

ViTrox Corporation Berhad

3D AOI:
3D AOI Algorithm Best Practice Cookbook



Revision History

Revision	Type Of Change	Date	Author
1.00	3D CR Type Algorithm Best Practices	9th Jan 2018	KHOO CHUN YENG
2.00	3D AOI Algorithm Best Practices [C,R, B, S-Type]	9th March 2018	TEOH CHAI LING
3.00	3D AOI Algorithm Best Practices [C,R, B, S-Type]	16th March 2018	KHOO CHUN YENG

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Important Notes

- a) The setting of the best practice cookbook is based on general standard specification.
- b) The suggested setting is based on Vitrox's testing PCB, which is known as Vitrox Test Vehicle.

Tips:

- 1. The setting shall base on customer's KGB (known as good board) condition.***
- 2. Minimum 10 PCB needed during fine tuning to monitor and maintain false calls***

1.0 Introduction

1.1 Presence/Absence

To determine whether a component is in placed where it supposed to present. The algorithm is comparing the mean greyscale (2D mode) or height (3D mode) of component to **Presence Threshold** to determine whether the component is present or absent.

3D mode: The measured height of component body is larger than [**Missing Threshold(%) * Component Height($\mu\text{m})$)] will pass as a component is present. Else, Missing will be reported when the percentage of a measured height is lower than the value in **Missing Threshold(%)**.**

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.

2D mode: Pixels under **Joint Grey Threshold** are considered part of joint and colored in pink.

3D mode: Height of joint measured above **Joint Height Threshold** are considered part of joint and colored in pink.

Joint Coverage Threshold defines the minimum percentage of pixels in joint box that must be colored pink for the joint to pass.

1.4 Bridging

To check for solder bridges between leads and pads.

2D mode: 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.

3D mode: Any height measured inside the yellow bridging box that is higher than the **3D Bridging Height & Size Threshold** is considered to be part of the potential solder bridge.

1.5 Polarity

To determine whether polarized components are placed properly.

2D mode: The theory is to assign 2 boxes (4 boxes) on the package body, and specify which box should be brighter (or darker) if the component is oriented correctly.

3D mode: The theory is to assign 2 boxes (4 boxes) on the package body, and measures the height difference between Green Box and Red Box to determine they are placed with correct orientation.

1.6 OCV/eOCV/OCR

Optical Character Verification, OCV is used to identify texts or logo. Optical Character Recognition, OCR allows user to create program 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/Tombstone

To detect *Billboard/Tombstone* (side standing) components.

2D mode: A part is considered to be billboard if there is an area of the body that is brighter than **Billboard Grey Threshold** and between **Billboard Min Width %** and **Billboard Max Width %** in width.

3D mode: A part is considered to be billboard if the measured height of component body size is larger than the total height of **Component Height(μm)** and **Billboard Threshold(μm)**.

1.8 Flip

To check for flipped (upside down) component. **Flip Threshold** determines if the mean intensity of the centre of the component is greater than the Flip Threshold, the component will fail as flip if flip check setting “ON” .

1.9 Extra Part

This allows user to check specific locations to make sure no component is placed on non-population location.

2D mode: Will fail if the presence score > **presence threshold** when **presence threshold** is positive value (> 0) ; or if the presence score < absolute value of the **presence threshold** when the presence threshold is negative value (< 0)

3D mode: Will fail as extra part if the height measured within component search area is larger than all the 3 threshold, which is **Foreign Height Threshold**, **Foreign Gray Threshold** and **Foreign Size Threshold**. **Foreign Mask Width Expand(μm)** and **Foreign Mask Length Expand(μm)** is set to masking area extended from the component body.

1.10 Lifted Lead

To check if the leads of the component are correctly placed and also to detect bent, lifted or missing leads.

3D mode: Lead height measured lower than ***L1 Missing Lead (μm)*** will be captured as missing lead while lead height measured higher than ***Lifted lead threshold (μm)*** will be captured as lifted lead.

1.11 Coplanarity

To determine the acceptance of maximum distance between the physical contact points of a surface mount device (SMD) and the seating plane.

3D mode: Height difference measured between 2 ROIs (either vertical or horizontal). When measured height difference is higher than ***Coplanarity Threshold Vertical(μm)*** or ***Coplanarity Threshold Horizontal(μm)*** will be captured as coplanarity.

1.12 Damaged

To check if the component body is damage from the appearance.

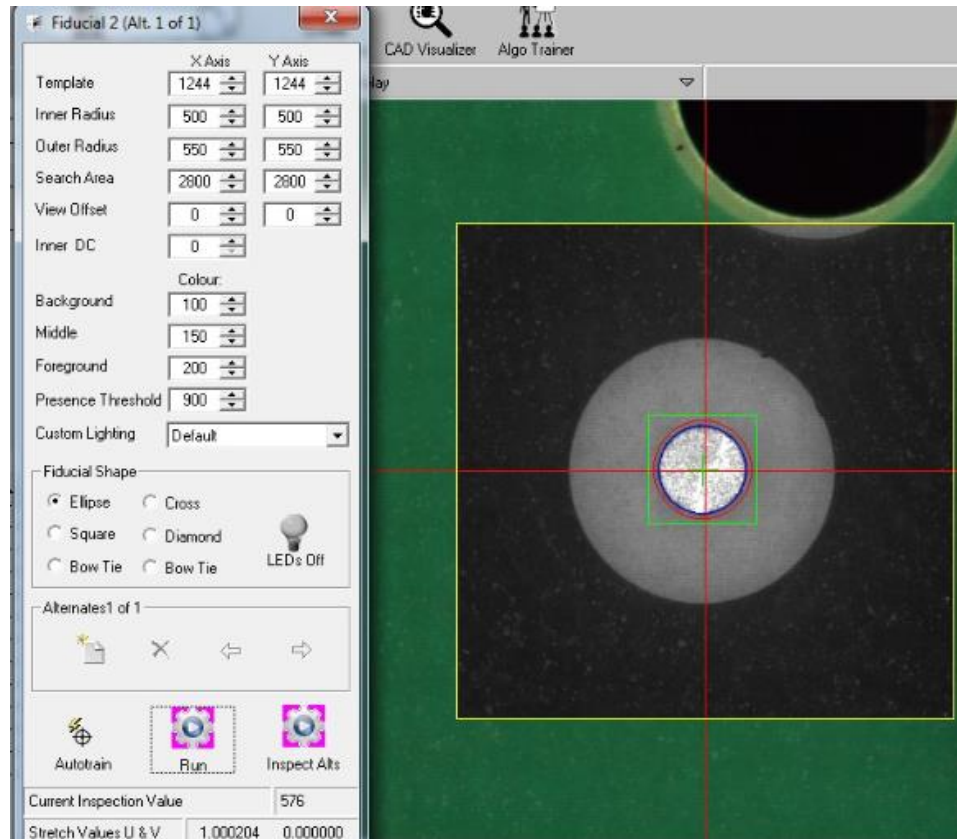
3D mode: 8 ROIs will be measured. The absolute height difference between any of one ROI's height and component's height higher than the ***Damaged Threshold(μm)*** will fail as Damaged.

1.13 Barcode

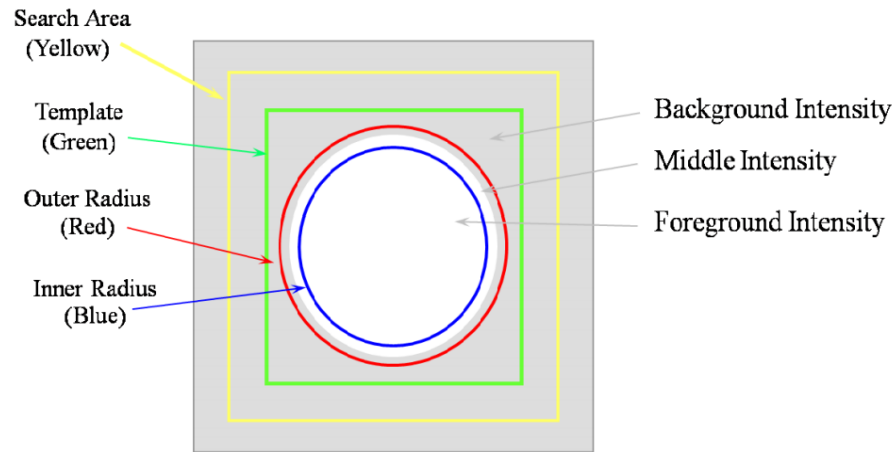
The software allows 1D/2D barcodes to be read using machine camera by using U-type algorithm.

2.0 Fiducial Setup

Fiducial feature on the board that the V510 AOI uses to align the system to the coordinates of the board. The V510 automatically carries out 2D inspection to determine the location of the fiducials.



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 & OuterRadius. 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 turned off (set to 0).
6. ***Inner DC*** means to exclude the “dirty” area residing inside the inner part of the fiducials. It should only be applied when the dirty area in the inner part of the fiducial creates a significant impact on 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 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 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. **Inspect** and observe the value obtained in **Current Inspection Value**. The above parameter should be set appropriately in order to get the highest score for “Current Inspection Value”.
13. **Current Inspection Value**, ensure that an appropriate **Presense Threshold** is set. Presense threshold should not be set too loose (**typically > 700**).
14. **Custom lighting** custom_#no.txt stores the lighting setting information. User may change the lighting configuration in the file.
15. **Alternate** fiducial can be set when necessary (eg. When there is different fiducial sizes or shapes)

C&R Type

1. Enable 3D switch in **3D Inspection** tab.
2. To locate the component, **body size** in **Geometry** and **Component Height(μm)** in **3D Inspection** tab must be setup correctly.
*Alternatively, right-click on component body to **Auto fill body** for body size setup and **Update Body Height** to setup component height.*



3.0 C&R Type

3. Setup in **Geometry** :

- 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.

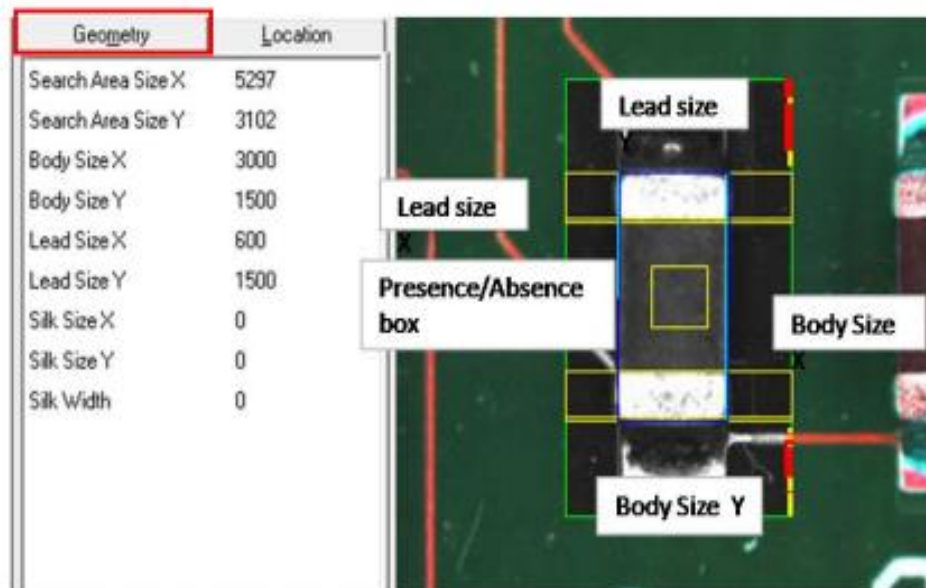
Recommended value is 1.5 times larger than body size in the vertical direction.

