TEACHING RESOURCES

SCHEMES OF WORK
DEVELOPING A SPECIFICATION
COMPONENT FACTSHEETS
HOW TO SOLDER GUIDE

LIGHT UP YOUR DAY WITH THIS

WINDUP TORCH KIT

Version 1.1

Index of Sheets

Introduction

About the project kit

Both the project kit and the supporting material have been carefully designed for use in KS3 Design and Technology lessons. The project kit has been designed so that even teachers with a limited knowledge of electronics should have no trouble using it as a basis from which they can form a scheme of work.

The project kits can be used in two ways:

1. As part of a larger project involving all aspects of a product design, such as designing an enclosure for the electronics to fit into.
2. On their own as a way of introducing electronics and electronic construction to students over a number of lessons.

This booklet contains a wealth of material to aid the teacher in either case.

Using the booklet

The first few pages of this booklet contains information to aid the teacher in planning their lessons and also covers worksheet answers. The rest of the booklet is designed to be printed out as classroom handouts. In most cases all of the sheets will not be needed, hence there being no page numbers, teachers can pick and choose as they see fit.

Please feel free to print any pages of this booklet to use as student handouts in conjunction with Kitronik project kits.

Support and resources

You can also find additional resources at www.kitronik.co.uk. There are component fact sheets, information on calculating resistor and capacitor values, puzzles and much more.

Kitronik provide a next day response technical assistance service via e-mail. If you have any questions regarding this kit or even suggestions for improvements, please e-mail us at:

support@kitronik.co.uk

Alternatively, phone us on 0845 8380781.

Schemes of Work

Two schemes of work are included in this pack; the first is a complete project including the design & manufacture of an enclosure for the kit (below). The second is a much shorter focused practical task covering just the assembly of the kit (next page). Equally, feel free to use the material as you see fit to develop your own schemes.
Before starting we would advise that you to build a kit yourself. This will allow you to become familiar with the project and will provide a unit to demonstrate.

Complete product design project including electronics and enclosure

Hour 1	Introduce the task using 'The Design Brief' sheet. Demonstrate a built unit. Take students through the design process using 'The Design Process' sheet. Homework: Collect examples of torches, including some dynamo and wind up types. List the common features of these products on the 'Investigation / Research' sheet.
Hour 2	Develop a specification for the project using the 'Developing a Specification' sheet. Resource: Sample of torches. Homework: Using the internet or other search method, find out what is meant by 'design for manufacture'. List five reasons why design for manufacture should be considered on any design project.
Hour 3	Read 'Designing the Enclosure' sheet. Develop a product design using the 'Design' sheet. Homework: Complete design.
Hour 4	Using cardboard, get the students to model their enclosure design. Allow them to make alterations to their design if the model shows any areas that need changing.
Hour 5	Split the students into groups and get them to perform a group design review using the 'Design Review' sheet.
Hour 6	Using the 'Soldering in Eight Steps' sheet, demonstrate and get students to practice soldering. Start the 'Resistor Value' worksheet. Homework: Complete any of the remaining resistor tasks.
Hour 7	Build the electronic kit using the 'Build Instructions'.
Hour 8	Complete the build of the electronic kit. Check the completed PCB and fault find if required using the 'Checking Your Wind up Torch PCB' section. Homework: Read 'How the Wind up Torch works' sheet in conjunction with the 'How a Generator works' and Diodes sheets
Hour 9	Build the enclosure.
Hour 10	Build the enclosure.
Hour 11	Build the enclosure.
Hour 12	Using the 'Evaluation' and 'Improvement' sheet, get the students to evaluate their final product and state where improvements can be made.

Additional Work

Package design for those who complete ahead of others.

Electronics only

Hour 1	Introduction to the kit demonstrating a built unit. Using the 'Soldering in Ten Steps' sheet, practice soldering.
Hour 2	Build the kit using the 'Build Instructions'.
Hour 3	Check the completed PCB and fault find if required using 'Checking Your Wind up Torch PCB'.

Answers

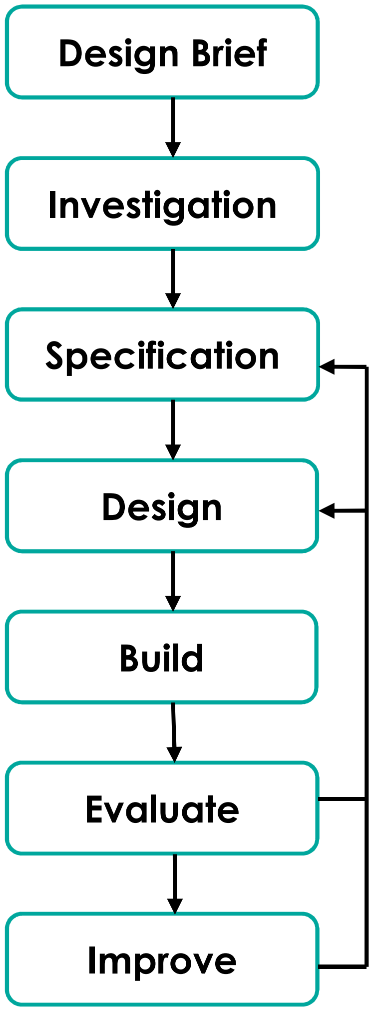
Resistor questions

1st Band	2nd Band	Multiplier x	Value
Brown	Black	Yellow	*100,000 Ω*
Green	Blue	Brown	*560 Ω*
Brown	Grey	Yellow	*180,000Ω*
Orange	White	Black	*39Ω*

Value	1st Band	2nd Band	Multiplier x
180 Ω	Brown	Grey	*Brown*
3,900 Ω	Orange	White	*Red*
47,000 (47K) Ω	Yellow	Violet	*Orange*
1,000,000 (1M) Ω	Brown	Black	*Green*

The Design Process

The design process can be short or long, but will always consist of a number of steps that are the same on every project. By splitting a project into these clearly defined steps, it becomes more structured and manageable. The steps allow clear focus on a specific task before moving to the next phase of the project. A typical design process is shown on the right.



