“0201 Parts (0.25 Mm X 0.125 Mm, 008004”) “Arrived on the Scene in Order to Make the Technology for Future Device Terminals Possible

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Abstract for Fuji Machine 0201 component placement technology:

“0201” metric parts (0.25 x 0.125 mm, 008004") arrived on scene in order to make the technology for future device terminals possible.

Introduction:

To answer the high functionality expected of mobile device terminals, such as smartphones and wearable devices, panels need to be created even smaller while increasing the quantity of parts and maintaining a large-capacity battery space.

To be able to meet these needs, the miniaturization of passive parts such as capacitors, resistors, and inductors is progressing rapidly. Each of these parts have a singular function and are simple in design, but they are also parts which are indispensable in mobile devices which use high frequency power. Capacitors and inductors are particularly important for IC peripherals used for configuring communication modules, and thus the miniaturization of parts is even more important for the goal of making modules smaller overall.

One major feature of using 0201 parts is the reduction of the placement area. The below shows the shrinking of the space between placed parts. 0402 (01005”) parts with a space between each part of 0.17 mm in the X direction and 0.13 mm in the Y direction. And in comparison, 0201 (008004”) parts with a space of 0.13 mm in the X direction and 0.09 mm in the Y direction.

The placement area is reduced from 10.30 mm^2 down to 4.61 mm^2. This means a reduction of 55% in the placement area.

Based on these results, it is reasonable to presume that establishing a placing process for 0201 (008004”) parts will contribute to the miniaturization and higher functionality of electronic devices.

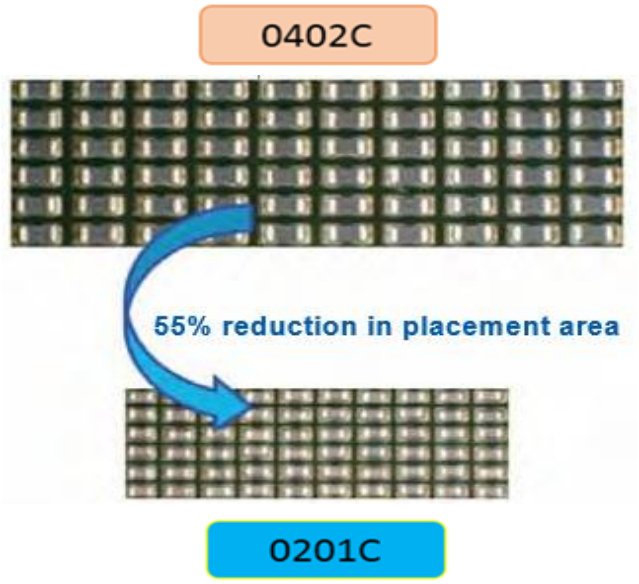

Figure 1

Mounting technology:

1. Background

Currently, the smallest parts being used in compact devices are 0402 (01005”) parts. Support for 0402 (01005”) parts on the equipment required to handle these parts has accelerated, and now almost any make of mounter has the capability to place these parts.

On the other hand, we are aware that even 03015 parts, which arrived on the scene before 0201 (008004”) parts, sometimes cannot be supported on mounters using current methods.

While the effect the pickup nozzle has on parts becomes greater as parts become smaller, being capable of achieving fine-pitched placing also becomes a necessity. For example, even if a part is able to be picked up, the resolution of the camera needed to vision process the part must be dramatically improved. It can also be assumed that a situation will arise where accuracy cannot be maintained without slowing the cycle from pickup to placement.

Under the supposition that the variety of problems mentioned above may happen at just one machine, it is likely alarming to think of the trouble that could occur across an entire line.

It is our hope that in explaining the placement process for 0201 (008004”) parts in this way, we can alleviate those fears. It is likely that any cause for concern arises when attempting to place 0201 (008004”) parts without understanding the changes and processes required at the machine, and thus not achieving the expected results.

2. Experimental results

The very first thing that was sought for the placement of 0201 (008004”) parts was high accuracy mounting, which is the basic technology behind mounting machines that makes the placement of 0201 (008004”) parts possible. The accuracy factors which relate to mounting parts are; 1. the part dimensional tolerance (it is necessary to inspect the actual part), 2. the mounter placement accuracy (the accuracy of parts placed before and after), 3. factors in part pickup positioning (the deviation amount between the center of the part and the center of the nozzle), and 4. the nozzle dimensional tolerance (the amount the nozzle sticks out beyond the edge of the part). By squaring the average of each of these elements, it is possible to show the adjacent pitch F calculated from the preplaced part elements and postplaced part elements α, and the nozzle deviation amount r. For actual production using 0402 (01005”) parts, it was thought that the required mounting accuracy would mean specifications that could meet spacing of 100 μm between adjacent parts. However, specifications which meet a greater part density are required. The actual accuracy which can be achieved when placing 0201 (008004”) parts is in the realm of 3σ 10 μm at 3σ, thus it can be determined that the part density required for module panels can be achieved. The situations described above use placement correction after vision processing of the part using a parts camera. However, there is another camera which can perform the necessary task while maintaining quality part placement. By using a camera beside the part side surface for monitoring, it is possible to check the thickness of the part, as well as checking for tombstoned parts and whether a part is present, thus making it possible to remove parts which would adversely affect the quality of the product. A repair method has yet to be established for 0201 (008004”) parts. Therefore, we believe that it is necessary to establish a line in which the placing quality prevents defective products. It is this issue that is the largest hurdle when it comes to placing 0201 (008004”) parts.

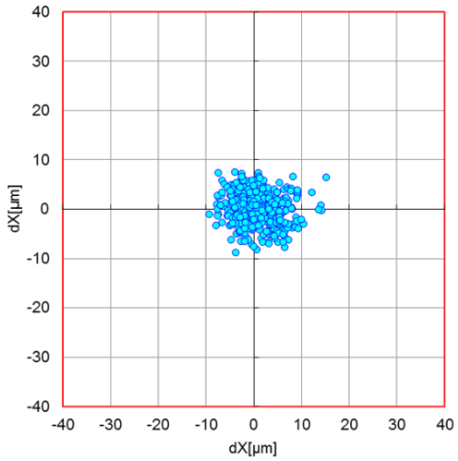

Image: 0201C (008004”) placing accuracy

Figure 2

The pads in the panel design used for 0201 (008004”) parts are very intricate and it is easy to imagine the fine pitch required for such placements. It is all too easy for solder bridges to form between electrodes and adjacent parts when mounting parts onto printed solder. It is imperative that parts are placed with as little impact load as possible to prevent bridges from occurring. On the other hand, small variations in part shape can lead to too little force used being used, resulting in defective parts. With this in mind, it is possible to mount 0201 (008004”) parts with the desirable impact load of 0.5 N, without flattening the solder. The usual method for low impact placement is to lower the speed of the Z-axis. We can show that is possible to perform low impact placement without increasing the cycle time. Low impact placement control without negatively impacting on the cycle time is essential when handling 0201 (008004”) parts.

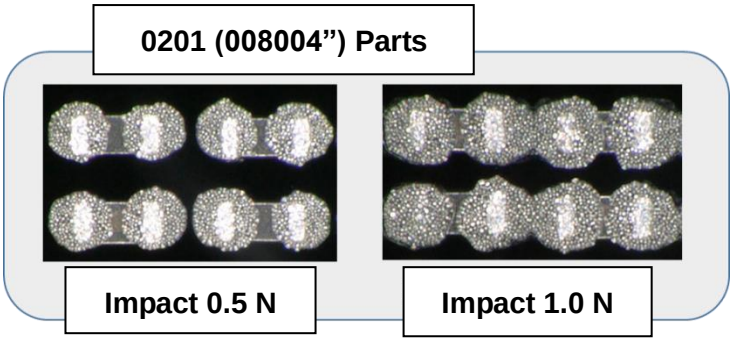

Figure 3

When using 0201 (008004”) parts, the space between parts is even smaller and there is a reduction of the placement area. In order to make this kind of placement possible, the desirable nozzle is one for which the tip does not extend beyond the edges of the part.

A nozzle that supports 0201 (008004”) parts was designed to prevent instances of the nozzle tip extending over the edge of the part, and is constructed in a way which allows for the nozzle tip to slide in order to reduce the impact load when placing. Features of this nozzle include a nozzle internal diameter which takes airflow and vacuum pressure into consideration, nozzle tip design for breaking vacuum, ease of nozzle maintenance taking solder blockages into consideration, and durability which takes into account wear on the nozzle.

Figure 4

Another important factor in this matter is the improvement in part pickup accuracy. For supplying miniaturized parts, W8P2 paper tape was widely used when 0402 (01005") parts were introduced, then the newly developed W4P1 (tape width 4 mm, pitch 1 mm) embossed tape came out.

In 2009 when W4P1 embossed tape came out, a W4P1 feeder was developed and put into mass production. W4P1 embossed tape is the only packaging which can supply parts as small as 0201 (008004”) parts. These feeders and tape have been employed to great effect by manufacturers, where both a stable pickup rate and pickup accuracy have been maintained for such small parts. Using W4P1 embossed tape does not have the same level of issues which surround paper tape supply, such as chaff problems, peeling electrostatic, waste, and storage space.

We investigated what happened when a production site transitioned to using W4P1 embossed tape. A pickup success rate of 99.969% achieved using W8P2 paper tape over a time period of one week was improved to be 99.999% when using W4P1 embossed tape for the same period of time. Definite improvements can be seen when using W4P1 tape. The pickup success rate here shows that parts can successfully be supplied without pickup errors or vision processing errors occurring.

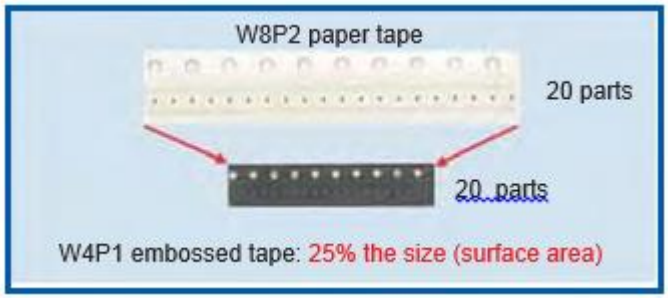

Image: Introducing W4P1 tape

Figure 5

There are further issues to contend with when mounting 0201 (008004”) parts. The small lands we recommend make use of over-resist (SMD: Solder Mask Defined) which covers the lands to form mounds to keep printed solder inside as a way to counter the occurrence of excess solder balls flowing beyond the land. The thickness of the resist was not a big issue for the placement of 0402 (01005”) parts, but it has been found that managing the resist thickness is important for 0201 (008004”) parts.

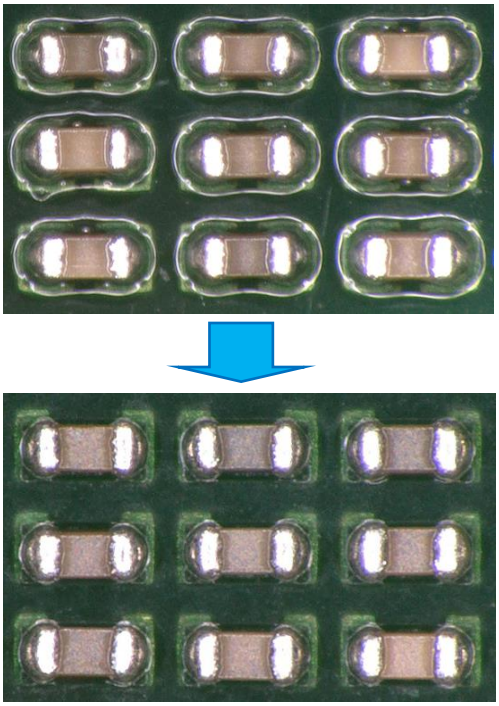

Image: Design to prevent solder balls (Checked after hardening)

Figure 6

When solder printing for 0201 (008004”) parts, the mask apertures are so small with such a fine pitch that it is hard to control solder bleeding and maintain a stable transfer amount. When there is too much solder, the risk of solder balls is increased. Providing a countermeasure on the panel side is seen to be a logical and effective step.

It is also recommended that the size of the solder particles used be between 5 and 20 µm (average 10 µm) when printing solder for 0201 (008004”) parts. This is based on the assumption of a fine pitch placement with space between parts being less than 100 µm. However, it is likely that there are cases in which a larger size for particles one size up can be used on less complicated boards when it is necessary to keep costs down.

In regard to the all-important land design and mask aperture diameter employed when using 0201 (008004”) parts, we can make recommendations based on the size and shape of the device in question. Using test panels and masks of different thickness and aperture size which meet the conditions of each device, we first test printed using various types of solder.

As an example, the graph below shows a mask thickness of 60 µm with varying amounts of solder for each mask aperture. A mask thickness of 60 µm was selected to cater to 0201 (008004”) part placement on the main panel of a smartphone.

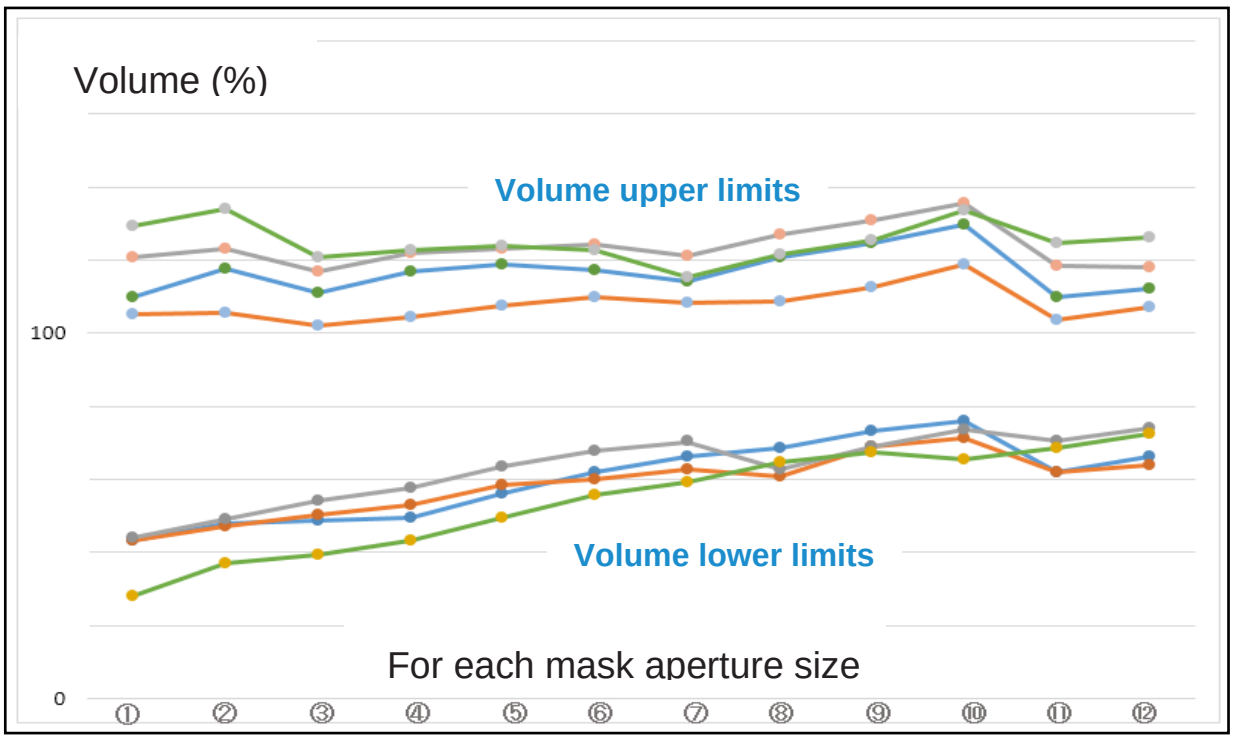

Image: Graph depicting solder amounts for a 60 µm thick mask

Figure 7

It is thought that a transfer volume between 60% and 140% is appropriate in order to maintain placing quality for 0201 (008004") parts. However, based on past experience it can be assumed that actual production sites use a volume ratio of closer to 40% to 170%. Also, the differences between manufacturing processes for even 0402 (01005") parts can mean a change in volume of 80% to 120% for fluorine treated water repellent masks, 70% to 100% for chemical polished masks, and 50% to 90% for etched only masks. Fluorine treated water repellent masks also have the effect of improving solder release and maintaining solder volumes. As a result of this, repeat printing and the number of cleaning times can also be reduced.

