

Electronic Hardware

Onboarding: Soldering

#005



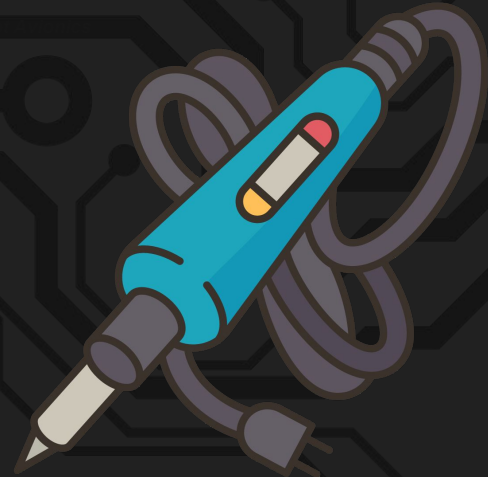
Introduction

Agenda:

1. What is Soldering?
2. Types of Soldering: Through Hole and Surface Mount
3. Materials
4. Equipment
5. Safety
6. Desoldering
7. Common Issues
8. Debugging

Goal:

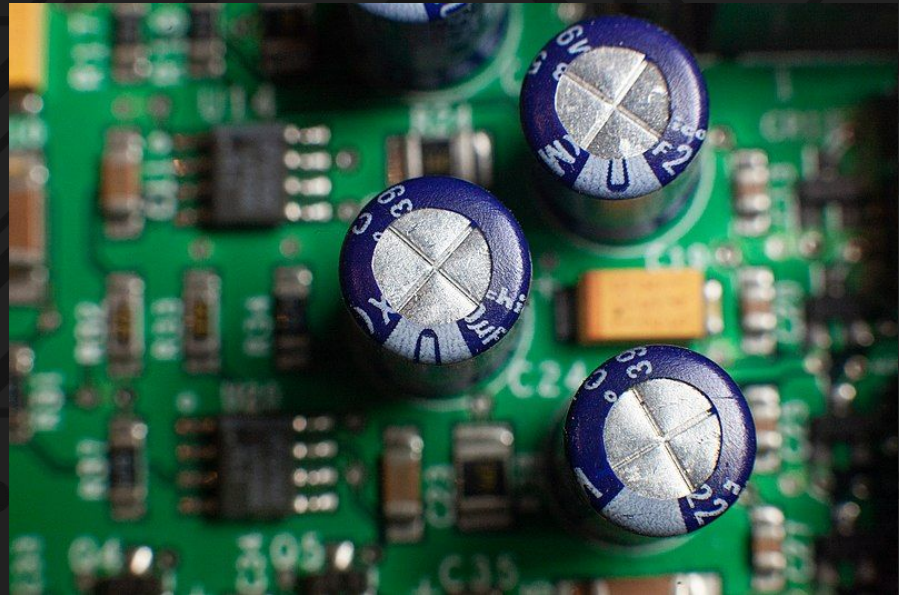
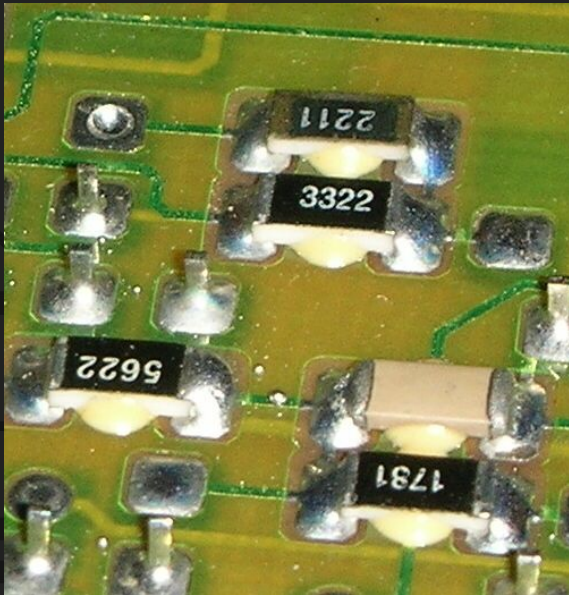
Understand the preparation, safety measures, and processes associated with different types of soldering





What is Soldering?