- ii. '**Body size X/Y**' is set with the blue box is around the body as shown in the attached sample.

Software will auto locate when clicking on 'Auto Fill Body'

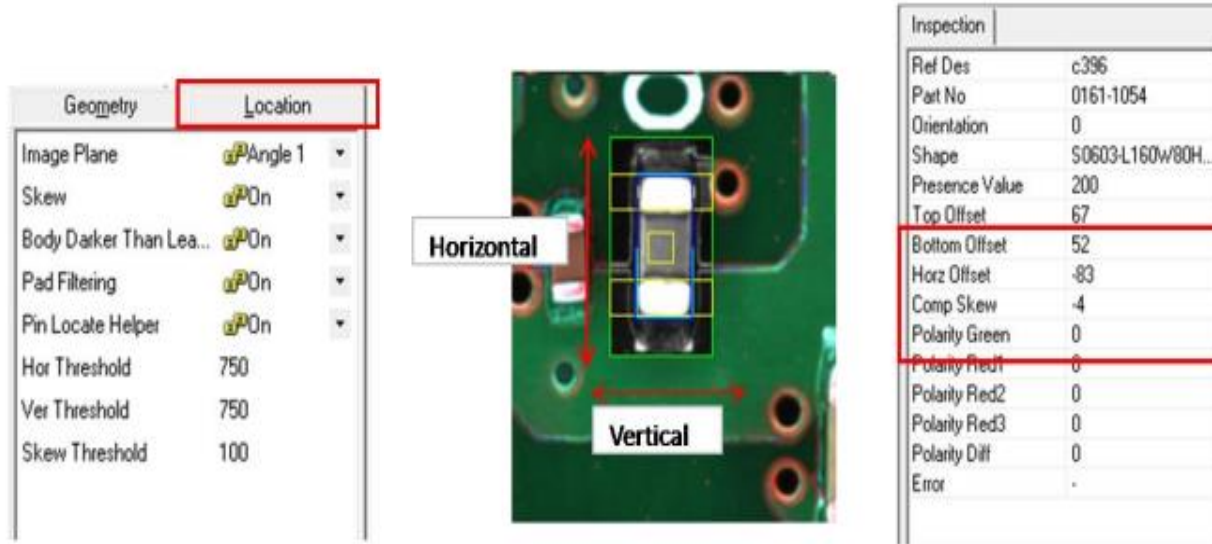
- iii. '**Lead size X/Y**' (for chip) is setup where lead size y is the same as body size y. Lead size x will determine the width of the leads in long axis and can be seen from the yellow lines going across the search area.

This is typically set between 25% and 50% of lead size y



Geometry Parameter Settings

4. Setup in **Location** :



- i. '**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.

This is only applicable when turn on 2D locator.

- ii. '**Skew**' is turn to On. This enables skew measurement and recommended for both capacitor and resistor.

- iii. '**Body Darker Than Lead**' set to On if body of component is darker than the terminal/lead.

This is only applicable when turn on 2D locator.

- iv. '**Pad Filtering**' set to On to help with the location of both capacitor and resistor in the long axis (horizontal).

This is only applicable when turn on 2D locator.

- v. '**Pad Locate Helper**' set to On to help with the location of both capacitors and resistors in the long axis (vertical)

This is only applicable when turn on 2D locator.

vi. If the component is correctly locating and geometry is correct then set **Horizontal Threshold**, **Vertical Threshold** and **Skew Threshold**.

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

Recommended Parameter table:

	Body Size X	Body Size Y	Hor Threshold (um)	Ver Threshold (um)	Skew Threshold
01005	400	200	60 - 100	60 - 100	60
0201	600	300	80 - 150	80 - 150	80
0402	1000	500	160	180	100
0603	1600	800	300	300	100
0805	2000	1250	300	300	100
1206	3200	1600	300	300	100

Tips:

- ***These parameters are for user reference.***
- ***The actual threshold, need to rely on the design of the actual board.***
- ***If the components layout is very close to each other or with small pad design, the threshold must be tighten (set to smaller value)***

5. Setup in **3D Inspection** :

- i. '**3D Main Switch**' should be set to Enable to enable 3D inspection.
- ii. '**2D Locator**' should be set to **Disable** for normal 3D inspection. Only set to **Enable** if unable to locate component by 3D. Normally it could be applied when there is tall component nearby.
- iii. Recommended to set the '**3D Locator**' to '**Auto2D + 3D**'. Software would auto choose the best 2D angle with 3D locator.

3D Main Switch	 Enabl 
2D Locator	 Disabl 
3D Locator	 Auto2 

- iv. '**Component Height (μm)**': Right click on component, click **Update Body Height** then the software will auto learn the component height and auto-fill in the height value.



5. Setup in 3D Inspection :

- v. **'Billboard Threshold (μm)'** is normally set to 50 - 100. Please refer the table in next slide for reference.
- vi. **'Billboard 2D'** is normally Off. Enable to turn on 2D billboard inspection. The algorithm will perform 2D + 3D inspection. Either 2D or 3D algorithm detects billboard failure, the inspection will fail the component as billboard.

For small resistor such as R0402, R0201, R01005 are recommended to Enable 2D billboard. The height difference may be too small when billboard. Please refer to page 18 for more details settings.

Component Height(um) 489

Billboard Threshold(um) 150

Billboard 2D  On



5. Setup in **3D Inspection** :

vii. '**Missing Threshold (%)**' is normally set to 70%. Please refer to table below for reference.

viii. '**Missing Location**' is normally set to Center. Please refer to table below for reference.

Recommended Parameter table:

Package	Billboard Threshold (um)	Billboard 2D	Missing Threshold (%)	Missing Location
01005	50	Enable	70	Center
0201	80	Enable	70	Center
0402	100	Enable	70	Center
0603	100	Disable	70	Center
0805	100	Disable	70	Center
1206	100	Disable	70	Center

Tips:











i) *Billboard is normally turn on for resistors and some capacitors only (0805 and above). This is because chip capacitors are square in shape for 0603 and smaller packages (0402, 0201, 01005).*

ii) *There is **no switch to turn off 3D Billboard checking** for small capacitors, user can disable the Billboard checking in 3D mode by **setting the threshold to a larger value (>300)** to by-pass the checking.*

5. Setup in **3D Inspection** :

- ix. '**Coplan Location**' is normally set to 80%. Please refer to table below for reference.
- vii. '**Coplan Alternate**' is normally set to 60%. Please refer to table below for reference.
- viii. '**Coplan Threshold Vertical(μm)**': Please refer to table below for reference.
- xi. '**3D Coplan Horiz Switch**' is normally set to Enabled.
- xii. '**Coplan Threshold Horizontal (μm)**': Please refer to table below for reference.
- xiii. '**3D Damaged Switch**' : Please refer to table below for reference.
- xiv. '**Damaged Location**' : Please refer to table below for reference.
- xv. '**Damaged Threshold(μm)**' : Please refer to table below for reference.

Damaged switch usually OFF for small component

Coplan Location	 80% o	
Coplan Alternate	 OR 6	
Coplan Threshold Verti...	100	
3D Coplan Horiz Switch	 Enabl	
Coplan Threshold Hori...	100	
3D Damaged Switch	 Enabl	
Damaged Location	 80% o	
Damaged Threshold(um)	200	

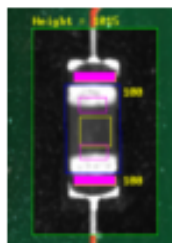
Coplan Location	80% o
Coplan Alternate	OR 6
Coplan Threshold Verti...	100
3D Coplan Horiz Switch	Enabl
Coplan Threshold Hori...	100
3D Damaged Switch	Enabl
Damaged Location	80% o
Damaged Threshold(um)	200

- ix. '**Coplan Location**' is normally set to 80%. Please refer to table below for reference.
- vii. '**Coplan Alternate**' is normally set to 60%. Please refer to table below for reference.
- viii. '**Coplan Threshold Vertical(μm)**': Please refer to table below for reference.
- xi. '**3D Coplan Horiz Switch**' is normally set to Enabled.
- xii. '**Coplan Threshold Horizontal (μm)**': Please refer to table below for reference.
- xiii. '**3D Damaged Switch**' : Please refer to table below for reference.
- xiv. '**Damaged Location**' : Please refer to table below for reference.
- xv. '**Damaged Threshold(um)**' : Please refer to table below for reference.
Damaged switch usually OFF for small component

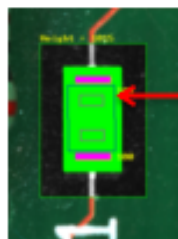
Recommended Parameter table:

Package	Coplan Location	Coplan Alternate	Coplan Threshold Vertical (um)	Coplan Horizontal Threshold (um)	Damage Location	Damage Threshold (um)
01005	90	60 - 80	40	40	Disable	--
0201	90	60 - 80	50	50	Disable	--
0402	80	60	80	60	80	200
0603	80	60	100	60	80	200
0805	80	60	100	60	80	200
1206	80	60	100	60	80	200

xiv. **'Foreign Object Detection'** Normally **On**. Need to ensure the search area of the component does not overlap the components surrounding.



Normal View by select
"Enable"

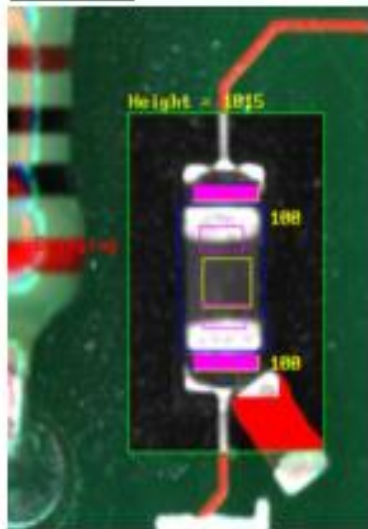


Masking View by select
"Enable Masing Dsp"

- This area is excluded from foreign material detection.
- This area must cover the pad area to avoid false call



Example:







Setting:

Gray Threshold : 50
Height Threshold : 150
Size Threshold : 100

case	Measured Gray value	Measured Height Value (um)	Measured Size (um)	Result
1	80	20	40	PASS
2	20	300	200	PASS
3	80	300	40	PASS
4	80	300	200	FAIL

6. Setup in **Device Specific** (to check 2D billboard) :

- i. **'Billboard Check'** 2D billboard check only ON for small Resistor such as R0402, R0201, R01005. The height difference may be too small when billboard.
- ii. **'Flip Check'** set to **On** for resistor.
- iii. Ensure the **'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. **Flip check is commonly turned on resistor only, or on components which surface and flipped surface are with significant contrast.**
- iv. **'Billboard Grey Threshold'** sets the grey threshold above which pixels are considered to contribute to a billboard. It's normally set at 160.

Billboard Check	 On	▼
Flip Check	 On	▼
Comment	Resistor - 40	
Billboard Grey Thresh	160	
Billboard Image Plane %	 Angle	▼
Billboard SearchWidth %	 Wide	▼
Billboard Min Width %	25	
Billboard Max Width %	70	
Flip Threshold	180	

- v. Ensure that the correct '**Billboard Image Plane**' is selected to give the best contrast between component and background.
- vi. Component's width inspected in between '**Billboard Min Width %**' and '**Billboard Max Width %**' will be considered as Billboard. Refer to the table in next slide for recommended settings.
- vii. 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)].

