“Easy Bake” Reflow Soldering

Step by step

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INTRODUCTION

Are you an old-time soldering buff like me? Several years ago, I decided to try my hand at SMD soldering. Since then, I have soldered many boards by hand. Lots of practice, ample light, magnification, good tweezers, and a decent iron eventually led to success. Along the way I acquired additional tools which, although unnecessary, make SMD soldering an enjoyable task. I regularly use my binocular microscope, hot air gun, and small-caliber syringes filled with high-quality flux and soldering paste. I can hand-solder most SMD boards and, chances are, you can too.

There are times, however, when SMD hand-soldering is suboptimal. Tiny boards with microscopic parts take extra care and extra time, especially when my intention tremor is acting up. Leadless SMD components like QFN present another challenge, especially when your only heat source is a 60W iron. And soldering multiple boards gets tedious when making them one at a time. For each of these scenarios you should consider reflow soldering.

There are many ways to reflow soldering. You can purchase a temperature-controlled reflow oven. You can DIY it, outfitting your toaster oven with thermocouples and a microcontroller. I’ve even seen reflow soldering in a frying pan. In this article I will describe, step by step, how I use a stencil and unmodified toaster oven. Although far from perfect, it is simple and it works.

GET ORGANIZED

Your through-hole component bins aren’t a good choice for SMD. A few sample books are all you need. I also dedicate a small tray for my SMD tools.



SMT sample book. Each strip can contain about 25 components in 0805 size. I label each with its value and vendor stock number.

TOOLS THAT YOU'LL NEED

1. Good lighting & magnification
2. A good set of tweezers
3. A stencil
4. Soldering paste, warmed to room temperature (4 hrs. from fridge)
5. A few scrap PCBs
6. A toaster oven
7. Flashlight, toothpick, masking tape, etc. See below.

As you can see from the list above, you don't need much. Order the stencil when you order the PCB. It's usually just an extra click or two. I find that a 10x10cm stencil works for most projects and gives me adequate working space.

If you don't have a preferred brand of soldering paste, consider the following:

Chipquik SMD291AX50T3

It is 50 grams of 63/37 soldering paste in a small, wide-mouthed container. You can do a LOT of soldering with 50 grams, and the T3 size works well with most hobby projects.

I use an old Black and Decker oven. When we upgraded the oven in our kitchen, the old one got repurposed for reflow. Whatever you do, don't use the same oven for reflow and your meals. Keep that ingestible lead away from your food.

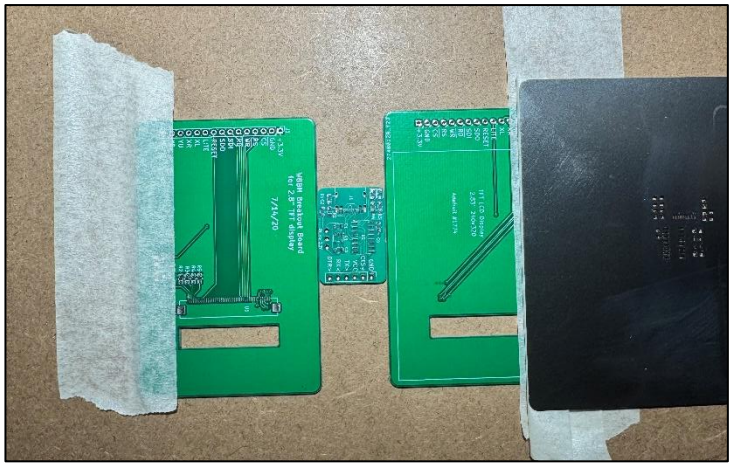
Your oven must be able to generate sufficiently high temperatures. Ovens that use two heating elements are better than those that use one, and ovens with ceramic elements are generally better than those with non-ceramic elements. All things being equal, a smaller oven is better than a larger one (it has less volume to heat).

Test your oven before committing a PCB to its care. Apply soldering paste to a few pads on a scrap PCB and place the PCB in the center of the oven. Turn the temperature control to its highest setting (usually "Toast"). Then time how long it takes for the solder to melt. The phase change is usually rapid, with the dull paste suddenly becoming shiny and wet. A flashlight will help you see the board. Write down how long it took for the solder to melt. My toaster takes just under 3 minutes, which is perfect. If your toaster takes significantly longer (say, 6 minutes or more), it's time to check out neighborhood garage sales.

HOW TO STENCIL

For stenciling, like the rest of this exercise, I recommend clearing a space on your desk and giving yourself plenty of light. Good lighting is necessary to confirm precise alignment of the stencil and PCB.

1. You will need a flat, smooth board (or another clean surface) on which to work. Place the PCB on a board in between two or more scrap PCBs of the same thickness. Use masking tape to fix the outside edges of the holder PCBs, so that the target PCB is snugly held between them. Avoid taping *inside* edges, as the tape can create a tiny gap between the PCB and stencil. Gaps allow the solder paste to migrate beyond the stencil holes.



My stencil jig: a flat board and two or three scrap PCBs.

2. Place the stencil on top of the PCB and move the stencil so that each PCB solder pad is perfectly outlined by its corresponding stencil hole. Take time to get an exact alignment. You should see a shiny pad in each stencil hole – and nothing else. When everything is aligned, tape down *one* edge of the stencil to the board, so that the stencil can swing upwards, like a door, after the paste has been applied.

3. There are stencil applicators available for purchase, but an old credit card is hard to beat. Cut one edge of the card so that it fits into the wide-mouthed paste container.

