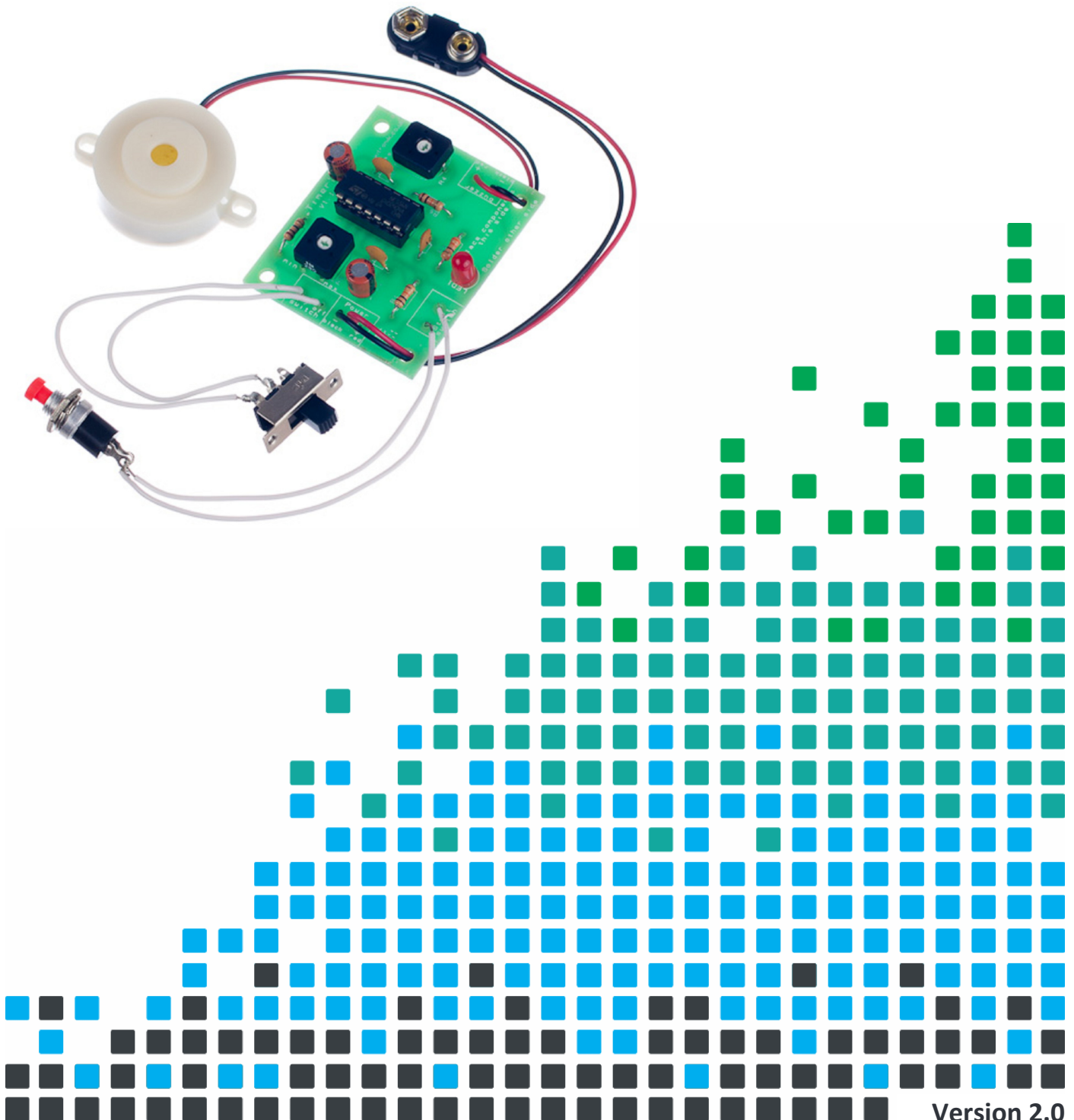


TIME SOMETHING WITH THIS

# TIMER PROJECT KIT



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- Designing the Enclosure
- How the timer works
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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 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](http://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.<br><u>Homework:</u> Collect examples of timing products that are currently on sale. These may include clocks, watches, stop watches etc. List the common features that make these suitable for their intended use. |
| Hour 2  | Develop a specification for the project using the 'Developing a Specification' sheet.<br><u>Resource:</u> Sample of timing products.<br><u>Homework:</u> 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.<br><u>Homework:</u> Complete design.  |
| Hour 4  | Split the students into groups and get them to perform a group design review using the 'Design Review' sheet. Start the 'Resistors' sheet.<br><u>Homework:</u> Complete any of the remaining resistor tasks.   |
| Hour 5  | Using the 'How to solder' sheet demonstrate and get students to practice soldering. Start the 'Capacitor' worksheet.<br><u>Homework:</u> Complete any of the remaining capacitor tasks.  |
| Hour 6  | Build the electronic kit using the 'Build Instructions'.   |
| Hour 7  | Complete the build of the electronic kit. Check the completed PCB and fault find if required using 'Checking Your Timer PCB' and fault finding flow charts.<br><u>Homework:</u> Read 'How the Timer Works' sheet.  |
| Hour 8  | 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 9  | Build the enclosure.<br><u>Homework:</u> Collect some examples of instruction manuals.   |
| Hour 10 | Build the enclosure.<br><u>Homework:</u> Read 'Instructions' sheet and start developing instructions for the student's timer design.   |
| Hour 11 | Build the enclosure.<br><u>Homework:</u> Complete instructions for the student's timer design.   |
| 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 'How to solder' sheet practice soldering.           |
| Hour 2 | Build kit using 'Build Instructions'.   |
| Hour 3 | Check completed PCB and fault find if required using 'Checking Your Timer PCB' and fault finding flow charts. |

