HIGH SENSITIVITY AUDIO RECEIVER

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To my dearest parent

Mohad Kamil bin Abd Halim and Mariana binti Ibrahim

and all my siblings

To my respected project and academic advisor

Assoc. Professor Abdul Rani bin Othman

"Thank you very much for all the attention and advice through my final year project"

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ABSTRACT

This thesis presents the development of High Sensitivity Audio Receiver. The project consists of a parabolic reflector, audio amplifier with 100dB voltage gain, microphone and speaker. This project is designed to capture voice signal from the distance of 20 meters. With the help of parabolic reflector and high gain amplifier, the voice signal from 20 meters can be hear clearly and suitable for application on science research.

ABSTRAK

Tesis ini membentangkan kajian dan penambahbaikan terhadap Penerima Bunyi Bersensitivi Tinggi. Projek ini terdiri daripada reflektor berbentuk parabola, amplifier audio dengan gandaan voltan sebanyak 100dB, mikrofon dan speaker. Projek ini direka untuk menangkap isyarat suara dari jarak 20 meter. Dengan bantuan reflektor berbentuk parabola dan amplifier bergandaan voltan yang tinggi, isyarat suara dari sumber 20 meter boleh didengar dengan jelas dan sesuai untuk aplikasi kajian sains.

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CHAPTER I

INTRODUCTION

1.1 Background

Nowadays, there are a lot of applications that involve with audio signal and as we know that a lot of our activities will play around with audio signal. When we say about signals it should have receive and transfer medium either in wired medium or wireless medium. Transmitter is the source of the signal and the receiver is the receive tool that will deliver the signal to the desired application. So the main parts of a communication system that closed to human application are the receiver part [1].

There is various type of audio receiver. An audio receiver system implement with microphone as input signal followed by amplifier to amplify then speaker as the output of audio signal. In order to receive the good audio signal is to focus the audio signal into one point [2]. This means that the audio signal have a high intensity and make it easier to be amplify by the amplifier. To focus this audio signal into one point, we can use the help tool known as reflector. There are a various type and shape of reflector such as square, rod, parabolic, and so on. The best is the parabolic shape of reflector since it is has a very accurate point that it can focus [2]. A parabolic surface has the interesting ability that all sound waves that disseminate parallel to its central axis travel the same distance to get to its focus. That means that when we aim the dish at a distant sound source, all the

sound bounces off the dish and converges towards the focus in phase, with its pressure peaks and troughs synchronized so that they work together to make the loudest possible sound vibrations. The sound is thus enhanced at the focus, but only if it originated from the source you are aiming it at [3].

The microphone with parabolic reflector is also known as the parabolic microphone or audio receiver with parabolic reflector. This type of instrument usually use by the military division since it can capture sound from long range and this can make them able to get confidential information without being known. For military, this gadget has a lot different sizes and this determine the different range of hearing. After a few decades after this technology being used by military, it has been open for surveillance use and has been use by the spy team which is to help on their spy jobs. Usually spies use this audio instrument because of the same purpose as the military but the capture sound range is not the as the military [1]. However, it still have a higher price on market and not affordable for all. So an invention like this type of audio receiver can be made to have a lower cost so it can be use by people to help people to do their research. So parabolic microphone can be use by zoologist to do research on animal habitat that hard to reach such as birds and also can be use by rescue team in case such as earthquake; to find human under the ruins by detect the sound of human that searching for help. The basic block diagram for audio receiver is as follows:

