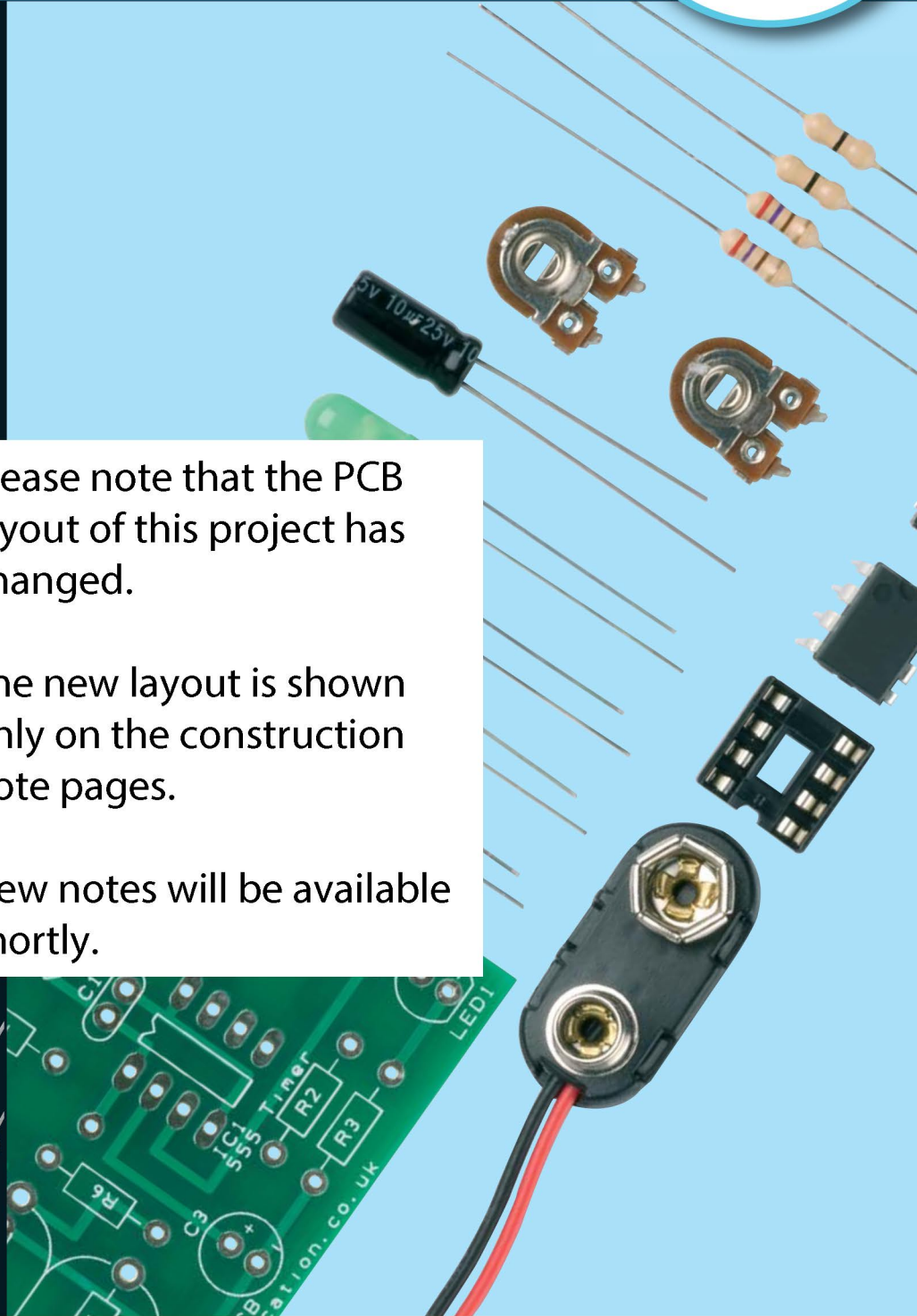
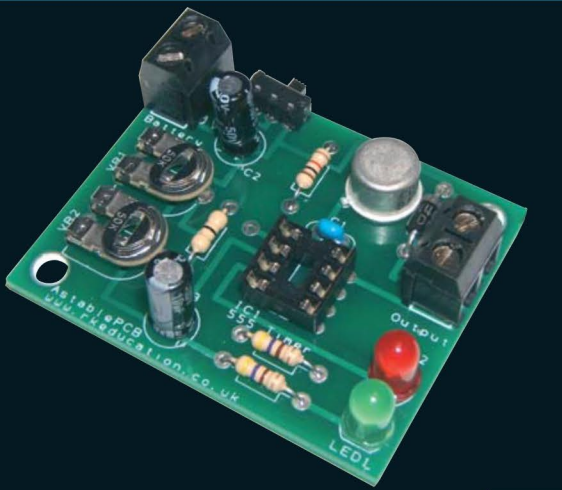


