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Table of Contents

Low cost – qualitative Hearing Aid

Introduction -

A very special note about human-ear is that humans do not posses control over activity of this vital organ. An incidental sound has to be heard by a human being unless she /he is sleeping or unconscious. Of course there are artificial ways, but natural. However, another fact is that everyone of us may have different capacities of listening to the same sound.

We range from people who can listen to even a slightest noise to people – completely deaf. This particular document intends to connect a technological solution (to this problem) and the socio-economical (and why not political) conditions in India (and like countries).

Scope of the problem

We observe at least two verticals to address. Our schooling system has to do numerous improvements when it comes to educational quality and then logistics.

A few other problems do exist, which may or may not be related. The vision and listening capacity of students, is another important set of capacities that contributes how a child learns and understands what is being demonstrated. A usual problem, we observe, is that the back benchers are often left out of the daily experience of learning. Many a times not being able to listen to the speaker causes these children to lose their interest, other reasons kept apart.

The other scenario is that of our elderly population that loses the hearing capacity largely due to the age factor. Our villages have another dimension that because of highly priced solutions they often do not chose the hearing aid or it becomes a life time job for them to earn a hearing aid. We have observed that not being able to listen to others makes these people suspicious about the situation and/or people around them.

What can be done?

For both the problems above (and we understand these are only representative examples), we propose a low cost, qualitative electronic device that will help our children and elderly people (and others) to resolve the situation to an acceptable extent. Under the moto of 'development through education' we encourage the readers to actually build the solution through schools and propagate the same to local areas.

The device

The circuit diagram explains how to build the electronic part of this device. However, before we study and/or make the device, let us have a look at a few basic concepts that we are going to ride upon during this journey.

Amplification -

A process of increasing the value (amplitude) of a given parameter such as voltage, current etc. We have always heard of Sound Amplifiers. Following diagram depicts the amplification of a 1V signal to a 5V signal. The device that does Amplification is an **Amplifier**.

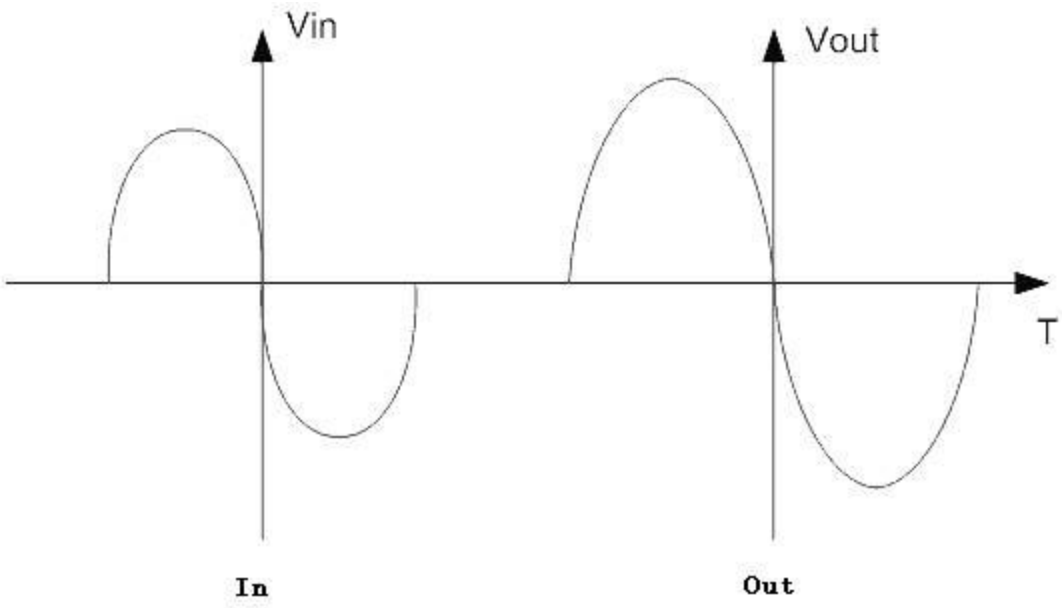
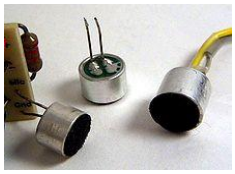


Fig. 1

Difference between the two waveforms shown above, is quite clear. While they have similar shape, there amplitudes are different. In an amplification process the original shape of the input waveform does not change, but the amplitude.



