

AOI Algorithm Best Practice Cookbook

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1. INTRODUCTION

1.1 Presence/Absence

To determine whether a component is in place where it is supposed to be present. The algorithm is comparing the **Presence Value** of the components when the component is present and absent.

1.2 Skew/Offset

To determine whether a component is placed at the accurate position on the PCB and is not shifted from the CAD centroid. It is measured in microns (horizontal and vertical directions) and degrees of rotation.

1.3 Joint Inspection

To check the solder quality of the component on the pads. Pixels under **Joint Grey Threshold** are considered part of the joint and colored in pink. **Joint Coverage Threshold** defines the minimum percentage of pixels in the joint box that must be colored pink for the joint to pass.

1.4 Bridging

To check for solder bridges between leads and pads. Any pixel seen inside the yellow bridging box that is brighter than the **Bridging Threshold** is considered to be part of the potential solder bridge.

1.5 Polarity

To determine whether polarized components are placed properly. The theory is to assign 2 boxes (or 4 boxes) on the package body, and specify which box should be brighter if the component is oriented properly.

1.6 OCV/OCR

Optical Character Verification, OCV is used to identify text or logos. **OCR (Optical Character Recognition)** allows the user to program the V510 system to read text printed on the body of a component. Both can be used for wrong part check and also parts orientation.

1.7 Billboard

To detect billboarded (side standing) components. A part is considered to be billboarded if there is an area in the body that is brighter than **Billboard Grey Thresh** and between **Billboard Min Width %** and **Billboard Max Width %** in width.

1.8 Flip

To check for flipped (upside down) components. **Flip Threshold** determines if the mean intensity of the center of the component is greater than the **Flip Threshold**, the component will fail for flip.

1.9 Extra Part

This allows users to check specific locations to make sure no components are placed on no-load location.

2. FIDUCIAL SETUP

Example on Ellipse shaped fiducial

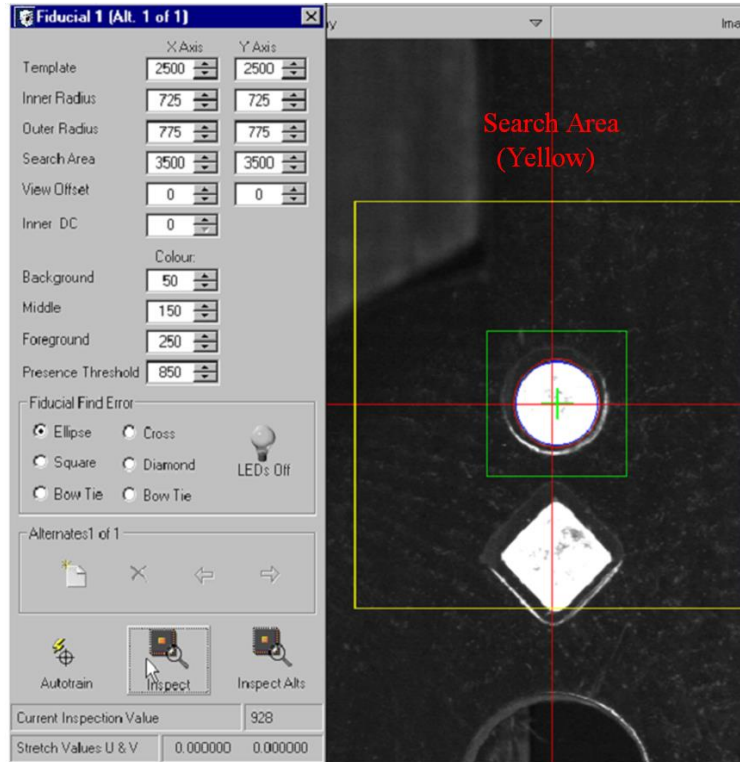


Figure 1: Example on Ellipse shaped fiducial

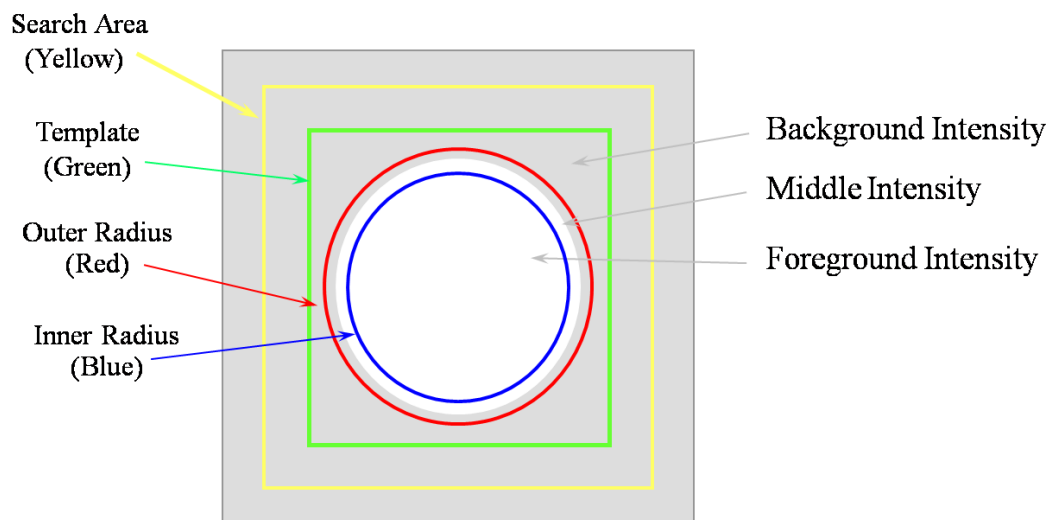


Figure 2: Example on Ellipse shaped fiducial

1. Ensure correct Fiducial Shape is selected. In this case, **'Ellipse'** should be chosen.
2. Normally a fiducial is brighter compared to the PCB/background.
3. Ensure that appropriate size is set for **'Search Area'** which is in yellow colour. Search Area should be big enough to cover Template and Inner & Outer Radius. Search Area is normally set as a square and should not cover any bright area/pad of similar size to the actual fiducial.
4. **'Template'** should be slightly bigger than the actual fiducial, but smaller than 'Search Area'. It's in green colour.
5. **'View Offset'** should normally be turn off (0).
6. **'Inner DC'** means to disclude the 'dirty' area residing inside the inner part of the fiducial. It should only be applied when the dirty area in the inner part of the fiducial creates a significant impact to the total score of the 'Current Inspection Value'. It should be set smaller than the actual fiducial.
7. **'Inner Radius'** should be set slightly smaller than the actual size of the fiducial, on the bright area/pad.
8. **'Outer Radius'** should be set slightly bigger than the actual size of the fiducial, on the dark area/PCB. **The difference between 'Inner Radius' and 'Outer Radius' is normally set at 30-50.**
9. **'Background'** refers to the average greyscale level in between 'Template' and 'Outer Radius'. Normally this area should be dark and thus it should be set in between **50-100**.
10. **'Middle'** refers to the average greyscale level in between 'Outer Radius' and 'Inner Radius'. Normally this area should consist of dark and bright area and thus it should be set in between **100-200**.
11. **'Foreground'** refers to the average greyscale level inside the 'Inner Radius'. In case if 'Inner DC' is used, then 'Foreground' refers to the average greyscale level in between the 'Inner Radius' and 'Inner DC'. Normally this area is bright and thus it should be set in between **200-250**.
12. Click **'Inspect'** and observe the value obtained in **'Current Inspection Value'**. The above parameters should be set appropriately in order to get the highest score for 'Current Inspection Value'.
13. Based on the score obtained for 'Current Inspection Value', ensure that an appropriate **'Presence Threshold'** is set. Presence threshold should not be set too loose (**typically >700**).
14. **Alternate** fiducial can be set when necessary (eg. When there is different fiducial size or shape).

3. C&R TYPE

1. To set absence presence mode and threshold, Geometry setup must be done first.
2. Setup in **Geometry**:

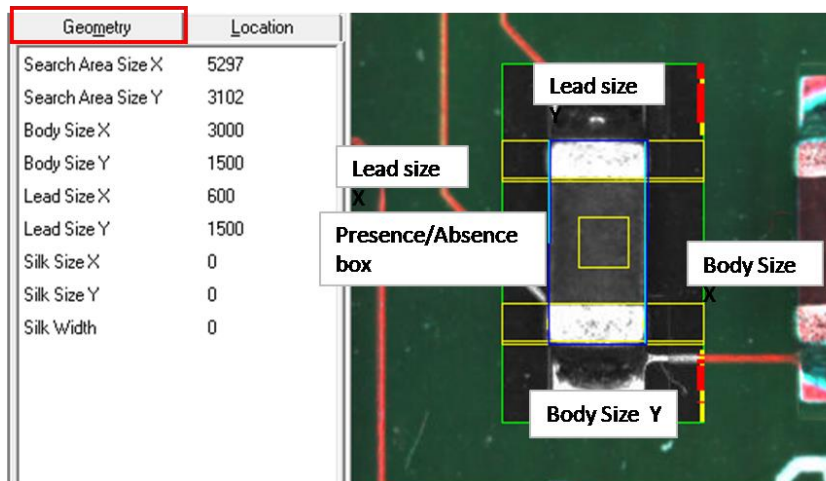


Figure 3: Geometry Parameter Settings

Inspection	
Ref Des	1:110
Part No	1206-L
Orientation	0
Shape	SHAPE
Presence Value	200
Top Offset	25
Bottom Offset	25
Horz Offset	670
Comp Skew	0
Polarity Green	0
Polarity Red1	0
Polarity Red2	0
Polarity Red3	0
Polarity Diff	0
Error	-

Figure 4: Results

- i. **** 'Search Area Size X/Y'** should be setup such that it includes the component and enough area around it, so that if the component is offset, this is included in the search area.
Recommended value is 1.5 times larger than body size in vertical direction.
- ii. **'Body size X/Y'** is set with the blue box is around the body as shown in the attached sample.
- iii. **'Lead size X/Y'** (for Chip) is setup where **lead size y is the same as body size y**. Lead size x will determine the width of the leads in long axis, and can be seen from the yellow lines going across the search area, as image above.
This is typically set between 25% and 50% of lead size y.