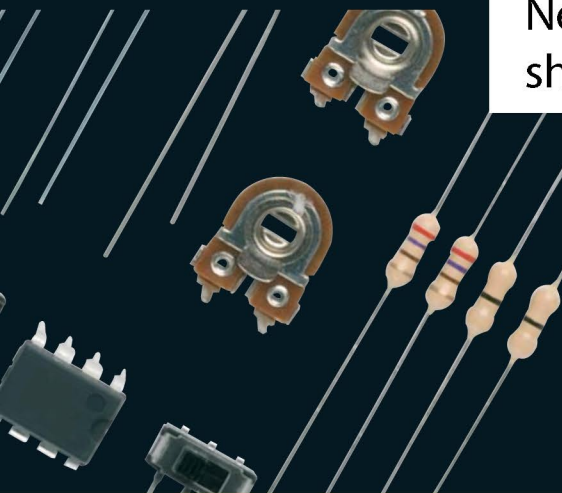
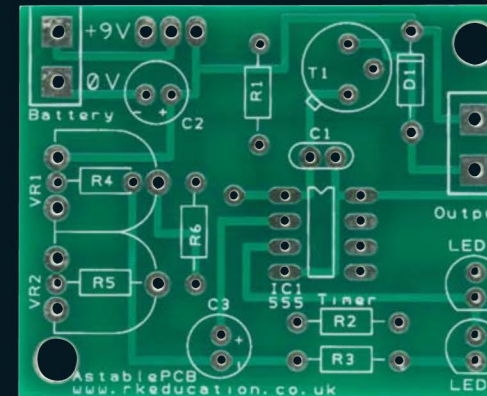
555 Timer astable project



Please note that the PCB layout of this project has changed.

The new layout is shown only on the construction note pages.

New notes will be available shortly.



Class and teaching notes for:

555 Timer astable projects

Economy

With drive circuit

Deluxe

70-6017

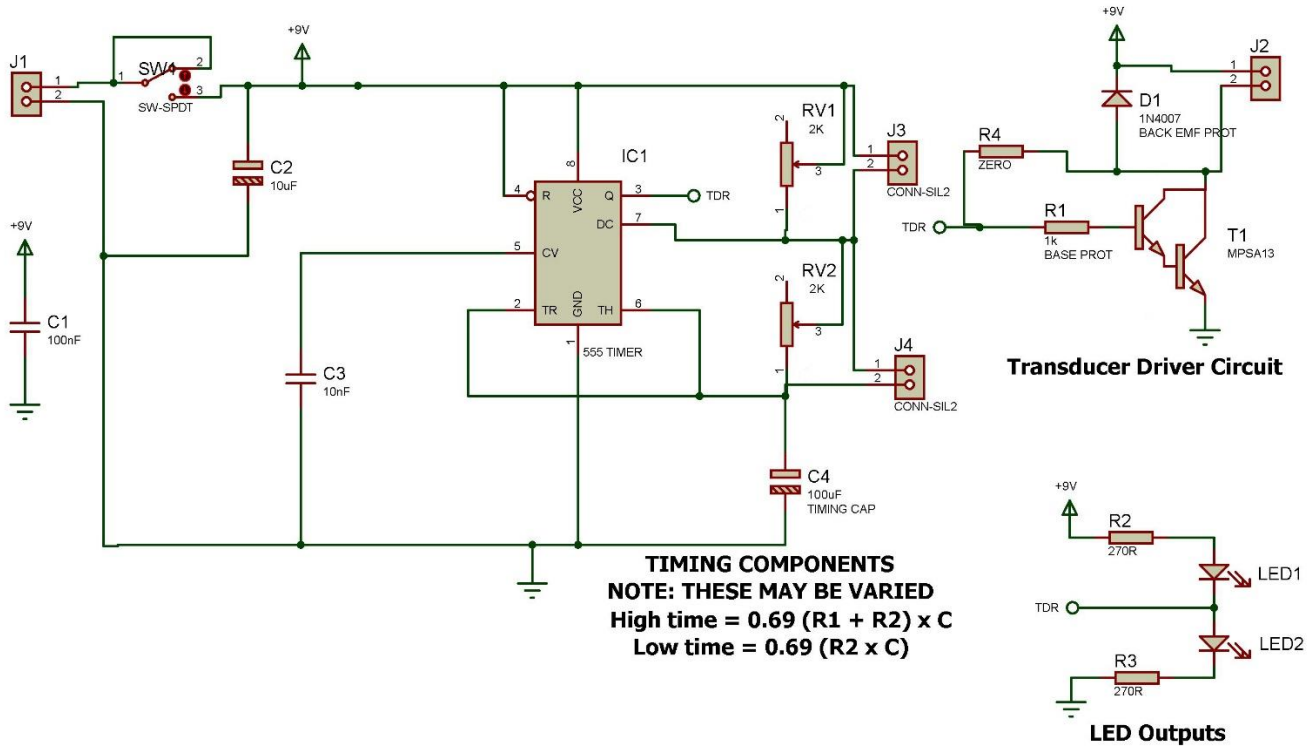
70-6018

70-6019

The logo for Rapid, featuring a stylized 'R' with three horizontal lines to its left, followed by the word 'Rapid' in a bold, italicized sans-serif font.

Circuit Construction – 555 Timer Astable Project

555 Astable Timer Project Schematic - www.rkeducation.co.uk



The circuit diagram above is the circuit diagram for your project, it is called a 555 timer astable circuit, it is called an astable circuit as it has no stable state, its output changes between +VE and 0V, if 2 LEDs are used this would be seen as alternate red/green flashing.

The frequency of this can be calculated using a formula and is determined by the values of the timing components, the timing resistors and timing capacitor.

The speed of the motor is varied according to the frequency of the astable.

