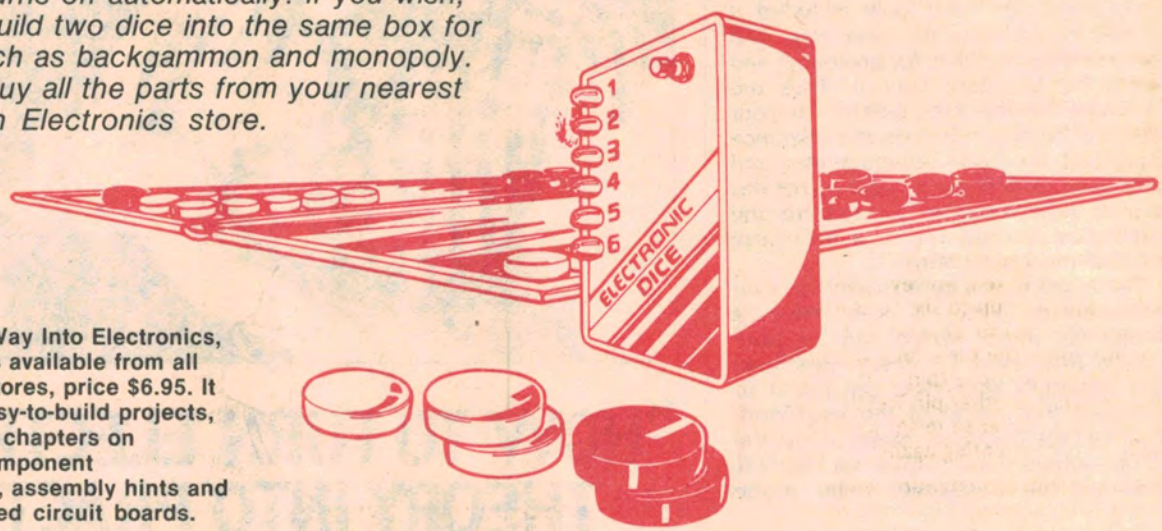
Simple Electronic Dice

Here's another great project which we've reprinted straight from Dick Smith's "Fun Way Into Electronics, Volume 2". It's an electronic dice that not only "rolls" and displays the result but then turns off automatically! If you wish, you can build two dice into the same box for games such as backgammon and monopoly. You can buy all the parts from your nearest Dick Smith Electronics store.



Note: "Fun Way Into Electronics, Volume 2" is available from all Dick Smith stores, price $6.95. It details 20 easy-to-build projects, and includes chapters on soldering, component identification, assembly hints and making printed circuit boards.

you will need these components

Resistors:

R1 22k ohms
R2 220k ohms
R3 1k ohms

Capacitors:

C1 .022uF ceramic
C2 33uF 10 volt electrolytic
C3 4.7uF 16 volt electrolytic

Semiconductor devices:

LEDs 1 – 6 small red LEDs
D1 1N4001 diode
IC1 555 timer integrated circuit
IC2 4017 CMOS decade counter integrated circuit
TR1 DS548 or similar NPN transistor

Miscellaneous:

PB1 Momentary contact press button switch
Battery snap, hook-up wire, solder, etc

You will also require a 9 volt transistor battery (not normally supplied with a kit) or some other DC power supply.

A suitable mounting board or printed circuit board of correct design (see text). DSFW2 K-2625 Electronic Dice kit contains the correct PCB.

