APPLICATIONS ENGINEERING
Speedline | MPM
16 Forge Park
Franklin, MA 02038-3137
Dave Hemmelgarn
dhemmelgarn@speedlinetech.com
04/26/2013

INSPECTION - Best Practices
2D & Bridge Detection

Abstract
Inspection is used to verify an accurate deposit of solder paste onto the Printed Circuit Board (PCB) pads to insure mechanical and electrical connection with the components. The Accela and Momentum series platforms have the capability to inspect for pad coverage and bridging of a just-printed circuit board, as well as the bridging potential using stencil inspection (StencilVision). This document is based on the system operating 3.xx software or higher.

Inspection definitions on the Platforms:

Preview every PCB
Boards processed using inspection; the machine must look at (preview) the unprinted pads of the board so as to determine the actual pad area. This pad area will then be compared to the remaining uncovered pad area after printing to calculate the actual pad coverage

Contrast Based Pad Coverage
This is the amount of pad that is covered in paste. Paste is seen as dark (black) as compared to the pad, which is seen as light (white). This would be used to insure that paste is being deposited over the pads within user selected accepted values.

BridgeVision Inspection
After learning the paste texture, the machine is capable of looking in the "gap" areas between the pads for paste. This is done in two ways:

1. The amount of coverage of the gap area (area between the pads that is covered in paste).
2. The "span" across this gap, (how far does the paste intrude between the pads).

This is useful in multiple ways; such as to identify any gasketing issues board to stencil, any leakage during the print operation and to assist with the set up the wiping frequency of the machine.

StencilVision Inspection
This function is similar to BridgeVision. This will assist with the setup of the wiping frequency even more than the board since it will actually see a process trend. Board bridging is very often a quick "all of a sudden" thing that may actually go away on the next print. Whereas the bleed out on the stencil will tend to progressively get worse every print.

Blockage

This uses the trained paste and looks at the actual stencil aperture area. Determination can then be made as to how much paste still remains in the aperture, i.e. how much was released from the stencil. This could be helpful in determining the correct settings for the Slow Snap Off routine (the controlled release of the board from the stencil after the print operation).

There are known issues revolving around this method however. As the paste becomes "more friendly" to print delays (i.e. increased stencil life), the pastes can exhibit a very "wet" appearance. Very often, high flux or high solvent pastes (the faster printing type) will form a "bubble" over the aperture area – which, in turn, the system will see as a complete blockage and cause false errors. Another note is that although stencils continue to get better it can take time for the apertures to become "wet" and release well, and even though the system is printing adequately by pushing paste that adheres to the wall of the aperture on every print the system will report excessive blockage.

High Speed Inspection:

Implemented in version 2.0 software a new routine for inspection was introduced. The routine creates an inspection path based upon all of the taught devices and raster's the camera instead of inspecting on a device by device basis. This method drastically increases the speed of inspection by allowing multiple devices to be inspected simultaneously as they fit within the camera's field of view (FOV).

The following sections will provide both explanations on the inspection technologies as well as the best practices when setting up the system.

Devices to inspect

Although the system now can be setup to theoretically allow the user to inspect 100% of the board this is not always the best usage.

There are some devices that will require to be taught as a 'custom' component:

- QFP, Dual Inline, or Single Inline devices with a single larger pad on a side
- 5-pad devices
- QFN's Irregular shaped devices
- BGA's with different or varying pitch in a single row or column

There are still some devices that the system cannot handle, these include:

- Very large devices that do not fit in the cameras FOV (0.4" x 0.3")
- Devices or pads with dimensions less than 0.007".
- Through-hole devices

Not all devices require all the inspection options. There are certain devices which only require coverage. In this instance all bridging can be disabled. These devices include:

Devices with pitches greater than 0.050" (SOICs, PLCCs, BGAs, Some Connectors, etc…) this is just a suggestion and the process engineer should be aware of which devices have a bridging tendency.

*Note: 1, 2, 3 pad devices are not inspected for bridging by the system at all.

Disabling these types of devices for bridging will not have an effect on cycle time if the following is true:

1. Running SW Version 2.0 and higher
2. Ring-Light fitted (and enabled) and
3. "Use Train Paste to set Contrast Thresholds" on the Inspection Tab is checked and location has been taught.