Recommended Parameter table:

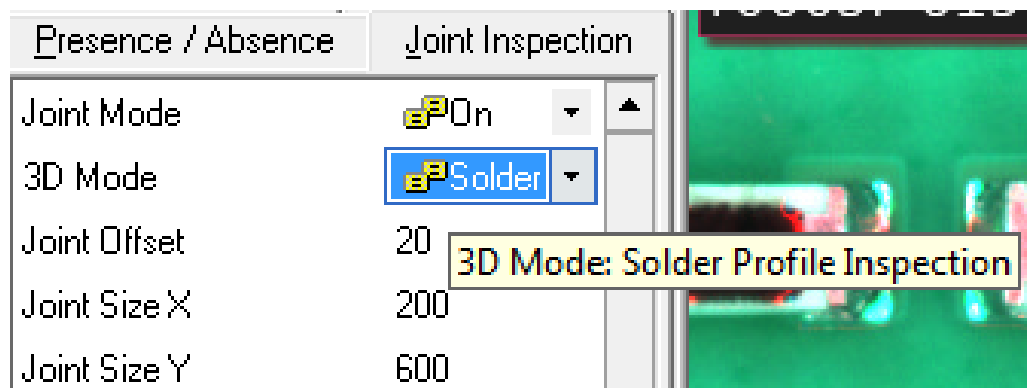
	Capacitor	Resistor
Billboard Grey Threshold	160	160
Billboard Min Width %	30	25
Billboard Max Width %	80	70

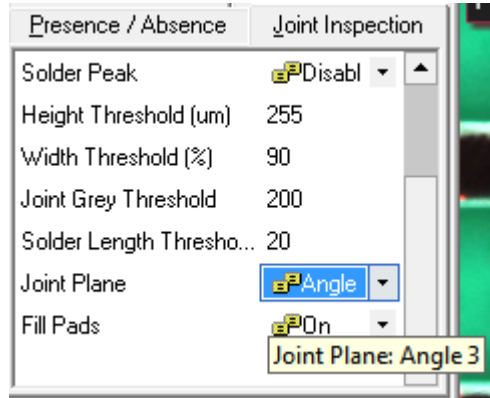
Notes :

2D Billboard is normally turned “ON” for resistor and some capacitor only (0805 and above). This is because chip capacitor is square in shape for 0603 and smaller packages such as 0402,0201 and 01005.

7. Setup in **Joint Inspection** :

- i. Turn on '**3D mode**' and recommend to select **Solder Profile Inspection**.
- ii. Setup location of the joint box
 - '**Joint Offset**': Joint box have to slightly offset from the body, 20um to 40um. This is important for insufficient & non-wetting solder detection.
 - 0402, 0603: offset 20µm to 30µm
 - 0805, 1206 & etc: offset 40µm to 50µm
 - Width of the joint box can be setup approximate to 90% of terminal width in '**Joint Size Y**'.
 - Length of the joint box shall be setup to cover 50-80% of the pad area from lead tip to the end of pad in '**Joint Size X**'.





iii. **'Solder Peak'** is enabled to detect the solder peak, normally “OFF”.

iv. **'Height Threshold (μm)'** which indicates the threshold of solder height should set to 50.

This setting affects the score of solder width and solder length.

v. **'Width Threshold (%)'** normally set to 40 to 50 as solder profile threshold for the width of the solder box.

Pass/ Fail indicator.

vi **'Joint Grey Threshold'** grey scale is ranging from 0-255. For chip capacitor and resistor, the typical range set would be 130 to 160.

This setting affects the score of solder width and solder length.

vii. **'Solder Length Threshold(%)'** measure expected solder length, which normally set to 40% to 60%.

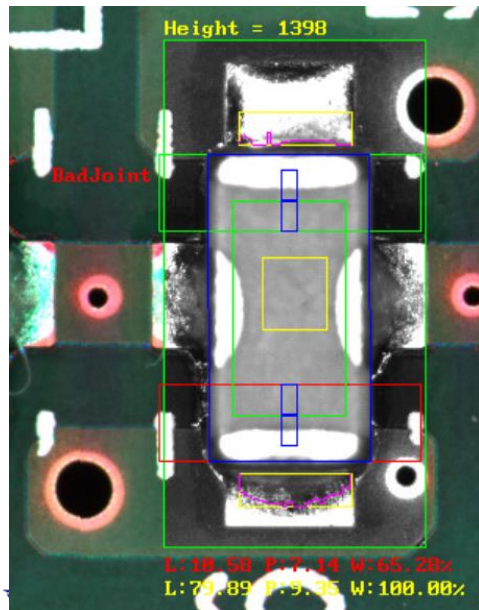
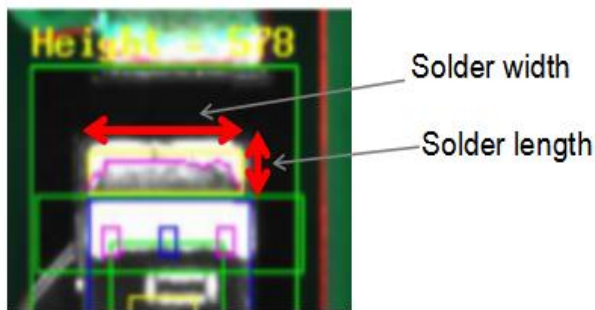
Pass/ Fail indicator.

viii. **'Joint Plane'** set to Angel 3 (90 degree angle lighting) yield a higher score in both joint boxes and avoid the bright solder fillet which contributes to high false fail (especially chip resistor).

This setting affects the score of solder width and solder length.

Note:

The pass/fail criteria is based on the analysis and measurement of solder length and contour, which start from component's terminal.



Other than Solder Profile, user may choose other type of 3D joint inspection:

➤ **3D Solder Volume Inspection**

Pass criteria: either 2D grey threshold score or 3D volume score larger than the threshold.

➤ **3D Coverage Inspection (%)**

Pass criteria: coverage score must be larger than '**Joint Coverage Threshold**' (the score is affected by both '**Joint Height Threshold(%)**' and '**Joint Grey Threshold**').

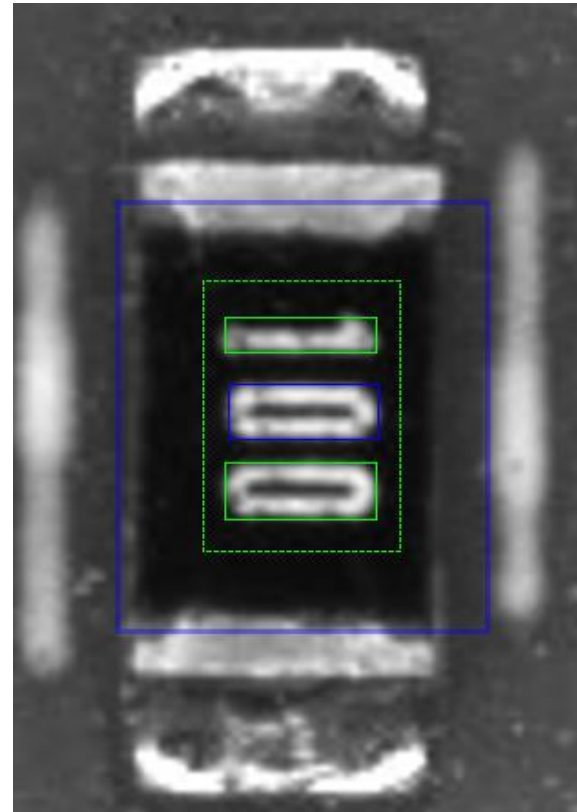
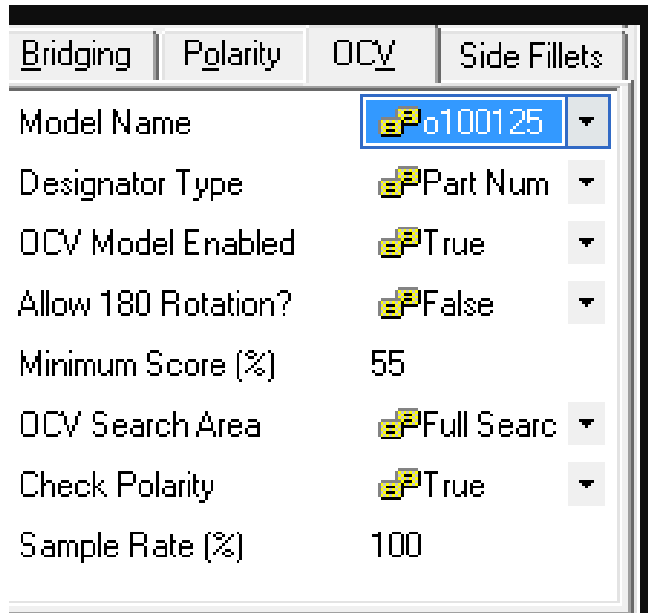
➤ **3D Coverage Inspection (μm)**

Pass criteria: coverage score must be larger than '**Joint Coverage Threshold**' (the score is affected by both '**Joint Height Threshold(μm)**' and '**Joint Grey Threshold**').

Note: 3D mode must be enabled in 3D inspection tab to enable 3D joint inspection.

8. Setup in **eOCV/OCV** (to detect wrong part):

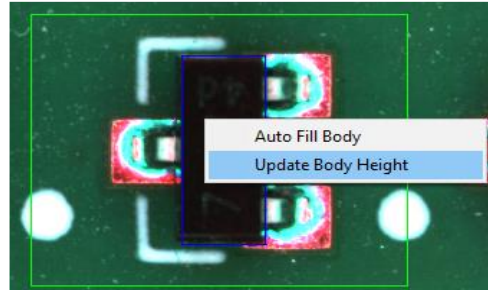
- i. Normally apply on resistor only to check for wrong part.
- ii. '**Allow 180 Rotation**' must set to "True" as chip resistor are not polarized parts.



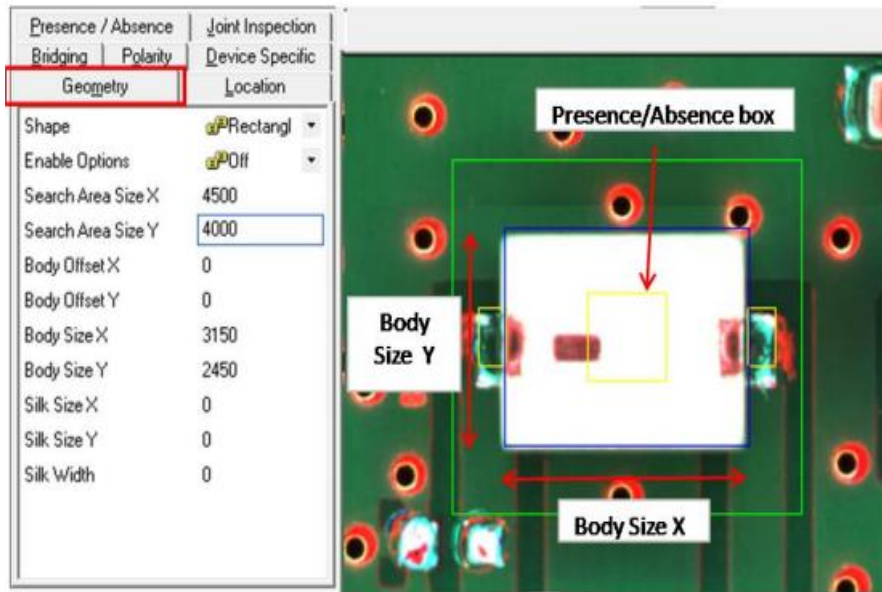
4.0 B Type

1. Enable 3D switch in **3D Inspection** tab.
2. To locate the component, **body size** in **Geometry** and '**Component Height(μm)**' in **3D Inspection** tab must be setup correctly .

