SOLDERING LAB

YOUR NAME______________________ GTA'S SIGNATURE_________________

LAB MEETING TIME______________

Objectives: Learn and practice techniques for through hole and surface mount soldering.

The focus of this lab is to practice soldering, continue getting familiar with lab equipment and most importantly, have fun. Take your time. Do not worry if the components or lab equipment are unfamiliar. Ask for assistance if you are unsure of any step or setup. It is important that you review the tutorials below before coming to the lab session.

TUTORIALS

1. Follow the links below to learn about soldering:

- Review the information on http://electronicsclub.info/soldering.htm. If interested, this guide has several additional links to soldering resources and component information
- Read pages 1-5 http://www.elecraft.com/TechNotes/N0SS_SolderNotes/N0SS_SolderNotesV6.pdf
- Watch the video http://store.curiousinventor.com/guides/How_to_Solder. Under the Contents section, review link 5 "Heat and Solder the Joint"

2. The next section of tutorials focuses on surface mounted devices (SMD)

- Two videos on how to solder an IC and connector using solder wick (SMD how-to) http://www.sparkfun.com/tutorials/96
- SMD rework station demo http://www.youtube.com/watch?v=7tzRwSfggbA
- Hot air rework introduction http://www.sparkfun.com/tutorials/98
- Several video demonstrations showing the use of the hot air rework unit can be found at http://www.sparkfun.com/tutorials/102
- Video showing the use of solder paste http://www.youtube.com/watch?v=MqivHi7Qjvk

3. **Electrostatic discharge** – optional reading http://www.minicircuits.com/app/AN40-005.pdf (you may have to cut-and-paste into your browser)

SOLDERING EQUIPMENT

Safety First - When soldering, please observe safety precautions.

<u>Wear safety glasses</u>. Be careful not to burn yourself and do not let cables from equipment get near the soldering iron stand. Before starting, determine the location of the fire extinguisher and first aid kit. Avoid breathing in flux fumes. If available, use the fume absorber to minimize exposure. All solder waste should be put in the metal tins located at the soldering area.

Figure 1.
Weller WESD51 soldering station

<u>ESD protection</u>: Few stations are equipped with an electrostatic discharge mat. These help prevent damaging components via ESD. Although not crucial for this lab, it is a good idea to be ESD safe when working with sensitive electronics.

<u>Soldering iron</u>: In this lab, a Weller WESD51 or similar soldering iron will be used (Figure 1). It consists of a control unit and a stand. If the iron has temperature control, set it to approximately 475° F. If it does not have a display, set the temperature dial roughly half way. No matter the type of iron being used, do a few practice joints and adjust the temperature accordingly.

Figure 2.
Soldering iron wand

The temperature should be adjusted based on the melting point of the solder that is being used and the components being soldered together to achieve a quality solder joint without applying excessive heat. A good rule of thumb is to set the iron temperature to around 475° F and increase the temperature as needed. Using lower temperatures will lessen the danger of damaging the board or part. It will take practice to get a feel for where the temperature needs to be set for the particular application.

Figure 3.
Aoyue 852 rework station

A quality solder joint will have a smooth and shiny appearance (smooth and dull is ok if using silver based alloys), good wetting/adherence to the soldered surface, no spikes, no grittiness, no pin holes or blistering, and does not have insufficient solder or excessive solder. The iron temperature is only one factor to consider. "The key element is controlling the heat cycle of the work. How fast the work gets hot, how hot it gets, and how long it stays hot is the element to control for reliable solder connections" [1]. Do not press down hard on the joint with the iron. Doing so can damage the board and iron tip.

Figure 4.
Aoyue wand with different nozzles

Figure 2 shows the iron wand. It can be disassembled to change the tip. This particular model has a housing that can be unscrewed. Different irons have a set screw at the end to hold the tip in place. There are a variety of tips available ranging from small conical types for tight spaces and small components to large chisel types for larger pads, wires, and components. Choosing the correct tip depends on the particular application (information on tip selection is available on the web). Selecting one that is too small for the work will not transfer heat effectively and make soldering difficult. Using a tip that is too large may damage the printed circuit board. When finished with the iron, leave a little solder on the tip and make sure it is off. Leaving solder on the iron tip helps minimize oxidation and corrosion.

