Electronics equipment

1 Tools for electronics

As with any practical technology, having the right tools for the task is important. Indeed, some of the tools are not just important, they are critical. You simply cannot do electronics construction without them.

Tools you absolutely, positively, indisputably, and without a doubt need: Soldering iron to solder components into place. Miniature side-cutters, to cut wire or component leads. Miniature long-nosed pliers, to form leads. Wire-strippers, to strip insulation from wires. Solder removal tools, to remove solder from a soldered joint. Drills and bits, to drill holes.

1.1 Side – cutters

After your soldering iron, the single most important tool in your toolbox is a decent-to-good quality pair of miniature side-cutters. As side-cutters are so important, it's best not to skimp on this tool – buy the best you can afford.

Before you baulk at the price, remember that the side-cutters you buy will be used every time you solder a printed board, to trim the component leads after soldering joints. They' ll be used every time you cut wires to length, for insertion into a printed circuit. They' ll be used every time you trim your toenails. They should not be used for cutting thick wires or metal.

And finaly, just to labour the point, a decent pair of side-cutters will last a lifetime in electronics, but a cheap pair will probably last till you need them.

1.2 Long – nosed pliers

Like side-cutters, a miniature pair of long-nosed pliers is an essential tool for the builder of electronics circuits. Like side-cutters also, it's pretty important to have a decent-to-good quality pair. And, if you haven't already guessed it, like side-cutters too, they may be expensive. Again, get the best you can afford – they will be worth it. Figure shows a pair of long-nosed pliers.

Long-nosed pliers are very useful for forming component leads prior to mounting the component in the printed circuit board. They should not be used for anything heavier than this – and should definitely not be used for tightening nuts onto large bolts, or working on the car. They are precision instruments which require a little forethought in handing.

1.3 Wire – strippers

Printed circuit boards are not usually complete entities, and they need to be connected to the outside world. The easiest and most popular way to do that is with interconnecting wires, which are normally insulation-covered to prevent short circuit with their neighbours. Each wire has to be soldered to the printed circuit board, so it's necessary to remove a piece of insulation at the wire end, leaving a short length of uninsulated wire that can be soldered. It's perfectly possible to strip a short piece of insulation away by putting the end of the wire into your mouth between your teeth, biting on the wire while pulling it back out of your mouth. Indeed, I used to do this very thing before I wore o hole in my front teeth and suffered many expensive dental bills. Now I use a pair of wire-strippers, and I wholeheartedly recommend you do the same.

Wire-strippers work in exactly the same way that front teeth do, in that you insert the wire into the wire-strippers jaws (and yes, they are called jaws) whereupon you squeeze the wirestrippers' handles together so that the wirestrippers' teeth catch the wire between them. Further squeezing of the handles forces the teeth into insulation and simultaneously pulls the jaw back, stripping the insulation from the wire. Figure shows a pair of wire-strippers in action.

Such wire-strippers aren't too expensive, although you can get much more expensive ones. As with the case of wire-cutters and long-nosed pliers, get the best you can afford. The best wire-strippers have replaceable jaws so can be always maintained with a good set of teeth. The cheaper one are just throw-away tools.

1.4 Solder removal tools

If you solder electronic components into printed circuit boards, then sooner or later you will need to desolder them to remove them from printed circuit boards. It goes without saying that you will at some stage put a component in the wrong place and need to take it out, or you will find that you have a faulty component and need to replace it.

The tool for desoldering purposes is a desoldering pump. Commonly called a solder sucker. This works something like a bicycle pump in reverse – you operate the pump (which is spring-loaded) to push out air, then apply the pump to molten solder on a joint and release the plunger to literally suck the molten solder away from the joint into the pump where it rapidly hardens. The next operation of the pump forces out the hardened solder and primes the pump ready for the next desoldering operation. Figure shows a desoldering pump in position over a joint as the joint is heated to become molten by a soldering iron bit tip. The pump has been primed (ie, its plunger has been pushed down the pump body), and as the solder becomes molten, the button catch on the desoldering pump body is pushed, thereby releasing the springloaded plunger which returns to the top of the pump body.

While a little more expensive than desoldering braid, desoldering pumps last considerably longer. Indeed, really the only part of the pump that may be worn by the desoldering process is the pump nozzle, due to the repetitive application of the heat of soldering, which nevertheless will have an operating life of many thousands of operations. Most desoldering pumps have replaceable nozzle, so even if the nozzle is worm, the pump is not necessarily written off.

1.5 Drills and bits

Each and every component mounted on a printed circuit board in the conventional way (note I say conventional way here: there are other methods which don't normally affect the individual electronic circuit builder, most notably the surface mounted component method) has its component leads going through holes in the printed circuit board. Thus, the printed circuit board has to be drilled with holes for those very same component leads. The hole size is around 1mm (give or take a very small percentage – depending on the actual component's leads), which means that your average power drill that you use to drill masonry or steel is not exactly the best tool to use. Power drills are good where the thing being drilled is hard, and the holes don't have to be too accurately positioned.