Construction of circuit

You will need to collect the following equipment before you start soldering your circuit:

- Soldering iron and stand
 - Damp sponge
 - Solder wire
 - Side cutters
 - Pliers
 - Components:
 - T1 – MPSA13 Darlington transistor (70-6018 and 70-6019 only not used on 70-6017)
 - C1 – 100nF capacitor
 - C2 – 10uF capacitor
 - C3 – 10nF capacitor
 - C4 – 100uF capacitor*
 - D1 – 1N4007 diode (70-6018 and 70-6019 only not used on 70-6017)
 - IC1 – IC holder and 555 timer IC
 - R1 – 1k resistor (70-6018 and 70-6019 only not used on 70-6017)
 - R2, R3 – 270R resistor (red, violet, brown)
 - R4, - Zero ohm (included with 70-6019 only). Used to bypass drive circuit to J2 if using a piezo sounder
 - RV1, RV2 – 2k preset resistor*
 - Power switch
 - Battery – Battery clip, a terminal block may be used
 - LED1 – 5mm Red
 - LED2 – 5mm Green
 - Input J1 - A terminal block could be used here (included in 70-6019)
 - Output J2 – A terminal block could be used here (included in 70-6019)
- * These components can be varied

This project PCB has been designed with maximum flexibility in mind and how it is constructed will depend on what it is you are aiming to achieve with it, for example a teacher or lecturer completing a project with a number of students will probably use it in a different way to a hobbyist with a specific task in mind. The circuit has a drive circuit that utilises a MPSA13 Darlington transistor (70-6018 and 70-6019 only not used on 70-6017). If a Piezo sounder is required a PCB mount Piezo can be inserted into J2 and a shorting link or OR resistor will need to be inserted into R4 to connect pin-3 of the 555 timer directly to the buzzer. The circuit has space for 2 LEDs but 1 can be left out as required and if an output is being used then they both may be left out. If an output is being used, for example a DC motor then this should be inserted into the terminal block marked J2, a back EMF diode has been included. To allow the time to be varied the circuit uses variable resistors – RV1 and RV2, these can either be PCB mount or an external panel mount type, VR1 and VR2 can also be replaced with fixed resistors or resistive sensors such as a thermistor.

How the circuit is constructed is very much dependent on what it is being used for and calculations will need to be made using the following formulae:

$$f = \frac{1.4}{(R1 + 2R2) \times C1}$$

and

$$T = 0.7 \times (R1 + 2R2) \times C1$$

T = time period in seconds (s)

f = frequency in hertz (Hz)

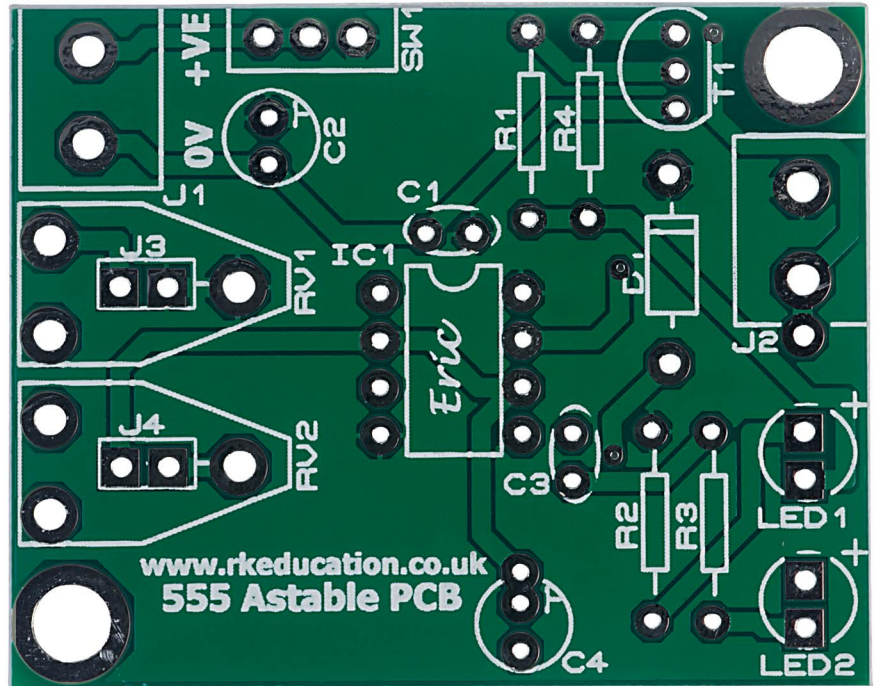
R1 = resistance in ohms (Ω)

R2 = resistance in ohms (Ω)

