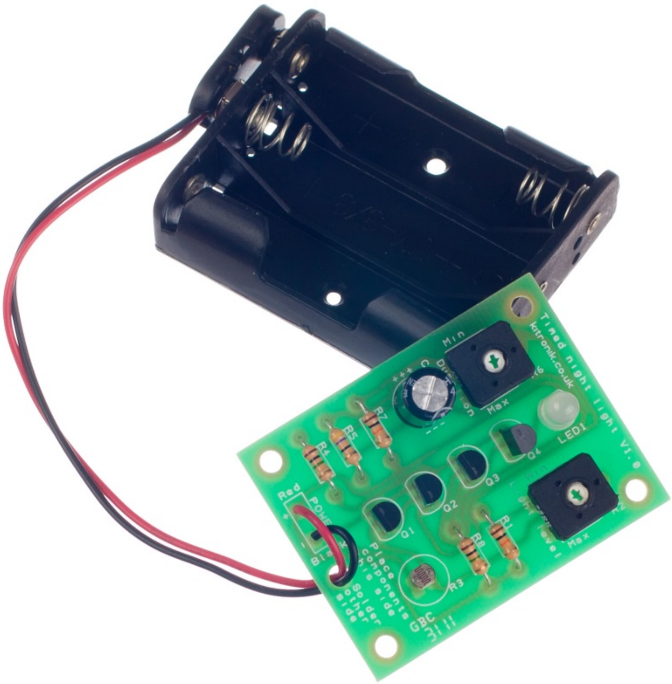
TEACHING RESOURCES

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

RELAX YOUR WAY TO SLEEP WITH THIS

TIMED NIGHT LIGHT KIT



Version 2.0

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 lamps and night lights. 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 lamps and night lights. 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 Ten 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 Circuit' section and the fault finding flow chart. Homework: Read 'How the Timed Night Light Works' sheet in conjunction with the LDR and FET sheets.
Hour 9	Build the enclosure. Homework: Collect some examples of instruction manuals.
Hour 10	Build the enclosure. Homework: Read 'Instruction Manual' sheet and start developing instructions for the night light.
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 'How the Timed Night Light Works' and fault finding flow chart.

Answers

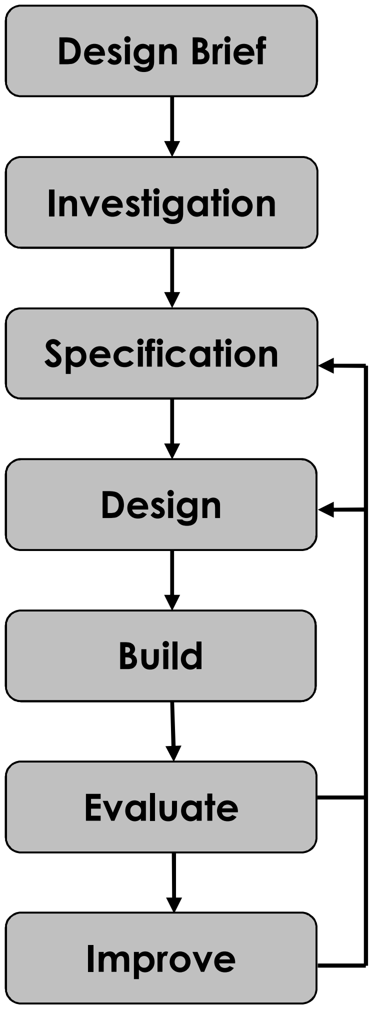
Resistor questions

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*

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

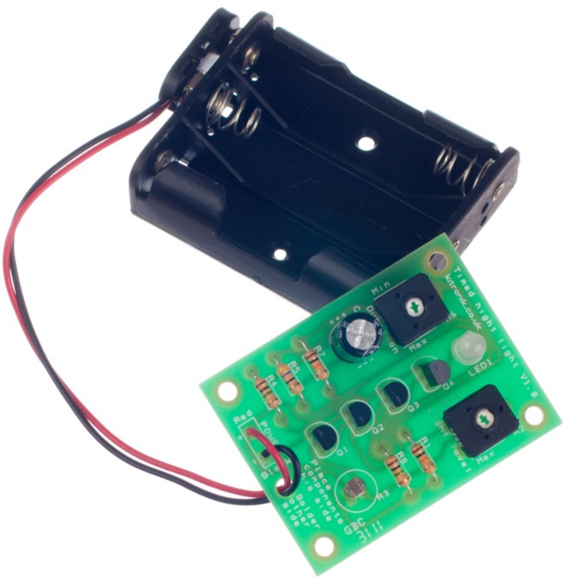
A manufacturer of bedside lamps has developed a simple lamp that turns on automatically when it goes dark at night. The lamp uses a special LED which cycles through a number of different colours when it is turned on. The lamp also has an ‘auto off’ timer. The lamp will automatically turn on when it becomes dark, it then stays on for a specific period of time before automatically turning off. This means that the lamp can be used for a couple months before the batteries need to be changed.

