An Introduction to Electronics Systems Packaging
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Module No. # 07
Lecture No. # 33
Reflow and Wave Soldering methods to attach SMDs

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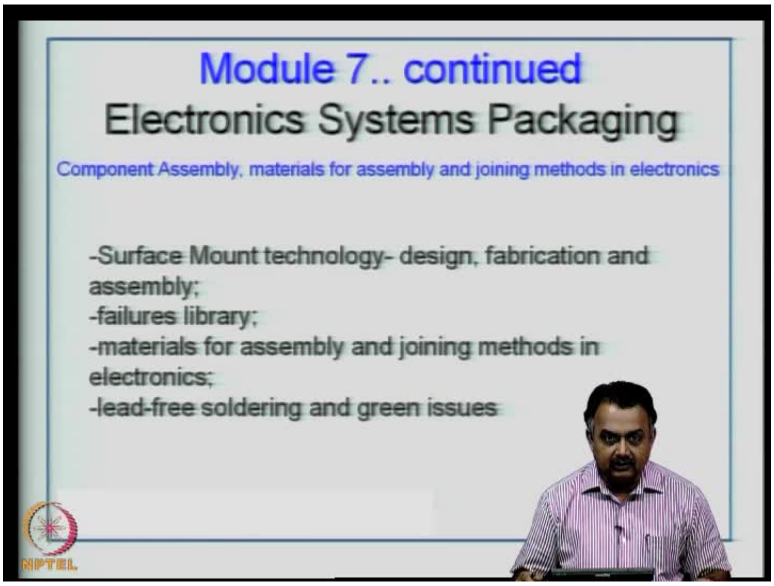

We will continue with the module on Surface Mount Technology and Surface Mount Device Assembly. We had spent an hour on the introduction to component assembly, materials for assembly, and joining methods in electronics. We began with introducing the surface mount technology. We also discussed the pros and cons or the benefits and disadvantages of surface mount technology, compared to a through-hole technology, where the components have leads. You have to take care of the substrate, according to the component requirement or configuration.

We have seen that in the introduction, as the name indicates, surface mount technology requires surface mounting and therefore, the equipment that is required for surface mount device assembly is completely different. The design has to be appropriately selected and we have also mentioned that if we have multiple components in your design, then accordingly the board goes through the process of multiple assembly.

We have defined what surface mount technology is. We have seen the chief importance or the requirements or the drivers for surface mount technology, including the lead free assembly that is a big possibility in surface mount technology and the assembly of advanced packages like BGA and CSP using surface mount assembly methods.

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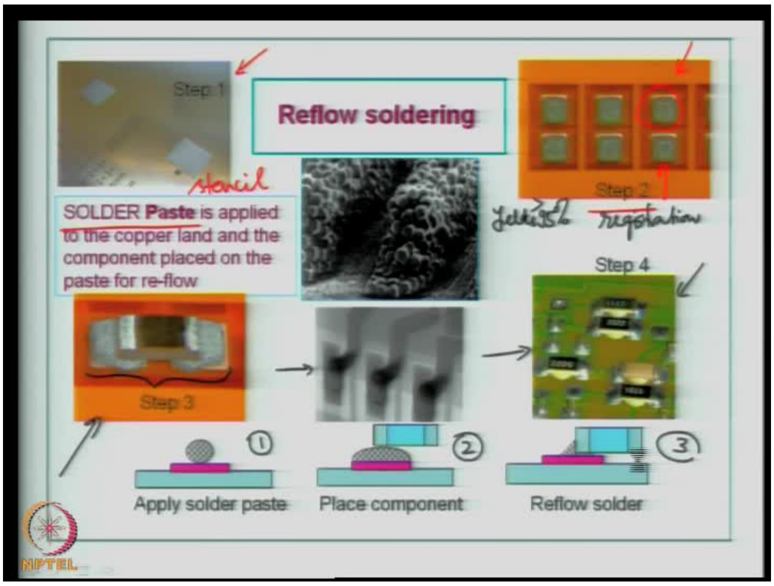

We will continue with this chapter. If you can recollect, we have introduced to the topic of soldering process. We have seen what manual soldering is and machine soldering is. Obviously, for industry and for large volume production, you have to depend on volume manufacturing. Therefore, machine soldering is a must and here we are going to discuss different methods of machine soldering and one of them is Reflow soldering. The other one we saw is a wave soldering process.

In reflow soldering, as you can see here, in step 1, there is a stencil. You can see there are slots that pertain to the footprint of the surface mount devices and the idea is to dispense solder paste to the copper land, on the Printed Circuit Board and then the component is placed on the solder paste and then it is subject to a reflow. If you can recollect, solder paste is the material that contains solder particles, very fine particles; powdered metallic particles; and they are actually dispersed in an epoxy media, a polymeric media which contains a binder, which contains some kind of a glue. In addition to all these components, it contains also the requisite flux material.

Therefore, this is a very important material for reflow soldering process compared to the wave soldering process, where you are depending on attachment of the through-hole component. Through a large wave, which basically helps in wicking the solder, through the component lead into the via and performing an interconnection process. So, solder paste is applied to the copper land. As you can see here, this is a stencil and the foot print is available on this stencil. The solder paste is supposed to be squeezed through, during the stencil printing process through these perforations, which represent the copper lands.

In step 2, as you can see, this stencil printing process is completed. You can see here that in the background, there is a copper land and on top of it, the solder paste material is actually printed. Therefore, a large area on the board can be stencil printed by the solder paste method. The only important criterion is that you have to align this stencil correctly with the copper lands on the Printed Wiring Board. Otherwise, you are going to end up with mixed registration of components and you require repair and rework. This is equally important, because the copper lands are very small; because the surface mount devices, the footprints are very small. Therefore, you require a very good registration at this stage. This is equally important, because you want very high yields as close to 95 percent and above, when you think of surface mount technology.

Step 3 as you can see here, there is a surface mount device like a resistor or a capacitor that is placed on the footprint; where the solder paste has been dispensed. Here again, we use equipment based placement.

Then in step 4, you can see that the entire set of board with all the components placed on the board is now reflowed, which means the solder paste melts and then it attaches itself to the component lead at the edges. You can see that a perfect wet soldering process of solder material is seen on the board, at the component joint area. It is classified as a good quality joint. You have to avoid dry joints during this process. What you see here at the center is a micrograph picture or an X-Ray picture of a very good registration process that has taken place during the reflow process.

Reflow indicates that you have to use temperatures that pertain to the melting point of the solder paste material; so that you get a very good metallurgical bond. These steps are: apply solder paste typically; place the component and then do a reflow process.