Printed circuit board, on the other hand, is made from a thin and fairly soft substrate, and the copper track is but a few micrometers thick, while the copper pads you' ll be drilling through are not that much bigger than the holes required themselves. So, a drill for the task of drilling printed circuit board has few power requirements, but accuracy is of prime importance.

Small, hand-held, low-voltage drills (complete with mains transformer) are available from most do-it-yourself stores, and these are ideal for hand drilling of printed circuit boards. Figure shows such a drill, being used to drill holes in a printed circuit board, prior to mounting and soldering of components.

Later, we' ll see that larger drills do actually have a place in the electronics circuit builder's toolbox, for drilling of large holes in housings for example. But you do need to have a lowvoltage, hand-held drill for the finer tasks like that in Figure. Even the cheapest will do the job effectively. Usually they are sold in kits, complete with a range of drill bits, together with small grinding wheels, polishing wheels and engraving tools. If you buy a kit, complete with a range of drills, then you will probably have all the drill sizes you need. If you buy the drill alone, make sure you also buy drills of 1 mm and 1.5mm sizes – they are the most common ones you' ll need.

2 Soldering irons

Soldering in electronics does not have any particular requirements, other than the soldering iron should not be too powerful. On the fact of it, this might sound odd to a newcomer given that the process of soldering requires solder to be melted thus forming a soldered joint, but it's quite logical when you consider exactly what are soldering – electronic components. The problem is that electronic components can be damaged by too much heat – and the more powerful the soldering iron, the greater its capacity to deliver heat.

Soldering iron power is measured in watts, and a reasonable wattage for soldering electronic components is somewhere between 15 and 25watts. Prices vary between models, but you should expect to pay between about 10 and 25 euro for a basic soldering iron, although more expensive irons (with extra features) exist.

A typical soldering iron is shown in Figure, where you can see its main parts – a handle to hold it, a bit (the part that heats the joint and the solder), and a heating element (the part that heats the bit). Also in Figure is a mains lead, although not all soldering irons require mains electricity to function, as we' ll see soon.

2.1 Soldering iron types

There are several variants of soldering irons, in terms of heating methods, listed below.

Mains-powered irons-the most common. The advantage of these is that they work wherever a main outlet is available. The disadvantage is that they do have a mains lead, which some people find a little fiddly in use. Basic soldering irons of this type have no temperature control, and merely get as hot as they can. Soldering irons with thermostatic controls are available, and even complete soldering iron/base station combinations are common. Your budget defines what you buy.

Gas-powered irons – the ultimate in portability. Fitted with small refillable charges of butane gas which last up to around 30 minutes of constant use, these soldering irons require no electrical power. Figure shows a gas soldering in use.

Priced between around 30 to 50 euro, these soldering irons are useful for certain awkward soldering jobs where electrical power is not available. They tend to be quite powerful, particularly the more expensive models, though with care can be used to good effect in electronics soldering.

Low-voltage irons – for battery-powered applications. Occasionally, when working on a car, say, there are applications where a low-voltage soldering iron might be useful. Some 12V – powered soldering irons are available, usually having battery clips attached to the power lead.

2.2 Soldering iron stations

While we're on the subject of soldering iron types, it's worth taking a look at soldering iron stations. These are complete units, comprising a soldering iron, a stand to hold the iron when not in use, and a controlling circuit of some description. A typical soldering iron station is shown in Figure. The controlling circuit typically controls the power to the soldering iron element, so that the bit stays at a constant, definable temperature. While such stations are expensive, ranging from around 50 to over 150 euro, they are excellent tools if you do a considerable amount of soldering.

2.3 Soldering iron bits

Alongside the iron itself, you need to think about the bit. The bit is the part of the iron that comes into contact with the parts to be joined, so is a fairly critical part of the process.

A typical range o bit shapes is shown in Figure. Usually, for soldering electronic component joints an angled bit of about 2.4mm diameter is ideal.

How the bit fits onto the soldering iron element is of concern, for two reasons: First, it determines how much of the heat generated by the iron's element passes to the bit's tip – and hence to the joint to be soldered. Second, it determines how easy it is to remove the bit – important if you are to solder different types of joints (for example, a bit with a smaller diameter would be used for finer joints), or for when you need to replace an old and worn bit.

In general, bits that slide over a soldering iron's element are most efficient, allowing much of the heat generated by the element to pass to the bit's tip. Figure shows such a bit, fitted to its element. Also, this bit type is the easiest to remove.

