

Project: LED Lamp Unit

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Description: This worksheet gives you guidance on using PCB Wizard to build an LED lamp unit which can be used as a light source in lighting projects. You will need to know how to place components and tracks and add copper labels to copy the ideas in this worksheet.

If you are reading this worksheet from within PCB Wizard, you can click on the various Style buttons in the left-hand toolbar to see the **Artwork** or **Real World** views of these circuits.

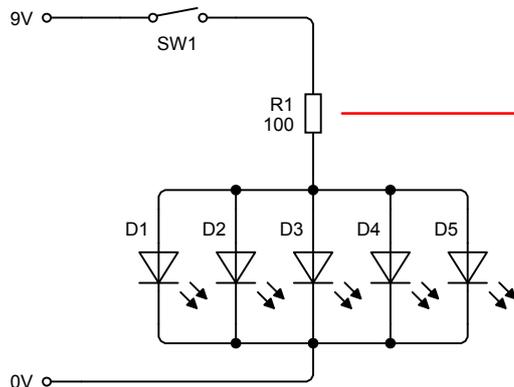
This worksheet assumes a basic working knowledge of PCB Wizard. Those new to the software should refer to the User Guide (press **F1** now if in PCB Wizard) and [Tutorials](#) for assistance.

1 Why LEDs?

Our lamp circuit makes use of white LEDs (see Info! panel) instead of traditional torch bulbs. Here's why:

1. They use far less power than normal bulbs.
2. They produce little or no heat when running.
3. They are extremely tough and can survive harsh conditions.

A basic LED lamp circuit is shown below. It consists of a set of five LEDs controlled by a switch.



LEDs only need a small current to light (typically 20mA each). This *current limiting resistor* makes sure the LEDs don't become overpowered.

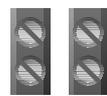
Info! White LEDs have only been available commercially since 2001. By the end of 2003 they cost very little and could give a good strong light. A single LED is still not bright enough to substitute for torch bulbs but five used together gives enough useable light to make a reading lamp or wall panel.

2 Simple PCB

A basic PCB layout for the lamp circuit is shown below. This PCB is a simple design intended to connect the LEDs to the power as easily as possible. Terminal blocks are used so the battery (a standard 9V type) and switch wires can be easily changed.

It uses:

- 2 x 2 pin 5mm terminal block
- 1 x 100 ohm resistor
- 5 x White LEDs



Switch contacts

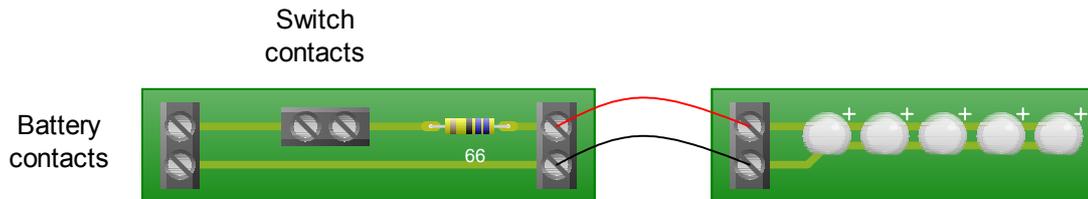


Battery contacts

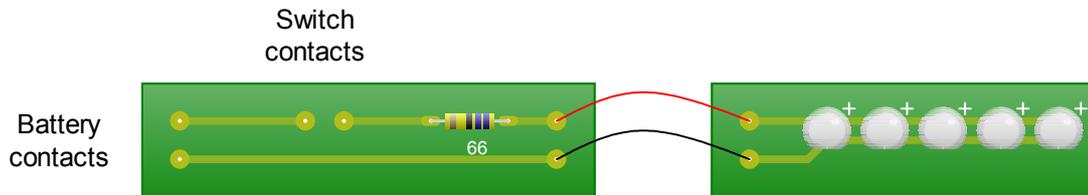
3 Making it useable

The PCB we have produced is fine for circuit testing but would not be a lot of use in the real world. Ideally we have to separate the power from the LEDs so the batteries (the heavy bulky bit) can be some distance from the lights (the slim lightweight bit).

