

# Institute for STEM Education



Stony Brook University  
College of Engineering  
and Applied Sciences

## *Audio Laser*

Student Lab Guide



Engineering Teaching Laboratory

Name \_\_\_\_\_ Date \_\_\_\_\_

Lab Partner(s) \_\_\_\_\_

## **NEW TERMS**

Electric Circuit: Electric circuits are paths for transmitting electric current, or moving electricity. Such circuits allow electricity to be used to provide power to lights, appliances, and many other devices

Capacitor: a device used to store electric charge. It is similar to a battery except it stores energy instead of providing new energy. These are used to amplify power supplies and filter out electronic ripples.

Resistor: a device that is designed to resist the passage of an electric current.

Transistor: a semiconductor device that can be either used as an amplifier of a signal or as a switch. It has three terminals: input, output, and control.

Integrated Circuit (IC): An IC is a collection of electronic components (resistors, transistors, capacitors, etc.) all stuffed into a tiny chip, and connected together to achieve a common goal. In this design, the IC will that make our audio signal stronger and is called an Op Amp.

Printed Circuit Board (PCB): a board that mechanically supports and electrically connects electronic components using conductive tracks, pads, and other features etched into the nonconductive board in copper. Components are generally soldered onto the PCB.

Potentiometer: A potentiometer can act as a variable resistor. The value of its resistance can change with moving its shaft.

Solar Cell: a device that receives light and give out voltage according to how much light it received.

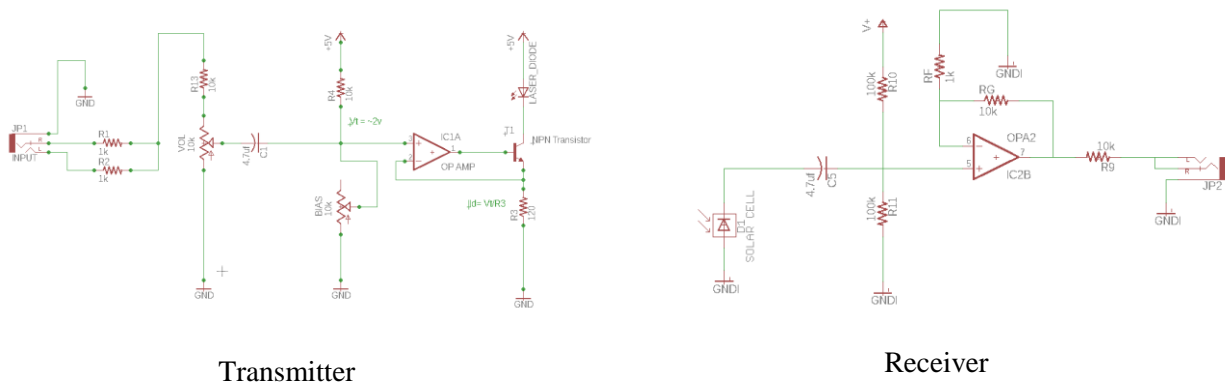
Terms to be familiar with:

Circuits  
Series  
Parallel  
Voltage  
Electricity  
Conductors  
Insulators

# INTRODUCTION

Electronics use electricity to perform a multitude of functions. We characterize electricity in our circuits using current and voltage. Current, voltage, and resistance are related through Ohm's Law ( $V= I * R$ ). Simply put, a current is defined as a voltage across a known resistance and a voltage is defined as the current through a known resistance. Putting together voltage, current, and resistance develops a circuit. Circuits are very powerful tools used all throughout our daily lives. They are used to turn on our lights in the house and power our electronic devices. Circuits are composed of various components that contribute to its functionality. They all need a power source to function and have different combinations of resistors and capacitors to determine what the output signal will be. The output can be regulated by how many of these components are present, as well as the components' values. This will lead to different circuits making different signals. In this lab activity, a circuit will be built to transfer sound using a laser light.

