

# Automating 0201 Rework

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Automation and conductive heating are essential for effective rework of tiny 0201s—and beyond.

Next-generation designs for products in the consumer, medical and automotive markets will proliferate the growth of 0201 components due to their small size, low cost, low current and limited power dissipation. In addition, the emergence of 01005 components by 2005 will further assist in the design and manufacture of even smaller assemblies and products. Assembly challenges that 0201s present, including placement accuracy and tombstoning, are currently being addressed by major pick-and-place manufacturers. However, effective 0201 and 01005 rework processes will be required even if high first pass yields are achieved.

## Rework Challenges

The 0201 component is small enough to fit through the eye of a needle (Figure 1). These devices are extremely lightweight and are typically tightly spaced with adjacent clearance of 0.010 in. or less (Figure 2). The extremely small size and weight of these devices, combined with virtually non-existent adjacent clearance, creates significant rework challenges.

## Tooling Design

Tooling design is one of the most critical aspects of 0201 rework. Unlike the assembly

process, the rework tooling must be designed not only to accurately pick and place the tiny device but to reflow it without impacting adjacent components. The most critical design considerations include vacuum pickup, adjacent clearance and thermal transfer, all of which are complicated by the extremely small component size.

Conductive, or contact-based, heating is a logical approach for these tightly spaced devices; however, several major issues must be overcome. One issue is that the contact area is so small that heat transfer to the device may be ineffective. Incorporating vacuum pick up into the contact heating tip further complicates the thermal transfer issue by reducing the already small contact heating area. In addition, conductive heating typically utilizes single-point temperature control, which can result in thermally shocking the device. Although thermal shock is not a concern during the removal process as the device is typically discarded, it is a significant issue during replacement of these thermally sensitive ceramic capacitors.

Several new conductive heating technologies are now available, which feature programmable, multi-set-point heating control, high thermal transfer and an integrated hypodermic vacuum tip to overcome these issues. One technology uses a current-driven, embedded ceramic heating element as the heating source (Figure 3), while another technology uses hot gas exhausted away from the contact tip (Figure 4).

## Removal

No-clean flux is applied to the device with a micro-tip syringe. A 0.006-in. tip diameter provides controlled flux dispensing of these tiny devices. The addition of flux reduces the volume of solder that is removed from the pads when the component is lifted.

While flux is being applied, the conductive heating tool is preheated to a fixed starting temperature, which provides thermal repeatability. The head is lowered automatically after preheat is complete. The device is reflowed very quickly during the removal process, as thermally shocking the device is not a concern. Once the device is

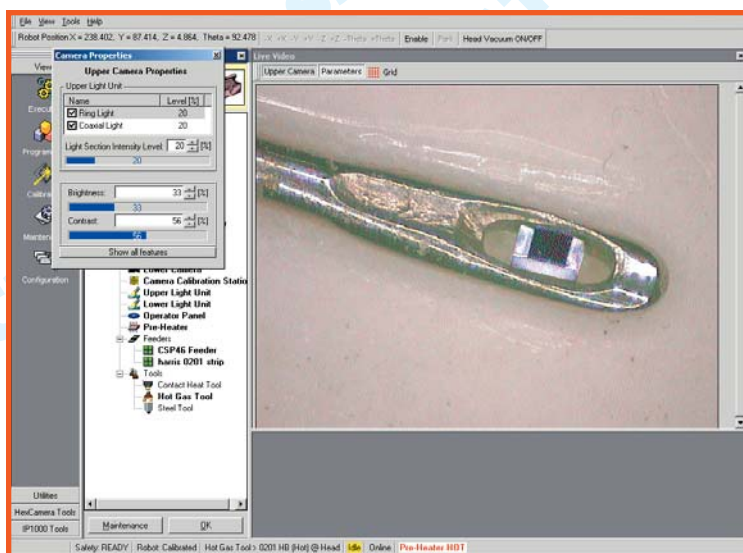


FIGURE 1: An 0201 component in the eye of a needle.

reflowed, the vacuum activates and the 0201 is automatically removed and dropped off.

### Site Preparation

The use of flux combined with a controlled z-axis withdrawal velocity results in very little solder being removed from the pads; however, some icycling may occur. After fluxing the pads, a micro-soldering iron tip, or a mini-hoof tip, with a small solder reservoir can be used to smooth the pads (Figure 5). Solder wick is not recommended due to the fragile nature of the tiny pads.