Version with terminal blocks to link the two separate circuit boards together:



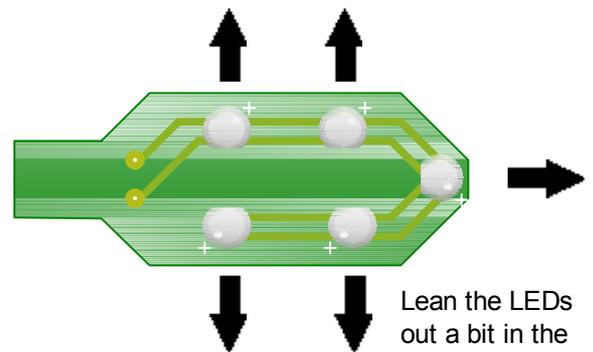
Version with pads to link the two separate circuit boards together:



4 Ergonomics

Sticking the five LEDs in a line will produce a narrow strip of light, which is not what we want for a lamp. To produce a broader spread of light arrange the LEDs in a pattern and solder them in at a slight angle.

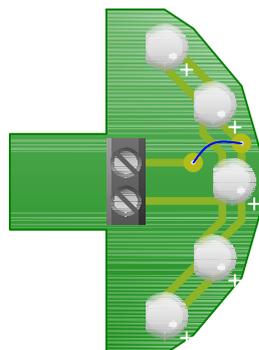
You can also use the edges and the centre of the PCB to fasten the LED unit to your design, especially if you add in fixing areas when you draw your PCB.



Lean the LEDs out a bit in the direction of the arrows when soldering.

This layout is designed to fit on the end of an arm on a desk lamp.

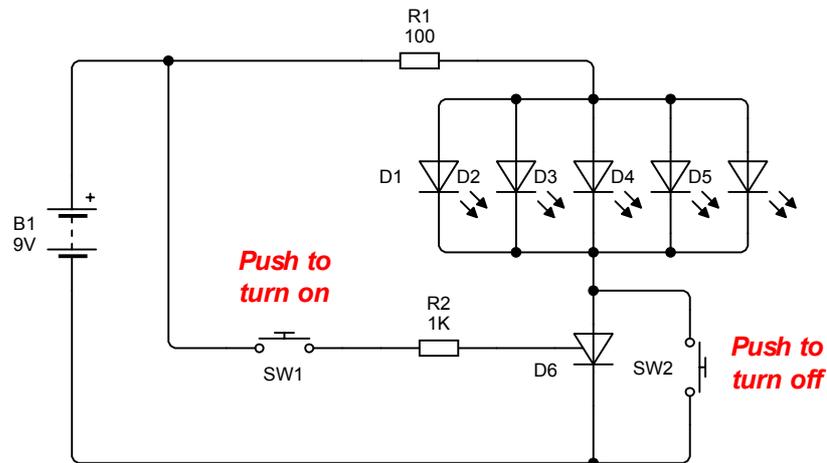
Note that a link (blue wire) is needed to make the circuit work.



These super light bulbs allow much more imaginative designs to be made

5 Better control

The circuit we have seen so far is fine if you want a manual switch, but such switches tend to be bulky or difficult to blend into slimline or futuristic designs. It is a bit odd to have the sort of switch you would find on a kettle or fishing alarm on a smooth sleek design. One way around this is to use a circuit which uses a press switch to turn on and off the LEDs. You can buy press switches called *latching switches*, but this circuit lets you use simple push-to-make switches, or even make your own out of copper foil or wire.

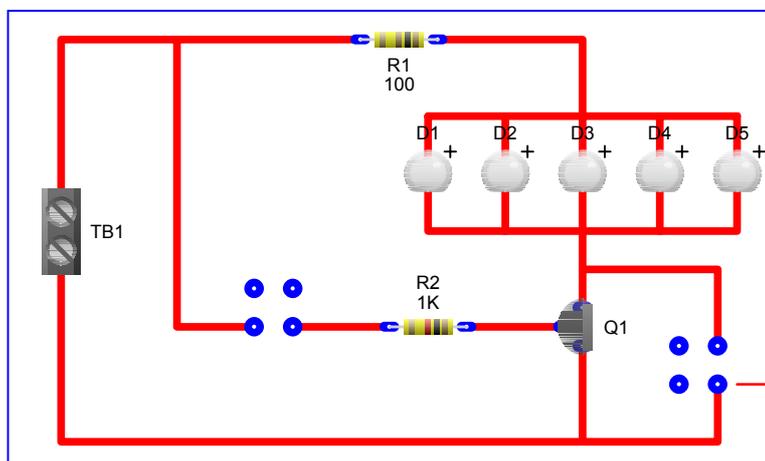


The thyristor circuit above is controlled by two push switches. When built with a 2N5060 thyristor, the circuit is sensitive enough to use plain metal contacts as a touch sensor to turn the circuit on, and one of the new generation of ultra low profile keyboard switches to turn it off.

