PRACTICAL PRODUCTION USES OF SMT ADHESIVES

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Introduction

Adhesives are typically used in surface mount Printed Circuit Board (PCB) assemblies to hold the passive, (and sometimes active), components on to the bottom side of the board during wave soldering. The adhesive is used to bond the surface mount device (SMD) to the PCB, thus forming a joint between the body of the (SMD) and the solder resist or bare FR-4 board between the solder pads. This is necessary to avoid the displacement of components from their sites during high speed placement of passive components. Dispensing equipment must be able to dispense a precise consistent dot shape with different volumes as appropriate for different size devices. After the SMD is placed, the wet adhesive must have
sufficient “wet” or “green” strength to hold the SMD in position until cured.

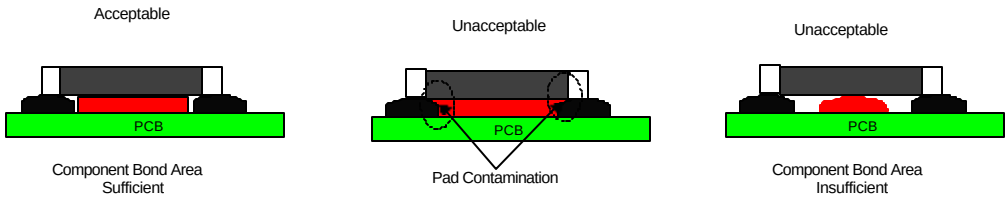


Figure 1

The hardening process must be fast and simple. The cured adhesive must then have sufficient strength to hold the SMD to the PCB during the solder wave operation. After soldering the adhesive must not affect operation of the circuit in any way.

Generally the spacing between the component pads dictates the maximum allowable adhesive dot diameter that can be dispensed between the pads. Typically the adhesive dot diameter will be 2/3 the pad spacing. Once the allowable adhesive dot diameter has been determined, the appropriate nozzle can be selected. A dual dot nozzle or single dot nozzle should be chosen at this time.

Why Dual Dots

From time to time the question comes up about why dual dots are sometimes used and sometimes not. The reasons are very logical but rarely stated. Adhesive adheres to a surface in a way that is directly proportional to its area. The amount of adhesive one can put under a component with a single dot is shown in figure 2. This assumes a 3 mil stand off and pad widths matching the component. The mass of each of these common components is also shown in figure 3. The 0805 and larger components are thicker and therefore have more mass. The amount of adhesion area required increases because of the increase in mass. However the space under the component is limited. The relationship between mass and area is shown in figure 3.

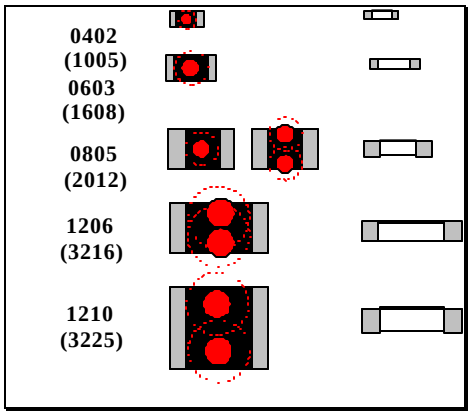
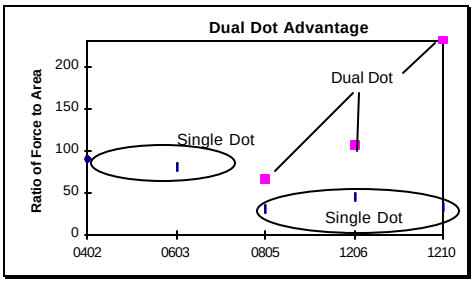


