the fifth divider) gives a signal of 450 / 32 ≈ 14 Hz and so on. If during the spin process we successively select clock signals further down the divider chain to clock the ring counter then we will get the effect we need: that of a wheel slowing down and then eventually coming to a halt.

Here we use an eight-channel multiplexor type 4051 to select which clock signal is routed through to IC3. The logic signal levels on inputs A, B and C determine which of the inputs is routed through to the output (X). Outputs Q3 to Q9 of IC1 connect to X0 to X6 of IC2 and Q11 to Q13 of the 4060 are used to select the input. When push button S1 is pressed the 4060 is reset (we shall come back to this in a moment) and begins counting. At start up all the outputs will be low so inputs A to C of IC2 will be low which causes the signal on input X0 (about 28 Hz) to be routed through to the output to drive IC3. After a little time output Q11 will go high and IC2 then routes the signal on X1 (about 14 Hz) through to drive IC3. As the binary value on inputs A, B and C increases the multiplexor will select lower frequency clock signals until A, B and C are all high. When this happens input X7 will be selected which isn't a clock signal but is instead connected to ground so the counter IC3 and the rotating-wheel effect stops. To ensure that IC1's oscillator also stops at the same time three diodes D3, D4 and D5 are wired to form a discrete AND gate; only when Q11, Q12 and Q13 are all high the node at R9/D3/D4 and D5 will go high and via zener diode D6, switch on transistor T2 to pull the P1 input of IC1 to ground, masking the clock signal input and stopping this counter. IC1 now remains in this condition until it is reset.

The design of the sound generator part of the circuit is really simple. We have already shown how the variable (decreasing) clock signal produces the rotating light chaser and now we use this same signal to also control a transistor which drives a loudspeaker to make a click sound. In the diagram this part is made up of T3, LS1 and associated components. Capacitor C4 blocks DC current through the loudspeaker via R11.

Continuing on the reverse cause and effect sequence to explain the circuit operation we finally get to the start and reset behavior of the circuit. From above we saw how the oscillator stops when the wheel effect comes to a halt. To start the wheel spinning effect again it is only necessary to reset IC1 by taking its RST input (pin12) high. For that we could just use a pushbutton and resistor. Using this simplistic solution the wheel spin time would be the same each time you press the start button and that would not be exactly random and not the effect we want. How did we get round this? After switch on the wheel goes through a spin sequence and then stops waiting for a start/reset signal. Counter IC3 will have stopped at an arbitrary value. The additional circuitry ensures that it will not be possible to predict where the wheel stops once you press the start button. We could of course have built a true random generator circuit but that would require additional hardware. The solution used here uses fewer components and takes into account the length of time you hold the start pushbutton down (which is effectively a random time period). The circuit resets the 4060 twice; once when the pushbutton is pressed and once when it's released so the wheel spins for a random time as you would expect a real wheel to.

The components used to produce this double reset are all centered on transistor T1. When pushbutton S1 is pressed a positive-going edge is transferred via network C2, R5 and diode D2 to the reset pin, producing the first reset. At the same time the positive level at T1's base makes it conduct so that the C1/R3 node is pulled low. When S1 is now released T1 turns off, its collector voltage goes high and this rising edge is transferred to the reset pin via network C1, R4 and D1 to generate the second reset pulse at push button release.

Putting the wheel together

The layout for the complete circuit (**Figure 2**) is available as a double-sided PCB from the Elektor shop and all the files to produce your own are available to download for free [1]. Populating the board shouldn't pose too many problems because we have only used thru-hole leaded components. Stick to the usual sequence of mounting: PCB pins and headers, connectors then any sockets for components or ICs, resistors, diodes/LEDs, capacitors and then finally the ICs. Make sure that the LEDs are fitted at the correct distance from the board. The actual spacing will depend on how you plan to finish the wheel. The accompanying photos will give you a good idea how we built the prototype. A good tip for mounting the LEDs is to first only solder one lead of each LED, this allows you to assemble the unit and make sure all LEDs are at the right distance. It's much easier to make adjustments when only one lead is soldered and means there is less chance of overheating an LED. When everything is in order go back and solder the remaining LED leads. An example front panel for the wheel of fortune is shown in **Figure 3** which is available as a .pdf file (130338-11 at [1]). The 20 LEDs are positioned so that they protrude through the enclosure lid and the speaker can be mounted behind some holes to allow the sound out. The on/off switch and start pushbutton can be mounted on the enclosure and connected to the corresponding points on the PCB using short lengths of wire. A 9 V battery is used to power the unit, with only one LED lit at any one time the circuit doesn't use much energy and it will generally not be in continuous use.