This circuit does not need an on/off switch. The thyristor can be left permanently connected and the push-to-make switches used instead.

6 Simple PCB

Below is a translation of the circuit diagram into a PCB layout. The simplicity of the circuit, and the fact it has no crossovers, means that we can substitute the components and draw tracks in PCB Wizard to connect them together.



This PCB will work fine, but is no use for fitting into a quality design.

It is better to split the circuit up so the LEDs can be separate from the switching circuit. Also making the switches on a separate board gives you more flexibility in designing the final product.

These four pads are correctly spaced for mounting a standard keyboard switch

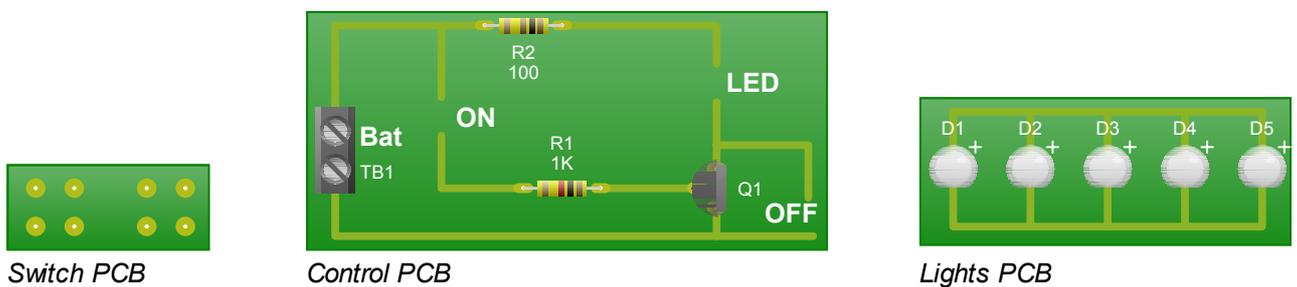
7

Slice and dice

Here are the three main parts of the PCB (switches, control and lights) separated onto different boards. For the circuit to still work, however, the three parts need to be connected together.

You have two main ways to connect the boards together:

1. Use solder pads and solder the leads into place.
2. Use screw terminals and screw the leads into place.
3. For this circuit we will use screw terminals for all connections except the small switch PCB, which needs to be as thin as possible in order to allow more design flexibility.

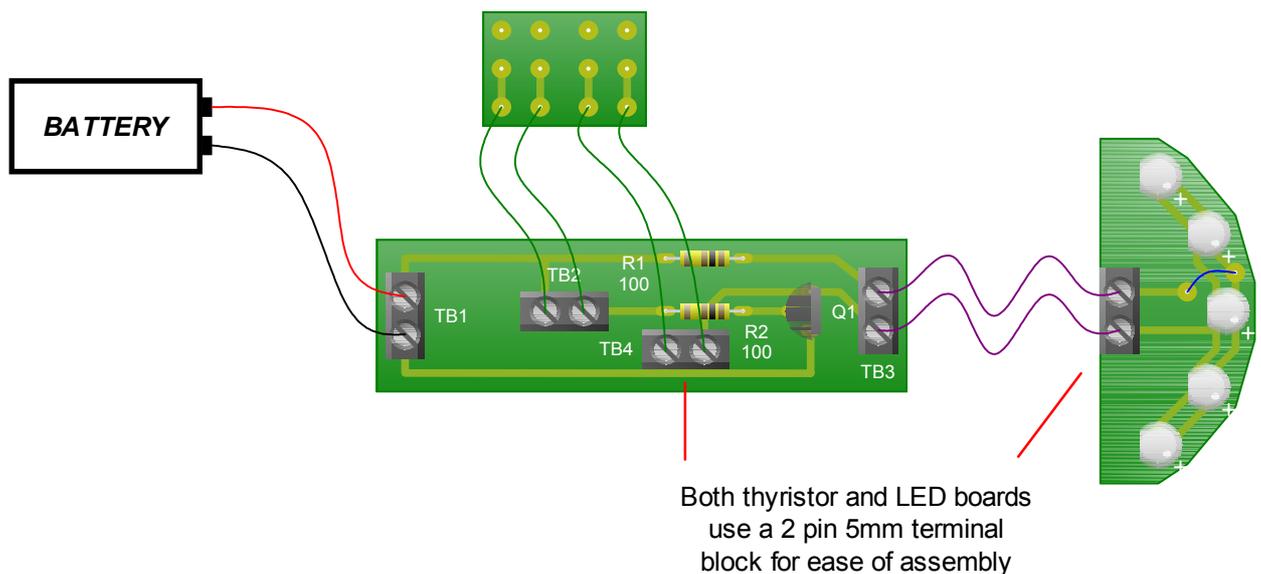


8

All for one and one for all...