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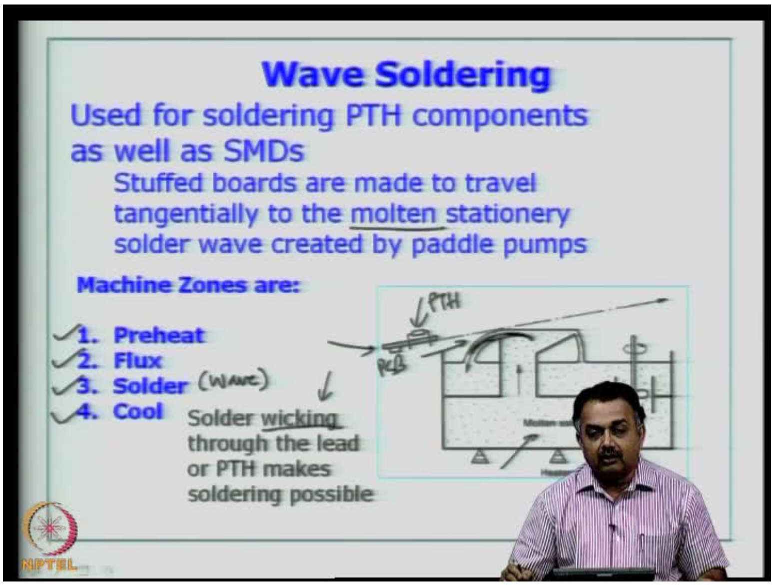

Wave soldering is another process that is used for soldering through-hole components. But initially, when surface mount technology was beginning to take over, wave soldering was used for surface mount devices. But today, most of the surface mount devices have qualified themselves for reflow soldering process, because it is much more accurate, more yield and probably you can control the temperatures using a reflow soldering process, avoiding thermal shock to the board as well as to the components.

Because in a wave soldering process, what basically happens is that the stuffed boards or the boards with the component inserted into the through-hole, in the case of a through-hole component, are made to travel tangentially through the molten solder wave that is created in an equipment as you can see in this figure here on the right. Typically, a wave soldering equipment will have a molten solder. There are heaters that keep the solder molten at all the time and then using some kind of a paddle pump, you generate a kind of a wave at the top.

Now, your PCB with the component inserted especially the through-hole components here, as you can see, is made to move on a belt tangentially to the wave. So, the wave touches the leads of the through-hole components at the back side for the solder side of the board and using a kind of a solder wicking process through the lead or the plated through-hole. So, soldering is established and thereby an electrical connection is established. Here we are talking about complete wet joint and we are concerned about the reliability at the stage of the through-hole assembly.

Now, the machine zones in wave soldering equipment is preheating the board, applying the flux, applying the solder through the wave, and then slowly cooling the board to room temperature. Now as I said initially, wave soldering was also used for surface mount devices. But when we use a surface mount device for wave soldering, you have to make sure that the device is well glued to the board. As you can see in this picture here, one component is depicted as a through-hole and you can understand that the pin is touching the wave and therefore, there is no chance of the component falling down.

But if you have a wave soldering process for a surface mount device, you can see that the device is on the other side. There is a good chance of falling into the wave, but you are gluing it by using suitable adhesives so that during the wave soldering process, the component is not shifted or it does not fall down into the wave soldering unit.

But the one point that I emphasize is you have no control over the temperatures because we are talking about molten solder and there could be thermal shocks for surface mount devices especially some kind of active devices, if you are trying to solder though wave soldering process.

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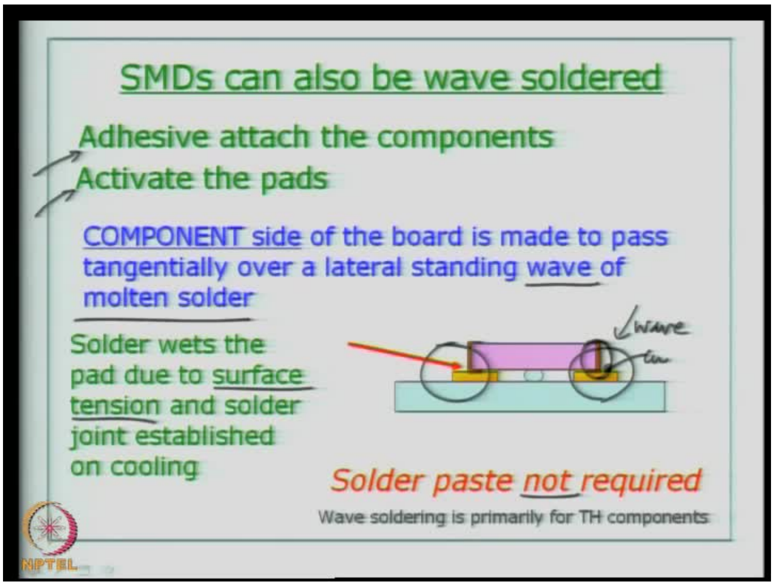

So, you have to use a judgment in terms of the thermal shock on the substrate as well as the components. Typically, in making a general statement, surface mount devices can also be wave soldered. But the requirement is that you have to use adhesive. First you adhesive attach the components, then you activate the pads and then the component side of the board is made to pass tangentially over a standing wave of molten solder. So in the through-hole components, you are having the solder side that is the pin side pass through the wave but in a surface mount device, it will be the component side, that is the component has to touch the wave, so that the lateral pins of the capacitors or the resistors or the surface mount pins can pick up solder from the wave. So, the solder wetting takes place due to surface tension. Whereas in the first case, it is a case of a wicking process because there is a hole and there is a pin coming out from the hole and it helps in a wicking process in pulling the solder through the pin due to some kind of a capillary action.

In this case, the wetting is taking place due to surface tension and it is basically happening at this point. So you can imagine the component side touching the wave and then the wave actually adheres to the copper here and then it pulls the required amount of solder based on the available area of the metal contact and then establishes a connection at the edges. That is how a joining process takes place in a surface mount device using wave soldering process.

As you can understand, because we are using an adhesive you do not have to use a solder paste. Solder paste application is not required. But as we have moved on over the years, today the percentage of wave soldering for surface mount devices has considerably reduced. Today we are talking about wave soldering for through-hole components and reflow soldering for most of the surface mount devices including BGA.

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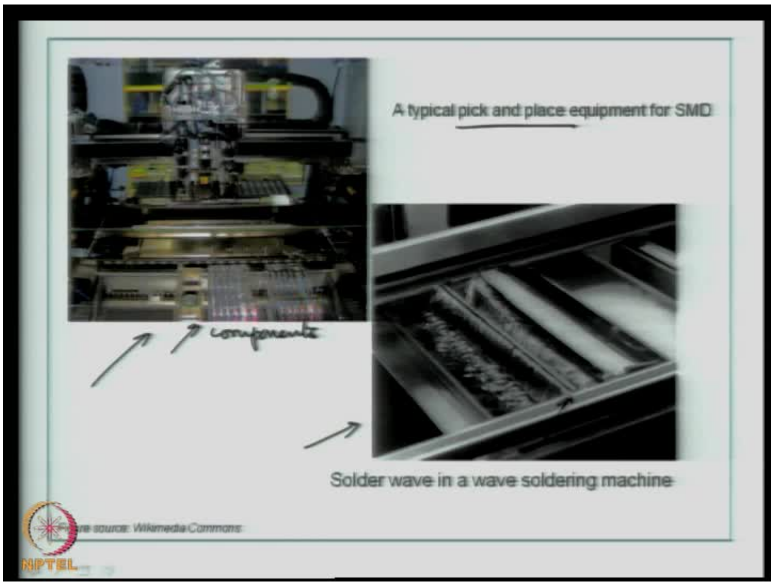

Here in this picture, you can have a look at pick and place equipment for surface mount device. As you can see here in this picture, it is a huge machine, an expensive machine and it contains the loading of various components that can be done that is required for a particular design. Various tapes or reels of resistors and capacitors and your active devices can be loaded and then you have the paste on the CAD data, you have the a pick and place forceps or the arm of the equipment picking the components from here from the respective bins and moving to the board and placing it in the respective coordinates that it is assigned to,

You can expect that when you use a reflow soldering process you are dispensing the solder paste. Then the next step is the pick and place process, typically using high volume, high end machines. You can also do manually for prototyping boards. Here in this picture, you can see there is a solder wave in a wave soldering machines. You can see here at this point, a wave is generated from a mother tank containing molten solder and here again, because the solder at this point of time is exposed to air, there can be lot of oxidation and therefore, you have to make sure that the oxides are moved continuously from this molten bath. Otherwise, you can expect oxides to be transferred on to your solder joints. All it requires here for wave soldering machine is that it requires a good maintenance of the parameters and the material.

