2 Circuit Board Assembly

Objective

This lab exercise will introduce the practice of soldering. Soldering is the process of joining metal objects with solder. Solder is a low melting point metal alloy typically in the form of wire. In this exercise, we will practice soldering pin-headers to a perforated circuit board.

Theory

There are many different solder alloys that are suitable for soldering. Alloys are composite materials that consist of two or more different metal types. Historically, solder had consisted of lead and tin, however lead is a harmful metal that when exposed to humans can cause lead poisoning. For this reason, other lead-free solders have been become available and will be used while in our laboratory. Lead-free solders can be identified by the "RoHS" (Restrictions of Hazardous Substances) symbol. Lead-free solders do not melt a readily as leaded solder, therefore lead-free solder often has a flux core within the solder wire. Flux is an agent that helps lead-free solder flow easier and adhere to other metal surfaces.

Soldering irons are wand-shaped tools that heat a metal tip to high temperatures sufficient for melting solder. Soldering irons will have a temperature control unit that can be adjusted for the application. Different solder alloys will require different temperature ranges to melt effectively. Also depending on the physical size of the electrical component being soldered, the temperature may need to be adjusted. The soldering irons in our lab consist of the wand or handle, the soldering tip, and a base station/stand. The stand may also have brass wool or a small sponge for cleaning the soldering tip.

Soldering irons are not only used for joining metal, but may be used to remove solder joints as well. There are tools called solder suckers which consist of a spring-powered pump that when released briefly creates a vacuum which can be used to suck the molten solder away from the component. Another tool for removing solder joints is solder wick. The solder wick is thin-stranded copper wire braided into a wick which can be applied over the joint with heat from the soldering iron. When the solder melts, it absorbs into the wick and away from the component being de-soldered.

When soldering, it is helpful to have the work piece or circuit board held stationary by either a vice or alligator clips. Components can be temporarily held by against the work piece using the "helping hands" tool: alligator clips on articulated arms for easy manipulation. With the work piece and components held stationary, the solderer has two hands free for holding the soldering iron and feeding solder wire.

Soldering takes time and practice to produce good results. There are many examples of poor solder joints that may not create the desired electrical connection. See Figure 7 and Figure 8 for reference. A good solder joint will appear smooth and shiny, it should appear to flow completely around the pin and cover the entirety of the metal pad on the perfboard.

