HOW LOUD WAS THAT NOISE? FIND OUT WITH THIS

SOUND METER KIT
Index of Sheets

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Checking Your Sound Meter PCB
Adding an On / Off Switch
Fault Finding
Designing the Enclosure
How the Sound Meter Works
Online Information
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**

<table>
<thead>
<tr>
<th>Hour</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 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 audio equipment, particularly items with a visual volume indicator. List the common features of these products on the ‘Investigation / Research’ sheet. |
| 2     | Develop a specification for the project using the ‘Developing a Specification’ sheet.  
**Resource:** Pictures or samples of products (audio equipment).  
**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. |
| 3     | Read ‘Designing the Enclosure’ sheet. Develop a product design using the ‘Design’ sheet.  
**Homework:** Complete design. |
| 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. |
| 5     | Split the students into groups and get them to perform a group design review using the ‘Design Review’ sheet. |
| 6     | Using the ‘Soldering in Ten Steps’ sheet, demonstrate and get students to practice soldering. Start the ‘Resistor Value’ and the capacitor worksheets.  
**Homework:** Complete any of the remaining resistor / capacitor tasks. |
| 7     | Build the electronic kit using the ‘Build Instructions’. |
| 8     | Complete the build of the electronic kit. Check the completed PCB and fault find if required using the ‘Checking Your Sound Meter PCB’ section and the fault finding flow chart.  
**Homework:** Read ‘How the Sound Meter Works’ sheet. |
| 9     | Build the enclosure.  
**Homework:** Collect some examples of instruction manuals. |
| 10    | Build the enclosure.  
**Homework:** Read ‘Instruction Manual’ sheet and start developing instructions for the sound meter. |
| 11    | Build the enclosure. |
| 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.
Sound Meter Teaching Resources  
www.kitronik.co.uk/2142

**Electronics only**

<table>
<thead>
<tr>
<th>Hour 1</th>
<th>Introduction to the kit demonstrating a built unit. Using the ‘Soldering in Ten Steps’ sheet, practice soldering.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour 2</td>
<td>Build the kit using the ‘Build Instructions’.</td>
</tr>
<tr>
<td>Hour 3</td>
<td>Check the completed PCB and fault find if required using ‘Checking Your Sound Meter PCB’ and fault finding flow chart.</td>
</tr>
</tbody>
</table>

**Answers**

**Resistor questions**

<table>
<thead>
<tr>
<th>1st Band</th>
<th>2nd Band</th>
<th>Multiplier x</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>Black</td>
<td>Yellow</td>
<td>100,000Ω</td>
</tr>
<tr>
<td>Green</td>
<td>Blue</td>
<td>Brown</td>
<td>560Ω</td>
</tr>
<tr>
<td>Brown</td>
<td>Grey</td>
<td>Yellow</td>
<td>180,000Ω</td>
</tr>
<tr>
<td>Orange</td>
<td>White</td>
<td>Black</td>
<td>39Ω</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>1st Band</th>
<th>2nd Band</th>
<th>Multiplier x</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 Ω</td>
<td>Brown</td>
<td>Grey</td>
<td>Brown</td>
</tr>
<tr>
<td>3.900 Ω</td>
<td>Orange</td>
<td>White</td>
<td>Red</td>
</tr>
<tr>
<td>47,000 (47K) Ω</td>
<td>Yellow</td>
<td>Violet</td>
<td>Orange</td>
</tr>
<tr>
<td>1,000,000 (1M) Ω</td>
<td>Brown</td>
<td>Black</td>
<td>Green</td>
</tr>
</tbody>
</table>

**Capacitor Ceramic Disc values**

<table>
<thead>
<tr>
<th>Printing on capacitor</th>
<th>Two digit start</th>
<th>Number of zero’s</th>
<th>Value in pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>222</td>
<td>22</td>
<td>00</td>
<td>2200pF (2.2nF)</td>
</tr>
<tr>
<td>103</td>
<td>10</td>
<td>000</td>
<td>10000pF (10nF)</td>
</tr>
<tr>
<td>333</td>
<td>33</td>
<td>000</td>
<td>33000pF (33nF)</td>
</tr>
<tr>
<td>473</td>
<td>47</td>
<td>000</td>
<td>47000pF (47nF)</td>
</tr>
</tbody>
</table>
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

An audio equipment manufacturer has developed a sound meter circuit, which displays the volume the on board microphone picks up on ten LEDs. The circuit has been developed to the point where they have a working Printed Circuit Board (PCB). Although they are used to the design of stereo equipment, they have not designed a case for a sound meter before.

The manufacturer would like ideas for an enclosure for the PCB and battery to be mounted in. 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 such a 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.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: The enclosure should have some holes.</td>
<td>Example: So that the microphone can pick up the sound.</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Comment</th>
<th>Reason for comment</th>
<th>Accept or Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
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 \( \Omega \) (ohms) and is often referred to as its ‘resistance’.