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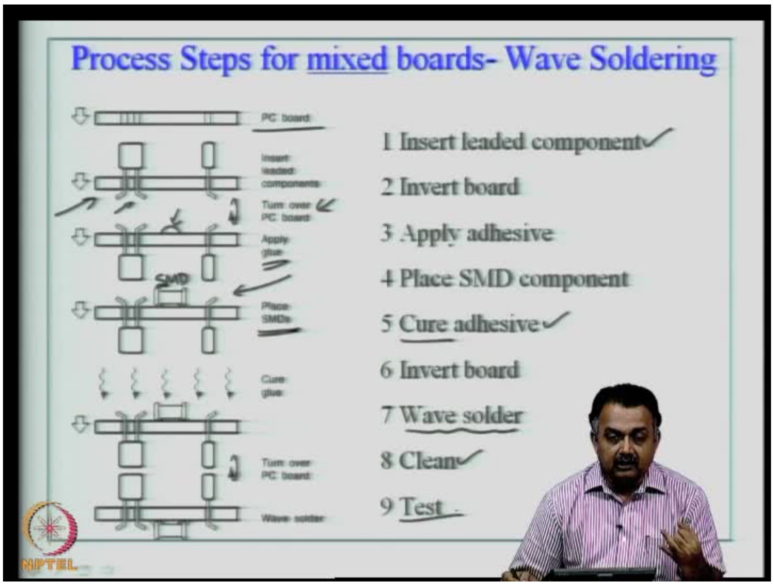

What are the process steps for mixed boards? When I say mixed boards, I mean plated through-hole type of component as well as surface mount devices using wave soldering. The first thing is that you have your PC board ready that is a Printed Circuit Board is ready. Now you insert the leaded component into the through-holes of the boards. You can see here in this particular figure, we have inserted the various types of components. It is inserted through the plated through-hole. Remember the through-hole is plated with copper and then it is bent so that it does not move away from its position during the wave soldering process when it enters the wave soldering equipment.

Now, you can apply the adhesive. Suppose if you want to mount a surface mount device on the other side of the board as you can see here, the board is turned over. Glue is supplied. This is the glue that is supplied. Now you place your SMD device. Here is the SMD device there is placed.

Obviously your design has taken care of placing these devices in between the through-hole components if you have, so that there is no problem during the machine soldering using solder wave. Once the SMDs are placed, what you have to do now is to make the

SMDs secure in its place. You do a curing process. You have to cure the adhesive at certain temperatures. Typically epoxy adhesives are used and you can use temperatures around 80 to 100 centigrade for about 10 minutes to cure the adhesive and make the SMD firmly placed in its position. Remember we are now going to use this side of the board for wave soldering and simultaneously both the through-hole components and the SMD devices are going to be soldered.

Once you have done the curing process, you invert the board and then send it for a wave soldering process. You can expect the attachment to take place for both the SMD and the through-hole component. After this process is over, you can clean the board with suitable materials like Isopropyl alcohol. The basic idea is to remove the oxides and other foreign particles that could have got itself attached to the board during the wave soldering process.

Then you do an electrical test for shorts and open. Then you qualify the assembled board. This is a typical process step for wave soldering using mixed boards design. We have seen how to assemble a board using wave soldering for through-hole, for surface mount devices, and for mixed boards.

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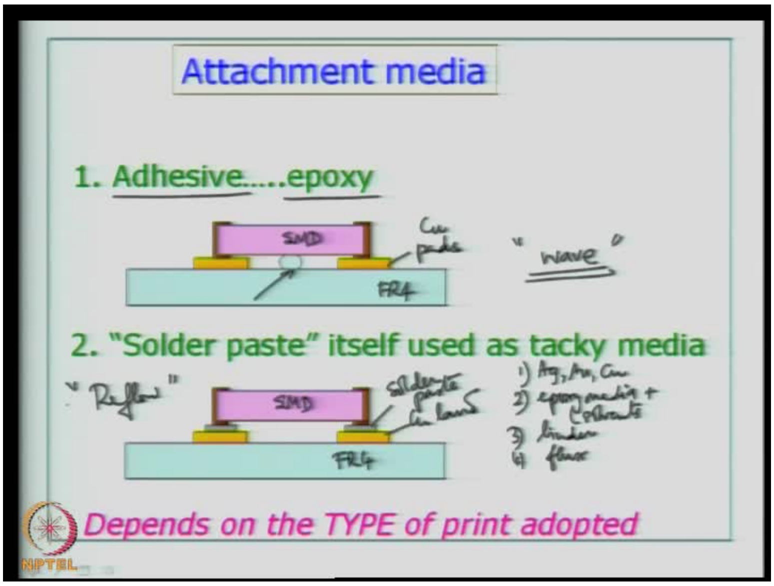

Now, let us look at some of the other processes typically that is used in a reflow soldering process. We must know about the attachment media. When a surface mount device whether it is an active device or a passive device, if it has to be attached to substrate then you have to use adhesive. So, typically we use adhesive which is again epoxy based. I have been mentioning and talking about epoxy in this course for a long time and you will now understand that epoxy has got various applications in packaging.

The affordability is one important criterion for choosing epoxy. There may be other adhesives, but we use epoxy based materials for various applications like chip on board encapsulant or a flip-chip under fill process or an epoxy in solder mass applications, conductive adhesives or simply a nonconductive glue and so on.

You can see glue is supplied. This is the FR4 board for example, and these are the copper pads and you can see a device SMD device that is placed after the glue has been dispensed. So the component is actually held because the glue is cured and here right now there is no attachment. But this is ready for attachment. In this case, you will go in for a wave soldering process. This is an important step for wave soldering process.

If you look at the other figure here, you have the FR4, you have the SMD device, then this is the copper land and then you can see here a solder paste has been dispensed on which the surface mount device is now firmly held. It is held because there is some percentage of glue that is present in the solder paste. After the pick and place process you have to physically move the board to reflow equipment

During that process cycle, the component should not move from its coordinates. Therefore, there is a tacky media that is available in this solder paste media itself. A small percentage of glue is added and that is part of the ingredient in the solder paste.

Typically, a solder paste will have metal particles like silver or gold or copper. Then you have the epoxy media itself or solvents. Then you have the binder or the glue and then you have flux material and so on. This is used for reflow process. This particular methodology is used for reflow soldering process. Make sure you adopt the attachment media process appropriately whether you are using a wave soldering process or a reflow soldering process.