### Pickup

Typically, 0201s are supplied on tape and reel. Component pickup should be done directly from the tape to avoid tedious and time-consuming manual handling with micro-tweezers. Picking out of the tape pocket must be vision-assisted (Figure 6) to properly center the component on the tool as conventional industry taping specifications allow too much movement of the 0201 in the pocket. Advanced image recognition systems automatically identify and locate the 0201 in the tape pocket.

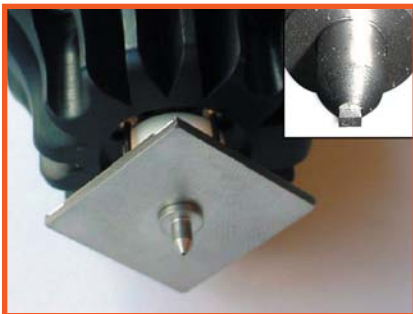


FIGURE 3: Rework tooling for 0201s: ceramic heating element version.

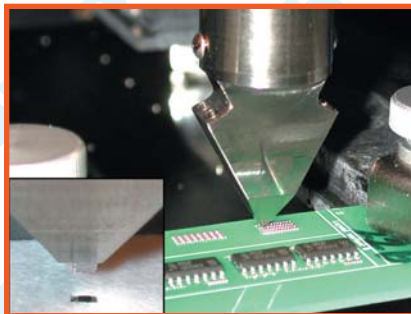


FIGURE 4: Rework tooling for 0201s: hot gas version.

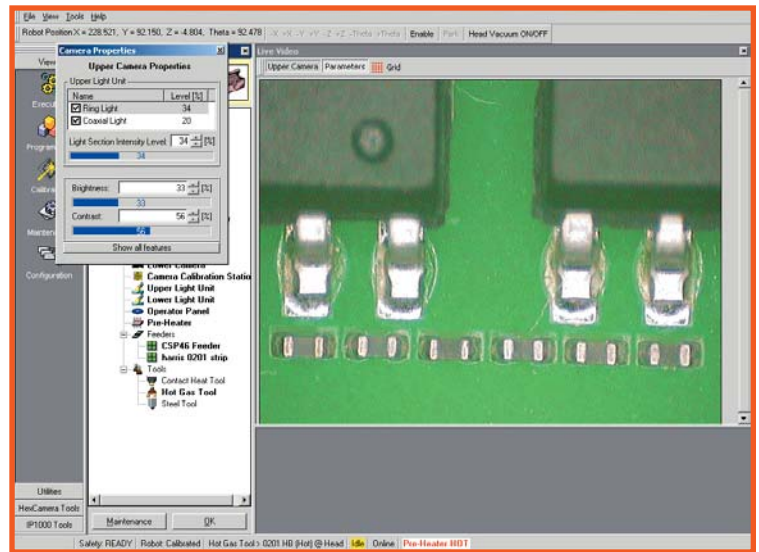


FIGURE 2: Tightly spaced 0201s.

### Alignment

After the component has been picked and is accurately centered on the tool, it must now be aligned. Unlike ball grid arrays (BGAs), which require beam-splitter-based alignment due to hidden solder interconnects, 0201s can be aligned at board level using a camera or microscope.

Semi-automated alignment systems require the operator to align the device using x/y micrometers and theta adjustment. Fully automated rework systems utilize fiducial recognition and component modeling to identify and match component and pad features, eliminating the need for operator-based alignment (Figure 7).

### Placement

Accurate and repeatable placement of these tiny devices is dependent on a number of machine features, including the optical system, the z-axis mechanism such as motors, encoders and bearings, and force placement control. In addition, semi-automated rework systems utilize operator-dependent alignment systems so the skill of the operator will also be a factor. Fully automated rework systems eliminate operator involvement; therefore, placement accuracy is totally machine-dependent (Figure 8).

Placement tolerances are tight due to the extremely small size of the component and pads. In addition, 0201s have minimal self-centering capability.

