SOLDERING TIPS
by: Tom Hammond

Good equipment and a good soldering technique are both essential to successful assembly of any device. Please read these tips before you start.

TOOLS YOU'LL NEED

1. **Temperature-controlled soldering station with a fine tip for use with printed circuit boards.** Ordinary (non-temperature-controlled) soldering irons will often produce very poor results when soldering or desoldering components, especially when working with double-side printed circuit boards. They simply cannot provide (and maintain) enough heat when soldering to large foil areas or when several joints are soldered in rapid succession.

   Tip width will normally be in the range of 1/32" (0.79mm) through 1/8" (3.2mm), depending upon the width of the pad to which you are soldering. The width of the tip selected should be about 75% to 90% of the width of the pad.

   If the heat range of the tip is specified by temperature, choose those with a 600 °F to 700 °F (315 °C to 370 °C) rating.

   Though some applications may require the use of a '**conical**' pointed tip, a '**screwdriver**' or '**chisel**' style tip is generally preferable because it offers more contact (heating) surface against the joint.

2. **The right solder.** *Mildly active* rosin-core, 0.020" (0.5mm) to 0.035" (0.98mm) diameter solders with 63/37 or 60/40 Tin-Lead (Sn-Pb) content will work best. Small-diameter solder (.020") is preferable when working with double-sided PC boards with plated-thru holes because it allows easy regulation of the amount of solder you apply to each connection.

   Silver-content solder (generally 2%) may sometimes be specified. While silver-content solders 'flow' more smoothly and make a stronger joint, they also require more heat and are more difficult to remove when de-soldering a joint, for component replacement. More heat means a better chance of damaging a PC board trace by 'lifting' the pad because the adhesive used to attach the pad to the PC board material has been overheated. Use silver-content solders only when *required* to do so.

3. **A damp sponge** (or a kitchen 'curly' metal pot scrubber). ***Always*** keep the tip of your soldering iron clean. If using a damp sponge, wipe the tip quickly, so as not to cool the tip excessively. If you use a 'curly', stainless steel, pot scrubber (available in the 'kitchen wares' section of any grocery store), to clean the tip of your soldering iron, no moisture is involved and the thermal mass of the pot scrubber is negligible, so virtually no heat is lost during the tip cleaning process.

4. **Small, sharp, wire cutters, either of the diagonal or flush-cutting (preferable) type.**

5. **Small-tipped needle-nose pliers.**

   Also useful: **Medical hemostats with locking handles.**

A WORD ABOUT KEEPING THE TIP OF YOUR SOLDERING IRON CLEAN

The name of the game in soldering is *"heat transfer"*. If you cannot quickly and adequately heat the joint to be soldered, you risk making a poorly soldered connection, *and* you risk damaging the PC board itself as well. It is **essential** to keep the tip of your soldering iron clean and well-tinned at all times. Ensure that the tip of your iron is clean before you attempt to apply solder to a connection. Once the tip is cleaned of any debris (burnt rosin, excess solder, tiny bits of component lead, etc.), ensure that the tip is well tinned. If the tip is a dull gray color (instead of a bright silver), apply a tiny bit of solder to 'wet' the tip before you place the tip against the joint to be soldered. Heat transfers from the tip to the joint by *physical contact*. A clean, solder-wetted tip will significantly decrease the length of time spent on each connection because it enhances heat transfer, even before additional solder is applied. In some instances, it may mean the difference between success and failure in completing a solid connection.