The circuit has been developed to the point where they have a working Printed Circuit Board (PCB).

The manufacturer would you to design an enclosure into which the electronics can be housed. It is important that you make sure that the final design meets all of the requirements that you identify for such a product. For instance, if you decide to design the lamp for a young child, it should meet the requirements of this type of user.

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 allow easy access to the batteries.	Example: So that they can be quickly changed when they become flat.

Design

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

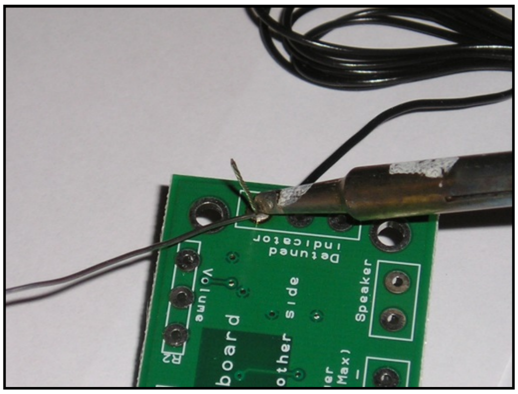
Name…………………………………………… Class……………………………

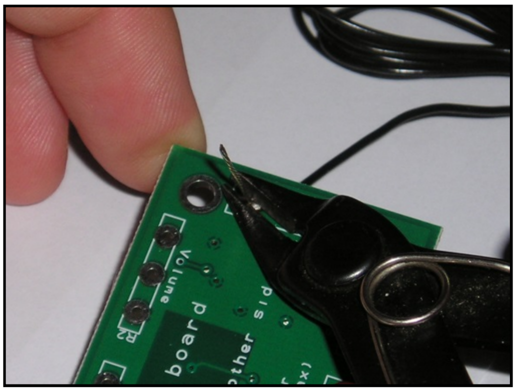
Design Review (group task)

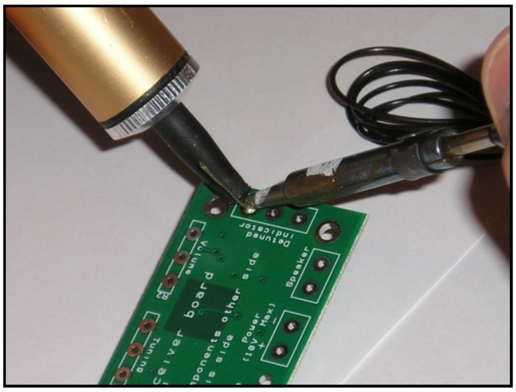
Split into groups of three or four. Take it in turns to review each person's design against the requirements of their specification. Also look to see if you can spot any additional aspects of each design that may cause problems with the final product. This will allow you to ensure that you have a good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

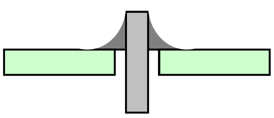




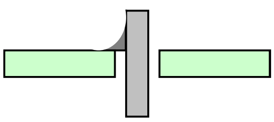


1. Start with the smallest components working up to the taller components, soldering any interconnecting wires last.
2. Place the component into the board, making sure that it goes in the right way around and the part sits flush against the board.
3. Bend the leads slightly to secure the part.
4. Make sure that the soldering iron has warmed up and if necessary, use the damp sponge to clean the tip.
5. Place the soldering iron on the pad.
6. Using your free hand, feed the end of the solder onto the pad (top picture).
7. Remove the solder, then the soldering iron.
8. Leave the joint to cool for a few seconds.
9. Using a pair of cutters, trim the excess component lead (middle picture).
10. If you make a mistake heat up the joint with the soldering iron, whilst the solder is molten, place the tip of your solder extractor by the solder and push the button (bottom picture).