Wireless transfer of information is a backbone of modern society. Think of the ways you would send information to a friend without using any physical means between you. Today you will be constructing a system that uses light produced by a laser to transmit audio. This project is a take home gadget that can be easily implemented in your own home to show how one can transfer sound using laser light.



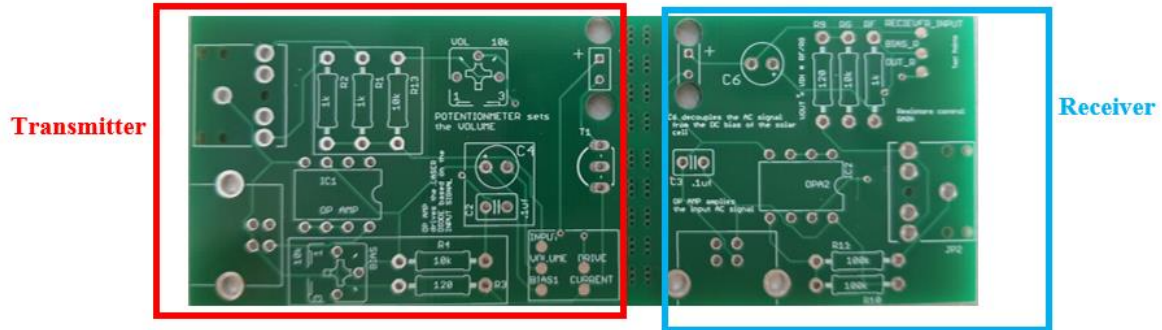
To transfer a signal from one place to another we need to have a transmitter (a device that transmits a signal) and a receiver (a device that receives the signal transmitted). In our design we want to transmit an audio signal (sound) from one device to another using a laser beam. First, we need to design a transmitter. Thus, the transmitter should have an input. From the schematic above, in the transmitter, we have JP1 as a connector to our input signal. In our case, the input signal will be provided by an audio jack.

Next, we want to transmit this audio signal to the receiver end. We have a laser diode in our circuit, a device that converts current to light, which can help us along with other components transmit the audio signal with minimal distortion. In simple words, the laser diode will use the input audio signal voltage and converts it to light. The light from the transmitter end will be targeted to the receiver end. The stronger the audio signal (more voltage) the more light we have.

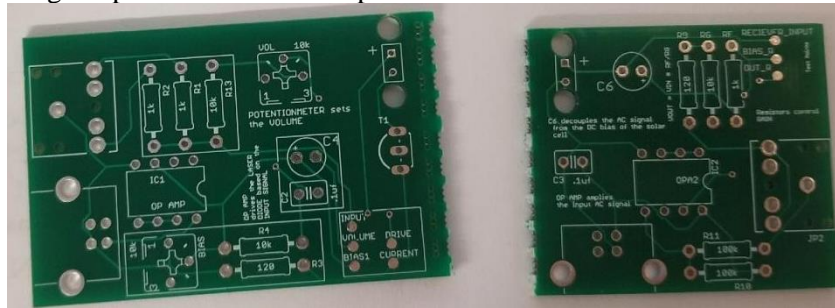
The first component on the receiver end that gets the light from the transmitter end is a solar cell. This being the case, the original voltage that started off with on the transmitter end will be transferred to the receiver end. We then amplify the audio signal received using an Op Amp transistor to be able to hear it. Finally, the signal is outputted on another audio jack ready to be plugged into the audio device of your choice. So, you can use any pair of headphones to listen to the audio you inputted from the transmitted side.