In regard to repair work for 0201 (008004") parts, because the pitch between adjacent parts can be assumed to be 100 µm or less, problems are likely to occur such as the repair nozzle being unable to contact the target part correctly. On the other hand, while the situation surrounding repair work for 0201 (008004") parts is still uncertain, it does not detract from the fact that inspection using inspection machines goes a long way towards maintaining quality after that point.

As a way of maintaining product quality during SMT processes, inspection devices are installed to check the quality between each process. At the start of the line, a solder inspection machine is used to check the quality of the solder printing. It is not possible to check the printing status for 0201 (008004") parts with the current ±7 megapixel 2-way, 10 µm resolution camera, but there are SPI machines supporting 0201 part inspection which have entered the market.

The next checks are performed by an automatic optical inspection machine, which checks for missing parts, placing deviations, and upside down parts for 0201 (008004") parts after the parts have been mounted. Inspection machines with higher capabilities than conventional inspection machines and those mentioned above have arrived on the market. We believe that by connecting these inspection machines to the printer and mounters and using machine to machine communication in a closed loop, the quality when using 0201 (008004") parts can be guaranteed in processes within the production line. This logic also fits well with the analysis of big data, a part of the widely discussed Industry 4.0.

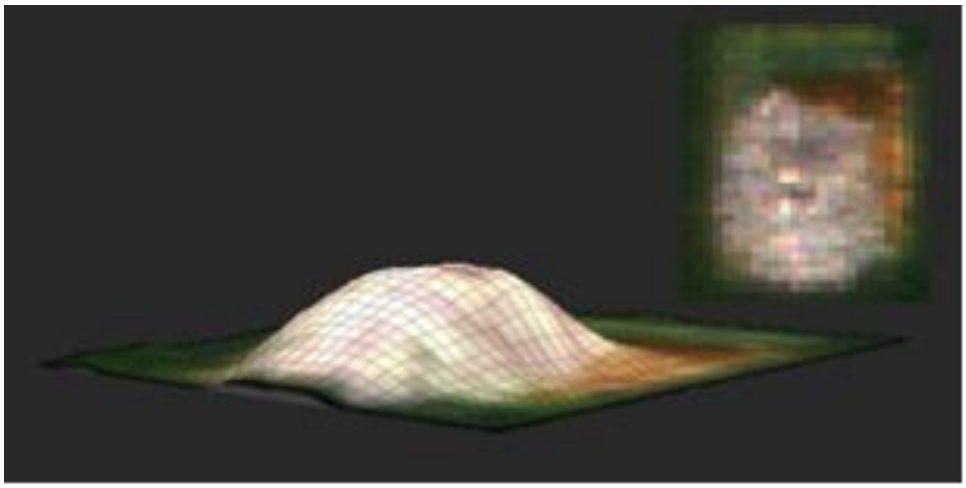

Figure 8

Recently, triangular trapezoidal reflow profiles can often be seen. This is to prevent the quick evaporation of flux, solder balls from solder spattering, and wetting defects which occur if the heating is too fast. We also believe that this profile arose with moving at a fixed speed throughout the heating period to reduce the stress on parts in mind. The necessity to keep the temperature difference across the entire panel small and the challenge of managing the maximum temperature for Pb-free solder has led to the introduction of reflow in which many heating zones can be established for easy temperature control and these kind of ovens are what make a profile like this possible. In addition, a feature of this profile is that reflow can be performed under atmospheric conditions and many zones in reflow mean flux vaporization can be reduced and oxidation prevented without having to use nitrogen. However, if items such as wettability, oxidization, tombstoning and self-alignment are considered, achieving sufficient quality for 0201 (008004") parts under atmospheric conditions can still be difficult.

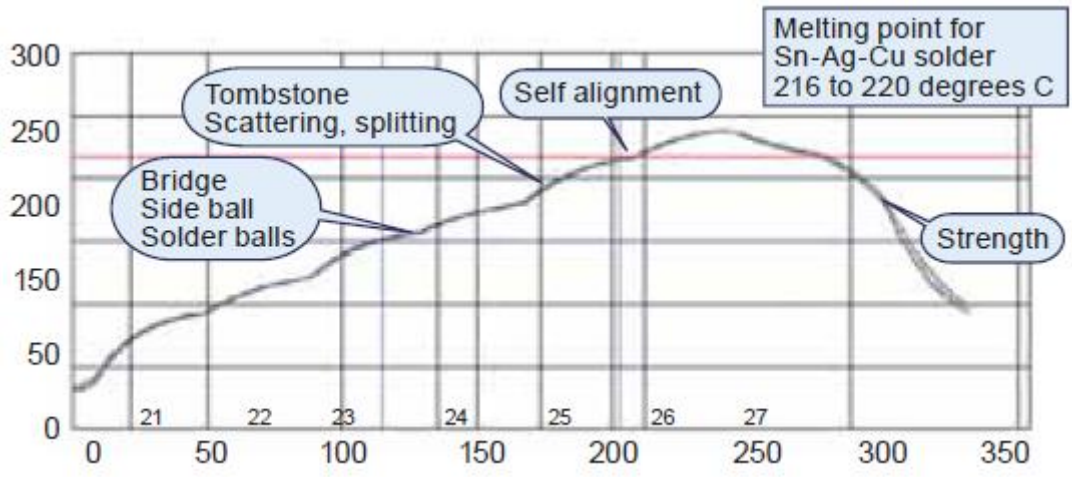

Figure 9

Conclusions

It is evident that mounters more technologically advanced than those for placing 0402 (01005") parts are required when mounting 0201 (008004") parts. As well as the technological requirements, the manufacturing cost is also of concern. We believe that it would be necessary to update an entire line configuration to be able to place 0201 (008004") parts. But we also believe that quality placement can be realized through the understanding of what is necessary and responding accordingly.

An important discussion for the future regarding trends in placing 0201 (008004”) parts is deciding how far fine pitch placements on the types of module boards used in smartphones and wearable devices can go. We may be able to see these being used in the production of communication module boards as early as 2017. If this is achieved, further analysis of the quality at each stage of production will be vital. We hope that this can form the basis for guidelines to handle future changes in fine pitch placement and the continuing miniaturization of parts.

Mass Production Technology for 0201 Mm (008004") Components (0.25 X 0.125mm)

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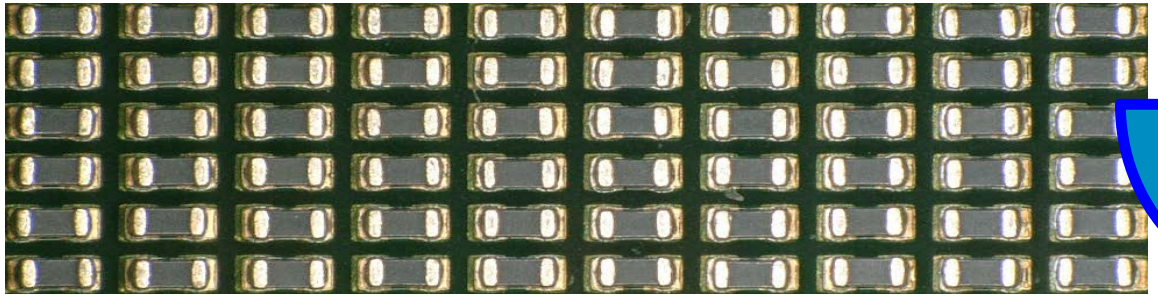
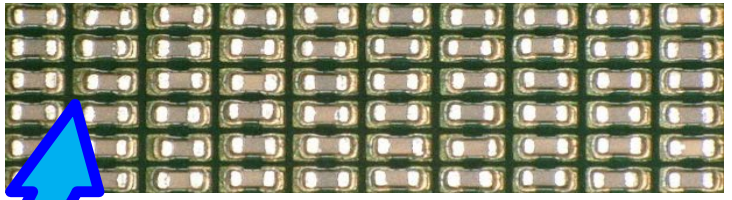
Merits for using small parts

0402C (01005"C)



0201C (008004"C)



Placing surface area reduced around 55%

Placed component quantity		60 (10 columns by 6 rows)	
Gap	X	0.17 mm	0.11 mm
	Y	0.13 mm	0.09 mm
Occupied area		10.30 mm^2	4.61 mm^2

- Smaller parts
- Finer pitches between parts

Higher density placement

Reduced area for placing

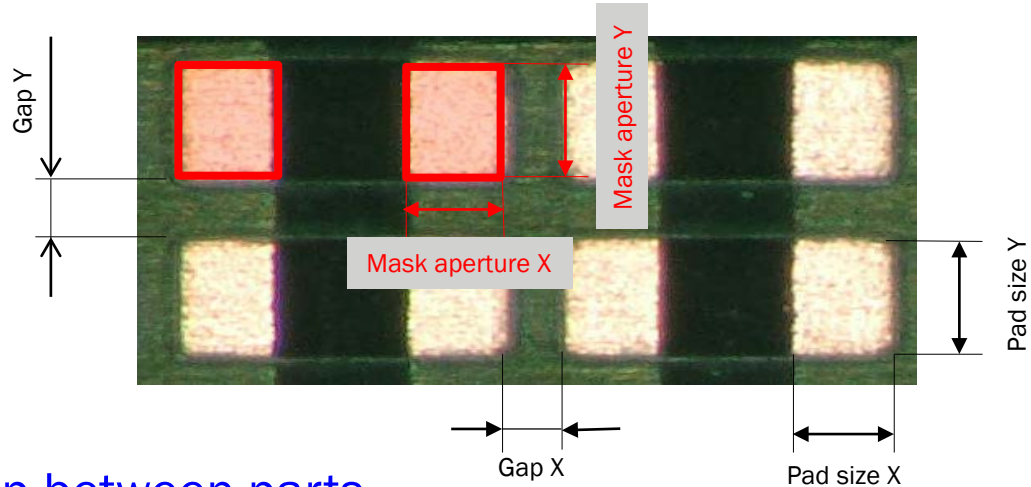
Mass production technology for 0201 mm (008004") components

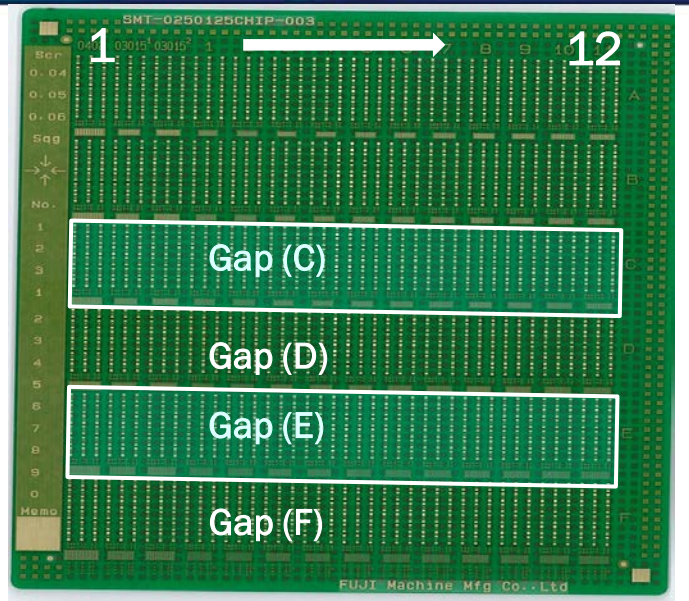
- Panel lands for 0201 mm (008004″) placements
- Solder printing
- Placing
- Reflow

Test Panel

Mask opening and pattern size (rectangle)

Wiring height		10 µm
Solder resist thickness		13 µm
Surface treatment	Nickel	> 3 µm
	Gold	> 0.03 µm



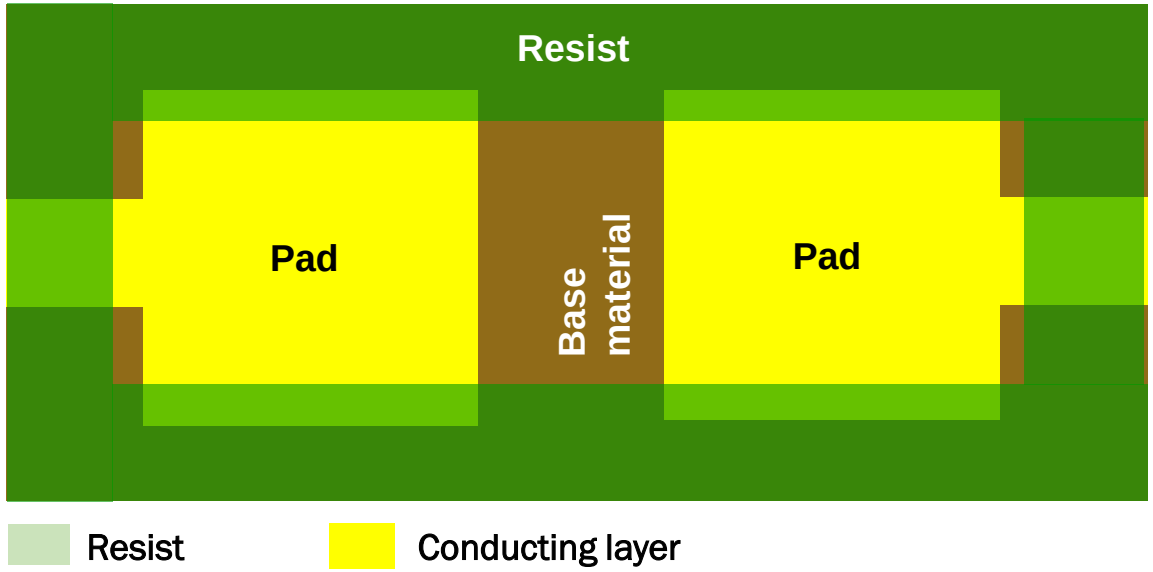


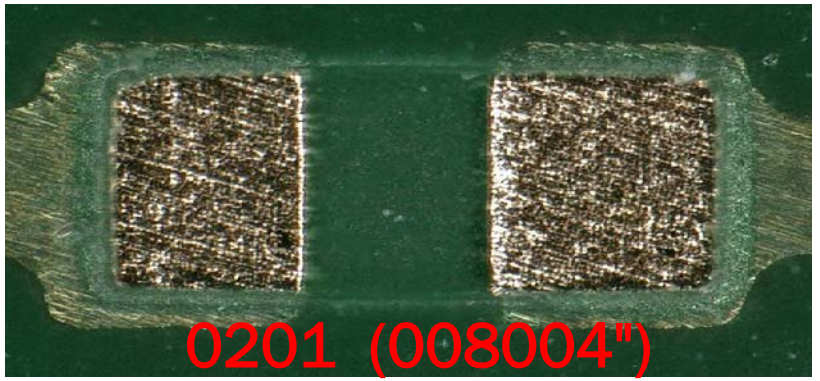
Mask thickness 0.06 mm - Gap between parts

