

## SETUP FOR OPTIONAL AUTOMATIC FIDUCIAL CORRECTION

### REQUIREMENTS:

The user should have a solid understanding of the machine's functionality and setup before attempting to setup the automatic fiducial correction functions

**Refer to:** 1. Programming 2. Outline setup.

**Description:** Automatic Fiducial Correction (AFC) automatically locates a fiducial for precise alignment of component placement during run time without the intervention of an operator.

### A. AUTOMATIC FIDUCIAL FIND BASICS

1. The automatic fiducial option can apply to four different commands as follows:
  - a. Panel Reference - uses Outline number 200
  - b. Panel Check - uses Outline number 199
  - c. Board Reference - uses Outline number 198
  - b. Board Check - uses Outline number 197
2. The outline defines the fiducial search area, graphically shown as the outer (blue) outline and the region of interest (ROI) inner outline.
3. The applied software algorithm uses the variation of light intensity between the fiducial and the surrounding area. The higher the contrast and image definition of the fiducial, the higher the potential for better and more accurate results.
4. The level of illumination of the area between the fiducial search area and the ROI should be as even as possible to avoid potential errors. The same principle should apply for the fiducial area. See fiducial **General Recommendations**.

### B. VIDEO WINDOW TOOL BAR (Refer to Fig. A)

The five buttons associated with the automatic fiducial alignment are:

1. Select Live Video: Is used to activate the live video mode after an Image Grab was executed.
2. Image Grab: Image grab will stop live video and acquire an image. It will also find the average light intensity value from the outline number 196 (bad board). The resulting value will display over the image at the top/left corner area.
3. Fiducial Find Results Chart: This button displays a chart for the last fiducial find function executed. The chart Pixel vs Intensity, displays the light value of the Fiducial Search Area vs the light intensity for each pixel. It also displays the ideal threshold value and the number of points detected. Some of this information is for advanced troubleshooting only. An option is provided to switch between the X and Y axis of the pixel direction.
4. Find Fiducial: This button triggers the fiducial find function. The results are displayed as an overlay on the Video Window screen. The results include the pass/fail status, number of pass/fail and the percentile of passed inspections.
5. Find Fiducial Loop: The loop button will toggle a function continuously trigger the find fiducial. It useful when trying to fine tune the light intensity adjustment.

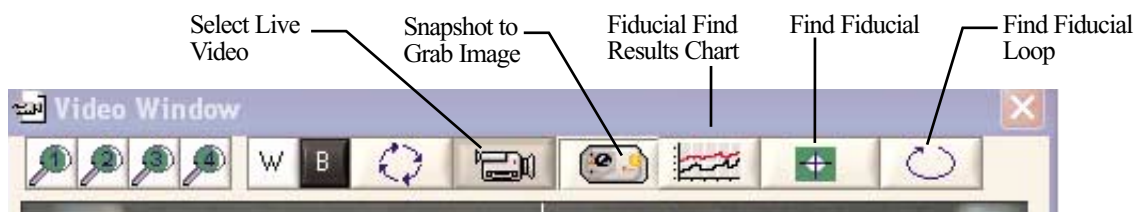


Fig. A.

**C. AUTOMATIC FIDUCIAL SETUP PROCEDURE:**

1. Setup Video Size to 3
2. Move XY gantry so that the camera center cross and fiducial center properly line up.
3. Using the potentiometer on the front of the camera assembly, adjust the light intensity so that the fiducial and the surrounding area shows the highest possible contrast. (Refer to Figs B. and C.)
4. Open Outline Menu. (Fig. D.)

Select the proper outline (197 thru 200)

Set the outline size such that:

- a. The center of the ROI matches the center of the fiducial. (refer to Fig E.)
  - b. The ROI matches as much as possible the fiducial shape. For a round fiducial the sides of the square should be tangent to the perimeter of the fiducial.
5. Use the find fiducial function from the Video window to trigger and test. Light adjustment could be required to obtain good results. The chart display function can be used as an indicator of the light intensity across the fiducial in both X and Y direction. A example of good results chart can be seen on Fig. F.
  6. Once acceptable results are achieved on the above steps, the operator can proceed to the pick and place program window.