Design brief

What is the purpose or aim of the project? Why is it required and who is it for?

Investigation

Research the background of the project. What might the requirements be? Are there competitors and what are they doing? The more information found out about the problem at this stage, the better, as it may make a big difference later in the project.

Specification

This is a complete list of all the requirements that the project must fulfil - no matter how small. This will allow you to focus on specifics at the design stage and to evaluate your design. Missing a key point from a specification can result in a product that does not fulfil its required task.

Design

Develop your ideas and produce a design that meets the requirements listed in the specification. At this stage it is often normal to prototype some of your ideas to see which work and which do not.

Build

Build your design based upon the design that you have developed.

Evaluate

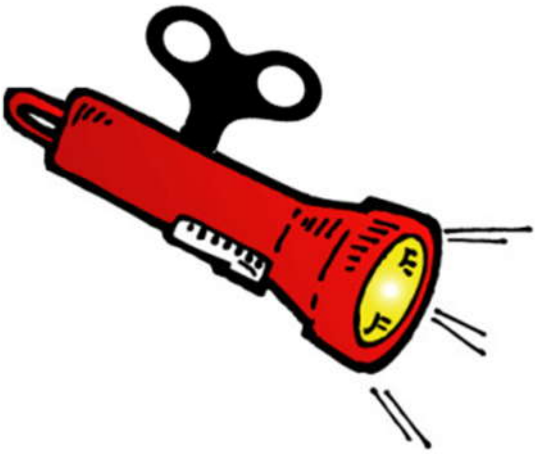
Does the product meet all points listed in the specification? If not, return to the design stage and make the required changes. Does it then meet all of the requirements of the design brief? If not, return to the specification stage and make improvements to the specification that will allow the product to meet these requirements and repeat from this point. It is normal to have such iterations in design projects, though you normally aim to keep these to a minimum.

Improve

Do you feel the product could be improved in any way? These improvements can be added to the design.

The Design Brief

A manufacturer has developed a simple circuit for producing a light that is powered by a hand wound generator. The circuit has been developed to the point where they have a working Printed Circuit Board (PCB).



The manufacturer would like ideas for a product that can be created by designing an enclosure for this PCB.
For example: The light could be used in remote areas where there is no power.

The manufacturer has asked you to do this for them. It is important that you make sure the final design meets all the requirements that you identify for such a product.

Complete circuit

A fully built circuit is shown below. The LED is soldered to the circuit board in this picture, but it could also be attached to wires if the design required. The generator unit connects with wires to the circuit board.

Investigation / Research

Using a number of different search methods, find examples of similar products that are already on the market. Use additional pages if required.

Name……………………………………………… Class……………………………

Developing a Specification

Using your research into the target market for the product, identify the key requirements for the product and explain why each of these is important.

Name.. Class..................................

Requirement	Reason
Example: The enclosure should allow access to the winding mechanism.	Example: So that a winding handle can be fitted

Design

Develop your ideas to produce a design that meets the requirements listed in the specification.

Name…………………………………………… Class……………………………

Design Review (group task)

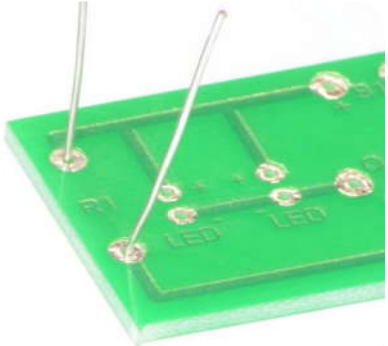
Split into groups of three or four. Take it in turns to review each person's design against the requirements of their specification. Also look to see if you can spot any additional aspects of each design that may cause problems with the final product. This will allow you to ensure that you have a good design and catch any faults early in the design process. Note each point that is made and the reason behind it. Decide if you are going to accept or reject the comment made. Use these points to make improvements to your initial design.

Comment	Reason for comment	Accept or Reject

Soldering in 8 Steps

1 INSERT COMPONENT

Place the component into the board, making sure that it goes in the correct way around, and the part sits closely against the board. Bend the legs slightly to secure the part. Place the board so you can access the pads with a soldering iron.

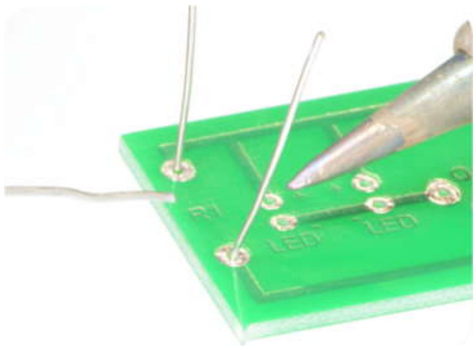


2 CLEAN SOLDERING IRON

Make sure the soldering iron has warmed up. If necessary use a brass soldering iron cleaner or damp sponge to clean the tip.

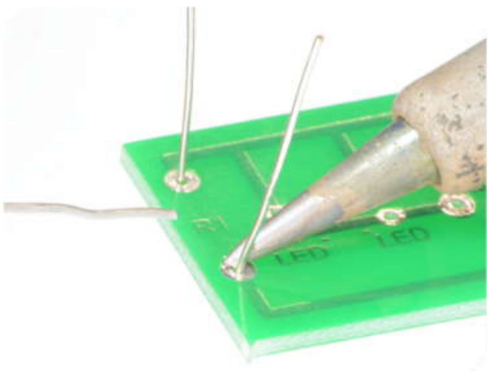
3 PICKUP IRON AND SOLDER

Pick up the Soldering Iron in one hand, and the solder in the other hand.