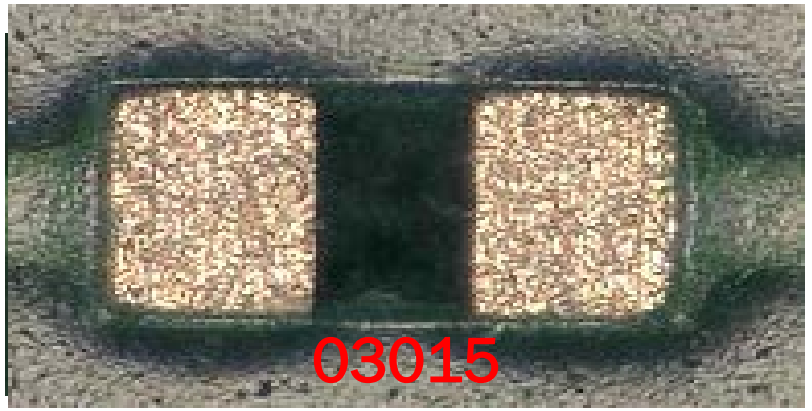
pattern	Units	1	2	3	4	5	6	7	8	9	10	11	12
Mask aperture X	mm	0.06	0.06	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.1	0.1
Mask aperture Y	mm	0.09	0.1	0.085	0.09	0.095	0.105	0.115	0.105	0.115	0.125	0.1	0.11
Pad size X	mm	0.07	0.07	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.11	0.11
Pad size Y	mm	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Gap X (C)	mm	0.07	0.09	0.07	0.08	0.09	0.11	0.07	0.08	0.09	0.13	0.13	0.17
Gap X (D)	mm	0.09	0.11	0.09	0.1	0.11	0.13	0.09	0.1	0.11	0.15	0.15	0.19
Gap X (E)	mm	0.11	0.13	0.11	0.12	0.13	0.15	0.11	0.12	0.13	0.17	0.17	0.21
Gap X (F)	mm	0.13	0.15	0.13	0.14	0.15	0.17	0.13	0.14	0.15	0.19	0.19	0.23
Gap Y (C)	mm	0.07	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--
Gap Y (D)	mm	0.09	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--
Gap Y (E)	mm	0.11	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--
Gap Y (F)	mm	0.13	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--	<--

Recommended minimum lands

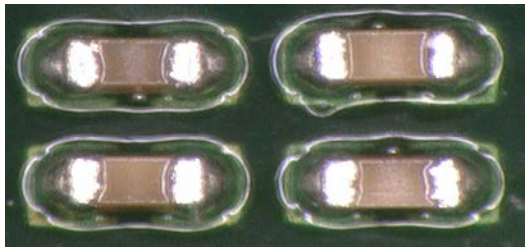
- Use over resist (SMD) to cover the land with the resist
- Set spaces to collect surplus solder to prevent side balls



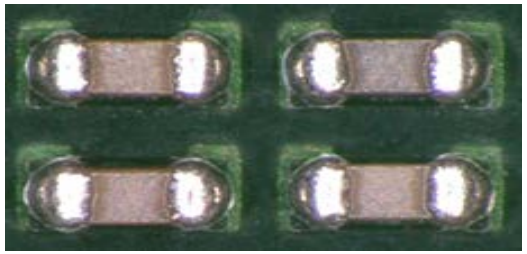




SMDs (have resist)

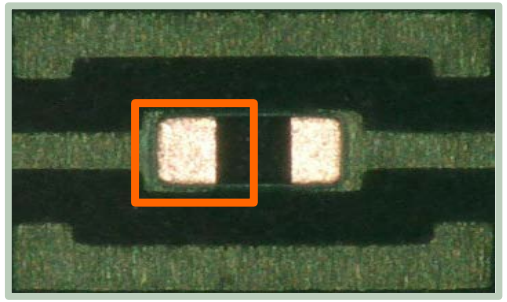


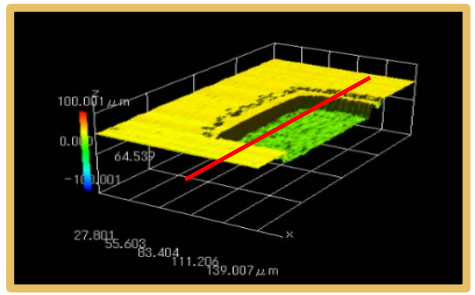
SMDs (no resist between pads)

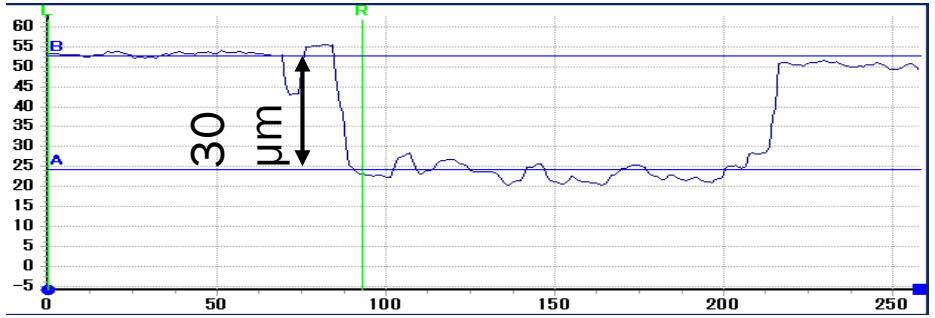


Considerations when placing on panels

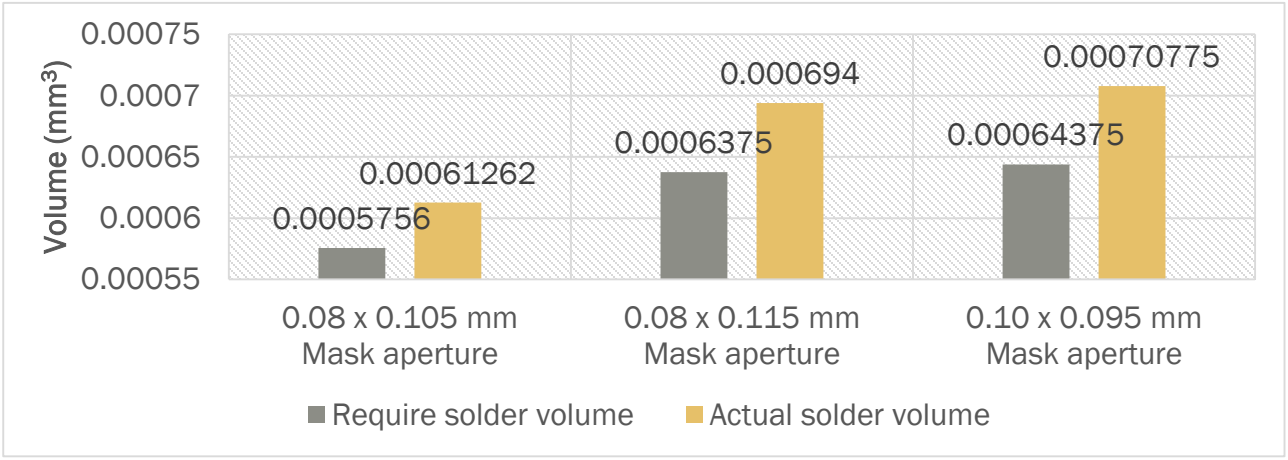
There was almost no influence from the thickness of resist on the placement level of small parts to 0402 (01005") parts.



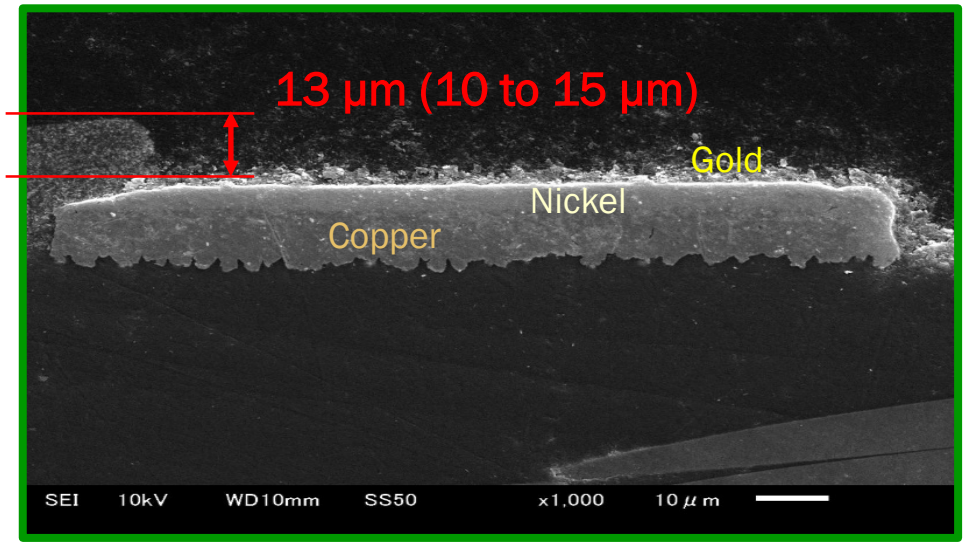




Comparing with the ideal volumes



Recommended resist thickness for 0201 mm (008004") parts



Mass production technology for 0201 mm (008004") components

- Panel lands for 0201 mm (008004″) placements
- Solder printing
- Placing
- Reflow

Solder supporting 0201 mm (008004”) placements

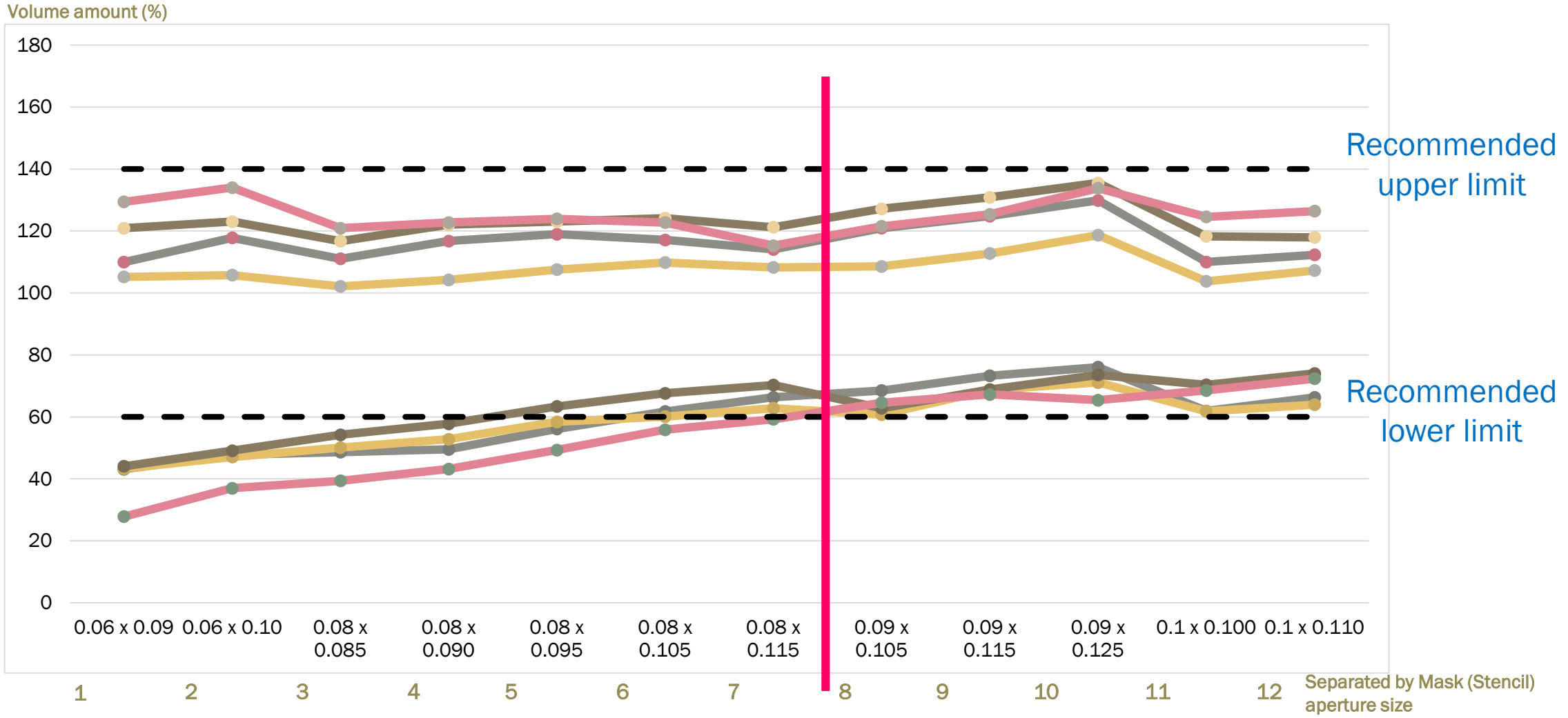
Particle type	Type 5		Type 6	
	Paste A	Paste B	Paste C	Paste D
Composition	Sn 3.0 Ag 0.5 Cu	Sn 3.0 Ag 0.5 Cu	Sn 3.0 Ag 0.5 Cu	Sn 3.0 Ag 0.5 Cu
Powder size	15-25 um	10-25 um (ave. 20 um)	5-15 um	5-20 um (ave. 12 um)
Viscosity	200 Pa・s	220 Pa・s	200 Pa・s	220 Pa・s
Melting temperature	217-220 C	217-219 C	217-219 C	217-219 C
Halogen	Has halogen	Halogen free	Has halogen	Halogen free
Oxygen concentration	1,000 ppm or less	1,000 ppm or less	1,000 ppm or less	1,000 ppm or less

