UV LED Light

More efficient PCB exposure

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Commercial PCB exposure light boxes usually employ gas discharge tubes as an ultraviolet (UV) light source, these devices are however bulky, fragile and costly. Incandescent lamps are not a good alternative; they produce a lot of heat and relatively little UV. An interesting development boasting high efficiency and excellent reliability is the recently introduced UV LED.

This design will be welcomed by anyone considering homebrew PCB production, it uses the L-7113UVC type UV LED from the 'Super Bright LED Lamps' range by Kingbright to build a UV light box. The emission wavelength of this LED is precisely 400 nm, ideal for transferring a mask pattern to the photo-resist layer of coated PCBs. The maximum LED forward current is quoted as 30 mA, producing a voltage drop of 4.2 V.

The entire light source is made up of 24 diodes arranged in a grid pattern to ensure even illumination across the Eurocard sized PCB. The beam angle for this LED is given as 20 degrees. Beam edges are defined as points in the radiation pattern where the luminous intensity has fallen 50 % compared to its peak at the centre of the beam. The LED grid spacing is chosen to ensure that the overlapping light cones produce an even distribution of light over the complete area of exposed PCB.

Figure 1 gives the exposure time as a

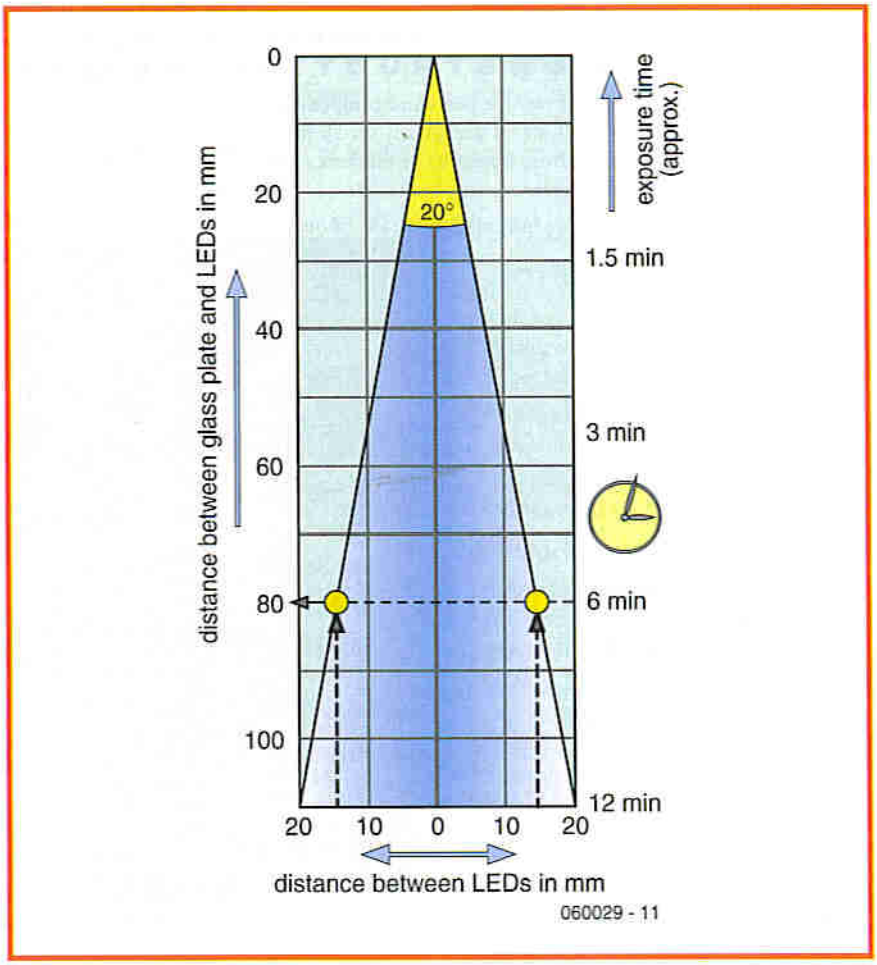


Figure 1.
Correlation of LED spacing, distance to the glass platen and exposure time.

Box

function of LED spacing and distance from the LEDs to the glass platen. There will be some variance between PCB materials supplied by different manufacturers and to some extent the age of the material.