3. Setup in Location:

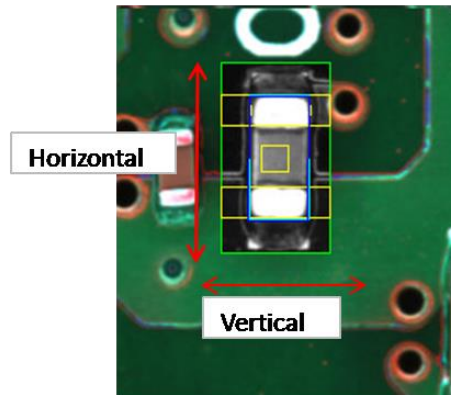


Figure 5: Location Parameter Settings

Inspection	
Ref Des	c396
Part No	0161-1054
Orientation	0
Shape	S0603-L160W80H...
Presence Value	200
Top Offset	67
Bottom Offset	52
Horz Offset	-83
Comp Skew	-4
Polarity Green	0
Polarity Red1	0
Polarity Red2	0
Polarity Red3	0
Polarity Diff	0
Error	-

Figure 6: Results

- i. For '**Image Plane**', scroll through all of the available options and observe on the changes appeared. Make sure that the image plane is giving the best contrast with sharpest view.
- ii. '**Skew**' is turn to **On**. This enables skew measurement and is recommended for both capacitors and resistors.
- iii. '**Body Darker Than Lead**' is set to **On** if body of component is darker than the terminal/lead (depending on body colour).
- iv. '**Pad Filtering**' is set to '**On**' to help with the location of both capacitors and resistors in the long axis (horizontal).
- v. '**Pin Locate Helper**' is set to '**On**' to help the location of the capacitors and resistors in the short axis (vertical).
- vi. ****** If the component is correctly locating and geometry is correct then set '**Horizontal Threshold**', '**Vertical Threshold**' and '**Skew Threshold**'.

The setting is dependant on manufacturing criteria, however, suggested values are:

- ✓ **Hor Threshold - 50% of lead size (in microns)**
- ✓ **Ver Threshold - 50% of lead size (in microns)**
- ✓ **Skew - 100 (in 10th of a degree)**

4. Setup in **Presence/Absence**:

- i. The recommended setting for '**Presence Mode**' is **Classic**.

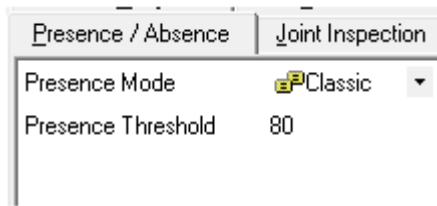


Figure 7: Presence mode Parameter Settings

- ii. The Presence/Absence box is indicated by a **yellow box** located at the center of the search area, which measures the **mean grey scale**. The score for the presence/absence is displayed in Results tab when inspect the component. User can perform a "**Visit All**" to inspect all the components under a same device type to obtain the details of results: Min presence value, Max presence value, Mean presence value etc. This can help user to determine the best presence threshold.

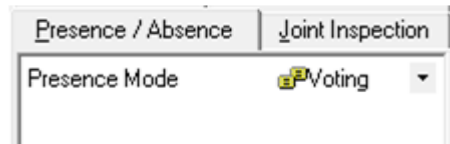


Figure 8: Presence mode Parameter Settings with SLA

Self-learning

- a. If SLA is not done, '**Presence Mode**' should set to **Classic**. '**Presence Threshold**' can be set by capturing the Presence Value in Results tab as in Figure 6.

This can be done by comparing the presence score for a populated and unpopulated component. Typically, the presence threshold can be set to a value in between the min presence value when the components are present & the value obtained when the part is missing.

- b. If SLA is being done, recommended setting for '**Presence Mode**' is **Voting**. However, user cannot set the threshold for Voting mode.
SLA is done by run inspection on 3 populated boards and bare boards. After training 3 populated and bare boards, a measure of confidence is given based on the look up table. The algorithm decides if the component is present or absent and gives a result of 0 or 200.

Note:

- a. **-Positive** Threshold: Presence Value must be **greater than or equal to** Presence Threshold in order to pass.
-Negative Threshold: Presence Value must be lesser **than or equal to** Presence Threshold in order to pass.
- b. ****** Search area size and offset threshold also depending on other factor such as pad size, if there is any surrounding component close by.

5. **Setup in Joint Inspection:**

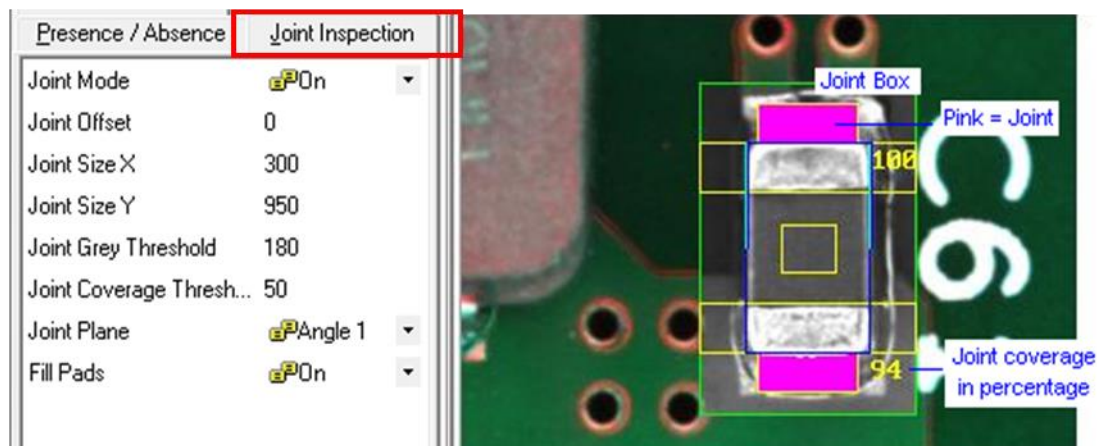


Figure 9: Joint Inspection Parameter Settings

- i. Ensure '**Joint Mode**' is turned '**On**'.
- ii. Ensure appropriate '**Joint Size X**' and '**Joint Size Y**' are setup. In C and R type, 2 joint boxes will be setup automatically at the end of the terminals/leads.
- iii. '**Joint Offset**' could be utilised if the joint boxes are required to be moved inward/outward.

- iv. Ensure that appropriate **'Joint Grey Threshold'** is setup. All areas with greyscale below this 'Joint Grey Threshold' will be coloured pink which represents for joint. The grey scale is ranging from 0-255, but for chip capacitor and resistor, the typical range would be **150-180**.
- v. The recommended **'Joint Plane'** is **Angle 1**. Anyway, when the solder fillet is bright and contributes to high false fail (especially chip resistor), try switching to Angle 3 (90 degree angle lighting) and it would yield higher score in both of the joint boxes.
- vi. Ensure that appropriate **'Joint Coverage Threshold'** is setup. Joint check would pass when the score of the joint area from both the joint boxes are above this set 'Joint Coverage Thresold'. It should not be set too low to eliminate escape. Typically is set to **40-60%**, also depending on the Joint Grey Threshold set. The score of the joint area is represented in percentage, where 94 means that 94% of the total area within the joint box is considered having solder joint.
- vii. Click at **'Next'** or perform a **'Visit All'** to verify on the other similar package type.

Extra features:

- a. Fill pads is useful in finding joints by flooding the pad area outside the joint with light.
 - b. Side fillet can be added to detect component absence presence especially on dark resistor. The side fillet windows is set on the body of the resistor and it is measured by greyscale coverage % instead of the mean greyscale (the conventional presence/absence check). Pls refer to side fillet setup in the later topic.
 - c. Coverage including: insufficient solder joint, excess solder joint, lifted lead, non-wetting/unsoldered.
6. **Polarity** setup is **not required** for R and C type generally since they are not polarized parts.
7. **Bridging** is also **not required**.

8. Setup in **Billboard**:

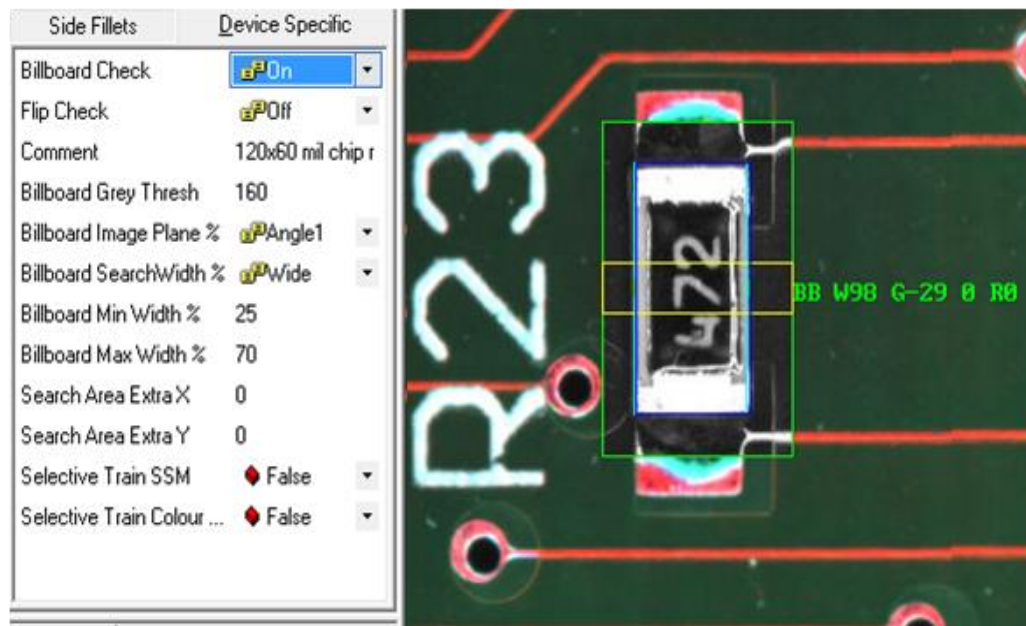


Figure 10: Billboard Parameter Settings

- i. Go to '**Device Specific**' tab.
- ii. Ensure that '**Billboard Check**' is turned '**On**'.
- iii. 'Billboard Grey Threshold' sets the grey threshold above which pixel are considered to contribute to a billboard. It's normally set at **160**.
- iv. Ensure that the correct '**Billboard Image Plane**' is selected to give the best contrast between component and background.
- v. Component width inspected in between '**Billboard Min Width %**' and '**Billboard Max Width %**' will be considered as Billboard. Refer to below table for recommended settings.
- vi. In the Inspection Window, the number after the W is the Width of Area. The number after the G is the Greyscale score [Mean - (2 x Std. Dev.)].