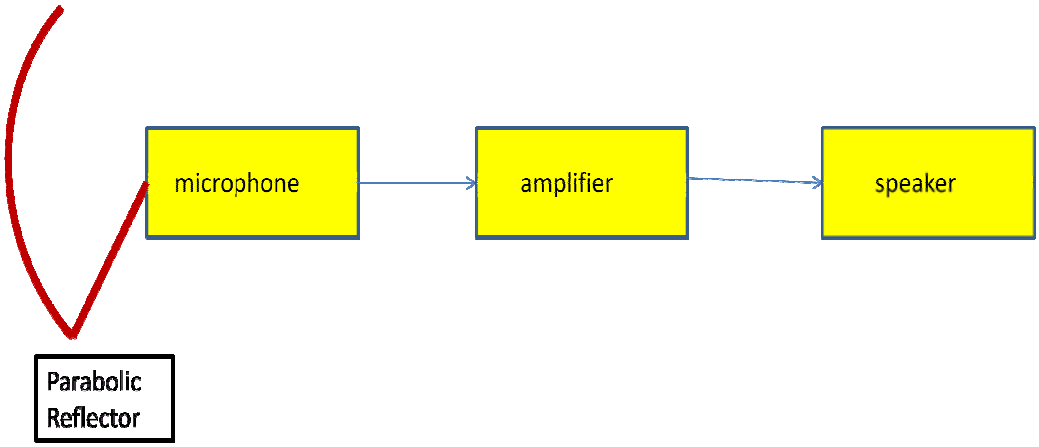

Figure 1.1 – Basic Audio Receiver block diagram

1.2 Problem Statement

A regular audio receiver (microphone) has a short range of sound that can be captured; about 5-10m [2]. Sound from long distance of source is hardly to be capture using regular microphone as the sound power drops significantly in longer ranges. This sound range and sound intensity that can be capture can be improve by the help of parabolic reflector.

1.3 Objectives

The objectives of this project are:

- To design and develop a high gain of audio amplifier (almost 100dB)
- To increase the range of voice signal receive by an audio receiver (20 meters).

1.4 Scope of Work

At first, the scope of this project is to study and determine on how to design the best amplifier that has a very high gain. The research will involve on choosing the suitable op-amp and stages of amplifier. Then the scope will continue on choosing the best parabolic reflector and this will involve on choosing the best type, size, and material of the reflector. Next, the microphone will be chose to suit the amplifier; the most sensitive microphone will be chosed. Then all the equipment will be assembled in appropriate way and the research continue to investigate the range of sound that can be capture by the system (high sensitivity audio receiver).

1.5 Organization of the Thesis

The structure of this project report was planned to provide a clear explanation about the project entirely. This thesis is divided into five chapters.

Chapter One is about background, problem statement, objectives and scope of work.

Chapter Two provides the literature review on op-amp use for amplifier, parabolic reflector type and type of microphone.

Chapter Three involve on details of the methodology during the amplifier design, parabolic and assembly of all the equipment.

Chapter Four is about discussion and analysis on the results that obtain on simulation and actual result of the whole instrument.

Lastly, in **Chapter Five** there is the conclusion and some recommendation on the project; which part can be corrected or improve in order to get better result in future.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

In this chapter, the author will discuss about the whole part of this high sensitivity audio receiver using parabolic reflector. This chapter will consist of all the main electronics parts for the amplifier design, parabolic reflector theory and about microphone.

2.2 About high sensitivity audio receiver (parabolic microphone)

A parabolic microphone is a device or instrument that has a capability to hear or record the vocalization of sound from substantial distance. This type of microphone is actually consists of a sensitive microphone, amplifier and parabolic reflector. The microphone must be the most sensitive microphone that can detect small amount of sound then will be transfer to the amplifier that will amplify the sound. Before the microphone can detect the sound, all the sound has been capture by the parabolic and reflect to the microphone which located at the focal point of the parabolic microphone [1]. When the dish is aimed at a distant sound source it can be assume that all the sound waves from the source to the dish are parallel to the central axis of the dish. Therefore, a sensitive microphone placed at the focus point will receive an enhanced signal level.

2.3 Amplifier

Amplifier is a device that used to amplify the amplitude of signal and usually amplifier is used to make amplitude signal become higher. For sound signal, if the amplitude of sound signal is increased, the sound will be louder. Amplifier will increase the amplitude of sound depends on the gain of the amplifier. The voltage gain is:

Voltage gain, Av = 20 log (Vo/Vi)

The design of the single stage amplifier will consist of one transistor or one op-amp. A single stage amplifier also will produce a high voltage gain but in order to get the high input impedance, we need to use multistage and multistage is the best design in the fulfill of desired amplifier design in industry [5].

2.3.1 Deciding the amplifier using BJT or FET

BJT is bipolar junction transistor and it has two types of BJT which is PNP and NPN. Nowadays NPN is widely use for designing an amplifier since it is more suitable for daily use. BJT has 3 terminals that work with it which is base, emitter, and collector. These three terminals will contribute on the biasing of the BJT. The direct-current bias for base will work with the given collector current. If there any changes at the collector current, the original bias is no longer correct. The commonly used type of transistor is the germanium type s it will changes with temperature, a circuit is need that can turn automatically change the bias when collector current changes. When the appropriate direct-current bias points are chosen, then the signal or alternating-current operation can be analyzed. The cause that related to the gain of transistor amplifier are the amplification factor of the particular type of transistor, the input and output impedance of the stages and the method of coupling stages. Figure 2.1 below show the structure and the electron flow of a BJT [4].