- a. Select the appropriated program command (Panel Ref, Panel Check, Board Ref, Board Check), from the command pull down menu and accept.
- b. On the rotate column select manual or auto for the fiducial alignment function & accept. (Fig. G.)
- c. The function can only be entered if the appropriated software option had been activated.

7. Select the XY data position for the line, for the expected position of the fiducial.

NOTE: Different fiducials can be used for Panel Ref, Panel Check, Board Ref and Board Check. Using the proper outline size will allow you to do it, however the light intensity will remain common to all. Attention should be paid to the variation of metallization, and pcb characteristics.



Fig. B. - low contrast

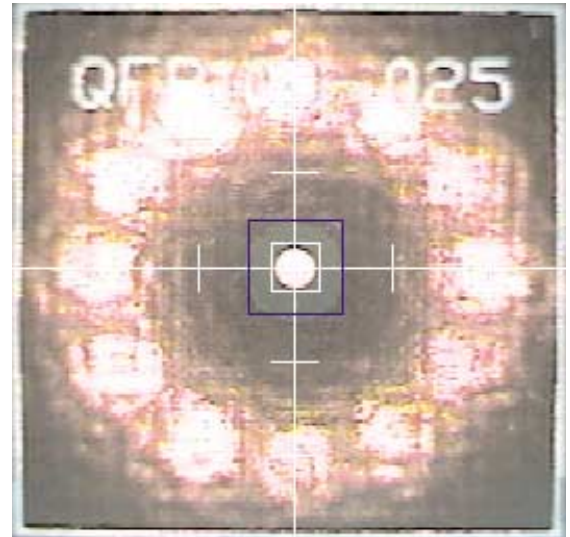


Fig. C. - Good contrast

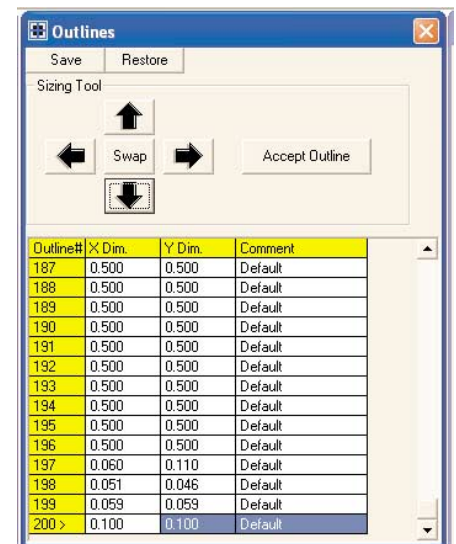


Fig. D.

**D. AUTOMATIC BAD BOARD DETECTION:**

This function will test the board for a bad board mark and skip the pcb under test.

Procedure:

1. Setup Video Size to 3.
2. Move XY gantry so that the camera center cross is on the center of the expected location for the bad board mark.
3. Adjust the light intensity so that it provides enough contrast between the bad board mark and the surrounding area.
4. Open Outline Menu.

Select the outline number 196.

Set the outline size so that:

- a. The center of the outline matches the center of the bad board mark
  - b. The outline size should be less or the size of the bad board mark. This is done so that, if the bad board mark is present the outline will be inside the mark.
5. Use the image grab function to confirm the functionality by testing a bad marked board and a non-bad marked board. Note the result values shown on the top left of the screen.
  6. Open the Pick and Place program window, select bad board and accept. (Refer to Fig. H)
  7. Select the Threshold value from the pull down menu. From 0 to 250 in increment of 10. Choose a value that is at least 10 higher than the highest value for the bad board noted in step 5. above. (Refer to Fig. I)
  8. Select the XY data position for the line, for the expected location of the bad board mark.

