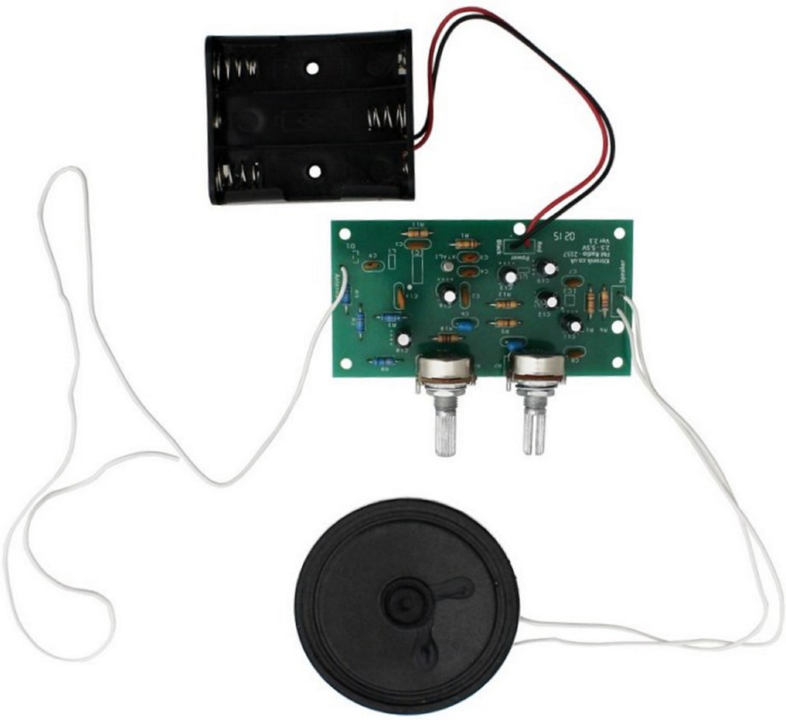
Kitronik

TEACHING RESOURCES

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

GET IN TUNE WITH THIS

FM RADIO KIT



Version 2.2

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 radio and audio products. List the common features of these products on the 'Investigation / Research' sheet.
Hour 2	Develop a specification for the project using the 'Developing a Specification' sheet. Resource: Sample of radios and audio products. Homework: Using the internet or other search method, find out what is meant by 'design for manufacture'. List five reasons why design for manufacture should be considered on any design project.
Hour 3	Read 'Designing the Enclosure' sheet. Develop a product design using the 'Design' sheet. Homework: Complete design.
Hour 4	Using cardboard, get the students to model their enclosure design. Allow them to make alterations to their design if the model shows any areas that need changing.
Hour 5	Split the students into groups and get them to perform a group design review using the 'Design Review' sheet.
Hour 6	Using the 'Soldering in Ten Steps' sheet, demonstrate and get students to practice soldering. Start the 'Resistor Value' and 'Capacitor Basics' worksheets. Homework: Complete any of the remaining resistor / capacitor tasks.
Hour 7	Build the electronic kit using the 'Build Instructions'.
Hour 8	Complete the build of the electronic kit. Check the completed PCB and fault find if required using the 'Checking Your FM Radio PCB' section and the fault finding flow chart. Homework: Read 'How the FM Radio Kit Works' sheet.
Hour 9	Build the enclosure.
Hour 10	Build the enclosure.
Hour 11	Build the enclosure.
Hour 12	Using the 'Evaluation' 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	Build the kit using the 'Build Instructions'.
Hour 4	Check the completed PCB and fault find if required using 'Checking Your FM Radio PCB' and fault finding flow chart.

Answers

Resistor questions

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

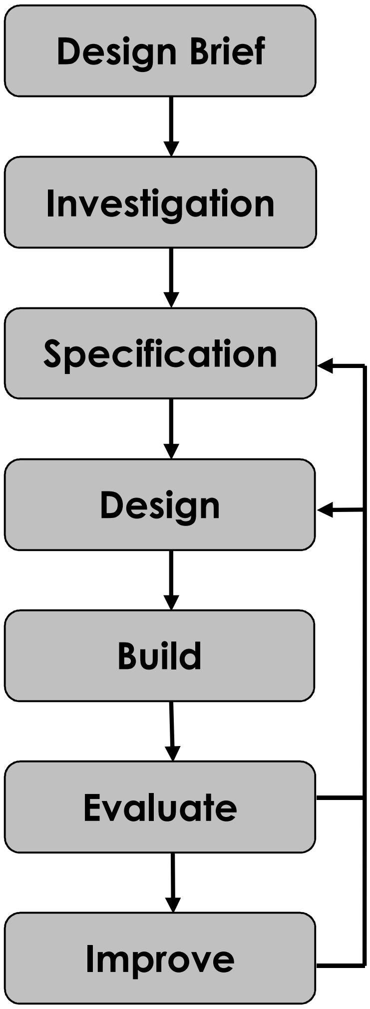
Value	1st Band	2nd Band	Multiplier x
180 Ω	**Brown**	**Grey**	***Brown***
3,900 Ω	**Orange**	**White**	***Red***
47,000 (47K) Ω	**Yellow**	**Violet**	***Orange***
1,000,000 (1M) Ω	**Brown**	**Black**	***Green***

Capacitor Ceramic Disc values

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

The Design Process

The design process can be short or long, but will always consist of a number of steps that are the same on every project. By splitting a project into these clearly defined steps, it becomes more structured and manageable. The steps allow clear focus on a specific task before moving to the next phase of the project. A typical design process is shown on the right.



