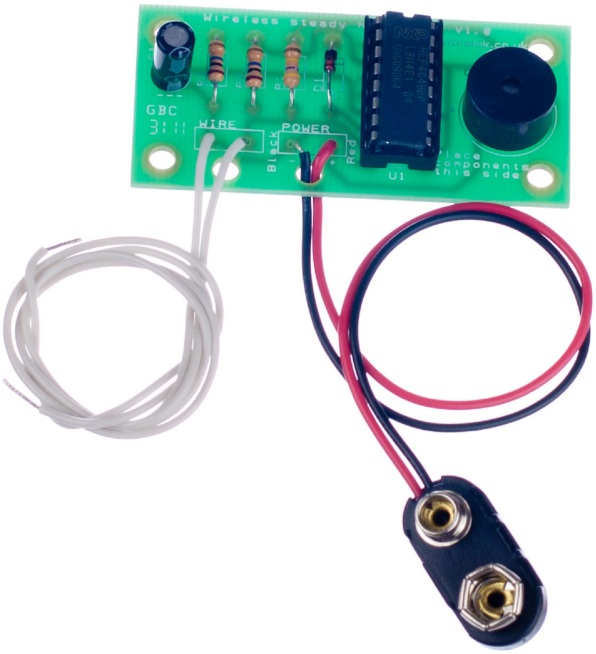
Kitronik

TEACHING RESOURCES

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

TEST YOUR HAND-EYE COORDINATION WITH THIS

Wireless Steady Hand Game 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 simple games. 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 basic games. 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 'Resistors' work sheet. 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 Steady Hand Game PCB' and 'Fault Finding Flow Chart' sections. Homework: Read 'How the steady hand game works' sheet
Hour 9	Build enclosure. Homework: Collect some examples of instruction manuals.
Hour 10	Build enclosure. Homework: Read 'Instruction Manual' sheet and start developing instructions for the steady hand game.
Hour 11	Build 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 'Soldering in ten steps' sheet practice soldering.
Hour 2	Build the kit using the 'Build Instructions'.
Hour 3	Check the completed PCB and fault find if required using 'Checking your steady hand game PCB' and fault finding flow chart.

Answers

Resistor questions

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

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

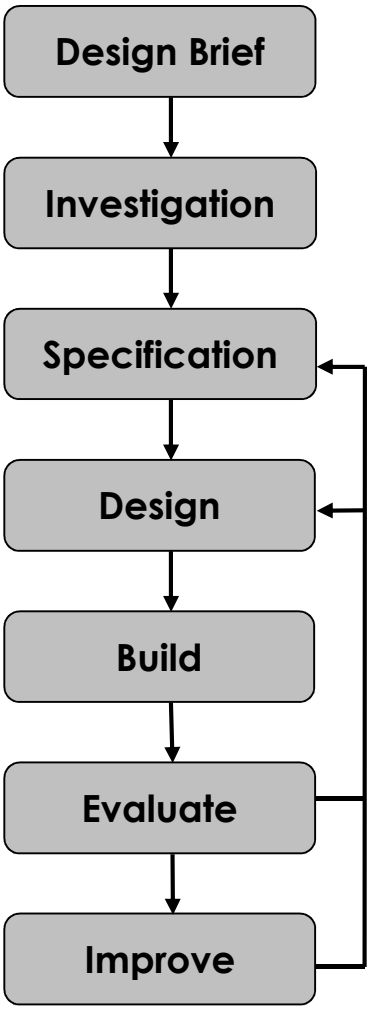
Notes

The tinned copper wire for the loop and bent wire track which is supplied on a reel. There is enough wire for each student to have 1m, in order to make sure there is enough wire to go around we would recommend putting a 1 metre ruler, a pair of cutters and the tined copper on a bench. The student can then measure and cut themselves a 1 metre length.

Kitronik would like to thank Gareth Evans at the Trinity School (Surrey) for developing this kit and allowing us to produce it.

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.