### Reflow

Unlike the removal process where the objective is to take the device off as quickly as possible, reflow of the replacement device should be based on wave soldering

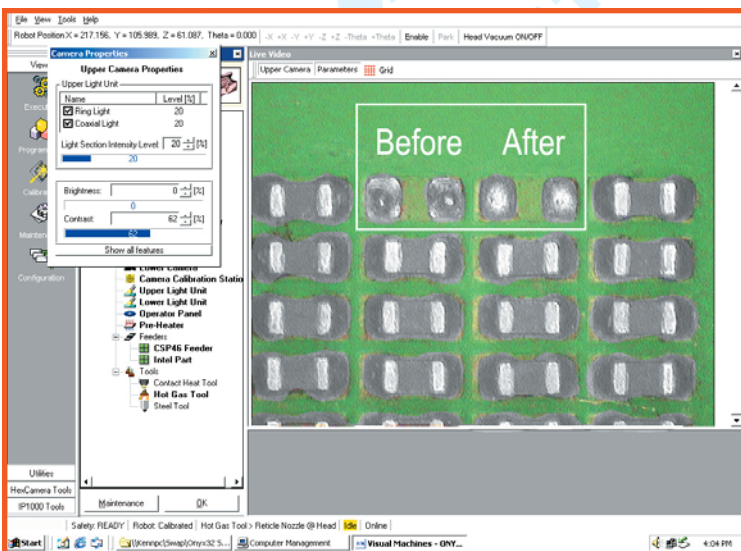
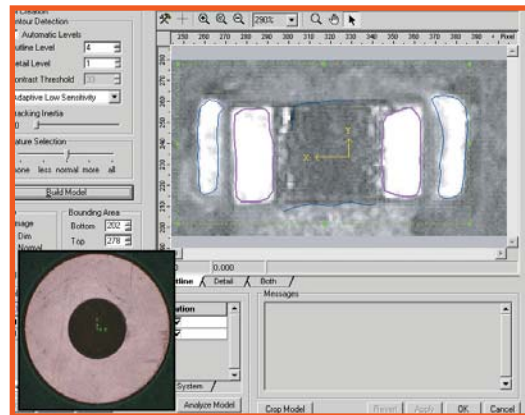
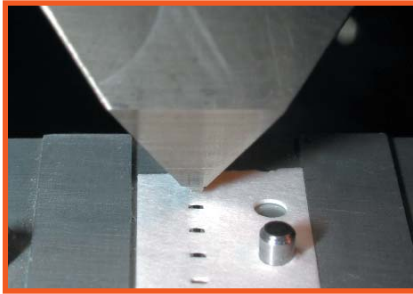
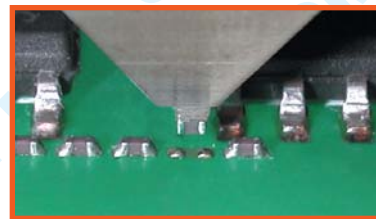


FIGURE 5: 0201 pads before and after site preparation.

**FIGURE 6:**  
Vision-  
assisted  
pickup.



**FIGURE 7:** Fully automated alignment using fiducial recognition and component modeling.



**FIGURE 8:**  
Placement  
of 0201s.

profiles as recommended by component manufacturers. The 0201 ceramic capacitors are thermally sensitive; therefore, sudden, significant temperature changes should be avoided to prevent thermal shock. The recommended temperature rise for 0201s is 2°C/sec. A recommended thermal profile for 0201s includes preheating to 160°C; maintaining 160°C for 30 to 60 seconds, followed by reflow for 30 to 60 seconds.

The type of solder paste being used and the thermal characteristics of the substrate will both influence the recommended profile. Non-forced cooling is recommended as it allows a gradual relaxation of any thermal mismatch stress in the solder joints. Cleaning with cold fluids such as alcohol immediately after soldering may result in cracking of the ceramic capacitor.<sup>1</sup>

### Summary

Next-generation ceramic capacitors including 0201s and 01005s pose new rework challenges due to their small size, tight adjacent spacing and thermal requirements. As the component size continues to shrink, manual rework methods using micro-tweezers, magnifying glasses and soldering irons will become more and more impractical. In addition, successful rework of these devices will require process control capabilities that can meet the thermal recommendations for these temperature-sensitive devices.

The ability of the rework system to handle most of the rework process automatically will be essential. Advanced rework systems, combined with state-of-the-art conductive heating tools, provide the automation, accuracy and process control necessary for effective 0201 rework. With the right technology, 0201 rework is no more difficult or time-consuming than BGA rework as the machine, rather than the operator, addresses and resolves the new challenges related to these tiny devices. ■

### Reference

1. Venkel LTD. Reflow Soldering Multilayer Ceramic Capacitors. 2002 Application Notes.

### Acknowledgment

Thanks to Chris Dewsnap of EFD for providing the micro dispensing tips used in this study.

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