POSITIONING COMPONENTS ON THE BOARD

With the exception of some transistors (e.g. TO-92), unless otherwise specified, all components should be pressed down flush with the surface of the PC board as far as they will

go. **Figures 1 & 2** show both the right and wrong (**X**) ways to mount individual components and sockets. When installing ICs and sockets, solder only *one* lead. Check the positioning of the device (reheat the joint and re-seat the device if necessary) and then proceed to solder the remaining pins once you are

Figure 1

satisfied that the device is properly seated against the PC board. *Before* a wire-lead component is inserted into the PC board, component leads should be formed, using your fingers or long-nose pliers, to fit into the PC board holes.
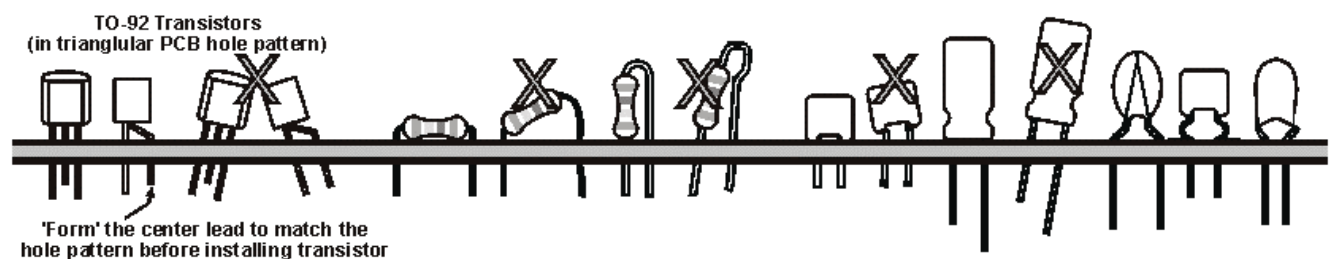

Figure 2

It is generally accepted as "good technique" to install components in all the same direction (horizontally or vertically) if at all possible. This is done so that all 'readable' nomenclature (text or resistor bands) can be read by holding the PC board in either the normal (front-facing) or the 90-degree rotated position. For instance, with the PC board oriented so the front edge of the board is facing you, all horizontally-mounted resistors should have their bands oriented so they are readable from left to right, and the text for all other non-position-critical components (small caps, etc.) is readable as well. Components mounted with their leads running front-to-back are generally mounted so they are readable when the PC board is rotated 90 degrees counter clockwise.

CLEANING AND TINNING HEAT-STRIPPABLE ENAMELED LEADS

Many enamel-insulated copper wires use a 'heat-strippable' enamel. You can usually identify this type of wire by its color. Most NON-heat-strippable enamels are of a dark color (often a brownish-red), while most heat-strippable enamels are of a much lighter, translucent color (generally red, green, or an orange-yellow).

Measure and clip the lead to a length slightly longer than that required by the joint. Using a HOT (725 °F / 385 °C, or hotter) soldering iron with a medium width (.05" / 1.25mm) tip, melt a 'blob' of solder onto the tip of the iron.

Insert the clipped *end* of the wire into the solder blob and wait a few seconds for the heat-strippable enamel to begin to smoke and bubble.

As the enamel begins to bubble, insert more of the wire into the solder blob. Adding a bit more solder to the new rosin will assist in the tinning process.

Once you have inserted and stripped the lead to the length required, *slowly* pull the wire back out of the solder blob. This should produce a nicely tinned lead with possibly a bit of burnt rosin remaining on the outside of the tinned lead. Any remaining rosin can be easily removed by pulling the wire between your index finger and your thumbnail.

CLEANING AND TINNING NON-HEAT-STRIPPABLE ENAMELED LEADS

Leads which are insulated with enamel (e.g. Formvar) which us *not* heat-strippable must be scraped clean before they can be tinned.

WARNING: When using a knife (or other device with a sharp blade) to strip enamel from a wire, be very careful to not cut or nick the wire itself. A wire which has been nicked will not withstand much flexing at the nick before it breaks.

Determine the length of the lead which must be stripped. Lay the lead on a hard surface and, using a sharp blade held *vertically* and placed at the inner end of the length to be stripped, slide the blade toward the end of the wire. Rotate the wire slightly and repeat until all of the enamel has been removed from the end of the wire.

Once the enamel has been stripped of enamel, heat the lead with your soldering iron and apply a *light* coating of solder.