Design brief

What is the purpose or aim of the project? Why is it required and who is it for?

Investigation

Research the background of the project. What might the requirements be? Are there competitors and what are they doing? The more information found out about the problem at this stage, the better, as it may make a big difference later in the project.

Specification

This is a complete list of all the requirements that the project must fulfil - no matter how small. This will allow you to focus on specifics at the design stage and to evaluate your design. Missing a key point from a specification can result in a product that does not fulfil its required task.

Design

Develop your ideas and produce a design that meets the requirements listed in the specification. At this stage it is often normal to prototype some of your ideas to see which work and which do not.

Build

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

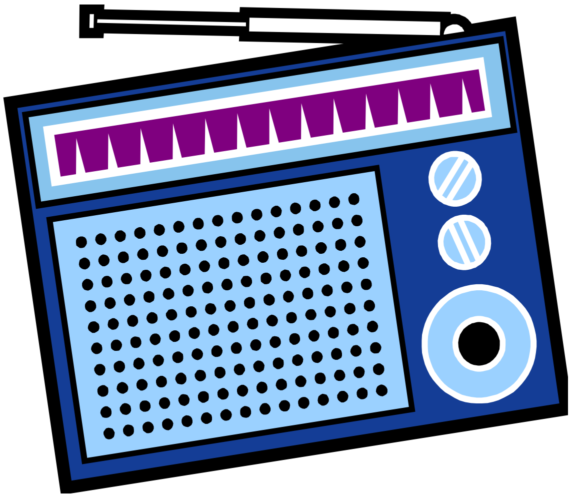
Evaluate

Does the product meet all points listed in the specification? If not, return to the design stage and make the required changes. Does it then meet all of the requirements of the design brief? If not, return to the specification stage and make improvements to the specification that will allow the product to meet these requirements and repeat from this point. It is normal to have such iterations in design projects, though you normally aim to keep these to a minimum.

Improve

Do you feel the product could be improved in any way? These improvements can be added to the design.

The Design Brief

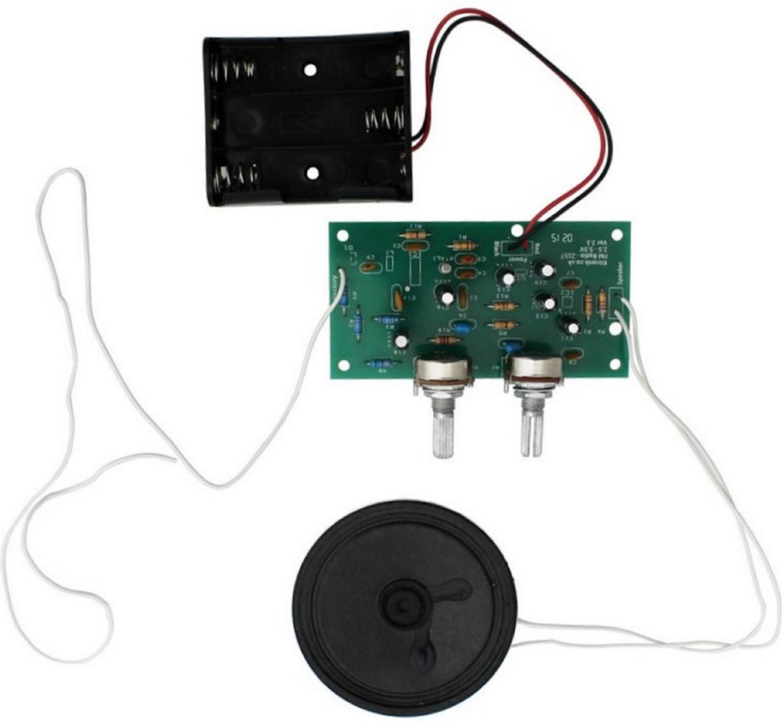


A manufacturer has developed a circuit for an FM radio. The circuit has been developed to the point where they have a working Printed Circuit Board (PCB). The manufacturer would like ideas for how this PCB could be housed to create a final product.

The manufacturer has asked you to do this for them. It is important that you make sure that the final design meets all of the requirements that you identify for an FM radio.

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: It must be easy to access the batteries.	Example: So that they can easily be changed when they become flat.

Design

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

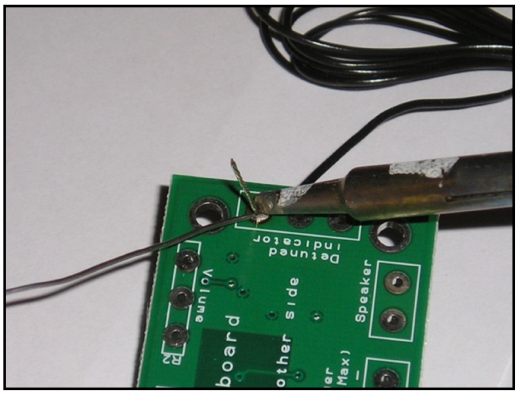
Name…………………………………………… Class……………………………

Design Review (group task)

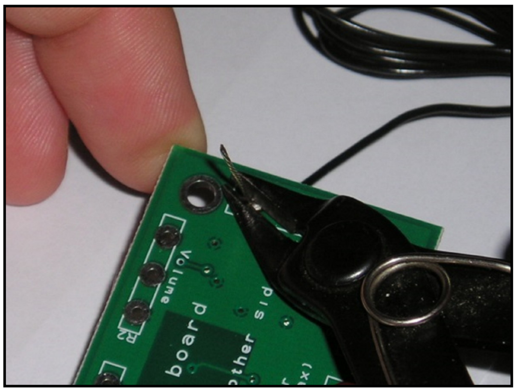
Split into groups of three or four. Take it in turns to review each person's design against the requirements of their specification. Also look to see if you can spot any additional aspects of each design that may cause problems with the final product. This will allow you to ensure that you have a good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