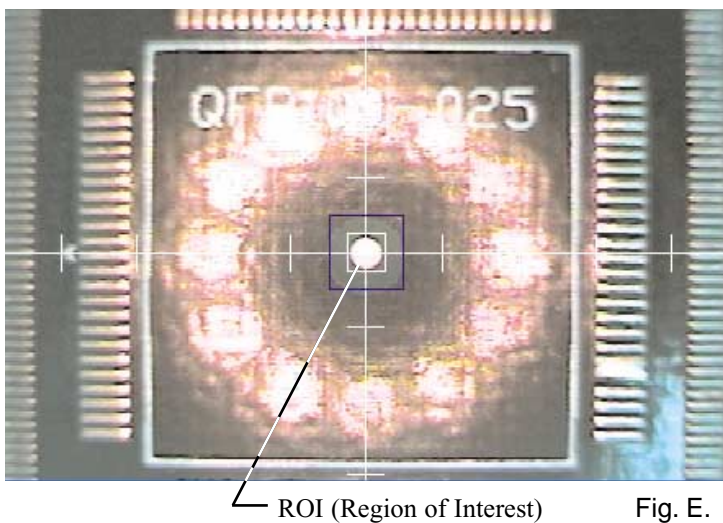


Fig. E.

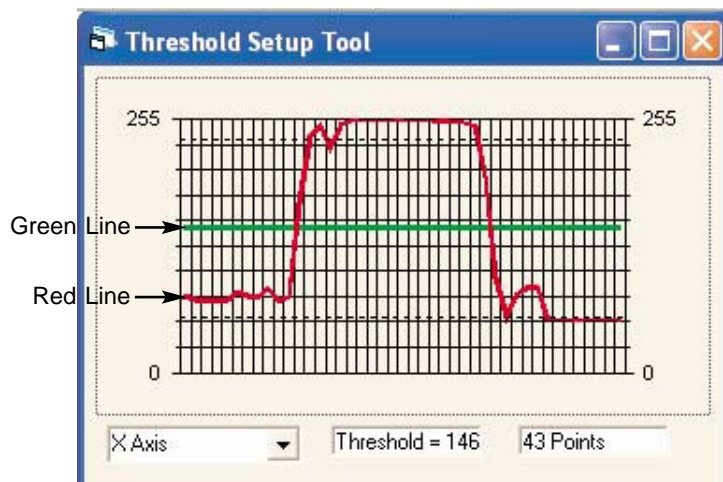


Fig. F.

**Pick & Place Program: "true8inch"**

Save All   Restore All   Ins Line   Add Line   Del Line   Cancel Ln   Accept Ln   Check Ln   Move To

Line#	Command	Designator	Feeder	Manual	X Data	Y Data
0 >	Panel Ref.	PANEL Ref		Manual	0.008	-2.311
1	Panel Check			Manual	2.752	0.010
2	Pick & Place	PART #1	1	0	0.000	2.000
3	Pick & Place	PART #1	1	0	0.000	3.000

**Runtime**  
Thickness   S  
0.062

Fig. G.

**Pick & Place Program: "true8inch"**

Save All | Restore All | Ins Line | Add Line | Del Line | Cancel Ln | Accept Ln | Check Ln | Move To

0 Panel Ref. PANEL Ref Manu 8.548 16.882

Line#	Panel Ref.	Designator	Feeder	Rotate	X Data	Y Data
0 >	Panel Ref.	PANEL Ref		Manual	8.548	16.882
1	Board Check	PART #1	1	0	0.000	1.000
2	Board Check	PART #1	1	0	0.000	2.000
3	Begin Boards	PART #1	1	0	0.000	3.000
4	Next Board	PART #1	1	0	0.000	4.000
5	Bad Board	PART #1	1	0	0.000	5.000
6	Load Tool	PART #1	1	0	0.000	6.000
7	Pick & Place	PART #1	1	0	0.000	7.000
8	Pick & Place	PART #1	1	0	0.000	8.000

Runtime | References

Thickness: 0.062 Starting: NA

- Use Previous Adjust
- Go To Panel Ref
- Go To Panel Check
- Go To Board Refs
- Go To Board Check

Fig. H.

**Pick & Place Program: "true8inch"**

Save All | Restore All | Ins Line | Add Line | Del Line | Cancel Ln | Accept Ln | Check Ln | Move To

1 Bad Board 0 -8.524 -15.250

Line#	Command	Designator	Feeder	Rotate	X Data	Y Data
0	Panel Ref.	PANEL Ref			8.548	16.882
1 >	Bad Board				-8.524	-15.250
2	Pick & Place	PART #1	1	0	0.000	2.000
3	Pick & Place	PART #1	1	0	0.000	3.000
4	Pick & Place	PART #1	1	0	0.000	4.000
5	Pick & Place	PART #1	1	0	0.000	5.000
6	Pick & Place	PART #1	1	0	0.000	6.000
7	Pick & Place	PART #1	1	0	0.000	7.000
8	Pick & Place	PART #1	1	0	0.000	8.000

Runtime | References

Thickness: 0.062 Starting: NA

- Use Previous Adjust
- Go To Panel Ref
- Go To Panel Check
- Go To Board Refs
- Go To Board Check

Fig. I.