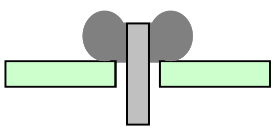
Solder joints



Good solder joint



Too little solder

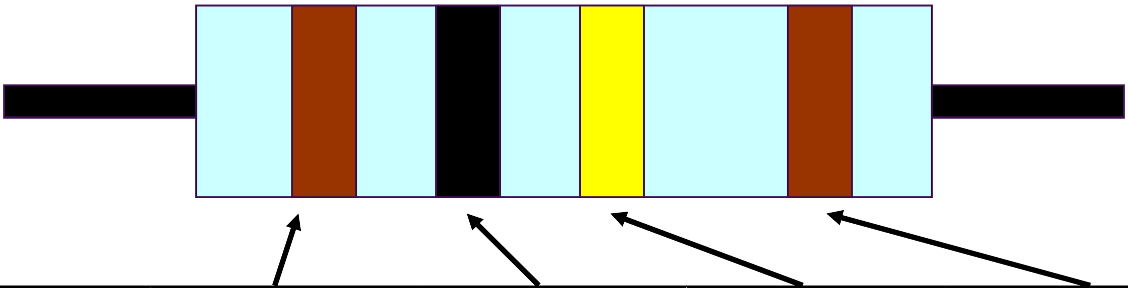


Too much solder

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

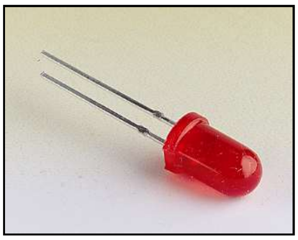
There are a number of different ranges of values for resistors. Two of the most popular are the E12 and E24. They take into account the manufacturing tolerance and are chosen such that there is a minimum overlap between the upper possible value of the first value in the series and the lowest possible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

LEDs & Current Limit Resistors

Before we look at LEDs, we first need to start with diodes. Diodes are used to control the direction of flow of electricity. In one direction they allow the current to flow through the diode, in the other direction the current is blocked.



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.

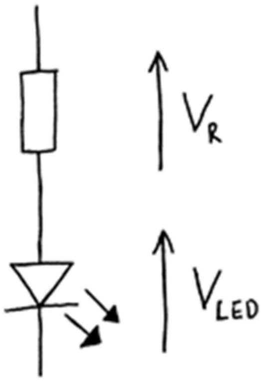
For an LED to light properly, the amount of current that flows through it needs to be controlled. To do this we use a current limit resistor. If we didn't use a current limit resistor the LED would be very bright for a short amount of time, before being permanently destroyed.

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 LED used in the 'white light' version of the lamp drops 3.5 volts.



The USB lamp runs off the 5V supply provided by the USB connection 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. 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 0.01 Amps, the resistor can be calculated.

Using Ohms Law in a slightly rearranged format:

$$R = \frac{V}{I} = \frac{1.5}{0.01} = 150\Omega$$

Hence we need a 150Ω current limit resistor.

LEDs Continued

The Colour Changing LEDs used in the 'colour' version of the lamp has the current limit resistor built into the LED itself. Therefore no current limit resistor is required. Because of this, a 'zero Ω' resistor is used to connect the voltage supply of 5V directly to the Colour Changing LED.

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 break lights.

Disadvantages of using LEDs

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

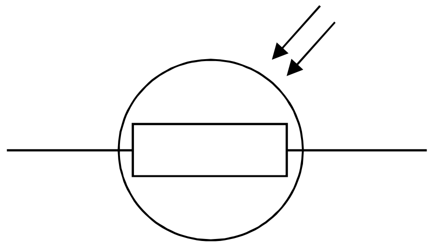
Cost	LEDs currently cost more for the same light output than traditional bulbs. However, this needs to be balanced against the lower running cost of LEDs due to their greater efficiency.
Drive circuit	To work in the desired manner, an LED must be supplied with the correct current. This could take the 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 (break and headlights)
- Traffic lights
- Indicator lights on consumer electronics
- Torches
- Backlights on flat screen TVs and displays
- Road signs
- Information displays
- Household lights
- Clocks

LDR (Light Dependent Resistor)