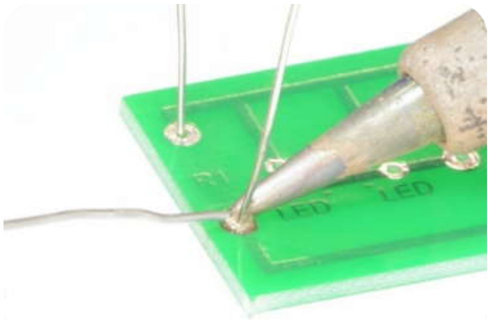
4 HEAT PAD

Place soldering iron tip on the pad.



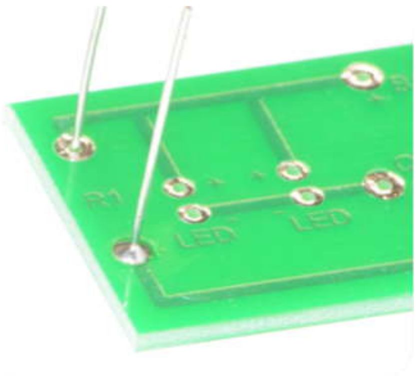
5 APPLY SOLDER

Feed a small amount of solder into the joint. The solder should melt on the pad and flow around the component leg.



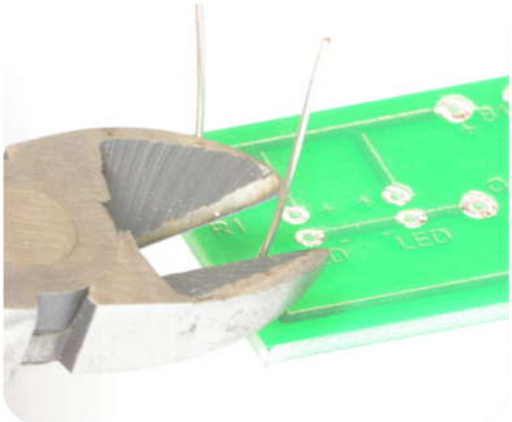
6 STOP SOLDERING

Remove the solder, then remove the soldering iron.



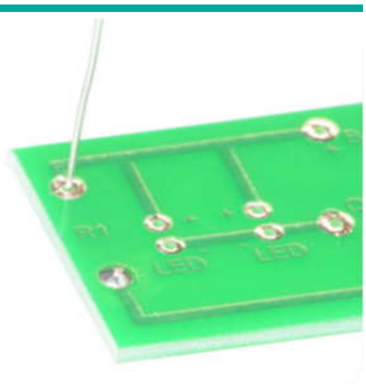
7 TRIM EXCESS

Leave the joint to cool for a few seconds, then using a pair of cutters trim the excess component lead.



8 REPEAT

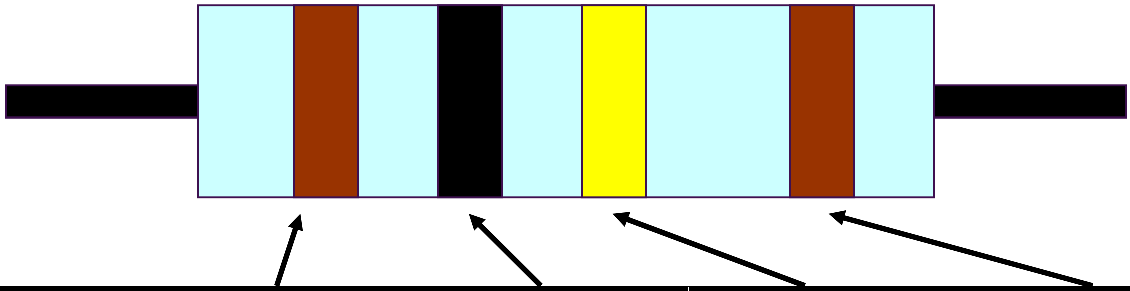
Repeat this process for each solder joint required.



Resistor Values

A resistor is a device that opposes the flow of electrical current. The bigger the value of a resistor, the more it opposes the current flow. The value of a resistor is given in Ω (ohms) and is often referred to as its 'resistance'.

Identifying resistor values



Band Colour	1st Band	2nd Band	Multiplier x	Tolerance
Silver			÷ 100	10%
Gold			÷ 10	5%
Black	0	0	1	
Brown	1	1	10	1%
Red	2	2	100	2%
Orange	3	3	1000	
Yellow	4	4	10,000	
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7		
Grey	8	8		
White	9	9		

Example: Band 1 = Red, Band 2 = Violet, Band 3 = Orange, Band 4 = Gold

The value of this resistor would be:
2 (Red) **7** (Violet) x **1,000** (Orange) = 27 x 1,000
= **27,000** with a 5% tolerance (gold)
= **27KΩ**

Too many zeros?

Kilo ohms and mega ohms can be used:

1,000Ω = 1K

1,000K = 1M

Resistor identification task

Calculate the resistor values given by the bands shown below. The tolerance band has been ignored.

1st Band	2nd Band	Multiplier x	Value
Brown	Black	Yellow	
Green	Blue	Brown	
Brown	Grey	Yellow	
Orange	White	Black	

Calculating resistor markings

Calculate what the colour bands would be for the following resistor values.

Value	1st Band	2nd Band	Multiplier x
180 Ω			
3,900 Ω			
47,000 (47K) Ω			
1,000,000 (1M) Ω			

What does tolerance mean?