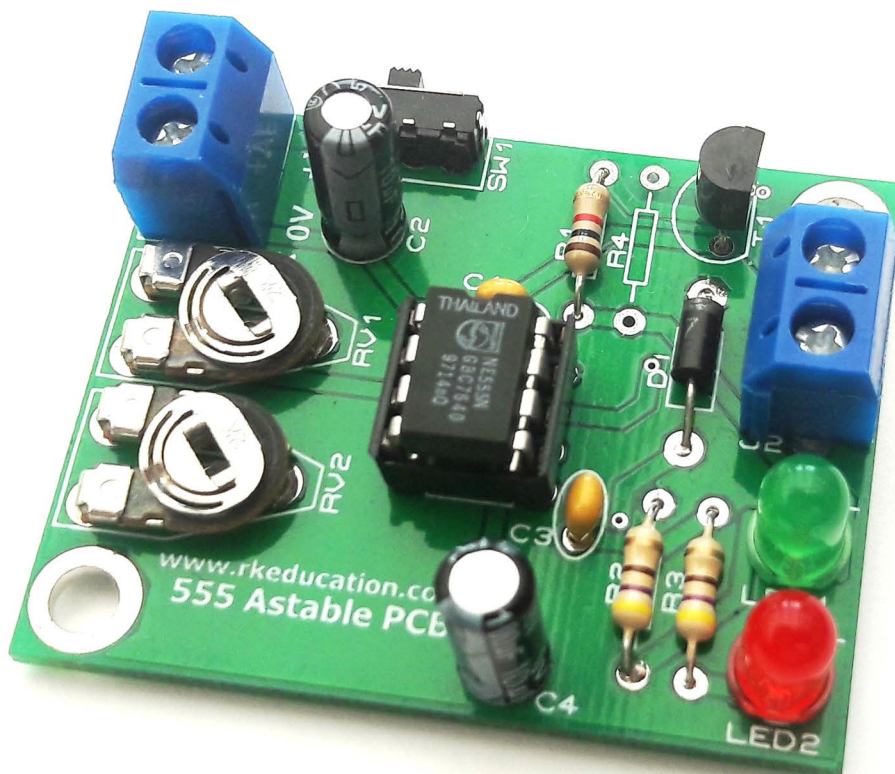
C = capacitance in farads (F)

Procedure for construction

1. Solder the resistors into your PCB, take care to insert the correct resistor into the correct place, if in doubt ask your teacher.
When soldering be sure to heat the area sufficiently but not too much as it will damage the PCB
2. Solder the remainder of the PCB mounting components in place
3. Solder your power switch in place
4. Solder your battery clip in place
5. Solder your LEDs into the PCB, if you have attached flying leads insert these, be sure to get the LED the correct way round, remember the long and short legs ...



The order in which you solder and what you solder is dependent on your final outcome



Case design

There are lots of different ways that you can construct a case for this project but a very simple and effective way is to make an MDF box.

Below is an example:



For your case you should create three different designs using A4 plain paper. On each piece of paper produce a quality design showing all relevant details. Add labels where necessary e.g. show the location of your LEDs etc., also evaluate each design against your specification and state what is good and bad about the design and why you think it is a good design and why it would appeal to the user.

Select a final design that you will build into your final product, state your reasons for the choice you have made. Your final design must be a high quality working drawing, i.e. it must contain enough information to allow a third party to manufacture it.

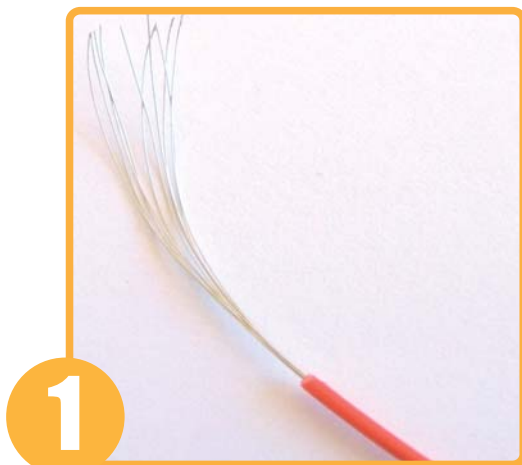
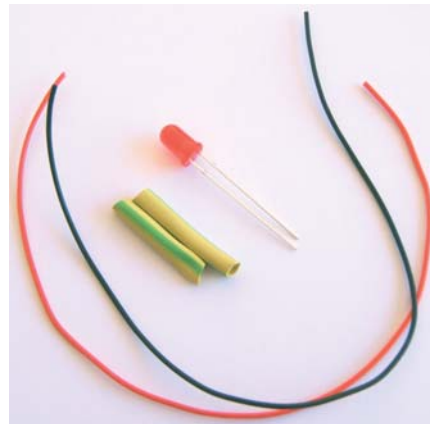
Extension task: draw your final design in 3D

Construct an LED with flying leads

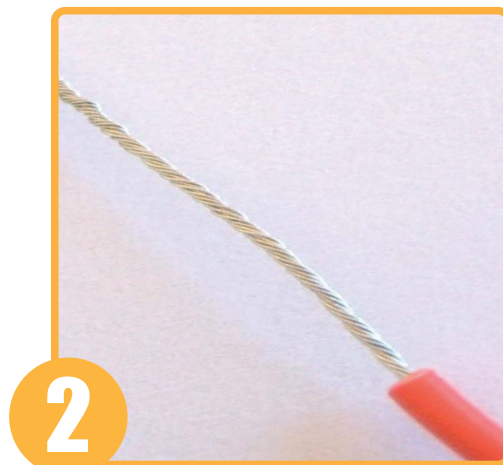
This method is also suitable for constructing push to make switches with flying leads. You may attach your LEDs to your project using flying leads, if this is the case then use this method. This example uses multi core wire, you may also use single core.

