**Phototransistor**

At the receiver part, we decided to use a phototransistor to detect the incoming light. Phototransistor can be considered as a BJT whose base voltage is controlled by light. Therefore, we can convert light to electrical current by using a phototransistor as in Fig x.

(Fig x)

**LPF, HPF**

After the convertion of light to current, we have both audio signal and reference signal. To obtain audio signal from the current, we decided to implement 3rd stage Butterworth Filter [x] with cut-off frequency at 3.5 kHz. To obtain reference signal, we decided to use the same circuit with capacitors and resistors are interchanged to use it as high-pass filter. The schematics of the filters are shown in Fig x. below.

(Fig x)

The output of the low-pass filter will be sent to the speaker through the power amplifier, and the output of the high-pass filer will be used for RGB led signal indicator.

**RGB Signal Indicator**

The colors we decided to use are shown in the Table x.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Signal Level** | **Color** | **R pin** | **G pin** | **B pin** |
| **1** | No Signal | - | 0 | 0 | 0 |
| **2** | Weak Signal | Red | 1 | 0 | 0 |
| **3** | Moderate Signal | Yellow | 1 | 1 | 0 |
| **4** | Good Signal | Green | 0 | 1 | 0 |
| **5** | Excellent Signal | Blue | 0 | 0 | 1 |

To determine the signal level, we decided to use 4 comparator circuit each compares the amplitude of the signal with a reference value. Each comparator has a positive output voltage if the amplitude of the signal is higher than the reference signal, and negative or 0 output if not. The red pin has positive voltage for the 1st and 2nd range, so that we feed the pin by the output obtained by substracting the 3rd comparator’s output from the 1st comparator’s output. Similarly, the green pin is fed by the output obtained by substracting the 4th comparator’s output from the 2nd comparator’s output. The blue pin is directly connected to the output of the last comparator. The overall circuit schematic is shown in Fig x.

(Fig x)

The output of the 1st comparator will be connected to gate terminal of a NMOS which is connected to the speaker in order to turn on the speaker if the received signal is higher than a threshold value.

**Clipped Indicator**

We decided to use a comparator at the end of the power amplifier to check whether the audio signal is clipped or not. We will connect 11.5-12 V to the negative terminal of the comparator and peak detecter which is used to get the amplitude of the audio signal to the positive terminal of the output. If the audio signal is clipped, the comparator has positive output voltage and the LED which is connected to the output of the comparator will be indicating clipping.