Another item to keep in mind is that the system will allow you to have almost an infinite number of devices taught. Each one of these devices contains a large amount of data associated with it and this increases the actual file size on the Hard Drive and can slow the system down some. Although Hard Drive size is not a limiting factor on today's computers it can and will affect the way the machine runs.

For example: On programs with more than 2500-3000 devices the file can be in excess of 6MB. Every time the file is accessed it can take time to display on the system (even when devices are not inspected). This will also increase the time to display 2D errors, to see what files are using a certain wiper profile or fiducial name (Show Clients), to load a file from a Barcode, or to delete a file and its dependent objects. The system also keeps track of SPC data for each part inspected as well as a log file of all changes made to a given program. Thus for every board inspected the machine will save data on each device. When a board of that many devices is inspected the amount of SPC data, per board, can easily be 1MB. The system will create backups of data, but unless a network location is available the system will only save up to 1G of data.

So, disabling devices to make the drop rate of the system faster is good, but other areas can still be affected. The user should (when possible) delete devices that they really do not care about.

How to set the correct settings for 2D

Typically this data comes from actual practice and actual process numbers. The users should specify what the correct amount of pad coverage is for a given device based upon end of line yields. The following are just *suggestions* and *starting points*. The only options covered in this section will be the most useful inspection tools, including: Pad Coverage, BridgeVision, Advance Pad Coverage Settings and StencilVision. (Figure 1)