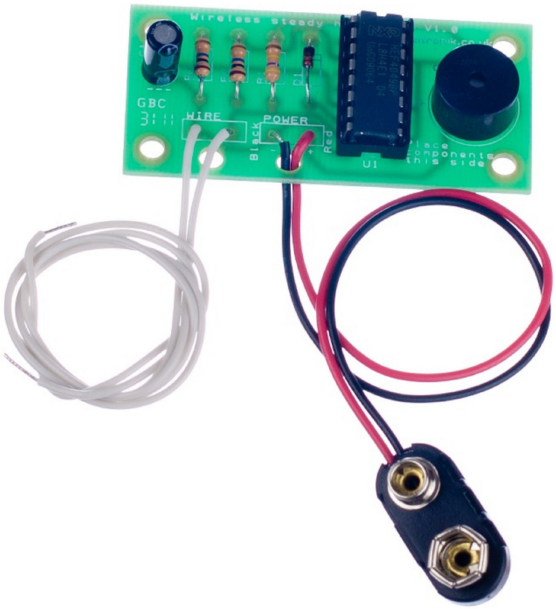
The Design Brief

A toy manufacturer has developed a simple circuit for producing a steady hand game. The circuit causes a buzzer to sound when the user fails to negotiate a course of bent wire with a loop without the two touching. The circuit will sound the buzzer for around a second with even the briefest of touches. With this circuit there is no wire between the loop and the circuit board. Instead the person operating the game makes the connection, so a metal contact to touch must be present on the enclosure. The circuit has been developed to the point where they have a working Printed Circuit Board (PCB).

The manufacturer would like ideas for an enclosure design for the PCB that will make the final product suitable for use by children. The manufacturer has asked you to do this for them. You must make sure the final design meets all the requirements that you have identified for this type of product.

Complete Circuit

A fully built circuit is shown below.



Investigation / Research

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

Name…… Class……

Developing a Specification

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

Name…… Class……

Requirement	Reason
Example: The enclosure should have 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.

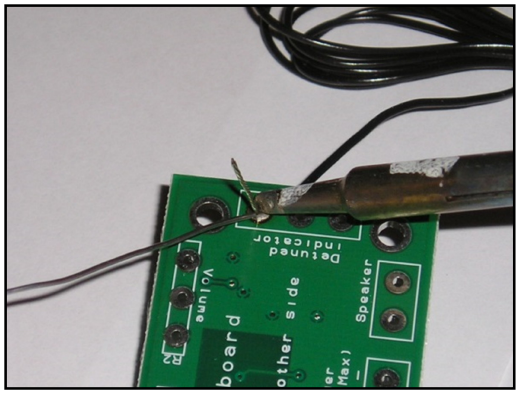
Name…… Class……

Design Review (group task)

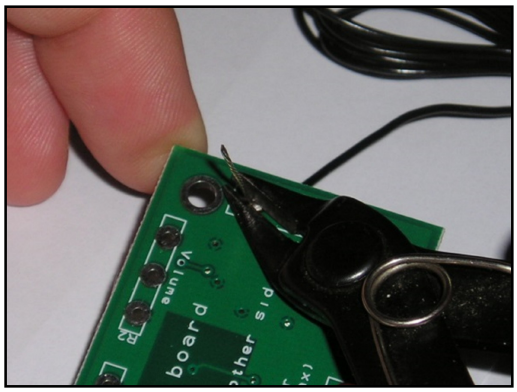
Split into groups of three or four. Take it in turns to review each person's design against the requirements of their specification. Also look to see if you can spot any additional aspects of each design that may cause problems with the final product. This will allow you to ensure that you have a good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

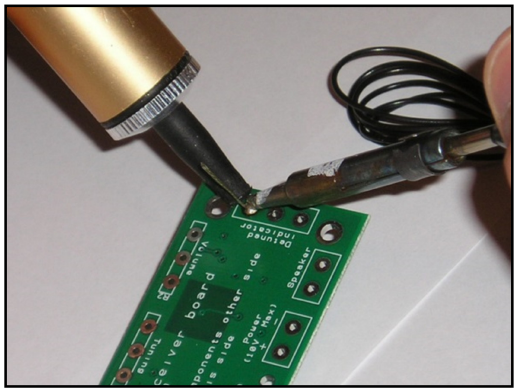
Comment	Reason for comment	Accept or Reject

Soldering in Ten Steps

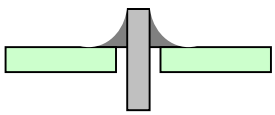
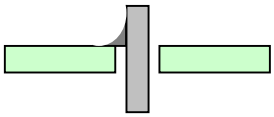
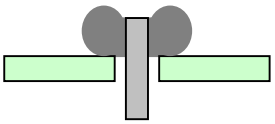


1. Start with the smallest components working up to the taller components, soldering any interconnecting wires last.
2. Place the component into the board, making sure that it goes in the right way around and the part sits flush against the board.
3. Bend the leads slightly to secure the part.
4. Make 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).