Hot Air Station: For hot air soldering, an Aoyue 852 or 852+ hot air rework station will be used (Figure 3). The temperature and air flow rate can be adjusted. Similar to the iron, the temperature will need to be set based on the solder and components you are working with. Start with a lower temperature (375-425° F) and increase it if needed. As shown in Figure 4, different attachments can also be placed on the end of the wand via a clamp with a Phillips screw. Like the iron, there are many different nozzles and selecting the correct one depends on the application. The 852+ has a different interface and an additional suction wand to aid in component removal. When powering off the device, it will stay on and enter a cool down mode. Do not leave either the hot air station or iron unattended while on.

Figure 5. Fume absorber

Use the fume absorber shown in Figure 5 to minimize the exposure to flux fumes. Be mindful of your classmates near the device as the noise can be disruptive.

PRACTICE

Use the techniques learned in the tutorials before attempting to build the circuit. There are a few boards that are available to practice using "J" hooks to attach leads, to experiment with the de-soldering pump, solder wick and flux.

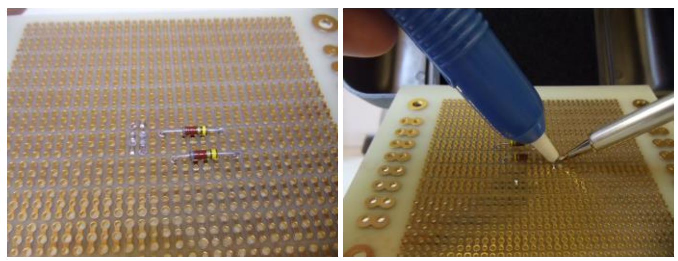


Figure 6. Practice board and desolder pump in use

Fill up a few holes and solder down a few resistors into the practice board as shown in Figure 6. Desolder a few holes using the desolder pump and solder wick. If the wick is not effectively wicking up the solder, try applying some flux to the wick before attempting to desolder. Connect a few pins with a wire that has a "J" hook on the ends similar to Figure 7. Attach the hook on a lead. Lightly crimp the wire around the lead and then solder it. Tweezers or needle nose pliers work well for this task. Avoid letting wire insulation get into the solder joint when "J" hooking wire and leads together.

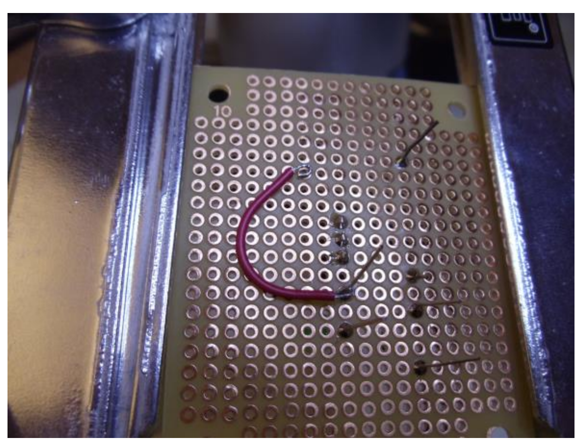


Figure 7. Example of "J" hook

Remove a resistor without damaging the board or part with either desoldering method. When desoldering a resistor, sometimes the lead will still be soldered to the side of the barrel even though most of the solder has been removed from the hole. At this point, just take the iron tip and gently press horizontally against the component lead to free it from the side wall.

If time allows after finishing the main build, a few SMD stations will be set up to practice soldering surface mount components. Try removing an IC or chip resistor.

CIRCUIT

The circuit that will be constructed is shown in Figure 8. The section outlined by the dashed rectangle will be implemented on the perforated prototype circuit board, similar to what is shown in Figure 13. It consists of two resistors, a light emitting diode (LED), and a transistor. For this lab, it is not required to know the exact details of the circuit operation. The components will be studied in future labs and courses. For now, think of the transistor as an on-off switch that controls the light emitting diode. The value of R_1 can be changed to adjust the current through the LED. The value of R_1 needs to be selected based on the characteristics of the LED being used to limit the current through the LED to prevent it from burning out. The transistor was selected based on its cost, general purpose characteristics, suitability for logic level gate drive sources and the mechanical package. The spacing between the pins of the transistor matches that of standard prototyping boards. In addition, a heat sink can be attached to the transistor to dissipate heat for higher power applications.