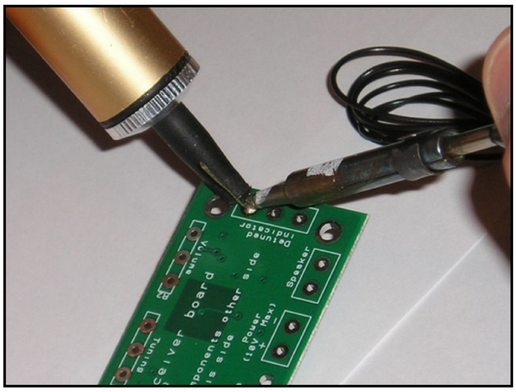
Comment	Reason for comment	Accept or Reject

Soldering in Ten Steps

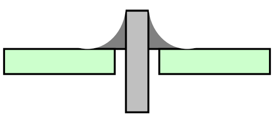


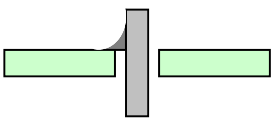
1. Start with the smallest components working up to the taller components, soldering any interconnecting wires last.
2. Place the component into the board, making sure that it goes in the right way around and the part sits flush against the board.
3. Bend the leads slightly to secure the part.
4. Make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

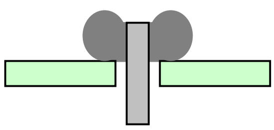




Solder joints


Good solder joint

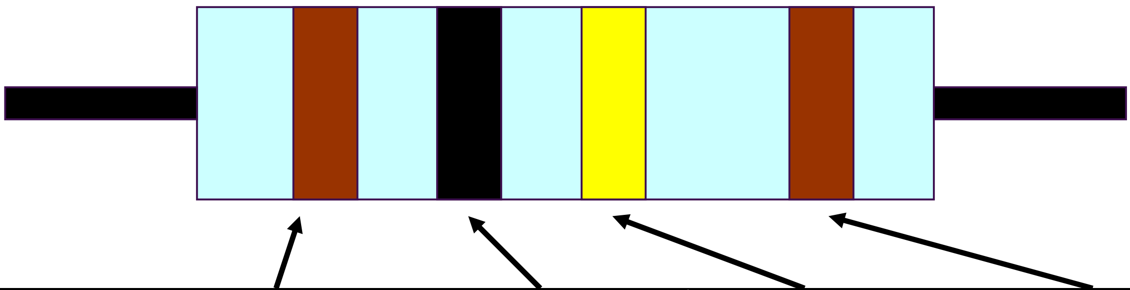

Too little solder


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

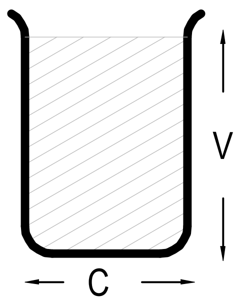
There are a number of different ranges of values for resistors. Two of the most popular are the E12 and E24. They take into account the manufacturing tolerance and are chosen such that there is a minimum overlap between the upper possible value of the first value in the series and the lowest possible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

Capacitor Basics

What is a capacitor?

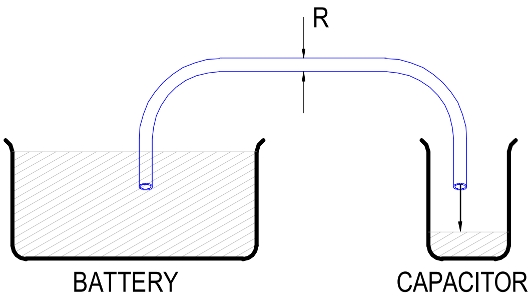


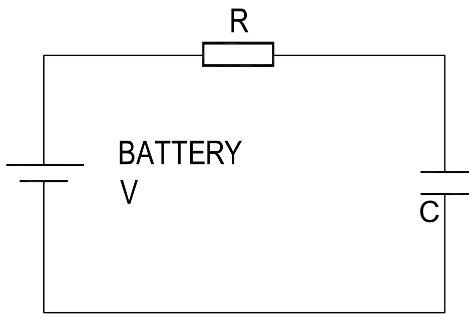
A capacitor is a component that can store electrical charge (electricity). In many ways, it is like a rechargeable battery.

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

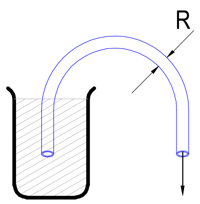




When a capacitor is connected to an item such as a battery, charge will flow from the battery into it. Therefore the capacitor will begin to fill up. The flow of water in the picture above left is the equivalent of how the electrical charge will flow in the circuit shown on the right.

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

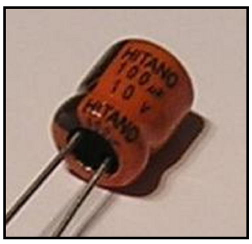


Once a capacitor has been filled with an amount of charge, it will retain this charge until it is connected to something into which this charge can flow.

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.



