Small Volume Dispensing

Micro-Valve Dispensing Can Minimize Setup between PCB Runs and Reduce Material Costs

By Russell Peek

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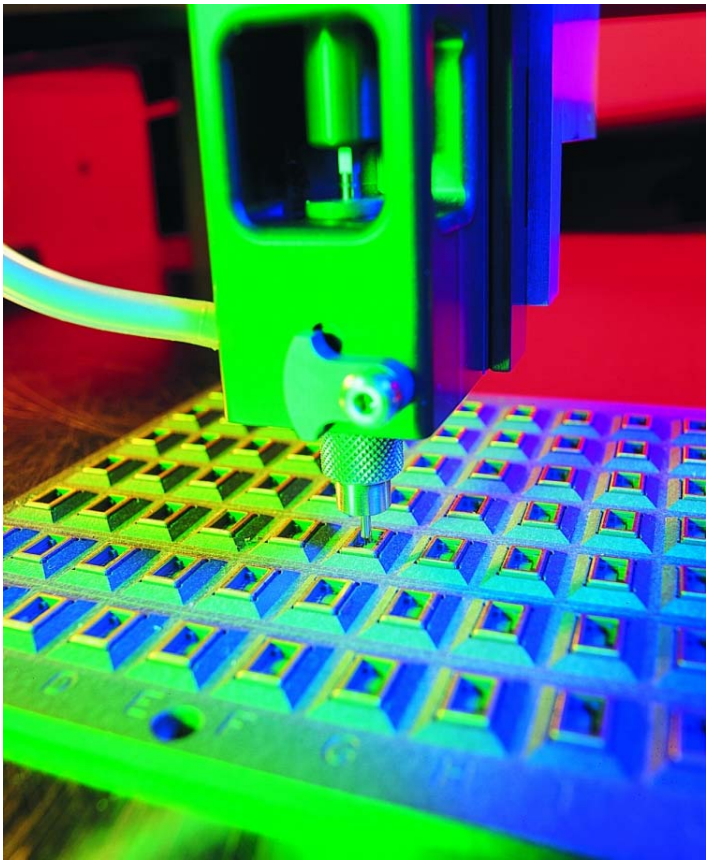
The continuing trend toward miniaturization in consumer electronics — from cellular phones to hand-held computers to stereo systems — has resulted in increasingly smaller surface mount technology (SMT) components and more densely assembled printed circuit boards (PCBs). Efficient handling of these small, crowded packages and substrates during assembly requires a precise method for depositing small volumes of material (such as solder pastes, conductive epoxies and adhesives) to adhere components and complete electrical connections without creating shorts or bridges. This has become a necessity for direct chip attach (DCA), multi-chip module and high-density interconnect processes, most of which require placement accuracy of 0.0015 inch (0.0381mm) or better.



In the case of solder paste and conductive epoxy, dot sizes are 0.010 inch (0.254mm) or smaller (Figure 1). For area fills and patterns, thicknesses of 0.0020 inch (0.0508mm) or less are required. These needs have resulted in the development of technologies specifically designed to facilitate small-volume dispensing.

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The Search for Better Deposition

For years, PCB assemblers have used stencil printers to deposit assembly materials on PCBs. While this approach has served these functions well in the past, and will most likely continue to have a place in PCB assembly for traditional printing applications, there are disadvantages to this technique.

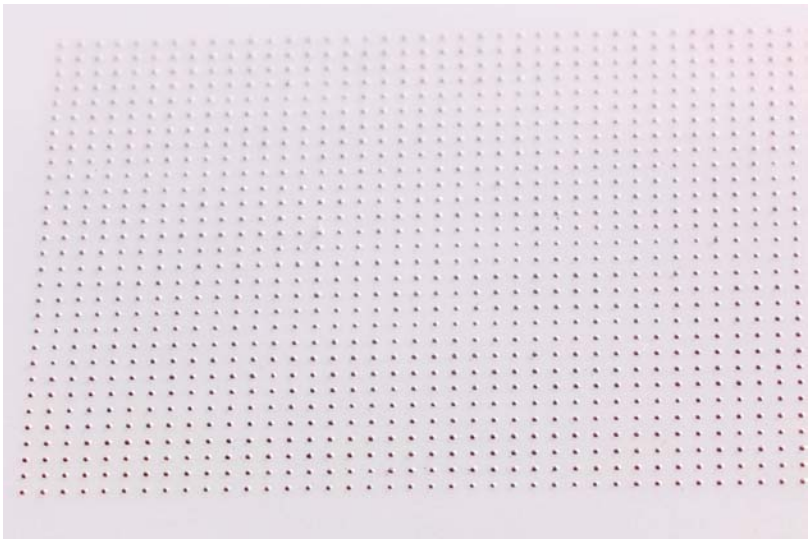

Figure 1. Valve is designed to dispense dots as small as 0.010 inch (0.254 mm) in diameter

First, stencil printing cannot be used for depositing material in multi-layer packages, assemblies with existing components or assemblies requiring different thicknesses of material. Also for every job or engineering change order a new stencil is required, which can take up to two days to produce. In terms of cost, stencil printing includes material waste, stencil cleaning and set up time on each job.