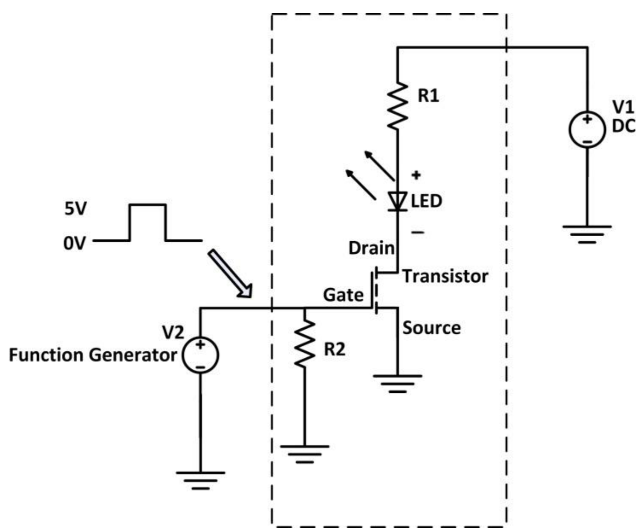


Figure 8. R_1 = 330 Ω, R_2 =10 kΩ, Transistor = N-channel logic level MOSFET (PSMN022-30PL) , V_1 = 5 V

IMPLEMENTATION

After soldering practice, assemble and test the circuit.

Step 1:
Prepare necessary components for assembly as shown in Figure 9. Components that will be needed are 1 LED, 1 transistor, 1 330 Ω resistor, 1 10 kΩ resistor, 1 prototype perforated board, and 4 jumper wires approximately 3.5 cm in length with 3-4 mm of insulation stripped off of the ends. Before building the circuit, verify the resistor values using the color bands or a multi-meter. The resistor color band decoding guide is located here.

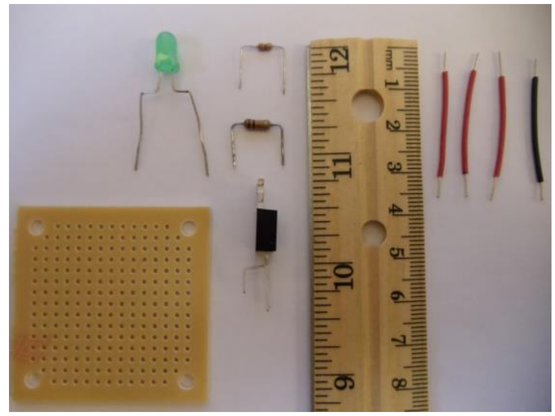


Figure 9. Components needed for assembly

Step 2:
Insert the components into the proto board as shown in Figure 10. Bend the component leads a bit so that the parts do not fall out when the board is turned upside down. When satisfied with the component orientation (see step 3), solder the leads to the protoboard. Although it is usually good practice to clip leads before soldering to avoid fractured joints, **do not cut the leads at this step.** It will be easier to connect the leads together with a wire if the leads are longer.

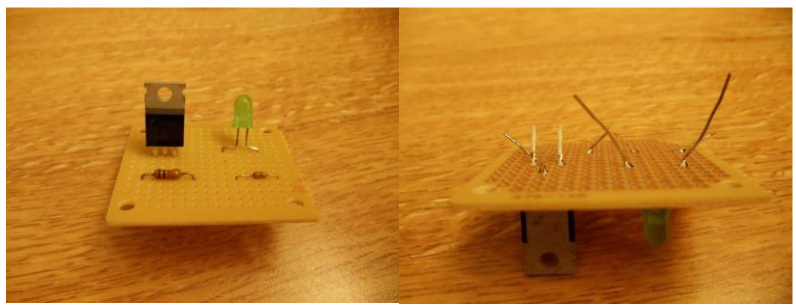


Figure 10. Inserting components and soldering

Step 3:
Following the schematic within the dashed rectangle in Figure 8, connect the component leads together with jumper wires. Make sure to connect the LED properly as it has polarity (See Figure 11). There are several ways to determine which lead is the anode and which is the cathode. Usually the housing of the LED will have a flat spot which indicates the cathode side. In addition, one lead of the LED will be slightly longer than the other indicating the anode. Connect the cathode to the drain of the transistor and attach the anode to one pin of R1. Figure 12 shows the pinout of the transistor. In this figure, the etched part number in the black body of the transistor is facing up. The middle pin is the drain, the bottom is the gate, and the top is the source. Connect the source to ground. Connect the gate to one lead of R_2. Try and use “J” hooks to connect the component leads.