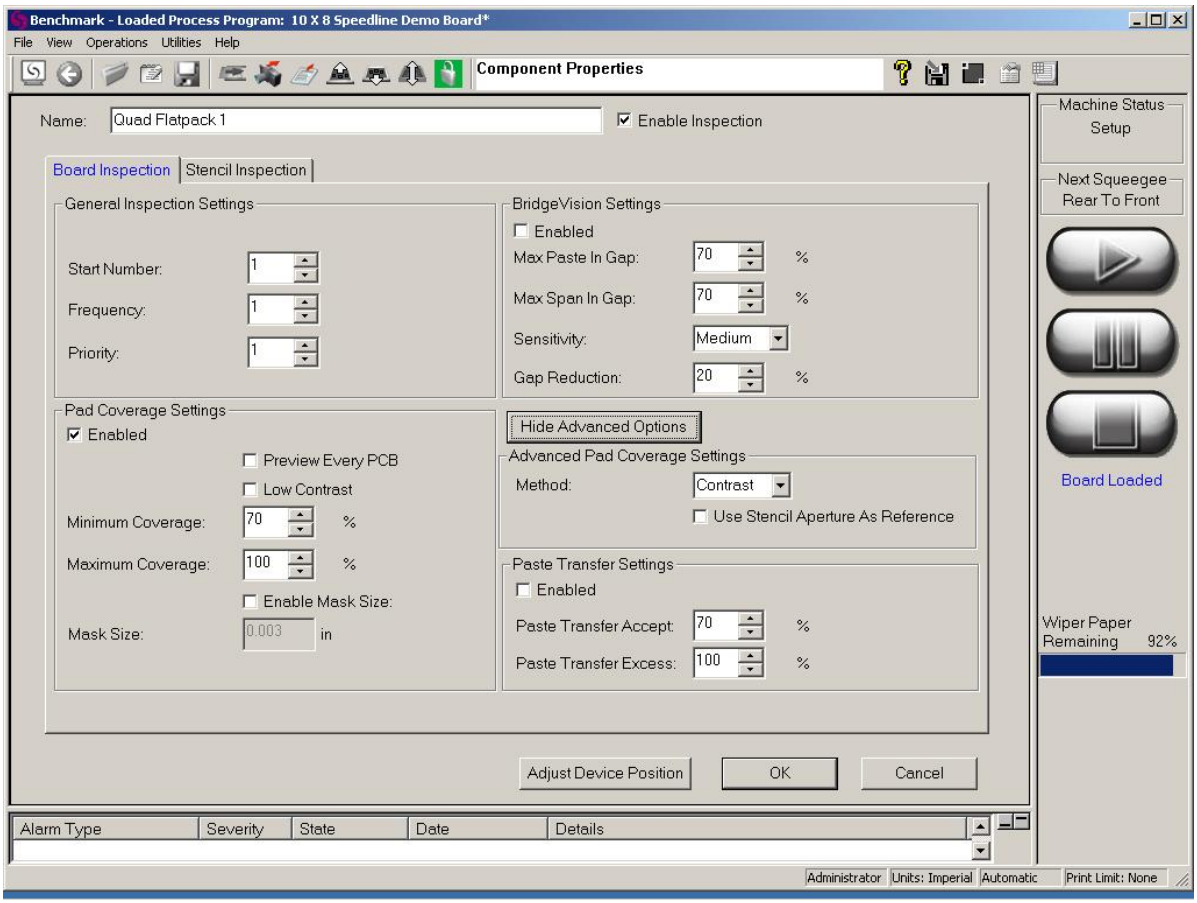

Figure 1

Pad Coverage Settings:
Typically the reject criteria defaults are a good starting point and have proved to work for most applications.

These are:

Preview every PCB:
Disabled (default); the results of the first board previewed will be used to compare all boards that are printed during the current production run.
Enabled; a preview routine will be performed on every board entering the printer during the current production run. The results will be used on the current board.
*Note: Enabling this feature will increase cycle time.

Minimum Coverage = 70%.
This will need to be changed if the devices have extremely reduced apertures. Devices like resistors with home plate design apertures are good examples.

Maximum Coverage = 100%

Enable Mask Size = Enabled.
This field can assist with the issues revolving around solder mask alignment and exposing of traces. The tighter the mask opening size the more of the traces the system will ignore. However, if the opening is too small then any board stretch can result in coverage failures.

Mask Size = 0.003" (0.0762 mm) (default)

Advanced Pad Coverage Settings:

Use Stencil Aperture as Reference
This can be used if the user prefers to see the coverage as more indicative of how much paste was released on a reduced aperture than how much of the pad is covered.
Example: If unchecked the coverage of a home pate deposit will give 60%, where checked this number will be closer to 100%.

Notes:
This will *ONLY* work if the device were taught on the system OR if the offline programming tool has the capability of programming the % reduction in aperture area.

If the aperture size is greater than one to one with the pad size, this should be disabled.

Method
This setting should always be set to 'Contrast'.
'Texture' and 'Both' are not used with the current inspection operation.

Bridge Vision
There are numerous ways to set this up. The following suggestion is to only flag a bridge when there is a "true bridge". It will allow for "whiskers" of paste to pass as it is believed that these will often pull back. These settings will drastically reduce amount of "false positives". The default settings are a starting point and may require adjusting depending on the process.

Max Paste In Gap = 70% (default)
This is the maximum paste area allowed to be present in the gap (space between the pads). Valid range is 0 to 100. This is the maximum percentage of gap area coverage that is deemed acceptable before being identified as a failure. (Figure 2)

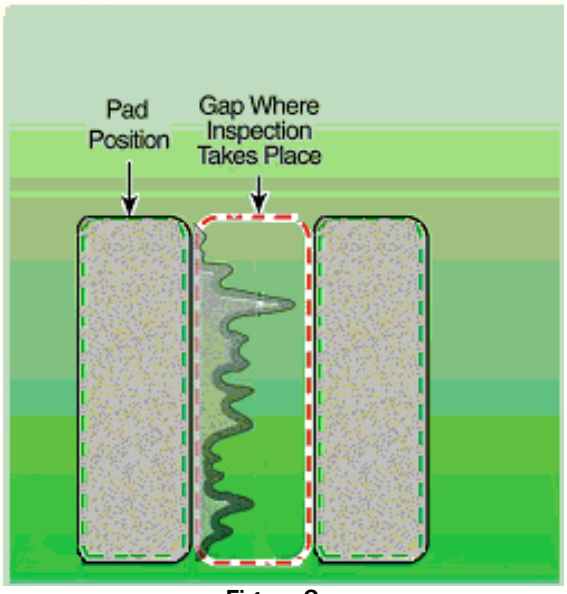

Figure 2

Max Span in Gap- (example 80%)
This is the maximum distance the paste may intrude in the gap, between the 2 deposits. (Figure 3)