Alternatively, right-click on the component body to “Autofill body” for body size setup and “Update Body Height” to setup component height.



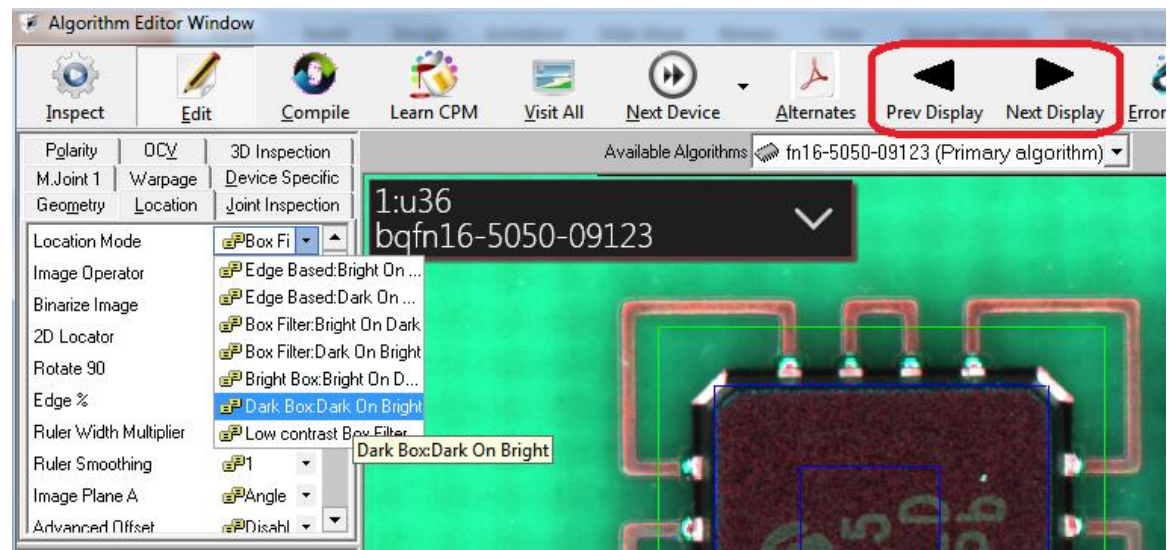
3. Setup in **Geometry** :



- 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.
Recommend value: 1.5 times larger than body size in the vertical direction.
- ii. '**Body size X/Y**' is set with the blue box is around the body as shown in the attached sample.
Software will auto locate when clicking on 'Auto Fill Body'.
- iii. '**Body offset X/Y**' shall set to '0'. Body offset is non zero only for a component where the component body centroid is not at the center of the CAD.

4. Setup in **Location**:

a) Enable 2D locator



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 the sharpest view. Select the best image plane.

If the component body contrast is very low compared to the background and all the parameters cannot locate the component correctly in 2D Mode, select the suitable image plane by using the '**Image Operator**'.

Geometry	Location
Location Mode	Box Filter: ▾
Image Operator	A / B ▾
Binarize Image	Off ▾
Rotate 90	On ▾
Edge %	20% ▾
Ruler Width Multiplier	0 ▾
Ruler Smoothing	1 ▾
Image Plane A	Angle 2 ▾
Image Plane B	Angle 1 ▾
Hor Threshold	150
Ver Threshold	150
Skew Threshold	50

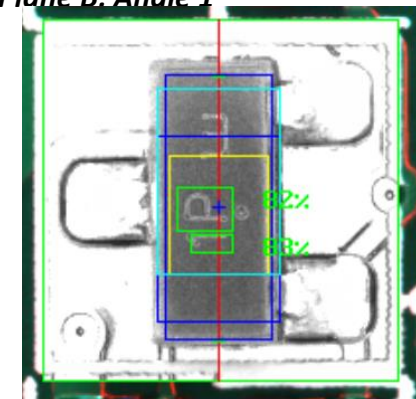
- Arithmetic Operator to blend multiple image plane
- Apply threshold to binarize the locator image plane
- Location for the edge ruler
- Plane A for Image Operator. When "Image Operator" is off, this is the locator plane.
- Plane B for Image Operator.

Example for Dark Component on Dark PCB surface:

Arithmetic Operation: A/B

Image Plane A : Angle 2

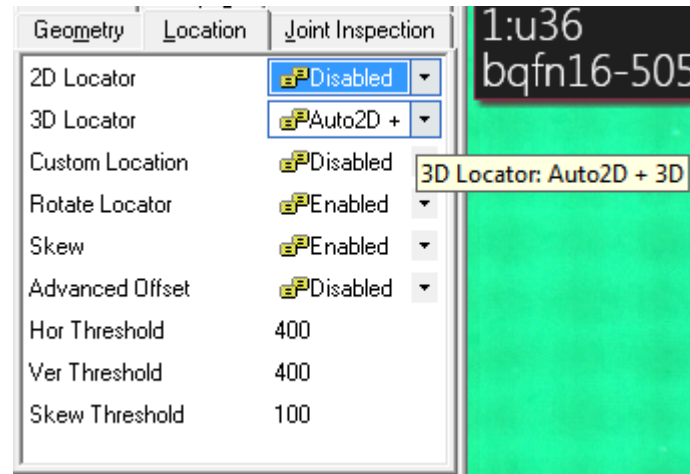
Image Plane B: Angle 1



- 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 setting can be set to 'off' by default. Anyway, you may select **On'** or **'both** whenever necessary depends on the edges contrast on horizontal or vertical direction.
- iii. **'Edge %'** is where the position of edges finding ruler to locate the best contrast on the component body. The default value is set to 25%.

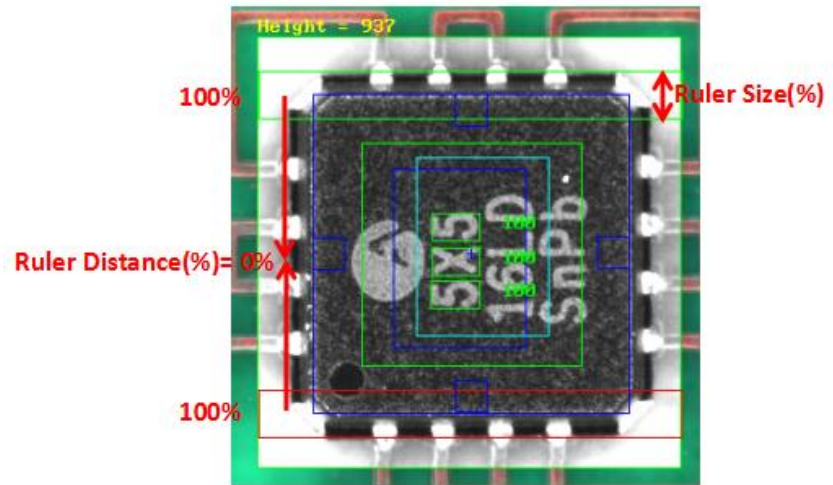
*****If enabled 2D locator, 3D locator will be automatically disabled.***

b) Enable **3D locator** (Recommended setting)



- i. Set the **'3D Locator'** to **'Auto2D + 3D'** to let the software auto choose the best contrast 2D angle with 3D locator.

Custom Location	<input checked="" type="checkbox"/> Enabl
Ruler Size (%)	30
Ruler Distance (%)	30

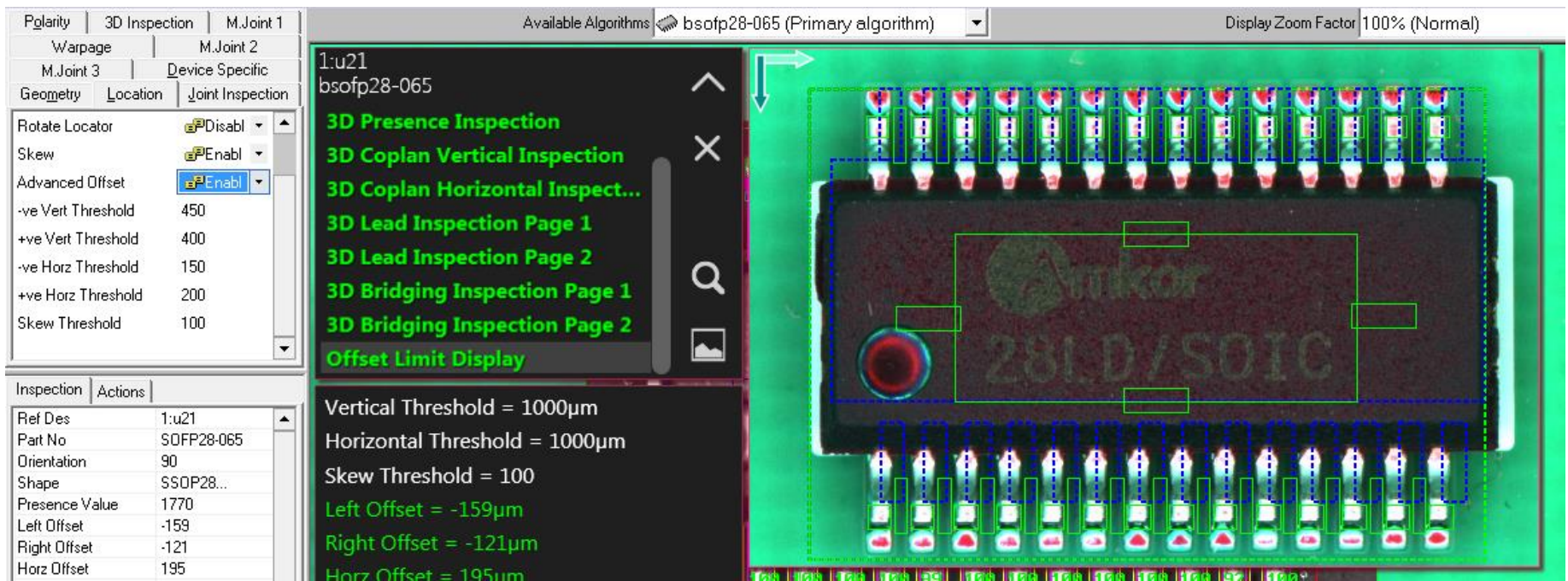


- ii. **'Custom Location'** is enabled when the ruler is not able to locate the component. User can define:
 - ✓ Width of ruler by **'Ruler Size (%)'**: Larger value indicates wider ruler
 - ✓ Location of ruler by **'Ruler Distance (%)'**: 100% calculate from the edge of component's body size.

- iii. **'Rotate Locator'** is to either perform the component body edge searching by the default angle or 90-degree perpendicular to it. It is indicated by the ruler across the component body from the search area.
 This setting set to 'Disabled' by default. Anyway, you may select **'Enabled'** whenever necessary depends on the edges contrast on horizontal or vertical direction.

- iv. **'Skew'** turns to On. This enables skew measurement and is recommended for components of using B-type algorithm.

