

Soldering 101



- Soldering is the process of joining two metals together to form an electrically and mechanically secure bond using heat and a third metal alloy known as solder.
- Poor soldered joints will fail, causing partial or complete failure of the circuit (CCT).
- NOTE: If part of a CCT fails, it could permanently damage a board, depending on the circuit design.
- In industry, a failed CCT costs money \$\$\$ and time \$\$\$

Solder – The Stuff



- The solder you will be using is a metal alloy of 63% tin 37% lead with a low melting point of 183C & a rosin core (acts like flux to help remove oxidation).
- This is eutectic solder – goes directly from solid to liquid state when melted (no plastic phase).
- Solder properties
 - A) Melting point
 - B) Mechanical resistance to fractures
 - C) Cost
- Solder poses a health hazard
 - Do not hold solder with your teeth
 - Do not lick, bite or place hands in mouth
 - Do not hold solder for excessive periods of time
 - Avoid breathing fumes... guaranteed it's not nicotine!
 - Wash your hands before leaving the lab each day**EVEN IF YOU HAVEN'T TOUCHED SOLDER**



Soldering Why It's Hard



- A list of things you don't want to do:
 - **Don't overheat the part or pad**
 - ✦ Might damage your part or the pads/traces
 - **Don't underheat the part or pad**
 - ✦ Creates poor bonds, cold joints
 - **Don't melt the solder on cold parts**
 - ✦ Creates poor bonds, cold joints
 - **Don't use too much solder**
 - ✦ Creates a mess, prevents inspection of good bonds and could 'bridge' or connect onto other parts.
 - **Don't use too little solder**
 - ✦ Creates poor bonds

Before Soldering



- Plug in and turn on iron.
- Ensure iron is hot enough
(melt a little solder and visually inspect how fast it melted).
- Clean your tip on wet sponge to remove any oxidation, excess molten solder or debris on your iron.
- Tin (apply a little solder) your iron. This is **CRITICAL** for good work.
- Prepare your part for soldering
 - Place your part in the PCB or in a third hand
 - Ensure part is clean - free of oxidation or debris (glues)

Before Soldering, cont.



- Ensure most parts are on tight against the board unless otherwise specified.
- Service clinch ~45 degrees – easier to desolder later.
- Full clinch – usually when automatically inserted.



Before Soldering, cont.

- **Bend allowance** – do not bend wire right against resistor body. Bend less than 90°, slightly rounded.
- Can use fingers, needle nose pliers.
- In industry – tools like those pictured below may be used.



Manual cut and bend tool for axials on tape.



Hand-held resistor lead bending tool.



Soldering Process



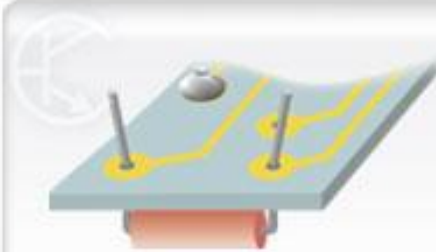
- The trick to soldering is identifying when you have the right amount of heat and solder.
 - 1) Place iron on both part and pad to heat both up.
 - 2) Apply solder to the connection opposite the iron.
 - 3) Allow solder to completely wet (coat) the connection – if temp is high enough, solder will wick toward the iron (solder creates a “cone” around the lead).
 - 4) Remove solder first, hold iron on your part for no more than 1 second after solder wire removed to ensure the solder has fully surrounded your joint. If iron is left on joint for too long, flux evaporates and oxidation can occur, causing a bad/cold solder joint.
 - 5) Allow solder to cool and solidify undisturbed.
 - 6) Use diagonal cutters to remove excess lead. Cut away from yourself and others nearby. Cut cleanly, do not twist or unduly stress joint.

Pictorial View of Soldering

HOW TO: Basic Soldering Techniques for Kit Building



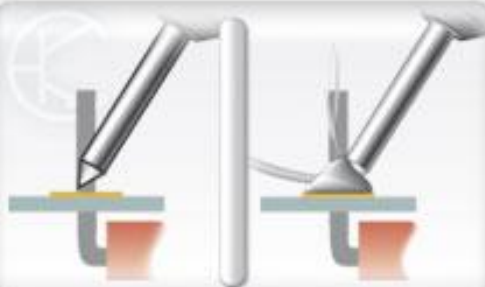
1. Assemble the proper tools.