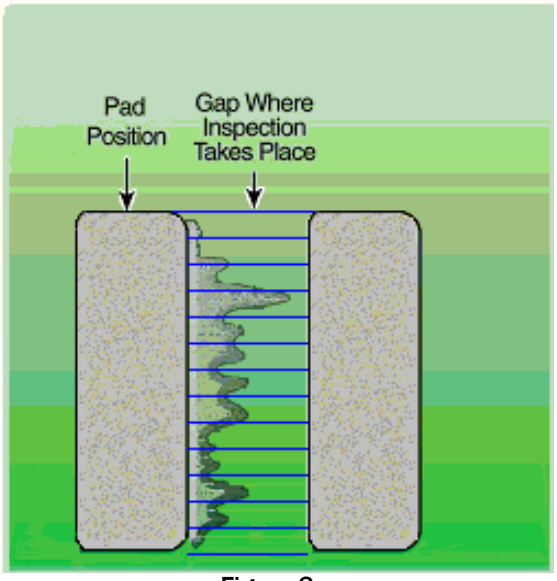

Figure 3

Sensitivity

Span and Sensitivity work together. To be considered a highly probable bridge between two pads, the paste must intrude in the gap in excess of the Span value *and* must be wider than the sensitivity setting. This setting is essentially a filter. This will reduce and filter out the small, very thin, "wisps" of paste.

Minimun Sensitivity

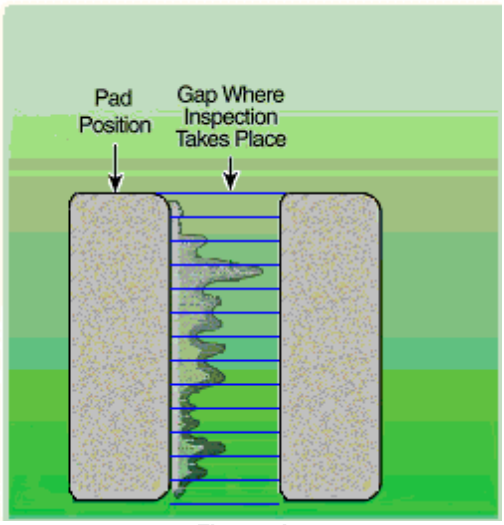

Figure 4

Maxium Sensitivity

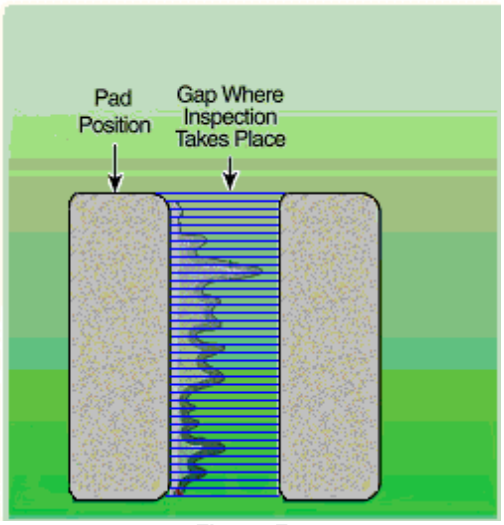

Figure 5

- Maximum Sensitivity (width of 1 mil) - minimal "averaging", looks at the smallest variation, most stringent. (Figure 5)
- High Sensitivity (width of 4 mils)
- Medium Sensitivity (width of 8 mils)– medium "averaging", will pick up failures that most likely will cause actual bridges.
- Low Sensitivity (width of 11 mils)
- Minimum Sensitivity (width of 15 mils) – maximum "averaging", gross look for large variations, most lenient. (Figure 4)

Gap Reduction = 20%.

Because BridgeVision is based on the distance between the apertures on the STENCIL, you must account for reduced apertures. Gap Reduction should be set to a percentage that nullifies the reduction in aperture size. (Figure 6)

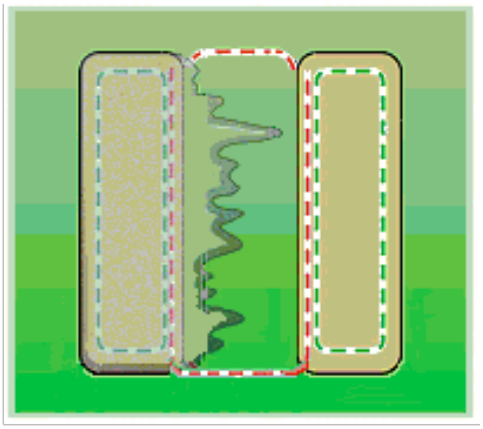

Figure 6

If you set Gap Reduction % to 0, (Figure 7) you will overlap the pad edges, and any paste that is present will be counted as being in the gap area, even though it is actually on the pad.