## PROCEDURE

Your printed circuit board looks like this:

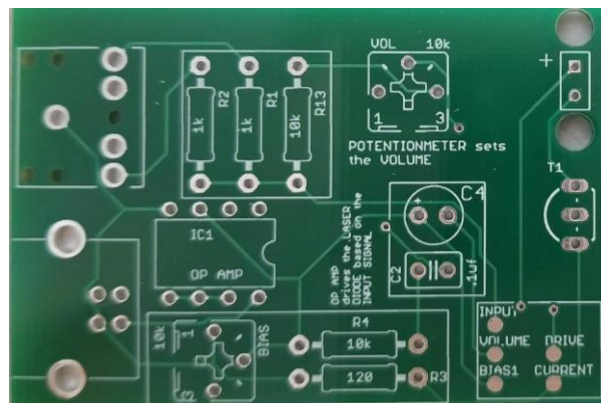


Break the board along the perforated lines to separate the transmitter and receiver ends.

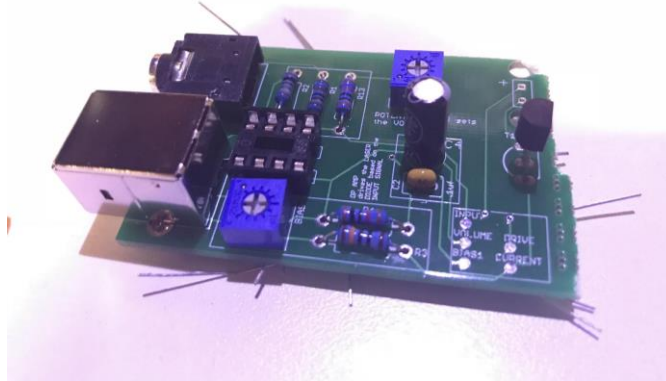


### A) Transmitter End

1. Place the circuit board as shown. All the components must be installed on this side of the board. The terms 'right', 'left', 'top', and 'bottom' refer to the board in this position.




2. Install the USB receptacle as shown below. Snap the component into location X1 and solder it.




3. Locate the jack input and place it in JP1 location on the board.
4. **Orientation critical:** Install black socket with 8 legs in IC1 location on the board. Note that this part has a small indentation on one side. **The indentation will match a similarly shaped mark on the printed circuit board.**

5. **Orientation critical:** Install the two-blue potentiometer



6. **Orientation critical:** Install the transistor  in location T1 as shown in the figure above. This part goes in a specific direction. The flat surface side of this component should be right faced as shown in the figure above. Ask for assistance if you can't figure it out.

7. **Orientation critical:** Install the 4.7uF capacitor into location C4 on the board. **This capacitor goes in a specific direction** and has two legs of different length. The longer leg goes into the hole with a + sign above it and the shorter leg goes into the adjacent hole.

8. **Install the 0.1uF capacitor**  into location C2 on the board. This component goes in either directions.

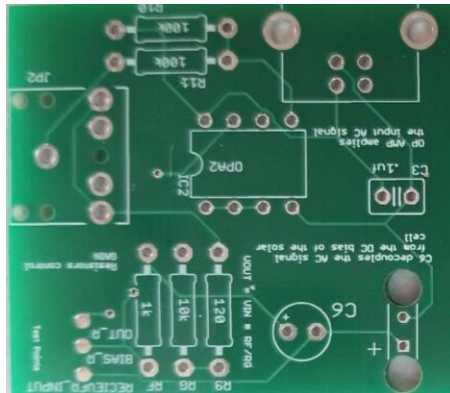
9. Install 1 kΩ resistor (**brown, black red, gold**) into two locations on the board: R1 & R2 as shown in the figure above.

10. Install 10 kΩ resistor (**brown, black, orange, gold**) into two locations on the board: R4& R13 as shown in the figure above.
11. Install 120 Ω resistor R3 (**brown, red, brown, gold**) as shown in figure above.
12. Install the laser into the holes marked with LASER DIODE. The red wire goes to the positive **square** hole and the other wire goes in the **round** hole. **NOTE**. There are two *larger* holes for strain relief for the cable. You can first insert the cable into these holes before inserting into the plated hole for soldering to reinforce your cable.

