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Leaded vs. Lead-free Solder – A Brief History

One of the most important things to be aware of when it comes to solder is that, traditionally, solder was composed of mostly lead (Pb), tin (Sn), and a few other trace metals. This solder is known as **leaded solder**. As it has come to be known, lead is harmful to humans and can lead to lead poisoning when exposed to large amounts. Unfortunately, lead is also a very useful metal, and it was chosen as the go-to metal for soldering because of its low melting point and ability to create great solder joints.

With the adverse effects of leaded soldering known, some key individuals and countries decided it was best to not use leaded solder anymore. In 2006, the European Union adopted the Restriction of Hazardous Substances Directive (**RoHS**). This directive, stated simply, restricts the use of leaded solder (amongst other materials) in electronics and electrical equipment. With that, the use of **lead-free solder** became the norm in electronics manufacturing.

Lead-free solder is very similar to its leaded counterpart, except, as the name states, it contains no lead. Instead it is made up of mostly tin and other trace metals, such as silver and copper. This solder is usually marked with the RoHS symbol to let potential buyers know it conforms to the standard.

Choosing the Right Solder for the Job

When it comes to manufacturing electronics, it's best to use lead-free solder to ensure the safety of your products. However, when it comes to you and your electronics, the choice of solder is yours to make. Many people still prefer the use of leaded solder on account of its superb ability to act as a joining agent. Still, others prefer safety over functionality and opt for the lead-free. SparkFun sells both varieties to allow individuals to make that choice for themselves.

Lead-free solder is not without its downfalls. As mentioned, lead was chosen because it performs the best in a situation such as soldering. When you take away the lead, you also take away some of the properties of solder that make it ideal for what it was intended – joining two pieces of metal. One such property is the melting point. Tin has a higher melting point than lead resulting in more heat needed to achieve flow. And, although tin gets the job done, it sometimes needs a little help. Many lead-free solder variants have what's called a **flux core.** For now, just know that flux is a chemical agent that aids in the flowing of lead-free solder. While it is possible to use lead-free solder without flux, it makes it much easier to achieve the same effects as with leaded solder. Also, because of the added cost in making lead-free solder, it can sometimes be more expensive than leaded solder.

Aside from choosing leaded or lead-free solder, there are a number of other factors to consider when picking out solder. First, there are tons of other solder compositions out there aside from lead and tin. Check out the Wikipedia solder page for an extensive list of the different types. Second, solder comes in a variety of gauges, or widths. When working with small components, it's often better to use a very thin piece of solder – the larger then number, the smaller the gauge. For large components, thicker wire is recommended. Last, solder comes in other forms besides wire. When getting into surface-mount soldering, you'll see that solder paste is the form of choice. However, since this is a through-hole soldering tutorial, solder paste will not be discussed in detail.

Soldering Irons

There are many tools that aid in soldering, but none are more important than the soldering iron. If nothing else, you need at least an iron and some solder to accomplish the task at hand. Soldering irons come in a variety of from factors and range from simple to complex, but they all function roughly the same. Here, we'll discuss the parts of an iron and the different types of irons.

Soldering Iron Anatomy

Here are the basic parts that make up a soldering iron.

- **Soldering Tips** - No iron is complete without an iron tip. The tip is the part of the iron that heats up and allows solder to flow around the two components being joined. Although solder will stick to the tip when applied, a common misconception is that the tip transfers the solder. The tip actually transfers heat, raising the temperature of the metal components to the melting point of the solder, and the solder melts accordingly. Most irons give you the option to change your tip, should you need to replace an old tip or if you need to switch to a different style of tip. Tips come in a variety of sizes and shapes to accommodate any component.

Several types of tips. From left to right, the bevel tip (aka hoof tip), two conical tips with varying widths, and the chisel tip.

Changing the tip is a simple process that consists of either unscrewing the wand or simply pushing in and pulling out the tip

- **Wand** - The wand is the part of the iron that holds the tip. This is also the part that is handled by the user. Wands are usually made of a variety of insulating materials (such as rubber) to prevent the heat of the tip from transferring to the outside of the wand, but they also house wires and metal contacts that transfer heat from the base or outlet to the tip. This dual role of heating and preventing burns makes a high quality wand much appreciated.

Two varieties of wands. Notice how the tips screw into the wand allowing for interchangeability. Some wands have tips that simply push in and pull out without any attaching mechanism.

- **Base** - The base of the soldering iron is the control box that allows the adjusting of temperatures. The wand attaches to the base and receives its heat from the electronics inside. There are analog bases, which have a dial that controls the temperature, and there are digital bases, which have buttons to set the temperature and a display that tells you the current temperature. Some bases even have extra features such as heat profiles that allow you to quickly change the amount of heat provided to the tip for soldering a variety of components.

Two variations of a soldering iron base. On the left, a digital base, complete with control buttons and a digital display. On the right, an analog base that uses a dial to control the temperature.

The base typically is comprised of a large transformer and several other control electronics that safely allow you to vary the heat of your tip.

- **Stand (Cradle)** - The iron stand (often referred to as a cradle) is what houses the iron when it is not in use. The stand may seem trivial, but leaving an unattended iron laying around on your desk or workbench is a potential hazard: it could burn you, or, worse, it could burn your desk and start a fire. Again, they can be as simple as a metal stand, or they can be complex, offering an auto-shutoff feature that reduces the temperature of the tip when the wand is placed in the cradle. This helps prevent the wearing of your tip over time.

Different types of iron cradles. Notice some allow for a regular sponge while others hold a brass sponge.

- **Brass Sponge** - As you solder, your tip will tend to **oxidize**, which means it will turn black and not want to accept solder. Especially with lead-free solder, there are impurities in the solder that tend to build up on the tip of your iron, which causes this oxidization. This is where the sponge comes in. Every so often you should give your tip a good cleaning by wiping off this build-up. Traditionally, an actual wet sponge was used to accomplish this. However, using a wet sponge can drastically reduce the lifespan of your tip. By wiping your tip on a cool, wet sponge, the tip tends to expand and contract from the change in temperature. This expansion and contraction will wear out your tip and can sometime cause a hole to develop in the side of the tip. Once a tip has a hole, it is no good for soldering. Thus, brass sponges have become the standard for tip cleaning. Brass sponges pull the excess solder from your tip while allowing the tip to maintain its current heat level. If you do not have a brass sponge, a regular sponge is better than nothing.