## Answers

### Resistor questions

| 1st Band | 2nd Band | Multiplier x | Value            |
|----------|----------|--------------|------------------|
| Brown    | Black    | Yellow       | 100,000 $\Omega$ |
| Green    | Blue     | Brown        | 560 $\Omega$     |
| Brown    | Grey     | Yellow       | 180,000 $\Omega$ |
| Orange   | White    | Black        | 39 $\Omega$      |

| Value                   | 1st Band | 2nd Band | Multiplier x |
|-------------------------|----------|----------|--------------|
| 180 $\Omega$            | Brown    | Grey     | Brown        |
| 3,900 $\Omega$          | Orange   | White    | Red          |
| 47,000 (47K) $\Omega$   | Yellow   | Violet   | Orange       |
| 1,000,000 (1M) $\Omega$ | 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 (2M $\Omega$ ) | 0.000,1 (100 $\mu$ F)  | 200 Seconds      |
| 100,000 (100K $\Omega$ ) | 0.000,1 (100 $\mu$ F)  | 10 Seconds       |
| 100,000 (100K $\Omega$ ) | 0.000,047 (47 $\mu$ F) | 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**

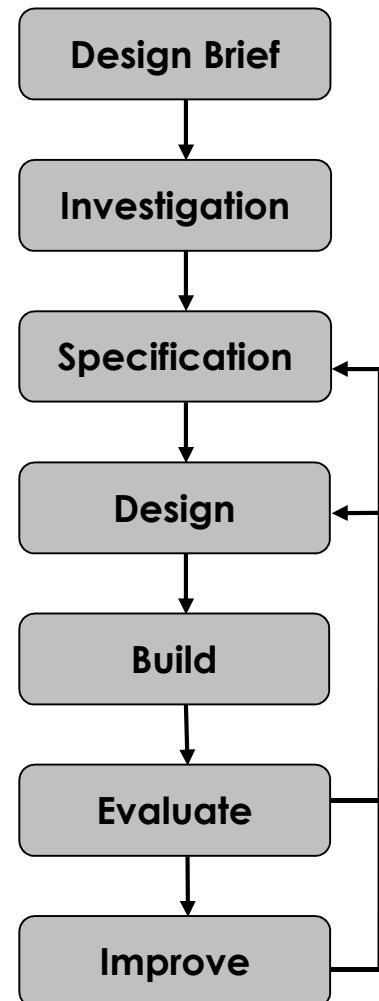
Build your design based upon the design that you have developed.

### **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 clock manufacturer has designed a simple timer. The timer will be very cheap to produce and can be used for applications that do not require split second accuracy.

The manufacturer can think of a great many applications that the timer could be used for, such as for timing peoples turns on a board game.

The manufacturer would like you to research and select a particular use for the timer. They would then like you to produce a design that is suitable for that use. The design must meet all the requirements of the selected target market.

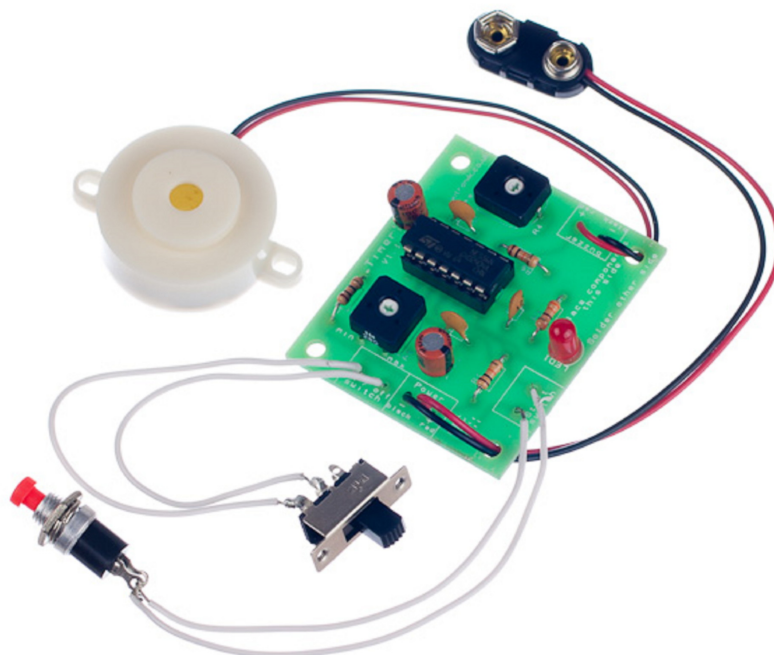


## Description of the Timer

Once the timer is started it waits for a period of time and then produces a tone using a buzzer. There are two adjustable features of the timer. The first is the amount of time taken before the buzzer sounds. The second is the amount of time for which the buzzer sounds. There is a switch which is used to start the timer and also an on / off switch. The maximum time out is 200 seconds and the maximum sounder duration is 10 seconds.

## 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 some holes. | Example: So that the sound can be heard. |



## Design

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

Name.....

Class.....