- v. 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 (μm)**
 - ✓ **Vertical Threshold - 50% of lead size (μm)**



vi. If the location of a component is not at a CAD's centroid, '**Advanced Offset**' shall be Enabled. Settings to be fine-tuned are as below:

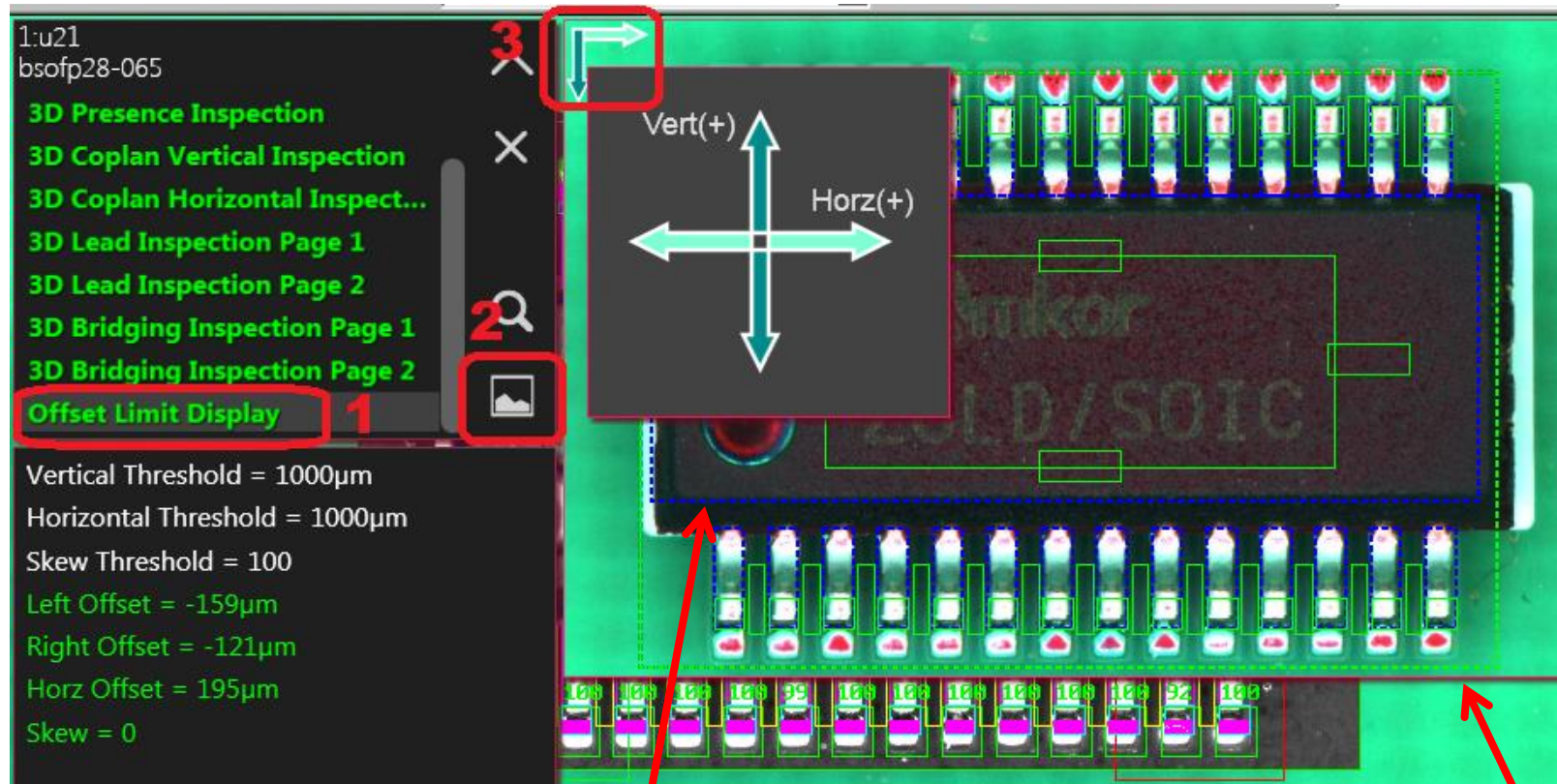
- ✓ '+ve Ver Threshold'
- ✓ '-ve Ver Threshold'
- ✓ '+ve Hor Threshold'
- ✓ '-ve Hor Threshold'

The setting is dependant on manufacturing criteria.

Tips:

**User may follow the steps in the screenshot below for the ease of fine tune on 'Horizontal Threshold' and 'Vertical Threshold'.*

**The Offset Limit Display is the virtual display for offset acceptance range of entire component.*



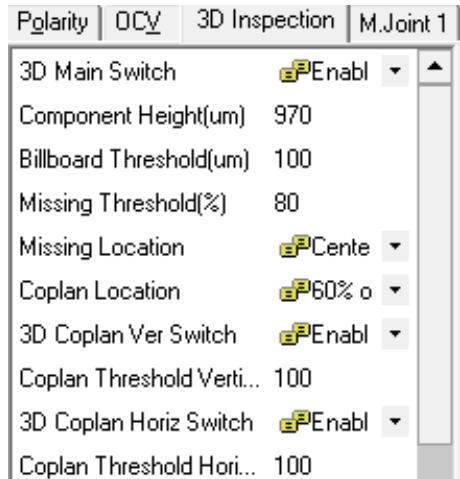
Blue Dotted Box:
Live view of virtual component's location

Green Dotted Box:
Maximum Offset of
component

5. Setup in **3D Inspection** :

- i. '**3D Main Switch**' should be at to **Enable** to enable 3D inspection.
- ii. '**Component Height (μm)**' Right click on component, click **Auto Fill Body** and **Update Body Height** then the software will auto-detect the component body size and component height to fill in the height value.

[MUST ensure the 3D image of the component is well constructed when using this feature]



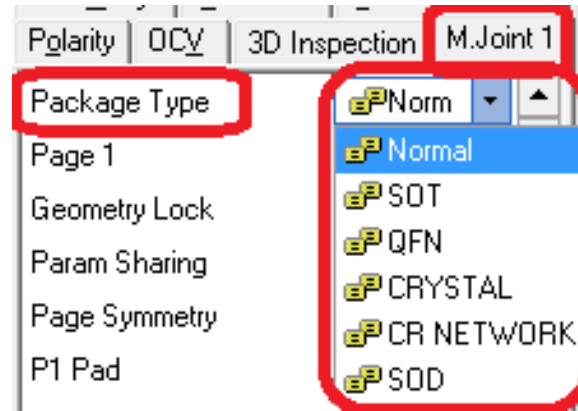
- iii. '**Billboard Threshold (μm)**' Normally set to **100 - 150**. [depends on component body size, larger component shall have larger billboard threshold]
- iv. '**Missing Threshold (%)**' Normally set to **50%** for B-type component. If measured height is 50% lower than component nominal height, the component is considered missing.
- vi. '**Missing Location**' Normally set to **Center**.
- vii. '**Coplan Location**' Normally set to **80% of Body**.
- viii. '**3D Coplan Ver Switch**' & '**3D Coplan Hor Switch**' Normally set to **Enabled**.
- ix. '**Coplan Threshold Vertical (μm)**' & '**Coplan Threshold Horizontal(μm)**' Normally set to **100-120**.



- x. '**3D Damaged Switch**' Normally **Enabled** unless component has different heights on the surface.
- xi. '**Damaged Location**' Set to **80% of body**.
- xii. '**Damaged Threshold(μm)**' Set to **100-150**.
- xiii. '**Foreign Object Detection**' Normally **On**. Need to ensure the search area of the component does not overlap the side component. [**Adjust 'Foreign Mask Width Expand($\mu\text{m})$ ' & 'Foreign Mask Length Expand'**]
- xiv. '**Foreign Height Threshold(μm)**' set to **100**.
- xv. '**Foreign Gray Threshold**' Normally set to **50**.
- xvi. '**Foreign Size Threshold**' set to **100**.

For solder ball detection, the threshold value of foreign object detection shall be tighten.

6. Setup in **M. Joint**:



a) Package Setup

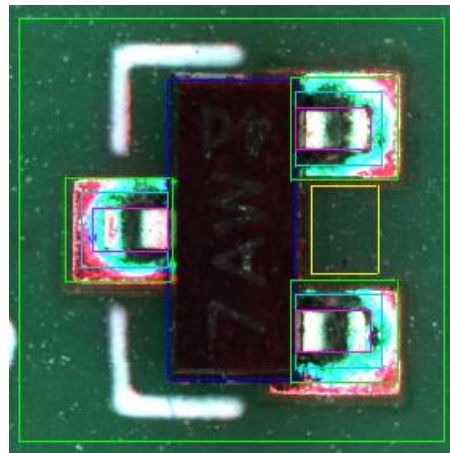
*Select either **SOT**, **QFN**, **CRYSTAL**, **CR NETWORK**, or **SOD** in '**Package Type**' for component's package setup. Please refer to the next slide for image of each package

b) M-Joint Customize Setup

*Select **Normal** for '**Package Type**' and fine tune up to 6 set of joints accordingly.



QFN



SOT

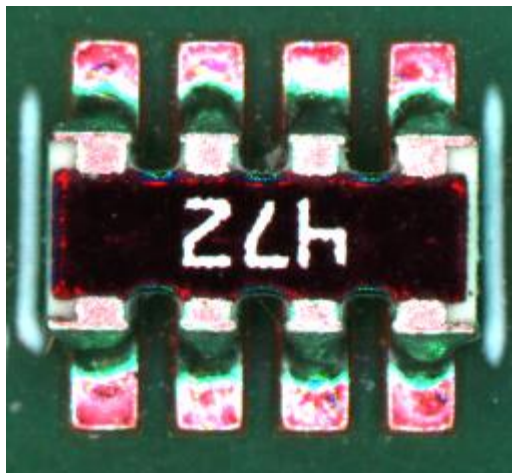


Visible Lead

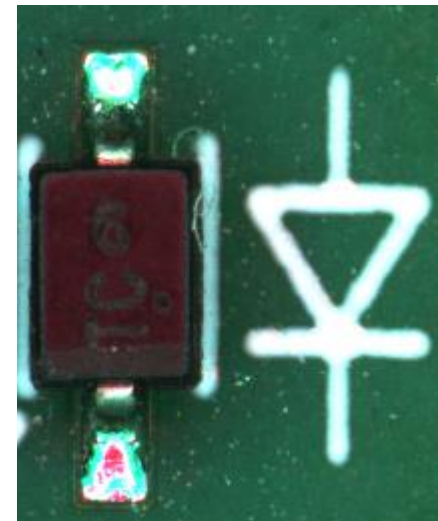
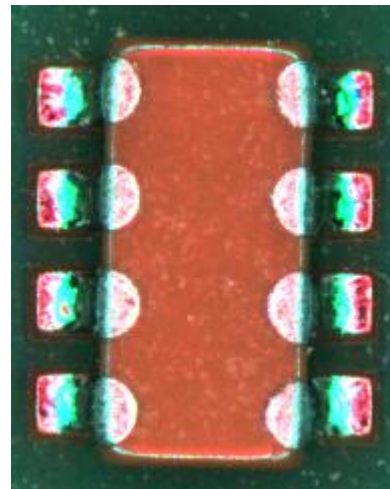


Manual Insert

Crystal



CR Network

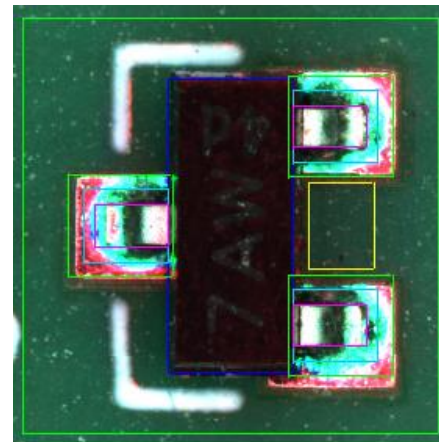


SOD

6. Setup in *M. Joint*:

Example for Package Setup: SOT

Package Setup	Device Specific
Package Type	SOT ▼
P1 Pad	Manu ▼
L1 Direction	Horizo ▼
L1 No of Lead	1
L2 No of Lead	2
L1 Lead Pitch (um)	1900
L1 Lead Relocation	3D 0 ▼
L1 Tip Length (%)	30
L1 Lead Height (um)	165
L1 Lifted Lead Mode	Absol ▼
L1 Lifted Lead Thresh...	100
L1 Missing Lead (um)	100



SOT

i. '**Package Type**' Select **SOT**.

ii. '**P1 Pad**' Normally set to **Manual**, and draw follow the pad size.
(Set to Auto if the program convert to .plx using Vayo Accelerator)

iii. '**L1 Lead Relocation**' Normally set to **3D Only**.

iv. '**L1 Tip Length (%)**' Normally set to **30%** for SOT component.