Notes:

- a. Billboard is normally turn on on resistors and some capacitors only (0805 and above). This is because chip capacitors is square in shape for 0603 and smaller packages (0402, 0201, 01005).
- b. Recommended setting as below:

	Capacitor	Resistor
Billboard Grey Threshold	160	160
Billboard min width %	30	25
Billboard max width %	80	70

9. Setup in **Flip**:

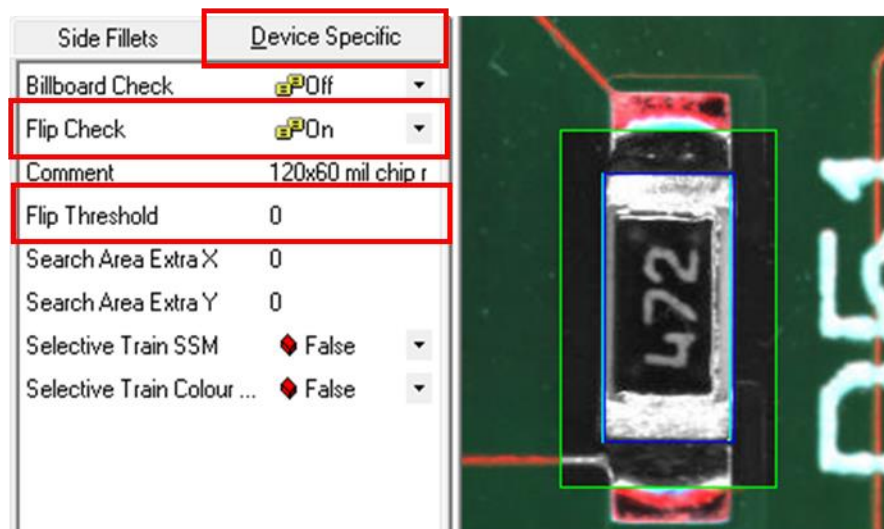


Figure 11: Flip Parameter Settings

- i. Go to '**Device Specific**', ensure that '**Flip Check**' is turned '**On**'.
- ii. Ensure that '**Flip Threshold**' is setup appropriately. The component will be considered flip if the average greyscale within the blue box exceeds the 'Flip Threshold' set. 'Flip Threshold' is commonly set within **180 - 200**.

Note:

- a. Flip check is commonly turned on **resistors only**, or on components which surface and flipped surface are with significant contrast.

11. **Others:**

- i. The default **Search Area Extra X** and **Search Area Extra Y** is set to **0**. They can be setup when necessary. Eg. When the component has false call due to the position of the component in the edge of the FOV and the lighting quality near the edge of the camera view is sometimes of slightly lower than the light near the centre of the view. The Search Area Extra meant to create a larger search area for the component 'virtually' to move it in the center of the FOV.

4. B TYPE

1. To set absence mode and threshold, Geometry setup must be done first.
2. Setup in **Geometry**:

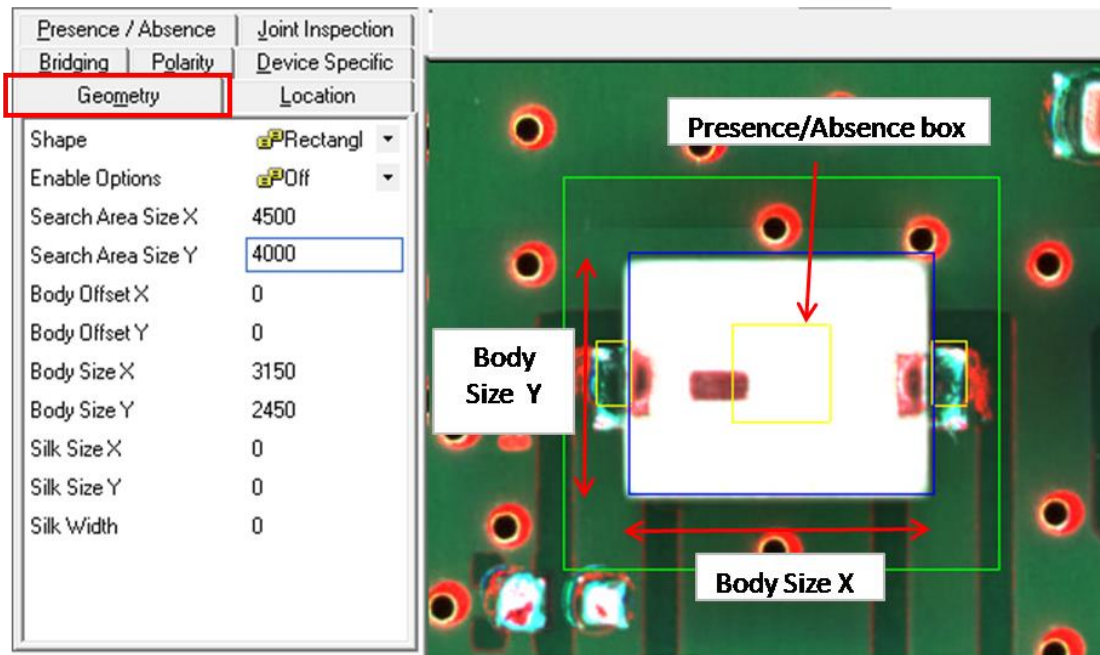


Figure 12: Geometry Parameter Settings

- i. **** 'Search Area Size X/Y'** should be setup such that it includes the component and enough area around it, so that if the component is offset, this is included in the search area.

Recommended value is 1.5 times larger than body size in vertical direction.

- ii. **'Body size X/Y'** is set with the blue box is around the body as shown in the attached sample. **Body Offset X and Y** shall always set to **0**. Body offset is non zero only for components where the component body centroid is not at the center of the CAD.

3. Setup in Location:

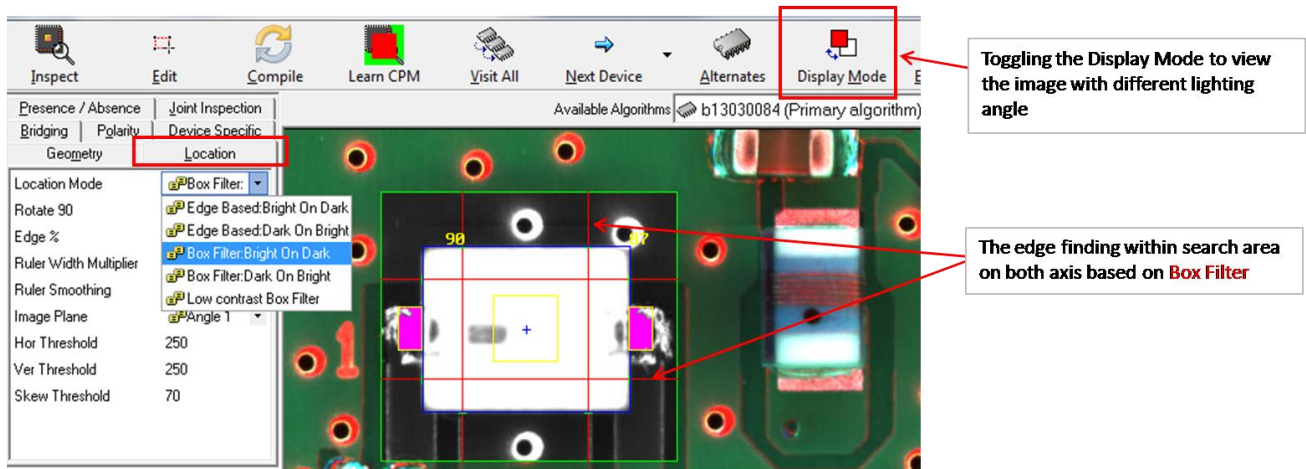


Figure 13: Location Box Filter Parameter Settings

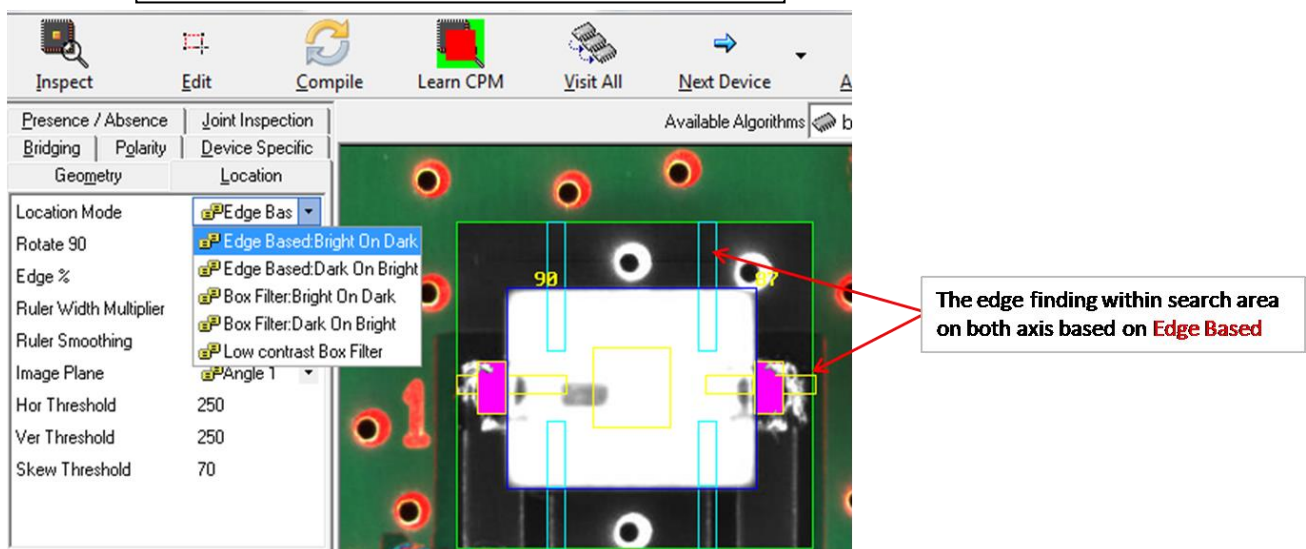


Figure 14: Location-Edge Ruler Parameter Settings

- i. Scroll through all the available options of the lighting angle and observe on the changes appeared. Make sure that the image plane is giving the **best contrast with sharpest view**. Select the best image plane.
- ii. '**Rotate 90**' is to either perform the component body edge searching by the default angle or 90 degree perpendicular to it. It is indicated by the red lines across the component body from the search area.

This settings can be set to '**off**' by default. Anyway, you may select '**on**' or '**both**' **whenever necessary** depends on the edges contrast on hor or ver direction.

If the component body contrast is very low compared to the background and all the 4 parameters cannot locate the component correctly, Low Contrast Box Filter shall be used. Take note that it will incur in increment of inspection time if a lot of components is set to Low Contrast mode.

- iii. **Edge %** is where the position of edges finding ruler to locate the best contrast on the component body. For Box filter, it is set to default which is 50%.
- iv. **'Ruler Width Multiplier'** is to set the width of the edge finding ruler for **Edge Based mode**. The larger the width of the ruler will help to improve the edge finding when the edges looks 'bur'.
- v. **'Ruler Smoothing'** is to smoothen the edge contrast when searching for the edges.
- vi. ****** If the component is correctly locating and geometry is correct then set **'Horizontal Threshold'**, **'Vertical Threshold'** and **'Skew' Threshold**.

The setting is dependant on manufacturing criteria, however, suggested values are:

- ✓ **Hor Threshold - 50% of lead size (in microns)**
- ✓ **Ver Threshold - 50% of lead size (in microns)**
- ✓ **Skew - 100 (in 10th of a degree)**

4. Setup in **Presence/Absence**:

- i. **'Presence Mode'** shall be set to **Classic** with **1 box mode**. This particularly is good for monotone components where they have different contrast compare to background (PCB).

You may move the yellow box around the body to get the best score if there is noise or dark area on the component body versus dark PCB (or bright area on component body versus bright PCB).

