

Surface-mount Soldering

Bruce E. Hall, [W8BH](#)

Here are a few notes on how I learned to solder surface mount devices. I am over 50 and I can easily solder SMD, so you can too. I assume that you already know how to solder through-hole parts. What follows is not a step-by-step guide, but rather a collection of notes, ideas, and recommended equipment for the beginner.



How to learn to SMD solder:

- Start with the right equipment. You must have a decent soldering iron, low power magnification, adequate lighting, good solder, flux, and solder-wick. Leaded solder is easier to use than unleaded solder. See my list below and obtain what you need. The hot air station is not necessary, but is an excellent tool for removing parts.
- Get an SMD kit to learn on. I used the GitFun Kit AE1173 (about \$9 on Amazon) which has 0806, 0603, SOT-23, SOIC-16 and QFP44 components. This kit has smaller components than some of the others. The finished kit doesn't do anything, so no anxiety! Just practice.
- While you are waiting for your equipment to arrive, start watching some YouTube SMD tutorial videos.
- Practice on your board. Don't do the entire board at the outset, just a few components of each type. Write down what works for you, and what doesn't. Create solder bridges on purpose and learn to correct them. If you have a hot air station, try removing components and resoldering them. Each component can be removed and resoldered several times.
- Go back and watch those videos again, to see how they avoided the problems you encountered.
- Finish the board.

The tools I use.

- Soldering Iron: Weller WES51. A 50-watt iron is sufficient. You can spend more money on newer irons, digital displays, etc. I prefer this simple analog one. The old-fashioned knob is faster to use than pushbuttons! If you need a new iron, look at models by Hakko and Weller. Not good enough? Try JBC with a T245 or T210 handle.
- Solder: Kester 63/37. Leaded solder is easier to use than unleaded solder. I prefer the shiny, eutectic 63/37 to my older 60/40 stock. Kester is a great brand. I use .031" solder primarily, applying solder to the iron rather than the joint. This technique works because you will use additional liquid flux on the board. Thinner solder 0.015" is great if you prefer to apply solder directly to the joint.
- Flux: Kester 186 in 2oz bottle, also Chip Quick SMD291 in 10g syringe. See notes below.

- Solder-Wick
- Silicone work pad. Not necessary, but it nicely insulates your desktop from the heat. I use Adafruit #3536 (\$10). I can't imagine working without it now.
- Tweezers. If you don't have any, search for SMD tweezer and get a set. I often used two sets when placing components. I like tweezers with a 45-degree angled tip.
- Kimtech wipes. You will need a lint-free wipe to clean flux off of the board. These work well.
- 99.9% isopropyl alcohol in push-top dispensing container for spot cleaning. The 99.9% (anhydrous) alcohol is expensive, but dries quickly.
- 91% isopropyl alcohol for whole-board cleaning. Cheaper than anhydrous and available in your local pharmacy, grocery, Walmart, etc. But since it is 9% water, it takes longer to dry.
- Quick 957DW hot air rework station with 3 tips (Adafruit #1869, about \$100)
- Illuminated magnifier. If you want to splurge, think about a 10x optical microscope (AmScope SE400-Z, about \$200)
- Blunt-tip dispensing needles are handy for dispensing solder paste. They are also useful for dispensing small amounts of flux. Your solder paste will likely come with a needle, but eventually that needle will clog. Use 20ga needles for standard 0805 work. I like the bent-needle variety. Buy a bag of 50-100 on Amazon for around \$10.
- Even better than needles, try "conical dispensing tips" (yes, you can search on that term). I like the 22 and 25ga plastic tips. Solder paste is *much* easier to dispense from these plastic tips compared to stainless steel needles.



*IPA dispensing bottle.
Expensive but worth it.*

Soldering Iron:

- The temperature is set to 700F.
- Use a wide chisel or screwdriver tip. The conical tips aren't nearly as good!
- What surprised me: I didn't need a small tip (or very fine solder) to do this soldering. The wider tips did a better job of transferring heat than the thinner ones.

Hot Air Station:

- Mine came with three nozzles. The medium one (3mm) works great.
- Use a temperature of 275C.
- Use a low flow rate, so as not to disturb the component. A setting of 2-3 works fine.

Solder paste:

- Using ChipQuick leaded solder: **SMD291AX** (63 Sn/37 Pb). Alternate choices are Kester EP256 and MG Chemical 4860P. Some say that Kester is too thick.
- Solder paste has a limited shelf life: one year if refrigerated.



- Refrigerated paste must be rewarmed to room temperature (3 hours) before using.
- Shelf life at room temperature is 6 months or less.
- I have decided to keep mine at room temperature.
- To temporarily store the paste, here is what I do:
 - Suck up small amount of flux in base of dispensing needle.
 - Put thin rubber cap over needle tip
 - Place whole tube of solder paste in ziplock baggie, marked with expiration date.

Flux:

Wow, is this important. It is OK to use a lot of flux, and using more is better than not using enough. Kester 951 is a clear, no-clean flux that burns off very quickly. I thought I would prefer a no-clean flux, but I am disappointed with the results. Kester 186 is a rosin-based flux that will leave a thick residue, but burns more slowly and works better. I prefer the look of **Kester 186** followed by an alcohol cleaning. This flux makes a mess of your board, and takes a while to clean properly, but results in very nice solder joints.



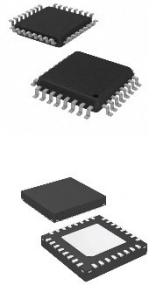
For small amounts of flux, **ChipQuik SMD291** works great: apply with a syringe or toothpick to the pads of interest. The flux is slightly tacky, will stay where you apply it, and is not nearly as messy as Kester 186. I use both.

