Kitronik

ESSENTIAL INFORMATION

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

CREATE YOUR OWN SPEAKER DOCK WITH THIS

DELUXE STEREO AMPLIFIER KIT

Version 1.0

Deluxe Stereo Amplifier Essentials

www.kitronik.co.uk/2180

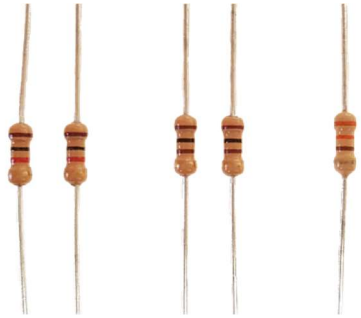
Build Instructions

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 SOLDER THE RESISTORS

Start with the five resistors. The text on the PCB shows where R1, R2 etc go.
Ensure that you put the resistors in the right place.
It does not matter which way round they go.
Once you are happy with them, solder in place.

PCB Ref	Value	Colour Bands
R1 & R2	1kΩ	Brown, black, red
R3 & R4	100Ω	Brown, black, brown
R6	330Ω	Orange, orange, brown



2 SOLDER THE CERAMIC DISK CAPACITORS

There are two ceramic disc capacitors (as shown right). These should be soldered into C1 and C2. It does not matter which way round they go.

3 SOLDER THE LED

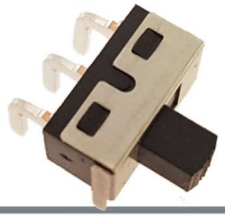
Solder the LED into the PCB where it is labelled LED1. When putting it into the board, make sure that the flat edge on the LED matches the outline on the PCB.

4 SOLDER THE ELECTROLYTIC CAPACITORS

Now solder in the three electrolytic capacitors (an example is shown right).
They should be soldered into C3, C4 and C5. Make sure that the capacitors are the correct way round. The capacitors have a '-' sign marked on them, which should match the same sign on the PCB.

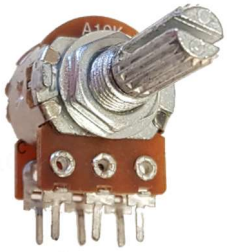
5 SOLDER THE SWITCH

Solder the PCB Mount Right Angled On / Off Switch into SW1. The row of three pins that exits the back of the switch must be soldered, but it doesn't matter if you can't solder the other two pins.



6 SOLDER THE DUAL POTENTIOMETER

Solder the potentiometer into the PCB where it is labelled R5. Make sure the volume knob is facing away from the PCB.



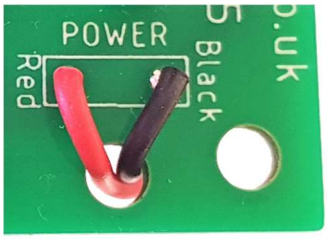
7 CONNECT THE SPEAKERS

The kit is supplied with a meter of twin cable. This cable will be used to connect the two speakers. You will need to cut this to the required length for each speaker in your enclosure design.

Take each piece of wire that you have cut off and strip the ends of the wire. Solder one end of each wire to the two terminals on the speaker (shown right). Solder the other end of each wire to the terminals on the PCB marked ‘SPEAKER1’ and ‘SPEAKER2’, after feeding it through the strain relief hole. It does not matter which way around these connections go.

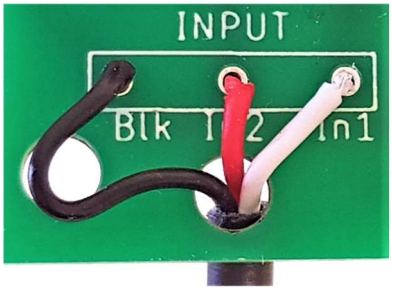
8 ATTACH THE BATTERY CAGE OR USB POWER LEAD

The power leads (from either the battery cage or the USB power lead) should be attached to the terminals labelled ‘POWER’. Solder the red wire to ‘+’ and solder the black wire to ‘-’ after feeding it through the strain relief hole.



9 CONNECT THE AUDIO CABLE

The stereo Jack lead should be soldered to the ‘INPUT’ terminal. First, feed the wires through the strain relief hole. The black wire should be soldered to the terminal labelled ‘BLK’. The other two can go the either of the two remaining inputs.



Checking Your PCB

Check the following **before** you insert the batteries:
Audio equipment may become damaged if connected to an incorrectly built amplifier.