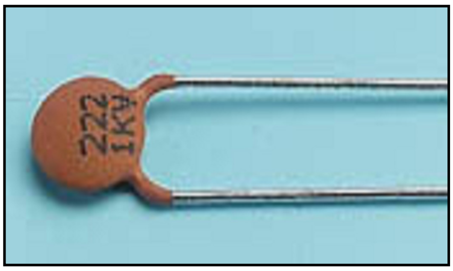
Ceramic Disc Capacitors

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 (μF), nano Farads (nF) and pico Farads (pF). A μF is a millionth of a Farad, 1μF = 1000 nF and 1nF = 1000 pF.

1F	= 1,000mF
1F	= 1,000,000μF
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 μF)

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

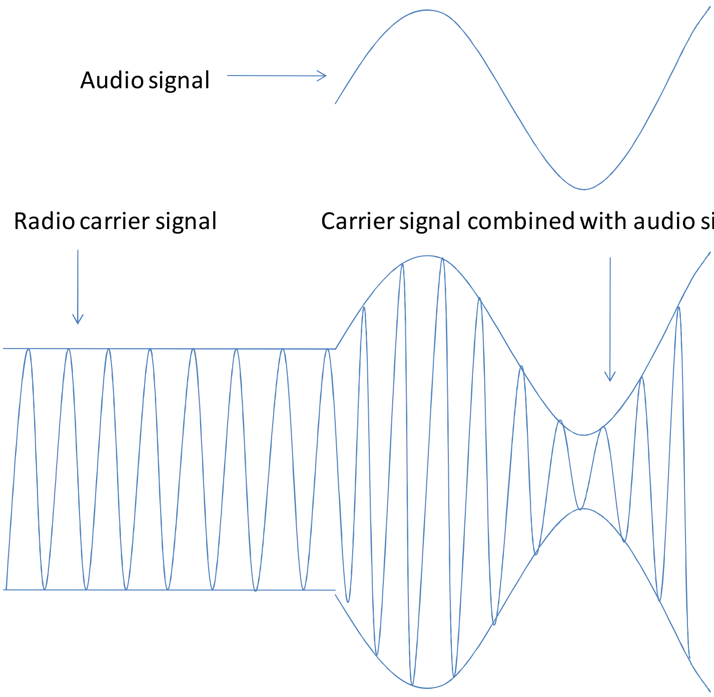
Printing on capacitor	Two digit start	Number of zero's	Value in pF
222			
103			
333			
473			

How Does a Radio Work?

For around 100 years, radio stations have been transmitting signals which people have been able to receive and listen to. Early radio transmissions were AM and were received either on simple crystal radios or radios that used vacuum tubes (valves).

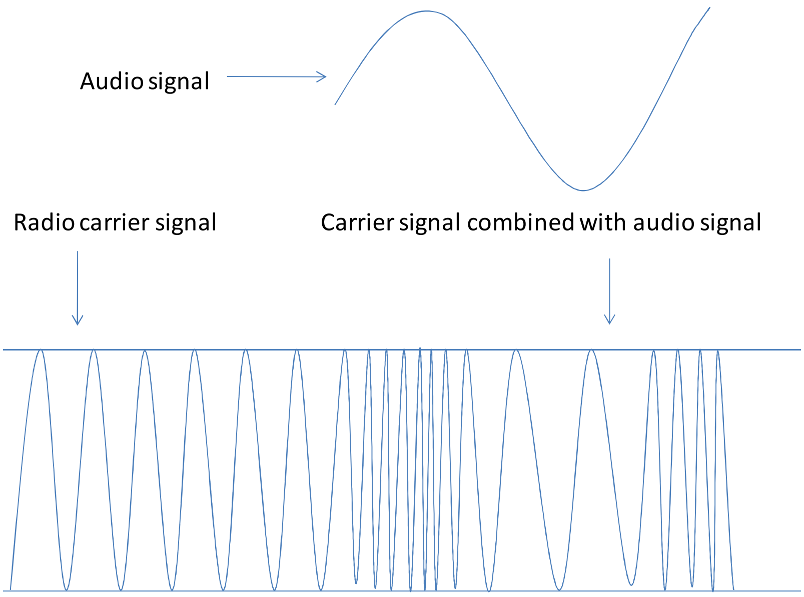
AM radio

AM radio work by combining the audio signal which you wish to transmit with a higher frequency carrier signal. AM stands for 'Amplitude Modulation' as it is the amplitude of the carrier signal that is used to carry the audio signal. This can be seen in the diagram to the right. The receiver is tuned into the frequency of the carrier frequency. It then removes the carrier to recover the audio signal, which you can then listen to.



FM radio

FM radio came along after AM radio and offered a much improved signal quality. FM stands for 'Frequency Modulation'. As the name suggests, instead of altering the amplitude of the carrier signal, FM radio works by changing the frequency of the carrier signal (increasing it or decreasing it) to reflect the audio signal you wish to transmit. This can be seen in the diagram to the right.



Transistor radios

Transistors started to be used in radio during the middle of the last century. Transistors have many advantages over vacuum tubes including being cheaper, smaller and requiring less power. As a result of this, they helped bring radio ownership to the masses.

