DRS25

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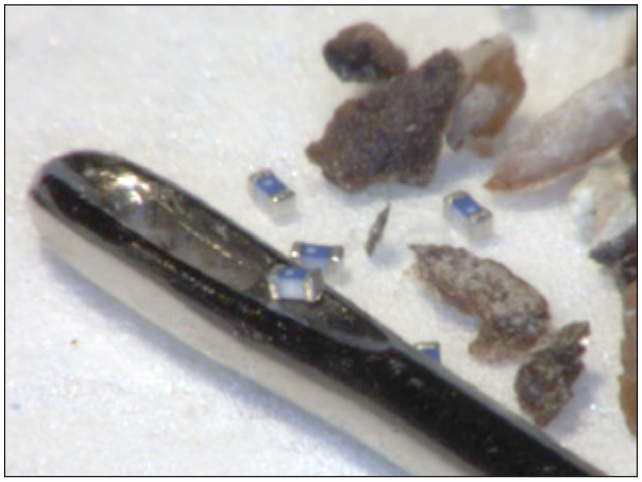
01005 Rework Using A Man/Machine Rework Interface

Small enough to pass through the eye of a needle and multiple times smaller than a pepper flake, 01005's are nearly invisible to the human eye. These microscopic devices pose significant rework challenges including component handling, site preparation and reflow.



01005 in eye of needle and next to pepper flakes.

Most companies rely on highly skilled operators to rework 01005's using tweezers and a soldering iron or a hot air pencil. The main advantage of manual operator rework is speed which is important as a large number of 01005's may require rework on a single board.

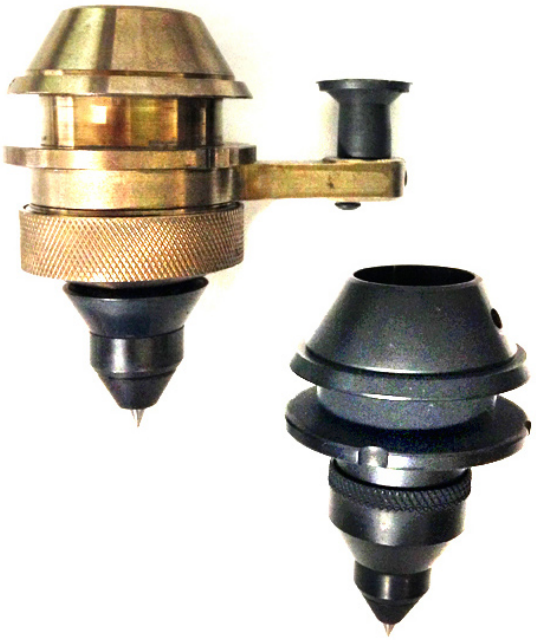
Some companies have opted for machine-based 01005 rework in an effort to reduce operator dependence and improve process control. Some machines designed for BGA rework can be used for 01005 rework, however the cost and practicality of these systems has prevented their widespread adoption. One of the major disadvantages of using BGA rework systems for 01005 rework is the need to us a beamsplitter to align the nozzle tip with the component/pads for component removal, site cleaning, pick and place due to the extremely small component size. The need for beamsplitter-based alignment prevents the operator from performing some tasks such as removing multiple 01005's on a board in rapid succession. In addition, most BGA rework systems do not have an integrated process for applying solder paste to the 01005 pads prior to component placement and reflow.

One alternative for 01005 rework is to combine the best features of hand soldering and machine-based rework into a "Man" (ie: man or woman)/Machine Rework Interface (MMRI). In this approach, the operator has manual control of all machine processes which are done directly at board level without using slower beamsplitter-based systems. The board level rework approach also eliminates "Z" axis accuracy issues that exist with beamsplitter-based systems. If the beamsplitter is not calibrated accurately and often, the nozzle will not properly contact the 01005 during removal, and the positioning will be off during placement. In addition, some BGA Rework Systems do not have the accuracy necessary for placing micro-discretes regardless of how often the vision system is calibrated. Remember that we are talking about microscopic devices, so minor placement errors which had no impact is in past on BGA rework, now become significant.

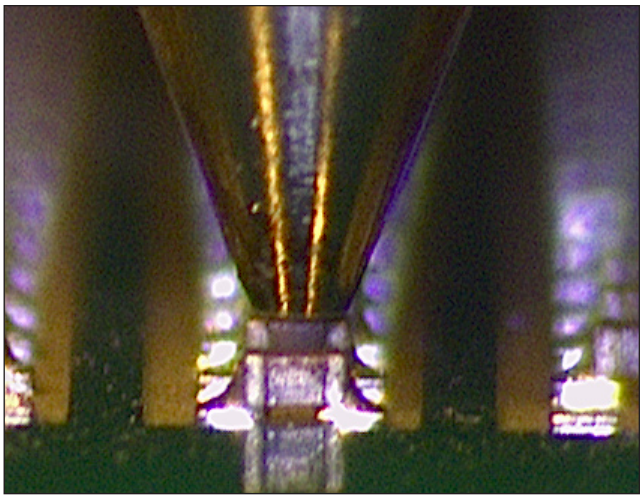
In addition to manual control, the MMRI approach also provides the operator with numerous machine-related advantages, including inspection quality microscope-based optics, integrated top and bottom heating and perhaps most importantly manual x/y/z and theta controls which eliminates the precise manual dexterity required for hand soldering.