You will need to collect the following equipment before you start soldering your circuit:

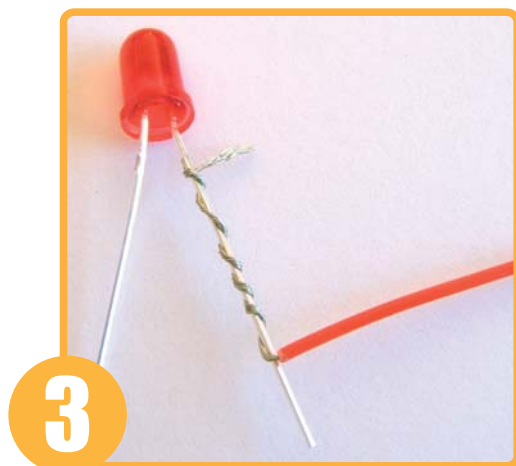
- Soldering iron and stand
- Damp sponge
- Solder wire
- Side cutters
- Pliers
- Wire strippers
- Red and black wire
- Rubber tubing
- LEDs
- LED tester



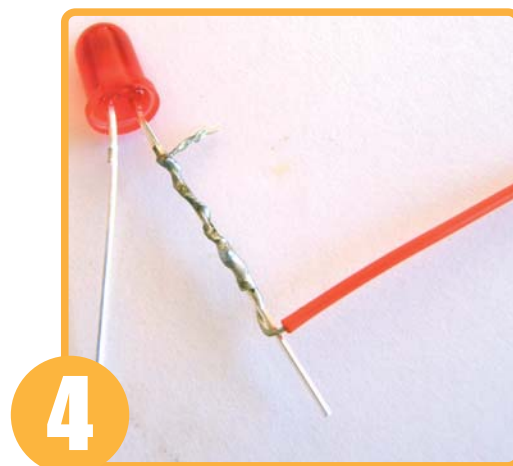
Strip wire using wire strippers



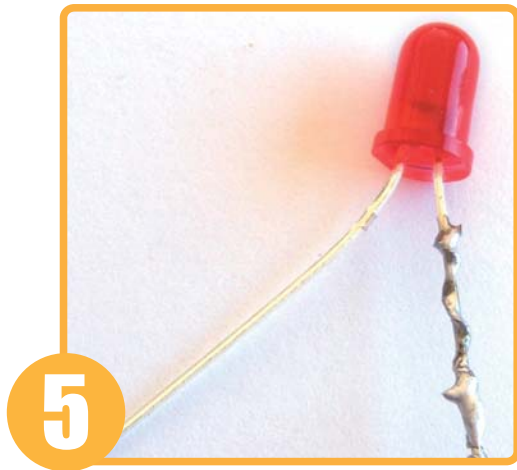
Twist the wire between your finger and thumb to stop fraying



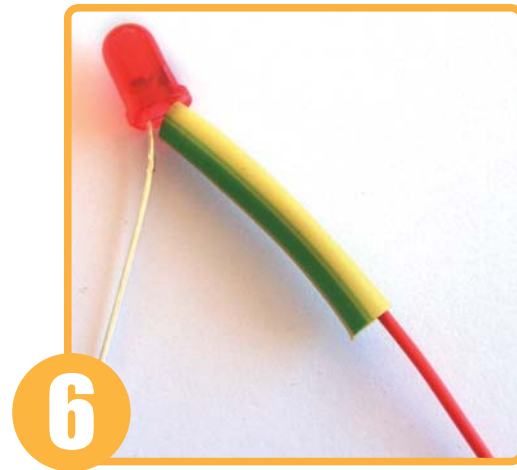
Wrap around the LED leg, remember the long leg, use pliers to help