Instruction Manual

Your radio 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

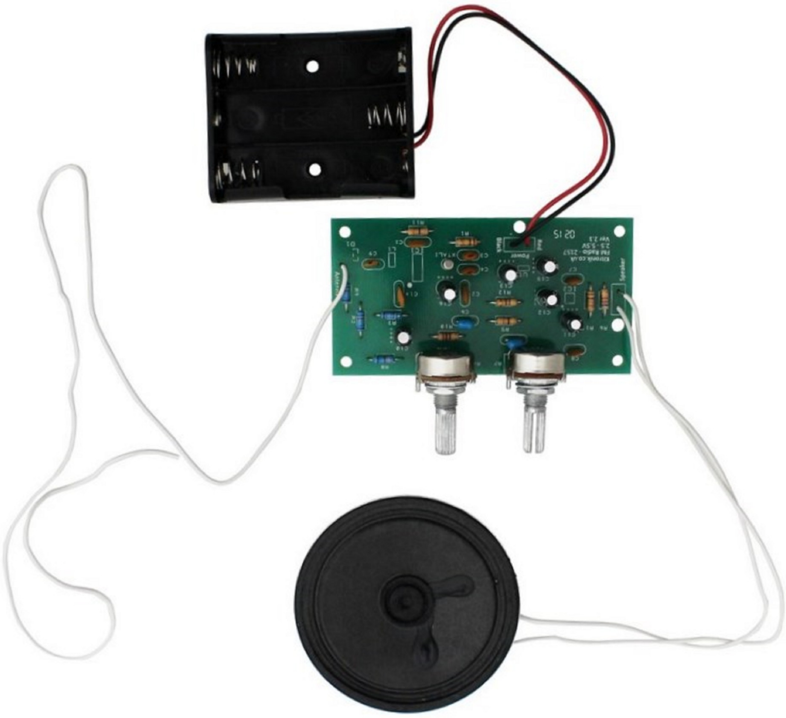
Develop a packaging design for your product that meets these requirements. Use additional pages if required.

ESSENTIAL INFORMATION

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

GET IN TUNE WITH THIS

FM RADIO KIT



Version 2.2

FM Radio Essentials

www.kitronik.co.uk/2157

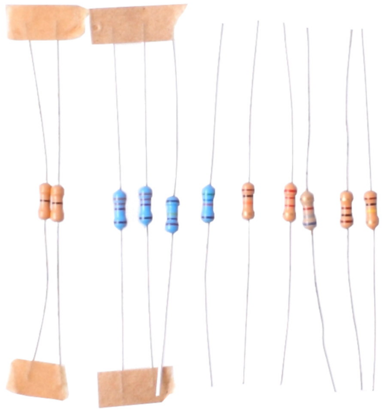
Build Instructions

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

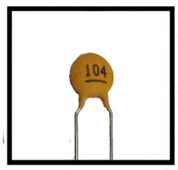
PCB Ref	Value	Colour Bands
R1	100k	Brown, black, yellow
R2 & R9	220k	Red, red, yellow
R3	56k	Green, blue, orange
R5 & R11	0Ω	Black
R6	6.8k	Blue, grey, red
R8	3.3k	Orange, orange, red
R10	100Ω	Brown, black, brown
R12	470Ω	Yellow, purple, brown
R13	10k	Brown, black, orange



2 SOLDER THE CERAMIC DISC CAPACITORS

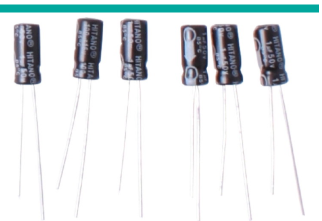
The ceramic disc capacitors should be soldered into the board. There are a lot of these so be careful to put them all in the correct place. The capacitors can be identified by the text printed on them (see close up image below right). To allow for easier soldering wide footprints have been used on the board, the smaller capacitors do not need to be pushed firmly in to the PCB.

PCB Ref	Value	Text
C1, C2, C14	100nF	104
C3, C4	22pF	22
C5, C6	470nF	474
C7	470pF	471
C8	1nF	102
C9	33pF	33



3 SOLDER THE ELECTROLYTIC CAPACITORS

The other six capacitors are electrolytic capacitors. The capacitor C10 is marked 100µF, place this one first. Make sure that the device is the correct way around. The capacitors have a '-' sign marked on them, which should match the same sign on the PCB. The other 5 are all marked 1µF and should go in the spaces marked C11, C12, C13, C15 and C16.

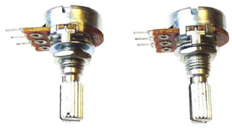


4 SOLDER THE TIMING CRYSTAL

This is a very small metal cylinder with two very thin legs protruding from one end. Gently place this component into the holes in the PCB where it is marked ’XTAL1’. The legs are fragile so care should be taken when putting them through the holes in the PCB.

5 SOLDER THE POTENTIOMETERS

The two potentiometers are different so make sure that you check which is which before soldering them into position. When placing the potentiometer into the board make sure the knob is pointing outwards from the PCB.



Value

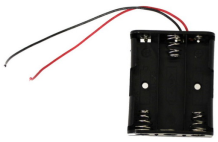
PCB Ref	Value
R4	100k
R7	10k

6 SOLDER THE ANTENNA

Strip one end of the thin white wire and solder it into the hole on the PCB labelled ‘Antenna’. The longer the antenna wire is up to 56cm the better it will perform. It is not a problem to have an antenna longer than 56cm as it won’t degrade the reception. Keep the off cut for the speaker.

7 SOLDER THE BATTERY CAGE

Next look for the two holes labelled ’Power’. Thread the wires from battery cage through the strain relief hole near these holes then solder the red wire into the hole marked ‘red’ and the black wire into the hole marked ‘black’.



8 SOLDER THE SPEAKER

Finally, cut the wire left over from the antenna connection in half and strip the ends. Thread both lengths of wire through the strain relief hole marked ‘Speaker’ and solder one of the wires to each of the two holes, it doesn’t matter which one goes in either hole.
Solder the other end of the speaker wires to the terminals on the speaker. Again it doesn’t matter which way around these go.

Checking Your FM Radio PCB

Check the following before you connect any batteries to your radio.

