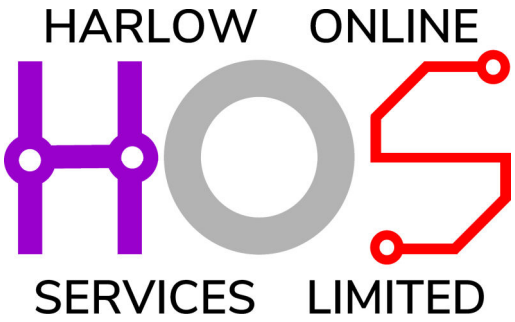
Harlow Online Services Limited



LED TORCH

VERSION 1.1

20/05/2025

Written by

Ian Bentall

LED Torch

The H006 is designed as an introduction to Project Electronics. We will take you through the design principles and basic electrical theory behind the design.

Electronic Design Process

All projects will start off with a **Design brief**. Depending on the project this can be just a list of punch points or it could go into much more detail.

The Design brief will likely cover the following points

- outline the main aims of the project
- what its functionality should be
- the target audience

This is followed by some **Research.** Start by researching the background of the project. What are the likely requirements? Are they any competitors, how are they solving the issue, are there any problems with their design?

The **Specification** is a complete list of requirements that the project must meet. This allows the designers to focus on the specifics at the design stage. If anything is missing from this list it is likely to be missed off on your final design,

The **Design** phase comes next. At this stage we develop ideas to produce the product so that it meets all of the requirements listed in our Specification. We can test different ideas by building up parts of the circuits to see which ideas work best.

For this project the main aim of the project is based around out TARGET AUDIENCE – the people that the project is aimed at. This project is aimed at trainees and students so it needs to be easy to understand as a teaching tool. They wont have a lot of experience working with electronics but are keen to learn and progress.

Once the design has been completed **Build** the design up.

Next we will **Evaluate** and **Test.** Does the product meet all the points listed in the specification? Does it meet all the requirements of the design brief? If not then go back and change the design to meet these requirements. It is normal to have some iterations at this stage but you would normally aim to minimise these by paying attention to all the requirements.

After testing do you think that the product could be **improved** in any way? If so add this to the design for the next iteration.

The AIMS of this project is to develop a small kit of parts that can be assembled by our target audience. It should be fun to do an teach them some principles on the way.

From the FUNCTIONALITY point of view we want to be able to see our project working so the easiest way to do this is to put a light on it. The user will press a switch and an light will turn on if everything is working.

Component Selection

This project uses SIX different components. All of these components are easily identifiable so you should not be able to fit into the wrong space.

Light	Lots of electronic projects will include a light of some form. Most lights used in electronics use a component called a Light Emitting Diode or LED for short. A diode is a semi conducting material which will conduct electrical current in one direction but block it if current tries to flow the other way. An LED is a diode that emits light when current is flowing through it. LEDs come in a range of colours but for this project we are going to use a white LED as we want our torch to shine a white light so we can see where we are going in the dark. All LEDs will have a Forward Voltage and a Operating Current defined in the data sheet for the part. The forward voltage is the voltage that is dropped across the LED and the operating current is the current that needs to flow through it to turn the light on. Our white LED has a forward voltage of 3.2V and an operating current of between 10 - 30mA. We will see why these are important later on. Through hole LEDs will typically have a LONG LEG and a SHORT LEG to denote which way they should be fitted. Many will also have a flat side on the LED body – you may need to look closely to see this.
Switch	We want to be able to turn our Light on and off so to do this we will use a switch. A swich is a mechanical device that is OPEN or CLOSED depending on the switch setting. On our switch it is NORMALLY OPEN when the button is not pressed. To CLOSE it we need to press the BUTTON on the top of the switch. The data sheet for the switch will give its VOLTAGE RATING and CURRENT RATING. These are the maximum values that the contacts in our switch can safely operate between. As part of our design process we will need to check that these limits will not be exceeded. Switches come in many formats but we are using a push button for this project.
Battery	We need a power source for our Light. This will come from the battery as is usual for any hand held items like this. The battery voltage needs to be high enough to operate our light so needs to be higher than the FORWARD VOLTAGE on our LED. We have several options for batteries here but we want it to be small so that our torch is easy to hold but we need more than 3.2V. Most small batteries are rated at 1.5V (sizes AA, AAA) so we would need at least three of these. A small coin cell is 3V so again we would need at least two of these to operate our LED. We have selected a single 12V N style battery that can be replaced when its charge runs out.
Resistor	Remember we specified that the forward volage on our LED was around 3V and its operating current is 10mA and we have a battery voltage of 12V. If we connect these parts the voltage across the LED will be greater than the 3V limit. To reduce this voltage we need to add some RESISTANCE to the circuit to limit the volage across and the current through our LED. OHMS LAW states that the VOLTAGE across a circuit is equal to the CURRENT through the circuit and the RSISTANCE in the circuit.