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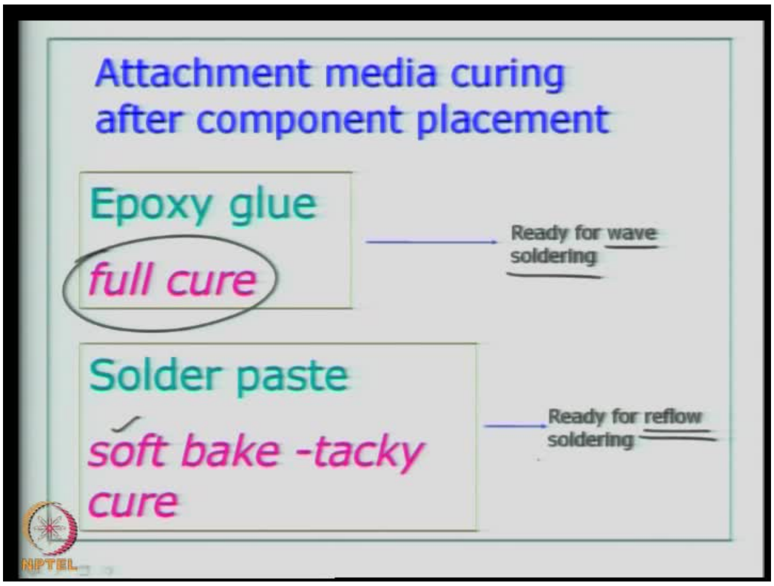

If you have used epoxy glue and if you are going to use a wave soldering process, you have to make sure that the board is glue is fully cured. It should not be tacky cure; it should be fully cure and that full curing process makes sure that the component is held firmly on the board during the wave soldering process. Otherwise you will miss out in the coordinates and the epoxy cure will not be affected by the temperatures or the material during the wave soldering process. So that is an important criterion.

In the solder paste application process for reflow, you will see that you have to use a soft bake, also known as a tacky curing process. You do not do a full cure here. The full cure will take place when the entire system is sent during the reflow soldering process in the equipment.

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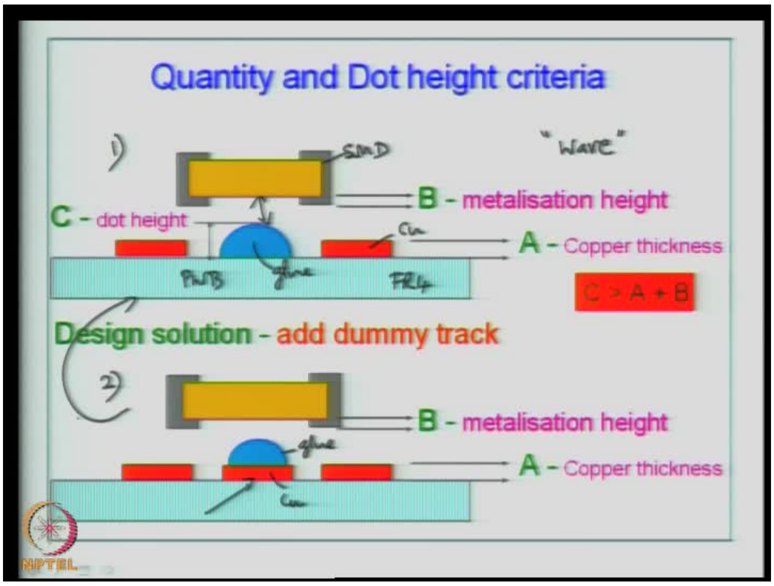

Now, we talk about quantity and dot height criteria for a dispensing a glue or a solder paste as the case may be. If you look at the figure at the top, there is a FR4 material here, there is a Printed Wiring Board or the PCB, then you have the copper land here, this is the SMD device. Now you have put some glue here. Let us say, for a wave soldering process you have dispensed glue here. Now, sometimes there is no control over the quantity of the glue because the glue has to touch the surface of the surface mount device in order to keep the component in its place.

In some cases what happens is that because the pad height the thickness of the copper is very low you are dispensing too much of glue and for a small device dispensing too much glue economically cannot be possible in large companies in large world in production. So the idea in some cases in some companies is that during the design stage itself you take care of minimizing the quantity of glue.

How do you do that? Because adding more glue will also create problems called swimming of the surface mount device when you dispense or when you place it on the glue during the full cure process or you have to use the right amount of glue at the right place. A design suggestion has been in searched by many companies at the design stage itself. You create an additional copper pad which is not an interconnect, which is not part of the design itself. It is a dummy pad that is generated.

The idea is you can reduce the height and also reduce thereby reduce the volume of glue that can be dispensed. So, this is the glue. Compared to this figure here you are going to add much less glue that in itself enhances the reliability because it is very light compared to the weight of the component. The volume of glue is much large in the first case whereas, in the second case it is compensative by adding a dummy track and here you can expect very firm attachment and the orientation of the component will be enhanced compared to the first case that is described here in this illustration.

Therefore adding dummy tracks for small, very light devices to reduce the volume of glue is a built-in process, an enhancement that we have seen over the years for surface mount device assembly.

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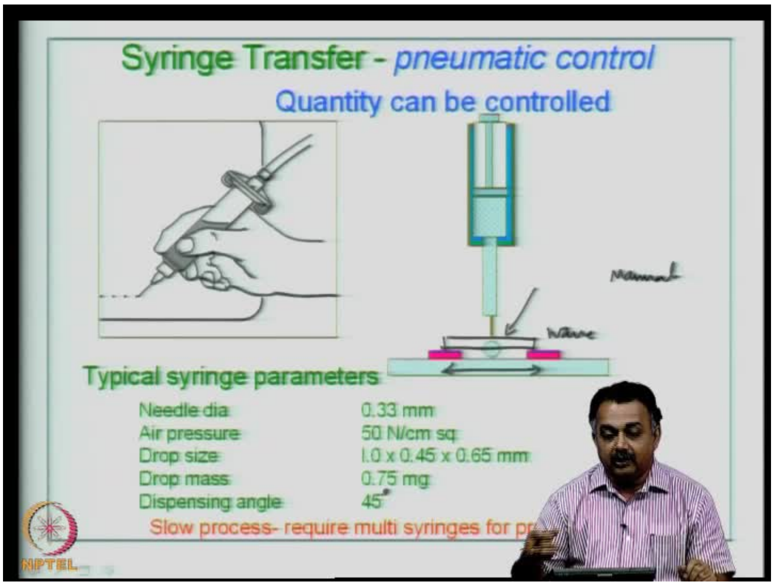

The other way of dispensing attachment media can be using a syringe. You can use syringe transfer with pneumatic control and here you can control the quantity of the glue or even the solder paste of dispensing for reflow. So, you can use syringe for dispensing the glue for wave soldering or dispensing the solder paste for reflow soldering. You can see here a tiny dot of glue or a solder paste is dispensed. In this case, it is for wave soldering because the glue is dispensed in between the copper pad that is meant for placing your surface mount device. After this process, your surface mount device will be placed here.

You can also do manual dispense using syringe. If you have very good experience and control, you can easily dispense the glue on your prototyping boards manually instead of depending upon a equipment which has a pneumatic control.

Typically, for example, if you take a needle dia[meter]- which is about 0.33 mm, air pressure is 50 Newton per centimeter square, drop size is given here, drop mass is 0.75 mg, dispensing angle should always be at 45. Therefore, you can expect a very good flow to take place if you work at these dispensing angles. It is a slow process if you are doing manually but even if you are doing pneumatic control it is a slow process because you are going to dispense 1 by 1 over the various pads.

Therefore, today people have moved into multiple syringe dispensing. It is dependent on your CAD input. You need to have very good tight control on the various syringes that you are using. If you are using 3 to 5 syringes simultaneously, then you have to make sure what are the drop sizes or drop mass that is required for various devices. We are not going to look at equivalent or equal mass of the material for the entire board.

