

Surface Mount Construction Techniques

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“Oh no, this project uses SMT parts!” Some homebrewers recoil at the thought of assembling a kit that uses surface mount technology (SMT) components. They fear the parts are too small to see, handle, solder or debug when assembled. I had these same concerns until I tried it and found that it wasn't so difficult when using the right tools. Further, I discovered some benefits of using SMT parts that made my QRP projects smaller, lighter and more portable for optimized field use.

I've chosen two quite different projects to illustrate some successful SMT assembly techniques. One is a small DDS signal generator “daughtercard” kit that comes with an assortment of SMT capacitors, resistors and inductors, and an SOIC integrated circuit. The other example circuit is a small one-stage audio amplifier built “Manhattan-style”! Yes, you can homebrew using SMT parts – results can sometimes be even better than when using conventional leaded parts.

But first, here is some component history and what you need to do to get your work area ready for constructing an SMT project.

What is an SMT component?

Resistors and capacitors with axial or radial leads have been most common over the years. Same too for integrated circuits arranged in dual in-line package (DIP) format with rows of leads separated by a generous 0.3”-or-so. This open leaded component and easily-accessed IC pins made for easy circuit board assembly back in the Heathkit days. Although these types of components are still available today, parts miniaturization has brought about more compact and less expensive products. Discrete components packaging has shrunk to .12” x .06”, as shown in the ‘1206’ capacitor in **Figure 1**. Even smaller packages are common today, requiring much less pc board area for the same equivalent circuits. Integrated circuit packaging has also been miniaturized to create 10mm x 5mm ‘SOIC’ packages with lead separations of .025”, as shown in **Figure 1**. Truly, one needs some extra skills beyond what was necessary when assembling that SB104 Transceiver back in 1974!

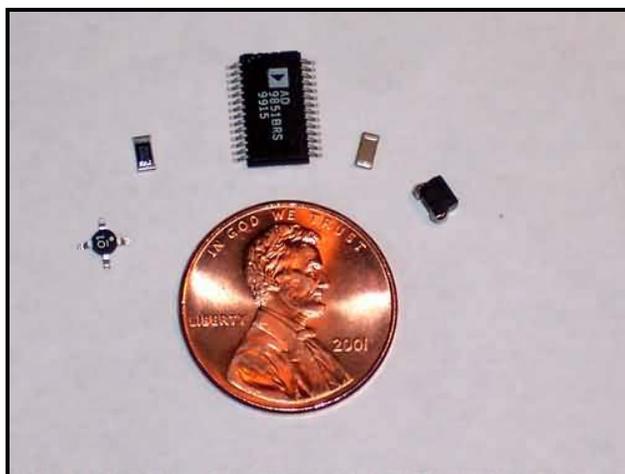


Figure 1: SMT components are small but they offer a dimension of compact design for portable projects. Clockwise from left: MMIC RF amp, 1206 resistor, SOIC integrated circuit, 1206 capacitor, and ferrite inductor.

Preparing for the job

As described at the beginning of this section, the key to being successful with any construction project is selecting and using the proper tools. For SMT projects, the tools are easy to find, as shown in **Figure 2**. A magnifying lamp is essential for well-lighted, close-up work on the components. Tweezers or fine-tipped pliers allow you to grab the small chip components with dexterity. Thinner solder (.015”) than you might normally use is preferred because of its being quicker to melt and smaller in solder volume on the component lead. Use of a fine-tipped soldering iron make soldering the leads of these small parts straightforward and easy. A clean work surface is of paramount importance because SMT components often have a tendency to fly away even when held with the utmost care in tweezers – you'll have the best chance of recovering your wayward part if your table is clear. When the inevitable happens, despite your best efforts of holding an SMT part in your tweezers, you'll have lots of trouble finding it if it falls onto a rug-covered floor covered. It's best to have your work area in a non-carpeted room, for this reason as well as to protect static-sensitive parts.