Identifying Resistor Values

<table>
<thead>
<tr>
<th>Band Colour</th>
<th>1st Band</th>
<th>2nd Band</th>
<th>Multiplier ( \times )</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver</td>
<td></td>
<td></td>
<td>+ 100</td>
<td>10%</td>
</tr>
<tr>
<td>Gold</td>
<td>1</td>
<td>0</td>
<td>+ 0</td>
<td>5%</td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>1%</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>3</td>
<td>100</td>
<td>2%</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>4</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>5</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>6</td>
<td>100,000</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>7</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Grey</td>
<td>8</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example: Band 1 = Red, Band 2 = Violet, Band 3 = Orange, Band 4 = Gold

The value of this resistor would be:

\[
2 \text{ (Red)} \times 7 \text{ (Violet)} \times 1,000 \text{ (Orange)} = 27 \times 1,000 = 27,000 \text{ ohms}
\]

Too many zeros?

Kilo ohms and mega ohms can be used:

\[
1,000\Omega = 1\text{K} \\
1,000\text{K} = 1\text{M}
\]

Resistor Identification Task

Calculate the resistor values given by the bands shown below. The tolerance band has been ignored.

<table>
<thead>
<tr>
<th>1st Band</th>
<th>2nd Band</th>
<th>Multiplier ( \times )</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>Black</td>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Blue</td>
<td>Brown</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>Grey</td>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>White</td>
<td>Black</td>
<td></td>
</tr>
</tbody>
</table>
Calculating resistor markings

Calculate what the colour bands would be for the following resistor values.

<table>
<thead>
<tr>
<th>Value</th>
<th>1st Band</th>
<th>2nd Band</th>
<th>Multiplier x</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 Ω</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,900 Ω</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47,000 (47K) Ω</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000,000 (1M) Ω</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>E-12 resistance tolerance (± 10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E-24 resistance tolerance (± 5 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>33</td>
</tr>
</tbody>
</table>
LEDs & Current Limit Resistors

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

An LED is a special diode. LED stands for Light Emitting Diode. LEDs are like normal diodes, in that they only allow current to flow in one direction, however when the current is flowing the LED lights.

The symbol for an LED is the same as the diode but with the addition of two arrows to show that there is light coming from the diode. As the LED only allows current to flow in one direction, it’s important that we can work out which way the electricity will flow. This is indicated by a flat edge on the LED.

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

To work out the best resistor value we need to use Ohms Law. This connects the voltage across a device and the current flowing through it to its resistance.

Ohms Law tells us that the flow of current (I) in a circuit is given by the voltage (V) across the circuit divided by the resistance (R) of the circuit.

\[ I = \frac{V}{R} \]

Like diodes, LEDs drop some voltage across them: typically 1.8 volts for a standard LED. However the high brightness LED used in the ‘white light’ version of the lamp drops 3.5 volts.

The USB lamp runs off the 5V supply provided by the USB connection so there must be a total of 5 volts dropped across the LED (V\text{LED}) and the resistor (V\text{R}). As the LED manufacturer’s datasheet tells us that there is 3.5 volts dropped across the LED, there must be 1.5 volts dropped across the resistor. (V\text{LED} + V\text{R} = 3.5 + 1.5 = 5V).

LEDs normally need about 10mA to operate at a good brightness. Since we know that the voltage across the current limit resistor is 1.5 volts and we know that the current flowing through it is 0.01 Amps, the resistor can be calculated.

Using Ohms Law in a slightly rearranged format:

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

Hence we need a 150Ω current limit resistor.
LEDs Continued

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

Packages

LEDs are available in many shapes and sizes. The 5mm round LED is the most common. The colour of the plastic lens is often the same as the actual colour of light emitted – but not always with high brightness LEDs.

Advantages of using LEDs over bulbs

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

- **Power efficiency**: LEDs use less power to produce the same amount of light, which means that they are more efficient. This makes them ideal for battery power applications.
- **Long life**: LEDs have a very long life when compared to normal light bulbs. They also fail by gradually dimming over time instead of a sharp burn out.
- **Low temperature**: Due to the higher efficiency of LEDs, they can run much cooler than a bulb.
- **Hard to break**: LEDs are much more resistant to mechanical shock, making them more difficult to break than a bulb.
- **Small**: LEDs can be made very small. This allows them to be used in many applications, which would not be possible with a bulb.
- **Fast turn on**: LEDs can light up faster than normal light bulbs, making them ideal for use in car break lights.