Microphone (mic) -

Fig. 2

Microphone is an electronic component that captures sound and converts the same to an equivalent electrical signal. Amongst the different types of microphones, the one that we are going to use is a condenser microphone, working principle of which is based upon a property called **capacitance**. As the sound waves are made incident onto the diaphragm of a condenser mic, capacitance between two plates changes (as the diaphragm moves to and fro) causing change in the output signal. This varying signal is a direct function of variations in the incident sound.

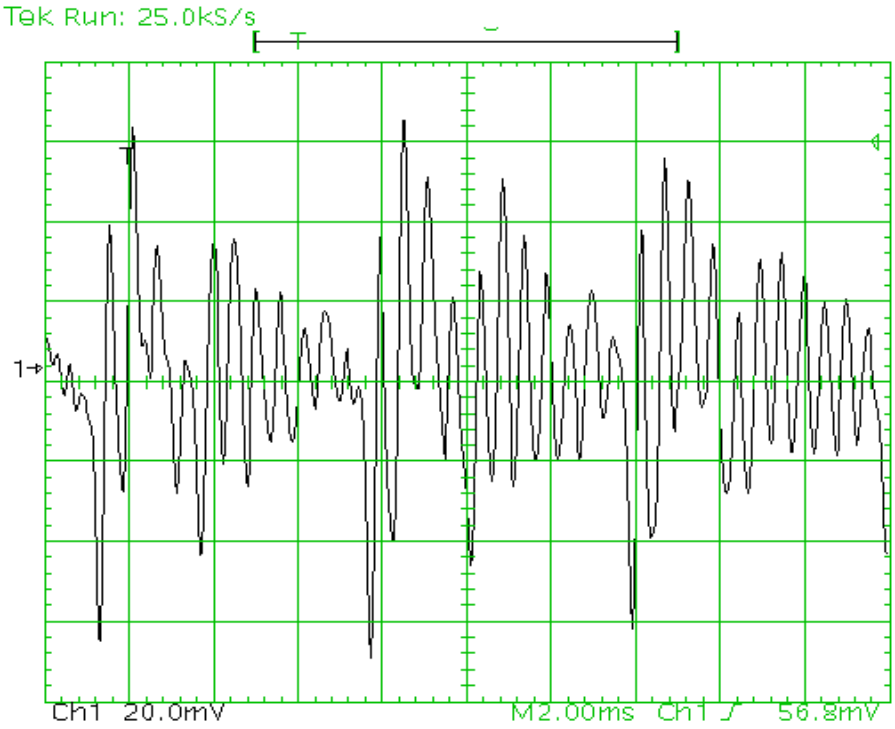
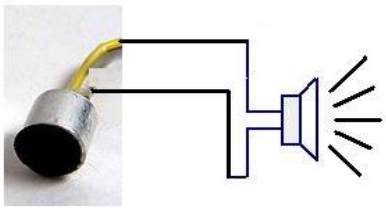
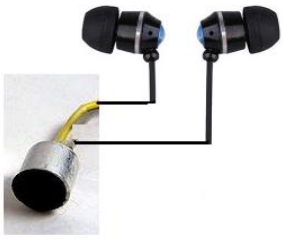


Fig. - 3

Figure 3 above shows the electrical equivalent of sound waves. An oscilloscope would show similar of different wave-pattens when output of a microphone is connected.

With this much introduction, let us move onto the actual device making up.





Following diagrams show possible interfaces that may seem to be working.

Fig. 4 - A

Fig. 4 - B

However, these kind of connections will not work even if the used components are the best one on market. A microphone produces electrical signals that are very low intensity and these electrical signals cannot make a speaker or even a headphone to sing for us. An amplifier can now be discussed.