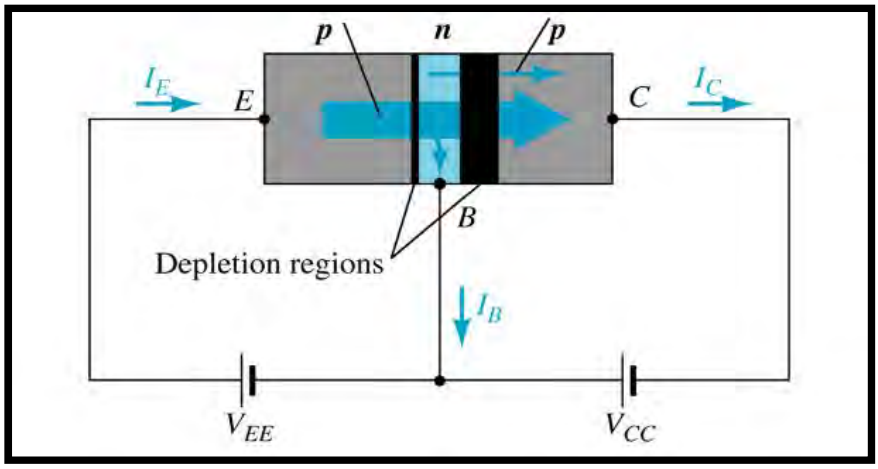

Figure 2.1- BJT

FET is a feel effect transistor; FET is slightly different from BJT and FET use different principle from BJT. FET depends on electric field to control the channel conductivity in the semiconductor material. The parts inside FET are like Figure 2.2 below:

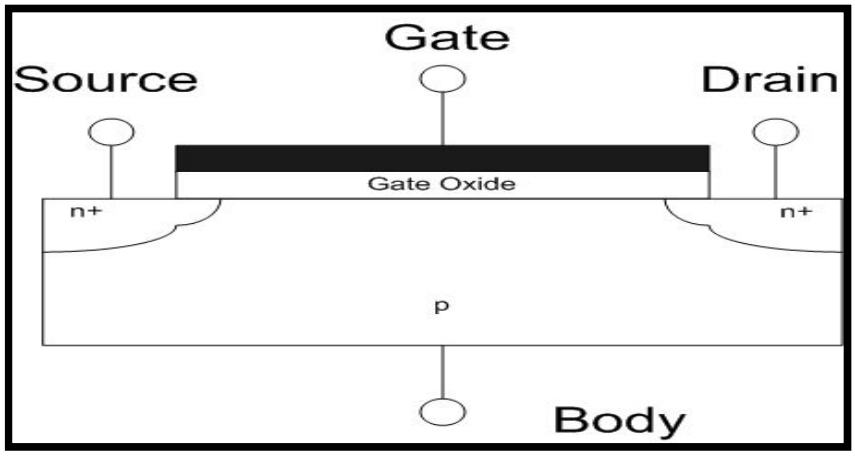

Figure 2.2 – FET

As a conclusion, the most suitable transistor for the audio amplifier is the BJT. There are a lot of advantages using BJT compare to FET and Table 2.1 below shows the comparison.

Table 2.1 – comparison of BJT vs. FET

	Bipolar Junction Transistor (BJT)	Feel Effect Transistor (FET)
Control	Based on voltage control	Based on current control
Switching speed	Fast switching speed	Slower switching speed
Voltage gain	High voltage gain	Low voltage gain
Cut-off Frequency	Higher cut-off frequency and higher maximum current	Lower cut-off frequency than BJT

BJT transistor has been chose for the high gain audio amplifier for this project.

