

Introduction to Soldering

Purpose: Become familiar with the general practices involved with soldering circuit boards, wires, and other electrical components.

Equipment Required

- 1 – Soldering Iron and associated power supply
- 1 – Sponge, wet
- 1 – Proto-board
- 1 – Wire-stripping tool
- 1 – ‘third-hand’ (if available) or tape or clamps.
- (Varies) – Misc chips (failed), resistors (shortened), wires, shrink tubing.

Prelab

Read and understand the ~~Lecture notes~~ ^{tutorial} pertaining to Soldering techniques and practices. Know what a good solder joint looks like and what a bad or ‘cold’ solder joint looks like.

Procedure

1. The project

This lab will involve 2 separate soldering sections. One will be to solder a microchip to a proto-board as well as soldering wires and resistors to the proto-board. You could simulate the wiring of an op-amp, as the chips being soldered this time are the failed quad op-amps from the prior weeks (reduce, reuse, recycle!).

The other will be to solder various wires into a shape of your choosing. The only requirements are:

- a. You use at least 8 sections of wire (each lab partner).
- b. You use thick stranded wire in several of the sections
- c. You use small single strand wire in several of the sections
- d. You use small stranded wire in several of the sections
- e. You join 3 or more wires at a single junction at least once
- f. You use shrink-tubing on one junction
- g. One of your small single-wire sections is soldered to different junctions at each end, and is not longer than 1cm.

2. Prepare the area for soldering

- A. Moisten the sponge so that it won't drip water if you don't squeeze it, but so it will drip water if you gently squeeze it.
- B. Examine the cold soldering iron tip to make sure it is not damaged. It should appear shiny for the last few millimeters.
- C. Make sure you have the materials you are going to solder ready, wire ends stripped, proto-boards with chips mounted, etc.
- D. Turn on the soldering iron, it will take a couple of minutes to get hot enough to work with.

***** **NEVER LEAVE A SOLDERING IRON ON FOR EXTENDED PERIODS** *****

If you expect to be doing something else for more than ~10 minutes, you should shut off the soldering iron to protect the tip from damaging oxidation.

3. Soldering technique

Proper soldering is a skill that is acquired through practice and repetition. Generally speaking the following guiding principles are true regardless of what you are soldering.

- A. The materials to be joined must be clean and dry. (flux may assist with this in certain cases). Sometimes sanding/emery paper will be required before soldering as well as application of flux. Most electronics solder has flux contained within the solder itself.
- B. The surfaces should be pre-tinned, especially wires and contact 'fingers'. (the copper holes in the proto-board are an exception as well as the legs to integrated circuits). Individually pre-tinning the items to be soldered will greatly facilitate good solder joints being formed. Failure to pre-tin wires and other components can often result in more time wasted than saved, as well as risking cold solder joints.
- C. The materials to be joined must **both** reach a temperature where solder will melt when in contact with them. This means larger materials (thick wires, metal blocks, etc) will require heat to be applied for a longer period. This also requires

careful application of heat when nearby components or insulation will be damaged from too much heat. In general, silicon chips should NOT exceed ~80 degrees C, or dopant diffusion in the silicon chip will permanently damage the devices on the chip.

In other words Too much heat = bad and Too little heat = bad.

The best way to get a feel for this is practice.

- D. Once both (or more) components to be soldered are the proper temperature, apply extra solder as necessary to provide sufficient bonding between the components.