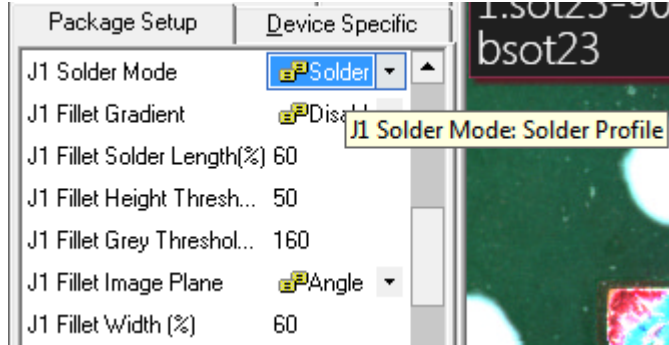
vi. '**L1 Lead Height(μm)**' Set base on height measure on 3D image. MUST set correctly as it will affect lead and joint inspection result.

vii. '**L1 Lifted Lead Mode**' Select **Absolute**.

viii. '**L1 Lifted Lead Threshold(μm)**' Normally set to **100**. The lead will fail as lifted lead if the measured height higher than the total height of lead height and lifted lead threshold.

ix. '**L1 Missing Lead(μm)**' Normally set to **100**.

To Detect Bad Solder



x. '**J1 Solder Mode**' Select **Solder Profile**.

xi. '**J1 Fillet Gradient**' Normally **Disabled** in SOT component.

xii. '**J1 Fillet Solder Length(%)**' Normally set to **50**. [Pass/Fail indicator]

xiii. '**J1 Fillet Height Threshold(μm)**' Normally set to **50**.

xiv. '**J1 Fillet Grey Threshold**' Normally set to **130-160**.

xv. '**J1 Fillet Image Plane**' Select **Angle 2_3**.

xvi. '**J1 Fillet Width(%)**' Normally set to **60%**. [Pass/Fail indicator]

xvii. '**J1 Slope Profile**' Normally **Enabled**.

xviii. '**J1 Slope Solder Height Threshold(μm)**' Normally set to **50**. [Pass/Fail indicator]

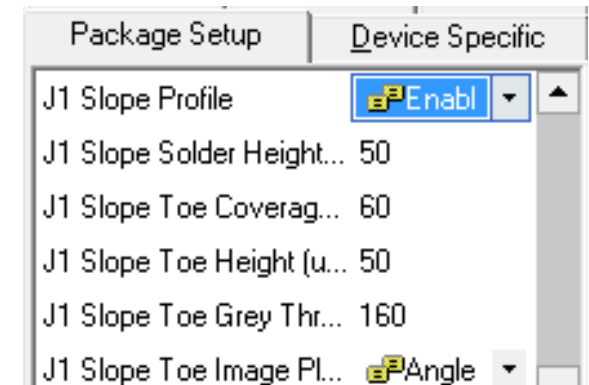
xix. '**J1 Slope Toe Coverage Threshold (%)**' Normally set to **60**.

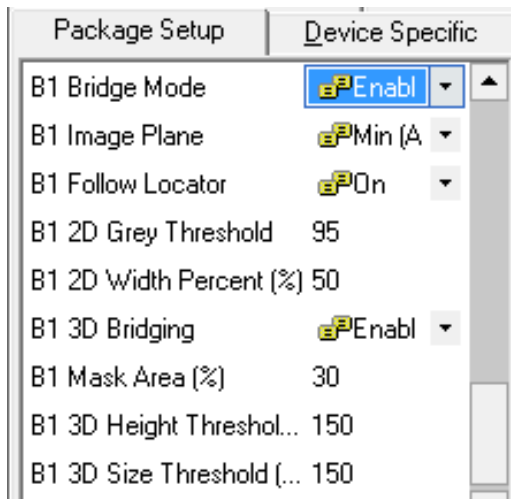
xx. '**J1 Slope Toe Height(μm)**' Normally set to **50**.

xxi. '**J1 Slope Toe Grey Threshold**' Normally set to **160**.

xxii. '**J1 Slope Toe Image Plane**' Select **Angle 2_3**.

To Detect Non-wetting Solder





xxiii. '**B1 Bridge Mode**' Normally **Enabled**.

xxiv. '**B1 Image Plane**' Select **Min (Angle 1, 2, 3, 4)**.

xxv. '**B1 Follow Locator**' Normally **Off** as pad will not shift.

xxvi. '**B1 Grey Threshold**' Normally set to **95**.

xxvii. '**B1 2D Width Percent(%)**' Normally set to **50**.

xxviii. '**B1 3D Bridging**' Normally **Enabled**.

xxix. '**B1 Mask Area(%)**' Normally set to **30**.

xxx. '**B1 3D Height Threshold(μm)**' Normally set to **150**.

xxxi. '**B1 3D Size Threshold(μm)**' Normally set to **150**.

Lead Setup in Different Package

Package Type	SOT	QFN	Crystal	CR Network	SOD
P1 Pad	Manual	Auto	Manual	Auto	Manual
L1 Lead Relocation	3D only	N/A	3D only	N/A	3D only
L1 Tip Length (%)	30	N/A	100	N/A	30
L1 Lead Height (um) *Depends on Part Specification (refer to Part Datasheet of customer)	Part Specification	N/A	Part Specification	N/A	Part Specification
L1 Lifted Lead Mode	Absolute	N/A	Absolute	N/A	Absolute
L1 Lifted Lead Threshold(μm)	100	N/A	150	N/A	100
L1 Missing Lead (μm)	100	N/A	150	N/A	80

Note:

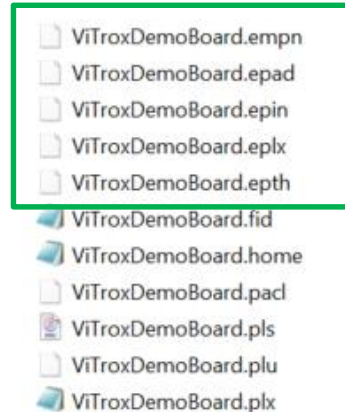
***The lead setup for Manual Insert Crystal (non-visible lead) shall be N/A.**

Extra Notes:

“P1 Pad Mode” shall set to **“Auto”** only when:

i) Solder slope inspection is **NOT** required, OR

ii) The PLX and related pad information files as listed below are available in C:\CPI\cad)



These pad information files are to be converted by using **VAYO Accelerator**.



MUST setup “P1 Pad Mode” to **Manual** for Solder Slope Inspection
(to detect non-wetting solder) when no pad information files

Solder Joint Setup in Different Package

	Package Type	SOT	QFN	Crystal	CR Network	SOD
To Detect Insufficient Solder	J1 Solder Mode	Solder Profile	Solder Profile	Solder Profile	Solder Profile	Solder Profile
	J1 Fillet Gradient	Disabled	Disabled	Disabled	Enabled	Disabled
	J1 Fillet Solder Length (%)	50	50	50	50	50
	J1 Fillet Height Threshold(um)	50	50	50	50	50
	J1 Fillet Grey Threshold	130 - 160	130 - 160	130 - 160	130 - 160	130 - 160
	J1 Fillet Image Plane	Angle 2_3	Angle 2_3	Angle 2_3	Angle 2_3	Angle 2_3
	J1 Fillet Width (%)	60	60	60	60	60
To Detect Non-wetting Solder	J1 Slope Profile	Enabled	Disabled	Enabled	Disabled	Enabled
	J1 Slope Solder Height Threshold(um)	50	N/A	50	N/A	50
	J1 Slope Toe Coverage Threshold(%)	60	N/A	60	N/A	60
	J1 Slope Toe Height(um)	50	N/A	50	N/A	50
	J1 Slope Toe Grey Threshold	130 - 160	N/A	130 - 160	N/A	160
	J1 Slope Toe Image Plane	Angle 2_3	N/A	Angle 2_3	N/A	Angle 2_3

Bridging Setup in Different Package

Package Type	SOT	QFN	Crystal	CR Network	SOD
B1 Bridge Mode	Enabled	Enabled	N/A	Enabled	N/A
B1 Image Plane	Min (Angle 1, 2, 3, 4)	Min (Angle 1, 2, 3, 4)	N/A	Min (Angle 1, 2, 3, 4)	N/A
B1 Follow Locator	Off	Off	N/A	Off	N/A
B1 Grey Threshold	95 - 135	95 - 135	N/A	95 - 135	N/A
B1 2D Width Percent(%)	50	50	N/A	50	N/A
B1 3D Bridging	Enabled	Enabled	N/A	Enabled	N/A
B1 Mask Area(%)	30	30	N/A	30	N/A
B1 3D Height Threshold(um)	150	100	N/A	150	N/A
B1 3D Size Threshold(um)	150	100	N/A	150	N/A

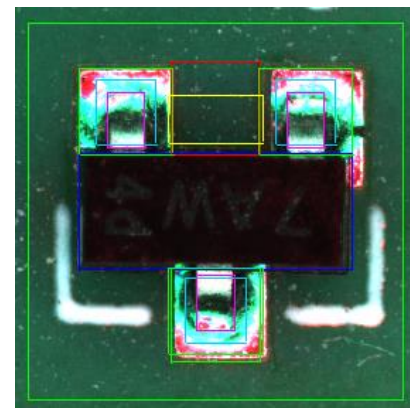
7. Setup Polarity

Polarity setup is required if it is a polarized part.

i) Setup in 'Polarity' Tab if there are obvious marking/ height difference.

- Click on 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' is '**Enabled**' option is set to '**True**'.
- '**Number of Boxes**', ensure that '**Two**' is selected (2-box mode is commonly used for tantalum cap, SOT, SOD, IC and BGA, whereas 4-box mode is commonly used for square components such as square BGA and QFN).
- '**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 appropriate size to cover the desired inspected polarity stripes/marks.
- Ensure that appropriate '**Calculation Mode**' is selected. In this case, '**[3D] Height of Green Box - Height of Red Box**' should be chosen.