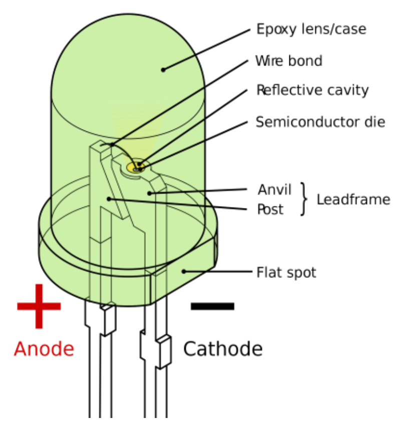


Figure 11. LED structure

Figure 12. PSMN022-30PL pinout

Step 4:
After the circuit has been assembled, clip the leads off of the components. Take care not to cut into the solder joint and **keep the clipped leads from becoming projectiles**! The finished circuit should look similar to Figure 13. It does not have to be routed exactly as shown below.

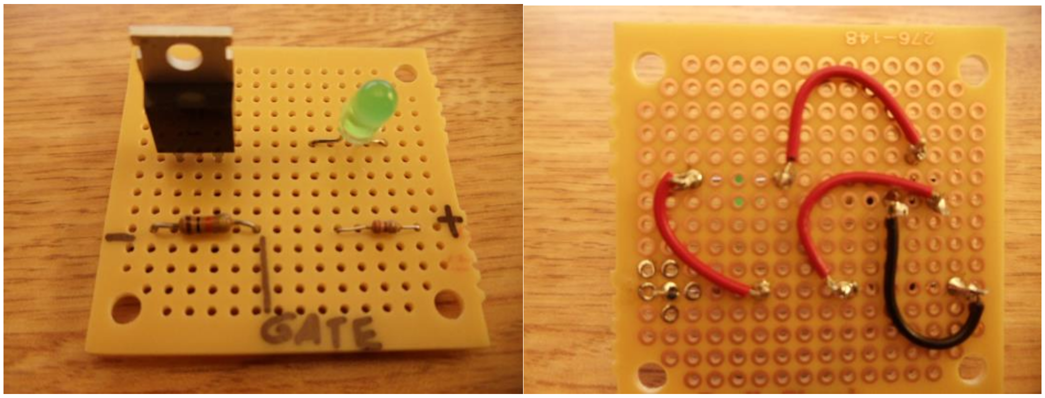


Figure 13. Finished circuit: top and bottom

VERIFICATION AND TESTING

Once the build is completed, verify that the components are connected properly (a GTA will also verify the connections). There will be a station set up to test the circuit with a GTA's assistance. If finished early, practice with the SMD rework station or help your peers if needed. Make sure to clean up any debris from soldering and wash your hands to prevent ingestion of flux residue or lead!

FOR EXTRA FAME AND GLORY

Although the circuit is complete, the inputs cannot be easily attached to the circuit. A helpful addition to this circuit is adding header pins as shown in Figure 14. Break three 2-pin sections and solder them to the board as shown in Figure 15 to create easy connection points for the power supply and function generator. Also, the wire connecting the pin of R_1 to the anode of the LED has been replaced with a 1 Ω resistor. Why would that be helpful?