SOLDERING

Proper positioning of the soldering iron tip and solder are essential in obtaining a well-made soldered joint. (**Figure 3**) The tip must be in contact with both the lead to be soldered <u>and</u> the PC board pad.

Apply heat to BOTH the PCB pad AND the component lead
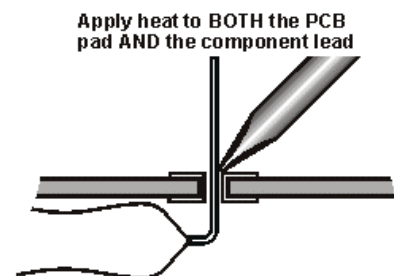
Figure 3

The soldering iron will heat the lead and pad, and their combined heat will then melt the solder. This ensures a well-made, solid joint. (**Figures 4 & 5**)
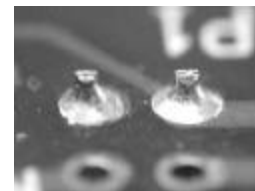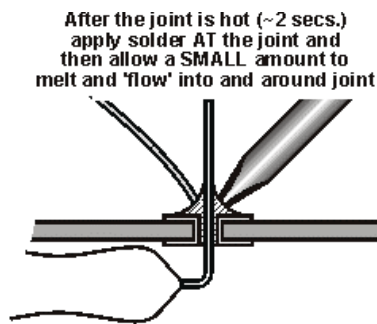
After the joint is hot (~2 secs.) apply solder AT the joint and then allow a SMALL amount to melt and 'flow' into and around joint

Figure 5

Figure 4

Figure 6 shows a well-made connection to a single-sided PC board. A small amount of solder has been melted by the heat from the component lead and the PC board pad. A small additional amount of solder has been added to the joint to form a small rising *fillet* around the lead.
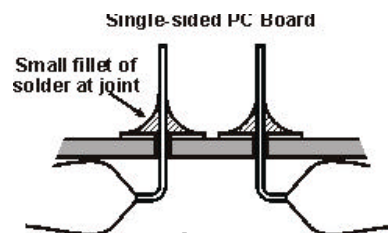
Single-sided PC Board

Small fillet of solder at joint

Figure 6

If the PC board was of the plated-thru hole type, capillary action of the lead in the *plated-through hole* has drawn the solder down into the hole. (**Figure 7 left**)
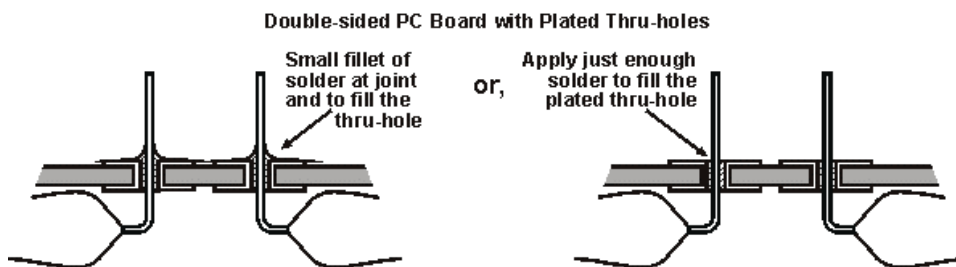
Double-sided PC Board with Plated Thru-holes

Small fillet of solder at joint and to fill the thru-hole

or,

Apply just enough solder to fill the plated thru-hole

Figure 7

Note that some soldering requirements may dictate that *no fillet* be created when soldering to plated-thru holes. (**Figure 7 right**) In this instance, apply only enough solder to *fill* the plated-thru hole. Use of .020" diameter solder greatly enhances your ability to perform this operation. Use of .03" or larger diameter solders will generally cause more solder than required to be applied the instant the solder is applied to the joint.

When soldering plated-thru holed which are to only be filled, apply a small amount of solder and allow your iron to remain a short while longer. This will ensure that the solder is 'wicked' down into the hole. You will be able to *see* the solder as it flows into the hole.

