# DVD-91C
# Introduction to Surface Mount Rework

*Below is a copy of the narration for DVD-91C. 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.*



The electronics industry has come a long way within our lifetimes.

For over 40 years, electronic components have been attached to printed circuit boards by inserting the component leads into plated-through holes.

Then the component leads and the through-holes are electrically connected with solder.

The solder also provides a strong mechanical connection. You can see how the solder "locks" the component lead and the circuit board into one solid structure.

The major problem with this type of "through-hole" soldering system is that both sides of the board are used in making the connection.

If we could attach components on just one side of the board, this would free up the other side to hold additional components.

During the last decade, new styles of components have evolved to take advantage of this one-sided mounting technique. "Surface Mounting" is the term used to describe this style of component.

Surface mounting has allowed a major increase in the density–or number of components that can be attached to the board. This has allowed us to miniaturize many of the products that we use today.

The manufacturing process for surface mount assembly has also evolved to keep up with the new component styles that are continually being developed. And like any manufacturing process, there have been a number of challenges to overcome in order to optimize the assembly process.

This video will discuss both the theory and the specific equipment that has been developed in order to deal with surface mount solder joints that need to be reworked.

The first–and perhaps most important step–is the decision process. How do you decide when to rework a solder joint? Generally speaking, this decision falls into two categories: Obvious decisions and questionable imperfections. Lets begin with the obvious.

If an electronic component does not function properly then the decision has already been made.

There are also specific types of obvious soldering defects–like bridging or non-soldered leads. These conditions will also require minor rework.

Other conditions, like component misalignment and insufficient or excess solder, will require an educated decision. When is it appropriate to rework a solder joint that is slightly imperfect?

There are a number of factors involved in making this important decision.

The acceptance criteria for surface mount solder joints is clearly defined in the IPC A-610 and the J-STD-001 specifications.

These industry standards define three classes of products–ranging from high reliability to consumer applications. The acceptance criteria for each class are slightly different. Your company may already be using these standards to define what is, and what is not, an acceptable solder joint.

Your company may be using an internal specification to make rework decisions. Regardless of which criteria you use it's your job to know how to evaluate a surface mount solder joint–in order to know when rework is necessary–but perhaps even more important–to know when **not** to rework a solder joint.

Whenever you have a question, you can always ask your supervisor. Keep in mind that asking a question doesn't show that you're ignorant, it shows that you care about the quality of your work.

The reason that it's so important to avoid unnecessary rework is to avoid potential damage to the component, the circuit board, and any adjacent solder joints.

Every time the assembly is subjected to heat, its physical properties can be degraded. The adhesion between the resin in the laminate and the copper lands on the surface of the board can be weakened by heat.

Excessive heat and unnecessary force–caused by pushing with a soldering iron–or by attempting to remove a component before the solder is completely melted–can cause the land to separate and "lift" off from the board.

A lifted land can be very difficult to fix. Your customers may not even accept this type of rework–which means the entire assembly may be scrapped.

Of course, we will need to fix the obvious problems that keep the product from functioning, but we definitely want to avoid any cosmetic or unnecessary touch up operations that can create more serious problems than they cover up.

This may be hard to accept–since most people want their solder joints to look as perfect as possible. Adding a little solder here or there can cover up some minor variations, but it's important to recognize that you may be creating a more serious problem during this cosmetic touch up process.

The primary rule is avoid rework unless it's absolutely essential.

We also want to perform all of our initial soldering and rework operations in a rapid, yet controlled manner. The idea is to get in and get out as quickly as you can, but safely.

Let's stop now to review the information we've covered so far.

In this next section, we'll explain the purpose of flux, why it's so important, and how to use it properly.

There are several types of fluxes used for soldering and desoldering electrical connections. Generally your company will choose a type that is compatible with the specific processes used for the initial soldering operation.

Flux has several important functions. One purpose is to remove oxides from the metal surfaces.

Oxidation is a chemical reaction that occurs naturally on most metal surfaces.

We're all familiar with the rust that forms on exposed or unprotected metal. This is a highly visible form of oxidation.

Oxidation will also occur on solder–although it's not nearly as visible. If you look at a solder joint that is several years old, you'll notice that it will be slightly duller than a brand new solder joint.

But even fresh solder will have some oxidation on it, although it won't be visible without a microscope. These oxides can prevent a proper molecular bond from forming during the soldering operation.

The purpose of the flux is to remove oxidation, immediately prior to soldering or desoldering. When the flux is heated, it will chemically reduce or eliminate these oxides–and allow a proper chemical and physical bond between the solder and the copper land and lead. Removing oxidation will also aid in the transfer of heat.

Oxidation can act as an insulator between the tip of the iron and the solder. This will make it more difficult to melt the solder.

You'll remember that we want to heat the joint as quickly as possible–to avoid damage to the board, the component to be installed, and any adjacent components. The flux will help to transfer the heat quickly and evenly to the entire joint.

You may also have noticed that whenever you reheat a solder joint a second time–without adding flux–that the texture and color of the solder may change considerably.