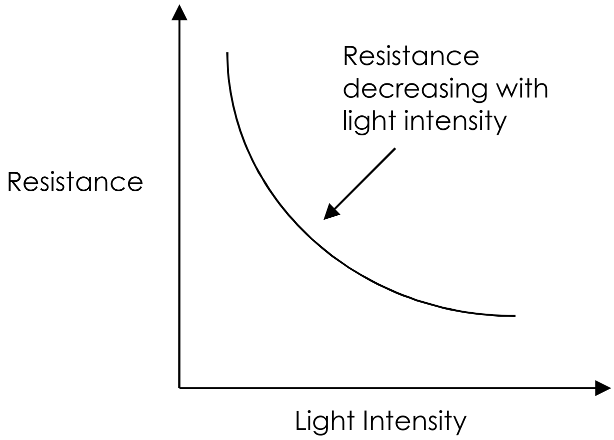


An LDR is a component that has a resistance that changes with the light intensity that falls upon it. They have a resistance that falls with an increase in the light intensity falling upon the device.

The resistance of an LDR may typically have the following resistances

Daylight = 5000Ω
Dark = 20000000 Ω

You can therefore see that there is a large variation between these figures. If you plotted this variation on a graph, you would get something similar to that shown in the graph to the right.



Applications

There are many applications for Light Dependent Resistors. These include:

Lighting switch

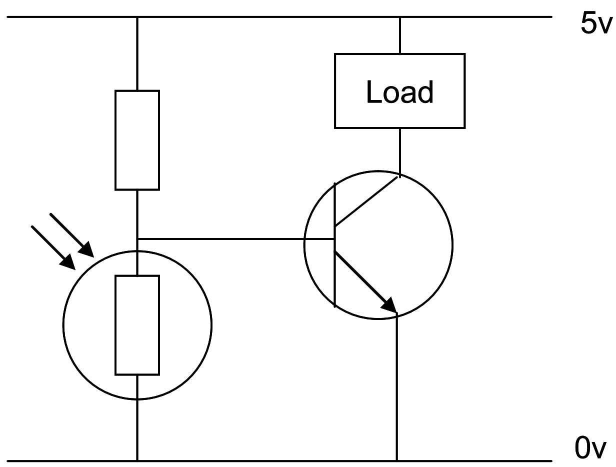
The most obvious application for an LDR is to automatically turn on a light at certain light level. An example of this could be a street light.

Camera shutter control

LDRs can be used to control the shutter speed on a camera. The LDR would be used the measure the light intensity and then set the camera shutter speed to the appropriate level.

Example

The circuit shown right shows a simple way of constructing a circuit that turns on when it goes dark. The increase in resistance of the LDR in relation to the other resistor, which is fixed as the light intensity drops, will cause the transistor to turn on. The value of the fixed resistor will depend on the LDR used, the transistor used and the supply voltage.



Field Effect Transistors (FETs)

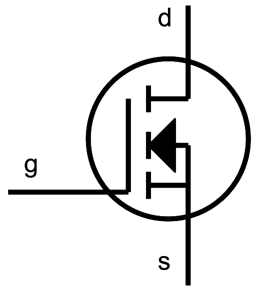
Functionality

An FET is a type of transistor and, like regular transistors, a small amount of power on input of the FET can be used to switch a large amount of power on the output. There are two types of FET: an N-channel and a P-channel. This sheet only examines the N-channel FET.

A FET has three legs: the gate, drain and source. When a voltage is present on the gate (relative to the source) the FET switches on and current flows from the drain to the source. The amount of current that flows into the gate is so small that it isn't worth considering. However the FET will be able to switch anything from a few hundred milliamps to tens of amps, depending upon the case that it is packaged in.

Schematic symbol

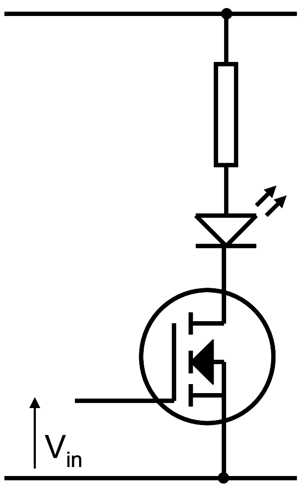
The symbol for an N-channel FET is shown to the right along with the pins being labelled.