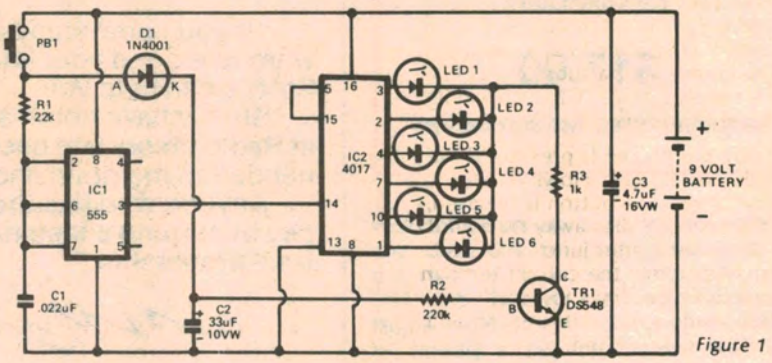


Figure 1

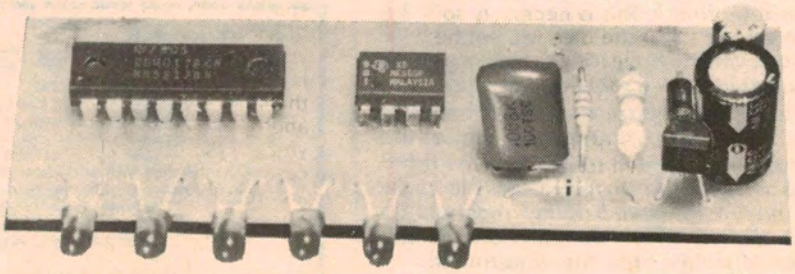


Figure 2

how it works

When the push button switch PB1 is pressed, power is supplied to C1 via R1. C1 gradually charges, until a certain voltage is reached where IC1 conducts, supplying a pulse to IC2 at the same time as it discharges C1. C1 then starts to charge again, repeating the process.

The combination of R1, C1 & IC1 is called a 'relaxation oscillator', as every time a pulse occurs, the circuit 'relaxes', ready to start over.

IC2 is a counter, which simply detects the pulses supplied by IC1 and counts them. It shows how many pulses it has counted by causing a LED to glow representing that number. This IC can, in fact, count to ten; however, we want it to count up to six. So instead of causing a LED to glow on the seventh pulse, the pin which would be used for this purpose (pin 5) is connected to another pin which causes the counter to re-set to zero, ready to start counting again.

The counter keeps counting while pulses keep arriving. When the push button is released, the oscillator stops and no more pulses are received. The counter then shows what it had counted to at that particular instant.

Because we do not want the LED to stay on indefinitely (wasting the battery), a separate circuit causes the LED to go out after a short time. This circuit consists of D1, C2, TR1 and its associated resistors.

Whilever the button is pressed, C2 is charged via D1. This allows TR1 to turn on. When the button is released, the charge in C2 dies away through R2 and the base/emitter junction of TR1. After a short time, the current through the transistor becomes too small to keep it conducting, so it turns off and the LED is extinguished.

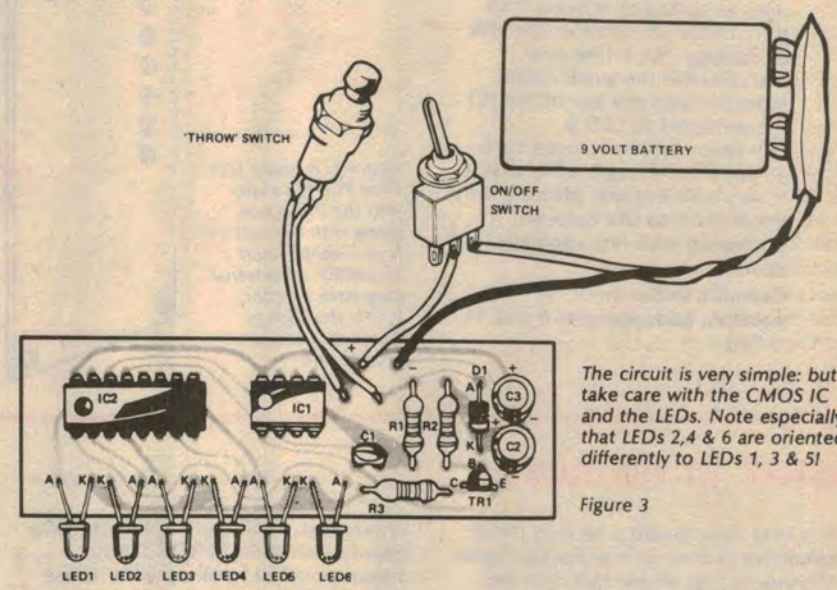
With the .022uF capacitor shown, the LEDs will flash in sequence so quickly that they all appear to be on at once (although dimly). This is necessary so that anyone using the dice will not be able to cheat by releasing the button at a certain time to obtain a certain number.