Solder printing evaluation

Type 6 solder paste

Printing results separated by Mask (stencil) apperture size

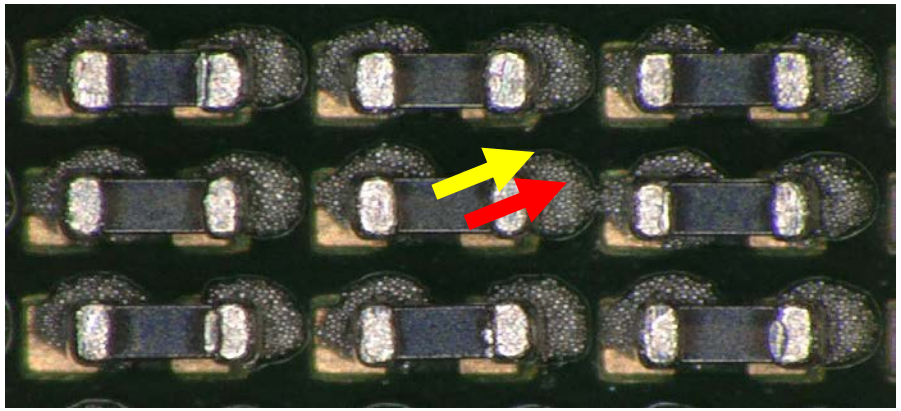
Mask (Stencil) thickness: 0.06 mm



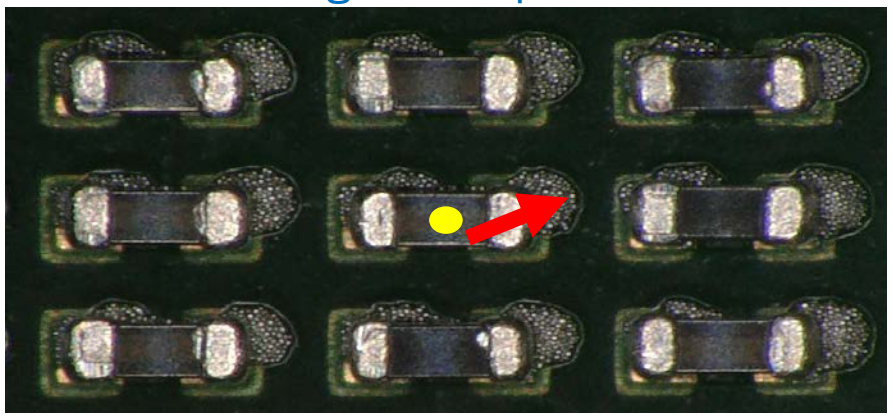
Placing conditions

Mask (Stencil) thickness: 0.06 mm - 10/20/30um shifts

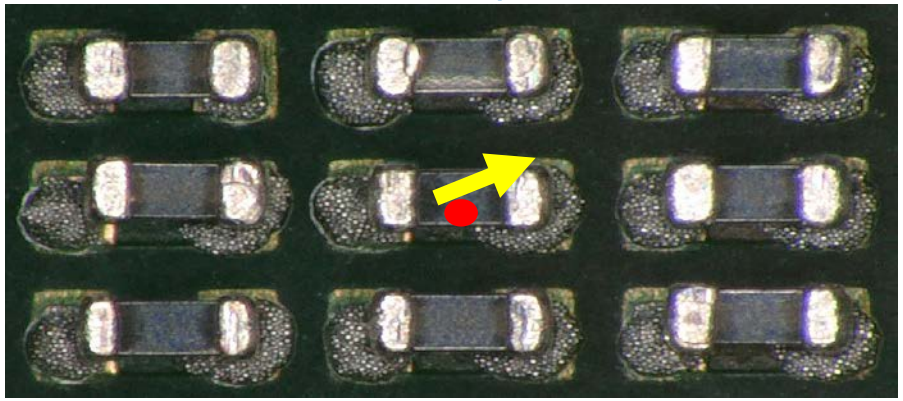
1. TOP placement (solder placed)



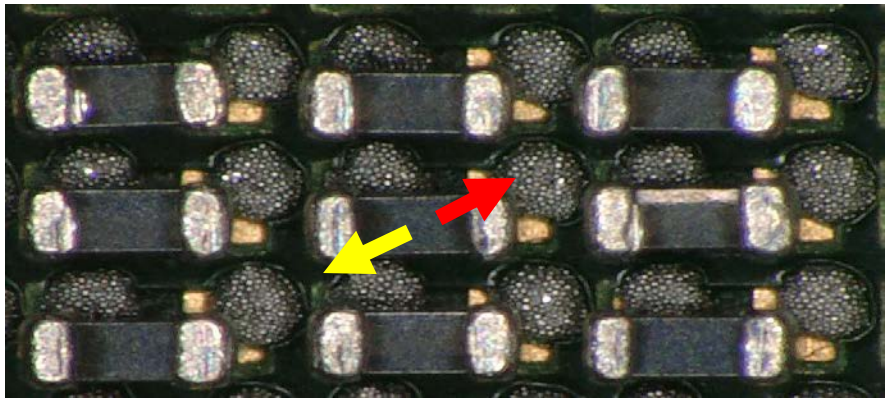
2. Printing shifted placements



3. Parts shifted placements



4. Printing and part shifted placements



Placing evaluation – Minimum gap between parts

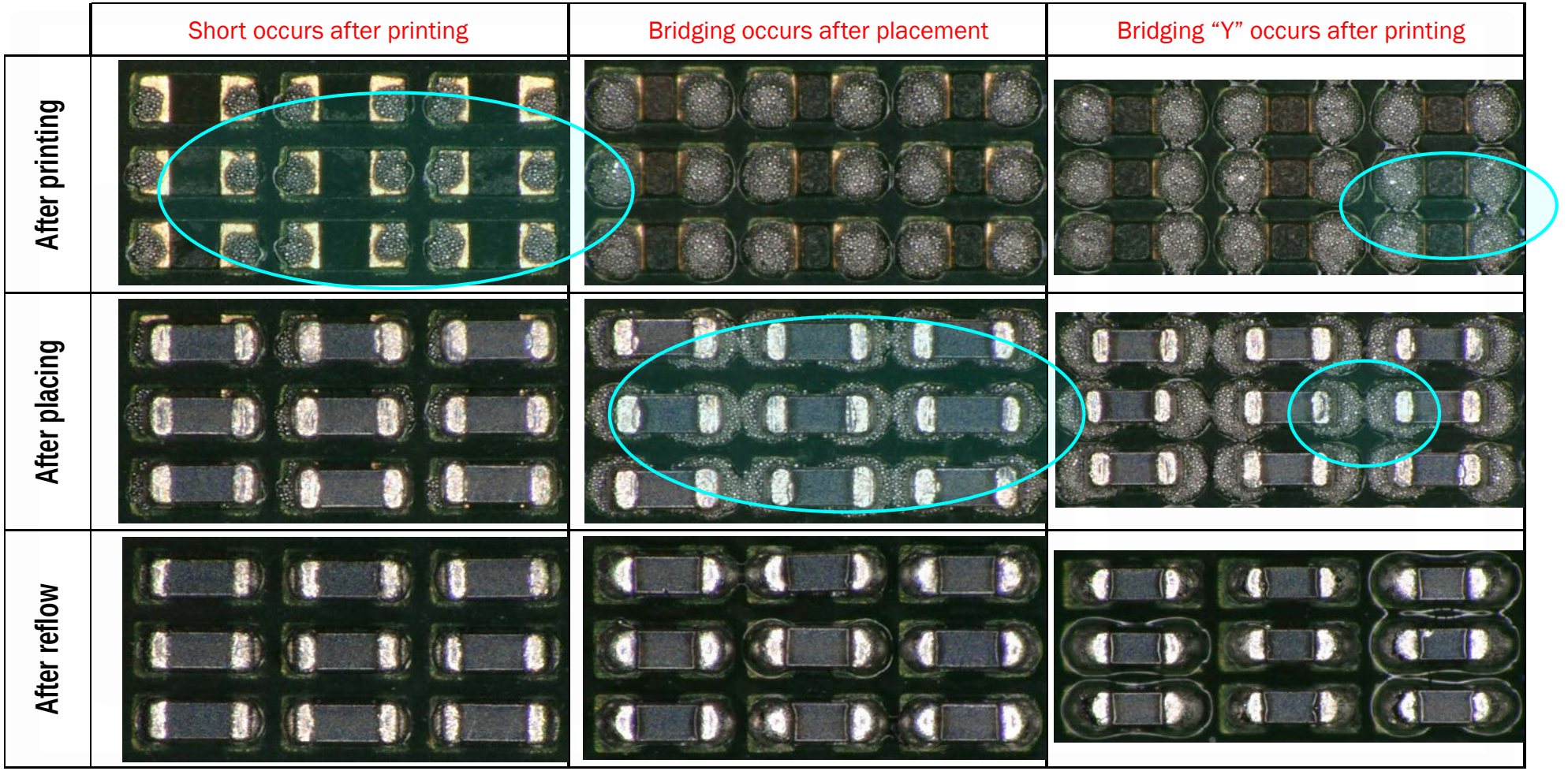
Mask (Stencil) thickness: 0.06 mm - Different printing and placing conditions

Units: mm

	SB ratio	Mask (Stencil) aperture short side	Mask (Stencil) aperture long side	Land interval	Fillet	Best placement	TOP placement	Printing shifted placements	Parts shifted placements	Printing and part shifted placements
1	3.2	**0.06**	**0.09**	0.11	0	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
2	3	↑	**0.1**	0.13	0.01	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
3	2.7	**0.08**	**0.085**	0.07	0	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
4	2.64	↑	**0.09**	0.08	0.005	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
5	2.59	↑	**0.095**	0.09	0.01	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
6	2.46	↑	**0.105**	0.11	0.02	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
7	2.53	↑	**0.115**	0.07	0	Bad printing	Bad printing	Bad printing	Bad printing	Bad printing
8	2.48	**0.09**	**0.105**	0.08	0	Micro-bridges	Micro-bridges	Micro-bridges	Micro-bridges	Micro-bridges
9	2.42	↑	**0.115**	0.11	0.02	Micro-bridges	Micro-bridges	0.13 / 0.09	0.13/0.09	0.11 / 0.07
10	**2.29**	↑	**0.125**	**0.13**	**0.03**	**0.15 / 0.09**	**0.15 / 0.09**	**0.15 / 0.09**	**0.15/0.09**	**0.15 / 0.09**
11	2.24	**0.1**	**0.1**	0.09	0.03	0.15 / 0.09	0.15 / 0.09	0.15 / 0.09	0.15 / 0.09	0.17 / 0.11
12	2.16	↑	**0.11**	0.13	0.05	0.17 / 0.11	0.19 / 0.09	0.17 / 0.11	0.17 / 0.11	0.19 / 0.09

If printing and part shifted placement amount exceeds 0.02 mm in X and Y directions, quality defect problems can occur under any conditions.

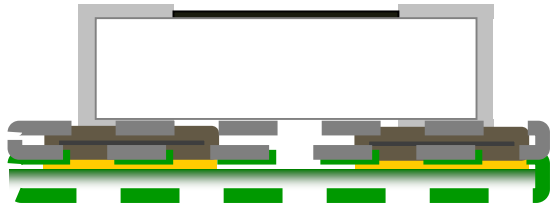
Defect quality images



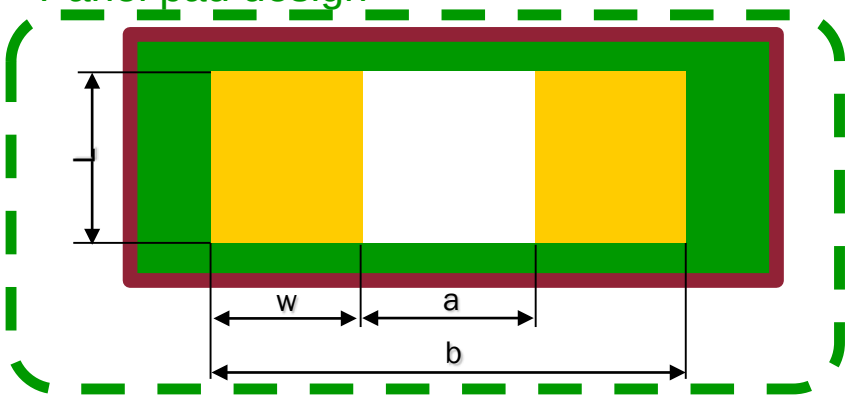
Bridging occurs after printing and placing, but there was an improvement seen for all cases after reflow processing.

Recommended land sizes

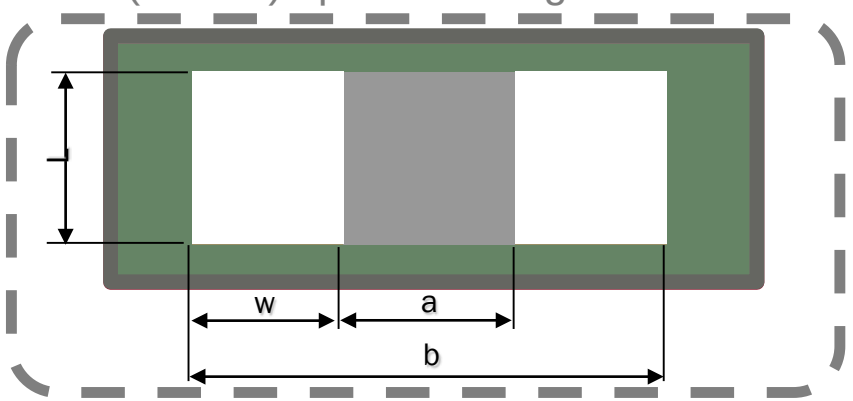
1. Determining the panel pad size and metal mask opening size



Panel pad design



Mask (Stencil) aperture design



Mask (Stencil) thickness	**0.05 mm**	**0.06 mm**
L (pad length)	0.125 mm	0.125 mm
W (pad width)	0.09 mm	0.09 mm
a (distance between pads)	0.07 mm	0.13 mm
b (pitch between pads)	0.25 mm	0.31 mm
c (fillet length)	0.00 mm	0.03 mm

*The resist formation is over resist.

Mask (Stencil) thickness	**0.05 mm**	**0.06 mm**
L (aperture length)	0.1 mm	0.125 mm
W (aperture width)	0.08 mm	0.09 mm
a (aperture interval)	0.09 mm	0.13 mm
b (pitch between apertures)	0.25 mm	0.31 mm

Module panel and hybrid panel (smartphone)

Introducing SPI



	Specifications
Camera	12 million pixels or more
Camera lighting direction	4 way
XY-axis drives	XY-axis ball screw servos, XY-axis linear motors
Camera resolution	6 um or less
Camera field of depth	±2.0 mm or more
Minimum paste size	60 x 60 um or less

Note: The above is the machine specifications for performing solder inspection for 0201 mm (008004") parts.