If you set Gap Reduction 10%, for example (Figure 8) the inspection areas will be between the pads. If solder is still present on the pad edge it will not be labeled as a bridge.

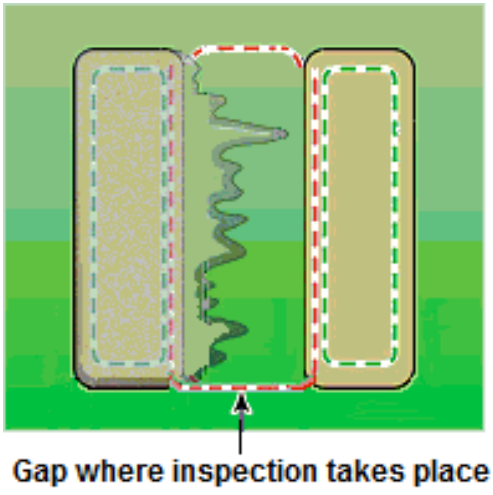

Figure 7

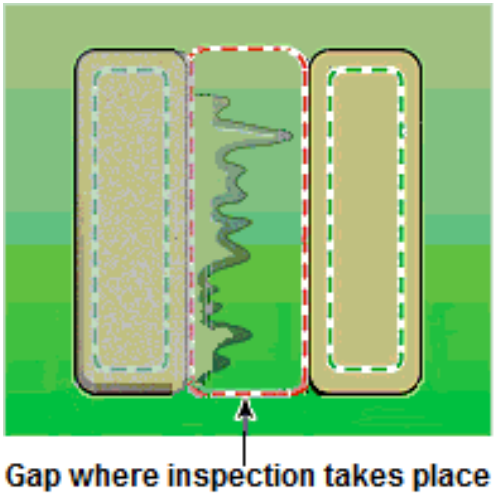

Figure 8

Stencil Inspection / BridgeVision Settings

Max Paste In Gap = 70%.
Maximum paste allowed within the gap (space between the apertures).

Max Span In Gap = 70%.
Maximum distance the paste may intrude in the gap between the apertures

Sensitivity = Medium

Gap Reduction = 10%.
This is similar to having a “mask” opening for the apertures. It will allow for small variations and less “false positives”.

General Inspection Settings

The following section describes the general inspection settings for a user that wants to utilize all of the available inspection options. (Figure 9)

