EE 164 PROJECT:

Laser Pointer Communicator

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E.E. 164 Fiber Optics Communication
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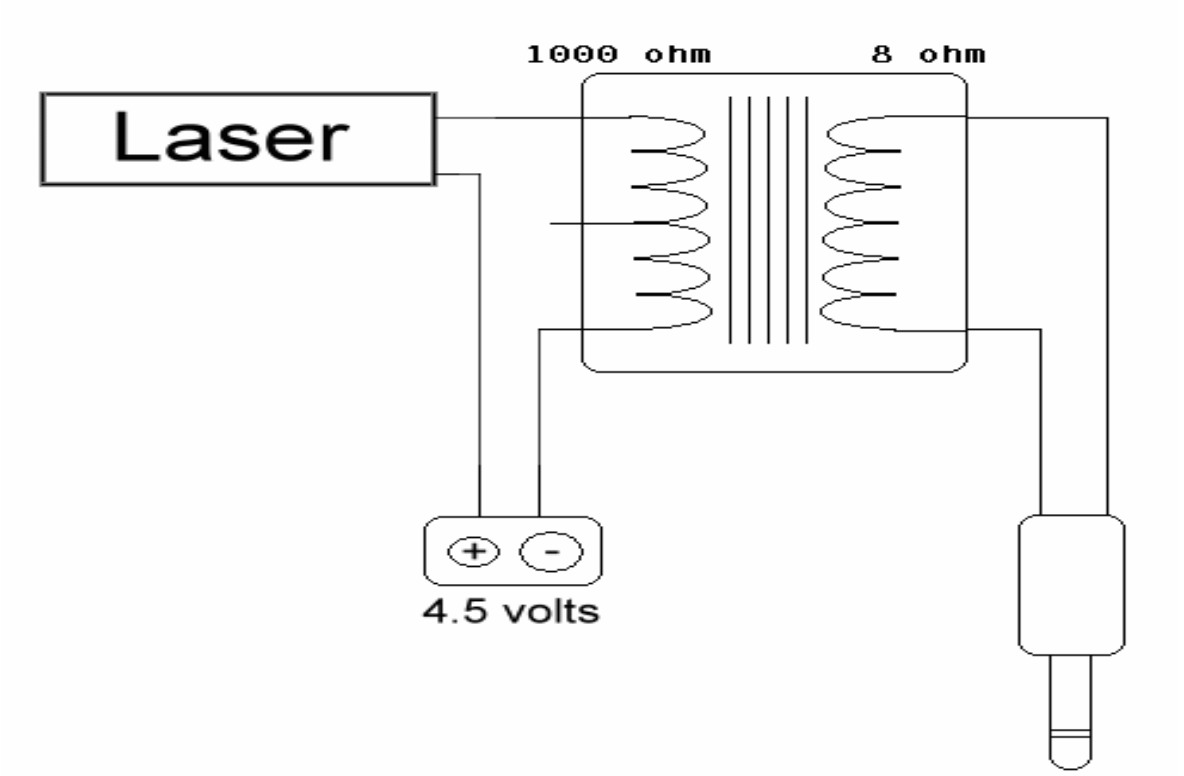
For this lab, students were challenged to make a simple laser communicator using the basis of improving it in any of three different particular ways. The group was composed of four electrical engineering students. The basic design of the laser communicator was exactly as follows: A 4.5 volt battery, a 8ohm ➔ 1kohm transformer, a laser, and an audio jack were all connected in series to form the transmitting portion of the communication portion of the system. The following picture shows a brief idea of what the schematic of the system should look like.



The receiver portion of the communicator was constructed by putting a photo-resistor in series with a 100ohm resistor and two speakers.

PROBLEMS / ISSUES:

While this setup was very easy to construct, we came across numerous problems that we needed to solve. For instance, the communicator was only good for "line of sight" transmission. In addition, as the distance between the transmission and the receiver

increased, the noise to signal ratio significantly increased due to the disturbance of the laser with air particles.

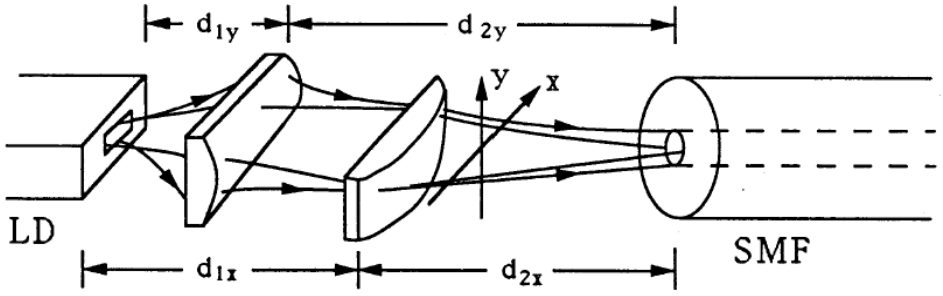
More over, since the laser was not very precise, the signal was being distorted every time the light was focused on the photo-resistor. Finally, the signal being received by the receiver was very weak and contained a significant amount of noise. This resulted in a response of unwanted emission impeding the students and spectators to hear any quality music emit from the speakers and since the system needs to be insulated in order to block out any noise introduced by the ambient light sources.

