TEACHING RESOURCES

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

HARNESS THE POWER OF THE SUN WITH THIS

SOLAR TORCH KIT

Version 1.0

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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 contain 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 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 bike lights / safety lights or similar products. 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 products. 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' and 'Capacitor Basics' worksheets. Homework: Complete any of the remaining resistor / capacitor 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 PCB' section and the fault-finding flow chart. Homework: Read 'How the Square Wave Generator Works' sheet.
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 Eight 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 PCB' and fault-finding flow chart.

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***

Capacitor Ceramic Disc values

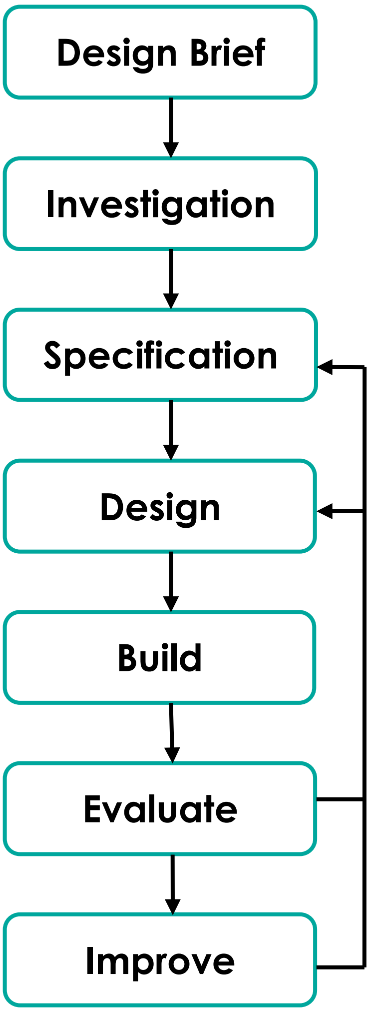
Printing on capacitor	Two digit start	Number of zero's	Value in pF
222	22	00	2200pF (2.2nF)
103	10	000	10000pF (10nF)
333	33	000	33000pF (33nF)
473	47	000	47000pF (47nF)

RC Time Constants

Resistor Value	Capacitor Value	RC Time Constant
2,000,000 (2MΩ)	**0.000,1 (100µF)**	200 Seconds
100,000 (100KΩ)	**0.000,1 (100µF)**	10 Seconds
100,000 (100KΩ)	**0.000,047 (47µF)**	4.7 Seconds

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

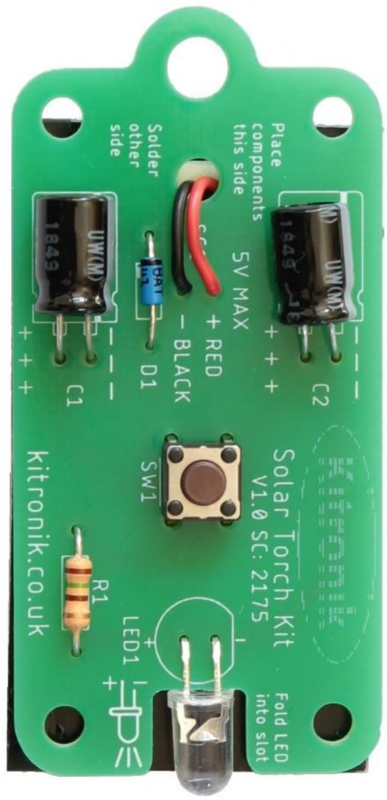
A manufacturer has developed a simple circuit for storing solar energy, which can then be used to power a torch. The circuit charges some capacitors from a solar cell, and then powers a bright LED when a button is pressed. The circuit has been developed to the point where they have a working Printed 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.



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 have holes in it.	Example: So that the LED's can be seen.

Design

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

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

Design Review (group task)

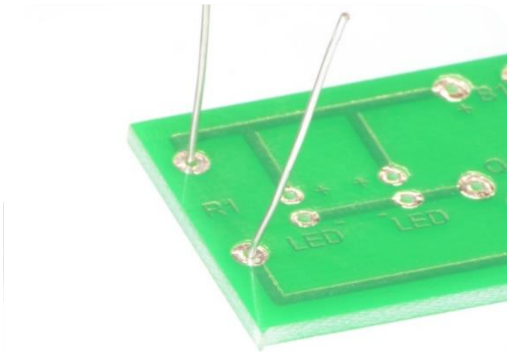
Split into groups of three or four. Take it in turns to review each person's design against the requirements of their specification. Also look to see if you can spot any additional aspects of each design that may cause problems with the final product. This will allow you to ensure that you have a good 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.

