
DVD-15C

Soldering Iron Tip Care

Below is a copy of the narration for DVD-15C. The contents for this script were developed by a review group of industry experts and were based on the best available knowledge at the time of development. The narration may be helpful for translation and technical reference.

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Introduction

The key to the hand soldering process is the person who does the job. There's a lot involved in making a good solder connection. It takes knowledge and practice to develop the correct hand soldering technique. It also takes knowledge and practice to properly *maintain* the soldering iron tip in good condition. Even the best hand soldering skills are not effective when using a damaged soldering iron tip.

One of the major causes of unsatisfactory solder joints stems from defective soldering iron tips. How do these tips get damaged? Soldering iron tip care is one of the most important elements in giving any company an edge in the competitive electronics assembly industry. This is especially true when considering the negative impact lead free solder alloys have on tip life. Let's face it – lead free means reduced tip life and greater operating costs. Throughout this DVD, we'll be examining how we can reduce these costs. There are a number of factors that influence how long a soldering iron tip remains in good condition. For example – there is operator technique, the type and quality of the solder, the type of flux used and the soldering application.

In this video, we'll be discussing the causes of tip failure – and we'll provide guidelines on how you can increase soldering iron tip life. Extended tip life will result in more reliable solder connections and less expense for your company. With the average cost of soldering iron tips starting at around ten dollars and ending in excess of one hundred dollars per tip, you can see why it's important to keep tips in good condition.

Soldering iron tip life has always been a difficult problem, but has been made worse by the transition to lead free soldering. One of the biggest complaints about soldering with a lead free alloy is the negative effect it has on tip life. This is primarily due to the high tin content found in lead free solders. For example, eutectic solder contains 63% tin and 37% lead. In contrast, the tin-silver-copper solder common to lead free hand soldering consists of 96.5% tin, 3% silver and .5% copper.

Tin is a very aggressive metal. At the 96.5% concentration, it will eventually eat through the plating on the tip of the soldering iron – reducing the life of the tip. That’s because as the tin dissolves the plating, the tip becomes pitted and eventually cannot hold the solder. This phenomenon is similar to when a soldering iron tip becomes oxidized and will no longer hold the solder, *or* transfer the necessary heat.

To better understand the problem, let’s look more closely at soldering iron tips. In general, soldering iron tips are similar in composition, with the exception of the heating method, or element. The tip is made of copper with a plating of iron. The sides of the tip usually have additional nickel plating followed by chrome. The chrome prevents solder from wicking up away from the working area of the tip. The soldering iron tip manufacturers then apply a coating of solder to the tip.

There are many factors that will affect tip life – in particular, plating failure of the iron coating. The increased tin content of lead free solders, along with the more aggressive nature of the lead free fluxes, may cause a plating failure to occur *more* rapidly. Most tip manufacturers have now increased the iron plating thickness – in the hope that this will prolong tip life with the more aggressive high tin content of the lead free solders. Some people ask, “why not plate it with really thick iron?” The reason is that if the iron plating is too thick, the tip performance is degraded. In particular, this can affect the heat response time.

In addition to the increased iron plating, the final solder coating of the tip is accomplished with lead free solder. This tip will then be acceptable for use in either a tin-lead process or a lead free process.

The tin in both the tin-lead solder and the lead free solder will form *intermetallics* with many other metals. This formation of tin *intermetallics* allows the solder to “stick” to the surface being soldered – which is referred to as *wetting*. This means that the tin in the solder is *mixing* with other metals – in particular, the iron plating on the tip that protects the copper core. Every time the solder is wiped from the tip, it takes a little bit of the iron plating with it. Eventually it will remove enough iron plating to expose the copper that is underneath it. Copper is a great heat source but is not very durable. Once the copper is exposed, the flux and tin from the solder corrodes it, creating holes or cracks. These holes and cracks can weaken the tip so much that the tip may just snap off.

Preventing Tip Oxidation

Now that you understand the tip life issue with lead free solder, let’s examine the other factors that are involved in tip damage and what we can do to minimize or avoid them. These factors include oxidation buildup, over use of tip tinner, using the wrong temperature settings, excessive pressure, incorrect tip geometry, feeding solder into the tip, and mechanical damage.

Let's start with oxidation buildup. Soldering iron tip oxidation occurs naturally when the iron is exposed to the air during the soldering process. If the tip is oxidized, or contaminated, the solder will not stick to it. This is known as *dewetting*. Flux is used to clean the oxidation from the tip so that when solder is applied it wets to the iron tip. When oxides form on a soldering iron tip, the tip performance is degraded. Oxides create a barrier that decreases the heat transfer from the tip to the connection. If the tip is not cleaned and tinned before putting the iron into the stand – the oxides can build up and render the tip unusable. The tip must then be scrapped or reconditioned.