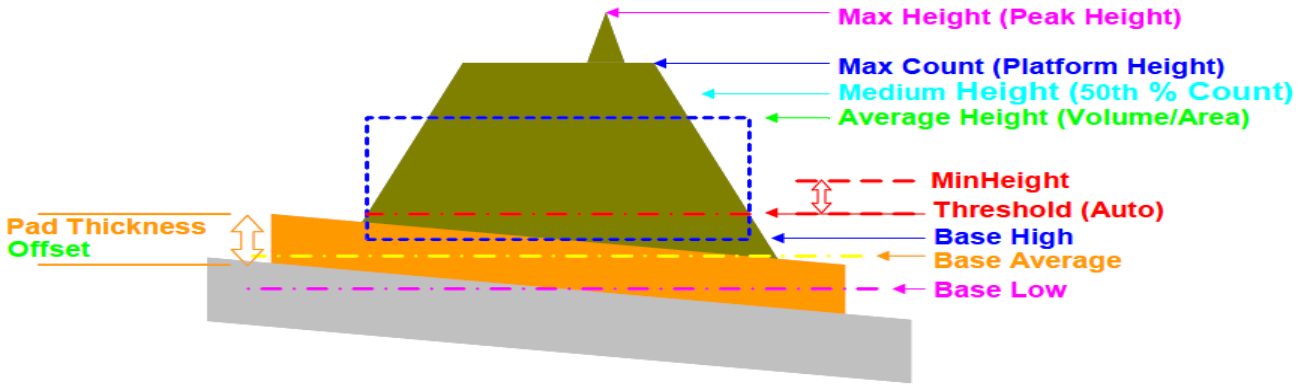
Specification explanations

- **Camera:** Requires a camera with a high pixel count in order to perform high-speed inspection. This ensures a wide field of view.
- **Camera lighting direction:** It was determined that four way lighting is best in order to prevent shadows. More lighting provides better images of very small solder pads when adjacent distances are narrow.
- **Camera resolution:** Company B uses a camera resolution of 7.7 um as an optimal setup for 03015 mm parts. We believe a higher resolution capability is required for 0201 mm (008004") parts. The higher the resolution, the cleaner the image.
- **Camera field of depth:** When panels are warped, there can be inaccurate measurements due to the image being out of focus. A field of depth of $\pm$2 mm or greater is required.
- **Minimum paste size:** Minimum paste size is 60 x 60 um
- **Solder area extraction method:** Although the name is different for each company, the method of taking the image by cameras is the same: light the panel using more strips and take an image with the light reflected from the panel.

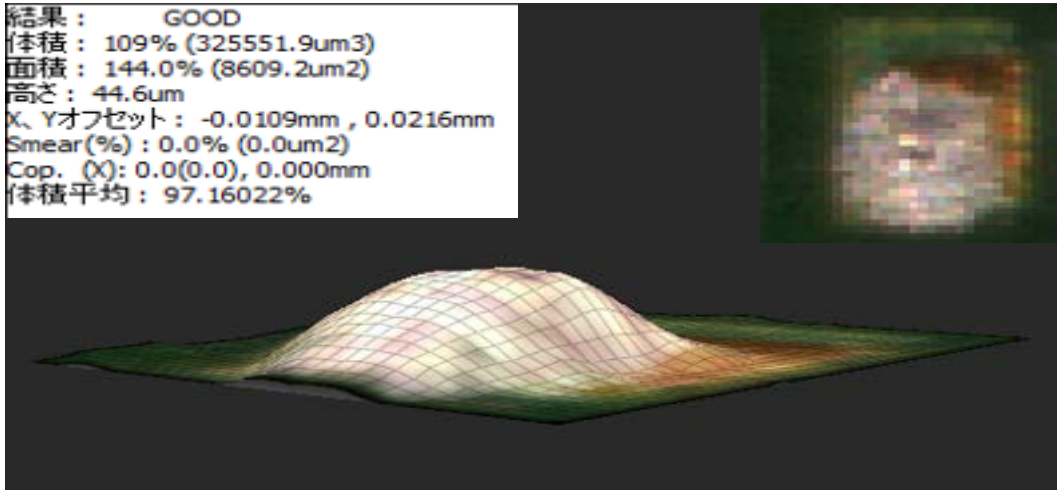
SPI inspection

Threshold (height reference)

For the height inspection set position reference, the reference position is different for each company and there are differences in the functions.



Solder inspection image



It is extremely difficult to measure the absolute amount of solder volume. This is because the results for the solder volume amount are completely different from the degree of extraction for the solder area.
Therefore, for the assumption that very small solder volumes are going to be measured, selecting an SPI with a function capable of setting the extraction method finely for the solder volume can be thought of as appropriate.

AOI introduction

Visual inspection machine from Company A

Machine to be tested

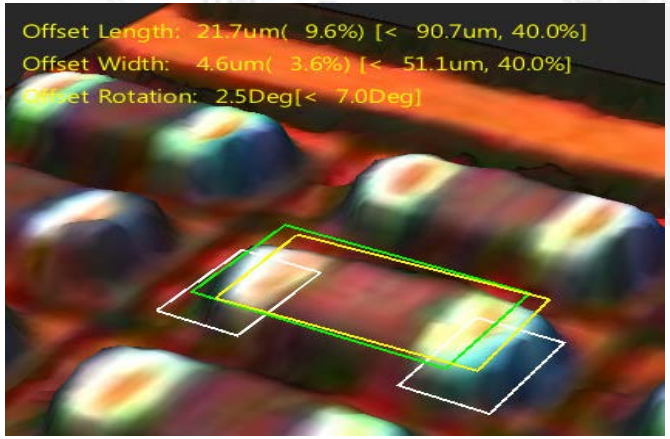
Specifications

Item	Contents
Measurement method (direction)	More phase shift (PMP) (8 directions)
Camera size	8 million pixels
Camera resolution	10 um
Field of view size	Around 2.8 mm x 2.8 mm
Inspection speed	Approx. 0.65 seconds per field of view
Platform	C Platform

Inspection results

Missing	Dimensions	Solder deviation	Floating	Polarity	OCVR	Solder	Foreign obj ect	Short
0	0	0	0	-	-	0	0	-

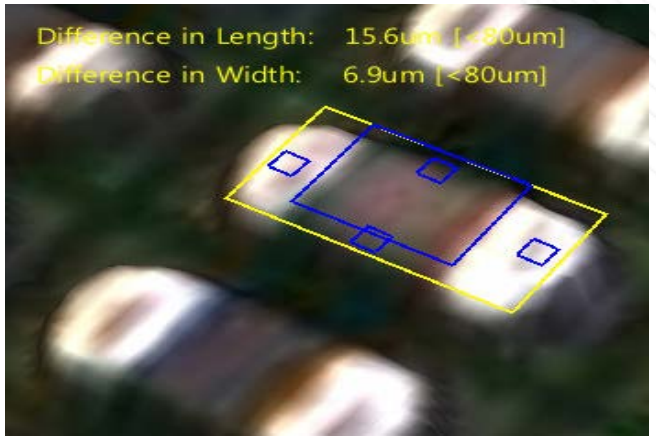
Missing parts / sizes / position deviations



The following is measured from the 3D data:

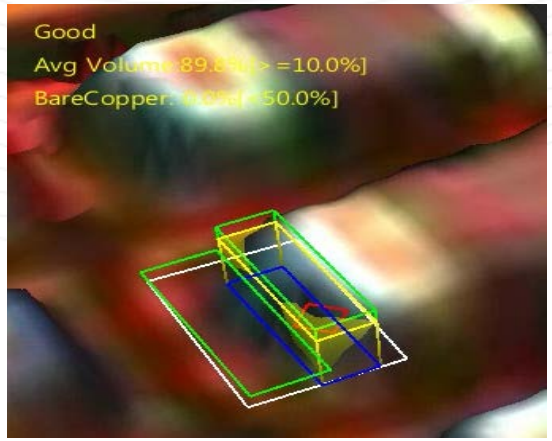
- Determines the part presence (by measuring volume)
- Measure the size (extracted parts)
- Solder deviation (extracted part center position)

Part lifting



Determine the part lifting by measuring the part surface tilt

Solder



Measure the solder height and volume from the lead tips

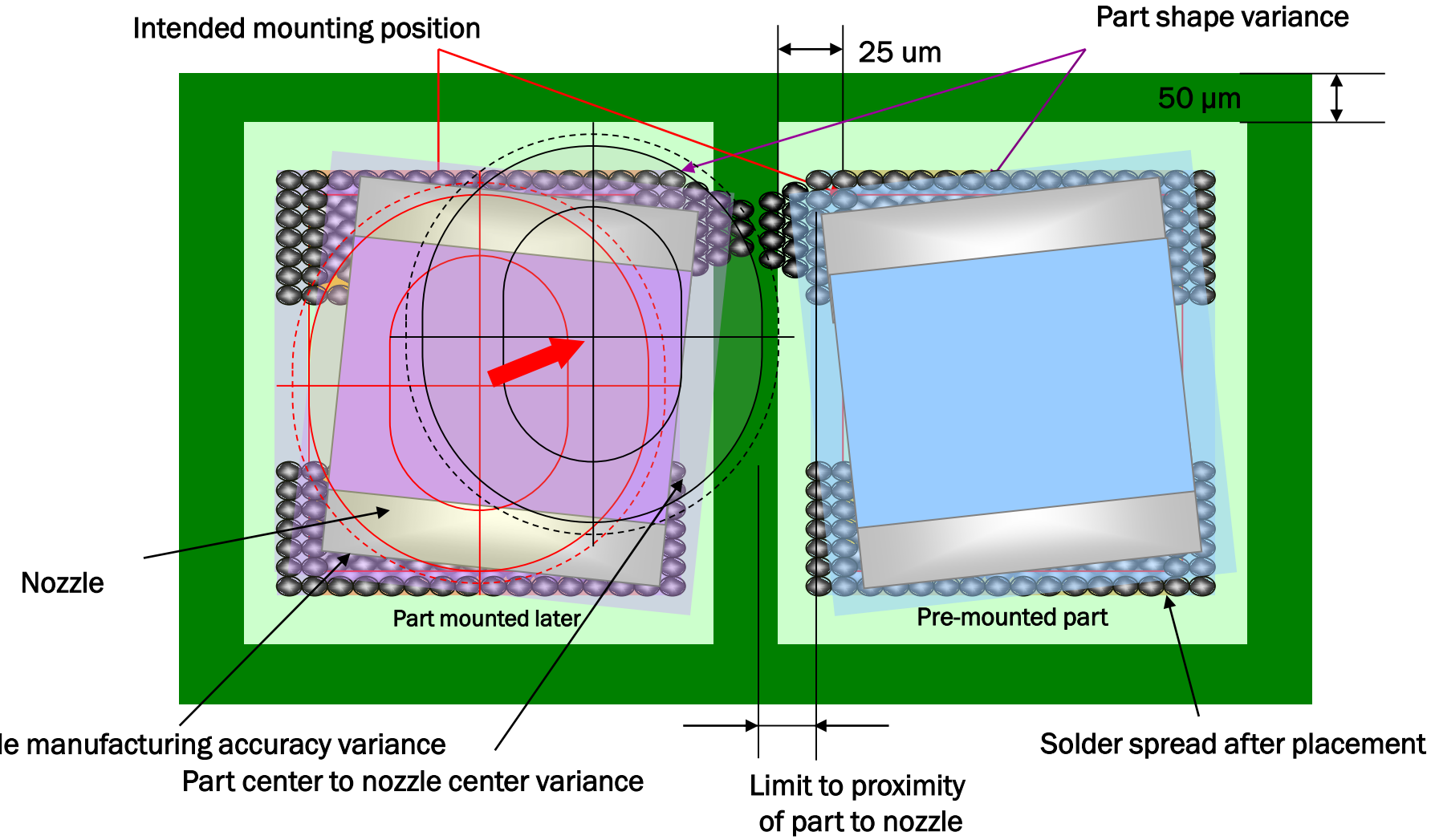
Results → Support for all the inspection items

Mass production technology for 0201 mm (008004") components

- Panel lands for 0201 mm (008004″) placements
- Solder printing
- Placing
- Reflow

Considerations when performing fine pitch placement

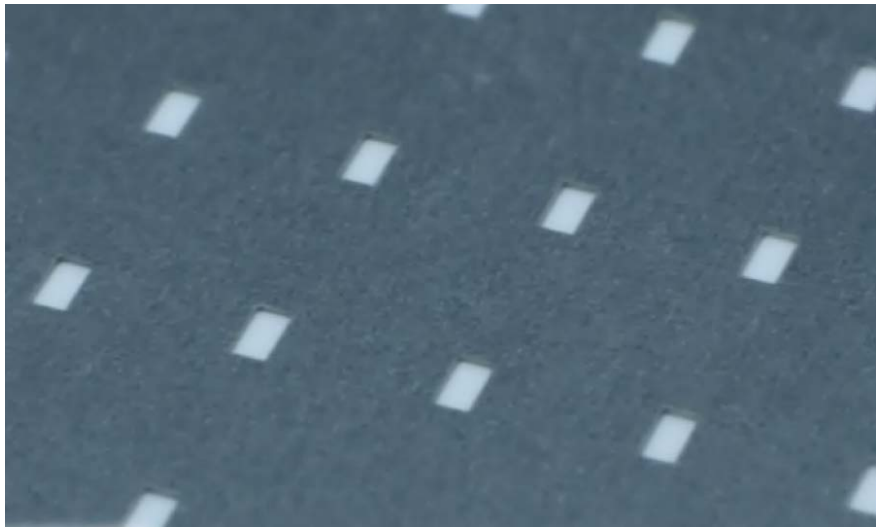
1. Fillet dimensions
2. Resist width
3. Width margin
4. Printing accuracy
5. Mounting accuracy
6. Part size variance
7. Pre-mounted parts
8. Microbridging
9. Nozzle accuracy
10. Part pickup accuracy
11. Parts mounted later
12. Bridging
13. Self alignment
14. Non-wetting and tombstoning

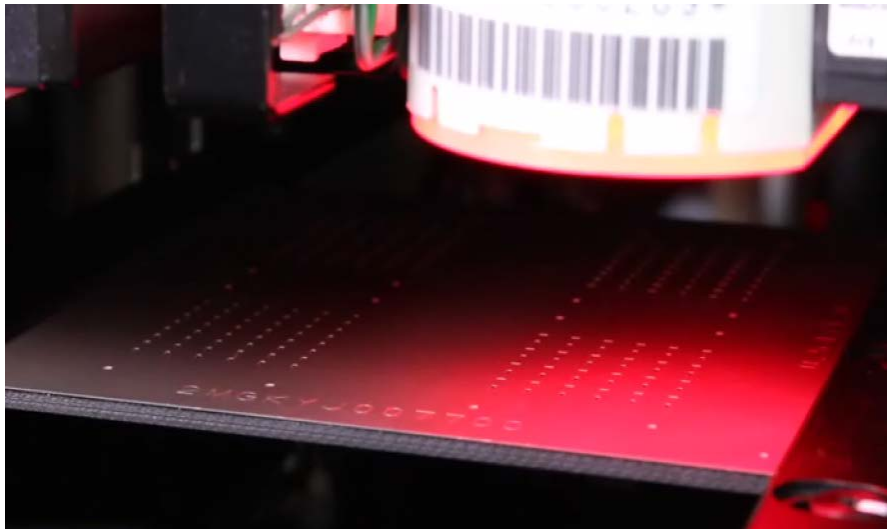


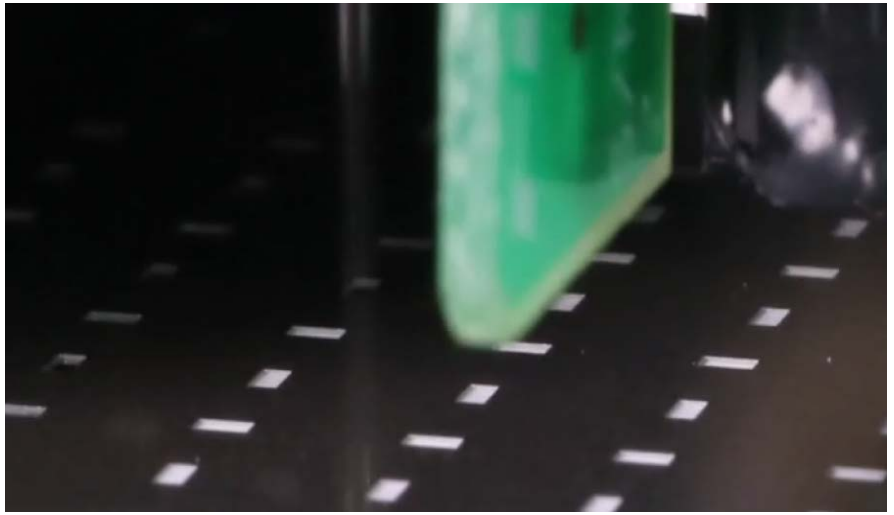
Lighter compact high-speed placing head: Head G