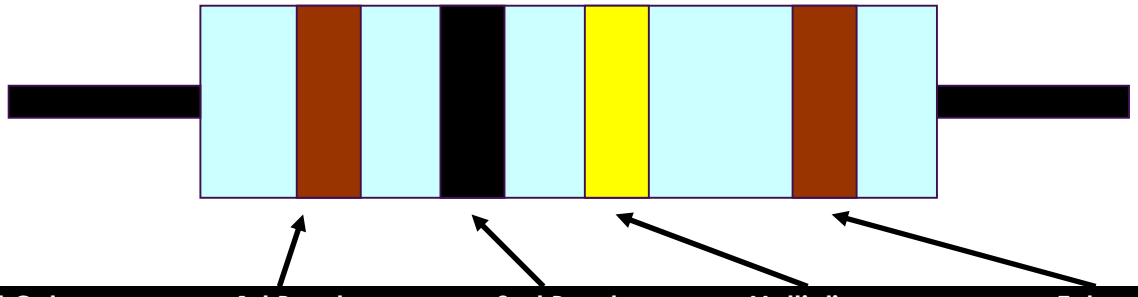
Solder joints

		
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

Instruction Manual

Your wireless steady hand game 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.

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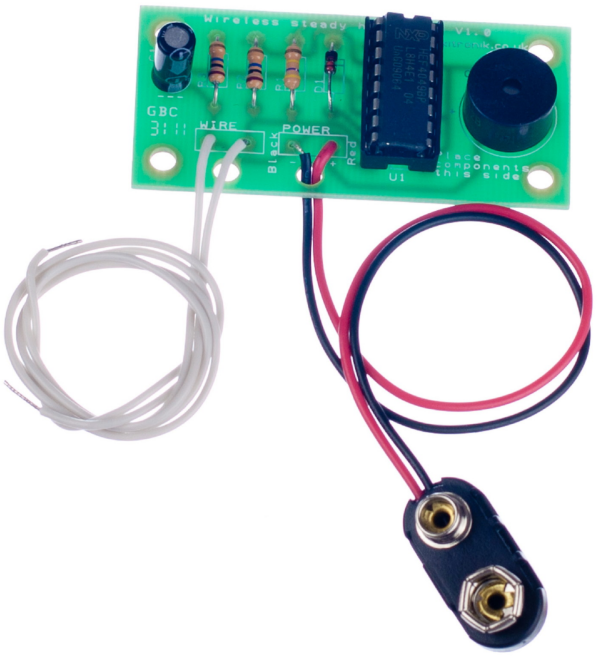
ESSENTIAL INFORMATION

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

TEST YOUR HAND-EYE COORDINATION WITH THIS

Wireless Steady Hand Game Kit



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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 three resistors:
The text on the PCB shows where R1, R2 and R3 go.
Ensure that you put the resistors in the right place.

PCB Ref	Value	Colour Bands
R1 & R2	10M	Brown, black, blue
R3	407k	Yellow, purple, yellow

2 Place the diode

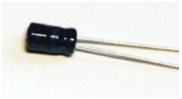
Solder the diode into the board where it is labelled D1. Make sure the device is the correct way around. The black band on the diode should be in line with the band marked on the PCB outline for the diode.

3 Place the IC holder

Solder the Integrated Circuit (IC) holder into IC1. 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.

4 Place the Capacitor

Place the capacitor into the board where it is labelled C1. Make sure the device is the correct way around. The capacitor has a '-' sign marked on it which should match the same sign on the PCB. Once the capacitor is in the right way around solder it in place.



5 Place the Buzzer

The buzzer should be soldered into Q1. The buzzer has a '+' mark on the side and the PCB also is marked with a '+'. The '+' on the part should be lined up with the '+' on the PCB.