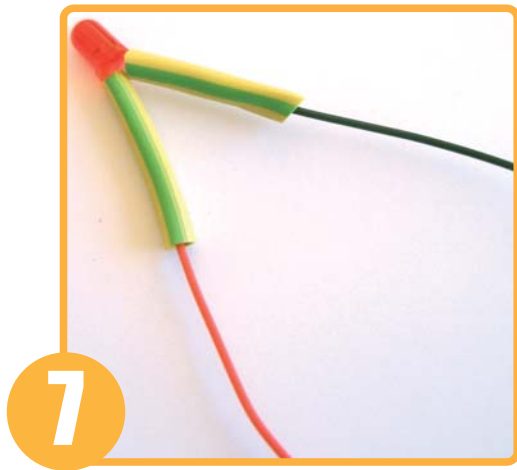
Solder



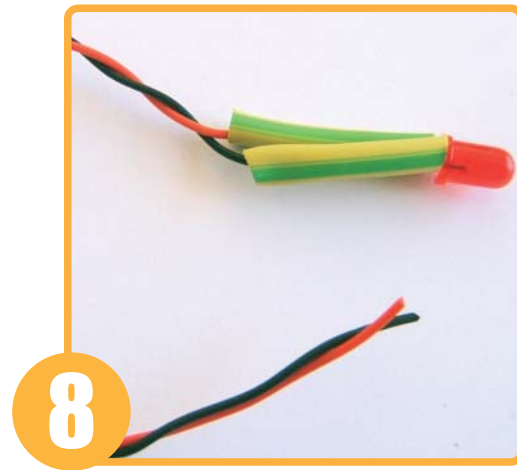
Trim with cutters



Cover with rubber tube



Repeat for other leg



Twist together

Tip

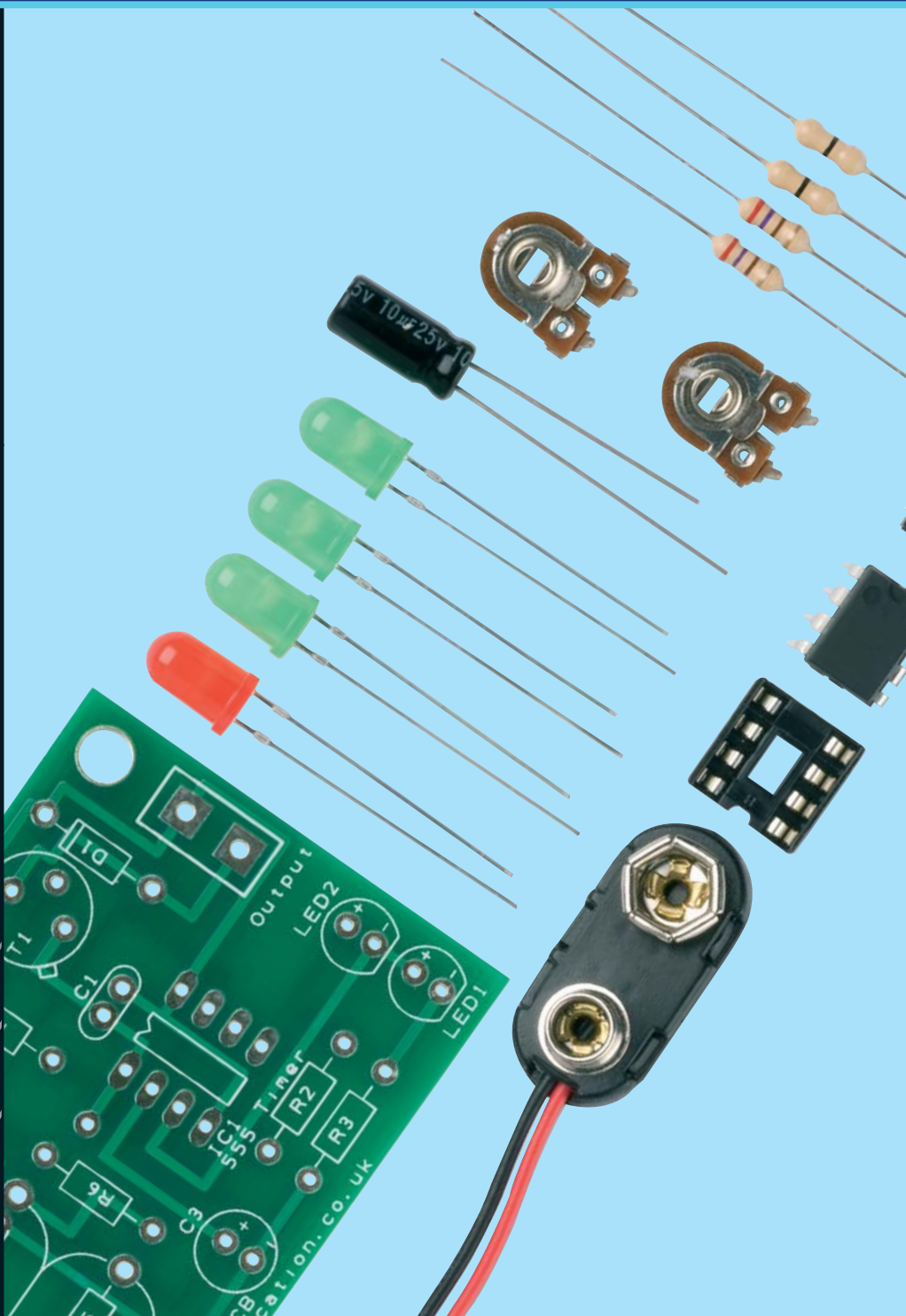
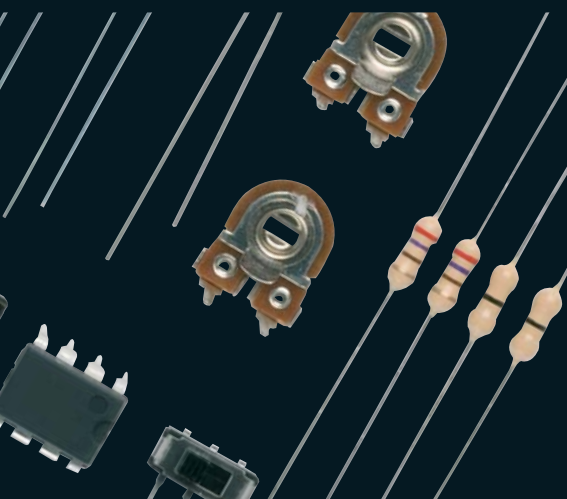
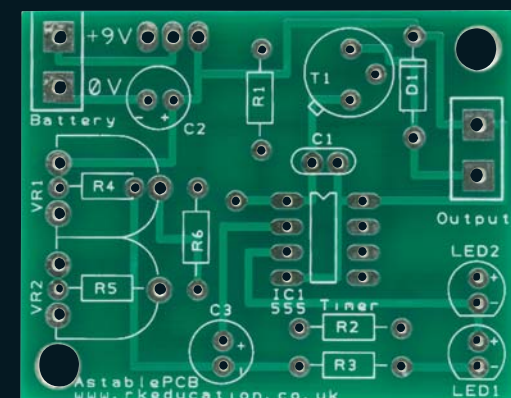
When you have finished, wrap some masking tape around the leg and write your name on it; this will avoid your LEDs getting mixed up with those of other pupils.