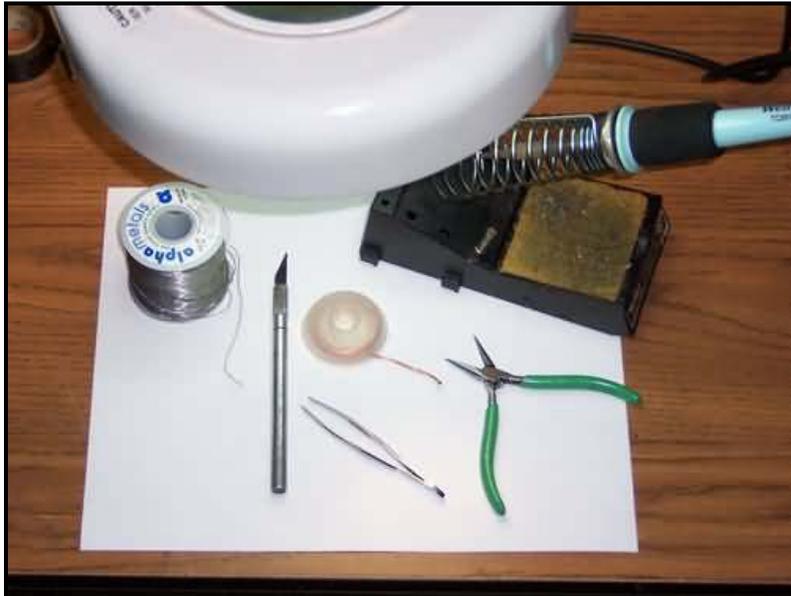


Figure 2: SMT soldering tools: magnifying lamp, .015" solder, fine-tipped soldering iron, tweezers, Xacto knife, Solder-Wick, needle-nose pliers.



Figure 3: A magnifying visor is a good alternative for close-up work on a circuit board. These headsets are often available for less than \$10 at hamfests and some even come with superbright LEDs mounted on the side to illuminate the components being soldered.

Assembling SMT parts on a PC board

The first project example is the **DDS Daughtercard** – a small module that generates precision RF signals for a variety of projects. This kit has become immensely popular in homebrew circles despite its use of SMT parts, and is supplied with the chip components contained in color-coded packaging that makes an easy job of identifying the little parts (**Figure 4**), a nice touch by a kit supplier.

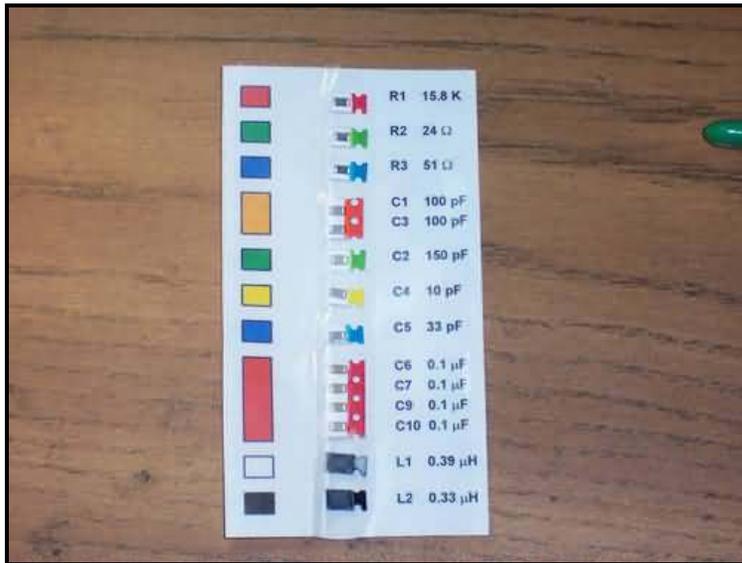


Figure 4: SMT Parts Kit. A great technique developed by the AmQRP kitting team of Tom (W8KOX) and Nancy (NJ8B) Feeny is to provide each SMT part on a color-coded card. This allows the builder to remove each part as-needed and be assured of its type and value.

Taking a look at the DDS pc board in **Figure 5** shows a typical layout for SMT components – all traces are usually on one side since the component leads are not “thru-hole”, and little square pads denote the places where the 1206 package-style chips will eventually be soldered. The SOIC-packaged integrated circuit will attach on the left side at the dual row of pads.