Check the bottom of the board to ensure that:

- All holes (except the 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 four wires are connected to the right place (power, stereo input, 2 x speaker).
- The '-' on the electrolytic capacitors match the same marks on the PCB.
- The colour bands on R1 and R2 are Brown, Black, Red.
- The colour bands on R3 and R4 are Brown, Black, Brown.
- The colour bands on R6 are Orange, Orange, Brown.
- C1 and C2 match the outline on the PCB.
- The battery lead red and black wires match the red and black text on the PCB.
- The flat edge on the LED matches the outline on the PCB.

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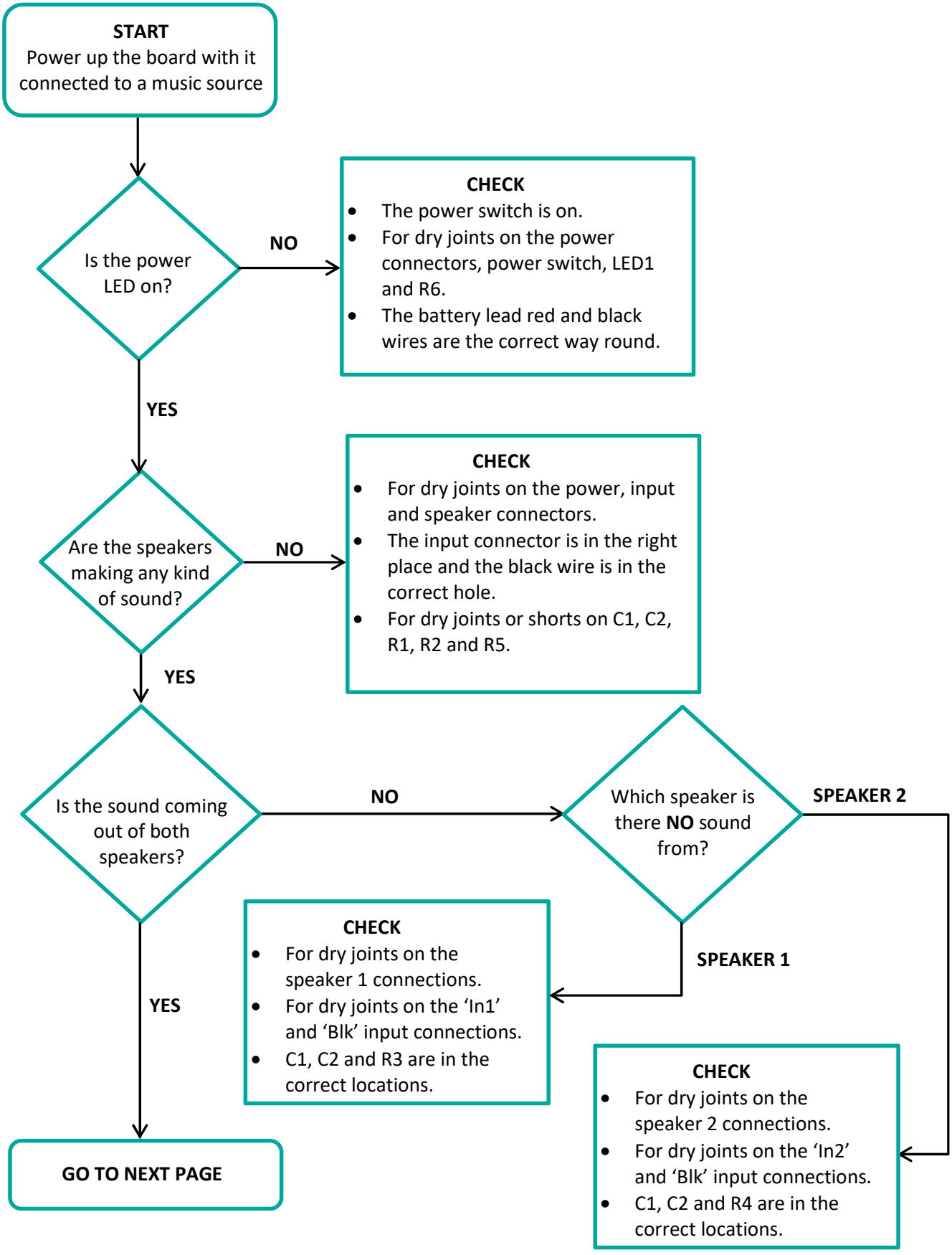
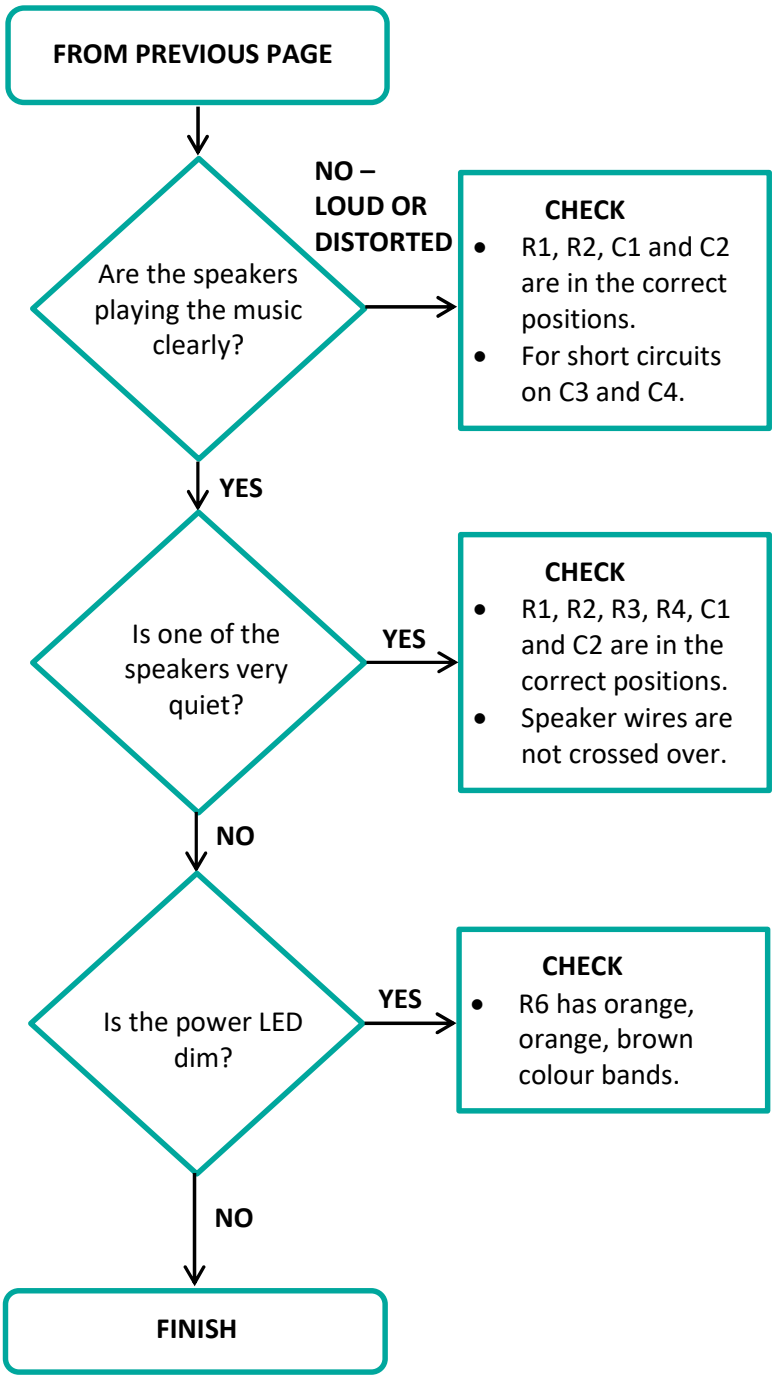