The circuit needs no set up or adjustments just make sure that all components are correctly fitted and the ICs are properly orientated in their sockets. Connect the bat-

Parts List

Resistors:

R1,R3,R9,R14,R15 = 10 k
R2,R4..R7 = 100 k
R8 = 1 M
R11..R13 = 100 Ω
R10 = 1 k

Capacitors:

C1,C2 = 10 n
C3 = 2n2
C5 = 100 n
C4 = 1 µ/50 V radial

Semiconductors:

D1..D5 = 1N4148
D6 = zener diode 3.9 V/500 mW
T1..T5 = BC547
LED1..LED20 = LED red, 5 mm
IC1 = CD4060
IC2 = CD4051
IC3 = CD4017
IC4 = CD4013

Odds and ends:

S1 = PCB mount push-button (e.g.Multicomp MCDTS2-1R, Farnell-No. 9471669)
S2 = 3-pin PCB-mount switch with 2.54 mm pin spacing, on/off switch
K1,LS1 = 2-way pin header
Miniature 8 Ω loudspeaker (e.g. Visaton FR8)
9-V PP3 battery with connector
Project case, 150 x 70 x 50 mm (approx), with integrated PP3 battery compartment.
PCB ref. 130338-1 [1]

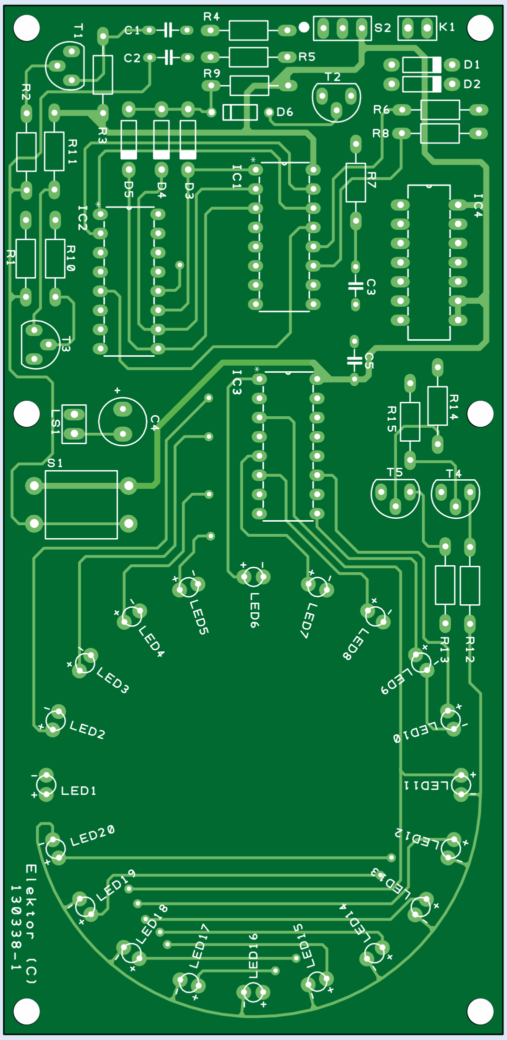

Figure 2.
All components including the 20 LED's fit on the double-sided PCB. On the prototype the start push button is fitted to the case instead of the PCB.