6 Attach the battery clip

Attach the battery clip to the 'POWER' connection. The wire should be thread through the strain relief next to the power terminal. The red lead should be soldered to the '+' terminal (also marked with the text 'red') and the black lead should be soldered to the '-' terminal (also marked with the text 'black').

7 Attach the wire

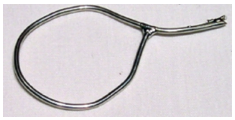
Cut the short length of wire in half, then strip all four ends. Twisting the strands together will allow the wire to be put into the board easier. Connect one end of each wire to the PCB where it is marked 'WIRE'. Again use the strain relief hole. It does not matter which way around the two wires go.

Making the game and attaching it to your PCB

Start by cutting 1m of solid tinned copper wire off the reel.

8 Creating the loop

To create the loop cut about 15 - 20cm from your piece of solid tinned copper wire. Bend the end to form the desired sized loop and handle. Solder the end to the middle of the wire being careful to hold the wire with a pair of pliers and not your hands.



9 Creating the course

The remaining piece of copper wire will form the shape that will have to be negotiated with the loop. When fixing this shape to your enclosure make sure the loop has been placed on the wire before securing it. Now solder one of the wire connections from the PCB to the wire shape. The stripped section of the other wire should be feed through to the outside of the case. It is possible to connect this wire to a small piece of metal on the outside of the case.

10 Place the IC

Finally put the Integrated Circuit (IC) into the IC holder. When doing this make sure the notch on the IC matches the notch on the IC holder.

Checking your steady hand 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 in the corners) are filled with the lead of a component.
- All the leads are soldered.
- Pins next to each other are not soldered together.

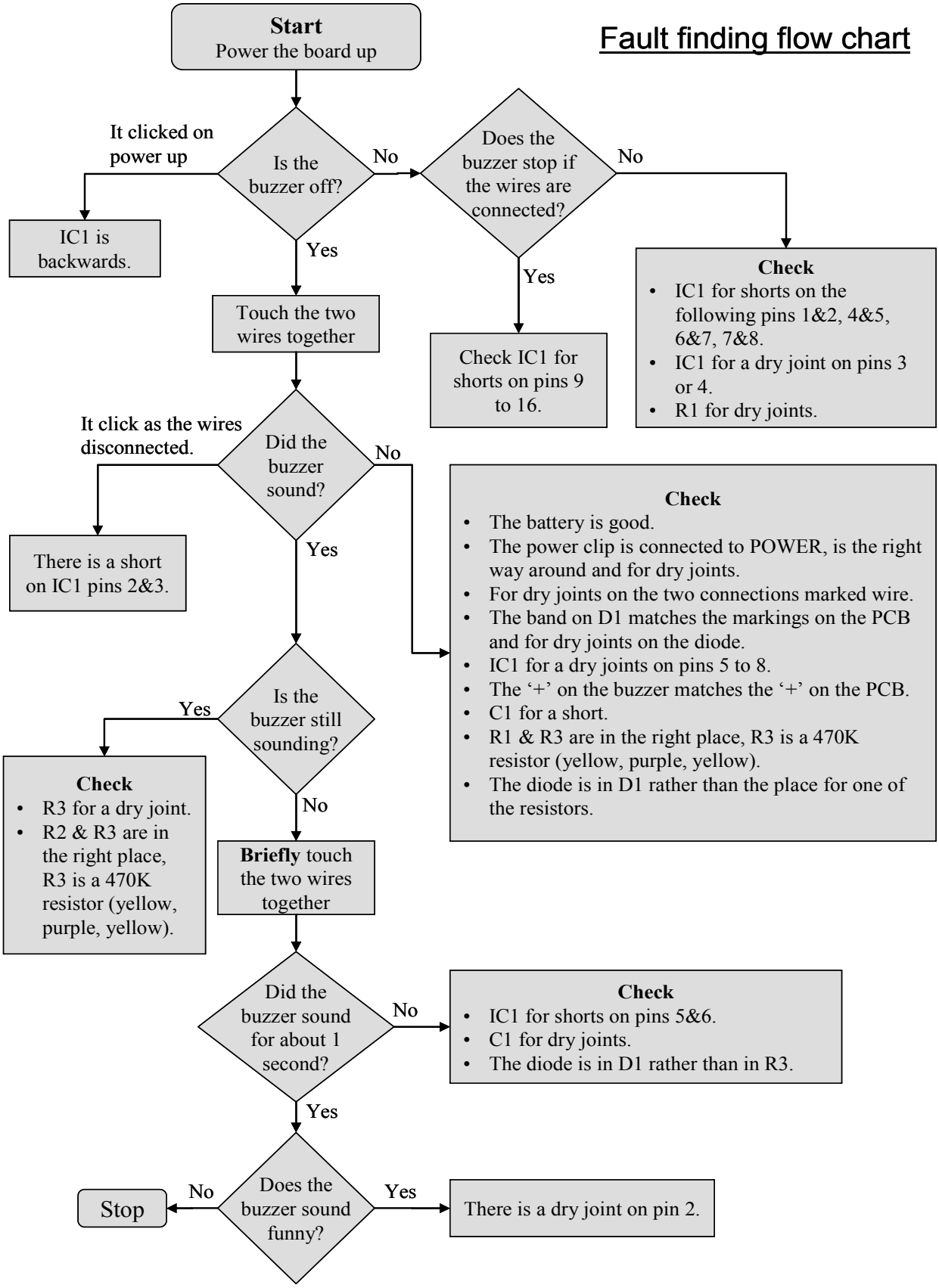
Check the top of the board to ensure that:

- The band on the diode matches the outline on the PCB.
- The '-' on the capacitor matches the '---' on the PCB.
- The '+' on the buzzer matches the '+' on the PCB.
- The notch on the IC is next to the text "hand game".
- The colour bands on R3 are yellow, purple, yellow.
- The power clip is connected to the 'Power' and the red wire connects to the '+'.

Testing your steady hand game

When you power up the board it should be silent.
Holding the two wire connections will cause the buzzer to sound. A brief touch will sound for about a second. If this is not the case use the fault finding flow chart to work out what is wrong.

Fault finding flow chart

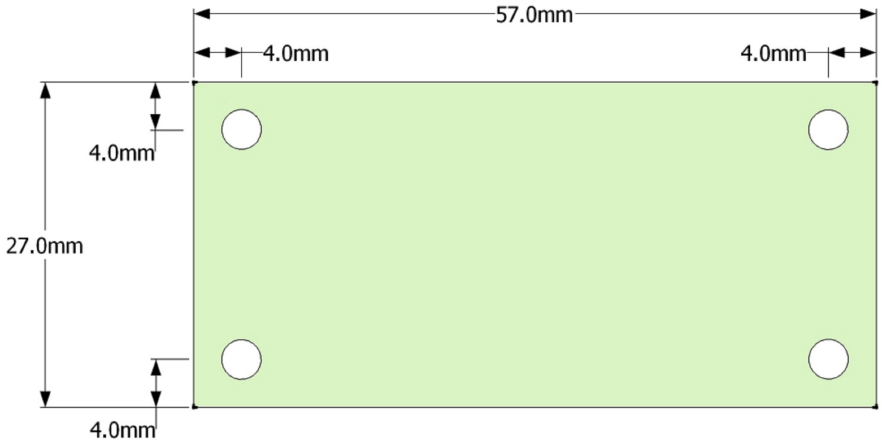


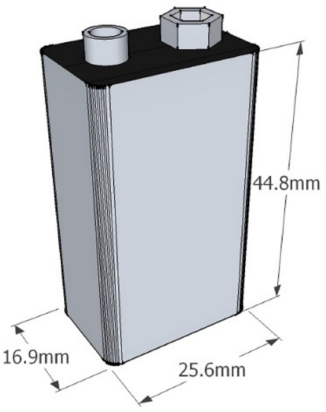
Designing the Enclosure

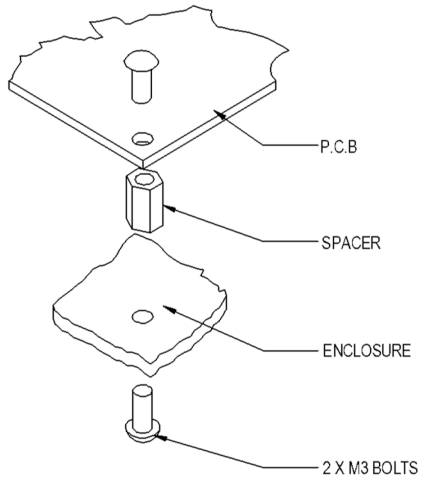
When you design the enclosure, you will need to consider:

The size of the PCB (below – left)
Where the batteries will be housed (below - right)

These technical drawings of the steady hand components should help you plan this.
All dimensions are in mm.
The four PCB mounting holes are 3.3 mm in diameter.