Man/Machine 01005 Rework Interface (MMRI)

A precision micro-tip with a .008" vacuum opening and a .014" outside diameter allows densely packed micro-discretes to be reworked without adjacent component interference. The vacuum in the micro-tip eliminates the need for the operator to use tweezers to remove or place the part.



Nozzles: Removal/Site Cleaning (left), Replacement (right)



Micro-Tip Contacting 01005 During Removal

The board is preheated to 125-150°C prior to component rework which reduces the nozzle temperature required to reflow the 01005 which in turn reduces the thermal stress of the board at the rework site.

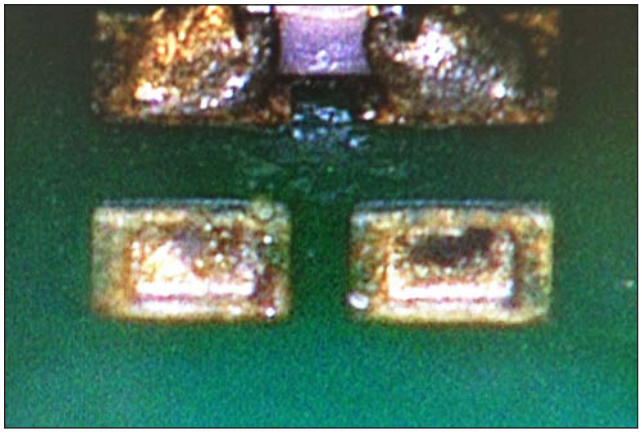
01005 removal is extremely fast, typically 5-10 seconds due to combined convective (hot gas) and conductive (tip touches device) heating. After the first 01005 is removed and dropped off into a reject bin, the operator can proceed immediately to the next 01005 site by using the stereo microscope which provides magnified three dimensional viewing and the machine x/y/z controls to position the nozzle tip on the next 01005. One hundred 01005's can be removed from a board in approximately 30 minutes using this method.

Tacky no clean flux is applied to the site with a micro-tipped syringe prior to component removal. The combination of flux and nitrogen significantly improves solder wetting which releases the component from the solder and leaves most of the solder on the pads with a rounded shape which facilitates component replacement.

If the volume of solder remaining on the pads is both uniform and sufficient, the operator can proceed directly to the replacement process. However, if the solder volume is non-uniform (more solder on one pad than on the other) or insufficient, the solder on the pads must be removed and

new solder paste applied prior to component replacement. It is highly likely that insufficient solder volume will occur at some time as insufficient solder is a common 01005 assembly defect. The 01005 pads and solder mask are very fragile due to their extremely small size. The same nozzle that is used to remove 01005's is used to clean the pads. The nozzle convectively heats the residual solder while the micro-vacuum tip removes the solder which passes into a collector.

Non-uniform Residual Solder on Pads

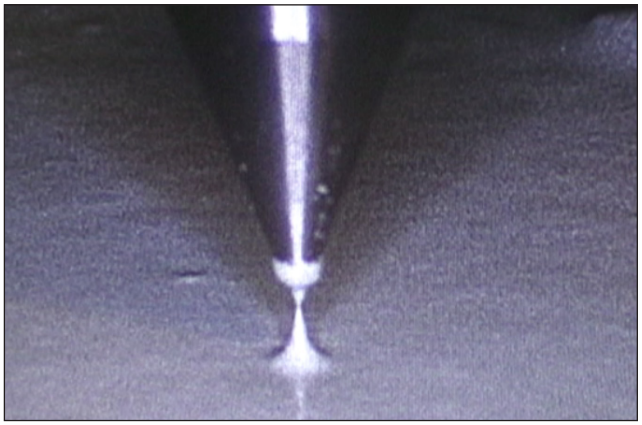


Cleaned Pads

The top and bottom heaters are shut off after all of the defective 01005's on the board have been removed and site cleaned. The board cooling and nozzle cooling systems are activated to cool down the board and the machine head. The micro-nozzle is removed with the nozzle handling tool. The operator puts on thermal gloves to remove the tip from the nozzle and cleans it with a fine gage wire.