Part size	0201 (0.25 x 0.125 mm, 008004") to 5 x 5 mm 24 nozzle operation: 0201 (0.25 x 0.125 mm, 008004") to 3216 (1206") 12 nozzle operation: Up to 5 x 5 mm
Placing accuracy (3σ CPK ≥ 1.00)	±0.025 mm ±0.038 mm (heightened accuracy mode: ±0.015 mm)
Throughput	35,000 cph, 42,000 cph

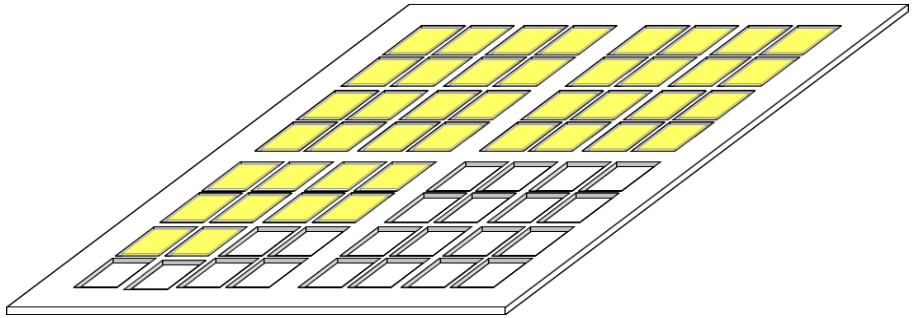
Stability of compact rotary heads



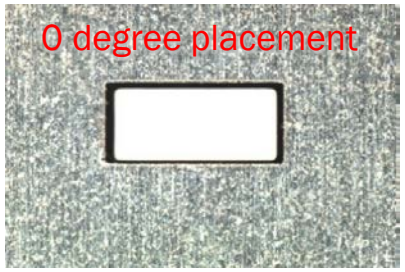


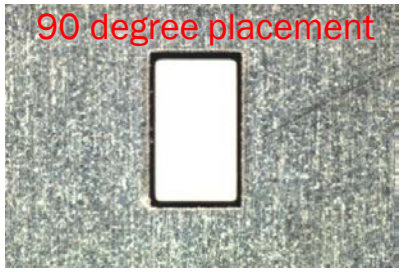


Challenges to placing in cavities

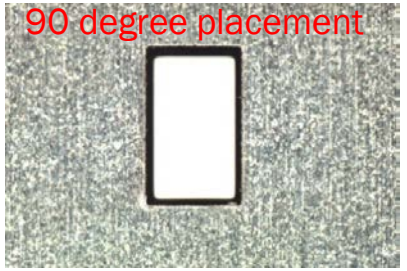


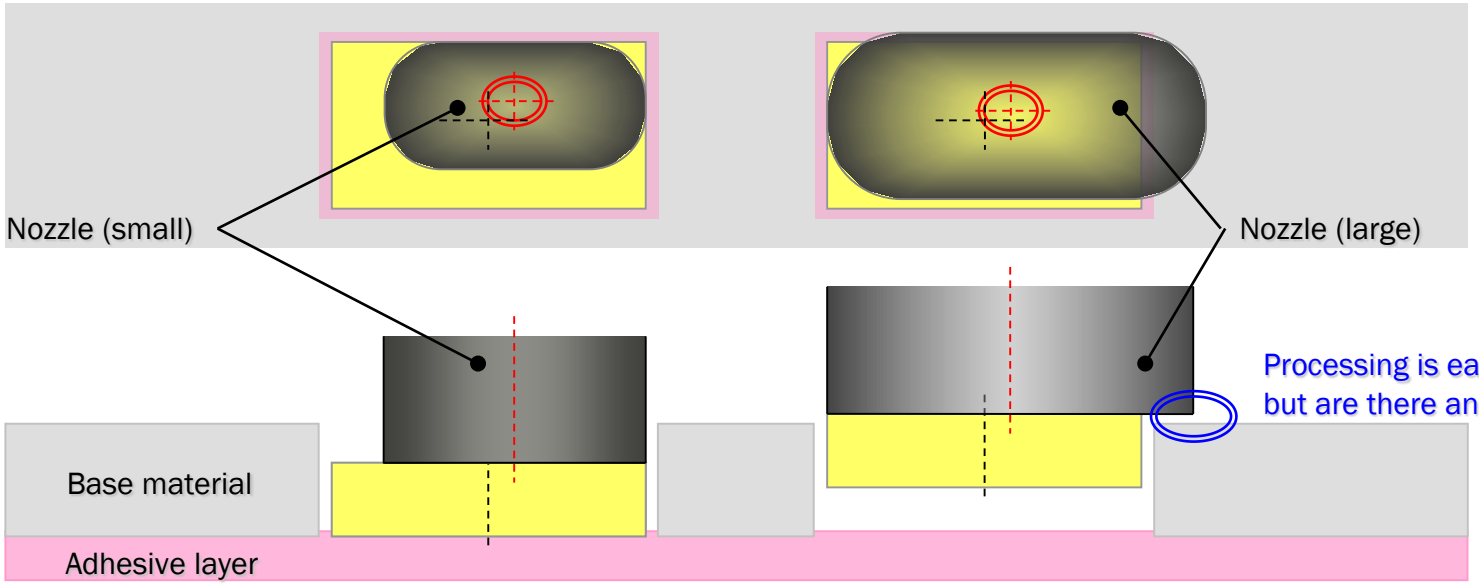
Cavity to part gap: 20 um





Cavity to part gap: 30 um

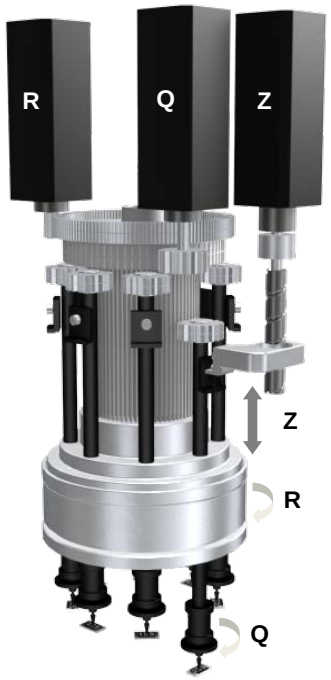




Processing is easy and vacuum pressure can be maintained, but are there any concerns for this?

Compact lightweight heads (rotary)

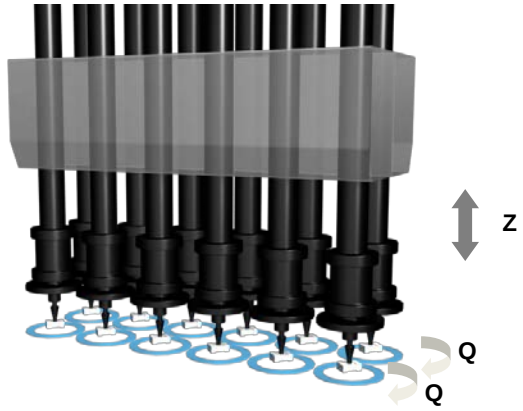
3 motors
1 air channel



One Z-axis, Q-axis, R-axis
Total of 3 axes

14 motors
12 air channels

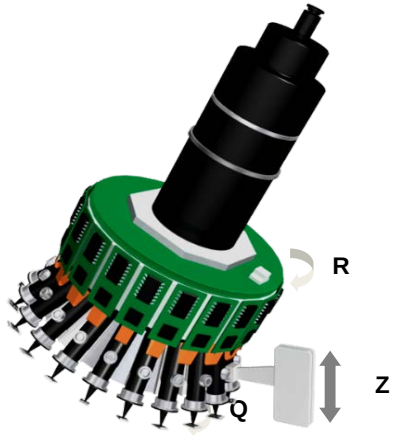
12 high heat generation linear axes motors are used for the Z-axes
↓
A cooling unit is required



12 Z-axes, 2 Q-axes
Total of 14 axes

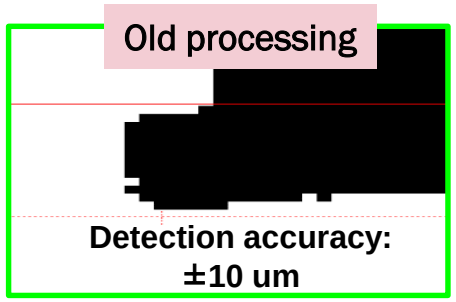
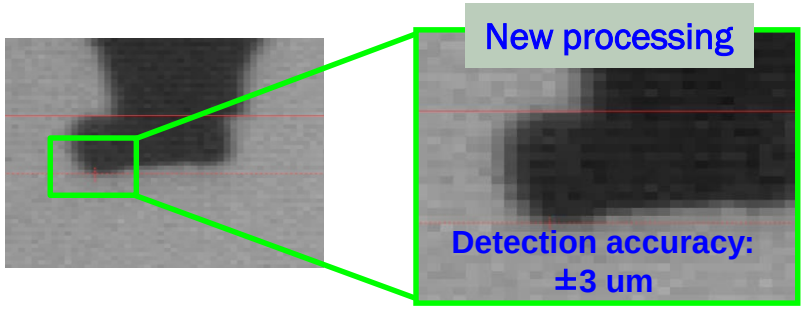
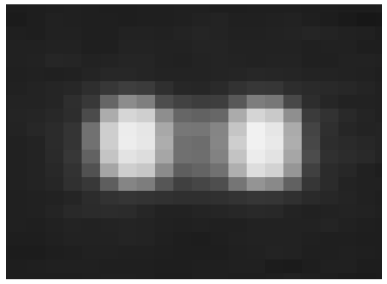
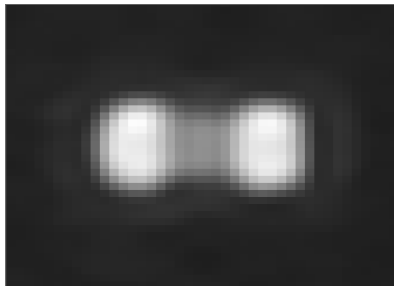
22 motors
Unknown air channels

Need power and communication to the 20 motors in the rotating end
↓
Power and data transceiver units are required

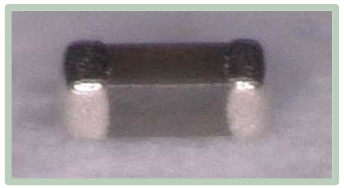


One Z-axis and R-axis, 20 Q-axes
Total of 22 axes

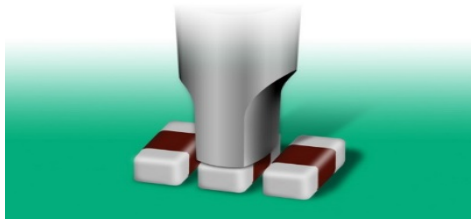
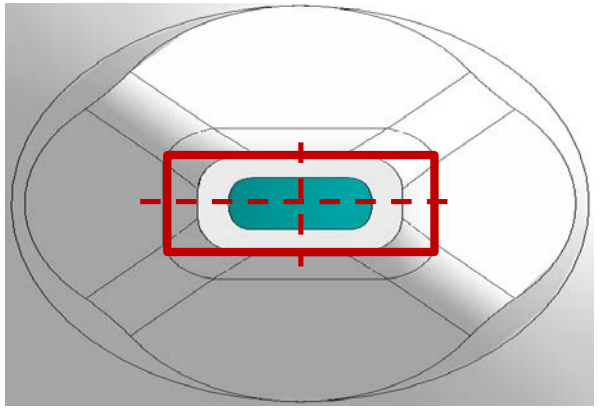
Requires mechanisms to attach the many axes
Difficult to make compact

Heads	Placing with higher accuracy 	
Image taken with side looking camera		
	Vision processing algorithm	Vision processing algorithm (new)
Image taken with up-looking parts camera		

Fine pitch placement nozzle



0201 mm (008004") part weight: 0.000017 grams

Nozzles	Standard nozzles
Nozzle tip material	Zirconia
Nozzle and part position relationship 	

Machine issues related to fine pitch placement

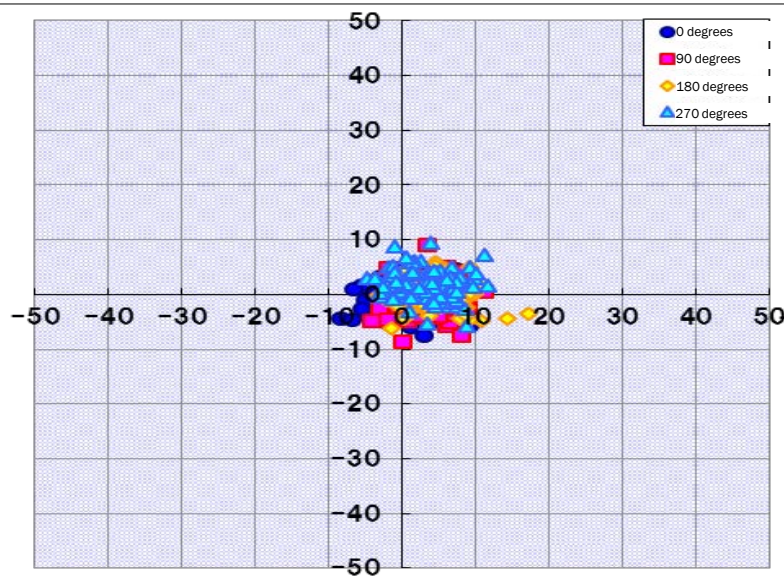
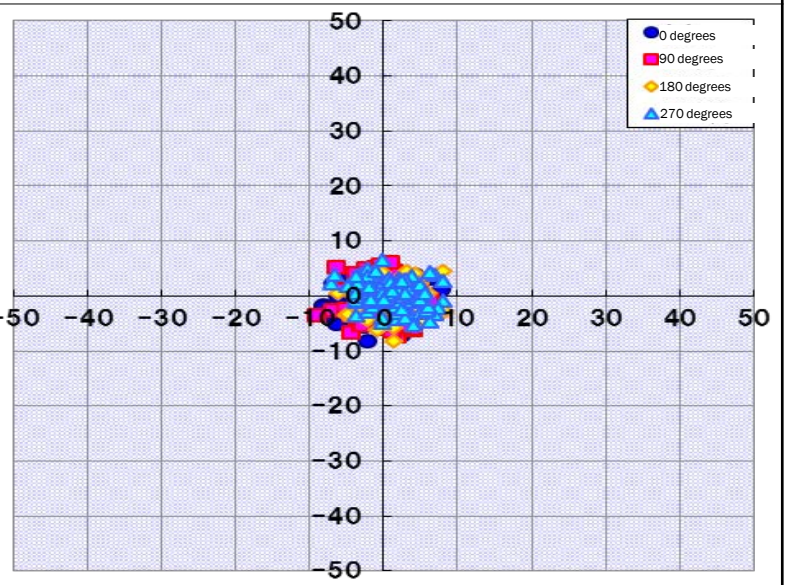
- Variance in part dimensions (Issue 1)
  - ✓ Research regarding resistors (R) and capacitors (C)
- Variance in mounter placing accuracy (Issue 2)
  - ✓ Placement accuracy for pre-mounted parts and parts placed later
- Variance in part pickup position (Issue 3)
  - ✓ Between part center and nozzle center
- Variance in nozzle dimensions (Issue 4)

