**Wentworth Institute of Technology**

**HTMAA – Circuit Board Construction/Soldering**

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**Objectives:**

1. To learn how to read a circuit diagram.
2. To Identify various electrical components and orient them correctly on a printed circuit board
3. To solder components to a printed circuit board

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**Equipment:**

Soldering Iron and solder

Soldering Iron Stand w/ damp sponge

Wire cutters

Plyers

Solder wick

**Parts and Supplies:**

Printed circuit board

2 – 1k Ω Resistors (R1, R2)

2– 10k Ω Resistors (R3, R4)

2– 500k Ω Potentiometer (R5, R6)

2– BC547 transistors (Q1, Q2)

2– Jumbo Red 10mm LEDs (D1, D2)

2- 10µF, 50V electrolytic capacitors (C1, C2)

9V Battery

9V battery snaps

**Discussion:**

* Soldering is the process of melting a conductive material in order to make a thermal, physical, and/or electrical connection. In the case of soldering electrical components to a circuit board or to other electrical components, solder is melted by a small (but very hot) heating element called a soldering iron.
* Due to the very high temperatures and potential hazards of soldering a circuit board, it is imperative that the attached safety guidelines be read in their entirety prior to turning on your soldering iron.
* In the construction of a circuit board, it is important to be aware of all of the components that are being utilized and any potential hazards associated with them. In the circuit being constructed in this lab you will be using the following components:

**Resistors** – Resistors are components that limit the flow of electrons through the circuit. They are typically use to control voltages or currents in a circuit. They can also be utilized as a reference value when integrating resistance based sensors into a system.



*Potential Hazards*

*Connection*: Do not allow the metal leads on both sides of a resistor to physically touch. This will cause a short and a spike in the current (or flow rate of the electrons in the circuit). This can damage the circuit and any equipment attached to it.

*Thermal*: The process of restricting the flow of electrons in a circuit produces heat. It is possible that this heat can get to temperatures that can burn you or other materials that contact it.

**Potentiometers** – Potentiometers serve as a variable (or adjustable) resistors. They can be tuned by turning, or sliding, an adjustment on the potentiometer. They are typically use to allow for a physical input from a user to adjust the current or voltage at certain points in a circuit. They can also be used to tune a resistance in the circuit where either a precise resistance value is needed or a calibration component is needed.



*Potential Hazards* (same as resistor in addition to the following)

*Connection*: Potentiometers have the ability to be tuned to very low resistance values. Therefore, make sure that you account for the potential increase in current that is possible at these lower resistance values.

**Transistors** – Transistors serve as electrically controlled switches in a circuit. They use semi conductive material to control a connection. Although there are many applications associated with them, they are commonly used for routing currents, amplification, or controlling a high power component with a low power input.



*Potential Hazards*

*Connection*: There are three connections on most standard transistors (NPN or PNP). Ensure that you connect the correct lead in the correct orientation in your circuit (Base - Low power input, Collector – High Power Input, Emitter – High Power output)

*Thermal*: Transistors often generate heat. There for make sure that you provide the appropriate cooling if necessary. It is possible that this heat can get to temperatures that can burn you or other materials that contact it.

**Diodes and LEDs (Light Emitting Diodes)** – Diodes are components that allow current to only flow in one direction. Light emitting diodes perform the same way; however, light is emitted when they are conducting. Diodes are typically used to force current to flow in only one direction in a circuit and can be used to protect sensitive components.



*Potential Hazards*

*Connection*: Since diodes only allow current to flow in one direction in a circuit, it is imperative that they are connected to the circuit correctly. If connected in reverse, a diode will act as an open circuit and will prevent a circuit from working as intended. Also, since diodes perform like a short circuit when conducting, it is important to make sure that there is something that will limit the current going through it. This s commonly done by connecting a resistor in series with the diode.