SMD Component Packages and Sizes:

- Two-pin passive components, like resistors and capacitors, come in a variety of sizes. For example, a 1206 part mean that the part of 0.12" long by 0.06" wide.
- The larger SMD sizes, 1210 and 1206, are good for applications that require more power, but are not currently being used as much as the smaller sizes.
- The smallest sizes, such as 0201 and 0402, are really, really small! They are hard to see and easy to lose. Yes, people can hand-solder them, but not me.
- 0805 is a good compromise size that you can see, place, and hand solder with low power magnification. 0603 is doable with practice and patience. I am sticking with 0805.
- Resistor codes: "472" = 47 with 2 zeros = 4700 = 4.7K. "100" = 10 with no zeroes = 10. 4R7 = 4.7 ohms. "4712" = 471 with 2 zeros = 47100 = 47.1K. If the code is "45N" with a letter at the end, this is the EIA96 coding system and must be looked up.
- Three leaded components use the "SOT" = small outline transistor packages. The most common is SOT-23. SOT-89 has an enlarged tab on one side which is same as middle lead. SOT-223 is used for voltage regulators and looks like a large SOT-89.
- Integrated circuits:
 - SOIC = small outline integrated circuit. Typical lead pitch = 50 mills = 1.27 mm.
 - Very Small Outline Packages (VSOP) have lead pitch of 25 mills = 0.65 mm



- Quad Flat Pack (QFP) chips have leads on all four sides, often 32 or 44 pins, with a typical pitch of 0.8 mm. Variants include TQFP = thin quad flat package (1mm thick) and PQFP = plastic quad flat package (2-4 mm thick).
- QFN (Quad Flat No-leads) do not have pins and more challenging to solder. See below for some soldering tips.
- A number after the package indicates total number of pins/pads. For example “QFP44”. Pins are numbered counter clockwise with pin 1 at the package dot/dimple.
- SMD Transistors are often prefixed with MMBT, like MMBT4401, MMBT2222



Steps to mount an SMD component with soldering iron:

1. Clean the board. Mechanically clean, then alcohol wash.
2. Apply light coating flux to pads
3. Position component on pads.
4. Apply flux again. One drop over a smaller component will do.
5. Clean soldering tip and apply fresh solder to tip
6. Hold down component with tweezers or toothpick in left hand.
7. Apply solder to one pad with iron.
8. Apply flux to second pad and solder it.
9. For IC components, apply flux again, put fresh solder on tip, and drag across pins

Steps to mount a small SMD component with hot air station:

1. Apply solder paste to the pads.
2. Use tweezers to place component on pads. Push down gently.
3. Pre-heat the component and surrounding board for one minute by holding the hot-air gun 1½ - 2" above the board. (I am usually in too impatient to do this step)
4. Slowly lower the hot-air gun ½" or less above the board. It only takes about 10-15 seconds for part to snap into place. Move the nozzle back-and-forth over the part to distribute heat evenly and minimize part movement. You don't need to hold part in place while heating, as long as airflow is not too fast.

Fixing Solder-Bridges:

- Apply flux to affected pins.
- If it is a small bridge, touch dry iron to the affected pins, and drag away from IC.
- For larger bridges, put small piece of solder-wick across pins, and apply soldering pencil to pads (not the IC).

Cleaning the board:

- To clean around a component, apply alcohol to a kimwipe, place the wipe on the board and brush over the wipe using a toothbrush. Rosin will be transferred into the wipe without disturbing the rest of the board. For small spaces use a toothpick instead of a toothbrush. Do this twice, then dry.
- The whole board can be safely washed in a shallow bath of 91% IPA in a food storage container. Pick a sandwich-size container with a tight-fitting lid. I like glass containers better than plastic ones. Tri-chloroethane is safe on plastics but has environmental issues and is getting harder to obtain. Do not use acetone, as it can dissolve plastics, enamel, silkscreen, etc.

Removing a component:

- This is the job of a hot air station. It takes a while, up to a minute, to remove the quad flat packages. The medium-size nozzle works great, and is faster than the smaller nozzle. Grab a corner lead with the tweezers in your left hand, and wave the nozzle over the pins with your right hand. The chip will pop off rather quickly when the solder melts.
- For small components, it doesn't take more than 15 seconds or so. Hold the body of the component with tweezers in your left hand.
- Once the component is removed, clean excess solder left on the pads with flux and solder wick.

Soldering QFN Packages:

- Watch this [video tutorial](#). As a beginner, I find doing the following procedure under an illuminated magnifying glass is easier than doing it under a microscope. I can hold the air nozzle more vertically over the part, minimizing the chance that the part will blow away.
- Flux the PCB pads and apply solder, avoiding the center pad (if you do solder the center pad, apply solder sparingly; solder on this pad must be lower in height than the solder on the outer pads). Try to get a nice mound of solder on each pad.
- Remove flux residue and apply new flux
- Position QFN package over its footprint with good alignment.
- Heat up board and part to about 150C for 2 minutes, activating the flux. With my settings, the hot air nozzle is about 1" to 1.5" above the board and I start to hear the sound of air hitting the board. Move nozzle back and forth so that part is not disturbed.
- Carefully and slowly lower nozzle to ½" to ¼" above the board, moving the nozzle back and forth so that part is not disturbed. Flux will start to bubble and solder will melt. Hold this position for 30 seconds.
- Slowly raise nozzle away from the board, gradually lowering the temp.
- Let board cool off for a few minutes, then clean with IPA.
- Inspect work.