## Design Review (group task)

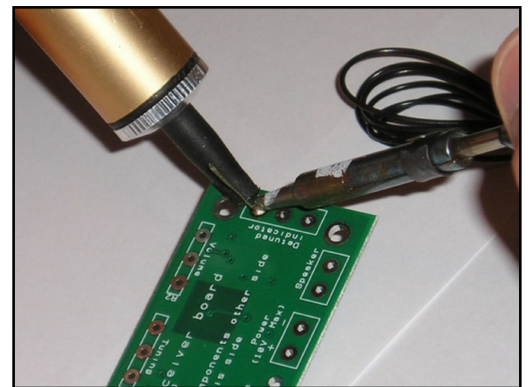
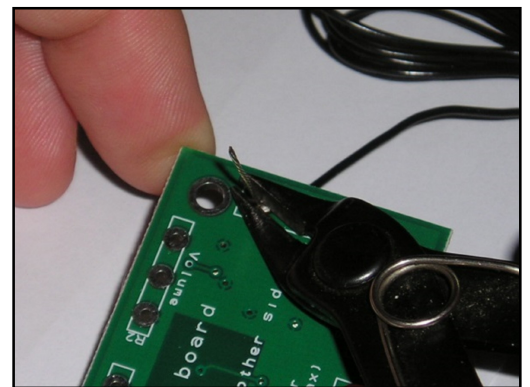
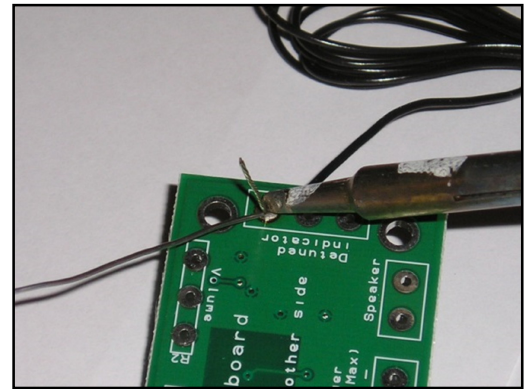
Split into groups of three or four. Take it in turns to review each person's design against the requirements of their specification. Also look to see if you can spot any additional aspects of each design that may cause problems with the final product. This will allow you to ensure that you have a good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

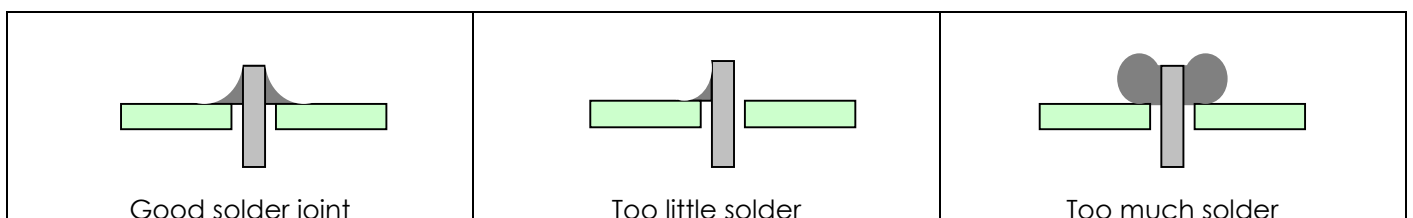


## Soldering in Ten Steps

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).



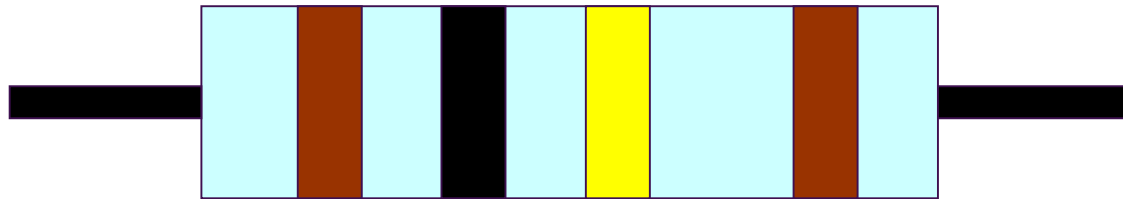
## Solder joints



## 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  $\Omega$  (ohms) and is often referred to as its 'resistance'.

### Identifying resistor values



| Band Colour | 1st Band | 2nd Band | Multiplier x | Tolerance |
|-------------|----------|----------|--------------|-----------|
| Silver      |          |          | $\div 100$   | 10%       |
| Gold        |          |          | $\div 10$    | 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:

$$\begin{aligned}
 &2 \text{ (Red)} \ 7 \text{ (Violet)} \times 1,000 \text{ (Orange)} &&= 27 \times 1,000 \\
 &&&= \mathbf{27,000} \text{ with a 5\% tolerance (gold)} \\
 &&&= \mathbf{27K\Omega}
 \end{aligned}$$

#### Too many zeros?

Kilo ohms and mega ohms can be used:

$$1,000\Omega = 1K$$

$$1,000K = 1M$$

### 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 $\Omega$            |          |          |              |
| 3,900 $\Omega$          |          |          |              |
| 47,000 (47K) $\Omega$   |          |          |              |
| 1,000,000 (1M) $\Omega$ |          |          |              |

## 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.

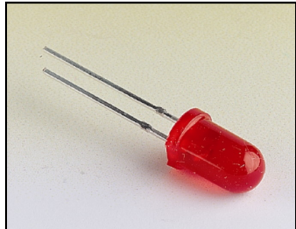
| E-12 resistance tolerance ( $\pm 10\%$ ) |    |    |    |    |    |    |    |    |    |    |    |
|--|----|----|----|----|----|----|----|----|----|----|----|
| 10                                       | 12 | 15 | 18 | 22 | 27 | 33 | 39 | 47 | 56 | 68 | 82 |

| E-24 resistance tolerance ( $\pm 5\%$ ) |    |    |    |    |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|----|----|----|----|
| 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. For a standard red LED this is 1.8 volts.