Current rating

FETs are available in different current ratings; the style of the package changes as the current rating goes up. Low current FETs come in a 'D' shaped plastic package, whilst the higher current FETs are produced in metal cans that can be bolted on to heat sinks so that they don't over heat. The 'D' shape or a tag on the metal can is used to work out which pin does what. All FETs are wired differently so they have to be looked up in a catalogue to find out which pin connects where.

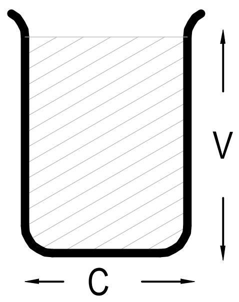
Example circuit



In this circuit an FET is connected to an LED, however it could be used to drive any load including higher power loads. When V_{in} is at zero volts the gate of the FET has no voltage on it and no current flows through the LED. When V_{in} is high the FET turns on and current flows through the FET from the drain to the source and the LED lights.

Capacitor Basics

What is a capacitor?

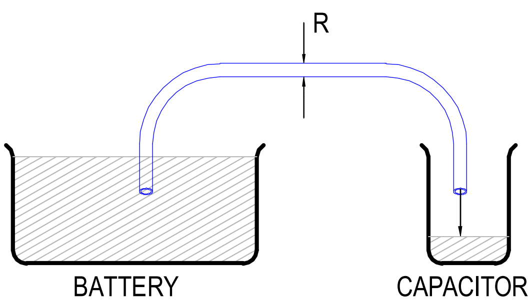


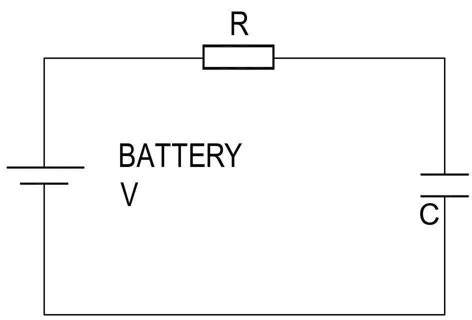
A capacitor is a component that can store electrical charge (electricity). In many ways, it is like a rechargeable battery.

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

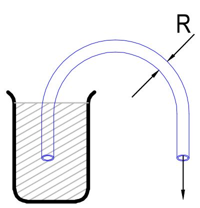




When a capacitor is connected to an item such as a battery, charge will flow from the battery into it. Therefore the capacitor will begin to fill up. The flow of water in the picture above left is the equivalent of how the electrical charge will flow in the circuit shown on the right.

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

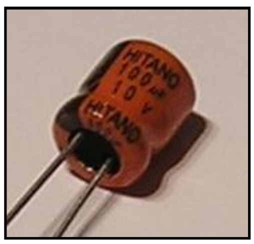


Once a capacitor has been filled with an amount of charge, it will retain this charge until it is connected to something into which this charge can flow.

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.



Instruction Manual

Your night light is going to be supplied with some instructions. Identify four points that must be included in the instructions and give a reason why.

Point to include:

Reason:

Point to include:

Reason:

Point to include:

Reason:

Point to include:

Reason:

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

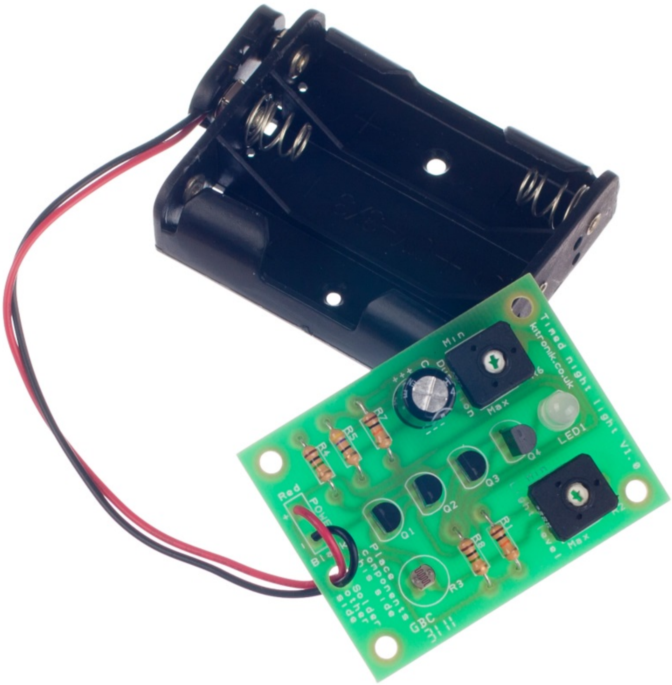
Develop a packaging design for your product that meets these requirements. Use additional pages if required.