Check the bottom of the board to ensure that:

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

Check the top of the board to ensure that:

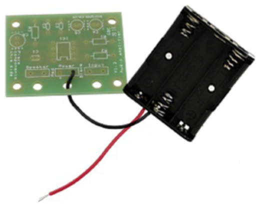
- The negative markings on the electrolytic capacitors line up with the same markings on the PCB.
- The red wire on the PP3 lead is connected to the power connector labelled 'Red' and the black wire on the PP3 lead is connected to the power connector labelled 'Black'.
- Additionally check that the resistors and capacitors are in the correct place if your board does not work.

Adding an On / Off Switch

If you wish to add a power switch, don't solder both ends of the battery clip directly into the board, instead:

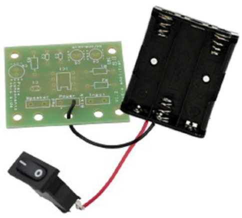
1

Solder one wire from the battery cage to the PCB, either black to '-' or red to '+'.



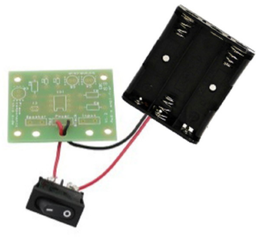
2

Solder the other wire from the battery cage to the on / off switch.

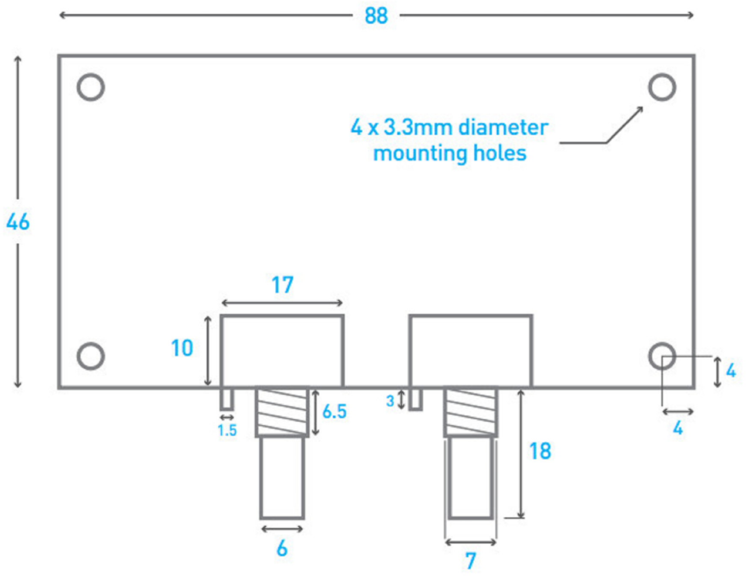


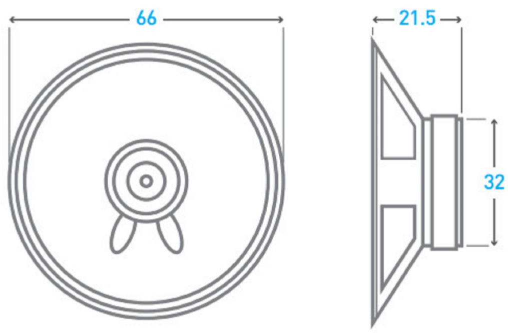
3

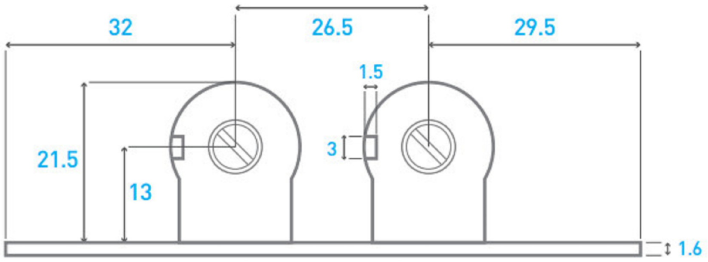
Using a piece of wire, solder the remaining terminal on the on / off switch to the remaining power connection on the PCB.



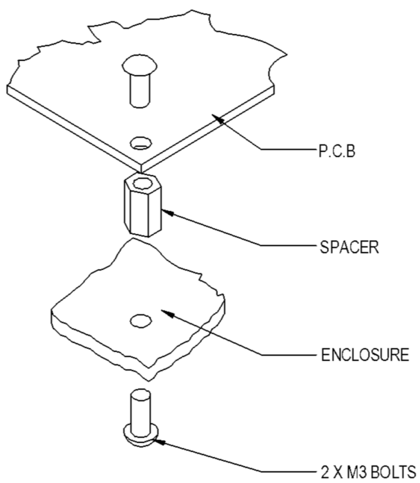
Designing the Enclosure







(All measurements 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.

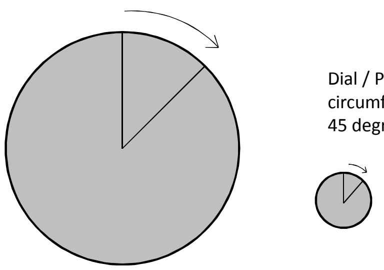
Your PCB has four mounting holes designed to take M3 bolts.

Improving the Radio Tuning

Tuning the radio using the potentiometer can be a tricky task. This is because one turn of the potentiometer covers the whole frequency range. This means that only very small adjustments of the potentiometer are required to tune into the different stations.