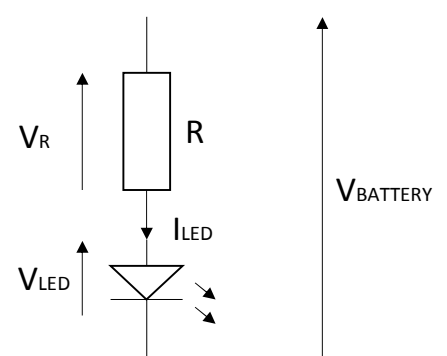
Suppose this LED is run off a 5V supply there must be a total of 5 volts dropped across the LED ( $V_{LED}$ ) and the resistor ( $V_R$ ). As the LED manufacturer's datasheet tells us that there is 1.8 volts dropped across the LED, there must be 3.2 volts dropped across the resistor. ( $V_{LED} + V_R = 1.8 + 3.2 = 5V$ ).

LEDs normally need about 10mA to operate at a good brightness. Since we know that the voltage across the current limit resistor is 3.2 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:

$$R = \frac{V}{I} = \frac{3.2}{0.01} = 320\Omega$$

Hence in this circuit we would need a 320 $\Omega$  current limit resistor, or the nearest value of 330 $\Omega$ .



## 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 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:

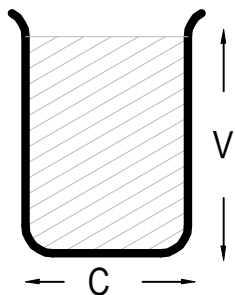
- Bicycle lights
- Car lights (break and headlights)
- Traffic lights
- Indicator lights on consumer electronics
- Torches
- Backlights on flat screen TVs and displays
- Road signs
- Information displays
- Household lights
- Clocks





## Capacitor Basics

### What is a capacitor?

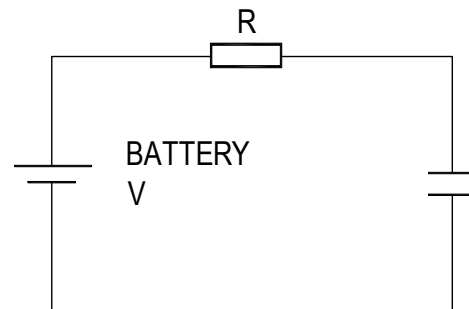
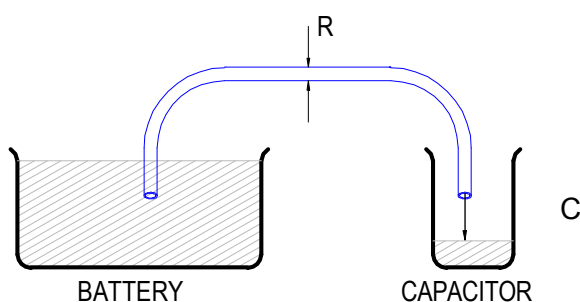


A capacitor is a component that can store electrical charge (electricity). In many ways, it is like a rechargeable battery.

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.

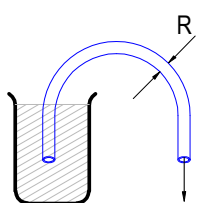
### Filling a capacitor with charge



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

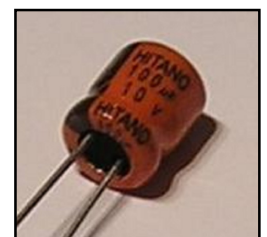


Once a capacitor has been filled with an amount of charge, it will retain this charge until it is connected to something into which this charge can flow.

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.



## Ceramic Disc Capacitors

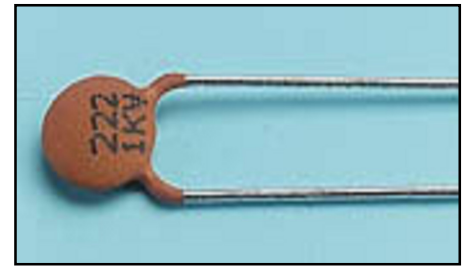
### Values

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 ( $\mu\text{F}$ ), nano Farads (nF) and pico Farads (pF). A  $\mu\text{F}$  is a millionth of a Farad,  $1\mu\text{F} = 1000\text{ nF}$  and  $1\text{nF} = 1000\text{ pF}$ .

|    |                           |
|----|---------------------------|
| 1F | = 1,000mF                 |
| 1F | = 1,000,000 $\mu\text{F}$ |
| 1F | = 1,000,000,000nF         |
| 1F | = 1,000,000,000,000pF     |

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  $0.1\ \mu\text{F}$ )

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                   |                 |                  |             |



## Instruction Manual

Your timer 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.



