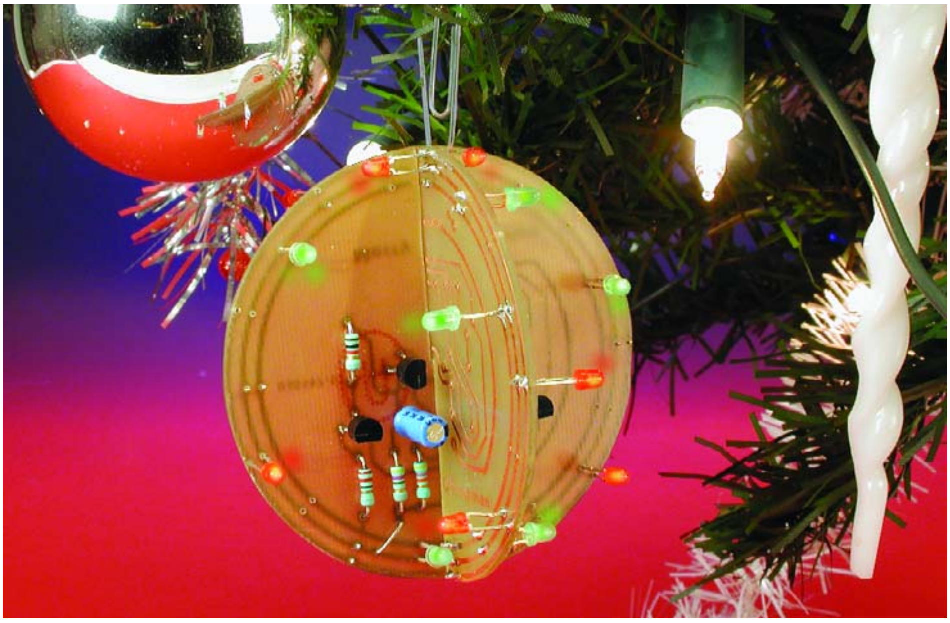
LED Christmas Decoration

A novel ornament

Design by M. Gaudin

As this issue comes through the letterbox, it's around the time that the Christmas decorations are taken out of the attic. And if you hurry up there is just enough time to add a homemade electronic ornament to your tree. This article shows you how to do just that



It has become something of a tradition that the December issue of *Elektor Electronics* includes a project for some kind of distinctive Christmas decoration. Since a true electronics hobbyist should not be content with a standard Christmas ornament, we have provided the opportunity to add a personal, homemade touch.

An electronic Christmas ornament generally falls in one of two camps: either it produces suitable sound effects or it produces light effects. A 'suitable sound effect' during these festivities quickly becomes a full-fledged rendition of a Christmas song, and this cannot be easily accomplished without the use of dedicated ICs. For this reason the optical variant is usually chosen.

Even these can be made as complex as you like. A few years ago we took this route and designed a microprocessor controlled lights effect generator that had much to offer. But gauging from their reactions, it appears that most readers would prefer a simpler design for Christmas decorations. So this time round there is no complex circuit, no processor and no software, but just some simple electronics that can be constructed by anybody. The shape of the design makes it particularly appealing.

An astable

A quick glance at the circuit diagram in **Figure 1** confirms that this really is a very simple circuit. Four transistors, a row of LEDs, two batteries for the supply, and that's about it. We would almost call it child's play.

At the heart of the circuit are T1 and T2, configured as an astable multi-vibrator, which is usually called an 'astable' or 'AMV'. One of the two transistors in this circuit is always conducting, while the other is blocking. However, due to the regular charging and discharging of electrolytic capacitors C1 and C2 the conducting and blocking states of the transistors alternate as regular as clockwork. The circuit therefore doesn't have a stable state and so really lives up to its name. It is in fact a square wave oscillator, and circuits such as those round T1 and T2 are therefore often used as simple clock generators.

The only difference with those clock generators is that they usually operate at frequencies of several KHz or more, whereas in our astable the RC time-constants of R6/C2 and R8/C1 have been chosen to give a low enough frequency that is visible to eye.