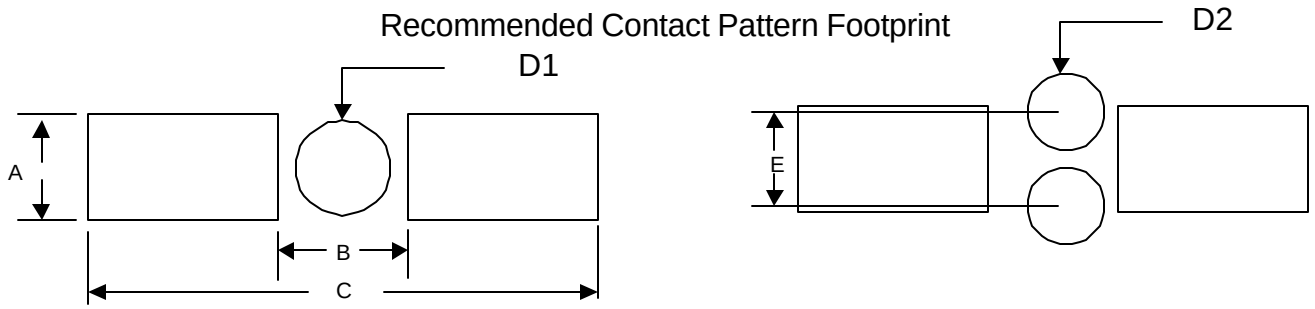
Figure 2

The 0805 component is the breaking point where the advantage of using dual dots exists but is not strong. The components larger than 0805s require dual dots. In addition to the increased mass these larger components have higher centers of gravity due to the increased thickness. Naturally, the exact point where the area and the green or cured strength balance, depends on the specific adhesive and the G forces of the chip shooter.



Nozzle Selection

Choosing a nozzle for use in dispensing adhesives requires knowledge of what dot size is required. The dot size requirements can be derived from the board design being utilized or specifically the pad spacing of components. It is not uncommon for Manufacturing Engineer personnel or Quality Engineering personnel of a printed circuit board manufacturing facility, to inquire what a recommended adhesive dot diameter should be for a particular component type. Much has been written in regards to recommended surface mount component pad designs and layouts for bottom side applications. (“Wave Solder”) Top side pad designs are used on bottom side PCB fabrication. However these guidelines are rarely utilized. The pad spacing for a particular component for each individual customer product is unique. Universal’s surface mount laboratory, has recommended component pad spacing guidelines for use when designing printed circuit boards for adhesive application.



	0402	0603	0805	1206	1210
A	0.013"	0.020"	0.035"	0.040"	0.060"
B	0.025"	0.040"	0.040"	0.070"	0.070"
C	0.121"	0.140"	0.140"	0.205"	0.205"
D1	0.010"-0.015"	0.020"-0.025"			
D2			0.020"-0.035"	0.020"-0.035"	0.020"-0.035"
E			0.035"	0.035"	0.035"

Table 1

Because the pad spacing for most typical surface mount components is not standardized from one customer product to another, it becomes a challenging task when recommending what tooling should be utilized to satisfy a particular customers adhesive deposition requirement for a particular component.

Typically, surface mount component pads for a particular circuit board are designed for either adhesive deposition or screening of solderpaste. (See Figure 4) The pad spacing is generally smaller for solderpaste application as opposed to that of adhesive deposition. For example, the component pad spacing between the pads of an 0603 chip cap/resistor is typically 0.020” if the board was designed to be screen printed with solderpaste. The pad spacing for the same board can be 0.040” if adhesive deposition was intended to be utilized.

A 0.030” diameter dot of adhesive would easily be recommended for use if the component pads on the board were indeed designed for adhesive deposition. However, if the pad design for the same board was originally designed for utilization of solderpaste, as a method of adhering the component to the board, obviously an 0.030” diameter dot of adhesive would be too large, as the spacing between the pads is now 0.020”. A

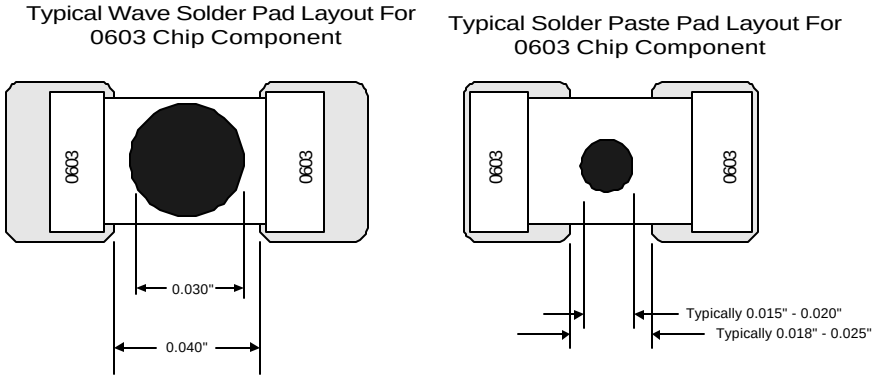


Figure 4

0.015” to 0.018” diameter dot is required for this particular application.