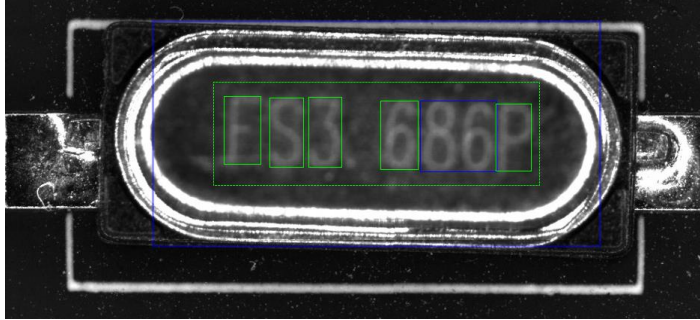
Geometry	Location	Polarity
Selected Polarity Page 1 of 4		
Enabled	True	
Number Of Boxes	Two	
Use Red Box Offsets	False	
Page Comment		
Polarity Box Offset X	1092	
Polarity Box Offset Y	0	
Polarity Box Size X	500	
Polarity Box Size Y	470	
Polarity Box Mark X	0	
Polarity Box Mark Y	0	
Polarity Box MarkW	400	
Polarity Box MarkH	400	
Calculation Mode	[3D]	
Expected Value	Positi	
Height Threshold	-30	
Lock Boxes	Off	



- g. When select 2D Calculation Mode, setup 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.
- h. SOT example, '**Expected Value**' should be set to '**Positive**' which means the polarity will be classified as PASS when **[3D] Height of Green Box - Height of Red Box yields Positive value**.
- i. Ensure that the '**Polarity Score**' is positive (and preferably with a high value) and larger than '**Height Threshold**'. **User MUST put a '-' sign in front of the threshold value to indicate minimum threshold**.
- j. Click at '**Next**' or perform a '**Visit All**' to verify on the other similar package type.

Expected Value	Threshold	Polarity Difference	Pass/Fail
Positive	-100	120	Pass
Positive	-100	-120	Fail
Positive	-100	90	Fail
Negative	-100	-120	Pass
Negative	-100	120	Fail
Negative	-100	-90	Fail

ii) Setup in EOCV 'Check Polarity' options



Geometry	Location	Polarity	OCV
Model Name	ocrystal-a		
Designator Type	Part Num		
OCV Model Enabled	True		
Allow 180 Rotation?	False		
Minimum Score (%)	55		
OCV Search Area	Custom		
Custom Offset X	446		
Custom Offset Y	550		
Custom Size X	9495		
Custom Size Y	4748		
Check Polarity	True		
Sample Rate (%)	100		

a. Go into the Algorithm Editor to Add OCV model and select the appropriate body marking region to be inspected (avoid blurry marking, date code.. etc.). Select '**Create OCV model**'. (Software will auto naming for eOCV model follow part number).

b. '**Allow 180 Rotation**' shall be turned **False** for common polarized parts, except for non-polarized parts such as resistor.

c. '**Minimum score(%)**' shall be set typically **55%-70%**, depending on the quality/contrast of the body marking.

d. '**OCV Search Area**' shall be set to **Custom**, and the inspection search area will automatically setup 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.

e. '**Check Polarity**' can be set to **True** if the programmer wants the OCV model check to report polarity failure as well when the OCV model failed. Else, set to False.

Note:

i. **Multiple page can be setup in polarity as alternate if required (could be because of different component color/ different height due to vendor change). There are up to 4 pages available.**

ii. **eOCV (Enhanced Optical Character Verification) also can also cover polarity check other than grayscale/height difference on the green-red box.**

5.0 S Type

1. Setup in **Geometry**:

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)**'.

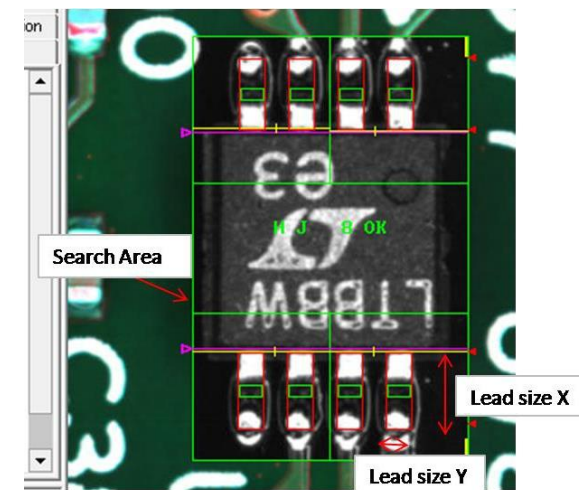
iv. '**Row Spacing X/Y**' should be set so the red boxes are lining up correctly over the rows of leads.

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.



Geometry	Location
Multiple Views	Off
Search Area Size X	3800
Search Area Size Y	4000
Row Spacing Size X	1700
Row Spacing Size Y	2150
Shoulder Height	0
Side Pins (N)	0
Side Pins (S)	0
Side Pins (E)	3
Side Pins (W)	3
Shoulder Height	0
Side Pins (N)	0
Side Pins (S)	0
Side Pins (E)	3
Side Pins (W)	3
Lead Size X	389
Lead Size Y	700
Lead Pitch	950
No Mid Leads Mode	Symm
No Mid Leads Num	0

2. Setup in **Location**:

Geometry	Location
Location Mode	 Flexible Lead
Lateral Location	 False
Refine Location	 True
Correlation Channel	 Angle 1 A
Image Plane	 Angle 3
Hor Threshold	200
Ver Threshold	400
Skew Threshold	100

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 locate 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 with the ends of the leads (toe).

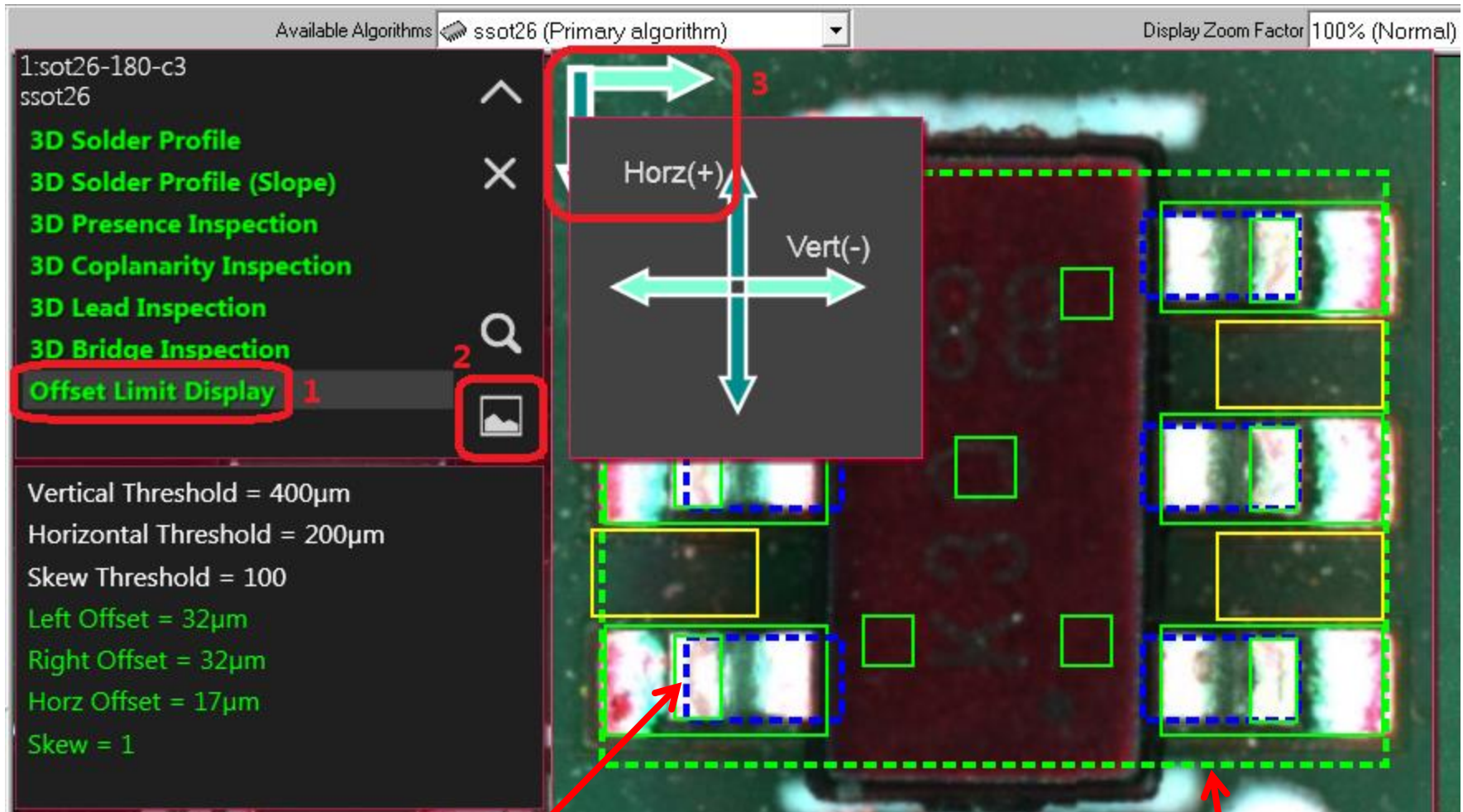
vii. '**Horizontal Threshold**', '**Vertical Threshold**' and '**Skew Threshold**' setting is dependant on manufacturing criteria. However, suggested values are:

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

Tips:

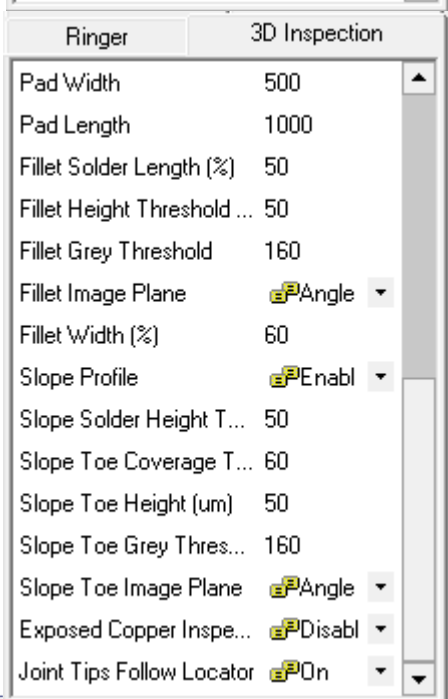
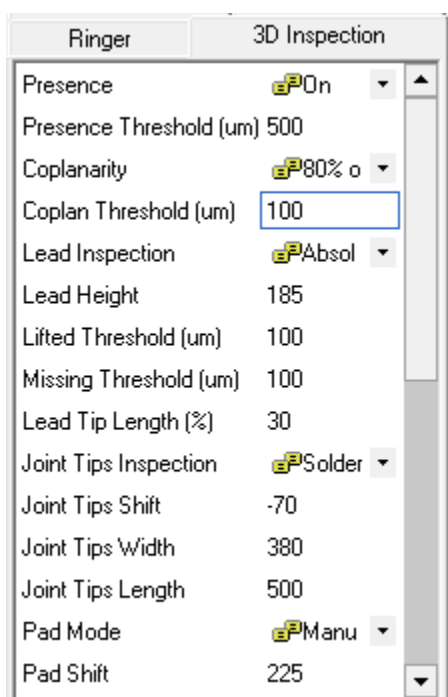
***User may follow the steps in the screenshot below for the ease of fine tune on 'HorizontalThreshold' and 'Vertical Threshold'.**

