
DVD-44C

Component Preparation and Manual Insertion

Below is a copy of the narration for DVD-44C. 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.

Copyright © IPC – Association Connecting Electronics Industries. All Rights Reserved.

Introduction

Through-hole component assembly – the beauty and speed of automation. But what about components that cannot be inserted by machine?

This video will examine what's involved in the preparation and manual insertion of these types of components. Our discussion will be organized in three subject areas – *kitting* of components and solder mask application; component preparation; and the manual insertion of components.

There are many steps in the assembly of an electronic circuit board. Each company handles these steps in different ways depending on what type of product they are making. Manual insertion can occur several times during the assembly process – before wave soldering, or pre-wave soldering; after, or post-wave soldering; and after a cleaning operation.

Components and other types of parts that are sensitive to the heat used during wave soldering, or the fluids used in cleaning operations – are manually inserted and soldered by hand *after* the board has gone through those processes.

Most manually inserted components don't have an issue with heat or cleaning chemistries. The primary purpose of manual insertion involves the size or shape of the component – meaning that certain styles of components simply won't fit in automatic insertion machines.

There are several things we'll need to review before we take a look at the job of component preparation and manual insertion. We'll start with personal safety. Personal safety involves wearing safety glasses, and any other protective clothing and equipment that's required; observing caution and warning signs; learning about hazardous materials; using correct lifting techniques; and becoming aware of how important it is to keep all work areas neat and clean. For more details on safety related information, refer to IPC videos DVD-11C and DVD-66C.

Another important consideration is protecting the sensitive electronic components we'll be working with. Electrostatic discharge, or ESD, is something that must be controlled during electronics assembly. ESD occurs when static electricity from your body comes in contact with and is discharged into an electronic component. This electricity can degrade or destroy the functionality of certain types of components.

There are a wide variety of materials and techniques to eliminate the build up and discharge of static electricity. IPC has a detailed video training program on ESD prevention. The general principles, however, are easy to remember. Always be sure that your body, your workplace and the workpiece are at the same electrical potential -- by properly grounding the workplace and yourself. These grounding wires will capture any built up electrical charges and conduct them harmlessly into the ground.

In terms of handling, it's important to always handle circuit board assemblies by the edges and components by the component body. Also, in order to help keep body oils and other contaminants off all metal surfaces, many companies have their employees wear gloves or finger cots.

Our final topic in this introductory section involves responsibility and teamwork. Everyone in this business learns the habit of checking all work before and after they do their part. This means that everyone checks each assembly when it first comes to them, and checks it again before passing it on. We're all on the same team – which means we all want to do the best job possible. It's important to communicate clearly and to assist each other.

Kitting and Solder Mask Application

Now, let's take a look at what's involved with *kitting* and solder mask application. We'll start with kitting. *Kitting* is the process of collecting all the production materials required for a particular job.

These materials are called out on a *pick list* – which includes various types of hardware; different kinds of components; and the circuit board. There are also detailed assembly instructions that are provided. This list of instructions is sometimes called a Traveler.

The components that will need to be manually inserted are all kitted together. These components include sockets, relays, inductors, transformers and thermistors – as well as odd sized or shaped transistors, diodes, resistors and capacitors. In addition, non-component parts like various types of hardware, tags and stickers may be picked and kitted with the components to be manually inserted.

It's important to be able to identify the various types of components you'll be working with. That's because many components have a similar appearance – even though they perform a completely different electronic function. If an incorrect component is attached and soldered to the circuit board, the assembly won't work as intended. IPC has a component identification desk

reference manual that can be helpful in determining the types of components you'll be working with – along with a more detailed training DVD.

After kitting, the next step is the application of *temporary solder mask* to the circuit board. During the wave soldering process, if we want to keep melted solder off of a certain part of the board, we cover it up with solder masking. Some of these places are holes in the board for various types of hardware – such as screws and conductor posts; the holes for components that will be inserted after wave soldering; and holes for components that are installed on the back or termination side of the board. Almost always, gold finger connectors on the edge of a board are masked to keep solder off their contact surfaces.

Solder mask comes in several forms. Liquid solder resist, solder boots, tape dots, and solder resist tape. All of these solder resist applications are applied by hand. However, liquid solder resist can also be applied by automated machines to speed things up – if a number of holes need masking. The type and location of solder mask to be applied is fully detailed in the instructions that go along with each board.

It's important to remember that after the resist tape has done its job, the tape should be removed slowly. If it is removed too quickly, ESD damage can occur. It is also very important that the solder mask is applied to the correct through-holes. Most boards have *legends* with indicators that designate locations for specific components; component polarity; and component orientation.