Homework

Produce a storyboard that shows how to make an LED

Teacher Notes

555 Timer astable project



Teacher notes

Introduction

The aim of this seven week (two hour lesson) project is to design and manufacture an electronic product based on the 555 timer monostable circuit. The circuit is ideal for timer based projects, e.g. toothbrush timers, cooking timers etc. The project will introduce or reinforce the use of resistors, capacitors, LEDs, transistors and output devices such as buzzers. Students will learn about various aspects of electronics including the systems approach, components and circuit diagrams as well as product design. They will learn new or develop existing practical skills i.e. soldering, graphics and RMT skills.

This is a rough guide and the time needed for each activity will vary between schools and groups. These notes are based on experience with year 9 groups of approximately 20 students of mixed ability and gender in an average state school. The lessons are broken up into seven, two hour sessions.

These project notes are primarily aimed at **Key Stage 3** but it is an excellent project for **Key Stage 4** students as it is covered by the GCSE syllabus. For **Key Stage 4** students these notes will need to be modified to include greater differentiation by outcome and more emphasis on the various GCSE syllabi.

An excellent way of helping students understand the electronics is by using the training system. It allows students to change various components, input and output and therefore is an effective way of prototyping. It is also very good for exam revision as it is relevant to past exam questions.

If you have any comments to make about the project and notes or you would like to contribute then please contact us.

Aims and objectives

The project is to design and make an electronic product using a 555 timer monostable circuit. The product must use a suitable method to indicate when the product is timing and/or when it has finished timing. It would need an LED or buzzer at a minimum.

The project will enable students to experience the design and manufacture of simple electronic circuits.

CONCEPTS:

- Electronic circuits
- PCB design
- Design and manufacture
- Model making
- Evaluation

OBJECTIVES:

Pupils should understand:

- The need to investigate the background to a problem
- How to select appropriate components to build simple electronic circuits
- How to select appropriate tools and materials
- The importance of planned manufacture
- The need to build models to evaluate design ideas
- How to improve a product by evaluation

SCIENCE OPPORTUNITIES:

- Understanding of circuit theory
- Resistance/Ohms law
- The importance of timing circuits
- The 555 timer as a monostable

WIDER CURRICULUM OPPORTUNITIES:

- Accurate measurement and marking out

IT OPPORTUNITIES:

- Use of Crocodile Clips to develop and test circuit ideas
- Graphic packages to help generate design ideas
- PCB design and production

OTHER OPPORTUNITIES:

- Product styling

Introduction and investigation

Please note: There are many different possible outcomes of this project and these notes have been written with the aim of producing a timer enclosed in an MDF case.

Aim:

- Review safety in a workshop, state safety rules as a group
- Introduction to project, show previous examples
- Explain the different skills they will be learning
 - Electronics
 - CAD
 - Circuit design
 - PCB design etc.
- Write design brief and design specification

Teaching input:

- Discuss the project with the class
- The importance of product evaluation in the design process
- Teach about briefs and specs, their use in industry and importance, use examples such as mobile phones, electrical goods, games machines, cars and other things with which they are familiar
- Teach about designing products that are fit for purpose and aiming products at particular consumer groups

Student:

- Discuss and record workshop safety rules
- Evaluate several electronic products – the aim of this is to understand the key components of an electronic product – PCB + components, battery, switches, wiring, case etc.
- Discuss as a class
- Learn about briefs and specs, their use in industry and importance
- Research existing and similar products using, for example, the internet or catalogues; produce an image board in small groups
- Design Brief – maybe give them it – e.g. Design and make an electronic timer that indicates to the user in an appropriate way
- Specification – discuss as a class

Resources:

- Examples of existing practical outcomes
- Examples of image boards
- Access to ICT or product catalogues
- A range of old electronic products to evaluate

Homework:

- Bring £1.50 (suggestion) to pay for the project
- Diary record

Designing the product

Aim:

- Design the product, an electronic timer, this may be a class theme, e.g. egg timer, or an individual theme; concentrate on fitness for purpose and target audience
- Produce a 3D model
- Evaluate designs

This is a suggestion; modify to suit your requirements –

- Manufacture a box from MDF with the outer dimensions 15 x 7 x 7cm – the case must be big enough to comfortably hold the PCB, battery, switches, LEDs and wiring

Week 2 continued on next page

Teaching input:

- Explain what is required using examples of previous work or a teacher's example
- Produce an example design and display using an OHP or on the whiteboard
- If students are all making the same case then the material will need to be cut prior to making and if they are designing individual cases then they will need to produce a cutting list

Student:

- Students to produce three design ideas. These designs do not have to include dimensions but they should be of good enough quality to demonstrate thinking and include labels showing the locations of switches, LEDs etc. and evaluate each design. They should produce at least three and explain why they have picked the design they will make
- A final working drawing should be produced that includes enough information to allow a third party to accurately manufacture the case without any further intervention from the student. As an extension task a 3D design may be drawn
- The next stage would be to produce a 3D model, depending on how long the designing takes this could be done in class and/or as homework. If it is done for homework then a cereal box could be used

Resources:

- Drawing resources
- Card for 3D models
- Examples of previous work

Homework:

- Finish designs and 3D model
- Diary record

Manufacturing the casing

Aim:

- Manufacturing the case
- Decorating the case

Teaching input:

- Review health and safety
- Provide assistance to students during practical

Resources:

- Each student will need materials to allow them to manufacture their case
- Access to suitable materials
- Access to tools
- Access to paints

Demonstration:

- Demonstrate to the students how to manufacture case with appropriate tools and methods paying close attention to H&S
- Holes will need to be drilled for the switches, LEDs etc.
- Demonstrate how to use a pillar drill to drill the holes.