Therefore, because all pad design and spacing is not the same from one circuit board to another the actual spacing between the pads of the particular component must be known.

Note that the volume of adhesive needed to maintain the component in place during the high speed placement or wave solder process may be larger than possible for some specific pad designs. Nozzle selection refers in this case to specific nozzle specifications for a known dot size requirement.

When selecting a nozzle for use in dispensing adhesives, the main parameters needed for correctly determining correct nozzle selection are *Nozzle ID, Nozzle Stand-Off,* and *Dot Diameter*. The nozzle standoff can be defined as the distance from the tip of the dispensing surface to the end of the mechanical standoff. The nozzle standoff is used to maintain the distance between the PCB and the dispensing tip. Most dispensers in use today are designed to utilize some sort of mechanical standoff with the nozzles.

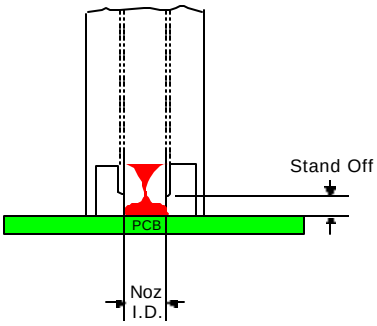


Figure 5

The stand-off usually dictates, to some degree, the height of the dispensed dot. If the stand-off is too large the adhesive may never contact the board. If this condition exists than the adhesive will build up on the bottom side of the nozzle. Generally this condition leads to poor dot shapes, inconsistent volume, stringing and missing dots.

Relationship Of Adhesive Dot Height To Component Height From the Board

The distance between the bottom of the component and the top of the PC board is typically between 0.003” to 0.005”. In order to assure a good bond or wetting of the adhesive to the bottom of the component as it is placed onto the PC board, a good rule of thumb is to utilize a dot height that is twice the distance between the bottom of the component and the top of the PC board.