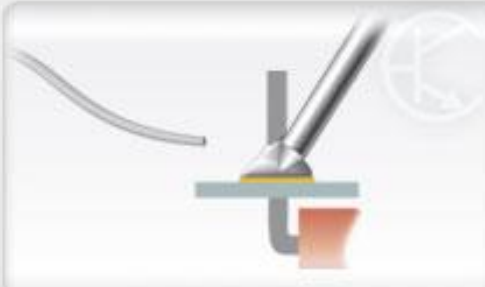
2. Mount component by bending leads out sightly.



3. Heat iron. Clean tip with damp sponge.



4. Apply heat. Apply solder.



5. Remove solder. Remove iron.



6. Inspect solder. Cut lead.

Inspect Your Bond



- Always inspect your work!
- What to look for:
 - 1) Bond should be a cone and shiny.
 - 2) Profile of bond should be concave, not convex.
 - 3) Bond surrounds part completely.... not 99%.
 - 4) Bond does not cover other connections.

Inspect Your Bond



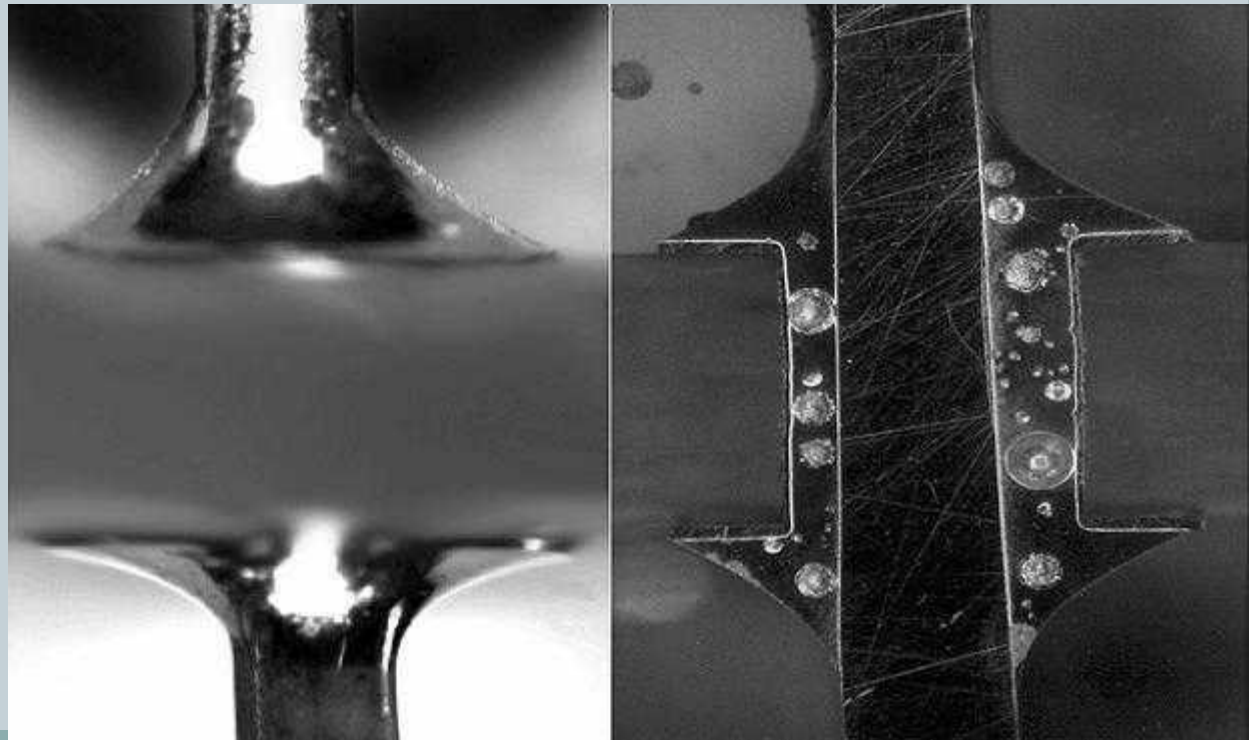
- How to fix problems:
 - Apply heat again, not as long as before, with clean iron.
 - Add a small amount of solder... very small.
 - If too much solder is applied, use a copper wick or solder sucker to remove the solder.

Note: Solder sucker removes most of the solder. You will have to re-solder after this process. This may produce excessive heat on your part... possibly damaging it.