2.3.2 Op-amp

Op-amp is an operational amplifier and op-amp is widely used nowadays in order to design audio amplifier. For this high sensitivity audio receiver, the amplifier is designed by using the op-amp. There is a lot of op-amp in the market and it depends on our design and chooses the best type of op-amp. An operational amplifier or op-amp is a very high gain differential amplifier with high input impedance and low output impedance. Common uses of operational amplifier are to provide a voltage amplitude change, oscillators, filter circuits and many types of instrumentation circuits. The internal circuit of op-amp is consisted of a connection of BJT and all the connection has been built in a single op-amp [6]. Figure 2.3 shows the internal circuit of one of the op-amp in that commonly used.

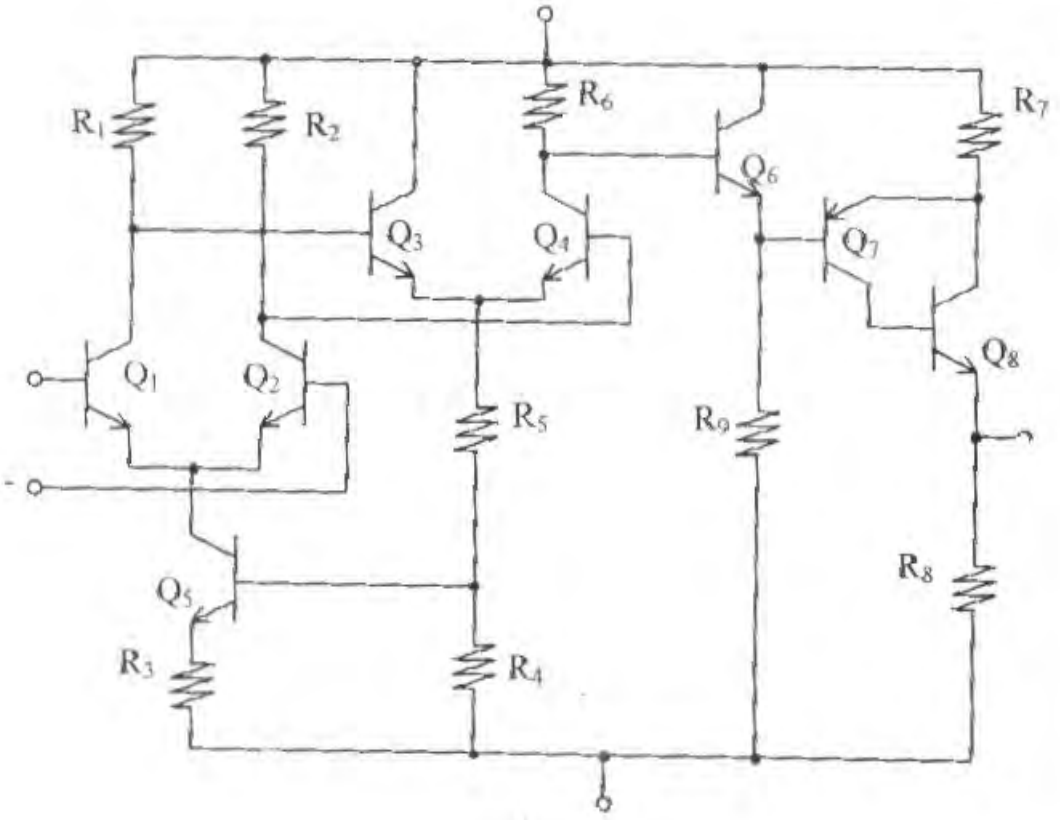

Figure 2.3 – internal circuit of Op-amp

For other definition, "operational amplifier is a very high gain integrated circuit amplifier with two high input terminals and one low impedance output" [7]. Figure 2.4 shows the basic op-amp symbol.

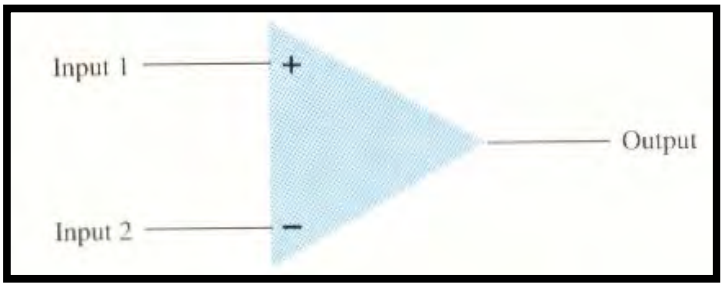

Figure 2.4 – op-amp basic symbol [6]