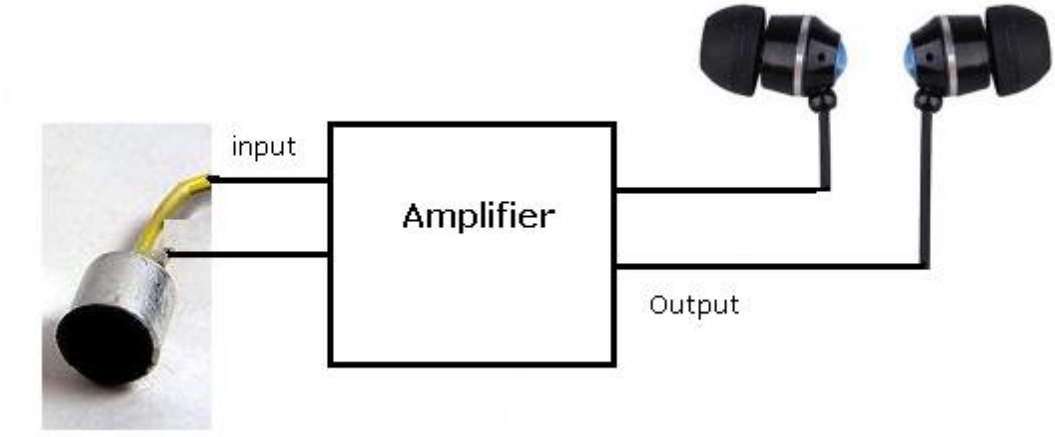


Fig. 5

A microphone must be connected to an amplifier and the output of amplifier is then to be fed to a headphone. An amplifier that can amplify a signal by around 100 times or even more needs to be designed in such cases. This 'times' is actually called as Gain of the amplifier.

Let us look inside an amplifier and also start building the hearing aid.

Design

An "Operational Amplifier" (Op amp) is a ready to use amplifier available of the shelf. Using an Op-amp one can build a complete circuit quite quickly and cost effectively. LM358 is the choice that we have made for our device. This is a popular one and cost effective (Rs. 7 or so).

This is an 8 pin IC, containing 2 independent Op-amps inside. In the world of musical instruments and tools, this one is a popular amplifier.

A circuit based on LM358 has been shown herewith. This has a gain of around 100.

