

Challenges in 01005 placement

As demand for lighter and more compact products in the field of mobile phones, PDAs and other devices continues, use of 01005 components - at 50% the weight and one quarter the area of 0201 components - will grow in coming years. New product designs will become yet more compact. Companies can also add new features into existing designs by introducing 01005. Compare the 01005 against the 0201:

Size	Weight	Area
0201	0.08mg	200mil ²
01005	0.16mg	50mil ²

Implementation of 01005 produces new challenges in field of SMT in terms of product, process and equipment. Such challenges will be discussed in this article.

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01005, Transition to 01005, Pick & place concerns.

Major hindrances to the use of 01005 components

1. Cost:

Cost of 01005 components will be very, very high. Even the cost of 0201 is still on the higher side compared to 0402. As the market becomes more and more price sensitive, viability of using 01005 will be a major issue.

2. Product and process:

Transition to 01005 is not simple. It requires time and money to determine the optimum process conditions for using 01005 components. Proper resources in terms of printing equipment, pick and place machine, rework and reflow oven are required to implement the same. Board design also becomes critical to achieve track width, track to track spacing, pad to pad spacing, board tolerance and etched copper tolerance.

To explain how critical will be the usage of 01005 in SMT industry let me try to explain it through a simple board design. Let's take twenty 01005 components replacing 0201s.

Paste printing process

Purposed land pattern design for this component pad (figure 1) will be width 6mil and pad to pad spacing as 6mil. So, if we have 20 of these components in a single row or, say, two rows of 10 each, then we have 12mil pitch printing pattern all over the PCB. The pad size for 01005 components is 6mil x 3mil; consequently we have a tiny opening in stencil. In deposition, or transfer of solder



Figure 1. Pattern design.

paste onto the PCB, stencil technology, in terms of stencil opening, stencil thickness and stencil process, all become critical.

Transfer efficiency

Ratio of actual volume versus theoretical volume calculation of solder paste.

$$\text{Transfer Efficiency (\%)} = \text{TE} = \text{VD}/\text{VA}$$

$$\text{Volume APERTURE} = \text{V}_a = \text{Theoretical Volume Stencil Aperture}$$

$$\text{Volume DEPOSIT} = \text{V}_d = \text{Actual Volume of Deposit}$$

Area ratio

Area Ratio (pad area to wall area) = $A_p / A_w \geq 0.66$
 As the area ratio increases, the transfer efficiency also increases. This is obvious and to be checked in every stencil design.

Aperture size

It is recommended that aperture openings are made smaller than the landing pad size. The main reasons for this are:

1. Improved alignment accuracy & repeatability between the PCB pad and the stencil aperture.
2. This also gives gasketing action to prevent printing defects as smearing, smudging and bleeding.
3. In a few cases we have to do over printing as in case of BGA. These components require large quantity of solder paste.

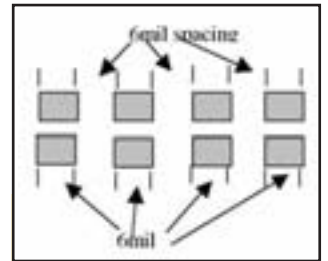


Figure 2. Stencil opening design consideration.

Aspect ratio

Aspect ratio = width of the aperture/Thickness of the stencil = $W/T > 1.5$
 This has to be checked carefully when designing the stencil.

Stencil technologies

The three primary technologies for stencil manufacturing are chemical etching, laser cutting, and electroforming. Each has distinct advantages and disadvantages.

Chemical etching and laser cutting are subtractive processes. Electroforming is a process in which you do addition in your process. The main consideration should be performance coupled with cost and turnaround time. Generally, chemically etched stencils are just as effective as those of the other technologies when used for applications where the tightest pitch is 0.055" and over. Laser-cut and electroformed stencils should be considered when dealing with 0.020" pitch and under.

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Pick and place machine

Most of the machine manufacturers are designing their machines with 01005 package in mind. Pick and place machine will not be a critical area. But still there are a few critical areas that need to be considered.