Tinning the tip is the best way to combat oxidation. The tinning process begins with the application of solder onto the working surface of the hot soldering iron tip. The solder *coats* the tip – forming a *barrier* that prevents oxygen from reacting with the tip.

The flux in RMA cored solder improves this tinning process by breaking down any oxides already present on the tip and allowing oxides to float to the surface of the solder. Because of the reduced solids and lower *activity* of *low residue* flux cored solder, it is not as effective at tinning the tip – as other types of flux cored solder.

Since tips are now more prone to oxidation, proper tip maintenance is more important than ever. Proper tip maintenance involves one of two methods – either wiping the tip on a slightly damp, sulfur free sponge --- or dabbing it on a brass pad made specifically for hand soldering. After wiping the tip, *always* apply a fresh coating of solder to the tip before placing the iron in the holder.

The way you store soldering irons when out of use is also important. You'll need to either turn the power off to the iron, or to use a temperature control technology that will reduce the tip temperature while the iron is not actually being used for soldering. An example of this type of technology is the *tip holder*. Some tip holders will automatically drop the temperature to 300 degrees Fahrenheit, or about 149 degrees Celsius – well below the melting temperature of solder. Remember that solder becomes liquid at about 220 degrees C for lead free and 183 degrees C for tin-lead. Specific types of *tip holders* are made by the soldering iron manufacturers for individual models of soldering irons. By turning the heat down automatically when you're not using the iron, the solder on the tip will *solidify* – and will not eat away at the tip.

Whenever a tip has a heavy oxide buildup, normal cleaning and tinning won't work. As we stated earlier, the tip will need to be scrapped or reconditioned. There are several methods of *reconditioning* an abused tip. One method is to utilize a *tip scrubber*. This method uses an abrasive material to remove oxides and any other build-up from the tip. Another method is to use a *tip tinner* – usually a mixture of solder alloy and flux – to recondition the tip.

A less abrasive technique is to apply flux to the tip, then dip it into a molten solder pot. The best method of *reconditioning* the tip is to *never* let it degrade. Don't rely on frequent reconditioning to overcome poor maintenance habits. The surface of a tip is *plated* and excessive use of reconditioning methods will *degrade* the plating and reduce the tip life. And *never* use sandpaper or an excessive amount of flux to remove the oxidation. This will remove the plating along with the oxidation.

More Tips to Prolong Tip Life

Now, let's take a look at how excessive heat can cause *degradation* or *damage* to the soldering iron tip. Lead free soldering processes may require higher soldering temperatures -- which means that the tip plating will be exposed to higher surface temperatures. Bringing the hot tip into contact with a cleaning sponge that is too wet -- can result in an *extreme temperature shock* -- that can produce *micro cracks* in the iron plating layer.

Keeping the tip clean *is* important, but *constantly wiping it* with a damp sponge can cause early tip failure. Excessive wiping causes the tip temperature to rise and fall dramatically. When this occurs, the different metal layers in the tip expand and contract repeatedly. This temperature cycling leads to metal fatigue -- and ultimately tip collapse. The more frequently you wipe the tip, the more you stress it.

It *is important* to clean your tip *often*, but not *constantly*. We recommend gently dabbing it into a brass mesh pad -- or swiping it over a genuine cellulose sponge *slightly* dampened with de-ionized water. Domestic plastic sponges should *never* be used. When a hot iron heats the plastic it can release chemicals that can corrode the tip. It may also release fumes that could be harmful to your health.

The use of tap water will cause mineral scale to form on the tip -- resulting in a non-wetting barrier. This can have the same type of effect as an oxidized tip.

The *brass pad* is the preferred method of cleaning the soldering iron tip. That's because the temperature will not rise and fall.

The other problem with excessive tip temperatures is that the higher the tip temperature -- the faster that oxidation will take place. Always use the *lowest possible* working temperature. 315 degrees C, or about 600 degrees F is a good *starting point* for hand soldering applications.

Another cause of tip damage is using *excessive pressure* during soldering. Many operators feel the need to press down *harder* when confronted by a difficult connection -- in order to transfer *more heat* to complete the connection. But *pressing harder* doesn't make the connection heat up any faster. In fact, it has nothing to do with how quickly the heat transfers from the soldering iron to the connection. Not only does this practice cause damage to the circuit board lands and laminate material, but the soldering iron tip itself can also become *deformed*.

Here are some examples of tips that have been deformed from too much pressure. Notice that this typically happens with conical, or pointed tips. Very fine surface mount tips are particularly susceptible. Bending the tips will eventually cause the plating to develop micro cracks, or fissures. Once a fissure is created in the tip's surface, the copper core is exposed to moisture, oxygen and tin. This mechanical damage will speed up the erosion of the copper -- and the tip will no longer be usable.