Resistors always have a tolerance but what does this mean? It refers to the accuracy to which it has been manufactured. For example if you were to measure the resistance of a gold tolerance resistor you can guarantee that the value measured will be within 5% of its stated value. Tolerances are important if the accuracy of a resistors value is critical to a design's performance.

Preferred values

There are a number of different ranges of values for resistors. Two of the most popular are the E12 and E24. They take into account the manufacturing tolerance and are chosen such that there is a minimum overlap between the upper possible value of the first value in the series and the lowest possible value of the next. Hence there are fewer values in the 10% tolerance range.

E-12 resistance tolerance (± 10%)											
10	12	15	18	22	27	33	39	47	56	68	82

E-24 resistance tolerance (± 5 %)											
10	11	12	13	15	16	18	20	22	24	27	30
33	36	39	43	47	51	56	62	68	75	82	91

How does a Generator Work?

Generators convert mechanical energy into electrical energy. A basic generator is made up of a magnet and a coil of wire. When a wire is moved through a magnetic field a current is generated in the wire. Michael Faraday discovered the laws related to electromagnetic induction in 1831.

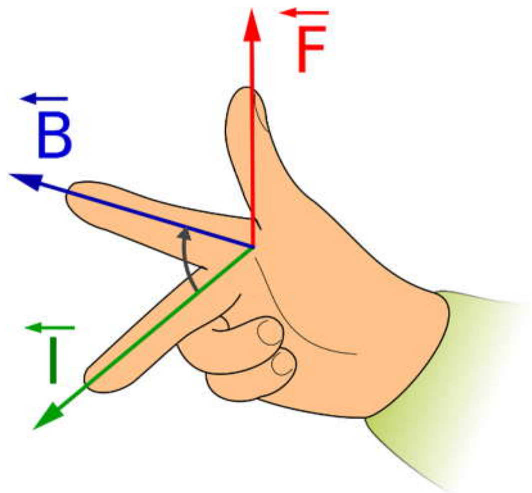
The size of the current depends on three factors
- The speed that the wire is moving with (this is analogous to the force applied)
- The length of the wire in the magnetic field
- The strength of the magnetic field

The current that will flow can be calculated by the following equation.

Current α (Force X Wire length X Magnetic field)

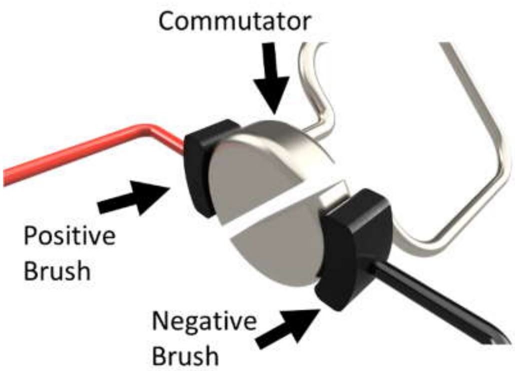
Increasing any of these factors will increase the generated current.

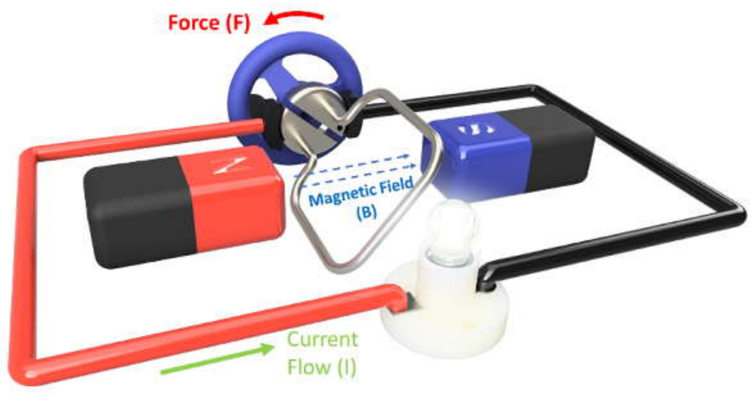
The direction of the current, the magnetic field, and the force are related. John Ambrose Fleming devised the Right hand rule to show the direction of current flowing in a wire that is moving through a magnetic field.
Fleming's Right Hand Rule shows:
- Direction of the current flow in the wire (middle finger).
- Direction of the magnetic field (Index finger).
- Direction of the movement inducing the current (thumb).



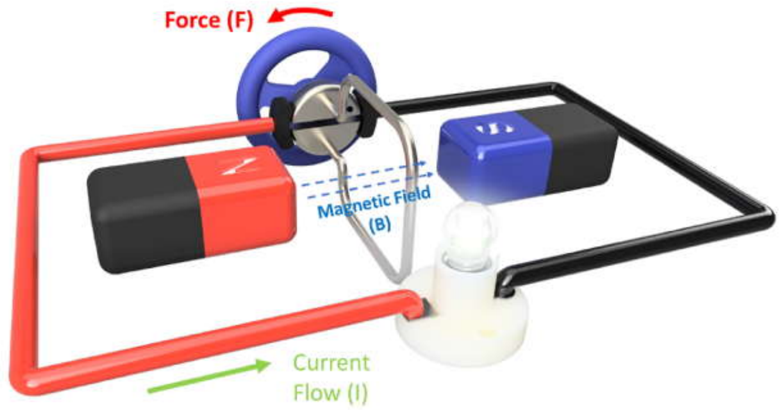
In order to allow current to flow through a moving wire, a brush can be used. This slides over the connection surface. In a generator this rotating surface is called a commutator.
In the following example the commutator is split into two, to allow connection to each end of the single coil of wire. Generators can have commutators with many segments. Each end of the coil is connected to part of the commutator and will rotate with the input shaft.