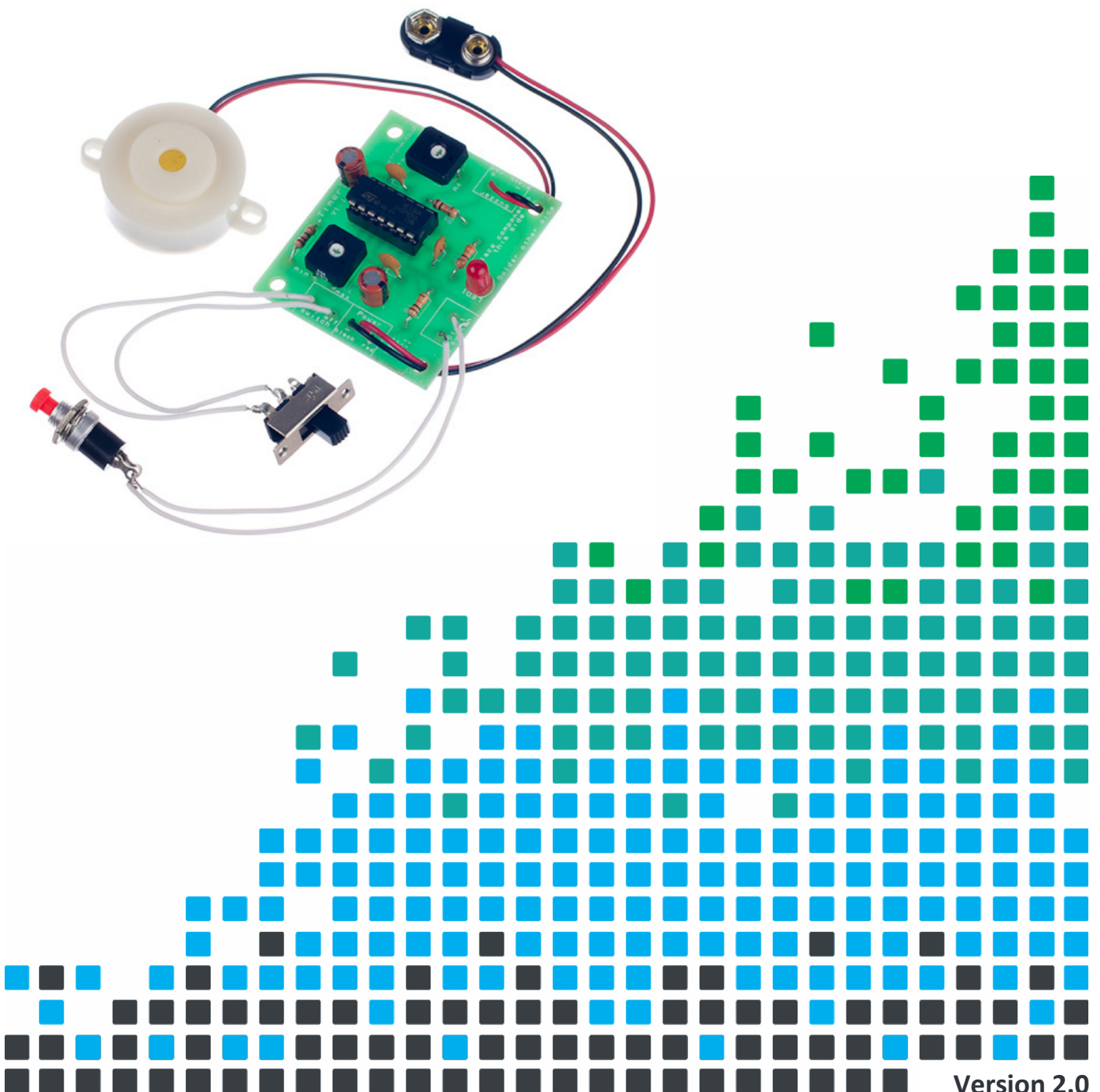


## ESSENTIAL INFORMATION

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

TIME SOMETHING WITH THIS

# TIMER PROJECT KIT



Version 2.0

## 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 RESISTORS

Start with the 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 & R6 | 10K $\Omega$ | Brown, black, orange  |
| R3      | 330 $\Omega$ | Orange, orange, brown |
| R2      | 1M $\Omega$  | Brown, black, green   |

Fit R2 if you want your timer to have a time out period between 100 and 200 seconds.

Fit a wire link if you want the timer to last less than 100 seconds.



### 2 Place the potentiometers

There are two variable potentiometers. One is 1M $\Omega$  and the other 100k $\Omega$ . They are clearly marked on the side of the housing.

Solder the 100k $\Omega$  variable potentiometer into R4 on the PCB.

Solder the 1M $\Omega$  variable potentiometer into R5 on the PCB.



### 3 Place the ceramic capacitors

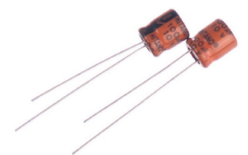
Solder the three ceramic capacitors in to C1, C2 and C3. They can go in either position as they are all the same.



### 4 Place the electrolytic capacitors

Solder the two electrolytic capacitors in to C4 and C5. They can go in either position but it is important that the '-' on the capacitor line up with the ---- markings on the PCB.

**Using an electrolytic capacitor backwards could result in it being destroyed.**



### 5 Place the IC holder

Solder the Integrated Circuit (IC) holder in to U1. When putting this into the board, be sure to get it the right way around. The notch on the IC holder should line up with the notch on the lines marked on the PCB.



# Timer Project Kit Essential Information



[www.kitronik.co.uk/2104](http://www.kitronik.co.uk/2104)

## 6 Place the LED

Solder the Light Emitting Diode (LED) in to LED1. The timer 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.



## 7 Place the buzzer

The buzzer should be soldered into the 'buzzer' terminal. The red wire must go to the + terminal and the black wire must go to the – terminal.



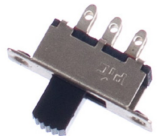
## 8 Connect the battery connector

The battery connector should be soldered into the 'Power' terminal. The red wire must go to the + terminal and the black wire must go to the – terminal.



## 9 Connect the on/off switch

Cut and strip two pieces of wire to the required length for connecting to the on/off switch. Solder one end of each wire to an edge and the center terminals (both connections on the same row) on the switch and the other end to the terminals labeled 'On/Off switch'. It does not matter which wire goes to which terminal.



## 10 Connect the timer switch

Cut and strip two pieces of wire to the required length for connecting to the timer start switch. Solder one end of each wire to each of the terminals on the switch and the other end to the terminals labeled 'Start Switch'. It does not matter which wire goes to which terminal.



## 11 Connect the IC

The IC can be put into the holder ensuring the notch on the chip lines up with the notch on the holder.