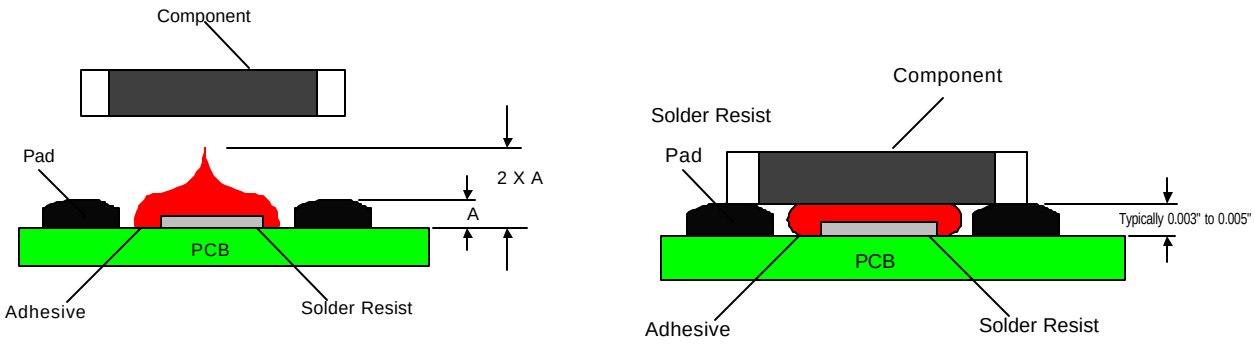


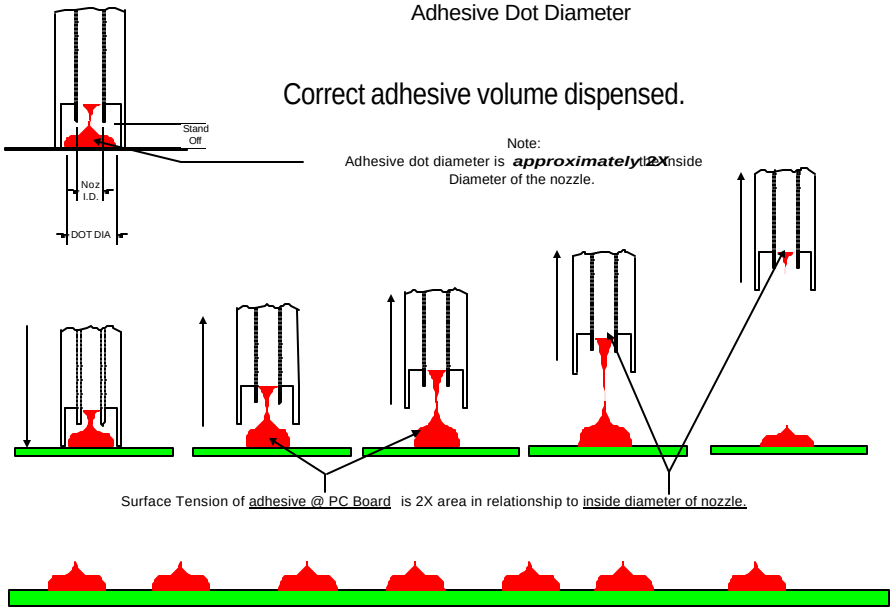
Figure 6

Nozzle ID	Nozzle Standoff	Dot Diameter Range	Optimal Dot Diameter
8	5	16-20	18
10	5	18-22	20
12	8	24-35	28
16	10	28-45	35
23	15	40-60+	45
33	20	50-100+	60

Table 2

From table 2 above it can be derived that as the nozzle ID and nozzle standoff decrease the dot diameter range also diminishes. It can also be noted that the recommended standoff for the 8 mil ID nozzle is the same as the 10 mil nozzle. It is recommended not to to go below the 5 mil standoff due to tolerancing of PCB fabrication. Dot diameters smaller than that of a 16 mil dot require special care from board manufacturing. Slight variations of pad heights and solder mask on the PCB add up to large variations in actual mechanical standoff while dispensing. When dispensing dots that require going through nozzles of 8 mils or less the adhesives used and the particle size within the adhesives. Small nozzle ID's with large particle size will tend to clog more often making for a less than robust manufacturing process.

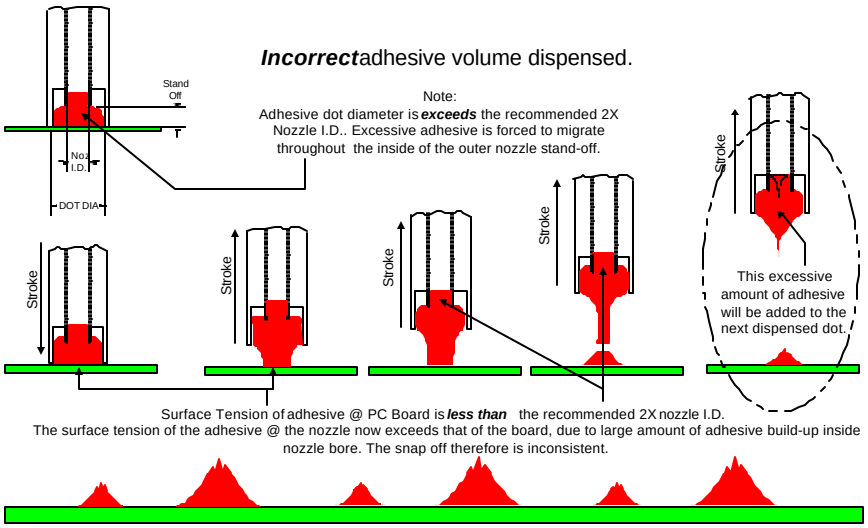
Correct Relationship Between Nozzle I.D./ Nozzle Stand-Off/ Adhesive Dot Diameter



Final result is repetition of well defined dot of constant volume.

Figure 7

Incorrect Relationship Between Nozzle I.D./ Nozzle Stand-Off/ Adhesive Dot Diameter



Final result is inconsistent dot volume and poor dot shape. A pattern of large dot, small dot may develop. This occurs because @ ever other dispense there is almost twice the amount of dispensed adhesive @ the nozzle tip.