Example of a Good Bonds



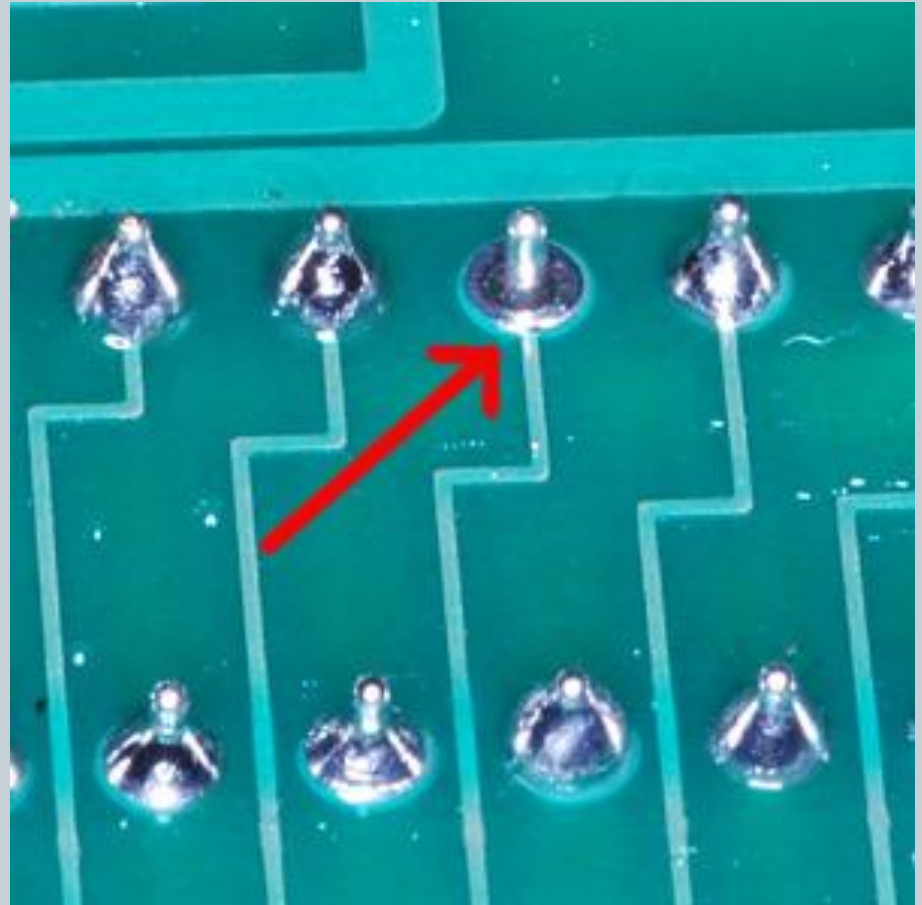
- Here is a picture of a good bond. Note the concave cone, and the shiny metal. The second picture is a cross section of the wire soldered through a via (hole) in a PCB.



- Picture provided by NASA

Soldering Bond Inspection

- This is an example of not enough solder.
- Note other bonds are shiny and surround the entire part.