ESSENTIAL INFORMATION

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

RELAX YOUR WAY TO SLEEP WITH THIS

TIMED NIGHT LIGHT KIT



Version 2.0

Timed Night Light Essentials

www.kitronik.co.uk/2139

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 RESISTORS

Start with the five resistors:
The text on the PCB shows where R1, R2 etc go.
Ensure that you put the resistors in the right place.

PCB Ref	Value	Colour Bands
R1 & R7	10K	Brown, black, orange
R4 & R8	1M	Brown, black, green
R5	47Ω	Yellow, purple, black

2 SOLDER THE LDR

The LDR needs to be soldered into the board where it is marked R3.

3 SOLDER THE VARIABLE RESISTORS

Solder the variable resistors into R2 & R6. They will only fit in the holes in the board when they are the correct way around. The two resistors are different values, R2 is a 220K and R6 is 10M, make sure that you put both in the right place.

4 PLACE THE FETs

The four FETs should be placed into Q1 to Q4. All four are the same type but it is important that they are inserted in the correct orientation. Ensure that the shape of the device matches the outline printed on the PCB. Once you are happy, solder the devices into place.

5 SOLDER THE LED

Solder the Light Emitting Diode (LED) into LED1. The LED won't work if it doesn't go in the right way around. If you look carefully one side of the LED has a flat edge, which must line up with the flat edge on the lines on the PCB.

6 SOLDER THE CAPACITOR

Solder the capacitor into the board where it is marked C1. It is important that the '-' on the capacitor matches the '----' markings on the PCB.

7 ATTACH THE BATTERY CONNECTOR

Now you must attach the battery clip. It needs to be connected to the terminals marked 'Power'. The red lead should be soldered to the '+' terminal also marked 'red' and the black lead should be soldered to the '-' terminal also marked 'black'. Connect the PP3 snap on to the 3xAA battery box. Do not use a 9V battery with this circuit.

Checking Your Circuit

Check the following before you connect power to the board:

Check the bottom of the board to ensure that:

- All the leads are soldered.
- Pins next to each other are not soldered together.

Check the top of the board to ensure that:

- The body of the four FETs matches the outline on the PCB.
- The flat edge on the LED lines matches the outline on the PCB.
- The red wire on the power clip goes to the connection marked 'red' and the black wire to the connection marked 'black'.
- R1 & R7 are 10K resistors (brown, black, orange colour bands).
- R5 is a 47Ω resistor (yellow, purple, black colour bands).
- R2 has 220K printed on the side.

Testing the PCB

Set the duration to min – fully anti-clockwise.
Set the light level so that it points at the other trimmer.

Power the board up and cover the LDR – the LED should turn on for about five seconds. Uncover the LDR, then cover it again, the LED should turn on again for about five seconds. The duration and light level can be adjusted.

If the circuit doesn't function as expected, use the fault finding flow chart to locate the problem.

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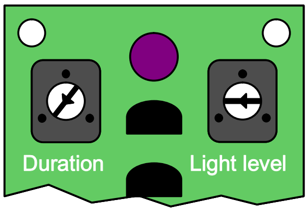
Fault finding flow chart

Start
Set the two trimmers as shown in the diagram. Then power the board up



Is the LED off?

No →

The LED is constantly on
All 3 pins on Q2 are shorted.

The LED is on dim & goes brighter when the LDR is covered
Check Q2 & Q3 for shorts.

Yes ↓

Cover the LDR (and keep it covered)

Does the LED light?

No →

Check

- The batteries are good and in the right way around.
- Check the power clip is connected the right way around and soldered correctly.
- The LED is the right way around, for a short or dry joint.
- Q1 is the right way around, for shorts or dry joints.
- Q2 for shorts or dry joints.
- Q3 is the right way around or for shorts.
- Q4 for shorts or dry joints.
- R3 for a short or dry joint.
- R1, R2, R5 & R8 for dry joints.
- R5 is a 47Ω resistor (yellow, purple, black).
- R1 is a 10K resistor (brown, black, orange).
- C1 for a short.