The collectors of T1 and T2 are connected to two driver transistors. They switch two rows of parallel-connected LEDs, which will light up alternately at the oscillator frequency. The frequency at which D1-D9 and D10-D18 alternately light up is about 2 Hz. Should you find this too fast or too slow, you can easily modify this by increasing or decreasing C1 and C2 respectively.

Resistors R4 and R2 are used to set the current through the LEDs. It

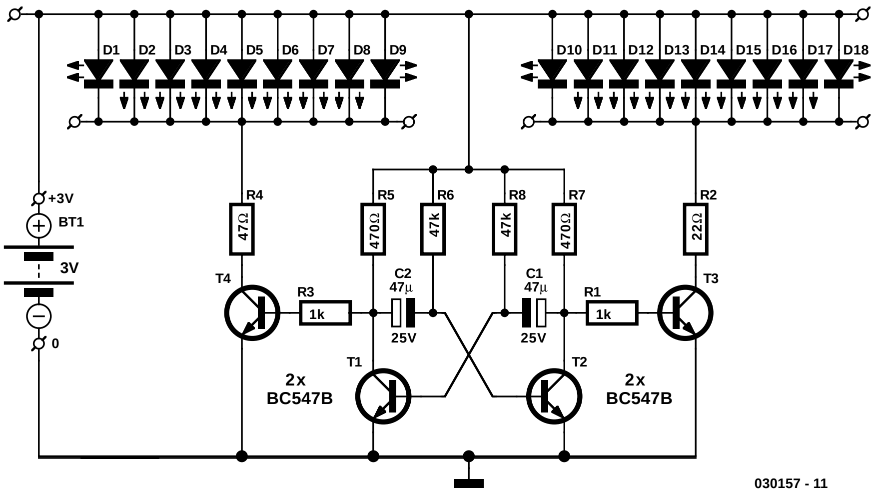


Figure 1. The electronics in the bauble is limited to an astable multivibrator driving two groups of LED.

is noticeable that these resistors are unequal in value. The reason for this is that D1-D9 are red LEDs and D10-D18 are green LEDS.

These types of LEDS have two different characteristics. Firstly, the brightness of green LEDS is clearly less than that of the red ones. Secondly, the forward voltage drop across green LEDs is greater than that of red ones, so there is less of a voltage drop across R2 than across R4. R2 has therefore been given a smaller value so that a large enough current flows through the green LEDs.

COMPONENTS LIST

Resistors:
R1,R3 = 1kΩ
R2 = 22Ω
R4 = 47Ω
R5,R7 = 470Ω
R6,R8 = 47kΩ

Capacitors:
C1,C2 = 47µF 25V radial

Semiconductors:
D1-D9 = LED, high-efficiency, red
D10-D18 =LED, high-efficiency, green
T1-T4 = BC547B

Miscellaneous:
Two penlight (AA) batteries
Battery holder for above
PCB, order code **030157-1**, see Readers Services page

PCB

As we said earlier, what makes this circuit special is its PCB design. Since we wanted to make a bauble, the PCB obviously had to be adapted for that. **Figure 2** shows the result: a circular PCB in a 'bauble like' form, finished with a festive white lacquer on one side and for the occasion it has silver tracks. The control circuit is in the centre of the board, with the LEDs mounted along the outer edge. Along this edge are three circular tracks; the middle one is the positive supply, which goes to the anodes of all LEDS. The outer track is connected to the cathodes of the red LEDS and the inner track is for the