Electrically attaching components to a circuit board using solder: a metal compound that melts at low heat and is a great conductor of electricity



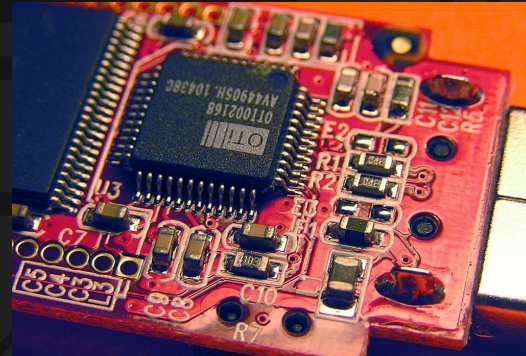
Types of Soldering

Through Hole



- Wires extend through the board and are soldered on the other side
- Melt solder wire onto the pad using the iron
 - A volcano-like shape around the wire of the component is ideal
- Cut off the extra portion of the wire

Surface Mount

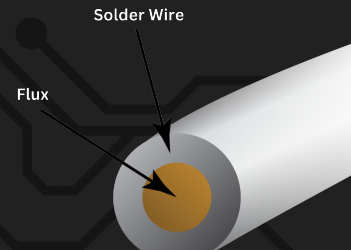



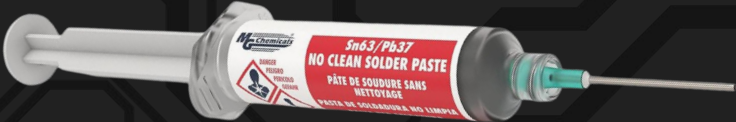



- All soldering takes place on the same side of the board.
- Place the component onto the pads.
- Apply heat using an iron or heat gun to melt the solder, connecting the pads and the component.



Solder Wire/Paste

- Used to form an electrical bond between components and the board
- Generally Contains Flux



	Melting Temperature	Appearance	Packaging
Lead Sn63/Pb37	183°C	 Leaded	
Lead-free SAC305 (Sn96.5/Ag3/Cu0.5)	220°C	 Lead-Free	
Lead-free low temperature Sn42/Bi57/Ag1	138°C		



Other Materials

Flux

- Clean surfaces and prevent oxidation, allowing for better connections

Copper wick

- Used to absorb solder

Isopropyl alcohol

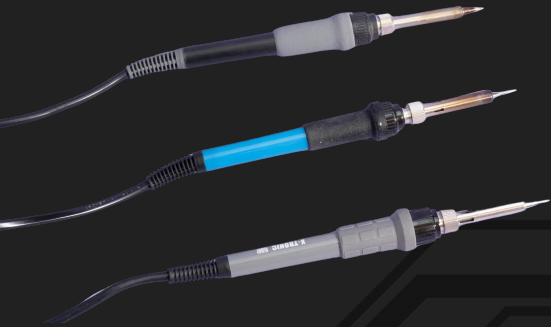
- Useful for cleaning purposes





Hot Equipment

Soldering Iron



- Used to apply heat to a specific area, melting solder and heating pads
- Can switch out tips for a variety of different applications
- Must clean using a sponge or brass wire to remove old, oxidized solder and flux, which can prevent the tip from properly transferring heat



Heat Gun



- Used to heat up larger areas than an iron



Bent Tip



Knife Tip



Bevel

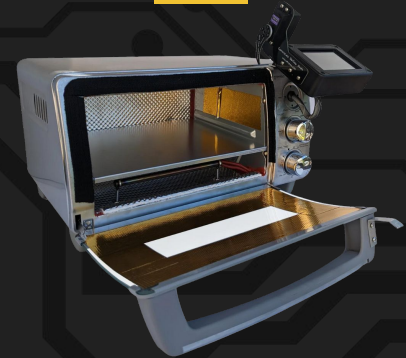


Chisel



Conical

Oven



- Heats the entire board
- Used for surface mount
- Reflow ovens gradually raise temperature to avoid damaging components, until the solder is melted



Advanced Equipment

Pick-and-place machine

- Places components in their respective positions once paste has been applied
- Used for surface mount

V-One PCB Printer

- Drill holes, print traces, dispense paste, and reflow in one machine
- Used for quickly prototyping PCBs