Student:

- Students to manufacture their cases
- Students to drill the holes for the switches, LEDs etc.
- Students to decorate their cases

Homework

- If not completed during lesson finish decorating at home or during lunch/break/after school
- Diary record

Week 4 begins on next page

Electronics

There is quite a lot in this lesson and it may be that some bits are left out. If you have the facilities available a good idea is to concentrate on Crocodile Clips and Real PCB. This lesson will differ between **Key Stages 3** and **4**, for **Key Stage 4** refer to the appropriate GCSE syllabus for information of what is required. Textbooks are an excellent source of information and there are some excellent UK based websites with some excellent and relevant teaching and learning materials, e.g. BBC Bitesize.

Aims:

- Introduction to electricity and electronics – current and voltage
- Power supplies – mains, solar, wind, sea, batteries, parallel and serial
- Introduction to the Systems approach – systems have an input, process and output, relate to examples they are familiar with, e.g. microwave oven

Teaching input:

- Discuss the lesson aims with the class and use Q&A to reinforce

Student:

- Worksheet – Identify Input, Process and Output components on a worksheet, stronger students can state the function of the components by using research material, class books, wall charts etc.
- Discuss as a group
- Introduce the electronic circuit with a worksheet – this could be constructed using Crocodile Clips, the circuit being used is a 555 monostable circuit
- The first task is for students to identify the various components and suggest their function
- Go through the answers with the group then give an explanation of the circuit and how it works
- Introduction to PCBs and Q&A – what they are, what they are made of and why, where they are found, how they are made etc. This may be a good opportunity to do a demo of how to make a PCB using a workshop etch tank – if possible. This is also a good opportunity to introduce Real PCB or an alternative PCB design package and allow students to design a PCB of their own, this could be reinforced using a worksheet where students identify mistakes in a PCB design

Resources:

- Worksheets
- ICT facilities including Crocodile Clips and Real PCB
- Examples of components
- PCB examples
- Etch facilities

Demonstration:

- Using Crocodile Clips and Real PCB
- Producing a PCB in an etch tank – there are some good resources for this on the Rapid website

Homework:

- Apply the systems approach to a household appliance, differentiate by ability, the more able to do a more complex appliance, the less able a simpler.

OR

- Worksheet, for example identify mistakes on PCB designs
- Diary record

Soldering

Aim:

- Introduction to soldering
- Students start soldering

Teaching input:

- Q&A session, what is solder? why these materials? why solder? etc.
- Discuss health and safety
- Discuss quality issues

Week 5 continued on next page

Demonstration:

- Demonstrate soldering, insert component securely, bend legs back a little, heat the area including the leg for 5 seconds, apply a small amount of solder, take solder away, take iron away – aim for a neat ‘mountain’ of solder around the leg, it is very important that soldering is not rushed and that legs do not touch as this will cause a short circuit – there are some good resources on the Rapid website

Student:

- Activity – Start soldering
- This will depend on the individual teacher as to how it is organised. It may be that one component is soldered at a time; each student doing the same. Students may be given the component list, and components, and be allowed to complete the task independently

The LED(s)

How this is done will depend on the final outcome. If wires need attaching to the LED these steps may be followed. Remember long leg is +ve.

- Cut a length of red wire
- Strip about 2cm of the plastic sleeving
- Twist to stop fraying
- Wrap around the longer leg
- Apply a thin coat of solder
- Snip off any excess wire
- Insulate with rubber tubing/heat shrink
- Repeat with black wire for shorter leg

Resources:

- Soldering equipment
- Tools

Homework:

- Storyboard on how to solder or make LEDs with wires (6 steps), this helps reinforce the skill as it would be likely they will solder again in the future in D&T

OR

- LED worksheet – identify 10 things at home that contain an LED
- Diary record

Finish soldering and assemble product**Aim:**

- Finish soldering
- Finish any other practical work
- Construct final product
- Test

Teaching input:

- Discuss with Q&A quality control and testing
- Discuss test sheets
- Help students as required

Student:

- Finish all practical work
- Students to produce a test sheet
- Test circuit using test sheet

Resources:

- Access to tools

Homework:

- Diary record

Week 7 begins on next page

Evaluation

Students who have unfinished practical work should complete any and assemble final product

Aim:

- Evaluation

Teaching input:

- Discuss the importance of evaluation in design and technology

Student:

- Produce a detailed production plan of their project
- Evaluate their work
- Complete any unfinished work
- Put folders into order
- Students may complete a test based on the project – this may be set as homework

Resources:

- Worksheets
- Test sheet
- Access to tools

Homework:

- Diary record
- Complete test