Bits that fit inside an element, or screw onto it, are probably best avoided, if only because the very nature of the soldering process means that metal bits often corrode – even slightly – due to heat, and this may mean that the bit becomes hard to remove. Excessive pulling or twisting of the bit to remove it may then damage the element.

Some soldering irons use a bit type that also comprises the element. The bit/element combination attaches to the soldering iron by two prongs that slide into the soldering iron body. Element and bit tip being unified in this way, there is a highly efficient heat transfer between element and tip, and this design has the great advantage that changing the bit effectively replaces the element in one operation. One of the best examples is the rechargeable soldering iron bit tip shown in Figure.

2.4 Soldering iron accessories

Soldering iron stand. There' s a few accessories for soldering irons that are worth buying. First – and most important – of these is a soldering iron stand (a typical stand is shown in Figure), which holds an iron while it's not in use. Soldering irons, of course, by their very nature are hot, so having a stand to put one in when not actually using it adds up to quite a safety feature. The stand in Figure is around a fiver – so shouldn't break the bank.

Sponge. Talking of a soldering iron stand with a sponge, a sponge is actually a very handy accessory to have. Even if you have to resort to – as I have done on occasion – using a simple kitchen sponge, dampened with water, stood on a tea-place, then so be it!

The 8 euro soldering iron stand of Figure, featuring an integrated sponge is a great way to combine the two accessories – not essential, just neat.

You use a dampened sponge to wipe your hot soldering iron bit tip on, immediately prior to tinning it and using it to solder joints. As you' ll see later, a clean soldering iron bit tip is one of the prerequisites of good soldering.

Put another way: if your soldering iron bit tip is not clean, don't expect to make good soldered joints, and do expect your circuit not to work!

3 Soldering guide

All the electronic devices consist of one or more PCB boards (Printed Circuit Board). On the PCB are placed the electronic components stuck in the pods of the copper. There are two technologies of PCB construction: A) Through-hole-technology in which we use components with terminals, that through the holes they enter the PCB and are soldered on the other side and B) SMT Surface mount technology in which the components don't have wire terminals and are soldered directly on the copper pods of the PCB.

The wide consumption electrical devices are manufactured with automated methods. When we want to manufacture an amateur electrical device we use manual methods, like the use of a soldering iron and the manual cut of the terminals.

For the best result we use a soldering station with a temperature control and a sensitive nose for use in a PCB. With the soldering station we have a fixed temperature when we solder in areas with a wide copper area, in contrast to the simple soldering irons which don't have a fixed temperature. According to the application we use the corresponding nose, for example a "conical" soldering nose while other applications require a wide type nose so that more temperature is transferred to the board from the soldering iron in order to have the right soldering.

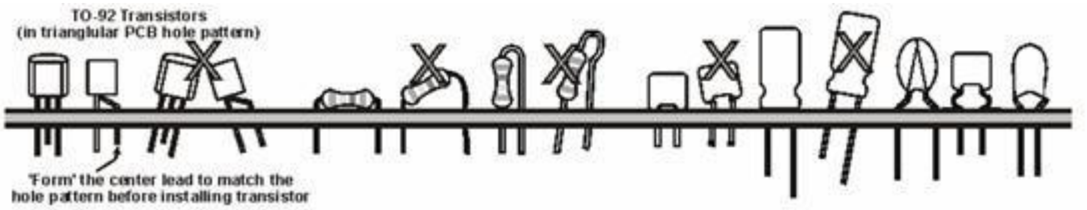
We use the appropriate soldering material. This material must have a diameter from 0.5mm to 0.98mm containing tin/lead 63/37 or 60/40. Small diameter solder is preferred for soldering in double side (PCB) boards. This happens because it allows the easy spread of the material in such type holes in each connection we construct. Further more there is the solder which contains almost 2% of silver. While this type of materials flow better and achieve stronger soldering, they need higher temperature in order to melt and it is more difficult to remove the electronic elements from the board during the detachment – replacement. Apart from that more temperature means greater possibility to destroy the board since the material which defines the holes can get warm and detach them. Use a solder containing silver only when it is absolutely necessary.

Solder is often used with a flux. Flux is a reducing agent and when used within solder, its purpose is to reduce (return oxidized metals to their metallic state) metal oxides at the points of contact. Dry joints are caused when the solder oxidizes and causes a joint that has poor properties both in terms of strength and electrical conduction. Dry joints may also be intermittent.

For manual or hand soldering the traditional format of the solder is that of a wire. This wire has flux core. This is often supplied as a coiled wire of solder, with one or more continuous bodies of non-acid flux embedded lengthwise inside it. As the solder melts onto the joint, it frees the flux which flows onto the joint to clean the joint prevent oxidation of the solder.