	V = I * R By rearranging this to calculate resistance R = V / I We want 10mA (0.01A) flowing through our LED and the volage across our resistor will be the battery voltage less the forward voltage on our LED. VBAT – VFR = 12 – 3.2 = 8.8V R = 8.8 / 0.01 = 880 Ohms Resistor values are only available in a standard range of values so we select the closest value to this calculated figure for our circuit. We have selected 680 Ohms which is slightly lower so a bit more current will flow but still within the current limit of the LED so it will be a bit brighter.
Battery Holder	The battery holder is selected to hold the chosen battery.
Printed Circuit Board	The Printed Circuit Board or PCB is a key component in all electronic designs, As well as holding all of the components in place it will route the signals between each component as defined in our circuit diagram. Each signal is carried between components using TRACKS. These allow the current to flow around the circuit. Tracks must be thick enough to carry the current that is expected to flow through them. They also need to be spaced out so that signals can not link between the tracks – this is called a SHORT. Tracks can pass between COMPONENT PADs but again must have a clearance to avoid getting shorts. Our circuit board has tracks only on one side as it is a very simple circuit, the bottom. Most PCBs will use tracking on at least 2 sides. Some can have many layers of tracking within the PCB itself. These are called MULTI LAYER boards,

Build the Torch

Full instructions on the assembly of the torch are in the separate document 'LED Torch Assembly'.

Take the Printed Circuit Board (PCB). The white lettering is on the **TOP** side. All components are placed on this side with the component legs going through the PCB. The **BOTTOM** side of the PCB has the component **PADS** and **TRACKS** which carry the electrical signals from one component to the other. We will solder our components in on this bottom side.

Next pick up the **RESISTOR** This is a part will be labelled up with a number of coloured bands. These bands tell us the value of the resistor. This project only uses a single resistor so we don't need to identify the value using the bands but as a 680 Ohm resistor it will be marked up with a Blue, Grey and Brown band. The fourth band will identify the resistor tolerance (and indication

if how accurate the resistor value will be to the specified value). Bend the legs on the resistor so that they are at right angles to the resistor body. It does not matter which way this part is fitted into the board. Poke the two leads through the PCB for the component identified as 'R1' on the white lettering. Turn the board over and solder the legs in place.

The next component to fit will be the **SWITCH**. This is a 4 pin device but the pins on each side are connected together so these will count as 1 contact. It does not matter which way the switch is fitted into the board in location 'SW1' as long as all of the pins with fit through the holes. Again solder this in place on the bottom of the PCB.

The next part of fit is the **LED**. This part will not work if it is not fitted the correct way round. If you look carefully at the LED it will have a FLAT edge. This must line up with the flat edge on the symbol D1 on the PCB. You will need to bend the LED legs at right angles with a pair of pliers so that the LED will fit into the PCB with the LED pointing away from the circuit board. Make sure that the flat edge matches that on the PCB as you fit the LED into the circuit board. When you are happy solder this part in place.

Next take the **Battery Holder**. This needs to be soldered into the PCB in the position labelled BT1. Make sure that you put this part into the PCB so that the SPRING in the holder is at the end with the big hole in the PCB (away from the Resistor and Switch). Solder in place when ready.

Check your Torch

That completes the main assembly. Before we fit the battery into the holder

Check the bottom of the PCB to ensure that

- All holes except the large hole are filled with the lead of a component.
- All of these lead as soldered into place.
- We have not connected any pins together with solder.

Check the top side of the PCB to ensure that

- The flat edge on the LED matches the outline on the PCB
- The spring in the battery holder is next to the big hole and away form the Resistor / Switch.

If any of the above faults exist you need to correct these before proceeding any further.

Test

If all the above is OK then we can fit the battery. The battery will go into the holder with the flat end pushing against the spring and the knob end going into the holder next to the resistor.

Once the battery is in place the LED light should be OFF. Press the button SW1 and make sure that the LED now turns on. Release the button the LED goes off again.

Well done you have just bult your self an LED torch.

If it does not work as above then you need to go through the steps outlined in the section 'Check your Torch' once again and double checking everything has been fitted correctly. It is all soldered in place and there are no solder bridges or shorts between pins close to each other.

You can also get shorts between pins and tracks, so check this. This is unlikely to occur as the tracks are all covered in solder resist to protect them from shorts but it can still happen occasionally.

Finally

We hope that you have enjoyed working on this project. Visit our web site for more information on other similar projects that we have.

If you would like to talk to us about a project that is not shown please get in touch and we will see if we can help you.

Harlow Online Services Limited

35 Latton Bush Centre
Southern Way
Harlow
Essex CM18 7BL

01279 260600

https://HarlowOnlineServices.co.uk (General web site)

https://d.hos35.uk/h006 (Product Documentation)