Figure 8

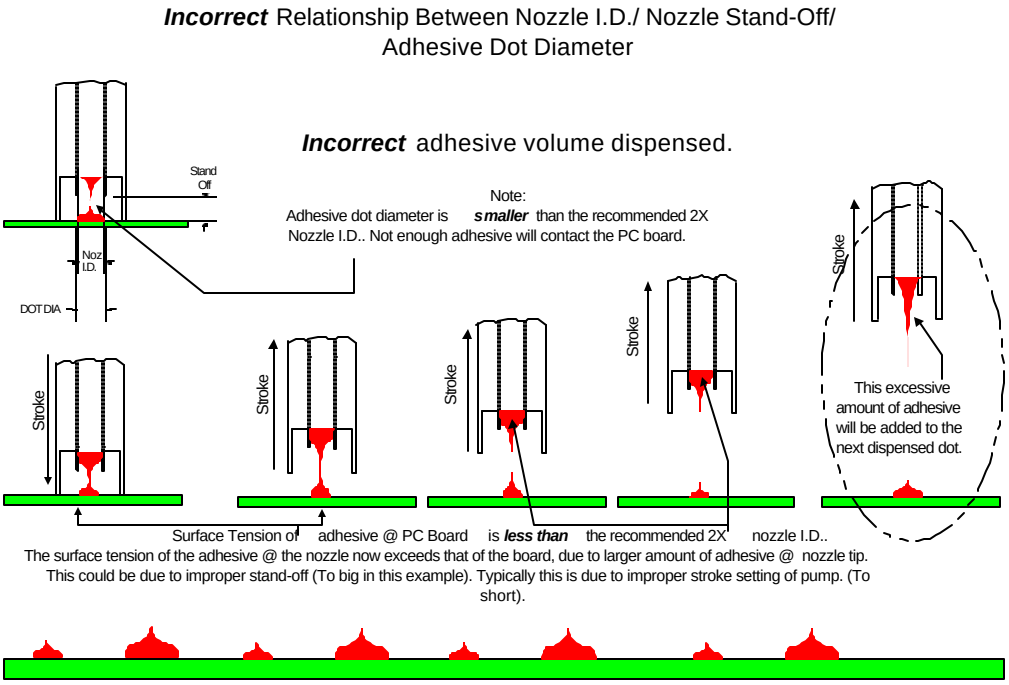


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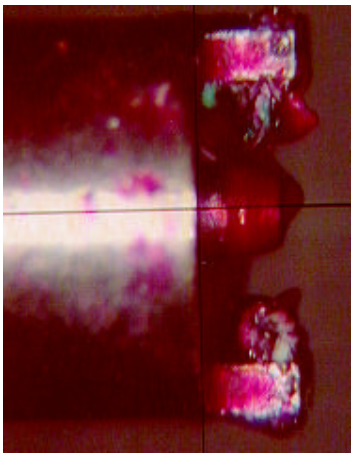
Figure 9

Nozzle Tolerancing and Wear

Since the dot diameter is integrally tied to the nozzle ID and the nozzle standoff, nozzles will vary slightly in performance due to nozzle tolerancing and nozzle wear. With the repeated force of the nozzle standoff hitting the PCB the mechanical standoff will wear. The amount of wear seen on the nozzle depends on the type of solder mask used on the PCB and the type of metal used in the nozzle construction. It is important to monitor this wear so that the nozzle performance is optimal. A reduced mechanical standoff will result in a smaller dot diameter range capability. Low standoffs limit the size of the large dots. As the standoff wears down the adhesive will contaminate the dispensing tip.