Calculate a value for placement reliability

$$F = \sqrt{\alpha_{premountedpart}{}^2 + \alpha_{postmountedpart}{}^2 + \gamma^2}$$

Can perform fine pitch placements of 50 µm

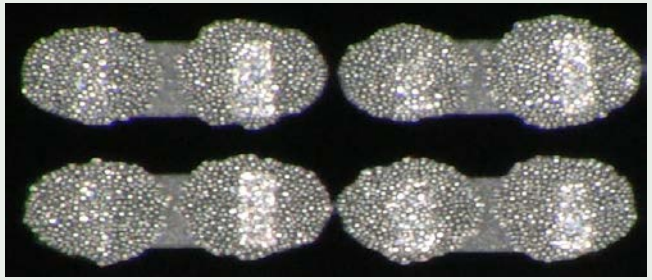
Placing quality at top speed (35,000 CPH)

		Component Supplier A	Component Supplier B
Placing accuracy			
	3σ (X)	11.3 µm	9.6 µm
	3σ (Y)	8.7 µm	8.1 µm
	3σ (Q)	1.75 degrees	1.78 degrees

Low impact load control

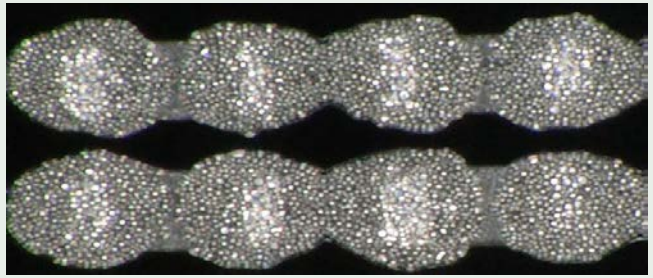
03015

Good



Impact: 0.5 N

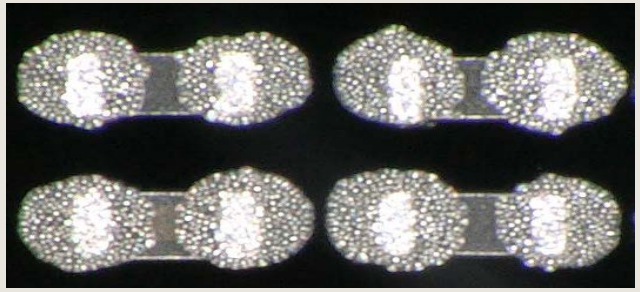
Bad



Impact: 1.0 N

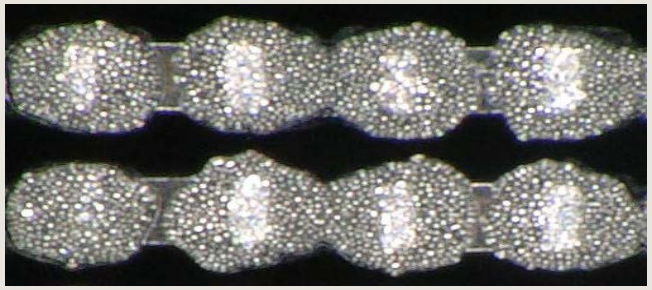
0201 mm (008004")

Good

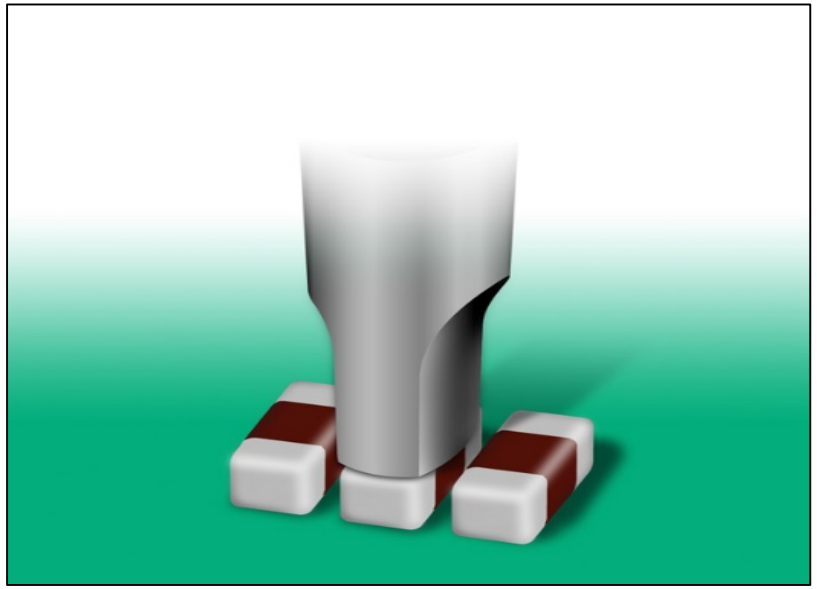


Impact: 0.5 N

Bad

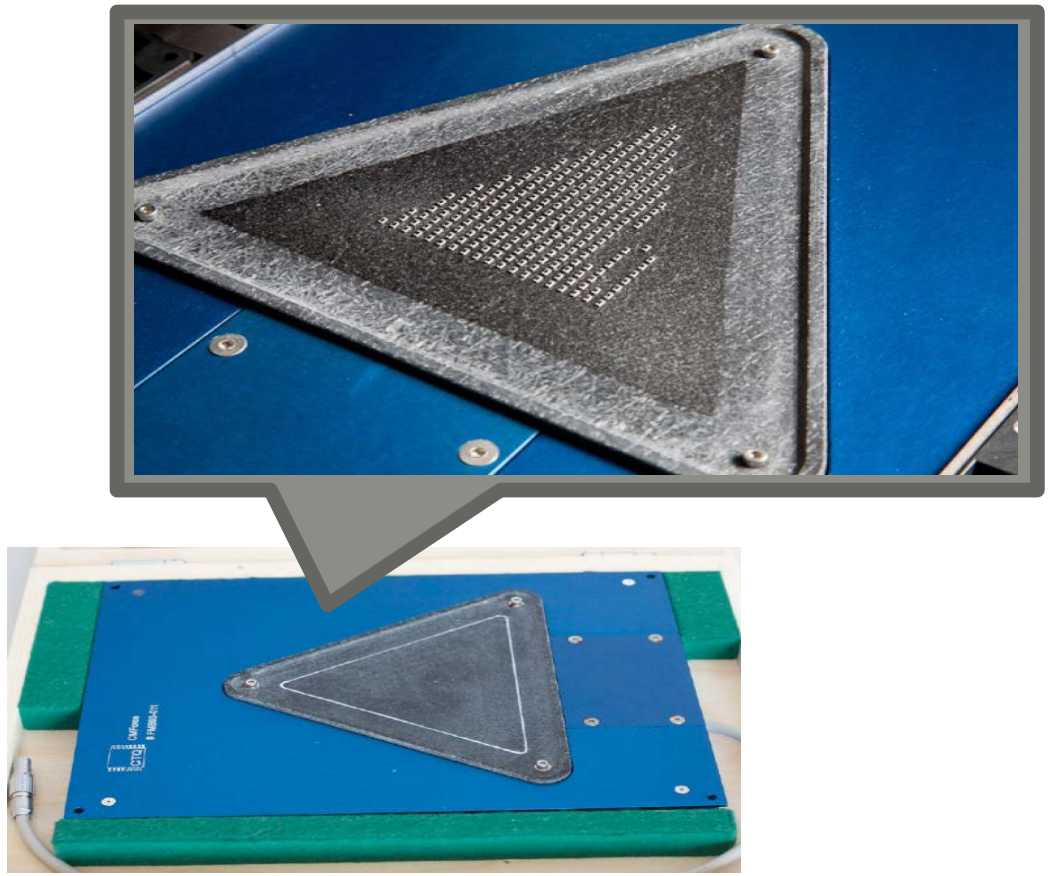


Impact: 1.0 N



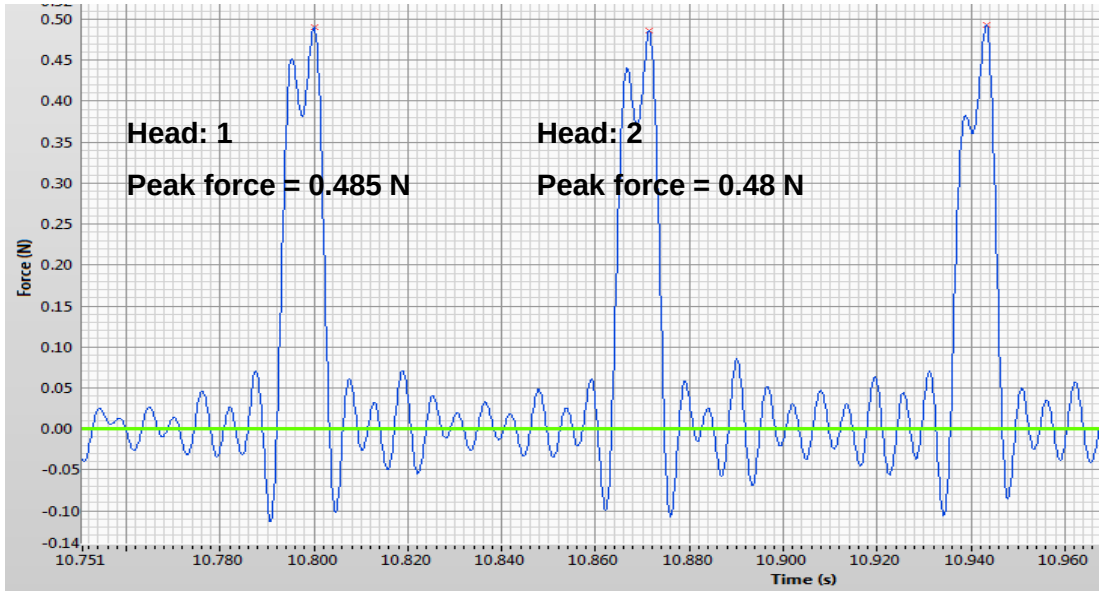
Placement force that does not squash printed solder paste = High density placement possible

Greatly reduced impact force (calibration)

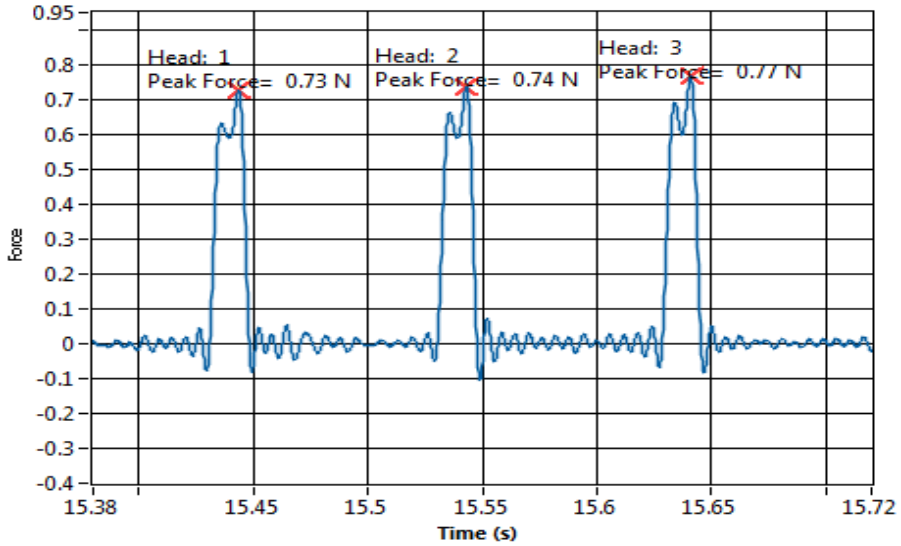


Production Placement Force Measurement System

Head G



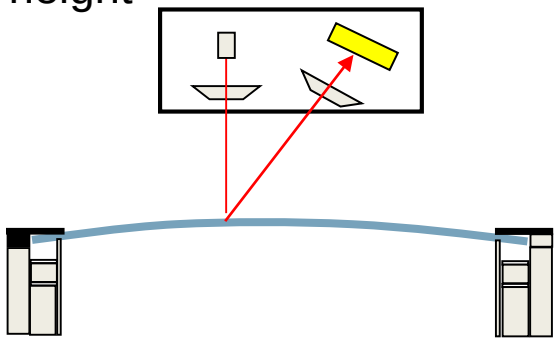
Head V



Impact is further reduced by combining panel height detection with part height measurement

By linking PCB height detection with the parts height detection function, it's possible to get higher placing quality.