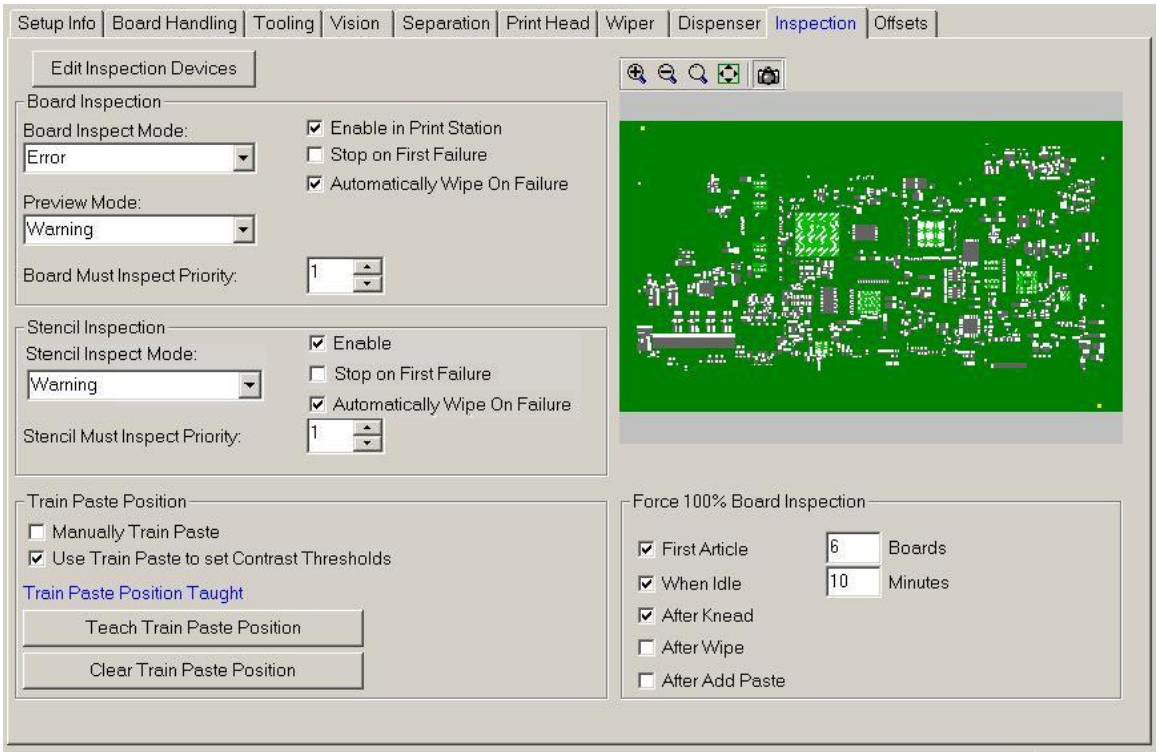

Figure 9

Force 100% Board Inspection

Starting with software version 3.x.x, there is advance settings to force 100% inspection after certain events have occurred based on enabled components and includes ALL priority levels.
By placing a check in the box before each event will enable that specific routine

First article: At the start of the production run, the quanity of boards entered into the ‘Board” location will have 100% inspection performed. Boards:

When idle: This is based in minutes as per the time entered into the 'Minutes' location. During production only, when the system sits idle for the predetermined time entered into the 'Minutes' location the system will perform 100% inspection.

After Knead: 100% inspection will occur after the knead routine, either Recover or Reject,

After Wipe: 100% inspection will occur after a wipe routine.
Note: if wiping every board the system will perform 100% inspection even if the priority levels are used

After Add Paste: 100% inspection after the Add Paste routine is performed.

Board Inspection:

Board Inspect Mode:
Error: This will stop production and force the user to view the errors when an inspection error occurs. It will also enter a message into the alarm log.

Warning: This will not stop production. It will enter an inspection failure message into the alarm log.

Preview Mode:
Error: This will stop production and force the user to view the preview errors when a preview error occurs.

Warning: This will not stop production. It will enter a preview error message into the alarm log.

Stop on First failure = Unchecked (default)
This will stop inspection immediately when an error occurs. No data will be available on the uninspected part of the board and the inspection will not continue once it is stopped.

Automatically Wipe on Failure = Unchecked.
When checked the system will automatically perform an "On Inspect Fail" wipe, if available.

Board Must Inspect Priority = 1.
This item solves 2 issues:

First: if the devices are scattered on the left and right sides of a board the user could select all the devices on one side and make them Priority 1 devices and all of the devices on the other side and make them Priority 2. Setting this to 2 will force all the devices to be inspected but it will do the Priority 1 devices first and then do the Priority 2 devices next. This can help inspection time.

Second: If there are a lot of devices that the user knows will print well and only wants them to be inspected if there is time then any priority 2,3,4,5 devices will be inspected in that order if:

1. Must Inspect Priority = 1*and*
2. The downstream segment (if staging boards) is empty *and*
3. There is no board waiting to come into the machine.

As soon as (2) or (3) happen the board will immediately stop inspecting any lower priority devices.

Stencil Inspection

Stencil inspection should not be used in the same manner as Board Inspection. The real purpose of this utility is to help "monitor" the printing process and react, as necessary, to changes in it. The user should find one or two devices that represent the process reaching its limits, i.e. the devices that will have the highest tendency to bridge. Once these are determined the system can react automatically to them, without warning, and keep things in check.

Stencil inspection is a serial process. Nothing else (wiping, board inspection, loading of boards, etc…) can happen when this is going on. This means that the more stencil inspection you have the more cycletime. The following settings reflect the above mind set.

Stencil Inspect Mode = Warning.
Once the user feels comfortable with the stencil inspection results setting this to "warning" will allow the system to carry out its functions quickly and without interaction.

Stop on First failure = Checked.
This will stop inspection immediately when an error occurs. No data will be available on the uninspected part of the stencil and the inspection will not continue once it is stopped.

Automatically Wipe on Failure = Checked.
When checked the system will automatically perform an "On Stencil Inspect Fail" wipe, if available.

Stencil Must Inspect Priority = 1.
This item works similarly to the Board Must Inspect Priority.