Increasing the value of R1 and/or C1 will cause this speed to slow down, due to the longer charging time required. Wired as a flashing brooch, with a 3.3uF capacitor in C1 and a link across the 'PB1' pads, the LEDs will flash slowly in sequence as long as the battery is connected.

putting it together

(1) If you have purchased a kit (Dick Smith Cat. K-2625 or similar), check off the components against the above list to make sure they are all there and are the correct types and values.

(2) If you have not purchased a kit you will need to obtain the components listed and either make a printed circuit board using the component position drawing as a guide, or use perforated or tracked board.



The circuit is very simple: but take care with the CMOS IC and the LEDs. Note especially that LEDs 2,4 & 6 are oriented differently to LEDs 1, 3 & 5!

Figure 3

(3) Mount the components as shown in the component position drawing, resistors and capacitors first, being careful to mount C2 and C3 capacitors the right way around as they are polarised. If you are building the brooch, C1 is also an electrolytic and requires the same caution as C2 and C3 in mounting. It is possible that in some cases you will have an axial electrolytic to mount on the PCB. If there is space provided between the holes you can mount it flat as you would a resistor, but if there is not, stand it up as shown in the section on 'Assembly hints and tips'. Take extra care that you get the polarity right in this case. Check that all components are neatly placed and properly 'dressed' before soldering them in.

(4) Solder in the six LED's making sure that they are the correct polarity – remember that the short lead is the cathode (K) also marked by the flat side of the LED. Keep all of the leads the same length to facilitate mounting in a box if you wish to do this later on, as described in **'What to do Next'.**

(5) Solder in D1 after making sure that you have it the right way around, that is, with the banded end nearest TR1.

(6) Solder in TR1, taking care that it is the correct polarity and using a heatsink clip to prevent damage from overheating. Note that the base of TR1 connects to R2. Be particularly careful when soldering on this board as some of the tracks and pads are very close.

(7) Now IC1 the 555 timer integrated circuit. This may be the first IC you have ever soldered in but don't worry, just follow the steps; insert the IC into the holes on the PCB until the shoulders on the pins prevent it from going further; make sure it is the right way around by noting that pin 1 (the one marked with the small circle indented into the top of the IC) is connected to the negative track on the PCB; then turn the PCB over and carefully solder each of the pins to the pads, making sure that you don't run solder between the pads. See **How to Solder,** for the correct method of soldering an IC. When soldering is complete inspect the connections, making sure that you've soldered them all without shorting any of the pads and that's it. Easy wasn't it?

putting it together . . . continued

(8) The 4017 integrated circuit is a CMOS device and therefore very sensitive to static electricity. This is why it is supplied already stuck into special conducting foam which shorts out all the pins and prevents damage from static charges. **Leave it in the foam until you are actually ready to solder it in.** Then, being very careful not to touch the pins, insert the IC into the holes provided making sure you place it the right way around the first time as having to remove it to turn it around increases the risk of damage. Pin 1 (the one marked with the small circle indented into the top of the IC) is connected to LED 6.
The reason we have used such an apparently fragile IC is that it is very efficient and places a very small drain on the battery compared with less sophisticated devices.
Carefully solder the IC in position, soldering pins 8 and 16 in first.

(9) Solder on the press button wires and connect and solder them to the PCB to the pads marked PB1. You are now ready to connect and solder the battery snap wires, taking care to see that you have the correct polarity – red, positive, to the pad marked '+' and black negative to the pad marked '–'.

(10) After checking that all components are correctly inserted and soldered, connect the battery and check that the circuit works by pressing the button. All LEDs should appear to come on dimly; one should come on brightly when you release the button, then slowly die out.