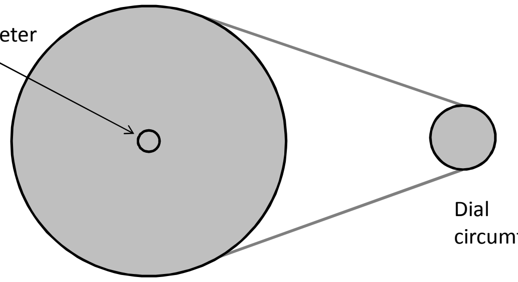
Large Dial

One way to improve the tuning mechanism is to attach a large dial to the end of the potentiometer. Look at the two dials below. As the smaller dial has a circumference six times smaller than the large dial, it would take six time the travel on the larger dial to achieve the same degree of change than if you used the smaller dial. This would therefore make fine tuning the radio six times easier.



Using a Pulley to give Mechanical Gearing

Another solution is to use a pulley system to improve the tuning mechanism. Take the system shown below. In this arrangement the larger pulley would be attached to the tuning potentiometer and the smaller dial would be used to make the tuning adjustments. As the smaller dial (pulley) has a circumference six times smaller than the large pulley, it would take six full rotations of the smaller dial to give one full rotation of the larger pulley. This would therefore make fine tuning the radio six times easier than if the small pulley had been connected directly to the tuning potentiometer.

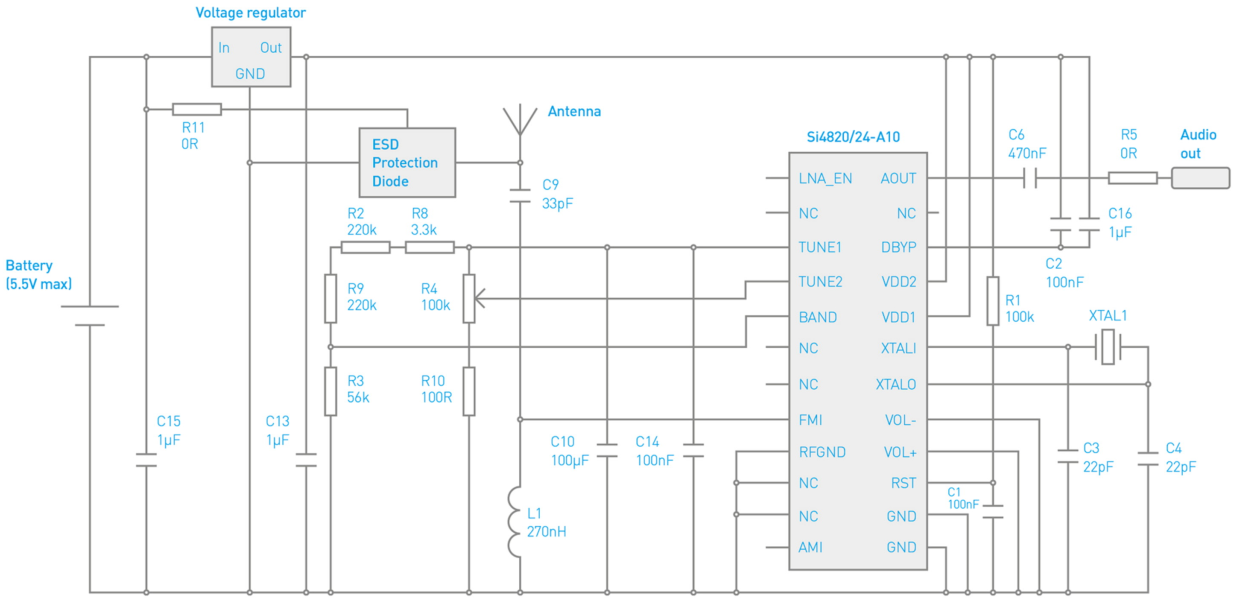


Using both a Pulley System and a Large Dial

Of course and even better solution would be to add a large dial in front of, but on the same shaft that the small pulley/dial in the above diagram is attached to. That way you would get the benefit of both systems this would give thirty six times better adjustment.

How the FM Radio Kit Works

To aid the description of the circuit we have split it into two parts. The first deals with the decoding of the FM radio signal and the second deals with the audio amplification.



Radio decoding

For the radio circuit to work it needs a stable power supply. To provide the stable power supply a voltage regulator is used. This provides a 3.3V output for the circuit to run from. Capacitors C15 and C13 help the regulator to output a steady voltage by removing noise from its input and output.

The key component of the radio circuit is the Si4820/24-A10 chip. This chip is used to receive radio signals via an 'antenna' and then decodes this signal to recover the audio signal it carries. To recover the radio signal the chip needs to generate a timing signal to match the radio signal to. This is achieved using the timing crystal XTAL1 and the two capacitors C3 and C4.

