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SURFACE MOUNT TECHNOLOGY® MAGAZINE

Automated "Odd-form" Placement

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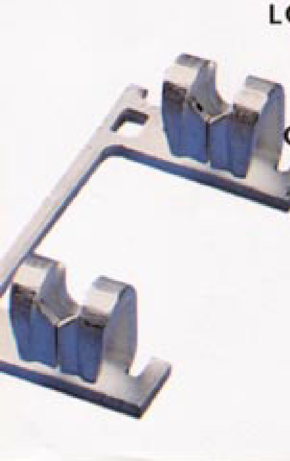
Surface Mounting the

AUTOMATED PLACEMENT HAS PROVEN ELUSIVE WITH CERTAIN "ODD-FORM" TERMINALS, PROMPTING ADOPTION OF INEFFICIENT, MAKESHIFT ALTERNATIVES THAT PROVIDE NEITHER LONG-TERM NOR COST-EFFECTIVE SOLUTIONS.



Odd-form or odd-shaped terminals by definition feature nonstandard dimensions that make automated surface mount placement difficult. Common examples are pins/posts, receptacles, jumpers, insulation-displacement connectors (IDC), quick disconnects, tabs and battery clips. Some placement processes for such common PCB hardware attempt to employ existing pick-and-place equipment while others utilize separate, mostly manual processes. There are problems inherent with both options. However, new methods which integrate terminal design with feeding/presentation systems are streamlining use of these difficult parts.

Manual Placement

This is often the easiest solution because it requires the lowest initial financial investment as well as the smallest commitment of time and planning. Typically, operators wait for partially completed PCBs to come off line to place odd-form components and terminals in the solder paste at their designated sites, keeping clear of other parts already placed automatically, after which the boards are returned to the production line for reflow and cleaning.

There are many obvious disadvantages to this procedure. Manual placement's slow pace forces the acceptance of yields unacceptable elsewhere in the process while also incurring heavy ongoing labor costs as an added insult. Compromising speed, accuracy and consistency, manual placement can generally be justified only as a temporary measure, bridging the gap until a permanent, automatic solution can be developed.

Robotic Cell Placement

Many line operations featuring production volumes or other variables that demand an automated solution have turned to high-tech robotic cell placement. The robot, a one-part-at-a-time handler, can be a stand-alone machine or integrated into the production line. The cell consists of a robotic arm and a parts-feeder system, the latter of which can constitute up to 50 percent of the cell's cost.

Such an investment can be especially painful if, as sometimes happens, the feeder system must be discarded owing to a production change. However, when production shifts to another part, the robot, at some cost, can usually be retooled and reprogrammed.

While taking considerable space on the production line, robots place terminals and other hardware at a disappointingly low rate. To increase production speeds, more robots must be added. When properly situated and controlled, however, robots place terminals consistently and accurately, and usually have the flexibility to adapt to changing production needs.

In-line Placement Using Standard Equipment

Obviously, a placement solution that integrates existing pick-and-place equipment is preferable. There are several such methods:

Tape-and-reel. Carrier tape consists of a reel of small plastic cavities filled with terminals and sealed by cover tape for delivery to a pick-and-place machine via a standard feeder. The feeder also peels back the cover tape to expose the part for the vacuum pick-up nozzle.

The most obvious drawback with packaging terminals in tape carriers is extra cost, which can exceed the cost of the hardware itself by as much as 3 to 10 cents (Figure 1). Such costs for placement of a passive, low-value component can easily

Examples of common PCB-mounted hardware parts whose configurations pose problems for automated handling and placement.

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HARDWARE

render a product noncompetitive.

Another problem is pick-up location. The part, held in a loosely toleranced cavity, can easily shift location, foiling attempts by the vacuum pick-up nozzle to successfully capture it (Figure 2). Terminals with small pick-up surfaces, such as a 0.025" sq. pin, cannot be reliably oriented in a plastic cavity for repeatable handling.

Matrix tray. A matrix or waffle tray is another method for feeding nonstandard parts to pick-and-place systems. The matrix is a molded plastic tray containing multiple cavities in a grid pattern loaded with parts for presentation to a pick-up nozzle. For volume placement, trays can be stacked adjacent to the machine in magazines and automatically fed to the pick-up location. Extra care must be taken with loaded trays since the gravity-held parts can be easily bounced or jostled from their cavities.

There are two ways to transfer parts from the trays to the pick-and-place machine: 1) the machine is programmed to move throughout the tray, picking parts from each compartment until the tray is exhausted and a new one loaded; 2) a shuttle system (new equipment) takes parts from the tray and presents them to the placement machine. Both solutions are expensive and neither justifies the extra cost for slow performance and inefficient use of line space.