Soldering Bond Inspection



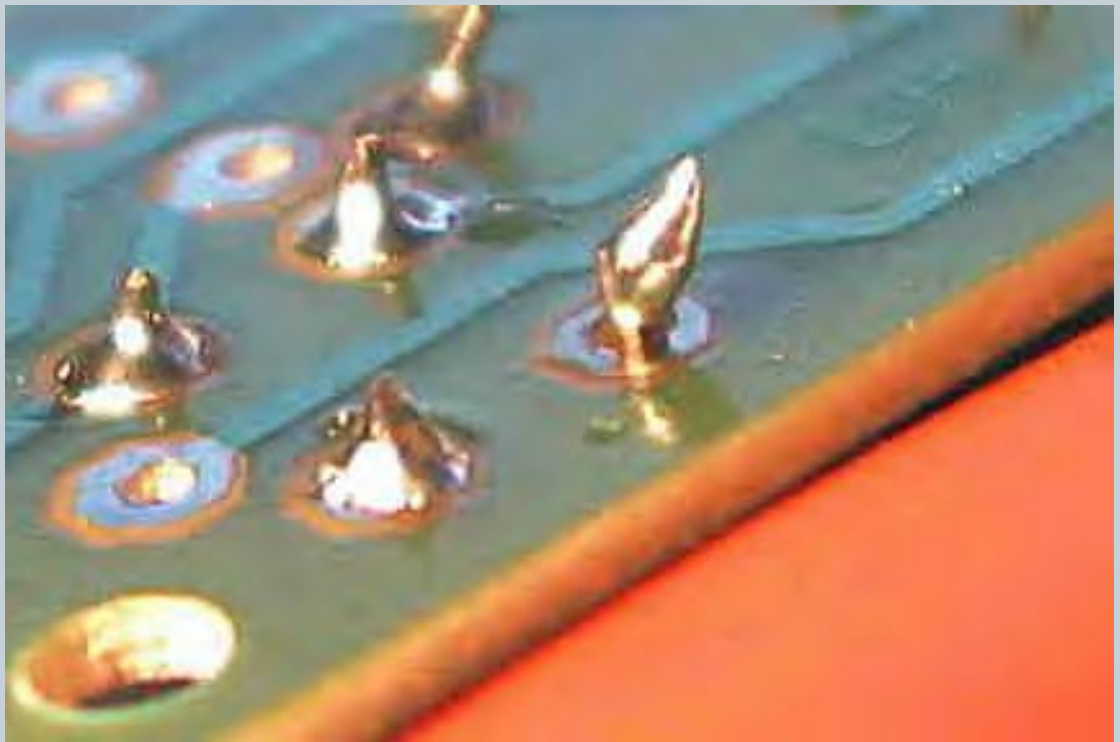
- Cold joints look greyish.
- Can occur when not enough heat is applied
- Can occur if the bond is moved before solidification



Soldering Bond Inspection



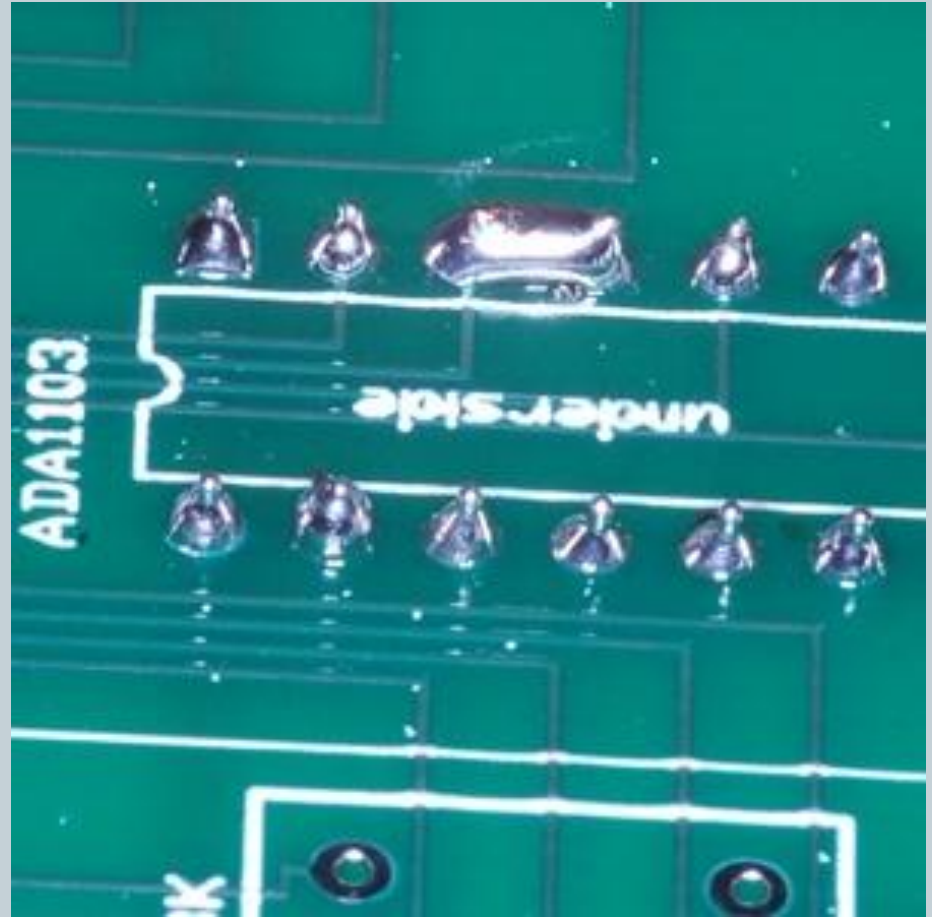
- One connection is a cold joint. Note the molten metal is only on the pin, not the pad.
- Two other bonds are not around the entire part.
- Top left is a good bond.