**Capacitors (Electrolytic)** – Capacitors are energy storing elements that store charge in an electric field. Capacitors are typically used for filtering/smoothing signals, preventing voltage spikes, and occasionally for storing charge for later use. Electrolytic capacitors typically have a white band with a (-) symbol on it that is associated with one of the leads. This must be oriented to the negative terminal on the circuit board.



*Potential Hazards*

*Connection*: Electrolytic Capacitors are polar components and they must be connected in the correct orientation. If connected in reverse, they will explode!

*Eyes:* Due to the possibility of a capacitor failing and exploding, shield your eyes from the path that the component may fail in when applying power. The direction that it may fail is typically indicated by an x on the top.

In this lab you will be constructing the circuit shown in Fig.1.

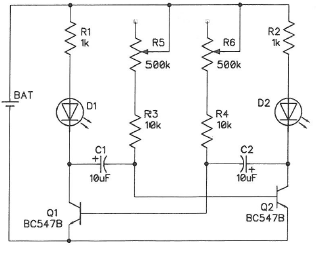


Figure 1 Circuit Diagram

**Procedure\*:**

1. Separate the supplied components and ensure that all are the correct value.
2. To avoid potential burns, before plugging in your soldering iron, practice holding the soldering iron in one hand and solder in the other while touching both to the circuit board. Although this may feel somewhat unnatural at first, practice until you are comfortable. Once you are confident that you will be able to do this without touching the soldering iron tip, a component lead, molten solder, or touching the soldering iron to the table top, you may plug in the soldering iron. Within minutes your soldering iron will be very hot and will instantly burn skin, the table top, or any other surface it may come in contact with. It will also remain hot for long after you unplug it. **BE CAREFUL!**
3. Installing resistors: Separate the 1 kΩ (brown-black-red) and 10 kΩ resistors (brown-black-orange). The resistors are not polar components so they can be installed in either direction. One at a time, bend one of the leads so that it is facing in the same direction as the other lead. Pull both leads through the circuit board with the supplied pliers until one side of the resistor is almost flush with the circuit board. Be careful not to pull too hard since you want to avoid breaking the circuit board, the resistor, or the lead. Put a slight bend (no more than 30 degrees) in the lead so that it is able to hold in place while soldering. Apply solder as directed by the instructor. If you are not confident doing this, call over the instructor for direction. Once soldered, trim the excess wire with the provided wire cutters
4. Installing potentiometers: Install the potentiometers according to the silkscreen and hole pattern on the PCB. Bend the leads on the other side to help hold the component in place while you solder the leads. Trim the excess.
5. Installing Transistors: Install the transistors according to the silkscreen pattern on the PCB. The half-circle must match the half-circle on the PCB. Bend the leads on the other side to hold the component in place while you solder the leads. Trim the excess.
6. Installing Capacitors: This capacitor is polarized and can only be installed in one direction. The PCB has a '+' plus sign near the pad for the positive lead. The capacitor has a stripe with the minus sign going down one side to show which lead is negative. Place the component on the PCB in the correct orientation and bend the leads to hold it in place and solder the leads. Trim the excess.
7. Installing LEDs: The longer lead is the positive and the shorter is the negative lead. The square pad is for the positive lead. Correctly install the LED and bend the leads to hold it in place while you solder it. Trim the excess.
8. Installing battery holder: The space marked 'BAT' is for the battery holder. The pad with the dot near it is the pad for the positive lead. Install the red wire to the positive pad and solder the wire. You may need to use tape or a third hand to keep the wire in place. Install the black wire in the other pad and solder.
9. Once completed, your circuit should look like the Fig. 2



Figure Completed circuit

1. Plug in the battery: Plug in the 9V battery and the LEDs should begin to flash. Use a small screwdriver to adjust the tuning knobs/screws on the potentiometer. Each potentiometer will adjust the flash rate of one LED. As long as both adjustment screws are at the same position, the LED flash should be the same duration.

**\*Installation directions from Jameco Electronics Jumbo LED Flasher Kit**

**http://www.jameco.com/Jameco/Products/ProdDS/2216606KitInstructions.pdf**