Disadvantages of using LEDs

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

- **Cost**: LEDs currently cost more for the same light output than traditional bulbs. However, this needs to be balanced against the lower running cost of LEDs due to their greater efficiency.
- **Drive circuit**: To work in the desired manner, an LED must be supplied with the correct current. This could take the form of a series resistor or a regulated power supply.
- **Directional**: LEDs normally produce a light that is focused in one direction, which is not ideal for some applications.

Typical LED applications

Some applications that use LEDs are:

- Bicycle lights
- Car lights (break and headlights)
- Traffic lights
- Indicator lights on consumer electronics
- Torches
- Backlights on flat screen TVs and displays
- Road signs
- Information displays
- Household lights
- Clocks
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 (\(\mu\)F), nano Farads (nF) and pico Farads (pF). A \(\mu\)F is a millionth of a Farad, 1\(\mu\)F = 1000 nF and 1nF = 1000 pF.

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 \(\mu\)F)

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

<table>
<thead>
<tr>
<th>Printing on capacitor</th>
<th>Two digit start</th>
<th>Number of zero’s</th>
<th>Value in pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>222</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>333</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>473</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Your sound meter is going to be supplied with some instructions. Identify four points that must be included in the instructions and give a reason why.

<table>
<thead>
<tr>
<th>Point to include:</th>
<th>Reason:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
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<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 fulfills 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.

<table>
<thead>
<tr>
<th>Good aspects of the design</th>
<th>Areas that could be improved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Reason</th>
</tr>
</thead>
</table>

Develop a packaging design for your product that meets these requirements. Use additional pages if required.
HOW LOUD WAS THAT NOISE? FIND OUT WITH THIS

SOUND METER 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.

PLACE RESISTORS

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

<table>
<thead>
<tr>
<th>PCB Ref</th>
<th>Value</th>
<th>Colour Bands</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>10K</td>
<td>Brown, black, orange</td>
</tr>
<tr>
<td>R2</td>
<td>1.5K</td>
<td>Brown, green, red</td>
</tr>
</tbody>
</table>

SOLDER THE IC HOLDERS

Solder the two Integrated Circuit (IC) holders into IC1 and IC2. When putting them into the board, be sure to get them the right way around. The notch on the IC holder should line up with the notch on the lines marked on the PCB.

SOLDER THE ELECTROLYTIC CAPACITORS

Now solder in the five electrolytic capacitors. Make sure that the capacitors are the correct way around. The capacitors have a ‘-’ sign marked on them, which should match the same sign on the PCB. The leads should be bent so that the capacitors end up flat on the board. The capacitors have text printed on the side that indicates their value. The capacitors are placed as:

<table>
<thead>
<tr>
<th>PCB Ref</th>
<th>Value</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 &amp; C2</td>
<td>1μF</td>
<td></td>
</tr>
<tr>
<td>C3 &amp; C4</td>
<td>10μF</td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>220μF</td>
<td></td>
</tr>
</tbody>
</table>

SOLDER THE CERAMIC DISC CAPACITORS

The two ceramic disc capacitors should be soldered into the board as follows:

<table>
<thead>
<tr>
<th>PCB Ref</th>
<th>Value</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5</td>
<td>10nF</td>
<td>103</td>
</tr>
<tr>
<td>C6</td>
<td>100nF</td>
<td>104</td>
</tr>
</tbody>
</table>

SOLDER THE TRIMMER POTENTIOMETRE

The trimmer potentiometer should be soldered into the board where it is marked R3.
The microphone should be soldered into the board where it is marked M1. The microphone is polarized (the two pins are off centre). For it to work the part must go inside the circle marked on the PCB.

**SOLDER THE MICROPHONE**

The ten Light Emitting Diodes (LEDs) should be soldered into the board. The LEDs won’t work if they don’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. You may want to solder them in at a specific height depending upon how you have designed your enclosure (if you are making one). LED1 to LED5 should be green, LED6 to LED8 yellow and LED9 and LED10 should be red.

**SOLDER THE LEDs**

The PP3 battery clip should be attached to the terminals labelled ‘POWER’. Connect the red wire to ‘+’ and the black wire to ‘-’ after feeding it through the strain relief hole.

**ATTACH THE BATTERY CLIP**

The two ICs can now be placed into the IC holders, when doing this make sure that the notches on the ICs line up with the IC holder.

**INSERTING THE IC INTO THE HOLDER**
Checking Your Sound Meter PCB

Carefully check the following before you insert the batteries:

Check the bottom of the board to ensure that:
- All holes (except the 4 large (3mm) 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 ‘-’ on the capacitors match the same marks on the PCB.
- The colour bands on R1 are brown, black, orange.
- C1 and C2 are a 1\mu F capacitor and C7 is a 220\mu F capacitor.
- C5 is marked 103.
- All of the LEDs match the outline on the PCB.
- The battery clip red and black wires match the red & black text on the PCB.
- The notch on the small IC is next to the LEDs and the notch on the large IC is next to C6.