Solder Bridges

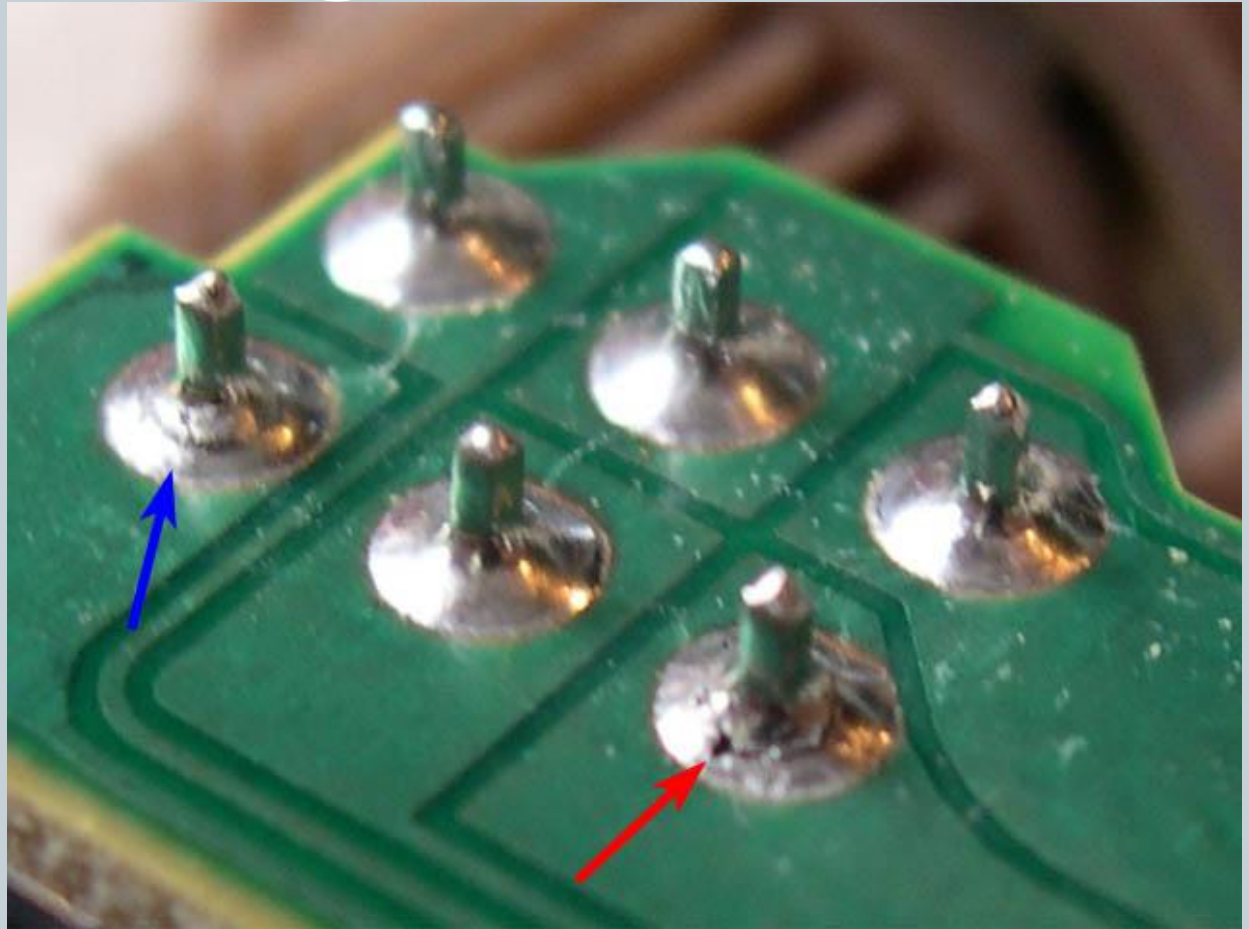


- Be careful not to bridge bonds
- Fix: Heat pin with clean iron, remove sideways.
- Fix: Redo, use solder sucker.
- Fix: Modify by removing some solder with wick.



Why Are Parts Flush Mounted?

- Your parts must be flush mounted on the board to avoid broken bonds. The picture on the right shows two bonds that are mechanically broken. Let the PCB take the stress, not your bonds.