- ii. The Presence/Absence box is indicated by a yellow box located at the center of the search area, which measures the **mean grey scale**. The score for the presence/absence is displayed in Results tab when inspect the component. User can perform a **"Visit All"** to inspect all the components under a same device type to obtain the details of results: Min presence value, Max presence value, Mean presence value etc.
- iii. 3 Box modes can be setup if the presence scores (component body versus PCB background) does not differ significantly in 1 box mode.

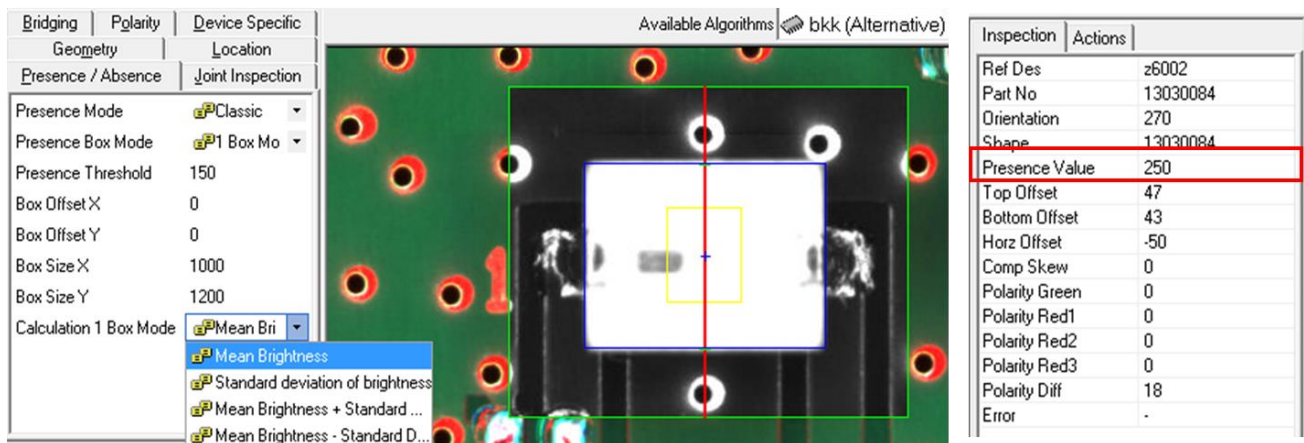


Figure 15: Presence/Absence – 1 box mode

Note:

- a. **-Positive Threshold:** Presence Value must be **greater than or equal to** Presence Threshold in order to pass.
-Negative Threshold: Presence Value must be **lesser than or equal to** Presence Threshold in order to pass.
- b. **** Search area size and offset threshold also depending on other factor such as pad size, if there is any surrounding component close by.**

5. **Setup in Joint Inspection:**

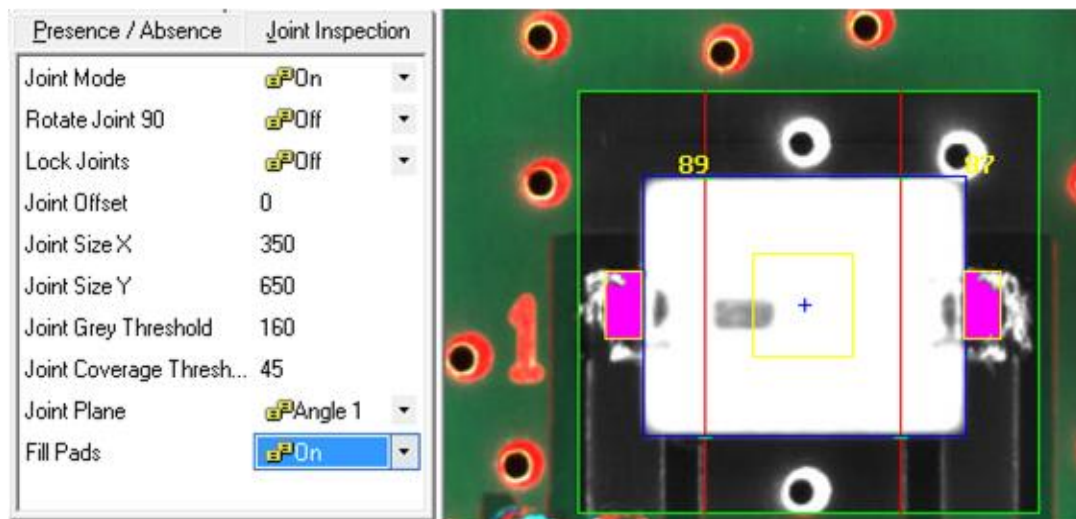


Figure 16: Joint Inspection Parameter Settings

- i. Ensure **'Joint Mode'** is turned **'On'**.

- ii. Ensure appropriate **'Joint Size X'** and **'Joint Size Y'** are setup. In C and R type, 2 joint boxes will be setup automatically at the end of the terminals/leads.
- iii. **'Joint Offset'** could be utilised if the joint boxes are required to be moved inward/outward.
- iv. Ensure that appropriate **'Joint Grey Threshold'** is setup. All areas with greyscale below this 'Joint Grey Threshold' will be coloured pink which represents for joint.
The grey scale is ranging from 0-255, but for chip capacitor and resistor, the typical range would be **150-180**.
- v. The recommended **'Joint Plane'** is **Angle 1**. Anyway, when the solder fillet is bright and contributes to high false fail (especially chip resistor), try switching to Angle 3 (90 degree angle lighting) and it would yield higher score in both of the joint boxes.
- vi. Ensure that appropriate **'Joint Coverage Threshold'** is setup. Joint check would pass when the score of the joint area from both the joint boxes are above this set 'Joint Coverage Threshold'. It should not be set too low to eliminate escape. Typically is set to **40-60%**, also depending on the Joint Grey Threshold set. The score of the joint area is represented in percentage, where 94 means that 94% of the total area within the joint box is considered having solder joint.
- vii. Click at **'Next'** or perform a **'Visit All'** to verify on the other similar package type.

Extra features:

- a. Fill pads is useful in finding joints by flooding the pad area outside the joint with light.
- b. Side fillet can be added to detect component absence presence especially on dark resistor. The side fillet window is set on the body of the resistor and it is measured by greyscale coverage % instead of the mean greyscale (the conventional presence/absence check).
Pls refer to side fillet setup in the later topic.
- c. Coverage including: insufficient solder joint, excess solder joint, lifted lead, non-wetting/unsoldered.

6. **Polarity** setup is required if it is polarized part

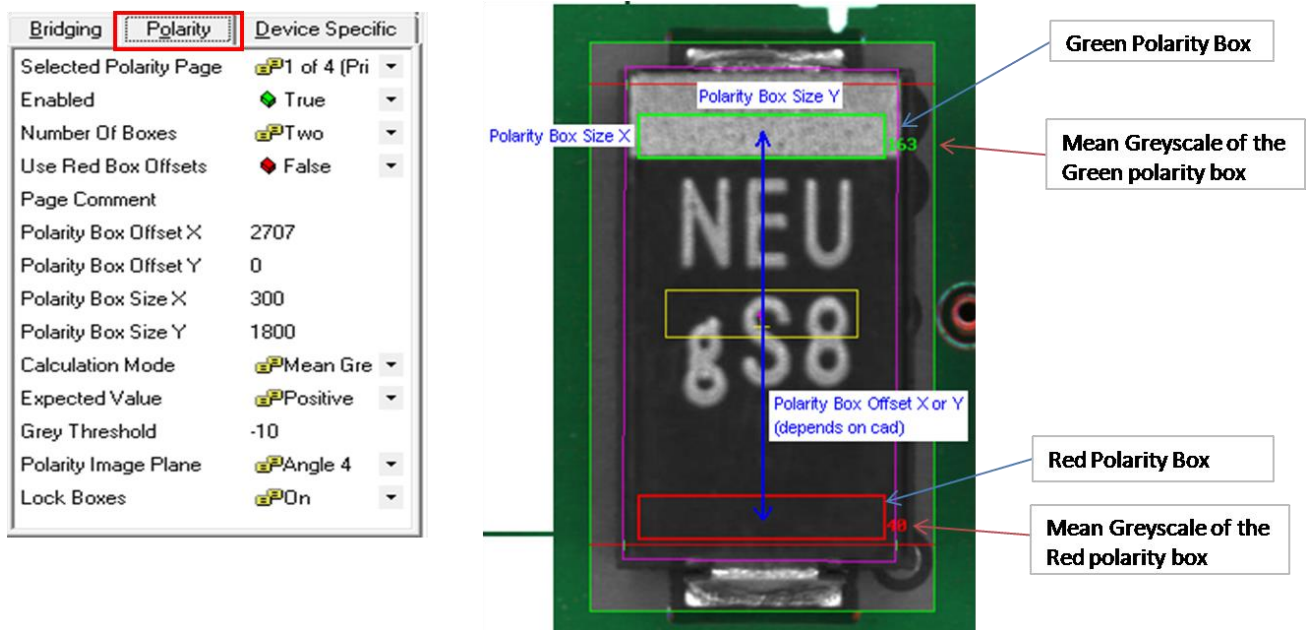


Figure 17: Polarity Inspection Parameter Settings

- i. Open up the '**Polarity**' tab.
- ii. If there's no alternate part for this component type, ensure that the '**Selected Polarity Page**' is set to apply only '**1 of 4**', which means only '1 of 4' is 'Enabled' option is set to 'True'.
- iii. In '**Number of Boxes**', ensure that '**Two**' is selected (2-box mode is commonly used for tantalum cap, IC and BGA, whereas 4-box mode is commonly used for square components such as square BGA) can be set to **On** so the green and red polarity boxes can be shifted to the most suitable position.
- iv. '**Use Red Box Offsets**' is normally set to '**False**'. For cases where the components where the polarity mark and the other end is not symmetry, the Red Box offset can be set to **On** so the green and red polarity boxes can be shifted to the most suitable position.
- v. Set up '**Polarity Box Size X**' and '**Polarity Box Size Y**'. The polarity box size should be of appropriate size to cover the desired inspected polarity stripes/marks.

- vi. For '**Polarity Image Plane**', scroll through all of the available options and observe on the changes appeared within the Green and Red polarity boxes set. Make sure that the image plane which contributes to greater differences in the Green and Red polarity boxes, as well as yields the highest value in 'Polarity Score' is chosen.
- vii. Ensure that appropriate '**Calculation Mode**' is selected. In this case, '**Mean Grey in Green Box - Mean Grey in Red Box**' should be chosen.
- viii. For this example, '**Expected Value**' should be set to '**Positive**' which means the polarity will be classified as PASS when 'Mean Grey in Green Box - Mean Grey in Red Box' yields Positive value.
- ix. Ensure that the '**Polarity Score**' is positive (and preferably with high value).
- x. Click at '**Next**' or perform a '**Visit All**' to verify on the other similar package type.