As the commutator rotates, it connects with two contacts, known as brushes (a positive and a negative brush). Because the commutator is split this causes the current to continue to flow in the same direction as the generator turns, even though the ends of the coil have changed.

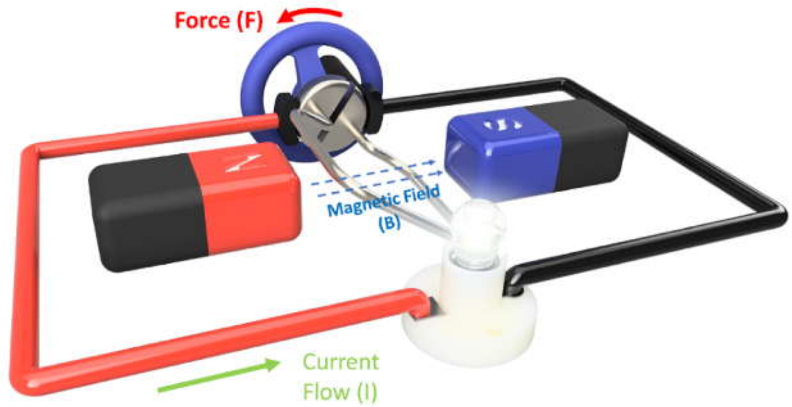




When the generator shaft is turned the coil moves. From moving the coil in the magnetic field a current is created. The current flows round the coil and out of the commutator. The current moves in accordance with Flemings Right Hand Rule.



As the coil rotates towards the opposite side the current would change direction.
To prevent this, the commutator switches the current to flow in the opposite direction through the coil, which then continues to rotate.



This process is done every half turn and keeps on repeating while there is a rotation on the coil.

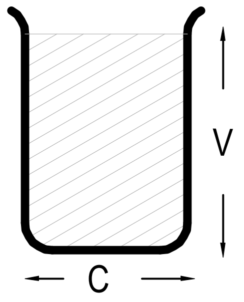
A DC generator can have multiple coils to ensure that they provide current continuously

Windup Torch Kit Teaching Resources

www.kitronik.co.uk/2164

Capacitor Basics

What is a capacitor?

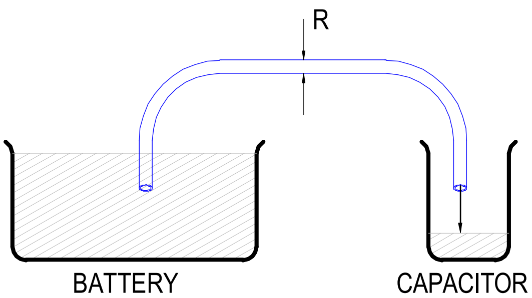


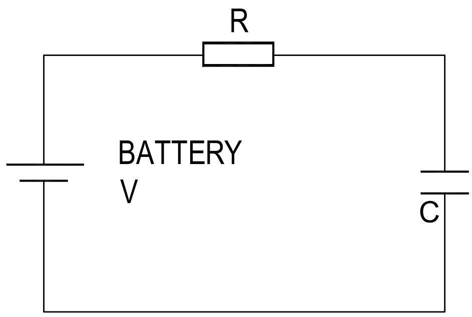
A capacitor is a component that can store electrical charge (electricity). In many ways, it is like a rechargeable battery.

A good way to imagine a capacitor is as a bucket, where the size of the base of the bucket is equivalent to the capacitance (C) of the capacitor and the height of the bucket is equal to its voltage rating (V).

The amount that the bucket can hold is equal to the size of its base multiplied by its height, as shown by the shaded area.

Filling a capacitor with charge

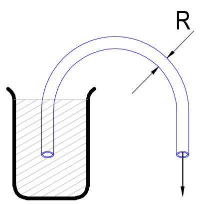




When a capacitor is connected to an item such as a battery, charge will flow from the battery into it. Therefore the capacitor will begin to fill up. The flow of water in the picture above left is the equivalent of how the electrical charge will flow in the circuit shown on the right.

The speed at which any given capacitor will fill depends on the resistance (R) through which the charge will have to flow to get to the capacitor. You can imagine this resistance as the size of the pipe through which the charge has to flow. The larger the resistance, the smaller the pipe and the longer it will take for the capacitor to fill.

Emptying (discharging) a capacitor

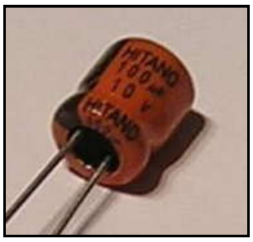


Once a capacitor has been filled with an amount of charge, it will retain this charge until it is connected to something into which this charge can flow.

The speed at which any given capacitor will lose its charge will, like when charging, depend on the resistance (R) of the item to which it is connected. The larger the resistance, the smaller the pipe and the longer it will take for the capacitor to empty.

Maximum working voltage

Capacitors also have a maximum working voltage that should not be exceeded. This will be printed on the capacitor or can be found in the catalogue the part came from. You can see that the capacitor on the right is printed with a 10V maximum working voltage.



Diodes

Diodes let current flow in one direction, but stop it from flowing in the other. They are like a one way valve. A lot of electronics, particularly integrated circuits can be permanently damaged if they are connected the wrong way round. Diodes can be used to protect electronics from people connecting the power supply or battery up the wrong way around.