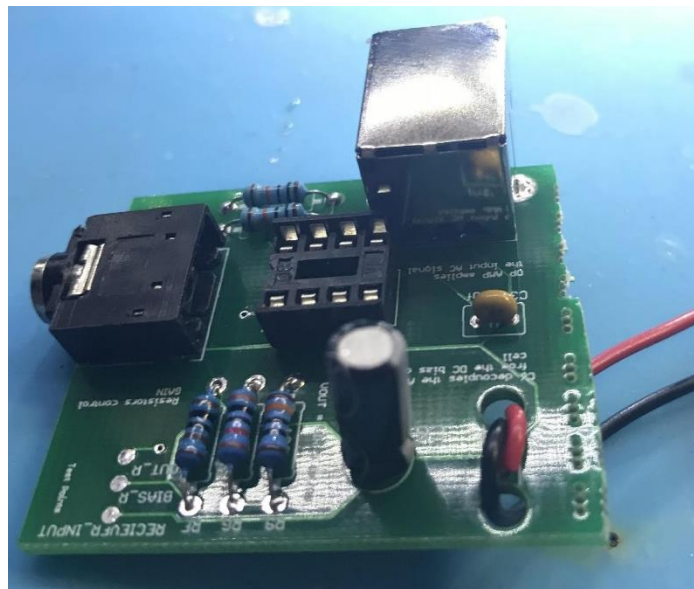
## B) Receiver End

The following components must be installed in a particular direction. After installing the component, solder it down and trim the leads if necessary.

1. Place the circuit board as shown. All the components must be installed on this side of the board. The terms ‘right’, ‘left’, ‘top’, and ‘bottom’ refer to the board in this position.



2. Install the USB receptacle as shown below. Snap the component into **location X2** and solder it.



3. Locate the jack input and place it in JP2 location on the board.
4. **Orientation critical:** Install black socket with 8 legs in IC2 location on the board. Note that this part has a small indentation on one side. **The indentation will match a similarly shaped mark on the printed circuit board.**



5. **Orientation critical:** Install the 4.7uF capacitor into location C6 on the board. **This capacitor goes in a specific direction** and has two legs of different length. The longer leg goes into the hole with a + sign above it and the shorter leg goes into the adjacent hole.



6. **Install the 0.1uF capacitor** into location C3 on the board. This component goes in either direction
7. Install 1 k  $\Omega$  resistor (**brown, black red, gold**) into locations RF on the board
8. Install 10 k  $\Omega$  resistor (**brown, black, orange, gold**) into locations RG as shown in the figure above.
9. Install 120  $\Omega$  resistor R9 (**brown, red, brown, gold**) as shown in figure above.
10. Install 100 k  $\Omega$  resistor (**brown, black, yellow, gold**) into two locations on the board: R10 & R11 as shown in the figure above.
11. Install the solar cell into box marked SOLAR CELL. The red wire goes to the positive **square** hole and the other wire goes in the **round** hole. **NOTE.** There are two *larger* holes for strain relief for the cable. You can first insert the cable into these holes before inserting into the plated hole for soldering to reinforce your cable.

### C) Testing

After you assemble your circuit you're going to have to carefully adjust the potentiometer to get a clean audio signal on your receiver's output. The circuit will transmit audio best when the laser diode is just turning on. Listen to the output and see how the quality of the sound changes as you change the output. There are several test points on the circuit board, if you have time you can use the oscilloscope to see how the signal progresses through your circuit and how each stage affects the character of the signal.

**QUESTIONS**

1. What is the function of the laser diode?

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2. What is the function of a capacitor in a circuit?

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3. What is the function of the Op amp in our circuit?

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4. What is the function of the solar cells? What is its input and what is its output?

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5. Was energy conserved in our design?

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6. Electrical energy was transformed into \_\_\_\_\_ energy.

**Think like an engineer - Questions & Discussion:**

1. Besides cost, what are other potential issues with materials and design to be considered?
2. Do you think engineers must make important tradeoffs between costs, environmental considerations, and other issues? Are there any other improvements to this design that you would employ?