SOLUTIONS:

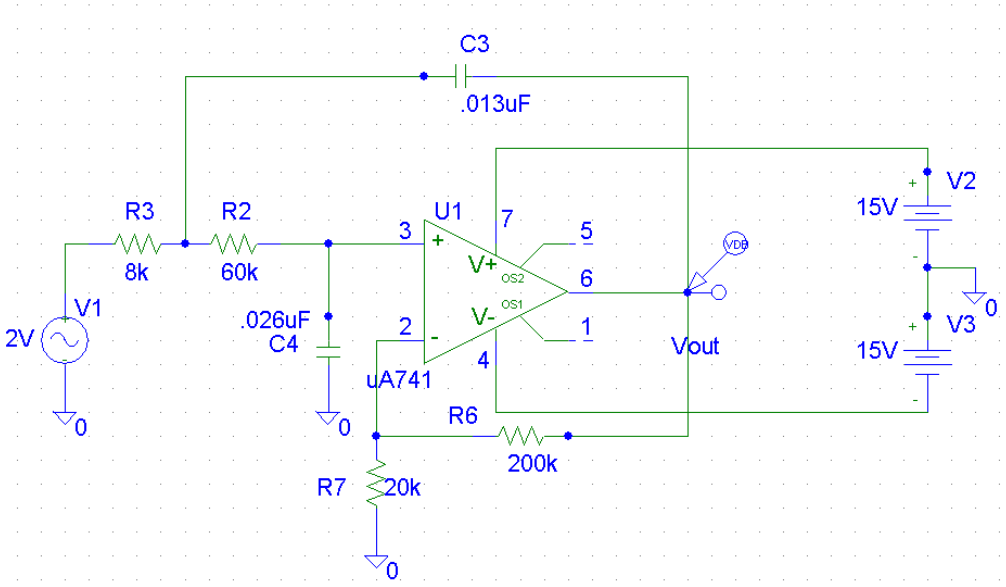
In order to correct the noise that the speakers were emitting, it was decided that the connections needed to be solid and covered with electric tape. This ensured that the system encounter minimal noise from its surroundings. It was noted that the sound quality was inversely proportional to the surface area of the photo resistor, while experimenting. A conclusion was reached to only have a circular opening with a diameter of 3mm on the photo-resistor. These were some of the trivial improvements that the system needed.

In addition to these miniscule problems, the group decided to improve on the noise and transmission problem initially encountered in the project. First and foremost, instead of having the light travel through air, where it has a very high loss, it was agreed upon to use fiber optic cable instead, which has relatively very low power loss. In addition, using the fiber optic cable will remove the barrier of line of sight communication, and allow the signal to be transmitted over very long distances. Experimentally, we were able to transmit the signal through 200 feet single mode fiber optic wire.

First, the output of the laser needed to be confined to a very small Gaussian circular beam in order to maximize the intensity per sq cm, to maximize the power transmitted through the fiber. Using two cylindrical lenses; one to compress the vertical component and the second one to compress the horizontal componenet of the Gaussian beam. The diameter of this spot was not around .5mm, as compared to 5mm without the lenses. The setup is graphically shown in the diagram below.



However, while using this setup lots of unwanted noise was getting through, and being amplified. To address this problem lowpass filter was added, which would amplify human voice, and attenuate everything else. Since human voice is typically between 300Hz to 3.4Hz, a lowpass filter using LM 741 op-amp with its 3db frequency at 3.5Hz and gain of 10 was designed. This filter was never implemented in the actual design due to time constrain. However, theoretically if it were put in series with the receiver, it would greatly enhance the quality of sound outputted through the speakers. The schematics for the lowpass filter butterworth filter is shown below.



In addition it is important to note at this point that the receiver would also need to be modified in order to properly detect the signal traveling from a fiber optic wire. Thus, the photo-resister would be cover with electric tape, leaving only enough room for the fiber optic wire to shine the light, around diameter of .5 mm. Moreover, anti reflective coating on the surface of the photo-detector, and lenses, and applying ¼

wave coating to the fiber optic wire exposed to the laser would also help in reducing feedback. However, these options were simply pondered upon, but never implemented due to its complexity.

CONCLUSION:

In conclusion, the laser communicator was success. However, more importantly we were able to use the theoretical knowledge from 164 lectures to solve a practical problem. Also, while trying to solve the problem we were encouraged to think outside the box and use creative ideas to solve the problem. We were definitely to improve the communicator's range, and had ideas to improve the sound quality. Thus, the criteria provided by Prof. Kwok were met successfully.