## Checking Your Timer PCB

Check the following before you insert the batteries:

Check the bottom of the board to ensure that:

- All holes (except the 4 large 3 mm 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:

- The notch on the IC and the IC holder are in the same orientation as the markings on the printed circuit board.
- You are confident that all the resistors are in the correct places.
- The red wire on the battery connector goes to the + terminal on the power terminals and the black wire goes to the – terminal.
- The red wire on the buzzer goes to the + terminal on the buzzer terminals and the black wire goes to the – terminal.
- The LED is in the right way around.

## Testing the PCB

The circuit has been designed to allow easy testing of the PCB.

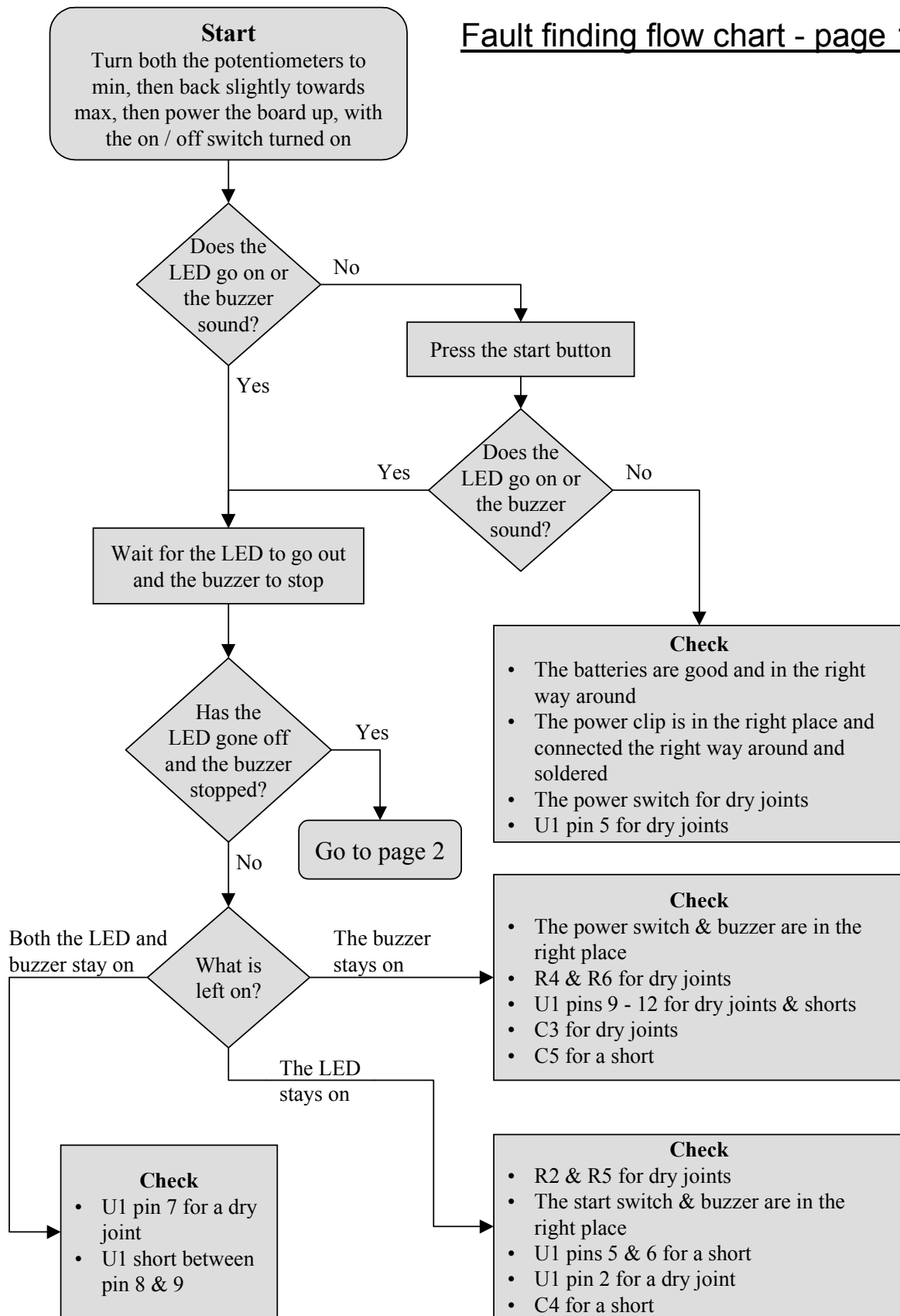
Turn both the potentiometers to minimum and then back slightly towards max (Almost fully anti-clockwise – as marked 'min' on your PCB). Then insert the batteries with the power switch in the on position.

- The timer may illuminate LED1 or / and sound the buzzer for a period of time.
  - If this is the case, just wait for the LED to go out and the buzzer to stop, before testing as follows:
- Press the start button and check again that the LED lights for a period and when the LED goes out the buzzer sounds for a period.
- Check that R5 can be used to adjust the time out period and that R4 can be used to adjust the period for which the buzzer sounds.
- Turn the timer off using the on/off switch.