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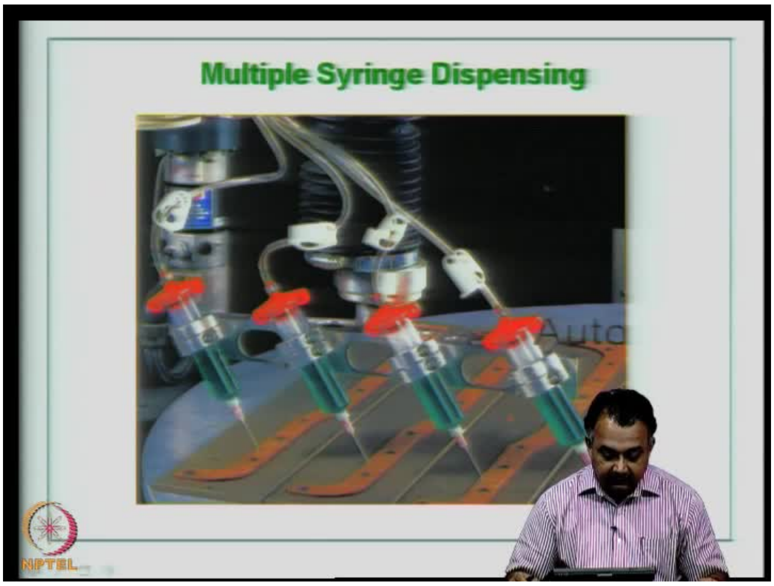

In some cases, for larger devices which have lot of weight and the area, you might think of dispensing more glue and that also depends on the height of the package. So, all of this criteria have to be taken into your account when you are looking at multiple syringe dispensing. As you can see here in this figure, this is a typical multiple syringe dispensing of attachment media. It can be a glue, it can be a solder paste. We will now look at a video where we are going to highlight manual method of dispensing solder paste on to a Printed Circuit Board by syringe method.

Let us follow this video as we go along. As we can see here, the technician here is now filling the empty syringe with solder paste The solder paste typically has a set contains various ingredients including flux material that helps in proper wetting. Make sure that there is no air gap or bubbles or voids and that will help in good mass distribution over the entire board.

Now the components for the prototyping have to be ready. You can see here in this particular slide, all of them are surface mount devices, various sizes and formats including resistors, potentiometers and so on. This is the board and you can see here the technician is now dispensing. Based on the experience of dispensing quite a few boards, you will get to know what kind of volumes is required based on the pad area. You can see the material is dispensed on the copper land.

The problem is you should not dispense too much of material because it will muck up the board and you have to do a lot of cleaning. If you have a very good steady hand, you can. This is the stage where the solder paste material is completely dispensed on all the copper surfaces or pads for this particular circuit. This is a manual placement. You can see these tiny devices are placed. Here you can see a snapshot of a completely placed manually placed board on the solder paste that we have just dispensed.

Now we are moving into a reflow oven here. Before we actually start, you have to create a temperature profile which means you have to understand at what temperature the solder paste is going to melt, what is your glass transition temperature of the board. I think you are aware of the glass transition temperature which we have discussed and then are there any components that can fail at that peak temperature. So, these three important criteria have to be carefully noted before you move into the reflow soldering process.

Here, the board is mounted. The equipment is switched on. The concerned thermal profile will now be loaded which means you have programmed the rate of heating. The rate of heating should not be very fast; it can create a thermal shock on the devices. So make sure you have a control rate of heating like 5 degree centigrade per second and so on.

Set the peak temperature and you can also set temperatures where you know that the solvent is going to. You can see this graph here, the ramp-up takes place which means there is a steady heating, slow heating. Typically it can go up to your T G of the board. Then you can hold the board for some time at a particular temperature so that the substrate gets heated up. The solder paste starts melting and it starts to reflow because this is a crucial point where the leads have to become active. The board has to be active, the copper pads have to be active, and the material has to get attached to the component pads.

Then you start the attaining the peak temperature from here. This can be a very short process and then it attains the peak temperature and it is held there for a very few seconds typically about 20 to 30 seconds and then it is slowly allowed to cool. Slow cooling is important because if you do a rapid cooling, then again it can create a huge thermal shock. After the board is cooled, then you can check the board for electrical continuity and other electrical test that you require for a particular board.

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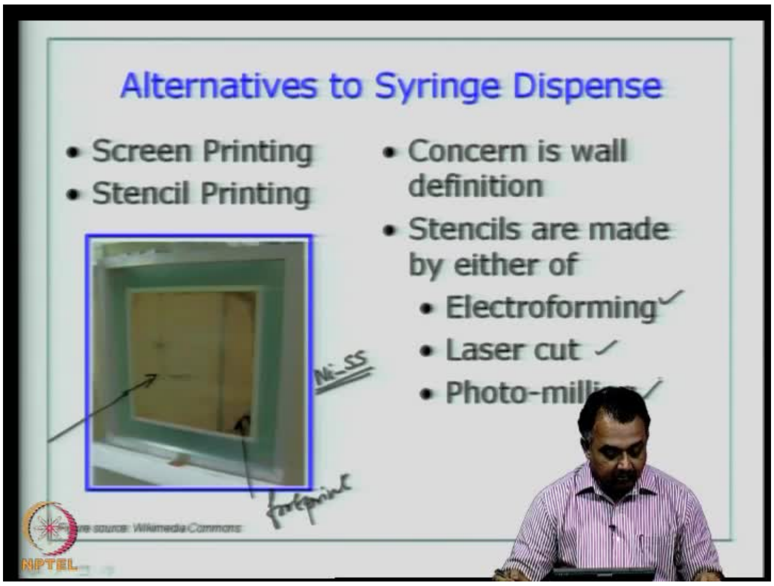

Now, we will look at alternatives to syringe dispense. Syringe can be used for both glue dispensing as well as any nonconductive glue, a conductive paste or a conductive adhesive or a solder paste. So, the applications are varied. Screen printing and stencil printing are the other methods that can be used to dispense materials or media. The concern here is the wall definition that means you have to generate these kinds of screens that are made out of typically nickel, stainless steel, very thin sheets and then you have to generate the footprint of your SMD assembly pattern on this particular stencil. The concern here is the wall definition. Do you get the right image transferred and have you made a very good laser cut definition or it could be a photo-milling or electro chemical milling and so on.

Depending on the process, you are going to make sure that the image is well transferred. It could be electroforming, laser cut, or photo-milling to achieve a good stencil. Now, we will look at stencil printing and soldering, that is reflow soldering process. How they are typically done in a prototyping. Here we are talking about all these video highlights that is typically done in a lab. These are typically done by students and this gives a very good exposure for the students to understand this technology, the difficulties in this technology and typically they know how these are upgraded in the industry with expensive equipment and low lead times for these processes.