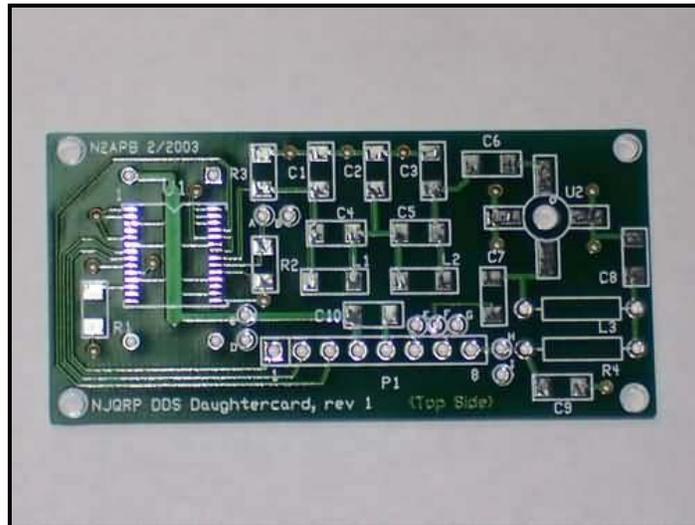


Figure 5: This bare DDS Daughtercard pc board shows a typical layout for circuit traces. All interconnections are on the top layer, as there are no thru-hole parts. Connections to the ground plane on the backside of the board are made by the use of “vias” on the pc board.

The trick to soldering surface mount devices to pc boards is to (a) pre-solder one of the pads on the board where the component will ultimately go; (b) hold the component in place with needle nose pliers or tweezers on the tinned pad; (c) re-heat the tinned pad and component to reflow the solder onto the component lead, thus holding the component in place; and lastly (d) solder the other end of the component to its pad. See **Figure 6** (attaching an IC) and **Figure 7** (attaching a capacitor) for details of using this technique.

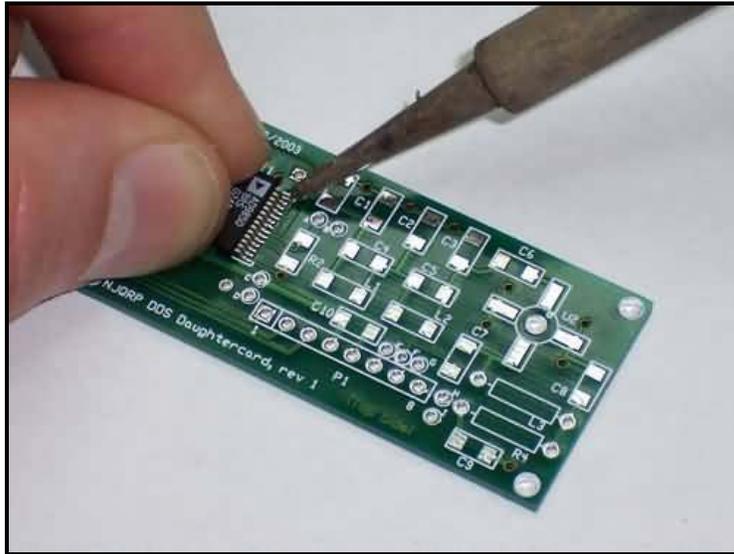


Figure 6a: Attaching an IC – Pre-solder the pad in one corner of the layout (for pin 28), then carefully position the leads of the IC over its set of pads on the pc board. I generally use my fingers to carefully align the IC over all its pads and then reheat pad 28 to reflow the solder onto the IC pin. This should leave the IC attached by pin 28. Again making sure the IC pins are aligned over all pads, carefully solder the opposite corner lead (pin 14) to its pad. This should leave all other pins of the IC aligned over their respective pads, making it easier to solder them. Next solder each of the other pins to their respective pads, being careful not to bridge solder across any adjacent pads or pins. If this does happen, that's okay! Just grab some solder wick or a solder sucker and use it to draw off the excess solder, which should be fairly easy and clean because of the solder mask on the circuit board.