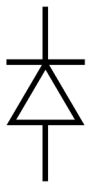
Diodes are also used in almost every mains operated electronic product that is more complicated than a light bulb. The mains sockets provide 240 volts AC at 50 Hz frequency. AC stands for alternating current, which means it switches from being positive to being negative, 50Hz means it does this 50 times a second. Electronic circuits require DC (direct current), which does not change its direction. A diode can be used to stop the negative parts of the AC power, leaving just the positive section. Often four diodes are used together, known as a bridge rectifier, to give a smoother supply by keeping the positive parts and inverting (changing) the negative sections into positive.

In a similar manner to the effort required to push open a one-way door a typical silicon signal diode has a forward voltage drop of 0.7 volts. Other diode types have different voltage drops, depending on their construction. A Schottky diode has a typical forward voltage drop of between 0.15 volts and 0.4 volts. This means less energy is wasted in the diode, making them useful for renewable energy use.

Diodes can only control the direction of a voltage up to a certain value, which is known as the breakdown voltage. If a normal diode is used to block too high a voltage it will start to conduct, and may be permanently damaged.
A special sort of diode, known as a Zener diode is designed to break down at a certain voltage and not be damaged. This is useful to give a set voltage to a power supply for instance, where the diode will limit the voltage available to its zener voltage. Zener diodes are available in various voltage ratings.

Schematic symbol

The symbol for a normal diode is an arrow with a cross bar across the end of the arrow. The arrow shows the direction that current will flow. The component has a band on one end so it can be put into the circuit the right way around. The band on the part corresponds to the line on the end of the arrow on the schematic symbol.



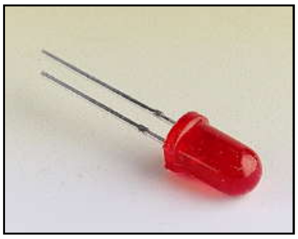
A Schottky diode has square brackets added to the ends of the cross bar:

A Zener Diode has lines on the end of the cross bar:

Values

Diodes don't have a single value, but they do have a maximum current that they can take, as well as forward voltage drops, reverse breakdown voltage, and other parameters. This information is not printed on the part, however a number, which identifies the part, will be printed on it. This part number can be used in a catalogue to find out what the various parameters of the diode are.

LEDs & Current Limit Resistors



An LED is a special diode. LED stands for Light Emitting Diode. LEDs are like normal diodes, in that they only allow current to flow in one direction, however when the current is flowing the LED lights.

The symbol for an LED is the same as the diode but with the addition of two arrows to show that there is light coming from the diode. As the LED only allows current to flow in one direction, it's important that we can work out which way the electricity will flow. This is indicated by a flat edge on the LED.

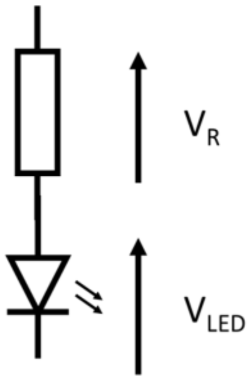
For an LED to light properly, the amount of current that flows through it needs to be controlled. To do this we use a current limit resistor. If we didn't use a current limit resistor the LED would be very bright for a short amount of time, before being permanently destroyed.

To work out the best resistor value we need to use Ohms Law. This connects the voltage across a device and the current flowing through it to its resistance.

Ohms Law tells us that the flow of current (I) in a circuit is given by the voltage (V) across the circuit divided by the resistance (R) of the circuit.

$$I = \frac{V}{R}$$

Like diodes, LEDs drop some voltage across them: typically 1.8 volts for a standard LED. However the high brightness white LED used in the wind up torch drops 3.5 volts.



The charged capacitor supplies 5V when discharging so there must be a total of 5 volts dropped across the LED (V_{LED}) and the resistor (V_R). As the LED manufacturer's datasheet tells us that there is 3.5 volts dropped across the LED, there must be 1.5 volts dropped across the resistor. ($V_{LED} + V_R = 3.5 + 1.5 = 5V$).

LEDs normally need about 10mA to operate at a good brightness. For this LED we need 15mA. Since we know that the voltage across the current limit resistor is 1.5 volts and we know that the current flowing through it is 0.015 Amps, the resistor can be calculated.

Using Ohms Law in a slightly rearranged format:

$$R = \frac{V}{I} = \frac{1.5}{0.015} = 100\Omega$$

Hence we need a 100Ω current limit resistor.

LEDs Continued

Packages

LEDs are available in many shapes and sizes. The 5mm round LED is the most common. The colour of the plastic lens is often the same as the actual colour of light emitted – but not always with high brightness LEDs.

Advantages of using LEDs over bulbs

Some of the advantages of using an LED over a traditional bulb are:

Power efficiency	LEDs use less power to produce the same amount of light, which means that they are more efficient. This makes them ideal for battery power applications.
Long life	LEDs have a very long life when compared to normal light bulbs. They also fail by gradually dimming over time instead of a sharp burn out.
Low temperature	Due to the higher efficiency of LEDs, they can run much cooler than a bulb.
Hard to break	LEDs are much more resistant to mechanical shock, making them more difficult to break than a bulb.
Small	LEDs can be made very small. This allows them to be used in many applications, which would not be possible with a bulb.
Fast turn on	LEDs can light up faster than normal light bulbs, making them ideal for use in car brake lights.

Disadvantages of using LEDs

Some of the disadvantages of using an LED over a traditional bulb are:

Cost	LEDs currently cost more for the same light output than traditional bulbs. However, this needs to be balanced against the lower running cost of LEDs due to their greater efficiency.
Drive circuit	To work in the desired manner, an LED must be supplied with the correct current. This could take the form of a series resistor or a regulated power supply.
Directional	LEDs normally produce a light that is focused in one direction, which is not ideal for some applications.