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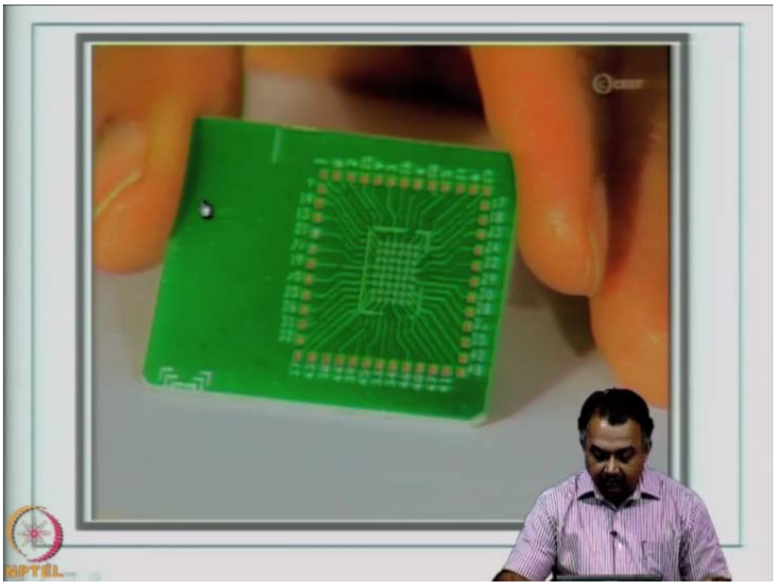

We look at this video highlight for stencil printing and soldering by reflow. You can see here. This is the board on which the stencil printing has to be done. You can see here at the periphery, there are copper pads and at the inside you can see a provision for a BGA attachment. Now, we are going to use a stencil. Here, you can see that the patterns for the BGA have been created on a very thin laminate like Teflon or a BT epoxy or simply an

FR4. This video shows typically how you can do this in your lab, which explains expensive processes like stencil printing and solder paste dispensing.

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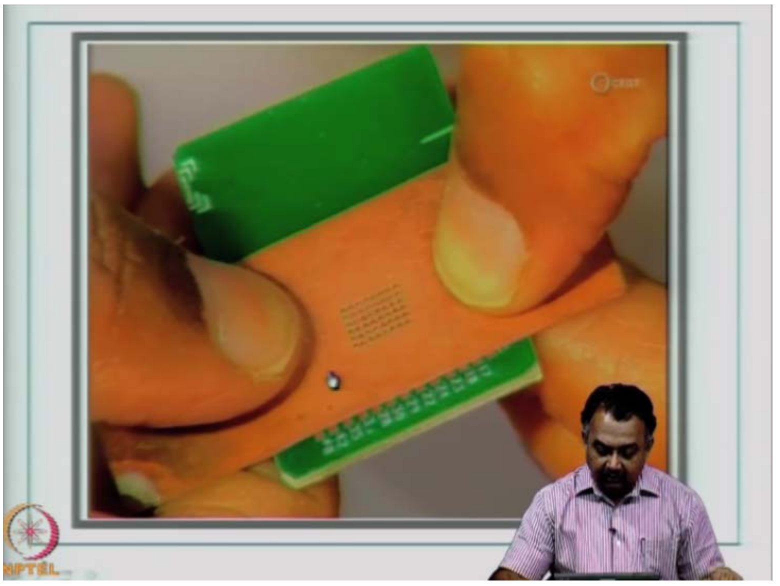

You have to align perfectly. After you align, make sure it is firmly held in its place by an adhesive or a tape. Now you are going to use a kind of a squeezing blade material. Here you can see this is the solder paste. The solder paste is now printed through the perforations representing the BGA solder balls and then the solder paste is transferred. You can see here the solder paste is transferred on to the copper pads of the BGA pattern.

What is the next step? This solder paste material will be allowed to reflow. You can mount BGA here and do a reflow process. You can see here, this is the component that is placed. Because here we do not have equipment typically to place this but you can see there is a package outline that has been generated.

So, we will use this as the estimate for placing the package manually. We have seen earlier that how automatic alignment takes place. Because the solder paste melts and due to surface tension, the entire package is pulled back even if there is a movement during reflow to its original position.

Therefore, you can see the assembly is now loaded into the reflow equipment. The equipment is switched on. The temperature profile for this particular process is set up.

The peak temperature is defined the times at which the board will dwell in each of these zones. That is we are talking about the ramp zone, the soaking zone, and the reflow zone and the peak temperature zone. This is the cooling zone.

We are going to define for every individual design and material all of these zones and then we have to wait till it attains the peak temperature and then slowly it cools to room temperature. To avoid thermal shock, you should not remove the board from the tray and allow it to cool. You should allow it to come to room temperature as a natural phenomenon or process. This is a typical prototyping methodology that we have shown you that can be done for the reflow process using stencil printing.

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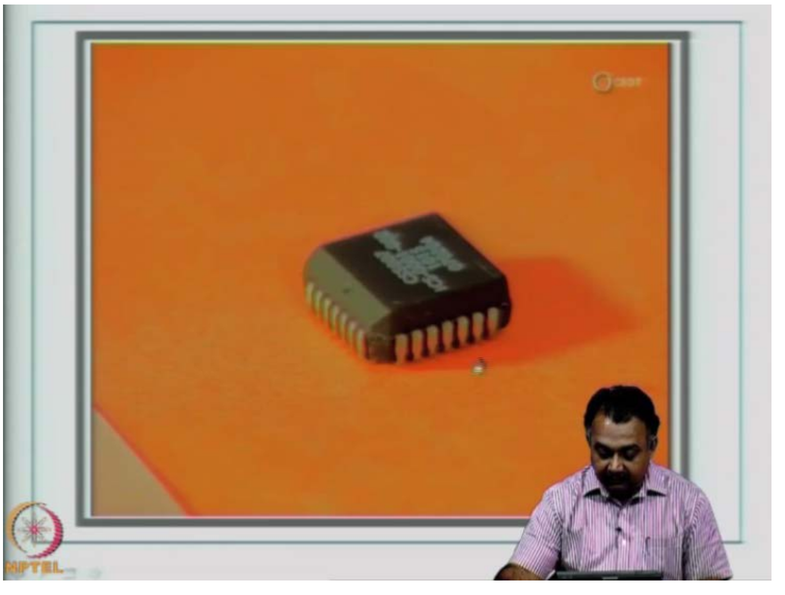

Now, we can see the similar process that is used for a J leaded component. As you know there are various components with the J bent configuration. Here again, the landing pads are inside. Here, this is the footprint for such a package and here you can see that the stencil has been created for such a foot pattern. It is now aligned with the component footprint on the substrate. Now, use a squeeze and then squeeze the solder paste through the stencil material. If you have a proper stencil containing large number of such prints to be done then it will be a huge stencil. Here, we are talking about a very small board size that needs to be printed.

Now you can see that the solder paste is dispensed. Because the feature sizes are very small, there is overlap; there is bridging but it does not matter. Because as you know when the solder paste melts; when it reflows and when the component is placed, due to surface tension the leads will pick up the requisite motor of solder and there will be no solder bridging that you might expect to take place. But it does not happen. So, it is a complete 100 percent yielding process.

Now the component is placed approximately because you are not doing a cent percent alignment here and you expect the alignment to take place based on the surface tension. Because these conductors coming out from the pads will give you a very good idea and approximation took place the device at the center of the pads. So, this is a very good indicator for aligning your component. Now you can do your final adjustments to make sure that from your side you have placed the component. You can see here the device is placed perfectly on the footprint.

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Now, once it is set at room temperature for a few minutes, it is now placed in the reflow oven, again the similar process of setting a thermal profile for this particular material. If it is a new material then you have to change thermal profile. If it is a new substrate you have to change a thermal profile. If you have a sensitive component you have to change the thermal profile. So, please do not ignore the thermal profile setting for surface mount device and for reflow soldering process. In wave soldering, it is a different situation. So, note down peak temperatures, note down ramp-up timing and temperatures, and also note down the soak zones which are very important. You can see here a very good attachment. There is no solder bridging between the pins, no extra solder and this resembles a perfect joint that has been generated using reflow solder paste and for a J leaded component.

