LED source for optics (cover story)

We describe the design of an array of 10 LEDs providing you with a source for many types of experiments in optics.

This idea of using an LED array as a source for the pinhole camera and other experiments in optics is the result of looking for a substitute for traditional sources such as the candle flame and carbon filament lamp. We are not alone in coming up with this invention. Se-yuen Mak [1], the able Chinese experimenter, pipped us in getting the idea published first.

Our light source has an array of 10 LEDs (Table 1) laid out in a pattern of the capital letter 'F', this character being chosen because of its top-bottom, left-right asymmetry. In the illustration (Fig. 1 & front-cover), the LED source is shown with a converging lens producing a real image on a paper screen. The lab need not be blacked out for the source is sufficiently bright to be usable in daylight.

The LEDs were mounted on 0.1" stripboard (72 mm high by 45 mm wide), whose strips run vertically. To minimise the number of cuts in strips and interconnections, two sets of 5 LEDs were each wired in parallel, and the two sets were wired in series with a 22 Ω resistor across a 5 V dc regulated power supply (Fig. 2). Thus there is about 1.9 V dropped across each LED and about 1.2 V across the resistor. The LEDs conduct about 10 mA each.

When wiring LEDs in parallel, all 10 LEDs must be taken from the same batch to ensure that each one matches the others for the same forward voltage.

Colour	Order code	Price (£)	Luminous intensity (mcd)	View angle (°)
Red – water clear	77-8976	0.18	2500	50
Orange – water clear	77-8972	0.18	2000	50
Yellow – water clear	77-8974	0.18	1300	50

Table 1 - Recommended choice of LEDs – all from Rapid Electronics.

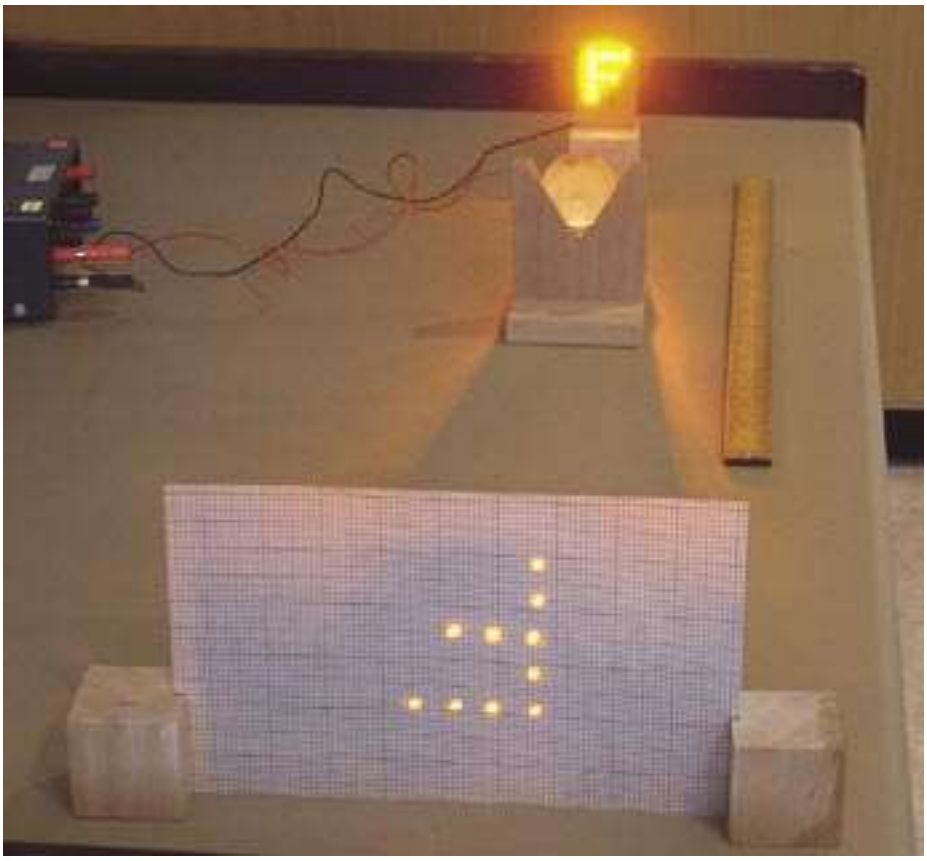

Figure 1 - A real inverted image of the letter 'F' with a LED array source and converging lens.