Eurocard illumination

Placing the LEDs closer together allows a shorter distance between the LEDs and the glass platen. This would increase the UV intensity and reduce the PCB exposure time but at the expense of more LEDs, as ever we run into the speed verses cost trade off.

The LEDs in this design are arranged in a grid on a Eurocard sized PCB with a spacing of approximately 31 mm. The total number of UV LEDs required for this 100 mm x 160 mm card is 24 (**Figure 2**). At a distance of about 80 mm between the LEDs and the glass platen the light exposure time for a PCB was found to be around six minutes.

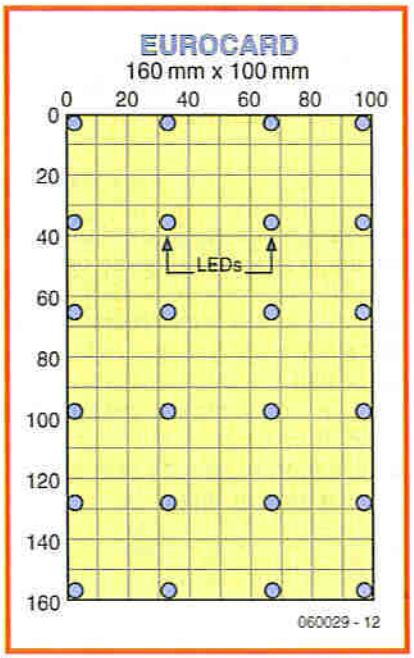
The optimal distance between the LEDs and glass platen to give an even light distribution can be determined empirically; put on a pair of UV protection glasses and place a sheet of white paper over the glass platen, move it away from the LEDs until the individual pools of light overlap to form a uniform area of illumination on the sheet. The distance can be increased to cover a greater area but the PCB mask exposure time will need to be increased correspondingly.

Circuits don't get much simpler

The electrical assembly work for this design involves little more than soldering the LEDs to suitable series resistors. The LEDs are wired as 12 pairs, each with a single 120 Ω series resistor connected to the 12 V input (**Figure 3**). Each pair draws about 25 mA so the 12 V mains adapter must be capable of supplying a total of around 300 mA. The reverse breakdown voltage of an LED is relatively low compared to a silicon diode so D1 protects the entire circuit against input voltage polarity reversal.

For simplicity and speed the complete circuit can be built on a sheet of perforated prototyping board. The author

Figure 2. LED layout on the Eurocard sized PCB.



has also produced a Eurocard sized PCB for the circuit (**Figure 2** and **Figure 3**) and also a half size board containing 12 LEDs. Both of the layouts can be downloaded from www.elektor-electronics.co.uk free of charge, the file number is **060029-1.zip** (see articles listed for this month May 2006).

Construction

Before any components are mounted on the board it is necessary to apply some form of reflective layer to the board surface. This can be self adhesive white plastic film or a few layers of white spray paint, a particularly good finish can be achieved with a layer of metallic silver followed by a layer of clear lacquer. The light-scattering property of this finish helps to produce good, even illumination across the board.
The PCB carrying the LEDs can now be fitted (glue or screw) into the base of a suitably sized container or enclosure. Leads carrying power to the circuit are fed from the back of the PCB through a hole in the casing or via a suitable connector to a 12 V mains adapter. The unit is now complete and only requires the glass platen to be fitted or glued to the container. Finally don't be tempted to cut corners with the PCB material, in the long run it always pays to use the best quality material you can afford.