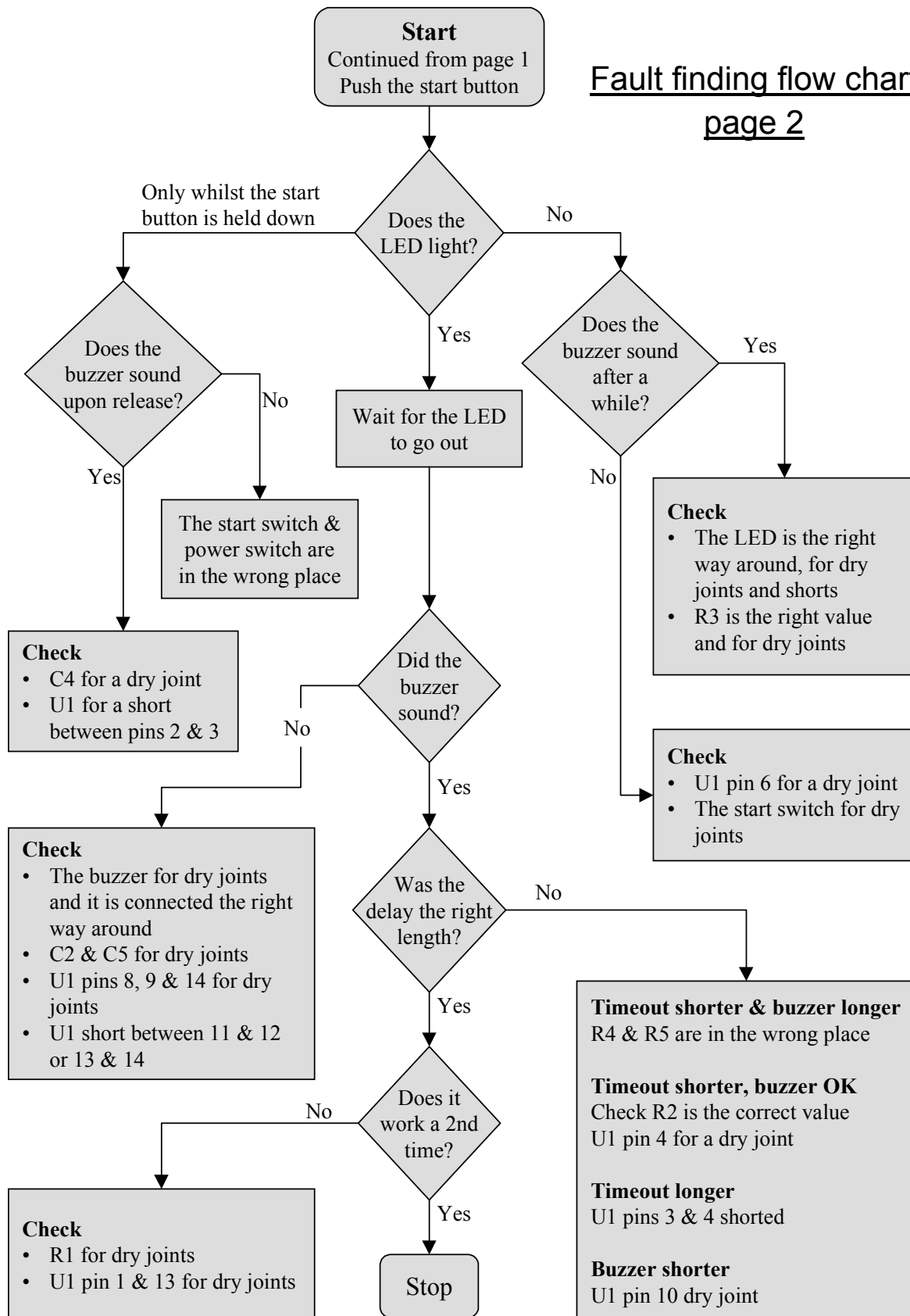
If you have problems with any of the above use the fault finding flow charts to find the cause of the fault.



## Fault finding flow chart - page 1



## Fault finding flow chart page 2



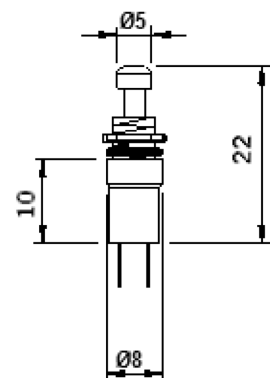
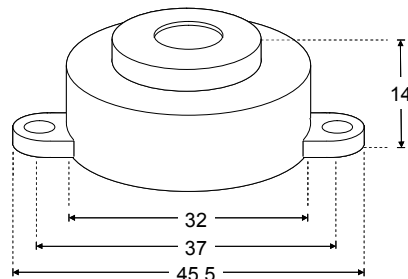
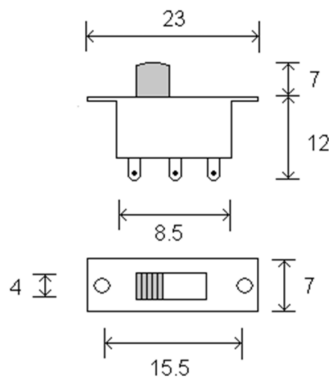
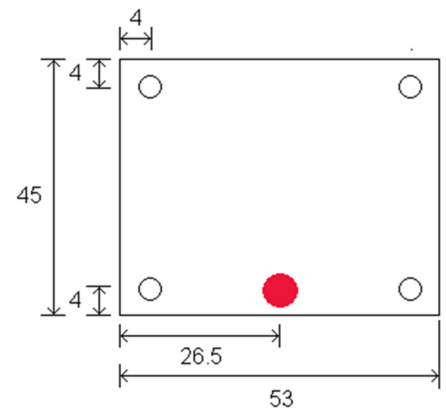
## Designing the Enclosure

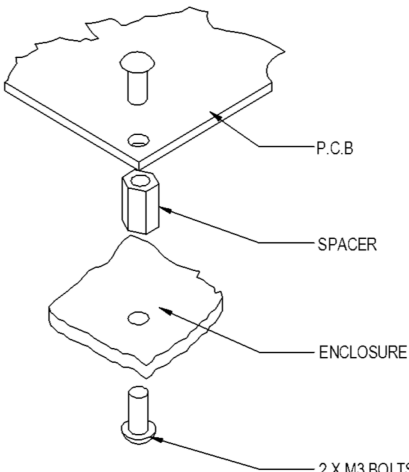
When you design the enclosure, you will need to consider:

- The size of the PCB (right)
- Where the start switch will be (below right)
- Where the on/off switch will be (below left)
- Where the buzzer will be mounted (below centre)
- Where the LED will be mounted (5mm diameter)
- Access to the batteries to allow them to be changed (bottom right)

These technical drawings of all of these items are illustrated on this page, which should help you design your enclosure.