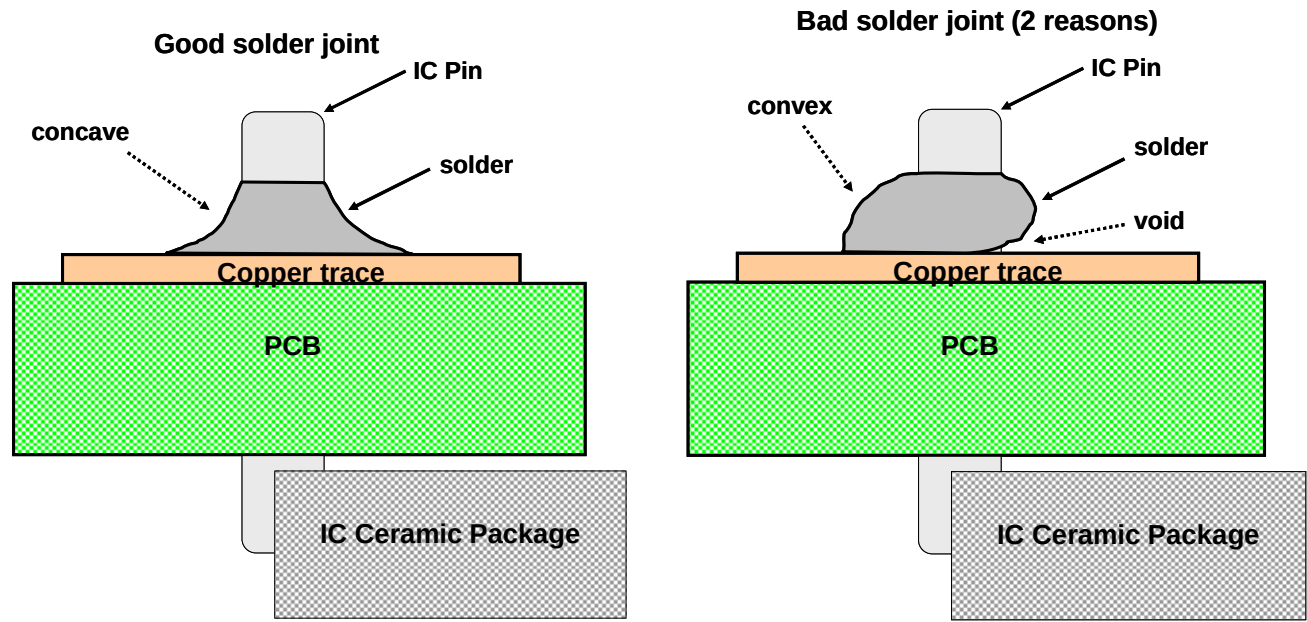
As before: Too much solder = bad and Too little solder = bad.

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- E. Once a small amount of solder has been applied to the solder joint, remove the solder supply and the soldering iron. **Do NOT allow any of the components to move as the liquid solder hardens and cools**, or you will generate defects in the solder potentially leading to high resistance and intermittent thermal contact problems!
- F. After it is cool, inspect the solder joint for quality. Solder surfaces should be shiny 'silver' in appearance with a concave nature. There should be no voids or gaps. Convex solder surfaces and solder that appears dull grey or white in appearance are indicative of a cold solder joint and should be repaired, either by reheating, or adding more solder, or removing most of the solder and starting over.
- G. After the entire circuit is assembled, gentle application of heat, using a heatgun, to the shrink tubing that you prepared will protect your circuit from inadvertent shorts, metal fatigue, corrosion, and other problems. Do not shrink the shrink-tubing until you are sure your soldering is a success. The only way to remove it is to cut it away, making re-installation of shrink-tubing a tedious chore.

4. Soldering inspection

- A. Visual inspection can often reveal problems with a solder joint (see below).
- B. Slight Mechanical force can often reveal problems with a solder joint.
- C. Electrical resistance measurements can sometimes reveal a problem, although remember a resistance measurement of a component in a circuit may have many paths from point A to point B, so should only be used with skepticism and careful thought.



5. Other soldering information

There are many kinds of solder, including solder 'paste' which is often used in surface-mount applications. The advantage of solder paste is that it can be put down before joining two components, and it can be melted with a hot-air gun. Different kinds of solder have different temperature limits, different strength limits, and different costs.

Copper household water-supply plumbing is soldered, typically using silver or other lead-free solder. Why wouldn't you use a more conventional SnPb alloy for household plumbing?

Flux, over a long period of time, can lead to corrosion on circuit boards. Therefore it should be removed (a scrub brush with methanol can help with this, or there are specific products to assist with flux removal).

There are several ways to remove solder. There are solder-sucker tools (some motorized, some not), and copper braid.

Conclusion

From the past multi-week lab, most of you should now have a feeling about how difficult troubleshooting complicated circuits can be. With that in mind, comment about the quality of solder joints and how important they can be to a printed circuit board assembly, like a computer motherboard, or even the electronics in your microwave oven. If the failure rate of any given solder joint is very small but non-zero, what impact does that have when you consider the whole electronic assembly?