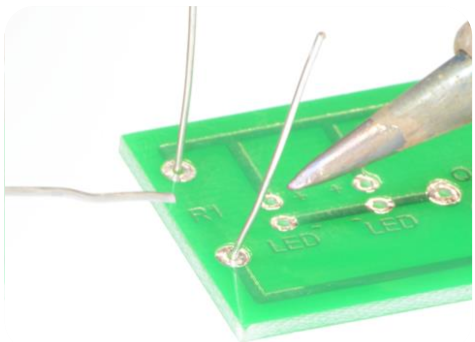


2 CLEAN SOLDERING IRON

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

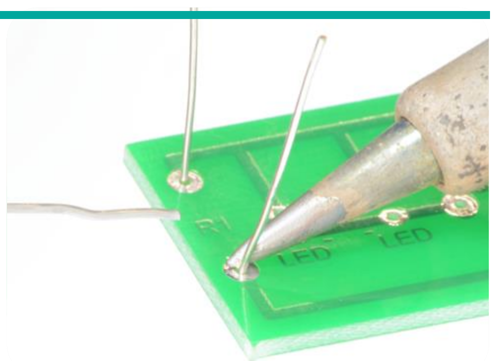
3 PICKUP IRON AND SOLDER

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



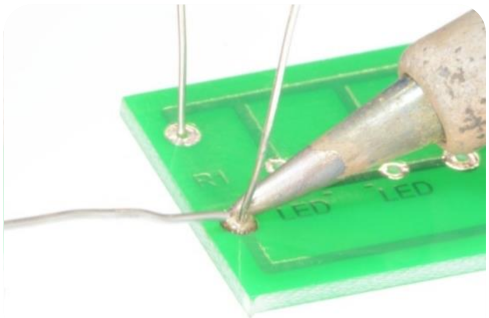
4 HEAT PAD

Place soldering iron tip on the pad.



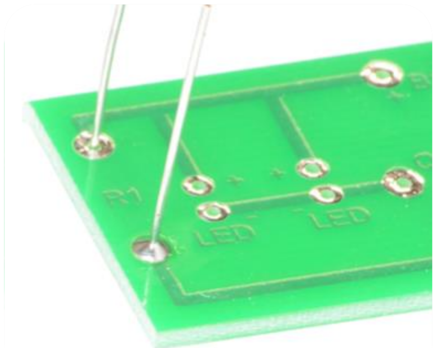
5 APPLY SOLDER

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



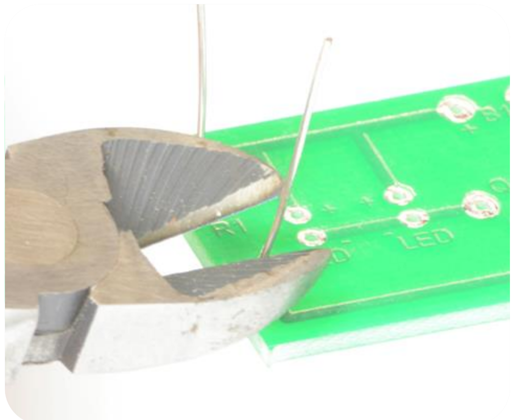
6 STOP SOLDERING

Remove the solder, and then remove the soldering iron.