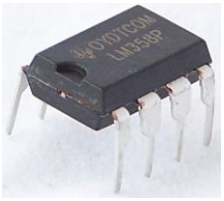


Fig. 6

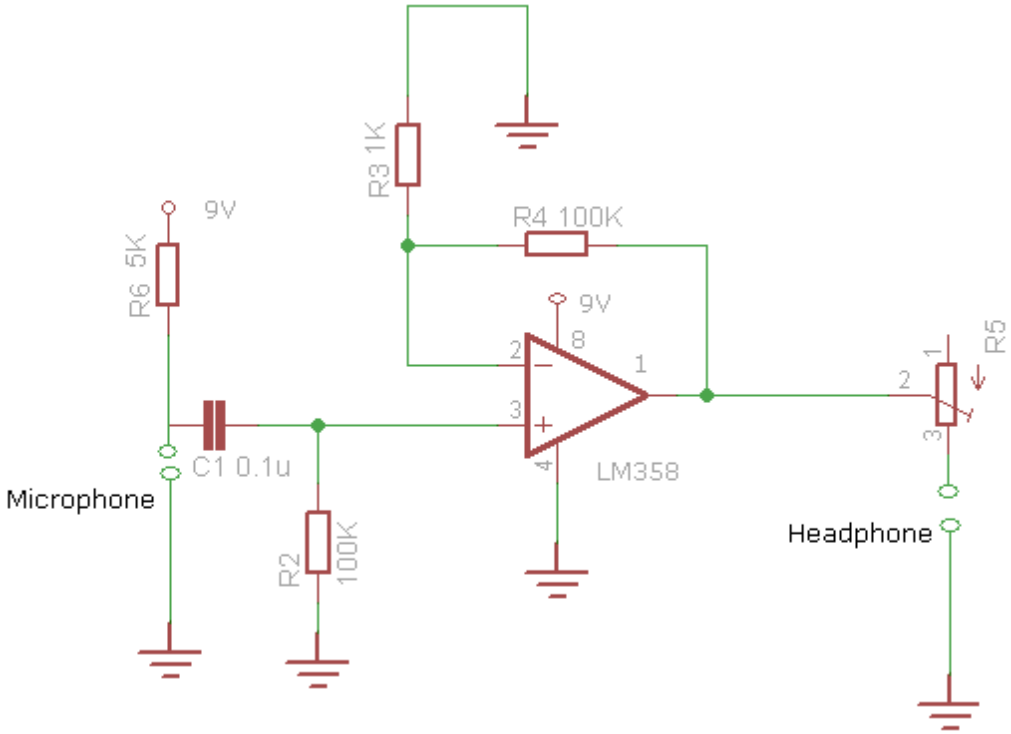
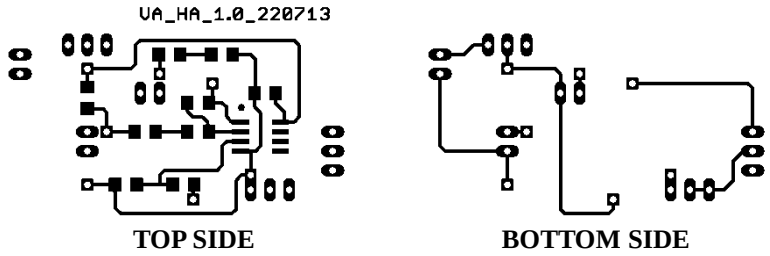


Fig. 7

PCB Board Files:



Please find the above Board files on the following link:

http://www.scribd.com/doc/160924524/Hearing-Aid-Board-File

Background

The diagram above uses the components based on a mathematical relationship. These relationships are always provided in the data-sheets of electronic components.

A fact (which we can validate is) that a microphone generates very weak signals – in the range of 20 mV or so. On the other hand a headphone requires something like 2V to sing.

Based on the information above, we now decide to design an amplifier with atleast a gain of 100. Fig. 7 depicts some electronic components, which can be talked about as follows -

- R6 – This resistor works as a current limiter for microphone. It avoids the microphone to be exposed to high current being released from the battery.
- C1 and R2, together form a filter that allows only AC signals to pass through and the DC signals (if at all present) are barred from going ahead. In the absence of this filter one might have to listen to a constant hum in addition to the signal of interest.
- R3 and R4 are the main players to decide the gain of the amplifier. They have been selected in such a way that the amplifier has a gain of 100. That means changing these would also change the gain. R3 and R4 are related to each other as per the equation given below -