Solder-shorted pads

Figure 8 illustrates two adjacent, but separate, connections which have been shorted together by the application of excessive solder.
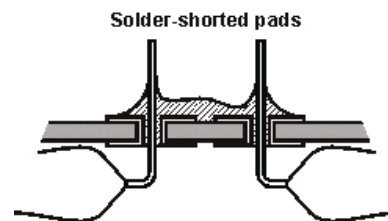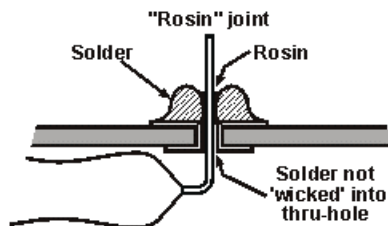
Figure 8

Figures 9 & 10 show what can happen if the component lead is not heated along with the PC board pad. A *rosin joint* will result. The solder flows onto the PC board pad, but since the component lead is not hot enough to melt solder, rosin accumulates around the wire. The solder then forms <u>around</u> the rosin coating on the component lead, and there is no connection. Generally, joints of this type can be corrected by reheating the joint.
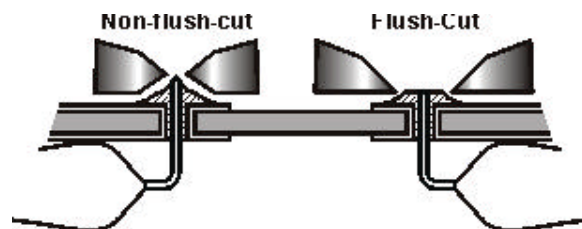

Figure 9

Figure 10

Similarly, a poor joint will result if you do not properly strip and tin the enameled wire leads of inductors *before* the lead is inserted into the PC board for soldering. Enamel coating allowed to remain on the inductor lead can create a joint similar to the rosin joint, preventing the lead from being adequately heated by the soldering iron. Such a joint *cannot* normally be restored by reheating. Remove the lead from the PC board, strip it of all enamel and tin it. Then resolder the joint.

CLIPPING COMPONENT LEADS

Commonly-used *diagonal cutters* have blades which are beveled to an edge from both sides. The cutting action of such a blade can flare, or mound-up, the soldered joint (**Figure 11, left**).

In contrast, the blade of a *flush cutting* wire cutter (**Figure 11,right**) is flat on its bottom and beveled only from the top. Flush-cut connections will be flat across the surface of the cut, making them cleaner and less likely to cause shorts to nearby pads. Clip leads just slightly above the surface of the PC board (1/16", 1.5mm). This will leave enough excess lead length to facilitate reheating the connection if it is necessary to remove the component, and to reinstall it later, if required.

Figure 11

To determine if you are using too much solder, look at your connections once the excess lead length has been trimmed from the component. As shown in **Figures 12 & 13**, if your wire cutters have cut too deeply into the solder, there is probably too much solder being applied.
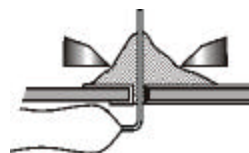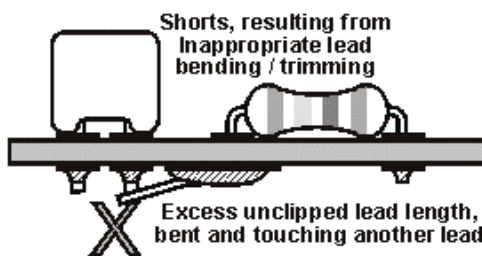

Figure 12

Figure 13

Adjacent components may become accidentally shorted together when their leads are clipped following soldering. Examples of this are shown in **Figures 14 & 15**. A lead from the resistor has first been folded flat against the PC board. Then, when it was clipped, it was not clipped close enough to the joint, and was allowed to lie up against the lead of the nearby capacitor.

Shorts, resulting from Inappropriate lead bending / trimming

Excess unclipped lead length, bent and touching another lead

Figure 14

Figure 15