We're not going to study board *legends* now. A little later we will talk about legends, polarity and orientation again when we examine component insertion. What is important to remember here is that there is an easy way to know where to put the solder mask.

Several problems can come up if masking applications are not done properly. Too much liquid resist might be applied – covering areas that must receive solder. Too little mask might leave gaps that will allow the solder to leak through. The liquid mask might not dry completely before the board goes into wave soldering. Some types of liquid resist must be mixed, and the wrong proportions might be used. And the correct *type* of liquid resist must always be used.

When a company uses a final cleaning process, *water soluble* resist is used. This type of resist washes away during cleaning. *No-clean resist* is applied in a no-clean assembly process. This type of resist must be removed by hand after wave soldering.

With solder resist, tape dots or boots, care must be taken to be sure that there are no gaps or openings for solder to seep into. All of these problems can be avoided by following instructions exactly and checking your work before passing it on to someone else.

Component Preparation

Now that you have an understanding of kitting and solder mask application, let's take a look at *component preparation*.

When the kit arrives in the component prep area, some of the components may need to have their leads clipped to the proper length. The assembly instructions will specify exactly how long the leads should be. If leads are too short, they may not extend into the through-holes far enough to form a good solder joint or fillet. If they are too long – the component may not sit on the board in the correct position. Or during wave soldering, molten solder may web across to another component's through hole. This could cause the board to function improperly.

After leads are clipped to the correct length, the component might be covered with a material called *heat shrink sleeving*. This is done for several reasons. For example, heat shrink sleeving would protect component leads if they cross over a non-common conductor, where a short circuit could occur.

Now, let's discuss the *preforming* of component leads. There are some very important reasons for bending leads into specific shapes. Just what shape the leads need depends on the requirements for the particular circuit board.

One reason for *preforming* leads is to provide *stress relief*. Some components heat up during normal product operation. When they heat up, their leads expand. If they don't have the proper stress relief bends – they could pull on the board. This pulling may cause damage to the through hole lands; crack a solder fillet; or crack the end of the component.

Throughout the assembly process, the entire circuit board will heat and cool. Again, stress relief bending keeps component leads from pulling and damaging both the component and the board lands as everything expands and contracts.

One type of component preforming is called *Lock-in Crimping*. This type of preform helps hold components in place on the board whenever the board may be subjected to high vibration. Other performing shapes hold certain types of components above the board. Some components get so hot during normal operations that they could damage the board if they were too close.

There are special shapes for space or “real estate” considerations. A component that is normally placed on the board in a horizontal position may have its leads shaped so that it can stand vertically off the board. This way it will take up less board space. This makes room for other components underneath – or can create more perimeter space around the component. When making this type of bend, care must be taken to protect the end of the component. The bend must be made far enough away from the end of the component so that the *end seal* doesn't crack.

Finally, component leads must be *performed* to fit exactly into the through-holes of the board. If they are not bent just right, they will be difficult to manually insert. If the leads are forced into through-holes, damage can be done to the lands or the component itself.

Component leads can be shaped in one of two ways. They can be preformed on a machine, or by hand. Let's look at machines first.

Different manufacturers supply these machines, and any one company may use several different types. Preforming machines are either motor-driven or hand-powered. But all preform machines use different *dies* to make specific types of bends. Some motor driven machines may even cut leads as well as shape them.

A preform machine operator first selects the correct die according to the type of bend the instructions call for. The die is then inserted into the jaws of the machine and locked down tight. We'll need to take special care that oils and dust from other parts of the machine stay off of the dies where these contaminants could rub off onto components. These contaminants may make the components more difficult to solder.

The height of the die is adjusted using the *height adjustment setting*. Then, a number of components can be loaded into the feeder chute, if the machine has one. If it doesn't, each component is placed in the die by hand, one at a time. It's important to make sure that your hands, clothing and hair are well clear of the jaws when activating the machine by hand switch or foot pedal. A machine that uses a feeder chute may continue to run until all the components in the chute are preformed, or until the activation switch is released.

A person using a hand-powered, preforming machine follows the same procedures used for a motor-driven machine, except that a hand lever supplies the force to drive the mechanism.

If there is no perform machine available to make the correct bends, hand tools can be used. These hand tools may include specially shaped pliers, a number of different types of jigs and several types of cutters.

Almost every company uses the same procedure to check preform work. After the very first component lead is trimmed and shaped, it is carefully checked and measured. If any adjustments are needed, the next component is also checked. This goes on until just the right bend is made and the component lead is the correct length. Then the work can proceed. Every now and again a component is "spot-checked" to make sure the preforming procedure continues to work properly.