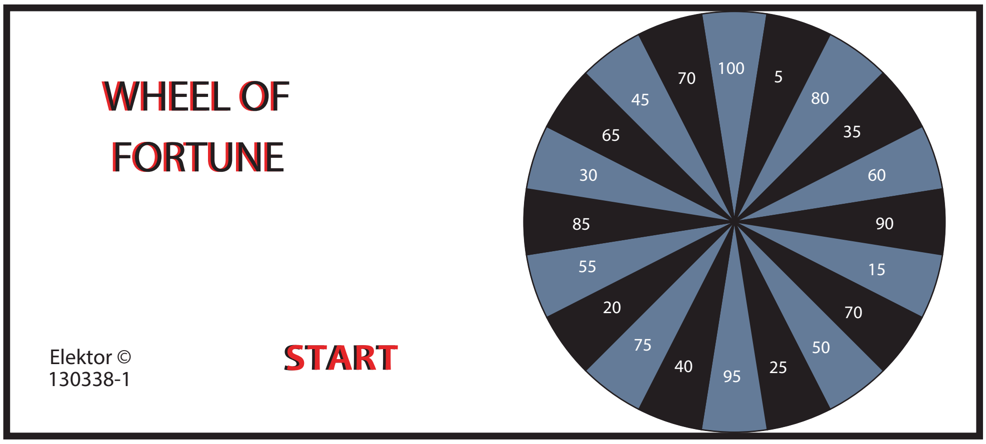

Figure 3.
A front panel design for the wheel of fortune (90% full size). You can of course make your own version with your choice of values or prizes in the segments.

tery and switch on, if everything is in order the Wheel of Fortune will immediately start working. You can alter the operating speed slightly by changing the values of R7 and/or C3 (smaller capacitor value will make it spin faster, larger capacitor, slower).
Good luck with your very own Wheel of Fortune!

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Web links

[1] www.elektor-magazine.com/post

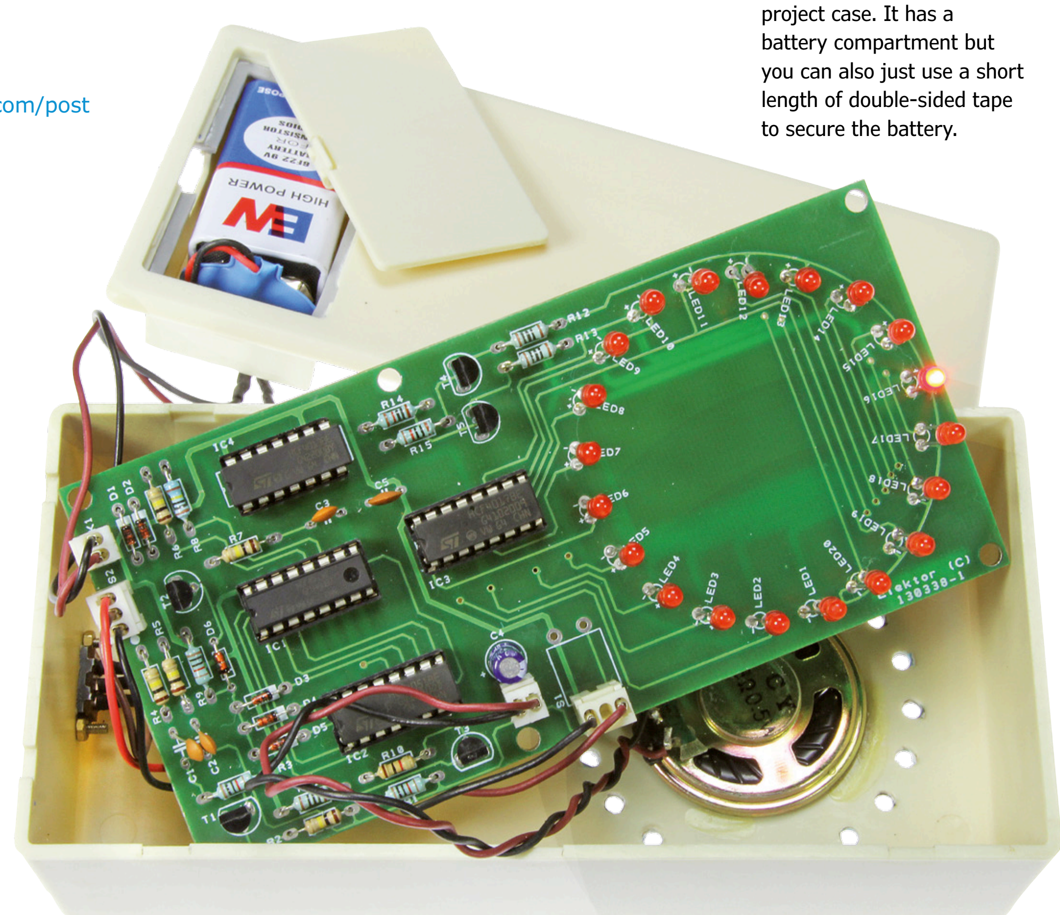

Figure 4.
The complete circuit fits neatly into a standard project case. It has a battery compartment but you can also just use a short length of double-sided tape to secure the battery.