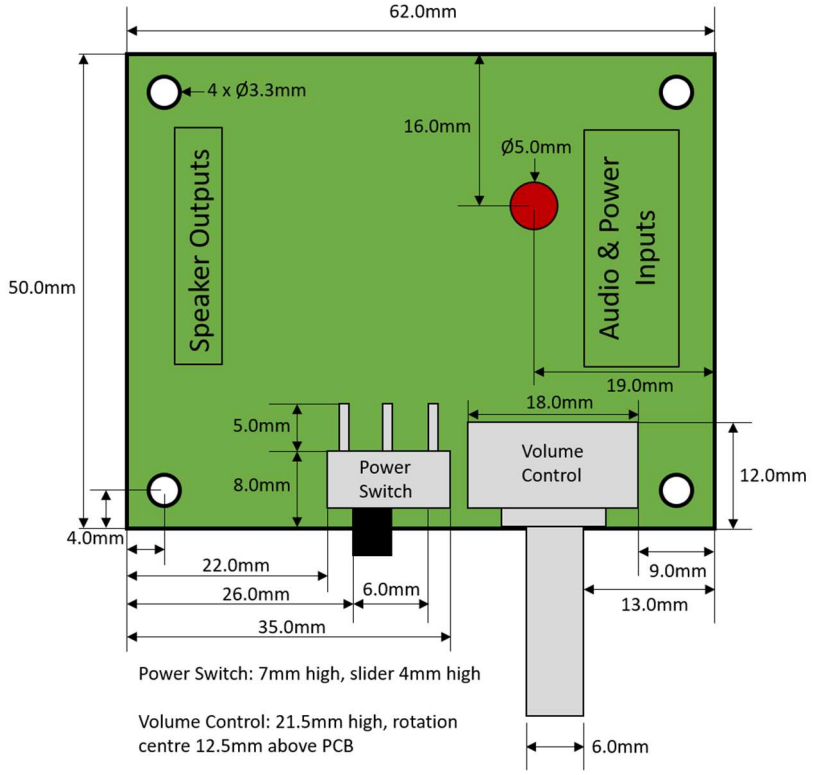

FROM PREVIOUS PAGE
Are the speakers playing the music clearly?
NO – LOUD OR DISTORTED
CHECK
R1, R2, C1 and C2 are in the correct positions.
For short circuits on C3 and C4.
YES
Is one of the speakers very quiet?
YES
CHECK
R1, R2, R3, R4, C1 and C2 are in the correct positions.
Speaker wires are not crossed over.
NO
Is the power LED dim?
YES
CHECK
R6 has orange, orange, brown colour bands.
NO
FINISH

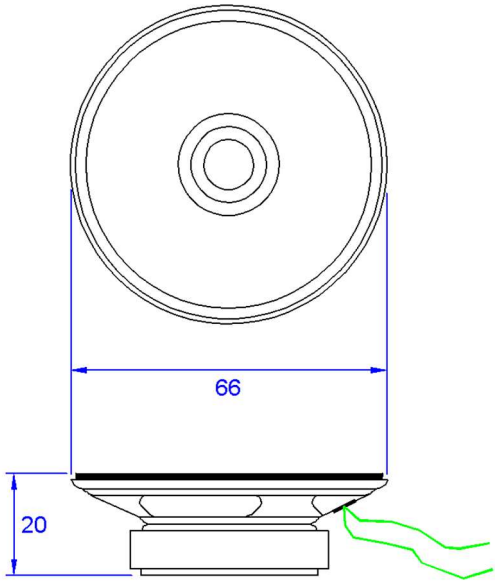
Designing the Enclosure

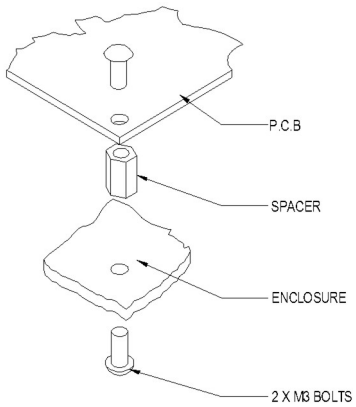
When you design the enclosure, you will need to consider:

- The size of the PCB (below left, height including components = 26mm).
- How big the batteries are.
- How to mount the two speakers (below right).
- How to allow the audio cable out of the box.
- Are you making the amplifier for a particular MP3 player, if so, should the MP3 player go in the box?
- Position of the volume control, switch and LED.

These technical drawings of the amplifier PCB and speaker should help you plan for this (all dimensions 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.