Extra features:

- a. Multiple page can be setup as alternate if required (**could be because of different component color due to vendor change**). There are up to **4 pages** available.
 - b. **OCV (Optical Character Verification)** algo can also covers polarity check other than gray scale difference on green-red box.
 - c. For tantalum capacitors (mixture of yellow and black tantalum), OCV check is recommended due to the changes of greyscale (black versus yellow).
7. **Bridging** is normally **not required**.

5. S TYPE

1. Setup in **Geometry**:

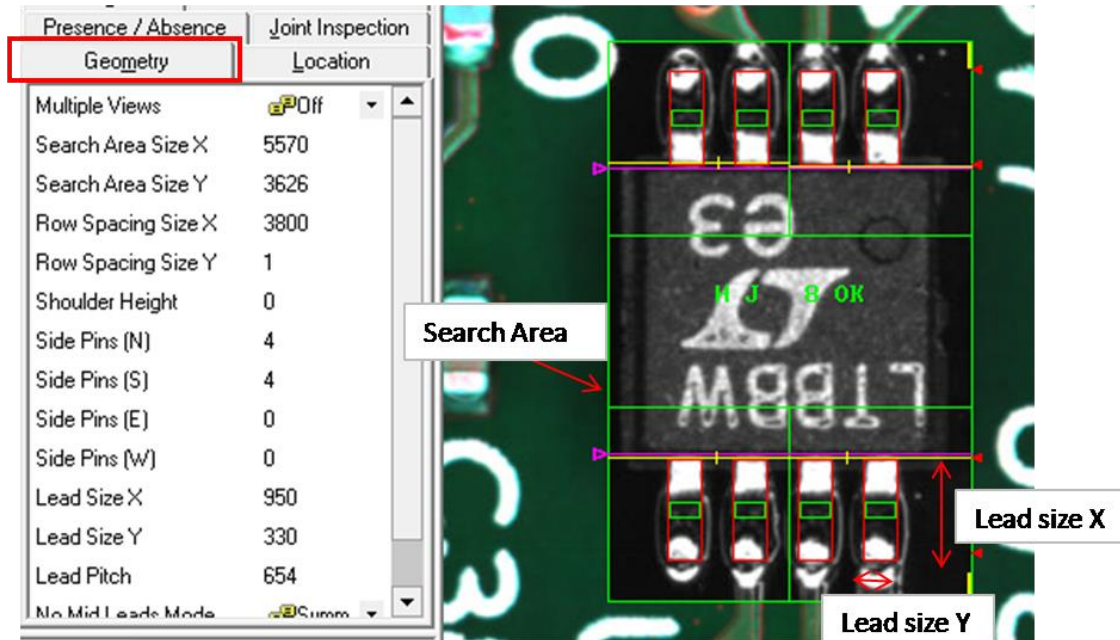


Figure 18: Settings

- i. **'Multiple Views'** is normally set to **Off** for common IC type (could be other options according to component type).
- ii. **'Search Area Size X/Y'** is set in the way it extends just beyond the pad geometries (recommended is beyond the pads 1.5 to 2 times one pad width to ensure the search area is wide enough to capture components that are shifted 1 pin or beyond IPC specifications).
- iii. Number of pin according to component lead on each side (north, south, east or west) is set correctly in **'Side Pins (N/S/E/W)'**.
- iv. **'Row Spacing X/Y'** should be set so the red boxes are lining up correctly over the rows of leads.
- v. **'Lead Pitch'** should be set so the red boxes are placed correctly over the rows of leads.
- vi. **'Lead Size X/Y'** should be set so the red box fits tightly around the lead.
- vii. **'No Mid Leads Mode'** defines how leads are removed. This is useful when there is pin(s) that can be skipped for checking.
- viii. **'No Mid Leads Num'** defines how many leads are removed from each side.

2. Setup in **Location**:

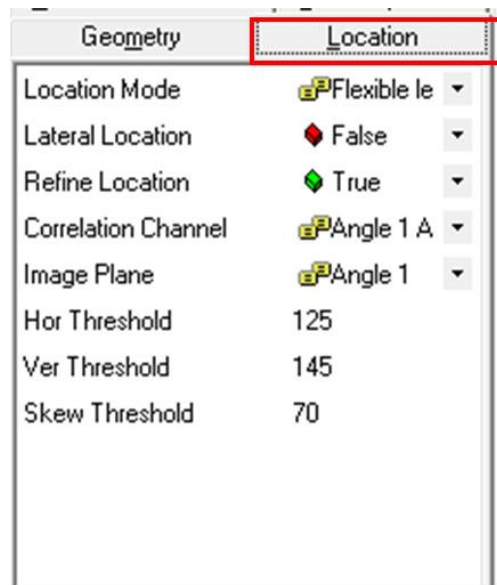


Figure 19: Location Settings

- i. Recommended setting for '**Location Mode**' is **Flexible Lead**. If the component is not being correctly located, then consider changing Location mode to **Correlation** or **Vector Mode**.
- ii. '**Lateral Location**' set to **False** (post-reflow) - This can assist during joint inspection in location of the joints.
- iii. '**Refine Location**' could be set to **True** to help location the component more accurately.
- iv. '**Image Plane**' is set to get the best image view (default is **Angle 1**).
- v. '**Correlation Channel**' is used to determine the image used for location (default is **Angle 1 and Angle 2**).
- vi. Confirm if the component is correctly locating and geometry is correct. Fine tune if required. Inspect on the component to ensure the inspected graphic locates correctly over the image such that the ends of the red boxes align over the ends of the leads (toe).
- vii. '**Horizontal Threshold**', '**Vertical Threshold**' and '**Skew Threshold**' setting is dependant on manufacturing criteria, however, suggested values are:

- ✓ **Hor Threshold - 50% of lead width**
- ✓ **Ver Threshold - 50% of lead width**
- ✓ **Skew - 100**

3. Setup in **Presence/Absence**:

Presence / Absence	Joint Inspection
Presence Mode	Classic
Presence Threshold	100
Green Box Offset X	0
Green Box Offset Y	0
Green Box Size X	160
Green Box Size Y	300

Figure 20: Presence/Absence Settings

Inspection	Actions
Ref Des	u80
Part No	1816-3425
Orientation	180
Shape	COMP SHAPE0052
Presence Value	149
Top Offset	17
Bottom Offset	14
Horz Offset	27
Comp Skew	1
Polarity Green	0
Polarity Red1	0
Polarity Red2	0
Polarity Red3	0
Polarity Diff	0
Error	-

Figure 21: Presence score



Figure 22: Sample of good setup of Green boxes on the leads

- i. Presence/absence check is set on component lead for S-algo (takes the average grey scale for the red lead boxes and subtracts the average grey scale for the green boxes (shoulder) to give a presence score).
Recommended **Presence Mode** for S-type is **Classic**.
- ii. Ensure the red leads are drawn around the leads of the component correctly, and green boxes outline the dark shoulder of the component, by clicking on 'Inspect' button.
- iii. Recommended **Presence Threshold** is **>80**, which is generally a good value for standard components, non-standard components may vary. User can perform a "Visit All" to inspect all the components under a same device type to obtain the details of results: Min presence value, Max presence value, Mean presence value etc. This can help user to determine the best presence threshold.

4. Setup in **Bridging**:

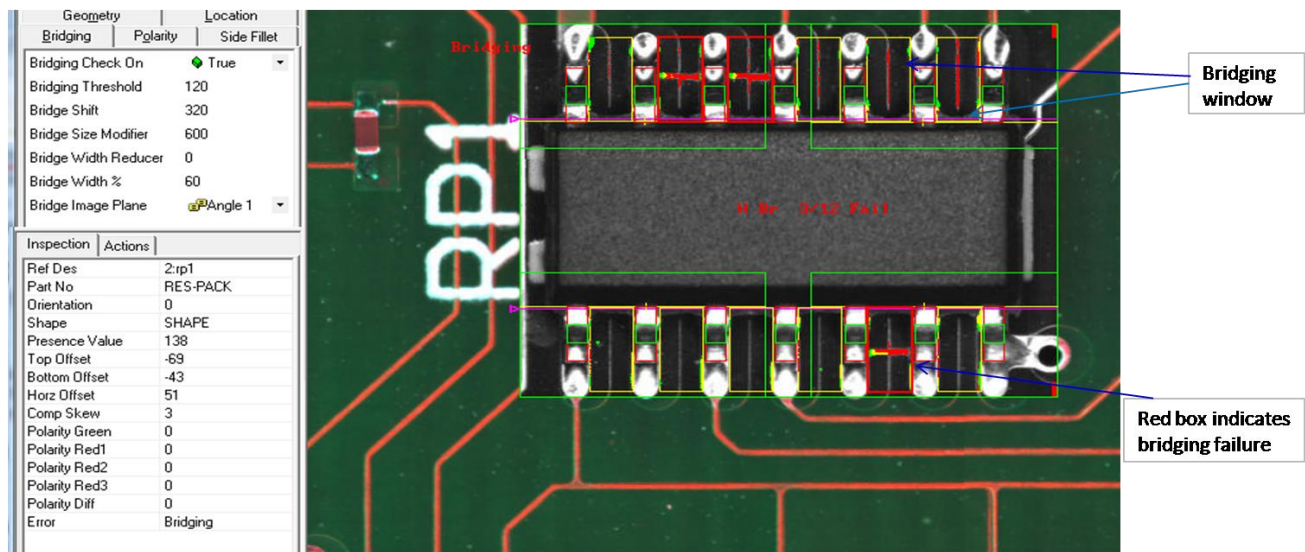


Figure 23: Bridging Parameter

- i. Go to '**Bridging**' tab. Ensure that '**Bridging Check On**' is turned to '**True**'.
- ii. Ensure that the yellow bridging boxes are setup correctly with '**Bridge Size Modifier**', '**Bridge Width Reducer**' and '**Bridge Shift**'. A good bridging window should cover from sides of 2 leads till end of the pads.
- iii. Ensure that the correct '**Bridge Image Plane**' is selected to give the best contrast between leads and background. **Angle 2** is usually a good image plane for bridging detection.
- iv. Ensure that '**Bridging Threshold**' is setup appropriately. Area/Pixel within the Bridging window with greyscale above this 'Bridging Threshold' will be considered as bridging, and the amount/length of this bridging will directly contribute to bridging calls. Typically, bridging threshold can be set to **160-200**.
- v. Ensure that '**Bridge Width %**' is setup appropriately to capture all the bridging defects. Bridging defect will pop up if the amount/length of the bright spot captured in step (4) exceeds 'Bridge Width %'.
- vi. Bridging windows with bridging detected will be highlighted in **RED**.