Nozzle design:

I was discussing in a seminar the 0201 and how it is also called 'eye of a needle' because it fits inside the eye of a sewing needle. You can imagine now how small 01005 will be. I feel it is very critical to design the right nozzle for this 10mil x 5mil component. First of all, the air channel used to pick this component is so small that it will be very difficult to detect the vacuum. With such a narrow air channel, clogging will become a serious concern and nozzle cleaning frequency will increase. Machine manufacturers have to keep this aspect in mind. There should be an option of cleaning the nozzle by the machine itself, else it will kill useful production time. For this, nozzle design by Assembléon is very good; it has two channels in it that can detect component droppage very easily. Second, if the 01005 component is placed between two 0402 or 0603 components, the nozzle outer diameter should be such that it does not strike the adjacent component. Yet it should not be so thin that it results in frequent nozzle change during production - this would negatively affect productivity.

Feeders:

Because component weight is very light, indexing and peeling of tape has to be very smooth. Using mechanical feeders could lead to jumping of components from the pocket. Thus, electronics feeders should be used. Secondly, a major concern will be static charge generated due

to peeling and indexing of component cover tape. Electrostatic charge could lift the components from the pickup pocket or it will stick to the cover tape. Care must be taken for proper grounding of the feeder. Also, antistatic tape may be best to use for these components, or we can use ionizers in the machine feeder location. Thirdly feeders should be designed in such a manner that, if there is droppage in the component pickup, it should have a channel so that the dropped component gets collected in some form. This is critical in the case of mechanical feeders - the component can adhere to the sprocket wheel, changing the pickup position.

Pickup position

Tiny component, tiny nozzle and paper tape are cumulative factors that make component pickup in the case of 01005s very sensitive. Machines should have a facility to auto calibrate pickup positions.

There are a number of methods for doing this. Assembléon FCM has an auto-calibration feature where if the nozzle does not find the component at the pick-up position it searches the components in a defined vicinity and re-calibrates the pickup position. Alternatively, two or four fiducials could be defined near the feeder pickup pocket, allowing the vision camera to automatically check for the pickup position correction, in case there is any displacement in the feeder. Finally, the component itself could be defined as a fiducial. Pickup position could be calibrated by measuring the XY head movement. This may require modification in the camera unit of the machine.

Pickup impact

For the pickup impact on the components, the machine has to be designed in such a manner that pickup of the components is smooth - any

unwanted force will damage the component. Feeders should be designed so that they monitor the tape indexing height with respect to nozzle pick-up height. A closed-loop system that warns to the machine of a change in tape height during indexing is ideal.

Component placement pressure

There are number of variables in machine, product and process which effect placement pressure. Main factors are the co-planarity of the PCB with respect to nozzle, board support pin, warpage in the PCB, board clamping and placement nozzle design. It is difficult for the machine manufacturer to control all these factors, but it becomes very important when placing 01005 components as it may damage the component in terms of crack development during placement, a defect that is very difficult for inspection equipment or the QA inspector to visually detect. Thus, the machine has to be designed in such a manner that PCB is clamped perfectly flat, and the machine places the component gently and also gives closed-loop feedback. High-speed machines are available with closed-loop systems that ensure that placement pressure does not exceed defined limits.

Vision Camera

As component pitch or size go smaller and smaller, the camera's field of view also shrinks, reducing the ability to use one camera for all components. With the pace of SMT miniaturization, the day is not far away that we will have a camera changing unit like the nozzle changing unit for SMT placement machines.

Repair

The conventional method of repairing 0402 components is to use a tweezer with a soldering iron or hot air tool.

Hot tweezers are available to solder and desolder the component, but their use is restricted by the proximity of adjacent components. Designing a repair tool for 01005 will be another critical area to be taken into account.

Conclusion

Whenever a new process, product or component is introduced, it brings a phase of slight confusion, but new products, processes and components are designed on paper with all possible quality factors taken into account. Slight patience and proper experimentation, by strictly following the design guidelines, will give 85% perfect result.

As we know that there is always 15% difference between theory and experiments. This is where confusion lies. We can either exaggerate the confusion to such an extent that it cloaks 85% of the success in ambiguity, or we have patience. Sharing of practical experience and creative ideas by everyone removes all these ambiguities and gives clear path towards success. 01005 components will be another era for SMT technology, so let's work together for better technology and future.

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