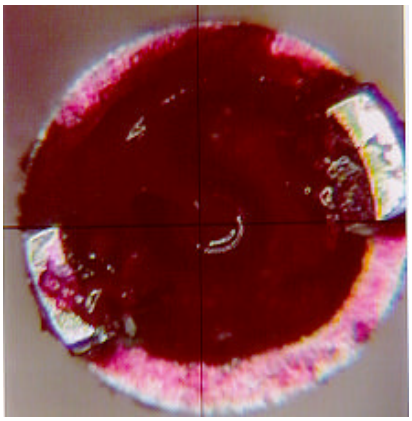
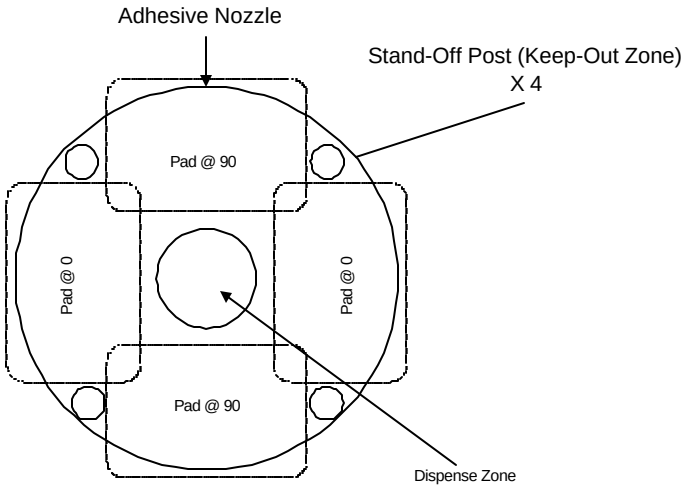


Figure 10

Applications at the upper range of the dot diameter from the Figure above are more at risk than that of the applications using dots within the lower range. As part of the Pre-startup procedure the nozzle standoff should be measured and compared to the equipment manufactures specifications. The nozzle ID should also be looked at to make sure that it hasn't been damaged during the manufacturing cycle or during cleaning.

Adhesive Between Pads With Solder Paste

In some process applications it is necessary to screen print solder paste onto pads and dispense adhesive after screening. Dispensing adhesive between pads that have been pasted can be a difficult process. The nozzle has to be designed so that the standoff doesn't touch the pads when dispensing adhesive. As the board density increases this process can be extremely difficult to find board real-estate which can be utilized for a mechanical standoffs. Knowing or designing in keep out zones for component circuitry when designing PCB's can be very helpful to the equipment manufactures when designing custom nozzles for this application. One sample of how to figure out where a keep out zone might be is to take a pad design and superimpose pad locations at 0 and 90 degrees. there is usually four locations nozzle standoffs can be designed into the process as shown below.

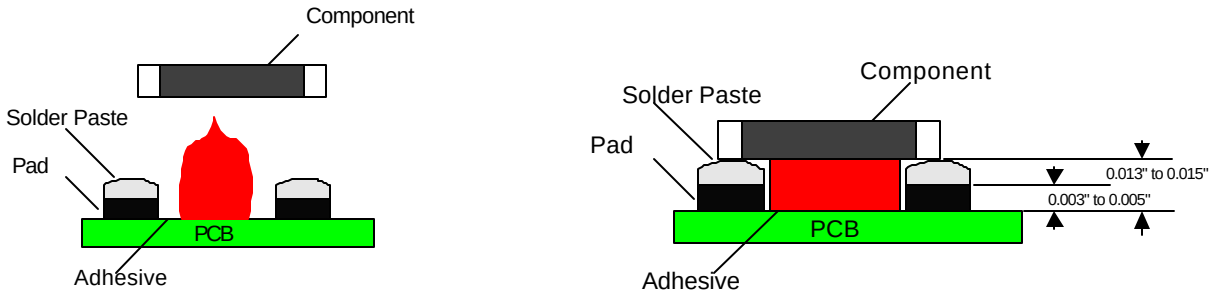


By putting the mechanical standoffs at one or two locations 45, 135, 215 or 315 degrees around the pad circuitry nozzle rotation is not necessary for 0 and 90 degree components. One nozzle design can be utilized for these applications. It is recommended to use reduced apertures on the stencil design so that it reduces the risk of nozzle contamination with the solder paste.

Figure 11

Another consideration when dispensing adhesive between pads that have had solder paste applied to them, is the type of adhesive utilized. An adhesive that is formulated to give very specific rheoligical, or flow properties to allow for a higher profile dot that exhibits very little slump, should be used in this application. Dots more in the shape of tall cylinders are required as opposed to the typical triangular hershey kiss dot profile.