5. Setup in **Polarity**:

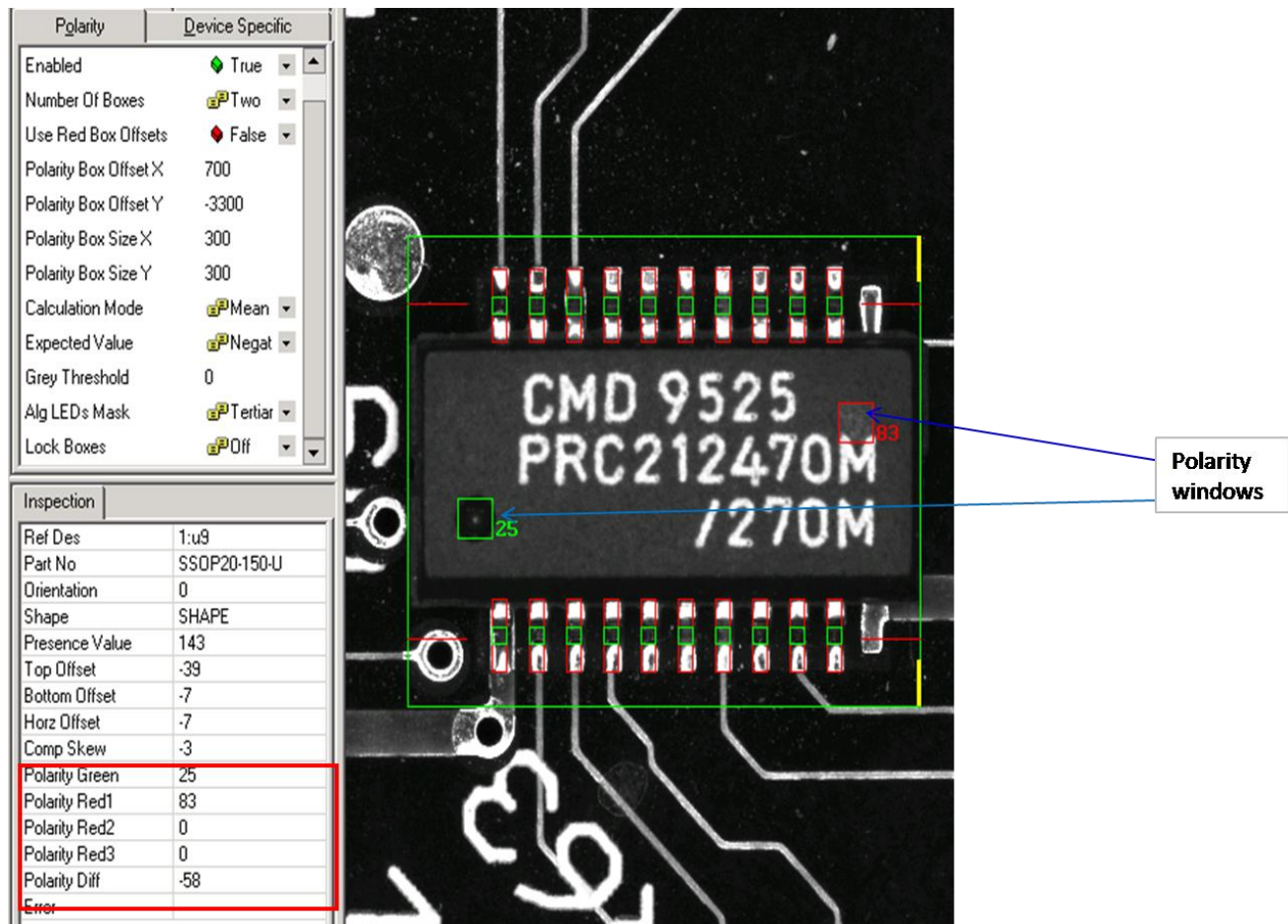


Figure 24: Polarity Parameter

- Open up the '**Polarity**' tab.
- If there's no alternate part for this component type, ensure that the '**Selected Polarity Page**' is set to apply only '**1 of 4**', which means only '1 of 4's' 'Enabled' option is set to 'True'.
- In '**Number of Boxes**', ensure that '**Two**' is selected (2-box mode is commonly used for tantalum cap, IC and BGA, whereas 4-box mode is commonly used for square components such as square BGA).
- '**Use Red Box Offsets**' is normally set to '**False**'. For cases where the components where the polarity mark and the other end is not symmetry, the Red Box offset can be set to **On** so the green and red polarity boxes can be shifted to the most suitable position.
- Set up '**Polarity Box Size X**' and '**Polarity Box Size Y**'. The polarity box size should be of appropriate size to cover the desired inspected polarity stripes/marks.

- vi. For '**Polarity Image Plane**', scroll through all of the available options and observe on the changes appeared within the Green and Red polarity boxes set. Make sure that the image plane which contributes to greater differences in the Green and Red polarity boxes, as well as yields the highest value in '**Polarity Score**' is chosen.
- vii. Ensure that appropriate '**Calculation Mode**' is selected. In this case, '**Mean Grey in Green Box - Mean Grey in Red Box**' should be chosen.
- viii. For this example, '**Expected Value**' should be set to '**Negative**' which means the polarity will be classified as PASS when '**Mean Grey in Green Box - Mean Grey in Red Box**' yields Negative value.
- ix. The polarity check is passed if the '**Polarity Score**' is lower than the Grey Threshold.
- x. Click at '**Next**' or perform a '**Visit All**' to verify on the other similar package type.

Note:

- a. Multiple page can be setup as alternate if required (**could be because of different component color due to vendor change**). There are up to **4 pages** available.
- b. **OCV (Optical Character Verification)** algo can also covers polarity check other than gray scale difference on green-red box.

6. OCV_OCR

1. OCV Setup:

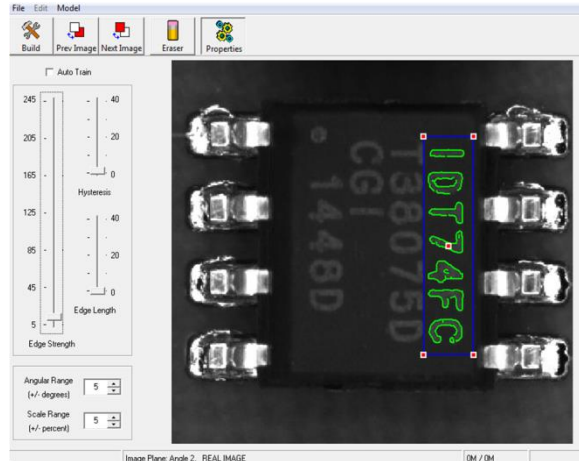


Figure 25: OCV Editor Window

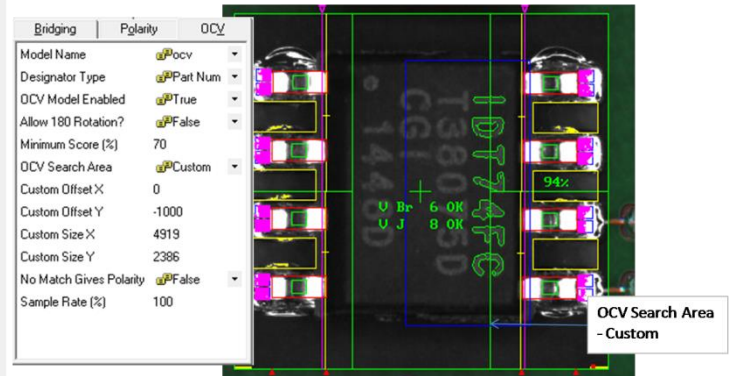


Figure 26: OCV Inspection Parameter Settings

- i. Go into the Algorithm Editor to Add OCV model and select the appropriate body marking region to be inspected (**avoid blurry marking, datecode..** etc.). Create the new OCV model by part number (or body marking characters) for easy identification.
- ii. **Autotrain** feature is usually good for auto detecting the marking outline. If it is not satisfactory, programmer can setup the OCV model by unchecking the Auto Train and manually adjusting the **Edge Strength**, and **Hysteresis**. **Angle 2** Image plane usually is the chosen angle, but it always depends on the marking quality, contrast etc.
- iii. **Allow 180 Rotation** shall be turned **False** for common **polarized parts**, except for non-polarized parts such as resistor.
- iv. **Minimum score** shall be set typically **60-70%**, depending on the quality/contrast of the body marking.
- v. **OCV Search Area** shall be set to **Custom**, and programmer shall setup the inspection search area covering **about 1.5 times of the body marking region**. This is to consider the offset tolerance of the marking position printed on the package body.
- vi. **No Match Gives Polarity** can be set to ON if programmer wants the OCV model check to **report polarity failure** as well when the OCV model failed. Else, set to True.

- vii. **Sample Rate** shall be set to **100% by default** in order to inspect the components under the same device type.
- viii. Click '**Inspect**' and observe the marking outline detected and the score/results read by the software. Passed OCV will be shown but there will be "**OCV fail**" error when the marking outline is detected does not match with the learned OCV model(s). This happened when the end results/score is **lower than the threshold** (**Minimum Score**) set.
- ix. Click at '**Next**' to verify on the other similar package type.

Note:

- a. OCV Search Area would impact the inspection time as well. It will incur in longer inspection time when there are a lot of OCV models assigned with large search area.
- b. Multiple page can be setup as alternate if required (**different component body marking due to vendor change**).