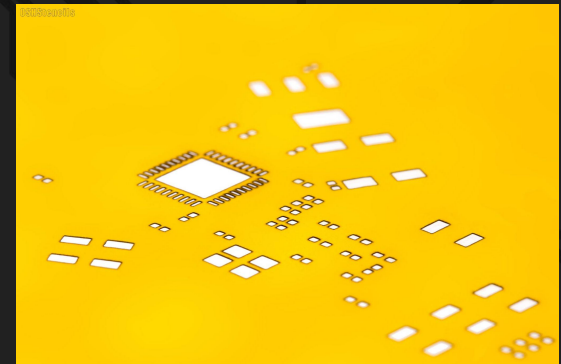
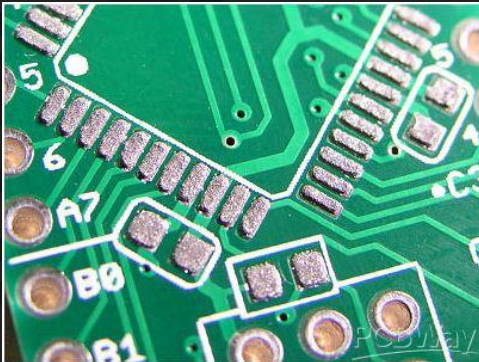
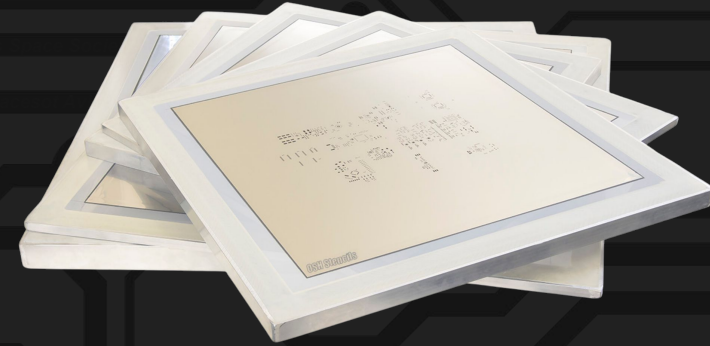
- **Be careful around hot objects** — soldering irons are generally several hundred degrees celsius
 - Use stands for soldering irons to reduce risk of coming into contact with them accidentally
- **Protect from fumes created by solder and flux**
 - Good ventilation
 - Fume extractors
- **Wash hands and avoid touching the face after working with solder**





Stencils

- **A stencil is a sheet with holes for each pad**
 - Used to apply paste to the entire board for surface mount soldering
 - Generally laser-cut stainless steel/brass or polyimide film
 - Frameless and framed variants
- **Apply paste to the pad using a stencil:**
 - Align the stencil with the pads on the board.
 - Use a squeegee to spread paste across the stencil and through the holes.





Desoldering

Through hole:

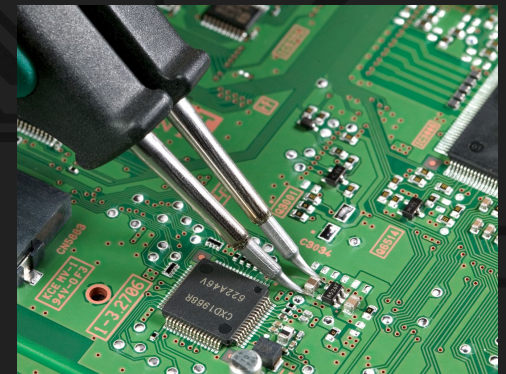
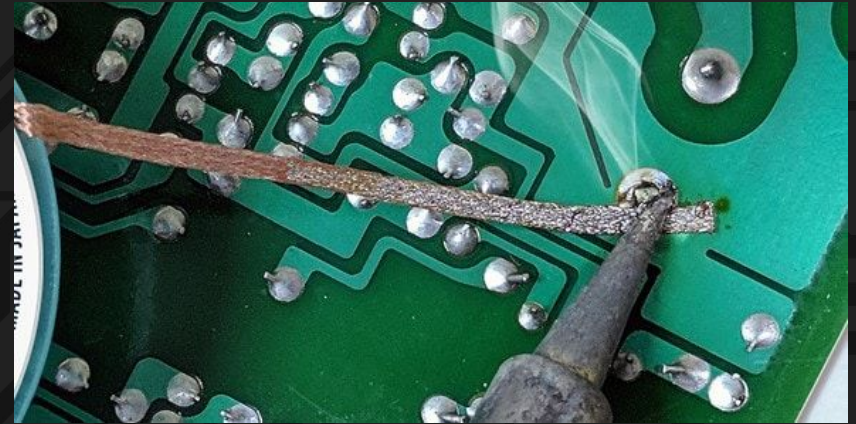
- Hold copper wick to the solder and apply heat using an iron
- Solder will melt into the wick
- Remove wick and iron together to avoid wick being soldered to the board