Solder Paste On Pads

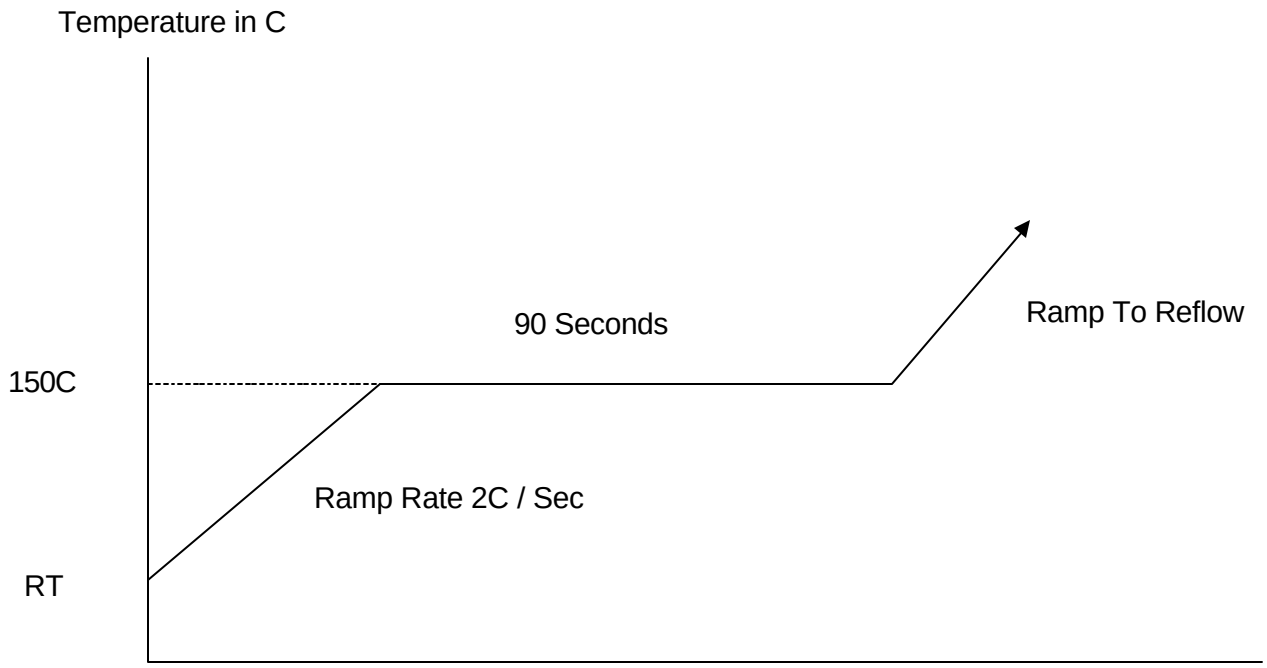


A taller, narrower yet more cylindrical dot is required in order to provide proper bonding.

Figure 12

When printing solder paste and dispensing epoxy between solder pasted pads a specialized cure cycle is required. Curing epoxy at 150º C is a bondline temperature that should be verified with thermocouples at various locations. Curing epoxy at temperatures above 160º C can caaause the adhesive to become brittle, leading to possible component loss during the solder wave process.

Solution:
The epoxy must be cured at 150º C for about 90 seconds prior to ramping to the reflow temp. The graph below is a sample of what the cure cycle should look like.



Conclusion

The volume of the dispensed adhesive dot should posses enough wet (green) strength to hold the passive and active components on the PCB during placement. To much adhesive could lead to pad contamination causing faulty solder joints and potential clogging of the nozzles on high speed chip placement machines. Too little adhesive could lead to components falling from the PCB.

The pad spacing will dictate the volume of adhesive utilized. PCB's designed for deposition of adhesive will have adequate space between the pads. PCB's designed for screen printing of solder paste will have much less space between the component pads therefore requiring the need for custom nozzles.

Nozzle selection is dependent on recommended dot diameter and dot height. The ID of the nozzle generally dictates the volume of adhesive dispensed. The nozzle stand-off will dictate the height of the dispensed dot.

Special applications such as dispensing adhesive between pads with paste, may require the use of special designed nozzles.

When all these variables are understood, the process of determining the best fit volume of adhesive to be dispensed, should be a simple one.