It isn't cost-effective in low-volume, high-mix manufacturing environments, particularly in contract shops, because of the cost of hard tooling. There are also limitations in terms of stencil printing, handling high-density PCB assembly and the need for tight spacing and tolerances.

Micro-valves

Dispensing for high-density applications requires precise material control. Not only must the dispensing system offer control of the X, Y and Z positions of the dispensing needle tip but repeatability of the material deposited on the substrate or package must exceed all previous standards. Previous attempts to develop a functional small-volume dispensing system have not succeeded well because the pumps couldn't deposit repeatable amounts of solder paste or conductive material in dots as small as 0.010 inch (0.254mm) or less in diameter.

However, advances in micro-valve technology have resulted in pump mechanisms that can better control small-volume dispensing. The ideal liquid dispensing system for this application employs a micro-dispense valve that is controlled by a closed-loop brushless servo motor and encoder (Figure 2a).

Specifically designed for small-volume dispensing, this valve can be indexed to dispense material according to encoder counts (Figure 2b).

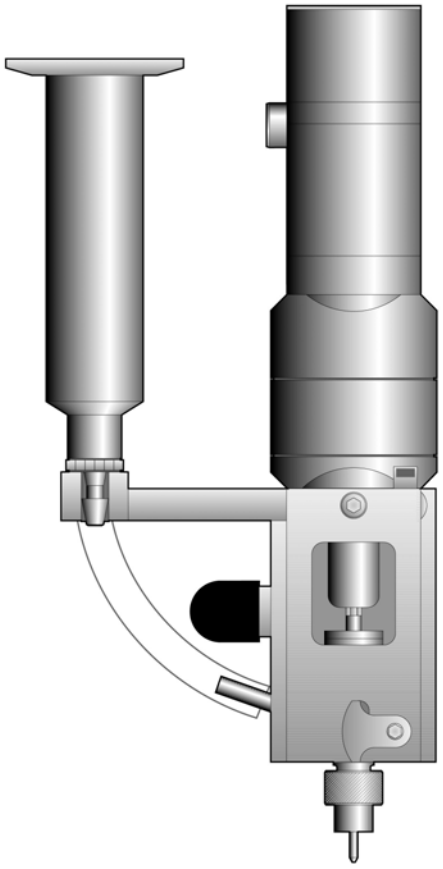

Figure 2a. The valve features a rotary auger pump with an encoder for precision. The system is "soft mounted" to the pump housing to prevent material packing.

Tips and Properties

There are additional factors to consider when working with a micro-volume dispenser. Specifically, it's important to have an effective dispensing needle design and workable approaches to maintain material properties.

Effective micro-volume dispensing requires the use of a unique dispensing tip or "needle" on the valve. Conventional dispensing tips are, in most cases, constructed from rolled tubing, which can hinder micro-volume dispensing because of poor interior surface characteristics that impede material flow. In the case of micro-volume dispensing of solder paste and conductive epoxy, the dispensing needle is fabricated from a single block of stainless steel within very tight tolerences; the tip is conically chamfered in the direction of material flow to reduce surface tension between the needle and the material; and the inside needle diameter (ID) is purposely kept

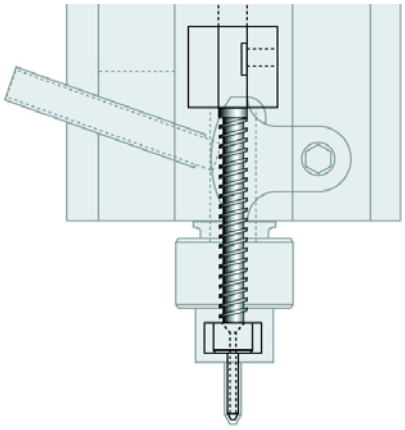

Figure 2b. The valve can be indexed to dispense material according to encoder counts.

larger than the exit tip diameter. In short, because the small-dot dispensing needle has smooth wetted surface characteristics, it enhances material flow and prevents material clogging.

Maintaining material properties throughout the dispensing process is critical for micro-volume dispensing. Micro-volume dispensers monitor both pump RPMs and air pressure. Dispensing processes can be programmed for the proper auger speed, indexing interval and acceleration/deceleration rate to ensure optimal dispensing parameters for each application and type of material.

Flexibility and Material Savings

As electronics assembly continues to evolve, it is expected that the demand for micro-volume dispensing technology will increase. It can provide an immediate advantage for assemblers in high-mix, low- volume environments. By reducing stencil printer setup time and material waste, micro-volume dispensing enables electronics assemblers to work efficiently and cost effectively. While the benefits of small-volume dispensing technology may not seem as dramatic for *high-volume, low-mix* assembly environments, the competitive nature of the electronics industry, coupled with a growing consumer demand for miniaturized products, may compel assemblers to value flexibility and automation as a way to maintain a competitive edge.

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