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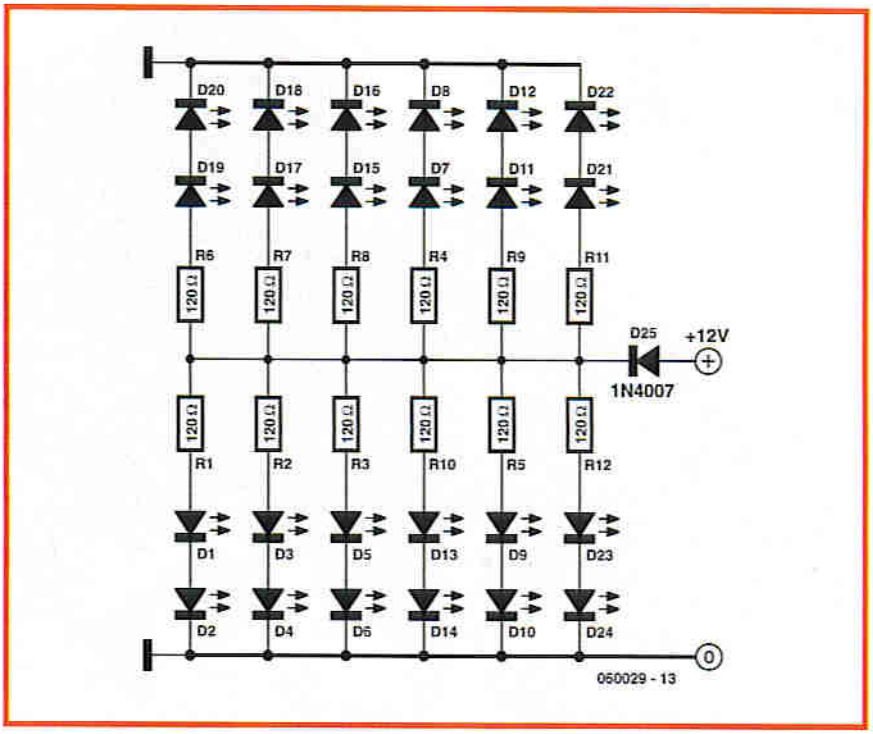
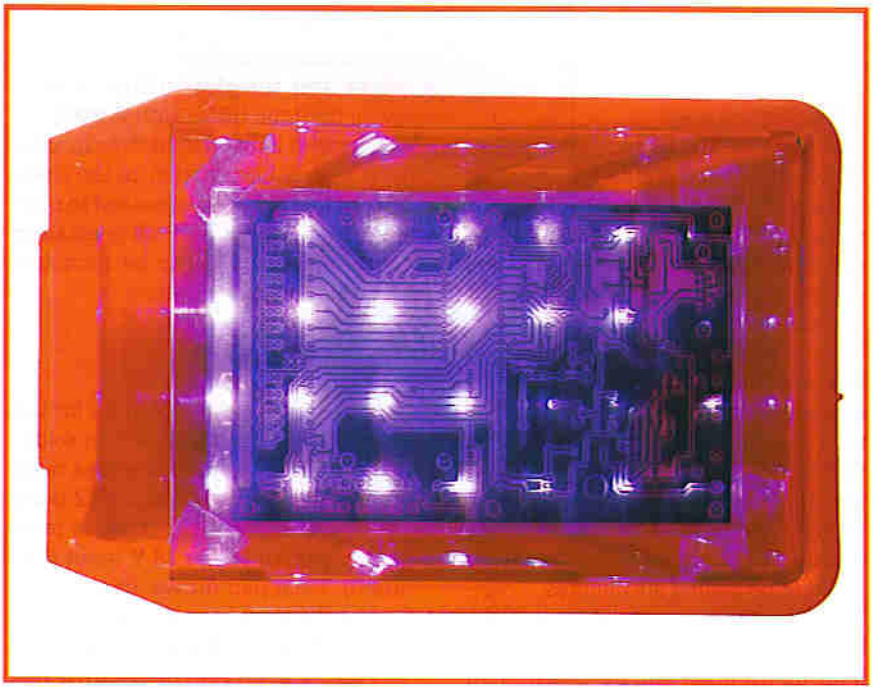


Figure 3. The circuit uses 24 LEDs. A free PCB layout can be downloaded from www.elektor-electronics.co.uk.

Figure 4. This warning symbol can be used on the unit. UV protection glasses must be worn; eyes can be damaged by the high intensity UV.
It is especially important not to look directly into the UV beam!

Materials and suggested sources:

12 pcs. 120-Ω resistor
1 pc. diode 1N4001
24 pcs. UV-LED, Kingbright L-7113UVC (RS Components Stock No 507-4034)
1 pc. connection cable for mains adapter
1 pc. components storage cabinet with drawers, approx. size 140 x 220 x120 mm (W x L x H)
1 pc. glass platen, cut to size, or glass cover of frameless picture holder.
White or metallic silver self-adhesive foil (or clear lacquer, see text)



Links

www.kingbright.com
www.rs-components.co.uk
www.reichelt.de