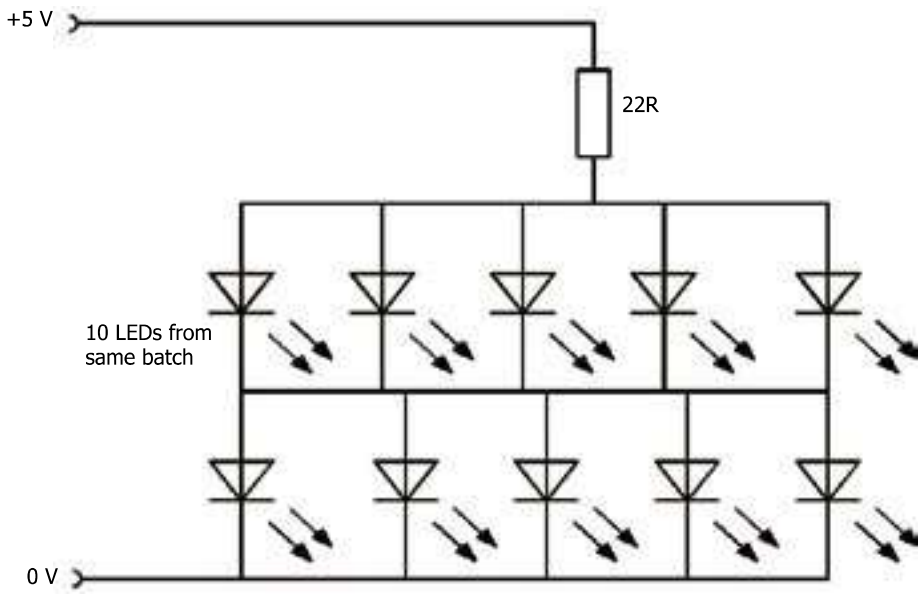

Figure 2 - Circuit diagram for a 5 V dc supply.

The vertical and horizontal separation between adjacent LEDs is 0.3" (Fig. 3). The 5 LEDs making up the vertical stroke of the 'F' are all in parallel. It can be seen that they are soldered across adjacent copper strips. Of the remaining 5 LEDs that make up the horizontal strokes of the letter 'F', 2 pairs are wired across adjacent strips and one LED, the top-rightmost of the 'F', is on its own.

The height above the benchtop of the letter 'F' source was determined by the lens holder we decided to work with. Having chosen to work with 50 mm diameter lenses held in the Harris lens holder B8A45408, this set the height of the optical axis at 90 mm. Furthermore, having chosen to mount the stripboard on a mirror support block (Harris, B8A44593), which measures 50 x 50 x 50 mm, the bottom of the stripboard when lodged within the support's slot is 44 mm high. This results in the mid-point

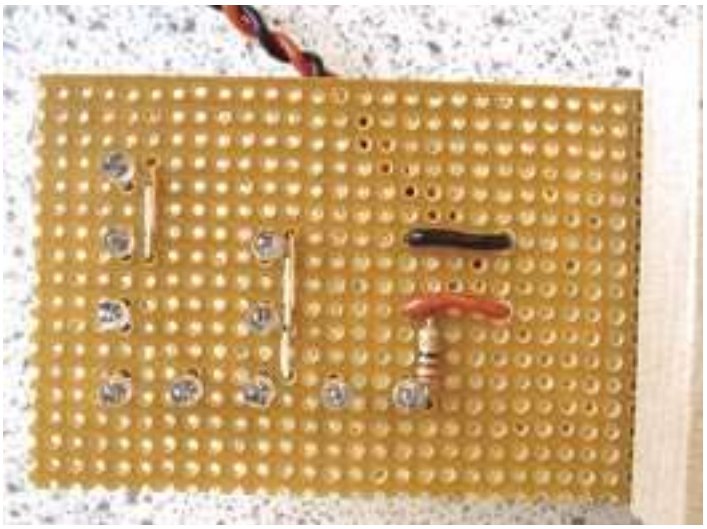

Figure 3 - Front view of stripboard with 10 LEDs forming the letter 'F'.

