EE 313 Analog Laboratory Proposal Report

Optical Wireless Communication System: Photophone

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I. INTRODUCTION

In this project, our aim is to transmit an audio signal with the help of an optical transmitter module. To achieve this, we divided the project into two parts, transmitter and receiver. In our design, we included some special circuit designs such as low-pass and high-pass filters, automatic gain control circuit and power amplifier to drive the speaker. In this report, specifications, components and the stages of the project will be explained briefly.

II. SPECIFICATIONS AND COMPONENTS

Specifications:
Bandwidth of the band-pass filter: 300Hz – 3.5kHz
Frequency of the reference signal: 15kHz
Optical transmitter: Infrared LED
Optical receiver: Photodiode

Components:
Resistors
Potentiometers
Capacitors
BJTs
Diodes
Op-Amps
Breadboards
Infrared LED
Photodiode
Common Cathode RGB LED
Microphone
Speaker

III. CIRCUIT STAGES

Our project consists of two parts which are transmitter and receiver.

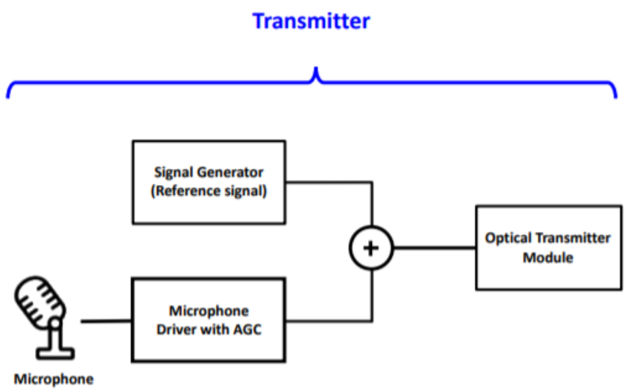

Figure 1: Transmitter part of the project

As can be seen in Figure 1, firstly, in the transmitter part, we need to convert our speech signal to electrical signal, and we must do this with an electret (resistive) microphone. The resistance of the electret microphone changes with the intensity of the sound signal. According to these changes, we can send information to the other part of the circuit.

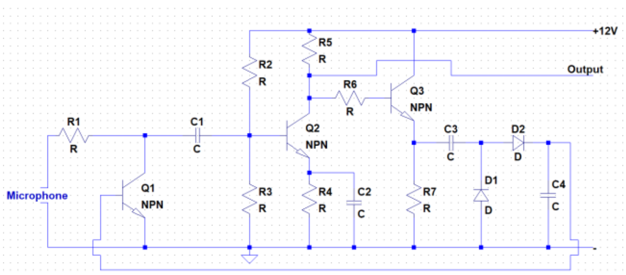

Figure 2: Circuit schematic of AGC circuit

Because the output of the microphone depends on the distance and the frequency, we need to use Automatic Gain Controller to obtain a constant output voltage. The Automatic Gain Controller circuit can be seen in Figure 2.

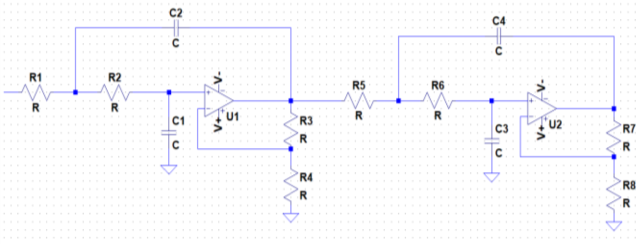

Figure 3: Two staged Sallen-Key low-pass filter

Frequency range of human voice is from 80Hz to 14kHz, but Narrowband telephony uses the frequencies less than 3.4kHz. Therefore, we need to use lowpass filter for the narrowband after the microphone. We decided to use a two staged Sallen-Key lowpass filter as shown in Figure 3.

Afterwards, by generating a high frequency, constant amplitude reference signal with the signal generator, we will sum our signal with this reference signal with the help of a summing amplifier, and we will transmit this summed signal with infrared LED.