Typical LED applications

Some applications that use LEDs are:

- Bicycle lights
- Car lights (brake and headlights)
- Traffic lights
- Indicator lights on consumer electronics
- Torches
- Backlights on flat screen TVs and displays
- Road signs
- Information displays
- Household lights
- Clocks

Evaluation

It is always important to evaluate your design once it is complete. This will ensure that it has met all of the requirements defined in the specification. In turn, this should ensure that the design fulfils the design brief.

Check that your design meets all of the points listed in your specification.

Show your product to another person (in real life this person should be the kind of person at which the product is aimed). Get them to identify aspects of the design, which parts they like and aspects that they feel could be improved.

Good aspects of the design	Areas that could be improved

Improvements

Every product on the market is constantly subject to redesign and improvement. What aspects of your design do you feel you could improve? List the aspects that could be improved and where possible, draw a sketch showing the changes that you would make.

Packaging Design

If your product was to be sold in a high street electrical retailer, what requirements would the packaging have? List these giving the reason for the requirement.

Requirement	Reason

Develop a packaging design for your product that meets these requirements. Use additional pages if required.

ESSENTIAL INFORMATION

BUILD INSTRUCTIONS
CHECKING YOUR PCB & FAULT-FINDING
MECHANICAL DETAILS
HOW THE KIT WORKS

LIGHT UP YOUR DAY WITH THIS

WINDUP TORCH KIT

Version 1.1

Windup Torch Kit Essentials

www.kitronik.co.uk/2164

Build Instructions

Before you start, take a look at the Printed Circuit Board (PCB). The components go in the side with the writing on and the solder goes on the side with the tracks and silver pads.

1 PLACE THE SCHOTTKY DIODE

Start with the diode D1. The text on the PCB shows where D1 should go. The black band on the diode should match the drawing on the PCB to which end the diode goes. D1 is marked BAT 41.

2 PLACE THE ZENER DIODE

Next, place the second diode D2. The text on the PCB shows where D2 should go. The black band on the diode should match the drawing on the PCB to which end the diode goes. D2 is marked 1N750A.

3 PLACE THE RESISTOR

The resistor R1 is 100 Ω. The text on the PCB shows where R1 should go. It doesn’t matter which way around the resistor goes into the board.

4 PLACE THE CAPACITOR

The capacitor fits in the centre of the PCB and needs to be fitted the correct way. To do this, make sure the negative band on the capacitor that’s marked with ‘-‘ is placed in the ‘---‘ hole on the PCB.

5 PLACE THE LED

The LED to be placed in the holes indicated by LED. This component also needs to be fitted the correct way round. The longer leg of the LED should be placed into the ‘+’ hole. This would leave the side of the component with a flat edge to be located into the ‘-‘ hole. If you wish to have the LED flat out of the PCB, as in the example, then bend the legs before soldering. The alternative is add wires between the LED and the board. If you do this it is a good idea to use different colour wires for the different legs.

6 CONNECT THE MOTOR

The motor is connected from its brush connections to the holes marked MOTOR with wires. It doesn’t matter which way round the motor is connected, but the wire length will depend on the final design of your torch.

Checking Your Windup Torch PCB

Check the following before you wind up the torch for the first time.

- Check diode 1 and 2 are positioned correctly, with the bands towards the version text
- Check the Zener Diode (D2, marked 1N750) is positioned closest to the capacitor
- Check that the capacitor is positioned correctly, with the -ve stripe on the side where the --- is indicated on the PCB.
- Check the LED is attached with the correct polarity.

Check the bottom of the board to ensure that:

- All holes (except the two large mounting holes and one strain relief hole) are filled with the lead of a component or wire.
- All these leads are soldered.
- Pins next to each other are not soldered together.

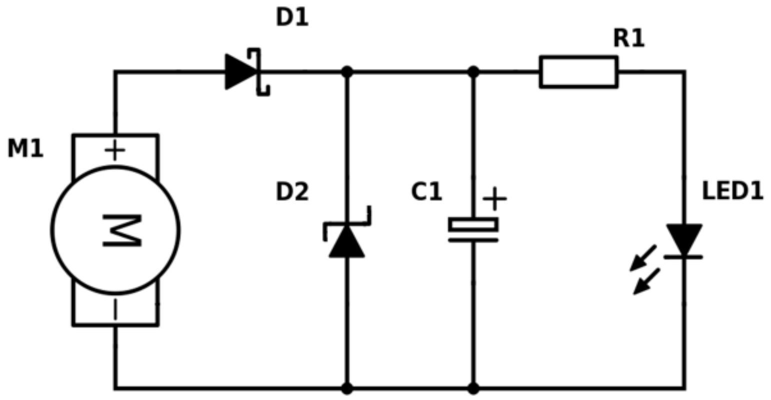
Using your torch

To use your torch simply wind the generator handle. After a few seconds of winding the LED should light up.
If it doesn't try turning the handle the other direction.
The gearbox attached to the motor has a built in, self-resetting, clutch mechanism. This makes a clicking noise when it is activated. Stop winding if you hear clicking and the clutch will reset. Try winding more gently if the clutch continues to activate.

If your torch doesn't stay lit long check the solder joints on the capacitor. A dry joint or a short will prevent the capacitor from storing charge, and keeping the LED lit.

Some of the winding energy goes to lighting the LED directly, and the excess is stored in the capacitor. Winding faster will increase the amount of stored energy, meaning the LED will stay lit for longer after winding stops.

How the Windup Torch Works



The circuit diagram for the Windup Torch is shown above. It is a very simple circuit. The motor (M1), acting as a generator, powers the circuit when turning the handle. The faster rotation of the generator the higher the voltage supplied to the circuit

The Schottky diode (D1) is to ensure that there is polarity protection if the generator is turned the opposite direction. The Schottky diode also has a low voltage drop, so the smallest amount possible of voltage is lost.