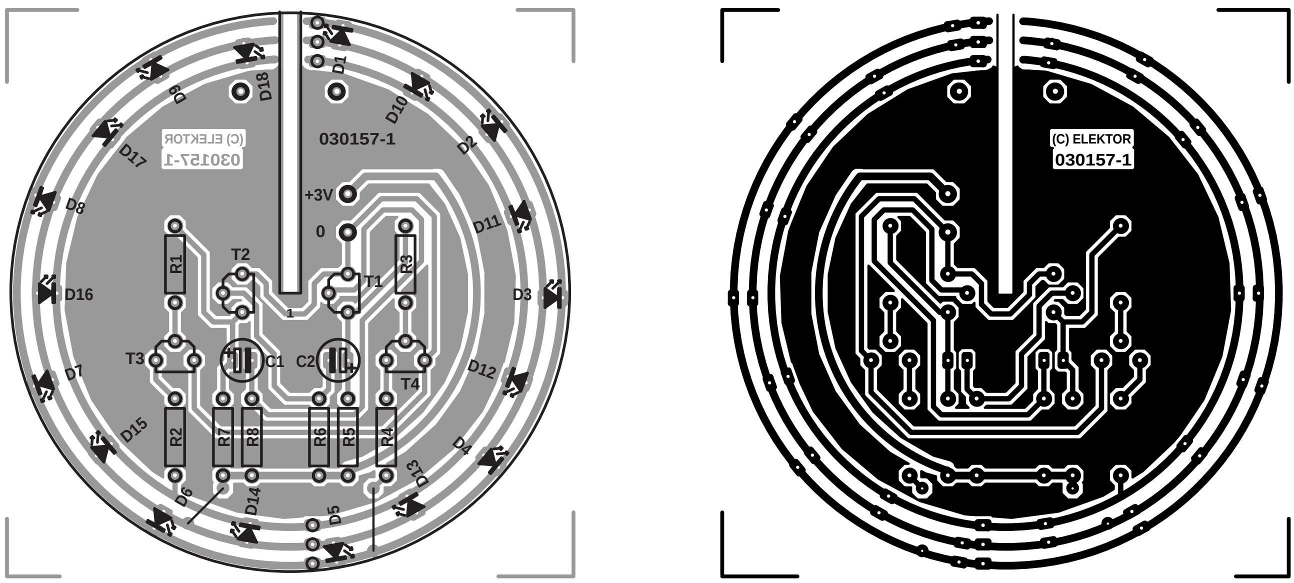


Figure 2. The PCB is shaped like a bauble, has an appropriate colour and can be extended with a second board.

cathodes of the green LEDs.

We found that the best effect was obtained with red and green LEDs mounted alternately on the board. You may also mount the LEDs on the track side, as well as on the component side. Do take care that you don't accidentally connect red and green LEDS in parallel, because the lower forward voltage drop of red LEDs will make just the red LEDs light up.

A noteworthy feature of the board is the provision of a slot, so that a second PCB can be inserted at right-angles, giving the bauble a three-dimensional shape. The second PCB should only contain the LEDs and the three circular tracks on both PCBs should be connected in parallel using two rows of three wire links. The PCBs already have holes for these. The main photo with this article shows clearly how this is done.

With two PCBs, the maximum number of LEDs obviously increases from 2 × 9 to 2 × 18, which affects the values of resistors R2 and R4. When using the maximum number of LEDs (2 × 18), R2 should be reduced to 15 Ω and R4 to 33 Ω. However, when using two PCBs a good effect may also be obtained with fewer LEDs. On our prototype we spread them out evenly and ended up with 12 LEDs per board. The values given in the circuit diagram for R2 and R4 are still suitable for use with this number of LEDs.

Supply

As can be seen from the circuit diagram, the circuit requires a supply voltage of 3 V. Since the current consumption is fairly modest, the electronic bauble can easily be powered by two AA cells. Our prototype with 2 x 12 LEDs had an average current consumption of about 35 mA, so two alkaline cells with a typical capacity of 1500 mAh should last for up to 50 hours. If that is insufficient, you could always use a stabilised 3 VDC mains adapter.

And finally

Unfortunately, in practice there is a noticeable deviation in brightness between LEDs. If you want to make sure that all LEDs have a similar brightness it may be best to buy a few extra and select the best ones. This is easily achieved using a small stripboard with an IC socket and a series resistor of either 47 Ω or 22 Ω to the 3 V supply. If you place several LEDs in the socket at the same time you can see clearly how well their brightness matches.

One thing we should mention about the PCB. If you look closely at Figure 2, you'll see that there are two wire links: one from the outer circular track to R4 and one from the middle circular track to R7. Don't forget these wire links; otherwise the circuit will certainly refuse to operate! One final remark: since the boards weigh very little it is perfectly safe to hang them up from the battery cables. However, for completeness the PCB also has two extra holes for a 'real' cord.

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