3.1 Placing Electronic Data on the Board (PCB)

Apart from some transistors e.g. the TO-92 all the components must be placed in the board until they "step" well on the board and as deep as possible in the holes. The designs 1 and 2 show how the elements must be placed correctly and with (X) the wrong placement. During the placement of the electronic elements first we solder only one of their legs and move the element to the desired position and then we solder the rest of the legs. We check again the position of the element and we reheat the solder if it is needed so that the element comes to the desired position. Many times we need to modulate the legs of the elements in order to fit in the holes. This happens with a nose snipe plier.

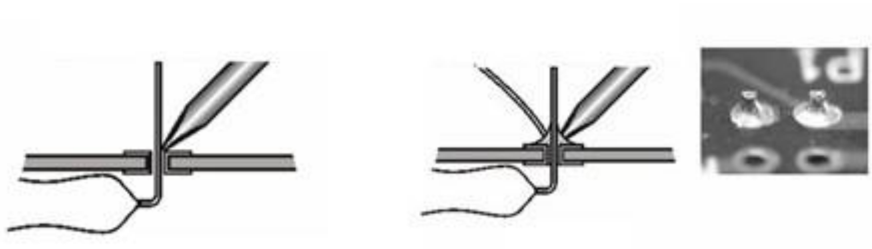


It is generally an acceptable and it is considered to be a good component placement technique, to place them all in the board in the same direction horizontally or vertically as long as it is possible. We do this in order to be able to read the text (resistor value, pins and IC) which exist in the printed circuit board keeping it normally or in a 90o grade. For example by holding a board from the front to be able to see all the values of the resistors that have been placed in the circuit. It is generally good to place the electronic elements in such a way in order to be able to read the values of the board easily.

3.2 Soldering

In order to achieve the correct soldering we use the following method: We heat the soldering point (the pad of the tablet and the terminal of the component) with the nose of the soldering tool for five (5) seconds the most without applying any pressure to the pad.

We touch the solder to the exact opposite point of the joint (pad's and terminals), paying attention to keep stable the soldering iron until the soldering point is covered by solder. We avoid touching the solder directly to the soldering iron, as it is considered to be a bad soldering technique.



The quantity of solder that we must use must be that much, in order our terminal to be covered evenly all around, without being too much and appear as a marble, but not insufficient either, so that in some points not to be a joint between the terminal and the pad.

When the soldering has been completed we remove the soldering iron and the solder, in order for the junction point to cool, something that does not lasts more than a few seconds. We pay attention not to move the material after soldering it until our soldering to cool off. In the end, we cut with a small cutter the edges of the terminals that exceed, in order to avoid possible short-circuits.

Summing up we can say that the critical points for a successful soldering are: 1) The cleanliness of the soldering point (tablet and components' terminals) 2) The correct choice of soldering temperature (where this is possible) 3) The time of soldering 4)The correct quantity of solder in the soldering (neither too much nor insufficient).

3.3 Soldering control

After finishing our soldering, it would have been recommended to make a visual control, in order to see how good our soldering is. More specifically: 1) A good soldering is even and has a smooth and shiny surface. 2) If the soldering is blurry and not even, then we have a "cold" soldering. In this case we reheat the soldering iron and let it cool without moving it. 3)If the soldering forms a ball, then we must have used an excessive amount of solder. Our next move must be the removal of a solder quantity with the soldering iron and the help of the appropriate tool. 4) If the soldering does not cover completely the terminal at the soldering point, then you will need to repeat the soldering using a bigger quantity if solder.

3.4 Suction pump

Apart from the soldering procedure, there will sure be a moment when we will want to desolder some component from the tablet (e.g. if it has been destroyed or it has been placed the wrong way) or simply will need to repeat a soldering, as the first was not successful (e.g. "cold" soldering). In this cases we will need the appropriate tools for removing the solder from the soldering.

The simplest and cheapest tool that can be convenient for our desoldering works is the master cylinder suction. This specific tool consists of a cylinder which has inside it a piston which is pressed by a spring. The cylinder has a nose in one of its edges, metal or made of Teflon, with which the suction is conducted.

3.5 Way of use

We start pressing the piston of the suction pump until it locks in the lowest place. Then, with the help of a soldering at the soldering point we melt the solder at the soldering point while, at the same time, we touch at the same point the nose of the suction pump. As soon as we see the soldering start melting, we press the button which is placed on the suction pump so the spring is released and we achieve the suction of the solder. Most of the times we need 2-3 attempts in order to achieve the desired result. As the pump collects solder internally and becomes full very quickly, you must clean it in frequent times, by unscrewing the nose and by cleaning the inlet and the pumping chamber of the solder.

Apart from the suction pumps, in the market other detachment tools are sold (component detachment stations, etc), which, however, are for professional use only.

Bibliography

For writing this article, the following book is used:

Starting electronics