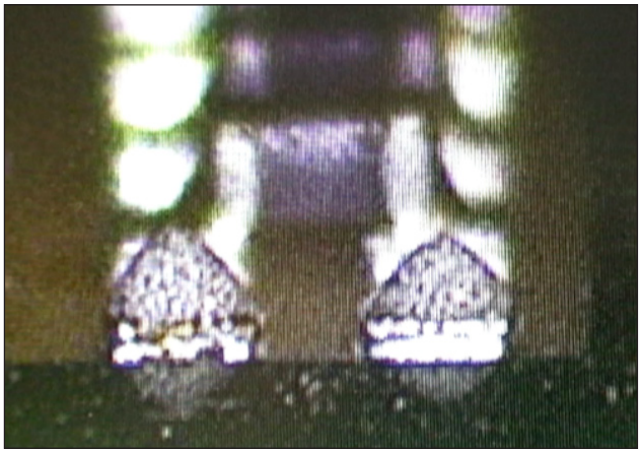
Fine grain solder paste (Type 4 or 5) is applied to a dipping tray with a precision machined depth. A squeeze blade is used to create a uniform solder paste dipping station which controls the volume of solder paste that will be transferred to the pads.

A pin transfer nozzle with a micro-tip contacts the fixed depth of solder paste on the dip try and a controlled volume of solder paste is transferred to the tip.



Controlled volume of Solder Paste transferred to the Tip

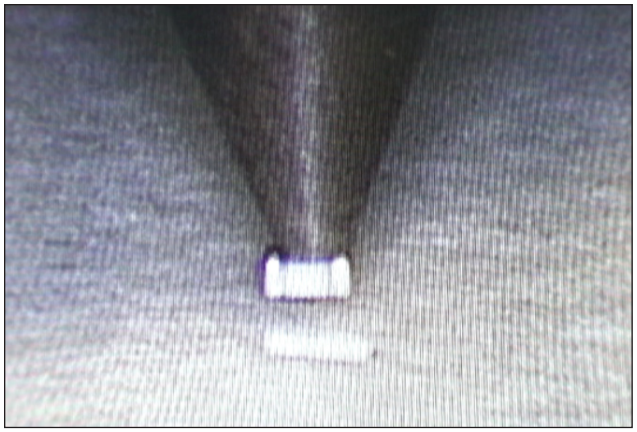
The tip then transfers the solder paste to each pad.



01005 Pads with Solder Paste

A new 01005 is picked directly out of a tape strip using the stereo microscope for viewing and the machine x/y/z controls to

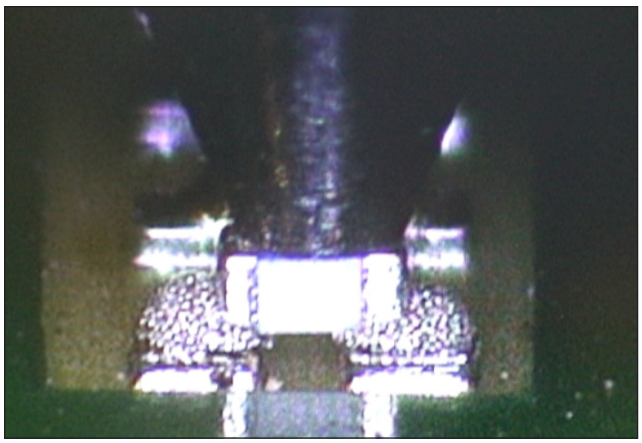
position the micro-tip. Once the micro-tip is in position, vacuum is activated and the part is picked from the tape.



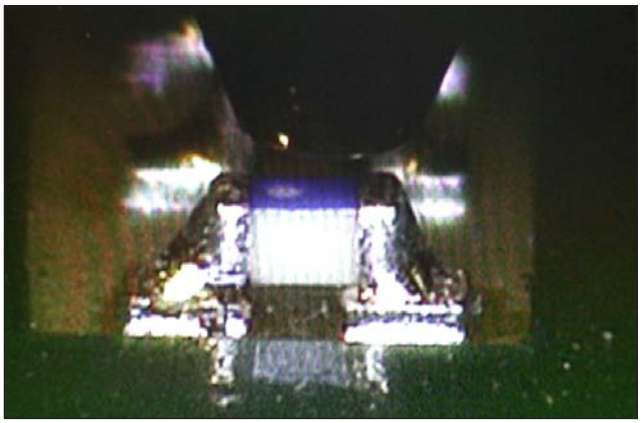
Component Pick from Tape Strip

The stereo microscope, x/y/z/theta controls and the micro-tip are used to place the component into the solder paste using zero placement force by deactivating the tip vacuum and releasing the component into the solder paste. The micro-tip is then raised slightly so that it is not in contact with the 01005 during reflow.