With the PCB separated into three boards, it is easier to re-design the lights section to make it better suited as a lamp. In the circuit below, the lights have all been made to face in the same direction.

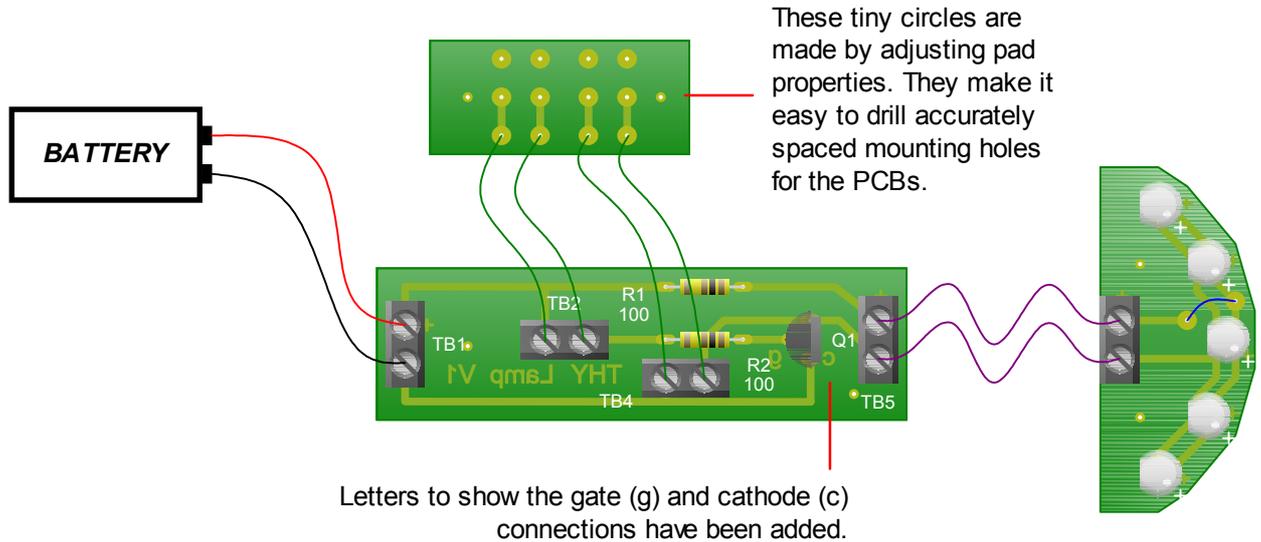
You will also notice that wires have been used to connect the three boards together. When laying out a circuit with more than one board in PCB Wizard, it is a good idea to add wires to your circuit to show how everything connects. This will help you when assembling the final design later.



9 The finishing touches...

Finally, copper label text and symbols have been added to the PCB. Hints, such as + symbols, greatly help when soldering the PCB. Always remember that anything drawn as a copper label will conduct electricity on the final PCB so place text and symbols carefully to avoid short circuits

A name and version number is also added to the PCB (this is good practice for all your PCBs).