The solder will become duller and grainier and the color will be slightly darker.

A dull gray colored solder joint may be brittle–which might not hold up to the stresses of expansion and contraction.

Now when you add flux and then properly remelt a solder joint, the flux will remove the oxides–and allow the solder to flow into a smooth, lustrous fillet.

Most solder wire contains flux inside the core–almost like a garden hose with water inside. The flux in the core of the wire is released right before the solder begins to melt.

You can see the flux residue around the edges of a hand soldered joint.

Certain types of flux residues can create problems if they are left on the board. Their acidic residue can cause corrosion of the solder over a period of time.

Corrosion can erode the solder connection and the component lead–and result in solder cracking.

The sticky residue can also attract and hold other contaminants that may be electrically conductive.

If this residue happens to bridge across to another conductor or land, it will provide an electrical path or short circuit, causing the product to fail.

Certain types of flux residues **are** electrically conductive–and definitely need to be cleaned off.

Removal of the flux residue is a lot easier if you get it off the board as soon as possible. Your company will supply you with a compatible cleaner and some type of applicator–such as a brush or swab.

It's also important to blot up the cleaning agent to keep from spreading the residue around.

Unless you are using a special no-clean flux that does not leave a corrosive or conductive residue, it's also advisable to reclean the entire assembly within a few hours–or the residue may harden to the point that it becomes difficult to remove. The maximum time between the preliminary and final cleanings should be specified by your company.

Another issue relating to heat transfer is the practice of pre-baking an assembly prior to specific rework operations. Baking is designed to remove any moisture that plastic components might absorb, in order to avoid cracking when the component is heated up to soldering temperature. The need for baking or pre-drying will be determined by your company's procedures.

Lets stop once again to discuss the specific types of flux, and the cleaning and baking procedures that are used in your facility.

In this next section we'll discuss the different types of solder that are used in surface mount rework applications.

Before we begin, it's important to insure the safety of the electronic components–through proper ESD grounding procedures.

IPC has both a detailed video and a computer based training program on ESD prevention.

Let's start now with a discussion of "flux-cored solder wire". We touched on this subject earlier during our explanation of flux.

Flux cored solder comes in various compositions–containing different percentages of tin and lead, as well as different types of fluxes. Typically, your company will decide which particular solder is compatible with your assembly process.

Flux-cored solder also comes in various diameters–for soldering different sized connections. It's your job to decide which thickness to use for each joint.

Most surface mount rework experts use a half millimeter diameter–or even a quarter millimeter–for fine pitch soldering.

If you use solder wire that's too thin–you may need to keep the heat applied for a longer period of time–in order to melt the proper amount of solder into the connection.

If the solder wire is too thick, even the slightest addition of solder can result in excess solder in the fillet. Excess solder is also undesirable, because it can conceal the visibility or proof of a properly wetted joint.

Now let's talk about solder paste or solder cream.

Solder paste is actually tiny particles of solder–mixed with flux–and various solvents. These solvents are included to keep the solder paste at the proper consistency, and to keep the solder particles from oxidizing.

If the solvents evaporate prior to use, this will change some of the properties of the solder paste–which will cause problems during the screen printing or stenciling process.

When the solvents evaporate too quickly **during** the soldering process, the tiny explosions that result can spread solder balls all over the board.

These electrically conductive particles could end up in the wrong place and create problems.

Solder paste needs to be heated slowly–to avoid splattering during the reflow soldering process. This is why solder paste is **not** recommended for use with most continuously heated hand soldering irons.

Solder paste can also absorb water over time. This moisture can then explode during the heating process–and splatter solder balls all over the assembly.

The freshness of the solder paste is equally important. If the paste is not properly stored, it can become unusable.

A solder paste "coalescence test" should be performed on a daily basis–to insure that your paste will perform properly.

Solder paste is typically applied during rework–with a paste dispenser–or some type of syringe.

The amount of paste applied will affect the size and shape of the solder joints.

If too little paste is applied, the result will be an insufficient volume–and a weak solder joint.

If you apply too much paste you may end up with solder bridging–or excess solder in the fillets.

Experience with your particular applicator and paste will teach you the right amount for each type of solder joint.

Finally, since flux is contained in the solder paste, the same cleaning requirements will apply.

*Heating Tools*

In this next section, we're going to discuss the different heating systems used during the various rework operations.

There are essentially two heating systems for surface mount rework: Conductive and Convective.

Conductive heat means **direct** heat transfer. In this system, the heat is conducted or transferred from one object to another–by direct contact.

The conductive heating tools also break down into two categories: the continuously heated devices–like a typical hand soldering iron; and the pulse heated type–which "pulses" measured amounts of heat to the tip for more gradual heating.

Let's begin with the simplest form of continuously heated soldering tool: the hand soldering iron. Hand soldering irons–with some type of small chisel or conical tip–are generally used to resolder certain types of surface mount joints.

