Awaz-e-Buland : A Voice Amplification System
EE-241. Introductory Electronics Laboratory*

Nadir Shah Afshar, Muhammad Shah Rangeela and King Georga II
{9211001,9211002,9211003}@ee241.edu.pk

Oct 15, 1728

1 Summary.

In this project we propose to build an electronic system capable of amplifying faint sounds to those of audible quality. Such systems are extremely important in many applications where the human ear is not capable of directly perceiving very faint sounds. A basic sound amplification system is at the heart of many important devices such as hearing aids, spy microphones, speaker phones, audio recording & playback and so on. Systems built on the same principles include ultrasonic distance finders that can transmit and detect sounds above the audio frequency range; hydrophones that listen to sounds under water; active noise cancelation systems etc.. In this project, we will focus on building a device that raises human voice at the level of whispering to a level where it can be listened to by person close by. One can also think of it as a "speaking aid," whereby it can be used by patients who are old or weak enough to speak aloud.

2 Objectives and Requirements

The objective of this project is to build a portable device capable of amplifying human voice at the whispering level of $0 - 10$ dB to a loud audio at $50 - 60$ dB (See the appendix for a justification of these figures). Portability dictates that the device should be powered by its own battery (and not by a bulky lab power supply). The device should be as small and integrated as possible with provisions for connection to an external speaker or a headphone. Optional add-ons include a visual decibel meter for device calibration and monitoring.

3 Design Overview

In this project we will design different parts of a basic audio amplification system. We will demonstrate how to use a mic to convert sound into electricity; an amplifier to magnify the voltage of a feeble audio signal; and a speaker to convert the amplified signal back into sound. This design has been explained

*LUMS School of Science & Engineering, Lahore, Pakistan.

in various experiments outlined in [1]. A block diagram of the proposed design has been given in Figure 1. Below is brief description of each block.

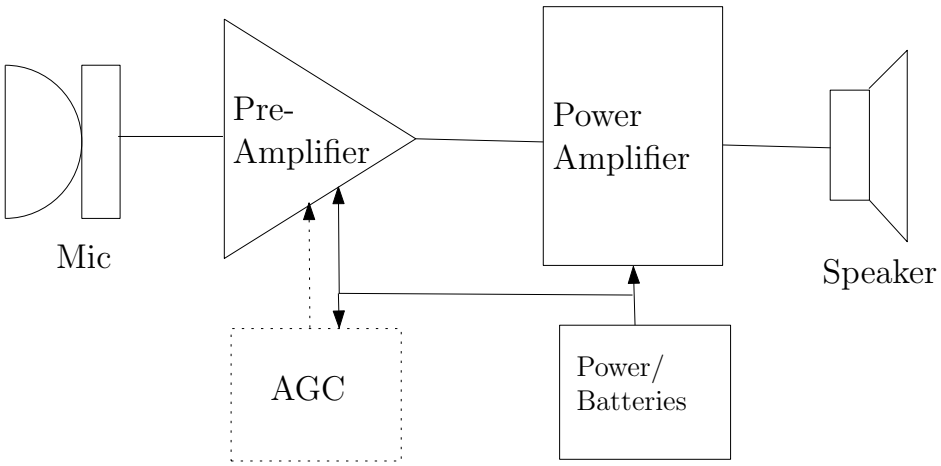

Figure 1: Block diagram of a complete sound system.

3.1 Microphone

The microphone is an electro-acoustic transducer that converts sounds into electrical signals. We will use one of the several types of microphone sensors available. In some types of microphones, a biasing circuit is also needed to operate the microphone. If required, this biasing circuit will also need to be designed.

3.2 Pre-Amplifier

The signal coming from the microphone is very feeble (on the order of a tens of millivolts). Since this signal is not strong enough to drive a speaker or a headphone directly, we will need to design an amplifier. The pre-amplifier will serve to amplify the voltage to a required level. Several options are available, including amplifiers made up of discrete transistors as well as OP-Amps. We will try several configurations and come up with an appropriate design.

3.3 Power Amplifier

If the signal coming out of the pre-amplifier is not strong enough to drive the speakers directly, we will need to design a power amplifier. At this time, we anticipate that this will be a very complex circuit and we do not consider it within our capability to design it completely. Therefore, if such a stage is needed, we will use a single-IC solution solution to meet the requirements.

3.4 Speakers

Speakers of appropriate power and impedance will be used. The circuit will also have provision to connect to a headphone for private hearing.

3.5 Power supply and other peripherals

Since the device needs to be portable, we will design an on circuit power supply. Normal Ni-Cd batteries will be used to power up the circuits. If there is a need to use different reference voltages, we will use different single IC voltage regulators for this purpose. The device will also have appropriate connectors for hooking up with external speakers, microphones or other peripherals. Also, the circuit will have control knobs to adjust the volume for comfortable listening.

3.6 Optional and Unknown

We do not yet know if the proposed design will be stable enough for regular use. If there are any stability issues, we may need to design and incorporate an automatic gain control unit (AGC). Also, if time and budget permits, our team will look into the feasibility of adding a sound intensity or decibel meter to the device. At this stage, we do not promise this as part of our deliverables.

4 Project Deliverables

1. A complete portable system running on its own power with tight integration and stable assembly.
2. Provisions for debugging and enhancement to the design.
3. Appropriate controls for turning the device on and off and making appropriate volume control.
4. Final demo will be ready for of demonstration of waveforms at various stages, proof of amplification, and a justification of design parameters.

5 Project Plan

The project will be carried out in the following steps.

1. Microphone selected and its biasing circuit designed and tested on a bredboard. Speakers of appropriate quality and performance will be selected. Together, they will generate requirements for the amplifier.
2. Pre-amplifier designed and simulated on PSPICE. Its performance curves traced and time-frequency responses studied on a bredboard.
3. If needed, the power amplifier IC is selected. It is independently tested on a bredboard using manufacturer's data sheets.
4. Full prototype assembled and tested on bredboard. Performance verified. Appropriate debugging points are marked and included in the design. If the required performance is still not achieved, the design is revisited.

5. Power module is designed and tested.
6. Circuit PCB is designed and etched. The etched design is verified for continuity and fidelity.
7. Circuit is soldered on the PCB. Tests are run on the assembled board and comparisons are made to prototype.
8. Circuit housed in proper assembly and box.
9. Performance results are documented for future reference.

References

[1] Y. Tsividis, *A first lab in circuits and electronics,* John Wiley & Sons, 2002.

[2] Laboratory for Cyber Physical Systems, `http://cyphynets.lums.edu.pk/index.php/EE-241`.

[3] *Encyclopedia Encarta*, 2005.

A Sound Intensities

For reference and comparison, a list of sound intensities [3] is given below.

dB	Type
0	Threshold of hearing
10	Rustle of leaves, a quiet whisper
20	Whispering
20-50	Normal conversation
50-65	Loud conversation
65-70	Traffic on a busy street
65-90	Train
75-80	Factory noise
90	Heavy traffic
90-100	Thunder
110-140	Jet aircraft takeoff
130	Threshold of pain
140-190	Rocket takeoff