Soldering Two Wires



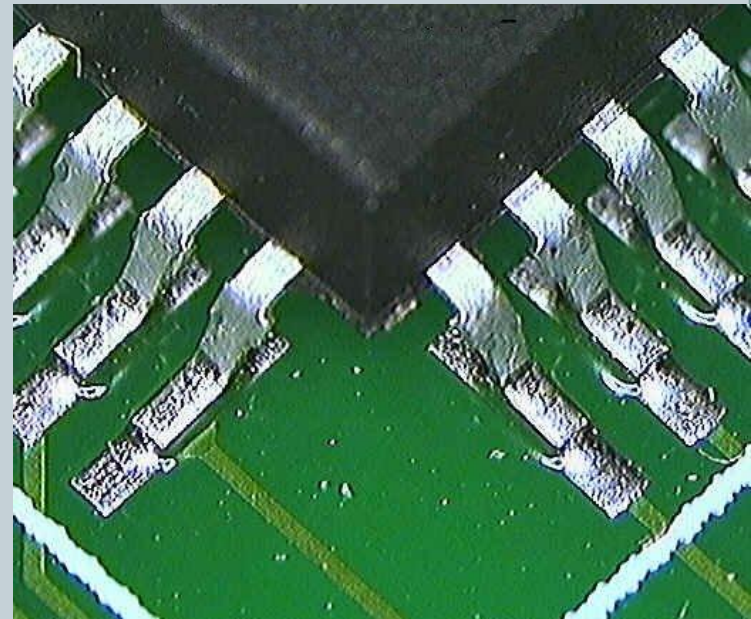
- Before soldering two wires, cut a piece of heat shrink tubing, and place on one wire.
- When soldering two wires, interlace them and add enough solder to cover all strands.
- Heat shrink tubing to cover bond, or apply electrical tape.



SMT Bonds



- This is beyond this course, but in case you are curious:
- SMT parts are also bonded either by hand or by oven.
- Good bonds look like the figure on the right.
- Be careful not to add too much solder to these types of bonds.



Additional Information



- <http://www.epemag.wimborne.co.uk/solderfaq.htm>
- <http://en.wikipedia.org/wiki/Soldering>

De-soldering Techniques



- De-soldering should be avoided if possible, but done if necessary; excessive heat could cause problems with parts failing and with PCB pads/traces lifting.
- Two methods for simple components:
 - 1) Solder Sucker: Is a device which sucks the molten lead.
 - 2) Copper Wick: Thin braided copper wires form a cloth like wire. Some have flux on them, other are just copper. Solder will get wicked up the braid, away from the PCB connection.

De-soldering Techniques



- Industrial method:
 - Industry often uses an iron with a suction compressor built in. There is a small hole in the iron, where the molten solder is sucked. This reduces time and amount of heat required to accomplish the task.

De-soldering Iron

Suction Pressure

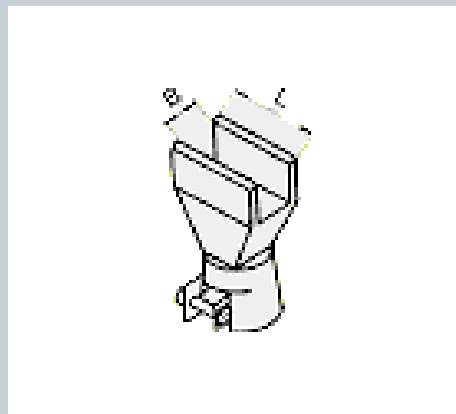
Suction Hose



De-Soldering Techniques



- SMT Methods:
 - Special tips are made for de-soldering multi-pin ICs. They allow the user to melt the solder on all pins simultaneously to then remove the component.
 - Others use a very hot air gun, with tip fittings that are specifically made for the component in question.



De-Soldering What to Watch For?



- Excessive heat to the pads or traces.
 - Might cause them to peel off PCB.
- Incomplete removal of solder from the PCB pad or component.
 - If most of the solder is not removed, the part will not be free.
- Damage to components, PCB pads, wires or terminals from heat.



De-Soldering Tool (Solder Sucker)

- To use the solder sucker, pre-heat the joint, apply the tip of the sucker directly on the joint, then press the button to suck the molten metal away.
- If you wait too long, the molten metal will solidify
- **This takes some practice!**



Soldering Wick



- Place wick on solder bond.
- Heat wick with soldering iron.
- Wait until solder is fully absorbed up into wick (slowly rolling iron up the wick can help).
- Minimize time heating component.