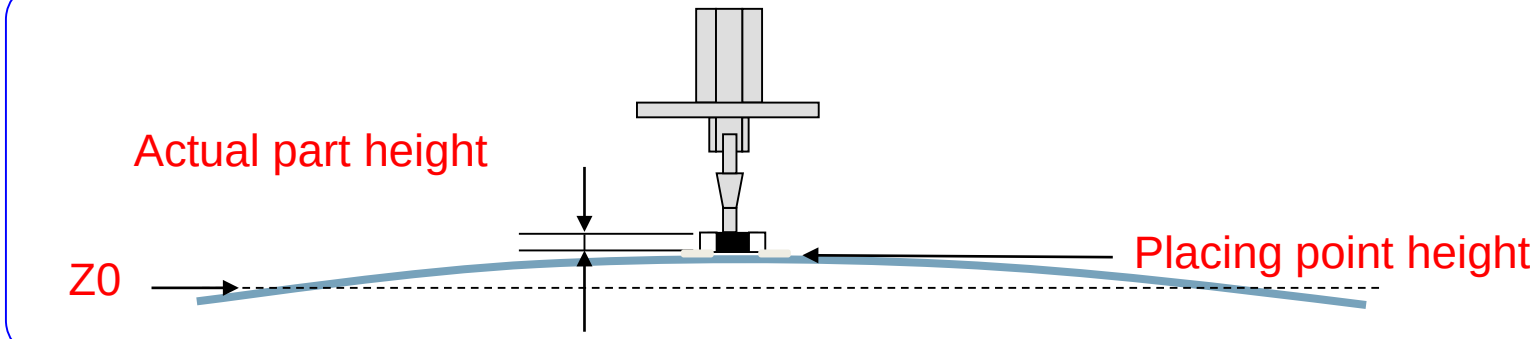
Detects panel height



+

Measures part height using side looking cameras

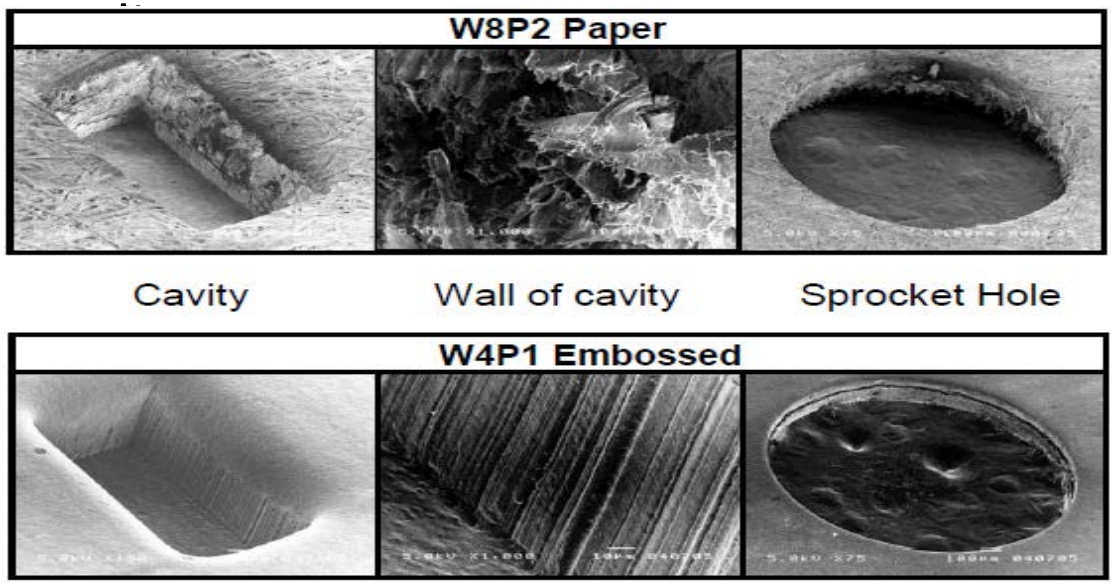
Can consider the height of individual parts



International standard: IEC standard approval Standard number: IEC 60286-3-2 Ed. 1.0

W4P1 tape - Contributing to productivity and the environment as well as increasing placing

Feeder supports W4P1 tape



- Precise molding
- Manufactured surfaces are smooth
- Stable cavity sizes
- Reduced peeling static electricity
- Reduced amount of generated dust

→

Stable part pickup rates
Stable product quality
Reduced solder joint defects
Reduced machine cleaning frequency

Nozzle Maintenance - Smart Nozzle Cleaner

Smart Nozzle Cleaner

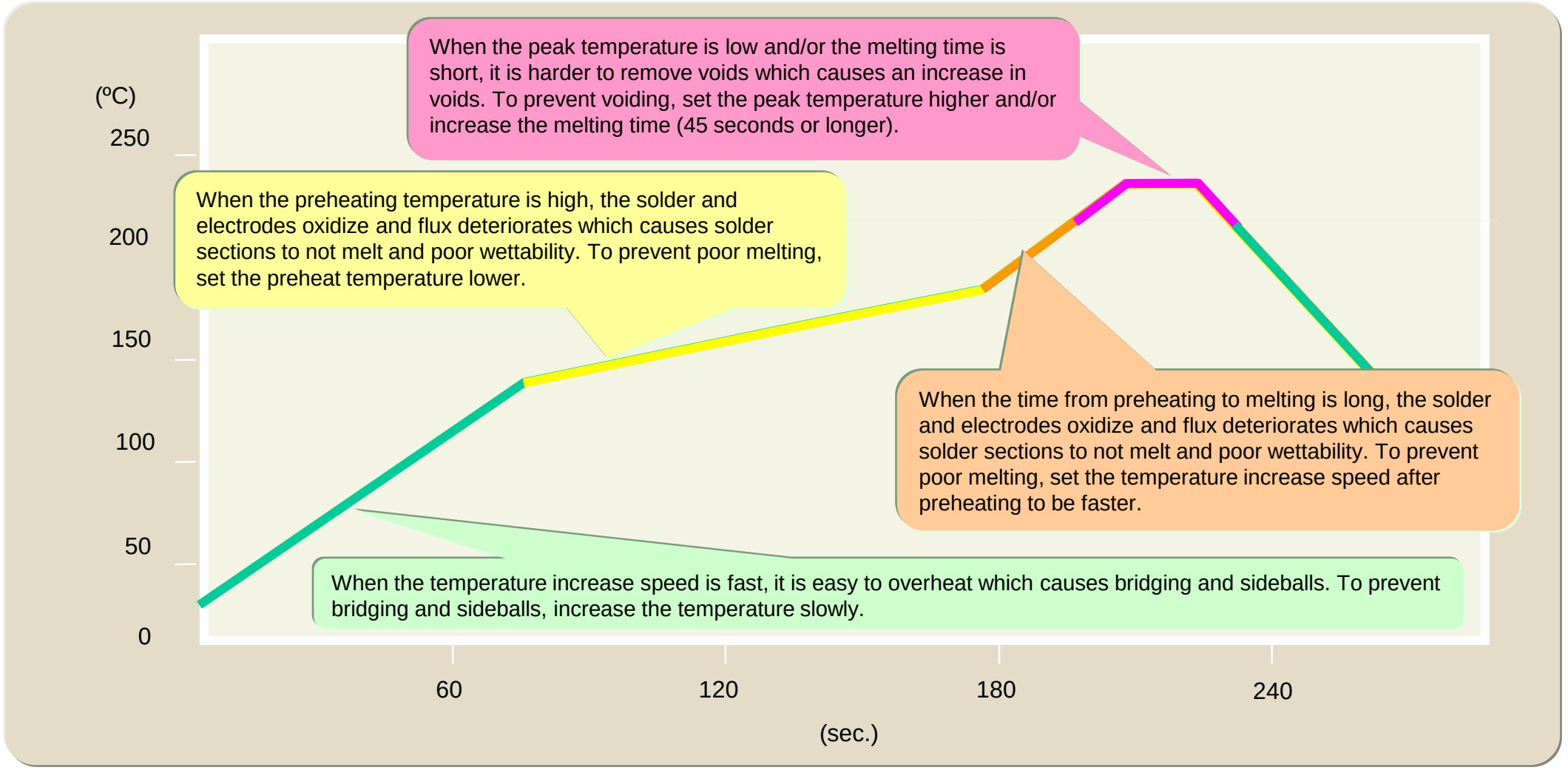
Automates nozzle cleaning, inspection, and setting

- Inspection items
  2D code reading, air flow, nozzle sliding movement, nozzle tip damage
- Defective nozzles are sorted by problem cause and ejected
- Nozzles can be automatically set from the storage section of the unit based on the next production program
- Automatically registers in the system when nozzles are maintained

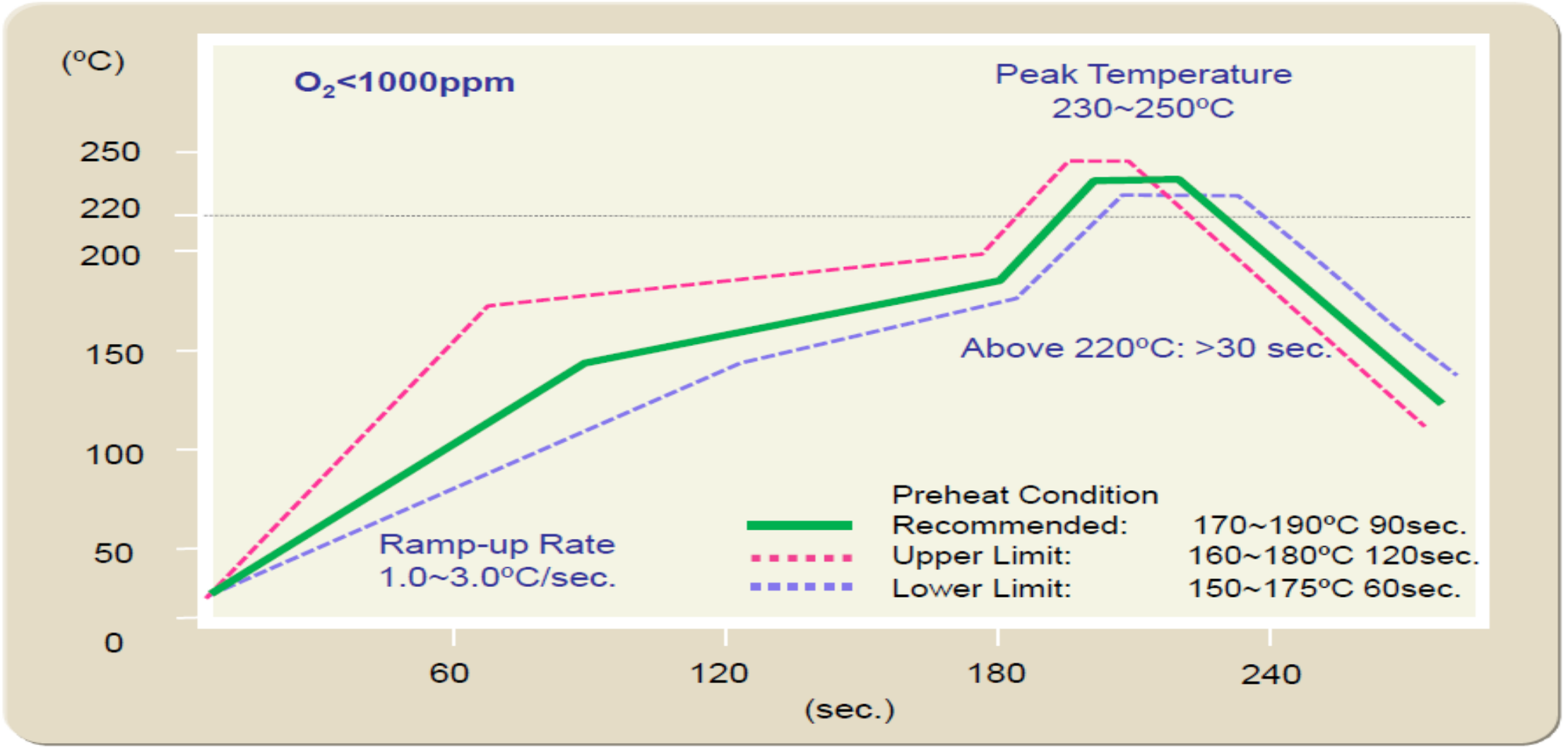
Mass production technology for 0201 mm (008004") components

- Panel lands for 0201 mm (008004″) placements
- Solder printing
- Placing
- Reflow

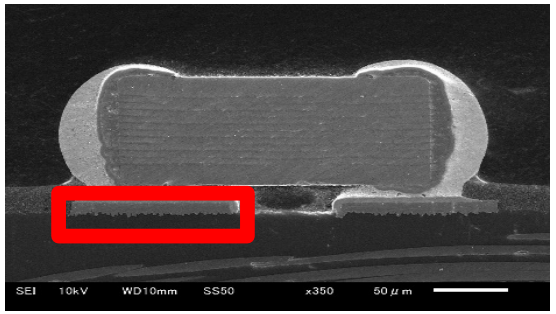
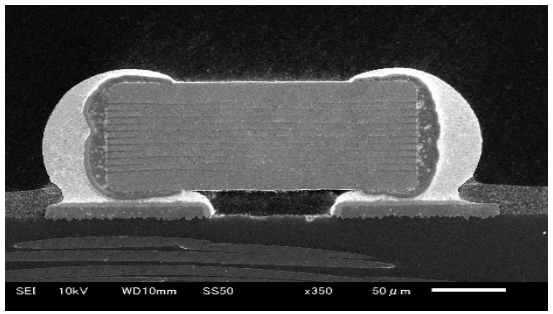
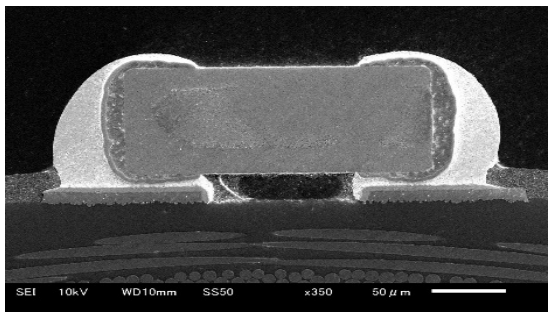
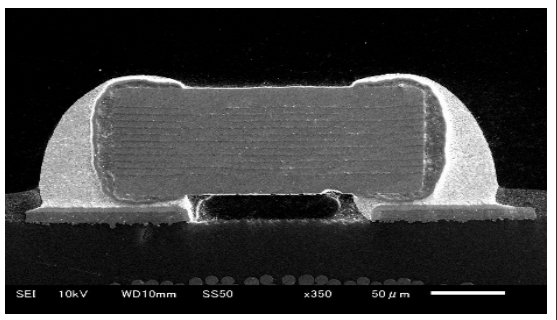
Reflow profile

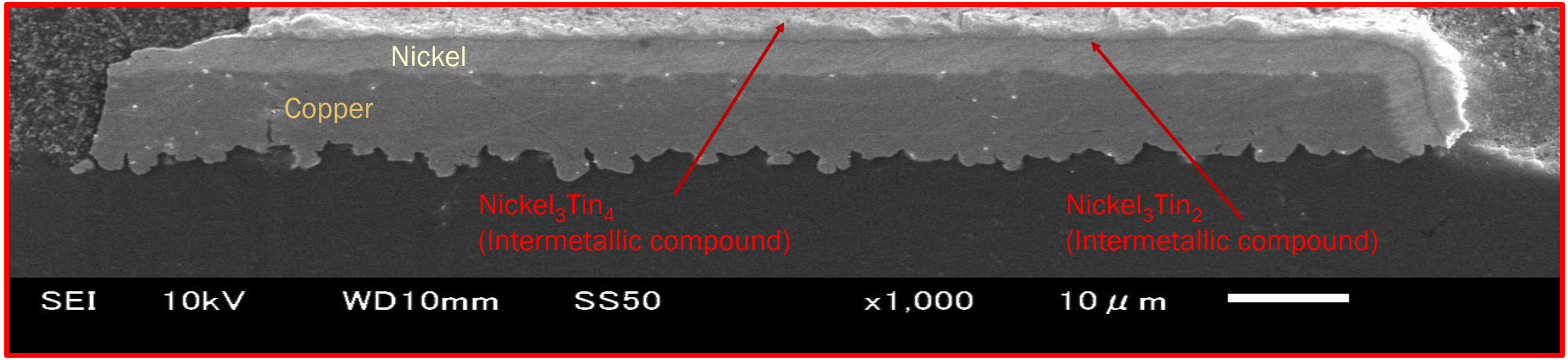


Recommended reflow profile



Checking the bonding status

Pad	0.125(L) x 0.09(W) mm			
Fillet width	Less	0.01 mm	0.02 mm	0.03 mm
Aperture	0.10 x 0.08 mm	0.11 x 0.08 mm	0.125 x 0.08 mm	0.125 x 0.08 mm
Overall				



Conclusions

- The high speed / high accuracy placement of 0201 (008004”) components in a production environment is possible
- Combining ultra small components with larger components still presents real challenges
  - *Mask (stencil) thickness*
- Placement challenges have been overcome using advanced engineering technology
- Rework has much more work to be done