Surface mount:

- Apply heat to melt the solder.
- Pull component off using tweezers or similar tool
- Alternatively, use hot tweezers

Solder suckers

- Another useful tool for removing solder





Common Issues

Cold Joints

- Solder did not melt completely, maybe appearing rough and lumpy
- Reheat the solder and allow it reform

Insufficient Wetting

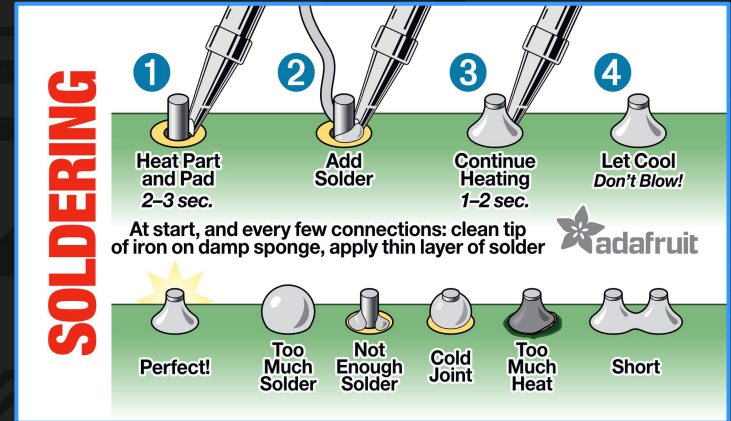
- Solder did not properly connect with the pad or pins
- Add more solder and reheat

Pads Ripping

- Often caused when copper wick is removed incorrectly
- Attempt to reattach, otherwise use a jumper wire

Shorts

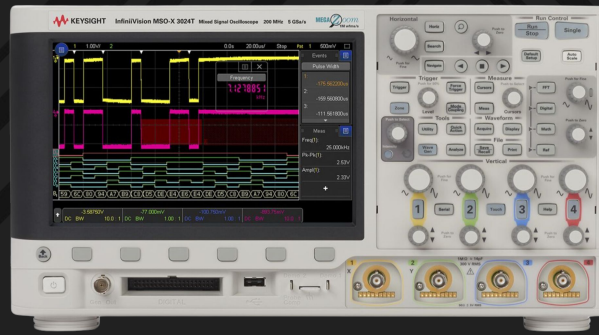
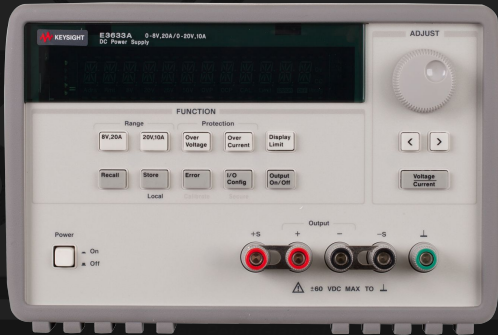
- Two pads are connected by excess solder
- For minor cases, go over again with an iron and flux
- If needed, remove excess solder with the iron





Debugging

- Before connecting to power, check for shorts using a multimeter
 - Check continuity between nearby pads as well as to power lines
- Connect to power and flash code to the board
- Use an oscilloscope to read signals and diagnose problems





Further Reading

Brewster, Signe. "The Best Soldering Irons." *Wirecutter*, The New York Times, 15 Sept. 2021,
<https://www.nytimes.com/wirecutter/reviews/best-soldering-irons>.

Earl, Bill. "Adafruit Guide to Excellent Soldering." *Adafruit Learning System*, 18 May 2019,
<https://learn.adafruit.com/adafruit-guide-excellent-soldering>.

Holliday, M. "Intro To Soldering," *Stanford Electrical Engineering Department*, 2019,
<https://sites.google.com/stanford.edu/soldering-internal/learning>.