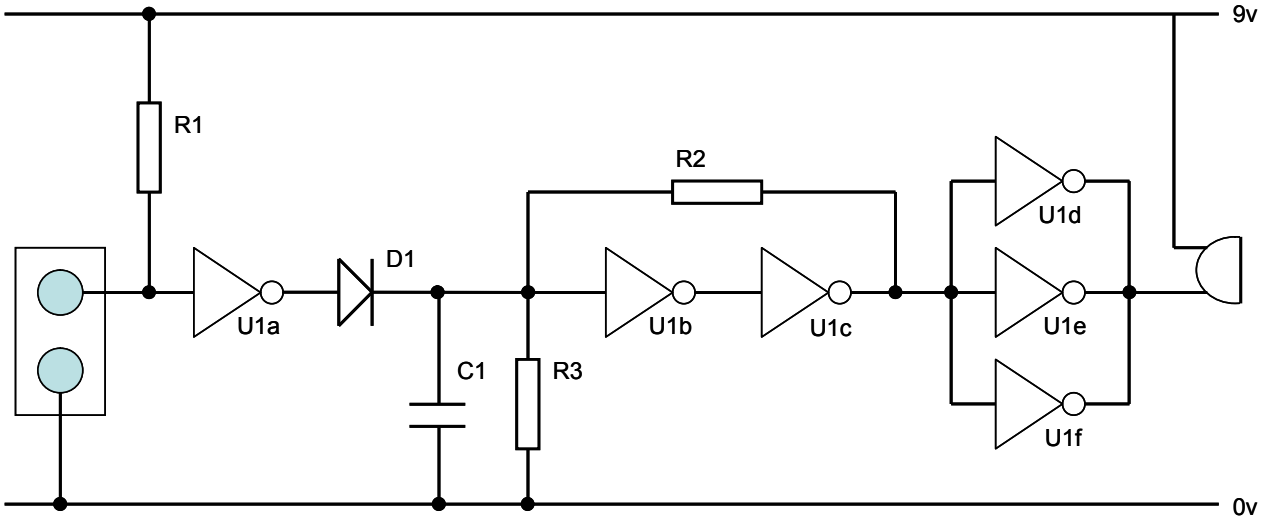


Mounting the PCB to the enclosure

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 wireless steady hand game works



The connections to the wire are shown on the left of this diagram. When the two are joined there will be a resistance across the connections made by the body. Resistor R1 is a 10M resistor and this normally holds the input to the not gate (U1a) in a high state. When the connection is made across the input, which will be in the order of a few hundred KΩ, the input to the not gate (U1a) will be low.

Since this is a not gate the output will be the opposite of the input, so it will normally be low, going high when the input is touched together. Whilst the output of this first gate (U1a) is high the capacitor C1 is charged. When the wires are no longer touched, the output of the not gate (U1a) drops low, however on the other side of the diode D1 the capacitor will still have voltage across it. Over the period of about a second (the time the buzzer sounds for) the capacitor C1 discharges through R3. As this happens the input to the 2nd not gate (U1b) changes from a high state to a low state.

The third not gate (U1c) inverts the signal back to the same state it was in at the input to gate (U1b). Whilst this might not sound very useful there will only be a small amount of current driving the input and the output can drive a higher current so it has worked as a buffer. Finally the three not gates (U1d, U1e, U1f) are used to drive the buzzer. As the three are used in parallel the current driven into the buzzer is three times higher than it would have been for a single gate and is therefore enough for the buzzer to work. When the output from U1c is in a high state the output of the three not gates (U1d, U1e, U1f) will be low and there will be 9V across the buzzer, so it will sound.

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:

http://www.kitronik.co.uk/2140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