2. OCR Setup:

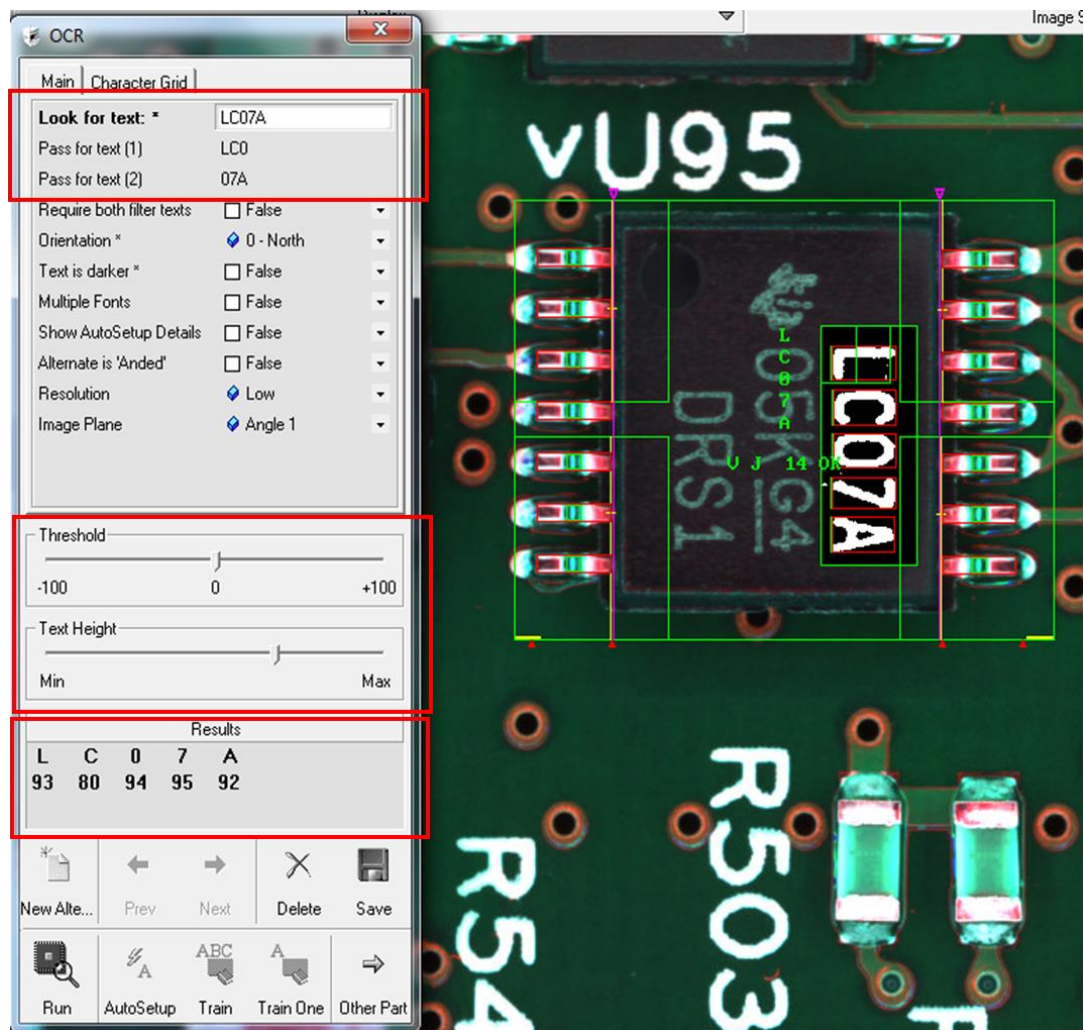


Figure 27: OCR Inspection Parameter Settings

Go to any S type with OCR turned on.

Ensure that the text/OCR box is drawn on the appropriate area to cover the desired inspected characters. The text/OCR box should be set slightly bigger than the actual characters.

- Select the device and right click to insert OCR region.
- Ensure that the markings/characters to be checked are sharp and continuous.
- Ensure that the OCR/Text box (in green color) is drawn to cover the exact markings/characters to be inspected, with some tolerances.

- iv. Ensure that the **'Text Height'** is setup correctly. This could be done by dragging the 'Text Height' from min-max and observe the clarity of the characters being read in each individual green rectangular box. If the 'Text Height' is setup correctly, each character should appear sharp and clear.
- v. Ensure that the **'Orientation'** is setup correctly. This refers to the green line displayed underneath each character/text. Correct 'Orientation' is important as it determines the orientation the character/text is being read.
- vi. Ensure that the **'Image Plane'** is setup correctly by toggling the various image planes available. A good image plane should project sharper and clearer text/characters.
- vii. Greyscale above/below **'Threshold'** will be considered as bright/dark to be read as character/text (this depends on 'Text is darker' option). Ensure 'Threshold' is setup correctly by observing the sharpness of the characters/text appear.
- viii. Ensure that **'Text is darker'** is turned on if the characters/text appear to be darker than the background/component surface.
- ix. 'Alternate is 'Ended'' could be used if alternate parts/characters/markings are observed.
- x. Observe the score of each character read (in percentage) in **'Results'**. If the text/character is read up sharp and clear, the score should be high.
- xi. Ensure that the **'Pass for text (1)'** and **'Pass for text (2)'** are setup correctly. 2 passing criteria area allowed here. * is used for common character.
- xii. Click **'Run'** and observe the Green characters/text appear besides the OCR box which indicate the results read by the software. Passed characters according to the 'Pass for text' criteria will be displayed in Green, whereas failed characters will be displayed in Red. Characters displayed in Yellow refers to common characters (with *) and will not contribute to the end results.
- xiii. Click at **'Next'** to verify on the other similar package type.

Note:

- a. OCV algo shall be used instead of OCR algorithm due to the easiness and reliability.

7. EXTRA PART

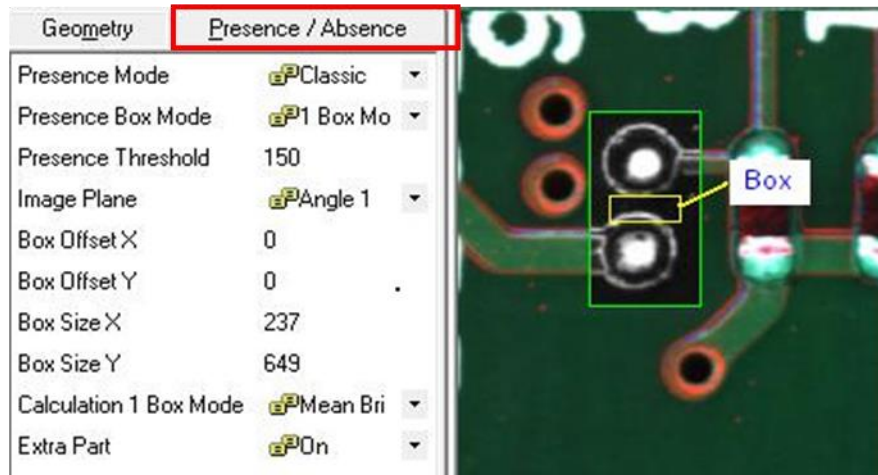


Figure 28: Presence/Absence Setting

1. Ensure that correct algorithm type is used. In this case, it should be D type.
2. In '**Presence/Absence**' tab, ensure that '**Extra Part**' is turn '**On**'.
3. Ensure that the box size is setup appropriately with '**Box Size X**' and '**Box Size Y**', and is located at the appropriate empty area (which is normally dark) where no component should be mounted on. The box is in yellow colour and it can be moved with '**Box Offset X**' and '**Box Offset Y**'. Normally the greyscale within this box is expected to be bright with the existence of a foreign material/part.
4. Ensure that the correct '**Image Plane**' is selected by toggling the available image planes. A good image plane should yield high contrast between the empty area and when a foreign material/part exists.
5. Ensure appropriate '**Presence Threshold**' is setup. Presence Threshold refers to the maximum grey scale allowable in yellow box (in reversed to populated components). 'Extra Part' error will pop up once the average greyscale within the yellow box exceeds the 'Presence Threshold' set.

Extra features:

- a. Various 'Presence Box Mode' could be used depending on the contrast between the empty area against foreign material/part.
- b. OCI could be used for extra part checking as well.

8. APPENDIX

0402 Chip Res Black Color

What is 0402 Chip Res Black Color?

0402 Chip Resistor – Black Color

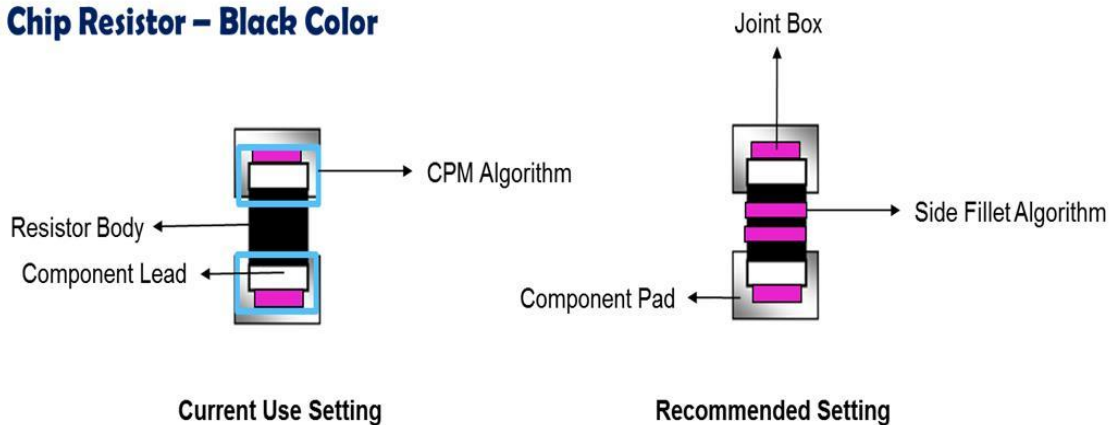


Figure 29: Settings

Step in practicing of AOI Fine Tuning in 0402 Chip Res Black Color

1. Turning **OFF** CPM

Change any value at CPM Threshold to 0

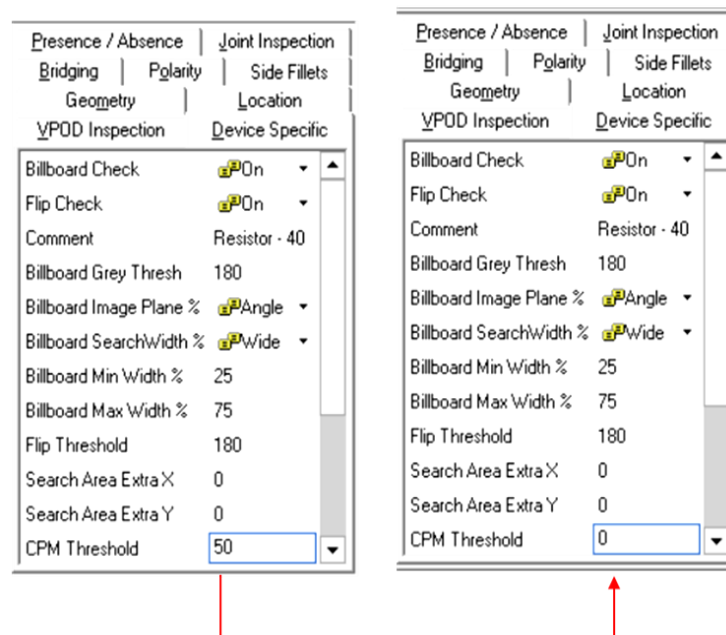


Figure 30: CPM Setting

2. Turning **ON** Side Fillet

- Enable side Fillets, False to True
- Follow all the setting at the figure 32
- Paste Fail as change from Bad Joint to Missing (defect name)

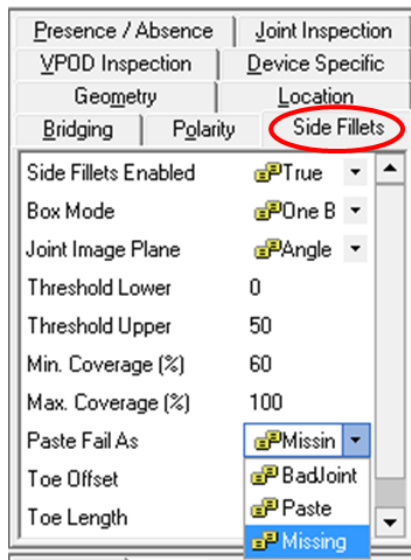


Figure 31: Side Fillet Setting

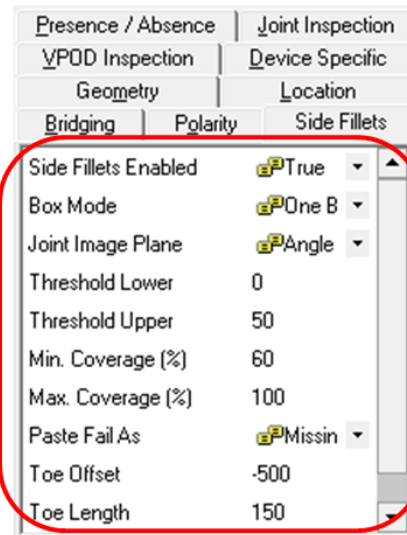


Figure 31: Side Fillet Setting

3. Recommended **Joint Setting**

Ensure angle 3 used for sector joint inspection Joint Coverage Threshold recommended is about 50-70.