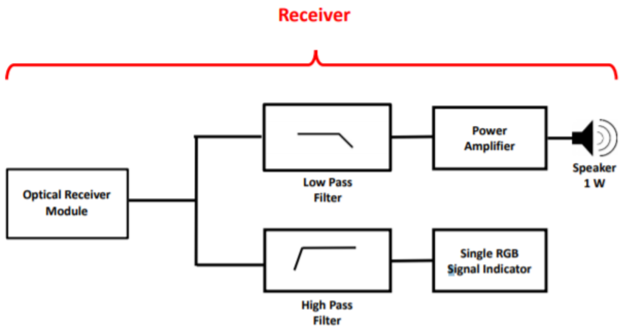

Figure 4: Receiver part of the project

At the receiver part of our project, we will determine the strength of our signal as can be seen in Figure 4. In this part, we will convert light signal to electrical signal with the photodiode.

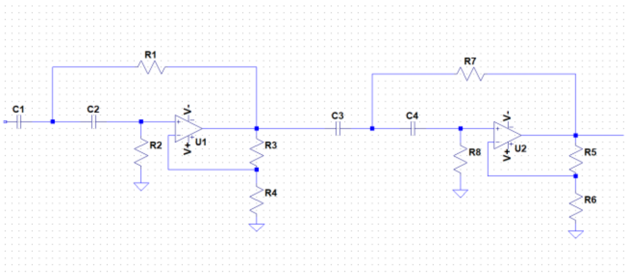

Figure 5: Two staged Sallen-Key high-pass filter

At the output of the optical receiver module, we will have the summed signal. In order to split this signal into high and low frequency parts, we need to use high-pass and low-pass filters. For the low-pass filter, we will use again two staged Sallen-Key low-pass filter that we have used in the transmitter part. For the high-pass filter, we will use two staged Sallen-Key high-pass filter which can be seen in Figure 5.

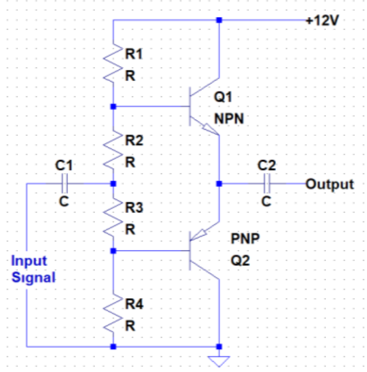

Figure 6: Circuit schematic of the output stage

After the low-pass filter, we need to use power amplifier to drive the speaker. Incoming signal should not be clipped. To buffer our signal, we will use power transistors and an output stage which is shown in Figure 6.

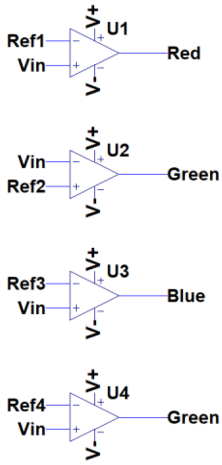

Figure 7: RGB Signal Indicator part

After the high-pass filter, we need to determine the intensity of the incoming reference signal. After determining its peak value, we compare it with four different reference voltages as can be seen in Figure 7. Our aim is to light the RGB in a different way in all five cases. We used a common cathode RGB, so the according light will be displayed if the voltage is positive. According to this design, green will light if the voltage is less than Ref2 or higher than Ref4, red will light if the voltage is higher than Ref1, and blue will light if the voltage is higher than Ref3. This way, the RGB will display different colors for different cases as can be seen in Table 1.

	Ref1	Ref2	Ref3	Ref4
Green	Green			Green
	Red	Red	Red	Red
			Blue	Blue

Table 1: The colors of the RGB for different cases

IV. CONCLUSION

We made a lot of research during the making of the project to solve the filtering and transmission via light problem. In the filters, we tried to eliminate the unwanted frequency bands as could as possible. While designing the project, we made use of the special circuit designs that we have learned in the laboratory sessions. Also, the RGB signal indicator part required a simple logic design to light the RGB by using as few components as possible. In conclusion, this project was a good chance to learn about transmission via light, automatic gain control unit and amplifier design.