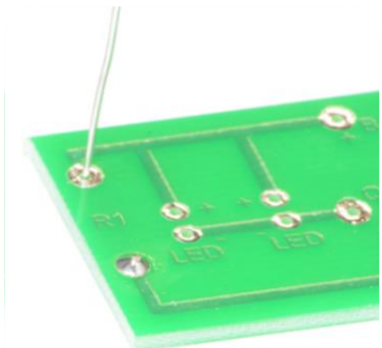
7 TRIM EXCESS

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



8 REPEAT

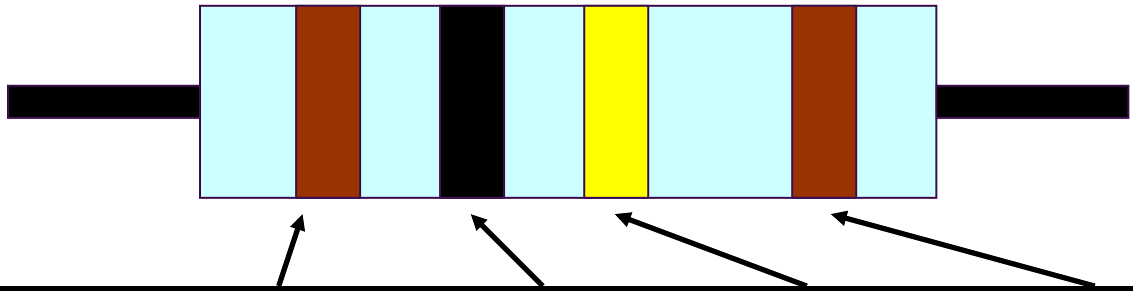
Repeat this process for each solder joint required.



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.

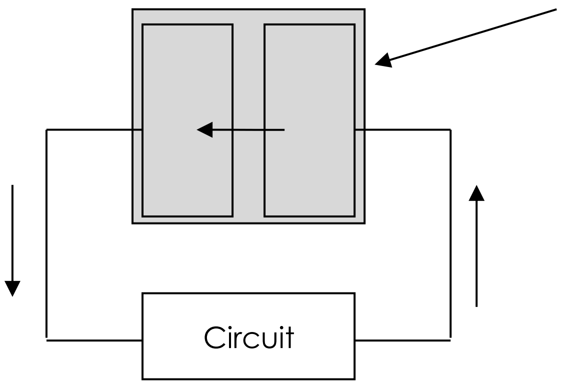
E-12 resistance tolerance (± 10%)											
10	12	15	18	22	27	33	39	47	56	68	82

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 Solar Cell Work?

A solar cell (sometimes known as photovoltaic cells) is a device that converts light from the sun into electricity that can then be used to power other electronic devices.

Most solar cells are made of silicon. The silicon is separated into two parts and each part has another chemical added to it. This is called 'doping'. When sunlight hits the solar cell, it causes electrons to 'jump' between the two doped parts of silicon. The direction that the electrons 'jump' is always the same as this is controlled by the way the two parts of silicon are doped. It is this constant flow of electrons that we think of as electricity.



Electrons jump between two silicon layers when the sunlight hits the cell. They then flow around the electric circuit.

The sun generates a lot of energy but not all of this can be converted into electricity by the solar cell. The amount of the sun's energy that can be converted into energy is determined by the efficiency of the solar cell. A typical solar cell may have an efficiency of 12%. This means that if 100 Watts of light energy fell on a solar cell, it would generate 12 Watts of electrical energy.

Electrical power (in Watts) is given by:

Power = Volts x Amps

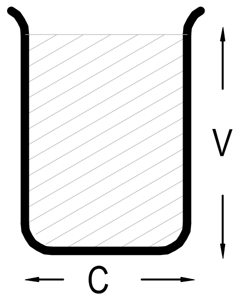
The solar cell in the solar torch kit typically produces 5V and 40mA. Therefore, it produces:

5V x 0.04A = 0.2 Watts.

The electricity produced by a solar cell is just like that from a normal battery. However, unlike a battery, a Solar cell does not go flat – as long as there is enough light shining onto the solar cell it will produce its rated output. In dim light the solar cell may not produce any electricity.

Capacitor Basics

What is a capacitor?

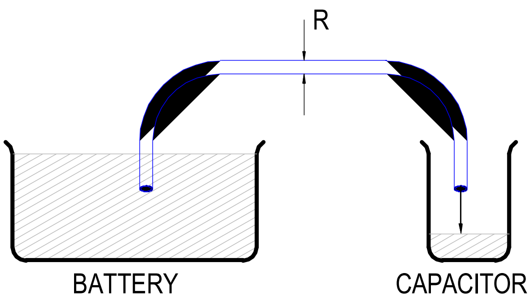


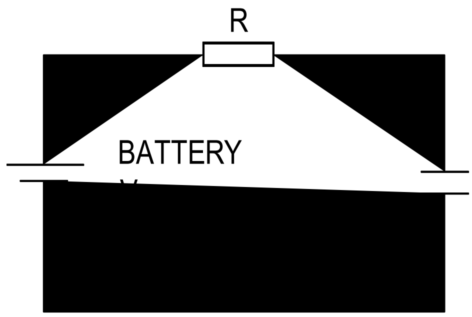
A capacitor is a component that can store electrical charge (electricity). In many ways, it is like a rechargeable battery.