The Zener diode (D2) makes sure the voltage does not go to high and damage the capacitor. If the voltage from the generator (M1) climbs above 5V the Zener diode will breakdown and start to conduct, limiting the voltage across the capacitor to 5V. Once the voltage dips below 5V the Zener diode will recover, and stop conducting.

The capacitor stores the excess charge created by the generator, over the amount required to light the LED. When the generator stops the capacitor slowly discharges and keeps the LED illuminated.

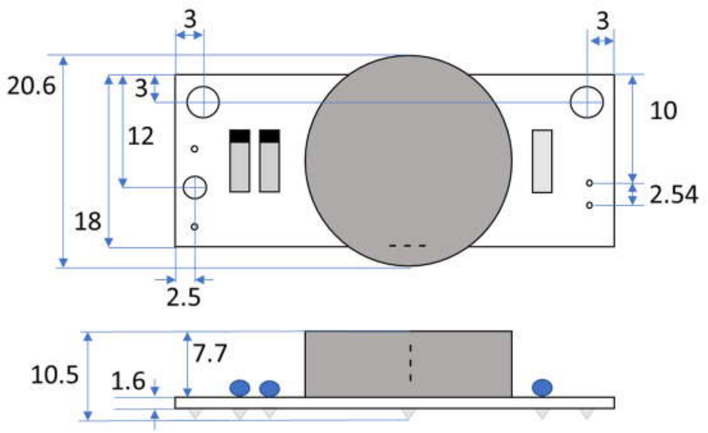
The resistor limits the amount of current to the LED.

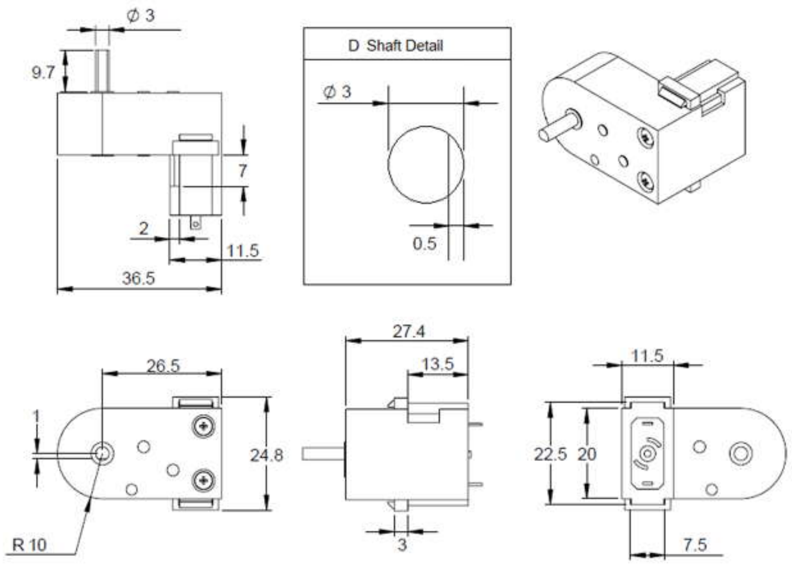
Rotating the motor generates the current to charge the capacitor and illuminate the LED. Because the LED is lit at the same time as the capacitor is charging it will take longer to charge the capacitor to keep the LED on than if the capacitor was charged and then the LED switched on.

Designing the Enclosure

When you design the enclosure, you will need to consider:

- The size of the PCB.
- Where the generator will be mounted
- The winding handle
- Where the LED will be mounted
- There are 2 3.3mm holes in the corners of the PCB to secure the PCB in the enclosure.





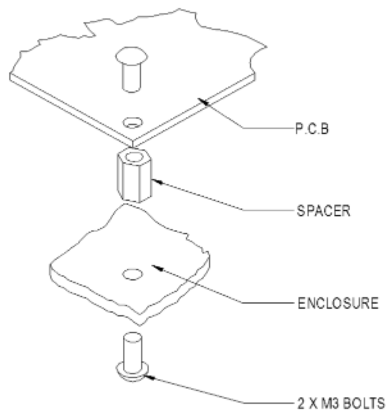
The following technical drawings of the built PCB and motor should help you to design your enclosure and winding handle. All dimensions are in mm

The 2 mounting holes are 3mm from the board edge.
The assembled PCB is approximately 10.5 mm tall including solder points.
The Capacitor is larger than the PCB, it is about 20.6mm in diameter, and 7.7mm tall.

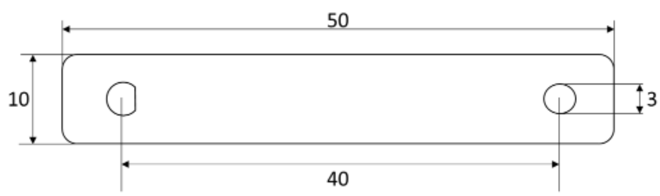
The generator wires run through a strain relief hole that is 2.5 mm in diameter.
The motor shaft is 3mm in diameter, with a flat 1mm from the centre.

Mounting the PCB to the enclosure

The drawing below shows how a hex spacer can be used with two bolts to fix the PCB to the enclosure.
Your PCB has two mounting holes designed to take M3 bolts.



A simple winding handle can be made using a laser cut sheet and an M3 nut and bolt. The drawing to the right shows suitable dimensions



Online Information

Two sets of information can be downloaded from the product page where the kit can also be reordered from. The 'Essential Information' contains all of the information that you need to get started with the kit and the 'Teaching Resources' contains more information on soldering, components used in the kit, educational schemes of work and so on and also includes the essentials. Download from:

www.kitronik.co.uk/2164

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