The vibratory bowl. Filled with all the same type loose terminals, the bowl vibrates in such a way that singular oriented parts are fed up spiral tracks on the sides. When they have reached the top, the parts move back down a feeder track that lines them up for pick-up. Correct orientation of parts delivered via bowl feeders can be problematic, however. To work, the geometry of the part must lend itself to bowl feeding without entanglement with others in the bowl. Also, like matrix trays, the bowls take up large spaces that could be used for other part feeders. And in many board population procedures, feeder space is at a premium. Thus, to require a placement system for one odd-form component that may take the space of six to eight standard feeders is generally unacceptable.

Tube feeders. In another method of odd-form hardware placement, tubes of preloaded parts can be placed at an angle. The tubes use gravity as well as vibration to move terminals to a waiting pick-and-place machine. While one long, thin tube feeder does not take excessive line space, each tube can accommodate only a limited number of parts, requiring the stacking of multiple feeders at the placement machine to ensure continuous production. Apart from taking up much-needed feeder space, this solution also leaves unwanted packaging behind.

With this array of "solutions", it is no wonder that automating the placement of odd-shaped components has often posed daunting problems. Forced to rely on one of the conventional methods, a high price is usually paid to achieve the accuracy and speed of automated placement. Further, for many applications, none of these are viable solutions. Fortunately, one option, stressing an integrated approach, can often resolve the problem.

Figure 1. Carrier tape can add between 3 and 10 cents per component — sometimes double the cost of the terminal itself.

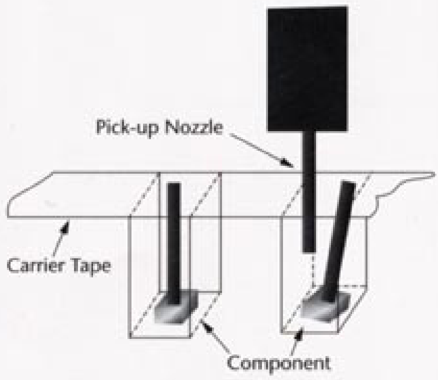

Figure 2. Part misalignment in carrier tape. Terminals with small pick-up surfaces cannot be oriented for consistent handling.

An Integrated Parts-Presentation System

An often overlooked aspect of odd-form terminal placement is terminal design. For a terminal to have practical value, its design must accommodate affordable, volume placement to create an efficient interconnection solution. This solution involves the forming of odd-shaped terminals into a continuous reel format in a process similar to that of conventional through-hole terminal stamping. The reels can then be placed on an integrated presentation system ("smart" feeder) alongside those of standard surface-mount components utilizing conventional tape feeders. The terminals themselves are designed so that they can be fed, sheared and presented in correct orientation and high repeatability to the vacuum pick-up nozzle of the pick-and-place machine. By integrating with the existing equipment in this manner no extra packaging costs or problems with placement accuracy are incurred. Also, apart from a small feeder, no significant new investment in equipment is required: odd-form components are finally treated just like standard parts.

For most production lines, the switch to an integrated parts-placement solution requires only the removal of the standard tape-and-reel feeder and replacement by the "smart" feeder equipped with continuous reel parts. The typical feeder for integrated parts placement needs only standard electric and air pressure to operate.

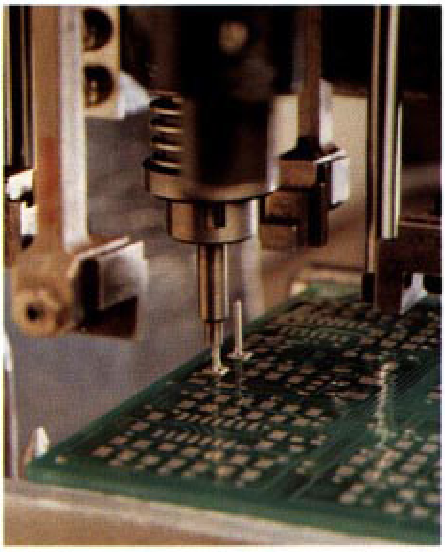

Figure 3. Special terminal design assures reliable, continuous pick-up together with the use of capillary action to maintain accuracy of placement.

Controlling Positional Accuracy

Separating and presenting a part to a pick-and-place machine are not the only tasks that must be performed in automatically placing odd-form terminals. The process must also assure that the hardware will remain where it is initially placed on the PCB. Thus, with surface mount, PCBs are pretreated with solder paste to receive the part and then sent to a reflow oven for permanent attachment. One difficulty encountered in this process would be parts sometimes "floating" away from their emplacements as the solder reflowed only to solidify out of alignment. Fixturing to hold the parts in place while the solder reflowed and cooled only introduced another expense.

A better solution is to employ a solder-wicking process in which the surface tensions ordinarily causing the parts to float are instead "manipulated" to hold the part in place (Figure 3). This is possible via a design element of the terminal that permits liquid solder to rise by capillary action within the part, settling it on the board and preventing lateral movement from its initial position. In effect, with capillary wicking action, post reflow location is defined by the placement accuracy of the pick-and-place system. SMT

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