The LED flashes briefly ←

Check

- Q2 for dry joints.
- R5 is in the right place, 47Ω resistor (yellow, purple, black).
- C1 for dry joints.

Yes
Even if dimly ↓

After about 5 seconds does it go off?

No →

Check

- Q2 is the right way around.
- Q3 for dry joints.
- Q4 is the right way around and for shorts.
- R6 for dry joints.
- R7 for dry joints.
- R7 is a 10K resistor (brown, black, orange).

Yes ↓

Can you adjust the light level & duration OK?

Yes ← Stop

No →

If the setting of the light level is close to min & the maximum duration is about a minute

The two trimmer pots are in the wrong place.
(R2 should be the 220K)

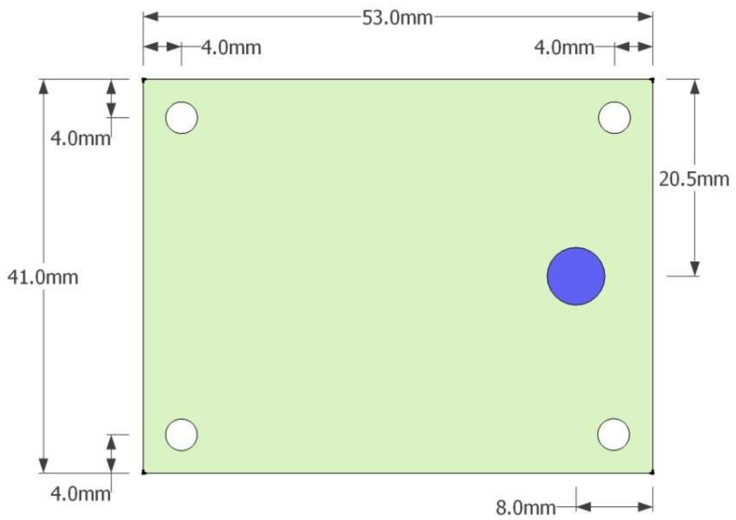
Designing the Enclosure

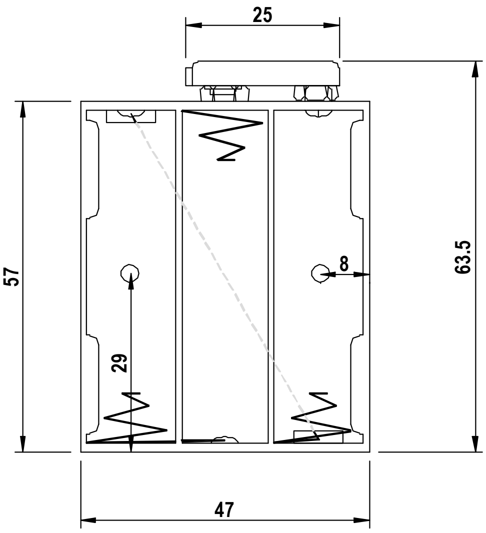
When you design the enclosure, you will need to consider:

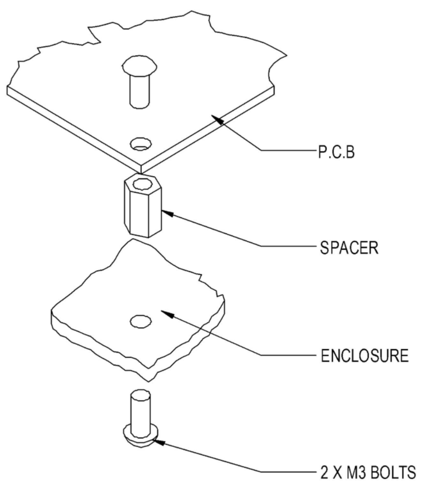
- The size of the PCB (below left).
- How big the batteries are (below right).

These technical drawings of the PCB and battery holder should help you to plan this.

All dimensions in mm.
Four PCB mounting holes are 3.3 mm in diameter.