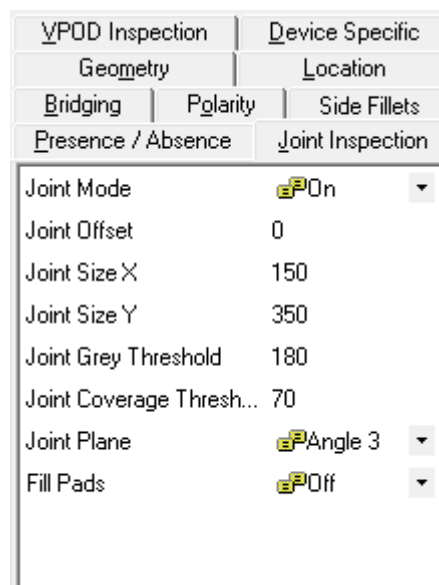


Figure 33: Joint Setting

4. Recommended **Absence/Presence** Setting

At Presence Threshold value 0-40 (Make it to pass inspection only).


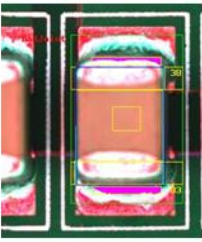
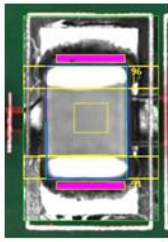
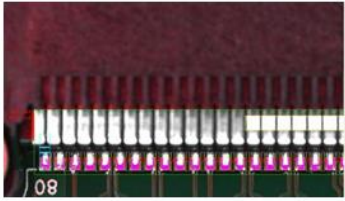
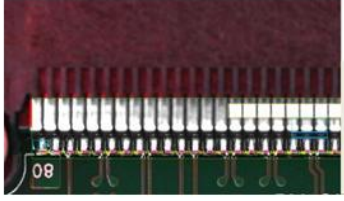
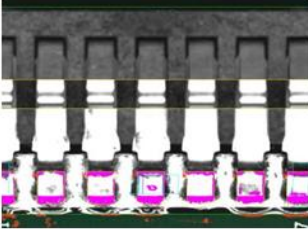
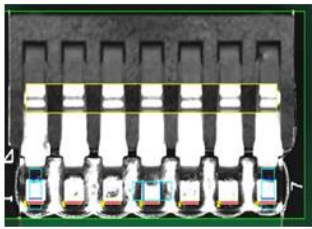
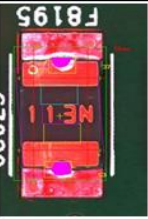
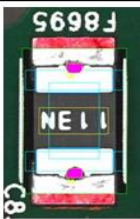
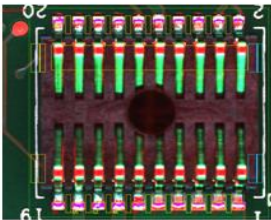
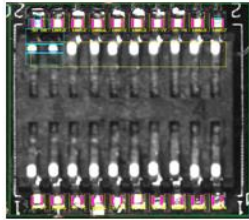

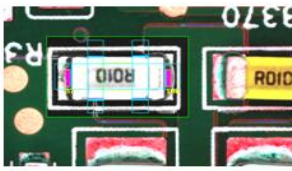
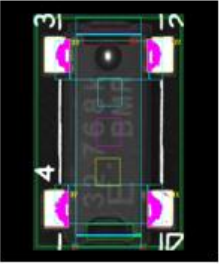
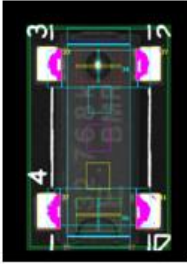
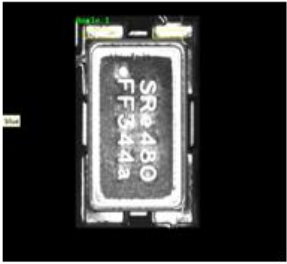
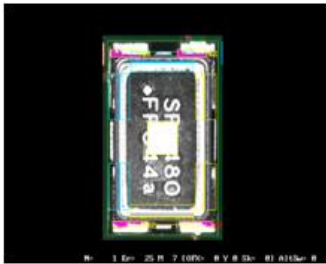

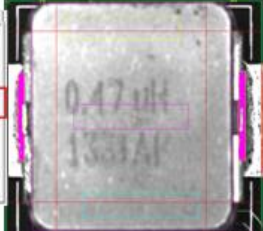


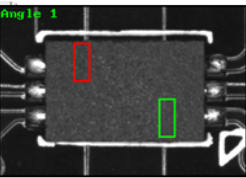
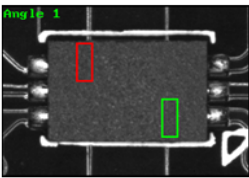

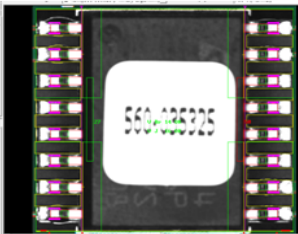
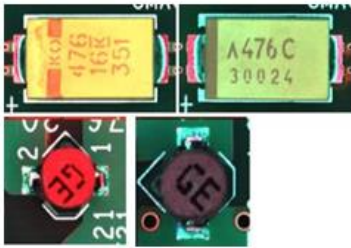
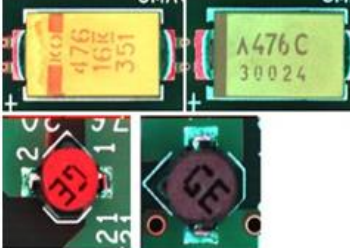
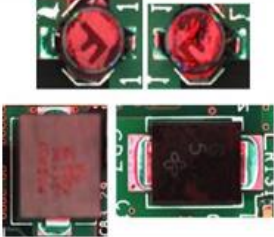
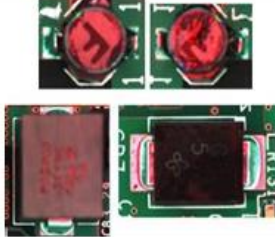


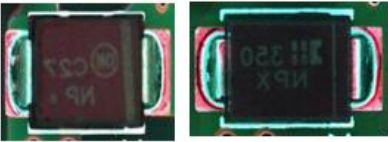
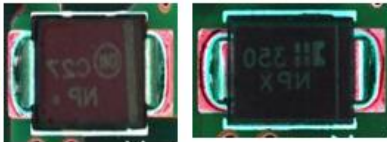
VPDD Inspection		Device Specific	
Geometry		Location	
Bridging	Polarity	Side Fillets	
Presence / Absence		Joint Inspection	
Presence Mode		 Classic ▼	
Presence Threshold		0	

Figure 34: Absence/Presence Setting

Before			After		
Image	Algorithm used	Remark	Image	Algorithm used	Remark
	C-type	False call on bad joint due to the joint box locating on component lead as the component locator box (blue color) is smaller than actual component size.		C-type	Change the locator size to fit the component size, readjust joint size.
	U-type	Joint box too big for the leads which will cause potential escapee		U-type	Adjust locator and reduce joint box size to cover end of leads.
	U-type	Joint box too big for the leads which will cause potential escapee		U-type	Use pin to set on the location (use the most contrast angle to perform this) and readjust the joint box size.

Before			After		
Image	Algorithm used	Remark	Image	Algorithm used	Remark
	B-type	High false fail on offset and skew due to locator unable to locate properly		U-type	Re-assign to u-type, find the most contrast area and use bright box locator to locate to cover offset check.
	U-type	Joint box too big for the leads which will cause potential escapee. Locator box at side of component body, potential shift due to noise cause by silkscreen.		U-type	Use pin to set the locator (use the most contrast angle to perform this) and readjust the joint box size.
	B-type	High false fail on offset and skew due to locator unable to locate properly		U-type	Re-assign to u-type, find the most contrast area and use bright box locator to locate to cover offset check.

Before			After		
	U-type	Polarity score is low due to low contrast difference between the polarity boxes (green minus red). This leads to a potential escapee		U-type	Change polarity type to "edge find, dark inside"(detecting the dark dimple mark) in which the opposite terminal has no round dimple mark.
	U-type	Angle 2 chosen has lower contrast compared to background (PCB) which the score of absence versus presence would be almost same. This could lead to an escapee. (component body is darker versus PCB but the bright body marking would lead to a similar score).		U-type	Angle 3 has strong contrast on component body comparing to angle 2. This increases the absence/presence score (bright when component present, dark when component absent)
	B-type	Body offset is not '0', which means locator is not at component centroid. This causes inaccuracy in locating the component and joint box is not locating the right position.		B-type	Body offset set to '0'. Joint boxes are located at correct position.
Before			After		
	B-type	Angle 2 chosen has lower contrast compared to background (PCB) which the score of absence versus presence would be almost the same. This could lead to an escapee. (component body is darker versus PCB but the bright body marking would lead to a similar score).		B-type	Angle 1 has better contrast of component body versus PCB color. This increases the absence/presence score difference. (bright when component present, dark when component absent).
	U-type	Absence/presence threshold is in -ve (lower than) value. By comparing the greyscale of the component body versus the PCB, it should be in a positive value since the body is brighter than the background (greyscale score higher).		U-type	Change presence threshold to positive value (greater than).
	S-type	Joint box (side fillet) is placed at end of lead but the contrast of fillet is not obvious. This may lead to false calls or escapes.		S-type	Move side fillet windows to side of leads, increase grey threshold to 180 instead of 200. Side fillet windows shall sit besides the lead from the knee until slightly exceeded end of lead.

Before		After	
	OCV False call contributed by alternate supplier		OCV Used of alternate algorithm to support the marking variance from different supplier
	OCV False call due to poor and blur body marking		OCV Body marking printing quality which cannot be controlled contribute to unclear and blur marking. This will lead to false call.
	OCV High false call during AVL change. Learn and inspect the date code instead of part number		OCV To learn and inspect the part number instead of date code. Change of AVL supplier, the date code can be different, but the part number remains the same.
	OCV High false call during AVL change, it will cause wrong part (different body marking) and polarity (different polarity line)		OCV The best practice to reduce the false call is to create more alternate algorithm from all different AVL.

9. REVISION HISTORY

Version	Date	Summary of Changes	Author	Remarks
01	31 August 2015	Initial release	Piet Gek Tan	