## FIDUCIAL MARK DESIGN GUIDELINES

These guidelines are intended to provide a generic outline for the design and layout of circuit pattern recognition marks, commonly called Fiducial Marks. The guidelines adhere to design rules standardized by the Surface Mount Equipment Manufacturers Association and are supported by IPC.

### 1. FIDUCIAL MARKS

- 1.1. Fiducial Marks are a feature of the printed circuit board artwork, created in the same process as the circuit artwork. The circuit pattern and fiducial should be etched at the same step.
- 1.2. Fiducial Marks provide common measurable points for all steps in the assembly process. This allows all automated assembly equipment to accurately locate the circuit pattern. Fiducial Marks are generally categorized in two types:

#### 1.2.1. Global Fiducials

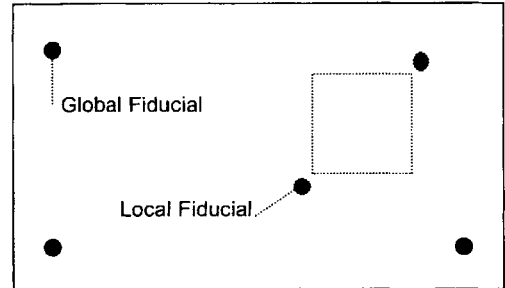
Fiducial marks used to locate the position of all features on an individual printed circuit board. When multiple boards are processed as a panel, the global fiducials may also be referred to as panel fiducials if used to locate the circuits from the panel datum.

#### 1.2.2. Local Fiducials

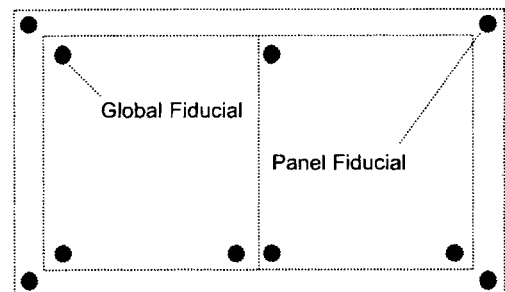
Fiducial marks used to locate the position of an individual component that may require more precise location, such as a .020 pitch QFP.

- 1.3. Global and/or panel fiducials should ideally be located on a three point grid based system, with the lower left fiducial located at the 0,0 datum point and the other two fiducials located in the positive X and Y directions.
- 1.4. Global fiducials should be located on all PCB layers that contain components to be mounted with automated equipment. This is true even if the circuit design contains no fine pitch ( $\leq .020$  pitch) components, as most modern assembly equipment uses vision recognition for PCB alignment. While other circuit objects (via-holes, etc.) can be used, this can compromise accurate component placement.
- 1.5. All Fine Pitch components should have two local fiducials designed into the land pattern of the component.

- 1.6. Fiducials should have a soldermask opening large enough to provide good contrast and keep the fiducial clear of soldermask to enable accurate identification by all vision alignment systems.



Global & Local Fiducials



Panel Fiducials

- 1.7. A minimum of two global fiducial marks is needed for correction of translational offsets (x and y position) and rotational offsets (theta position). These should be located diagonally opposed and as far apart as possible on the circuit or panel.
- 1.8. A minimum of three fiducial marks is required for correction of non-linear distortions (scaling, stretch and twist). These should be located in a triangular position as far apart as possible on the circuit or panel.
- 1.9. A minimum of two local fiducial marks are required for correction of translational offsets (x and y position) and rotational offsets (theta position). This can be two marks located diagonally opposed within the perimeter of the land pattern.
- 1.10 If space is limited, a minimum of one local fiducial mark may be used to correct translational offsets (x and y position). The single fiducial should be located in the center of the land pattern.
- 1.11 The minimum recommended size for fiducials is 1.0mm. It is good practice to keep all fiducial marks the same size as some assembly equipment is less flexible in its ability to recognize different size marks on the same printed circuit board.