All dimensions are in mm.

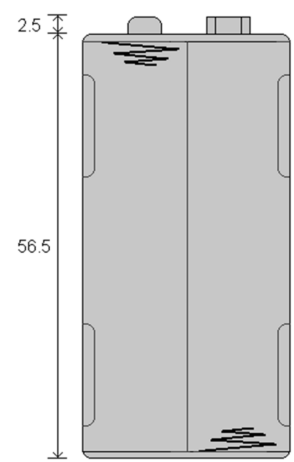
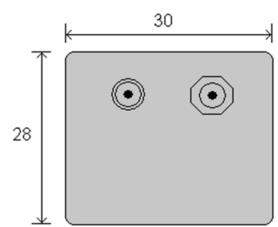




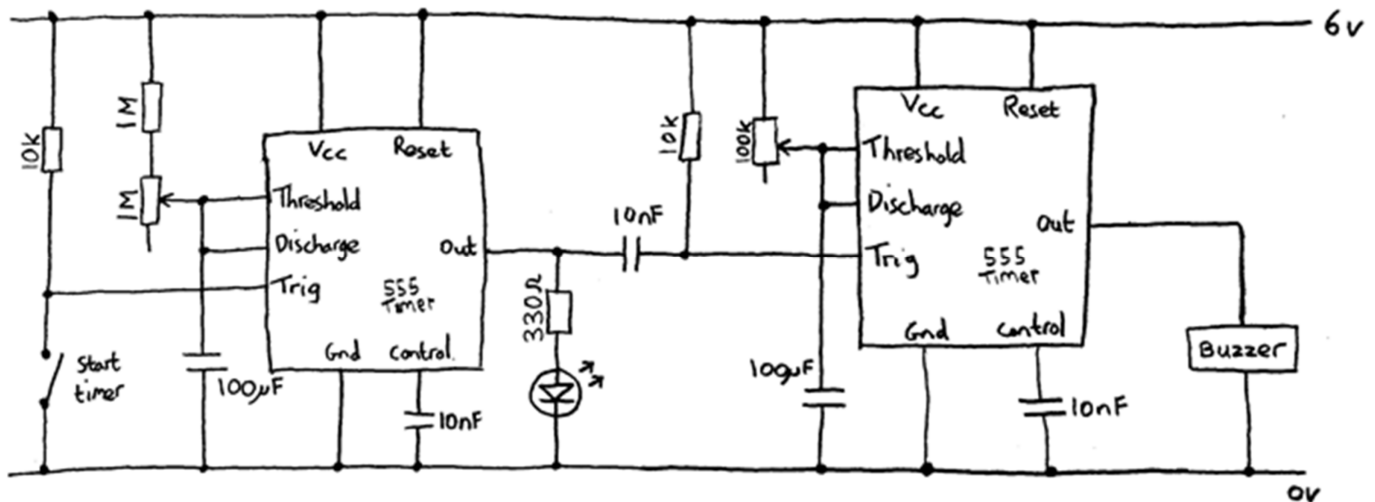
**Mounting the PCB to the enclosure**

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 timer works



The timer is based around the 556 timer. This is simply two 555 timers in the same device.

The 555 timer is a versatile IC (integrated circuit) and can be used to form many circuits. One of these circuits is a monostable timer. This circuit produces a single pulse when triggered. This means the Out pin is high (causing the LED to light or buzzer to sound).

To trigger the circuit the Trig input must go from a high to a low voltage. When the start switch is pressed (closed) the Trig input is taken low and the output pulse starts.

The duration of the pulse generated is determined by the RC constant (see Capacitor worksheet) formed by the resistor and capacitor connected to the Threshold input. When triggered the Discharge pin is used to start the 100µF cap charging. When it reaches 2/3 of the battery voltage the Out pin changes from high to low.

The first 555 timer is used to provide the timing delay, which is the time you have to before the buzzer is sounded. This can be adjusted between 0 seconds and 200 seconds. This is because R5, the variable 1MΩ can be adjusted between 1MΩ and 0Ω and an additional 1MΩ resistor can be added. This gives a maximum RC constant of 100µF x 2MΩ (1MΩ+1MΩ) = 200 seconds and a minimum of 100µF x 0MΩ (0MΩ+0Ω) = 0 seconds.

When this times out the output goes low and causes the second 555 timer circuit to start and the LED to go out. At this point the buzzer will begin to sound. The second timer and therefore the period for which the buzzer sounds can be adjusted to between 0 seconds and 10 seconds (100µF x 100KΩ = 10 seconds).



## Using the Timer

- Insert four batteries into the battery holder
- Turn the timer on using the on / off switch
- To start the timer press the start switch
- Follow the steps below if you want to adjust the time out period or the buzzer length
- Don't forget to switch the timer off when not being used, otherwise you will flatten the batteries

### ***Adjusting the time out period***

- The time out period can be adjusted in length. To make it shorter turn R5 in anti-clockwise direction or to make it sound for longer turn R5 in the clockwise direction

### ***Adjusting the buzzer length***

- The period for which the buzzer sounds can be adjusted in length. To make it sound for less time turn R4 in the anti-clockwise direction or to make it sound for longer turn R4 in the clockwise direction



## 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/2104](http://www.kitronik.co.uk/2104)



This kit is designed and manufactured in the UK by Kitronik

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