There are many other types and shapes of tips that can be used to perform specific functions. We will recommend a useable tip style as we review each specific procedure–later in this series.

The condition of the tips is an important factor. When a continuously heated tool is not being used, the heat will cause rapid oxidation of the metal tip.

Oxidation can block the transfer of heat between the tip and the parts to be soldered. This will slow down the soldering operation. Remember that we always want to get in and out as quickly as possible.

To prevent this problem, it's important to always keep a fresh coat of solder on the tip of the iron. This is called "tinning" the tip.

Most modern soldering irons have an adjustable temperature control. The preferred tip temperature will vary depending on the operator's skill level and the particular application. Today's advanced irons can operate quickly and efficiently at lower temperatures–in the range of three hundred degrees C. They should also be capable of maintaining the selected tip temperature within plus or minus five degrees C.

Lower tip temperatures make soldering safer, easier to control, and reduces the oxidation rate on the iron tips.

The size and shape of the tip will also control how fast the heat is transferred to the solder joint. A larger tip–with more contact surface–will transfer heat faster than a smaller tip.

The ability to transfer heat quickly is one of the major advantages of continuously heated tools–especially during the removal of the larger sized surface mount components.

Whenever we need to remove a multi-leaded component, the ideal method is to reflow all of the joints simultaneously.

When the solder joints are all in the liquid stage, we can then remove the component without any unmelted or rehardened solder pulling on the lands or the leads.

For smaller surface mount components, the surface tension of the molten solder between the heated tip and the component leads will be sufficient to lift the component without additional mechanical force.

Conductive heated tools can also reach into tightly packed areas and remove components–without transferring "errant" or unwanted heat to any of the nearby solder joints.

Resoldering with a continuously heated tip can be done with solder wire. We'll be explaining a number of techniques later in this series.

Continuously heated tools are not recommended for use with solder paste–because of the rapid heating of the solvents.

The second type of continuously heated device uses vacuum suction to remove the components after the joints have all been liquified.

The operator controlled vacuum allows for easy removal of larger and heavier components.

The third type of "constant heat" tool is called a "thermal tweezer".

This is essentially two soldering irons connected by a hinge mechanism.

The tips come in different sizes and shapes–for two sided and four-sided component removal applications. After the solder melts, the operator uses a gentle mechanical force to lift the component off of the board.

"Pulse Heated Tools" are the final type of conductive heating device for surface mount rework operations.

The heat of the tool is controlled by activating a foot switch–to start and stop the heating process.

The gradual heat buildup allows the use of solder paste–for component replacement.

The pulse heated tips are made out of a "non-tinnable" metal that won't hold solder. This means that the tips can remain in contact with the leads when the component is resoldered onto the board.

After the solder paste melts, the heat is turned off so the solder can solidify.

When the solder has hardened, the tool is removed without affecting the solder joints.

Pulse heated tools can be used to install all different types of surface mount components.

They can also be used to remove most of the smaller two and four sided components. Their use in removing larger components is limited.

Convection heat–or **indirect** heat–is the other type of heat source for surface mount soldering and desoldering.

Hot air and inert nitrogen gas are the primary convection methods. Solder paste works best with convection heat. The slower heating provides the proper "ramp-up" time required to keep the solvents in the solder paste from evaporating too quickly, and splattering solder balls all over the assembly.

There are basically two types of convection heating systems: hand-held work pieces with controllable airflow and temperature settings, and stand-alone "rework stations" with programmable time and temperature settings.

Rework stations use specially designed nozzles to focus the airflow around each particular size and type of component. This helps to minimize the effects of the unwanted heat on all of the surrounding components and solder joints.

Rework stations also have the advantage of melting or reflowing all of the solder joints at once.

When all of the joints are liquified, the operator activates the vacuum–which gently lifts the component away from the board.

If one specific component needs to be removed and replaced on a number of assemblies, a rework station can be programmed to perform this type of repetitive task with minimal variation.

The hand-held convection devices–or hot air pencils–are generally used for soldering components back onto the board, although they can also be used to remove small chip components.

There are different sized tips–and air flow controls–which can be used to focus the hot air into the desired pattern, to help avoid heating adjacent solder joints.

Again, we will be discussing the specific techniques for each of the different types of desoldering and soldering tools in the continuing series of videos.

During this first video, we stressed the importance of avoiding unnecessary rework and why a cosmetic fix can create more problems than it solves. Not only is it a waste of your valuable time, it can also result in physical damage to the board.

The decision to rework a joint should be based on your company's acceptance standards–or on the J-STD-001 criteria.

The rework techniques which will be explained in future videos should be based on the procedures outlined in the IPC-R-700 Rework Guidelines.

We also covered the role of flux, and the importance of cleaning, to insure that specific flux residues are removed.

Then we examined flux-cored solder and solder paste, and reviewed the basic considerations for each of the heating tools that can be used for surface mount rework.

During the next videos in this series, we will review the recommended rework procedures for rectangular chip components, gull wing leaded devices, J-Lead solder joints, and other new styles of surface mount components.