## 2. FIDUCIAL MARK DESIGN SPECIFICATIONS

### 2.1. Shape

The optimal fiducial mark is a solid filled circle.

### 2.2. Size

The minimum diameter of the fiducial mark should be 1mm (0.040 in). The maximum diameter of the fiducial should be 3mm (0.120 in). Fiducial marks on the same PCB should not vary in size by more than 25 microns (0.001 in).

### 2.3. Clearance

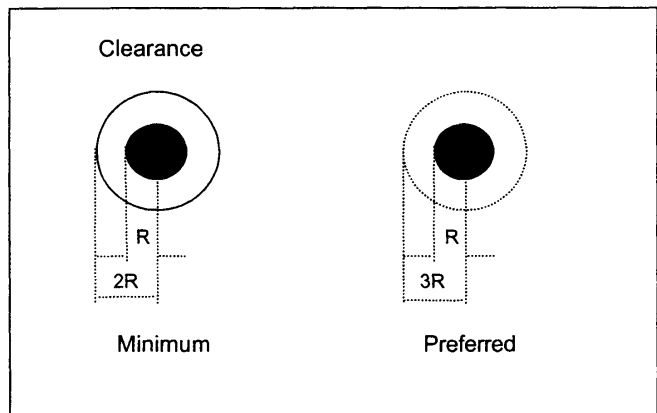
A clear area devoid of any other circuit features or markings should be maintained around the fiducial mark. The size of the clear area should be equal to the radius of the mark. A preferred clearance around the mark is equal to the mark diameter.

### 2.6. Edge Clearance

The fiducial marks should be located no closer to the PCB edge than the sum of 7.62mm (0.300 in) (SMEMA Standard Transport Clearance) and the minimum fiducial clearance required.

### 2.7. Contrast

Most machine vision recognition systems perform best when a consistent high contrast is present between the fiducial mark and the PCB base material.



### 2.4. Material

The fiducial may be bare copper; bare copper protected by a clear anti-oxidation coating, nickel or tin plated, or solder coated (HASL).

The preferred thickness of the plating or solder coating is 5 to 10 microns (0.0002 to 0.0004 in). Solder coating should not exceed 25 microns (0.001 in).

If solder mask is used, it should not cover the fiducial or the clearance area.

### 2.5. Flatness

The flatness of the surface of the fiducial mark should be within 15 microns (0.0006 in).

**AUTOMATED PRODUCTION SYSTEMS**

OCTOBER 6, 2005

**DOCUMENT:** Fiducial Specifications for Panel and Board Alignment.

Objective: To provide guidelines to help the end user to take advantage of enhanced automation on the L-Series machine by designing fiducial marks that are reliable and consistent.

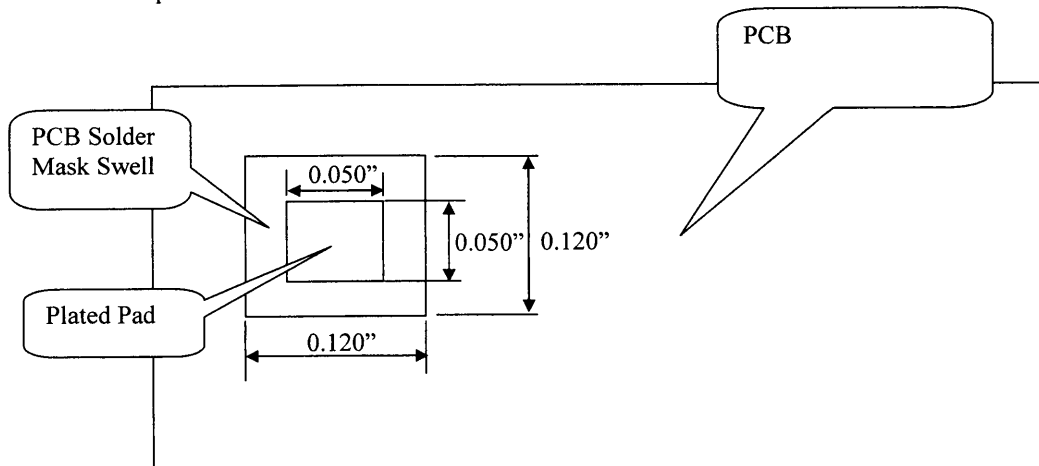
**General Recommendations:**

In general a fiducial to work most comply with the following rules:

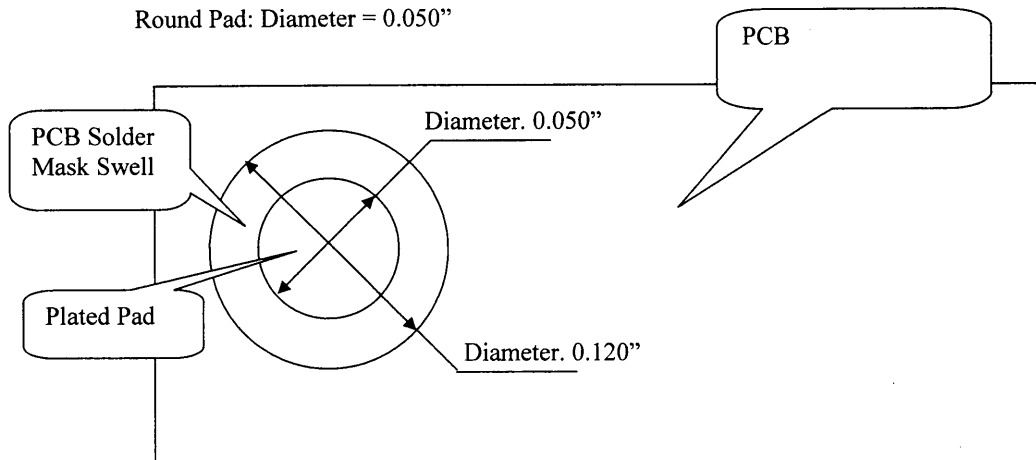
1. The surface should be very reflective when compared to the surrounding area. Solder plated or Gold plate is usually good.
2. When solder mask is used the swell around the reflective fiducial should be at least twice the side of the fiducial plus 10 mils in every direction.
3. The fiducial shape should be symmetrical.
4. The two examples below represent tested minimum dimensions.
5. The desired dimensions should be between 50 mils and 200 mils max.

**FIDUCIAL EXAMPLES**

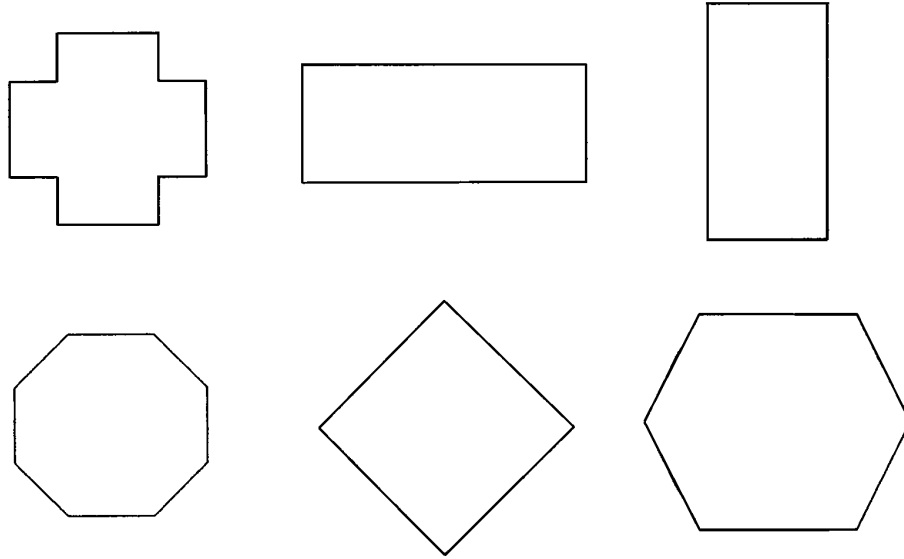
Squared Pad: 0.050" x 0.050"



Round Pad: Diameter = 0.050"



**Other recommended Fiducial Shapes:**



**Not recommended Fiducial Shapes:**