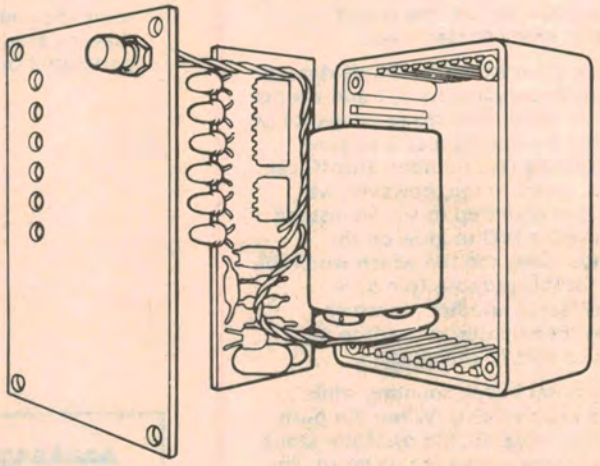


Figure 4: A single LED Dice PCB fits easily into the Zippy box; along with the battery. If you want to add a socket for an external plug-pack adaptor, follow the wiring diagrams given in project one.

what to do next

It is very easy to add a second DICE circuit for games such as Backgammon, Monopoly, etc, where two dice are normally thrown at one time.

Of course, we could simply build a second dice, identical to the first, and press both buttons at one time. But this is inconvenient.

Our method of mounting the second dice avoids the second push button and, indeed, a few other components by 'sharing' some of the functions between the two dice.

Obviously, we cannot share the oscillator components or the counter, as we would simply get a duplicate reading between the two dice. So two individual oscillators and counters are provided, giving two completely random numbers. (Because of the 'tolerance' of components, the two oscillators will run at different speeds, even though we use components of nominally the same value).

To build the dual dice, you will need to build two kits. The first is exactly as per the instructions above (you could use your single dice if you wish). The second is virtually identical – but leave out D1, C2 and C3, as well as the wires to the switch and battery.

Where shown in figure 5, link the two boards with short lengths (about 30mm or so) of hook-up wire. These links should come from the component side of the second board, to the copper track side of the first board. It is fairly easy to solder to the copper pads – just make sure that you don't solder across to another pad and short circuit it.

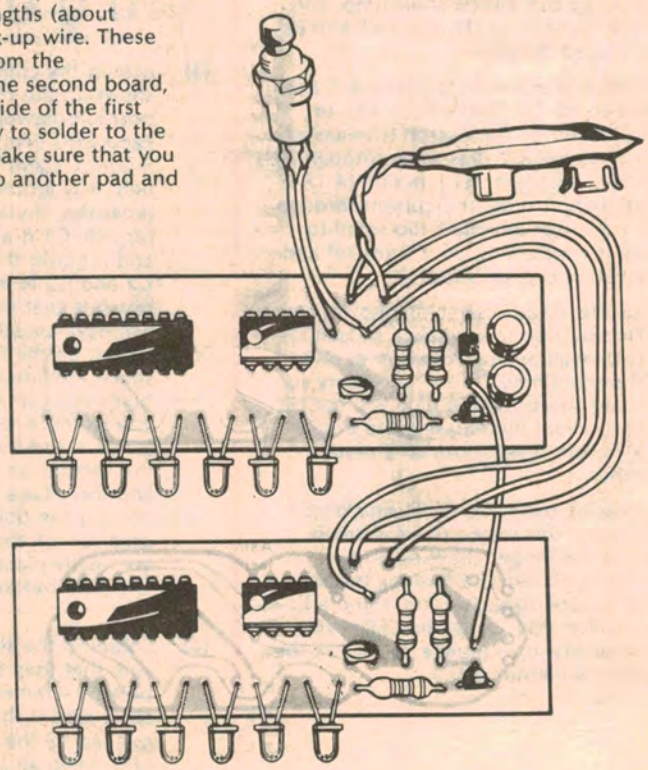


Figure 5: Wire the double LED Dice like this. As you can see, there are a number of components not needed on the second PCB.