Trimming the gain resistor (R3)

Turn the trimmer fully anti-clockwise. Then in a quiet room, slowly bring it back in a clockwise direction until just LED1 is left illuminated.
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 end of the battery clip to the PCB, either black to ‘−’ or red to ‘+’.

2

Solder the other end of the battery clip 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.
Start
Set the trimmer fully anti-clockwise, then power the board up

Do any LEDs light?
No
Yes

Were any LEDs missing?
No
Yes

Are all the LEDs now off?
No
Yes

Do the LEDs light with noise?
No
Yes

Are some or all LEDs dim?
No
Yes

Check
- The battery is good and in the right way around.
- Check the power clip is connected the right way around and soldered correctly.
- R3 for dry joints.
- IC1 for dry joints on pins 5 to 7.
- IC2 for dry joins or shorts on pins 2 to 9.
- For shorts on C2 or C7.
- For dry joints on C4.

Check
- IC1 pins 1 to 4 and 6 & 7 for shorts.
- IC1 for dry joints on pin 3/4.
- The notch on IC1 is next to the LEDs.
- C1 for a short.

Check
- IC1 pins 1 & 8 for dry joints.
- IC1 pins 5 & 6 for a short.
- C2 & C3 for dry joints.

Check
- R2 for dry joints and that it is 1.5K (brown, green, red).
- IC2 pins 7 & 8 for a short.
- IC2 pin 8 for dry joints.

Which LED was missing?
LED1 Is LED1, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 1.
LED2 Is LED2, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 18.
LED3 Is LED3, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 17.
LED4 Is LED4, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 16.
LED5 Is LED5, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 15.
LED6 Is LED6, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 14.
LED7 Is LED7, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 13.
LED8 Is LED8, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 12.
LED9 Is LED9, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 11.
LED10 Is LED10, backwards, shorted or has a dry joint?
Dry joint on IC2 pin 10.
Fault finding flow chart - page 2

* If the battery voltage is below 7V under load, only some of the LEDs will be lit and flickering won’t be seen. For testing an alkaline battery is recommended.

Are the LEDs flickering on & off?*

Yes

Turn the trimmer R3 clockwise until only LED1 is on.

No

Are the LEDs constantly on?

Yes

Check
- The notch on IC2 is next to the capacitor (C6).
- R3 for dry joints.
- IC1 pins 7 & 8 for dry joints.
- IC2 pin 5 for a dry joint.

No

Check
- C3 for shorts.
- C7 for dry joints.

Was this possible?

Yes

No

Check
- IC2 pins 5 & 6 for a short.
- IC2 pin 4 & 6 for a dry joint.

When there is a lot of noise do all LEDs light?

No

Check
- R1 for dry joints.
- C1 for dry joints.
- C4 for a short.
- C6 for dry joints.

Yes

Is LED1 very bright / discoloured?

Yes

There is a short on IC2 pins 1&2.

Look carefully, on power up did the LEDs light one at a time from LED10 down to LED1?

Yes

There is a dry joint on pin 9.

No

Stop

Is there still a problem?

No

Continued from page 1
Designing the Enclosure

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

- The size of the PCB (below, height including components = 9mm).
- How big the 9V PP3 battery is.

This technical drawing of the sound meter PCB should help you to plan this.

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 Sound Meter Works

The sound meter circuit uses a microphone to detect sound and then uses a number of LEDs to indicate the how loud the sound is.

First of all the sound is detected by the microphone. This is then fed into the LM386 op amp via capacitor C1. This capacitor removes any DC offset from the signal generated by the microphone. The op amp amplifies (increases) the signal to a level that can be used. This is because the signal from the microphone is very small. The gain of the LM386 in this circuit is 200 and is set by capacitor C3.

The amplified signal is then filtered again by capacitors C2 and C4, which remove any DC offset and high frequency noise.

The LM3914 chip then looks at the size of this signal and lights up the relevant number of LEDs. It does this by generating a 1.2V reference voltage. A proportion of this is then fed into 10 comparators (inside the LM3914). Each comparator, in turn, is fed with a slightly lower proportion of the 1.2V reference voltage. For example the first comparator will get the full 1.2V, the next 1.1V, the next 1.0V, etc. The comparators are also then fed the amplified signal from the microphone. If this signal is bigger than the comparators reference voltage, then the comparator turns on its LED. The louder the sound, the bigger the signal from the microphone and the more LEDs come on.

Resistor R3 is used to adjust the amount of signal fed to the LM3914 chip and can, therefore, be used to adjust the scale to the desired level.
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/2142](http://www.kitronik.co.uk/2142)

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