Several things can go wrong during preforming. The wrong die for a certain shape of bend may be installed in a preforming machine. Or the wrong *height setting* might be made. *Jaw settings* may change or drift while the machine is in operation if the lock-down screws become loose. Leads can have insufficient stress relief bends, sometimes called "no-give." Incorrect center-to-center lead spacing can occur – so the component doesn't fit properly in the through-holes. The leads might be deformed or damaged with kinks, cracks or heavy indents. Or, the component itself can be cracked or chipped.

Manual Insertion

In this final section, we'll be discussing the installation process for manually inserted components. After preforming, every component must be inserted in exactly the right position. Remember when we discussed using *board legends* to know where to put solder masking? We mentioned that component designation, polarity and orientation were also indicated on these

legends. Now we'll explain how legends are used to place components in the correct position on the board.

Many types of components are oriented or *polarized* – such as polarized capacitors, I.C.s, sockets, filters and transistors. Those parts that are polarized have a plus or positive lead and a minus or negative lead. There are different kinds of *markings* on polarized components that show which lead is positive. The positive lead must go through the positive hole, and the negative lead must go into the negative hole, or the component won't function properly. Legends often show which hole is for the positive lead and which hole is for the negative lead.

Orientation means that each lead must go into the hole assigned to it. For polarized components, polarity determines orientation. Usually the lead closest to the orientation marking is the number one lead and goes in the number one hole. The legend may show the outline of the component with the number one lead marked. Even if a component does not have polarity or orientation it must still be inserted in the correct location on the board.

Each company trains its technicians on how to recognize polarity and orientation markings. Also the instructions will point out the location of every component and where the leads should be inserted. Following these instructions is very important. If you're not sure about something, it's a good idea to ask questions.

There are some simple rules we'll need to follow during the manual insertion process. First – always check a part before you insert it. Second – make sure that the insertion location is correct according to the instructions. Third – never force a component into its through-holes if the leads are not preformed for the correct fit. Fourth – insert the components in the order the instructions give them. Usually the smallest components go in first. However, the instructions determine what components go where and when. Fifth – check that each component you insert is straight. Finally, always make a last check to see that your own work and the work done before you is correct.

After a component has been inserted – and before the board goes to wave soldering – it may be fixed on the board so that it cannot move. This is done by clinching the leads – or by using adhesive bonding to hold the component in place. This may be necessary if the boards are being stored or moved around the assembly floor in a vertical position... or when the finished product will be subjected to heavy vibrations – as a part of its normal use.

Clinching consists of bending over the ends of the leads that extend through the holes. Adhesive bonding involves gluing the component to the board after it has been inserted.

There are specific rules on how to clinch leads – and where to place the correct quantity of bonding material. These rules or standards define what is acceptable and what is unacceptable. The IPC-A-610 describes what is acceptable work and what is unacceptable in every area of circuit board assembly.

On some machines, preformed components are placed in special bins. The correct bin is automatically presented to the operator whenever the laser indicates that particular component

should be inserted next. Of course, everyone using these machines should be thoroughly trained in their operation.

Another system for manually inserting components is on an assembly line. There are two types of lines. Push lines (also known as slide lines) and motor driven lines.

On a manual insertion line, each operator is responsible for a certain number of parts or for a certain area of the board. Instructions define which people do what jobs on an assembly line.

When a board comes into the manual insertion area it is usually mounted in a holder or pallet. The pallet provides a way of handling an assembly and moving it from one area to another without touching it or scraping it against hard surfaces. Pallets also help protect the board from ESD. Whenever an operator finishes their work, they either place it on a motor driven line that carries it automatically to the next person or it is pushed or slid down the line to the next station.

Assembly lines require teamwork. Everyone must know what the person in front and behind them is doing and how long that takes. They must know that the quality of their work affects the quality of the next person's work. This is another example of why teamwork is so very important in every area of the electronics industry.

Finally, after all the machine and manually inserted components are in place, they are wave soldered. When the molten solder cools and hardens, it forms a solid mass that creates a mechanical and an electrical connection. This means that the component will be held firmly in place and that electricity will flow through the connection.

This program has examined the component preparation and manual insertion operation. We've taken a look at kitting – and solder mask application; described the different techniques used in preparing the components for insertion; and explained how manual insertion is accomplished.

We also discussed the importance of teamwork and personal responsibility in each of these areas. It's important to recognize that your abilities and attention to detail play a major role in producing quality products.