McCarty, Chris. "PCB Bring-Up with SparkFun and inspectAR." *SparkFun Electronics*, 25 March 2020,
<https://www.sparkfun.com/news/3268>.

"Soldering." *University of Technology Sydney*, 2016,
https://www.uts.edu.au/sites/default/files/Soldering_0.pdf.

"The Ultimate Guide to Soldering Iron Tips: Types, Sizes, and Uses." *AiXun*, 2023,
<https://www.aixuntech.com/newsinfo/the-ultimate-guide-to-soldering-iron-tips-types-sizes-and-uses/>.

"Understanding What is Solder Wick." *MG Chemicals*, 2023,
<https://mgchemicals.com/knowledgebase/what-is-solder-wick/>.



Suggested Products

Hot Equipment

- Soldering Irons: <https://www.nytimes.com/wirecutter/reviews/best-soldering-irons>
- Brass Sponge: <https://www.sparkfun.com/products/8964>
- Heat Gun: <https://store.metcal.com/en-us/shop/convection-rework/hot-air-tools/HCT-900-10>
- Reflow Oven: <https://whizoo.com/products/ready-to-run-reflow-oven>

Materials

- Solder Paste: <https://mgchemicals.com/category/soldering-supplies/solder-paste/>
- Flux: <https://mgchemicals.com/products/soldering-supplies/soldering-flux/soldering-flux-paste/>
- Solder Wire: <https://mgchemicals.com/products/soldering-supplies/solder-wire/lead-free-solder/>
- Copper Wick: <https://mgchemicals.com/products/soldering-supplies/desoldering-braids/solder-wick/>
- Isopropyl Alcohol: <https://www.amazon.com/Swan-Isopropyl-Alcohol-99-Pint/dp/B001B5JT8C?th=1>

Advanced Equipment

- Voltera V-One: <https://www.voltera.io/v-one>
- Pick and Place: <https://www.opulo.io/products/lumenpnp>

Fume Extractors

- Fume Extractor: <https://www.parts-express.com/Solder-Fume-Extractor-370-358>
- Exhaust Arm: <https://www.fishersci.com/shop/products/exhaust-arm-basic-model-2/p-7146258>

Stencils

- OSH Stencils: <https://www.oshstencils.com/#%20>
- PCBWay: https://www.pcbway.com/pcb_prototype/SMT_stencil_and_Laser_Stencil.html

Desoldering

- Solder Sucker: <https://anchor-electronics.com/product/eclipse-tools-dp-366p-solder-sucker/>
- Hot Tweezers: <https://hakkousa.com/fx-8804-hot-tweezer.html>

Debugging

- Multimeter: <https://www.fluke.com/en-us/product/electrical-testing/digital-multimeters/fluke-115>
- Oscilloscope: <https://www.keysight.com/us/en/product/MSOX3024T/mixed-signal-oscilloscope-200-mhz-4-analog-16-digital-channels.html>
- Power Supply: <https://www.keysight.com/us/en/product/E3631A/80w-triple-output-power-supply-6v-5a-25v-1a.html>



Image Credits

- Adafruit. "Card 4 Back." 23 Dec. 2016. *GitHub*,
<https://github.com/adafruit/Reference-Cards/blob/master/Card%204%20Back.pdf>
- Aisart. "Soldering a 0805." 21 Nov. 2006. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:Soldering_a_0805.jpg.
- Fader, John. "SMT Closeup." 7 Dec. 2004. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:Smt_closeup.jpg.
- Giovanna 27. "Electrolytic capacitors mounted on a circuit board." 2021. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:Electrolytic_capacitors_mounted_on_a_circuit_board.jpg.
- Glosome. "Circuit Soldering." 1 Feb. 2020. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:Circuit_Soldering.gif.
- Heller Industries Inc. "Mark5 1826 Reflow Oven." 29 Nov. 2011. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:Mark5_1826_Reflow_Oven.jpg.
- Hutschi. "Surface Mounted Device, Soldered." 29 Feb. 2008. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:Surface_Mounted_Device_soldered.jpg.
- Taube, Christian. "MOS6581." 29 Dec. 2006. *Wikimedia Commons*,
https://commons.wikimedia.org/wiki/File:MOS6581_chtaube061229.jpg.