Releasing the 01005 into solder paste with zero placement force avoids mechanical damage to the component which may occur due to placement force in excess of two Newtons (204 grams)[1]. In addition, increased force occurs during conductive heating processes as the conductive tip, the 01005 and the board all expand during heating.

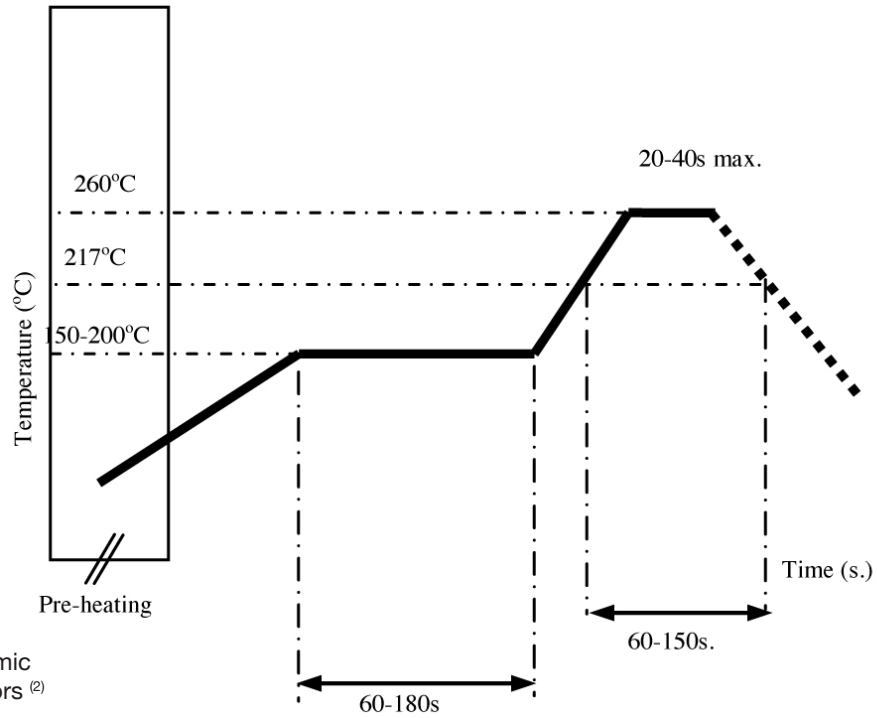


01005 Placement into Solder Paste with Zero Force



Micro Tip raised slightly during Reflow provides Convective Heating and allows Self-Centering

A high precision mass flow controller provides a repeatable low volume of nitrogen that convectively reflows the solder paste without disturbing the position of the 01005 or the adjacent components. Nitrogen improves wetting and reduces oxidation that occurs more frequently with Type 4 or 5 solder paste. Convective heating with nitrogen provides significant advantages to conductive-based (heating tip in contact with 01005) heating. First, ceramic capacitors are prone to cracking from thermal shock due to excessive heating rates. One ceramic capacitor manufacturer states that "ceramic capacitor attachment with a soldering iron is discouraged due to the inherent limitations on precisely controlling soldering temperature, heat transfer rate and time"[2]. The same component manufacturer also states "never contact the ceramic surface with the iron tip"[2]. Convectively heating the 01005 after a preheat stage provides the same heating curve as the initial reflow oven process. Convectively heating the 01005 also allows the device to self-center often as much as 50 microns which is not possible when the component is held in place with a conductive heating tip.



Reflow Profile for Ceramic Capacitors and Inductors [2]

SUMMARY

The Man/Machine Rework Interface (MMRI) on the DRS25 provides significant advantages over both hand soldering and beamsplitter-based machine rework. The MMRI rework process provides combined convective and conductive heating along with integrated micro-tip vacuum for fast and effective 01005 removal and pad cleaning. Pin transfer using a precision depth dip tray provides the ability to apply a controlled volume of solder paste on the 01005 pads. Convective-only reflow of 01005's in solder paste provide a controlled temperature ramp rate necessary for preventing thermal shock and for allowing self-centering to occur.

The stereo microscope with zoom lens provides magnified, 3 dimensional viewing throughout the entire process eliminating the need for beamsplitter-based alignment of multiple process steps.

Precision x/y/z and theta manual machine controls provide machine-based accuracy eliminating the extreme dexterity required by hand soldering.

Murata's introduction of the 008004 in 2013 features a 75% lower volume than 01005's. The continued drive toward smaller and smaller consumer products leaves no doubt that these devices will soon find their way into these products and as always, rework solutions will be required.

A video of 01005 Rework on the DRS25 can be viewed at www.air-vac-eng.com under "Applications".

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[1] *Siemens "01005 Assembly Process - From the Board Design to the Reflow Process".*

[2] *Johanson Technology web site "Soldering Profiles and Guidelines for SMT Ceramic Components".*

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June 24, 2015