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

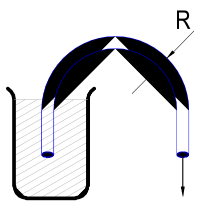




When a capacitor is connected to an item such as a battery, or in this kit a solar cell, charge will flow from the battery into it. Therefore, the capacitor will begin to fill up. The flow of water in the picture above left is the equivalent of how the electrical charge will flow in the circuit shown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

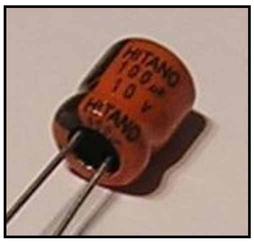


Once a capacitor has been filled with an amount of charge, it will retain this charge until it is connected to something into which this charge can flow.

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.



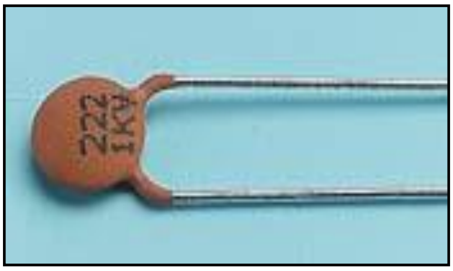
Ceramic Disc Capacitors

Values

1F	= 1,000mF
1F	= 1,000,000µF
1F	= 1,000,000,000nF
1F	= 1,000,000,000,000pF

The value of a capacitor is measured in Farads, though a 1 Farad capacitor would be very big. Therefore, we tend to use milli Farads (mF), micro Farads (µF), nano Farads (nF) and pico Farads (pF). A µF is a millionth of a Farad, 1µF = 1000 nF and 1nF = 1000 pF.

The larger electrolytic capacitors tend to have the value printed on the side of them along with a black band showing the negative lead of the capacitor.



Other capacitors, such as the ceramic disc capacitor shown on the right, use a code. They are often smaller and may not have enough space to print the value in full, hence the use of the 3-digit code. The first 2 digits are the first part of the number and the third digit gives the number of zeros to give its value in pF.

Example: 104 = 10 + 0000 (4 zero's) = **100,000 pF** (which is also 0.1 µF)

Work out what value the four capacitors are in the table below.

Printing on capacitor	Two digit start	Number of zero's	Value in pF
222			
103			
333			
473			

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.

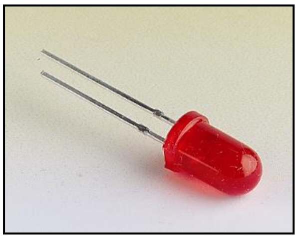
A Schottky diode has square brackets added to the ends of the cross bar:

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 up.

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.

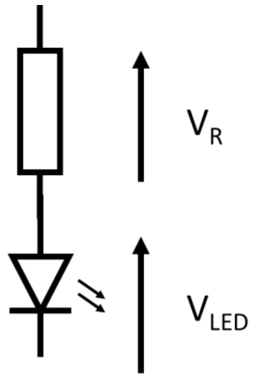
For an LED to light properly, the amount of current that flows through it needs to be controlled. To do this we use a current limit resistor. If we didn't use a current limit resistor the LED would be very bright for a short amount of time, before being permanently destroyed.

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

Ohm's 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 solar torch drops 2.9 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 2.9 volts dropped across the LED, there must be 2.1 volts dropped across the resistor. ($V_{LED} + V_R = 2.9 + 2.1 = 5V$).

LEDs normally need about 10mA to operate at a good brightness. For this LED we need 20mA. 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 0.02 Amps, the resistor can be calculated.

Using Ohms Law in a slightly rearranged format:

$$R = \frac{V}{I} = \frac{2.1}{0.020} = 105\Omega$$

Because not all values are easily available we use the next largest preferred value, which is 150Ω resistor in this case. This will result in a reduced current flow, which will make the LED slightly less bright, but will also increase the time that the torch will light up on a single charge.

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

Renewable Energy

Renewable energy is becoming more important as our demand for energy grows, while, at the same time, traditional forms of generating power such as coal, gas and oil are a finite resource. Once these are used up, they will be gone forever. A renewable energy source is something that is naturally occurring and can be replaced.