***The Offset Limit Display is the virtual display for offset acceptance range of entire component.**



Blue Dotted Box:
Live view of virtual component's location

Green Dotted Box:
Maximum Offset of
component



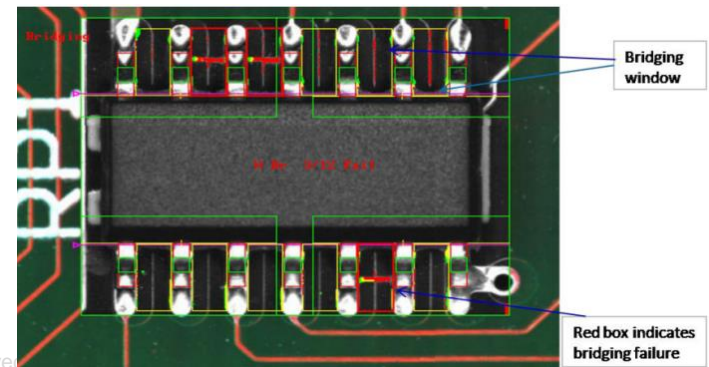
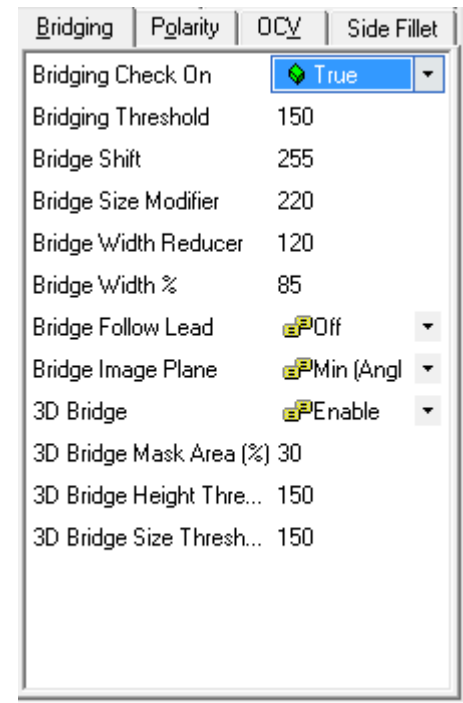
3. Setup in **3D Inspection**:

- i. '**Presence**' should be set to **On** to enable 3D inspection on S-type component body.
- ii. '**Presence Threshold (μm)**' Normally set to **500** to detect presence/absence of S-type component.
- iii. '**Coplanarity**' Select **80% of body(corner)**.
- iv. '**Coplan Threshold (μm)**' Normally set to **100**.
- vi. '**Lead Inspection**' Select **Absolute** mode.
- vii. '**Lead Height**' Normally set between **160 to 200** for SOIC, SOT and SOP component.
- viii. '**Lifted Threshold(μm)**' Normally set to **100**. A good lead shall not have a height higher than the total height of lead and threshold.
- ix. '**Missing Threshold (μm)**' Normally set to **100**.
- x. '**Lead Tips Length (%)**' Normally set to **30%** to detect the lead's toe end connection with the pad.

- xi. **'Joint Tips Inspection'** Select **Solder Profile**.
- xii. **'Pad Mode'** Normally set to **manual**. [If the program is converted from CAD using VAYO Accelerator, user may set the mode to Auto.]
- xiii. **'Fillet Solder Length(%)'** Normally set to **50**. [Pass/Fail indicator]
- xiv. **'Fillet Height Threshold(μm)'** Normally set to **50**.
- xv. **'Fillet Grey Threshold'** Normally set to **160**.
- xvi. **'Fillet Image Plane'** Select **Angle 2_3**.
- xvii. **'Fillet Width(%)'** Normally set to **60%**. [Pass/Fail indicator]
- xviii. **'Slope Profile'** Normally **Enabled**.
- xix. **'Slope Solder Height Threshold(μm)'** Normally set to **50**. [Pass/Fail indicator]
- xx. **'Slope Toe Coverage Threshold (%)'** Normally set to **60**.
- xxi. **'Slope Toe Height(μm)'** Normally set to **50**.
- xxii. **'Slope Toe Grey Threshold'** Normally set to **160**.
- xxiii. **'Slope Toe Image Plane'** Select **Angle 2_3**.
- xxiv. **'Joint Tips Follow Locator'** Normally **On**.

4. Setup in **Bridging**:

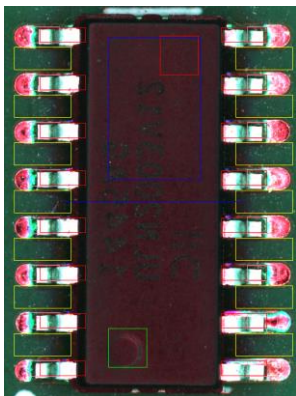
- i. '**Bridging Check On**' Normally **True**.
- ii. '**Bridging Threshold**' must be setup appropriately. Area/Pixel within the Bridging window with greyscale above this '**Bridging Threshold**' will be considered as bridging, and the amount/length of this bridging will directly contribute to bridging calls. Typically, bridging threshold can be set to **95-135**.
- iii. '**Bridge Size Modifier**', '**Bridge Width Reducer**' and '**Bridge Shift**'. A good bridging window should cover from sides of 2 leads till the end of the pads.
- iv. '**Bridge Width %**' must setup appropriately to capture all the bridging defects. Bridging defect will be reported if the amount/length of the bright spot captured in bridging exceeds 'Bridge Width %'. Normally set to **50 % to 70%**.
- v. '**Bridge Follow Lead**' Normally **Off** as the pad position will not shift.
- vi. '**Bridge Image Plane**' Select **Min (Angle 1, 2, 3, 4)**.
- vii. '**3D Bridge**' Normally **Enable**.
- viii. '**3D Bridge Mask Area(%)**' Normally set to **30** to avoid Chamfer on a component.
- ix. '**3D Bridge Height Threshold(μm)**' Normally set to **150**.
- x. '**3D Bridge Size Threshold(μm)**' Normally set to **150**.
- xi. Bridging windows with bridging detected will be highlighted in **RED**.



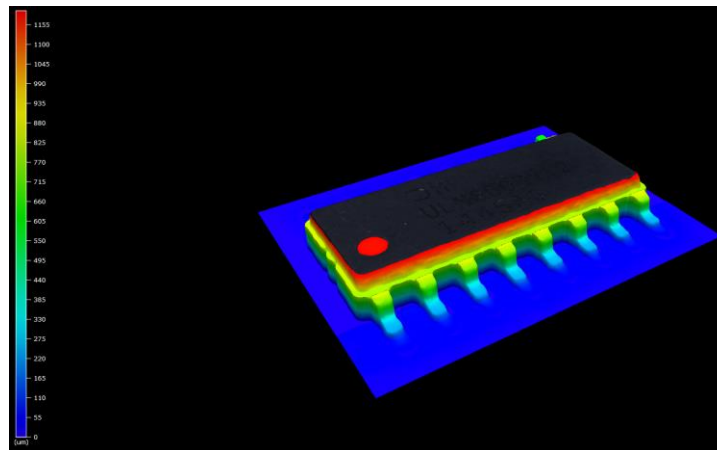
5. Polarity

Polarity setup is required if it is a polarized part.

i) Setup in 'Polarity' tab if there are obvious marking/ height difference.



a. Click on the '**Polarity**' tab.



Bridging	Polarity	OCV	Side Fillet
Enabled	<input checked="" type="checkbox"/> True		
Number Of Boxes	<input checked="" type="checkbox"/> Two		
Use Red Box Offsets	<input checked="" type="checkbox"/> False		
Page Comment			
Polarity Box Offset X	3897		
Polarity Box Offset Y	684		
Polarity Box Size X	515		
Polarity Box Size Y	508		
Polarity Box Mark X	0		
Polarity Box Mark Y	0		
Polarity Box MarkW	400		
Polarity Box MarkH	400		
Calculation Mode	<input checked="" type="checkbox"/> [3D]		
Expected Value	<input checked="" type="checkbox"/> Positi		
Height Threshold	-10		

b. 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**'.

c. '**Number of Boxes**', ensure that '**Two**' is selected (2-box mode is commonly used for tantalum cap, SOT, SOD, IC and BGA, whereas 4-box mode is commonly used for square components such as square BGA and QFN).

d. '**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.

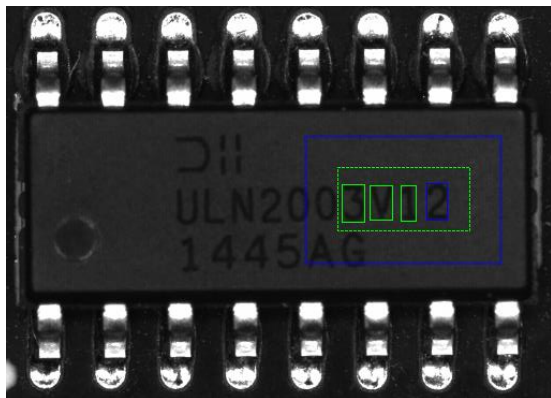
e. Set up '**Polarity Box Size X**' and '**Polarity Box Size Y**'. The polarity box size should be of appropriate size to cover the desired inspected polarity stripes/marks.

f. Ensure that appropriate '**Calculation Mode**' is selected.

In this case, '**[3D] Range of Green Box - Range of Red Box**' should be chosen.

- g. When select 2D Calculation Mode, setup 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.
- h. For this example, '**Expected Value**' should be set to '**Positive**' which means the polarity will be classified as **PASS** when '[3D] Range of Green Box - Range of Red Box' yields Positive value.
- i. Ensure that the '**Polarity Score**' is positive (and preferably with a high value), the passing score indicator is base on '**Height Threshold**'.
User MUST put a '-' sign in front of the threshold value to indicate minimum threshold.
- j. Click at 'Next' or perform a 'Visit All' to verify on the other similar package type.

ii) Setup in EOCV 'Check Polarity' options



Bridging	Polarity	OCV	Side Fillet
Model Name	Poso16_te		
Designator Type	Part Num		
OCV Model Enabled	True		
Allow 180 Rotation?	False		
Minimum Score (%)	55		
OCV Search Area	Custom		
Custom Offset X	-2475		
Custom Offset Y	-29		
Custom Size X	3791		
Custom Size Y	2464		
Check Polarity	True		
Sample Rate (%)	100		

a. Go into the Algorithm Editor to Add OCV model and select the appropriate body marking region to be inspected (avoid blurry marking, date code.. etc.). Select **'Create the new OCV model'** (Software will auto naming by part number).

b. **'Allow 180 Rotation'** shall be turned **False** for common polarized parts, except for non-polarized parts such as resistor.

c. **'Minimum score'** shall be set typically **55%-70%**, depending on the quality/contrast of the body marking.

d. **'OCV Search Area'** shall be set to **Custom**, and the inspection search area will automatically setup 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.

e. **'Check Polarity'** can be set to **True** if the programmer wants the OCV model check to report polarity failure as well when the OCV model failed. Else, set to False.

Note:

i. **Multiple pages can be setup in polarity as alternate if required (could be because of different component color/ different height due to vendor change). There are up to 4 pages available.**

ii. **eOCV (Enhanced Optical Character Verification) algo can also cover polarity check other than grayscale/height difference on the green-red box.**

Thank You