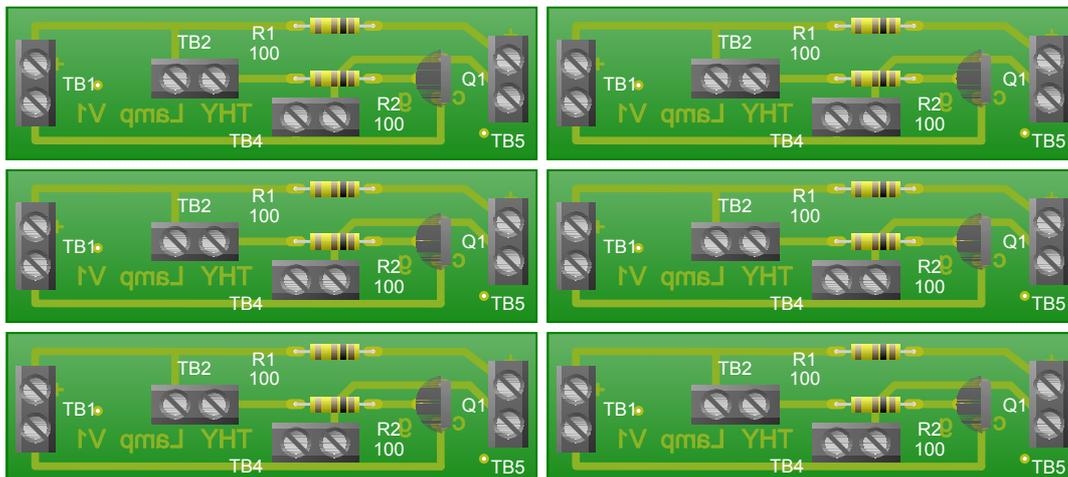


If you are viewing this document from within PCB Wizard, clicking on the **Artwork** button on the left-hand Style bar will show the actual copper area which will be on your PCB. You will print out this view when constructing your PCB.

10 Batch production

Producing the PCBs in bulk is an easy way to reduce manufacturing costs.

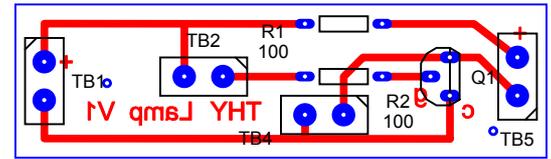
Once you have a finished PCB, save your file and then cut and paste the section of your PCB into a blank PCB Wizard document (grouping the PCB first will ensure that the circuit is not accidentally changed). Copy and paste until you have a block of PCBs with about 1/10th of an inch (2.5mm) gap between each. The number of copies on a page and the shape of the block will depend on your PCB production facilities.



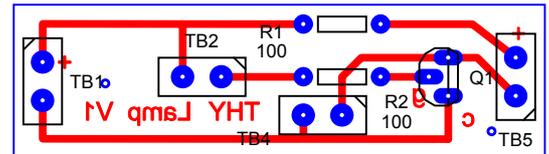
11 Hints and tips

The lamp circuit is now completed.

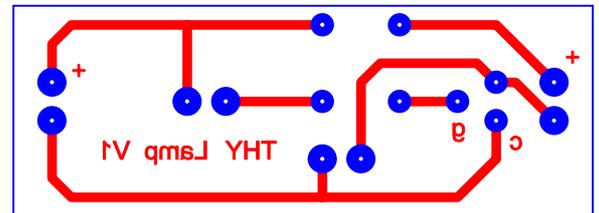
Tip! When drawing your own circuits you may find that the standard pads in PCB wizard are quite small.



Right clicking over any pad or component will allow you to change the standard pad size. You will need even bigger pads for the screw terminals as the mounting wires are typically 1.5mm thick.



Drawing the PCB freehand without using the built-in components lets you customise the design to make it easier for small hands to solder.



12 Lamps and stuff...

Info! Twenty years ago, all bulbs in lamps were either filament (a small coil of wire inside a glass bulb is heated to white hot by the electricity forcing its way along the wire) or fluorescent (electricity is used to emit specific electromagnetic rays which strike a special coating, making it glow). Over the past twenty years, both these technologies have improved with low voltage filament halogen lights now able to glow brightly running on only battery power, and fluorescent tubes packed into very small casings and sold as economy bulbs. Recently there has been a new technology that will probably see both types of bulbs becoming largely obsolete within ten years. These new bulbs are LEDs.

Light Emitting Diodes were developed as diodes, components which could be used in an electronic circuit to make power only flow one way. A researcher discovered that they could be made to glow brightly and soon LEDs were being manufactured for use as indicators in electronic circuits.

At first LEDs were only available in reds and oranges, and were very dim. In the past three years, white LEDs have come onto the market. Initially these were expensive and also quite dim, but today they are much cheaper and are now extremely bright.

LEDs have two key properties that make them extremely useful to designers:

1. They use extremely small amounts of power. A single LED linked to a 9V square Alkaline battery will glow non-stop for up to a year. Low power ones are available which can last up to five years. A single LED can be powered from wires as thin as a strand of cotton.
2. They produce little or no heat which means that they can be cast inside other materials or wrapped with delicate fabrics and paper without any fire hazard.