Fiducial Marks

Very often pick and place machines are programmed using CAD data. This data increases the accuracy, precision, and repeatability of its component placement objectives. CAD data makes fine pitch and small component assemblies repeatable, but cannot adjust to a particular board unless it is exactly the same size and shape of the original board used for programming. The process by which printed circuit boards (PCBs) are made only allows some minor changes in board size and shape, but these small differences are enough for parts to be misplaced. For this reason we use fiducial marks to increase the chances of precise component alignment.

Fiducial marks are standardized symbols (typically circles, squares, triangles, and crosses) used for circuit pattern recognition which provide common measurable points for an automated assembly process. The circle is often selected for automated pick and place and is most commonly used for panel, circuit, and local fiducials.

Panel fiducials are located outside the body of the board where components are placed. Usually only three are necessary for programming, but when possible, four are placed on the PCB. If the orientation of the board needs to be changed for any reason, the extra fiducial allows the programmer flexibility in the machine set up. Panel fiducials are the most often recommended method since they are far from the components. This allows easier camera resolution and contrast for automated machine inspection and less chance a via or component might be confused as a fiducial mark.

Circuit fiducials are located inside the component placement area near the corners or as far apart as possible (Figure 1). When three (or four) circuit fiducials are used properly, they can correct theta distortions and compensate for scaling, stretching, and twisting or warpage of the PCB. These fiducials are a secondary method for increased reliability of placement, and are used in place of, or in addition to, panel fiducials. If panel fiducial inspection is not providing a precise placement for a panelized matrix PCB, then the fiducials must be used on each board in the matrix. Vision recognition is more difficult to program for circuit and local marks, because vias, surface mount, and through-hole components can be mistaken for fiducials.
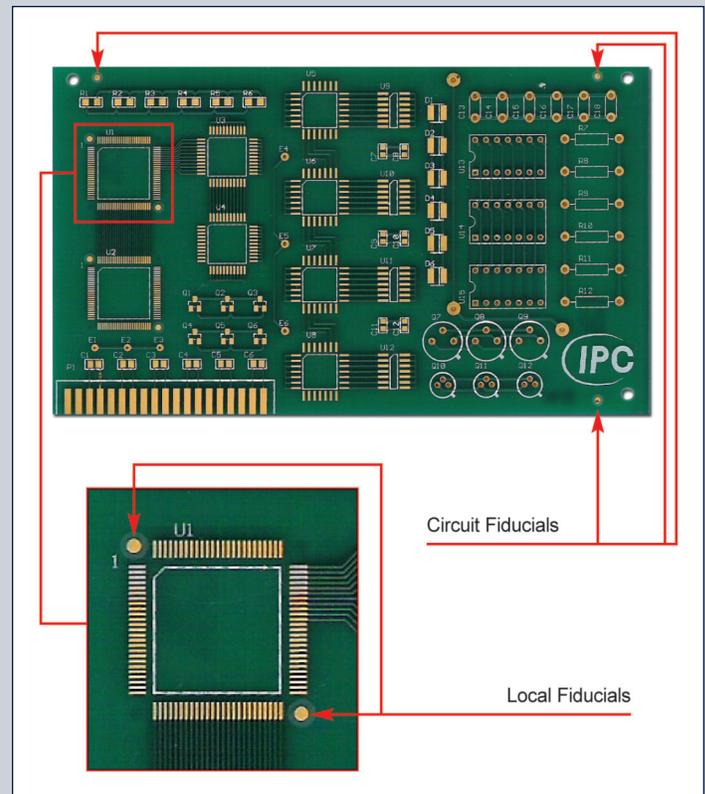

Figure 1: Circuit and Local Fiducials

Local fiducials are used to find the precise placement of an individual land location. They are usually used for fine pitch components like quad flat packs or ball grid arrays (see Figure 5-1). Local fiducials increase the precision of fine pitch placement, but it is vital to program the mark using the proper light level and contrast because of the close proximity of parts and vias to the fiducial.

Fiducials are between 1mm and 3mm in size and should not vary on the same PCB. Marks should be at least of 2mm away from any similar feature which could cause an error. In addition, the mark should be more than 4.75mm from the board edge to prevent obstruction by the board locking mechanism. The search window size varies from
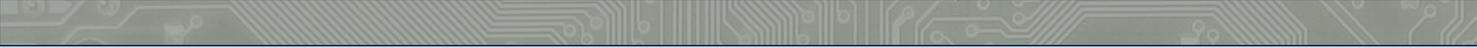
machine to machine. A window three times the size of the mark in x and y direction is an acceptable search size. Usually search windows are set so the mark is in the center, but it may be necessary to move the search window slightly off center to mistakenly recognize a similar looking, unwanted mark. This can succeed, but some machines have automatic fiducial search window correction which will automatically set your window back to the center and occasionally find the wrong fiducial mark. When assigning a light level during programming you must be able to clearly see the mark, but not create a shiny reflection. When an automatic fiducial inspection is not working properly, additional contrast can often help. If you see a blurry image, change the contrast level until the shapes are solid and easily identified. If fiducial marks are intermittently recognized, check to see if oxidation, solder mask, or some sort of coating is covering the mark. Taking a simple pencil eraser and rubbing it over the unrecognized mark can sometimes alleviate a very annoying problem. If this still does not work and there is no manual fiducial alignment, washing and reprogramming the PCB may be necessary.

Learn more about board layout and design through courses taught at ACI Technologies. Come see pick and place machines in action on our factory floor. More information can be found by visiting the ACI website, www.aciusa.org, or by calling the ACI Helpline at 610.362.1320.

ACI Technologies