4. Take a small amount of paste from the container and spread it over the stencil with even force, so that paste is applied on to all pads. Apply pressure only to areas with PCB material underneath. Ideally, stenciling is done with one smooth, even pass. Multiple passes reduce the risk of an unpasted pad but increase the probability of solder migration beyond the pad edges. I hedge my bets and make 2 or 3 passes.



Solder Paste Applicator

5. Transfer unused paste back into its container. When you are finished with the solder, tighten the lid and place the container in a Ziplock bag. Solder paste has a shelf life of months to years if it is kept cold and sealed. I have a small dorm-

room refrigerator that I use for this purpose. Do not store solder paste in your kitchen fridge, or anywhere where it could come in contact with human food.

6. Remove the stencil from the PCB in one clean motion. Taping one side of the stencil, as recommended above, will help avoid smearing the paste. If your PCB was not adequately anchored, it may lift with the stencil. Do not panic if this happens: lower the combo and then carefully peel off the stencil. You will anchor your PCB better next time.

7. Check your work under high magnification. I use my microscope for this. Is there paste on all pads? Is the paste in good alignment with each pad? Consider a "re-do" if you did not achieve 80% alignment, if the paste has smeared, or if more than a few pads remain unpasted.



Check your work: good alignment and pad coverage

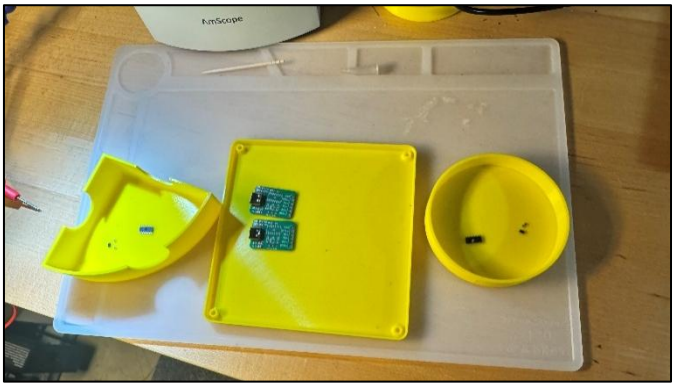
8. After checking your work, move the PCB away from your work area until you are ready to place parts. I am not kidding. If you leave it on your work surface, expect to find it on the floor upside down after you've gathered your parts. Move it away where it will be undisturbed.

PARTS PLACEMENT

I shouldn't need to explain how to place parts. And yet, if you are not used to SMD soldering, consider the following tips. The following is my reminder checklist.

1. I find it very helpful, especially when doing my own boards, to print out the schematic and have it in front of me.

2. Use a small, lightly colored container to hold your parts. I have a nice silicone mat on my desk that has small indented "trays" for parts. However, my parts are energetic and easily scale those silicone walls, launching themselves onto my desk, into the cuff in my jeans, and on to parts unknown. If you are making


Parts placement: use small, lightly colored trays.

multiple boards, have a container for each.

3. For small boards, arrange the parts for easier placement. For example, put the voltage regulator components in one spot, the microcontroller components in another spot, the output circuit in one spot, etc. For larger boards, use a segmented container that can keep those groups separate.

4. The more magnification I use, the slower I go and the worse my intention tremor gets. Use the smallest amount of magnification you need. For this reason, I avoid using a microscope to place parts. My hands are steadiest with no magnification and good lighting. I get the best placement results with a low magnification visor.



My go-to tweezer: the Hakko CHP 110-SA

5. Unless you have a fancy vacuum tool for SMD placement, invest in a good (professional, not Amazon brand) set of tweezers. You don't have to spend $100, but you should spend more than you would for a cup of coffee. I like my Hakko CHP 110-SA and CHP 105-SA. They are made specifically for SMD parts. You should be able to confidently grasp a component without fear of it flying. When you let go, the component should drop without sticking. Stickiness is the result of residual flux on the tweezer. To avoid sticky tweezers, periodically swish the ends in IPA and let dry.

6. Use whatever placement order works for you. I usually move left to right on the board, using the groupings that I made in my parts container. For larger boards I check them off the schematic.

7. After placing all the SMD components, examine your work under high magnification, nudging anything misaligned. A toothpick is the perfect nudging tool, because it is lightweight and easier to control than heavier/bulkier tweezers.

REFLOW!

The final step is the simplest. The toaster oven does all the work.



1. Remind yourself how long the reflow process should take. You should have already timed it with a scrap PCB.

2. Use a scrap stencil or another piece of thin metal to transfer the PCB to the *center* of the oven. Stay away from the front cover, where the temperature will be lowest.

3. Set the oven for high heat. For mine, this setting is “Toast”.

4. Turn on the toaster. Do not use the built-in timer.

5. Check reflow progress periodically with a flashlight. Confirm complete solder melt at the expected time. If the solder doesn’t melt, stop and discover why (I forgot to plug in the toaster once.)

6. Turn off the toaster and open the front cover door. Allow it to cool for 10 minutes.

You might be thinking “Wait, there is no temperature monitoring, no heat curve, and no feedback loop. How can this method possibly work, and how can it be good for my components?” Well, you are right. There is no temperature control. This quick and dirty method works because:

1) Toaster ovens just barely reach soldering temperatures, doing so in a reasonable amount of time.
2) Passive cooling creates an acceptable cool-down curve.
3) Components can tolerate conditions exceeding those specified for perfect reflow-soldering. Usually.

This method works for me. There are no guarantees, but I suspect it will work for you, too. It’s given me an easy introduction to reflow soldering without having to purchase a reflow oven. Most importantly, I’ve had fun and learned a lot. For me that’s what it’s all about.

Bruce.

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