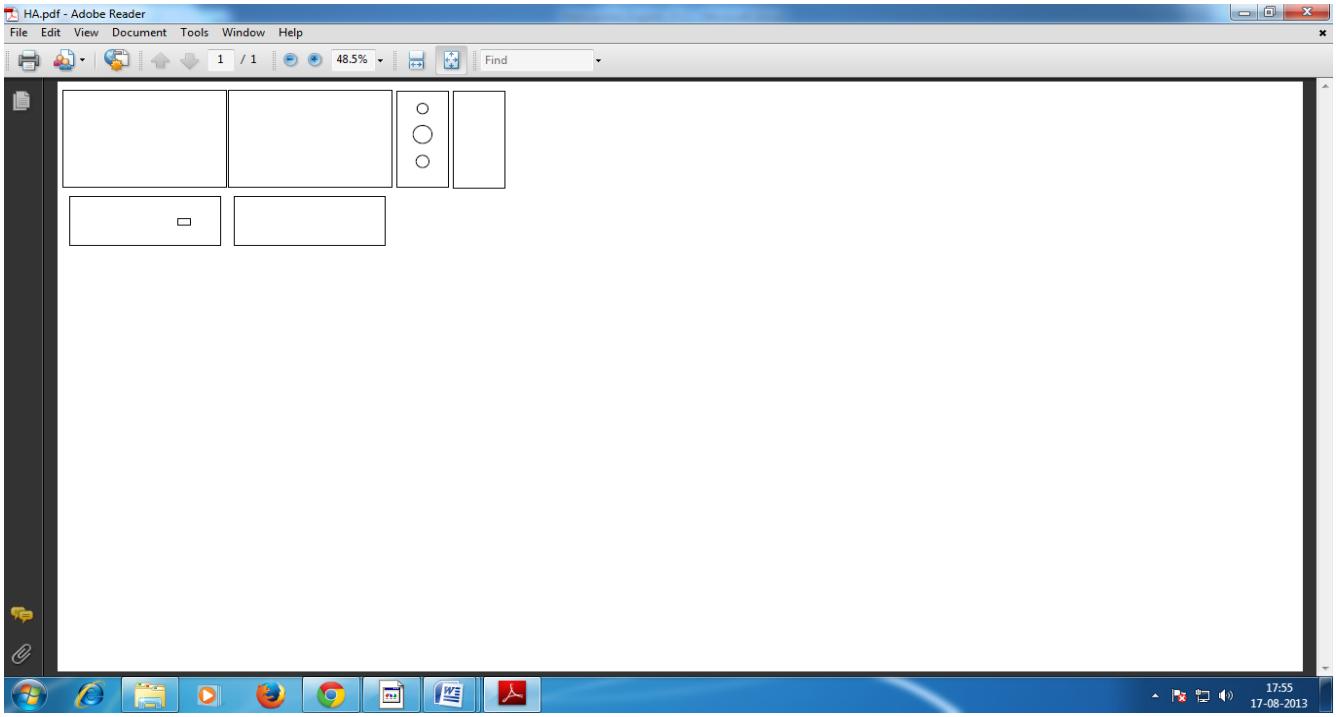
- Gain = 1 + (R4/R3) = 1 + (100KOhm/1KOhm) = 101
- R5 – This one is a variable resistor that allows the user to choose a right intensity of output volume. In short this works as the volume control.

Material list and tentative price

Componets	Quantity	Rate (Rs)	Price (Rs)
Electret Microphone	1	6	6
Headphone	1	50	50
Headphone Jack-F	1	15	15
LM358 IC	1	10	10
10 K Ohm	2	1	2
100 K Ohm	1	1	1
4.7 K Ohm	1	1	1
1 K Ohm	1	1	1
330 Ohm	1	1	1
10K Ohm (pot)	1	10	10
0.1 uF Cap.	1	0.25	0.25
0.1 uF Cap.	1	0.25	0.25
9V Battery (6F22)	1	10	10
Multistrand Wire	1 (m)	7	7
Double Sided PCB	1	15	15
Enclosure	1-Set(6 Cut Pieces)	100	150

Total ~ Rs. 279/-

Enclosure:



Please find the above enclosure files on the following link:

http://www.scribd.com/doc/160923265/Hearing-Aid-Enclosure

Scope ahead

This device is just a first version of a simple hearing aid. Our survey with people here at Papal, tells us a number of improvements to be made. A few are given below -

1. Possibility of Wireless headphone.
2. Increased sensitivity (which is a function of microphone as well as the gain of the amplifier).
3. Rechargeable power supply (preferably over solar power as most of the Indian parts have to undergo load shading at some point in time).
4. Better headphones that can fit into the outer-ear.
5. Better packaging (not only easy to handle but rugged enough to withstand weather conditions).

Propagation

We encourage the readers or enthusiasts to build this circuit and/or modify and try out around. If schools can take up this with the students then schools can be a center for appropriate solutions for society.

As per our studies this particular market is flooded with devices that are considerably unaffordable. Also, the problem of low hearing capacity is a common problem across globe, which takes a person towards complete deafness if not treated in time and supported accordingly.

References

1. http://www.slideshare.net/dheemanvaidya/hearing-aids-market-in-india-presentation
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3. https://www.national.com/ds/LM/LM158.pdf