Figure 14. Header pins

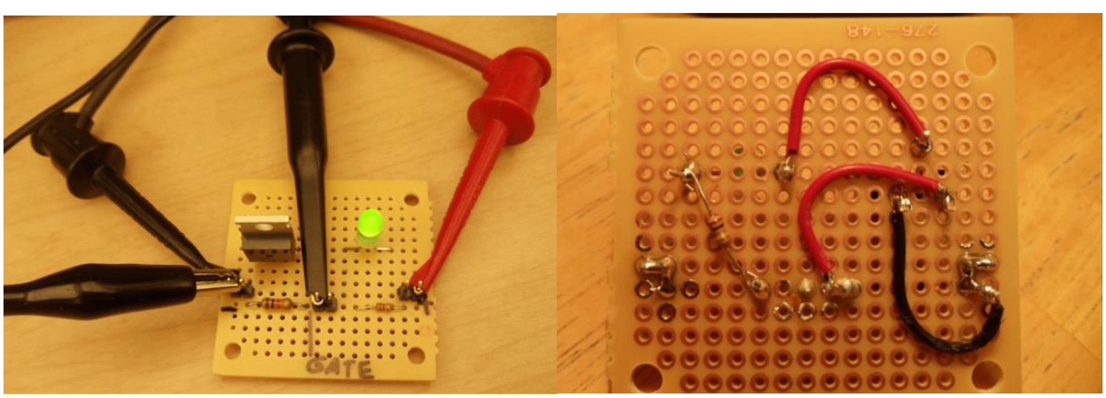
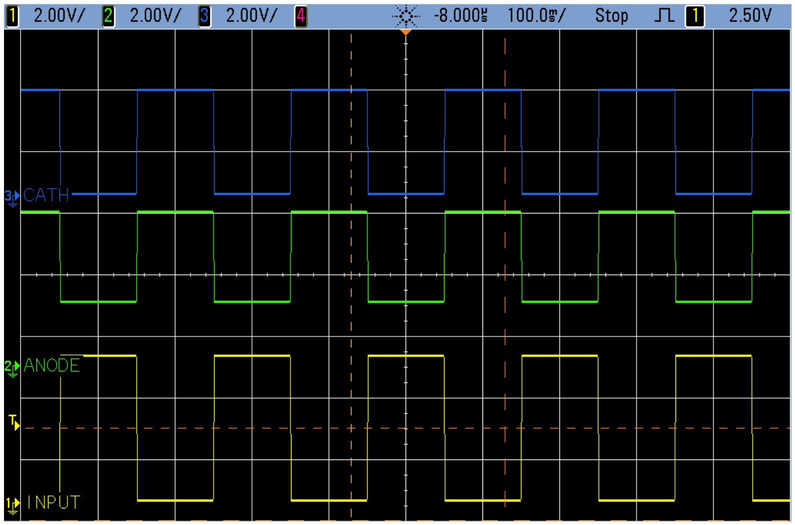


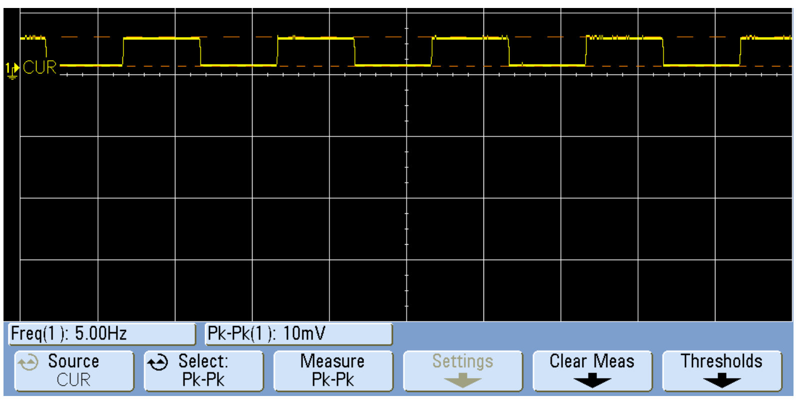
Figure 15. a) Circuit with headers added b) Bridged pins of the 2 pin header.

Ocilloscope traces for comparison are shown below:

- Traces at the input, cathode, and anode pins with a 5 Hz, 5V, 50% duty cycle should look similar to:



- Current through the 1Ω resistor is approximately 10mA when the switch is on.



Sources:
[1] Circuit Technology Center, Inc. *Soldering Basics*. Retrieved January 16, 2013 from http://www.circuitrework.com/guides/7-1-1.shtml.

Upon completion of this lab, obtain your GTA's signature on the front page.