Types of renewable energy include:

Solar
Solar energy is energy generated from sunlight. Applications of solar energy include generating power by turning the sun's rays into electricity by using a solar cell and by heating water, which can then be used for showers, baths or for heating radiators.

Wind
Wind power is energy generated from the wind. Normally the wind is used to turn a wind turbine. A wind turbine looks like a large windmill, which rotates when the wind blows on it. This is then used to turn a turbine that turns the rotating movement into electricity. Often a number of wind turbines are located near each other in what is known as a 'wind farm' that can generate enough electricity to power a few thousand houses.

Hydroelectricity
Hydroelectricity uses the power of water falling to generate electricity and is one of the most widely used forms of renewable energy. The force of the water is used to turn a turbine, which generates electricity. Most hydroelectric power plants are created by damming a river and then using the force of the dammed water to turn a turbine.

Tidal
Tidal power is another form of hydropower. Instead of using the power of falling water to generate electricity, it uses the movement of water due to the tides to generate energy. There are currently a lot of different designs for tidal energy devices that are coming into use but they all use the force of the water in some way to turn a turbine, which generates electricity.

Geothermal
Geothermal power comes from heat energy that is stored within the ground. Geothermal power plants are often located near tectonic plate boundaries where there can be large sources of geothermal heat created as two tectonic plates meet. Normally, some form of 'heat engine' is used to convert the heat in to electricity. Sometimes the geothermal heat is used to simply heat water, which can then be used to heat homes and businesses.

Bio fuels
Bio fuels are fuel sources that are derived from some form of biological mass (plants). They are renewable because the plant from which they are created can be re-grown and replaced. Bio fuels can be used to power cars and other vehicles and can be used to power generators, which can be used to create electricity.

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

HARNESS THE POWER OF THE SUN WITH THIS

SOLAR TORCH KIT

Version 1.0

Solar Torch Essentials

www.kitronik.co.uk/2175

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 RESISTOR

The resistor R1 is 150 Ω. The text on the PCB shows where R1 should go. It doesn't matter which way around the resistor goes into the board.

2 SOLDER THE SCHOTTKY DIODE

Place the BAT41 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.

3 PLACE THE SWITCH

The TACT switch is labelled SW1 on the PCB. It does not matter which way round the switch goes. Make sure to push the switch against the PCB.

4 SOLDER 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.

5 SOLDER THE CAPACITORS

The capacitors placements are marked C1 and C2. The 2 capacitors 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.

6 SOLDER SOLAR CELL

Thread the solar cell wires through from the solder side of the PCB and insert them into the holes marked +RED and -BLACK. Ensure that the wire colours match the hole description. Do not attach the solar panel to the PCB until after testing as it covers the solder joints.

Checking Your PCB

Check the following before you power up the unit:

Check the bottom of the board to ensure that:

- All holes (except the large mounting holes) are filled with the lead of a component.
- All these leads are soldered.
- Pins next to each other are not soldered together.

Check the top of the board to ensure that:

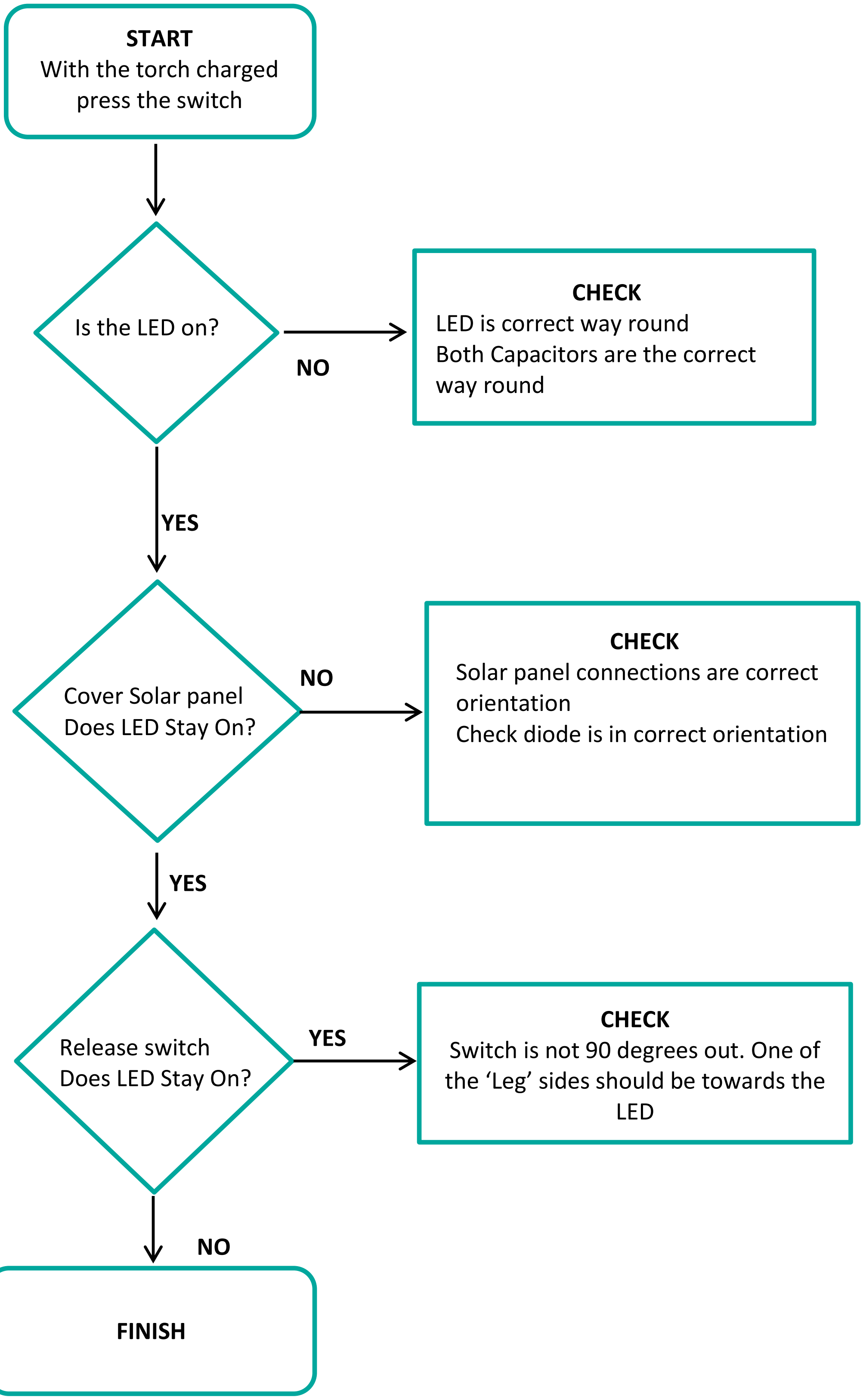
- C1 and C2 match the outline on the PCB.
- The resistor bands on R1 are Brown, Green, Brown
- The diode has its band away from the LED end of the PCB
- All flat edge of the LED matches the outline on the PCB
- The solar panel connecting leads are the correct way around.

Charge the Torch by illuminating the solar cell with a bright light for approximately 10 minutes. This should give enough charge to allow testing of the torch. A full charge can take around 30 minutes.

Once your torch has charged and is working you can use the supplied double sided pads to secure the solar panel to the PCB. Place the pads in 2 stacks of 2 to allow clearance for the solder joints.

Solar Torch Essentials

www.kitronik.co.uk/2175



Solar Torch Essentials

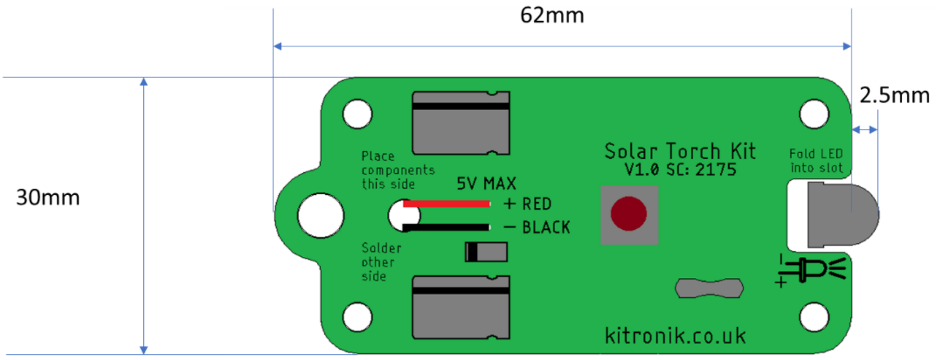
www.kitronik.co.uk/2175

Designing the Enclosure

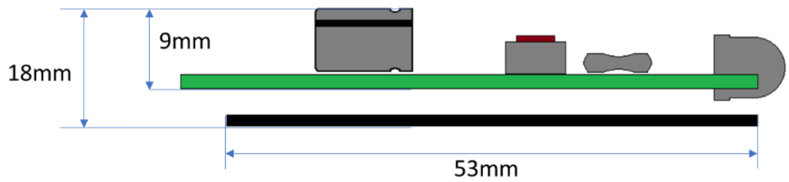
When you design the enclosure, you will need to consider:

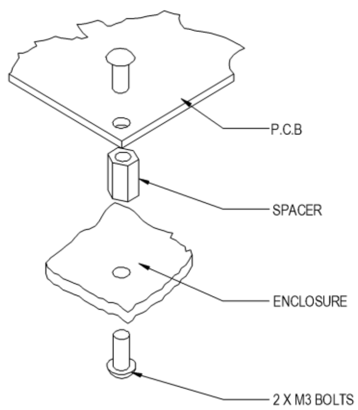
- The size of the PCB (below left).
- Access to the switch
- Height of the components.
- The Solar Cell needs to get light to charge the torch

This technical drawing of the PCB and other components should help you to design your enclosure.



All dimensions are in mm. The PCB has four mounting holes 3.3mm in diameter. The centres of the holes are 4mm from the board edge



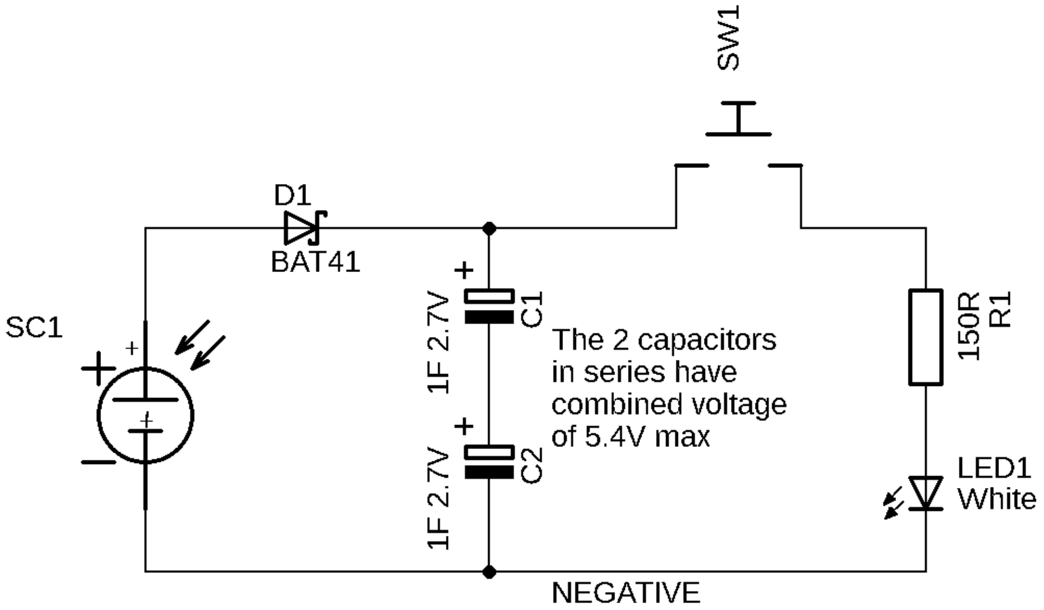


Mounting the PCB to the enclosure

The drawing to the left shows how a hex spacer can be used with two bolts to fix the PCB to the enclosure.

Your PCB has four mounting holes designed to take M3 bolts.

How the Circuit Works



The circuit has 2 distinct sections, an energy storage section – consisting of the capacitors, diode and solar cell, and an energy using section – the LED. The sections are joined by the switch.

When the Solar Cell is illuminated it provides current to charge the 2 capacitors (C1 and C2). The diode D1 prevents the Capacitors discharging back through the Solar Cell. The Solar Cell puts out 5V, so there are 2 capacitors rated at 2.7V each in series. This means the maximum voltage across the pair of capacitors can be up to 5.4V safely.

When the switch is pressed the circuit will use the available energy, either stored in the capacitors, or from the solar cell, to illuminate the LED.

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/2175

This kit is designed and manufactured in the UK by Kitronik

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RoHS

Every effort has been made to ensure that these notes are correct, however Kitronik accept no responsibility for issues arising from errors / omissions in the notes.