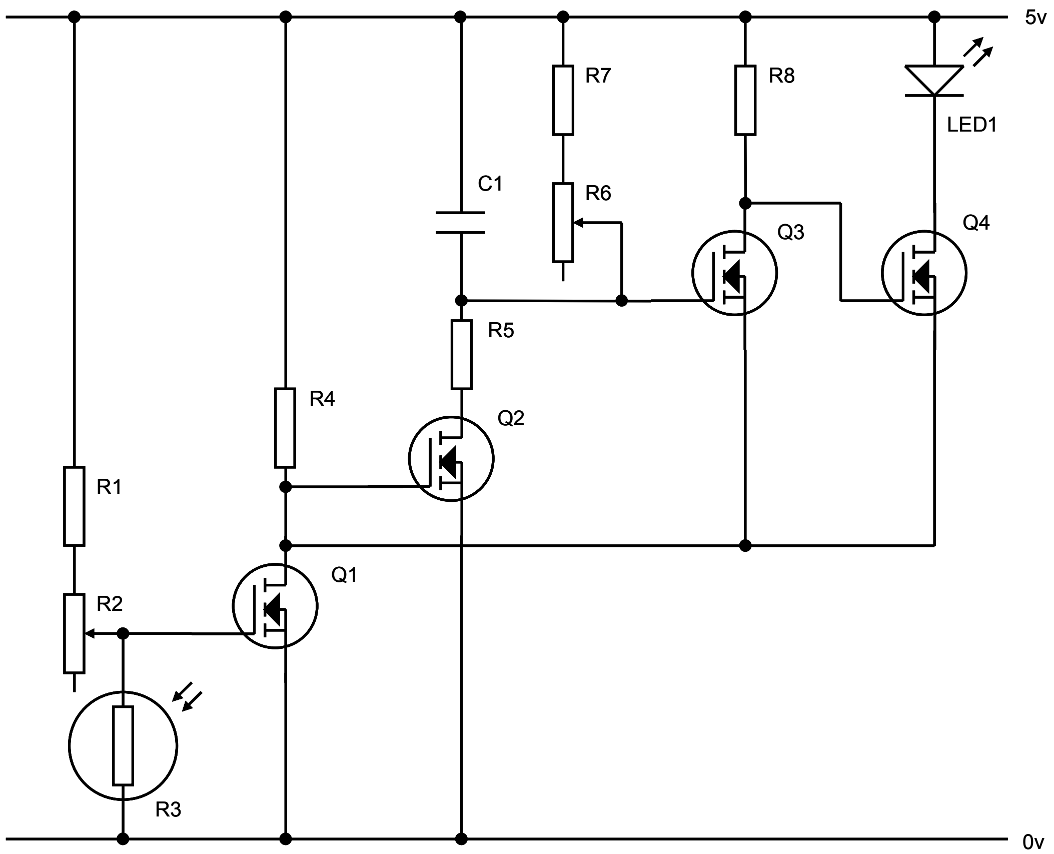


Mounting the PCB to the enclosure

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 Timed Night Light Circuit Works



When the Light Dependant Resistor, or LDR for short, (R3) is in day light, the resistance will be low. R1, R2 & R3 are connected together to form a potential divider, where R2 sets the amount of light needed to switch the FET. With the LDR having a low resistance, the voltage on the gate of the FET Q1 will be low and the FET will be off. In this case the two FETs Q3 and Q4, which drive the LED, don't have a 0V connection and as a result the LED won't light. Also whilst Q1 is off, the resistor R4 pulls the gate of FET Q2 into a high state and, as a result, current flows through the drain source of Q2 and charges capacitor C1 through R5.

When the LDR (R3) is dark the resistance is much higher and, consequently, the voltage on the gate of the FET Q1 is high and the FET is turned on. In this case the FETs Q3 and Q4 now have a 0V connection and the LED can operate. Initially the capacitor C1 is charged and, as a result, has 5V across it. This means that the gate of FET Q3 is low, and therefore the FET is turned off. As a result, the gate of Q4 is held in a high state by resistor R8 and the LED is turned on. Over time the Capacitor (C1) is discharged through R6 & R7 and, gradually, the voltage across it drops. As the capacitor voltage reduces, the voltage on the gate of Q3 starts to rise. After a period of time there will be sufficient voltage on the gate of FET Q3 and the FET will turn on. When this happens the gate of FET Q4 will be pulled low and the FET Q4 will switch off, as will the LED.

Resistors R1 & R7 are present so that the circuit can't be damaged if the trimmer potentiometers are set to zero.

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/2139

This kit is designed and manufactured in the UK by Kitronik

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