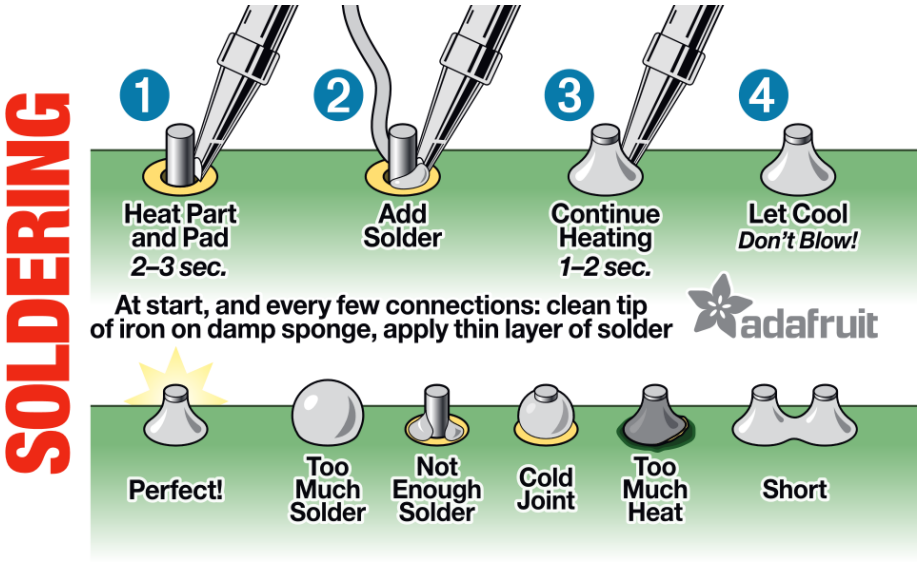

Figure 7: Soldering guide `https://github.com/adafruit/Reference-Cards`

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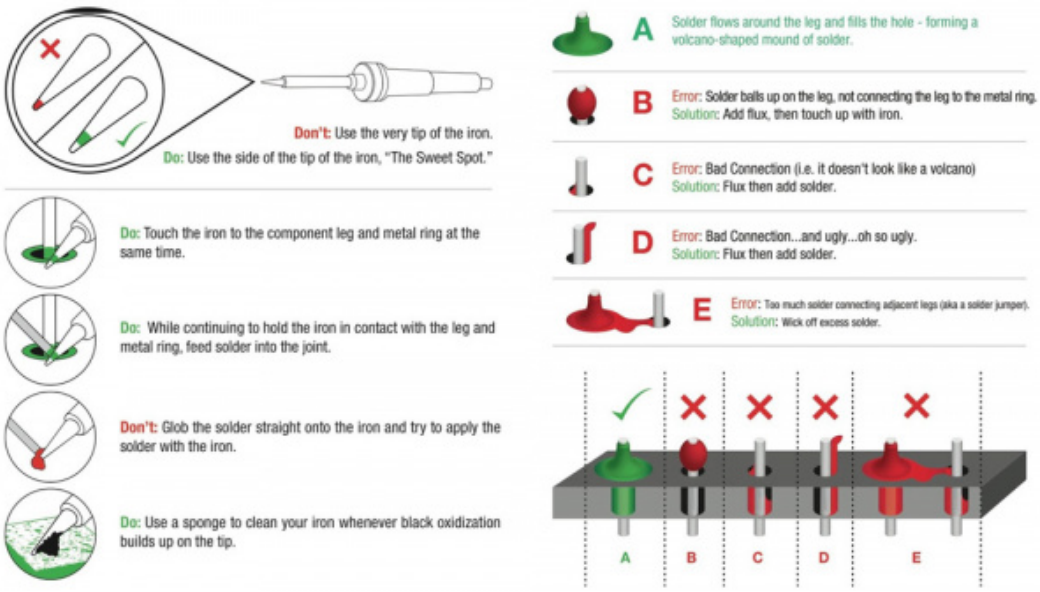

Figure 8: Soldering best practices `https://learn.sparkfun.com/tutorials/how-to-solder-through-hole-soldering/all`

Equipment

- Soldering iron
- Solder wire
- Safety glasses
- Perforated circuit board
- Pin-headers

Procedure

2.1 Soldering Practice

In this lab, we will be practicing soldering pin-headers onto perforated circuit boards or perfboard for short. Pin-headers are electrical connectors that consist of a male-type and female-type. Pin-headers are useful when prototyping on perfboard because it allows for other components to be attached and removed without having to solder directly to the perfboard.

Perfboards are used for prototyping circuits that need to be more permanent than breadboard prototypes. Sometimes the long jumper wires used with breadboard may produce extra resistance or have imperfect electrical contacts that negatively affect sensitive circuitry. Radio circuitry is especially susceptible to theses undesired effects, the long wires can act as antenna and pick up electromagnetic noise from the environment. Perfboard consists of an array of holes with metal contact pads surrounding the hole. Perfboard is typically used with through-hole components. The through-hole components are fed through the holes of the perfboard and solder is applied with the soldering iron to permanently fix the component to the board. Components are then connected together using short lengths of wire according to the circuit design.

Use the following steps to solder the female-type pin-header to the perfboard.

1. Obtain the equipment from the equipment list above. **Record the make and model of the soldering iron in use. Also record the type of solder wire in use.**
2. Wear the safety glasses at all times while the soldering iron is powered on.
3. Prepare the circuit board. The circuit board should be clean and free of debris.
4. Power up soldering iron. Set the temperature control to the temperature rating of the solder wire.
5. Carefully clean the tip of the soldering iron by rubbing it on the brass-wool or wetted sponge. Make sure to only touch the soldering iron handle, all metal parts on the soldering iron will be extremely hot.
6. Hold the soldering iron and apply a small amount of solder to the tip. This process is called tinning and it is important for allowing the solder to melt properly.
7. Apply soldering iron tip directly on the pin to be soldered for about 2-3 seconds. Lingering too long can cause heat to travel into a component potentially damaging it.

8. Feed solder wire into the tip and pin. The solder will melt and flow around the pin and pad. Pull the solder wire away when sufficient solder has flowed onto the pin.
9. Wait 1-2 seconds then remove the soldering iron tip from the work piece. The solder will begin to solidify as soon as the heat is removed. Do not attempt to cool the solder by blowing. Solder that cools too fast can become brittle and crack.
10. Assess the solder joint. A clean solder joint will be smooth and continuous. Poor solder joints may appear foggy and/or rough. Poor/Cold solder joints indicate a poor electrical connection that may be prone to failure. Use Figure 7 and 8 for reference.
11. Repeat the procedure for all the pins. Ensure that all partners have the chance to become comfortable with the process.
12. When finished, clean the soldering iron tip, power off the device and allow time for it to cool.
13. Return all equipment.

Questions

1. What is the make and model of your soldering iron?
2. What type of soldering wire was used?
3. What temperature was required for your soldering wire?
4. What are some of the negative consequences to applying the soldering iron to the perfboard and component for too long?
5. Explain at least two reasons why soldering prototypes on perfboard may be desired over breadboard prototyping.
6. Explain at least two reasons why prototyping on a breadboard may be desired over soldering on perfboard.