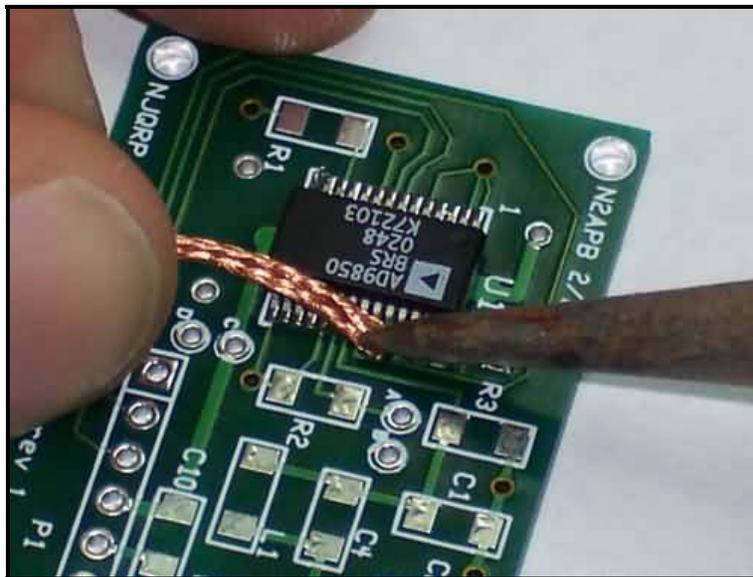


Figure 6b: Remove solder bridges from closely-spaced leads using SolderSponge, Solder-Wick or SolderSucker. The IC can take a fair amount of abuse, so don't worry too much about applying too much heat.

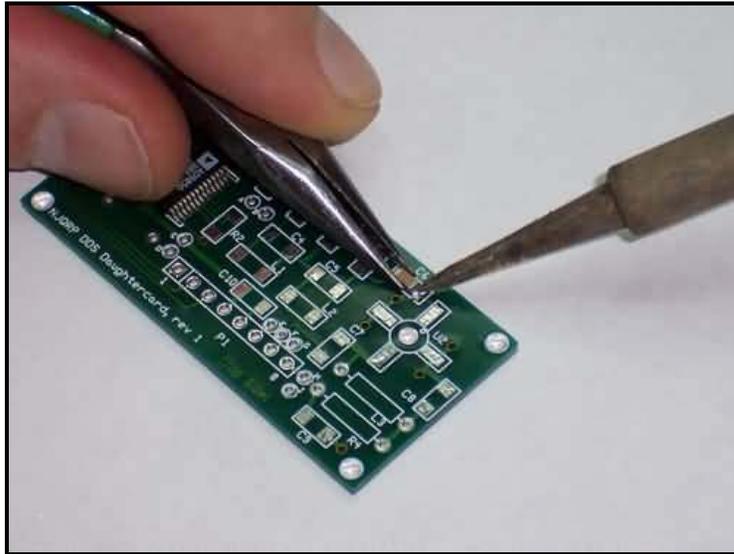


Figure 7: Attaching a Capacitor – Things get lots easier when attaching capacitors, resistors and other discrete components. Carefully hold the component in place and properly aligned using needle nose pliers or tweezers and solder one end of the component. Then reheat the joint while gently pushing down on the component with the pliers to ensure it is lying flat on the board. Finally, solder the other side of the component.



Figure 8: The fully-populated DDS Daughtercard pc board contains a mix of SMT and thru-hole parts, showing how the packaging technologies can be used together.

Homebrewing with SMT parts

The second project example is the **K8IQY Audio Amp** – a discrete component audio amplifier that is constructed “Manhattan-style”. This is a technique of gluing little pads to the board wherever you need to attach component leads or wires. Instead of using little squares or dots of pcb material for pads, another popular way to create isolated connection points is to cut an “island” in the copper using an end mill, as illustrated in the diagrams of **Figure 9**. No matter how the pads are created, SMT components may be easily soldered from pad-to-pad, or from pad-to-ground plane to build up the circuit.