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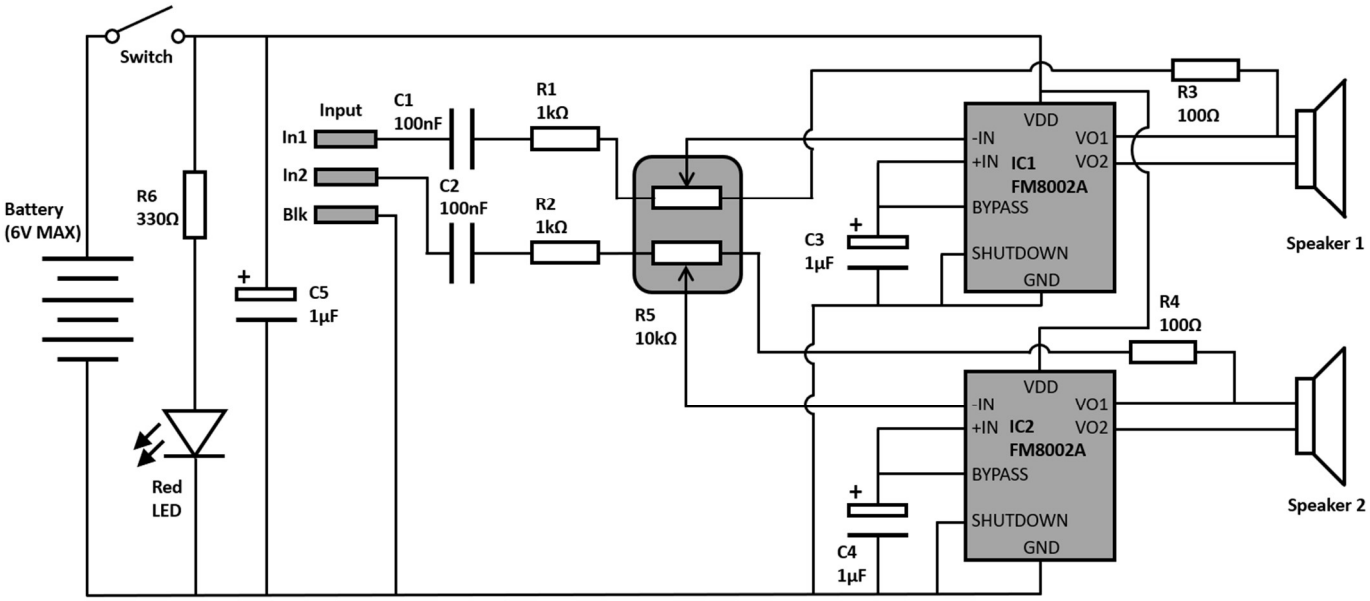
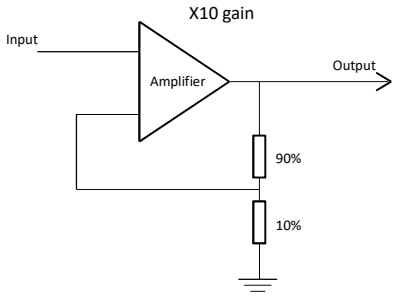
How the Circuit Works



The deluxe stereo amplifier circuit is comprised of two identical mono amplifier circuits, with one taking 'In1' as an input and then sending amplified audio out to Speaker 1, and the other taking 'In2' as an input and sending amplified audio out to Speaker 2. At the centre of each mono amplifier circuit is an audio amplifier Integrated Circuit or IC. Inside the IC 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 that 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. 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 amplifier's 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 inputs 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, it can be seen that the feedback path is via resistors R3 and R4, then through the potentiometer R5 (from VO1 to -IN on the FM8002A amplifier IC). To make the gain useful in our application, the variable potentiometer R5 can be used to adjust the ratio of the feedback to input resistors, which in turn varies the gain and therefore the output volume.

The gain of the amplifier is calculated using the following formula:

$$Gain = 2 \times \frac{R_f}{R_i}$$

Where Rf is the feedback resistor (R3 or R4 + part of R5), and Ri is the input resistor (R1 or R2 + part of R5). Therefore, the minimum and maximum gain of each mono amplifier section can be found to be:

$$Minimum\ Gain = 2 \times \frac{R3}{R1 + R5}$$

$$Minimum\ Gain = 2 \times \frac{100}{1000 + 10000}$$

$$\boldsymbol{Minimum\ Gain = 0.02}$$

$$Maximum\ Gain = 2 \times \frac{R3 + R5}{R1}$$

$$Maximum\ Gain = 2 \times \frac{100 + 10000}{1000}$$

$$\boldsymbol{Maximum\ Gain = 20.2}$$

C5 is connected across the supply to make sure that it remains stable. The other capacitors have a filtering role, either to cut out high frequency noise or get the best out of the speaker.

A power switch is inserted in the positive (+V) power line, which is used to turn the amplifier on and off. There is also a power LED that lights up when the power switch is on. R6 is used to limit the current flowing into this LED, which stops it drawing too much power, which over time will damage the LED.

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:

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This kit is designed and manufactured in the UK by Kitronik

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