Now, we will look at stencil printing and soldering by reflow method for a galving component. We are now trying to describe and show you how you can use different types of surface mount devices; but at the same time using the same technology that is reflow surface mount assembly.

Here you can see, this is a gull wing. The shape is like a gull wing. Therefore, it is a QFP type of a package but with a gull wing configuration. For this again, you have the footprint ready, you have the test points ready. You start dispensing the solder paste using a stencil, very thin material is used as the stencil base. You can now see that the solder paste is dispensed.

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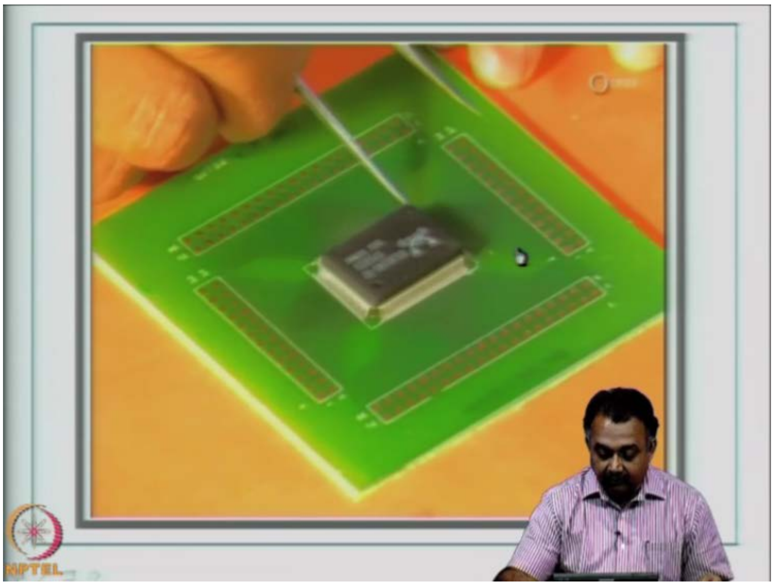

You are now using your manual method of alignment and trying to make sure that to the maximum possible you can do a good alignment before reflow. Once you are satisfied with the alignment process, again you take the board to the reflow and then you expect due to surface tension, the solder does not bridge, all the solder that is reflowed will get attached itself to the pins of the gull wing component and making sure that the gap between pins which is the dielectric is completely devoid of the solder paste material because of the surface tension process. You can expect to some extent a very good, a self alignment. But for BGAs you will see later in this chapter, how self alignment becomes very important when you mount BGAs, the solder balls you cannot really view from the top. At least in this case for surface mount devices, the pins are outside the package outline and you can have a look at the soldering process and look at the defects.

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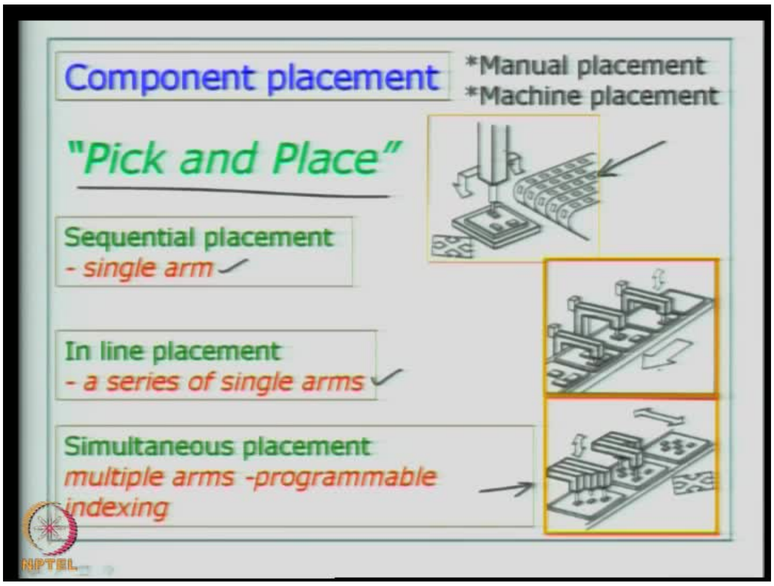

So, component placement becomes a very important issue you can have manual placement or machine placement and typically we describe this process as a pick and place process. You have various equipments, you have lab equipments, and you have industry large scale equipments. You can have a sequential placement where a single arm is used, in line placement where you have a series of single arms to increase the production and you can also have simultaneous placement where you can have multiple arms and it depends on the programmable indexing.

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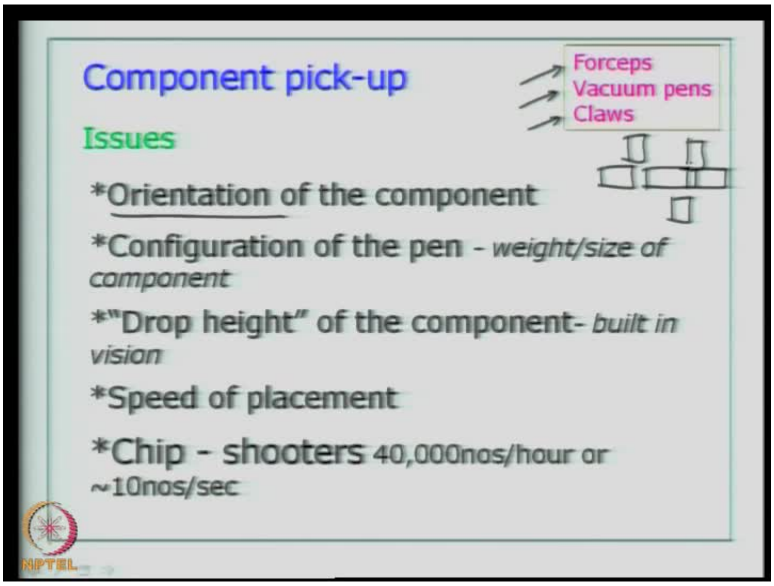

So, the idea is it should pick the components from the tape or the reel from which the packages are shift from the manufacturer and it has to pick individual components and place on the board based on your assembly data that you have generated from your PCB layout. So, the component pick up issues are; here we use forceps or vacuum pens or we also call it as Claws.

The issues are orientation of the component; never have different orientation in your board design. Typically if you have x orientation, try to maintain it. If you are going to have different orientations along the board x and y, then you are going to have wastage of time because the forceps or the vacuum pens have to rotate and then place the component which will take up time and this is not a very good design from the view point of the wave soldering process or even the reflow soldering process. Because if you are going to having tiny components placed in different orientation close to a component which has got good height, then you will have thermal issues in the sense that the tiny component or the short component will not attain that much of heat and therefore, you can end up with the dry joint or a poor joint. So, orientation has to be taken care of by the designer. The configuration of the pen is very important, weight and size of the component, the drop height of the component is an important issue as far as the equipment is concerned.

Typically the equipment does not place by moving the component to its right coordinates on the board. It typically drops at a certain height away from the board and a solder pate material in the case of reflow soldering has to get the component attached to itself. Typically, you can view this in high end equipments using a built-in vision whether the placement is perfect and the drop height is well maintained. Technicians would knowsss how to maintain this drop height in equipments.

Speed of placement is an issue. That is what more and more new equipments are trying to incorporate in their equipments to increase the yield percentage of this SMD assembly. These are typically called Chip-shooters, the pick and place equipments. We are talking about 40,000 numbers per hour which is a huge number in large volume manufacturing or typically about 10 numbers per second. It could be more. So, as far as pick and place is concerned, you have to have a very good design visions so that your placement process is having high yield based on orientation, based on the packed sizes that you have defined for your assembly devices and so on.