Cracks in the tip plating can also occur from careless handling of the soldering iron -- even with *large tips*. Some operators heat up the tip and purposely deform the tip thinking it will make their job easier. This too will speed up the erosion problem.

Both excessive pressure and excessive temperature can be prevented by selecting or procuring the *right shaped tip* for the job. Effective heat transfer is mostly accomplished through proper tip selection – specifically the contact area and the thermal mass. When selecting a tip, always select a tip that has the greatest *contact area* without overhanging the joint area. A chisel tip with a flat surface has a much greater contact area than a conical tip. It's important to always use the tip closest in size to the *width* of the land to be soldered – but *never* any wider than the land. What you want is the *maximum tip-to-land contact area* to heat the connection quickly.

Imagine the tip to land contact area as a plumbing pipe in a swimming pool. A one inch pipe will take fifteen minutes to fill a three hundred gallon pool. A fifteen inch pipe will only take one minute to fill the same pool. Using a soldering iron tip with the greatest area of contact with the land will allow the tip to transfer its available energy into the connection much faster.

The thermal *mass* of the tip is also important for effective heat transfer. Thermal mass relates to the *size* of the tip and the amount of heat it can hold. For example, a tip with a weight of one ounce heated to 600 degrees Fahrenheit may be able to heat seven grams of copper to 600 degrees before the heating element has to energize and restore the tip temperature. A tip with a weight of three ounces heated to 600 degrees Fahrenheit may be able to heat 21 grams of copper without the heat element energizing... even if the contact areas are *identical*. This means the soldering operation can be done *faster*.

The thermal mass of the tip is important for connections that dissipate heat quickly. This means that the solder connection needs to be completed as quickly as possible, while allowing for adequate solder wetting.

Having the wrong tip size on your soldering iron can cause other problems. For example, if the tip is too small, there may be incomplete solder flow, or a cold solder joint. Too small a tip will also increase the dwell time, or the time the soldering iron is in contact with the connection. Increased dwell time is due to poor heat transfer -- which happens when you use a conical tip on a large surface area. Increased dwell time can lead to component, conductor or circuit board damage.

If the tip is too large, it can overhang the connection area and cause thermal damage to the circuit board *substrate*. These are the reasons why tip selection is such a critical issue in the hand soldering process.

Another tip life factor involves feeding the solder onto the tip -- to force it to melt. This is different than quickly touching the solder to the iron before moving it to create a heat bridge. When the solder is continually fed onto the tip, the active fluxes cause rapid surface oxidation, which forms pinholes in the plating. The tin eats away at the copper – which causes the holes to enlarge. Once the copper begins to dissolve, the tip becomes unusable. These are examples of tips that have been damaged from feeding solder directly onto the tip.

The best way to protect the tip during soldering and to create the most efficient heat transfer is to use a *solder heat bridge*. To do this, the tip of the iron is applied to the junction of the land and lead to be soldered. This starts the heat flowing to the connection area. The heat bridge is formed by touching the solder to this same junction, then moving the solder wire over to the opposite side of the land. This causes the liquid solder to move *toward* the heat source to complete the solder joint.

Our final topic for extending soldering iron tip life has to do with mechanical damage due to *tools*. Using pliers to remove and replace soldering tips will often create *tooling marks* on the tips – which will invalidate any warranties.

When changing tips, always use *gripper hot pads*. Gripper hot pads won't damage the tips and will also protect your fingers from being burned. It's important – especially in the case of a tip with a 30° long sharp bend – that we not push the tip down against a solid object, such as a table – when inserting it into the handle. This could damage the end of the tip. It's even a bigger problem if the heating element is in the end of the tip.

Another factor in mechanical damage is to make sure that the soldering iron *support stand* is the correct one for the iron. An improper stand can result in the iron dropping out of the holder if it doesn't locate correctly into the funnel.

This program has presented the essential information on soldering iron tip care. We started out by discussing why tip care is important and examining the composition of a soldering iron tip. Then we took a look at how to prevent plating failures and oxidation damage. Finally, we described the problems that occur during the hand soldering process – including using the wrong tip temperature, excessive pressure, incorrect tip geometry, feeding solder onto the tip and mechanical damage due to tools.

Remember – lead free means reduced tip life and greater operating costs. Proper maintenance of soldering iron tips will greatly *increase* tip life. If you find yourself burning through tips faster than your co-workers, there are specific reasons why this happens. It's kind of like a scuba diver... where they use a lot less air as they become more proficient. So they can stay down much longer.

A professional knows how to preserve a soldering iron tip... and takes pride in using their tools properly. By treating tips with care and respect, you'll be doing your part in not only improving the quality of your solder joints, but in saving your company money and helping to increase profitability.