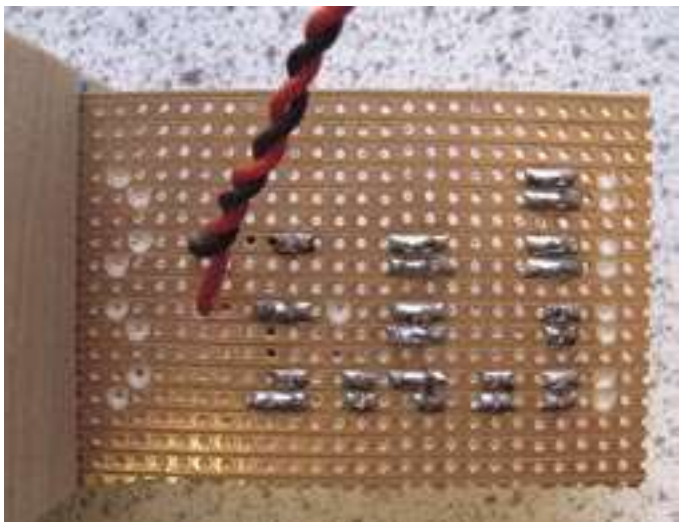

Figure 4 - Rear view showing layout, track breaks & interconnections.

of the letter 'F' being 46 mm above the bottom edge of the stripboard (Fig. 5) (or 18 0.1" holes).

Other designs

The main design criteria are:

1. Array shape: Numeral '4' is also suitably asymmetric, but the spacing between LEDs on the diagonal stroke is not in a simple ratio.

2. LED colour: The forward voltages of red, orange, yellow and yellow-green are less than or near to 2 V whereas for other colours they are 3 or more volts, requiring a different supply voltage and resistor, or a different circuit.

3. Power supply: The circuit should be designed around the chosen power supply, which is needed in class set numbers. For instance, if you choose to work with a 3 V battery of two 1.5 V cells, all 10 LEDs should be connected in parallel and wired in series with a 4.7 Ω resistor to the battery. But the battery current would be 100 mA, which is rather hefty. A better choice would be a 4.5 V battery of three 1.5 V cells and the circuit as here in Figure 2 except that the resistor value should be reduced from 22 Ω to 15 Ω.

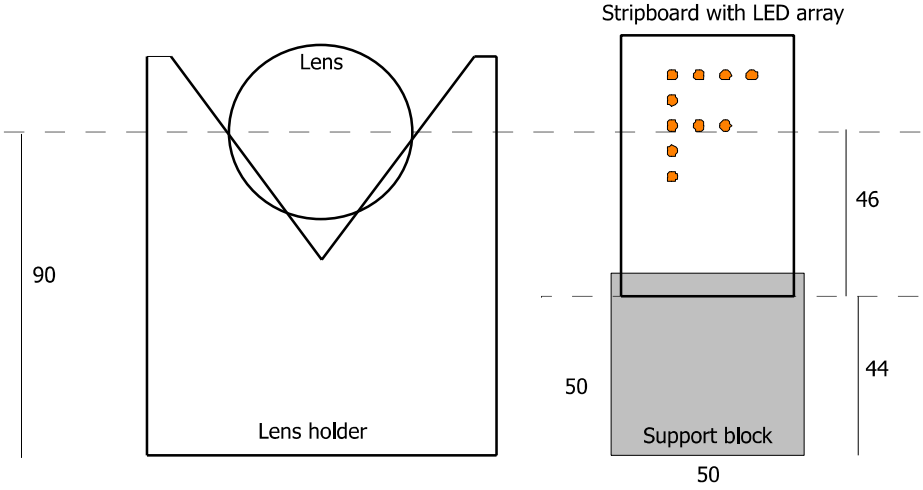

Figure 5 - The lens and lens holder set the height of the optical axis (dimensions in mm).

4. Lens and lens holder: The mid-point of the source should be at the same height as the mid-point of the lens, and depends on what type of lens holder you decide to use.

Applications - light source for :

- studying lenses and mirrors.
- use with the pinhole camera.
- use with a diffraction grating to measure the wavelength of light.

Reference

1. Se-yuen Mak, *A multipurpose LED light source for optics experiments*, The Physics Teacher, 42, 550-552, (December 2004).

SafetyNet CD - this year's update now being distributed.

Another year has gone by and this year's update of the SafetyNet CD should be winging its way to you by now. To the uninitiated the CD gives you most of what can be found on the Members area of the SSERC website on a single disc - no problems with web access! Why not mount it on your school or authority intranet so that the information is easily available to all. Just make sure that the information isn't accessible on the web. For up-to-the-minute information you can still access the SSERC website :-

http://www.sserc.org.uk/members/SafetyNet/Safety_MENU.HTM

There's 100 Mb more on this disc compared to last year - 15,500 files, 55,000 links, four more SSERC Bulletins, the last four Primary Bulletins, a Bulletin articles spreadsheet, major update on *Radiological Protection* advice, the final report on *CPD & Related Activities for Technical Support,* risk assessments from Fife and Dumfries & Galloway, biological reagents included in the main chemicals list of *Hazardous Chemicals* and advice on Van de Graaff generator hazards etc.