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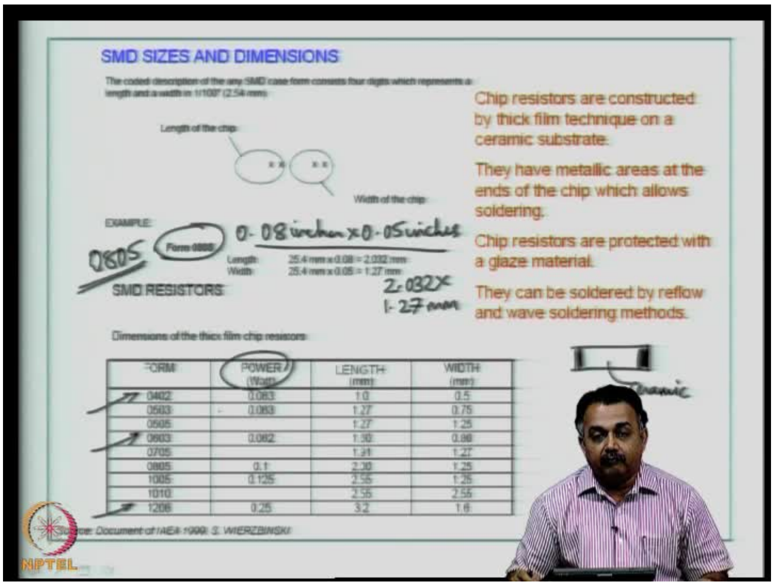

We will talk about surface mount device sizes and dimensions now. As you know, the chip resistors are constructed by thick film technique on a ceramic substrate; your resistors or your capacitors. They have metallic areas at the end of the chip like you have the surface mount devices; so at the end you will have the connector points. These are the metallic areas and here it could be the ceramic material with a well defined dielectric property, thickness is well defined based on the electrical requirement. Also, the size again depends on the value of the resistor or the capacitor. Chip resistors are protected with a glaze material and they can be soldered by reflow and wave soldering methods. We have seen this how chip resistors and capacitors can be soldered by both reflow and wave soldering.

You should know about the terminologies that are used in packaging or electronics about SMD dimensions how they are denoted. For example, if you look at the number like form 0805; if you look at this number then that means your chip component will have the dimension of 0.08 inches. It means the dimensions are 0.08 inches by 0.05. So, the length and width of the chip component is defined in this way. It denotes the case of the case form as you call it for the chip component. If it is 0805 it means it is a 25.4 mm into 0.08 which is about 2.03 mm by 1.27 mm.

So typically it is about 2.032 mm by 1.27 mm. This denotes the length and the width of the component. If you have for example, 0402, it means 0.04 inches by 0.02 inches; 0603 means 0.06 inches by 0.03 inches; 1206 again means 0.12 by 0.06. These are the standard notations which will give an idea about the size of the chip component.

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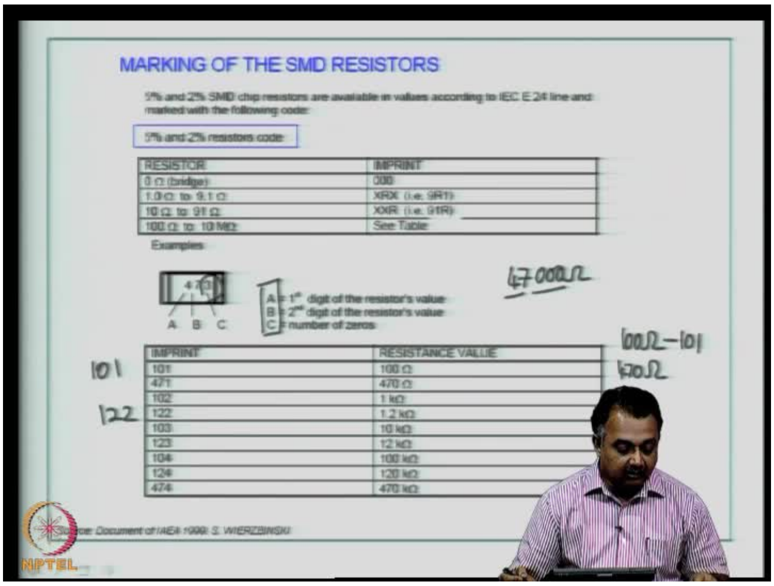

You can look up at the data sheet of those components for the power ratings for each of these case forms. So, the marking of the SMD resistors the first one here; we have talked about the case form, now we are looking at the marking of the SMD resistors that you will see on the component surface.

Now there are resistors with 5 percent tolerance, resistors with 2 percent tolerance and also less 1 percent tolerance. If you have an imprint that is 101, let us say, that means the value is the last digit. The first digit ABC here for example, if it is 473 that means C denotes the number of zeroes that means if C is equal to 3 then you have 3 zeroes and then you have 47. So, this is the value of the resistor. If you have 101 that means you have 10 and therefore, it is 100 hundred ohms. This is for an imprint of 101. If you have for example 471, 1 denotes 10 then you have 470 ohms. So, this would mean 473 that mean you have 3 zeroes and then you have a prefix of 47; so this is the value of the resistor. If you have 122 for example, that is the imprint; then you have 12 followed by 2 zeroes; so it is 1.2 kilo ohms. That is how you look at or you get an idea of the marking on the SMD resistor.

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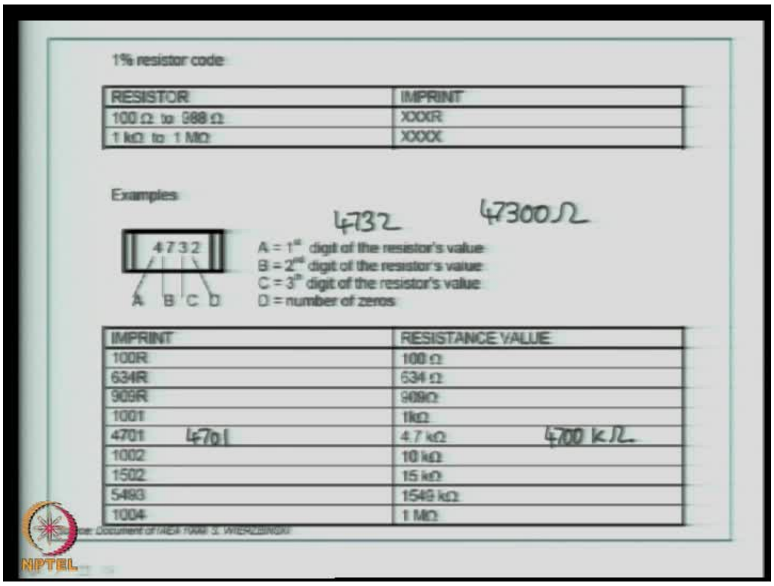

So similarly, you can have the values denoted for a 1 percent resistor. If we have 4732 because it is a 1 percent resistor, you have 1 more digit added to the marking. So, 4732 would mean 473 followed by 2 zeroes. This is the value of the resistor. So for example, if you have 4701 that means 4700; so it is 4.7 kilo ohms. These are the conventions that are used for marking the resistors.

We will now look at other notations and will also look at the other aspects of soldering in the next class.