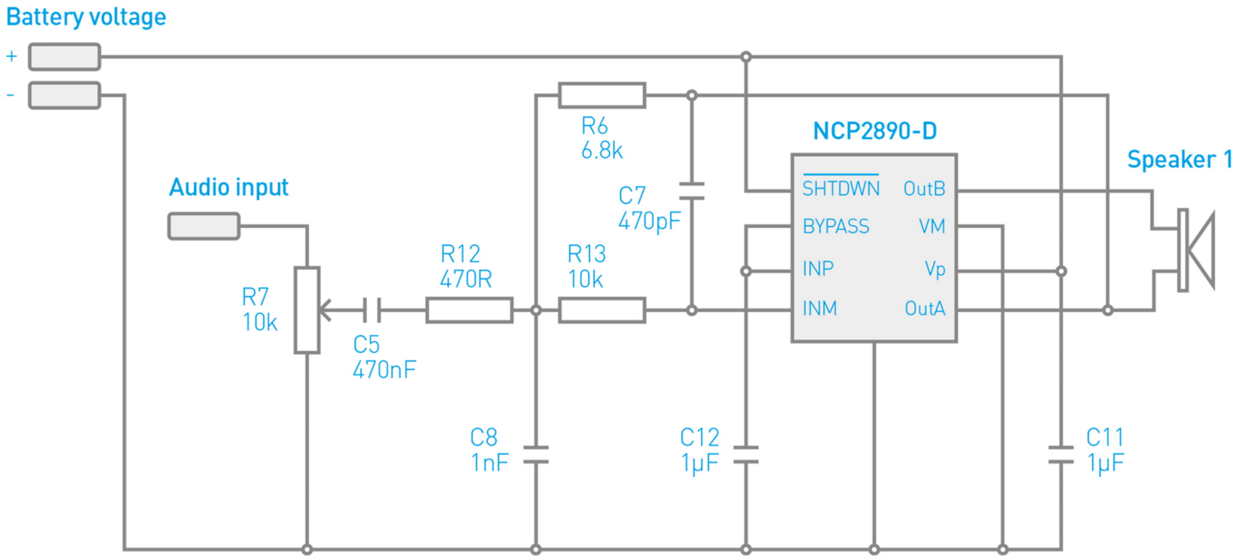
The resistor network composed of R2, R3, R4, R8, R9 and R10 controls the range or 'band' of frequencies that the IC is able to tune into. Different countries use different bands for FM radio and these values have been chosen for best performance in the UK and Europe. R4 is a potentiometer which can be turned to swap from station to station.

L1 and C9 help to filter out unwanted signals received by the antenna. C10 and C14 help to keep the tuning signal to the IC steady to prevent fluctuations in power from causing the IC to lose the station it has been tuned to.

The ESD protection diode protects the IC in the event of a static shock being delivered to the antenna. Static shocks are harmless to people but can damage the silicon inside the IC. The ESD protection diode redirects any such shock harmlessly to the ground rail.

C1 controls the reset timing of the IC which in this case only applies when switching on the device as this pin is held low by R1. C6 takes any DC bias out of the output signal from the radio IC and R5 and R11 just acts as a wire links to "jump" over tracks on the PCB.

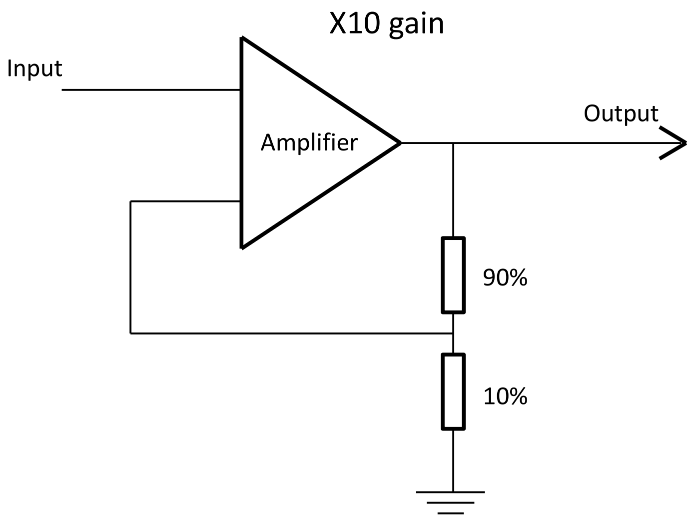
Audio amplification



The audio amplification is performed by another Integrated Circuit or IC called an NCP2890-D. Inside the NCP2890-D are lots of transistors, which are connected together to allow the small input signal to be amplified into a more powerful output that can drive a speaker.

All amplifiers need to use feedback to ensure the amount of gain stays the same. This allows the output to be an exact copy of the input just bigger. The gain is the number of times bigger the output is compared to the input, so if an amplifier has a gain of 10 and there is 1 volt on the input there will be 10 volts on the output. Before looking at how the feedback works, we first need to understand how a standard amplifier works. An operational amplifier has two inputs, these are called the inverting (-) and non-inverting (+) inputs. The output of the operational amplifier is the voltage on the non-inverting input less the voltage on the inverting input multiplied by the amplifiers gain. In theory an operational amplifier has unlimited gain so if the non-inverting input is a fraction higher than the inverting input (there is more + than -) the output will go up to the supply voltage. Change the inputs around and the output will go to zero volts. In this format the operational amplifier is acting as a comparator, it compares the two inputs and changes the output accordingly.

With an infinite gain the amplifier is no good to amplify audio, which is where the feedback comes in. By making one of the input a percentage of the output the gain can be fixed, which allows the output to be a copy of the input but bigger. Now when the two inputs are compared and the output is adjusted, instead of it going up or down until it reaches 0 volts or V+, it stops at the point when the two inputs match and the output is at the required voltage.



Looking at the circuit diagram for the audio amplifier you can see R6 connecting the pin 'OutA' back into the input pin 'INM'. This is the feedback for the amplifier.

Audio amplification continued

The output of the NCP2890-D uses two op-amps that are connected in a differential configuration. The second amplifier produced a 'mirror' (or reverse) of what the first op-amp produces. The output of one feeds OutA and the other feeds OutB. This configuration allows twice the power to be generated compared to amplifiers using a single op-amp configuration.

The rest of the components are needed as follows:
R7 is the volume control potentiometer. C5 and R12 filter the input signal. C7 increases bass response by allowing it to bypass R13. C11 and 12 keep the power supply to the IC smooth.

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/2157

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