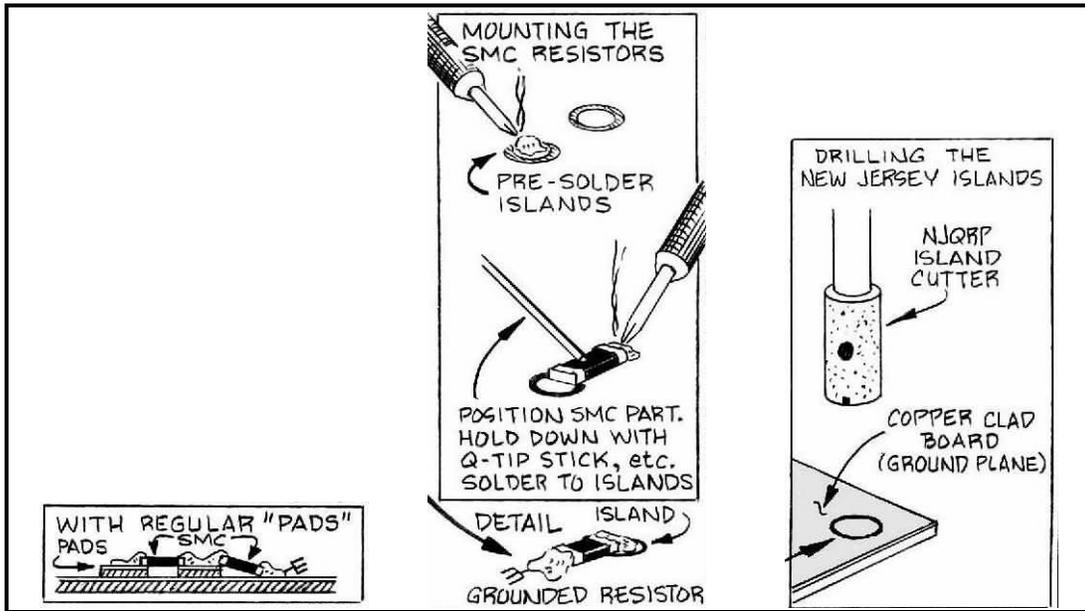


Figure 9: These three diagrams illustrate ways of attaching SMT components to a copper-clad base board. (a) Using regular glue-on pads; (b) Using island "cuts" in the copper ground plane; and (c) Making the island cuts with an end mill. [Illustrations provided by Paul Harden, NA5N.]



Figure 10: SMT resistors soldered to base board of the Audio Amp in the beginning stages of assembly.



Figure 12: The completed homebrew Audio Amp assembly shows simple, effective use of SMT components used with conventional leaded components when constructed Manhattan-style.

Homebrewing with SOIC-packaged integrated circuits is a little trickier and typically requires the use of an “SOIC carrier board” such as the one shown in **Figure 11**, onto which you solder your surface mount integrated circuit. You can then place the carrier board onto your homebrew project, copper-clad base board or whatever you’re using to hold your other circuit components.

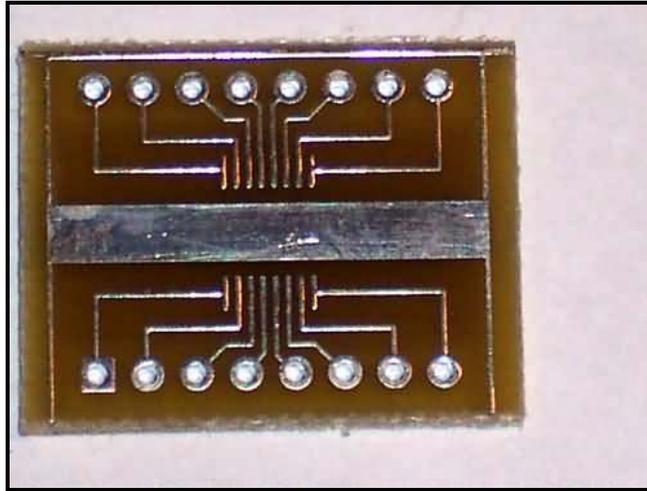


Figure 11: Surface mount ICs can be mounted to general-purpose carrier boards, then attached as a sub-module to the base board of the homebrew project.

So start melting solder!

The techniques are easy, the SMT components are actually cheaper than conventional thru-hole leaded components and you’ll have a smaller, more portable project when you’re done. Go for it!

References

- 1) The author is available at n2apb@amqrp.org
- 2) Full details on the DDS Daughtercard, the K8IQY Islander Audio Amp, and the Islander Pad Cutter may be found online at www.njqrp.org/dds, www.njqrp.org/islanderamp, and www.njqrp.org/islanderpadcutter, respectively.