Train Paste Position

Incorporated in version 2.0 the system greatly depends upon paste training to set all the correct light levels to perform inspection. This location should be taught in an area that guarantees a good print deposit. If the user chooses a specific location ("Teach Train Paste Position") then they should choose a larger pad and make the box slightly smaller than the pad size (so the routine only sees paste (Figure 10) and not pad (Figure 11)). If a location is not taught then the user should teach a simple (large pad area) device that will print easily. The system will automatically try this location first. This device can even be disabled for inspection.

There are two ways to teach the Train Paste Location.
First is to use a printed board (preferred). By selecting the Teach Train Paste Position button you will be prompted to load in a board which has already been printed. By following the instructions you will box in the paste deposit as shown in figure 10. Select Finish when done.

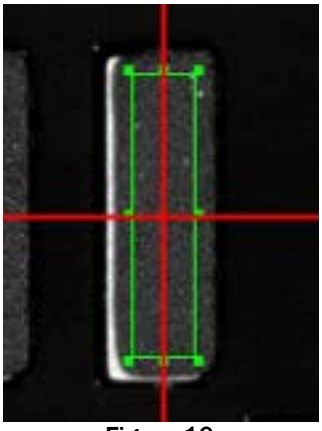

Figure 10

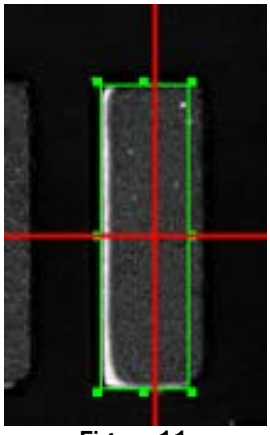

Figure 11

The second way to train the paste location is to use the stencil. This should be done only if a pasted board is unavailable. By selecting the 'Teach Train Paste Position' button you will be prompt to load the board. Once the board is loaded and aligned, locate a pad on the board that will be used for the Teach Routine. Click the right mouse button to bring up a menu, than select *Stencil Lamp* (Figure 12).

Figure 12

The stencil aperture will be used as a reference to size the box. Size the box within the aperture (Figure 13). This box will be the size required without having any pad area exposed when the teach routine is performed.
Next, click the right mouse button to bring up a menu and select the *Board Lamp* (Figure 12) and align the box over the pad (Figure 14).

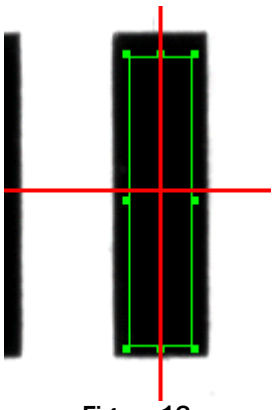

Figure 13

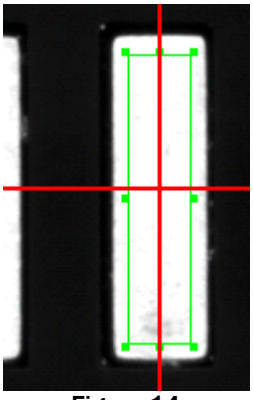

Figure 14

Manual Train Paste = Unchecked (default)
When checked the operator will need to manually locate a position to train paste on. This is only used when troubleshooting.

Use Train Paste To Set Contrast Thresholds: Checked (default).
When the 'Use train Paste To Set Contrast Thresholds' is checked, the vision system will move to the taught trained position and adjust the vision values to set the inspection lighting levels. This allows for a single picture to do both Contrast Pad Coverage, as well as, Bridge detection. If this is unchecked the system will take 2 separate pictures, one for each method, and this will drastically increase cycle time.

When 'Train Paste Position Not Taught' is in *red* this indicates no location has been taught. An error message will appear stating the train paste has failed. At this point a manual movement to a paste deposit location and boxing with in a paste deposit area is required. When a Train Paste Position has been taught, the writing will be in *blue* and the train paste operation will be performed automatically. (Figure 9)

NOTE: Train paste is required when using the Bridge Vision feature for both the board and / or stencil.

Conclusion

The above discussion, descriptions and suggestions are such that the system should be optimized as much as possible. It also revolves around the fact that the user has some knowledge of the system and how it works, that the machine is running Version 3.x.x software, and that the machine is configured correctly (i.e. the ring-light is configured).

NOTE: Some settings and capabilities are not available on version 2.0 to 2.9.4. The items that are available can be set or adjusted per the instructions described above.